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1.0 INTRODUCTION AND OVERVIEW OF ISSUES

Rocky Flats SEC-00030 Petition (USWA 2005) has raised concerns about worker exposures to a unique form of plutonium (Pu) referred to as high-fired plutonium oxide (PuO_2). Formed at temperatures of 1,000ºC or higher, this plutonium compound has been shown to remain in the lung for much longer times than predicted by default Type S ICRP lung model.

Important to dose reconstruction is the fact that changes in the proportion of plutonium lung burden in the respiratory tract relative to that in systemic tissues have a profound effect on the interpretation of bioassay data that may include chest counting and urinalysis. For example, a chest count that assumes Type S plutonium would significantly underestimate the duration of time that plutonium remained in the lung and, therefore, underestimate the lung dose. Even more troublesome is the reconstruction of lung doses based on urinalysis. This is explained by the fact that, when urine data is used, the first step in dose reconstruction is to estimate the inhaled intake, based on a model that mathematically describes the relationship between the **observed** Pu content in urine samples and the amount of previously inhaled Pu. For example, the erroneous assumption of default Type S Pu, for the interpretation of bioassay results from urine samples that corresponds to a high-fired Pu intake, will significantly underestimate the amount of inhaled plutonium. In addition to the underestimation of the intake, if default Type S parameters are used, Pu in lung is further underestimated by the assumption of faster biological removal processes.

NIOSH has accepted the fact that high-fired plutonium existed at Rocky Flats and that select workers may have been exposed. Secondly, NIOSH has acknowledged the fact that high-fired plutonium oxide (Pu-239) may exhibit long- term retention in the lung exceeding that predicted by the default Type S model. Correspondingly, NIOSH has attempted to address these issues in ORAUT-OTIB-0049 and other support documents.

As part of SC&A's review of the Rocky Flats SEC-00030 Petition, we have conducted a thorough review of the methodology proposed by NIOSH in terms of its scientific merit and the degree with which outstanding uncertainties are bounded by assumptions that give the benefit of doubt to the claimant.

2.0 SC&A REVIEW METHODS

SC&A has reviewed the *NIOSH Site Profile for the Rocky Flats Plant* (Falk 2004) and submitted its draft review to the Advisory Board on Radiation and Worker Health on December 8, 2005. In that review, SC&A stated that workers might have been exposed to high-fired plutonium oxides which is characterized by high plutonium lung burden in relation to the systemic organs burdens, at long times after exposure. As part of its focused review of NIOSH's SEC evaluation for RFP, as requested by the Advisory Board, SC&A has supported the Board's working group review of the high-fired Pu issue. This review has included an evaluation of draft ORAUT-OTIB-0049 (*Estimating Lung Doses for Plutonium Strongly Retained in the Lung*)[1] and its supporting analyses as well as data related to U.S. Transuranium and Uranium Registry (USTUR) autopsy cases. Autopsy cases were used by NIOSH to validate the conservatism of ORAUT-OTIB-0049 empirical-based assumptions.

The SC&A staff reviewed the methods used by NIOSH to derive the lung dose adjustment factors, from in-vivo bioassay results and from urine results, as well the adjustment factors for systemic organs, GI tract and the extra-thoracic region. The SC&A staff reviewed the autopsy results, the lung count data and the urinary excretion data for a representative number of Rocky Flats cases. Cases included individuals that had known intakes of the high-fired plutonium oxide, Type SS or super S absorption type, and other types of exposures to plutonium oxides, not necessarily classified as Type SS at the time of the exposures. Our review compared post-1965 measured lung count data with autopsy data and the predicted values using the NIOSH ORAUT-OTIB-0049 empirical model. Calculations were performed considering Type S material and Type SS using the urine excretion data as well as the lung count data. Autopsy data for lung, liver, and skeletal plutonium content was available in most cases reviewed. For living former workers, lung count and urine data was modeled for organ deposition estimates.

The SC&A also compared the NIOSH approach with a model recently proposed in the literature for exposures to high-fired plutonium oxides at Mayak Production Association, a plutonium production facility in the former Soviet Union.

Results of our reviews are summarized below.

3.0 SALIENT ELEMENTS OF THE SEC PETITION AND NIOSH'S GENERAL ACKNOWLEDGEMENT OF ISSUES

Petition SEC-00030 asserts that:

> *Exposure to a unique form of plutonium referred to as high-fired oxides or super class Y materials that are metabolized differently and have self-shielding properties which make accurate assessment of dose impossible. In addition, the uniquely small particle size of high-fired oxides – as small as 0.12 μm Activity Median Aerodynamic Diameter (AMAD) – makes current dose models inaccurate. Dose models in use at Rocky Flats use a particle size of 1.0 AMAD and underestimate high-fired oxide doses by a factor of 1-2. Current models in use by NIOSH – International Commission on Radiological Protection (ICRP) 66 – use a particle size of 5.0 AMAD and underestimate these doses by as much as a factor of 10. High-fired oxides were generated from the Building 771 fire in 1957, the Building 776 fires in 1965 and 1969, numerous other smaller fires, and multiple high temperature processes in furnaces, incinerators and production process areas used in our petition. The impossibility of accurate dose assessment for*

[1] The 2006 draft of this document was used for review. It should be noted that ORAUT-OTIB-0049, Rev. 00, has now been issued (February 2007).

> *high-fired oxides exposure is summarized in more detail on the following pages [of the petition].* [USWA 2005; NIOSH 2006, p. 67]

NIOSH agrees that "there is evidence of high-fired Pu oxides at the Rocky Flats Plant," but concludes that "such materials [do] not, however, affect the feasibility of dose reconstructions." The basis for NIOSH's conclusion is two-fold, with a separate methodology applied to non-respiratory tract (e.g., liver, bone,) and respiratory tract organs, respectively:

> *Forms of Pu that are more soluble than Type Super S are assumed for maximizing dose reconstructions for cancers in non-respiratory tract organs. This results in claimant-favorable dose reconstructions for non-respiratory tract organs. For respiratory tract claims that have a POC <50% using Type S material, NIOSH will assume type Super S, and will calculate lung doses using the methodology outlined in ICRP 66, together with empirically-observed solubility and retention parameter values as described in ORAUT-OTIB-0049.* [NIOSH 2006, p. 67]

Regarding the difference in particle size between high-fired oxides and the assumed value used in NIOSH dose reconstructions, the NIOSH response is that this is not a dose reconstruction feasibility issue because intake is based on urine bioassay or lung count measurement, rendering particle size not relevant except for reconstructing doses to the GI tract. NIOSH's Evaluation Report (ER) further observed that the default particle size of 5.0 μm in that case is claimant favorable.

Another issue raised by petitioner concerns involved potential self-shielding of the high-fired plutonium oxide particles due to their being ceramicized in the heating process. In the petition, it was contended that an outer ceramic layer surrounding the particle would "challenge the ability of lung counting to detect Pu inhalation intakes" (NIOSH 2006, p. 68). NIOSH's response is that self-shielding of the 60 keV gamma radiation from the Am-241 daughter (upon which Pu lung counting relies) would not be plausible at any but insignificant levels. Moreover, the weakness of this claim is evident from the following relationship that involves the relative penetration of a 60 keV photon to that of an alpha particle: since the penetration of a 60 keV photon is many orders of magnitude greater than the mean free path of an alpha particle, then even a small fraction of one percent attenuation of photons by the ceramicized encapsulation would ensure essentially 100% attenuation of alpha particles and thereby eliminate tissue dose and health effects associated with plutonium.

4.0 HIGH-FIRED PLUTONIUM – ICRP CHARACTERIZATION

Studies of the behavior of various oxide forms of Pu in the respiratory tract show two distinct phases of absorption to blood: a small fraction, typically less than 1% of the inhaled amount, is absorbed within about a day, with the remainder being cleared from the lung with half-times of the order of years. Both the fraction rapidly absorbed and the long-term retention half-time can be influenced by the method of formation of the material and its history. Plutonium oxide, formed by complete oxidation of the metal or salt at about 1,000°C (high–fired) has repeatedly demonstrated the very low absorption generally associated with Type S (ICRP 1995).

In addition, in several cases of inhaled plutonium high-fired oxides, it has been shown that there is a longer retention in the lung than currently predicted using default Type S parameters. Plutonium oxide, in many cases, is transferred at an extremely slow rate from the lung into the systemic circulation. Thus, there is a component of retention in the lung that is not currently described by the current ICRP 66 Human Respiratory Tract Model (HRTM).

5.0 SC&A REVIEW OF ORAUT-OTIB-0049

The purpose of ORAUT-OTIB-0049 "is to provide a method for estimating annual lung doses for intakes of plutonium that is retained in the lung longer than predicted by the normal absorption Type S model and to describe the conditions for applicability of this method." (ORAUT-OTIB-0049)

NIOSH further states:

> *This TIB does not propose a new class of material for general modeling purposes or propose a new variation of the lung model. Rather, to account for the increased lung doses, the TIB analysis* ***developed empirical "dose adjustment factors" from selected cases from RFP and Hanford that exhibited Type SS behavior following intakes of*** ^{239}***Pu mixtures.*** [Emphasis added.]
>
> [The TIB does not] *recommend a generic modification to the HRTM suitable for evaluating cases that exhibit Type SS retention*. [The TIB] *recommends an alternate approach to modeling Type SS plutonium cases, referred to as the "Dose Adjustment Factor." This approach enables the evaluation of Type SS plutonium cases without explicitly making generic changes to the HRTM.*

The Human Respiratory Tract Model (HRTM) is a physiological-based model that describes the major processes governing the fate of an inhaled aerosol (This Model is discussed for background purposes in Appendix A). The ICRP clearly states that there can be circumstances in which it is feasible, and desirable, to obtain a more accurate or more reliable assessment of intake or dose, by using information specific to the situation. Typically, this is likely to be the case when assessing doses retrospectively. The ICRP at present does not address the specific case of inhalation exposures to high-fired plutonium oxides. Although the long-term retention of high-fired oxides has been reviewed in the scientific literature, there is no consensus among authors on how to address how particles are handled within the lungs and on how to address the dose to the cells at risk.

Given these circumstances, NIOSH's use of empirical data to derive adjustment factors to existing ICRP biokinetic models for Pu is considered by SC&A as a reasonable alternate approach for estimating doses for high-fired plutonium oxides.

5.1 *The Design Cases*

NIOSH's use of empirical data is outlined in ORAUT-OTIB-0049:

> *Individual-specific HRTM parameters were derived for all design cases. The data for the design cases were custom modeled in the IMBA computer code to get a curve fit to plutonium lung data that could be used to generate, analytically, the plutonium retention in the lungs at any time and for any intake scenario, using the IMBA Intake-to-Bioassay feature. (ORAUT-OTIB-0049)*

In addition to customization of absorption parameters, particle transport rates and deposition fractions in the alveolar-interstitial (AI) regions were modified to fit lung contents and urinary excretion. As stated above, these modifications of the HRTM are not intended to generate a biologically plausible biokinetic model. The transport rates and the deposition fractions do not depend on the chemical form of the material. The derived models empirically reproduce lung contents and urinary excretion.

The complete case-by-case evaluation of the design cases is provided in Appendix B.

SC&A evaluation:

SC&A has reviewed the available design case data and concludes that the empirically derived parameters for each design case fit the bioassay data for those cases. In three of the design cases, not all bioassay urine data were used. The data that are used are bioassays representing later excretions, which NIOSH has determined more accurately characterize the long-term retention in the lung. The early time urine excretions were not included in these cases. Case RFP 872, which was used as a design case, is one of the cases for which not all urine data was used, as can be seen in Appendix B, Case 872.

In the lung, clearance results from a combination of movement of particles towards the GI tract and lymph nodes (*particle transport*), and movement of radionuclides from the respiratory tract into the blood and hence body fluids (*absorption*). NIOSH empirical models, for all cases that were included in the study, introduce modifications in both clearance rates for particle transport and absorption to body fluids (blood).

The longer retention time in blood is achieved by:

- Decreasing the slow absorption rate from the lung (st is decreased from 1E-4) to values between 2.5E-5 and 4E-6 (the fraction which is decreased with slower absorption rate will vary between cases, sometimes being smaller than Type S)

- Decreasing the slower transport rate from AI from 1E-4 to 1E-6, and the rate to lymph nodes from 2E-5 to 1E-6

The empirical model was derived to fit the bioassay results. Other transport rates were modified. For most of the cases the faster transport rate does not exist. The fraction of activity deposited in the lung that will clear with the slower transport rate was different from case to case. The higher this fraction, the more activity will stay in the lung for a longer time.

The two cases that were used to derive the adjustment factors are HAN-1[2] and RFP 872.[3] From all empirically derived parameters, those two cases present the highest fractions that are cleared with this very slow transport rate. The adjustment factors for the lung were derived using these two cases. The ratios between the retention in the lung for those two cases and Type S were calculated. The highest ratio was used. Case RFP 872 presents the highest retention, at times higher than 15 years (see appendix B).

Given the preceding, SC&A has requested that NIOSH clarify more definitively why only the late excretion data was considered in deriving these factors. SC&A did not have the opportunity to review the actual bioassay data upon which HAN-1 was derived; such a review would be important to validate the selection and use of the bounding cases.

Likewise, NIOSH did not explain fully how these particular cases were selected to derive the adjustment factors. SC&A has requested access to RFP, and as necessary, other site worker dose files (with identifiers) where exposure to high-fired plutonium took place. A comparison of the long-term retention in lung for these workers and the ones selected as design cases is needed, before HAN-1 and RFP 872 can be accepted as the most conservative ones available for the derivation of these adjustment factors.

5.2 Derivation of Lung Dose Adjustment Factors

ORAUT-0TIB-0049 states:

> *The derivation of lung dose adjustment factors is based on an empirical comparison of the plutonium retained in the lungs for 10 well-documented cases involving acute intakes of plutonium (nine from RFP and one from Hanford) in relation to the amount projected for each case using the default Type S model for the same intake.*
>
> *In relation to Type S, the design cases tend to exhibit a higher retention of plutonium in the lungs, especially after the first several years, with a similar flatness of the retention curves after 10 yr. Two cases represent a similar upper bound, one from RFP (RFP 872) and one from Hanford (HAN-1). The dose adjustment factor is the ratio of the plutonium retention for the highest of the design cases (RFP 872 or HAN-1) and the plutonium retention predicted by the default Type S model, any year after an acute intake or start of a chronic intake. Cases RFP 872 and HAN-1 consistently represented the upper bound for the design cases, for an acute intake and for a simulated 30-yr chronic intake.*

[2] HAN-1: empirical model, parameters described in ORAUT–OTIB-0049, page 33.
[3] RFP 872: empirical model, parameters described in ORAUT–OTIB-0049, page 33.

SC&A has reviewed and reproduced the lung adjustment factors as provided. The revision of data is presented in Appendix B.

The parameters used to derive empirical lung contents and urinary excretions were **not** used by NIOSH to calculate equivalent doses to the lung, as noted in ORAUT-OTIB-0049 [emphasis added]:

It must be emphasized that these biokinetic models were selected simply to match empirical lung contents and urinary excretion and were not used to calculate equivalent doses to the lung. [ORAUT-OTIB-0049]

Since the current ICRP dose model is used to calculate doses for Type S compounds, resultant doses must be multiplied by adjustment factors, which are discussed and evaluated later in this section of the report.

SC&A evaluation: SC&A considers this approach as appropriate because the parameters used to empirically match lung and urinary excretion from exposed workers do not correctly describe the partition of activity in the HRTM regions and tissues containing target cells for dose calculations.

5.3 Effect of Smoking

The ICRP Human Respiratory Tract Model suggests that smoking modifies the mechanical transfer rates of deposited particles, decreasing the mechanical transfer rates of deposited particles from the AI compartments (ICRP Supporting Guidance 3, 2003). For nonsmokers, 30% of the activity in the AI compartment is assumed to be removed with a mechanical transfer rate of 0.02 d^{-1}, 60% with 0.001 d^{-1} and 10% with 0.0001 d^{-1}. For smokers, 9% is removed at a rate of 0.03, 81% at a rate of 0.0007, and 10% at a rate of 0.00007 (ICRP Supporting Guidance 3, 2003). According to Robert Bistline, an RFP site expert, many of the workers at RFP during this time period were smokers, some of them heavy smokers, smoking as many as two to three packs of cigarettes a day. Although there is no mention of the effect of smoking in ORAUT-OTIB-0049, the NIOSH approach is sufficiently conservative to accommodate this issue, since the transport rates used in the empirical model are much smaller than the ones suggested by the ICRP for smokers (in the two cases used to derive the empirical parameters, 60% and 70% of the AI activity is removed with a transfer rate of 1E-6). **SC&A, therefore, concludes that any effect from smoking is covered by the NIOSH approach.**

5.4 Intake Adjustment from Urinalysis Data

SC&A has reviewed the adjustment factors provided in the draft "Approach to Dose Reconstruction for Super Type S Material," March 2006, now an integral part of ORAUT-OTIB-0049 (ORAUT 2007). This document gives instructions on how to further adjust the doses when the bioassay urine results are used. It provides a summary of all methods and a comparison with autopsy cases.

5.5 Doses to the Extra-Thoracic Region

SC&A reviewed the procedure for calculating doses to extra-thoracic tissues, for high-fired plutonium. SC&A agrees with the assumptions made by NIOSH, and considers the adjustment factors suggested for the extra-thoracic region appropriate, given the approach suggested by NIOSH.

5.6 Doses to the Gastrointestinal Tract

SC&A reviewed the procedure for calculating doses to GI tissues for high-fired plutonium. In order to empirically fit the data to lung measurements, NIOSH has decreased the particle transport rates from the AI compartments to the upper airways and subsequently, has decreased the transfer rate to the GI tract. According to the document, Approach to Dose Reconstruction for Super Type S Material, March 2006: "…to estimate GI tract doses from urinalysis, the intakes using Type S assumptions should be multiplied by 4.0." No corrections are needed when calculating doses to the GI tract from Lung Counts.

SC&A has analyzed the effect of this adjustment. For doses calculated from in-vivo lung counting results, the use of Type S is claimant favorable. When aerosols are inhaled, radionuclides are cleared to the GI tract from the respiratory tract and from the systemic circulation. For doses calculated from urine bioassay results, it is necessary to take into consideration the larger potential initial intake because of the slower removal rate from the lung to systemic circulation. The NIOSH adjustment factor (multiplication by 4) is claimant favorable in this case.

SC&A has concluded that the approach proposed by NIOSH is reasonable and technically valid.

5.7 Doses to Systemic Organs

The application of the correction factor to be used to calculate doses to the systemic organs is explained in the draft "Approach to Dose Reconstruction for Super Type S Material," March 2006, as follows:

> *As noted earlier, according to ICRP models, integrated urine concentrations are proportional to systemic organ dose. Therefore, for the period of time that urinalysis data exists, no intake correction is necessary of systemic organs. Following the time of the last sample, intakes should be corrected by a factor of 4.0 or 4.7, depending on the exposure scenario. To summarize, systemic organ doses determined from urinalysis should be estimated by first using a type S assumption to determine intake and annual doses. Next, the annual doses that follow the year of the last urine sample used in the determination should be multiplied by a factor of 4.0 or 4.7. (ORAUT-OTIB-0049)*

On the other hand, when calculating systemic organ derived from lung counts, NIOSH states that no correction is necessary (doses should be calculated using Type S), without providing a clear basis for this approach.

SC&A has compared intakes derived from HAN-1 and RFP 872 per unit lung counts with Type S derived intakes. It is true that, depending on the time elapsed between measurements and exposure, Type S intakes are higher or equal to the ones derived using the empirical model. Theoretically, no intake corrections are needed.

As there are no adjustment factor corrections to envelope the conclusions taken from the empirical model, the relationship between systemic organs content and lung content must be reliable. ORAUT-OTIB-0049 is an empirical model, and the true transport and absorption rates from lung are probably different from the empirical model. Some models presented in the literature to explain the high-fired biokinetics use absorption parameters that are higher than the ones used in the Type S model, compensating for this effect by introducing a lung compartment with infinite half time (Khokhryakov, V.F., 2005). Depending on the time after intake, the activities in systemic organs may be higher than expected using default Type S. This is discussed in the following comparative analysis using such a model.

6.0 EVALUATION AND VALIDATION OF THE NIOSH APPROACH

6.1 Comparison of the Approach used by NIOSH to a Recent Model (ICRP66-A) used to Describe the Retention of PuO_2 in the Lungs of Mayak Workers (Khokhryakov 2005)

The Mayak Production Association (MPA) was the first plutonium production facility in the former Soviet Union. The plant first produced plutonium in 1948. Exposure to ^{239}Pu and other Pu isotopes was substantial, with post mortem measurements indicating body burdens greater than 3 kBq in many cases.

V.F. Khokhryakov, K.G. Suslova, V.V. Vostrotin, S.A. Romanov, K.F. Eckerman, M.P. Krahenbuhl, and S.C. Miller have recently (2005) published a paper in the Health Physics Journal, *Adaptation of the ICRP Publication 66 Respiratory Tract Model to Data on Plutonium Biokinetics for Mayak Workers,* in which the ICRP's Human Respiratory Tract Model (HRTM) was adapted to the kinetics of industrial plutonium compounds inhaled by MPA workers by using information on the distribution of plutonium in the body observed at autopsy. Five hundred and thirty autopsy cases were considered in this paper, but only 58 cases (50 smokers and 8 non smokers) were associated with exposures to Pu aerosols (metal and oxide) with low clearance from the lungs.

The main task of this study was to fit a model to the autopsy data by adjusting selected parameters of the respiratory tract model for each autopsy case. The resultant model was called ICRP66-A. The quantity that was optimized was the fraction of the worker's plutonium burden at autopsy within the respiratory tract, excluding the lymph nodes. The authors have assigned the value of 0.003 to the rapidly absorbed fraction *f*r. As in the HRTM, an absorption rate, *s*r, of 100 d^{-1} was applied to the rapid fraction. The "bound" compartment of HRTM was taken to represent a fixed Pu deposit. Activity in this compartment was not subject to absorptive, mechanical, or biological removal processes (s_b =0). While this modeling approach simulates the relative burdens from each of these sources, it was noted that the anatomical identity of the bound compartment is unknown and thus, also is its contribution to dose to the cells considered at risk in the lung; e.g., the basal and secretory cells. For insoluble plutonium, no real difference in the optimum values of *f*b and s_s between smokers (f_b=0.193, s_s= 3.22E-4 d^{-1}) and non-smokers (f_b=0.147, s_s=3.61E-4 d^{-1}) was evident, although the number of non-smokers was too small for a statistically strong conclusion.

The HRTM suggests that smoking modifies the mechanical transfer rates of deposited particles from the alveolar-interstitial (AI) compartments. For nonsmokers, 10% of the AI activity is assumed to be mechanically removed at a fractional rate of 0.0001 d^{-1}, while for smokers, this rate is 0.00007 d^{-1}. For non-smokers, 60% of the AI activity is removed at a rate equal to 0.001 d^{-1} and 30% at 0.02 d^{-1} rate. For smokers, 81% is removed with a rate of 0.0007 d^{-1} and 9% with a rate of 0.03 d^{-1}. The mechanical transport rate from BB1 is 5 d^{-1} for smokers and 10d^{-1} for non-smokers.

Validation of the model was obtained by comparing the observed lung and body burdens at death with values calculated based on the urinary excretion of plutonium in these cases. For the insoluble Pu aerosols, the geometric mean of the predicted-to-observed lung burden ratio was 88%, with a GSD of 2.19.

6.1.1 Comparison of the NIOSH Approach to the ICRP66-A Model

For purposes of testing the technical plausibility of the NIOSH approach provided in ORAUT-OTIB-0049, SC&A compared it with the ICRP66-A model. To that end, SC&A derived exposures and monitoring scenarios for comparison sake, as follows.

Scenario A:

- Acute intake
- Monitoring method: urine sample (samples taken 1d, 30d and 150d after exposure)

SC&A evaluation: The NIOSH approach gives much higher 50y committed equivalent doses to bone surfaces, liver and kidneys (i.e., when the doses derived using Type S are multiplied by the adjustment factors, it produces equivalent doses much higher than when ICRP66-A model is used).

Scenario B:

- Acute intake
- Monitoring Method: Lung Counting (counting at 1d, 30d and 150 days after exposure)

SC&A evaluation: NIOSH approach gives a much higher 50y committed dose to the lung (i.e., when the lung doses derived using Type S are multiplied by the adjustment factors, it produces doses much higher than of the ICRP66-A model).

Committed doses to systemic organs, however, like bone and liver are about one-half of the doses produced using ICRP66-A. This may be explained by the fact that the NIOSH approach to calculate systemic doses from lung measurement results does not use a correction factor. Systemic doses should be calculated as if they were Type S. The ICRP66-A model has an increased rapid absorption fraction (f_r) and a faster removal rate, s_s, in relation to the ICRP 66 model. Those two modifications increase the activities accumulated in organs at 50 years after exposure, and are not offset by the fraction that remains permanently in the bound compartment.

Scenario C:

- 7 years continuous intake
- Monitoring method: urine bioassay (samples taken at 30 days, 90 days, 150 days and 1 year after first day of exposure)

SC&A evaluation: NIOSH approach gives a much higher 50y committed equivalent dose to bone surfaces, liver and lung (i.e., when the doses derived using Type S are multiplied by the given adjustment factors, it produces equivalent doses much higher than those afforded by the ICRP66-A model).

Scenario D:

- Continuous intake for 7 years
- Monitoring Method: Lung Counting (in-vivo counting at 30d, 90d and 150 days, 1 year and 2 years after first day of exposure)

SC&A evaluation: NIOSH approach gives a much higher 50y committed dose to the lung (i.e., when the lung doses derived using Type S are multiplied by the given adjustment factors, the resultant doses are much higher than those derived using the ICRP66-A model).

As noted earlier, however, the 50y committed doses to systemic organs, like bone and liver are about one-half of the doses produced using ICRP66-A for the reasons cited in the preceding scenario B.

6.2 Comparison of Predicted Activities in Lung, Liver, and Skeleton, Applying the NIOSH Approach, with Autopsy Data from USTUR

NIOSH states the following:

In order to evaluate if the adjustment factors proposed by NIOSH in ORAUT-OTIB-0049 and its complementing working document ("Draft Approach To Dose Reconstruction For Super Type S Material") provided plausible bounding results, autopsy and bioassay data from the United States Transuranium and Uranium Registry (USTUR) were obtained for a number of Rocky Flats workers with *confirmed plutonium intakes (Table 2). Seven cases were selected that had detectable values for both lung and urine bioassay measurements:*

Once the intakes were estimated, the expected lung content and liver content at autopsy was estimated using the adjustments discussed above. These estimated contents were compared to autopsy data to verify that the corrections are bounding. The results of this evaluation are provided in table 1 below.

Table 1 – Comparison of Lung and Liver estimates to Autopsy Data

Ratio of lung estimate to autopsy measurement	*Ratio of liver estimate to autopsy measurement*	*Type of Intakes*	*DTPA*
4.2	*9.2*	*Fire*	*No*
33.8	*3.3*	*Wound*	*No*
8.4	*3.6*	*Other air*	*No*
53.4	*1.0*	*Fire/wound*	*Yes*
8.6	*2.9*	*Fire*	*Yes*
30.2	*1.1*	*Various air*	*No*
123.5	*3.7*	*Wound*	*Yes*

The first column of Table 1 shows that the lung content is overestimated in every case.

The liver content was overestimated in all but one case. It is important to realize however, that this is based on an uncorrected estimate of liver content. Therefore, for these cases, the type S assumption alone is sufficient to overestimate the liver dose. (Draft "Approach to Dose Reconstruction for Super Type S Material")

6.2.1 SC&A Independent Comparison and Evaluation of the NIOSH Approach using RFP Case-Specific Data

SC&A has independently reviewed autopsy and bioassay data from the USTUR for eight Rocky Flats workers with confirmed plutonium intakes. The observed lung, liver and skeleton burdens at death were compared with values calculated based on the lung measurements and on the urinary excretion of plutonium in these cases. SC&A relied on the USTUR results for bioassay and for autopsy, including the calculation done by the USTUR to extrapolate the skeleton content. SC&A has followed the procedures presented in ORAUT-OTIB-0049 and its complement (draft "Approach to Dose Reconstruction for Super Type S Material") to predict the activities in systemic organs and in the lung from individual bioassay measurement results. SC&A used the lung measurement results and the urine bioassay results, independently, to test each individual approach.

A summary discussion of these case reviews is presented below. Appendix C provides a more detailed review of each case.

There were 3 cases from the 1965 fire: Cases A, B, and C:

Case A:

The worker was exposed to high-fired plutonium in the fire of October 1965. He was in the vicinity of presumed oxidized plutonium without a respirator. He died in 1971 (emphysema). From autopsy results, the activities in the lung, liver and skeleton, at the time of death, were 720 Bq, 9 Bq and 4 Bq, respectively.

Organ Activities Predicted Using Lung Measurements

His last lung measurement was reported in December 1966, just before leaving employment. The result was estimated at 1.1 maximum permissible lung burden (MPLB) (18 nCi or 666 Bq), the measureability of which was confirmed by Dr Robert Bistline, an RFP site expert familiar with the site's dosimetric technology at the time. The measured lung burden and the autopsy result have a 10% difference. When the ORAUT-OTIB-0049 lung dose adjustment factors (attachment B) are applied, the predicted concentration in lung at the time of death is 15 nCi (550 Bq), a value compatible with the starting lung burden result from his last measurement, 666 Bq, but smaller than the autopsy result.

However, ORAUT-OTIB-0049 instructs the dose reconstructor to further multiply the predicted dose in the lung by 2.6, when the energy employee is involved in a plutonium fire, to correct for particles with AMAD smaller than 5µm that were experienced in these fires. This is equivalent to predicting an activity in lung of 39 nCi (1440 Bq), at the time of death (as noted in ORAUT-OTIB-0049):

> *Assume that the annual equivalent dose $H_s(t)$ to the lung from an inhalation intake of Type S ^{239}Pu from t-1 yr to t yr is proportional to the lung content $q_s(t)$ at t yr,"* with the footnote: *" This is a good assumption if the retention curve for the lung is fairly flat over the period in question (1 yr), which it is for Types S and SS plutonium.)*

SC&A Evaluation: While the predicted activity in lung is higher than the autopsy result, it is also higher than the last measurement result. From the 18 nCi (666 Bq) lung measurement result, the predicted activities in bone and liver are 47.5 Bq and 32 Bq, respectively; higher than the autopsy values. As the NIOSH approach is not really a model, but an overestimate based on worst-case assumptions (HAN-1 and RFP-872), SC&A accepts the overestimate as claimant favorable.

Organ Activities Predicted Using Urine Bioassay Results

On October 26th, 1965, the first Pu non-zero result is presented: 0.26 dpm/24h of Pu. Before this date, there were four bioassay results, one in 1963, 2 in 1964 and one in February 1965. After October 26, until January 1966, all Pu urine bioassay results are positive and similar to each other (range of variation from 0.26 dpm/24h to 0.55 dpm/24h.).

SC&A Evaluation: Using all the 1965 urine bioassay results and considering that an acute intake occurred in October 15, 1965, the predicted amount in lung at the time of death is 6145 Bq, which is much higher than the 720 Bq from autopsy data. The predicted activities in skeleton and liver, at the time of death are 113 Bq and 182 Bq, respectively; values that overestimate the autopsy activities.

Case B:

The worker was exposed to high-fired Pu in the accidental fire of October 1965. He was in the vicinity of the presumed oxidized plutonium without a respirator. He died in 1983 (pneumonia, myocardial infarct). From autopsy results, the activities in the lung, liver and skeleton, at the time of death, were 1.39E4 Bq, 173 Bq and 226 Bq, respectively.

Organ Activities Predicted Using Lung Measurements

The lung burden in this case was estimated to be 8 times the maximum permissible lung burden on the day of the fire. There are several recorded results for Pu and Am from chest counts. There are also several results given for Pu lung counts reported in nCi from 1/12/66 until 8/22/73. All lung measurement results are less than the activities measured at autopsy. The highest measured activity was 8.8E3 Bq. The last result in the worker's record (from 8/22/73) is 107 nCi or 3,959 Bq, which is not consistent with the 13,900 Bq measured ten years later. According to Dr Bistline, this low measurement result may be due to interferences from black lung disease that the individual experienced from a previous job as a coal miner.

SC&A Evaluation: The predicted activity of Pu-239 in lung at the time of death, calculated using the first 200 days of results, together with the adjustment factors from ORAUT-OTIB-0049, is 25,400 Bq; higher than the autopsy value. The predicted activity of Pu in skeleton is 615 Bq and the predicted activity in liver is 411 Bq, both higher than the autopsy data.

The predicted activity in lung is higher than the autopsy result, but on the other hand, it is also higher than the last measurement result. As the NIOSH approach is not really a model but an overestimate, based on worst-case assumptions (HAN-1 and RFP-872), SC&A accepts the overestimate as claimant favorable.

Organ Activities Predicted Using Urine Bioassay Results

The bioassay records of the worker show urine results for Pu from 10/17/65 until 6/12/73.

SC&A Evaluation: Using the first 48 results and applying the adjustment factors, the predicted activity in lung at the time of death is 2.88E5 Bq which is 20 times the 1.39E4 Bq activity from autopsy. The predicted activities in skeleton and liver, at the time of death, are 7,050 Bq and 4,700 Bq, respectively, values that overestimate the autopsy activities.

Case C:

The worker was exposed to high-fired plutonium in the accidental fire of October 1965. He was in the vicinity of the presumed oxidized plutonium without a respirator. He died in 1970 (cancer of the urinary bladder). From autopsy results, the activities in the lung, liver and skeleton, at the time of death, were 1,627 Bq, 4.8 Bq and 21 Bq, respectively.

Organ Activities Predicted Using Lung Measurements

There are several results for Pu lung counts reported in nCi from 10/21/65 until 7/23/69. All lung measurements results from 1968 and 1967, with the exception of the last one, are smaller than the activity from autopsy. The last result in the worker's record (from 7/23/69) is 1,421 Bq, compared with 1,627 Bq from autopsy, and much higher than the results from 1968-1969. There is no history cited for this individual of another Pu exposure accident. According to Dr Robert Bistline, an RFP site expert, this last measurement result is more reliable than the previous ones, given the improved measurement technology.

SC&A Evaluation: Using the lung burden result from 7/23/69 (1,412 Bq), and the adjustment factors from ORAUT-OTIB-0049, the predicted activity of Pu-239 in lung at the time of death is 3,990 Bq, higher than the measured autopsy activity in the lungs, 1,627 Bq. The predicted activities at the time of death are 191 Bq for the skeleton and 123 Bq for the liver, both results higher than the corresponding autopsy data (21 Bq for skeleton and 4.8 Bq for liver).

While the predicted activity in lung is higher than the autopsy result, it is also higher than the last measurement result. As the NIOSH approach is not actually a model but an overestimate, based on worst-case assumptions (HAN-1 and RFP-872), SC&A accepts the overestimate as claimant favorable.

If all the in-vivo results are used to derive the intake (least square method), the predicted activity of Pu-239 in lung at the time of death is 1,240 Bq, close to, but less than the autopsy value of 1,627 Bq. The predicted activity of Pu in skeleton is 59 Bq and the predicted activity in liver is 38 Bq, both higher than the autopsy data.

Organ Activities Predicted Using Urine Bioassay Results

The bioassay records of the worker show urine results for Pu from 09/20/62 until 9/12/69. The first positive measurement is dated 10/27/65, the first measurement after the fire. There are two very high measurement results:

- 4.25 dpm on 03/06/67 (only on the Excel records, not confirmed using the other bioassay records of the worker). There are no follow up measurements. The next monitoring result is 4.23 dpm, almost one year after this sample was taken.
- 4.23 dpm on 03/05/68, followed by measurements at background in 04/22/68. There is no mention of accidents involving the worker in 1968, prior to the 03/05/68 sample.

Using all urine results, except the one on 03/06/67, as if they were related to the intake from the fire, and Type S excretion rates, the calculated intake from the fire is 2E6 Bq (unweighted least square). The intake related to the October fire, calculated using only the urine data set before 03/06/67 (from 10/27/65 until 01/03/67) and Type S excretion rates is 1.2 E6 (unweighted least square).

SC&A Evaluation: Considering that an acute intake of 1.2E6 Bq occurred in October 15, 1965, and applying the adjustment factors from ORAUT-OTIB-0049 and its complement (draft "Approach to Dose Reconstruction for Super Type S Material," March 2006) for Super Type S Material, the predicted activity of Pu-239 in lung at the time of death (1970) is 2.9E5 Bq, which is much higher than the 1.627E3 Bq activity from autopsy. The predicted activities in skeleton and liver, at the time of death, just using Type S, are 1,970 Bq and 1,270 Bq, respectively, values that overestimate the autopsy activities.

Case D:

The worker died in 1971. The autopsy values for Pu-239 are 309 Bq for the lungs, 0.4 Bq for the liver and 0.6 Bq for the skeleton. The worker has a single chest count result, in 7/1/68, with a recorded value of zero for Am.

The worker's Excel bioassay records provide urine results for Pu from 1958 until March 1972, which can be considered unusual since the worker died in 1971. The last bioassay data on the Health Physics Information Excreta Data is 6-20-68. He left work on 6-21-68. All the excreta data on the Excel table until 6-20-68 are the same as recorded in the Health Physics Information Excreta Data, except for August 14th 1958 (which included a remark that this apparent discrepancy may be due to a typo error).

Most positive urine excretion values are below the mean detection limit listed in the TBD for the period from 1958 to 1971, except for August 10, 1962; May 6, 1963; and October 15, 1965. The only accident recorded in his files associated with the urine results above the detection limits is an 8/8/62 accident, which was described as follows:

Contamination on back of neck, forehead, left forearm, left wrist, 4th right finger. After decontamination with sodium hypochloride, shaved areas, showered, and changed clothes. Initial counts infinitive. Final alpha counts -- Back of neck 4000 c/m… *[Case D individual record]*

In August 10, 1962, the value of Pu in the urinary excretion data increased one order of the magnitude, indicating that the worker had internal contamination, possibly from inhalation and from a wound (finger), in 08/08/1962.

SC&A Evaluation: Assuming a single inhalation intake of Pu Type S occurred on that date, the predicted quantities in lung, liver and bone at the time of death are 150 Bq , 57 Bq, and 83 Bq,, respectively. Thus, for liver and skeleton, the use of Type S alone is sufficient to overestimate the amount found at autopsy. If the Pu intake is treated as high-fired (even though there is no mention of a high temperature in this case), the predicted amount in the lung would have been 7,760 Bq, which also overestimates the concentration at autopsy.

Case E:

The worker died in 1979, and the autopsy values for plutonium are 1,920 Bq for the lung, 38.4 Bq for the liver and 57 Bq for the skeleton.

In this case, the worker has in his bioassay records, urine results from Pu from 1955 until 1965. All results are listed as zero (<MDA) with the exception of the last one, in 1965, after the fire. Using the urine bioassay results and considering chronic inhalation intakes from 1955 until 1965, and a urinary result equal to the MDA, the daily intake is equal to 17.5 Bq. If the MDA/2 would have been considered, the daily intake is equal to 8.8 Bq. At 24 years after exposure, the predicted amount in lung is 9,177 Bq. If the MDA/2 was used, the predicted activity in lungs would have been 4,589 Bq.

The ORAUT-OTIB-0049 method overestimates the 1,920 Bq from autopsy. The predicted activity in skeleton is 277 Bq. If the MDA/2 is used, the predicted activity in bone would have been 138 Bq. Thus, the NIOSH method overestimates the 57 Bq from autopsy. The predicted amount in liver is 184.8 Bq. If the MDA/2 is used, the predicted activity in liver would have been 92 Bq. Thus, the method overestimates the 38 Bq from autopsy.

If an acute intake by inhalation is assumed in the day of the fire, with resulting 0.45 dpm activity in the urine sample taken on October 17, 1965, the predicted Pu-239 in lung at the time of death is 8.21E3 Bq, an overestimate of the autopsy data. The predicted activities in the skeleton and liver are 233 Bq and 281 Bq, respectively. Both results overestimate the autopsy data.

SC&A Evaluation: NIOSH adjustment factors applied to urine bioassay data considered equal to the MDA and to MDA/2 produced predicted activities in the lungs, liver and skeleton, at the time of death, that overestimated the activities in those tissues as compared with measurements from autopsy.

Case F:

The worker died in March 1973. The autopsy activities for ^{239}Pu are 130 Bq for the lung, 75 Bq for the liver and 24 Bq for the skeleton.

The worker's bioassay records show urine results for Pu from 1957 until 1973. Most of these results have positive values. The worker was exposed to an acute inhalation intake on 8/15/58 when the G-5 Furnace caught fire or pressurized allowing contamination to billow out into the room. On October 21, 1958, the worker had a hand wound contamination. From the record, it appears that several other accidents followed.

SC&A Evaluation: An acute inhalation intake in 8/15/1958 was assumed, with exposure to high-fired plutonium given the recorded fire. Urine results from August 15th until October 20th, 1958, were assumed to be all related to the 8/15/1958 intake. The intake, calculated using Type

S, AMAD 5µm, and unweighted least square on the urine results from 8/15/58 to 10/20/58, is calculated as 8.35E5 dpm or 1.4E4 Bq. Using only this set of results, the amount predicted in lung, liver and bone are 5,500 Bq, 85 Bq and 125 Bq, respectively. These values overestimate the autopsy results.

Case G:

The worker died in 1979 (cardiac arrest). The autopsy activities are 194 Bq for the lung, 20.6 Bq for the liver and 36.4 Bq for the skeleton. The worker's file contains a list of several contamination incidents to which the worker may have been exposed through inhalation and wounds.

Organ Activities Predicted Using Lung Measurements

There are four Pu lung-counting results from 07/19/71 until 02/01/73, all of which were zeros. An MDA of 27 nCi (1,000 Bq) was used to derive the lung, liver and skeleton burden at the time of death.

Three scenarios were studied: continuous exposure from 1971 to 1973, continuous exposure between the two last measurements in 1973, and a single exposure in the middle of the last monitoring interval (1973). Using the first scenario and ORAUT-OTIB-0049 adjustment factors, the predicted lung burden at the time of death is 646 Bq, much higher than the autopsy activity (194 Bq). The predicted Pu organ activities at the time of death are 63 Bq for the skeleton and 42 Bq for the liver, both results being higher than the autopsy data (36.4 Bq for skeleton and 20.6 Bq for liver).

The second scenario leads to predictions in the lungs (1,070 Bq), liver (27 Bq) and skeleton (40 Bq), which are higher than the autopsy results. The first scenario leads to a predicted 780 Bq in the lungs, 22 Bq in the liver and 33 Bq in the skeleton, at the time of death. Those predictions are similar to the measure activities at autopsy. It is noted that there are several wound reports which could have increased the liver and skeleton concentrations.

SC&A Evaluation: NIOSH adjustment factors, applied to lung bioassay data considered equal to the MDA, produced predicted activities in the lungs that, at the time of death, overestimated the activities in those tissues, as compared with measurements from autopsy. For systemic organs, it is necessary to analyze the urine data to account for any intakes via wounds, which, however, do not significantly affect the lung burdens.

Organ Activities Predicted Using Urine Bioassay Results

The bioassay records of the worker show urine results for Pu from 08/28/57 until 5/31/73. The first positive measurement is dated 07/16/65. From the urine data, it is possible to derive three intake scenarios, which are not exclusive from each other (i.e., all three may have occurred)

- In the first scenario, an intake in the middle of the 8/4/71 and 8/18/71 interval is assumed. The predicted activities at the time of death are 760 Bq in the lungs, 236 Bq in liver and 349 Bq in skeleton, using just Type S and no adjustment factors for high-fired plutonium.

- In the second scenario, a single intake in the middle of the interval between 04/21/65 and 07/16/65 is assumed. Using ORAUT-OTIB-0049 and complement adjustment factors, an activity of 1.17E4 Bq is predicted for the lung, 472 Bq for the liver and 694 Bq for the skeleton.

- In the third scenario, a constant chronic exposure is assumed, in the interval 3/7/68 until 8/4/71. Using ORAUT-OTIB-0049 and complement adjustment factors, an activity of 4. 94E3 Bq is predicted for the lung, 117 Bq for the liver and 171 Bq for the skeleton.

SC&A Evaluation: The ORAUT-OTIB-0049 and its complement, draft "Approach to Dose Reconstruction for Super Type S Material," dated March 2006, overestimates the activities in the skeleton, liver and lungs, when urine data results are used. All lung results were below detection limits. The use of the adjustment factors together with the MDA for lung counting, overestimates the activity in lungs at the time of death. When the MDA for lung measurements is used to derive the bone and liver activities at the time of death, underestimation may occur, depending on the scenario that is chosen. This underestimation may be due to wound contamination, which is not accounted for in lung measurements.

Case H:

The worker died in 1970, from heart surgery. The autopsy results are 95.8 Bq in the lung, 321 Bq in the liver and 22.5 Bq in the skeleton.

The worker had a serious wound contamination on 11/06/65. He received DTPA treatment. He had two other recorded wound incidents in 2/26/1960 and 2/12/1963. He has several positive urine results since 2/9/60 until 10/24/69. Until the 1965 accident, urine results varied between less than the detection limit and 2.1 dpm/24h. This last value is probably related to the 1960 wound incident.

This is not a clear case of exposure to high-fired oxides of plutonium, but the autopsy activity result for the lung, nonetheless, is relatively high in comparison. The two wound accidents, before 1965, are associated with elevated excretion rates. There are no recorded lung measurements. The activity of plutonium in the lung from autopsy results cannot be explained by the assumption of low-level chronic inhalation intakes. When the chronic inhalation intake scenario is used together with the last excretion rate result before the 11/06/1965 wound accident, the predicted activity in lung is less than the autopsy activity. If high-fire adjustment factors are applied, the predicted activity in lung at the time of death is 1,771 Bq, an overestimation of the autopsy data. The likelihood of high-fired inhalation exposure in this case is doubtful.

7.0 VARIABILITY AND PROBLEMS OF REPRODUCIBILITY EXPERIENCED IN THE FIRST SEVERAL YEARS OF LUNG COUNTING MEASUREMENTS AND ITS IMPLICATIONS ON THE NIOSH APPROACH TO CALCULATE LUNG DOSES BASED ON MEASUREMENTS

Because of the variability and problems of reproducibility experienced in the first several years of lung counting measurements, it is difficult to calculate the level of uncertainty associated with those values. SC&A has some reservations on the use of in-vivo plutonium bioassay results before 1970. This is not a problem related to high-fired oxides, but one related to the measurement of plutonium, itself. When autopsy data was compared with measurement results, it was often found that the autopsy lung burden was higher than that obtained from lung counting. This is a condition that cannot be explained by any existing model.

The following graph, in Figure 1, illustrates the comparison between lung counting results and the activity present at autopsy for Case C. It can be seen that the lung activity at the time of death is higher than most of the lung measurements results. It is a caution that even when the most sophisticated and advanced techniques for the time were applied (which was the case in the monitoring after the fire), the lung burden derived from in-vivo measurements often underestimates the real amount in the lung.

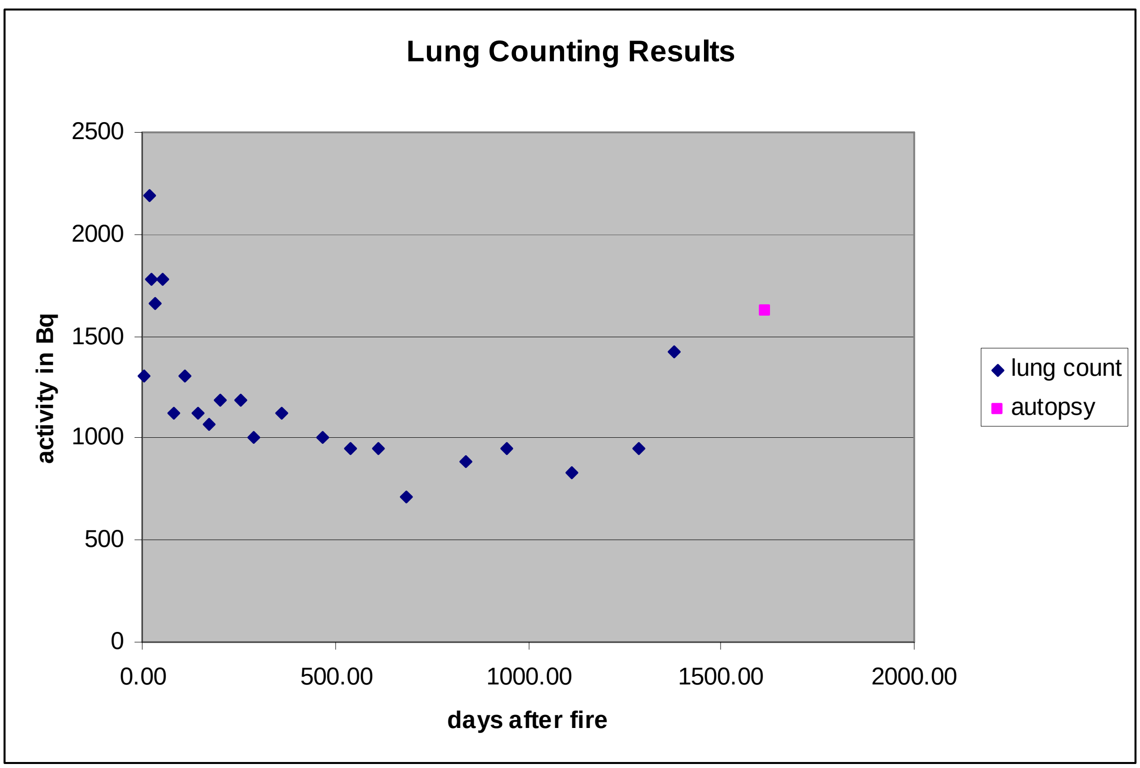

Figure 1. Comparison of Lung Counting Results to Autopsy Measurements for Case C

All other RFP cases from the USTUR that were reviewed, along with plutonium lung autopsy activity results above the detection limit for the lung counting, presented the same problem of underestimation of lung burden from in-vivo measurements (i.e., Cases B, A (small underestimation), and E; details are provided in Appendix C.

The following NIOSH statement, although theoretically correct, should be reevaluated to account for the inconsistencies between in-vivo lung burden and autopsy results:

> *If the Type S lung dose was calculated from a chest count, the application of the adjustment factor will result in an implied Type SS lung content that is inconsistent with the original chest count. To make the observed and predicted chest counts agree, the Type SS lung dose must be adjusted downward by the adjustment factor for the year of the chest count used to determine the intake;* (ORAUT-OTIB-0049)

However, comparisons of autopsy data for lungs and the lung count measurements, and the use of the empirical model in ORAUT-OTIB-0049 with its associated correction factors, always provided claimant favorable values. This even appears to hold true where problems existed in the in-vivo lung measurements such as with Case B, where the autopsy data showed approximately twice the amount of the lungs as was measured by the lung counting.

In this context, SC&A requests that NIOSH further justify the downward adjustment of the lung adjustment factor, when chest counts are used to determine the intake, taking the account the uncertainties in lung measurements before 1970.

8.0 SUMMARY CONCLUSION

Overall, SC&A is in agreement with the NIOSH approach for estimating annual dose from intakes of Pu-239 that are retained in the lung longer than predicted by the normal absorption Type S model, based on the applicability of empirically derived adjustment factors for the lung, systemic organs, GI tract organs and tissues and extra-thoracic regions. SC& A agrees it is claimant favorable under this approach to apply the adjustment factors if the intake material is unknown and plutonium oxide is a possibility.

NIOSH has identified in its design cases, selected cases of contamination to high-fired plutonium oxides. Among them, the two with the highest retention in the lung were chosen to derive the lung adjustment factors. However, as noted earlier, NIOSH did not explain fully the selection rationale for the design cases themselves. NIOSH needs to demonstrate that the most conservative cases among the design cases would also be among the most conservative within the whole data file from workers exposed to high-fired plutonium.

SC&A also concludes that doses to systemic organs can be underestimated when calculated from lung measurements.

Based on the SC&A review of ORAUT-OTIB-0049 and its complementing documents, and relevant cases that are the basis of the NIOSH approach, it is concluded that the use of the

empirical model and its correction factors is plausible for estimating annual dose to the lung, systemic organs, GI tract organs and tissues, and extra-thoracic regions for intakes of Pu-239 that are retained in the lung longer than predicted by the normal absorption Type S model. The SC&A evaluation found the empirical approach and its correction factors to be claimant favorable, typically over-predicting the organ depositions. However, the over-prediction for Type SS is not an unreasonable approach, considering the uncertainties that exist in the measured values (lung counts and urine assay models), and in particular, the autopsy extrapolations that were made. On this last point, Dr. Bistline, an RFP site expert, notes from first-hand knowledge that when the autopsy tissues were analyzed, the tracheal-bronchial lymph nodes and the bronchial-pulmonary lymph nodes were separated out, and the pathologist usually took a small portion of the lymph nodes and the lung tissue at the autopsy. Likewise, the pathologist usually took a portion of the liver, and, only representative samples of bone (a rib, a vertebral wedge, a femur ring, the sternum tree, a very small skull bone sample, part of the time the patella and a collar bone) were collected from which the skeletal deposition was extrapolated. This tissue sampling would contribute to the aforementioned uncertainties.

With respect to NIOSH responses in its evaluation report to other petitioner issues related to high-fired plutonium exposures, SC&A agrees with the position taken in the evaluation report, as follows.

Particle Size

SC&A agrees with the NIOSH position that this is not a dose reconstruction feasibility issue because intake is based on urine bioassay or lung count measurement, rendering particle size not relevant except for reconstructing doses to the GI tract. The ER further observes that the default particle size of 5.0 µm in that case would be claimant favorable. In reality an adjustment factor for particle sizes is proposed by NIOSH, when calculating doses to the lung from urine bioassay results.

ORAUT-OTIB-0049 clearly states on page 11, item 4.2:

> *Dose adjustment factors are based on the assumption of a 5-µm activity median aerodynamic diameter (AMAD) particle size. For the RFP plutonium fires, a particle size of 1 µm AMAD is recommended (ORAU 2005). The dose adjustment factors underestimate the annual lung doses by a factor of 2.6 for 1 µm AMAD aerosols because the deposition in the alveolar interstitial (AI) region of the lung is 2.6 times greater for 1 µm aerosols than 5 µm aerosols per unit intake. For energy employees involved in a plutonium fire at RFP (or any time the dose reconstructor deems use of a 1-µm AMAD particle size appropriate), the dose adjustment factors in Attachment D must be multiplied by an additional factor of 2.6.*

Self-Absorption in High-Fired Particles

SC&A agrees with the NIOSH position that any non-trivial self-shielding of the 60 keV gamma radiation (from the Am-241 daughter upon which Pu lung counting relies) from a "ceramicized" high-fired Pu particulate would not be plausible. This is based on the NIOSH calculation of expected reduction in radiation emitted by an assumed cermically encased particle of 0.12 µm diameter, which showed a reduction of approximately 0.03% in the emitted gamma signal.

Finally, the NIOSH approach for Super Type S, high-fired plutonium, is only effective if implemented as proposed, for all RFP dose reconstruction cases where the intake material is unknown and plutonium oxide is a possibility.

The SC&A analysis only applies to cases where the exposure was due to inhalation. The findings of this report about the proposed NIOSH approach for estimating lung dose and non-respiratory tract doses are restricted to that exposure route. Specifically, the model may not be scientifically suitable or claimant favorable if the main intake route was via a wound.

References

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APPENDIX A: THE ICRP HUMAN RESPIRATORY TRACT MODEL

The current Human Respiratory Tract Model (HRTM), which is described in ICRP 66 describes the processes, through a series of equations and calculations, that are involved when radioactive material is inhaled. When used with models for other parts of the body, it permits the prediction of how much of the inhaled material is present in organs. It may also be used, retrospectively, in assessing how much radioactive material an individual has inhaled, from measurements of activity in the body, in body organs, or excreta.

The ICRP has assigned numerical values to a wide range of model parameters. These values are known as default or reference values, and were chosen to be typical representative values. In any particular situation the actual values of many of the parameters will inevitably be different from the reference values. There can be circumstances in which it is feasible, and desirable, to obtain a more accurate or more reliable assessment of intake or dose, by using information specific to the situation. This is likely to be the case when assessing doses retrospectively.

The biokinetic model of the HRTM is based on three stages:

- How much air is breathed in through the nose and through the mouth
- How much of the radioactive material in inhaled air deposits in each part of the respiratory tract
- How quickly the radionuclides that have deposited are cleared, either by being carried in mucous to the throat where they are swallowed, or by being absorbed into the blood

The HRTM is represented by five regions:

- The extra-thoracic (ET) airways divided into: the anterior nasal passage; and the posterior nasal and oral passages, the pharynx and larynx
- The thoracic- bronchial region (BB: trachea, generation 0, and bronchi, airway generations 1–8)
- The thoracic bronchiolar region (bb: airway generations 9–15)
- The thoracic alveolar-interstitial region (AI: the gas exchange region)
- The lymphatic tissue associated with the extra-thoracic and thoracic airways (LNET and LNTH respectively)

These regions and airways are diagrammed in the following figure.

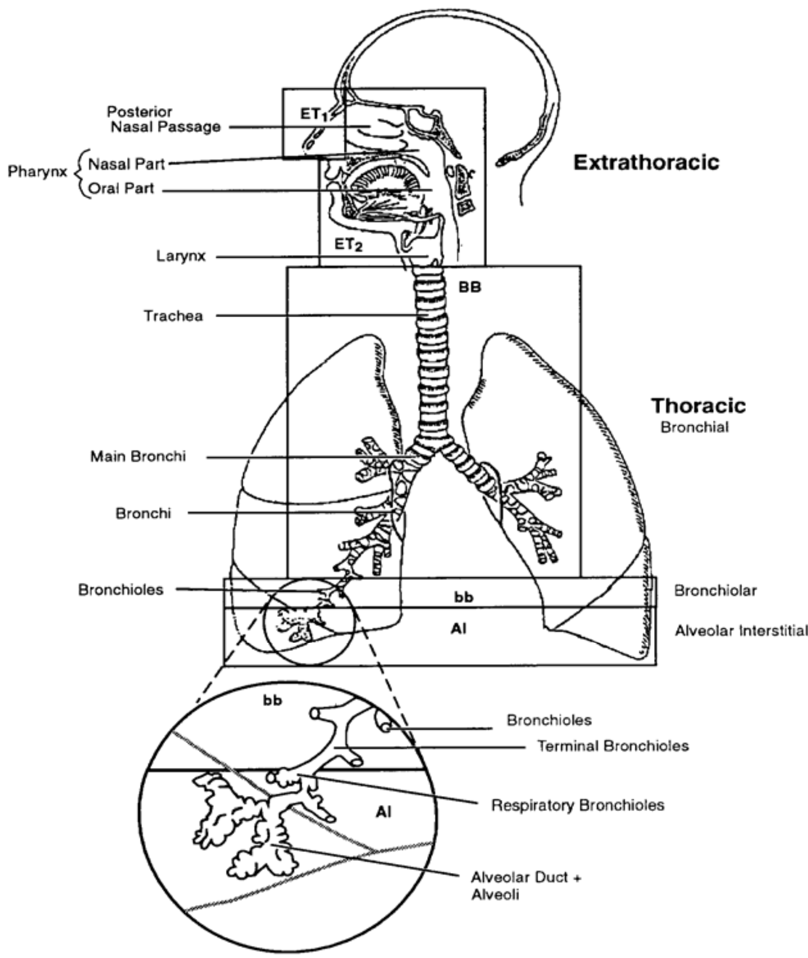


Figure 2. Diagram of ICRP Human Respiratory Tract Model Regions

The HRTM Deposition Model

The deposition model evaluates fractional deposition of an aerosol in each region, for all aerosol sizes of practical interest (0.6 nm–100 µm). Deposition parameters are given for four reference levels of activity (sleep, sitting, light exercise, heavy exercise).

The HRTM Clearance Model

The HRTM describes several routes of clearance from the respiratory tract, which involve three general processes. Material deposited in ET_1 is removed by extrinsic means such as nose blowing. In other regions clearance is competitive between the movement of particles towards the GI tract and lymph nodes (particle transport), and absorption into blood.

Particle Transport

It is assumed by default that particle transport rates are the same for all materials. A single compartment model is therefore provided to describe particle transport of all materials.

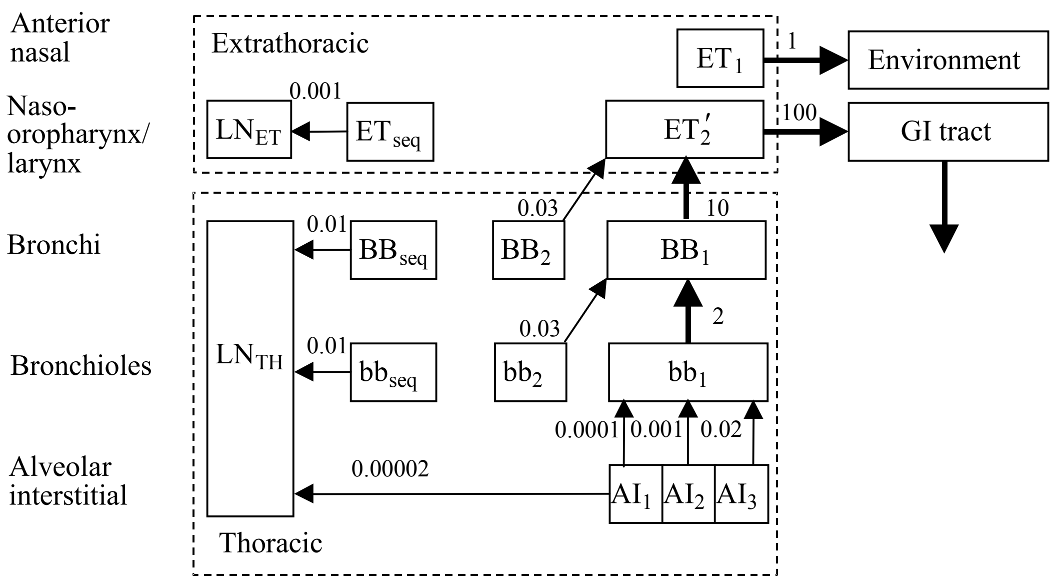


Figure 3. Compartment Model Representing Time-Dependent Particle Transport from Each Respiratory Tract Region

Rates shown alongside arrows are reference values in units of d^{-1}. It is assumed that (i) the AI deposit is divided between AI_1, AI_2 and AI_3 in the ratio 0.3:0.6:0.1; (ii) the fraction of the deposit in BB and bb that is cleared slowly (BB_2 and bb_2) is 50% for particles of physical size <2.5 µm and decreases with diameter >2.5 µm, and the fraction retained in the airway wall (BB_{seq} and bb_{seq}) is 0.7% at all sizes; (iii) 0.05% of material deposited in region ET_2 is retained in its wall (ET_{seq}) and the rest in compartment ET_2' which clears rapidly to the GI tract.

Absorption

Absorption into blood depends on the physical and chemical form of the deposited material. It is assumed to occur at the same rate in all regions (including the lymph nodes) except the anterior nasal region, where it is assumed that none occurs. Absorption is a two-stage process; dissociation of the particles into material that can be absorbed into blood (dissolution), and absorption into blood of soluble material and of material dissociated from particles (uptake). The clearance rates associated with both stages can be time-dependent.

The simplest compartment model representation of time-dependent dissolution is to assume that a fraction (fr) of the deposited material dissolves relatively rapidly, at a rate sr, and the rest (1-fr) dissolves more slowly, at a rate ss. This is diagrammed in Figure 4.

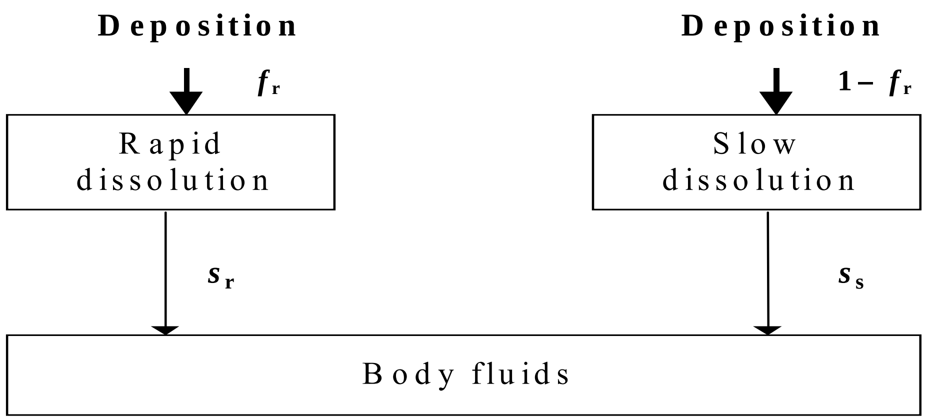


Figure 4. Compartment Model Representation of Time-Dependent Dissolution

Uptake to blood of dissociated material can usually be treated as instantaneous, but in some situations, a significant fraction of the dissociated material is absorbed slowly into blood as a result of binding to respiratory tract components. To represent time-dependent uptake, it is assumed that a fraction of the dissolved material f_b is retained in a bound state, from which it goes into blood at a rate s_b, while the remaining fraction goes to blood instantaneously. In the model, material in the bound state is not cleared by particle transport processes, but only by uptake to blood.

An alternative model is presented in Figure 5, below, in which the material deposited in the respiratory tract is assigned to compartments labeled "particles in initial state" in which it dissolves at a constant rate. Material is simultaneously transferred to a corresponding compartment labeled "particles in transformed state" in which it has a different dissolution rate. (The ratio of these two dissolution rates approximates to the fraction that dissolves rapidly.)

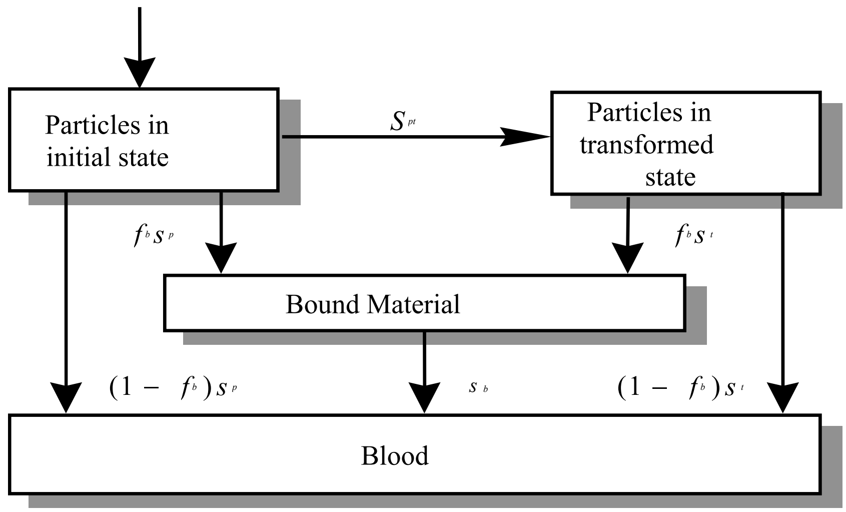


Figure 5. Compartment Model for Constant Rate Dissolution

It is recommended that material-specific rates of absorption should be used in the respiratory tract model for compounds for which reliable human or animal experimental data exist. For other compounds, default parameters are recommended according to whether the absorption is considered to be fast (Type F), moderate (M) or slow (S) Recommended values for each are specified in terms of dissolution and transfer rates. The bound state is not invoked for the default parameters.

Default ICRP parameters are shown in the table below:

Table 2. Default ICRP Parameters

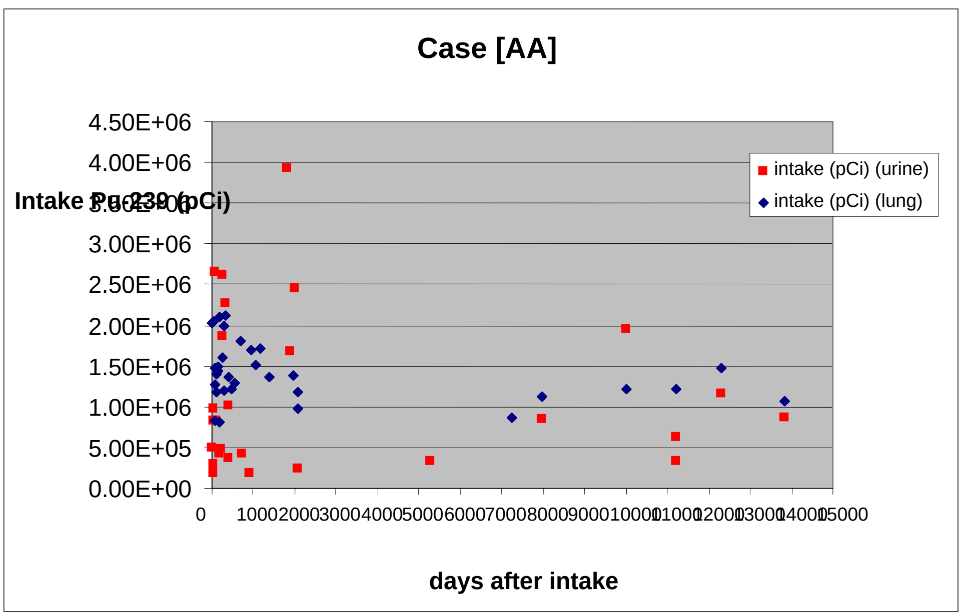
Parameters (days $^{-1}$)	Type F	Type M	Type S
s_p	100	10	0.1
s_{pt}	0	90	100
s_t	-	0.005	0.0001
f_b	0	0	0
s_b	-	-	-
f_r	1	0.1	0.001
s_r	100	100	100
s_s	-	0.005	0.0001

APPENDIX B: DESIGN CASES

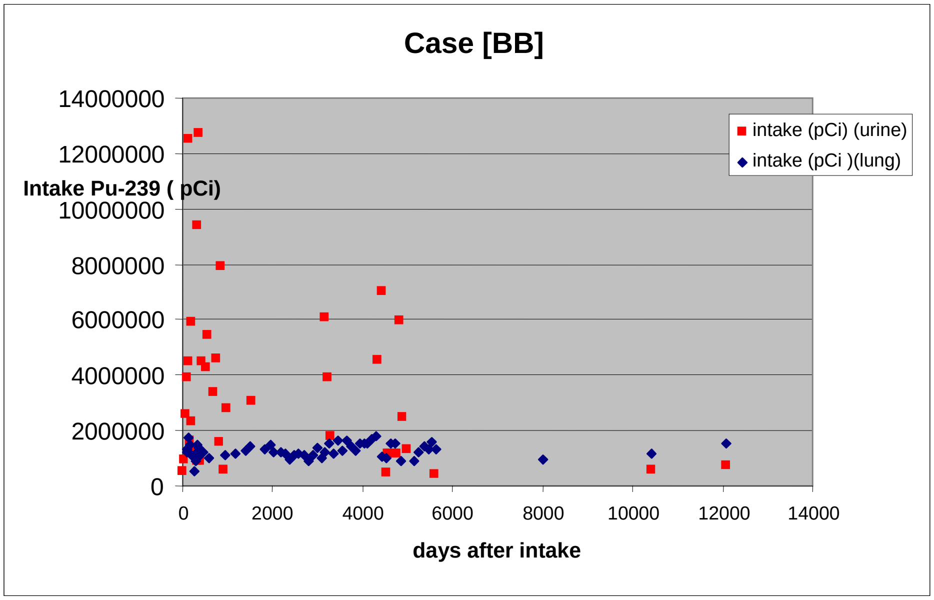
1. Individual Design Cases

SC&A has reviewed each individual RFP design case with the purpose of testing if the proposed empirical HRTM parameters model gave an acceptable fit to the bioassay data. For each individual case, intakes were derived for all bioassay results (lung and urine), using the individual case-specific NIOSH proposed HRTM parameter. For each individual case, a perfect fit between model and monitoring data is translated by having all data reproduce the same intake. Bioassay data have a natural variation that has to be considered in this fit, as well as uncertainties in the measurements. As expected because of the nature of urine excretion, the spread of values is high for urine predicted intakes. At times close to the day of the exposure, there may have been an influence from other plutonium compounds, not entirely oxidized in the fire, that are more rapidly absorbed to the systemic circulation. For each case, the intakes derived from lung measurement and urine excretion results are shown in the following graphs, as a function of time after the day of exposure. The graphs demonstrate that at long time intervals after exposure, the curve becomes flat, as expected, based on a model derived to fit long-term retention. The higher intake, predicted shortly after exposure, implies an over-prediction of doses levels.

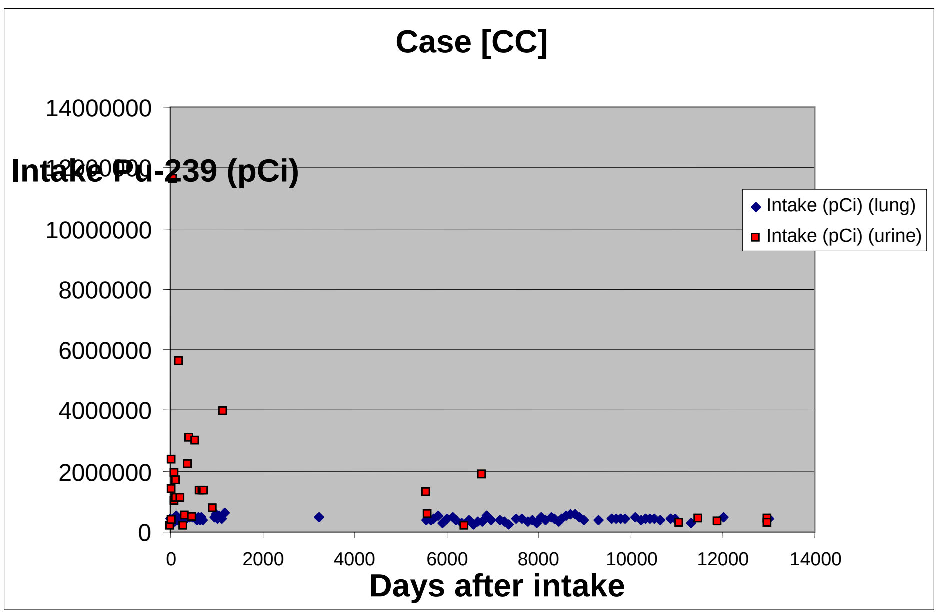
NOTE: Actual data from ORAUT-OTIB-0049 were used for these reviews, but the case numbers have been protected for this publication.



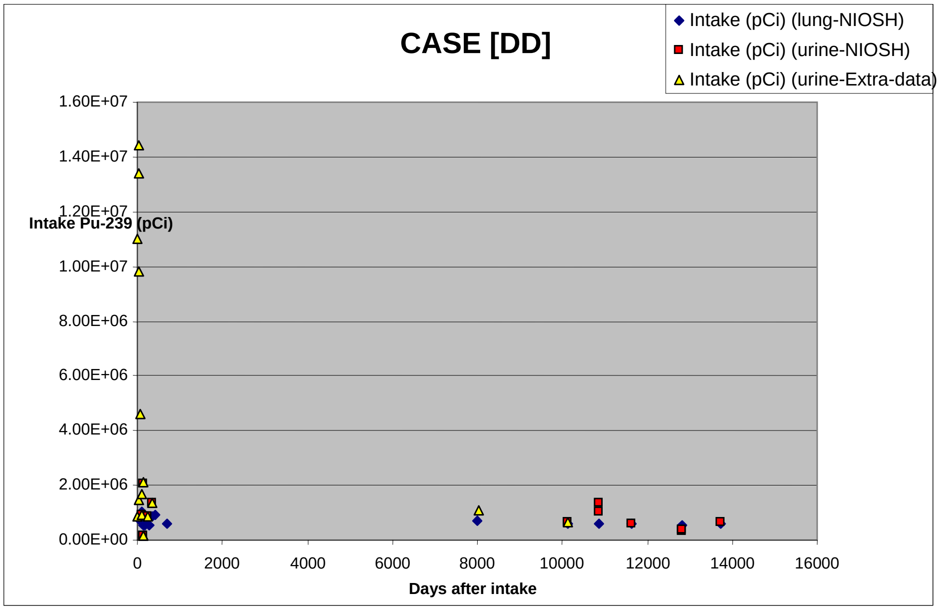
Case [AA] (no DTPA treatment, exposure from the 1965 fire)



Case [BB] (no DTPA treatment, exposure from the 1965 fire)

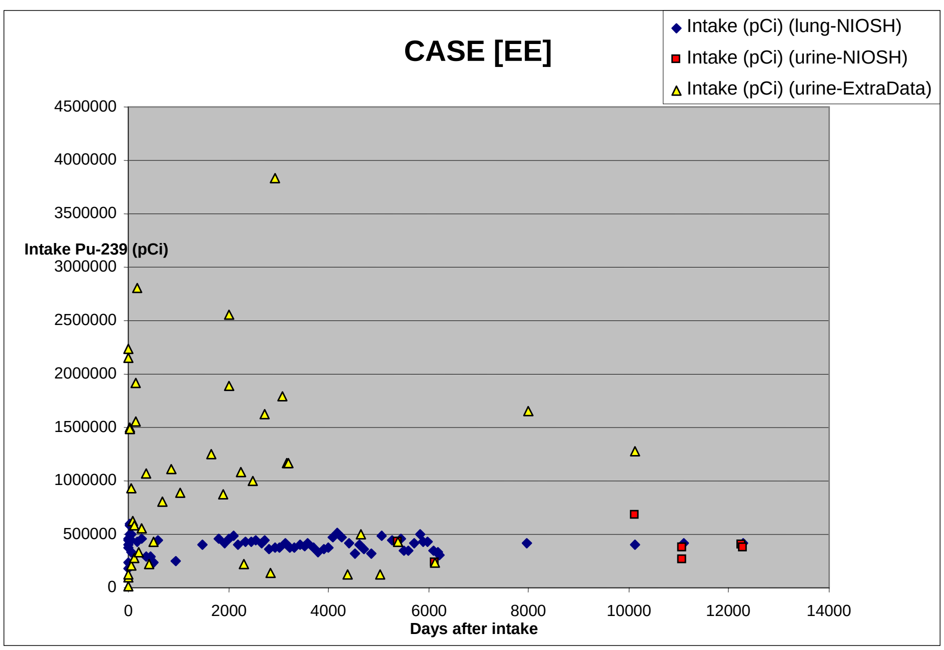


Case [CC] (no DTPA treatment, exposure from the 1965 fire)



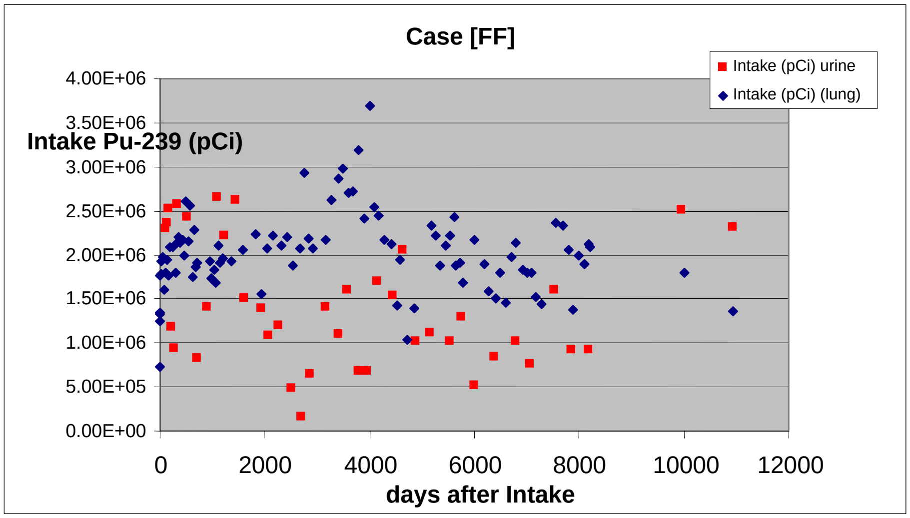
Case [DD] (DTPA, exposure from the 1965 fire)

In this case NIOSH did not use all available data. The additional data are shown in yellow.

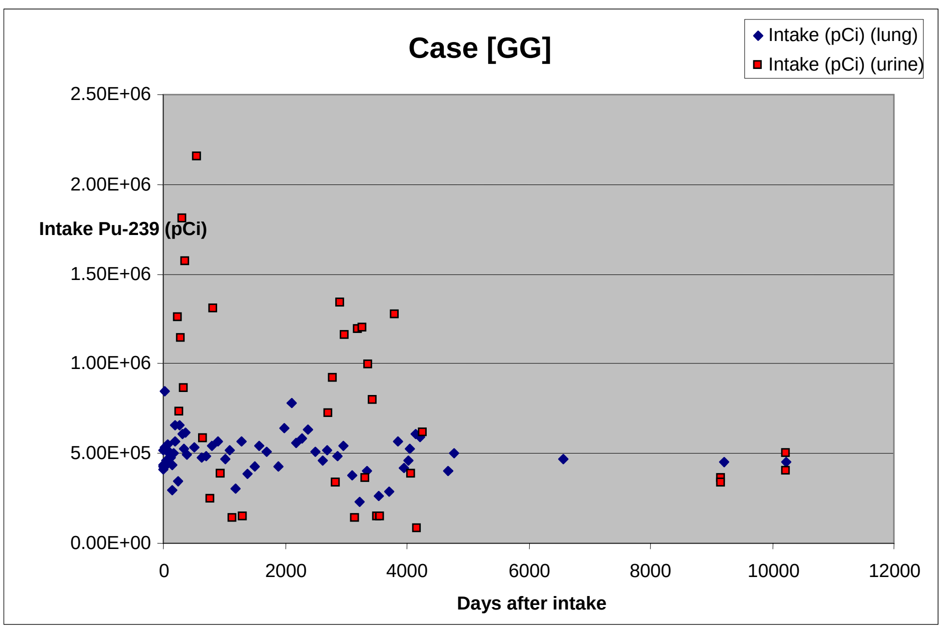


Case [EE] (DTPA, was exposed in the 1965 fire)

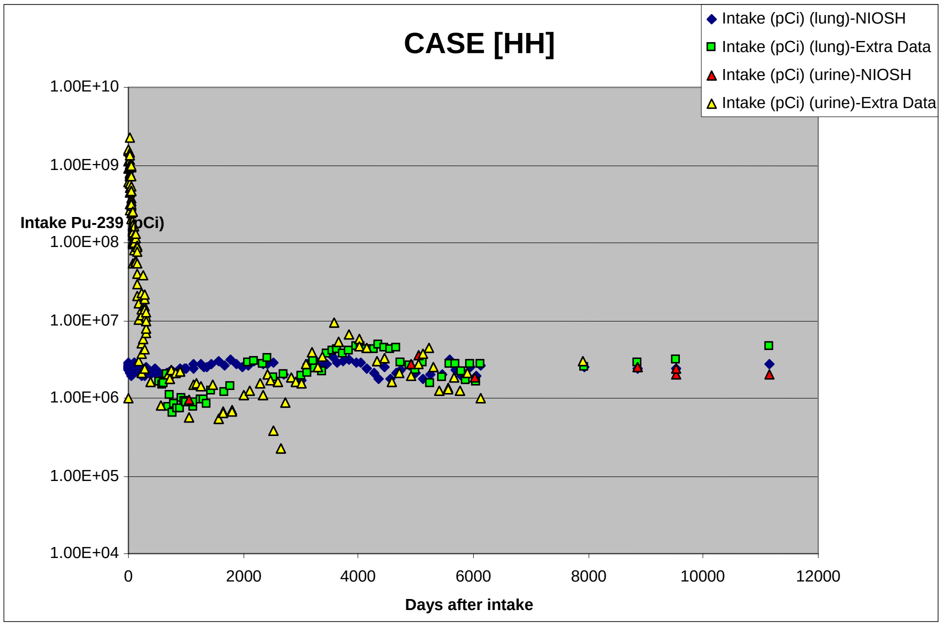
Adjustment factors were derived based on this case. NIOSH only used the urine results from late periods.



Case [FF] (DTPA, was exposed in the 1965 fire)



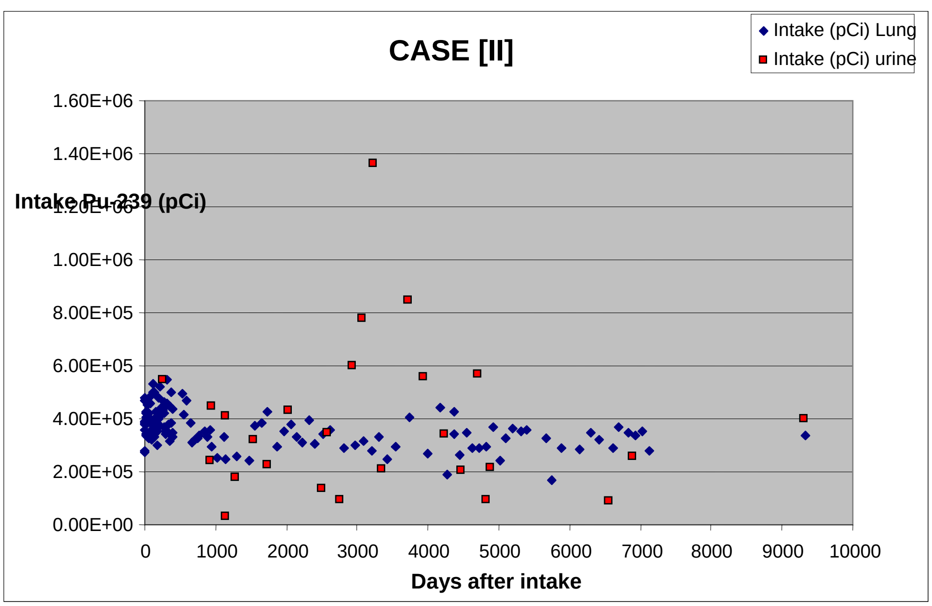
Case [GG] (DTPA, was exposed in a May 11, 1969 fire)



Case [HH] (DTPA, exposed on August, 1971)

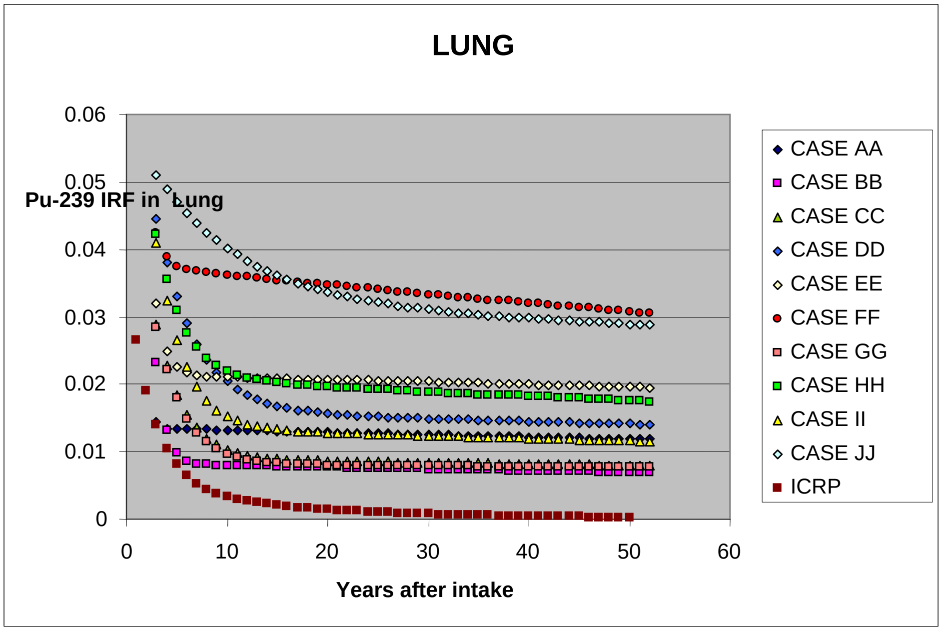
From spontaneous combustion of plutonium chips with carbon tetrachloride residue in a sample can in a laboratory)

Extensive treatment with DTPA may have influenced the early urine samples.

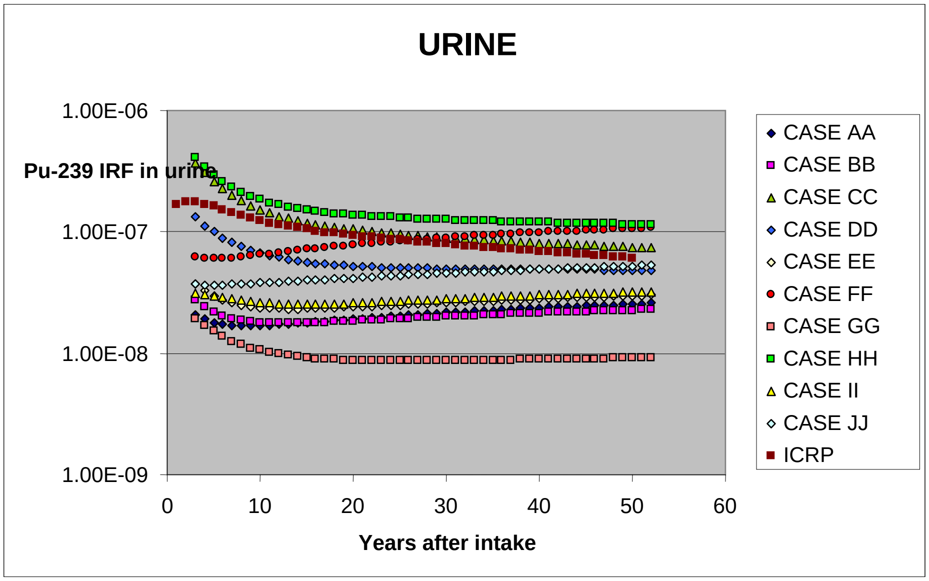


Case [II] (DTPA, exposure in 1975, not from fire)

2. Comparison of Empirical Models, per Bq intake of activity.



Cases HAN [JJ] and RFP [FF] are the ones with the highest retention in lung. It is reasonable to use them for the derivation of the adjustment factors.



Conclusions on urine data are not so straightforward. Adjustment factors should be done using the lung predictions, as proposed by NIOSH.

APPENDIX C: INDEPENDENT REVIEW OF AUTOPSY CASES

SC&A has independently reviewed autopsy and bioassay data from the USTUR for eight Rocky Flats workers with confirmed plutonium intakes. The observed lung, liver and skeleton burdens at death were compared with values calculated based on the lung measurements and on the urinary excretion of plutonium in these cases.

Case C:

The worker was exposed to high-fired Pu in the October 15, 1965, fire. Lung burden estimated to be 2.6 x maximum permissible amount.

Death: March 19, 1970 – cancer of the urinary bladder

Autopsy Data:

1,627 Bq Lungs
4.8 Bq liver
21 Bq skeleton

Lung Measurements:

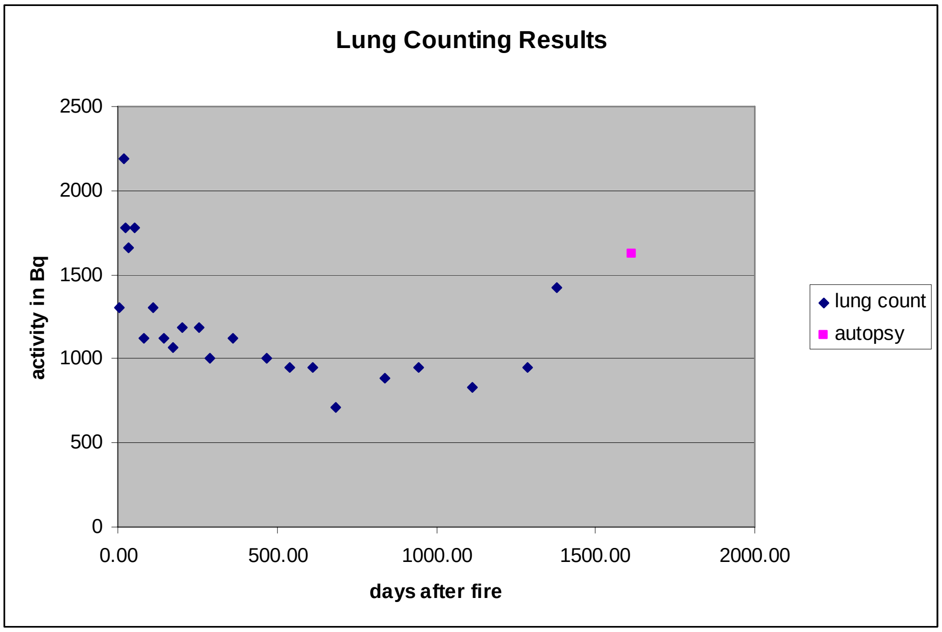
There are several results for Pu lung counts, reported in nCi, from 10/21/65 until 7/23/69. All lung in-vivo measurements results from 1968 and 1967, with the exception of the last one, are smaller than the activity from autopsy. The last in-vivo result in the worker's record (from 7/23/69) is 1,421 Bq, compatible with 1,627 Bq, from autopsy.

The last lung measurement result, from 7/23/69, is much higher than the other ones made in 69 or 68. There is no mention of another exposure accident.

Using the lung burden result from 7/23/69 (1,412 Bq), and the adjustment factors from ORAUT-OTIB-0049, the predicted activity of Pu-239 in lung at the time of death is 3,990 Bq, higher than the activity in lungs derived from autopsy data (1,627 Bq). The predicted activities at the time of death are 191 Bq for the skeleton and 123 Bq for the liver, both results higher than the autopsy data (21 Bq for skeleton and 4.8 Bq for liver).

If all the in-vivo results are used to derive the intake (least square method), together with the adjustment factors from ORAUT-OTIB-0049, the predicted activity of Pu-239 in lung at the time of death is 1,240 Bq, a value which is close, but smaller than the autopsy value 1,627 Bq. The predicted activity of Pu in skeleton is 59 Bq and the predicted activity in liver is 38 Bq, both higher than the autopsy data.

The following graph illustrates the comparison between lung counting results and the activity present at autopsy. It can be seen that the lung activity at the time of death is higher than most of the lung measurements results. It is a warning that even when the most sophisticated and advanced techniques for the time were applied (which was the case of the monitoring after the fire), the lung burden derived from in-vivo measurements often underestimates the real amount in lung.



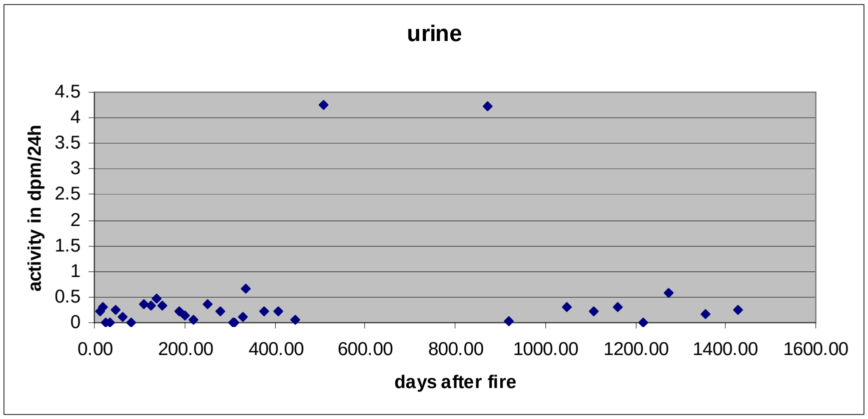
Urine Bioassay:

The bioassay records of the worker show urine results for Pu from 09/20/62 until 9/12/69. The first positive measurement dates 10/27/65, the first measurement after the fire. There are two very high measurement results:

- 4.25 dpm on 03/06/67 (only on the Excel records, not confirmed using the other bioassay records of the worker). There are no follow up measurements. The next monitoring result is 4.23 dpm, almost one year after this sample was taken.

- 4.23 dpm on 03/05/68, followed by background in 04/22/68. There is no mention of accidents involving the worker in 1968, prior to the 03/05/68 sample.

The following graph illustrates the urine results for this worker:



Using all urine results, except the one on 03/06/67, as if they were related to the intake from the fire, and Type S excretion rates, the calculated intake from the fire is 2E6 Bq (unweighted least square).

The intake related to the October fire, calculated using only the urine data set before 03/06/67 (from 10/27/65 until 01/03/67) and Type S excretion rates is 1.2E6 (unweighted least square).

(a) Lung predicted activity from urine bioassay data:

Considering that an acute intake of 1.2E6 Bq occurred in October 15, 1965, and applying the adjustment factors from ORAUT-OTIB-0049 and its complement (Draft Approach to Dose Reconstruction, March 2006) for Super Type S Material, the predicted activity of Pu-239 in lung at the time of death (1970) is 2.9E5 Bq which is much higher than the 1.627E3 Bq activity from autopsy. If the whole set of urine data is used (except the one from 03/06/67), the predicted amount in lung is 2.6E5 Bq.

(b) Skeleton predicted activity from urine bioassay data:

Considering that an acute intake of 1.2 E6 Bq occurred in October 15, 1965, the predicted activity of Pu in skeleton just using Type S, without the correction factor, is 1,970 Bq; much higher than the 21 Bq from autopsy.

(c) Liver predicted activity from urine bioassay data:

Considering that an acute intake of 1.2 E6 Bq occurred in October 15, 1965, the predicted activity of Pu in liver just using Type S, without the correction factor, is 1,270 Bq, much higher than the 4.8 Bq from autopsy.

Summary:

The ORAUT-OTIB-0049 and its complement, *Draft Approach to Dose Reconstruction for Super Type S Material*, March 2006, overestimate the activities in bone and liver. It overestimates the amount in lung, if urine dataset is used. If the lung measurement results are used, it overestimates the activity in lung, when the last lung measurements result (highest from 2 years) is used. When all data set of lung results are utilized to derive the intake on the date of the fire, the lung prediction is close, but smaller than the autopsy result.

Case B:

The worker was exposed to high-fired Pu in the October 15, 1965, fire. He was in the vicinity of a plutonium fire without a respirator.

Death: October, 1983 – pneumonia, myocardial infarct

Autopsy Data:

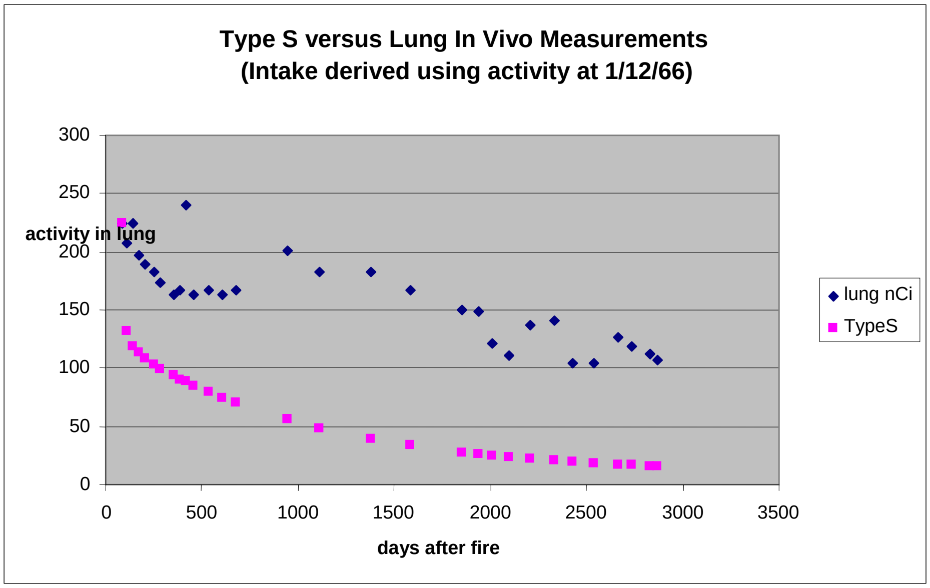
1.39E4 Bq lungs
173 Bq liver
226 Bq skeleton

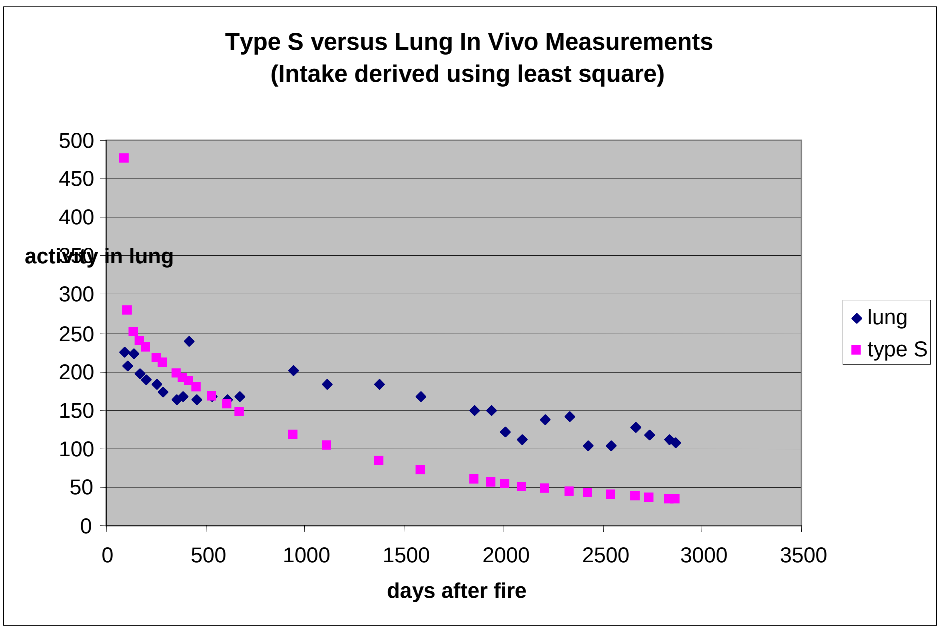
Lung Measurements:

Lung burden was estimated to be 8 times the maximum permissible lung burden, on the day of the fire. There are several results for Pu and Am from chest counts. There are also several results for Pu lung counts reported in nCi from 1/12/66 until 8/22/73. This last data set was used to derive the intake and to predict of the activities of Pu in the lungs, liver and skeleton, at the time of death.

All lung in-vivo measurements results are smaller than the activity from autopsy. The highest in-vivo measured activity was 8.8E3 Bq. The last in-vivo result in the worker's record (from 8/22/73) is 107 nci or 3,959 Bq, not compatible with 13,900 Bq, 10 years later.

The predicted lung burdens for Type S are compared to the in-vivo measurement results in the Figures below:



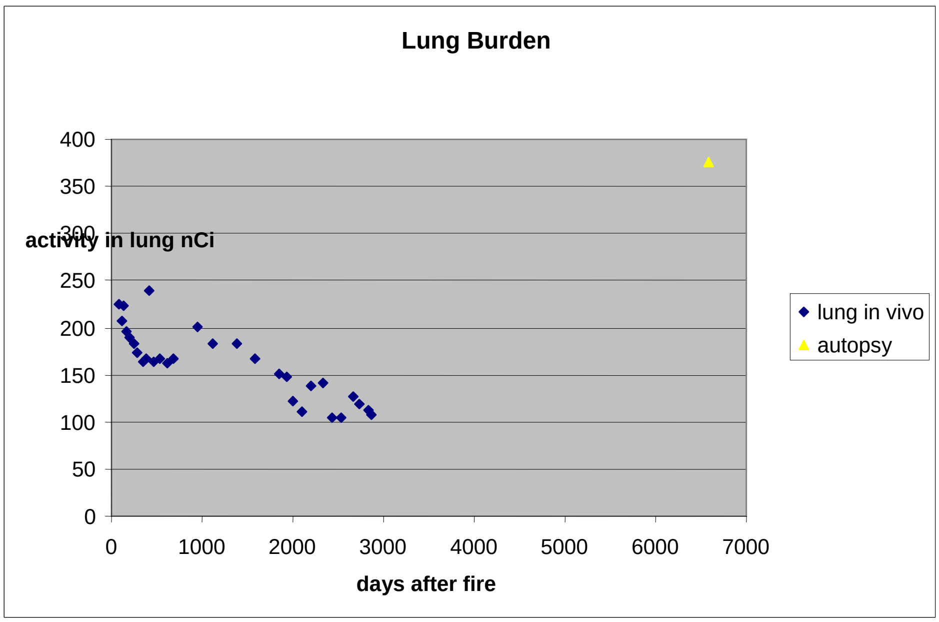


Using the lung burden result from January 12, 1966 (224 nCi = 8,300 Bq), and the adjustment factors from ORAUT-OTIB-0049, the predicted activity of Pu-239 in lung at the time of death is 12,000 Bq (324 nCi). This is more than the worker had on January 12, 1966, the starting point (8,300 Bq), even though smaller than the autopsy data 13,900 Bq (derived intake of 1.3E5 Bq). The predicted activities at the time of death are 296 Bq for the skeleton and 198 Bq for the liver, both results higher than the autopsy data (226 Bq for skeleton and 173 Bq for liver).

If the first 200 days data set of in-vivo results is used to derive the intake (least square method), together with the adjustment factors from ORAUT-OTIB-0049, the predicted activity of Pu-239 in lung at the time of death is 25,400 Bq, higher than the autopsy value (derived intake of

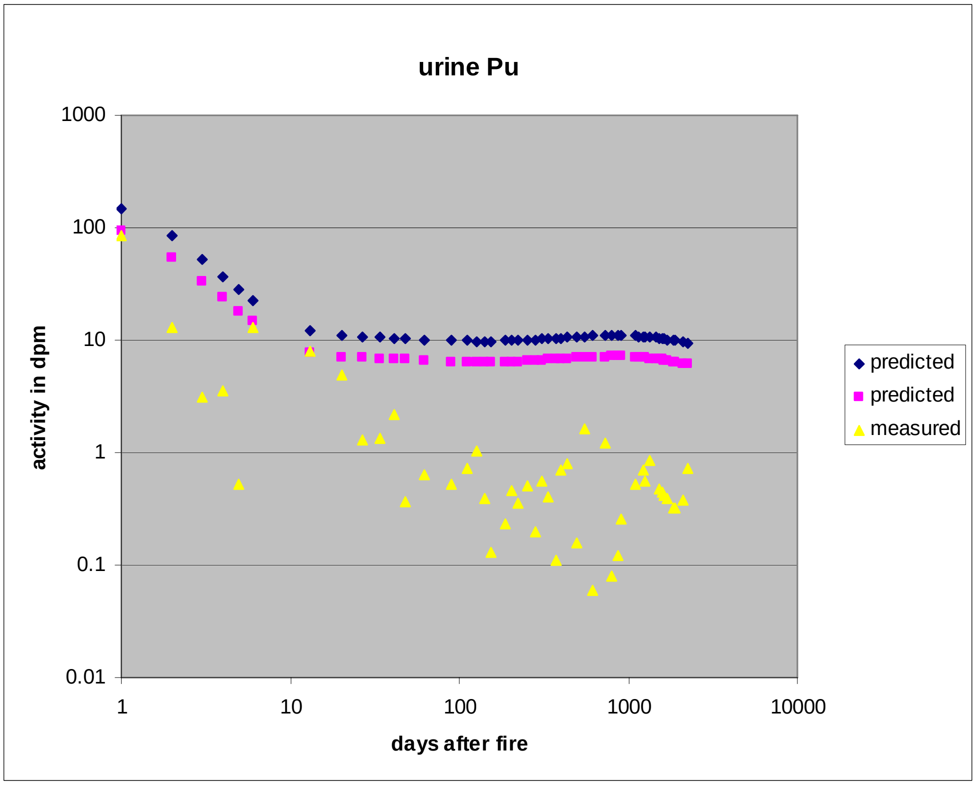
2.7E5 Bq). The predicted activity of Pu in skeleton is 615 Bq and the predicted activity in liver is 411 Bq, both higher than the autopsy data.

The activity in lung at the time of death, as derived from autopsy data is higher than all lung burden results derived from in-vivo measurements. The worker, in this case, had previously worked in a coal mine and had black lung disease. This situation might have contributed to this underestimation of lung burden from in-vivo monitoring. The following graph illustrates the comparison between lung burden results derived from in-vivo measurements and the one from autopsy:



Urine Bioassay:

The bioassay records of the worker show urine results for Pu from 10/17/65 until 6/12/73. If the first measurement result (10/17/65) is used, an intake of 1E6 Bq is derived. If the first 48 results and the least square method are used, the derived intake is 6.6E5 Bq. The following graph illustrates the predicted amount in urine using Type S plutonium, AMAD 5µm, for both derived intakes.



(a) Lung predicted activity from urine bioassay data:

Considering that an acute intake of 6.6 E5 Bq occurred in October 15, 1965, and applying the adjustment factors from ORAUT-OTIB-0049 and its complement (*Draft Approach to Dose Reconstruction for Super Type S Material*, March 2006), the predicted activity of Pu-239 in lung at the time of death (1983) is 2.88E5 Bq, which is 20 times the 1.39E4 Bq activity from autopsy.

(b) Skeleton predicted activity from urine bioassay data:

Considering that an acute intake of 6.6 E5 Bq occurred in October 15, 1965, the predicted activity of Pu in skeleton is 7,050 Bq, using the *Draft Approach to Dose Reconstruction for Super Type S Material*, March 2006. Thus the method overestimates the 226 Bq from autopsy.

(c) Liver predicted activity from urine bioassay data:

Considering that an acute intake of 6.6 E5 Bq occurred in October 15, 1965, the predicted activity of Pu in liver is 4,700 Bq, using the *Draft Approach to Dose Reconstruction for Super Type S Material*, March 2006. Thus the method overestimates the 173 Bq from autopsy.

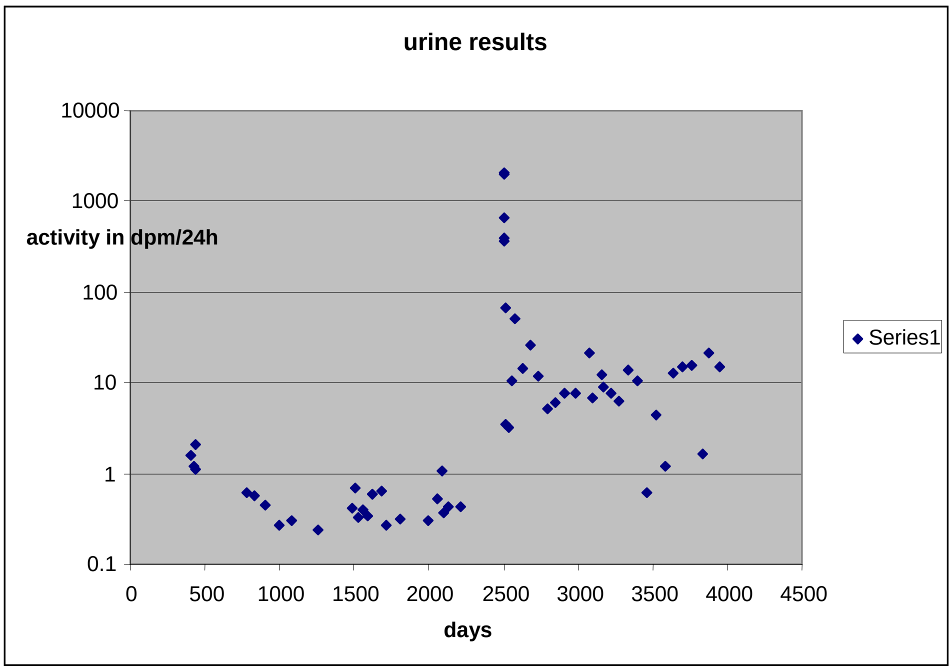
CASE H:

The worker died in 1970, from heart surgery. The worker had a serious wound contamination in 11/06/65. He received DTPA treatment. He had two other recorded wound incidents in 2/26/1960 and 2/12/1963.

Autopsy Data:

95.8 Bq in the lung,
321 Bq in the liver
22.5 Bq in the skeleton.

He has several positive urine results since 2/9/60 until 10/24/69. Until the 1965 accident, urine results varied between less than the detection limit and 2.1 dpm/24h. This last value is probably related to the 1960 wound incident.



This is not a clear case of exposure to high-fired oxides of plutonium, but the autopsy activity result for the lung is relatively high. The two wound accidents, before 1965, are associated with elevated excretion rates. There are no recorded lung measurements. The activity of plutonium in the lung from the autopsy result cannot be explained by the assumption of low-level chronic inhalation intakes. When a chronic inhalation intake scenario for 1960–1965 is used together with the last excretion rate result before the 11/06/1965 wound accident, the predicted activity in lung is 54 Bq, less than the autopsy activity. If high-fire adjustment factors are applied, the predicted activity in lung at the time of death is 1,771 Bq, an overestimation of the autopsy data. The application of high- fired inhalation exposure in this case is doubtful.

<u>Case A</u>:

The worker was exposed to high-fired plutonium in the fire accident in October 15, 1965. He was in the vicinity of a plutonium fire without a respirator. The lung burden was estimated to be 1.2 times the maximum permissible amount. Lung burden was estimated from in-vivo measurements using body counter.

Death: Sept. 14, 1971 – emphysema

Autopsy Data:

720 Bq Lungs
9 Bq liver
4 Bq skeleton

Lung Measurements:

Lung burden results are reported in two different ways, with different results. In the Excel tables, there is a reported measurement of 1.2 MPA in the day of the fire. This is the only measurement reported on the Excel tables. On the other hand, on the pdf exposure file, this measurement is reported as 2.1 Maximum Permissible Lung Burden. There are 12 lung measurements in the pdf exposure file. The last measurement was reported in December 1966, just before leaving the industry, and is equal to 1.1 MPLB (18 nCi or 666 Bq).

From the lung burden record in December 1966, 18 nCi, using the ORAUT-OTIB-0049 model, the amount of Pu-239 predicted in lung at the time of death is 15 nCi (679 intake multiplied by Type S fraction of 6.47E-3 multiplied by 6.8 and divided by 2) multiplied by AMAD correction of 2.6 = 39 nCi (1,443 Bq). This is more than the worker had in December 1966. The autopsy data is 720 Bq in lung or 19 nCi. Thus the amount predicted in lung is claimant favorable.

From the 18 nCi measurement result, the calculated intake is 679 Bq and the predicted activities in bone and liver are 47.5 Bq and 32 Bq, respectively, higher than the autopsy values.

Urine Bioassay:

The bioassay records of the worker show urine results for PU from 1963 to 1966. There are four results for the period August 1963 to May 1965, all of them listed as zero (<MDA). On October 26, 1965, the first Pu positive result is presented: 0.26 dpm/24h of PU. After this date, until January 1966, all Pu urine bioassay results are positive and similar to each other (range of variation: 0.26 dpm/24h to 0.55 dpm/24h)

On January 1966, the urine bioassay result is 7dpm/24 hr, indicating another intake. The predicted activities in organs were calculated using only the 1965 bioassay results, which are probably a consequence of the exposure to the 1965 fire.

(a) Lung predicted activity from 1965 urine bioassay data:

Using the 1965 urine bioassay results and considering that an acute intake occurred in October 15, 1965, an intake equal to 34,000 Bq is calculated, using Type S Pu, AMAD 5µm. At the time of death (1971) the predicted amount in lung, using ORAUT-OTIB-0049 and its complement (*Draft Approach to Dose Reconstruction for Super Type S Material, March* 2006), is 15,977 Bq, which is much higher than the 720 Bq from autopsy data.

Resolution: At 6 years after exposure, the predicted amount in lung, using Type S material, would have been 910 Bq. Using the correction factor for lung from ORAUT-OTIB-0049, for 6 years after acute intake, the result should be multiplied by 6.8. With the further correction (multiplication by 4.7) from urine measurements, the predicted activity in lung is equal to 910 x 6.8 x 4 = 6,145 Bq. A further multiplication by the AMAD correction factor 2.6, will give a predicted activity in the lung of 15,977 Bq.

(b) Skeleton predicted activity from 1965 urine bioassay data:

Using the 1965 urine bioassay results and considering that an acute intake occurred in October 15, 1965, an intake equal to 34,000 Bq is calculated, using Type S Pu, AMAD 5µm. At the time of death (1971) the predicted amount in skeleton, using the *Draft Approach to Dose Reconstruction for Super Type S Material*, March 2006 is 113 Bq. Thus, the method overestimates the 4 Bq from autopsy.

Resolution: At 6 years after exposure, the predicted amount in bone, using Type S material would have been 65 Bq. Using the correction factor for Type SS after 52d (last urine sample in 1965):

(Type S predicted amount at 6 years - Type S predicted amount at 52days) times 4.7 + Type S predicted amount at 52 days = 113 Bq.

(c) Liver predicted activity from 1965 urine bioassay data:

Using the 1965 urine bioassay results and considering that an acute intake occurred in October 15, 1965, an intake equal to 34,000 Bq is calculated, using Type S Pu, AMAD 5µm. At the time of death (1971) the predicted amount in liver, using the *Draft Approach to Dose Reconstruction for Super Type S Material*, March 2006, is 182 Bq. Thus the method overestimates the 9 Bq from autopsy.

Resolution: At 6 years after exposure the predicted amount in liver, using Type S material would have been 43 Bq. Using the correction factor for Type SS after 52d (last urine sample in 1965):

(Type S predicted amount at 6 years - Type S predicted amount at 52 days) times 4.7 + Type S predicted amount at 52 days= 182 Bq

Summary:

	Autopsy (Bq)	Predicted from lung bioassay (Bq)	Predicted from urine bioassay (Bq)
lung	720	1,443	6,145 (15,977 with AMAD correction)
skeleton	4	47.5	113
liver	9	32	182

<u>Case D</u>:

The worker died in September 1971.

Autopsy Data for Pu-239:

309 Bq Lungs – 42 Bq LNTH
0.4 Bq liver
0.6 Bq skeleton

The worker had a single chest count result, in 7/1/68, with a recorded value of zero for Am.

The worker has in the Excel bioassay records, urine results of Pu from 1958 until March 1972, which is strange since the worker died in 1971. The last bioassay data on the Health Physics Information Excreta Data is 6/20/68. He left work on 6/21/68. All the excreta data on the Excel table until 6/20/68 are the same as recorded in the Health Physics Information Excreta Data, except for August 14, 1958, but there is remark that it might be due to a typo error.

Most positive urine excretion values are below the mean detection limit listed in the TBD for the period from 1958 to 1971, except for four dates: August 14, 1958 (typo error?); August 10th, 1962; May 6, 1963; and October 15, 1965. The only accident recorded in his files associated with the urine results above detection limits is an 8/8/62 accident, which was described as follows:

> *Contamination on back of neck, forehead, left forearm, left wrist, 4th right finger. After decontamination with sodium hypochloride, shaved areas, showed, and changed clothes. Initial counts infinitive. Final alpha counts -- Back of neck 4000 c/m;*

October 15, 1965 is the day of the fire.

On August 10, 1962, the value of Pu activity in the urinary excretion increased one order of the magnitude in relation to the previous monitoring results, indicating that the worker had internal contamination, possibly from inhalation and wound (finger). The incident occurred on August 8, 1962. Assuming that an acute inhalation intake of Pu Type S occurred in that date, the estimated intake value is 4.0E4 Bq. The urine excretion data used to predict the intake were 08/10/62 (3.32 dpm), 11/19/62 (0.24 dpm) and 12/05/62 (0.32 dpm). Just using theses results and Type S, AMAD 5μm, the predicted quantities in lung, liver and bone at the time of death are 150 Bq, 57 Bq and 83 Bq, respectively. Thus for liver and skeleton, the use of Type S overestimates the amount found at autopsy.

If the Pu intake was treated as high-fired (even though there is no mention of high temperature in this case), the predicted amount in the lung would have been: 7,760 Bq, which overestimates the concentration at autopsy.

On October 15, 1965, the value of Pu in the urinary excretion increased twice the previous value, indicating that the worker may have had an inhalation exposure. If it is assumed that the intake was from the exposure to the fire accident, it is difficult to calculate the intake. Depending on how long after the intake the sample was taken, there is a fairly high variation on the predicted intake. A reasonable guess, from the data is 1E4. The predicted activity in lung at time of death, using Type S plutonium is 66 Bq. The predicted concentration, using the ORAUT-OTIB-0049 adjustment factors is 5,500 Bq, which is much higher than the amount found at autopsy.

It is interesting to note that using only Type S Plutonium, the predicted amount in lung from the two incidents together is 216 Bq, a value smaller than the one from autopsy.

As the urinary excretion of the worker has several other positive results, the activity in lung might be due to other acute inhalation intakes or due to chronic inhalation intake. For example in 05/06/63, there is relatively high urinary excretion. There is no accident relating to this excretion in the files. But there are three background results reported, without dates and a measurement dated November 1963, with 0.28 dpm Pu activity. The assumption of an intake on the day before the measurement will give one of the smallest intakes possible. This would imply an additional 19 Bq in the lung. If it was assumed that the intake occurred in the middle of the interval 01/01/63–05/06/63, the predicted amount in lung at time of death, just from this intake would have been 280 Bq. If a continuous exposure was simulated from 01/01/63 until 05/06/63, the amount predicted in lung would have been 220 Bq, just from the chronic intake in the period 01/01/63–05/06/63.

CONCLUSION:

1. The ORAUT-OTIB-0049 is claimant favorable and predicts activities in lung and organs higher than found in autopsy.

2. If high-fired Pu adjustment factors are not applied, the accuracy on predicting the concentration in lung depend on the scenario that is assumed (intake model: chronic, acute on the day before measurement result, acute middle of monitoring interval, etc).

<u>CASE F</u>:

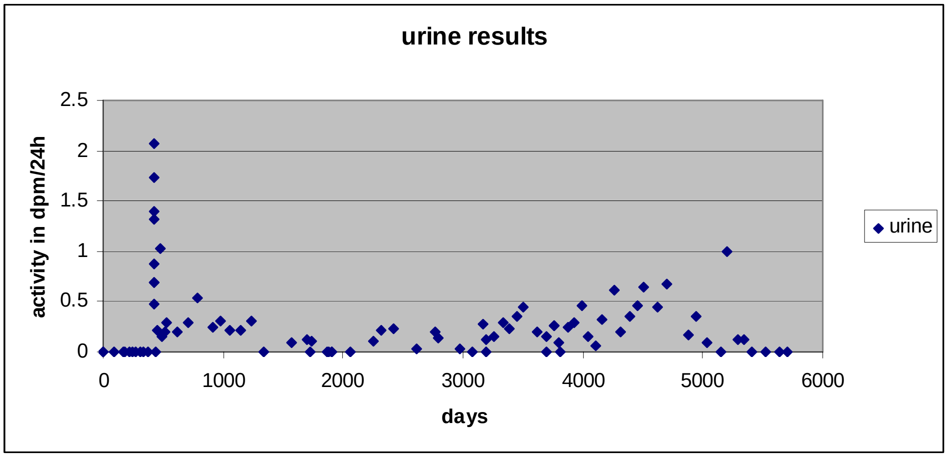
The worker died in March 1973.

The worker was exposed to an acute inhalation intake on 8/15/1958 described in his file as: Special G-5 Furnace caught fire or pressurized allowing contamination to billow out into the room. He was monitored when he came out of room: Right nostril 5,000 cpm, left nostril 4,500 cpm, forehead 1,000 cpm, cheeks 500 cpm back of neck 750 cpm.

Autopsy Data for Pu-239:

130 Bq Lungs
75 Bq liver
24 Bq skeleton

The worker has in his bioassay records, urine results of Pu from 1957 until 1973. Most of the results have positive values, although below the mean detection limit listed in the TBD for the period.



An acute inhalation intake was assumed to have occurred in 8/15/1958, in which the worker could have been exposed to high-fired plutonium, because of the fire. The urine results from August 15th until October 20th, 1958, were assumed to be related to the 8/15/1958 accident.

The intake, calculated using Type S, AMAD 5µm and unweighted least square on the urine results from 8/15/58 to 10/20/58 is 8.35E5 dpm or 1.4E4 Bq. Using only this intake, and the model described in ORAUT-OTIB-0049 and its complement Approach to Dose Reconstruction for Super Type S Material, March 2006, the activities predicted, at the time of death, in lung, liver and bone are 5.5E3 Bq, 85 Bq and 125 Bq, respectively.

Using only the inhalation intake from 08/15/58, the activities in organs are overestimated. There were other positive urine results after that, including intakes through puncture that would theoretically have increased, even further, the expected amount in the organs.

<u>Case G</u>:

The worker's file contains a list of several contamination incidents to which the worker might have been exposed, through inhalation and wounds.

Death: 1979 (beginning of 1979, authorization for autopsy dates 15/2/79) – cardiac arrest

Autopsy Data:

194 Bq Lungs
20.6 Bq liver
36.4 Bq skeleton

Lung Measurements:

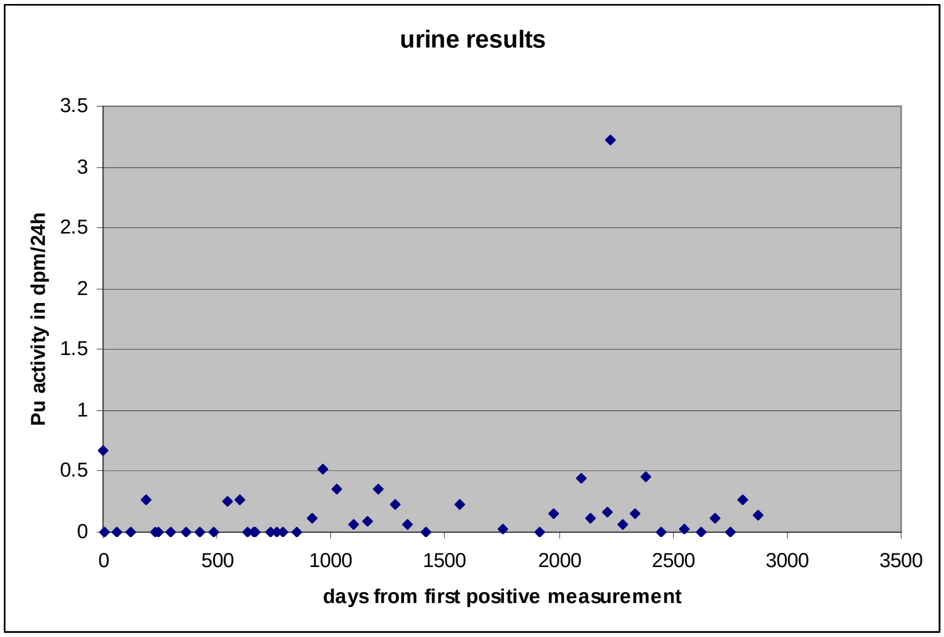
There are four Pu lung counting results from 07/19/71 until 02/01/73; all zeros. The MDA of 27 nCi (1,000 Bq) was used to derive the lung, liver and skeleton burden at the time of death. Three scenarios were assumed to interpret the in-vivo lung burden results: continuous exposure from 1971 to 1973, continuous exposure between the two last measurements in 1973, and single exposure in the middle of the last monitoring interval (1973). Using the first scenario and ORAUT-OTIB-0049 adjustment factors, at the time of death, the predicted lung burden is 646 Bq, much higher than the autopsy activity (194 Bq). The predicted activities at the time of death are 63 Bq for the skeleton and 42 Bq for the liver, both results higher than the autopsy data (36.4 Bq for skeleton and 20.6 Bq for liver).

The second scenario leads to predictions in the lungs (1,070 Bq), liver (27 Bq) and skeleton (40 Bq), which are higher than the autopsy results. The first scenario leads to predictions at the time of death, 780 Bq in the lungs, 22 in liver and 33 in the skeleton. Those predictions are similar to the autopsy activities for liver and skeleton. There were several wound reports which could have increased the liver and skeleton concentrations.

Urine Biosassy:

The bioassay records of the worker show urine results for Pu from 08/28/57 until 5/31/73. The first positive measurement dates 07/16/65.

The following graph illustrates the urine results for this worker:



From the urine data it is possible to derive three intake scenarios, not exclusive one from the others.

- In the first scenario, an intake in the middle of 8/4/71 and 8/18/71 interval is assumed. An intake of 1.7E5 Bq is calculated based on the urine data. The predicted activities at the time of death are 760 Bq in the lungs, 236 Bq in liver and 349 Bq in skeleton, just using Type S and no adjustment factors for Super Type S.

- In the second scenario, a single intake in the middle of the interval between 04/21/65 and 07/16/65 is assumed. Using ORAUT-OTIB-0049 and complement adjustment factors, an activity of 1.17E4 Bq is predicted for the lung, 472 Bq for the liver and 694 for the skeleton.

- In the third scenario, a constant chronic exposure is assumed, in the interval 3/7/68 until 8/4/71. Using ORAUT-OTIB-0049 and complement adjustment factors, an activity of 4.94E3 Bq is predicted for the lung, 117 Bq for the liver and 171 Bq for the skeleton.

Summary:

The ORAUT-OTIB-0049 and its complement *Draft Approach to Dose Reconstruction for Super Type S Material*, March 2006, overestimates the activities in the skeleton, liver and lungs, when urine data results are used. All lung results were below detection limits. The use of the adjustment factors together with the MDA for lung counting, overestimates the activity in lungs at the time of death. When the MDA for lung measurements is utilized to derive the bone and liver activities at the time of death, underestimation may occur, depending on the scenario that is chosen. This underestimation may be due to wound contamination, which is not accounted for from lung measurements.

Case E:

The worker died in 1979. Several accidents that could lead to internal exposures to Pu are listed in his file: 12/06/55; 01/26/56; 08/10/56; 03/08/57; 08/28/58; 04/254/59 (fire); 04/27/60; and 09/23/61.

Autopsy Data for Pu:

1,920 Bq lung
38.4 Bq liver
57 Bq skeleton

The worker has in his record a lung counting measurement in 11/24/65, in which the reason listed is the 1965 fire. The result of the measurement is not quantified for plutonium and there is a note of a slight Am-241 photopeak visible. There is another lung in-vivo measurement recorded, in 07/14/66, where there is a note small peak visible. Routine is listed as the reason for the measurement. The autopsy value, 1920 Bq (55 nCi), is above the limit of detection at the time and above recorded lung measurement results for other workers.

The bioassay records include urine results from Pu from 1955 until 1965. All results are listed as zero (<MDA) with the exception of the last one, in 1965, after the fire. The 1965 result has a positive value, although below the mean detection limit listed in the TBD for 1965.

Considering a chronic inhalation intake from 1955 until 1965, with the last year urine result equal to the MDA, the derived daily intake is equal to 17.5 Bq. If the MDA/2 would have been considered, the daily intake would be equal to 8.8 Bq.

At 24 years after exposure the predicted amount in lung, using Type S material would have been, as follows:

- The adjustment factor for lung from ORAUT-OTIB-0049, for 10y chronic exposure and 24y time after start of chronic intake, is 23. With the further correction (multiplication by 4) because urine data was used to calculate the lung burden, the predicted activity in lung should be 99.7 x 23 x 4 = 9,177 Bq. If the MDA /2 was used, the predicted activity in lungs would have been 4,589 Bq. Thus the method overestimates the 1,920 Bq from autopsy.

At 24 years after exposure, the predicted amount in the skeleton is calculated from the predicted activities at 10y and 24y, using Type S plutonium and the adjustment factors for Super Type S:

- The activity at 24y, minus the amount at 10y, is multiplied by 4. To this value the activity at 10y should be added. From urine measurements, the predicted activity in the skeleton should be (145.95 - 102.2) x 4 + 102.2 = 277 Bq. If the MDA /2 was used, the predicted activity in bone would have been 138 Bq. Thus the method overestimates the 57 Bq from autopsy.

At 24 years after exposure, the predicted amount in the liver is calculated from the predicted activities at 10y and 24y, using Type S plutonium, and the adjustment factors for Super Type S:

- The activity at 24 years minus the amount at 10y is multiplied by four. To this value the activity at 10y should be added. From urine measurements, the predicted activity in liver should be (96.6-67.2) x 4 + 67.2 = 184.8 Bq. If the MDA /2 was used the predicted activity in bone would have been 92 Bq. Thus the method overestimates the 38 Bq from autopsy.

If an acute inhalation intake is assumed at the day of the fire, with resulting plutonium activity of 0.45 dpm in the urine sample taken on the 17th of October 1965, the predicted activity of Pu-239 in lung at the time of death is 8.21E+03 Bq, an overestimate of the autopsy data. The predicted activities in the skeleton and liver are 233 Bq and 281 Bq, respectively. Both results overestimate the autopsy data.

ATTACHMENT 2: SC&A EVALUATION OF REPRESENTATIVENESS OF THE MODEL CASES

The list shown below is a summary of SC&A evaluations of the lung files of the 25 workers involved in the 65 fire.

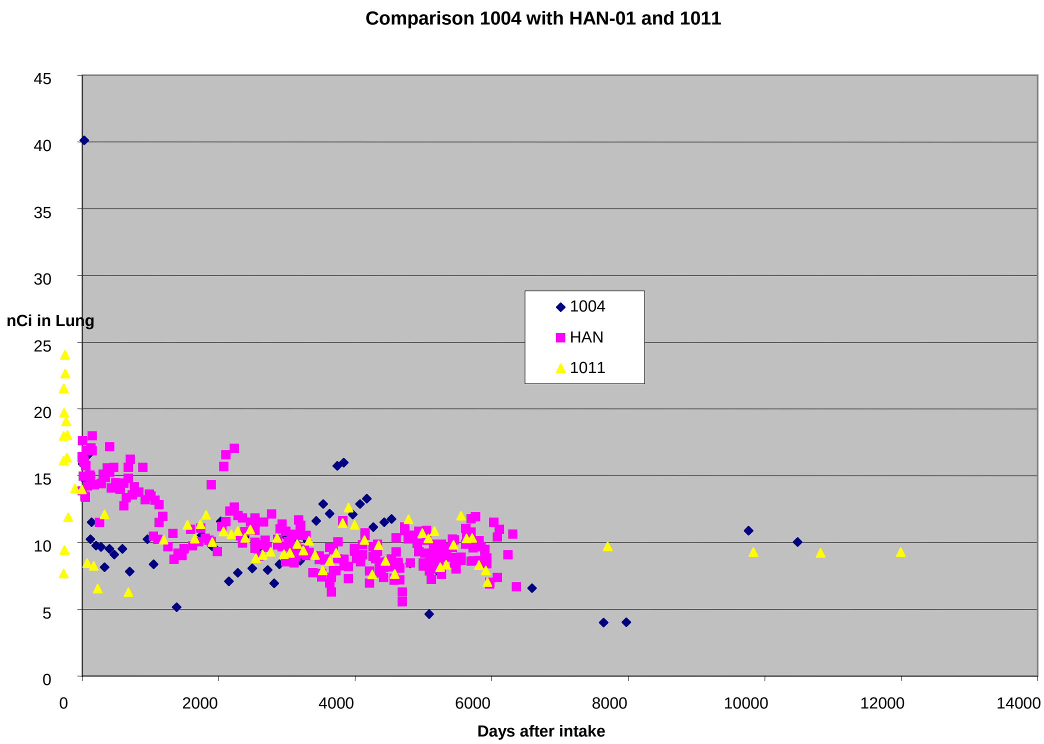
Note: An index number has been substituted for the original "expid" numbers.

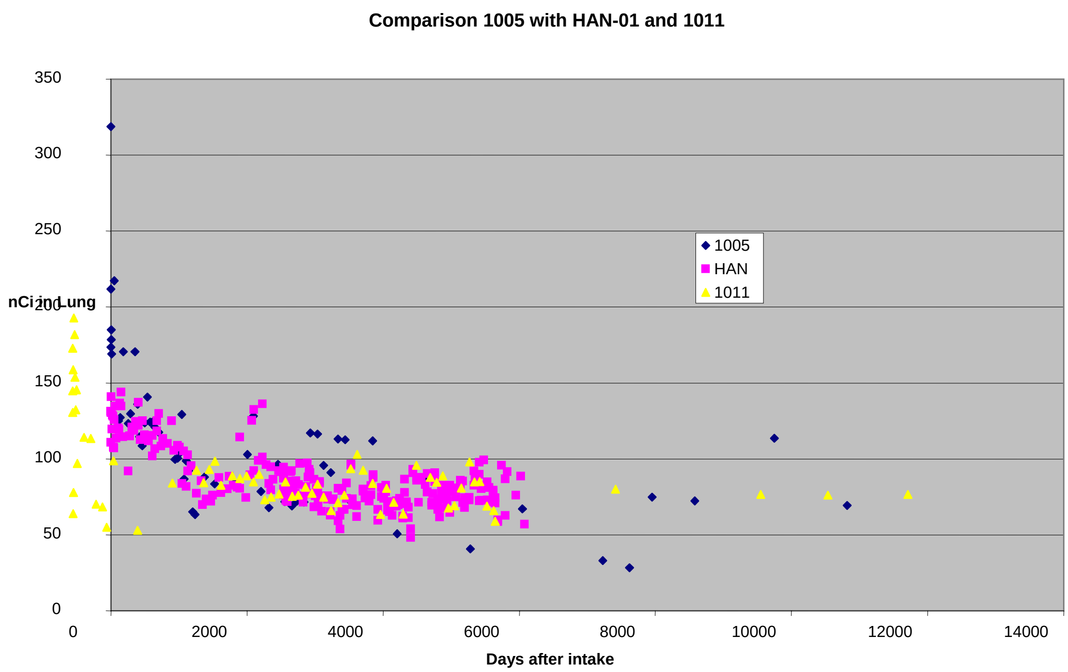
[The adjustment factors used in ORAUT-OTIB-0049 were derived based on data from two cases; one from RFP (RFP-1) and one from a Hanford worker (HAN-1).]

1001: lung data stop in 1987, lung data much lower than case RFP-1
1002: lung data stop in 1973
1003: lung data until 1998, lung data much lower than case RFP-1
1004: lung data until 1997, could have been used as a design case
1005: lung data until 1997, very high results, much higher than all the other results, previous exposure to Pu
1006: prior exposure to Pu, lung data much lower than case RFP-1
1007: lung data until 1987
1008: design case
1009: prior exposure to Pu, lung data lower than case RFP-1
1010: lung data until 1993, lung data much lower than case RFP-1, previous exposures to Pu, prior to the 1965 fire
1011: design case used to derive adjustment factors
1012: design case
1013: design case
1014: very few measurement results
1015: lung data only until 1970
1016: lung data only until 1966
1017: previous exposures to Pu prior to the 1965 fire
1018: design case
1019: lung data stop in 1987, very few measurements
1020: lung data stop in 1987, very few measurements
1021: very few measurements
1022: lung data stop in 1971
1023: design case
1024: lung data stop in 1969
1025: lung data stop in 1971

Lung data from cases 1004 and 1005 were compared to HAN-1 and to case 1011. The raw lung data was modified according to the adjustment factors described in TKBS-0011-5, Attachment B. These adjustment factors were not discussed with NIOSH, but were applied as they were set in TKBS-0011-5. The initial ppm of Am-241 was also not discussed with NIOSH. They are not SEC issues for ORAUT-OTIB-0049, but should be included in any future discussions from a site profile standpoint.

The main interest is the decrease in lung counting over time, and not really the amount deposited in the lung. The following graphs show a comparison of the cases with HAN-1 and case 1011. The data from HAN-1 and case 1011 were adjusted downward, in order to be compared in the same scale as cases 1004 and 1005. Therefore, an analysis of the following graphs should focus only on the inclination of the curves and not in the actual quantities deposited in the lung. The high-fired oxides of Pu are retained in the lung for a longer period of time than the other oxides. The amount of Pu retained in the lung as a function of time should show a very slow decrease, after the clearance of the more soluble compounds of Pu. According to ORAUT-OTIB-0049, the two bounding cases in terms of retention of Pu in the lungs are HAN-1 and case 1011. Based on the graphs shown below, the retention of Pu in the lungs of cases 1004 and 1005 were similar or lower than the retention of Pu in the lung of HAN-1 and 1011 .





In conclusion, the analysis of the data files of the 25 workers involved in the 1965 RFP fire has shown that the data from HAN-1 and case 1011 were correctly chosen to derive the adjustment factors of ORAUT-OTIB-0049.

ATTACHMENT 3: EVALUATION OF APPLICATION TO SPECIFIC RFP CASES, INCLUDING UNMONITORED WORKERS, PRIOR TO THE INTRODUCTION OF IN-VIVO COUNTING

(Scenarios based on a site expert's experience at RFP)

Dr Robert Bistline, an RFP site expert, has provided SC&A with possible exposure scenarios for RFP, based on real situations. These scenarios consist of exposures for which either no bioassay exists, or the bioassays would not detect the deposited material. There were many fires at the plant over the years, many of which, according to Dr. Bistline, occurred without record or notification of the fire department or management. For this reason, some scenarios may include unrecognized exposures to high-fired Pu oxides.

Dr. Bistline recalls that one of the major fires at the plant occurred in Building 71 in 1957, to which numerous workers may have had some exposure during, immediately after, or even months or years after the event, and may have been terminated or deceased prior to any bioassay sampling. There was evidence that some of those that may have had such exposure and continued to work at the site were picked up in later years on urine bioassays, and these cases would benefit from the models proposed in ORAUT-OTIB-0049. There were some cases, however, and one very notable one, where only one or two urine samples had been taken after the event and before termination of employment several years later; no fecal bioassay was conducted either. The urine samples showed nothing. By happenstance, the employee was picked up in an RFP recall follow-up some 40 years later at over 90+ years of age. (It is not clear whether there were other similar cases, but it is likely very few workers from that era were still alive when the recall program was occurring). In this particular case, according to Dr. Bistline, another RFP health physicist was reviewing individual health physics records and happened to notice a small note that the person was involved in some type of event in Building 71 in the 1950s. Just out of suspicion, the individual was brought in for a one-time check, and through a lung count, the individual was found to have one of the largest recorded lung depositions of plutonium seen at the time.

Based on Dr Bistline's suggested scenarios of exposure at RFP, SC&A has evaluated if dose reconstructions may be accomplished using the procedures suggested by NIOSH. The exposure scenarios included cancer in the main organs of deposition for Pu (lung, bone and liver) after a reasonable time after exposure (latency time for the production of solid tumors). The main uncertainties on these dose reconstructions were evaluated.

Scenario 1

Cases where individuals were exposed by inhalation to fire-produced Pu oxides prior to the Lung Counter and no bioassays recorded (high-fired Pu treatment)

In this case, dose reconstruction is accomplished using ORAUT-OTIB-0038 intake rates, along with the adjustment factors from ORAUT-OTIB-0049. There is no cross-referencing between the ORAUT-OTIB-0049 and ORAUT-OTIB-0038 models, although it is understood that under

ORAUT-OTIB-0049, all workers exposed or potentially exposed to plutonium are treated as if they were exposed to the high-fired form.

Scenario 2

> **Cases where individuals were exposed by inhalation to fire produced Pu oxides prior to the Lung Counter large lung depositions but below detection levels of urine bioassay and individual died prior to the recall program or prior to recall**
> or
> **the individuals not identified for participation in the recall because of the insoluble oxide in lungs not showing up in the urine (selection for recall was based on urine bioassay levels until the mid-1990s and by then many deceased or lost to follow-up),**
> or
> **the individuals declined to participate in the recall program, thus no lung counts or bioassays when insoluble material might start being detected and sensitivity was better.**

Dose reconstruction for scenario 2 is based on the missed dose concept and ORAUT-OTIB-0049. In order to calculate the missed dose, the MDA or reporting level should be known.

In TKBS-0011-5, the reporting level and the MDAs of the various methodologies used to calculate the Pu content of urine samples are discussed. Summarized below are the various methods described in the TKBS.

Reporting Level: 0.88 dpm/24h until 1961
0.20 dpm/24h from 1962–April 6th 1970

MDA:

1952–1961:
Carrier Precipitation: The Pu in the urine sample was carried into the precipitate with lanthanum fluoride. The precipitate was dissolved, and the solution was evaporated on a planchet, which was counted with a gas-flow proportional counter.

1961–1962:
Starting in December 13, 1961, an TTP extraction step was added to the carrier precipitation method to improve the specificity of the process to isolate Pu.

1963–1978:
Ion Exchange Method: Pu-specific. Evaporation of analyte was gradually replaced by electrodeposition on a stainless steel disk. About 1/3 of the samples were electrodeposited in 64 and ½ or more from 1967–1971.

Gross-alpha: 1952–1971
Until 1963→ in general credited to uranium
After 1964→ plutonium

The MDA for Pu is assessed for the median and for the extreme condition for the blank, the recovery, the volume factor and the alpha transmission factor individually and in combination. A count time of 150 minutes is used for all assessments.

MDA in dpm/24h samples

Period	Median Conditions	Extreme conditions	One extreme condition	Two extreme conditions	Three extreme conditions
1952–1953	0.57	5.0	0.76–1.3	1.3–2.2	2.2–3.7
1954–1962	0.51	4.5	0.68–1.2	1.1–2.0	2.0–3.4
1963	0.44	3.4	0.58–1.0	0.97–1.8	1.4–2.6
1964–1971	0.54	4.3	0.73–1.3	1.2–2.3	1.8–3.2

MDA for Gross Alpha (dpm/24h sample)

Period	Median Conditions	Extreme conditions	One extreme condition	Two extreme conditions	Three extreme conditions
1952 (U)	1.0	7.4	1.2–2.5	1.8–4.3	3.1–6.7
1953 (U)	0.88	6.2	0.98–2.1	1.5–3.6	2.6–5.6
1954–1959 (U)	0.79	5.6	0.88–1.9	1.4–3.2	2.4–5.1
1960–1962 (U)	0.55	3.9	0.61–1.3	0.96–2.3	1.6–3.5
1963 (Pu)	0.55	5.0	0.86–1.3	1.2–2.3	2.1–3.5
1964–1971 (Pu)	0.69	6.3	0.98–1.6	1.5–2.8	2.6–4.4

Whether to use the median value of the MDA or the extreme value depends on the purpose. If the purpose is to define a sample-specific conservative-bound parameter, the MDA for the extreme conditions should be considered. In general, the recovery is the variable that had the most influence on the sample-specific MDA. The use of the extreme condition for the recovery gave the highest MDA for one extreme condition. The median recovery varied from 0.57 (1952–1962) to 0.67 for 1963–1971. The extreme condition for recovery was 0.25 (1952–1962) and 0.28 (1963–1971).

The recoveries for 1952 to 1971 were determined by batch spikes. Experience has shown that a significant variability of recovery can exist within a batch of samples. Therefore, the recovery of a batch spike does not necessarily indicate the recovery of each sample in the batch (TKBS-0011-5).

Scenario 2 was split into the following scenarios in order to better understand the problems related to dose calculation.

Scenario 2a: Cancer of the lung 20–25 years after exposure.

– Worker submitted a single urine sample, one day after exposure and the result was below detection limits. The incident happened in 1963, the year with the lowest MDA for the median condition, 0.44dpm/d.

– Incident recognized as due to fire and High Fire Oxide treatment should be used to calculate the dose.

Scenario 2b: Cancer of the liver 20–25 years after exposure.

– Worker submitted a single urine sample, one day after exposure and the result was below detection limits. The incident happened in 1963, the year with the lowest MDA for the median condition, 0.44dpm/d.

– Incident recognized as due to fire. High Fire Oxide treatment should be applied to calculate doses.

Scenario 2c: Cancer of the liver 20–25 years after exposure.

– Worker submitted several urine samples, during **five** years after exposure and the result was always below detection limits. The incident happened in 1963, the year with the lowest MDA for the median condition, 0.44dpm/d.

– Incident recognized as due to fire: Type S is applied during first five years and High Fire Oxide treatment for the next 20y.

Scenario 2d: Cancer of the liver 20–25 years after exposure.

– Worker submitted several urine samples, during **ten** years after exposure and the result was always below detection limits. The incident happened in 1963, the year with the lowest MDA for the median condition, 0.44dpm/d.

– Incident recognized as due to fire. Type S is applied during first ten years and High Fire Oxide treatment for the next 15y.

– This scenario has problems because in 1967–1973 the lung counter was being used for monitoring.

Scenario 2e: Cancer of the liver 20–25 years after exposure.

– Worker submitted several urine samples, ten years after exposure and the result was always below detection limits. The incident happened in 1952, and the reporting level of 0.88dpm/d was used for the urine excretion.

– Incident recognized as due to fire. Type S is applied during first ten years and high-fired oxide treatment for the next 10y.

The dose calculation for these cases can be accomplished in a claimant favorable way, if a reasonable MDA is used, as for example the MDA for the recovery extreme condition is used. The uncertainties related to the MDA values are high. The feasibility of performing dose reconstruction with sufficient accuracy includes the use of a reasonable MDA value.

SC&A considers ½ the MDA for the median conditions to not be sufficiently conservative in this context; use of an MDA with at least one extreme condition is recommended. Further discussion regarding the differences between reporting levels and MDA is also important for those scenarios.

Scenario 3

Cases with individuals exposed to residual fire oxides from contamination events long after the fires occurred and not recognized as involving high-fired material; therefore, the contamination was assumed to be air oxidized, because this event did not involve a fire. Bioassay would not see the fired fraction and prior to reasonable MDA of lung counter to detect the uptake.

Scenario 3 was split into the following scenarios in order to better understand the problems related to dose calculation.

Scenario 3a: Cancer of the lung 25 years after exposure

– Worker submitted a urine sample one day after exposure and the result was below detection limits. The incident happened in 1963, the year with the lowest MDA for the median condition, 0.44dpm/d.

– Incident not recognized as high-fired material involved.

Scenario 3b: Cancer of the liver 25 years after exposure.

– Worker submitted a urine sample one day after exposure and the result was below detection limits. The incident happened in 1963, the year with the lowest MDA for the median condition, 0.44dpm/d.

– Incident not recognized as high-fired material involved.

Scenario 3c: Cancer of the liver 25 years after exposure.

– Worker submitted a urine sample one day after exposure and the result was below detection limits. The incident happened in 1963, the year with the lowest MDA, and the MDA for the recovery extreme condition was applied (1.0 dpm/d).

– Incident not recognized as high-fired material involved.

Scenario 3d: Cancer of the lung 25 years after first exposure.

– Worker submitted urine samples for 10y and the results were below detection limits. The first exposure occurred in 1954. The MDA for the median condition in the year of the last sample was 0.44 dpm/d.

- Exposure was not recognized as high-fired material involved.
- Dose reconstructions were accomplished assuming a continuous exposure during 10 years.

Scenario 3e: Cancer of the lung 25 years after first exposure.

- Worker submitted urine samples for 10 years and the results were below detection limits. The first exposure occurred in 1954. The MDA for the recovery extreme condition in the year of the last sample was 1 dpm/d.
- Exposure was not recognized as high-fired material involved.
- Dose reconstructions were accomplished assuming a continuous exposure during 10 years.

All those scenarios depend on the value of MDA that is used. The MDA values are a big source of uncertainties in dose reconstruction. Dose calculations for scenarios 3d and 3e may be based on the last measurement result and a continuous exposure for 10 years. The dose calculated using this scenario will be very small. This is an extremely unfavorable approach to calculate dose. A more claimant favorable and scientifically correct way is to use all measurement results and to assume a continuous exposure between two measurements within a year. The dose calculated using all monitoring results and assuming a continuous exposure for a time period not longer than one year, leads to a dose that is much higher than the one calculated using only the last monitoring result.

Conclusion:

Exposure to unrecognized fire-related Pu oxides is a problematic issue because of uncertainties related to the combined use of ORAUT-OTIB-0038 and ORAUT-OTIB-0049, because of the uncertainties related to the intake model of ORAUT-OTIB-0038 and because of uncertainties in the value of the MDA. These uncertainties may be resolved if doses are calculated in a claimant favorable way, i.e., applying the intake model from ORAUT-OTIB-0038 based on a percentile equal to or higher than the 95th percentile, and an MDA based on the recovery extreme condition, assumption of continuous exposure between two measurements within a limited period of time, and a time period no longer than one year.

ATTACHMENT 4: PETITIONER/WORKER INTERVIEW SUMMARY

Interviews were conducted with the 3 petitioners and 10 former RFP workers. Years represented by those interviewed range from 1952 to site closure. Kathryn Robertson-DeMers conducted the interviews from March 27–29, 2006, in Denver, Colorado. The purpose of these interviews was to receive clarification on the RFP petition basis and the petition process, accounts of past radiological control and personnel monitoring practices at RFP, and a better understanding of how operations were conducted. Discussions with petitioners and/or former workers have continued via telephone during the course of the RFP petition evaluation report review. Interviewees were identified through the petitioners, the Advisory Board meeting in Denver, former workers, and in working group sessions.

Those interviewed included petitioners, former RFP workers, and advocates assisting in the follow-through of the petition. Those providing affidavits or comments at the Advisory Board meeting in Denver were interviewed if clarification of the affidavits or comments was needed. Former workers represented operations in Buildings 123, 371, 444, 707, 771, 774, 776, 777, 779, 881, and 883. Some individuals had access to all areas of the plant. The job categories for former workers represented included the following:

- Assembly/Disassembly
- Clerk Packing
- Experimental Operations
- Field Engineering
- Health Physicist Research Scientist
- Machinist
- Production Laboratory Analyst
- Production Management
- Quality Assurance Inspection
- Radiation Monitors
- Records Management
- Subcontractors Supporting Engineering.

The information the petitioners and former workers provided to SC&A has been invaluable in providing a better understanding of the RFP SEC petition and its basis. This is not a verbatim discussion, but is a summary of information from multiple interviews with many individuals. The information provided by the interviewees was based entirely on their personal experience at the RFP. It is recognized that site expert and former RFP workers' recollections and statements may need to be further substantiated. However, they stand as critical operational feedback and reality reference checks. These interview summaries are provided in that context. RFP site expert input is similarly reflected in our discussion. With the preceding qualifications in mind, this summary has contributed to issues raised in the SEC petition evaluation report.

Petition Information

The petitioners found the SEC petition process to be rigid, with petitions needing to be filed in accordance with the requirements outlined in 42 CFR Part 83, *Procedures for Designating Classes of Employees as Members of the Special Exposure Cohort Under the Energy Employees Occupational Illness Compensation Program Act of 2000.* The original petition was submitted in February 2005. NIOSH assists the petitioners in filing an appropriate document for qualification. After review of the original paperwork filed by the petitioners, NIOSH asked that additional information in support of the petition be provided. As a result, the petitioners sent approximately 500 pages of additional material to NIOSH. This represents an addendum to the petition. Additional information can only be provided if it is requested by NIOSH. Any other information provided is not accepted. The petitioner must respond in accordance with a specific NIOSH procedure. The petitioners interviewed indicated that they believe that there is an inconsistency between the EEOICPA requirements for the SEC petition and how NIOSH is implementing the program. For example, there are rules associated with the evaluation of the petition with 180 days. In their view, NIOSH has not clearly defined when the clock starts.

The interviewees found that records from RFP were shipped to the Denver Federal Records Center (DFRC) and are not easily retrievable without authorization. The petitioners are not aware of any situations where the site purposely falsified records related to occupational exposure. There were procedures in place through time that resulted in zero dose assignments under conditions where this may not have been appropriate. The petitioners are not aware of specific instances of destruction of records, with the exception of the allegation regarding radiological records disappearing from the T690 trailer that was made at the Denver Advisory Board meeting. Records destruction was accomplished in compliance with the record procedures of the time. Petitioners indicated that there are classified documents that would help support the petition; however, the petitioners do not have access to these documents.

RFP is providing only those Medical and Health Physics records that have been specifically requested by NIOSH. As a result, there have been several follow-up calls to site personnel because of data gaps. One area where gaps have been observed is when an individual transfers to a subcontractor and is reassigned a badge number. When individuals return to the prime contractor, they are reassigned their original badge number. The individual who provided this service for NIOSH is no longer working at RFP. There is no one knowledgeable left to address follow-up questions related to dosimetry records.

The petitioners believe that there are too many variables associated with the detection of high-fired oxide (HFO) to be able to assign a dose. There was a potential for exposure to HFOs from routine processing. There were several production processes where temperatures were in the 800°C to 1,000°C ranges. The potential exposure to HFOs is not limited to the fires, but may include any Pu handling process where high temperatures were involved.

Some of the interviewees believe that a coworker dose assignment is not appropriate for internal exposure. The individual who receives an intake from a release of material is highly dependent on the direction of airflow and where an individual is standing. For example, two workers entered a contaminated area to perform some maintenance. They were dressed in plastics, a respirator, hoods, booties, and gloves. The PPE was taped to make sure the material would not get up under the Anti-C's. One individual was adjacent to the annular tank trying to fix the unit and in the flow pattern of the material. The other was standing upwind from the airflow. The first individual was grossly contaminated over his entire body. The second individual only had contaminated shoes. There may be a person working directly in front of the glovebox during a release and another working on the other side of the glovebox. If the airflow is towards the second individual, he will likely receive a higher intake than the person immediately in front of the glovebox. Internal dose potential should be tracked by work location and task.

General Information

The work at RFP provided jobs for the local community. There was an economic reliance on jobs provided at RFP. In the early years of operation, individuals felt like they were doing their patriotic duty in support of the cold war.

There was a unique working atmosphere at Rocky Flats. In the earlier days, individuals got away with a great deal. There were a limited number of DOE facility representatives in the field (e.g., 12 for the entire facility including administrative assistance.) A number of the former workers recalled a hostile work environment at that time where individuals got in trouble when unusual occurrences (e.g., smaller spills) occurred or when production was held up. This resulted in a "don't tell atmosphere." There were times when personnel were disciplined for bringing up safety concerns. If the trades and Decontamination and Decommissioning workers brought up safety concerns, according to the former workers, they were transferred out of the area.

The interviewees recalled that conditions were variable between exempt and nonexempt workers. Exempt individuals did not receive training due to budget costs. The contractors, in some cases, had hired uneducated personnel who were illiterate. These individuals were involved in fissile material handling.

The former workers noted that during the transition from Rockwell to Kaiser Hill there were a number of changes in management. At this time, employees were given ultimatums to become direct report employees. In the case of engineers and scientists, comments like "engineers and scientists are a dime a dozen" were made. This insinuated to the workers the company would attempt to find other employees if the current employees did not comply. Procedures were also under revision. This created a lot of confusion among the work force.

The interviewees noted increased requirements for procedures after the transition from an operating facility to a remediation facility. Since procedures were not as developed in the earlier years, the staff relied on the old-timers to inform them where problems existed.

After the Federal Bureau of Investigation raid, work packages were implemented. This slowed down the work process. Some step-by-step procedures required workers to sign off after particular steps.

According to former workers, subcontractors were not always aware of the hazards they were exposed to and did not have a general knowledge of how to treat this material. There was a double standard between RFP employees and subcontractors. Employees were, in general, suspicious of subcontractors and would not assist them in later years. In general, subcontractors did not receive medical monitoring as plant employees did, and they felt their monitoring program was not equivalent to plant employees.

Operations

The early designations for the facilities were Plants A, B, C, and D. These designations translated into the following.

Plant A	Depleted Uranium Facility (Building 444)
Plant B	Enriched Uranium Facility (Buildings 881 and 883)
Plant C	Plutonium Processing Facilities
Plant D	Assembly/Disassembly & Shipping and Receiving (Building 991)

Although RFP was primarily responsible for the manufacturing of pits, they were also involved in assembly and disassembly of weapons. This was originally done in Building 991 but later moved to the plutonium area, and continued until the shutdown of plutonium operations. RFP worked on other components as a part of their retrofit responsibilities. Plutonium recovered from disassembly of the site returns was reprocessed for use in other pits.

There were a number of non-routine or special operations that occurred at RFP that involved radionuclides other than uranium and plutonium. There were potentials for occupational exposure to tritium (gas, HTO and others), Sr-90, U-233, Po-210, Np-237, Am-241, Cm-244, and Pu-236. Several radiography sources were used at RFP for Non-Destructive Testing (NDT) including Cs-137, Sr-90, and portable iridium sources for x-raying welds. Uranium-233 processing at RFP was conducted intermittently from 1965–1982. Operations involving U-233 included metal processing, component manufacturing, material recovery, and waste handling. Handling of this material was also associated with the Zero Power Plutonium Reactor project that resulted in a number of high radiation exposures. Through the molten salt extraction (MSE) process in 776 and 779 americium and plutonium were separated. The plutonium was made into buttons and the americium salts became waste. As a part of the process, AmO had to be heated to temperatures in excess of 600°C. This was done on a production scale in 776 and 779 until 1989 when plutonium operations were shut down. There were experimental MSE and electrorefining processes done Building 779. Line 1 in Building 771 was used from the 1960s to the 1980s to produce americium for commercial use. Curium, neptunium, and polonium were used as tracers for the purpose of testing components and were handled in small quantities. RPF also accepted material from the United Kingdom.

Tritium activities occurred in multiple buildings onsite inclusive of Buildings 371, 561, 707, 774, 776/777, 779, and 881. It was introduced on the site as a contaminant of returned components. Pits were returned to RFP that involved tritium. Components associated with tritium were shipped from Lawrence Livermore National Laboratory (LLNL) and Los Alamos National Laboratory. Shipping procedures required that no more than 10 mCi of tritium be shipped onsite in a particular shipment. Although there was a limit on the tritium received, there were issues with tritium contamination spread in the area due to the diffusion of tritium. Since RFP was an alpha plant, it was difficult to reorient the workforce to the handling of tritium. There were two environmental releases of tritium. In the early 1970s, RFP received tritium contaminated material from LLNL. When working with the component, the tritium got away and was released to the environment. There was a release from the Special Assembly area in Building 777. Tritium was also a waste issue rather than a processing issue. Workers were told to flush their system with beer.

According to former workers, site returns were up to 20 years old. It was not unusual to see dose rates on these returns ranging from 1–13 R/hour. The site returns came into Building 776. A lathe was used to cut the pit for disassembly. As storage space became limited, carts with components were lined up along the hallway. This created dose rates from 100–200 mR/hour. The carts used for storage had boxes for shielding with a hole in the front. The older parts were of the type that had a directed beam.

Plutonium hydride operations occurred in Building 779, Room 154. This material was very flammable when it was exposed to the atmosphere. The plutonium was put into a chamber and hydrogen gas was added to form a hydride. The material was eventually changed to plutonium oxide. The particle size for this material was as small as 0.1 micron. The particle size rating for the respirators was 0.3 micron. The interviewees noted that Building 771 was declared by the DOE as the hottest building in the nation. And they declared the hydride-processing laboratory the most dangerous room within that building. Individuals did not want to enter the area.

Process specialists collected samples that had to be analyzed in the production laboratory for purity. Originally, each building operated independently of one another and had their own laboratory. This allowed for quick turnaround of samples. Individual laboratories were phased out after the termination of production activities and the analytical work was centralized in 559/561 Building. This significantly affected the efficiency of the laboratory. Laboratory analyses were conducted only on those radionuclides for which customers had requested data as a result of the workload. The analyses primarily involved the determination of plutonium and americium content, as well as other elements for which specifications were defined.

Storage space at RFP was at a premium, so makeshift storage areas were often observed by workers. There were three underground tunnels that were used for finished product storage and returns storage. Paducah ingots were stored in the uranium area.

Former workers noted that the Air Force and the Atomic Energy Commission brought military personnel to RFP to teach them how to assemble weapons on the way to the target. They had ownership of one-half of Building 991. This project had limited access. Maintenance was only allowed in this area as needed.

External Dosimetry

According to workers interviewed, the dosimetry program in the earlier years was felt to be more of a go/no go system with the emphasis on making sure employees did not exceed the regulatory limits of the time. Over time there were changes in the procedures for dosimeter assignment. Up until 1958, most exposed workers were not monitored for neutrons. In fact from 1952 through 1957, only 18 persons were monitored for neutrons and these were final assembly types of workers, when in fact, it was found that the most neutron-exposed workers were those working in the fluorination process area. A scientist from Los Alamos brought a newly invented neutron detector sphere up to Rocky Flats and found this problem in mid-1957. Exchange frequencies were as frequently as daily for special projects. Typical exchange periods were biweekly, monthly, quarterly, and annually. Individuals routinely working in production areas were on a monthly to bimonthly exchange cycle.

Neutron dosimeters had a metal clip so that the individual could clip the dosimeter to the collar or pocket of their anti-contamination clothing (Anti-C's). Some individuals wore them on lanyards. The design allowed dosimeters to fall away from the body when an individual bent forward. In some cases, the dosimeter would accidentally turn around.

The former workers pointed out that in the earlier years, there was real pressure for production and the external dosimetry group was very understaffed. The job of hand reading the dosimeters with the densitometers and doing all the conversions and calculations by hand was overwhelming, because this was before the days of calculators and computers. In addition, the reading of neutron films began in 1957 and production wanted readings every 2 weeks. These had to be hand read and counted neutron tracks using a microscope. The resulting flood of neutron films on top of the gamma readings totally overwhelmed the 3 workers in the external dosimetry laboratory. The interviewees noted that things were pretty sloppy before a new health physicist arrived and was able to get dosimetry under better control about 1967 or 1968.

Each badge was assigned to a coded area. During the period of time when all badges were not read, the technician would make the judgment whether to read the badge based on the coded area. There was no way for them to identify individuals who entered plutonium areas during the badge cycles. It took the Personnel Meters Technicians about 10 minutes to read each neutron badge received into the processing laboratory. They only had a set amount of time to read badges because of the volume they received. The Personnel Meters Technicians were not responsible for conducting dosimetry investigations in situations where badges were damaged. This was the responsibility of supervision. Damaged badges were noted on the log sheets maintained by technicians. By procedure, doses less than the minimum detectable dose were recorded as zero once this value was established. When a technician recorded "no data available" in the record, this indicated that the badge was not read.

There was not a routine problem with individuals turning in dosimeters late. Dosimeters were turned in late when a person was on vacation, out ill, or on a trip, but it was not a routine problem. When an individual did not turn in a dosimeter on time, a letter was issued to the employee and a copy was put in their dosimetry file. In the early days, the follow-up to get the dosimeters in was not always done and it appeared that some kept them until the next exchange. These were usually evaluated to see if the data were consistent with two periods of exposure or if a dose reconstruction or assigned dose needed to take place. The interviewees noted that if one looks in the records, there are holes in the data where badges were not turned in, and it was assumed that the badge was worn through another exchange period before turning in. There were times when badges were changed out while an individual was in the work area. There were times (in more current years) when the dosimeter badges were not turned in and dose reconstruction had to be performed. One method of assigning dose was to use coworker values.

Lead aprons were used in specific areas of the facility where dose rates were high. They were available to workers as far back as the 1950s. Aprons were worn in areas with particularly high gamma dose rates (e.g., assembly/disassembly, the hydrofluorination area, and the americium line). With greater neutron emissions, more stringent handling of the material was required. There were procedures related to high neutron emission material such as transportation requirements and requirements to wear lead aprons in some cases. Initially the lead aprons were similar to a butcher's apron with the sides unprotected by the apron. In the assembly/ disassembly areas, the individual may be carrying a pit under their arm where there was not coverage. The aprons were difficult to work in because of the weight. As a result many of the aprons were cut off at the bottom to reduce weight. Later a wraparound apron was implemented. Eventually the aprons were used to cover up pits on carts that had no shields. Most site experts recall wearing film badges under the lead aprons. The only effective neutron shielding was in the storage areas using Benelex, plexiglass, and/or Lexan. On some glove boxes plexiglass and Benelex shielding were used beginning in the late 1960s. Some vaults had thick walls of concrete, which also served as neutron shielding.

There were geometry issues associated with exposure in the field due to the design of the building. The rooms were designed with multiple rows of gloveboxes. An individual could be facing one glovebox line and have his/her back to another. Exposure from the glovebox behind the individual may result in more exposure to the body than the one directly in from of the individual. There was not a lot of space between the gloveboxes. The exposure levels were material dependent.

Secondary dosimetry such as pocket ionization chambers was used on special jobs where there were expected high gamma readings. The NDT group in particular used secondary dosimetry. When the chirpers made too much noise, the workers were spooked. The use of chirpers was discontinued about 20 years ago. Although extremity dosimetry was available, it was assigned to a limited number of personnel. There was a period of time when Radiation Monitors were not provided wrist badges although they were performing surveys on components.

Workers could receive up to 5 rem in a year without regard for the period of time over which it was received. For example, an individual could receive 5 rem dose in December of one year, and be allowed to received 5 rem dose in January of the next year. When individuals received external exposure in excess of the limit, they were sent to Building 774, the slow recycling area of Building 771, or the 903 Pad.

In general, the individuals interviewed were always assigned a dosimeter so they would not be able to tell if zeros were recorded when individuals were not badged. There were exceptions. Many of the petitioners and site experts interviewed were included in the Neutron Dose Reconstruction Project. In general, additional neutron dose was added to their initial neutron readings.

It was reported by former workers that individuals would manipulate their badge results to get the work assignment they wanted. Individuals working with plutonium and americium received hot pay so it was in their best financial interest to minimize their exposure. Conversely, if individuals didn't want to work in a particularly hot area, they would put the dosimeter on the glovebox, so they would burn out. If individuals took their badges off prior to entering an area, they were not likely to be caught. There was also horseplay in the radiological area. For example, workers would remove the coveralls of their fellow workers while they were in the controlled area.

Internal Exposure

As emphasized by former workers interviewed, one of the bases for the petition is the existence of HFO in the work environment. Workers are concerned about the formation of high-fired plutonium oxide during more routine processes and occurrences such as smaller fires, high temperature process steps, and incineration. There is no way to distinguish between high-fired plutonium oxide and more recent intakes of more soluble forms of plutonium. If an individual had an intake of both and had not been removed from plutonium work, you would not know whether positive bioassay results indicated a current uptake or a historical uptake.

There was a potential for the formation of high-fired uranium oxides at Rocky Flats. The process for fabricating uranium components was similar to that used for plutonium. There was a hydride process requiring heating of this material to very high temperatures. As with plutonium hydride, uranium would burn when it came in contact with oxygen sources. Fires were common when working with uranium. The incident list provided in the petition lists the various uranium fires.

Former workers recalled that routine lung counting was started in the late 1960s and involved trying to count workers in plutonium areas on an annual schedule, including anyone having known burdens above ½ maximum permissible body burden (MPBB) or 1 MPLB on a quarterly schedule (even if they did not work in plutonium areas any longer). Baseline counts were not complete on existing workers, but there was a policy of counting all terminations if they had worked in any production areas. Because lung counting was new and none of the workers had been counted before, it took awhile to get caught up and into a regular schedule. Therefore, some did not get counted annually at first. Counts as a result of an incident took priority over routine counts. When an individual reached 50% of a body burden or 100% of a lung burden, they were placed on work restriction and removed from hot work.

The in vivo counter was in operation until the last three months of the contract. In more recent times, in-vivo counting has been optional. Not all employees leaving the facility were required to submit a termination bioassay or receive a termination in vivo count. There was a period of three years when they discontinued lung counts following the Chernobyl accident.

According to former workers interviewed, eight of the 25 original high-fired cases in the 1965 fire received Ca-DTPA (Calicium-Diethylenetriamene pentaacetate). Three of them received 1g/day doses for 5 days and 5 received 1g/day doses for 4 days. At that point, it was evident that the DTPA was totally ineffective in treating the individuals and no more treatments were given.

Earlier experiences with inhalations of Pu-oxides and attempts to treat (flush the body again) with DTPA several years later proved to be quite ineffective. First, DTPA is very ineffective with Pu-oxide inhalations, and, second, treatments several years later with all chemical forms of plutonium only increase the urine output a fairly small amount and for a very short time (weeks to a couple of months at most). The plutonium in the lungs is not accessible to the DTPA and in the other organs is too tightly bound. There was some success getting plutonium out of the lungs using a lung lavage of DTPA a couple of days after the intake when macrophage activity was at its optimum within the lungs.

The recall program identified those individuals that had terminated or retired having, to the best of RFP staff's knowledge, body burdens and/or lung burdens that would give a dose of 20 rem or greater. The individuals invited to participate were determined in 1980 by going through all the old individual health physics records filed away in file cabinets in cargo containers. This was prior to the implementation of Committed Effective Dose Equivalent. In about 1993, when Public Law 102-484, under the 1993 congressional appropriations for DOE, was passed, DOE Headquarters contacted RFP staff asking them to come to Washington, DC. Congress asked RFP to expand the program to include all persons in the recall program with known external doses equal to or greater than 20 rem. Dosimetry staff raised concerns regarding the issue of unmonitored workers and poor neutron doses up to about 1970. Staff began reviewing old files for situations where individuals were involved in incidents that were not properly monitored or where incidents went undocumented. These groups were then included in the recall program, and the Neutron Dose Reconstruction Program was initiated. Initially, the program was contractor funded. Later the work was contracted with Oak Ridge Institute of Science and Education (ORISE) for completion. The records are maintained by ORISE. During the recall evaluations, individuals without measurable plutonium in urine or in vivo counts when they left the site were found to have detectable plutonium.

There have been somewhere around 120 individuals that were autopsied or whole-body donations under the United States Transuranium and Uranium Registry program and several more gave tissue at times of surgical procedures. Original autopsy records maintained by RFP were transferred to the Federal Center in Lakewood, Colorado. Individual files for most of the cases were copied and forwarded to the United States Transuranic Registry in the 1990s. They also have independent autopsy data that was not shared with the plant. The radiation exposure records, urine analysis, lung counts, wound count data, and any recall follow-up records will be at the Federal Center, or some recall data may be at ORISE.

RFP started using some special fecal sampling in the 1970s when there was an incident where a potential uptake may have occurred. This was made a routine procedure for potential uptakes in the 1980s and continued to the end of the plant in 2005. There was no method developed for the evaluation of curium and neptunium in urine.

RFP did not develop new models other than those that already existed to calculate internal doses received at RFP. There was a computer code written that modified the Langham Equation for calculating body burden estimates from urine data. This was code to calculate the body burden based on multiple exposures over years which basically averaged the contributions from previous exposures and subtracted that contribution from the data for the new urine data and recalculated the total body burden summing up all the separate body burden calculations. In about the late 1980s, a short explanation/documentation of this was written.

In the earlier days, it was rare to collect nasal and mouth smears unless there was indication of facial or hair contamination. If the person was able to decontaminate themselves within three tries they were sent back to work. There were situations where individuals had detectable nasal smear count above the trigger level where the urine showed no activity.

Several site experts interviewed indicated they had positive body burdens. According to them, there are former Rocky Flats workers with measurable burdens at other DOE complex sites (e.g., Los Alamos, Savannah River, LLNL, Hanford, Idaho Falls, Nevada Test Site). Whether these facilities re-evaluated the doses from former RFP personnel with uptakes is unknown.

Radiological Control Practices

There were few Radiation Monitors available to cover activities in the plutonium buildings. For example, one Radiation Monitor indicated that there was a period of time when he was the only monitor in Building 771. Radiation Monitors worked on the telephone dispatch principle. They were called in for coverage by operations when they were needed. There are several safety concerns regarding lack of technician coverage and not wearing appropriate respiratory protection for a job.

There were situations where individuals such as administrative workers were not expected to receive exposure but actually did. The placement of service areas (e.g., cafeteria, security posts, health physics offices) was on the other side of the wall from glove boxes used for production processes. For example, the cafeteria in Building 771 was located on the other side of the wall from the hydrofluorination area. This created low dose rates in the service areas as there was not sufficient shielding. The individuals in these areas were not monitored for some periods of time. It was later found that there were measurable dose rates in these areas. Outside areas such as the area around the Ponds were identified as having elevated radiation readings.

Exposure of non-production workers to contamination was also an issue. The cafeteria was surveyed on a daily basis and offices on a weekly basis. The cafeteria and office areas in Building 771 were contaminated many times, particularly the cafeteria. Cafeterias, locker rooms and offices in other buildings (i.e., 444, 707, 750, 776/777, 779, 881, and 883) were often found contaminated. In one serious incident, a secretary in Building 771 became highly contaminated and had to be extensively decontaminated when she inadvertently opened a contaminated file cabinet. An individual from production had brought a source from the line into the cold area for storage in the file cabinet. As a result of this event she received an uptake resulting in a positive body burden. A number of outdoor areas were contaminated with alpha activity.

- 771 Hillside
- Barrel storage area
- 771 Outdoor tank area
- Asphault in from of 771 and 774 Building
- Central Avenue from the 903 Pad down 771 Avenue to 771 Building

- 444 Building coffin area
- 776 dock area and the road running down past the dock area (contaminated during the 1969 fire)
- 776 Building rear portion including the bottle dock, compressor room, and asphalt area (contaminated during the 1965 fire)
- 776 Building roof (contaminated during the 1969 fire)

It was emphasized that the 776 Building areas mentioned above were **highly** contaminated. The 1965 fire also resulted in contamination of a guard vehicle, the ambulance, the fire truck, and many personnel. There was a turnings/oil-burning pit on the east side of the plant that was used for the burning of uranium contaminated lathe coolants. A barrel of contaminated lathe coolant from the plutonium area was inadvertently burned in this pit. These are only a few of the major contamination incidents occurring in areas outside of process buildings.

Particle size samples were interconnected to the Selective Alpha Air Monitors (SAAMs) or Continuous Air Monitors (CAMS) so when an alarm occurred, the particle size sampler would collect a sample. There was a requirement in the radiological control procedures to pull these samples. The filters were stored in the health physics office B-box, but were not collected for analysis and they built up over time. According to Radiation Monitors, these samples were not submitted for analysis. Samples from the hydride lab were found to be less than 0.3 microns, some as small as 0.1 microns, as measured by a filtered particle size impactor. This was of particular concern to Radiation Monitors, production personnel, and building Health Physicists because contamination was often found on respirator filters, routine air sample filters, SAAM filters, and the room exhaust filters. Although the filters were found to be contaminated, it was at times not evident anywhere else in the room or on personnel. This information never seemed to be raised to the level where action was taken to mitigate the situation. There was no formal report on particle size issues related to these samples to the knowledge of those interviewed.

The plutonium contamination was easily dispersible because of the rapid transition of plutonium into an oxide. Alpha particles were released from various plutonium sources, liquid and dry. At times, plutonium was found on the air filter, but Radiation Monitors could not identify the contamination source. Initial airflow tests for placement of air samplers were done using smoke bombs. The direction was made by upper level health physics that this was to be discontinued. Radiation Monitors and building foreman questioned this decision as they felt these smoke bomb tests were very effective. Air samplers were usually positioned at the air ducts rather than at the workers breathing zone, which made air-sampling data not representative of what workers were breathing.

Initially, every major building had its own laundry facility. The laundry was centralized in the 1960s to Building 778 and Building 881. The Building 881 facility was shut down in the mid-to-late 1970s. When the laundry facility was demolished in the 1970s the duct system and areas under equipment were found highly contaminated with uranium. The laundry personnel did not routinely wear respiratory protection and were not monitored for contamination upon exit from the area including at the end of the shift. They were required to transfer clothing in baskets for transportation to the laundry facility. They were not wearing respiratory protection when they were working with contaminated laundry. The soil outside some laundry facilities was contaminated when water ran out the door. The company tried to remediate the area, but they were unsuccessful.

According to former workers, there were issues associated with contamination control, particularly in the areas that handled uranium and beryllium. The ventilation in these areas was poor compared to that of the plutonium facilities. The break room had removable contamination. At one point the worker's lunch boxes were found to be contaminated. There were issues with badges getting contaminated.

The site used half-face respiratory protection. Half-mask respirators were used for emergency purposes including spills, CAM and SAAM alarms, and fire alarms. They were also used for bag cuts, decontamination, maintenance, and other routine contaminated operations until the 1980s when full-face respirators replaced them. The half-mask respirators were routinely worn around the neck or put in the pocket of the coveralls. Full-face respirators were carried in pouches. The half-mask respirators were reused repeatedly. There was no requirement for routine monitoring of these respirators. During the D&D era, RFP went to a single-use policy. In the uranium areas, although respiratory protection was required for certain tasks, workers would not always wear them unless a Radiation Monitor enforced the policy.

The plutonium area was contained in the Perimeter Security Zone. A number of postings were used at RFP to indicate hazards in the area including radiological postings. Radiation, high radiation, and very high radiation areas were found at RFP. Radiation Monitors do not recollect being required to post surveys adjacent to the area or provide dose rate information on postings. Radioactive items were labeled with appropriate tags or stickers. Locked areas such as vaults were not posted all of the time. Respiratory protection required postings were used to indicate when a respirator was required to enter the area. Several site experts indicated when tour groups came through the areas, the Radiation Monitors were asked to remove the Contamination Area and Respiratory Protection required sign prior to and during the duration of the tour. Once the group left, the area was reposted.

During interviews, several areas within the plant were identified as having neutron dose rates. These processes included plutonium reduction, dissolution of pink cake, the fluorination process including in the MSE process, enriched uranium areas, and the fluorination process. Various survey instruments were used for radiation surveys. Originally, sample locations were determined based on the discretion of the Radiation Monitor. Later, the survey locations were numbers on a survey map, and these locations were determined by supervision. The former Radiation Monitors indicated that these areas generally had less contamination and lower dose rates than areas where employees worked. Radiation Monitors emphasized that their job required them to be side by side with the operations and maintenance personnel. The process of bagging material out of a glovebox line and maintenance personnel resulted in a large amount of their exposure. In other cases, radiation areas were discovered in places where they were not expected for example in outside areas.

The site relied heavily on the engineering controls in place to protect the worker. There were situations where the engineering controls failed (e.g., hole in the glove, air reversals, etc.) Although this was not a routine occurrence, air reversals were obvious to workers since the gloves would be pushed out of the glovebox. The pressure was significant when this occurred. The uranium areas used B-boxes (similar to fume hoods), rather than gloveboxes.

The former workers indicated that the atmosphere at Rocky Flats was such that incidents were not always reported. This included production workers informing health physics of occurrences. Operations simply cleaned up spills and continued with their work. If these smaller incidents were documented, it is possible that the only place they were recorded was in the contamination control, foreman, and/or shift manager's logbooks. Another source of potential information on spills is the sample receipt logbook at the lab. When a spill occurred, a sample was sent for analysis to the process lab. If potential uptakes were not communicated to health physics, they could not require special bioassay to verify intakes had not occurred. In the later years, the site implemented Fact Finding meetings. Initially, the workers found this productive. After some time these meetings turned into a blaming session. People would hide things. No one wanted to make a mistake because they might be fired.

According to former workers interviewed, when individuals brought up safety concerns, they were threatened with retribution, disciplinary action, or in some cases retaliated against. If the trades and Decontamination and Decommissioning workers brought up safety concerns, they were transferred out of the area. During the first Occupational Safety and Health Administration inspection at RFP, operations in the beryllium buildings were shut down. He was disciplined for stopping operations.

Records/Information

There were multiple sources of incident information maintained by the site. These included Radiation Accident Reports, Occurrence Reporting, Shift Superintendent daily reports, etc. Incidents specifically mentioned by site experts included the major incidents such as the 1957 fire, the 1965 fire, and 1969 fire. Other occurrences mentioned included situations resulting in abnormal badge readings, examples of which follow:

- The employee was working around the annular tanks. There was a 10-minute stay time for this job. No dose was recorded.
- Another employee accidentally ran his dosimeter through an x-ray machine. The results for that dosimeter came back as zero.
- Certain high dose projects would result in film badges that were reported as black. The employees involved indicated that their dose was reported as zero.
- Facility management did not follow basic conduct of operations protocol and believe their field indicators.

The petition provided a listing of incidents occurring at Rocky Flats from 1952 to 2002.

According to one dosimetry technician, there was a period of time when the dose of record was being adjusted downward without appropriate rationale. The Chemical Operators located in high dose-rate areas, such as on the Americium line in Building 771, were on a 2-week NTA badge exchange cycle. Badges came into dosimetry processing and were read by a dosimetry technician. If the dosimeter was unusually high, each of the technicians read the film independently to ensure the reading was correct. Some of these films read in the Rem range for a 2-week period. The foreman told the dosimetry technicians that the results could not possibly be correct and that doses were adjusted to a lower value (not always zero).

The former workers noted issues associated with the reporting of zeros when dosimeters had what dosimetry felt were an anomalous reading. For example, one individual had a high penetrating dose. Six months later, dosimetry did an investigation and determined that coworkers did not receive dose. As a result of the investigation, a zero dose was assigned. Individuals do not clearly remember where they worked and who their coworkers were six months after the fact. In accordance with Conduct of Operations, you should trust the indicators and error on the conservative side. For example, you do not ignore a CAM when it alarms just because you think it is a false alarm. It was the interviewee's belief that in terms of dosimetry, the dose obtained on the badge should be considered accurate unless proven otherwise. Coworker dose should not be used to disprove high dosimeter results due to the nature of the field conditions. There were times when building health physics supervision would lower dosimetry reading on the supervisors reports so that personnel would be allowed to continue to work in the process areas.

A Radiation Monitor was covering Building 779 and Building 707 supporting Research and Development projects (i.e., MSE Project, Electro Refining (ER) Project, etc.) and Foundry Operations (i.e., machining, inspection, testing, non-destructive testing, assembly, disassembly, etc.) For the MSE and ER Projects, this individual was assigned special badges including an extra whole-body dosimeter, wrist dosimetry, and finger rings. The dose of record for this time period was recorded as zero or as a small value. At this period of time some of the bag cuts for waste in the line were routinely running 1–8 R/hour. Names, dates, body exposures, and wrist exposures were recorded in the 779 logbook. These values do not agree with those reported by dosimetry.

One possible explanation for missing dosimetry data in 1969 is that the badges were disposed of due to contamination. An individual who participated in the decontamination efforts indicated that if protective clothing was sometimes so contaminated, it was removed badge and all and disposed of as Radioactive Waste. Three former Radiation Monitors involved in monitoring activities at the fire indicated that they discharged badges themselves.

There were several situations relayed in addition to those listed above, which indicate that individuals were working hot jobs and dosimeter results showed up as zero. There were also situations where individuals had black film badges or a "no data available" recorded on periodic reports.

Job titles do not always indicate the time spent in the process areas. For example, there were various types of engineers employed at RFP. Some engineers were primarily located in offices whereas field engineers were required to enter radiological areas on a routine basis. One of the responsibilities of field engineers was to understand and appropriately label process lines, which were not always adequately identified on drawings. Field Engineers had to go into the field and flow the lines to make sure they were appropriately reflected and labeled. This took them into normally unoccupied areas that may or may not have been monitored for radiation. Because many of the lines were considered to be cold, initially Radiation Protection Technician (RPT) coverage was not provided. As lines were identified as mislabeled and potentially contaminated with radioactive material, RPT coverage was implemented.

Audits and Assessments

Audit and assessment information was documented in the petition. The petitioners are not aware of other audits that may support the basis for their petition.

The Tiger Team looked at some of the dosimetry issues when they visited RFP. The team of evaluators included persons out of Headquarters and other sites. There were assessments of the program in conjunction with some of the investigations into incidents and accidents that occurred at the plant. There were a couple of audits of Occupational Medicine and Radiation Protection in the 1970s and 1980s by several persons out of Headquarters. The location of the audit reports is unknown.

Safety Concerns

There was a safety concern filed by two Radiation Monitors. The individuals were working with a group of operators in the dirty fluoride area. There were high gamma and neutron dose rates in this area. As a result of the dose rates, there was a limited entry time into the area of four hours. For this job, the individuals were assigned supplemental dosimetry including wrist, extra whole-body badges, and rings. The Radiation Monitors asked to see the dosimetry results from the job. The results for the special badges were allegedly scratched out and replaced with zeros. During the safety committee meeting, Dosimetry staff stated that the badging system was worthless. This safety concern has been requested from DOE and is supposed to be provided early this week.

Unauthorized Practices

There were several unauthorized work practices identified during interviews. These unauthorized practices included:

- Eating in radiation control areas, although eating in the uranium area was allowed
- Not using respiratory protection when required
- De-posting airborne areas for tours
- Manipulation of dosimetry
- Performing jobs without Radiation Monitor coverage.

If documented, unauthorized practices would be noted in the contamination control logbooks.

*** While considered by former workers to be representative of the historic radiological practices at the plant, they believe that this summary only scratches the surface of the exposure problems encountered at Rocky Flats.**

ATTACHMENT 5: INCIDENT, FIELD MEASUREMENT, AND BADGE DESTRUCTION LOGBOOK ENTRIES

Logbook 10/1/57 – 8/26/60 (Kittinger 1957)

1-20-58: Page 13 – Destroyed both exchange and permanent badges of [Name] [Badge Number], notified [Name] of security of intent. He asked for no formal notification of destroyer. I asked guard [Name] to witness, which he did at 9:10 a.m. Badges were cut into small pieces and placed in the hot waste can.

1-31-58: Page 15 – [Name] called to check an assignment of monitors to maintenance jobs. He felt [Name] assignment was unnecessary – but main gripe is with maintenance who insist on monitor coverage, I told him 81 pm monitor could give some degree of coverage, but might in some cases be unavailable. I also told [Name] that cleanup of equipment had never been thorough enough to declare the maintenance job needed no precautionary measures.

11-18-58: Page 53 – [Name] exchange badge found "hot" (visitor).

11-19-58: Page 53 – Visitor badge # 3 found hot. Both badges destroyed with [Name] permission by [Name] with [Name] in attendance. Asked [Name] to check pm men's badges, he found 4 > 250 which were taken from the rack.

11-19-58: Page 53 – Asked [Name] to check all badges in the racks during his shift, he found 19 all from 81 > 250. Guards sent these down to H.P.

11-20-58: Page 53 – 5 badges of 19 unable to completely decontam. Got [Name] permission to destroy. Letter written for [Name] sign, concerning destroying of 11 exchange badges described above safety meeting- 81 H.P.

1-31-59: Page 64 – [Name] Badge (permanent F-26) was destroyed because of contamination level.

2-11-59: Page 65 – Destroyed 81…badge for [Name].

2-12-59: Page 65 – Destroyed [Name] permanent badge

4-10-59: Page 74 – Destroyed contamination exchange badge- [Name].

9-9-59: Page 101 – Badges found hot and destroyed:

[Name]	319-123	Perm & Exch.
[Name]	319-139	Perm & Exch
[Name]	181-268	Perm & Exch

Guard [Name] witnessed the badge destruction.

10-12-59: Page 104 – [Name] started 3rd shift today – to last only this wk. [Name] checked all exchanged badges in the clockroom on the 3rd shift – found 34 to be contam.

10-13-59: Page 104 – [Name] informed of the large number of badges that were found contam. He agreed to try to work toward a different badging system that would not require personnel to wear them in the area. He asked that [Name] be notified and his assistance enlisted to get Security to adopt a new system. I contacted [Name] with [Name] approval. [Name] is somewhat interested in the possibility of a film badge type substitution.

10-14-59: Page 105 – Consulted [Name] and [Name] about destru of contam badges. [Name] took down … telephone the entire list – both exchange and perm badges were requested – and agreed to make-up new badges before…old were destroyed. [Name] agreed to turn over all of the old badges to … for destruction.

10-26-59: Page 107 – Perm. Badge of [Name] destroyed.

11-9-59: Page 108 – New exchange badge system instituted – perm badge not worn in ….

3-29-60: Page 130 – Began study of 235 air contam. problem

6-14-60: Page 141 – Conferred with [Name] at his request concerning plant for facilities to handle chem. processing of normal U. Recommended ventil. about such as is used for Oy.

RFP Logbook 1962 Logbook Special Samples (RFP 1962)

This logbook involves special samples taken at the RFETS Mountain View Center and contains sampling results (often in c/m) at location numbers that run chronologically (i.e., S-60, S-61, S-62, S-63, S-64 etc.) often with smear and air samples taken at each location. Many are marked "WR smears", "WR surveys", and "WR survey." There is no information regarding dosimeters or other radionuclides (other than a cadmium air sample) and only a few entries, as noted below, for samples taken on specific individuals. Some samples are identified as EU sources.

Log Book 6-20-63 thru 10-27-67 (Kittinger and Vogel 1963)

6-24-63: Page 3 – [Name] asked permission previously was ok, and began today a short analytical run of about 20 grams of Oy samples in 41 Bldg. Air sampling and control procedures were set up.

3-11-64: Page 10 – Met with [Name], [Name] and [Name] in 233 foundry plant, [Name] not much in favor of portable down draft units

4-28-65: Page 41 – Special project going well- first metal made early this AM
[Name] 2hr EL

Special project 24 hrs behind schedule at end of day shift. PM OT cancelled – to await fluorination cycle, poor yield/ button.

5-4-65: Page 42 – Special project badges to 23.

6-4-65: Page 47 – U. contamination. Drinking fountain showed up at 91- from salvage- to be discarded

7-7-65: Page 51 – Talked to [Name] Re: Nitric Tu bath - he agreed to shut down till proper ventilation is available.

10-15-65: Page 63 – Talked to [Name] on Pu Sludge project- 229

2-28-66: Page 79 – Tu fire in 296.

6-21-66: Page 96 – Gamma alarm evac. at 2:00 PM. Good test. 72 people w/o film badges.

6-30-66: Page 98 – 233 going slow should finish making buttons tomorrow.

7-1-66: Page 98 – Small U fire in 81-244- no contamination sp.

6-1-67: Page 134 – Talked to [Name] about no neutron film in HP badges- says he will remedy.

Logbook 3/3/64– 9/4/64 (RFP 1964a)

3-10-64: Page 9 – Encouraged [Name] and [Name] to develop a method to feed calciner automatically rather than by hand (neutrons 200 to 300 n/cm/me) Neither seemed interested

3-19-64: Page 18 – [Name] [Badge Number] incident: His coveralls were > 100,000 c/m inside and outside. Under shorts found in locker room were to 6,000 c/m (wearer unknown). [Name] found [Name] shorts and button to be BKGD when checked at home. [Name] (Jump Foreman) and [Name] (guard) were present during survey. Survey delayed when 2 gas flow ins. in 76 and 2 in 23 were out of gas and weak batteries. See [Name] sheet for more details.

3-20- 64: Page 19 – Film badge racks installed west entrance.

4-20-64: Page 50 – Five in the line room 160. [Name] [Badge Number] was oxidizing samples the furnace had boom shut down for 30 min when [Name] [Badge Number] noticed a fire in the line in an ice cream carton Fire Dept came down. No personnel contamination noted. No contamination of area noted 05:20 hrs.

5/1/64: Page 60 – Special neutron and gamma survey for hall of calciner after cleanup still showed 275 n/sec/cm2 with supposedly no mtl. in the….

5/7/64: Page 65 – Gamma survey of very full dry boxes in 77 Bldg. 7 boxes averaging 100 mr/hr outside/200 to 400 mr/hr in the gloves.

5-13-64: Page 69 – [Name] burned classified paper for [Name].

5-26-64: Page 78 – Several pinholes in dead transfer lines ~ end east CHEM line also several leaking values and flanges decontam not completed.

6-2-64: Page 83 – Talked to [Name] about [Name] treatment of film badge. Also talked about destruction of numbers of accident report blanks at desk in Room 148 with obscene word scratched on top blank.

6-12-64: Page 91 –

11:45 Hrs 71 Bldg notified of accident in 76 Bldg [Name] went to 76 immediately

11:40 [Name] phone from 13 Bldg to inform us a [Name] (76 Bldg) was calling for supplied air suite.

12:00 [Name] was protracted about the incident he said the office area at that time was cold

12:05 Contacted [Name] he requested all available monitor in 71 Bldg be sent to 76 Bldg the following monitors were sent as soon as possible

[Name] x 8

RFP Logbook 9/8/64–3/26/65 (RFP 1964b)

9-22-64: Page 20 – [Name] [Badge Number] needs 2 new picture for his film badge old one 500 cpm.

1-19-65: Page 102 – Talked to [Name] about excessive gamma at the Am stripping box and F.R. Box Rm 114. In front of the columns reading to 250 mR/hr in glove port and up to 70 mR/hr in aisle 1 ft. from box. He is having 50 mil. lead gloves put on and is going to look into a way to shield the column.

Logbook 3/26/65–10/18/65 (RFP 1965a)

Page 39: 5-18-65 – Survey around old 146 fluorinator shows up to 60mr/hr and 15–30 mr/hr

Page 60: 6-17-65 – 2– more separate glove failure incident on lathe 768 on this shift. Will contact [Name] to investigate operation in this box.

Page 68: 6-28-65 – Explosion in 13 lathe in Rm 182 contamination throughout room and into hall 196. Supplied air on north lathe bar room if personnel in supplied air evacuated by hall 193 and spread contamination to the read.

Page 72: 7-2-65 – Tank 736 behind new Am box reading 18,000mr/hr on bottom of tank covered with lead apron, should be shielded as well as 734, 731, 737.

Page 80: 7-15-65 – Bag leaking on back side of Am box 600sq ft of floor contaminated to 10,000 c/m.

Page 81: 7-16-65 – Talked to [Name] about shielding tanks on the back side of am box okay he will take care of it Monday Tank 720 reading 1100mr/hr on bottom

Page 145: 10-8-65 – Contaminated Incident in Rm 180 Project

RFP Logbook 10/19/65–5/9/66 (RFP 1965b)

11-19-65: Page 28 – Floor area behind old skull box contaminated to > 100,000 c/m. Back hallway to 50,000 c/m. Hallway has been cleaned. Floor behind skull has been wet down it will be cleaned at the end of the shift. Day shift will be asked by [Name] to get this area cocooned as soon as possible.

11-19-65: Page 28 – An area (10' x 4') at the south end of the skull box under the air lock was covered with plastic. After a short time the plastic was inflated with air that seemed to be coming up thru a crack in the floor.

2-14-66: Page 91 – Started neutron integrating unit with film at Rm 148 Fluorination. Rate of exposure 50–70 mR/hr having trouble find a safe place to get up gamma integrator.

2-25-66: Page 99 – 01:45 a waste BB1 containing supplied air hot waste exploded. Blew the lid off and the contents of the BB1 caught on fire. Contamination spread over 100 sq/ft floor level not very high (2,000 – 3,000 c/m).

4-12-66: Page 132 – Fire in the incinerator plenum probably burned out 1st and 2nd stages of filters. No contamination noted outside of plenum.

RFP Logbook 5/10/66–12/3/66 (RFP 1966a)

6/22/66: Page 32 – Destroyed picture badge belonging to [Name] [Badge Number] due to contamination.

8-27-66: Page 82 – Fire in the incinerator plenum. Two filters burned out. 1 in the 1st bank and 1 in the second bank. No contamination released. The exhaust stack out of the top of the incinerator was hot enough to set the insulation on fire.

9/21/66: Page 99 – About 5 or 6 gal. of green liquid was found on the floor in Rm 146. It was behind the dry wall partition and it had run out of a stubbed off exhaust line that was only taped over. It is believed that it ran out today when there was a power failure and the dry box vacuum was lost. Contractor blueprints and equipment are all contaminated. Air samples B-3 & B-4 > 100K. [Name] was called concerning possible day shift exposures. Attempts to decontaminate brought little if any results. Plastic used to cover the worst areas.

Logbook 12/5/66– 6/11/67 (RFP 1966b)

6-7-67: Page 142 – Both fluorinators broke down. Oxides being stored in 114 fluor room. Area marked with do not loiter signs total 19 mR/hr.

6-8-67: Page 143 – Talked to [Name] about tube strung from Am tanks to Am box to transfer Am feed. 150 mr/hr in aisle – 4 mr/hr. at operators desk. Also talked about shields to cover glove ports not being used.

Logbook 12/12/66 –12/31/68 (Kittinger 1966)

1-10-67: Page 8 – Asked [Name] not to make projected addition to 77 a cold area based be, Tu, Oy and possible Pu storage in this area.

1-31-67: Page 11 – Worked with [Name] on specs. for special permission on radioactive metal shipments. He agreed to exclude Am and Np from table showing criticality limits – to make separate table asking for quantity agreement only.

8-4-67: Page 54 – Met with [Name] concerning possible project to make D-38 pellets in 05 Bldg. [Name] wanted to do the work on bench top. Advised him regarding ventilation needs since this will be messy work.

RFF Logbook 6/12/67–12/29/67 (RFP 1967)

6-21-67: Page 9 – Fire in one of the pots inside Line #3 ~ 2000. Extinguished almost at once by [Name]. No personnel contam. and no release of contam. to atmosphere.

6-25-67: Page 12 – [Name] found liquid on floor a valve was not turned off (I [Name]. witnessed [Name] shutting it off. Cooling water level was just about up. Water was leaking from windows, bolts. Reported to [Name] at 0630.

6-26-67: Page 13 – Area around W Box and Button Breakout put on resp. because of high level contamination found. Between shielding on boxes & boxes themselves operators to start cleaning around Button Breakout.

6-28-67: Page 15 – Found 2 plastic wrapped pieces of material laying unattended and unmarked on top of desk near casting furnace in Rm. 182. Radiation level of 55 mR/hr at surface of each one.

6-29-67: Page 16 – Talked to …about [Name] on 148 Fluorinator judging from readings and study with neutrometers it would indicate 777 mrem of exposure in the past 4 days. Front of box without shielding 75 to 80 mrem – with shielding 35 mrem.

7-15-67: Page 30 – Talked to …, [Name], [Name], [Name] about relocating film badge racks in 71 Bldg. It is ordered that the racks for maint. labs, & R&D be left in the west dock area and that Metal. Production, Mfg. Tech, & HP be relocated to hallway north of ….

8-22-67: Page 56 – Two bags north end of chloride line one on desk 250 mr/hr and one on barrel 800 mr/hr. Posted signs around area.

9-11-67: Page 69 – Lathe in Rm 182, ZPPR, south side of box has no shielding. Surface of glass reads 20 mR/hr. Man working at this location.

9-11-67: Page 69 – [Name] called about small lathe fire in 44 Bldg. working with ZPPR material. Told him to write possible exposure report & issue special urine sample to machinist.

11-21-67: Page 124 – I R columns loaded with Am feed. Windows to 310 mr/hr, gloves to 200 mr/hr, Bkdg. 3 ft. south of box to 25 mR/hr. Survey taken and sent to [Name], [Name], and [Name].

11-22-67: Page 125 – There is [Name] of ZPPR fluoride at the far south end of the Chem Line that reads 67 mrem/hr neutrons. A radiation sign has been posted at its location.

12-7-67: Page 134 – Took gamma and neutron survey of TLD's, Line 45. Middle of aisle at Line 4 12 mR/hr – site gauge 619 110 mR/hr and site gauge 617 70 mR/hr.

12-12-67: Page 136 – Survey taken of crusher-neutron levels excessive. Gamma levels at the windows on the ion columns to 22 mr/hr. Background at control panel. 3 mR/hr.

Logbook 1/2/68–7/5/68 (RFP 1968a)

1/27/68: Page 22 – 0930 hrs. #3 Booster became plugged to such an extent that the Boiler Operator had to reduce the Vac. on Lines 21, 23, 30, 45, and 46 in order to have a minimum.

4/6/68: Page 77 – Overhead filters on Line 31 leaking again.

4/26/68: Page 93 – Talked to [Name] and [Name] about reading of 19 mr/hr at the north end of Am Line. Reading in the center of aisle at the evaporating process.

5/4/68: Page 100 – Fire at the 114 fluorinator. A shielding bracket was being welded and welding slag landed on an intake filter box and started a fire. Some contamination was spread, but I think more contamination was tracked from hot operations in Room 149 by people trying to leave the area.

6-4-68: Page 123 – A sudden squall that blew in from the east spread contamination from the rabbit pen on to the people working there and into Bldg 03 itself contaminating the inside of the Bldg to 10,000 c/m. Lunch boxes in the Bldg were also contaminated. All lunches were discarded and lunches were furnished to them. [Name] street pants were contaminated. to 500 c/m. They were cleaned up with tape. Also [Name]'s car was generally contaminated to 300 and 400 c/m on both the inside and outside. It was driven into 74 Bldg. area and decontaminated. Operators were decontaminated in Rm 169.

6/26/68: Page 139 – Checked area under Am holding tank outside and just north of 71 Bldg. Dirt is running 300 to 500 c/m – cement base directly underneath tank is counting to 5,000 c/m – plastic bad around piping coming out from bottom of tank is OK. Did not check out the top of the tank. Roped area off and marked same.

RFP Logbook 7/8/68–2/4/69 (RFP 1968b)

8/16/68: Page 32 – Fire and explosion in Line #2 on day shift left south end of room highly contam. Cleaned up except for under line which was isolated with plastic. Plastic also laid on floor just alongside of Line 2. Floor under plastic needs paint.

8/16/68: Page 32 – Fire in Line 13 ~ 1730 – No contam. released to the area.

8/21/68: Page 35 – High gamma reading at the Am line desk was caused by a gauge failure that allowed Am feed to back up into a line that normally is cold. Condition has been corrected.

8/21/68: Page 35 – Talked to [Name] about Line 2 explosion on 8/16. He stated that they suspect the cause was a newly installed air line that may have had some oil in it and that oil got into the pot – they have discontinued use of the air line pending further investigation on the incident.

9-19-68: Page 56 – [Name] got n & γ survey storage area N. Rm 114. >130 batches green cake stored because of Fluorinator shut down reading to 45 mrem/hr n and 4 mR γ. Area should be posted.

10-9-68: Page 70 – Talked to [Name] concerning the wearing of lead aprons for bag cutting – [Name] and [Name] have been refusing to wear lead aprons for bag cuts and have been hand carrying bagged out material.

10-16-68: Page 75 – Bag cuts at Line #4 by [Name] and [Name] without the wearing of lead aprons. Bags up to 48 mR/hr.

1-10-69: Page 134 – Talked to [Name] and [Name] about using TLD for exposures during repacking of ZPPR barrels. TLD will be furnished. The pen for repacking these barrels will be built in Rm. 146. The TLD will be in the middle desk drawer and will be read daily. The numbers to the outside.

Logbook 2/5/69–9/3/69 (RFP 1969a)

4-24-69: Page 56 – Spill at Vac line around line # 10. Pipe fitters were cutting out 3 vac. [Name] when liquid ran out of pipe area was >100,00 c/m at spill to 4,000 c/m on floor in storage area and fluorinate area was wet down with KW and barricaded to prevent spread of contamination area still contaminated at end of shift requested pm shift wake

5-12-69: Page 70 – No production – (worked 76 fire all night at 76 Bldg plus decontamination 71 Bldg from 76 source

5-12-69: Page 70 – Decontaminated tunnel all night

5-13-69: Page 71 – [Name] to 76 one hell of a night decontaminating, taking care of medical mtc jobs, clean up, you name it – “Time for Beer” have fun [Name].

4-11-69: Page 47 – Decontam. crew worked all shifts on contam. area that resulted from the fire at K-2. Two and at times three monitors were needed on this job full time.

6-18-69: Page 96 – Let [Name] know of our dissatisfaction of upright for being used in tunnels

6-25-69: Page 101 – 2115 hrs criticality drain on line #30 ran over we only have cloth booties to use, material is running 146g/liter. At least 6 pr shoes contaminated to > 100 K. 3 chem. operators sent to medical for decontamination.

7-11-69: Page 112 – Fire at K2 – I glove burned also line 18 was pressurized causing crit drain to overflow decontamination not completed on this shift

7-30-69: Page 125 – 2300 hrs an oxide fire in the 776-771 tunnel a separate special report will be written.

7-31-69: Page 126 – Held over – [Name] – [Name] – [Name] 4 hrs to help with decontaminating personnel and eqpt from fire in tunnel.

7-31-69: Page 126 – Decontaminated entire shift. Several personnel sent to medical for decontamination – to my knowledge no forms were made out.

8-3-69: Page 128 – All the oxide has been removed from the tunnel and stored for burning as they get to it.

RFP Logbook 8-13-69 to 8-28-69 (RFP 1969b)

8-15-69: Page 5 – Scrubber floor in 154A. HP reports it is still hot. A roll-a-round ladder and a tool box washed. Ladder won’t come clean, 20K smear, and will probably need painted or discarded. The metal box was not checked.

8-15-69: Page 6 – Worked 8 men in 154A using ten scrubbers and two pickups. Hot spot of 30K just south of pit and near east wall. Also 30K west side of seam that divides the south section of the room. We had monitor check every single bucket in the vault and all hot spots were cleaned. All hot spots other than the floor as reported by the day shift were cleaned. In the vault, the floor is mostly 1–2K. A 4K hot spot was found on the north end of the second isle from the west end of the vault. The south end of the 3rd isle had a 4K spot. The 4th aisle was not checked. We could have a problem with the large scrubber having a contaminated brush. All ladders and other misc. equipment were bagged up and removed from the room.

8-16-69: Page 6 – Scrubbed floor in 154A. Readings up to 50K. Column House into 100K

8-16-69: Page 6 – Cleaned in 154A. We used 409 with a vacuum pickup. We got new scrub brushes from supply and scrubbed the 409 (NOT) using the scrubbers (buffers) because they get hot too rapidly and re-contaminate. Using the pickup, we had 4 men dry down the floor quickly with chem.-wipes before the floor had a chance to air dry. This technique cleaned up spots of order 10K and we got the vault area and northwest corner down to 500 to 2000 c/m. Since the floor has been scrubbed four times by jump shift, we got permission to paper. We covered the vault and the northwest corner of 154A with brown papers. We covered the containers in the vault with new plastic bags.

Hammond Logbook 9/19/65–5/14/69 (Hammond 1965)

Primarily compilation of attendance lists, vacation status, training and meetings, personnel issues, etc.

776 Building Logbook [May 26 1969 June 16 1969] (RFP 1969c)

No entries pertinent to data integrity, dosimetry, other radionuclides or secondary dosimetry reading were found. This is a narrative log that discusses shift and work starts and decontamination and cleanup instructions. No contamination levels or decontamination levels are recorded or discussed. No personnel dosimeter issues or exposure levels, in vivo, in vitro bioassay results are noted.

Page 69: 6-4-69 – Do NOT use tri-sodium phosphate granules as cleaning agent.

Page 70: 6-5-69 – Sodium bi-sulfate – two pounds per bucket of H_2O. Scrub with brush, rinse off and dry.

Page 78: 6-12-69 – Health Physics should outline a strict procedure on how to handle the face masks, hoses and waste …out in the compressor room. When 5 or more masks are thrown in a bag together it's next to impossible to get them clean. If the straps and hose are kept out of the inside of the mask there would not be a problem.

Page 82: 6-13-69 – Floors in S4 is OK to paint ASAP. This has been a hot spot – so let's get at it. We took all the insulation down from ducts and it was very hot. In checking the filter screen, we found that about 1/3 of them were hot. I think it would pay us to have a monitor check each one after the filter material is removed.

Page 85: 6-14-69 – We worked in full face masks all night (9 men). We could not keep up washing, decontaminating and drying filters because they were checked often and found to be cold.

Page 86: 6-15-69 – Still think everyone removing insulation should break off all fasteners. Somebody will be getting hurt if we don't.

RFP Logbook 6/16/69–8/28/69
Special Decontamination Crew Summer 1969 Fire (RFP 1969d)

7-4-69: Page 60 – it seems that in some places it is hotter in the cold areas than in the hot areas.

RFP Logbook 9/4/69 – 3/3/70 (Foreman's HP Log Bldg 771) (RFP 1969e)

Page 57: 11-12-69 – Talked to [Name] and [Name] about the ten barrels of ingots that are being stored at Line 21. Also in the area was a ten gallon can containing sweepings and metal and carts of material awaiting processing. The barrels contain about 100 kg of ingots from nuclear safety and they read to 6.5 mrem neutrons and 9 mR/hr gamma at the surface. Ten gallon container to 7 mR/hr at surface. Average background in the area at 7 to 8 mR/hr. It was agreed to move the barrels into the 148 Fluorinator Rm. and make this Rm. a limited access area. It was recommended that other material brought into the area be shielded and that only one cart of material at a time be brought into the area.

Page 58: 11-13-69 – High Radiation Area around Line 8 has signs posted. [Name] advised of this situation and copy of gamma-neutron survey at this location given to prod. supervision.

1-23-70: Page 111 – There are five carts of parts stored on the south side of Rm. 141. Gamma to 80 mR/hr and neutrons to 9 mrem. Storage south of Line 21 – several containers to 10 mR/hr. Informed [Name] and hung radiation tags on the carts.

2-16-70: Page 135 – A radiation hazard sign was posted on the door to Rm 141. Outside surface of glass to 12 mr/hr. In the doorway with the door open reads to 90 mR/hr and 29 mrem. I'm sure it's much higher inside vault. There is a lot of green liquid on the floor.

RFP Logbook_Sept _11_1969_Dec_26_1969 (RFP 1969f)

Page 3: 9-16-69 – Try having decon workers carry hand monitor for assembly area boxes (1~2) to check for contamination as they work.

Page 19: 10-14-69 – Cigarettes and matches were found in the clothing cabinet. These items should not be in the area.

Page 21: 10-21-69 – Started using full-face masks after lunch today.

Page 23: 10-27-69 – The gamma bdg. limit is 0.5 for boxes and *[illegible]*. The best way we have of staying below these limits is to be sure that all material steamed and foamed… before boxing or handling it. It is possible the boxes will have to be returned and repacked in *[illegible]* for counting if the box reading is more than the 0.5 allowed.

Page 26: 11-14-69 – A prime concern of the decon operation is to keep contamination from getting outside the operating area. Therefore nailing of the boxes is important. 1. Apply glue thoroughly 2. Nail lid sufficiently to seal 3. box can be removed from the bldg. for the carpenter for nailing or strapping. The boxes should never be removed from the building. Be sure all foremen get this word.

Page 28: 11-6-69 – No smoking on the dock.

Page 29: 11-9-69 – Please clean and seal areas that are marked on the chart barricaded area – 50K to 100K spots.

Page 31: 11-13-69 – Be sure to check for classification in items that may be ready to box out.

Kittinger's Log Book No. IV (1/2/69 – 3/28/72) (Kittinger 1969)

1/22/69: Page 6 – Considerable number of people eating in 76 & 77 locker rooms. Need to re-examine our position on this policy. Practice of eating at break muddles our position.

4/3/69: Page 30 – High gamma ct from 2 dreams in 774 produced high personnel exposure during last film badge period 3/13–3/27.

Asked [Name] to investigate – drums were:

Neutron	Gamma
5 mrem	1,000 mR
4 mrem	1,000 mR
1.5 mrem	500 mR

5/11/69: Page 42 – 776 Fire

1/6/69: Page 89 – Informed [Name] there is some concern in 771 about lack of neutron film in some badges – also about monitors concern (especially [Name]) that infor. is being generated for job eval. purposes by I.E. study.

2/5/70: Page 96 – I am concerned about possibility of accidental exposure from x-ray diffraction equipment. [Name] has consulted with [Name] about problems in 779. I asked him to write letter closing down two units in Rm 234 until satisfactory protection afforded. He has drafted a letter.

RFP Logbook 1-26-70 to 10-26-70 (Foreman Log) (RFP 1970a)

Page 24: 2-25-70 – [Name] and [Name] held over or 8 hours for gamma/neutron survey.

Page 39: 3-16-70 – Talked to [Name] about contaminated piping ductwork – general overhead of 777 checkout hallway. [Name] took smears up to 40K. [Name] will notify [Name] to decontaminate same.

Page 42: 3-20-70 – Called to Bldg 444 to investigate fire in collection box in basement – west of HP vac pump – check everything for both. Be --- and --- and could find none. Called in [Name] to complete operation.

Page 49: 4-1-70 – Informed [Name] (Captain Fire Command) to instruct his people about our rules in Bldg 776, 777, and 778 following incident with guard [Name] who was found in 77 without safety glasses, respirator, film badge and security badge – He said he would cooperate with HP.

Page 50: 4-2-70 – Very exciting evening. Heat detector alarms in Rm. 154 went off twice during shift. Screwy situation occurred in 559 concerning outside emergency lights. Will discuss this incident with [Name] when I come in 4-7-70. [Name] jumped off foundry dock and injured his left foot.

Page 52: 4-6-70 – Much discussion about the lack of monitor coverage in the south machining decon area. Had 4 decon monitors for area to take care of decon crews. Maintenance wanted for window chargers and [Name] wanted it for glove changers. Hard to Cover.

Page 79: 5-12-70 – Sheet metal dropped duct in 5-5 causing quite a release of contamination up to 500K – scrubbed but needs rechecked.

Page 87: 5-21-70 – Still having problems with monitor coverage for maintenance holding over for 4 hours. Two jobs turned in and no prior arrangements were made. Let's get this straightened out once and for all.

Page 112: 6-23-70 – Contamination on the North furnaces coming from the control panels and not from the fire area.

RFP Logbook 9-2-70 to 12-24-71 (Foreman's Log) (RFP 1970b)

Page 1: 9-21-70 – Spent part of this shift decontaminating Line 17. Not having much success. Should be completely surveyed.

Page 2: 9-22-70 – Decontaminated around Line 45 all night. Incident occurred at the end of PM shift. While checking for source of contamination, located 3 windows that were possibly leaking, #1, #25 and #28. Also located 8 gloves that were rotten on the back of box. Area is still on resp. and needs more decontaminating.

At the beginning of the shift [Name] and I toured the production areas. There were an unnecessary number of drums that were stored at S. end of 149. These drums are contributing to possible radiation exposures. Approximately 12 of the drums (about ½) were all monitored ready for barrel count. [Name] started moving them over to barrel count. Suggest [Name] be informed of this condition.

Incident report written on these (2) incidents and also on leaking flange behind Line 34.

Page 9: 9-30-70 – PM left word that a number of gloves had holes on the south side of Line 41. We found contamination on the sides of the box 50K, on a spot check, the paint in the area had been stripped. In order to decontaminate this area, I feel we should have the floor painted and covered to avoid contaminating the bare concrete floor.

Page 10: 10-1-70 – Incident at Line 5 greeted us at 2330. See Report. Kept having contamination problems around Line 3 most of shift. Thorough survey made and found several windows with yellow or lead tape on bottom hold down strip. All windows under tape smear 40K or more. Talked with [Name] about the condition, suggested that the windows be changed. Also found quite a few rotten gloves on backside with liquid in them.

Page 10: 10-1-70 – PM [Name] and [Name] found a 55 gallon drum in Rm. 162 giving off 100 mr/hr. It is tagged as empty 1 gallon cans – 2-16-70. Looks like plastic cartons with sludge in them.

Page 12: 10-3-70 – Gasket was changed in duct by Line 3. Floor has been cleaned a number of times but still comes up hot (3–5K). Floor was painted on mid-shift. I feel the contamination is coming up through the paint. They are scrubbing area one more time before end of shift.

Page 15: 10-6-70 – Found 500K c/m behind shield on Line #2 at bag out. Shielding was taken off and decon begun.

A seam is leaking behind Line #3. It is smearing 10^6. Floor is also smearing 10^6.

Page 15: 10-6-70 – [Name] came down as steward for [Name] grievance for ½ hours pay for monitors working directly with decon people.

Page 16: 10-6-70 – Gamma-neutron survey taken around fluoride volatility line as requested by R&H.

Page 19: 10-10-70 – Decontaminating Rm.11A all shift due to MR6 spill at mist tank area. Contamination now confined to immediate area. Strippable paint was put down after several washings to prevent contamination from spreading again.

Page 23: 10-13-70 – Still having problems with Line 17 airlock. Shielding should be removed and airlock decontaminated.

Page 24: 10-14-70 – Area around Line #2 was decontaminated. The area inside plastic pan was cocooned but not stripped because it was not dry. Respirator area covers Lines 1, 2 and 3. CAMs holding steady – 15–20K on cocoon and spots to 800K.

Page 31: 10-20-70 – It has been two weeks since the H&G valve leak by Line 14 occurred and no efforts are being made to clean this area. Looks like we are going back to pre-strike attitudes by Production (Cover it up with plastic and forget it).

Page 31: 10-20-70 – Found a cart with (4) bags cut out of Line #30 at the North end of the line. The gamma radiation runs from 20 mr/hr to 100 mr/hr. We put a No loiter – High Radiation Area sign on the cart.

Page 42: 10-3-70 – It's been 3 weeks since the H-G valve incident had occurred behind Line #14 and no further decontamination activity efforts have been made since the area was covered with plastic and cocooned. Discussed the hand carrying of high gamma FR waste from 114 storage to Line #4 with [Name] and [Name]. Advised them to either cart the material over to Line #4. Operators wore lead aprons or shut the operation down.

Page 43 10-31-70 – Line #3 seam is leaking – It was checked and it's reading 500K c/m. Line was not decontaminated on days.

Page 52: 11-9-70 – Toured the area at the beginning of the shift and the place is back where we were prior to the strike – contaminated be covered over with plastic or cocoon and the general area housecleaning is poor.

Page 61: 11-19-70 – Talked with [Name] and showed him gamma and neutron exposure problems in the area of Lines 15, 46, 47, and 48. Such things as badged items lying on the floor during cutting operation (to 50mr/hr) Luc TE cart shielded cart with FR sludge in the pots, dirt fluoride laying on the floor and covered up with lead aprons. Apparently have some confused people around. We'll cover this subject at their re-indoctrination that is coming up.

Back side of line 3 is hot – evidence of someone surveying and marking trouble spots, but area was not posted for respirators and contaminated floor.

Page 79: 12-4-70 AM – Another big spill at line 14 just about the time the vac trap leak at Line 13 was near completion on cleanup. Condensate return line sprung a leak and recontaminated entire area; air samples A-10, A-11, A-122, A-13 and A-14. Made specials. A-14 was 80,000 c/m. Only good thing, this shift was that everyone in the area was on respirators. Still working on the prior mess when this happened.

Page 124: Asked [Name] to rotate his people on barrel splitting for exposure control – he agreed to do it.

Page 126: 1-21-71 – Note- this is a must – refers to 1-7-71 Memoranda – Effective today, all respirators having 771 for laundry will be monitored and bagged separately. Hot from cold – all bags will be properly identified as the activity of the contents – Signed [Name]. (All shifts – each shift).

Page 128: 1-22-71 – High gamma problem exists on and around east side of Line 40 – Survey shows that exposure is great on west side when operator is working through gloves – most gloves are 30 ml PG – suggest that entire box go to 50 ml PG – Walkway on east side of box as high as 10 mrem, west side walkway 2.5 mrem. Posted east walkway.

Page 134: 1-28-71 – [Name] and [Name] – I could not find a incident report on the vac line leak atline #7. Deconed in area; all shift – leak was repaired at 2200 hrs, overhead in front of line deconed by end of shift.

No incident report on line 14 either – besides what was indicated on the map; we found a leaking window and approximately 40 sq ft. of the box to 50,000 c/m cleaned up by 2230 hours and window strip is taped with lead tape. Production supervisor promised to get it changed right away. This leak was the source of all contamination there.

Page 136: 1-30-71 PM shift [Name]. Stirpped the cocoon at the south end of tunnel. Count was reduced to 50,000 c/m direct and 1,000 c/m smear on the bare concrete. Epoxy was applied.

RFP Logbook 2/15/71 to 7/23/71 (Kittinger 1971)

Page 3: 2-10-71 – Decon on Line Complete. Floor needs to be stripped + painted. Floor is 500 c/m smear plus 50K c/m.

2/23/71: Page 9 – Line 32 incident due to a glove port leaking and contaminating approximately 100 ft of floor to 10K. The glove port was tightened and decontaminated. They also put epoxy around the gasket. Window should be replaced. Decon complete at 0315.

2/23/71: Page 9 – Bag failure on Line 2 East end. Contamination to the floor in the immediate area >104. Walking on all sides of line 2 contaminated due to tracking.

Page 11: 2-4-71 – Contamination released from bag cut at line 15 about $4ft^2$ of floor. Decon completed.

Page 11: 2-4-71 – Floor area on the West end of line 4 to 2K c/m. Pen which is around site gauge at 40K c/m outside perimeter. Respiratory area in all of West half of room and in flowmeter room.

Page 11: 2-4-71 – [Name] – B-36 <1000% RCG.2000 c/m.

Page 11: 2-4-71 – Maintenance job completed on line 11. Area has been deconed.

Page 12: 2-25-71 – [Name]. B-36 141 Nash pump vault 1175% RCG 3000 c/m.

Page 12: 2-25 -71 – Incident on line 38 – decon completed. Incident on line 20 – decon not completed. The east end of line 32 started leaking in several places. A pen was build around the east end.

Page 12: 2-26-71 – Deconed on line 20.

Page 13: 2-26-71 – [Name] 141 Mash pump vault 8000% RCG 20,000 c/m.

Page 13: 2-26-71 – Plastic house at line 32 should be checked each shift to ensure contamination from leaks is not moving and that respirator area is sufficient.

Page 13: 2-27-71 – 114 Fluorinator back side on respirators – Front decon complete.
148 Fluorinator decon complete 0200.

Page 15: 3-1-71 – Contamination to the Main Hall and Rm 114. Smith West area from line 14 south and west part of line 2. Due to liquid in a glove at line 4. Contamination spread due to tracking.

Deconed on line 17
Deconed on line 18
Deconed on line 32
Deconed on line 4

Page 16: 3-2-71 – Decon of area from line 4 incident (5-1-71) completed at 0200. Decon of 148 fluorimeter completed at 0315.

Page 17: 3-3-71 – Decon of 148 fluorimeter complete at 0100

Page 18: 3-3-71 – B36 Nash pump vault 2800% RCG 7000 c/m

Page 19: 3-4-71 – Back side of line 3 south end contaminated to 30K c/m. Contamination was spread due to tracking to the walkway on the north side.

148 fluorimeter in walkway around box is leaking at side of box and floor – is contaminated to 20K… Shielding should be removed and a complete survey should be done on the box, and overhead. Area is on respirators.

Page 19: 3-5-71 – Decon of line 13 & 14 (PM incident) Floor contaminated to 200K c/m and shielding contaminated in the air lining. Had them remove the shielding and decon – also had some windows leaking 100K c/m.

Line 3 contaminated due to bag leak. Floor on back side and front side of North was decontaminated. Shielding at back side of North end 70K c/m. Area on respirators. Decon completed at 0700.

Page 24: 3-10-71 – We had a spill on 4 line when [Name] pulled off his glove. The ladder he was standing on slipped and he fell back pulling off his glove. Floor box and ladder 100K c/m. Area deconed except for floor directly under glove – this has been cordoned.

Page 25: 3-11-71 – Contamination around line 37 due to barrel dump. Contaminated dust was released to the atmosphere due to lack of flow on the Down Draft. Top of box, overhead pipes and floor contaminated to 10K. Decon completed at 0315. Exhaust system from the Down Draft should be checked.
B36 141 Nash Pump Vault 3100% RCG 4000 c/m.

Page 27: 3-1-71 – Line 30 decontaminated at 0300. A dog was placed around the elbow and coupling. The floor below was leading into 60K…the elbow did not appear to be leaking, however a periodic check should be made.

Page 28: 3-14-71 – Many values and flanges were found to be leaking, in addition to the one on Tank 467. They should all be repaired before coming off respirators.

RFP Foreman Log 1/7/71 – 8/18/75 (RFP 1971a)

Page 1: 1-12-71 – Workers argued that they were not put in respirators when contamination alarms sounded while striping paint when decontamination shielding and floor in Rm. 114.

Page 23: 3-8-74 – Talked with [Name] about not leaving his maintenance people without monitor coverage during his breaks and lunch.

RFP Log July 24, 1971 to Jan 9, 1972 (RFP 1971b)

Page 105: 11/5/71 – Shipped Pu-238 to 776 from [Name] R & D. Mat'l read 148.6 n + 22.0 gamma at surface. of inner container and 3.2 gamma + 35.7 n at surface. of shipping container, and 0.4 gamma + 4.4 n at three feet from the container. [Name].

RFP Logbook 10/16/72 to 3/25/73 (RFP 1972)

1-9-73, Page 91 – As of the meeting today, in 776, send no air samples of any kind to 776 that are > 5000 c/m. We all know that the only way we can be sure is to check all the A + B routes, Incinerator, Buster III and any area of which we have had suspect – [Name].

RFP Logbook 8/30/73 to 3/19/74 (RFP 1973)

12-3-1973: Page 79 – Special study started on CAMs vs Radeco in 149 and 114. If CAM or Radeco alarm at location A5, A6 A10, B21 or B25 please change both samples and make specials out of both samples. The sampler in the Radeco is our routine sampler. Now the Air Hero is discontinued.

1-18-74: Page 117 – Contamination of unknown origin ([Name] exposure incident) at 500 series tank has been checked periodically and still no signs of leaks. Keep a close check on this area.

2-5-74: Page 133 – High neutrons in BBD area caused from fluorides being stored in Line 19 near "W" box. 1 count from surface of box (window #12) 50.0 to 90.0 mr/hr neutrons – 152G way – to 18 mr/hr neutrons. Area put on radiation zones.

2-15-74: Page 142 – Small incident at Line 45 (3 sq. ft. floor 100 K/s) No report. Incident on Line 41 (airlock operations).

2-20-74: Page 146 – The support duct running from 147 to the 141 vault is open now. Under no circumstances should the hallway door to the 141 vault opened. It could create a pressurized condition and could contaminate 147 again.

RFP Logbook 3/20/74–9/23/74 (RFP 1974)

Page 31: 8/14/74 – Incident Line 17 one possible inhalation. Glove failure.

Page 38: 8-7-74 – Air hoods, B16, B17, B-32 have been hot for a week. We surveyed the area and found many contamination areas. 300K under Line A. put on respirators. See map for problem areas.

Page 45: 7-29-74 – Lines 13, 14, 15, 16, 17, 8, 9, 10, 11, 12 put on respirators due to underline contamination found on the underline survey, unable to decon it on PMs.

Page 58: 7/11/74 – Incident on Line 24 – See report.

Page 73: 6-17-74 – Liquid spill in Line 1. Very high gamma readings. People cleaning will receive very high hand exposures.

Contamination Control Logbook_1982_1985 (5/28/81–7/8/85) (Passmore 1982)

3-3-83: Page 50 – Chip problem 444 – Booties create more problem than solving.

RFP Logbook Contamination Control Logbook Nov 1985 to March 1986 (RFP 1985)

No entries pertinent to data integrity, dosimetry, other radionuclides or secondary dosimetry reading were found. This is a Foreman's logbook recording unusual findings and actions taken. Entries discuss respirator use, leaks, smears taken, PPE needs, contamination events with c/m levels found. Entries are sketchy and most log pages are only one-half full with most being 1–3 lines per entry. No personnel dosimeter issues or exposure levels, in vivo, in vitro bioassay results are noted.

RFP Logbook Inspection Log May 1997 to Jan 1998 (RFP 1997)

No entries pertinent to data integrity, dosimetry, other radionuclides or secondary dosimetry reading were found. This logbook documents inspections done on a daily/shift basis. The inspections include: leaks or drips, alarms, sump levels, pipe cuts, pump inspections, inspection of the Mound site, pumping operations, tank inspections, and inspections of the Building 903A and 903B areas for leaks or drips. Log entries are 3–8 lines in length and most pages are nearly full. No contamination levels or decontamination levels are recorded or discussed. No personnel dosimeter issues or exposure levels, in vivo, in vitro bioassay results are noted.

Individual specific data was not found in the following logbooks.

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RFP (Rocky Flats Plant) 1968b, *RFP Logbook 7/8/68–2/4/69,* Dow Chemical Company, Golden, Colorado.

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ATTACHMENT 6: REVIEW OF EXTERNAL DOSE FOR 32 CASES OF RANDOMLY SAMPLED WORKERS AND 20 CASES OF WORKERS WITH HIGH CUMULATIVE EXPOSURES

This attachment contains the following tables.

Randomly Selected Workers:

Table 6-1: Data Compilation for a Random Sample of 32 RFP Worker Cases
Table 6-2: First Period Data for Random Sample of External Dose for 32 RFP Workers
Table 6-3: Cumulative Analysis of an External Dose Random Sample for 32 RFP Workers

Workers with High Cumulative Exposures

Table 6-4: Group 3 and 4 of the 20 Cases of Highly Exposed RFP Workers, External Dose
Table 6-5: 1950 Data for the 20 Cases of Highly Exposed RFP Workers, External Dose
Table 6-6: Review of Internal Dose for 20 Highly Exposed RFP Workers

Table 6-1: Data Compilation for a Random Sample of 32 RFP Worker Cases

32 cases random sample of RFP workers' DOE files reviewed for % of badging

ID #	Emp. Start	Emp. End	During 1952-1963				During 1964-1992				Notes
			emp. # years	# of years badged	# of years not badged	% of years badged	emp. # years	# of years	# of years not badged	% of years badged	
1	80s	90s					10	9	1	90%	Gap: 1990
2	50s	60s	4.5	3.5	1.0	78%	2	2	0	100%	Gap: 1963
3	50s	50s	2	1.5	0.5	75%					Gap: 1952
4	80s	90s					8.5	8.5	0	100%	
5	70s	90s					15.5	15	1	94%	Gap: 1992. (See note #1 for 1991.)
6	80s	90s					6	6	0	100%	
7	50s	90s	7.5	7.5	0.0	100%	28	26	2	93%	Gap: 1981 and 1982
8	60s	70s	1	1.0	0.0	100%	8	8	0	100%	
9	60s	80s					18	17	1	94%	Gap: 1969 (see note #2 & #3 for 1965.)
10	50s	60s	7	7.0	0.0	100%	6	5	?	83%	Gap: part of 1969 (see note #2).
11	70s	90s					22	22	0	100%	Gap: Nov & Dec of starting year, 1970
12	60s	90s					22	9.5	12.5	43%	Gap: 1969-72 & 75-83. Dose 1969-73 -1973.
13	80s	90s					8.5	8.5	0	100%	
14	90s	90s					2	2	0	100%	See note #4 below.
15	50s	70s	12	12.0	0.0	100%	10.5	10	?	95%	Gap: part of 1969 (see note #2).
16	80s	90s					10.5	9.5	1	90%	Gap: 1992
17	60s	80s	2.5	2.5	0.0	100%	18	17	?	94%	Gap: 1969 (see note #2).
18	50s	70s	7.5	7.5	0.0	100%	7.5	7.5	0	100%	
19	50s	60s	7.5	7.0	0.5	93%	4.5	4.5	0	100%	Gap: 1956
20	60s	80s	4	4.0	0.0	100%	24.5	25	0	100%	
21	70s	70s					4	4	0	100%	
22	60s	70s					10	3.5	6.5	35%	Gap: 1968-73, 77

Table 6-1: Data Compilation for a Random Sample of 32 RFP Worker Cases

32 cases random sample of RFP workers' DOE files reviewed for % of badging											
			During 1952-1963				During 1964-1992				
ID #	**Emp. Start**	**Emp. End**	**emp. # years**	**# of years badged**	**# of years not badged**	**% of years badged**	**emp. # years**	**# of years**	**# of years not badged**	**% of years badged**	**Notes**
23	60s	90s	0.5	0.0	0.5	0%	27	17	10	63%	Gap: 1963, 64-73
24	80s	90s					5.5	4.5	1	82%	Gap: 1992
25	60s	70s					6	6	0	100%	
26	80s	80s					3	3	0	100%	
27	50s	70s	5	1.0	4.0	20%	9.5	8.5	?	89%	Gap: 1958-61, 63, 69 (see note #2).
28	60s	90s					22	22	0	100%	
29	80s	90s					11	11	0	100%	1991 badge read '92 & incl. w/ 1992 (22 mrem).
30	80s	90s					11	10	1	91%	Gap: 1992
31	50s	50s	5	1.0	4.0	20%					Gap: 1956-59
32	50s	90s	10.5	5.0	5.5	48%	27	27	0	100%	Gap: 1953-56, 57, 60 (see note #5).
		Total =	***76.5***	***60.5***	***16.0***		***368***	***328***	***37***		

#1 The Occup. Dose Reports show blanks for 1991; however, there are detail sheets for 1991 that show zero.
#2 The Occup. Dose Reports show blanks for 1969; however, there are detail sheets for 1969, some show blanks and some zeros.
#3 Pages 14, 15, & 22 show 50 mrem for 1965, which is before start of employment.
#4 P.1 of DOE file does not show employment for '76, '83, or '84; but there are external dose data sheets for those years (0, 0, & 8 mrem respectively).
#5 Doses for 1957 & 1958 switched on some data sheets in DOE file.

Table 6-2: First Period Data for Random Sample of External Dose for 32 RFP Workers

ID #	Emp. Start	Emp. End	During 1952-1963				Notes
			emp. # years	# of years	# of years not badged	% of years badged	
2	50s	60s	4.5	3.5	1.0	78%	Gap: 1963
3	50s	50s	2	1.5	0.5	75%	Gap: 1952
7	50s	90s	7.5	7.5	0.0	100%	
8	60	70s	1	1.0	0.0	100%	
10	50	60s	7	7.0	0.0	100%	
15	50	70s	12	12.0	0.0	100%	
17	60s	80s	2.5	2.5	0.0	100%	
18	50s	70s	7.5	7.5	0.0	100%	
19	50s	60s	7.5	7.0	0.5	93%	Gap: 1956
20	60s	80s	4	4.0	0.0	100%	
23	60s	90s	0.5	0.0	0.5	0%	Gap: 1963
27	50s	70s	5	1.0	4.0	20%	Gap: 1958-61, 63
31	50s	50s	5	1.0	4.0	20%	Gap: 1956-59
32	50s	90s	10.5	5.0	5.5	48%	Gap: 1953-56, 57, 60 (see note #1).
		Total =	***76.5***	***60.5***	***16.0***		
			Average =	**79%**			

Note 1: Doses for 1957 & 1958 switched on some data sheets in DOE file.

Table 6-2: First Period Data for Random Sample of External Dose for 32 RFP Workers

ID #	Emp. Start	Emp. End	During 1952-1959: 1st period emp. # years	# of years badged	# of years not badged	% of years badged	Notes
2	50s	60s	0.5	0.5	0.0	100%	
3	50s	50s	2	1.5	0.5	75%	Gap: 1952
7	50s	90s	3.5	3.5	0.0	100%	
10	50s	60s	3	3.0	0.0	100%	
15	50s	70s	8	8.0	0.0	100%	
18	50s	70s	3.5	3.5	0.0	100%	
19	50s	60s	3.5	3.0	0.5	86%	Gap: 1956
27	50s	70s	2	0.0	2.0	0%	Gap: 1958-59
31	50s	50s	3.5	1.0	2.5	29%	Gap: 1956-59
32	50s	90s	6.5	2.0	4.5	31%	Gap: 1953-56, 57
Total			**36**	**26**	**10**	**28%**	

Table 6-3: Cumulative Analysis of An External Dose Random Sample for 32 RFP Workers

Period	#of workers	# with gap of 1 yr or more (Notes 1 and 4)	% workers with gaps of 1 year or more (Notes 1 and 4)	Cumulative years employed	Cumulative gap -- years	% cumulative gap (Notes 1 and 4)
1951–1963	14	4	29%	76.5	16.0	21%
1964–1992	30	10 (Note 2)	33%	368	37.0 (Note 3)	10%

Notes:

1. First or last partial year gaps not counted in # with gap of one year or more. Partial year gaps are counted in cumulative gap column.
2. Of the 10 employees with gaps of one year or more in 1964–1992, four had gaps only in 1992.
3. 1969 gaps data may be for part of the year or the full year. 1969 data gaps are not counted as full year gaps in this compilation.
4. A gap is recorded for the year if there are no film badge or TLD data at all for that year. Zero entries are counted as positive indications of recorded data. Only blank records are included in the compilation of the gaps.

Table 6-4: Group 3 and 4 of the 20 Cases of Highly Exposed RFP Workers, External Dose

Review of 20 RFP highly exposed workers' DOE files for % of badging during 1952-1992												
				During 1952-1963					During 1964-1992			
ID #	Exp. cat.	Emp. Start	Emp. End	emp. # years	# of badged years	# of years not badged	% of time	% not badged	emp. # years	# of years	% of time	Notes
1	3	50s	90s	6	4	2.0	67%	33%	29	29	100%	
2	3	50s	80s	9.5	7	2.5	74%	26%	20	20	100%	1986=10 mrem?
3	3	50s	70s	9	4	5.0	44%	56%	14.5	14.5	100%	
4	3	60s	80s	2.5	2.5	0.0	100%	0%	19	19	100%	
5	3	50s	80s	8	8	0.0	100%	0%	24	24	100%	1989 & '90 =0 mrem?
6	3	50s	90s	5	4	1.0	80%	20%	30	30	100%	
7	3	50s	90s	6	6	0.0	100%	0%	34.5	34.5	100%	
8	3	50s	80s	9	6	3.0	67%	33%	21	21	100%	
9	3	50s	80s	8.5	4	4.5	47%	53%	24	24	100%	
10	3	50s	60s	11	6	5.0	55%	45%	5.5	5.5	100%	
11	4	50s	80s	7.5	7.5	0.0	100%	0%	21	21	100%	
12	4	50s	80s	7.5	7.5	0.0	100%	0%	25	23	92%	
13	4	50s	90s	7.5	6.5	1.0	87%	13%	29	29	100%	
14	4	50s	70s	9.5	9.5	0.0	100%	0%	11.5	11.5	100%	
15	4	50s	80s	6	5	1.0	83%	17%	19	19	100%	
16	4	50s	80s	10.5	8	2.5	76%	24%	22	22	100%	'88=0, '89=9 mrem, '90=0?
17	4	50s	70s	5.5	5.5	0.0	100%	0%	8	8	100%	
18	4	50s	50s	0.33	0	0.3		100%				This period non-
												Rocky Flats work.
												Not included in analysis
18		50s	80s	8	7	1.0	88%	13%	22	22	100%	
19	4	50s	60s	8	7.5	0.5	94%	6%				This period non-.
												Rocky Flats work
												Not included in analysis
19		60s	80s	2	1.5	0.5	75%	25%	24.5	24.5	100%	
20	4	60s	70s	4	4	0.0	100%	0%	14.5	14.5	100%	
	# of years rounded to the nearest 0.5 years											

Table 6-5: 1950 Data for the 20 Cases of Highly Exposed RFP Workers, External Dose

ID #	Exp. cat.	Emp. Start	Emp. End	emp. # years	# of badged years	# of years not badged	Comments	Notes on Job Type
1	3	50s	90s	1.5	0.0	1.5	all initial	gaps in data: Production B
2	3	50s	80s	5.5	3.0	2.5	all initial	gaps in data: Production B to 4-23-56. No gaps in Production C
3	3	50s	70s	4.5	0.0	4.5	all initial	gaps in data in 81 and QC lab. Lab specialist
5	3	50s	80s	4.5	4.5	0.0		service and Plant D and staring in 57 Depart 83
6	3	50s	90s	1.0	0.0	1.0	all initial	gaps in data in Production B
7	3	50s	90s	1.5	1.5	0.0		Production B
8	3	50s	80s	5.0	2.0	3.0	initial	gaps in data in Production B. Production B 55, C in 56, back to B in 2-57,
							plus 58, 59	
9	3	50s	80s	4.5	0.0	4.5	all initial	gaps in data in Production B
10	3	50s	60s	6.5	2.0	4.5	initial plus 58	Laborer operator janitor to 5-55, Produc C from 4-56, 57 to 8-59 military leave
11	4	50s	80s	3.5	3.5	0.0		Production D-77
12	4	50s	80s	3.5	3.5	0.0		Health Physics
13	4	50s	90s	3.5	2.5	1.0	1959	gaps in data, 1959, in Production B, other times in the 1950s, A and C
14	4	50s	70s	5.0	5.0	0.0		Production A until 4 1957, then C
15	4	50s	80s	1.5	0.5	1.0	1959	Production C initially and in 1959 Production B. Data gap in production B
16	4	50s	80s	6.5	4.0	2.5	all initial	Pipe shop during no monitoring
17	4	50s	70s	1.0	1.0	0.0		Production C
18	4	50s	80s	4.0	3.0	1.0	all initial	Production B and Depart 83 except for a 3 month period in 1959.
Total				**63**	**36**	**27.0**	**43%**	col. I: percent cumulative gap
Group 3				**34.5**		**21.5**	**62%**	col. I: percent cumulative gap
Group 4				**28.5**		**5.5**	**19%**	col. I: percent cumulative gap

Table 6-6: Review of Internal Dose for 20 Highly Exposed RFP Workers

Review of 20 RFP highly exposed workers' DOE files for Bioassays During 1952-1992

ID #	Exp. cat.	Emp. Start	Emp. End	During 1952-1963				During 1964-1992				Notes
				emp. # years	# of years	# of years w/o bio	% of time	emp. # years	# of years	# of years w/o bio	% of time	
1	3	50s	90s	6	6	0.0	100%	29	29	0.0	100%	
2	3	50s	80s	9.5	9.5	0.0	100%	20	20	0.0	100%	
3	3	50s	70s	9	9	0.0	100%	14.5	14.5	0.0	100%	
4	3	60s	80s	2.5	2.5	0.0	100%	19	19	0.0	100%	
5	3	50s	80s	8	8	0.0	100%	24	23	1.0	96%	Could not find 1987
6	3	50s	90s	5	5	0.0	100%	30	30	0.0	100%	
7	3	50s	90s	6	6	0.0	100%	34.5	34.5	0.0	100%	
8	3	50s	80s	9	9	0.0	100%	21	21	0.0	100%	
9	3	50s	80s	8.5	8.5	0.0	100%	24	24	0.0	100%	
10	3	50s	60s	11	10	1.0	91%	5.5	5.5	0.0	100%	Could not find 1953
11	4	50s	80s	7.5	7	0.5	93%	21	21	0.0	100%	Could not find 1956
12	4	50s	80s	7.5	7.5	0.0	100%	25	25	0.0	100%	
13	4	50s	90s	7.5	7.5	0.0	100%	29	29	0.0	100%	
14	4	50s	70s	9.5	9.5	0.0	100%	11.5	11.5	0.0	100%	
15	4	50s	80s	6	6	0.0	100%	19	19	0.0	100%	
16	4	50s	80s	10.5	10.5	0.0	100%	22	22	0.0	100%	
17	4	50s	70s	5.5	5.5	0.0	100%	8	8	0.0	100%	
18		50s	50s	0.33	0	0.3						Non Rocky Flats employment -not included in analysis
18	4	50s	80s	8	8	0.0	100%	22	22	0.0	100%	
19		50s	60s	8	8	0.0						Non Rocky Flats employment - not included in analysis
19	4	60s	80s	2	2	0.0	100%	24.5	24.5	0.0	100%	
20	4	60s	70s	4	4	0.0	100%	14.5	14.5	0.0	100%	

(# of years rounded off to nearest 0.5 years)
(The vast majority were urinalyses; a few years were from WBC.)

ATTACHMENT 7: NIOSH BADGING PRACTICES FOR PERSONNEL AT THE ROCKY FLATS PLANT

The following statement was originally interpreted to mean that all personnel were badged:

> *In 1964, we were able to incorporate the dosimetry badge with the security badge. This was an improvement from the standpoint of assuring the employee was indeed wearing a badge while working on the job.* (Putzier 1982, p. 2.)

Dosimeters were issued to personnel likely to be exposed:

> *All Q-cleared non-Dow personnel associated with construction projects, such as architect-engineers, engineering firms, contractors, etc., will be issued film badges when deemed necessary by* [Name]. (Mann 1967)

> *Film badges are issued to all contractor personnel who must enter areas where the exposure to x-rays, gamma rays, and neutrons is likely to exceed 10 percent of the guide value for occupational exposure.* (Owen 1968)

However, subcontractor personnel with low exposure potential may not have been issued a dosimeter:

> *6.15.1 Conditions where General Health Physics Surveillance is Not Required*
> *a. In areas where penetrating radiation levels are not likely to exceed an average of 0.2 mrem/hr., outside contractor personnel may be utilized. Film badges will not be provided under these conditions unless, on advice of Health Physics, badging is desired for assessing a possible criticality exposure.* (Putzier 1970, Section 5.1.7)

The badged population was expanded:

> *Health Physics is going to expand the film badge coverage of personnel on the plant site. At your earliest possible convenience, please give us a list of the people who comprise your pertinent organization: Rocky Flats Employees' Credit Union, Dow-Rocky Flats mail department, Szabo Food Services.* (Mann 1968)

As the site transitioned from film badges to TLDs, a combined badge incorporating a TLD was developed:

> *The new combined dosimetry-security badge arrived…,* (Falk 1971)

In 1974, all prime contractor and government personnel were badged:

> *Starting January 1974, we have issued all employees on plant site (Dow and AEC) a TLD dosimeter.* (Lagerquist 1974a)

> *Beginning July 1, 1974, we are implementing a new policy where everyone on plant site will wear a radiation dosimeter (TLD) badge at all times.* (Lagerquist 1974b)

Visitors that entered the controlled areas were badged:

> *There are five different kinds of visitors to the plant site. … Our TLD program currently handles these groups as follows…* (Lagerquist 1975)

However, there is no indication that the 1970 policy for subcontractors was changed.

This continued through 1990, at which time the policy was changed:

> *Specifically, effective January 1, 1991, dosimeters will not be distributed to everyone, and dosimeters will stay on plantsite.* (Jens 1990)

ORAU performed an analysis on 1046 RFP claimants. This analysis reflects a significant increase in the proportion of employees monitored in 1964 (from 75% to 93%) consistent with increased badging. The increase in 1974 (from 94% to 98%) is much more consistent with a "tightening-up" process.

References:

Falk 1971, Roger B. Falk, Status Report to John Mann, May 11, 1971.

Jens, J.P. 1990, J.P. Jens memo to All EG&G Employees, Contractors and Subcontractors, December 4, 1990.

Lagerquist, C.R. 1974a, C.R. Lagerquist memo to E. A. Putzier, February 22, 1974.

Lagerquist, C.R. 1974b, C.R. Lagerquist memo to all supervision, June 28, 1974.

Lagerquist, C.R. 1975, C.R. Lagerquist memo to E. A. Putzier, December 29, 1975.

Mann 1967, John Mann memo to R. H. Miller and C. H. Salisbury, July 20, 1967.

Mann 1968, John Mann memo to L. Finfrock, J. Seastone, and T. Wilhelm, November 22, 1968.

Owen 1968, J. B. Owen memo to C. H. Salisbury, December 10, 1968.

Putzier, E.A. 1970, "Health Physics Guide for Rocky Flats Division," first issued July 1961, reviewed January, 1967, and re-issued January, 1970.

Putzier, E.A., 1982, *The Past 30 Years at the Rocky Flats Plant*, Rockwell International, Golden, Colorado, November 1982.

ATTACHMENT 8: NIOSH RESPONSE ON QUALITY ASSURANCE/QUALITY CONTROL OF THE NEUTRON DOSE RECONSTRUCTION PROJECT DATABASE

Submitted by Brant Ulsh, NIOSH
October 4, 2006

Question:

Is NIOSH aware of any QA/QC or third party reviews that been done to validate the NDRP database? With ongoing concern over data reliability, we just wanted to verify whether this has been done.

Response:

While funding did not permit a third party QA/QC review of the Neutron Dose Reconstruction Project (NDRP) database, the ORAU Team is confident that the extensive internal QA/QC procedures employed adequately assured the quality of the data. These procedures are described below.

The overall process was regularly reviewed by the Scientific Advisory Committee that oversaw the Rocky Flats Neutron Dose Reconstruction Project, consisting of the following members: Dale Hankins, Dr. Henry Spitz, Dr. Bryce Breitenstien, Dr. James Ruttenber, Dr. Thomas Borak, Dr. Warren Galke, Jack Weaver, Dr. Kenneth Skrable, Dr. Terry Lynn Thomas, and Dr. Edward Gillette. In addition, the project included oversight from DOE/Rocky Flats and DOE/Headquarters officials.

QA/QC Procedures for Neutron Dose Reconstruction Project (from Joe Aldrich, NDRP)

Prior to data entry of any type, each and every data sheet retrieved was assigned its own unique ID number and filed in a manner by which it could be consistently filed, tracked, and inventoried. All records that were retained for the NDRP were controlled through the use of a chain-of-custody logbook.

Initially, an original data sheet was entered into electronic data fields within a database under what we defined as "condition of discovery." In other words, we did not attempt to modify or change any data, names, badge numbers, issue/return dates, etc.

Data entry was performed following training to a work guidance instruction (procedure). Each project staff member who performed any task was required to read, sign, and be trained by an NDRP staff member prior to performing a task without direct supervision.

Daily QC of data entry was performed in this manner: An original data sheet (there were several types of data sheets electronically retained) was checked out of the storage file cabinet via the chain-of-custody logbook. The data entry person would then log into the NDRP database using passwords, and depending on the level of training and the task, the data entry personnel were restricted to certain sections of the NDRP database.

All data entry was performed one original data sheet at a time. Once all of the required data had been entered, the procedure required the data entry person to print out an electronic hard copy of this equivalent original data sheet. The electronic data sheets were formatted for ease of QC. The data entry person was then required to review and correct any errors they recognized to exactly match the original data sheet. If any corrections were made, then a second electronic hard copy data sheet was printed from the system. The final initial data entry electronic hard copy was dated and initialed by the first data entry person. The original data sheet was returned to the storage cabinet and logged back in through the chain-of-custody logbook. The electronically printed copy was then rotated (assigned) to a second data entry person. The second person would then retrieve the original data sheet via the log-out procedure, go into the NDRP database, and review the electronic data, the printed sheet, and the original data sheet for any discrepancies. If any errors were identified, the second data entry person would then make a correction in the database and print out another electronic hard copy, which was then attached to the first electronic hard copy. Once that was achieved, the second data entry person had to date and initial either the first electronic copy if there were no errors, or the second electronic copy to denote the initial errors and the corrections. Once this had been completed, the original data sheet was returned to the storage cabinet via the chain-of-custody procedure. The final electronic copy and/or the dual electronic copies were given to an NDRP staff member, who then reviewed performance of data entry personnel, proper documentation, and checked 10% of all data entries for accuracy and completeness. In summary, there were at least two full levels of routine QC on all data entry and a 10% QC check on error sheets and other data providing a third level of internal QC.

There were two other QC checks that occurred later in the project, but were not identified as such. In an effort to create timelines for each individual who had been assigned a dosimeter, it became apparent that extensive effort was required to ensure that the worker's name was spelled the same, their employee number was consistent, and that badge numbers were properly assigned to the correct worker for the correct wear periods. This is the point in which the NDRP final data is different than the original condition of discovery. During this process of creating timelines and calculating doses, a very few minor data entry errors were recognized and corrected. The second place where a very few minor data entry errors were discovered was during the statistical analysis and creation of the neutron-to-gamma ratios. When a neutron-to-gamma ratio and/or a gamma-to-neutron ratio were found to be greater than 10:1 or 1:10 respectfully, the original raw data was revisited for accuracy and corrected, if appropriate.

Through the duration of the project, there were three separate subcontracts for assistance with differing aspects. Dr. Thomas Borak and Sean Stanfield (NDRP) performed the initial effort to identify the viability of using neutron-to-gamma ratios in the absence of other data.

[Name] performed an onsite evaluation, wrote some initial guidelines, and assisted with implementation of processes comparable to DOELAP external dosimetry accreditation for film dosimetry. Dr. Phillip Chapman [NDRP] performed all of the statistical analysis and wrote all four statistical appendices to the NDRP protocol.

Samples of these initial data-capture processes have been retained in long-term storage at Oak Ridge, if needed.

ATTACHMENT 9: REVIEW OF NIOSH'S RFP EXTERNAL DOSE RECONSTRUCTION FOR HYPOTHETICAL CASES A, B, & C

<u>Case A</u> **Hypothetical Neutron Dose Assignment for Monitored Worker pre-1970**
Missed Dose Zeros Assigned for Blanks and Reported Zeros
ORAUT-OTIB-0050 Applied to Photons and Neutrons 1970–1976

Selection Criteria

- Hypothetical Radiation Monitor: worked from 1962 through 1989 in Buildings 771, 776, and 707, and was exposed to photons and neutrons.
- Neutron Dose Reconstruction Project (NDRP) dose evaluation available for the years pre-1971.
- Missed dose zeros were assigned for years prior to 1977 with blanks.
- ORAUT-OTIB-0050 was applied to the years 1970 through 1976 to calculate photon and neutron dose.

NOTE: Because assigned neutron doses for 1970–1976 are based on the applicable neutron-to-photon ratios, potential photon exposures have also been evaluated and included in the overall external dose estimate.

Cancer Description

Prostate (ICD-9 185)

Employment (Rocky Flats Plant)

Start: 1962
End: 1989

Approach

Likely non-compensable (i.e., < 50% POC)

Work History

NOCTS:	Radiation Monitor DOB: 1926, Diagnosis Date: 2000
Dosimetry Data:	NDRP neutron data through part of 1970, neutron dose data reported again from 1977 through end of employment, no neutron dose reported 1970–1976.

Data Summary

External		Reported Whole Body Dose[a]			Reconstructed Organ Dose		
Start (yr)	**End** (yr)	**Deep Total** (rem)	**Photons 30–250 keV** (rem)	**Neutrons All Energy** (rem)	**Deep Total** (rem)	**30–250 keV Photons** (rem)	**All Energy Neutrons** (rem)
1962	1989	26.768	12.699	14.069	53.972	20.279	33.693

a. Includes NDRP data (ORISE 2005), ORAUT-OTIB-0027, and ORAUT-OTIB-0050 de-convoluted data and post-1976 data.

Probability of Causation (POC)

Based on assumptions applied, 37.02%

SC&A's Evaluation

A number of issues raised by SC&A in their review of the external dose TBDs and OTIBs for RFP dose reconstruction are encountered in this dose reconstruction case as well. In addition, there are several areas where clarification is needed to determine claimant favorability.

(1) Single n/p value used for 1970–1976: The single n/p value recommended in ORAUT-OTIB-0050 (ORAUT 2005c) for 1970–1976 is the average n/p value of 0.42 derived from 1977–2000 dose data at the RFP. There are no adjustments provided for variations in n/p values for different work locations during 1970–1976. The only justification for selecting the 1977–2000 data is provided on page 8 of ORAUT-OTIB-0050, where it states that the NDRP project staff indicated that data for the period from 1977 to the present [2000] should be used to determine an n/p ratio for the period from 1970–1976. It has not been demonstrated that the operating conditions and resulting radiation fields were constant for all workers and locations during 1970–1976, or that they matched the period of 1977–2000. This is in contrast to the NDRP, which provides different n/p values for each year and different locations for 1952–1969 (ORAUT 2005b).

(2) Completeness of NDRP data for 1962–1969: SC&A found significant time gaps in the NDRP data during their recent review of the Department of Energy (DOE) files for 12 randomly selected RFP dose reconstruction cases. These time gaps were sometimes over a year, and in some cases even 5 years, in length and generally followed the photon film time gaps in the records. Because there are significant gaps in the photon film badge data, it is expected that there will be that many, or more, gaps in the neutron NTA films for the NDRP reread program. Therefore, assuming that there are complete NDRP data for 1962–1969 would not be realistic for some actual workers' cases.

(3) 102 photon vs. 85 neutron zeros: In this dose reconstruction case, why were there 102 dosimeter cycles where a zero was assigned for photons and only 85 for neutrons? Usually, if workers are only monitored for one radiation, they are more likely monitored for only photons rather than only neutrons. Rarely are they ever monitored only for neutrons. Additionally, the attachment labeled "External case #1, missed zeros.xls" lists

the photon actual zeros applied. The total of this column is 93, compared to 102 listed in the text; for neutrons it lists a total of 69 zeros compared to 85 listed in the text. Why is this?

(4) Zeros in dose of record: In this dose reconstruction case a potentially missed dose was assigned to each actual or potential dosimeter cycle where a zero was reported to provide a claimant-favorable estimate of the potential external doses received. If the dosimeter is actually worn for two periods and then read and recorded, the suggested procedure represents a claimant-favorable approach. However, there is no way to be certain that the badge was not lost, damaged, or unreturned if the dose of record shows No reading, No Current Data Available, or Zero and no other information concerning the data entry is in the worker's file. Assigning a missed dose based on LOD is not acceptable for lost, damaged, or unreturned badges as it in no way reflects the actual dose received. Assignment of dose based on adjacent readings is possible, if there are no incidents/accidents (such as fires) during the unmonitored periods to create abnormal exposures. This situation could lead to SEC issues unless documented evidence exists that correctly assigns dose during this period.

(5) Dose to organ dose conversion: Although it may be correct, it is not clear how the 30–250 keV photon reported WB dose of 12.699 rem + 3.443 rem maximum missed dose (16.142 rem total) is converted to 20.279 rem organ dose (prostate) using the maximum organ dose conversion factor (DCF) of 1.244 provided in the table in the dose reconstruction case (i.e., 16.142 rem x 1.244 = 20.081 rem). Likewise for neutrons, 14.069 rem + 8.811 rem = 22.880 rem vs. 33.693 rem organ dose using a maximum DCF of 1.361 (i.e., 22.880 x 1.361 = 31.140 rem).

These items are most likely not SEC issues (zero entries could be if proper information is not available), but they need to be addressed from a site profile basis to ensure claimant favorability.

Case B — Application of Glove Box Geometry Factor per OCAS-TIB-0010 and ORAUT-OTIB-0050 Applied to Photons and Neutrons 1970–1976

Selection Criteria

- Hypothetical Chemical Operator and QA Inspector: worked 1960 through 1989 in 771, 776, 777, 778, 707, 881, 991 and was exposed to photons, electrons, and neutrons.
- NDRP dose evaluation available for the years pre-1971.
- ORAUT-OTIB-0050 was applied to the years 1970 through 1976 to calculate photon and neutron dose.

Cancer Description

Prostate (ICD-9 185)

Employment (Rocky Flats Plant)

Start: 1960
End: 1989

Approach

Likely compensable (i.e., > 50% POC)

Work History

NOCTS: Chemical Operator and Inspector
DOB: 1922, Diagnosis Date: 1996

Dosimetry Data: Photon and/or penetrating dose data throughout employment. NDRP neutron data through part of 1970, neutron dose data reported again from 1977 through end of employment, no separate neutron dose reported 1970–1976.

Data Summary

External		Reported Whole Body Dose[a]			Reconstructed Organ Dose		
Start (yr)	End (yr)	Deep Total (rem)	Photons 30–250 keV (rem)	Neutrons All Energy (rem)	Deep Total (rem)	30–250 keV Photons (rem)	All Energy Neutrons (rem)
1960	1989	42.365	28.123	14.242	94.889	53.952	40.937

a. Includes NDRP data (ORISE 2005), ORAUT-OTIB-0027 and ORAUT-OTIB-0050 de-convoluted data and post-1976 data.

Probability of Causation (POC)

Based on assumptions applied, 59.03%

SC&A's Evaluation

This case is similar to case A, except it includes the use of gloveboxes. The same concerns (1–5) as stated in case A apply to this case also. Additionally, concerns with applying ORAUT-OCAS-TIB-0010 (OCAS 2005b) need to be addressed.

(1) Correction factor only applied to 8 out of 30 years: In the dose reconstruction of this case, it states that "The DOE dosimetry and the interview records indicate that the EE likely worked with plutonium in gloveboxes over his entire employment… The factors ranged from 1.90 to 16.2 (with no extremity dose reported for 1972) and provide additional confirmation that glovebox work was performed." However, in the same paragraph, it states "The glovebox correction factor was applied only to those years where the annual average factor exceeded 2.19 (the geometric mean correction factor from OCAS 2005b) and it was clear that he was working as a chemical operator in a

plutonium building." This included all years of employment from 1960 through 1969 except for 1961. It then states "The factor was not applied to later years even though the ratio data, dosimetry incident records and telephone interview would indicate glovebox use." This would indicate that this worker's dose was only corrected for working in a glovebox for 8 out of 30 years, although all records indicate that he worked most of the 30 years using a glovebox where his prostate would have received a higher dose than dosimeters located on the truck of the body. This would appear to underestimate the worker's dose and not be claimant favorable.

(2) Selected years not listed in OCAS-TIB-0010: The dose reconstruction case states "The photon correction factor of 2.19 for photons and neutrons was applied to the **selected years** as provided in the Technical Information Bulletin, OCAS-TIB-0010: *Special External Dose Reconstruction Considerations for Glovebox Workers*" [emphasis added]. A search of OCAS-TIB-0010 does not indicate any use of selected years. Could this be explained?

These items are most likely not SEC issues, but they need to be addressed from a site profile basis to ensure claimant favorability.

Case C **Coworker Unmonitored Dose Assigned per Draft ORAUT-OTIB-0058 Correction Factor for Lead Lined Apron Applied per Draft Rocky Flats Plant External TBD, Table 6-8**

Selection Criteria

- Hypothetical Research Engineer and Inspector: worked 1961 through 1982 in 707, 771, 776, 777, 991, and 881and was primarily exposed to photons and neutrons.
- Unmonitored for Two Years of Employment
- Utilized a Lead Apron During a Portion of Employment. Cancer not covered by apron, badge worn under apron.
- NDRP dose evaluation available for the monitored years pre-1971.

Cancer Description

Brain (ICD-9 Code 191.2)

Employment (Rocky Flats Plant)

Start: 1961
End: 1982

Approach

Likely non-compensable (i.e., < 50% POC)

Work History

NOCTS: Research Engineer, QA Inspector
DOB: 1916, Diagnosis Date: 2002

Dosimetry Data: No dosimetry data for 1968 and 1973. NDRP neutron data through part of 1970, neutron dose data reported again from 1977 through end of employment, no neutron dose reported 1971–1976. Photon dosimetry data for all years except unmonitored 1968 and 1973.

Data Summary

External		Reported Whole Body Dose[a]				Reconstructed Organ Dose[b]			
Start (yr)	End (yr)	Dose Total (rem)	Photons < 30 keV (rem)	Photons 30–250 keV (rem)	Neutrons All Energy (rem)	Dose Total (rem)	Photons < 30 keV (rem)	Photons 30–250 keV (rem)	Neutrons All Energy (rem)
1961	1982	4.470	0.178	2.419	1.873	33.214	0.395	19.343	13.476

a. Includes NDRP data (ORISE 2005), ORAUT-OTIB-0027, and ORAUT-OTIB-0050 de-convoluted data and post-1976 data, lead apron correction factors.
b. Includes in addition, maximized missed dose, unmonitored dose, DCF and ICRP multipliers and ORAUT-OTIB-0027 uncertainty correction factors.

Probability of Causation (POC)

Based on assumptions applied, POC = 26.07%

SC&A's Evaluation

This case is similar to case A, except it includes the use of lead aprons. The same concerns (1–5) as stated in case A apply to this case also. Additionally, concerns with correcting for the use of lead aprons need addressed.

(1) Small attenuation factor for low-energy photons: In the dose reconstruction of this case, it states that, "A correction factor of 1.15 was applied to the reported deep dose and a factor of 1.11 was applied to the reported shallow dose in accordance with Table 6-8 of Rev. 1-Draft A of ORAUT-TKBS-0011-6 (ORAUT 2006b). These correction factors appear very small in comparison to the attenuation of low-energy photon in Pb and to Pantex's reported (Passmore 1995) reduction of 57% in photon dose (57% would correspond to an average energy of approximately 175 keV as derived from data in GPO 1970, pg. 138). Photons below 40 keV are all essentially stopped by 0.45 mm of Pb. A brief summary of photon attenuation as derived from data in the Radiological Health Handbook (GPO 1970, pg. 138) is as follows:

keV	Attenuation	keV	Attenuation
<40	100%	400	11%
150	63%	600	6%
200	40%	700	5%
300	19%		

In contrast, a photon attenuation of 15% as used in this case would correspond to an average energy of approximately 350 keV, whereas the dose reconstructor assigned the photon energies to ≤250 keV.

SC&A agrees that adjustments for the wearing of Pb aprons can be made, but does not currently see where the small adjustment factor of 0%–15% is appropriate for a worker at the RFP. While this is not a SEC issue, it is of site profile dose reconstruction concern and could lead to underestimate of worker dose.

(2) Revised ORAUT-TKBS-0011-6: This dose reconstruction case refers to Table 6-8 in ORAUT-TKBS-0011-6, *Technical Basis Document for the Rocky Flats Plant – Occupational External Dosimetry, Rev 01-Draft A*, February 15, 2006. This new version of TBD-6 could not be found on the NIOSH/OCAS web site or the O-drive to verify the information used in the dose reconstruction. SC&A did find a Table 6-8 in the very recent release of Rev. 01 of ORAUT-TKBS-0011-6, February 8, 2007. This table lists bias correction factors for wearing a lead apron as 1 for shallow and deep photon doses for all cases, except when the badge was worn under the apron the correction factor is 1.2 for deep dose in unprotected areas only. If the values in this table are correct, the energy of the photons must have been relatively high (>600 keV) and therefore the apron was no use if it did not attenuate the photon dose received by the dosimeter (which is to represent the dose that the body received).

These items are most likely not SEC issues, but they need to be addressed from a site profile basis to ensure claimant favorability.

Summary

The above list of concerns was derived from analyzing the dose reconstruction cases to determine if the procedures were claimant favorable and reasonable. The details of each dose assigned for each dosimetry period were not feasible with the information and data sheets supplied. Therefore, the processes and accumulated doses were addressed to determine if they were claimant favorable.

DOSE RECONSTRUCTION EXAMPLE: CASE A

Hypothetical Neutron Dose Assignment for Monitored Worker Pre-1970
Missed Dose Zeros Assigned for Blanks and Reported Zeros
ORAUT-OTIB-0050 Applied to Photons and Neutrons 1970–1976

Selection Criteria

- Hypothetical Radiation Monitor: worked 1962 through 1989 in 771, 776, 707, and was exposed to photons and neutrons.
- NDRP dose evaluation available for the years pre-1971.
- Missed dose zeros were assigned for years prior to 1977 with blanks.
- ORAUT-OTIB-0050 was applied to the years 1970 through 1976 to calculate photon and neutron dose.

  NOTE: Because assigned neutron doses for 1970–1976 are based on the applicable n/p ratios, potential photon exposures have also been evaluated and included in the overall external dose estimate.

Cancer Description

Prostate (ICD-9 185)

Employment (Rocky Flats Plant)

Start: 1962
End: 1989

Approach

Likely non-compensable (i.e., < 50% POC)

Work History

NOCTS:	Radiation Monitor DOB: 1926, Diagnosis Date: 2000
Dosimetry Data:	NDRP neutron data through part of 1970, neutron dose data reported again from 1977 through end of employment, no neutron dose reported 1970–1976.

Data Summary

External		Reconstructed Organ Dose			Reported Whole Body Dose[a]		
Start (yr)	End (yr)	Deep Total (rem)	Photons 30–250 keV (rem)	Neutrons All Energy (rem)	Deep Total (rem)	(C1) 30–250 keV Photons (rem)	All Energy Neutrons (rem)
1962	1989	26.768	12.699	14.069	53.972	20.279	33.693

a. Includes NDRP data (ORISE 2005), ORAUT-OTIB-0027, and ORAUT-OTIB-0050 de-convoluted data and post-1976 data.

Probability of Causation (POC)

Based on assumptions applied, 37.02%

Narrative

The EE worked as a radiation monitor in Buildings 707, 771, 776, and 779 according to records provided by the Department of Labor (DOL), DOE, and the telephone interview. His primary exposure would have been to photons and neutrons with some potential for electrons. However, external electron radiation was not considered in this dose reconstruction, because it would not have added dose to the cancer site. In addition, the non-penetrating recorded dose was applied as <30 keV photons as appropriate for plutonium facilities. The external dose to the prostate and associated organ DCFs in this evaluation are based on those of the bladder presented in ORAUT-OTIB-0005 (ORAUT 2006a).

Radiation Type, Energy, and Exposure Geometry

The records supplied by the DOE and the interview process indicate the EE worked at various plutonium facilities, thus a plutonium facility spectra was chosen. The EE's exposure geometry was assumed to be consistent with the specific dosimetry parameters applicable to the RFP as described in the *Technical Basis Document for the Rocky Flats Plant – Occupational External Dosimetry,* ORAUT-TKBS-0011-6 (Langsted 2004). For determination of dose to the prostate, and to ensure claimant favorability, both 30–250 keV photon doses (based on the reported deep dose measurements) and <30 keV photon doses (based on the reported shallow dose measurements) have been applied.

In accordance with the NIOSH *External Dose Reconstruction Implementation Guideline*, OCAS-IG-001 (OCAS 2005a), DCFs appropriate for the era were used to calculate the dose to the prostate from exposure to photon and neutron radiation. This exposure assumes 100% anterior-posterior (AP) geometry. For photons and neutrons, a claimant-favorable organ DCF of 1 or greater was applied for all energy ranges except <30 keV photons. Plutonium-specific DCFs were used for <30 keV photons. In OCAS 2005a, organ DCFs are tabulated by averaging the energy specific values from ICRP 74 (1996) over the IREP photon energy range. The lowest photon energy interval in the Interactive RadioEpidemiological Program (IREP) is categorized as less than 30 keV. Plutonium emits several x-rays in this energy range; however, a simple average as used in the Implementation Guideline may not result in the most accurate DCF. For plutonium work, the average x-ray energy is approximately 17 keV. As a result, using the 20keV as a claimant-favorable single-point estimate is most appropriate. Since the low-energy photon dose to glovebox workers, laboratory technicians, maintenance workers, metallurgical operators, and D&D workers is predominately in the AP geometry (Langsted 2004), single-point estimate values using AP geometry were calculated for 16 organs listed in ICRP 74. Some workers (site support personnel, chemical operators when not working with gloveboxes, support personnel, radiation technicians) were estimated to have received varying amounts of non-AP dose (Langsted 2004). Since there is significant uncertainty in the individual exposure geometry and AP geometry is generally claimant favorable or neutral compared to other geometries for most cancers, an AP geometry is applied for all <30 keV photon exposures.

For neutrons, additional correction factors, which incorporate the energy range fractions and ICRP 60 correction factors, were applied in accordance with Langsted 2004. The Effective DCF is the result of multiplying all applicable factors together, and the reported and missed dose for photons and neutrons was multiplied by the Effective DCFs listed in the tables below.

Factors Used for External Dose Calculations (1962 to 1982)

	Photons		**Neutrons**			
Energy Range	<30keV	30–250keV	<10keV	10–100keV	100keV–2MeV	2–20MeV
Energy Fraction	100%	100%	—	—	—	—
ICRP 60 CF	N/A*	N/A*	0.0851	0.0342	1.3614	0.3271
Organ DCF	0.088	1.244	2.633	1.291	1.000	1.170
DCF $_{Effective}$	0.088	1.244	0.224	0.044	1.361	0.383

*Not applicable

Factors Used for External Dose Calculations (1983 to 1989)

	Photons		**Neutrons**			
Energy Range	<30keV	30–250keV	<10keV	10–100keV	100keV–2MeV	2–20MeV
Energy Fraction	100%	100%	—	—	—	—
ICRP 60 CF	N/A*	N/A*	0.0851	0.0342	1.3614	0.3271
Organ DCF	0.146	1.000	2.301	1.268	1.000	1.105
DCF $_{Effective}$	0.146	1.000	0.196	0.043	1.361	0.361

*Not applicable

To account for uncertainty in the dosimetry readings, additional factors appropriate for the era were applied to the reported photon dose (1962 through 1969) and neutron dose (1977 through 1989) from site-specific guidance provided in Table 4-2 of the *Technical Information Bulletin: Supplementary External Dose Information for Rocky Flats Plant* (ORAUT 2005a).

Neutron doses from 1962 through 1969 that were determined by the ORAUT 2005b were applied as a normal distribution with propagated error per guidance in the *Technical Information Bulletin: Use of Rocky Flats Neutron Dose Reconstruction Project Data in Dose Reconstructions*, ORAUT-OTIB-0050 (ORAUT 2005c). Neutron doses estimated for the era

1970 through 1976 were calculated using n/p ratios as directed in ORAUT 2005c and applied as lognormal distributions with a geometric standard deviation (GSD) of 3.

Prior to 1964, reported neutron dose resulting from neutrons below approximately 800 keV probably was not detected (Langsted 2004, ORAUT 2005a). Thus, all non-affected original neutron dose reported by the NDRP prior to 1964 was multiplied by an additional factor of 2.5 to correct for the potential unmonitored neutron bias.

Dosimeter Dose

Individual dosimeter results were used to reconstruct the EE's dose. Corrections to the reported doses were applied as described above. The dose from both 30–250 keV photons and <30 keV photons was estimated using algorithms from ORAUT 2005a. Claimant-favorable assumptions have been made for 1970, since it was a transition year between two different dosimeter types (Langsted 2004, ORAUT 2005a).

The NDRP re-evaluation of individual dosimetry data through 1970 provided complete detailed neutron dosimetry data through 1969 and was used as reported (ORAUT 2005b), per guidance in ORAUT 2005c. Neutron data for 1970 was not complete so n/p doses were estimated for the era 1970 through 1976 using neutron to photon ratios as directed in ORAUT 2005c.

Potential Missed External Dose

Because individual dosimeter results were not always available to reconstruct the EE's potential missed external dose for the period 1962–1976, an analysis of dosimeter results during the EE's employment period was used to assign potential missed photon and neutron doses for that period (Langsted 2004, ORAUT 2005a).

A potential missed dose was assigned to each actual or potential dosimeter cycle where a zero was reported to provide a claimant-favorable estimate of the potential external doses received by the EE. A missed dose represents the dose that could have been received but may not have been recorded due to the dosimeter detection limits or site reporting practices.

The total number of dosimeter cycles where a zero was assigned was 102 for photons. This number was determined using the methodology described as follows. The actual number of zeros found in the records was used for 1962 and 1963 as the dosimetry record was complete. The claimant-favorable estimate of photon zeros for the years 1964 through 1976 was equal to the maximum number of recorded or potential badge cycles minus the number of positive badge reports. The maximum number of badge cycles was estimated either by the maximum exchange frequency for this period as indicated in Table 6-2 (Langsted 2004), using a job title of radiation monitor, or the exchange frequency in the dosimetry reports, whichever was greater. The actual number of zeros present in the records was used for the years 1977 and forward, as all cycles were reported in that era (Langsted 2004). These numbers were chosen to ensure that a claimant-favorable estimate of zero badge reading was accounted for in this dose reconstruction. Based on limit of detection information provided in the Technical Basis Document for the Rocky Flats Plant (Langsted 2004), this results in a maximum potential missed dose for the EE of 3.443 rem from 30–250 keV photon radiation. All missed dose was assigned as 30–250 keV photons, as this is claimant favorable. Per the requirements of OCAS-IG-001 (OCAS 2005a), this value was/these values were used as the 95^{th} percentile of a lognormal distribution for the purpose of calculating probability of causation.

Missed neutron doses were also calculated. The number of zero dosimeter cycles applied was 85 for neutrons. The number of zeros for the years inclusive of 1969 was determined by direct inspection of the NDRP data present in the dosimetry records per discussions with RFP technical staff and guidance in the ORAUT-OTIB-0050 (ORAUT 2005c). The number of zeros for each of the years 1970 through 1976 was set equal to that found for the photon zeros since dosimeters of that era contained both photon and neutron sensing elements and were likely read at the same frequency. The actual number of zeros present in the dosimetry data for the years 1977 forward was used (Langsted 2004). Based on limit of detection information provided in ORAUT 2006b, this results in a maximum potential missed dose for the EE of 8.811 rem to the prostate from neutron radiation. Per the requirements of the OCAS-IG-001, this value was used as the 95^{th} percentile of a lognormal distribution for the purpose of calculating probability of causation.

Summary

The total assigned photon dose (20.279 rem) and neutron dose (33.693 rem) based on the approach described in this evaluation is considered a reasonable overestimate, erring on the side of claimant favorability for potential missed external dose, the application of DCFs of one or greater, and claimant-favorable estimates of uncertainty for photon doses and non-NDRP neutron doses other than 1970–1976. Specifically, the estimate of potential badge cycles reporting zero dose was overestimated and the estimate of neutron dose for the period of 1970–1976 [was an overestimate].

If the facts surrounding this dose reconstruction change (e.g., the date of diagnosis is modified, an additional covered cancer is diagnosed, or additional covered employment is identified), the efficiency measures used to reconstruct the dose may not be applicable. In this case, if the facts were to change, the dose reconstructed for the prostate could be lower than that reported using the efficiency process.

Note: The IREP input tables are available from SC&A or NIOSH for this case if needed.

DOSE RECONSTRUCTION EXAMPLE: EXTERNAL DOSE CASE B

Application of Glove Box Geometry Factor per ORAUT-OTIB-0010 ORAUT-OTIB-0050 Applied to Photons and Neutrons 1970–1976

Selection Criteria

- Hypothetical Chemical Operator and QA Inspector: worked 1960 through 1989 in 771, 776, 777, 778, 707, 881, 991 and was exposed to photons, electrons, and neutrons.
- NDRP dose evaluation available for the years pre-1971.
- ORAUT-OTIB-0050 was applied to the years 1970 through 1976 to calculate photon and neutron dose.

Cancer Description

Prostate (ICD-9 185)

Employment (Rocky Flats Plant)

Start: 1960
End: 1989

Approach

Likely compensable (i.e., > 50% POC)

Work History

NOCTS : Chemical Operator and Inspector
DOB: 1922, Diagnosis Date: 1996

Dosimetry Data: Photon and/or penetrating dose data throughout employment. NDRP neutron data through part of 1970, neutron dose data reported again from 1977 through end of employment, no separate neutron dose reported 1970–1976.

Data Summary

External		Reported Whole Body Dose[a]			Reconstructed Organ Dose		
Start	End	Deep Total	Photons 30–250 keV	Neutrons All Energy	Deep Total	30–250 keV Photons	All Energy Neutrons
(yr)	(yr)	(rem)	(rem)	(rem)	(rem)	(rem)	(rem)
1960	1989	42.365	28.123	14.242	94.889	53.952	40.937

a. Includes NDRP data (ORISE 2005), ORAUT-OTIB-0027 and ORAUT-OTIB-0050 de-convoluted data and post-1976 data.

Probability of Causation (POC)

Based on assumptions applied, 59.03%

Narrative

The EE worked as a chemical operator and inspector at various facilities within Rocky Flats, primarily in Buildings 771, 776, and 707, but also in 777, 778, and occasionally in 881 and 991. According to the interview records, the EE utilized gloveboxes both as an operator and when inspecting production parts. His primary exposure would have been to photons and neutrons. External electron radiation was not considered in this dose reconstruction because it would not have added dose to the cancer site. <30 keV photons were also not considered so as to minimize the dose estimate. The external dose to the prostate and associated organ DCFs in this evaluation are based on those of the bladder as a surrogate organ, as presented in ORAUT-OTIB-0005 (ORAUT 2006a).

Radiation Type, Energy, and Exposure Geometry

The records supplied by the DOE and the interview process indicate the EE worked at various plutonium facilities; thus a plutonium facility dose spectra was used in this dose reconstruction. The EE's exposure was assumed to be consistent with the specific dosimetry parameters applicable to the RFP, as described in accordance with OCAS-IG-001. DCFs appropriate for the era were used to calculate the dose to the prostate from exposure to photon and neutron radiation. This exposure assumes 100% AP geometry.

For neutrons, additional correction factors, which incorporate the energy range fractions, and ICRP 60 correction factors were applied in accordance with Langsted 2004. The Effective DCF is the result of multiplying all applicable factors together, and the reported and missed dose for photons and neutrons was multiplied by the Effective DCFs listed in the tables below.

Factors Used for Minimizing Pu Facility[a] (1960 to 1982)

	Photons		**Neutrons**			
Energy Range	**30–250keV**	**>250keV**	**<10keV**	**10–100keV**	**100keV–2MeV**	**2–20MeV**
Energy Fraction	85%	15%	—	—	—	—
ICRP 60 CF	N/A[b]	N/A[b]	0.0851	0.0342	1.3614	0.3271
Organ DCF	1.244	0.883	2.633	1.291	0.822	1.170
$DCF_{Effective}$	1.057	0.132	0.224	0.044	1.119	0.383

a. Maximum potential percentage of >250 keV photons used to minimize POC.
b. Not applicable

Factors Used for Minimizing Pu Facility[a] (1983 to 1989)

	Photons		Neutrons			
Energy Range	**30–250keV**	**>250keV**	**<10keV**	**10–100keV**	**100keV–2MeV**	**2–20MeV**
Energy Fraction	85%	15%	—	—	—	—
ICRP 60 CF	N/A[b]	N/A[b]	0.0851	0.0342	1.3614	0.3271
Organ DCF	0.873	0.913	2.301	1.268	0.796	1.105
$DCF_{Effective}$	0.742	0.137	0.196	0.043	1.084	0.361

a. Maximum potential percentage of >250 keV photons used to minimize POC.
b. Not applicable

Neutron doses prior to 1970 that were determined by ORAUT 2005b were applied as a normal distribution with propagated error per guidance in ORAUT-OTIB-0050 (ORAUT 2005c). Based on inspection of the dosimetry record, neutron dose was incomplete for 1970 so neutron doses estimated for the era 1970 through 1976 were calculated using neutron to photon ratios as directed in ORAUT-OTIB-0050 and applied as lognormal distributions with a GSD of 3.

In order to minimize the calculated dose, the maximizing uncertainty correction factors from ORAUT-OTIB-0027 (ORAUT 2005a) were not applied to photon or neutron dose.

Dosimeter Dose

Individual dosimeter results were used to reconstruct the EE's dose. Corrections to the reported doses were applied as described above. The dose from the 30–250 keV and > 250 photons was estimated using algorithms from ORAUT 2005a). Minimizing assumptions have been made for 1970, since it was a transition year between two different dosimeter types (Langsted 2004).

The recent re-evaluation of individual dosimetry data through 1970 provided detailed neutron dosimetry data and through 1969 and was used as reported,[7] per guidance in ORAUT-OTIB-0050 (ORAUT 2005c). The neutron data for the year 1970 was not complete so neutron and photon doses were estimated for the era 1970 through 1976 using neutron to photon ratios as directed in ORAUT 2005c.

The DOE dosimetry and the interview records indicate that the EE likely worked with plutonium in gloveboxes over his entire employment. As discussed in the *Technical Information Bulletin: Special External Dose Reconstruction Considerations for Glovebox Workers*, OCAS-TIB-0010 (OCAS 2005b), this could cause the recorded dose to be underestimated for an organ in the lower body such as the prostate. To ensure that the correction factor was applied only to the years when the EE likely received the majority of his recorded dose from working in gloveboxes, an average annual ratio of wrist reported exposure to WB reported exposure was calculated for each year. The factors ranged from 1.90 to 16.2 (with no extremity dose reported for 1972) and provide additional confirmation that glovebox work was performed. The glovebox correction factor was applied only to those years where the annual average factor exceeded 2.19 (the geometric mean correction factor from OCAS-TIB-0010), and it was clear that he was working as a chemical operator in a plutonium building. This included all years of employment from 1960 through 1969 except for 1961. The factor was not applied to later years even though the ratio data, dosimetry incident records and telephone interview would indicate glovebox use. The photon correction factor of 2.19 for photons and neutrons was applied to the selected years as provided in OCAS-TIB-0010.

A minimizing estimate of dose uncertainty for the years 1960 and 1962 through 1969 was obtained for photons by applying the glovebox factor corrected dose as a lognormal distribution with the GSD of the correction factor (1.34) only. The factor adjusted dose for neutrons for the same years was applied as a normal distribution with the propagated uncertainty reported by the NDR Project for the data also multiplied by the 2.19 factor.

Potential Missed External Dose

In accordance with the provisions of 42 CFR §82.10(k)(1), it was determined that the estimation of other sources of dose was sufficient to consider the dose reconstruction complete. Because of this, the potential missed external dose was not reconstructed.

Summary

The total assigned photon dose (53.952 rem) and neutron dose (40.937 rem) is based on the partial dose reconstruction described in this evaluation. Per the provisions in 42 CFR §82.10(k)(1),[1] it was determined that the partially reconstructed dose was of sufficient magnitude to consider the dose reconstruction complete. That is, the partially reconstructed dose produced a probability of causation of 50% or greater. The dose reported is an underestimate of the EE's total occupational radiation dose.

Note: The IREP input tables are available from SC&A or NIOSH for this case if needed.

DOSE RECONSTRUCTION EXAMPLE: CASE C

Coworker Unmonitored Dose Assigned per Draft ORAUT-OTIB-0058
Correction Factor for Lead Lined Apron Applied per Draft RFP External TBD, Table 6-8

Selection Criteria

- Hypothetical Research Engineer and Inspector: worked 1961 through 1982 in 707, 771, 776, 777, 991, and 881 and was primarily exposed to photons and neutrons.
- Unmonitored for Two Years of Employment
- Utilized a Lead Apron During a Portion of Employment. Cancer not covered by apron, badge worn under apron.
- Neutron Dose Reconstruction Project dose evaluation available for the monitored years pre-1971.

Cancer Description

Brain (ICD-9 Code 191.2)

Employment (Rocky Flats Plant)

Start: 1961
End: 1982

Approach

Likely non-compensable (i.e., < 50% POC)

Work History

NOCTS :	Research Engineer, QA Inspector DOB: 1916, Diagnosis Date: 2002
Dosimetry Data:	No dosimetry data for 1968 and 1973. NDRP neutron data through part of 1970, neutron dose data reported again from 1977 through end of employment, no neutron dose reported 1971–1976. Photon dosimetry data for all years except unmonitored 1968 and 1973.

Data Summary

External		Reported Whole Body Dose[a]				Reconstructed Organ Dose[b]			
Start (yr)	End (yr)	Dose Total (rem)	Photons < 30 keV (rem)	Photons 30–250 keV (rem)	Neutrons All Energy (rem)	Dose Total (rem)	Photons < 30 keV (rem)	Photons 30–250 keV (rem)	Neutrons All Energy (rem)
1961	1982	4.470	0.178	2.419	1.873	33.214	0.395	19.343	13.476

a. Includes NDRP data (ORISE 2005), ORAUT-OTIB-0027, and ORAUT-OTIB-0050 de-convoluted data and post-1976 data, lead apron correction factors.
b. Includes in addition, maximized missed dose, unmonitored dose, DCF and ICRP multipliers and ORAUT-OTIB-0027 uncertainty correction factors.

Probability of Causation (POC)

Based on assumptions applied, POC = 26.07%

Narrative

The EE worked as a research engineer and QA inspector in various locations on the RFP site, including Buildings 707, 771, 776, 777, 991, and 881. The work conducted in Buildings 771 and 776 was concerned with improving plutonium recovery and purification processes. He also worked for a period of time in the mid-1970s as an inspector of various parts and components. The work conducted in Building 881 was associated with enriched uranium. Based on this information from the DOE files, his primary exposure would have been to photon and neutron radiation, with a lesser potential for electron exposure. To maximize the applied dose in this dose reconstruction, all years of employment were assumed at plutonium facilities and shallow dose was applied as <30 keV photons. This is claimant favorable since potential external electron exposure would not have added dose to the cancer site. The calculated external dose to the brain in this evaluation is based on the use of thyroid as a claimant-favorable surrogate organ, as presented in ORAUT-OTIB-0005 (ORAUT 2006a).

Radiation Type, Energy, and Exposure Geometry

The EE's exposure geometry was assumed to be consistent with the specific dosimetry parameters applicable to the Rocky Flats Plant as described in Langsted 2004. For determination of dose to the brain, and to ensure claimant favorability, both 30–250 keV photon doses (based on the reported deep dose measurements) and <30 keV photon doses (based on the reported shallow dose measurements) have been applied.

In accordance with OCAS-IG-001, DCFs appropriate for the era were used to calculate the dose to the brain from exposure to photon and neutron radiation. This exposure assumes 100% AP geometry. For photons and neutrons, a claimant-favorable organ DCF of 1 or greater was applied for all energy ranges except <30 keV photons. Plutonium-specific DCFs were used for <30 keV photons. In OCAS-IG-001, organ DCFs are tabulated by averaging the energy specific values from ICRP 74 (1996) over the IREP photon energy range. The lowest photon energy interval in the IREP is categorized as less than 30 keV. Plutonium emits several x-rays in this energy range; however, a simple average as used in the Implementation Guideline may not result in the most accurate DCF. For plutonium work, the average x-ray energy is approximately 17 keV. As a result, using the 20keV as a claimant-favorable single-point estimate is most appropriate. Since the low-energy photon dose to glovebox workers, laboratory technicians, maintenance workers, metallurgical operators, and D&D workers is predominately in the AP geometry (Langsted 2004), single-point estimate values using AP geometry were calculated for 16 organs listed in ICRP 74 (ICRP 1996). Some workers (site support personnel, chemical operators when not working with glove boxes, support personnel, and radiation technicians) were estimated to have received varying amounts of non-AP dose (Langsted 2004). Since there is significant uncertainty in the individual exposure geometry and AP geometry is generally claimant favorable or neutral compared to other geometries for most cancers, an AP geometry is applied for all <30 keV photon exposures.

For neutrons, additional correction factors, which incorporate the energy range fractions and ICRP 60 correction factors, were applied in accordance with Langstead 2004. The Effective DCF is the result of multiplying all applicable factors together, and the reported and missed dose for photons and neutrons was multiplied by the Effective DCFs listed in the tables below.

PU Facility– Exposure (1961 to 1982)

	Photons		**Neutrons**			
Energy Range	**<30keV**	**30–250keV**	**<10keV**	**10–100keV**	**100keV–2MeV**	**2–20MeV**
Energy Fraction	100%	100%	—	—	—	—
ICRP 60 CF	N/A*	N/A*	0.0851	0.0342	1.3614	0.3271
Organ DCF	0.352	1.440	1.803	1.079	1.125	1.186
$DCF_{Effective}$	0.352	1.440	0.153	0.037	1.532	0.388

*Not applicable

To account for uncertainty in the dosimetry readings, additional factors appropriate for the era were applied to the reported photon dose (1961 through 1969) and neutron dose (1977 through 1982) from site-specific guidance provided in Table 4-2 of ORAUT-OTIB-0027 (ORAUT 2005a).

Neutron doses from 1961 through 1969 that were determined by ORAUT 2005b were applied as a normal distribution with propagated error per guidance in ORAUT-OTIB-0050 (ORAUT 2005c). Neutron and photon doses estimated for the era 1970 through 1976 were calculated using n/p ratios as directed in ORAUT-OTIB-0050 and applied as lognormal distributions with a GSD of 3.

Dosimeter Dose

When available, individual dosimeter results were used to reconstruct the EE's dose. Corrections to the reported doses were applied as described above. The dose from both 30–250 keV photons and <30 keV photons was estimated using algorithms from ORAUT-OTIB-0027 (ORAUT 2005a). Claimant-favorable assumptions have been made for 1970, since it was a transition year between two different dosimeter types (Langsted 2004, ORAUT 2005a).

The NDRP re-evaluation of individual dosimetry data through 1970 provided complete detailed neutron dosimetry data through 1969 and was used as reported (ORAUT 2005b), per guidance in ORAUT-OTIB-0050. Neutron data for 1970 was not complete so n/p doses were estimated for the era 1970 through 1976 using neutron to photon ratios as directed in ORAUT-OTIB-0050.

There were no dosimetry records for 1968 or 1973. A claimant-favorable approach was taken and the 95th percentile photon and neutron doses as presented in Tables 7-1 and 7-2 of the draft guidance *External Coworker Dosimetry Data for the Rocky Flats Plant*, ORAUT-OTIB-0058 (ORAUT 2006c), were applied. The coworker doses for 1968 were applied as a constant; however, ORAUT-OTIB-0027 uncertainty estimates were also applied. As directed in ORAUT-OTIB-0058, the coworker doses for 1973 were applied as a best-estimate lognormal distribution with a GSD of 3 utilizing the approach in ORAUT-OTIB-0050 for years in that era. Both approaches are claimant favorable and significantly exceed his highest reported penetrating photon dose over all years he was monitored.

It was also noted in the telephone interview that the EE inspected various machined parts and components during the years 1973 through 1976, and that he wore his badge inside of his lead apron. As noted in the draft Revision 1 of OAUT-TKBS-0011-6 (ORAUT 2006b), this can result in an underestimate of photon dose when the cancer (brain in this case) is not covered by the apron. A correction factor of 1.15 was applied to the reported deep dose and a factor of 1.11 was applied to the reported shallow dose in accordance with Table 6-8 of ORAUT 2006b. Although the correction factor for neutrons is 1 for this case, the application of ORAUT-OTIB-0050 algorithms, which calculate neutrons based on reported deep photon dose, results in a claimant-favorable increase in the neutron dose by the same 1.15 factor.

Potential Missed External Dose

Because individual dosimeter results were not always available to reconstruct the EE's potential missed external dose for the period 1961–1976, an analysis of dosimeter results during the EE's employment period was used to assign potential missed photon and neutron doses for that period.

A potential missed dose was assigned to each actual or potential dosimeter cycle where a zero was reported to provide a claimant-favorable estimate of the potential external doses received by the EE. A missed dose represents the dose that could have been received but may not have been recorded due to the dosimeter detection limits or site reporting practices. No additional missed dose was assigned for the unmonitored years 1968 and 1973, since maximized missed dose has been included in the 95th percentile coworker dose that was applied (ORAUT 2006c).

For the years prior to 1977, the maximum number of dosimeter cycles was based on information provided in Langsted 2004, and the number of zeros assigned was equal to the maximum potential badge cycles. From 1977 to the end of employment, all badge cycles were reported, and zeros were applied as reported. The total number of dosimeter cycles where a zero was assigned was 389 for 30–250 keV photon radiation. This number was chosen to ensure that all possible instances of a zero badge reading were accounted for in this dose reconstruction. Based on limit of detection information provided in Langsted 2004, this results in a maximum potential missed dose for the EE of 16.969 rem from 30–250 keV photon radiation. All missed dose was assigned as 30–250 keV photons as this is claimant favorable. Per the requirements of OCAS-IG-001, this value was used as the 95th percentile of a lognormal distribution for the purpose of calculating probability of causation.

Missed neutron doses were also calculated. The number of zero dosimeter reports for data from the NDR Project through 1969 was assigned per guidance in ORAUT-OTIB-0050. From 1970 through 1976, the number of zeros assigned for neutrons was the same as for photons since the dosimeters of that era contained both photon and neutron sensing elements (Langsted 2004), and would likely have been read on the same frequency. For 1977 to the end of employment, all badge cycles were reported (Langsted 2004), and zeros were applied as reported. The number of zero dosimeter cycles applied was 171 for neutrons. This number was chosen to ensure that all possible instances of a zero badge reading were accounted for in this dose reconstruction. Based on limit of detection information provided in Langsted 2004, this results in a maximum potential missed dose for the EE of 14.388 rem to the brain. Per the requirements of OCAS-IG-001, this value was used as the 95th percentile of a lognormal distribution for the purpose of calculating probability of causation.

<u>Summary</u>

The total assigned dose (33.214 rem) based on the approach described in this evaluation is considered a claimant-favorable overestimate. Some specific components of this dose reconstruction that made claimant-favorable assumptions included assigning zeros for potential missed external dose, the application of 95th percentile coworker dose, the application of DCFs of one or greater and claimant-favorable estimates of uncertainty for photon doses and non-NDRP neutron doses other than 1970–1976.

If the facts surrounding this dose reconstruction change (e.g., the date of diagnosis is modified, an additional covered cancer is diagnosed, or additional covered employment is identified), the efficiency measures used to reconstruct the dose may not be applicable. In this case, if the facts were to change, the dose reconstructed for the brain could be lower than that reported using the efficiency process.

Note: The IREP input tables are available from SC&A or NIOSH for this case if needed.

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ATTACHMENT 10: NIOSH'S REPORT CONCERNING BADGING OF PERSONNEL AT RFP AND SC&A'S EVALUATION

The following statement was originally interpreted to mean that all personnel were badged:

> *In 1964, we were able to incorporate the dosimetry badge with the security badge. This was an improvement from the standpoint of assuring the employee was indeed wearing a badge while working on the job.* (Putzier 1982, pg. 2).

Dosimeters were issued to personnel likely to be exposed:

> *All Q-cleared non-Dow personnel associated with construction projects, such as architect-engineers, engineering firms, contractors, etc., will be issued film badges when deemed necessary by* [Name]. (Mann 1967)

> *Film badges are issued to all contractor personnel who must enter areas where the exposure to x-rays, gamma rays, and neutrons is likely to exceed 10 percent of the guide value for occupational exposure.* (Owen 1968)

However, subcontractor personnel with low exposure potential may not have been issued a dosimeter:

> *6.15.1 Conditions where General Health Physics Surveillance is Not Required*
> *a. In areas where penetrating radiation levels are not likely to exceed an average of 0.2 mrem/hr., outside contractor personnel may be utilized. Film badges will not be provided under these conditions unless, on advice of Health Physics, badging is desired for assessing a possible criticality exposure. Health Physics Guide for Rocky Flats Division*. (Putzier 1970, Section 5.1.7).

The badged population was expanded:

> *Health Physics is going to expand the film badge coverage of personnel on the plant site. At your earliest possible convenience, please give us a list of the people who comprise your pertinent organization: Rocky Flats Employees' Credit Union, Dow-Rocky Flats mail department, Szabo Food Services*. (Mann 1968)

Also, a combined badge incorporating a TLD was developed as the site transitioned from film badges to TLDs:

> *The new combined dosimetry-security badge arrived…* (Falk 1971)

In 1974 all prime contractor and government personnel were badged:

> *Starting January 1974, we have issued all employees on plant site (Dow and AEC) a TLD dosimeter*. (Lagerquist 1974a)

> *Beginning July 1, 1974, we are implementing a new policy where everyone on plant site will wear a radiation dosimeter (TLD) badge at all times*. (Lagerquist 1974b)

Visitors that entered the controlled areas were also badged:

> *There are five different kinds of visitors to the plant site. … Our TLD program currently handles these groups as follows…* (Lagerquist 1975)

However, there is no indication that the 1970 policy for subcontractors was changed.

This continued through 1990, at which time the policy was changed:

> *Specifically, effective January 1, 1991, dosimeters will not be distributed to everyone, and dosimeters will stay on plant site*. (Jens 1990)

ORAU performed an analysis on 1,046 RFP claimants. This analysis reflects a significant increase in the proportion of employees monitored in 1964 (from 75% to 93%) consistent with increased badging. The increase in 1974 (from 94% to 98%) is much more consistent with a "tightening-up" process.

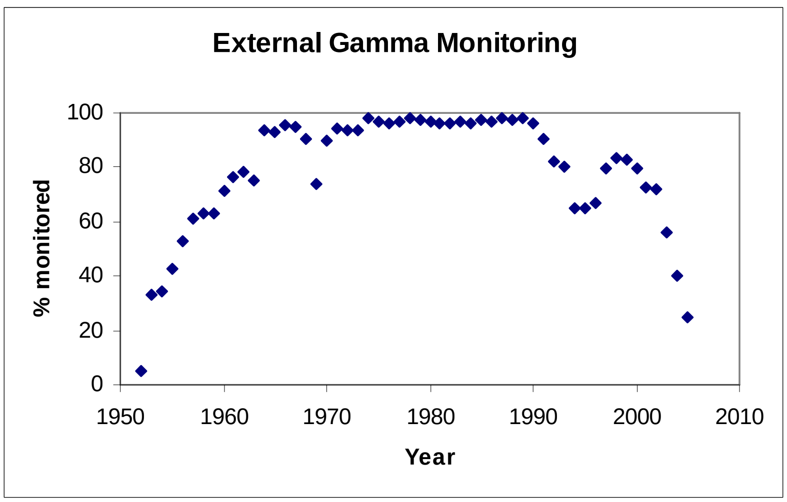

Table 1. Percent Badged

Year	Badged	Year	Badged	Year	Badged	Year	Badged	Year	Badged	Year	Badged
1951		1961	77%	1971	94%	1981	96%	1991	91%	2001	73%
1952	5%	1962	78%	1972	94%	1982	96%	1992	82%	2002	72%
1953	33%	1963	75%	1973	94%	1983	97%	1993	80%	2003	56%
1954	34%	1964	93%	1974	98%	1984	96%	1994	65%	2004	40%
1955	43%	1965	93%	1975	97%	1985	98%	1995	65%	2005	25%
1956	53%	1966	96%	1976	96%	1986	97%	1996	67%		
1957	61%	1967	95%	1977	97%	1987	98%	1997	79%		
1958	63%	1968	91%	1978	98%	1988	98%	1998	83%		
1959	63%	1969	74%	1979	98%	1989	98%	1999	83%		
1960	71%	1970	90%	1980	97%	1990	96%	2000	80%		

Source: ORAU analysis of RFP claimant files

To better understand the increased external monitoring in 1964, 28 claimant files were evaluated. These files were selected by reviewing the individual claimant data from the ORAU analysis (above). Any individual with 5 or more years of employment immediately preceding 1964 (1959–1963) in which no external dosimetry results were posted (not monitored) and with external dosimetry results posted in 1964 (monitoring started in 1964) was selected. The job title, organization, or company was determined (where possible) by review of the claimant file (which in many cases includes an image of the Employee History cards). For those files that do not have Employee History cards, the file was reviewed for incident reports or other records that might indicate the job title or organization.

For the 28 claimants with external dosimetry records that started in 1964, 12 were assigned as security (guards), 10 were non-production building positions (managers, auditors, clerks, and draftsman), and 6 were non-radiation worker positions (tool makers, clerk, boiler operator). This is consistent with an effort to start badging occasional-access personnel in 1964.

For further investigation of the effect of 1964 badging policy, dosimetry laboratory worksheets for portions of 1963 and 1964 were reviewed. Only non-plutonium building worksheets were available for this analysis. For 1963, 124 worksheets were reviewed, and 62 worksheets were reviewed for 1964. A comparison indicated that three buildings were added in 1964; Building 21 (guards), Building 51 (maintenance planning and warehouse), and Building 10 (MA). This is consistent with bringing occasional-access personnel into the external dosimetry program.

To better understand the effects of the 1974 badging policy, a similar analysis was performed for that year. Twelve (12) claimant files were identified and the job positions reviewed. Seven (7) were construction subcontractors (Swinterton & Wallberg, Lumus, Olsen Construction), 3 were unidentified-employer crafts, and 2 were secretaries. This is consistent with increased badging of construction contractors and miscellaneous onsite personnel.

Finally, a review of the *External Dosimetry Report* for the 1973 annual exchange was performed. This indicated that personnel in Building 121 (guards) were monitored (approximately 120 badges) and personnel in Building 131 (firefighters) were monitored (approximately 35 badges). This is consistent with these occasional-access personnel being monitored before 1974.

Conclusion

Review of dosimetry results from three different available sources is consistent with interpretation of the available memos, indicating that an effort in 1964 brought a significant number of unmonitored occasional-access personnel onto the external dosimetry program, and in 1974, an effort to bring remaining miscellaneous personnel onto the external dosimetry program was accomplished.

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SC&A Review of NIOSH's Report, "*Badging of Personnel at RFP*"

An analysis of the RFP badging practices was forwarded to SC&A on December 7, 2006. The article does a very good job of summarizing the badging policies and changes in badging philosophies over the years at the RFP. From this summary, the following can be derived:

1. **1952–1963** – This is the period of most concern. The article lists three items related to this period.

    a. That subcontractor personnel with low-exposure potential may not been monitored if the area was not likely to exceed an average of 0.2 mrem/hr (equates to 400 mrem/year).
    b. Analysis of 28 claimant files for workers who were not badged before 1964 showed that they were guards, management, clerks, drafters, toolmakers, etc., indicating that those that were not monitored had a low potential for exposure (the exception to these job titles may be guards, if they were stationed near material that was radioactive for extended periods of time).
    c. The article states that records show that workers in Buildings 21 (guards), 51 (maintenance), and 10 (MA) were added in 1964 to included occasional-access personnel.

    These badging policies suggest that the workers who were not badged during 1952–1963 were those that were not at risk for regular or high exposures, and that the majority of workers who were badged were those most likely to be exposed. If this were true, then in 1964, when all workers became badged, the number of zero entries should have increased noticeably. However, it can be shown that during the 5-year period of 1959–1963 (before 1964) that the average number of zero entries was 10.0% vs. 9.7% for the 5-year period for 1964–1968. This would indicate that workers monitored prior to 1964 were average radiation workers, and not the maximum-exposed workers. Therefore, because SC&A has found that most of the intervals of no dose records occurred during this period, and the article shows in the graph and Table 1 that the percent of monitoring is less during this period, it cannot be assumed that all potentially exposed workers were always monitored, and it is still necessary to evaluate each worker's case on an individual basis for possible unmonitored exposures.

2. **1964–1990** – If the term "% monitored" as used in the graph entitled "External Gamma Monitoring" means "% of **all** persons entering the site who were monitored" and does not just refer to prime contractor personnel, then for the years 1964–1990, most workers were monitored (average = 95.0%) during that period. The exception was during 1969, when 74% were monitored (the issue of the large increase in zero entries during 1969 and 1970 still remains). Lack of monitoring for regularly, or highly exposed, workers would be unlikely (except in the case of accidents/incidents or episodic events). Lack of monitoring records for persons that may have been exposed would have to be investigated on an individual basis during this period.

However, if the term "% monitored" does not include ***all*** persons entering the site, then these conclusions are not valid.

3. **1991–2005** – This was the period of closure and D&D. This era is not directly addressed in this article.

ATTACHMENT 11: NIOSH EVALUATION OF THE DENSE NEUTRON FILM MEMORANDUM

Submitted by Brant Ulsh, NIOSH
August 30, 2006

Evaluation of Dense Neutron Film Memo

During the July 26, 2006, RFP Working Group meeting, Kathy Robertson-Demers read from a memo regarding the procedure for assignment of doses when neutron films were too dense to read. Kathy read the following excerpt:

> *During the month of January there were 21 neutron films reported as too dense to read. This included 19 from buildings 76, 77, 77a and two from building 71. The current procedure is to report these films with a code indicating "too much gamma to read," resulting in an assigned neutron dose of zero*. (Kirchner and Kittinger 1965)

This understandably caused some concern, and I requested a copy of the memo from Kathy, which she sent me on July 28, 2006. The memo is attached. I have reviewed this short memo in its entirety, and the NIOSH/ORAU Team has done some further research on this issue. The questions we considered are listed below, along with the results of our follow-up research.

(1) How was dose assigned for these particular films?

The excerpt Kathy read is found in the first paragraph. As stated in the first paragraph, this memo concerned 21 neutron films from Buildings 76/77/77A and 71 which were too dark to read. Immediately following the excerpt Kathy read, the memo states, "Present plans are to adjust the procedure and assign an 'average' dose to these films. An investigation of the job descriptions and work locations of the 21 personnel involved indicated that assigning an overall average dose would not give the personnel involved a dose representative of their true exposure." The memo then goes on to recommend, "An investigation will be conducted by Building 76/71 supervision to determine the most probable exposure received by the personnel involved and report the results to Personnel Meters Section as soon as practical," and further, "The dose indicated by the investigation should be submitted to IBM as a true exposure." Therefore, the information in the memo itself describes that the doses assigned to these particular 21 films were determined by an investigation. The individuals involved were not arbitrarily assigned a zero dose, according to this memo.

(2) How were doses assigned in these situations after the date of this memo (March 16, 1965)?

The memo states the following:

> *The following procedure is therefore recommended:*

> *1. Health Physics supervision in Building 76 or 71 should be notified of the name and man number of all personnel who submit a neutron film which is too dense to read. The notification should be made as soon as practical after the film has been examined.*

The memo then goes on to recommend that an investigation be conducted to determine the most appropriate dose to assign, and that the resulting assigned dose be entered into the employee's record, as described above. It does not recommend arbitrarily assigning a zero dose.

(3) How were doses assigned in these situations prior to the date of this memo (March 16, 1965)?

This was the question of most concern, as the excerpt Kathy read could be interpreted to mean that employees with neutron films that were too dense to read were arbitrarily assigned zero dose prior to March 16, 1965. The memo is addressed to E.A. Putzier from R.A. Kirchner and W.D. Kittinger. To gain further insights into the procedures in these situations before 1965, ORAU spoke with one of the authors of the memo on August 2, 2006, who indicated that the practice at Rocky Flats was consistent with that in the rest of the AEC/ERDA/DOE system of assigning doses by "exposure questionnaires" (or the equivalent) for any question related to the validity of the personnel dosimeter reading. This memo outlining a recommended "standard procedure" for assigning reasonable dose rather than defaulting to "zero" assignment, and the fact that the particular films in question in this memo were investigated, is evidence of this practice rather than evidence of a standard practice of arbitrarily assigning zero dose.

To provide additional verification of this interpretation, NIOSH contacted [a site expert] on August 9, 2006. [This site expert's] services have been engaged by SC&A in support of their activities related to the Rocky Flats SEC petition, and numerous public comments indicate that [this site expert] is a source widely trusted by the petitioners and workers. [The site expert] confirmed that the assignment of doses in situations when film badges were too dense to read was determined by investigations/dose reconstructions. It was not the practice to arbitrarily assign zero doses in these situations.

And finally, a review of the neutron worksheets for January 1965, and other months and years, was made. These worksheets were part of the Neutron Dose Reconstruction Project (NDRP) database. Indeed, the cited films were observed (actually for 22 films). The films were coded with a "Code 5. No reading" and the neutron dose fields were blank on the worksheet. It is not known whether a neutron dose was assigned to the worker by a letter to the worker's file or a memo to the staff for data entry into the IBM database.

In any case, the NDRP process makes this issue moot. The NDRP process focused on the neutron doses recorded on the worksheets. Any neutron doses assigned to a worker but not recorded on the worksheet were not affected by the NDRP. The worker would be double-credited for neutron dose for that period when the NDRP assigned a neutron dose to that film, either from a film read or assigned a notional dose to that gap.

The NDRP data cover the following scenarios:

1. The NDRP found the film and matched it to the initially unreadable film:

    a. If the NDRP read the film, there is a NDRP neutron dose for that film.

    b. If the NDRP could not read the film, a notional dose was assigned if there was no original neutron dose noted on the original worksheet and if there was a gamma dose for that monitoring period. (If there was an original neutron dose stated on the worksheet, there was no gap, and that dose would stand without update.)

    c. If the NDRP could not read the film and if there was no neutron or gamma dose for that monitoring period, the NDRP would not assign a notional neutron dose. However, the Individual Timeline Report data would be available to the dose reconstructor that would allow assignment of a custom notional neutron dose.

2. The NDRP did not find and match a film to the initially unreadable film:

    a. The original neutron dose, if any, noted on the worksheet stands without update.

    b. If there was no original neutron dose on the worksheet, a notional dose was assigned if there was a gamma dose for that monitoring period.

    3. If the NDRP could not match or read the matched film and if there was no original neutron or gamma dose for that monitoring period, the NDRP would not assign a notional neutron dose. However, the Individual Timeline Report data would be available to the dose reconstructor that would allow assignment of a custom notional neutron dose. Only one case of this scenario was observed.

Conclusion:

So, what is the correct interpretation of the excerpt Kathy read, indicating that, "…the current procedure is to report these films with a code indicating 'too much gamma to read,' resulting in an assigned neutron dose of zero?" Note that the memo indicates that doses were submitted to IBM. This is a reference to the IBM mainframe computer upon which health physics results were stored. A logical interpretation is that the code "too dense to read" would result in the IBM system assigning a zero dose, because the film was unreadable. From this point, an investigation was initiated to determine the most appropriate dose to assign. This would be consistent with the information provided by one of the memo's authors and [a site expert], and the actions described in the memo itself. A copy of the code sheet used to enter data into the IBM system is also attached. Note that on page 2 of the memo, it is recommended that in the future, "The identification for these films should be changed from 'too dense to read' to 'too dense to read – dosage assigned.'" This is reflected in the attached code sheet (dated 9-6-68), where a code of "24" is used to designate a neutron film that is "over-exposed, dose assigned." At no time was a final dose of zero arbitrarily assigned in cases where neutron films were too dense to read.

March 16, 1965

E. A. Putzier

cc:
C. R. Johnson
J. R. Mann
R. M. Vogel
File (Record)

PROCEDURE FOR ASSIGNING DOSE TO DENSE NEUTRON FILMS

During the month of January there were 21 neutron films reported as "too dense to read". This included 19 from Buildings 76/77/77A and 2 from Building 71. The current procedure is to report these films with a code indicating "too much gamma to read", resulting in an assigned neutron dose of zero. Present plans are to adjust the procedure and assign an "average" dose to these films. An investigation of the job descriptions and work locations of the 21 personnel involved indicated that assigning an overall average dose would not give the personnel involved a dose representative of their true exposure. The following procedure is therefore recommended:

1. Health Physics supervision in Building 76 or 71 should be notified of the name and man number of all personnel who submit a neutron film which is too dense to read. The notification should be made as soon as practical after the film has been examined.

2. An investigation will be conducted by Building 76/71 supervision to determine the most probable exposure received by the personnel involved and report the results to Personnel Meters Section as soon as practical.

3. The dose indicated by the investigation should be submitted to IBM as a true exposure.

4. The code identification for these films should be changed from "too dense to read" to "too dense to read-dosage assigned".

Acceptance of the above procedures should not result in any delay in calculation and distribution of film badge results.

R. A. Kirchner
Health Physics - 76

W. D. Kittinger
Health Physics - 76

WDK:map

TABLE

IBM PRINT-OUT SHEET CODES

Work Sheet Codes

Condition	B-y Film: Body	B-y Film: Wrist	B-y Film: Neutron	Both B-y Film	Both Body Film	Wrist & Neutron Film	All Film
Not Returned	01	02	04	03	05	06	07
Damaged Film	11	12	14	13	15	16	17
Over-exposed, Dose assigned	21	22	24	23	25	26	27
Late	31	32	34	33	35	36	37
Prev. Employee Dose	41	41	41				
More than 1 film	51	51	51				

WORK SHEET CODE

Weekly	1
Bi Weekly	2
Monthly	3
Quarterly	4

9-6-68

1969

1969

ATTACHMENT 12: MASTER LIST OF RECORDS SEARCH RESULTS

Master List of Records Search Results

Receipt #	Bar Code	Orig. Date	Subject
10646	233	2-Aug-91	LOG BOOK MAIN DECON FACILITY MDF NO 001 WASTE MANAGEMENT
10646	240	4-Mar-92	LOG BOOK NO 35 OU2 DECONTAMINATION TECHNICIAN 2 MARCH 4 1992 THRU JULY 9 1992
10646	234	6-Dec-91	LOG BOOK OU2 DECONTAMINATION TECHNICIAN 1 DECEMBER 6 1991 THRU JULY 23 1992
10666	3803	30-Mar-93	FIELD DATA FOR BH 40893;PREWORK SURVEY;CONTAMINATION SURVEY;CONTAMINATION SURVEY;POSTWORK SURVEY;EQUIPMENT DECONTAMINATION AND WASH CHECKLIST;FIELD MONITORING RESULTS OF CUTTINGS OR CORE;VERIFICATION OF ORGANIC VAPOR MONITORING RESULTS;RECORD OF DRILLING FLUID AND CUTTINGS;DRUM FIELD LOG FORM;DRUM FIELD LOG FORM;CONTAMINANT CHARACTERIZATION FORM FOR GRAY DRUMS;CONTAMINANT CHARACTERIZATION FORM FOR GRAY DRUMS;SURFACE SOIL SAMPLE FORM SS 40004AE;SUBSURFACE SOIL SAMPLE FORM BH 40032AE;SUBSURFACE SOIL SAMPLE FORM BH 40029AE;SUBSURFACE SOIL SAMPLE FORM BH 40030AE;SUBSURFACE SOIL SAMPLE FORM BH 40031AE;RESULTS OF RADIOLOGICAL MEASUREMENT IN THE FIELD;PRELIMINARY WELL SITE LOG;HOLLOW STEM AUGER DRILLING FIELD ACTIVITIES REPORT;BOREHOLE ABANDONMENT FIELD ACTIVITIES REPORT;SURFACE SOIL DATA COLLECTIONS FORM;SURFACE SOIL SAMPLING FIELD ACTIVITIES REPORT;SURFACE SOIL SAMPLING FIELD ACTIVITIES REPORT;PHOTOIONIZATION DETECTOR FIELD DATA FORM;RIG GEOLOGIST LOGBOOK NOTES;RIG GEOLOGIST LOGBOOK NOTES;HEALTH AND SAFETY LOGBOOK NOTES;HEALTH AND SAFETY LOGBOOK NOTES;DRILLERS LOGBOOK
10666	3453	8-Aug-91	LOG BOOK 001 MDF DECON PAD RECORD
10666	7381	4-Jan-93	LOG BOOK MDF 74 MAIN DECONTAMINATION FACILITY TECHNICIAN #1
10666	3928	19-Oct-92	LOG BOOK OU6 #68 H&S OU2 OU6 DECON PAD
10672	7382	21-Sep-92	LOG BOOK MDF 60 TECHNICAL DECONTAMINATION #2
17514	7819	4-Mar-70	ENVIRONMENTAL MASTER FILE (EMF)// CALL REPORT - FIRE SAMPLES* AUTHOR: [Authors' names protected]
17514	10822	6-Nov-87	ENVIRONMENTAL MASTER FILE (EMF)// ROCKY FLATS PLANT ENVIRONMENTAL ANALYSIS AND CONTROL SAMPLING PROCEDURE TRITIUM AMBIENT AIR SAMPLING AUTHOR: [Author/addressee names protected]

Master List of Records Search Results

Receipt #	Bar Code	Orig. Date	Subject
18950	13583	2-Dec-93	<> DRILLING PACKAGE OU4 BH42193;PRE WORK SURVEY;PRE WORK SURVEY;CONTAMINATION SURVEY;CONTAMINATION SURVEY;EQUIPMENT DECONTAMINATION WASH CHECKLIST;FIELD MONITORING RESULTS OF CUTTINGS OR CORE;FIELD MONITORING RESULTS OF CUTTINGS OR CORE;RECORD OF DRILLING FLUIDS AND CUTTINGS;RECORD OF DRILLING FLUIDS AND CUTTINGS;DRUM FIELD LOG FORM;DRUM FIELD LOG FORM;DRUM FIELD LOG FORM;CONTAMINANT CHARACTERIZATION FORM FOR GREY DRUMS;CONTAMINANT CHARACTERIZATION FORM FOR GREY DRUMS;CONTAMINANT CHARACTERIZATION FORM FOR GREY DRUMS;US DOE SAMPLE COLLECTION FORM;US DOE SAMPLE COLLECTION FORM;US DOE SAMPLE COLLECTION FORM;US DOE SAMPLE COLLECTION FORM;RESULTS OF RADIOLOGICAL MEASUREMENTS IN THE FIELD;RESULTS OF RADIOLOGICAL MEASUREMENTS IN THE FIELD;RESULTS OF RADIOLOGICAL MEASUREMENTS IN THE FIELD;ROCKY FLATS PLANT BH LOG;PRELIMINARY WELL SITE FIELD LOG;PRELIMINARY WELL SITE FIELD LOG;PRELIMINARY WELL SITE FIELD LOG;SURFACE CASING INSTALLATION FIELD ACTIVITIES LOG;BH ABANDONMENT FIELD ACTIVITIES REPORT;SURFACE SOIL DATA COLLECTION FORM;SURFACE SOIL SAMPLING FIELD ACTIVITIES REPORT;SURFACE SOIL SAMPLING FIELD ACTIVITIES REPORT;PHOTOIONIZATION DETECTOR FIELD DATA FORM;RIG GEOLOGIST FIELD LOG BOOK KM;HEALTH AND SAFETY TECH FIELD LOG BOOK PG;SITE SAFETY BRIEFINGS;RECORD OF PROPERTY LEAVING RADIOLOGICALLY CONTROLLED AREAS;CONTAMINATION SURVEY;CONTAMINATION SURVEY;CONTAMINATION SURVEY;FIELD MONITORING RESULTS OF CUTTINGS OR CORE;VERIFICATION OF ORGANIC VAPOR MONITORING RESULTS;
19004	14153	9-Dec-93	FIELD RECORDS FOR BH 42993;DRUM FIELD LOG FORM;CONTAMINANT CHARACTERIZATION FORM FOR GREY DRUMS 1/20/93 1/25/93;US DOE SAMPLE COLLECTION FORM 1/18/93 1/20/93;US DOE RFEDS WELL INSTALLATION FORM;RESULTS OF RADIOLOGICAL MEASUREMENTS IN FIELD;ROCKY FLATS PLANT BOREHOLE LOG;PRELIMINARY WELL SITE FIELD LOG; HOLLOW STEM AUGER DRILLING FIELD ACTIVITIES;SURFACE CASING INSTALLATION FIELD ACTIVITIES; GROUNDWATER MONITORING WELL AND PIEZOMETER REPORT;SURFACE SOIL DATA COLLECTION;SURFACE SOIL SAMPLING FIELD ACTIVITIES REPORT; PHOTOIONIZATION DETECTOR FIELD DATA FORM;RIG GEOLOGIST FIELD LOG BOOK;HEALTH AND SAFETY FIELD LOG BOOK;PRE WORK SURVEY;CONTAMINATION SURVEY 1/25/93 1/28/93 1/20/93;POST WORK SURVEY; EQUIPMENT DECONTAMINATION WASH CHECKLIST RECORD;FIELD MONITORING RESULTS OF CUTTINGS OR CORE;RECORD OF DRILLING FLUIDS AND CUTTINGS;DRUM FIELD LOG FORM
19175	14154	9-Dec-93	FIELD RECORDS FOR BH 42593;PRE WORK SURVEY;CONTAMINATION SURVEY;EQUIPMENT DECONTAMINATION WASH CHECKLIST FIELD MONITORING RESULTS OF CUTTINGS OR CORE 3/16/93 3/17/93 3/26/93;RECORD OF DRILLING FLUID SAND CUTTINGS;DRUM FIELD LOG FORM 3/16/93 3/17/93; CONTAMINANT CHARACTERIZATION FORM FOR GREY DRUMS 3/16/93 3/17/93;US DOE SAMPLE COLLECTION FORM 3/9/93 3/16/93 3/26/93;RESULTS OF RADIOLOGICAL MEASUREMENTS IN THE FIELD 3/16/93 A 3/17/93 A 3/26/93 A;RESULTS OF RADIOLOGICAL MEASUREMENTS IN THE FIELD 3/16/93 B 3/17/93 B;PRELIMINARY WELL SITE FIELD LOG 3/16/93 3/26/93;HOLLOW STEM AUGER DRILLING FIELD ACTIVITIES REPORT;BOREHOLE ABANDMENT FIELD ACTIVITIES REPORT;SURFACE SOIL DATA COLLECTION FORM;SURFACE SOIL SAMPLING FIELD ACTIVITIES REPORT 3/9/93 B 3/9/93 C;PHOTOIONIZATION DETECTOR FIELD DATA FORM 3/16/93 3/17/93 3/26/93;HEALTH SAFETY TECHNICAL FIELD LOG BOOK 3/26/93 3/8/93;RIG GEOLOGIST FIELD LOG BOOK;RECORD OF PROPERTY LEAVING RCAS;PREWORK SURVEY; CONTAMINATION SURVEY 3/16/93 3/17/93;SITE SAFETY BRIEFINGS 3/8/93 3/26/93 4/8/93;SAMPLE COLLECTION FORM;ROCKY FLATS PLANT BOREHOLE LOG
19175	14155	9-Dec-93	FIELD RECORDS FOR BH 42893;FILE CHECKSHEET INTERNAL DOCUMENT;EQUIPMENT DECONTAMINATION WASH CHECKLIST RECORD RECORD;DRUM FIELD LOG FORM;CONTAMINANT CHARACTERIZATION FORM GREY DRUMS;US DOE SAMPLE COLLECTION FORM;RESULTS OF RADIOLOGICAL MEASUREMENTS IN FIELD;ROCKY FLATS PLANT BOREHOLE LOG;PRELIMINARY WELL SITE FIELD LOG; HOLLOW STEM AUGER DRILLING FIELD ACTIVITIES REPORT;VADOSE ZONE MONITORING BOREHOLE CONSTRUCTION DIAGRAM;RIG GEOLOGIST FIELD LOG BOOK;HEALTH SAFETY FIELD LOG BOOK;SITE SAFETY BRIEFINGS;PREWORK SURVEY;CONTAMINATION SURVEY 3/11/93 3/12/93;POST ACTIVITY SURVEY;EQUIPMENT DECON WASH CHECKLIST AND RECORD;FIELD MONITORING RESULTS OF CUTTINGS OR CORE;RECORD OF DRILLING FLUIDS AND CUTTINGS;SAMPLE COLLECTION FORM;RESULTS OF RADIOLOGICAL MEASUREMENTS IN FIELD;3/11/93 A 3/11/93 B;SURFACE CASING INSTALLATION FIELD ACTIVITIES;PHOTOIONIZATION DETECTOR FIELD DATA FORM;INSITU HYDRAULIC CONDUCTIVITY

Master List of Records Search Results

Receipt #	Bar Code	Orig. Date	Subject
20323	14223	16-Dec-93	BH RECORD 43193;PREWORK SURVEY;CONTAMINATION SURVEY;CONTAMINATION SURVEY;FIELD MONITORING RESULTS OF CUTTINGS OR CORE;FIELD MONITORING RESULTS OF CUTTINGS OR CORE;DRUM FIELD LOG FORM;CONTAMINANT CHARACTERIZATION FORM FOR GRAY DRUMS;US DOE SAMPLE COLLECTION FORM;US DOE SAMPLE COLLECTION FORM;US DOE SAMPLE COLLECTION FORM;US DOE SAMPLE COLLECTION FORM;RESULTS OF RADIOLOGICAL MEASUREMENTS IN THE FIELD;RESULTS OF RADIOLOGICAL MEASUREMENTS IN THE FIELD;ROCKY FLATS PLANT BH LOG;PRELIMINARY WELL SITE FIELD LOG;HOLLOW STEM AUGER DRILLING FIELD ACTIVITIES REPORT;HOLLOW STEM AUGER DRILLING FIELD ACTIVITIES REPORT;SURFACE CASING INSTALLATION FIELD ACTIVITIES REPORT;SURFACE SOIL DATA COLLECTION FORM;SURFACE SOIL SAMPLING FIELD ACTIVITIES REPORT;SURFACE SOIL SAMPLING FIELD ACTIVITIES REPORT;PHOTOIONIZATION DETECTOR FIELD DATA FORM;PHOTOIONIZATION DETECTOR FIELD DATA FORM;VADOSE ZONE MONITORING BH CONSTRUCTION DIAGRAM;HEALTH AND SAFETY TECHN FIELD LOG BOOK DB;VADOSE CREW FIELD LOG BOOK NJK;RIG GEOLOGIST FIELD LOG BOOK KM;SITE SAFETY BRIEFINGS;CONTAMINATION SURVEY;POST ACTIVITY SURVEY;EQUIPMENT DECON WASH CHECK LIST & RECORD;HEAVY EQUIPMENT DECON WASH CHECKLIST & RECORD;RECORD OF DRILLING FLUIDS AND CUTTINGS;CORE OF 43193
31252	15162	8-Aug-69	ENVIRONMENTAL MASTER FILE (EMF)// ESTIMATE OF MATERIAL LOSS IN 771 TUNNEL FIRE AUTHOR :[Author/addressee names protected]
31252	14811	9-Mar-70	ENVIRONMENTAL MASTER FILE (EMF)// PROGRESS ON FIRE SAMPLES* AUTHOR: [Author/addressee names protected]
31252	14802	21-Dec-93	FIELD RECORDS FOR BH 43393;US DOE SAMPLE COLLECTION FORM;US DOE SAMPLE COLLECTION FORM; RESULTS OF RADIOLOGICAL MEASUREMENTS IN THE FIELD;RESULTS OF RADIOLOGICAL MEASUREMENTS IN THE FIELD;PRELIMINARY WELL-SITE FIELD LOG;HOLLOW STEM AUGER DRILLING FIELD ACTIVITIES REPORT;BH ABANDONMENT FIELD ACTIVITIES REPORT;PHOTOIONIZATION DETECTOR FIELD DATA FORM;EQUIPMENT DECON WASH CHECKLIST AND RECORD;HEAVY EQUIPMENT DECON/WASH CHECKLIST & RECORD;ROCKY FLATS PLANT BH LOG;SURFACE SOIL DATA COLLECTION FORM;SURFACE SOIL SAMPLING FIELD ACTIVITIES REPORT;SURFACE SOIL SAMPLING FIELD ACTIVITIES REPORT;RIG GEOLOGIST FIELD LOG BOOK;HEALTH & SAFETY TECH FIELD LOG BOOK;RECORD OF PROPERTY LEAVING RADIOLOGICALLY CONTROLLED AREA;PRE ACTIVITY CONTAMINATION SURVEY;CONTAMINATION SURVEY;CONTAMINATION SURVEY;POST ACTIVITY CONTAMINATION SURVEY;FIELD MONITORING RESULTS OF CUTTINGS OR CORE;RECORD OF DRILLING FLUIDS AND CUTTINGS;DRUM FIELD LOG FORM;CONTAMINANT CHARACTERIZATION FORM FOR GREY DRUMS;US DOE SAMPLE COLLECTION FORM
31252	14803	21-Dec-93	FIELD RECORDS FOR BH 43493;BH ABANDONMENT FIELD ACTIVITIES REPORT;SURFACE SOIL DATA COLLECTION FORM;SURFACE SOIL SAMPLING FIELD ACTIVITIES REPORT;SURFACE SOIL SAMPLING FIELD ACTIVITIES REPORT;PHOTOIONIZATION DETECTOR FIELD DATA FORM;RIG GEOLOGIST FIELD LOG BOOK KM;004 DAILY DRILLING FORMS CHECKLIST;RECORD OF PROPERTY LEAVING RADIOLOGICALLY CONTROLLED AREA;PRE WORK SURVEY;CONTAMINATION SURVEY;EQUIPMENT DECON WASH CHECKLIST AND RECORD;SAMPLE COLLECTION FORM;ROCKY FLATS PLANT BH LOG;POND 207A SAMPLING PLAN;HEALTH & SAFETY TECH FIELD LOG BOOK;POST WORK SURVEY;FIELD MONITORING RESULTS OF CUTTINGS OR CORE;RECORD OF DRILLING FLUIDS & CUTTINGS;DRUM FIELD LOG FORM;CONTAMINANT CHARACTERIZATION FORM FOR GREY DRUMS;US DOE SAMPLE COLLECTION FORM;US DOE SAMPLE COLLECTION FORM;RESULTS OF RADIOLOGICAL MEASUREMENTS IN THE FIELD;PRELIMINARY WELL SITE FIELD LOG;HOLLOW STEM AUGER DRILLING FIELD ACTIVITIES REPORT

Master List of Records Search Results

Receipt #	Bar Code	Orig. Date	Subject
31252	14953	10-Mar-93	FIELD RECORDS FOR BH43693;CONTAMINATION SURVEY;POST ACTIVITY SURVEY;EQUIPMENT DECON WASH CHECKLIST AND RECORD;HEAVY EQUIPMENT DECON WASH CHECKLIST AND RECORD;DRUM FIELD LOG FORM;CONTAMINANT CHARACTERIZATION FORM FOR GRAY DRUMS;US DOE SAMPLE COLLECTION FORM;PRELIMINARY WELL SITE FIELD LOG;PRELIMINARY WELL SITE FIELD LOG;HOLLOW STEM AUGER DRILLING FIELD REPORT;BH CONSTRUCTION DIAGRAM;BAT GROUNDWATER MONITORING SYSTEM;RIG GEOLOGIST FIELD LOG BOOK KM;HEALTH & SAFETY TECHNICIAN FIELD LOG BOOK DB;HEALTH & SAFETY TECHNICIAN FIELD LOG BOOK ANE;RECORD OF PROPERTY LEASING RADIOLOGICALLY CONTROLLED AREAS;CONTAMINATION SURVEY;PRE ACTIVITY SURVEY;FIELD MONITORING RESULTS OF CUTTINGS OR CORE;FIELD MONITORING RESULTS OF CUTTINGS;US DOE SAMPLE COLLECTION FORM;RESULTS OF RADIOLOGICAL MEASUREMENT IN FIELD;ROCKY FLATS PLANT BH LRD LOG;SURFACE CASING INSTALLATION FIELD ACTIVITIES;SURFACE SOIL DATA COLLECTION FORM;SURFACE SOIL SAMPLING FIELD ACTIVITIES REPORT;PHOTOIONIZATION DETECTOR FIELD DATA FORM;SITE SAFETY BRIEFINGS;POND SAMPLING PLAN;1PHOTO IN DUPLICATE NO 44480-02
31252	15551	10-Dec-92	FIELD RECORDS FOR BH44193;PREWORK SURVEY;CONTAMINATION SURVEY;FIELD MONITORING RESULTS OF CUTTINGS OR CORE FORM NO FO.8A;RECORD OF DRILLING FLUIDS AND CUTTINGS;US DOE DRUM FIELD LOG FORM NO FO.10A;US DOE CONTAMINANT CHARACTERIZATION FORM FOR GRAY DRUMSPENDING CHARACTERIZATION FORM NO FO.10C;US DOE SAMPLE COLLECTION FORM;ROCKY FLATS PLANT BOREHOLE LOG;PRELIMINARY WELL SITE FIELD LOG;HOLLOW STEM AUGER DRILLING FIELD ACTIVITIES REPORT;PHOTOIONIZATION DETECTOR FIELD DATA FORM;HEALTH AND SAFETY TECH FIELD LOG BOOK DH;RIG GEOLOGIST FIELD LOG CM;RIG GEOLOGIST FIELD LOG KP;HEALTH AND SAFETY TECH FIELD LOG BOOK VR;CONTAMINATION SURVEY FORM 1.1B;EQUIPMENT DECON WASH CHECKLIST AND RECORD;HEAVY EQUIPMENT DECON WASH CHECKLIST RECORD;FIELD MONITORING RESULTS OF CUTTINGS OR CORE;VERIFICATION OF ORGANIC VAPOR MONITORING RESULTS FORM NO FO.8B;RECORD OF DRILLING FLUIDS AND CUTTINGS FORM NO FO.8C;RESULTS OF RADIOLOGICAL MEASUREMENTS IN FIELD;PROTECTIVE CASING INSTALLATION FIELD ACTIVITIES;BOREHOLE ABANDONMENT FIELD ACTIVITIES RECORD;SURFACE SOIL DATA COLLECTION FORM;SURFACE SOIL SAMPLING FIELD ACTIVITIES REPORT;PHOTOIONIZATION DETECTOR FIELD DATA FORM;SITE SAFETY BRIEFINGS;GEOPHYSICAL BOREHOLE LOGGING FORM;GEOPHYSICAL LOG;DUPLICATE PHOTOS NOS 44297-20;44297-22;44758-22;44758-20;44758-21
31252	15552	15-Dec-92	FIELD RECORDS FOR BH44393;PREWORK SURVEY;CONTAMINATION SURVEY;CONTAMINATION SURVEY;FIELD MONITORING RESULTS OF CUTTINGS OR CORE;DRUM FIELD LOG FORM;CONTAMINANT CHARACTERIZATION FORM FOR GRAY DRUM;US DOE SAMPLE COLLECTION FORM;RESULTS OF RADIOLOGICAL MEASUREMENTS IN FIELD;ROCKY FLATS PLANT BH LOG;PRELIMINARY WELL SITE FIELD LOG;HOLLOW STEM AUGERS DRILLING FIELD ACTIVITIES REPORT;PROTECTIVE CASING INSTALLATION FIELD ACTIVITIES;BH ABANDONMENT FIELD ACTIVITIES REPORT;SURFACE SOIL DATA COLLECTION FORM;SURFACE SOIL SAMPLING FIELD ACTIVITIES REPORT;PHOTOIONIZATION DETECTOR FIELD DATA FORM;BH CONSTRUCTION DIAGRAM;BAT GROUNDWATER MONITORING PRINTOUT;BAT GROUNDWATER MONITORING PRINTOUT;HEALTH AND SAFETY TECH FIELD LOG BOOK DB;RIG GEOLOGIST FIELD LOG BOOK;EQUIPMENT DECON WASH CHECKLIST & RECORD;HEAVY EQUIPMENT DECON WASH CHECKLIST & RECORD;RECORD OF DRILLING FLUIDS & CUTTINGS;2 DUPLICATE PHOTOS NOS 444709-09;44479-11
31252	15553	11-Dec-92	FIELD RECORDS FOR BH44593;PREWORK SURVEY;CONTAMINATION SURVEY;POST WORK SURVEY;RECORD OF DRILLING FLUIDS AND CUTTINGS;DRUM FIELD LOG FORM;CONTAMINANT CHARACTERIZATION FORM FOR GRAY DRUMS;US DOE SAMPLE COLLECTION FORM;RESULTS OF RADIOLOGICAL MEASUREMENTS IN FIELD;ROCKY FLATS PLANT BH LOG;HOLLOW STEM AUGERS DRILLING FIELD ACTIVITIES REPORT;BH ABANDONMENT FIELD ACTIVITIES REPORT;SURFACE SOIL DATA COLLECTION FORM;HEALTH AND SAFETY TECH FIELD LOG BOOK VR;RIG GEOLOGIST FIELD LOG BOOK JE;EQUIPMENT DECON WASH CHECKLIST AND RECORD HEAVY EQUIPMENT DECON WASH CHECKLIST AND RECORD;FIELD MONITORING RESULTS OF CUTTINGS OR CORE;PROTECTIVE CASING INSTALLATION FIELD ACTIVITIES;SURFACE SOIL SAMPLING FIELD ACTIVITIES REPORT;PHOTOIONIZATION DETECTOR FIELD DATA FORM;BH DESCRIPTION

Master List of Records Search Results

Receipt #	Bar Code	Orig. Date	Subject
31255	15554	28-Dec-92	FIELD RECORDS FOR BH 44693;PREWORK SURVEY;CONTAMINATION SURVEY;EQUIPMENT DECON WASH CHECKLIST AND RECORD;FIELD MONITORING RESULTS OF CUTTINGS OR CORE;RECORD OF DRILLING FLUIDS AND CUTTINGS;DRUM FIELD LOG FORM;DRUM FIELD LOG FORM;CONTAMINANT CHARACTERIZATION FORM FOR GRAY DRUMS;US DOE SAMPLE COLLECTION FORM;RESULTS OF RADIOLOGICAL MEASUREMENTS IN THE FIELD;ROCKY FLATS PLANT BH LOG;HOLLOW STEM AUGER DRILLING FIELD ACTIVITIES REPORT;BH ABANDONMENT FIELD ACTIVITIES REPORT;SURFACE SOIL DATA COLLECTION FORM;SURFACE SOIL SAMPLING FIELD ACTIVITIES REPORT;PHOTOIONIZATION DETECTOR FIELD DATA FORM;HEALTH AND SAFETY TECH FIELD LOG BOOK ENTRIES VR;RIG GEOLOGIST FIELD LOG BOOK ENTRIES JE;SURFACE SOIL SAMPLING FIELD ACTIVITIES REPORT;MEMO
31255	15555	11-Jan-93	FIELD RECORDS FOR BH44793;PREWORK SURVEY;PREWORK SURVEY;CONTAMINATION SURVEY;FIELD MONITORING RESULTS OF CUTTINGS OR CORE;RECORD OF DRILLING FLUIDS AND CUTTINGS;DRUM FIELD LOG FORM;CONTAMINANT CHARACTERIZATION FORM FOR GRAY DRUMS;US DOE SAMPLE COLLECTION FORM;US DOE SAMPLE COLLECTION FORM;RESULTS OF RADIOLOGICAL MEASUREMENTS IN FIELD;ROCKY FLATS PLANT BH LOG;ROCKY FLATS PLANT BH LOG;HOLLOW STEM AUGER DRILLING FIELD ACTIVITIES;BH ABANDONMENT FIELD ACTIVITIES REPORT;SURFACE SOIL SAMPLING FIELD ACTIVITIES REPORT;SURFACE SOIL SAMPLING FIELD ACTIVITIES REPORT;PHOTOIONIZATION DETECTOR FIELD DATA FORM;HEALTH AND SAFETY TECH FIELD LOG BOOK VR;RIG GEOLOGIST FIELD LOG BOOK KM;EQUIPMENT DECON WASH CHECKLIST AND RECORD;SURFACE SOIL DATA COLLECTION FORM
31255	15556	19-Jan-93	FIELD RECORDS FOR BH44993;GROUNDWATER MONITORING WELL & PIEZOMETER REPORT;PHOTOIONIZATION DETECTOR FIELD DATA FORM;HEALTH & SAFETY TECH FIELD LOG BOOK DB;RIG GEOLOGIST FIELD LOG BOOK KM;EQUIPMENT DECON WASH CHECKLIST AND RECORD;RECORD OF DRILLING FLUIDS AND CUTTINGS;ROCKY FLATS PLANT BH LOG;CONTAMINATION SURVEY;POST ACTIVITY SURVEY;FIELD MONITORING RESULTS OF CUTTINGS OR CORE;DRUM FIELD LOG FORM;CONTAMINANT CHARACTERIZATION FORM FOR GRAY DRUMS;WELL INSTALLATION FORM;RESULTS OF RADIOLOGICAL MEASUREMENTS IN FIELD;PRELIMINARY WELL SITE FIELD LOG;HOLLOW STEM AUGER DRILLING FIELD ACTIVITIES;SURFACE CASING INSTALLATION FIELD ACTIVITIES
31255	15558	19-Mar-93	FIELD RECORDS FOR BH45693;CONTAMINATION SURVEY;EQUIPMENT DECON WASH CHECKLIST AND RECORD;FIELD MONITORING RESULTS OF CUTTING OR CORE;VERIFICATION OF ORGANIC VAPOR MONITORING RESULTS;US DOE DRUM FIELD LOG FORM;CONTAMINANT CHARACTERIZATION FORM FOR GRAY DRUMS;US DOE SAMPLE COLLECTION FORM;US DOE SAMPLE COLLECTION FORM;RFEDS WELL INSTALLATION FORM;PRELIMINARY WELL SITE FIELD LOG;HOLLOW STEM AUGER DRILLING FIELD ACTIVITIES REPORT;PROTECTIVE CASING INSTALLATION FIELD ACTIVITIES REPORT;GROUNDWATER MONITORING WELL & PIEZOMETER REPORT;PHOTOIONIZATION DETECTOR FIELD DATA FORM;RIG GEOLOGIST FIELD LOG BOOK JE CM;PRE WORK SURVEY;CONTAMINATION SURVEY;RECORD OF DRILLING FLUIDS AND CUTTINGS;ROCKY FLATS PLANT BH LOG
31255	15560	16-Mar-93	FIELD RECORDS FOR BH45893;CONTAMINATION SURVEY 2 PAGES;CONTAMINATION SURVEY;EQUIPMENT DECON WASH CHECKLIST AND RECORD;FIELD MONITORING RESULTS OF CUTTINGS OR CORE;VERIFICATION OF ORGANIC VAPOR MONITORING RESULTS;RECORD OF DRILLING FLUIDS & CUTTINGS;DRUM FIELD LOG FORM;DRUM FIELD LOG FORM;CONTAMINANT CHARACTERIZATION FORM FOR GRAY DRUMS;US DOE SAMPLE COLLECTION FORM;RFEDS WELL INSTALLATION FORM;HOLLOW STEM AUGER DRILLING ACTIVITIES REPORT;GROUNDWATER MONITORING WELL & PIEZOMETER REPORT;RIG GEOLOGIST FIELD LOG BOOK CM;RESULTS OF RADIOLOGICAL MEASUREMENTS IN FIELD;ROCKY FLATS PLANT BOREHOLD LOG;PRELIMINARY WELL SITE FIELD LOG;PROTECTED CASING INSTALLATION FIELD ACTIVITIES REPORT;PHOTOIONIZATION DETECTOR FIELD DATA FORM;2 PHOTOS NOS 44756-14;44756-10

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Receipt #	Bar Code	Orig. Date	Subject
32429	15561	18-Jan-93	FIELD RECORDS FOR BH40293;OU4 DAILY DRILLING FORMS CHECKLIST;CONTAMINATION SURVEY;PRE WORK SURVEY;CONTAMINATION SURVEY;CONTAMINATION SURVEY;CONTAMINATION SURVEY;POST ACTIVITY SURVEY;EQUIPMENT DECON AND WASH CHECKLIST;HEAVY EQUIPMENT DECON WASH CHECKLIST;FIELD MONITORING RESULTS OF CUTTINGS OR CORE;RECORD OF DRILLING FLUIDS AND CUTTINGS;DRUM FIELD LOG; CONTAMINANT CHARACTERIZATION FOR GRAY DRUMS;SAMPLE OLLECTION FORM;SAMPLE COLLECTION FORM;RESULTS OF RADIOLOGICAL MEASUREMENTS IN FIELD;RESULTS OF RADIOLOGICAL MEASUREMENTS IN FIELD;ROCKY FLATS PLANT BOREHOLE LOG;PRELIMINARY WELL SITE FIELD LOG;HOLLOW STEM AUGER DRILLING FIELD ACTIVITIES REPORT;SURFACE CASING INSTALLATION FIELD ACTIVITIES REPORT;SURFACE SOIL DATA COLLECTION FORM;SURFACE SOIL SAMPLING FIELD ACTIVIATIE REPORT;SURFACE SOIL SAMPLING FIELD ACTIVITIES REPORT;PHOTOIONIZATION DETECTOR FIELD DATA FORM;BOREHOLE CONSTRUCTION DIAGRAM; BAT MONITORING SYSTEM;HEALTH & SAFETY TECH LOG BOOK;RIG GEOLOGIST FIELD LOG BOOK;CORE LOG OF 40293;2 PHOTOS NO 44345-12
32430	15562	28-Jan-92	FIELD RECORDS FOR BH41193;PREWORK SURVEY;CONTAMINATION SURVEY;CONTAMINATION SURVEY; POSTWORK SURVEY;EQUIP DECON WASH CHECKLIST 2 PAGES;HEAVY EQUIP DECON WASH CHECKLIST 3 PAGES;FIELD MONITORING RESULTS OF CUTTINGS OR CORE;RECORD OF DRILLING FLUIDS AND CUTTINGS;DRUM FIELD LOG FORM;DRUM FIELD LOG FORM;CONTAMINANT CHARACTERIZATIONS FORM FOR GRAY DRUMS; SURFACE SOIL COLLECTION FORM;SUBSURFACE SOIL SAMPLE FORM;SUBSURFACE SOIL SAMPLE FORM; SUBSURFACE SOIL SAMPLE FORM;SUBSURFACE SOIL SAMPLE FORM;SUBSURFACE SOIL SAMPLE FORM; RESULTS OF RADIOLOGICAL MEASUREMENTS IN THE FIELD;PRELIMINARY WELL SITE FIELD LOG 2 PAGES; HOLLOW STEM AUGER DRILLING FIELD ACTIVITIES REPORT;GROUNDWATER MONITORING WELL AND PIEZOMETER REPORT;SURFACE SOIL DATA COLLECTION FORM;SURFACE SOIL SAMPLING FIELD ACTIVITIES REPORT;SURFACE SOIL SAMPLING FIELD ACTIVITIES REPORT;PHOTOIONIZATION DETECTOR FIELD DATA FORM;RIG GEOLOGIST LOG BOOK NOTES;HEALTH & SAFETY LOG BOOK NOTES;RFP BH LOG;CORE LOG
32776	15563	9-Feb-93	FIELD RECORDS FOR BH 44093;PREWORK SURVEY;CONTAMINATION SURVEY;CONTAMINATION SURVEY;CONTAMINATION SURVEY;POST ACTIVITY SURVEY;EQUIPMENT DECON WASH CHECKLIST 2 PAGES;HEAVY EQUIP DECON WASH CHECKLIST 3 PAGES;FIELD MONITORING RESULTING OF CUTTINGS OR CORE;FIELD MONITORING RESULTS OF CUTTINGS OR CORE;DRUM FIELD LOG FORM;DRUM FIELD LOG FORM;CONTAMINANT CHARACTERIZATION FORM FOR GRAY DRUM;CONTAMINANT CHARACTERIZATION FORM FOR GRAY DRUM;SURFACE SOIL SAMPLE FORM;SUBSURFACE SOIL SAMPLE FORM;SURFACE SOIL SAMPLE FORM;SUBSURFACE SOIL SAMPLE FORM;SURFACE SOIL SAMPLE FORM;SUBSURFACE SOIL SAMPLE FORM;SURFACE SOIL SAMPLE FORM;SUBSURFACE SOIL SAMPLE FORM;SURFACE SOIL SAMPLE FORM;SUBSURFACE SOIL SAMPLE FORM;RESULTS OF RADIOLOGICAL MEASUREMENTS IN THE FIELD;RESULTS OF RADIOLOGICAL MEASUREMENTS IN THE FIELD;RECORD OF DRILLING FLUIDS AND CUTTINGS;PRELIMINARY WELL SITE FIELD LOG;HOLLOW STEM AUGER DRILLING FIELD ACTIVITIES;SURFACE SOIL DATA COLLECTION FORM;SURFACE SOIL SAMPLING FIELD ACTIVITIES REPORT;SURFACE SOIL SAMPLING FIELD ACTIVITIES REPORT;PHOTOIONIZATION DETECTOR FIELD DATA FORM;PHOTOIONIZATION DETECTOR FIELD DATA;BAT GROUNDWATER MONITORING SYSTEM;VADOSE ZONE MONITORING BH DIAGRAM;HEALTH AND SAFETY LOG BOOK NOTES 25 PAGES;HEALTH AND SAFETY LOG BOOK NOTES 3 PAGES;RIG GEOLOGIST LOGBOOK NOTES 2 PAGES;RIG GEOLOGIST LOGBOOK NOTES 4 PAGES;VACTOSE ZONE LOG BOOK NOTES;DRILLING LOG BOOK NOTES;RFP BH LOG;PROTECTIVE CASING INSTALLATION FIELD REPORT;BH 44093
33618	15812	30-Sep-93	DRILLING PACKAGE;WARP;MW NO 0181;DAILY CHECK LIST;SITE SAFETY BRIEFINGS; PRE ACTIVITY; CONTAMINATION SURVEY;HEAVY EQUIPMENT DECONTAMINATION WASH CHECK LIST AND RECORD;DRUM FIELD LOG FORM;CONTAMINANT CHARACTERIZATION FORM;DRUM COMPOSITE LOG FORM;SAMPLE COLLECTION FORM;GROUNDWATER LEVEL MEASUREMENT FORM;RESULTS OF RADIOLOGICAL MEASUREMENTS IN THE FIELD;HOLLOW STEM AUGER DRILLING FIELD ACTIVITIES FORM;BH ABANDONMENT FIELD ACTIVITIES FORM;PHOTOIONIZATION DETECTOR FIELD DATA FORM;WELL PLUGGING AND ABANDONMENT FORM;LOG BOOK COPIES

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33618	15805	30-Sep-93	DRILLING PACKAGE;WARP;MW NO 0471;DAILY CHECK SHEET;PRE ACTIVITY;CONTAMINATION SURVEY; HEAVY EQUIPMENT DECONTAMINATION WASH CHECK LIST AND RECORD;EQUIPMENT DECONTAMINATION WASH CHECK LIST AND RECORD;DRUM FIELD LOG FORM;DRUM CHARACTERIZATION FORM;DRUM COMPOSITE LOG FORM;FIELD MONITORING RESULTS OF CUTTINGS OR CORE;RECORDS OF DRILLING FLUIDS AND CUTTINGS;SAMPLE COLLECTION;GROUNDWATER LEVEL MEASUREMENT FORM;RESULTS OF RADIOLOGICAL MEASUREMENTS IN THE FIELD;HOLLOW STEM AUGER DRILLING FIELD ACTIVITIES REPORT;BH ABANDONMENT FIELD ACTIVITIES REPORT;PHOTOIONIZATION DETECTOR FIELD DATA FORM;WELL PLUGGING AND ABANDONMENT FORM; LOG BOOK COPIES
33618	15806	30-Sep-93	DRILLING PACKAGE;WARP;MW NO 1374;DAILY CHECK LIST;PRE ACTIVITY;CONTAMINATION SURVEY; HEAVY EQUIPMENT DECONTAMINATION WASH CHECK LIST;RECORD OF DRILLING FLUIDS AND CUTTINGS; DRUM FIELD LOG FORM;CONTAMINANT CHARACTERIZATION FORM;DRUM COMPOSITE LOG FORM;SAMPLE COLLECTION FORM;RESULTS OF RADIOLOGICAL SURVEY;HOLLOW STEM AUGER DRILLING;BH ABANDONMENT FIELD ACTIVITIES REPORT;PHOTOIONIZATION DETECTOR FIELD DATA FORM;WELL PLUGGING AND ABANDONMENT FORM;FIELD MONITORING RESULTS CUTTING OR CORE; LOG BOOK COPIES
33618	15807	30-Sep-93	DRILLING PACKAGE;WARP;MW NO 1474;DAILY CHECK LIST;PRE ACTIVITY;CONTAMINATION SURVEY; HEAVY EQUIPMENT DECONTAMINATION WASH CHECK LIST;RECORD OF DRILLING FLUIDS AND CUTTINGS; DRUM FIELD LOG FORM;CONTAMINANT CHARACTERIZATION FORM;DRUM COMPOSITE LOG FORM;SAMPLE COLLECTION FORM;RESULTS OF RADIOLOGICAL MEASUREMENTS;HOLLOW STEM AUGER DRILLING;BH ABANDONMENT FIELD ACTIVITIES;PHOTOIONIZATION DETECTOR FIELD DATA FORM;FIELD MONITORING RESULTS OF CUTTINGS OR CORE;LOG BOOK COPIES
33618	15808	30-Sep-93	DRILLING PACKAGE;WARP;MW NO 1574;DAILY CHECK SHEET;PRE ACTIVITY;CONTAMINATION SURVEY FORM;EQUIPMENT DECONTAMINATION;HEAVY EQUIPMENT DECONTAMINATION;FIELD MONITORING RESULTS;RECORD OF DRILLING FLUIDS;DRUM FIELD LOG FORM;CONTAMINANT CHARACTERIZATION FORM;DRUM COMPOSITE LOG FORM;SAMPLE COLLECTION FORM;GROUNDWATER LEVEL MEASUREMENT FORM;RESULTS OF RADIOLOGICAL MEASUREMENTS;HOLLOW STEM AUGER DRILLING;BH ABANDONMENT;PHOTOIONIZATION DETECTOR FIELD DATA FORM;WELL PLUGGING AND ABANDONMENT FORM;LOG BOOK COPIES
33618	15809	30-Sep-93	DRILLING PACKAGE;WARP;MW NO 1674;DAILY CHECK SHEET;PRE ACTIVITY;CONTAMINATION SURVEY; EQUIPMENT DECONTAMINATION;HEAVY EQUIPMENT DECONTAMINATION;FIELD MONITORING RESULTS; RECORD OF DRILLING FLUIDS;DRUM FIELD LOG FORM;CONTAMINANT CHARACTERIZATION FORM;DRUM COMPOSITE LOG FORM;SAMPLE COLLECTION FORM;GROUNDWATER LEVEL MEASUREMENT FORM;RESULTS OF RADIOLOGICAL MEASUREMENTS;HOLLOW STEM AUGER DRILLING;BH ABANDONMENT FORM;PHOTOIONIZATION DETECTOR FIELD DATA FORM;WELL PLUGGING AND ABANDONMENT FORM;LOG BOOK COPIES
33618	15649	24-Nov-65	ENVIRONMENTAL MASTER FILE (EMF)// CONTAMINATION LEVELS AND DECONTAMINATION ACTIVITIES SUBSEQUENT TO THE INCIDENT OF NOVEMBER 9 1965 BUILDING 71 AUTHOR: [Author/addressee names protected]
33881	15813	30-Sep-93	DRILLING PACKAGE;WARP;MW NO 0281;DAILY CHECK SHEET;SITE SAFETY BRIEFING;PRE ACTIVITY; SURVEY;CONTAMINATION SURVEY;EQUIPMENT DECONTAMINATION;FIELD MONITORING;RECORDS OF DRILLING FLUIDS AND CUTTINGS;DRUM FIELD LOG FORM;CONTAMINANT CHARACTERIZATION FORM;DRUM COMPOSITE FORM;SAMPLE COLLECTION FORM;GROUNDWATER LEVEL MEASUREMENT FORM;RESULTS OF RADIOLOGICAL MEASUREMENTS IN THE FIELD;HOLLOW STEM AUGER DRILLING ACTIVITIES FORM;BH ABANDONMENT FORM;PHOTOIONIZATION DETECTOR FIELD DATA FORM;WELL PLUGGING AND ABANDONMENT FORM;LOG BOOK COPIES

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33908	16153	30-Sep-93	DRILLING PACKAGE;WARP;BH NO 01193;DAILY CHECK SHEET;SITE SAFETY BRIEFING; PRE ACTIVITY; CONTAMINATION SURVEY; EQUIPMENT DECONTAMINATION AND WASH CHECK LIST;HEAVY EQUIPMENT DECONTAMINATION AND WASH CHECK LIST;FIELD MONITORING OF CUTTINGS AND CORE;RECORD OF DRILLING FLUIDS AND CUTTINGS;DRUM FIELD LOG;CONTAMINANT CHARACTERIZATION FORM;DRUM COMPOSITE LOG FORM;RFEDS GROUNDWATER LEVEL MEASUREMENT FORM;RADIOLOGICAL MEASUREMENT FORM;BH LOG;PRELIMINARY WELL SITE LOG;HOLLOW STEM AUGER DRILLING ACTIVITIES FORM;SURFACE CASING INSTALLATION FORM;ROTARY AND CORE FIELD ACTIVITIES FORM;BH ABANDONMENT FORM;PHOTOIONIZATION DETECTOR FIELD DATA REPORT;WELL PLUGGING AND ABANDONMENT FORM;GEOPHYSICAL BH LOG;GEOLOGIST LOG BOOK;HISS LOG BOOK;HEAT STRESS MONITORING;MERRICK SURVEY;LOG BOOK COPIES
33908	15815	30-Sep-93	DRILLING PACKAGE;WARP;MW NO 0486;DAILY CHECK LIST;SITE SECURITY BRIEFINGS; PRE ACTIVITY; CONTAMINATION SURVEY;HEAVY EQUIPMENT DECONTAMINATION WASH CHECK LIST;RECORD OF DRILLING FLUIDS AND CUTTINGS;DRUM FIELD LOG FORM;CONTAMINANT CHARACTERIZATION FORM;DRUM COMPOSITE LOG FORM;SAMPLE COLLECTION FORM;GROUNDWATER LEVEL MEASUREMENT FORM;RESULTS OF RADIOLOGICAL MEASUREMENTS IN THE FIELD;HOLLOW STEM AUGER DRILLING ACTIVITIES FORM;BH ABANDONMENT FORM;PHOTOIONIZATION DETECTOR FIELD FORM;WELL PLUGGING AND ABANDONMENT FORM;FIELD MONITORING RESULTS OF CUTTING OR CORE;LOG BOOK COPIES
33908	15816	30-Sep-93	DRILLING PACKAGE;WARP;MW NO 1186;DAILY CHECK LIST;SITE SAFETY BRIEFINGS; PRE ACTIVITY; CONTAMINATION SURVEY;HEAVY EQUIPMENT DECONTAMINATION WASH CHECK LIST;RECORD OF DRILLING FLUIDS AND CUTTINGS;DRUM FIELD LOG FORM;CONTAMINANT CHARACTERIZATION FORM;DRUM COMPOSITE LOG FORM;SAMPLE COLLECTION FORM;RESULTS OF RADIOLOGICAL MEASUREMENTS;HOLLOW STEM AUGER DRILLING FIELD ACTIVITIES FORM;BH ABANDONMENT FIELD ACTIVITIES REPORT; PHOTOIONIZATION DETECTOR FIELD DATA FORM;WELL PLUGGING AND ABANDONMENT FORM;LOG BOOK COPIES
33908	15817	30-Sep-93	DRILLING PACKAGE;WARP;MW NO 1286;DAILY CHECK SHEET;PRE ACTIVITY;CONTAMINATION SURVEY; EQUIPMENT DECONTAMINATION WASH CHECK LIST AND RECORD;FIELD MONITORING RESULTS OF CUTTINGS OR CORE;RECORD OF DRILLING FLUIDS AND CUTTINGS;RESULTS OF RADIOLOGICAL MEASUREMENTS IN THE FIELD;BH ABANDONMENT FIELD ACTIVITIES REPORT;PHOTOIONIZATION DETECTOR FIELD DATA FORM;WELL PLUGGING AND ABANDONMENT FORM;LOG BOOK COPIES
33908	17624	30-Sep-93	DRILLING PACKAGE;WARP;MW NO B207189;FILE CHECK LIST;DAILY CHECK LIST;CONTAMINATION SURVEY;HEAVY EQUIPMENT DECONTAMINATION AND WASH;PRE ACTIVITY;FIELD MONITORING RESULTS OF CUTTINGS AND CORE;RECORD OF DRILLING FLUIDS AND CUTTINGS;DRUM FIELD LOG FORM;CONTAMINANT CHARACTERIZATION FORM; DRUM COMPOSITE LOG FORM;SAMPLE COLLECTION FORM;GROUNDWATER LEVEL MEASUREMENT FORM;RESULTS OF RADIOLOGICAL MEASUREMENTS FORM;HOLLOW STEM AUGER DRILLING FORM;BH ABANDONMENT FORM;PHOTOIONIZATION DETECTOR FIELD DATA FORM;WELL PLUGGING AND ABANDONMENT FORM;LOG BOOK COPIES
34130	17627	30-Sep-93	DRILLING PACKAGE;WARP;MW NO 00193;DAILY CHECK LIST;PRE EVOLUTION BRIEFING RECORD; PRE ACTIVITY;CONTAMINATION SURVEY;EQUIPMENT DECONTAMINATION AND WASH CHECK LIST;FIELD MONITORING RESULTS;CONTAMINANT CHARACTERIZATION FORM;RECORD OF DRILLING FLUIDS AND CUTTINGS;DRUM FIELD LOG FORM;HEAVY EQUIPMENT DECONTAMINATION AND WASH CHECK LIST;RFEDS WELL INSTALLATION FORM;RESULTS OF RADIOLOGICAL MEASUREMENTS FORM;SAMPLE COLLECTION FORM;HOLLOW STEM AUGER DRILLING FORM;GROUNDWATER MONITORING WELL AND PIEZOMETER FORM;PHOTOIONIZATION DETECTOR FIELD DATA REPORT;BH LOG;LOG BOOK COPIES

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34130	17626	30-Sep-93	DRILLING PACKAGE;WARP;MW NO 0490;DAILY CHECK LIST;PRE ACTIVITY;SITE SAFETY BRIEFING; EQUIPMENT DECONTAMINATION AND WASH CHECK LIST AND RECORD;HEAVY EQUIPMENT DECONTAMINATION WASH CHECK LIST AND RECORD;FIELD MONITORING RESULTS OF CUTTINGS AND CORE; RECORDS OF DRILLING AND FLUIDS AND CUTTINGS;DRUM FIELD LOG FORM;CONTAMINANT CHARACTERIZATION FORM;DRUM COMPOSITE LOG FORM;SAMPLE COLLECTION FORM;GROUNDWATER LEVEL MEASUREMENT FORM;RESULTS OF RADIOLOGICAL MEASUREMENTS IN THE FIELD;CONTAMINATION SURVEY;HOLLOW STEM AUGER DRILLING FIELD ACTIVITIES REPORT;BH ABANDONMENT FIELD ACTIVITIES REPORT;PHOTOIONIZATION DETECTOR FIELD DATA FORM;WELL PLUGGING AND ABANDONMENT FORM;LOG BOOK COPIES
34130	17625	30-Sep-93	DRILLING PACKAGE;WARP;MW NO B304289;DAILY CHECK LIST;SITE SAFETY BRIEFING;PRE ACTIVITY; CONTAMINATION SURVEY;EQUIPMENT DECONTAMINATION AND WASH CHECK LIST;HEAVY EQUIPMENT DECONTAMINATION AND WASH CHECK LIST;FIELD MONITORING FORM;RECORD OF DRILLING FLUIDS AND CUTTINGS FORM;DRUM FIELD LOG FORM;CONTAMINANT CHARACTERIZATION FORM;DRUM COMPOSITE LOG FORM;SAMPLE COLLECTION FORM;RESULTS OF RADIOLOGICAL MEASUREMENTS FORM;GROUNDWATER LEVEL MEASUREMENTS FORM; HOLLOW STEM AUGER DRILLING FORM;BH ABANDONMENT FIELD ACTIVITIES FORM;WELL PLUGGING AND ABANDONMENT FORM;PHOTOIONIZATION DETECTOR FORM;LOG BOOK COPIES
34142	17628	30-Sep-93	DRILLING PACKAGE;WARP;MW NO 00293;DAILY CHECK LIST;PRE ACTIVITY;CONTAMINATION SURVEY; FIELD MONITORING RESULTS OF CUTTINGS AND CORE;HEAVY EQUIPMENT DECONTAMINATION AND WASH CHECK LIST AND RECORD;DRUM FIELD LOG FORM;CONTAMINANT CHARACTERIZATION FORM;DRUM COMPOSITE LOG FORM;SAMPLE COLLECTION FORM;GROUNDWATER LEVEL MEASUREMENT FORM;WELL INSTALLATION FORM;HOLLOW STEM AUGER DRILLING FIELD ACTIVITIES REPORT;GROUNDWATER MONITORING WELL AND PIEZOMETER REPORT;PHOTOIONIZATION DETECTOR FIELD DATA FORM;SURVEY REPORT;BH LOG;LOG BOOK COPIES
34142	17629	30-Sep-93	DRILLING PACKAGE;WARP;MW NO 00393;DAILY CHECK LIST;PRE ACTIVITY;CONTAMINATION SURVEY; EQUIPMENT DECONTAMINATION;HEAVY EQUIPMENT DECONTAMINATION;FIELD MONITORING RESULTS OF CUTTINGS;RECORD OF DRILLING FLUIDS;DRUM FIELD LOG FORM;CONTAMINANT CHARACTERIZATION FORM; SAMPLE COLLECTION FROM;GROUNDWATER LEVEL MEASUREMENTS FORM;RESULTS OF RADIOLOGICAL MEASUREMENTS;BH LOG;WELL SITE FIELD LOG;HOLLOW STEM AUGER DRILLING FORM;RFEDS WELL INSTALLATION FORM; GROUNDWATER MONITORING AND PIEZOMETER;PHOTOIONIZATION DETECTOR FIELD DATA REPORT;MERRICK SURVEY;LOG BOOK COPIES
34142	17630	30-Sep-93	DRILLING PACKAGE;WARP;MW NO 00593;DAILY CHECK LIST;PRE ACTIVITY;CONTAMINATION SURVEY; SITE SAFETY BRIEFING;EQUIPMENT DECONTAMINATION AND WASH CHECK SHEET;FIELD MONITORING RESULTS;RECORD OF DRILLING FLUIDS;DRUM FIELD LOG FORMS;CONTAMINANT CHARACTERIZATION FORM;DRUM COMPOSITE LOG FORM;SAMPLE COLLECTION FORM;GROUNDWATER LEVEL MEASUREMENT FORM;RESULTS OF RADIOLOGICAL MEASUREMENTS;BH LOG;PRELIMINARY WELL SITE FIELD LOG;HOLLOW STEM AUGER DRILLING FORM;SURFACE CASING INSTALLATION;ROTARY CORE;BH ABANDONMENT FORM;PHOTOIONIZATION DETECTOR FIELD DATA FORM;WELL PLUGGING AND ABANDONMENT FORM;MERRICK SURVEY;LOG BOOK COPIES
34142	17631	30-Sep-93	DRILLING PACKAGE;WARP;MW NO 00693;DAILY CHECK SHEET;PRE ACTIVITY;CONTAMINATION SURVEY; EQUIPMENT DECONTAMINATION;HEAVY EQUIPMENT DECONTAMINATION;FIELD MONITORING RESULTS; RECORD OF DRILLING FLUIDS; DRUM FIELD LOG FORM;CONTAMINANT CHARACTERIZATION FORM;DRUM COMPOSITE FORM;SAMPLE COLLECTION FORM;GROUNDWATER LEVEL MEASUREMENT FORM;RESULTS OF RADIOLOGICAL MEASUREMENTS; BH LOG;PRELIMINARY FIELD LOG;HOLLOW STEM AUGER DRILLING FORM;SURFACE CASINGS INSTALL;SITE SAFETY BRIEFING;ROTARY CORE;BH ABANDONMENT REPORT; PHOTOIONIZATION DETECTOR FIELD DATA REPORT;WELL PLUGGING AND ABANDONMENT FORM;BH GEOPHYSICAL LOG;MERRICK SURVEY;LOG BOOK COPIES

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34142	17632	30-Sep-93	DRILLING PACKAGE;WARP;MW NO 00893;DAILY CHECK SHEET;RADIATION WORK PERMIT; CONTAMINATION SURVEY;PRE ACTIVITY; EQUIPMENT DECONTAMINATION AND WASH CHECK LIST;HEAVY EQUIPMENT DECONTAMINATION AND WASH CHECK LIST;FIELD MONITORING OF CUTTINGS AND CORE; RECORD OF DRILLING FLUIDS AND CUTTINGS;DRUM FIELD LOG;CONTAMINANT CHARACTERIZATION FORM; RFEDS;GROUNDWATER LEVEL MEASUREMENT FORM;RADIOLOGICAL MEASUREMENTS FIELD DATA ACTIVITIES REPORT;DRUM COMPOSITE LOG FORM;BH LOG;PRELIMINARY WELL SITE LOG;HOLLOW STEM AUGER DRILLING FORM;SURFACE CASING INSTALLATION;BH ABANDONMENT REPORT;PHOTOIONIZATION DETECTOR FIELD DATA REPORT;WELL PLUGGING AND ABANDONMENT FORM;BH GEOPHYSICAL LOG;SITE SAFETY BRIEFING;HEAT STRESS MONITOR;MERRICK SURVEY;HISS LOG;LOG BOOK COPIES
34142	17637	30-Sep-93	DRILLING PACKAGE;WARP;MW NO 00993;DAILY CHECK SHEET;PRE ACTIVITY;CONTAMINATION SURVEY;EQUIPMENT DECONTAMINATION AND WASH CHECK LIST;HEAVY EQUIPMENT DECONTAMINATION AND WASH CHECK LIST;FIELD MONITORING RESULTS;RECORD OF DRILLING FLUIDS;DRUM FIELD LOG; CONTAMINANT CHARACTERIZATION LOG;SAMPLE COLLECTION FORM;RESULTS OF RADIOLOGICAL MEASUREMENTS;BH LOG; PRELIMINARY WELL SITE FIELD LOG;HOLLOW STEM AUGER DRILLING FORM;ROTARY CORE;SURFACE CASING INSTALL;BH ABANDONMENT REPORT;PHOTOIONIZATION DETECTOR FIELD DATA REPORT;WELL PLUGGING AND ABANDONMENT FORM;BH GEOPHYSICAL LOG;MERRICK SURVEY;LOG BOOK COPIES
37544	17638	30-Sep-93	DRILLING PACKAGE;WARP;MW NO 01093;DAILY CHECK LIST;RADIATION WORK PERMIT;CONTAMINATION SURVEY;PRE ACTIVITY; EQUIPMENT DECONTAMINATION AND WASH CHECK LIST;HEAVY EQUIPMENT DECONTAMINATION AND WASH CHECK LIST;FIELD MONITORING OF CUTTINGS AND CORE;RECORDS OF DRILLING FLUIDS AND CUTTINGS; DRUM FIELD LOG; CONTAMINANT CHARACTERIZATION FORM;DRUM COMPOSITE LOG;RFEDS;RADIOLOGICAL MEASUREMENTS IN THE FIELD REPORT;BH LOG;PRELIMINARY WELL SITE LOG;HOLLOW STEM AUGER FIELD ACTIVITIES REPORT; SURFACE CASING INSTALL;BH ABANDONMENT REPORT;PHOTOIONIZATION DETECTOR FIELD DATA REPORT; WELL PLUGGING AND ABANDONMENT REPORT;BH GEOPHYSICAL LOG;MERRICK SURVEY;HSS LOG; LOG BOOK COPIES
37650	17639	30-Sep-93	DRILLING PACKAGE;WARP;BH NO 01293;DAILY CHECK LIST;SITE SAFETY BRIEFING; PRE ACTIVITY; CONTAMINATION SURVEY;EQUIPMENT DECONTAMINATION AND WASH CHECK LIST;HEAVY EQUIPMENT DECONTAMINATION AND WASH CHECK LIST;FIELD MONITORING RESULTS OF CUTTINGS AND CORE;RECORD OF DRILLING FLUIDS AND CUTTINGS;DRUM FIELD LOG FORM;CONTAMINANT CHARACTERIZATION FORM;DRUM COMPOSITE LOG FORM;SAMPLE COLLECTION LOG FORM;GROUNDWATER LEVEL MEASUREMENT FORM;RESULTS OF RADIOLOGICAL MEASUREMENTS FORM;HOLLOW STEM AUGER DRILLING REPORT;SURFACE CASING INSTALLATION FORM;ROTARY AND CORE DRILLING FORM;PHOTOIONIZATION DETECTOR FIELD DATA REPORT;BH ABANDONMENT REPORT;WELL PLUGGING AND ABANDONMENT FORM;GEOPHYSICAL BH LOG;MERRICK SURVEY;LOG BOOK COPIES
37657	17709	30-Sep-93	DRILLING PACKAGE;WARP;MW NO 4586;DAILY CHECK LIST;CONTAMINATION SURVEY;SITE SAFETY BRIEFING;PRE ACTIVITY; EQUIPMENT DECONTAMINATION WASH CHECK LIST;HEAVY EQUIPMENT DECONTAMINATION WASH CHECK LIST;FIELD MONITORING OF CUTTINGS AND CORE;RECORD OF DRILLING FLUIDS AND CUTTINGS;DRUM FIELD LOG FORM;CONTAMINANT CHARACTERIZATION FORM;DRUM COMPOSITE LOG FORM;SAMPLE COLLECTION FORM;RESULTS OF RADIOLOGICAL MEASUREMENTS;HOLLOW STEM AUGER DRILLING FIELD ACTIVITIES FORM;BH ABANDONMENT FIELD ACTIVITIES FORM;PHOTOIONIZATION DETECTOR FIELD DATA FORM;WELL PLUGGING AND ABANDONMENT FORM;LOG BOOK COPIES
37657	17710	30-Sep-93	DRILLING PACKAGE;WARP;MW NO B201489;DAILY CHECK LIST;SITE SAFETY BRIEFING; PRE ACTIVITY; CONTAMINATION SURVEY;EQUIPMENT DECONTAMINATION WASH CHECK LIST;FIELD MONITORING RESULTS; RECORD OF DRILLING FLUIDS;DRUM FIELD LOG FORM;CONTAMINANT CHARACTERIZATION FORM;DRUM COMPOSITE LOG FORM;SAMPLE COLLECTION FORM;RESULTS OF RADIOLOGICAL MEASUREMENTS;HOLLOW STEM AUGER FIELDS ACTIVITIES FORM;BH ABANDONMENT FIELD ACTIVITIES FORM;PHOTOIONIZATION DETECTOR FIELD DATA FORM;WELL PLUGGING AND ABANDONMENT FORM;LOG BOOK COPIES

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37657	17711	30-Sep-93	DRILLING PACKAGE;WARP;MW NO B203689;DAILY CHECK LIST;PRE ACTIVITY;CONTAMINATION SURVEY;EQUIPMENT DECONTAMINATION;FIELD MONITORING RESULTS;RECORD OF DRILLING FLUIDS;DRUM LOG FORM;CONTAMINANT CHARACTERIZATION LOG FORM;RESULTS OF RADIOLOGICAL MEASUREMENTS; HOLLOW STEM AUGER DRILLING FORM;PHOTOIONIZATION DETECTOR FIELD DATA FORM;WELL PLUGGING AND ABANDONMENT FORM;SAMPLE COLLECTION FORM; DRUM COMPOSITE LOG FORM;LOG BOOK COPIES
37657	17713	30-Sep-93	MW 5987;WELL COMPLETION INFORMATION;FIELD LOG OF BOREHOLE;FILE CHECKSHEET;DAILY CHECK SHEET;PRE ACTIVITY CONTAMINATION SURVEY;HEAVY EQUIPMENT DECONTAMINATION;FIELD MONITORING RESULTS OF CUTTINGS AND CORE;RECORD OF DRILLING FLUIDS;DRUM FIELD LOG FORM;CONTAMINATION STRUCTURE;DRUM COMPOSITE LOG FORM;SAMPLE COLLECTION FORM;HOLLOW STEM AUGER DRILLING FORM;BH ABANDONMENT FORM;PHOTOIONIZATION DETECTOR FIELD DATA FORM;WELL PLUGGING AND ABANDONMENT FORM;LOG BOOK COPIES
37657	17714	30-Sep-93	MW 6387;WELL COMPLETION INFORMATION;FIELD LOG OF BOREHOLE;DRILLING PACKAGE;DAILY CHECK LIST;SITE SAFETY BRIEFING;PRE ACTIVITY; CONTAMINATION SURVEY;EQUIPMENT DECONTAMINATION WASH CHECK LIST;HEAVY EQUIPMENT DECONTAMINATION WASH CHECK LIST;FIELD MONITORING RESULTS OF CUTTINGS AND CORE;RECORD OF DRILLING FLUIDS AND CUTTINGS;DRUM FIELD LOG FORM;CONTAMINANT CHARACTERIZATION FORM;DRUM COMPOSITE LOG FORM;SAMPLE COLLECTION FORM;GROUNDWATER LEVEL MEASUREMENT FORM;RESULTS OF RADIOLOGICAL MEASUREMENTS;HOLLOW STEM AUGER DRILLING FORM;BH ABANDONMENT FIELD ACTIVITIES FORM;PHOTOIONIZATION DETECTOR FORM;WELL PLUGGING AND ABANDONMENT FORM;LOG BOOK COPIES
37693	17721	30-Sep-93	DRILLING PACKAGE;WARP;MW NO 00493;DAILY CHECK LIST;SITE SAFETY BRIEFING;PRE ACTIVITY; CONTAMINATION SURVEY;EQUIPMENT DECONTAMINATION AND WASH CHECK LIST AND RECORD;HEAVY EQUIPMENT DECONTAMINATION AND WASH CHECK LIST AND RECORD;FIELD MONITORING OF CUTTINGS AND CORE;RECORD OF DRILLING FLUIDS AND CUTTINGS;DRUM FIELD LOG FORM;CONTAMINANT CHARACTERIZATION FORM;DRUM COMPOSITE LOG FORM;RESULTS OF RADIOLOGICAL MEASUREMENTS IN THE FIELD;SAMPLE COLLECTION FORM;WELL INSTALLATION FORM;HOLLOW STEM AUGER DRILLING FIELD ACTIVITIES REPORT; GROUNDWATER MONITORING WELL AND PIEZOMETER REPORT;PHOTOIONIZATION DETECTOR FIELD DATA FORM;SURVEY REPORT; BH LOG COPY;LOG BOOK COPIES
37693	17722	30-Sep-93	DRILLING PACKAGE;WARP;MW NO 00793;DAILY CHECK LIST;RADIATION WORK PERMIT;PRE ACTIVITY; CONTAMINATION SURVEY;EQUIPMENT DECONTAMINATION AND WASH CHECK LIST;HEAVY EQUIPMENT DECONTAMINATION AND WASH CHECK LIST;FIELD MONITORING RESULTS CUTTING AND CORE;RECORD OF DRILLING FLUIDS AND CUTTING ;DRUM FIELD LOG FORM;CONTAMINANT CHARACTERIZATION FORM;SAMPLE COLLECTION FORM;RESULTS OF RADIOLOGICAL MEASUREMENTS REPORT;HOLLOW STEM AUGER DRILLING FIELD ACTIVITIES REPORT;SURFACE CASING INSTALLATION;BH ABANDONMENT REPORT;PHOTOIONIZATION DETECTOR FIELD DATA REPORT;WELL PLUGGING AND ABANDONMENT FORM;GEOPHYSICAL BH LOG;LOG BOOK COPIES
37693	17791	30-Sep-93	DRILLING PACKAGE;WARP;MW NO 05093;CORE PHOTOGRAPH;DAILY CHECK SHEET;FILE CHECK SHEET;SAMPLE LABEL SHEET;PRE WORK SURVEY;CONTAMINATION SURVEY;EQUIPMENT DECON AND WASH CHECK SHEET;FIELD MONITORING RESULTS OF CUTTINGS AND CORE;RECORDS OF DRILLING FLUIDS AND CUTTINGS;DRUM LOG FORM;CONTAMINANT CHARACTERIZATION FORM;SAMPLE COLLECTION FORM; COMPOSITE;VOA;RFEDS WELL INSTALLATION FORM;RESULTS OF RADIOLOGICAL MEASUREMENTS IN THE FIELD;BH LOG;WELL SITE LOG;HOLLOW STEM AUGER DRILLING FORM;GROUNDWATER MONITORING WELL AND PIEZOMETER REPORT;SURFACE SOIL DATA FORM;SURFACE SOIL SAMPLING FIELD REPORT;PHOTOIONIZATION DETECTOR FIELD DATA REPORT;HEALTH AND SAFETY LOG BOOK;BH CONSTRUCTION DIAGRAM;RIG GEOLOGIST LOG BOOK;GROUNDWATER LEVEL MEASUREMENT FORMOU4

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37693	17716	30-Sep-93	DRILLING PACKAGE;WARP;MW NO B204689;DAILY CHECK LIST;PRE WASH SURVEY;CONTAMINATION SURVEY;HEAVY EQUIPMENT DECONTAMINATION WASH CHECK LIST;FIELD RESULTS OF CUTTINGS AND CORE;RECORD OF DRILLING FLUIDS AND CUTTINGS;DRUM FIELD LOG FORM; CONTAMINANT CHARACTERIZATION FORM;DRUM COMPOSITE LOG FORM;SAMPLE COLLECTION FORM;RESULTS OF RADIOLOGICAL MEASUREMENTS;HOLLOW STEM AUGER DRILLING FORM;BH ABANDONMENT FORM;PHOTOIONIZATION DETECTOR FORM;WELL PLUGGING AND ABANDONMENT FORM;LOG BOOK COPIES
37693	17717	30-Sep-93	DRILLING PACKAGE;WARP;MW NO B206189;DAILY CHECK SHEET;PRE ACTIVITY;CONTAMINATION SURVEY;EQUIPMENT DECONTAMINATION;HEAVY EQUIPMENT DECONTAMINATION;FIELD MONITORING RESULTS;RECORD OF DRILLING FLUIDS FORM;DRUM FIELD LOG FORM;CONTAMINANT CHARACTERIZATION FORM;DRUM COMPOSITE LOG FORM;SAMPLE COLLECTION FORM;GROUNDWATER LEVEL MEASUREMENT FORM;RESULTS OF RADIOLOGICAL MEASUREMENTS;HOLLOW STEM AUGER DRILLING FORM;BH ABANDONMENT FORM;PHOTOIONIZATION DETECTOR FIELD DATA FORM;WELL PLUGGING AND ABANDONMENT FORM;LOG BOOK COPIES
37693	17718	30-Sep-93	DRILLING PACKAGE;WARP;MW NO B206389;DAILY CHECK LIST;SITE SAFETY BRIEFING;PRE ACTIVITY; CONTAMINATION SURVEY;HEAVY EQUIPMENT DECONTAMINATION WASH CHECK LIST;FIELD MONITORING RESULTS OF CUTTINGS AND CORE;DRUM FIELD LOG FORM;CONTAMINATION CHARACTERIZATION FORM;DRUM COMPOSITE LOG FORM;SAMPLE COLLECTION;RESULTS OF RADIOLOGICAL MEASUREMENTS;HOLLOW STEM AUGER DRILLING FORM;WELL PLUGGING AND ABANDONMENT FORM;PHOTOIONIZATION DETECTOR FIELD DATA FORM;BH ABANDONMENT FORM;LOG BOOK COPIES
37693	17719	30-Sep-93	DRILLING PACKAGE;WARP;MW NO B301889;DAILY CHECK LIST;SITE SAFETY BRIEFING;PRE ACTIVITY; CONTAMINATION SURVEY;HEAVY EQUIPMENT DECONTAMINATION AND WASH CHECK LIST;DRUM FIELD LOG FORM;CONTAMINANT CHARACTERIZATION FORM;DRUM COMPOSITE LOG FORM;SAMPLE COLLECTION FORM;HOLLOW STEM AUGER DRILLING FORM;BH ABANDONMENT FIELD ACTIVITIES FORM;PHOTOIONIZATION DETECTOR FORM;WELL PLUGGING FORM;LOG BOOK COPIES
37693	17715	30-Sep-94	MW 6787;WELL COMPLETION INFORMATION;FIELD LOG OF BOREHOLE;DRILLING PACKAGE;FILE CHECK SHEET;DAILY CHECK SHEET;PRE ACTIVITY; CONTAMINATION SURVEY;EQUIPMENT DECONTAMINATION WASH CHECK LIST;HEAVY EQUIPMENT DECONTAMINATION WASH CHECK LIST;FIELD MONITORING RESULTS;RECORD OF DRILLING FLUIDS;DRUM FIELD LOG FORM;CONTAMINANT CHARACTERIZATION FORM;SAMPLE COLLECTION FORM;GROUNDWATER LEVEL MEASUREMENT FORM;RESULTS OF RADIOLOGICAL FORM;HOLLOW STEM AUGER DRILLING FORM;BH ABANDONMENT FORM;PHOTOIONIZATION DETECTOR FORM;WELL PLUGGING AND ABANDONMENT FORM;LOG BOOK COPIES
37697	17792	30-Sep-93	DRILLING PACKAGE;WARP;MW NO 05193;PHOTOGRAPH OF CORE;DAILY CHECK SHEET;FILE CHECK SHEET;SAMPLE LABEL SHEET;PRE WORK SURVEY;CONTAMINATION SURVEY;EQUIPMENT DECONTAMINATION AND WASH CHECK LIST;FIELD MONITORING RESULTS OF CUTTINGS AND CORE;RECORD OF DRILLING FLUIDS AND CUTTINGS;DRUM FIELD LOG FORM;SAMPLE COLLECTION COMPOSITE;VOA;RFEDS WELL INSTALLATION FORM;GROUNDWATER LEVEL MEASUREMENT FORM;RESULTS OF RADIOLOGICAL MEASUREMENTS IN THE FIELD;BH LOG;WELL SITE FIELD LOG;HOLLOW STEM AUGER DRILLING FORM;GROUNDWATER MONITORING WELL AND PIEZOMETER REPORT;SURFACE SOIL DATA FORM;SURFACE SOIL FIELD SAMPLING REPORT ; PHOTOIONIZATION DETECTOR FIELD DATA REPORT;HEALTH AND SAFETY LOG BOOK;BH DIAGRAM;RIG GEOLOGIST LOG BOOK OU4

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37700	17793	30-Sep-93	DRILLING PACKAGE;WARP;MW NO 05293;PHOTOGRAPH OF CORE;DAILY CHECK SHEET;FILE CHECK SHEET;SAMPLE LABEL SHEETS;PRE WORK SURVEY;CONTAMINATION SURVEY;EQUIPMENT DECONTAMINATION AND WASH CHECK SHEET;FIELD RESULTS OF CUTTINGS AND CORE;RECORD OF DRILLING FLUIDS AND CUTTINGS;DRUM FIELD LOG FORM;CONTAMINANT CHARACTERIZATION FORM;SAMPLE COLLECTION FORM; COMPOSITE; VOA;RNS; RFEDS WELL INSTALLATION FORM;RESULTS OF RADIOLOGICAL MEASUREMENTS IN THE FIELD;BH LOG;WELL SITE LOG;HOLLOW STEM AUGER DRILLING FORM;GROUNDWATER MONITORING WELL AND PIEZOMETER REPORT;SURFACE SOIL DATA COLLECTION FORM;SURFACE SOIL FIELD ACTIVITY REPORT;PHOTOIONIZATION DETECTOR FIELD DATA REPORT;HEALTH AND SAFETY LOG BOOK;BH CONSTRUCTION DIAGRAM;RIG GEOLOGIST LOG BOOK OU4
37700	17794	30-Sep-93	DRILLING PACKAGE;WARP;MW NO 05393;PHOTOGRAPH OF CORE;DAILY CHECK SHEET;FILE CHECK SHEET;SAMPLE LABEL CHECK SHEET;PRE WORK SURVEY;CONTAMINATION SURVEY;EQUIPMENT DECONTAMINATION AND WASH CHECK LIST;FIELD MONITORING RESULTS OF CUTTINGS AND CORE;RECORD OF DRILLING FLUIDS AND CUTTINGS;DRUM FIELD LOG FORM;CONTAMINANT CHARACTERIZATION FORM;SAMPLE COLLECTION FORM;COMPOSITE;VOA; RFEDS WELL INSTALLATION FORM;RESULTS OF RADIOLOGICAL MEASUREMENTS IN THE FIELD;BH LOG;WELL SITE FIELD LOG;HOLLOW STEM AUGER DRILLING FORM; GROUNDWATER MONITORING WELL AND PIEZOMETER REPORT;SURFACE SOIL DATA FORM;SURFACE SOIL SAMPLING FIELD ACTIVITIES REPORT;PHOTOIONIZATION DETECTOR FIELD, DATA REPORT;HEALTH AND SAFETY LOG BOOK;BH CONSTRUCTION DIAGRAM;RIG GEOLOGIST LOG BOOK OU4
37700	21377	29-Oct-93	FIELD RECORDS FOR BH 46593;SITE SAFETY BRIEFINGS;RECORD OF PROPERTY LEAVING RCAS;PREACTIVITY CONTAMINATION SURVEY;CONTAMINATION SURVEY;POST ACTIVITY SURVEY;EQUIPMENT DECON WASH CHECKLIST AND RECORD;FIELD MONITORING RESULTS OF CUTTINGS OR CORE;RECORD OF DRILLING FLUIDS AND CUTTINGS;DRUM FIELD LOG FORM;CONTAMINANT CHARACTERIZATION FORM FOR GRAY DRUMS;SAMPLE COLLECTION FORM;SAMPLE COLLECTION FORM;RESULTS OF RADIOLOGICAL MEASUREMENTS IN FIELD;RFP BH LOG;PRELIMINARY WELL SITE FIELD LOG;HOLLOW STEM AUGER DRILLING FIELD REPORT;BH ABANDONMENT FIELD ACTIVITIES REPORT;SURFACE SOIL DATA COLLECTION FORM;SURFACE SOIL SAMPLING FIELD ACTIVITIES REPORT;PHOTOIONIZATION DETECTOR FIELD DATA FORM;HEALTH & SAFETY TECH FIELD LOG BOOK;RIG GEOLOGIST FIELD LOG BOOK;
37728	21378	2-Nov-93	FIELD RECORDS FOR BH 46693;SITE SAFETY BRIEFINGS;RECORD OF PROPERTY LEAVING RCA;PRE ACTIVITY SURVEY;CONTAMINATION SURVEY;POST ACTIVITY SURVEY;EQUIPMENT DECON WASH CHECKLIST;FIELD MONITORING RESULTS OF CUTTINGS CORE;RECORD OF DRILLING FLUIDS AND CUTTING;DRUM FIELD LOG;CONTAMINANT CHARACTERIZATION FORM FOR WHITE DRUMS;SAMPLE COLLECTION FORM;SAMPLE COLLECTION FORM;RESULTS OF RADIOLOGICAL MEASUREMENTS FIELD;RFP BH LOG;PRELIMINARY WELL SITE FIELD LOG;HOLLOW STEM AUGER DRILLING FIELD REPORT;BH ABANDONMENT FIELD REPORT;SURFACE SOIL DATA COLLECTION FORM;SURFACE SOIL SAMPLING FIELD ACTIVITIES REPORT;SURFACE SOIL SAMPLING FIELD ACTIVITIES REPORT;PHOTOIONIZATION DETECTOR FIELD DATA FORM;RIG GEOLOGISTS FIELD LOG BOOK;HEALTH & SAFETY TECH FIELD LOG BOOK
37751	21379	2-Nov-93	FIELD RECORDS FOR BH 46793;SITE SAFETY BRIEFINGS;RECORD OF PROPERTY LEAVING RAD CONTROLLED AREA;PRE ACTIVITY SURVEY;CONTAMINATION SURVEY;POST ACTIVITY SURVEY;EQUIPMENT DECON WASH CHECKLIST & RECORD;FIELD MONITORING RESULTS OF CUTTINGS CORE;RECORD OF DRILLING FLUIDS AND CUTTINGS;DRUM FIELD LOG FORM;CONTAMINANT CHARACTERIZATION FORM FOR WHITE DRUMS;SAMPLE COLLECTION FORM;SAMPLE COLLECTION FORM;RESULTS OF RADIOLOGICAL MEASUREMENTS IN FIELD;RFP BH LOG;PRELIMINARY WELL SITE FIELD LOG;HOLLOW STEM AUGER DRILLING FIELD ACTIVITIES;BH ABANDONMENT FIELD REPORT;SURFACE SOIL DATA COLLECTION FORM;SURFACE SOIL SAMPLING FIELD ACTIVITIES REPORT;PHOTOIONIZATION DETECTOR FIELD DATA FORM;HEALTH & SAFETY FIELD LOG BOOK;RIG GEOLOGIST FIELD LOG BOOK
37766	21600	13-Oct-92	DECON LOG BOOK

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37766	22001	18-Nov-93	FIELD RECORDS FOR BH 46893;SITE SAFETY BRIEFINGS;RECORD OF PROPERTY LEAVING RCA;PRE ACTIVITY SURVEY;CONTAMINATION SURVEY;POST ACTIVITY SURVEY;EQUIPMENT DECON WASH CHECKLIST & RECORD;FIELD MONITORING RESULTS OF CUTTINGS OF CORE;WHITE DRUM FIELD LOG BOOK;CONTAMINANT CHARACTERIZATION FORM GRAY DRUMS;SAMPLE COLLECTION FORM;SAMPLE COLELCTION FORM;RESULTS OF RADIOLOGICAL MEASUREMENTS IN FIELD;RFP PLANT BH LOG;PRELIMINARY WELL SITE FIELD LOG;HOLLOW STEM AAUGER DRILLING REPORTS;SURFACE SOIL DATA COLLECTION FORM;SURFACE SOIL SAMPLING FIELD ACTIVITIES REPORT;SURFACE SOIL SAMPLING FIELD ACTIVITIES REPORT;PHOTOIONIZATION DETECTOR FIELD DATA FORM;RIG GEOLOGIST FIELD LOG BOOK;HEALTH & SAFETY FIELD LOG BOOK
37766	22002	19-Nov-93	FIELD RECORDS FOR BH 46993;SITE SAFETY BRIEFINGS;RECORD OF PROPERTY LEAVING RCA;PRE ACTIVITY SURVEY;CONTAMINATION SURVEY;POST ACTIVITY SURVEY;EQUIPMENT DECON WASH CHECKLIST & RECORD;FIELD MONITORING RESULTS OF CUTTING OR CORE;WHITE DRUM FIELD LOG FORM;CONTAMINANT CHARACTERIZATION FORM FOR WHITE DRUMS;SAMPLE COLLECITON FORM;SAMPLE COLLECTION FORM;RESULTS OF RADIOLOGICAL MEASUREMENTS IN THE FIELD;RFP BH LOG;PRELIMINARY WELL SITE FIELD LOG;HOLLOW STEM AUGER DRILLING REPORT;SURFACE SOIL DATA COLLECTION FORM;SURFACE SOIL SAMPLING FIELD ACTIVITIES REPORT;SURFACE SOIL SAMPLING FIELD ACTIVITIES REPORT;PHOTOIONIZATION DETECTOR FIELD DATA FORM;POND 207B SAMPLING PLAN;HEALTH & SAFETY FIELD LOG BOOK
37795	22027	30-Aug-93	DECON HEALTH AND SAFETY LOG BOOK
37795	22036	1-Jan-01	FIELD RECORDS FOR BH 47093;FQT-021094-1;OU4 DAILY DRILLING FORMS CHECKLIST;SITE SAFETY BRIEFING;RECORD OF PROPERTY LEAVING RADIOLOGICAL CONTROLLED AREAS RCA;PRE ACTIVITY CONTAMINATION SURVEY;POST ACTIVITY CONTAMINATION SURVEY;EQUIPMENT DECONTAMINATION WASH CHECKLIST AND RECORD;FIELD MONITORING RESULTS OF CUTTINGS OR CORE;RECORD OF DRILLING FLUIDS AND CUTTINGS;WHITE DRUM FIELD LOG FORM;CONTAMINANT CHARACTERIZATION FORM FOR WHITE DRUMS PENDING CHARACTERIZATION;SAMPLE COLLECTION FORM;FO.14C;FO.14E;RESULTS OF RADIOLOGICAL MEASUREMENTS IN THE FIELD;ROCKY FLATS PLANT BH LOG;PRELIMINARY WELL SITE FIELD LOG;HOLLOW STEM AUGER DRILLING FIELD ACTIVITIES REPORT;SURFACE SOIL DATA COLLECTION FORM;SURFACE SOIL SAMPLING ACTIVITIES REPORT;GT.8B;GT.8C;PHOTOIONIZATION DETECTOR FIELD DATA FORM;HEALTH AND SAFETY FIELD LOG BOOK;RIG GEOLOGIST FIELD LOG BOOK
37796	42920	13-Nov-80	0011531;DECONTAMINATION & DECOMMISSIONING D&D CRITERIA FOR ROCKY FLATS FACILITIES;D&D OF NUCLEAR FACILITIES;SUGGESTED DOE POLICY FOR D&D;ACCEPTABLE SURFACE CONTAMINATION LEVELS FOR UNRESTRICTED USE TRANSURANICS;MODES OF D&D CONSIDERED AT MOUND FACILITY;PROJECT GUIDELINES PREVIOUSLY USED;ACCEPTABLE SOIL CONTAMINATION LEVELS PLUTONIUM;RADIOLOGICAL GUIDE FOR DOE DECOMMISSIONING OPERATIONS DRAFT OUTLINE;D&D HANDBOOK PREPARED BY NES
37796	24093	25-Oct-65	ENVIRONMENTAL MASTER FILE (EMF)// CONTAMINATION LEVELS AND DECONTAMINATION ACTIVITIES SUBSEQUENT TO THE INCIDENT OF OCTOBER IS 1965 [Author/addressee names protected]

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37796	52019	1-Mar-95	FIELD RECORDS FOR GEOTECH DRILLING BOREHOLES;OU4 GEOTECH DRILLING DATA PACKAGE NUMBER 54195;TABLE OF CONTENTS;SITE SAFETY BRIEFINGS;CERTIFICATE OF SCREENING RAD SCREEN;PRE ACTIVITY SURVEY FORM 1.1B;CONTAMINATION SURVEY FORM 1.1B;POST ACTIVITY SURVEY FORM 1.1B;EQUIPMENT DECON/WASH CHECKLIST FORM FO.3A;HEAVY EQUIPMENT DECON/WASH CHECKLIST FORM FO.4A;FIELD MONITORING RESULTS OF CUTTING AND CORE FORM FO.8A; RECORD OF DRILLING FLUIDS AND CUTTINGS FORM FO.8C;DRUM FIELD LOG FORM FORM FO.10A;DRUM INSPECTION FORM FORM FO.10B;SAMPLE COLLECTION FORM FORM FO.14E;RESULTS OF RADIOLOGICAL MEASUREMENTS IN THE FIELD FORM FO.16A;RESULTS OF RADIOLOGICAL MEASUREMENTS IN THE FIELD FORM FO.16B;RFP BOREHOLE LOG FORM GT.1A;BOREHOLE LOG FOR GEOTECHNICAL OPERATIONS FORM GT.1C; COMPUTER GENERATED BOREHOLE DESCRIPTION;DAILY FIELD DRILLING ACTIVITIES REPORT FORM GT.2A; WELL BOREHOLE ABANDONMENT FORM FORM GT.5A;PHOTOIONIZATION DETECTOR FIELD DATA FORM FORM GT.9A; RIG GEOLOGIST FIELD LOG BOOK;HEALTH AND SAFETY FIELD LOG BOOK;OU4 DAILY DRILLING FORMS CHECKLIST; PRELIMINARY WELL SITE FIELD LOG FORM GT.1B;CERTIFICATION OF SCREENING RAD SCREEN;MEMORANDUM PARSONS ENGINEERING SCIENCE;FIELD QA RECORDS TRANSMISSION FORM FORM FO.2A;FIELD QA RECORDS TRANSMISSION FORM FORM FO.2B
37796	52020	2-Mar-95	FIELD RECORDS FOR GEOTECH DRILLING BOREHOLES;OU4 GEOTECH DRILLING PACKAGE NUMBER 54294 TABLE OF CONTENTS;OU4 DAILY DRILLING FORMS CHECKLIST;SITE SAFETY BRIEFINGS;PRE ACTIVITY SURVEY FORM 1.1B; CONTAMINATION SURVEY FORM 1.1B;POST ACTIVITY SURVEY FORM 1.1B;EQUIPMENT DECON/WASH CHECKLIST FORM FO.3A;HEAVY EQUIPMENT DECON/WASH CHECKLIST FORM FO.4A;FIELD MONITORING RESULTS OF CUTTINGS OR CORE FORM FO.8A;RECORD OF DRILLING FLUIDS AND CUTTINGS FORM FO.8C;DRUM FIELD LOG FORM FORM FO.10A;DRUM INSPECTION FORM FORM FO.10B;SAMPLE COLLECTION FORM FORM FO.14E;RESULTS OF RADIOLOGICAL MEASUREMENTS IN THE FIELD FORM FO.16A;RESULTS OF RADIOLOGICAL MEASUREMENTS IN THE FIELD FORM FO.16B;ROCKY FLATS PLANT BOREHOLE LOG FORM GT.1A;COMPUTER GENERATED BOREHOLE DESCRIPTION;DAILY DRILLING ACTIVITIES REPORT FORM GT.2A;WELL/BOREHOLE ABANDONMENT FORM FORM GT.5A;PHOTOIONIZATION DETECTOR FIELD DATA FORM FORM GT.9A;RIG GEOLOGIST FIELD LOG BOOK;HEALTH AND SAFETY LOG BOOK;MEMORANDUM PARSONS ENGINEERING SCIENCE;CERTIFICATE OF SCREEN LAB SCREEN RESULTS;PRELIMINARY WELL SITE FIELD LOG FORM GT.1B;BOREHOLE LOG FOR GEOTECHNICAL OPERATIONS FORM GT.1C;FIELD QA RECORDS TRANSMISSION FORM FORM FO.2A;FIELD QA RECORDS OF TRANSMISSION FORM FORM FO.2B
37796	52021	2-Mar-95	FIELD RECORDS FOR GEOTECH DRILLING BOREHOLES;OU4 GEOTECH DRILLING PACKAGE NUMBER 54394 TABLE OF CONTENTS;OU4 DAILY DRILLING FORMS CHECKLIST;SITE SAFETY BRIEFINGS;PRE ACTIVITY SURVEY FORM 1.1B; CONTAMINATION SURVEY FORM 1.1B;POST ACTIVITY SURVEY FORM 1.1B;EQUIPMENT DECON/WASH CHECKLIST FORM FO.3A;HEAVY EQUIPMENT DECON/WASH CHECKLIST FORM FO.4A;FIELD MONITORING RESULTS OF CUTTINGS OR CORE FORM FO.8A;RECORD OF DRILLING FLUIDS AND CUTTINGS FORM FO.8C;DRUM FIELD LOG FORM FORM FO.10A;DRUM INSPECTION FORM FORM FO.10B;SAMPLE COLLECTION FORM FORM FO.14E;RESULTS OF RADIOLOGICAL MEASUREMENTS IN THE FIELD FORM FO.16A;RESULTS OF RADIOLOGICAL MEASUREMENTS IN THE FIELD FORM FO.16B;ROCKY FLATS PLANT BOREHOLE LOG FORM GT.1A;COMPUTER GENERATED BOREHOLE DESCRIPTION;BOREHOLE LOG FOR GEOTECHNICAL OPERATIONS FORM GT.2A;DAILY DRILLING ACTIVITIES REPORT FORM GT.2A;GROUNDWATER MONITORING WELL AND PIEZOMETER REPORT FORM GT.6B;PHOTOIONIZATION DETECTOR FIELD DATA FORM FORM GT.9A;HEALTH AND SAFETY LOG BOOK;RIG GEOLOGIST FIELD LOG BOOK;PRELIMINARY WELL SITE FIELD LOG FORM GT.1B;MEMORANDUM PARSONS ENGINEERING SCIENCE;CERTIFICATE OF SCREENING RAD SCREEN; GT.1B;FIELD QA RECORDS TRANSMISSION FORM FORM FO.2A;FIELD QA RECORDS OF TRANSMISSION FORM FORM FO.2B

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37796	52022	2-Mar-95	FIELD RECORDS FOR GEOTECH DRILLING BOREHOLES;OU4 GEOTECH DRILLING PACKAGE NUMBER 54494 TABLE OF CONTENTS;OU4 DAILY DRILLING FORMS CHECKLIST;SITE SAFETY BRIEFINGS;PRE ACTIVITY SURVEY FORM 1.1B; CONTAMINATION SURVEY FORM 1.1B;POST ACTIVITY SURVEY FORM 1.1B;EQUIPMENT DECON/WASH CHECKLIST FORM FO.3A;HEAVY EQUIPMENT DECON/WASH CHECKLIST FORM FO.4A;FIELD MONITORING RESULTS OF CUTTING OR CORE FORM FO.8A;RECORD OF DRILLING FLUIDS AND CUTTINGS FORM FO.8C;DRUM FIELD LOG FORM FORM FO.10A;DRUM INSPECTION FORM FORM FO.10B;SAMPLE COLLECTION FORM FORM FO.14E;RESULTS OF RADIOLOGICAL MEASUREMENTS IN THE FIELD FORM FO.16A;RESULTS OF RADIOLOGICAL MEASUREMENTS IN THE FIELD FORM FO.16B;ROCKY FLATS PLANT BOREHOLE LOG FORM GT.1A;COMPUTER GENERATED BOREHOLE DESCRIPTION;BOREHOLE LOG FOR GEOTECHNICAL OPERATIONS FORM GT.1C;DAILY FIELD DRILLING ACTIVITIES REPORT FORM GT.2A;WELL INSTALLATION NOTIFICATION FORM GT.6A;GROUNDWATER MONITORING AND PIEZOMETER REPORT FORM F+GT.6B;LOCATION OF THE PROPOSED WELL FORM GT.6A; COMPUTER GENERATED ADDITIONAL GT.6A INFORMATION;PHOTOIONIZATION DETECTOR FIELD DATA FORM FORM GT.9A;FIELD GEOLOGIST LOGBOOK;HEALTH AND SAFETY LOGBOOK;PRELIMINARY WELL SITE FIELD LOG FORM GT.1B;CERTIFICATE OF SCREENING RAD SCREEN;MEMORANDUM PARSONS ENGINEERING SCIENCE INC;FIELD QA RECORDS TRANSMISSION FORM FORM FO.2A;FIELD RECORDS TRANSMISSION FORM FORM FO.2B
37796	51112	7-Sep-94	WELL 10094;FILE CHECKSHEET;DAILY ACTIVITIES FORMS CHECKLIST;TAILGATE SAFETY MEETING;FORM 1.1B MODIFIED CONTAMINATION SURVEY;FORM FO.8A FIELD MONITORING RESULTS OF CUTTINGS OR CORE;FORM FO.10A REV 3 DRUM FIELD LOG FORM DRUM NOS 4762JE;4767JE;4768JE;FORM FO.14C US DOE ROCKY FLATS PLANT SURFICIAL SOIL SAMPLE FORM;FORM GT.2A REV 3.1 DAILY FIELD DRILLING ACTIVITIES REPORT;FORM GT.9A REV 2 PHOTOIONIZATION DETECTOR FIELD DATA FORM;LOGBOOK PAGES 75;30 THRU 33;DAILY ACTIVITIES FORMS CHECKLIST;AREA OR EQUIPMENT DRAWING SHOWING SURVEY POINTS;FORM FO.4A HEAVY EQUIPMENT DECONTAMINATION WASH CHECKLIST AND RECORD;FORM GT.1A ROCKY FLATS PLANT BOREHOLE LOG;FORM GT.6B REV 3 GROUNDWATER MONITORING WELL AND PIEZOMETER REPORT;FORM GT.6A REV 0 WELL INSTALLATION NOTIFICATION FORM;THE LOCATION OF THE PROPOSED WELL;COLORADO DIVISION OF WATER RESOURCES PERMIT APPLICATION FORM;LOGBOOK PAGE 87;42 THRU 45;PHOTOGRAPH NO 46622-10
38016	52023	2-Mar-95	FIELD RECORDS FOR GEOTECH DRILLING BOREHOLES;OU4 GEOTECH DRILLING PACKAGE NUMBER 54594 TABLE OF CONTENTS;OU4 DAILY DRILLING FORMS CHECKLIST;SITE SAFETY BRIEFINGS;PRE ACTIVITY SURVEY FORM 1.1B; CONTAMINATION SURVEY FORM 1.1B;POST ACTIVITY SURVEY FORM 1.1B;EQUIPMENT DECON/WASH CHECKLIST FORM FO.3A;HEAVY EQUIPMENT DECON/WASH CHECKLIST FORM FO.4A;FIELD MONITORING RESULTS OF CUTTING OR CORE FORM FO.8A;RECORD OF DRILLING FLUIDS AND CUTTINGS FORM FO.8C;DRUM FIELD LOG FORM FORM FO.10A;DRUM INSPECTION FORM FORM FO.10B;SAMPLE COLLECTION FORM FORM FO.14E;RESULTS OF RADIOLOGICAL MEASUREMENTS IN THE FIELD FORM FO.16A;RESULTS OF RADIOLOGICAL MEASUREMENTS IN THE FIELD FORM FO.16B;ROCKY FLATS PLANT BOREHOLE LOG FORM GT.1A;COMPUTER GENERATED BOREHOLE LOG;ITA RESULTS OF RAD SCREEN ANALYSIS;BOREHOLE LOG FOR GEOTECHNICAL OPERATIONS FORM GT.1C;DAILY FIELD DRILLING ACTIVITIES REPORT FORM GT.2A;WELL/BOREHOLE ABANDONMENT FORM FORM GT.5A;PHOTOIONIZATION DETECTOR FIELD DATA FORM FORM GT.9A;HEALTH AND SAFETY FIELD LOGBOOK;RIG GEOLOGIST FIELD LOGBOOK;MEMORANDUM PARSONS ENGINEERING SCIENCE; PRELIMINARY WELL SITE FIELD LOG FORM GT.1B;FIELD QA RECORDS TRANSMISSION FORM FORM FO.2A;FIELD QA RECORDS TRANSMISSION FORM FORM FO.2B

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38016	54330	20-Jun-94	WELL 10794;NOTES;FILE CHECKSHEET;DAILY ACTIVITIES FORMS CHECKLIST;FORM 1.1B PRE ACTIVITY CONTAMINATION SURVEY;AREA OR EQUIPMENT DRAWING SHOWING SURVEY POINTS;FORM FO.8A FIELD MONITORING RESULTS OF CUTTINGS OR CORE;SURFACE SOIL SAMPLING MANUAL 4-E42-ER-OPS FORM FO.14C REV 16 US DOE ROCKY FLATS PLANT SURFICIAL SOIL SAMPLE FORM;CONTAMINATION SURVEY;FORM GT.2A REV 3 DAILY FIELD DRILLING ACTIVITIES REPORT;LOGBOOK PAGES 98 THRU 101;LOGBOOK ENTRY OF JUNE 17 1994;AREA OR EQUIPMENT DRAWING SHOWING SURVEY POINTS;FORM FO.4A HEAVY EQUIPMENT DECONTAMINATION WASH CHECKLIST AND RECORD;FORM FO.10A REV 3 DRUM FIELD LOG FORM DRUM NOS 4690JE;4691JE;4692JE;LOGBOOK PAGES 84;85;FORM GT.1A REV 3 ROCKY FLATS PLANT BOREHOLE LOG;WELL SITE FIELD LOG;FORM GT.1B REV 3 WELL SITE FIELD LOG;FORM GT.6A REV 0 WELL INSTALLATION NOTIFICATION FORM;THE LOCATION OF THE PROPOSED WELL;FORM GT.6B REV 3 GROUNDWATER MONITORING WELL AND PIEZOMETER REPORT;FORM GT.9A REV 2 PHOTOIONIZATION DETECTOR FIELD DATA FORM;LOGBOOK PAGES 37;38;118;119 THRU 121;134;135;COLORADO DIVISION OF WATER RESOURCES PERMIT APPLICATION FORM;LOGBOOK PAGES 49 ;50;PHOTOGRAPH NO 46390-16
38016	54332	27-Jun-94	WELL 10994;FILE CHECKLIST;DAILY ACTIVITIES FORMS CHECKLIST;FORM GT.2A REV 3.1 DAILY FIELD DRILLING ACTIVITIES REPORT;FORM FO.10A REV 3 DRUM FIELD LOG FORM DRUM IDENTIFICATION 4481;FORM GT.1A REV 3 ROCKY FLATS PLANT BOREHOLE LOG;FORM GT.1B REV 3 WELL SITE FIELD LOG;TAILGATE SAFETY MEETING;FORM FO.8A FIELD MONITORING RESULTS OF CUTTINGS OR CORE;LOGBOOK PAGES 36 THRU 43;HEALTH AND SAFETY LOG ENTRY FOR MAY 19 1994;FORM FO.4A HEAVY EQUIPMENT DECONTAMINATION WASH CHECKLIST AND RECORD;FORM 1.1B CONTAMINATION SURVEY;AREA OR EQUIPMENT DRAWING SHOWING SURVEY POINTS;FORM GT.6A REV 0 WELL INSTALLATION NOTIFICATION FORM;THE LOCATION OF THE PROPOSED WELL;FORM GT.6B REV 3 GROUNDWATER MONITORING WELL AND PIEZOMETER REPORT;FORM GT.9A REV 2 PHOTOIONIZATION DETECTOR FIELD DATA FORM;FORM FO.16A REV 2 RESULTS OF RADIOLOGICAL MEASUREMENTS IN THE FIELD;COLORADO DIVISION OF WATER RESOURCES PERMIT APPLICATION FORM;FORM GW.2A REV 3 ROCKY FLATS PLANT WELL DEVELOPMENT REDEVELOPMENT LOG;FORM 1.1B PRE ACTIVITY CONTAMINATION SURVEY;PHOTOGRAPH NOS 46779-10;46390-03
38091	54333	20-Oct-94	WELL 11094;FILE CHECKSHEET;DAILY ACTIVITIES FORMS CHECKLIST;FORM GT.6A REV 0 WELL INSTALLATION NOTIFICATION FORM;THE LOCATION OF THE PROPOSED WELL;FORM GT.1A REV 3 ROCKY FLATS PLANT BOREHOLE LOG;FORM GT.1B REV 3 WELL SITE FIELD LOG;FORM GW.2A REV 3 ROCKY FLATS PLANT WELL DEVELOPMENT REDEVELOPMENT LOG;COLORADO DIVISION OF WATER RESOURCES PERMIT APPLICATION FORM;FORM FO.14L GROUND WATER LEVEL MEASUREMENT FORM;FORM FO.10A REV 3 DRUM FIELD LOG FORM DRUM NO 4482JE;4480 JACOBS;FORM 1.1B CONTAMINATION SURVEY;FORM FO.4A HEAVY EQUIPMENT DECONTAMINATION WASH CHECKLIST AND RECORD;AREA OR EQUIPMENT DRAWING SHOWING SURVEY POINTS;FORM GT.9A REV 2 PHOTOIONIZATION DETECTOR FIELD DATA FORM;FORM GT.6B REV 3 GROUNDWATER MONITORING WELL AND PIEZOMETER REPORT;FORM FO.16A REV 2 RESULTS OF RADIOLOGICAL MEASUREMENTS IN THE FIELD;FORM FO.8A FIELD MONITORING RESULTS OF CUTTINGS OR CORE;TAILGATE SAFETY MEETING;LOGBOOK PAGES 38 THRU 45;HEALTH AND SAFETY LOG ENTRIES OF MAY 15 1994 AND MAY 20 1994;FORM 1.1B PRE ACTIVITY CONTAMINATION SURVEY;PHOTOGRAPH NO 46390-18
38101	54334	19-Jul-94	WELL 11194;DAILY ACTIVITIES FORMS CHECKLIST;FILE CHECKLIST;FORM 1.1B PRE ACTIVITY CONTAMINATION SURVEY;AREA OR EQUIPMENT DRAWING SHOWING SURVEY POINTS;LOGBOOK PAGES 28;29;73;74;PHOTOIONIZATION DETECTOR FIELD DATA FORM;FORM GT.2A REV 3.1 DAILY FIELD DRILLING ACTIVITIES REPORT;FORM FO.10A REV 3 DRUM FIELD LOG FORM DRUM NO 4761JE;FIELD MONITORING RESULTS OF CUTTINGS OR CORE;FORM 1.1B MODIFIED CONTAMINATION SURVEY;FORM GWS-9 WELL ABANDONMENT REPORT;LOGBOOK PAGES 22 THRU 29;FORM GT.1A REV 3 ROCKY FLATS PLANT BOREHOLE LOG;WELL SITE FIELD LOG;COLORADO DIVISION OF WATER RESOURCES PERMIT APPLICATION FORM;PROPERTY WASTE RELEASE EVALUATION NO 072294-JAC121-002;072294-JAC122-003;072294-JAC120-001;FORM FO.4A HEAVY EQUIPMENT DECONTAMINATION WASH CHECKLIST AND RECORD;FORM GT.5A REV 3 WELL BOREHOLE ABANDONMENT FORM;LOGBOOK PAGES 69 AND 70;FORM FO.14C REV 16 US DOE ROCKY FLATS PLANT SURFICIAL SOIL SAMPLE FORM;PHOTOGRAPH NO 46622-14

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38103	54335	20-Oct-94	WELL 11294;FILE CHECKSHEET;DAILY ACTIVITIES FORMS CHECKLIST;FORM GT.6B REV 3 GROUNDWATER MONITORING WELL AND PIEZOMETER REPORT;LOGBOOK PAGE 129 THRU131;FORM GT.9A REV 2 PHOTOIONIZATION DETECTOR FIELD DATA FORM;FORM GT.2A REV 3 DAILY FIELD DRILLING ACTIVITIES REPORT;FORM FO.8A FIELD MONITORING RESULTS OF CUTTINGS OR CORE;FORM 1.1B CONTAMINATION SURVEY;TAILGATE SAFETY MEETING;LOGBOOK PAGES 132;133;135 THRU 139;AREA OR EQUIPMENT DRAWING SHOWING SURVEY POINTS;FORM FO.4A HEAVY EQUIPMENT DECONTAMINATION WASH CHECKLIST AND RECORD;FORM 1.1B PRE ACTIVITY CONTAMINATION SURVEY;FORM GT.6A REV 0 WELL INSTALLATION NOTIFICATION FORM;THE LOCATION OF THE PROPOSED WELL;LOGBOOK PAGES 127;128;PHOTOGRAPH NOS 46623-03;46623-01;46623-05;46622-11;FORM GT.1A ROCKY FLATS PLANT BOREHOLE LOG;WELL SITE FIELD LOG;COLORADO DIVISION OF WATER RESOURCES PERMIT APPLICATION FORM;WASTE PROCESSING REQUEST;MATERIALS TRANSFER DIRT FROM WELLS CONCRETE;LOGBOOK PAGES 118 THRU 125;9 THRU 24
38143	54336	20-Oct-94	WELL 11394;FILE CHECKLIST;DAILY ACTIVITIES FORMS CHECKLIST;FORM GT.1A REV 3 ROCKY FLATS PLANT BOREHOLE LOG;FORM GT.1B REV 3 WELL SITE FIELD LOG;FORM GT.6A REV 0;THE LOCATION OF THE PROPOSED WELL;LOGBOOK PAGES 136;137;102 THRU 115;COLORADO DIVISION OF WATER RESOURCES PERMIT APPLICATION FORM;FORM GW.2A REV 3 ROCKY FLATS PLANT WELL DEVELOPMENT REDEVELOPMENT LOG;WASTE PROCESSING REQUEST;MATERIALS TRANSFER DIRT FROM WELLS CONCRETE;LOGBOOK PAGES 20;21;PHOTOGRAPH NOS 46622-19;46622-21;46622-23;FORM 1.1B PRE ACTIVITY CONTAMINATION SURVEY;AREA OR EQUIPMENT DRAWING SHOWING SURVEY POINTS;TAILGATE SAFETY MEETING;FORM FO.4A HEAVY EQUIPMENT DECONTAMINATION WASH CHECKLIST AND RECORD;CONTAMINATION SURVEY;LOGBOOK PAGE 35;FORM GT.9A REV 2 PHOTOIONIZATION DETECTOR FIELD DATA FORM;FORM GT.6B REV 3 GROUNDWATER MONITORING WELL AND PIEZOMETER REPORT;FORM GT.2A REV 3 DAILY FIELD DRILLING ACTIVITIES REPORT;FORM FO.8A FIELD MONITORING RESULTS OF CUTTINGS OR CORE;LOGBOOK PAGES 33;34;FORM GT.9A REV 2 PHOTOIONIZATION DETECTOR FIELD DATA FORM;LOGBOOK PAGES 97 THRU 99
38143	54337	20-Oct-94	WELL 11494;FILE CHECKSHEET;DAILY ACTIVITIES FORMS CHECKLIST;LOGBOOK PAGES 96 THRU 105;109 THRU 111;114;115;FORM GT.9A REV 2 PHOTOIONIZATION DETECTOR FIELD DATA FORM;FORM GT.2A REV 3 DAILY FIELD DRILLING ACTIVITIES REPORT;FORM FO.8A FIELD MONITORING RESULTS OF CUTTINGS OR CORE;TAILGATE SAFETY MEETING;FORM GT.6B REV 3 GROUNDWATER MONITORING WELL AND PIEZOMETER REPORT;CONTAMINATION SURVEY;FORM GT.9A REV 2 PHOTOIONIZATION DETECTOR FIELD DATA FORM;FORM FO.4A HEAVY EQUIPMENT DECONTAMINATION WASH CHECKLIST AND RECORD;FORM FO.14L GROUND WATER LEVEL MEASUREMENT FORM;LOGBOOK PAGES 108;109;FORM 1.1B PRE ACTIVITY CONTAMINATION SURVEY;AREA OR EQUIPMENT DRAWING SHOWING SURVEY POINTS;WASTE PROCESSING REQUEST;MATERIALS TRANSFER DIRT FROM WELLS CONCRETE;COLORADO DIVISION OF WATER RESOURCES PERMIT APPLICATION FORM;FORM GT.1A REV 3 ROCKY FLATS PLANT BOREHOLE LOG;FORM GT.1B REV 3 WELL SITE FIELD LOG;LOGBOOK PAGES 134;135;PHOTOGRAPH NOS 46623-12;46623-15
38193	54338	20-Oct-94	WELL 11494;FILE CHECKSHEET;DAILY ACTIVITIES FORMS CHECKLIST;LOGBOOK PAGES 96 THRU 105;109 THRU 111;114;115;FORM GT.9A REV 2 PHOTOIONIZATION DETECTOR FIELD DATA FORM;FORM GT.2A REV 3 DAILY FIELD DRILLING ACTIVITIES REPORT;FORM FO.8A FIELD MONITORING RESULTS OF CUTTINGS OR CORE;TAILGATE SAFETY MEETING;FORM GT.6B REV 3 GROUNDWATER MONITORING WELL AND PIEZOMETER REPORT;CONTAMINATION SURVEY;FORM GT.9A REV 2 PHOTOIONIZATION DETECTOR FIELD DATA FORM;FORM FO.4A HEAVY EQUIPMENT DECONTAMINATION WASH CHECKLIST AND RECORD;FORM FO.14L GROUND WATER LEVEL MEASUREMENT FORM;LOGBOOK PAGES 108;109;FORM 1.1B PRE ACTIVITY CONTAMINATION SURVEY;AREA OR EQUIPMENT DRAWING SHOWING SURVEY POINTS;WASTE PROCESSING REQUEST;MATERIALS TRANSFER DIRT FROM WELLS CONCRETE;COLORADO DIVISION OF WATER RESOURCES PERMIT APPLICATION FORM;FORM GT.1A REV 3 ROCKY FLATS PLANT BOREHOLE LOG;FORM GT.1B REV 3 WELL SITE FIELD LOG;LOGBOOK PAGES 134;135;PHOTOGRAPH NOS 46623-12;46623-15

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38200	54860	7-Sep-94	WELL 24193;RADIATION WORK PERMIT NO ENV-034-94;FILE CHECKSHEET;DAILY ACTIVITIES FORMS CHECKLIST;FORM GT.15A GEOGRAPHICAL BOREHOLE LOGGING FORM;LOGBOOK PAGES 94-040 AND 94-041;150 AND 151;55 AND 56;CENTURY GEOPHYSICAL CORPORATION GRAPHS;RADS DATA AUGUST 30 1994;VOA VOLATILE ORGANICS ANALYSIS DATA;FORM 1.1B PRE ACTIVITY CONTAMINATION SURVEY;TAILGATE SAFETY MEETING;FORM FO.10A DRUM FIELD LOG FORM DRUM IDENTIFICATION NUMBER WITH SUBCONTRACTOR IDENTIFICATION 4829JE 4830JE 4833JE;FORM GT.2A DAILY FIELD DRILLING ACTIVITIES REPORT;LOGBOOK PAGE 3B-15 3B-16 AND 3B-17;121;FORM FO.8A FIELD MONITORING RESULTS OF CUTTINGS OR CORE;FORM GT.9A REV 2 PHOTOIONIZATION DETECTOR FIELD DATA FORM;LOGBOOK PAGES 129;130;6;7;8;9;133;101;LOGBOOK ENTRY OF SEPTEMBER 15 1994;FORM FO.4A HEAVY EQUIPMENT DECONTAMINATION WASH CHECKLIST AND RECORD;CONTAMINATION SURVEY;FORM GT.5A WELL BOREHOLE ABANDONMENT FORM;FORM NO GWS-9 WELL ABANDONMENT REPORT;LOGBOOK PAGES 135;102;103;104;105
38200	54838	6-Sep-94	WELL 6687;FILE CHECKSHEET;DAILY ACTIVITIES FORMS CHECKLIST;TAILGATE SAFETY MEETING;CONTAMINATION SURVEY;FORM FO.4A HEAVY EQUIPMENT DECONTAMINATION WASH CHECKLIST AND RECORD;FORM GT.9A REV 2 EXPLOSIVITY DETECTOR FIELD DATA FORM;LOGBOOK PAGES 93;56;57;WASTE PROCESSING REQUEST WO WORK ORDER 812;MATERIAL TRANSFER DIRT FROM WELLS CONCRETE
38200	54833	1-Sep-94	WELL 6874;FILE CHECKSHEET;DAILY ACTIVITIES FORMS CHECKLIST;TAILGATE SAFETY MEETING;FORM 1.1B PRE ACTIVITY CONTAMINATION SURVEY;AREA OR EQUIPMENT DRAWING SHOWING SURVEY POINTS;FORM FO.8A FIELD MONITORING RESULTS OF CUTTINGS OR CORE;FORM FO.14L GROUND WATER LEVEL MEASUREMENT FORM;FORM GT.2A REV 3 DAILY FIELD DRILLING ACTIVITIES REPORT;FORM GT.9A REV 2 PHOTOIONIZATION DETECTOR FIELD DATA FORM;LOGBOOK PAGES 91;92;TOM WADDLE HEALTH AND SAFETY LOG ENTRY OF JUNE 15 1994;LOGBOOK PAGES 76 THRU 79;SUMMARY LOGS OF TEST HOLES PROPOSED LANDFILL SITE 1 ROCKY FLATS PLANT;CONTAMINATION SURVEY;FORM FO.4A HEAVY EQUIPMENT DECONTAMINATION WASH CHECKLIST AND RECORD;FORM GT.2A REV 3 DAILY FIELD DRILLING ACTIVITIES REPORT;FORM GT.5A REV 3 WELL BOREHOLE ABANDONMENT FORM;FORM GWS-9 WELL ABANDONMENT REPORT;TOM WADDLE HEALTH AND SAFETY LOG ENTRY OF JUNE 16 1994;LOGBOOK PAGES 116;117;80 THRU 83;VICINITY MAP AND LOCATION OF TEST HOLES LANDFILL SITES;LOCATION OF TEST HOLES EXISTING LANDFILL;APPROXIMATE LIMITS OF LANDFILL AREA;SUMMARY LOGS OF TEST HOLES PROPOSED LANDFILL SITE 3;2;EXISTING LANDFILL
38201	57417	20-Feb-95	TANK 1 BOREHOLE BH01095 FILE;JEG JACOBS ENGINEERING GROUP OU9 BOREHOLE DRILLING FILE AND FORM CHECKLIST;TAILGATE SAFETY MEETING;RADIOLOGICAL ENGINEERING PROPERTY WASTE RELEASE EVALUATION SURVEY FORM;ROCKY FLATS UTILITY LINE CLEARANCE;SAMPLE SUB SAMPLE LOCATION;RADIOLOGICAL OPERATIONS GAMMA SURVEY;HEAVY EQUIPMENT DECONTAMINATION WASH CHECKLIST AND RECORD FORM FO.4A;CONTAMINATION SURVEY;FIELD MONITORING RESULTS OF CUTTINGS OR CORE FORM FO.8A;RECORD OF DRILLING FLUIDS AND CUTTINGS FORM FO.8C REV 2;DRUM LOG FORM FO.10A REV 3;SAMPLE COLLECTION FORM FO.14B;881 GENERAL LABORATORY RAD RADIATION SCREEN RESULTS;CERTIFICATE OF SCREENING;BOREHOLE LOG;WELL SITE FIELD LOG FORM GT.4B;LOG OF BORING;DAILY FIELD DRILLING ACTIVITIES REPORT FORM GT.2A REV 3.1;BOREHOLE ABANDONMENT FORM GT.5A REV 3;FIELD ACTIVITY DAILY LOG FORM GW.6A;ROCKY FLATS PLANT GROUNDWATER SAMPLE COLLECTION LOG FORM GW.6B REV 3;FIELD LOG BOOK MARCH 9 1995 THRU MARCH 14 1995
38205	58224	16-Feb-95	DECON PADS LOGBOOK

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38205	59632	11-Sep-95	FIELD RECORDS FOR OU4 C POND SOIL SAMPLING;SITE SAFETY BRIEFINGS;GAMMA AND NEUTRON SURVEY FORM 1.1A;PRE ACTIVITY CONTAMINATION SURVEY FORM 1.1B;CONTAMINATION SURVEY;AREA OR EQUIPMENT DRAWING SHOWING SURVEY POINTS;POST ACTIVITY SURVEY;MATERIAL TRANSFER TAG;EQUIPMENT DECONTAMINATION WASH CHECKLIST AND RECORD FORM FO.3A;FIELD MONITORING RESULTS OF CUTTINGS OR CORE FORM FO.8A;RESULTS OF RADIOLOGICAL MEASUREMENTS IN THE FIELD FORM FO.16A;PRELIMINARY WELL SITE FIELD LOG FORM GT.1B;ROCKY FLATS PLANT BOREHOLE LOG FORM GT.1A;DAILY FIELD DRILLING ACTIVITIES REPORT FORM GT.2A;WELL BOREHOLE ABANDONMENT FORM GT.5A;PHOTOIONIZATION DETECTOR FIELD DATA FORM GT.9B;HOT WORK CHECKLIST;ROCKY FLATS SOIL DISTURBANCE APPROVAL FORM;RIG GEOLOGIST FIELD LOG BOOK;HEALTH AND SAFETY LOG BOOK
38208	59633	18-Aug-95	FIELD RECORDS FOR OU4 C POND SOIL SAMPLING;SITE SAFETY BRIEFINGS;GAMMA AND NEUTRON SURVEY FORM 1.1A;PRE ACTIVITY CONTAMINATION SURVEY FORM 1.1B;CONTAMINATION SURVEY;AREA OR EQUIPMENT DRAWING SHOWING SURVEY POINTS;POST ACTIVITY SURVEY;EQUIPMENT DECONTAMINATION WASH CHECKLIST AND RECORD FORM FO.3A;FIELD MONITORING RESULTS OF CUTTINGS OR CORE FORM FO.8A;RESULTS OF RADIOLOGICAL MEASUREMENTS IN THE FIELD FORM FO.16A;PRELIMINARY WELL SITE FIELD LOG FORM GT.1B;ROCKY FLATS PLANT BOREHOLE LOG FORM GT.1A;DAILY FIELD DRILLING ACTIVITIES REPORT FORM GT.2A;WELL BOREHOLE ABANDONMENT FORM GT.5A;PHOTOIONIZATION DETECTOR FIELD DATA FORM GT.9B;HEAT STRESS MONITORING FORM;RIG GEOLOGIST FIELD LOG BOOK;HEALTH AND SAFETY LOG BOOK
38222	61574	15-May-92	BOREHOLE FILE CHECKLIST;BH43992;FIELD LOG BOOK COPIES;HEAVY EQUIPMENT DECONTAMINATION WASH CHECKLIST AND RECORD FORM FO.4A;VERIFICATION OF ORGANIC VAPOR MONITORING RESULTS FORM FO.8A;RESULTS OF RADIOLOGICAL MEASUREMENTS IN THE FIELD FORM FO.16A;RECORD OF DRILLING FLUIDS AND CUTTINGS FORM FO.8B;CONTAMINATION SURVEY FORM FO 1.1B;DAMES AND MOORE PRE WORK AREA SURVEY PER FOP 1.16;DRUM FIELD LOG FORM FO.10A;CONTAMINATE CHARACTERIZATION FORM FOR GRAY DRUMS PENDING CHARACTERIZATION FORM FO.10C;DRUM INSPECTION FORM FO.10B;HOLLOW STEM AUGER DRILLING FIELD ACTIVITIES REPORT FORM GT.2A;SAMPLE COLLECTION FORM FO.14B;ROCKY FLATS PLANT BOREHOLE LOG;PRELIMINARY WELL SITE FIELD LOG;SURFACE CASING INSTALLATION FIELD ACTIVITIES REPORT FORM GT.3A;ROTARY CORE DRILLING FIELD ACTIVITIES REPORT FORM GT.1A;GAMMA GUARD AND NEUTRON COMPARISON RUN;ELECTRICAL LOG SP PLUS LONG AND SHORT RESISTIVITY MAIN RUN;CALIBRATIONS LOG;SONIC LOG MAIN RUN;TEMPERATURE AND FLUID RESISTIVITY;GAMMA GAMMA DENSITY AND CALIPER COMPARISON RUN;GAMMA GAMMA DENSITY AND CALIPER MAIN RUN;BOREHOLE LOG GEOPHYSICAL LOGGING FORM GT.15A;BOREHOLE GEOPHYSICAL LOGGING QUALITY CONTROL CHECKLIST FORM GT.15B;CHAIN OF CUSTODY NO EB-00083-01;EB-00068-01;EB-00069-02; EB-00074-02;EB-00084-02;EB-00093-01;EB-00078-03;AIR BILL;SAMPLE SCREENING RELEASE FORM;IT ANALYTICAL RADIOCHEMICAL ANALYSIS REPORT;LAYNE ENVIRONMENTAL DRILLERS DAILY DRILL REPORT;FIELD DATA TRANSMISSION FORM FO.2A;RFEDS ROCKY FLATS ENVIRONMENTAL DATA SYSTEMS FIELD DATA TRANSMITTAL FORM FO.14A

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38222	61575	15-May-92	BOREHOLE FILE CHECKLIST;BH44092;FIELD LOG BOOK COPIES;HEAVY EQUIPMENT DECONTAMINATION WASH CHECKLIST AND RECORD FORM FO.4A;RESULTS OF RADIOLOGICAL MEASUREMENTS IN THE FIELD FORM FO.16A;VERIFICATION OF ORGANIC VAPOR MONITORING RESULTS FORM FO.8A;CONTAMINATION SURVEY FORM 1.1B;DAMES AND MOORE AREA SURVEY PER FOP 1.16;DRUM FIELD LOG FORM FO.10A; CONTAMINANT CHARACTERIZATION FORM FOR GRAY DRUMS PENDING CHARACTERIZATION FORM FO.10C; DRUM INSPECTION FORM FO.10B;RECORD OF DRILLING FLUIDS AND CUTTINGS FORM FO.8B;FIELD LOG BOOK COPIES;HOLLOW STEM AUGER DRILLING FIELD ACTIVITIES REPORT FORM GT.2A;BOREHOLE ABANDONMENT FIELD ACTIVITIES REPORT FORM GT.5A;SAMPLE COLLECTION FORM FO.14B;ROCKY FLATS PLANT BOREHOLE LOG;PRELIMINARY WELL SITE FIELD LOG;SURFACE CASING INSTALLATION FIELD ACTIVITIES REPORT FORM GT.3A;ROTARY CORE DRILLING FIELD ACTIVITIES REPORT FORM GT.1A;GEOPHYSICAL EQUIPMENT CALIBRATIONS;GAMMA GUARD AND NEUTRON MAIN RUN;ELECTRICAL LOG COMPARISON RUN;ELECTRICAL LOG MAIN RUN;SONIC LOG;TEMPERATURE AND FLUID RESISTIVITY;GAMMA GAMMA DENSITY AND CALIPER COMPARISON RUN;GAMMA GAMMA DENSITY AND CALIPER MAIN RUN;GAMMA GUARD NEUTRON REPEAT;BOREHOLE GEOPHYSICAL LOGGING FORM GT.15A;BOREHOLE GEOPHYSICAL LOGGING QUALITY CONTROL CHECKLIST FORM GT.15B;CHAIN OF CUSTODY EB-00093-01;EB-00066-03; EB-00064-01;EB-00065-02;EB-00067-02;AIR BILL;SAMPLE SCREENING RELEASE FORM;LAYNE ENVIRONMENTAL DRILLERS DAILY DRILL REPORT;;FIELD DATA TRANSMISSION FORM FO.2A;RFEDS ROCKY FLATS ENVIRONMENTAL DATA SYSTEMS FIELD DATA TRANSMISSION FORM FO.14A
38222	61576	15-May-92	BOREHOLE FILE CHECKLIST;BH44192;FIELD LOG BOOK COPIES;HEAVY EQUIPMENT DECONTAMINATION WASH CHECKLIST AND RECORD FORM FO.4A;RESULTS OF RADIOLOGICAL MEASUREMENTS IN THE FIELD FORM FO.16A;VERIFICATION OF ORGANIC VAPOR MONITORING RESULTS FORM FO.8A;CONTAMINATION SURVEY FORM 1.1B;DAMES AND MOORE PRE WORK SURVEY PER FOP 1.16;DRUM FIELD LOG FORM FO.10A;CONTAMINANT CHARACTERIZATION FORM FOR GRAY DRUMS PENDING CHARACTERIZATION FORM FO.10C;DRUM INSPECTION FORM FO.10B;RECORD OF DRILLING FLUIDS AND CUTTINGS FORM FO.8B; HOLLOW STEM AUGER DRILLING FIELD ACTIVITIES REPORT FORM GT.2A;BOREHOLE ABANDONMENT FIELD ACTIVITIES REPORT FORM GT.5A;SAMPLE COLLECTION FORM FO.14B;ROCKY FLATS PLANT BOREHOLE LOG;PRELIMINARY WELL SITE FIELD LOG;SURFACE CASING INSTALLATION FIELD ACTIVITIES REPORT FORM GT.3A;ROTARY CORE DRILLING FIELD ACTIVITIES REPORT FORM GT.4A;GAMMA GUARD AND NEUTRON COMPARISON RUN;GAMMA GAMMA DENSITY AND CALIPER COMPARISON RUN;GAMMA GAMMA DENSITY AND CALIPER MAIN RUN;ELECTRICAL LOG MAIN RUN;ELECTRICAL LOG COMPARISON RUN;SONIC LOG MAIN RUN;LOG CALIBRATIONS;LOGGING REPORT;TEMPERATURE AND FLUID RESISTIVITY;SONIC LOG MAIN RUN;GAMMA GUARD AND NEUTRON MAIN RUN;BOREHOLE GEOPHYSICAL LOGGING FORM GT.15A; BOREHOLE GEOPHYSICAL LOGGING QUALITY CONTROL CHECKLIST FORM GT.15B;CHAIN OF CUSTODY EB-00062-03;EB-00060-01;EB-00061-02;EB-00063-02;AIR BILL;SAMPLE SCREENING RELEASE FORM;RADIOCHEMICAL ANALYSIS REPORT;LAYNE ENVIRONMENTAL DRILLERS DAILY DRILL REPORT;FIELD DATA TRANSMISSION FORM FO.2A;RFEDS ROCKY FLATS ENVIRONMENTAL DATA SYSTEMS FIELD DATA TRANSMISSION FORM FO.14A
38222	61577	15-May-92	BOREHOLE FILE CHECKLIST;BH44292;FIELD LOG BOOK COPIES;HEAVY EQUIPMENT DECONTAMINATION WASH CHECKLIST AND RECORD FORM FO.4A;VERIFICATION OF ORGANIC VAPOR MONITORING RESULTS FORM FO.8B;FIELD MONITORING RESULTS FORM FO.8A;FIELD MONITORING RESULTS OF CUTTINGS OR CORE FORM FO.8A;RESULTS OF RADIOLOGICAL MEASUREMENTS IN THE FIELD FORM FO.16A;DAMES AND MOORE PRE WORK SURVEY PER FOP 1.16;RECORD OF DRILLING FLUIDS AND CUTTINGS FORM FO.8C;ROCKY FLATS PLANT BOREHOLE LOG;PRELIMINARY WELL SITE FIELD LOG;HOLLOW STEM AUGER DRILLING FIELD ACTIVITIES REPORT FORM GT.2A;GROUNDWATER MONITORING WELL AND PIEZOMETER REPORT FORM GT.6A;HAND DRAWN DIAGRAM OF WELL;LAYNE ENVIRONMENTAL DRILLERS DAILY DRILL REPORT

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38222	61578	15-May-92	BOREHOLE FILE CHECKLIST;BH44392;FIELD LOG BOOK COPIES;HEAVY EQUIPMENT DECONTAMINATION WASH CHECKLIST AND RECORD FORM FO.4A;VERIFICATION OF ORGANIC VAPOR MONITORING RESULTS FORM FO.8B;CONTAMINATION SURVEY FORM 1.1B;FIELD MONITORING RESULTS OF CUTTINGS OR CORE FORM FO.8A;RESULTS OF RADIOLOGICAL MEASUREMENTS IN THE FIELD;DAMES AND MOORE PRE WORK AREA SURVEY PER FOP 1.16;RECORD OF DRILLING FLUIDS AND CUTTINGS FORM FO.8C;HOLLOW STEM AUGER DRILLING FIELD ACTIVITIES REPORT FORM GT.2A;ROCKY FLATS PLANT BOREHOLE LOG;PRELIMINARY WELL SITE FIELD LOG;GROUNDWATER MONITORING WELL AND PIEZOMETER REPORT FORM GT.6A;HAND DRAWN DIAGRAM OF WELL;LAYNE ENVIRONMENTAL DRILLERS DAILY DRILL REPORT
38222	61579	15-May-92	BOREHOLE FILE CHECKLIST;BH44492;FIELD LOG BOOK COPIES;HEAVY EQUIPMENT DECONTAMINATION WASH CHECKLIST AND RECORD FORM FO.4A;RESULTS OF RADIOLOGICAL MEASUREMENTS IN THE FIELD; VERIFICATION OF ORGANIC VAPOR MONITORING RESULTS FORM FO.8A;DAMES AND MOORE PRE WORK AREA SURVEY PER FOP 1.16;RECORD OF DRILLING FLUIDS AND CUTTINGS FORM FO.8B;HOLLOW STEM AUGER DRILLING FIELD ACTIVITIES REPORT FORM GT.2A;ROCKY FLATS PLANT BOREHOLE LOG;PRELIMINARY WELL SITE FIELD LOG;GROUNDWATER MONITORING WELL AND PIEZOMETER REPORT FORM GT.6A;HAND DRAWN DIAGRAM OF WELL;LAYNE ENVIRONMENTAL DRILLERS DAILY DRILL REPORT
38222	61580	15-May-92	BOREHOLE FILE CHECKLIST;BH44592;FIELD LOG BOOK COPIES;HEAVY EQUIPMENT DECONTAMINATION WASH CHECKLIST AND RECORD FORM FO.4A;DAMES AND MOORE PRE WORK AREA SURVEY PER FOP 1.16;CONTAMINATION SURVEY FORM 1.1B;RESULTS OF RADIOLOGICAL MEASUREMENTS IN THE FIELD FORM FO.16A;VERIFICATION OF ORGANIC VAPOR MONITORING RESULTS FORM FO.8A;RECORD OF DRILLING FLUIDS AND CUTTINGS FORM FO.8B;HOLLOW STEM AUGER DRILLING FIELD ACTIVITIES REPORT FORM GT.2A;ROCKY FLATS PLANT BOREHOLE LOG;PRELIMINARY WELL SITE FIELD LOG;GROUNDWATER MONITORING WELL AND PIEZOMETER REPORT FORM GT.6A;HAND DRAWN DIAGRAM OF WELL;LAYNE ENVIRONMENTAL DRILLERS DAILY DRILL REPORT
38222	59634	6-Sep-95	FIELD RECORDS FOR OU4 C POND SOIL SAMPLING;SITE SAFETY BRIEFINGS;GAMMA AND NEUTRON SURVEY FORM 1.1A;PRE ACTIVITY CONTAMINATION SURVEY FORM 1.1B;CONTAMINATION SURVEY;AREA OR EQUIPMENT DRAWING SHOWING SURVEY POINTS;POST ACTIVITY SURVEY;MATERIAL TRANSFER TAGS;RADIOLOGICAL CONTAMINATION SURVEY FORM;EQUIPMENT DECONTAMINATION WASH CHECKLIST AND RECORD FORM FO.3A;FIELD MONITORING RESULTS OF CUTTINGS OR CORE FORM FO.8A;RESULTS OF RADIOLOGICAL MEASUREMENTS IN THE FIELD FORM FO.16A;PRELIMINARY WELL SITE FIELD LOG FORM GT.1B;ROCKY FLATS PLANT BOREHOLE LOG FORM GT.1A;DAILY FIELD DRILLING ACTIVITIES REPORT FORM GT.2A;WELL BOREHOLE ABANDONMENT FORM GT.5A;PHOTOIONIZATION DETECTOR FIELD DATA FORM GT.9B;HEAT STRESS MONITORING FORM;FIELD GEOLOGIST FIELD LOG BOOK;RADIOACTIVE SOURCE TRANSACTION FORM;PROPERTY RELEASE LOG;RFEDS ROCKY FLATS ENVIRONMENTAL DATA SYSTEMS FIELD DATA TRANSMITTAL FORM FO.14A
38223	61581	15-May-92	BOREHOLE FILE CHECKLIST;BH44692;ROCKY FLATS PLANT BOREHOLE LOG;PRELIMINARY WELL SITE FIELD LOG FORM GT.1B;WASTE MANAGEMENT CHAIN OF CUSTODY;HEAVY EQUIPMENT DECONTAMINATION WASH CHECKLIST AND RECORD FORM FO.4A;VERIFICATION OF ORGANIC VAPOR MONITORING RESULTS FORM FO.8B;FIELD MONITORING RESULTS FORM FO.8A;FIELD MONITORING RESULTS OF CUTTINGS OR CORE FORM FO.8A;RESULTS OF RADIOLOGICAL MEASUREMENTS IN THE FIELD FORM FO.16A;DAMES AND MOORE PRE WORK AREA SURVEY PER FOP 1.16;RECORD OF DRILLING FLUIDS AND CUTTINGS FORM FO.8C;FIELD LOG BOOK COPIES;HOLLOW STEM AUGER DRILLING FIELD ACTIVITIES REPORT FORM GT.2A;GROUNDWATER MONITORING WELL AND PIEZOMETER REPORT FORM GT.6A;HAND DRAWN DIAGRAM OF WELL;LAYNE ENVIRONMENTAL DRILLERS DAILY DRILL REPORT

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38223	61582	15-May-92	BOREHOLE FILE CHECKLIST;BH44792;FIELD LOG BOOK COPIES;WASTE MANAGEMENT CHAIN OF CUSTODY; HEAVY EQUIPMENT DECONTAMINATION WASH CHECKLIST AND RECORD FORM FO.4A;VERIFICATION OF ORGANIC VAPOR MONITORING RESULTS FORM FO.8B;FIELD MONITORING RESULTS OF CUTTINGS OR CORE FORM FO.8A;FIELD MONITORING RESULTS FORM FO.8A;RESULTS OF RADIOLOGICAL MEASUREMENTS IN THE FIELD FORM FO.16A;DAMES AND MOORE PRE WORK AREA SURVEY PER FOP 1.16;DRUM INSPECTION FORM FO.10B;CONTAMINANT CHARACTERIZATION FOR GRAY DRUMS PENDING CHARACTERIZATION FORM FO.10C;DRUM FIELD LOG FORM FO.10A;RECORD OF DRILLING FLUIDS AND CUTTINGS FORM FO.8C;HOLLOW STEM AUGER DRILLING FIELD ACTIVITIES REPORT FORM GT.2A;BOREHOLE ABANDONMENT FIELD ACTIVITIES REPORT FORM GT.5A;PRELIMINARY WELL SITE FIELD LOG;SURFACE CASING INSTALLATION FIELD ACTIVITIES REPORT FORM GT.3A;ROTARY CORE DRILLING FIELD ACTIVITIES REPORT FORM GT.1A;CALIBRATION LOG; ELECTRICAL LOG MAIN RUN;ELECTRICAL LOG COMPARISON RUN;TEMPERATURE FLUID RESISTIVITY MAIN RUN;SONIC MAIN RUN;GAMMA GUARD NEUTRON MAIN RUN;GAMMA GAMMA DENSITY CALIPER COMPARISON RUN;GAMMA GUARD NEUTRON MAIN RUN;GAMMA GAMMA DENSITY CALIPER MAIN RUN;CHAIN OF CUSTODY EB-00088-01;EB-00089-01;BOREHOLE GEOPHYSICAL LOGGING QUALITY CONTROL CHECKLIST FORM GT.15B;BOREHOLE GEOPHYSICAL LOGGING FORM GT.15A;LAYNE ENVIRONMENTAL DRILLERS DAILY DRILL REPORT
38223	853134	1-Jan-77	RADIATION MONITORING SURVEYS // CONTAMINATION CONTROL LOG BOOKS FOREMAN LOG BOOKS (1977-1981)
38226	8011442	19-Mar-91	CONTAMINATION CONTROL LOGBOOKS / BUILDING 707
38226	8063531	13-May-95	RADIATION MONITORING PROTECTION / B707 CONTAMINATION CONTROL LOGBOOK (1994-1996)
38226	8063528	8-Jun-95	RADIATION MONITORING PROTECTION / B707 FOREMANS LOGBOOK (1994-1996)
38226	8063530	11-Sep-95	RADIATION MONITORING PROTECTION / B707 FOREMANS LOGBOOK (1994-1996)
38226	8075761	31-Dec-95	RADIATION MONITORING PROTECTION / B707 FOREMANS LOGBOOK (1995-1996)
38226	8063527	10-Mar-94	RADIATION MONITORING PROTECTION / B991 CONTAMINATION CONTROL LOGBOOK (1994-1996)
38226	8043045	27-Feb-89	RADIATION MONITORING PROTECTION /// 2/27/89 - 7/9/89 CONTAMINATION CONTROL REPORT BOOK // 7/10/89 - 11/18/89 CONTAMINATION CONTROL REPORT BOOK // 8/26/90 - 11/15/90 CONTAMINATION CONTROL REPORT BOOK // 1/16/91 - 4/28/91 CC LOG BOOK // 4/28/91 - 8/7/91 CC LOG BOOK // 7/2/91 - 10/7/91 CC LOG BOOK // 8/7/91 - 9/28/91 CC LOG BOOK // 9/28/91 - 1/8/92 CC LOG BOOK // 1/8/92 - 3/4/92 CC LOG BOOK // 6/14/92 - 9/22/92 CC LOG BOOK // 9/22/92 - 1/1/93 CC LOG BOOK // 4/11/93 - 1/23/93 CC LOG BOOK // 7/23/93 - 1/31/94 CC LOG BOOK // 4/22/94 - 11/3/94 CC LOG BOOK // 9/5/94 - 4/21/94 CC LOG BOOK (1989-1993)
38226	8035701	22-Oct-94	RADIATION MONITORING SURVEYS / CONTAMINATION CONTROL LOGBOOK / BLDG 707 10/22/1994 THRU 1/27/1995
38226	8035702	7-Dec-94	RADIATION MONITORING SURVEYS / FOREMAN'S LOGBOOK / BLDG 707 12/7/1994 THRU 3/6/1995
38230	8075762	29-Jan-96	RADIATION MONITORING PROTECTION / B707 CONTAMINATION CONTROL LOGBOOK (1995-1996)
38263	8076606	1-Jan-94	CONSOLIDATED WATER TREATMENT FACILITY OPERATING LOGS/CHECKLISTS // 1995 AIR MONITORING LOGS / 1995 BULK CHEMICAL RECEIVING CHECKLIST / 1/95 - 6/95 DAILY O&M BRIEFING / 1995 DAILY PRESSURE GAUGE LOGS (IX)/ 3/7/95 - 7/10/95 DECON FACILITIES DAILY ACTIVITIES LOG BOOK / 1995 DECON PAD DAILY INSPECTION CHECKLIST / 1994 DECON PAD WATER RECEIVING LOG / 1995 DECON PAD WATER RECEIVING LOG / 1995 DECON PAD WATER RECEIVING LOG / 1995 DRUM INSPECTION FORMS / 1995 IX TREATMENT DAILY LOGS / 1994 NEUTRALIZATION TANK (T-210) TRANSFER TO B-374 1995 NEUTRALIZATION TANK (T-210) TRANSFER TO B-374 / 6/19/95 - 10/19/95 OU1 FTU OPERATORS LOG BOOK / 8/23/94 - 6/19/95 OU1 FTU OPERATORS LOG BOOK / 1995 OU1 PROCESSED WATER TRACKING MONTHLY / 9/94 - 12/94 OU1 PROCESSED WATER TRACKING MONTHLY / 10/2/95 - 12/31/95 OU2 TANK AND PIPE INSPECTION / 1994 RAD SCREEN RESULTS FOR NEUTRALIZED T-210 / 1995 RAD SCREEN RESULTS FOR NEUTRALIZED T-210 / 1995 RECEIVING WATER TRACKING LOG / 1995 STORAGE/TREATMENT TANK DAILY INSPECTIONS (RCRA) 1995 TANK LEVEL/VOLUME DAILY LOGS / 1995 UV/H2O2 DAILY TREATMENT LOGS / DECON PAD WATER RECEIVING LOG /

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38263	8076620	1-Jan-96	CONSOLIDATED WATER TREATMENT FACILITY OPERATING LOGS/CHECKLISTS //CHECKLISTS // 1996 AIR MONITORING LOGS / MAY 1996 - NOV 1996 CLAY FILTER DAILY LOGS / JAN 1996 - JUN 1996 CWTF STORAGE/TREATMENT TANK RCRA INSPECTION LOGS / JUN 1996 - AUG 1996 CWTF STORAGE/TREATMENT TANK RCRA INSPECTION LOGS / SEPT 1996 - DEC 1996 CWTF STORAGE/TREATMENT TANK RCRA INSPECTION LOGS / 1996 DAILY PRESSURE GAUGE LOGS (IX) / 1/1/1996 - 10/9/1996 DECON FACILITY DAILY OPERATIONS ACTIVITIES, OBSERVATIONS, AND CONCERNS LOG BOOK / 1996 IX TREATMENT DAILY LOGS / 1996 NEUTRALIZATION TANK (T-210) TRANSFER TO B-374 / 1996 PROCESS WATER TRACKING LOG / 1996 RAD SCREEN RESULTS FOR NEUTRALIZED T-210 / 1996 RECEIVING WATER TRACKING LOG / 1996 T-900 A, B FLOW SHEETS / 1996 TANK LEVEL/VOLUME DAILY LOGS / 1996 UVH2O2 DAILY TREATMENT LOGS ////
38263	8075764	1-Apr-96	RADIATION MONITORING PROTECTION / B707 FOREMANS LOGBOOK (1995-1996)
38263	8215382	1-Jan-96	RADIATION MONITORING PROTECTION / BOOK #5 RCT LOG BOOK DAILY OPERATIONS (BLDG 400-800)AREA (1993-1996)
38263	8215379	31-Jan-93	RADIATION MONITORING PROTECTION / BOOK#2 RCT LOG BOOK DAILY OPERATIONS LOG (BUILDING 883)
38263	8215380	1-Jan-95	RADIATION MONITORING PROTECTION / BOOK#3 RCT LOG BOOK DAILY OPERATIONS (BLDG 400-800) (1993-1996)
38263	8215381	1-Jan-96	RADIATION MONITORING PROTECTION / BOOK#4 RCT LOG BOOK DAILY OPERATIONS LOG (BLDG 865) (1993-1996)
38263	8215383	1-Aug-96	RADIATION MONITORING PROTECTION / BOOK#6 RCT LOG BOOK DAILY OPERATIONS LOG (400-800) AREA (1993-1996)
38263	8215384	1-Jan-96	RADIATION MONITORING PROTECTION / BOOK#7 RCT LOG BOOK DAILY OPERATIONS (BLDG 444) (1993-1996)
38263	8090552	6-Feb-95	RADIATION MONITORING SURVEYS / JACKET 36 / RCT'S DAILY LOG BOOK
38264	8223989	31-Dec-97	DECONTAMINATION AND DECOMMISSIONING CLEANUP AND TRANSITIONING CASE FILES /// B886 HIGHLY ENRICHED URANYL (HEUN) SOLUTION REMOVAL WP #50165 / FOLDER #1 RM 103 TANK DRAINING OPERATIONS LOGBOOK BLDG 886 / FOLDER #2 HEUN DRAINING & BOTTLING / FOLDER #3 HEUN DRAINING & BOTTLING PROCEDURE APPENDIX 2,4,7,1,3,8 / FOLDER #4 HEUN PACKAGING AND PROCEDURE / FOLDER #5 HEUN PACKAGING FL-10 TESTING & SAFETY ANALYSIS REPORTS / FOLDER #6 HEUN FL-10 BOTTLE AND CAP HISTORY
38264	8215385	1-Jan-95	RADIATION MONITORING PROTECTION / BOOK#8; RCT LOG BOOK DAILY OPERATIONS (BLDG 444) (1993-1996)
38265	8498202	7-Jul-98	DECONTAMINATION AND DECOMMISSIONING CLEANUP AND TRANSITIONING CASE FILES // FOLDER 24 903 PAD IHSS 112/115 DAILY RADIATION INSTRUMENTATION PERFORMANCE TEST LOG BOOK
38265	8498203	24-Jun-99	DECONTAMINATION AND DECOMMISSIONING CLEANUP AND TRANSITIONING CASE FILES // FOLDER 25 903 PAD IHSS 112/115 SAMPLE COLLECTION FORM LOGBOOK AND ER-IHSS-112/115-LB-98-381
38265	8498186	15-Sep-98	DECONTAMINATION AND DECOMMISSIONING CLEANUP AND TRANSITIONING CASE FILES // FOLDER 8 903 PAD LOGBOOK NUMBERS
38265	8302500	31-Dec-98	DECONTAMINATION AND DECOMMISSIONING CLEANUP AND TRANSITIONING CASE FILES /// FOLDER 1 TRENCH 1 LOG BOOKS
38265	8302501	31-Dec-98	DECONTAMINATION AND DECOMMISSIONING CLEANUP AND TRANSITIONING CASE FILES /// FOLDER 2 TRENCH 1 LOG BOOKS
38265	8255556	13-Nov-87	RADIATION MONITORING PROTECTION / FOLDER 2 LOG BOOK, DECON ROOM 779
38265	8226017	28-Apr-94	RADIATION MONITORING PROTECTION / FOREMANS LOG BOOK / BLDG# 776/777 (1994-1995)
38265	8226018	18-Feb-95	RADIATION MONITORING PROTECTION / FOREMANS LOG BOOK / BLDG# 776/777 (1994-1995)

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38265	8526748	1-Jan-71	RADIATION MONITORING PROTECTION // 16 BOOKS CONTAMINATION CONTROL RPT LOG BOOKS 1982 1986 1985 1987 1986 1988 1990 AND 1989 BLDG 771 (1971-1990)
38265	8526485	1-Jan-57	RADIATION MONITORING PROTECTION // 24 BOOKS FOREMAN LOG BOOKS BLDG 771 (1957-1975)
38265	8526749	1-Jan-71	RADIATION MONITORING PROTECTION // 6 BOOKS CONTAMINATON CONTROL RPT FOREMANS LOG BOOKS 1971 1976 1983 TO 1984 1985 AND 1987 BLDG 771 (1971-1990)
38266	8562766	15-Jun-70	RADIATION MONITORING PROTECTION // 2 FOREMAN LOG BOOKS 776-777 6/15/1970 THRU 2/17/1975 (1969-1976)
38266	8562771	8-Dec-69	RADIATION MONITORING PROTECTION // FOLDER 1 AREA CONTAMINATION DAILY LOG BOOK 12/08/1969 THRU 02/12/1970
38266	8562772	12-Feb-70	RADIATION MONITORING PROTECTION // FOLDER 2 AREA DECONTAMINATION DAILY LOG BOOK 02/12/1970 THRU 05/03/1970
38266	8526826	1-Jan-61	RADIATION MONITORING SURVEYS // INCIDENT REPORTS RF-21380 BLDGS 771 777 SITE SURVEY BLDGS 331 442 779 AND 559 RECORD BOOKS KITTINGER 1/7/1964 THRU 12/31/1968 1/1/1964 THRU 12/31/1968
38292	8562773	6-May-70	RADIATION MONITORING PROTECTION // FOLDER 3 AREA DECONTAMINATION DAILY LOG BOOK 05/06/1970 THRU 10/05/1970
38299	8562774	5-Oct-70	RADIATION MONITORING PROTECTION // FOLDER 4 AREA DECONTAMINATION DAILY LOG BOOK 10/05/1970 THRU 12/31/1970
38856	8562775	4-Jan-71	RADIATION MONITORING PROTECTION // FOLDER 5 AREA DECONTAMINATION DAILY LOG BOOK 01/04/1971 THRU 08/11/1971
38856	8562776	12-Aug-71	RADIATION MONITORING PROTECTION // FOLDER 6 AREA DECONTAMINATION DAILY LOG BOOK 08/12/1971 THRU 10/14/1971
40983	8563371	9-Oct-91	CONSOLIDATED WATER TREATMENT FACILITY OPERATING LOGS/CHECKLISTS // FOLDER 3 DECON PAD LOG BOOK DEC 6 1993 THRU JUNE 28 1994
40983	8568031	1-Mar-74	TERMINATED PERSONNEL RADIATION RECORDS // SPECIALS TLD BADGE MARCH THRU JUNE 1974
42315	8721736	27-Oct-67	MEDICAL OR HEALTH RESEARCH PROJECT CASE FILES // HISTORICAL HEALTH PHYSICS AND INTERNAL DOSIMETRY COLLECTION / / FOLDER 2 VOGEL LOGBOOK KITTINGER / VOGEL LOGBOOK 06/20/1963 THRU 10/27/1967
42315	8721737	28-Mar-72	MEDICAL OR HEALTH RESEARCH PROJECT CASE FILES // HISTORICAL HEALTH PHYSICS AND INTERNAL DOSIMETRY COLLECTION / / FOLDER 3 LOG BOOK KITTINGER LOG BOOK NUMBER 4 01/02/1968 THRU 03/28/1972
42320	8722008	10-Dec-73	321-72-101 - SPECIAL DOSE MEASUREMENTS USING TLD 07/01/1972 THRU 08/21/1972 / 321-72-103 - SPECIAL DOSE MEASUREMENTS USING TLD 08/01/1972 THRU 09/08/1972 / 321-72-104 - SPECIAL DOSE MEASUREMENTS USING TLD 09/01/1972 THRU 10/09/1972
42324	8722942	6-Jul-87	RADIATION MONITORING PROTECTION // FOLDER 8 RCT LOG BOOK 07/06/1987 THRU 10/01/1997 B444
42351	8830094	26-May-69	INDUSTRIAL HYGIENE & SAFETY HISTORICAL COLLECTION // FOLDER 3 POST 776 FIRE DECONTAMINATION ACTIVITIES DECONTAMINATION LOGBOOKS B776 05-26-1969 THRU 6/16/1969 AND 9/11/1969 THRU 12/26/1969
42374	8830094	26-May-69	This Record Contains Sensitive Information. Contact Records Management on X4006.
42380	8830095	16-Jun-69	INDUSTRIAL HYGIENE & SAFETY HISTORICAL COLLECTION // FOLDER 4 POST 776 FIRE DECONTAMINATION ACTIVITIES SPECIAL DECONTAMINATION CREW LOGBOOK SUMMER 1969 VOL 1 AND 2 B 776
42428	8830095	16-Jun-69	This Record Contains Sensitive Information. Contact Records Management on X4006.

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43495	000059632A	1-Jul-96	ENVIRONMENTAL RESTORATION MANAGEMENT PROJECT FILES // FIELD RECORDS FOR OU4 C POND SOIL SAMPLING;SITE SAFETY BRIEFINGS;GAMMA AND NEUTRON SURVEY FORM 1.1A;PRE ACTIVITY CONTAMINATION SURVEY FORM 1.1B;CONTAMINATION SURVEY; AREA OR EQUIPMENT DRAWING SHOWING SURVEY POINTS;POST ACTIVITY SURVEY;MATERIAL TRANSFER TAG;EQUIPMENT DECONTAMINATION WASH CHECKLIST AND RECORD FORM FO.3A;FIELD MONITORING RESULTS OF CUTTINGS OR CORE FORM FO.8A;RESULTS OF RADIOLOGICAL MEASUREMENTS IN THE FIELD FORM FO.16A;PRELIMINARY WELL SITE FIELD LOG FORM GT.1B;ROCKY FLATS PLANT BOREHOLE LOG FORM GT.1A;DAILY FIELD DRILLING ACTIVITIES REPORT FORM GT.2A;WELL BOREHOLE ABANDONMENT FORM GT.5A;PHOTOIONIZATION DETECTOR FIELD DATA FORM GT.9B;HOT WORK CHECKLIST;ROCKY FLATS SOIL DISTURBANCE APPROVAL FORM;RIG GEOLOGIST FIELD LOG BOOK;HEALTH AND SAFETY LOG BOOK / BUILDING/LOCATION: OU4
44872	000059633A	1-Jul-96	ENVIRONMENTAL RESTORATION MANAGEMENT PROJECT FILES // FIELD RECORDS FOR OU4 C POND SOIL SAMPLING;SITE SAFETY BRIEFINGS;GAMMA AND NEUTRON SURVEY FORM 1.1A;PRE ACTIVITY CONTAMINATION SURVEY FORM 1.1B;CONTAMINATION SURVEY; AREA OR EQUIPMENT DRAWING SHOWING SURVEY POINTS;POST ACTIVITY SURVEY;EQUIPMENT DECONTAMINATION WASH CHECKLIST AND RECORD FORM FO.3A;FIELD MONITORING RESULTS OF CUTTINGS OR CORE FORM FO.8A;RESULTS OF RADIOLOGICAL MEASUREMENTS IN THE FIELD FORM FO.16A;PRELIMINARY WELL SITE FIELD LOG FORM GT.1B;ROCKY FLATS PLANT BOREHOLE LOG FORM GT.1A;DAILY FIELD DRILLING ACTIVITIES REPORT FORM GT.2A;WELL BOREHOLE ABANDONMENT FORM GT.5A;PHOTOIONIZATION DETECTOR FIELD DATA FORM GT.9B;HEAT STRESS MONITORING FORM;RIG GEOLOGIST FIELD LOG BOOK;HEALTH AND SAFETY LOG BOOK / BUILDING/LOCATION: OU4
45062	000059634A	1-Jul-96	ENVIRONMENTAL RESTORATION MANAGEMENT PROJECT FILES // FIELD RECORDS FOR OU4 C POND SOIL SAMPLING;SITE SAFETY BRIEFINGS;GAMMA AND NEUTRON SURVEY FORM 1.1A;PRE ACTIVITY CONTAMINATION SURVEY FORM 1.1B;CONTAMINATION SURVEY; AREA OR EQUIPMENT DRAWING SHOWING SURVEY POINTS;POST ACTIVITY SURVEY;MATERIAL TRANSFER TAGS;RADIOLOGICAL CONTAMINATION SURVEY FORM;EQUIPMENT DECONTAMINATION WASH CHECKLIST AND RECORD FORM FO.3A;FIELD MONITORING RESULTS OF CUTTINGS OR CORE FORM FO.8A;RESULTS OF RADIOLOGICAL MEASUREMENTS IN THE FIELD FORM FO.16A;PRELIMINARY WELL SITE FIELD LOG FORM GT.1B;ROCKY FLATS PLANT BOREHOLE LOG FORM GT.1A;DAILY FIELD DRILLING ACTIVITIES REPORT FORM GT.2A;WELL BOREHOLE ABANDONMENT FORM GT.5A;PHOTOIONIZATION DETECTOR FIELD DATA FORM GT.9B;HEAT STRESS MONITORING FORM;FIELD GEOLOGIST FIELD LOG BOOK;RADIOACTIVE SOURCE TRANSACTION FORM;PROPERTY RELEASE LOG;RFEDS ROCKY FLATS ENVIRONMENTAL DATA SYSTEMS FIELD DATA TRANSMITTAL FORM FO.14A / BUILDING/LOCATION: OU4
46471	000107950A	1-Jul-96	ENVIRONMENTAL RESTORATION MANAGEMENT PROJECT FILES // DECONTAMINATION OPERATIONS AND SUPPORT DAILY LOG BOOK / BUILDING/LOCATION: 903B
46471	000107949A	1-Jul-96	ENVIRONMENTAL RESTORATION MANAGEMENT PROJECT FILES // MAIN DECONTAMINATION FACILITY DAILY LOG BOOK ER/RMRS/LB/97/218 / BUILDING/LOCATION: 903B
51086	000107951A	1-Jul-96	ENVIRONMENTAL RESTORATION MANAGEMENT PROJECT FILES // MAIN DECONTAMINATION FACILITY DAILY LOG BOOK ER/RMRS/LB/98/391 / BUILDING/LOCATION: 903B
51595	000108677A	1-Jul-96	ENVIRONMENTAL RESTORATION MANAGEMENT PROJECT FILES // LOG BOOK; GOLDER FEDERAL SERVICES; WATER OPERATIONS; MDF MAIN DECONTAMINATION FACILITY DRUM INSPECTIONS NO 9 / BUILDING/LOCATION: MDF
51595	000107952A	1-Jul-96	ENVIRONMENTAL RESTORATION MANAGEMENT PROJECT FILES // MAIN DECONTAMINATION FACILITY DAILY LOG BOOK ER/RMRS/LB/98/402 / BUILDING/LOCATION: 903B
55345	000108683A	1-Jul-96	ENVIRONMENTAL RESTORATION MANAGEMENT PROJECT FILES // LOG BOOK; GOLDER FEDERAL SERVICES; WATER OPERATIONS SITE MANAGERS NOTES FOR OU1; OU2; DECON / BUILDING/LOCATION: OU1; OU2; DECON

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55345	000108679A	1-Jul-96	ENVIRONMENTAL RESTORATION MANAGEMENT PROJECT FILES // LOG BOOK; GOLDER FEDERAL SERVICES; WATER OPERATIONS; JOURNAL MDF MAIN DECONTAMINATION FACILITY PAD / BUILDING/LOCATION: MDF
55345	000108684A	1-Jul-96	ENVIRONMENTAL RESTORATION MANAGEMENT PROJECT FILES // LOG BOOK; GOLDER FEDERAL SERVICES; WATER OPERATIONS; MDF MAIN DECONTAMINATION FACILITY OPERATIONAL LOG BOOK NO 903B / BUILDING/LOCATION: MDF
55660	000108805A	1-Jul-96	ENVIRONMENTAL RESTORATION MANAGEMENT PROJECT FILES // FIELD DATA FOR BOREHOLE 40093; PRE-WORK SURVEY; POST-ACTIVITY SURVEY; CONTAMINATION SURVEY; EQUIPMENT DECONTAMINATION/WASH CHECKLIST; HEAVY EQUIPMENT DECONTAMINATION/WASH CHECKLIST; FIELD MONITORING RESULTS OF CUTTINGS OR CORE; RECORD OF DRILLING FLUIDS AND CUTTINGS; DRUM FIELD LOG; FILE CHECK SHEET; CONTAMINATE CHARACTERIZATION FORM FOR GRAY DRUMS PENDING CHARACTERIZATION; SAMPLE COLLECTION FORM; RESULTS OF RADIOLOGICAL MEASUREMENTS IN THE FIELD; PRELIMINARY WELL-SITE FIELD LOG; HOLLOW-STEM AUGER DRILLING FIELD ACTIVITIES REPORT; BOREHOLE ABANDONMENT FIELD ACTIVITIES REPORT; SURFACE SOIL SAMPLING FIELD ACTIVITIES REPORT; PHOTOIONIZATION DETECTOR FIELD DATA FORM; RIG GEOLOGIST FIELD LOG BOOK; HEALTH AND SAFETY TECHNICIAN FIELD LOG BOOK / BUILDING/LOCATION: OU4
55660	000108806A	1-Jul-96	ENVIRONMENTAL RESTORATION MANAGEMENT PROJECT FILES // FIELD DATA FOR BOREHOLE 40193; CONTAMINATION SURVEY; EQUIPMENT DECONTAMINATION/WASH CHECKLIST; FIELD MONITORING RESULTS OF CUTTINGS OR CORE; RECORD OF DRILLING FLUIDS AND CUTTINGS; DRUM FIELD LOG; FILE CHECK SHEET; CONTAMINATE CHARACTERIZATION FORM FOR GRAY DRUMS PENDING CHARACTERIZATION; SAMPLE COLLECTION FORM; RESULTS OF RADIOLOGICAL MEASUREMENTS IN THE FIELD; HOLLOW-STEM AUGER DRILLING FIELD ACTIVITIES REPORT; BOREHOLE LOG; SURFACE SOIL SAMPLING FIELD ACTIVITIES REPORT; PHOTOIONIZATION DETECTOR FIELD DATA FORM; GROUNDWATER MONITORING WELL AND PIEZOMETER REPORT; SURFACE SOIL DATA COLLECTION FORM; RIG GEOLOGIST FIELD LOG BOOK; HEALTH AND SAFETY TECHNICIAN FIELD LOG BOOK / BUILDING/LOCATION: OU4
55660	000108808A	1-Jul-96	ENVIRONMENTAL RESTORATION MANAGEMENT PROJECT FILES // FIELD DATA FOR BOREHOLE 40493; CONTAMINATION SURVEY; EQUIPMENT DECONTAMINATION/WASH CHECKLIST; HEAVY EQUIPMENT DECONTAMINATION/WASH CHECKLIST; FIELD MONITORING RESULTS OF CUTTINGS OR CORE; DRUM FIELD LOG; CONTAMINATE CHARACTERIZATION FORM FOR GRAY DRUMS PENDING CHARACTERIZATION; SURFACE SOIL SAMPLE COLLECTION FORM; VERIFICATION OF ORGANIC VAPOR MONITORING RESULTS; RECORD OF DRILLING FLUIDS AND CUTTINGS; RESULTS OF RADIOLOGICAL MEASUREMENTS IN THE FIELD; PRELIMINARY WELL-SITE FIELD LOG; HOLLOW-STEM AUGER DRILLING FIELD ACTIVITIES REPORT; SURFACE CASING INSTALLATION FIELD ACTIVITIES REPORT; BOREHOLE ABANDONMENT FIELD ACTIVITIES REPORT; SURFACE SOIL DATA COLLECTION FORM; SURFACE SOIL SAMPLING FIELD ACTIVITIES REPORT; PHOTOIONIZATION DETECTOR FIELD DATA FORM; DRILLER LOG BOOK; GEOLOGIST LOG BOOK; H&S HEALTH AND SAFETY LOG BOOK / BUILDING/LOCATION: OU4
55660	000108809A	1-Jul-96	ENVIRONMENTAL RESTORATION MANAGEMENT PROJECT FILES // FIELD DATA FOR BOREHOLE 40593; CONTAMINATION SURVEY; PRE-WORK SURVEY; POST-ACTIVITY SURVEY; EQUIPMENT DECONTAMINATION/WASH CHECKLIST; HEAVY EQUIPMENT DECONTAMINATION/WASH CHECKLIST; FIELD MONITORING RESULTS OF CUTTINGS OR CORE; RECORD OF DRILLING FLUIDS AND CUTTINGS; DRUM FIELD LOG; CONTAMINATE CHARACTERIZATION FORM FOR GRAY DRUMS PENDING CHARACTERIZATION; SAMPLE COLLECTION FORM; RESULTS OF RADIOLOGICAL MEASUREMENTS IN THE FIELD; PRELIMINARY WELL-SITE FIELD LOG; HOLLOW-STEM AUGER DRILLING FIELD ACTIVITIES REPORT; SURFACE CASING INSTALLATION FIELD ACTIVITIES REPORT; SURFACE SOIL DATA COLLECTION FORM; SURFACE SOIL SAMPLING FIELD ACTIVITIES REPORT; PHOTOIONIZATION DETECTOR FIELD DATA FORM; BAT GROUNDWATER MONITORING SYSTEM; VADOSE ZONE MONITORING BOREHOLE CONSTRUCTION DIAGRAM SOLAR PONDS OU4; DRILLER LOG BOOK; HEALTH AND SAFETY LOG BOOK; RIG GEOLOGIST LOG BOOK; VADOSE ZONE FIELD LOG BOOK / BUILDING/LOCATION: OU4

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55660	000108810A	1-Jul-96	ENVIRONMENTAL RESTORATION MANAGEMENT PROJECT FILES // FIELD DATA FOR BOREHOLE 41293; CONTAMINATION SURVEY; EQUIPMENT DECONTAMINATION/WASH CHECKLIST; HEAVY EQUIPMENT DECONTAMINATION/WASH CHECKLIST; FIELD MONITORING RESULTS OF CUTTINGS OR CORE; RECORD OF DRILLING FLUIDS AND CUTTINGS; DRUM FIELD LOG; CONTAMINATE CHARACTERIZATION FORM FOR GRAY DRUMS PENDING CHARACTERIZATION; SAMPLE COLLECTION FORM; RESULTS OF RADIOLOGICAL MEASUREMENTS IN THE FIELD; PRELIMINARY WELL-SITE FIELD LOG; HOLLOW-STEM AUGER DRILLING FIELD ACTIVITIES REPORT; SURFACE SOIL DATA COLLECTION FORM; SURFACE SOIL SAMPLING FIELD ACTIVITIES REPORT; PHOTOIONIZATION DETECTOR FIELD DATA FORM; VADOSE ZONE MONITORING BOREHOLE CONSTRUCTION DIAGRAM SOLAR PONDS OU4; IN SITU PERMEABILITY TEST; H&S HEALTH AND SAFETY LOG BOOK; VADOSE ZONE FIELD LOG BOOK; FILE CHECKSHEET / BUILDING/LOCATION: OU4
55672		1976	DOE ROCKY FLATS PLANT GUIDE TO RECORD SERIES USEFUL FOR HEALTH RELATED RESEARCH PREPARED BY HISTORY ASSOCIATES (HAI)// THIS SERIES CONSISTS OF WORKSHEETS AND NOTES WHICH WERE CREATED FOR A REPORT CONCERNING THE LINE 17 HYDROFLUORINATOR IN BUILDING 771, ROOM 114B. THE SERIES DOCUMENTS RADIATION MONITORING'S EFFORTS TO TRACE THE SOURCE OF RADIATION LEVELS THAT REQUIRED WORKERS ON LINE 17 TO WEAR FULL-FACE RESPIRATORY PROTECTION AT ALL TIMES. RECORDS INCLUDE SPECIAL TLD [THERMOLUMINESCENT DOSIMETER] RECORDS OF EXTERNAL DOSES (IN MILLIREM) FOR A SMALL NUMBER OF EMPLOYEES. ALSO INCLUDED ARE GAMMA-NEUTRON SURVEYS.
55672		1963	MEDICAL OR HEALTH RESEARCH PROJECT CASE FILES // HISTORICAL HEALTH PHYSICS AND INTERNAL DOSIMETRY COLLECTION / / FOLDER 2 EQUIPMENT HISTORY FILES HEALTH PHYSICS CALIBRATION / BODY COUNT SPECIFICATIONS / BODY COUNT CRITERIA / BODY COUNT LETTERS / STATISTICS / SPECIFICATIONS INSTRUMENTATION / BODY COUNT HISTORY / G PG LAEL DATA / MANUALS BUILDING 22 ROCKY FLATS MECHANICAL / /TLD LOGBOOK / E L RAY COMMUNICATIONS / BODY COUNT DATA / LINEAR AMPLIFIER 04/19/1961 THRU 01/02/1963
55672		1971	OCCURRENCE REPORTS / INVESTIGATION OF THE DISCOVERY OF PLUTONIUM IN THE BOTTOM OF HYDROFLUORINATOR GLOVEBOX
55673		1979	RADIATION MONITORING PROTECTION / LOGBOOK
59556		1990	EXTERNAL DOSIMETRY REPORTS EXCLUDES INDIVIDUAL EMPLOYEE FILES / 1990 GATE CLEANERS / DOSIMETER DELIVERY AND PICK UP PAPERS / TLD READER CALIBRATION FORMS / TLD READER CALIBRATION WORKSHEETS / TLD READER QUALITY CONTROL FORMS / ECF GRAPHS / TLD RAW DATA EDIT / MEAN ECF DATA DETERMINATION FORMS / QC TLD IRRADIATION FORMS / ECF MEAN GENERATION / ECF IN MEAN UPDATE INFORMATION REPORT / ECF FAIL REPORTS / ECF DATABASE REPORTS / LABEL VERIFICATION REPORTS / ECF PASS REPORTS / PARAMETER DUMP REPORTS / READER NUMBER 1 CALIBRATION / DASE EQUIVALENT PROCESSING / BATCH ADDITION OF REFERENCE DOSIMETER / ECF DATABASE PASS REPORT 802 / ECF DATABASE PASS REPORT 809 / RAW DATA REPORTS
59556		1989	PBT PERFORMANCE BASED TRAINING COURSE MATERIALS //033-125-05/ CHEM OPS - HYDROFLUORINATION - 771 //
61268		1992	EXTERNAL DOSIMETRY REPORTS EXCLUDES INDIVIDUAL EMPLOYEE FILES // 1992 UD-710A TLD READER QUALITY CONTROL FORM READER #1-1\READER #1-2\ READER #1-3\ READER # 1-4 ////
61268		1992	EXTERNAL DOSIMETRY REPORTS EXCLUDES INDIVIDUAL EMPLOYEE FILES // 1992 UD-710A TLD READER QUALITY CONTROL FORM READER #3-1 / READER #3-2 / READER #3-3 / READER #3-4 / READER #3-5 / READER #3-6 ////

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62098		1952–1993	DOE ROCKY FLATS PLANT GUIDE TO RECORD SERIES USEFUL FOR HEALTH RELATED RESEARCH PREPARED BY HISTORY ASSOCIATES (HAI)// THE DOSIMETER RESULTS RECORDS DOCUMENT EMPLOYEE AND VISITOR EXPOSURES TO EXTERNAL RADIATION. THE SERIES CONSISTS OF FILM BADGE WORKSHEETS, TLD [THERMOLUMINESCENT DOSIMETER] WORKSHEETS, FINGER RING RESULTS, AND COMPUTER-GENERATED BADGE SUMMARY REPORTS, ALL OF WHICH PROVIDE DATA ON SKIN, ARM, HAND, AND WHOLE BODY EXPOSURES ON A MONTHLY, QUARTERLY, AND YEARLY BASIS. EMPLOYEE INFORMATION INCLUDES NAMES AND IDENTIFICATION NUMBERS, DEPARTMENT AND BUILDING ASSIGNMENTS, AND DOSIMETER NUMBER. THIS SERIES ALSO INCLUDES GATE SIGN-IN SHEETS AND BADGE DATA FOR TOUR GROUPS AND VISITORS TO ROCKY FLATS. ACCESSION NUMBER 434-92-0059 HAS A FOLDER OF "HARSHAW WRIST DATA." WHICH DOCUMENTS WRIST DOSIMETRY READINGS FOR EMPLOYEES IN ASSEMBLY, WELDING/ASSEMBLY, TESTING, AND 707 PRODUCTION CONTROL.
62098		1960–1962	DOE ROCKY FLATS PLANT GUIDE TO RECORD SERIES USEFUL FOR HEALTH RELATED RESEARCH PREPARED BY HISTORY ASSOCIATES (HAI)// THIS SERIES INCLUDES THE FOLLOWING: EMPLOYEE NAMES, MAN [EMPLOYEE] NUMBER, BADGE NUMBER, DENSITY READINGS, DOSES, AND DEPARTMENT NUMBER. BUILDINGS MENTIONED INCLUDE 71, 76, AND 91. RESULTS ARE GIVEN BASED ON USE OF VARIOUS FILTER MATERIAL, INCLUDING BR [BRASS], CD [CADMIUM], AND OW [OPEN WINDOW]. THE FILM BADGE WORKSHEETS MAY BE USEFUL FOR RESEARCHING DOSE COMPARISONS BEFORE AND AFTER THE FIRE. HOWEVER WORKSHEETS FOR 1957 ARE NOT INCLUDED.
62098		1963–1965	MEDICAL OR HEALTH RESEARCH PROJECT CASE FILES // HISTORICAL HEALTH PHYSICS AND INTERNAL DOSIMETRY COLLECTION / / FOLDER 3 EQUIPMENT HISTORY FILES HEALTH PHYSICS CALIBRATION / ELECTRO PHORESIS / TLD NEUTRON PAPERS / AM 241 GAMMA SOURCE / TLD GAMMMA / GAMMA SOURCE / TLD NEWTRONS 2 / TLD NEUTRONS PUBE BACKGROUND IRON ROOM QCT 1963 / COMM ABOUT BC TO AND FROM UP5 / SPECS FOR STATE BODY COUNT / COMMUNICATIONS METRIY PACKARD ETC. / NEUTRON CALIBARATIONS / NEUTRON STUDY / GE(LI) COAXIAL DETECTOR STUDY / INTERLABORAATORY CALIBRATION EXCRCIRE [Names protected] 10/01/1963 THRU 10/22/1965
62098		1996	RADIATION MONITORING PROTECTION / CONTAMINATION CONTROL LOGBOOK ////
62098		1995	RADIATION MONITORING PROTECTION / PA ANNOUNCEMENT FOE RESPIRATORY PROTECTION BLDG 707 JAN 1995 // FOREMAN SHIFT RELIEF CHECKLIST BLDG 707 JAN 1995 // SAAM ALARM LOGS BLDG 707 JAN 1995 // POSTING FOR RAD CONTROL BLDG 707 JAN 1995 // INSTRUMENT PERFOMANCE TEST LOGS JAN 1995 // CHAIN OF CUSTODY - DAILY AIRHEADS JAN 1995 // INSTRUMENT PERFORMANCE TEST LOGS JAN 1995 // PA ANNOUNCEMENT FOR RESPIRATORY PROTECTION FEB 1995 // FOREMAN SHIFT RELIEF CHECKLIST FEB 1995 // SAAM ALARM LOGS FEB 1995 // POSTINGS FOR RAD CONTROL FEB 1995 // INSTRUMENT PERFORMANCE TEST LOGS FEB 1995 // CHAIN OF CUSTODY - DAILY AIRHEADS FEB 1995 // INSTRUMENT PERFORMANCE TEST LOGS FEB 1995 // PA ANNOUNCEMENT FOR RESIRATORY PROTECTION MARCH 1995 // FOREMAN SHIFT RELIEF CHECKLIST MARCH 1995 // SAAM ALARM LOGS MARCH 1995 // POSTINGS FOR RAD CONTROL MARCH 1995 // INSTRUMENT PERFORMANCE TEST LOGS MARCH 1995 // CHAIN OF CUSTODY - DAILY AIRHEADS MARCH 1995 // INSTRUMENT PERFORMANCE TEST LOGS MARCH 1995 // PA ANNOUNCEMENT FOR RESPIRATORY PROTECTION APRIL 1995 // FOREMAN SHIFT RELIEF CHECKLIST APRIL 1995 // SAAM ALARM LOGS APRIL 1995 // POSTINGS FOR RAD CONTROL APRIL 1995 // INSTRUMENT PERFORMANCE TEST LOGS APRIL 1995 // CHAIN OF CUSTODY - DAILY AIRHEADS APRIL 1995 // INSTRUMENT PERFORMANCE TEST LOGS APRIL 1995 // PA ANNOUNCEMENT FOR RESPIRATORY PROTECTION MAY 1995 // FOREMAN SHIFT RELIEF CHECKLIST MAY 1995 // SAAM ALARM LOGS MAY 1995 // POSTINGS FOR RAD CONTROL MAY 1995 // INSTRUMENT PERFORMANCE TEST LOGS MAY 1995 // CHAIN OF CUSTODY - DAILY AIRHEADS MAY 1995 // INSTRUMENT PERFORMANCE TEST LOGS MAY 1995 // ONE (1) FOREMANS LOG BOOK 3/7/1995 - 6/7/1995 // ONE (1) CONTAMINATION CONTROL LOGBOOK 1/28/1995 - 5/12/1995 //
62098		1970–1975	RADIATION MONITORING PROTECTION // 2 FOREMAN LOG BOOKS 776-777 6/15/1970 THRU 2/17/1975
62098		1957–1975	RADIATION MONITORING PROTECTION // 24 BOOKS FOREMAN LOG BOOKS BLDG 771
62098		1970–1975	RADIATION MONITORING PROTECTION // 3 771 S. A. LOG BOOKS 06/24/1970 THRU 04/02/1975

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62098		1994	SAFETY EVALUATIONS:UNREVIEWED SAFETY QUESTIONS DETERMINATIONS (USQD)/// EVALUATION #: PRE-RFP-94.0458-CGM / TITLE: CONTAMINATION CONTROL LOGBOOK, / DOCUMENT #: ROI 10.03 REV 06/21/90 / MODIFICATION #: DMR 93-000919 / COMPLETE DATE: 01/07/1994 / CLOSEOUT DATE: 01/20/1994 / DOE APPROVAL DATE: N/A / INCOMING LETTER #S: N/A / USQ N/Y: N/A / BLDG: RFP
62098		1994	WELL 5771;FILE CHECKSHEET;DAILY ACTIVITIES FORM CHECKLIST;ATTACHMENT 4 TAILGATE SAFETY MEETING;FORM 1.1B PRE ACTIVITY CONTAMINATION SURVEY;AREA OR EQUIPMENT DRAWING SHOWING SURVEY POINTS;CONTAMINATION SURVEY;FORM FO.8A FIELD MONITORING RESULTS OF CUTTINGS OR CORE;SURFACE SOIL SAMPLING MANUAL 4-E42-ER-OPS SAMPLE COLLECTION FORM;SURFACE SOIL SAMPLING FIELD ACTIVITIES REPORT;LOGBOOK PAGES 52;53;50;51;LOG OF BORING NO 56-87;FORM FO.14L GROUND WATER LEVEL MEASUREMENT FORM;FORM GT.5A REV 3 WELL BOREHOLE ABANDONMENT FORM;FORM GWS-9 WELL ABANDONMENT REPORT;LOGBOOK PAGES 32 THRU 35;IT INTERNATIONAL TECHNOLOGY ANALYTICAL SERVICES RADIOCHEMICAL ANALYSIS RESULTS REPORTED ON 940711;1D PESTICIDE ORGANICS ANALYSIS DATA SHEET;PHOTOGRAPH NOS 45515-13;45515-12
62500		1972–1995	ENVIRONMENTAL MASTER FILE (EMF)// GLOVE RUPTURE AT HYDROFLUORINATOR BUILDING 771 AUTHOR: UNKNOWN; DOW CHEMICAL ROCKY FLATS ADDRESSEE: NONE
62500		1973–1995	ENVIRONMENTAL MASTER FILE (EMF)// PROGRAM TO MEASURE BACKGROUND GAMMA RADIATION WITH THERMOLUMINESCENT DOS METERS (TLD) AT ROCKY FLATS PLANT AND ENVIRONS [Author/addressee names protected]
62500		1971–1990	RADIATION MONITORING PROTECTION // 16 BOOKS CONTAMINATION CONTROL RPT LOG BOOKS 1982 1986 1985 1987 1986 1988 1990 AND 1989 BLDG 771
62512		1973–1997	INDUSTRIAL HYGIENE & SAFETY HISTORICAL COLLECTION /// 37 / OSA - 771.111 - HYDROFLUORINATION - DEACTIVATED 1992
62512		1975–1983	RADIATION MONITORING SURVEYS // C G HAYNES HP LOG BOOK NBS 6/1/1987 THRU 10/31/1983
62512		1975–1983	RADIATION MONITORING SURVEYS // C R JOHNSON UNIT LEADEER AND ADMINISTRATOR LOG BOOK NBS 5/1/1975 THRU 11/30/1979
62600		1981–1991	RADIATION MONITORING PROTECTION // 2 BOOKS GROSS ALPHA/BETA LOG BOOKS BLDG 881 6/11/1984 THRU 4/27/1988
62600		1976–1990	RADIATION MONITORING PROTECTION // 5 BOOKS SHIFT LOG BOOKS 1989 TO 1990 1987 TO 1988 1982 TO 1983 1984 TO 1985 1985 TO 1986 BLDG 771 (1976-1980)
62600		1977–1981	RADIATION MONITORING SURVEYS // CONTAMINATION CONTROL LOG BOOKS FOREMAN LOG BOOKS
63069		1985–2000	EXTERNAL DOSIMETRY REPORTS EXCLUDES INDIVIDUAL EMPLOYEE FILES // FOLDER 3 EXPOSURE FACILITY MANUAL BLDG 126 11/18/1985

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67796		1986–1991	HISTORICAL MICROFILM COLLECTION/FACILITIES ENGINEERING & CONSTRUCTION RECORDS / MTCE WORKORDER FILES BY AUTHORIZATION / 537844 GRIND FLOOR UNDER DRUM SCALE, B774, RM 203 CANCELLED / 537911 SST FLEX HOSE ALTERATION TO SLUDGE PUMPS, B774, RM 103 / 537914 TANK 208 VENT LINE, B771, RM 149 / 537946 REPLACE SP-2 SUMP PUMP W/TRIDENT SUMP PUMP, B774, RM 102 / 537951 REPAIR SITE GAUGE TK 550, B771, RM 114 / 537954 REROUTE CAUSTIC PIPING, B774, RM 203 / 537993 INSTALL INTERLOCK BET. SEAL WATER PUMPS, B771, RM 149 / 537997 INCINERAT0R FILTER PLENUM BRACKETS, B771, RM 149 / 538035 BERM BARRIERS, B771, RM 149 / 538100 INSTALL A SECOND TUBE DIFFERENTIAL GAUGE NEAR VALVE FOR TUBE / VACUUM, B771, RM 114-784 / 538101 S.S.T00L FABRICATION, B771, RM 114 / 538124 TANK D-971 VIEW PORT REPLACEMENT, B771, RM 149 / 538203 THERMOCOUPLE COVERS, B771, RM 114 / 538258 FABRICATE FUNNEL FOR DISSOLUTION, B771, RM 149 / 538300 FAB. STAINLESS STEEL COUPLING ADAPTORS, B771, RM 149 / 538320 PROCESS SIMULATION LAB TANK 1810 LEVEL XMTR.REMOVAL, B771, R 180A / 538367 MODIFY PINT-SIZE SAMPLE DROP, B771, RM 149 / 538373 SEAL BOX 3 SAMPLE, B771, RM 159 / 538444 LINE 7 HYDROFLUORINATOR GLOVEBOX, B771, RM 114 / 538445 BLANK LINES BET. TANKS 2F/T71 AND 1A/1RF, B774, RM 202 / 538513 LINE 37 DOWN DRAFT FEED PUMP ELEC. INSTALLATION, B771 RM 149 / 538521 FAB. DEFLECTOR COVER FOR LINE 2 DISSOLVER POT, B771, RM 114 / 538525 PROTECTIVE GUARD FOR 12 HOLE CART, B771 / 538553 REUSE WASH SOL. TO ANION EXCHANGE COL., B771, RM 149 / 538574 LN B4 EXHAUST HEADER DRAIN, B771, RM 149 / 538576 FAB & INSTALL SHELF, B771, RM 114 / 538922 FLOWMETER INSTALLATION, BINGHAM PUMP SYSTEM, B771, RM 105A
67796		1986–2000	HYDROFLUORINATION (LINES 4, 6, AND 7)
68341		1988–1989	PBT PERFORMANCE BASED TRAINING COURSE MATERIALS // 33-125-05 OPERATIONS MANUAL FOR HYDROFLUORINATION BLDG 771
68341		1989–2006	WIPP QUALITY ASSURANCE RECORDS// 129115 WIPP-041 AK ACCEPTABLE KNOWLEDGE REF 2 VSS-004-01 HYDROFLUORINATION LINES 4 6 AND 7 CO-1009 09/25/1989 INACTIVE PROCEDURE DESCRIBES HYDROFLUORINATION OPERATIONS IN BUILDING 771 LISTS TEMPERATURE ZONES OF ROTARY TUBE 360 TO 670 DEGREES CELSIUS FOR HYDROFLUORINATION LISTS RESIDENCE TIMES FOR OPERATIONS 8 HOURS PER BATCH LETTER TO DISTRIBUTION FROM R V HALE SUBJECT DESTRUCTION OF OBSOLETE PROCEDURES 10/13/1988
68351		1991–1994	CONTAMINATION CONTROL LOGBOOKS / BUILDING 707
68353		1994–1995	RADIATION MONITORING SURVEYS / CONTAMINATION CONTROL LOGBOOK / BLDG 707 10/22/1994 THRU 1/27/1995
68353		1994–1995	RETIRED EQUIPMENT HISTORICAL RECORD RADIATION INSTRUMENTATION OR HEALTH PHYSICS/// 1994 POCKET DOSIMETERS 862-L 4100059, 862-L 4100048, 862-L 4090015, 862-L 2091093, 862-L 2091089, 862-L 2091088, 862-L 2091082, 862-L 2091072, 862-L 2091068, 862-L 2091061, 862-L 2091059, 862-L 2091043, 862-L 2091048, 862-L 2091044, 862-L 2091084 // 1995 LUDLUM MICRO R H01312, LUDLUM MICRO R 9188 ///
68471		1994–1995	RADIATION MONITORING PROTECTION / CONTAMINATION CONTROL LOGBOOK ///
68475		1995–1996	RADIATION MONITORING PROTECTION / CONTAMINATION CONTROL LOGBOOK ///
68487		1995–2004	EXTERNAL DOSIMETRY REPORTS EXCLUDES INDIVIDUAL EMPLOYEE FILES // FOLDER 8 TLD READER STATUS SHEETS READER 1-2-3 11/22/1995 THRU 09/30/2004
69169		1996–2005	HISTORY FILES// FOLDER 7 PRO-1703-RDE-0056 CALIBRATION OF THE PANASONIC UD-710A TLD READER SERVICE READER ACTIONS 01/01/1996 THRU 12/31/2005
73170		2002–2005	EXTERNAL DOSIMETRY REPORTS EXCLUDES INDIVIDUAL EMPLOYEE FILES // FOLDER 2 EXTERNAL DOSIMETRY REPORTS WRIST MANUAL CALCULATIONS V AND V 01/30/2002

Master List of Records Search Results

Receipt #	Bar Code	Orig. Date	Subject
74106			RADIATION MONITORING PROTECTION // HISTORICAL RECORDS TRANSMITTAL/PERSONNEL RADIATION HISTORY FILES / HEALTH PHYSICS LOG BOOKS 2/60, 5/63 VISITOR FILM BADGE 4/61-6/63 AIR AND SMEAR SAMPLES CY 1962 SITE SURVEY RESULTS CY 1959-60, 1962 PU/URINE RE BOX ORIGINALLY LOCATED AT FRC UNDER ACCESSION 430-80-0011 THIS BOX WAS CONTAMINATED COPIED BY AN RCT ON 5-2-2002 AND RE-ENTERED UNDER RTI 32 FOLDER 9 LOG BOOK 4-14-1961 THRU 12-1-1962
74121			RADIATION MONITORING PROTECTION // HISTORICAL RECORDS TRANSMITTAL/PERSONNEL RADIATION HISTORY FILES / HEALTH PHYSICS LOG BOOKS 2/60, 5/63 VISITOR FILM BADGE 4/61-6/63 AIR AND SMEAR SAMPLES CY 1962 SITE SURVEY RESULTS CY 1959-60, 1962 PU/URINE RE BOX ORIGINALLY LOCATED AT FRC UNDER ACCESSION 430-80-0011 THIS BOX WAS CONTAMINATED COPIED BY AN RCT ON 5-2-2002 AND RE-ENTERED UNDER RTI 32 FOLDER 10 LOG BOOK 1962 SPECIAL 12-28-1961 THRU 12-6-1962
74121			RADIATION MONITORING PROTECTION // HISTORICAL RECORDS TRANSMITTAL/PERSONNEL RADIATION HISTORY FILES / HEALTH PHYSICS LOG BOOKS 2/60, 5/63 VISITOR FILM BADGE 4/61-6/63 AIR AND SMEAR SAMPLES CY 1962 SITE SURVEY RESULTS CY 1959-60, 1962 PU/URINE RE BOX ORIGINALLY LOCATED AT FRC UNDER ACCESSION 430-80-0011 THIS BOX WAS CONTAMINATED COPIED BY AN RCT ON 5-2-2002 AND RE-ENTERED UNDER RTI 32 FOLDERS 2 AND 3 LOG BOOK PRODUCTION AREA LOG HP 2-18-1960 THRU 6-24-1961
SA1215			PLANNING AND DESIGN FILES // FOLDER 1 CALC707EXH000212 EXHAUST FOR DRUM VENTING 707 / CALC707FW000208 FP REQW FOR CONTAMINATION CONTROL CELL 707 / CALC707GB000211 STRIP OUT OF GB 707-A-15 (ENDCAP LIFT) 707 / CALC707NA000209 FP IN 'C' CELL 707 / CALC707NA000214 FILTER TEST GLOVE BOX 707 / CALC707NA000215 ASH / DRY- GAMMA DOSE RATE 707 / CALC707NA000216 ASH / DRY - NEUTRON DOSE RATE 707 / CALC707NA000217 ASH / DRY - GAMMA / NEUTRON DOSE RATE BASELINE 707 / CALC707NA000220 EFFECT OB GB OXYGEN CONCENTRATION DUE TO STATIONARY PYROCHEMICAL FURNACE OP 707 / CALC707NAP000213 PACK/SHIP X-RAY EQUIPMENT TO LAS ALAMOS NAT'L LAB 707 / CALC707NAP000221 SALT RES STAB/RPK SUB;MOD F DEMO 707 / CALC707UPS000210 REPLACE UPS BATTERY/PERFORM BATTERY CAPACITY TEST 707 / CALC707VEXH000207 PLENUM EXHAUST SYS CAP FOR NEW RECORD SAMPLING SYSTEMS 707 /
SA2984			HISTORY FILES// FOLDER 4 PADC-1994-02630 RADIOLOGICAL DOSIMETRY EXTERNAL MANUAL TABLE OF CONTENTS
SA2984			HISTORY FILES// PADC-2001-00062 RFETS INTERNAL DOSIMETRY PROCEDURE MANUAL ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE INTERNAL DOSIMETRY PROCEDURE MANUAL
SA2984			SAMPLING AND ANALYSIS PROCEDURES / PHYSICAL AND DIMENSIONAL STANDARDS TESTING// 091085 DENSITOMETER/FILM STRIP
SC1556			HISTORY FILES// FOLDER 7 PADC-1994-02630 RADIOLOGICAL DOSIMETRY EXTERNAL MANUAL T.O.C. RADIOLOGICAL DOSIMETRY EXTERNAL MANUAL TABLE OF CONTENTS
SC1738			HISTORY FILES// FOLDER 5 PADC-1994-02611 RADIOLOGICAL DOSIMETRY INTERNAL MANUAL T.O.C. RADIOLOGICAL DOSIMETRY INTERNAL MANUAL TABLE OF CONTENTS
			General Requests
			BETA-GAMMA FILM BADGE RESULTS (771, 776, 777, 779) - 1963-1964
			BETA-GAMMA FILM BADGE RESULTS (771, 776, 777, 779) - 1969
			BETA-GAMMA FILM BADGE RESULTS (771, 776, 777, 779) - 1970
			FILM BADGE LABORATORY LOGBOOKS FOR 1965-1968

Master List of Records Search Results

Receipt #	Bar Code	Orig. Date	Subject
			HEALTH PHYSICS SPECIAL TLD DATA (1963-1995)
			HEALTH PHYSICS TLD DATA (1969-1995)
			IN VIVO/WOUND COUNTER LOGBOOK FOR 1969
			LOGBOOKS, FILM BADGE OR TLD DATA RELATED TO ZPPR
			INDIVIDUAL DOSIMETRY FILES
			DOSIMETRY PROCEDURE FOR THE INVESTIGATION OF LOST, DAMAGED, OR UNEXPLAINED BADGE REPORTS
			SECONDARY DOSIMETRY RESULTS FOR BUILDINGS 371, 444, 881, 771, and 776
			Technical Document Requests
			Health Physics Progress Reports (Usually Annual or Quarterly)
			Health Division/Medical Department Reports for May-July 1969
			An Alpha Counter for Glove box Operations, RFP 348, August 1963
			Incineration in Actinide Processing at Rocky Flats
			Actinide Processing at Rocky Flats
			Gasket Failures in Plutonium Reduction Furnaces October 1964
			Report on the Condition of the Line 7 Glove box
			Molten Salt Extraction of Americium from Molten Plutonium, RFP-2365, March 1976
			Neptunium Processing at the Rocky Flats Plant, RFP-2899, September 20, 1981

ATTACHMENT 13: SAFETY CONCERNS SUMMARY TABLE

Rocky Flats Safety Concern Review for Data Integrity Issues

Safety Concern No.	Description of Concern	NIOSH Response	SC&A Response
70-2	Senior Radiation Monitors raised five safety issues related to general work area radiation levels, adequacy of shielding, storage of plutonium, dry box window damage, and inadequate criticality drains. There was an agreement to reduce storage in the building. A review of the dosimetry results for manufacturing personnel indicated that there were four individuals receiving over 4 rem in 1969, and no individuals over 5 Rem. Criticality drains were recognized as an ongoing problem (JCUSC 1970).	While these safety concerns detail valid safety issues and it was important for these issues to be corrected, the concerns do not adversely impact NIOSH's ability to conduct dose reconstruction of sufficient accuracy. NIOSH therefore concludes that these issues do not have SEC implications.	Although plutonium storage, adequacy of shielding, dry box window damage, and inadequacy of criticality drains are important safety issues, this type of information is not used in dose reconstruction. Manufacturing personnel set an internal administrative exposure level at 4 Rem. (Note: There were more than four individuals in the external data file with greater than 4 Rem for 1969.) This safety concern is simply noting that several individual exceeded this level. This would not affect dose reconstruction as the individuals were monitored. *Concurrence with NIOSH assessment.*
71-4	The employee was concerned that the film badge results for December 1970 did not reflect the high level of neutron exposure measured by field instruments and film badge results of a coworker on the same special job (JCUSC 1971a).	As discussed on previous occasions, it is not reasonable to expect that all workers frequently perform different duties that put them in different proximity to the source. The Safety Concern in and of itself does not in and of itself demonstrate a problem with the integrity of RFP dosimetry data.	This safety concern aligns with issues raised in the petition about dosimeter results not reflecting field conditions. The effectiveness of the dosimeters has been raised numerous times during the course of the petition review. An explanation of why the dosimeter did not respond to alleged high dose fields warrants further investigation.

Rocky Flats Safety Concern Review for Data Integrity Issues

Safety Concern No.	Description of Concern	NIOSH Response	SC&A Response
71-7	Inadequate notification of Health Physics regarding maintenance work on booster fans potential caused inaccurate stack air sampling results. Other safety issues included such infractions as no dry box overhead alarm, taping a plastic bag and the end of the air duct to contain high-level contamination, and an unsafe drill press (JCUSC 1971b, JCUSC 1971c, JCUSC 1971d, JSUSC 1971e, JSUSC 1971f).	While these are important safety issues and it was important for these issues to be corrected, the concerns do not adversely impact NIOSH's ability to conduct dose reconstruction of sufficient accuracy. NIOSH therefore concludes that these Safety Concerns do not have SEC implications.	Inaccurate stack air sampling results have an implication for environmental doses; however, the doses from environmental exposure are small in comparison to occupational dose. This concern should be addressed in the context of the RFP site profile resolution process. *Concurrence with NIOSH assessment.*

Rocky Flats Safety Concern Review for Data Integrity Issues

Safety Concern No.	Description of Concern	NIOSH Response	SC&A Response
74-61	The employee has indicated that there is a need for a quantitative method to evaluate radioactive materials taken into the body to prevent unsafe exposures (JCUSC 1974).	The data were adequate and of sufficient quality to accurately assess the amount of Pu in the body. There is nothing in this Safety Concern that would adversely impact NIOSH's ability to conduct dose reconstructions with sufficient accuracy; therefore, this issue does not have SEC implications.	Further discussions with Rocky Flats RadCon staff having knowledge of this safety concern provided additional insight. In 1974, when the safety concern was issued, the site had three in-vivo counting systems of which two were used on a routine basis. The third counter, according to workers, resulted in more positive chest counts than those used on a routine basis. Workers questioned the accuracy of the counters used for routine in-vivo counts. Dosimetry staff met with the worker filing the concern and discussed the principles of the in-vivo counting systems. NIOSH has indicated that in-vivo counting results are not used in their analysis of claimant dose. If this is the case, and individuals were adequately monitored via urinalysis, NIOSH could use bioassay data to conduct dose reconstructions. If, however, NIOSH decides to use lung count data to "bound" intakes, or it is determined that bioassay monitoring was incomplete, this would impact internal dose reconstruction. Furthermore, if this data is used in the coworker model, the reliability of this data is in question and must be further evaluated.

Rocky Flats Safety Concern Review for Data Integrity Issues

Safety Concern No.	Description of Concern	NIOSH Response	SC&A Response
75-34	Employee concerned about downward adjustment of his TLD readings to account for his receipt of a medical procedure involving the administration of a radionuclide (JCUSC 1975).	The appropriate consideration of nuclear medicine techniques and the adjustment of the occupational dose record are important for accurate dose reconstruction. If an employee failed to notify the medical/dosimetry staff of such a procedure, dosimetry results may be biased high and it could result in a false positive result in a subsequent whole-body count. The procedure implemented addresses this concern.	*Concurrence with NIOSH assessment.*
84-19	"A very high percentage of the personnel working in Rooms 264-266 in 881 are getting abnormally high radiation from the body counter. These areas until recently were closed due to contamination." (JCUSC 1984)	There may be a valid concern that the work areas in question may still contain contamination, and it can be inferred that this may be what motivated the filing of this Safety Concern. It appears that the possibility of intake was evaluated using whole-body counts and bioassay. In such situations, NIOSH can use these data to conduct dose reconstructions of sufficient accuracy; therefore this Safety Concern does not appear to have SEC implications.	The bioassay results from this situation can be used for dose reconstruction. *Concurrence with NIOSH assessment.*
85-109	Workers were involved in decontamination of machine parts in their personal clothing. They questioned this practice but were told to continue. Employees were concerned that radiation monitoring in Bldg. 881 and the Medical Department came up with different results than the personnel involved (JCUSC 1985a).	While observance of proper contamination control requirements and use of appropriate personal protective devices has important safety implications, there is nothing in this Safety Concern that would prevent NIOSH from conducting dose reconstructions with sufficient accuracy. Uptakes resulting from work in contamination areas, if any, would be reflected in bioassay results, which NIOSH would not likely include in reconstructing internal dose.	Assuming the employee was adequately monitored via urinalysis, and the questionable data were not used in dose reconstruction, this would not present an issue with dose reconstruction. If, however, NIOSH decides to use the data, or it is determined that bioassay monitoring was incomplete, this would impact internal dose reconstruction.

Rocky Flats Safety Concern Review for Data Integrity Issues

Safety Concern No.	Description of Concern	NIOSH Response	SC&A Response
85-137	Employees were involved in a bag change and bag out procedures without the support of a Radiation Monitor. Respiratory protection was not worn while holding packages and the packages were not in secondary containment (JCUSC 1985b).	There is nothing in this Safety Concern that would prevent NIOSH from conducting dose reconstruction with sufficient accuracy. Uptakes resulting from work without proper coverage from Radiation Monitoring personnel, if any, would be reflected in the bioassay results, which NIOSH would use in reconstructing internal dose.	*Concurrence with NIOSH assessment.*
85-161	There is survey and decontamination of dosimeters prior to shipping them to External Dosimetry for processing. The site is allowing dosimeters that have to be surveyed to go to dosimetry to be taken home by employees after work (JCUSC 1985c).	The subject of this concern does not adversely impact NIOSH's ability to conduct dose reconstruction of sufficient accuracy.	This safety concern questions the decontamination of dosimeters prior to the time they are shipped to dosimetry for processing. Although this is a standard practice to protect the dosimetry lab, it raises the questions about when and how the dosimeter became contaminated, and what is the relative effect on external dosimetry results. It also raises questions regarding the potential for internal exposure from inadequate contamination control.
86-13	The frequency of an employee's badge exchange was twice rather than four times per year (JCUSC 1986a).	This issue does not cast doubt on the integrity of Rocky Flats dosimetry data, does not prevent NIOSH from conducting dose reconstruction with sufficient accuracy, and therefore does not have SEC implementation.	*Concurrence with NIOSH assessment.*

Rocky Flats Safety Concern Review for Data Integrity Issues

Safety Concern No.	Description of Concern	NIOSH Response	SC&A Response
86-161	Several inspectors received body counts. Four out of the five had high counts for uranium. The employee was concerned about this because there was a sudden focus on counting individuals from Building 460 where he worked. Later it was determined that there was a problem with the counters on the day of his count (JCUSC 1986b).	NIOSH relies primarily on bioassay data for reconstruction of internal doses at Rocky Flats. It appears that whatever the problem with these particular lung counts was, the problem was addressed and the individuals were recounted. Therefore, NIOSH concludes that there is nothing in the Safety Concern that would prevent dose reconstruction of sufficient accuracy.	Assuming the employee was adequately monitored via urinalysis, and in-vivo counting was not used in dose reconstruction, this would not present an issue with dose reconstruction. If, however, NIOSH decides to use lung count data to "bound" intakes, or it is determined that bioassay monitoring was incomplete, this would impact internal dose reconstruction. Furthermore, if these data are used in the coworker model, the reliability of this data is in question and must be further evaluated.
86-169	There is an inadequacy in the scheduling of personnel for body counts and a lack of coverage at the body counter during mid-shift. The Safety Concern indicated equipment problems created a temporary backlog. The individual filing the concern eventually did receive a body count (Leigh and James 1986, JCUSC 1986c).	It must also be noted that NIOSH dose reconstructions at Rocky Flats rely primarily on bioassay (urinalysis). For these reasons, NIOSH concludes that this Safety Concern does not raise issues that adversely impact our ability to conduct dose reconstructions of sufficient accuracy, and therefore does not have SEC implications.	Assuming the employee was adequately monitored via urinalysis, and in-vivo counting was not used in dose reconstruction, this would not present an issue with dose reconstruction. If, however, NIOSH decides to use lung count data to "bound" intakes, or it is determined that bioassay monitoring was incomplete, this would impact internal dose reconstruction. Furthermore, if this data is used in the coworker model, the reliability of this data is in question and must be further evaluated.
86-186	An electrode and base were left in the line after the completion of a job for an extended period of time. The bag was cut resulting in external contamination to the surface of the bag at >1,000,000 c/m smear. Workers involved in the job indicated the incident investigation was not adequate. (JCUSC 1986d).	While this is an important safety issue, this Safety Concern does not raise issues that adversely impact our ability to conduct dose reconstructions of sufficient accuracy, and therefore does not have SEC implications.	*Concurrence with NIOSH assessment.*

Rocky Flats Safety Concern Review for Data Integrity Issues

Safety Concern No.	Description of Concern	NIOSH Response	SC&A Response
87-005	In this concern the worker questions why he received very low or no exposure on his badge for 2 years. A review of his dosimetry files indicated that the zeros in the individual's records were the result of wrist badges being turned in without a corresponding body badge (JCUSC 1987a, Chanda and Overholt 1987).	This is an example of an employee who is suspicious of his dosimetry results. The basis for this suspicion is not described in the Safety Concern. However, the employee's records were reviewed by the JCUSC, who determined that (1) all dosimetry results were included in the employee's radiation file, (2) his results had been consistent for the time period in question; and (3) his results were in line with those of similar employees. Therefore this Safety Concern does not have SEC implications.	This safety concern relates to methods utilized to conduct external dosimetry investigations, as well as providing another example of individuals questioning the accuracy of the dosimetry system. The memorandum from R.N. Chanda and G.A. Overholt to P.A. Madsen (Chanda and Overholt 1987) indicates that a review of the dosimetry records was conducted and it was determined that the zeros were the result of wrist dosimeters turned in without corresponding body dosimeters. This individual was assigned to the NDA department in Building 371 where there was a potential for exposure. It is difficult to determine from a secondary source whether an adequate investigation was conducted and whether the response was appropriate to the employee's concerns. Direct data should be evaluated in this case, and the individual's dose should be compared to that of his coworkers performing the same tasks.

Rocky Flats Safety Concern Review for Data Integrity Issues

Safety Concern No.	Description of Concern	NIOSH Response	SC&A Response
87-038	The worker questioned the zero result he received on his dosimeter. The dose was initially 15 g and 246 n; it fell outside the average ratio expected for Building 771. The dosimeter result was to be recounted and a 3-1 ratio applied (JCUSC 1987b).	The Safety Concern, dated 1/30/87, states the print out (presumably the Supervisor's High-to-Low Dose Report, distributed after a TLD exchange) dated 1/22/87 shows zeros, and that the initial readings were 15 g and 246 n. It is assumed the 15 g stood for gamma and the 246 n stood for neutron dose, in mrem, although this is not stated in the Safety Concern. The Safety Concern also doesn't state for which dosimeter exchange period this reassessment was completed. (Further information can be obtained from NIOSH 2006).	The dosimeter value was modified due to quality control issues with the dosimetry results. There does not appear to be any kind of follow-up investigation on the individual's potential exposure. This relates to the issue regarding how dose was assigned when dosimeters were lost, damaged, contaminated, or had quality control problems. This individual was on a biweekly exchange period, indicating the potential for higher exposure. The adjustment to his dose does not reflect this, and adequate justification for this dose is not provided. This questionable dose would be used during the dose reconstruction process.
87-206	Employees were not receiving updated reports on their current dosimetry badge readings in accordance to RFP procedures (JCUSC 1987c).	This issue does not prevent NIOSH from conducting dose reconstruction with sufficient accuracy, and therefore does not have SEC implications.	*Concurrence with NIOSH assessment.*

Rocky Flats Safety Concern Review for Data Integrity Issues

Safety Concern No.	Description of Concern	NIOSH Response	SC&A Response
89-037	Employee worked in an area with uranium; however, only a single sample was collected over a three-and-a-half year period. The same individual was not assigned a dosimeter for a year (JCUSC 1989a).	NIOSH has established methods for calculating dose in the case of data gaps. There is no indication that this event constitutes a site-wide data integrity issue, and does not have SEC implications.	NIOSH states this is an isolated example. NIOSH has not provided a basis for their statement that there is no indication of a site-wide data integrity issue on the basis of this one safety concern. NIOSH has generic methods for assigning dose where there are data gaps; however, the exact method for addressing data gaps is still under consideration. Their method for identifying data gaps and assigning dose for multiple year data gaps is particularly of concern. Although lack of monitoring is not per se a data integrity issue, it does have a significant impact on dose reconstruction. In addition, gaps in the data of individuals exposed, but not adequately monitored, cast doubt on the integrity of the data made available for dose reconstruction.
89-148	The concern expressed was related to lack of procedures for documenting infractions in the Radiation Monitoring reports when individuals enter respirator-required areas without a respirator, gloves with removable contamination that have not been changed, or procedural violations which endanger the safety of individuals (JCUSC 1989b).	While the particular types of issues mentioned have obvious safety implications, a form for reporting such situations was implemented across the plant. These types of issues do not prevent NIOSH from conducting dose reconstructions of sufficient accuracy; and therefore do not have SEC implications.	*Concurrence with NIOSH assessment.*
89-167	The concern requested that a survey of Building 334 be conducted to verify there was no radiation present. One individual required a wound count and another had a positive bioassay result. A survey was conducted with negative results (JCUSC 1989c).	Bioassay was employed for the individual involved, and this is the information NIOSH would use to conduct dose reconstructions. There is nothing in this Safety Concern that would prevent NIOSH from conducting dose reconstruction of sufficient accuracy, and therefore it does not have SEC implications.	Assuming the employee was adequately monitored via urinalysis, this would not present an issue with dose reconstruction. If, however, NIOSH determines the bioassay monitoring at RFP was inadequate, this would impact internal dose reconstruction. Furthermore, if this data is used in the coworker model, the reliability of this data is in question and must be further evaluated.

Rocky Flats Safety Concern Review for Data Integrity Issues

Safety Concern No.	Description of Concern	NIOSH Response	SC&A Response
89-214	Procedures for "Personal and Confidential" records were not being followed with quarterly dosimetry records (JCUSC 1989d).	At some DOE sites, including Rocky Flats, periodic dosimetry results were posted publicly on a master list. This practice would have privacy implications, and this concern appears to be related to this practice. This issue does not appear to have data integrity or other SEC implications.	*Concurrence with NIOSH assessment.*
89-203	An individual working a breathing air job received a possible inhalation. The individual received an in-vivo count; however, during the in-vivo count the equipment malfunctioned. He was sent home without an adequate count. All personnel were contacted and scheduled for a follow-up in-vivo count as soon as the equipment was repaired. Corrective actions were taken regarding the detector problems. (JCUSC 1989e)	In this situation, NIOSH can use these data to conduct dose reconstructions of sufficient accuracy; therefore this Safety Concern does not appear to have SEC implications.	Assuming the employee was adequately monitored via urinalysis, and in-vivo counting was not used in dose reconstruction, this would not present an issue with dose reconstruction. If, however, NIOSH decides to use lung count data to "bound" intakes, or it is determined that bioassay monitoring was incomplete, this would impact internal dose reconstruction. Furthermore, if this data is used in the coworker model, the reliability of this data is in question and must be further evaluated.
89-259	Inaccurate cumulative radiation dose equivalent history from Dosimetry and a lack of earlier exposure information once a high cumulative radiation dose equivalent has been set (JCUSC 1989f).	The meaning of the concern is not entirely certain, but the response seems to indicate that the worker was concerned that he/she was not notified when the trends in cumulative dose would eventually put the worker over target dose limits. If the interpretation is correct, the issue does not constitute a data integrity issue or have SEC implications.	The safety concern is not clearly defined, making it difficult to ascertain whether this is a dosimetry or ALARA issue. *Inconclusive.*

Rocky Flats Safety Concern Review for Data Integrity Issues

Safety Concern No.	Description of Concern	NIOSH Response	SC&A Response
90-169	The worker submitted multiple urine samples including samples sent off site. He was told that the first sample was negative. One special sample and 4 or 5 samples were collected. Some samples were lost and another was invalid due to poor chemical recovery (JCUSC 1990a).	Evaluation of this Safety Concern in ongoing.	There appears to be an issue with the quality control in the bioassay laboratory, which may affect multiple individuals. *Concurrence with the NIOSH assessment that further investigation is needed.*
90-202	The submittal did not include a specific concern, but rather questions related to the potential exposure of Dosimetry Technicians from Cf-252 source in Building 126. [Name] from the External Dosimetry group issued a memorandum discussing the use of the source, how it is handled by the dosimetry technician, and the dose rates associated with the shielded and unshielded source. Calculations of expected annual dose from duties associated with the source were determined to be 52.1 mrem/person using conservative assumption. A survey of the area was conducted showing minimal exposure rates. Upon issuance of the safely concern, Dosimetry Technician personnel dosimeters were processed. The dosimetry results, representing six months of exposure, indicated a total dose of less than the detection limit including neutron dose (Hoffman 1990; Lesses 1990a). A review by Radiological Engineering indicated a lock to prevent inadvertent access should be installed and the Beacon light required repair (Lesses 1990b). No health hazard was believed to exist (JCUSC 1990b).	The employee was satisfied with the results and the proposed actions were completed. There is nothing in this safety concern that would prevent NIOSH from conducting dose reconstructions with sufficient accuracy.	The safety concern indicated that the employees were monitored for both beta/gamma and neutron dose. This data could be used in dose reconstruction. *Concurrence with the NIOSH assessment.*

Rocky Flats Safety Concern Review for Data Integrity Issues

Safety Concern No.	Description of Concern	NIOSH Response	SC&A Response
91-262	The safety concern questioned the practice of wearing dosimetry only when entering a Radiological Control Area. If there were a criticality accident, and the employee was exposed, there would be no record of their exposure (JCUSC 1991a).	The concern expressed is not relevant to NIOSH's ability to reconstruct doses with sufficient accuracy at Rocky Flats, as there is no evidence that an unplanned criticality ever occurred at Rocky Flats. However, it is true that in such an event, it is frequently possible to reconstruct doses from neutron-activated elements in biological materials such as hair and blood, and in nonbiological materials, as well as from area TLDs and TLDs worn by coworkers, depending on the specifics of the situation. Therefore, this issue does not have SEC implications.	The JCUSC agreed with the employee that dosimeters should be worn at all times when in the Perimeter Security Zone (PSZ). Concerns were expressed by the operations groups that this was not consistent with the health and safety procedures. HSP 18.07, *External Radiation Dosimetry*, updated June 15, 1991 (EG&G 1991), shortly after the Safety Concern was issued, continued to require that dosimetry be worn in Radiation Controlled Areas or when posting required it, and that it be stored on badge racks. There are other means of determining doses in cases where dosimeters are not worn. This was demonstrated with the Y-12 Criticality Accident in 1958. *Concurrence with NIOSH assessment.*

Rocky Flats Safety Concern Review for Data Integrity Issues

Safety Concern No.	Description of Concern	NIOSH Response	SC&A Response
91-395	Safety Concern 91-395 states that radiation exposures to employees in Building 664 were too high and unnecessary because grams of plutonium, americium, and uranium were being stored in drums at this location (JCUSC 1991b). Anderson (1991a) conducted a radiation survey of the aisles of waste drums and calculated the maximum potential Dose Equivalent for an individual exposed 30 minutes per week in this area. An estimated external gamma dose for this scenario was 631 mRad per year. No elevated levels of neutron exposure readings were detected. The estimated dose was below the Administrative Dose Guidelines and deemed to result in no significant health related problems. A Radiological Control Area was established for Building 664 a few months prior to the safety concern. The changes in RCA requirements, including use of a dosimeter, were incorporated into the Building 664 Site Specific Health and Safety Plan (Anderson 1991b). In late 1992, the drums were shipped from Building 664 to Building 569 (Lewis 1992). Further concerns were raised during the JCUSC evaluation about the location of the dosimeter exchange board and elevated background. Radiological Engineering reviewed survey and background dosimeter data from 1991 for the facility. The location of the dosimetry board was preferred and no relocation was necessary (Anderson 1991a).	While unnecessary radiation exposure to employees could have important safety implications, there is no indication that doses were unmonitored. NIOSH therefore concludes that this issue does not have SEC implications.	With respect to the storage of radioactive materials in the aisle of Building 664, it is unclear whether personnel in the building were required to wear dosimetry prior to the establishment of an RCA, or whether the RCA was created prior to the drums arriving. NIOSH has assumed that this is not an SEC issue; however, without the information discussed above, it is unclear how they were able to come to this conclusion. *Inconclusive*. In relation to the radiation background at the Dosimeter Exchange Board, it is common practice for the dosimetry group to place TLDs in the rack along with those worn by personnel. The methodology used for background subtraction has varied over time. Lagerquist (1975) indicated, effective January 1986, the total background subtracted from dosimeters would be environmental background (0.34 mrem/day) and instrument background. TLD operating procedures in 1983 also indicated that the total background subtracted was determined from environment and instrument background (RI 1983). The *Background Subtraction Methodology Study* was conducted the second quarter of 1999 at locations across the site. This study indicated that using a location-specific background may create potential problems because the dosimeters are not always stored at the assigned location. Furthermore, the study indicated subtracting backgrounds by location would generally reduce the reported dose (Klueber and Savitz 1999). A TLD

Rocky Flats Safety Concern Review for Data Integrity Issues

Safety Concern No.	Description of Concern	NIOSH Response	SC&A Response
91-395 (Continued)			background subtraction based on whether the location of the storage area was in a hard walled or non-hard walled building was implemented (RMRS 1999). In 2001, the actual TLD element residual signal together with a time-dependent and location-dependent background, results in a TLD specific background, which is subtracted, from the personal dosimeter (RFETS 2001). Methods for background subtraction prior to 1976 were not located. The concern here is whether the location specific background level is appropriate for background subtraction. Based on documentation reviewed, the location-specific background was not used until 1999. In 1999, studies were conducted and a revised methodology was implemented. The study included background level data by location. These data could be used to adjust dosimeter results as appropriate. Background subtraction is more appropriately addressed as a site profile issue. *Concurrence with NIOSH assessment that background concerns are not an SEC issue.*

Rocky Flats Safety Concern Review for Data Integrity Issues

Safety Concern No.	Description of Concern	NIOSH Response	SC&A Response
91-490	Safety Concern 91-490 expressed apprehension over the lack of positive control to prevent tampering, misuse, and other compromising situations with the current dosimeter storage system and location. External Dosimetry indicated that there were procedures in place to monitor for inappropriate dose results (JCUSC 1991c). The second issue raised concerned the affect of temperature and humidity variations on the dosimeter badge. Several reports relevant to the conditions of exposure for environmental dosimeters were discussed. Based on tests conducted on the TLDs, External Dosimetry dosimeters were found adequate to handle environmental conditions encountered, including temperature and humidity. A third issue indicated that a background control study was not conducted prior to the implementation of the new storage areas for dosimeters. A study began simultaneously with the placement of badges at the new locations. External Dosimetry noted ambient external radiation was monitored during surveys. In addition, as long as the individual stores the badge in the correct location, background levels are not an issue.	Throughout the operating history of Rocky Flats, suspect dosimetry badge readings were investigated, and in later years formal investigation reports were placed in individual radiation files. There is nothing in this Safety Concern that would prevent NIOSH from conducting dose reconstructions with sufficient accuracy.	With respect to positive control, there is really no system available to prevent individuals from tampering with dosimeters. This is why External Dosimetry evaluates the raw results from each element as an indication of inappropriate dose results. NIOSH has not specifically responded to the second, third, and fourth issues raised in this concern. *Inconclusive due to lack of response.* The environmental dosimetry program indicates that dosimeters can withstand temperature and humidity changes for the monitoring period of a year. Studies conducted by Bollinger (1990) on CaSO4:Dy dosimeters indicated dosimeters could be submerged in water yet give consistent results with controls. Ong (1985) demonstrated that TLD elements do not respond to sunlight when enclosed in a holder. Background subtraction and studies are discussed under Safety Concern 91-395. This does not constitute an SEC issue. Dosimeter storage locations were areas of maximum accessibility to the employees. There was a potential that a badge could be tampered with; however, a procedure was in place to evaluate inappropriate or suspicious dosimeter results. Employees were asked to protect the dosimeter from becoming contaminated or physically damaged; however, this did occur from time to time.

Rocky Flats Safety Concern Review for Data Integrity Issues

Safety Concern No.	Description of Concern	NIOSH Response	SC&A Response
91-490 (Continued)	A concern arose regarding violation of HSP 18.07, *External Radiation Dosimeter.* This procedure states that all employees shall protect their dosimeter from contamination, physical damage, moisture, and heat (EG&G 1991). External Dosimetry issued a revision to this procedure providing clarification on the employee's responsibility regarding their dosimeter (EG&G 1992).		Contaminated badges were decontaminated wherever possible; however, with the TLD chips contained in the holder, they were generally safe from contamination. Physical damage to a dosimeter, if it affected the TLD chips, resulted in a Dosimetry Investigation according to former staff. Extended External Dosimetry Investigations are documented in personal dosimetry files back to the mid-1980s; however, availability in Radiation Dose files was not routine until the late-1990s. External Dosimetry Investigations are considered in previous Safety Concerns.

Rocky Flats Safety Concern Review for Data Integrity Issues

Safety Concern No.	Description of Concern	NIOSH Response	SC&A Response
91-496	Safety Concern 91-496 questions the storage of film badges in the tunnel north of Portal 1. External Radiation Dosimeter requires that background studies be conducted prior to the implementation of badge racks (JCUSC 1991d). Similar concerns were raised in 91-490, so JCUSC addressed them together. A separate safety concern indicating there were violations of HSP 18.07 (EG&G 1992) was issued on March 2, 1992, and is included in the Safety Concern 91-496 file. Documentation indicated that a Radiation Protection Technician was without dosimeter protection, which resulted in an entire building being without RPT support (JCUSC 1991e).	However, there is nothing in this Safety Concern that would prevent NIOSH from conducting dose reconstructions with sufficient accuracy. Uptakes resulting from work without proper coverage from Radiation Protection personnel, if any, would be reflected in bioassay results, which NIOSH would use in reconstructing internal doses.	NIOSH has not specifically responded to the issue of storage of film badges in the tunnel. Independent external dosimetry assessments, as well as employees, raised concerns regarding the environmental conditions of the tunnel. Although no deficiency was cited, Radiation Protection agreed to relocate the dosimeter storage board to a more environmentally suitable location, including consideration of background radiation (Shinn 1991). For periods of time when location of specific backgrounds was used in background subtraction, the safety concern is *inconclusive*. There is no indication how the background radiation level changed, and if adjustments were applied to retrospective data. For those years where environmental dose levels were used for background subtraction, the location of the dosimeter storage areas would not affect the dosimeter results. With respect to RPT coverage, this does not impact the ability to reconstruct dose as long as all individuals supporting radiological operations within the building were appropriately monitored. *Concurrence with NIOSH assessment.*

Rocky Flats Safety Concern Review for Data Integrity Issues

Safety Concern No.	Description of Concern	NIOSH Response	SC&A Response
92-003	The Safety Concern was filed by an employee who sustained a minor injury while working in Building 707. The employee reported to Medical for a wound count. He expressed concern over the inconsistency of the wound counter, procedures related to wound counting, and training. The corrective actions included training for individuals operating wound counters, verification of background levels, filter changes in Room C, Bldg 112, and thorough cleaning of this room (JCUSC 1992a, Baker and McCoy 1992).	NIOSH relies primarily on bioassay data for reconstruction of internal doses at Rocky Flats. NIOSH concludes that this issue does not in and of itself compromise the integrity of Rocky Flats data, does not prevent NIOSH from conducting dose reconstructions of sufficient accuracy, and therefore does not have SEC implications.	Assuming the employee was adequately monitored via urinalysis, and wound counting was not used in dose reconstruction, this would not present an issue with dose reconstruction. If, however, NIOSH decides to use the wound count data, or it is determined that bioassay monitoring was incomplete, this would impact internal dose reconstruction.
92-036	External dosimetry reports used by the field to monitor the amount of exposure an employee has received to date for a particular year were not provided for a year (JCUSC 1992b).	This appears to be an issue of lack of timely reporting of dosimetry results to employees. There is no indication that employees were in fact unmonitored, but rather that the results of such monitoring were not reported promptly to the employees. As such, the safety concern does not have data integrity or other SEC implications.	*Concurrence with NIOSH assessment.*
92-048	The internal and external dosimetry programs at RFP are inadequate and not in compliance with requirements. There is a lack of communication between dosimetry and the workforce (JCUSC 1992c).	Evaluation of this safety concern is ongoing.	SC&A agrees that this safety concern deserves further investigation. This lack of trust in the internal and external monitoring programs and dosimetry systems are the fundamental concerns raised by the petitioners.
93-061	Safety Concern 93-061 indicates there is untimely turnaround time for samples submitted by workers (JCUSC 1993a).	Three employees submitted this concern and all of them signed the form stating that they were satisfied with the results. Untimely bioassay results do not compromise the integrity of Rocky Flats bioassay data, do not prevent NIOSH from conducting dose reconstructions of sufficient accuracy and therefore do not have SEC implications.	*Concurrence with NIOSH assessment.*

Rocky Flats Safety Concern Review for Data Integrity Issues

Safety Concern No.	Description of Concern	NIOSH Response	SC&A Response
93-109	This Safety Concern form is identical to that of Safety Concern 91-395 and has the same date. It appears that this safety concern was renumbered and additional response was provided. The additional response indicates that the resolutions described in Safety Concern 91-395 were not completed.	While unnecessary radiation exposure to employees could have important safety implications, there is no indication that doses were unmonitored. NIOSH concludes that this issue does not compromise the integrity of Rocky Flats dosimetry data, does not prevent NIOSH from conducting dose reconstructions of sufficient accuracy, and therefore does not have SEC implications.	Refer to response for Safety Concern #91-395.
93-124	The implementation of Personal Contamination Monitors resulted in discontinuation of monitoring by RPTs. RPT monitoring was still available upon request (JCUSC 1993b).	The employee indicated his satisfaction with the response on the JCUSC Concern Form. While contamination-monitoring practices at the exit from a radiological contamination area could have safety ramifications, the failure to perform such monitoring would not affect NIOSH's ability to conduct dose reconstruction with sufficient accuracy. Personnel entering such areas were required to participate in bioassay programs, and this is the data NIOSH relies upon for dose reconstruction. Therefore, the Safety Concern does not have SEC implications.	*Concurrence with NIOSH assessment.*
93-193	The employee issued a Safety Concern because he was involved in an incident, and was notified 1.5 days after the incident that he required an in-vivo count, bioassay sampling, and was restricted from the Material Access Area (MAA). There was acknowledgement that the bioassay sampling should have begun within 24 hours of the incident. Additional training was scheduled for Radiological Engineering regarding their responsibilities related to potential intakes and subsequent measurements (JCUSC 1993c).	This is an issue with safety implications. Corrective actions were taken, i.e. training was held. There is nothing in this concern that would compromise NIOSH's ability to reconstruct internal doses with sufficient accuracy; therefore NIOSH concludes that this is not an SEC issue.	A delay of 1.5 days for bioassay, whether urine, in vivo count, or fecal sampling will not prevent detection of an intake. *Concurrence with NIOSH assessment.*

Rocky Flats Safety Concern Review for Data Integrity Issues

Safety Concern No.	Description of Concern	NIOSH Response	SC&A Response
94 -072	Logbook entries made regarding the contents of a tanker truck do not reflect what was actually in the tanker truck (JCUSC 1994a).	The subject of the safety concern does not involve the data NIOSH used to conduct dose reconstructions at Rocky Flats (personal external and internal dosimetry). There is nothing in this Safety Concern that would adversely impact NIOSH's ability to conduct dose reconstructions with sufficient accuracy; therefore this issue does not have SEC implications.	*Concurrence with NIOSH assessment.*
94-079	No decontamination and showering facilities are available for Radiological Control Technicians at the Federal Records Center.	This issue appears to relate to emergency facilities at the Denver Federal Records Center, where records were being sent from Rocky Flats. As such, this issue is not germane to NIOSH's ability to conduct dose reconstruction of sufficient accuracy.	*Concurrence with NIOSH assessment.*
94-080	This safety concern indicates that there was no pre-evolution evaluation conducted for work being performed at the Federal Records Center. There was not a PRE or RWP generated and available at the worksite. There were also no emergency instructions for casualties issued. The response indicated that an evaluation of the need for a Radiation Work Permit was conducted, and any new or additional members will receive a briefing. It was further indicated that an RWP was not required for this job (JCUSC 1994b).	This issue appears to relate to emergency facilities at the Denver Federal Records Center, where records were being sent from Rocky Flats. As such, this issue is not germane to NIOSH's ability to conduct dose reconstruction of sufficient accuracy.	*Concurrence with NIOSH assessment.*
94-081	This concern indicated that there were no emergency response kits and appropriate forms available at the Federal Records Center. Management indicated that they would transport necessary emergency response equipment to and from the Federal Records Center (JCUSC 1994c).	This issue appears to relate to emergency facilities at the Denver Federal Records Center, where records were being sent from Rocky Flats. As such, this issue is not germane to NIOSH's ability to conduct dose reconstruction of sufficient accuracy.	*Concurrence with NIOSH assessment.*

Rocky Flats Safety Concern Review for Data Integrity Issues

Safety Concern No.	Description of Concern	NIOSH Response	SC&A Response
94-245	Two people had their TLDs confiscated as a result of an occurrence. TLDs were not returned immediately. The office personnel in Bldg. 776 were required to have TLDs but these workers were not (JCUSC 1994d).	While performing work in an RCA without appropriate external dosimetry may or may not affect NIOSH's ability to perform dose reconstructions with sufficient accuracy, it appears that this did not occur in this particular instance. Therefore the Safety Concern does not have SEC implications.	NIOSH indicates that performing work without appropriate dosimetry in an RCA may or may not affect the ability to do dose reconstruction. They further indicate that the employees with confiscated TLDs did not work in an RCA during the period of time without a TLD. There seems to be some disagreement regarding this fact. The employees indicated they did perform radiological work during this time period, while the JCUSC indicated the employees were not required to perform work in a radiological area without a TLD during this time period. No details of the JCUSC investigation were provided in the Safety Concern File. In addition, this Safety Concern raises the question of how frequently TLDs were taken away from workers and why. Were these workers prevented from entering radiological areas during this time period? Certainly if employees were entering radiological areas without TLDs, this would put their external exposure in question, and therefore impact dose reconstruction. NIOSH assumes the worker did not enter a radiological area, while SC&A believes the Safety Concern does not provide enough information to make this assumption. *Inconclusive*.

Rocky Flats Safety Concern Review for Data Integrity Issues

Safety Concern No.	Description of Concern	NIOSH Response	SC&A Response
95-061	TLD badges were pulled by the Building Manager of 776 as a result of Radiation Work Permit (RWP) violations. This was due to lack of communication by management to employees using the RWP on a daily basis and without a critique to find a root cause for the violations. Inconsistencies exist within management when pulling TLDs. The supervisor response indicated the company policy was to pull TLDs in any case where radiological procedures are violated. (JCUSC 1995a).	This Safety Concern appears to be a disagreement between management and the employee. The employee states that there are inconsistencies by management when pulling TLDs. Building management conducted toolbox and conduct of operations meetings to reinforce the RWPs. There is nothing in this Safety Concern that would prevent NIOSH from conducting dose reconstructions with sufficient accuracy.	There is no indication whether individuals having their dosimeters pulled were simultaneously banned from RCAs. The larger concern is whether a simultaneous restriction from radiation areas was enforced. The safety concern did not indicate what restriction was imposed on personnel. *Inconclusive.*
95-077	Retired workers are asked to provide a urine sample and return it via the U.S. mail. Some of these samples are contaminated (JCUSC 1995b).	The protocol for shipping bioassay samples from retired employees was determined to fall within the applicable laws and regulations. This issue does not relate to NIOSH's ability to conduct dose reconstructions with sufficient accuracy, and therefore does not have SEC implications.	*Concurrence with NIOSH assessment.*
96-182	An employee was involuntarily terminated. His dosimeter was not read within the month following (Local 8031, 1996).	The badge in question was read, though not within the timeframe called for in the site procedures. This is an issue of timeliness in reading the badge, rather than a data integrity issue, and the implication is that this was an oversight. Therefore, this Safety Concern does not have SEC implications.	*Concurrence with NIOSH assessment.*
97-163	There was a concern raised over animosity between Mission Support Specialist and Decontamination workers assigned to perform the same work creating a hostile work environment (Local 8031 1997).	The preliminary description of the Safety Concern mentioned a "hostile work environment." However, this issue does not appear to have SEC implications, as it does not deal with data integrity, or with NIOSH's ability to conduct dose reconstructions.	*Concurrence with NIOSH assessment.*

Rocky Flats Safety Concern Review for Data Integrity Issues

Safety Concern No.	Description of Concern	NIOSH Response	SC&A Response
97-176	An employee was given a TLD badge that did not contain TL elements. The TLD had been processed and the elements were not replaced at the time the supervisor came in and retrieved the dosimeter. The RCT entered radiological areas with inadequate dosimetry (Baker 1997).	The JSUSC Safety Concern Worksheet indicated that no action was required and that this issue was resolved. The employee also indicated satisfaction with the resolution. A bulletin was sent out on July 10, 1997 describing the issue, as well as the steps to prevent reoccurrence. According to information obtained in HIS_20, a dose reconstruction was performed by dosimetry personnel for the affected individual to address this situation and the individual was assigned positive dose.	With respect to the individual's situation, a dosimetry investigation was conducted to determine the dose received while wearing this inadequate dosimeter. This provides some positive affirmation the Extended External Dosimetry reviews were conducted at least during this time period. *Concurrence with NIOSH assessment the particular situation does not preclude dose reconstruction.*
98-073	External dosimetry reports received by employees in Building 374 indicated that many employees received zero doses for first quarter 1998. The employees questioned these results based on the exposures they had received in past reports. Employees felt that based on previous reports, the results were in error. Dosimetry explained to workers that dosimeter results less than 10 mrem were recorded as zero. A population dosimetry investigation was conducted by external dosimetry (JCUSC 1998, McCoy and Chestnut 1998).	This Safety Concern provides an example that workers' concerns on this subject were investigated. While the accuracy of external dosimetry results is certainly an issue with SEC implications, this Safety Concern does not provide any evidence of inaccuracies in Rocky Flats external dosimetry.	The External Dosimetry department looked at the dosimetry results of process specialists and Radiological Control Technicians for the fourth quarter of 1997 and the first quarter of 1998. Dosimetry indicated that dose for 12 process specialists went down, dose for 7 process specialists went up, and dose for 3 individuals stayed the same. For the same time the RCT doses decreased. The average dose for process specialists averaged 9.8 mrem in Q4 1997 and 6.1 mrem in Q1 1998. It is difficult to ascertain whether there is evidence of inaccuracies in individual files from the information provided. NIOSH has provided a hypothesis that inaccuracies did not exist without looking at individual cases. Some basis for this hypothesis is warranted.

Rocky Flats Safety Concern Review for Data Integrity Issues

Safety Concern No.	Description of Concern	NIOSH Response	SC&A Response
99-013	The employee was concerned that he was not notified of a positive bioassay sample and the subsequent dose assessment in a timely manner. The process of notification of the employee of positive bioassay samples was modified such that the employee would be notified in a timely manner (JCUSC 1999a).	This concern was recognized and addressed. Untimely reporting of bioassay results has potential safety and regulatory compliance implications, but NIOSH concludes that this issue does not compromise the integrity of Rocky Flats bioassay data and does not prevent NIOSH from conducting dose reconstructions of sufficient accuracy.	Although delaying communication of bioassay results and subsequent dose assessment is a poor practice, it does not prevent dose reconstruction. *Concurrence with NIOSH assessment.*
99-023	Employees believe foremen created a hostile work environment with outbursts of anger, name-calling, and arguments with employees, and potential sexual harassment (JCUSC 1999b).	The Safety Concern details inappropriate behavior by an individual toward his coworkers. While it was important for this situation to be rectified, the subject of this concern does not adversely impact NIOSH's ability to conduct dose reconstructions of sufficient accuracy. NIOSH therefore concludes that this Safety Concern does not have SEC implications.	*Concurrence with NIOSH assessment.*
00-075	A chemist who supervised work in the headspace area created a hostile work environment. He threw stainless steel canisters at a cabinet in a contamination area in the vicinity of others (Anonymous 2000).	The Safety Concern details inappropriate behavior by an individual toward his coworkers. While it was important for this situation to be rectified, the subject of this concern does not adversely impact NIOSH's ability to conduct dose reconstructions of sufficient accuracy. NIOSH therefore concludes that this Safety Concern does not have SEC implications.	*Concurrence with NIOSH assessment.*

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ATTACHMENT 14: PERSONNEL LOGBOOK ENTRIES

Logbook Building 771 Fire 1957 (RFP 1957)

This entire logbook contains bioassay data for the individuals involved in this fire. This includes results for blood, sputum, fecal, and urine samples.

Logbook 10/1/57– 8/26/60 (Kittinger 1957)

12-6-57: Page 9 – Notified [Name] resample at 23% and that weekly incinerator ask samples show 100-fold increases of orally content to level of 60 µg/gram for samples of Oct. 28, Nov. 4 and 11. Check out reveals the possible source to be sweeping from 1st floor hall containing chips. Collection of sweepings from stair in mid hall showed count to 15,000. Checks each night this week have shown chips in 2nd floor hall. Assigned attention overtime tomorrow

1-29-58: Page 14 – [Name] Reports 169% for latest urine sample from [Name].

1-30-58: Page 15 – Checked with [Name] to see if he had been notified of [Name] sample, he had not, so I informed him of result. I notified [Name] that H.P. would take no further action and make no contact with [Name] except at [Name] at [Name] request. [Name] visited 81 in afternoon to see what action had been taken. He suggested re-sample over weekend and that [Name] and his clothes be monitored before leaving work Friday night.

1-31-58: Page 15 – Made arrangements with [Name] to have [Name] notified of resample & to arrange monitoring.

1-31-58: Page 15 – [Name] called to notify me that [Name] sample of I-28 was 103%. I notified [Name] who called [Name] in immediately **–** arranged for resample tonight with rigid monitoring of his person **–** just like [Name].

1-31-58: Page 15 – [Name] & [Name] both monitored thoroughly before leaving. [Name] shorts found with some count. Brought shorts from laundry for him to wear home.

10-3-58: Page 46 – Notified by lab that [Name] urine sample (he had bucket home at time of acid) was 203% MPL. Told [Name] and [Name] – set up resample for at 6.

10-7-58: Page 47 – Notified by [Name], [Name] resample was ~ 25% MPL. I notified [Name] and [Name].

11-3-58: Page 51 – [Name] conferred with me about high air count trend in 233. He agreed to a special sampling program for this room.

11-18-58: Page 53 – [Name's] exchange badge found "hot" (visitor).

11-19-58: Page 53 – Visitor badge # 3 found hot. Both badges destroyed with [Name's] permission by [Name] with [Name] in attendance. Asked [Name] to check pm men's badges, he found 4 > 250 which were taken from the rack.

11-19-58: Page 53 – Asked [Name] to check all badges in the racks during his shift, he found 19 all from 81 > 250. Guards sent these down to H.P.

11-20-58: Page 53 – 5 badges of 19 unable to completely decontam. Got [Name's] permission to destroy. Letter written for [Name's] sign, concerning destroying of 11 exchange badges described above safety meeting – 81 H.P.

1-31-59: Page 64 – [Name's] Badge (permanent F-26) was destroyed because of contamination level.

2-11-59: Page 65 – Destroyed 81…badge for [Name].

2-12-59: Page 65 – Destroyed [Name's] permanent badge

3-26-59: Page 72 – Notified by [Name] that [Name], [Name], [Name], and [Name] neglected to take sample Buckets home. I made arrangements to get spot samples from these people today. [Name] notified that [Name's] second sample of 3-25 was shoot 210dpm/24hr

3-30-59: Page 72 – [Name] reported following results:

[Name] – 11
[Name] – 10
[Name] – 12
[Name] – Bkg
[Name] – 210 (evening sample)

4-10-59: Page 74 – Destroyed contamination Exch. Badge – [Name] [Badge].

4-27-59: Page 76 – [Name] began assignment to Bldg 83. Notified by [Name] that [Name] has urine result of 131% – He is to be resampled tonight – [Name] notified – Sample was submitted 4/23.

4-28-59: Page 76 – Notified by [Name] that [Name] has urine result of 50% – I notified [Name].

5-4-59: Page 77 – Spot sample from [Name] submitted at beginning of pm shift with his understanding of the problem and his cooperative assent.

5-5-59: Page 77 – Notified [Name] of spot sample taken from [Name] and discussed extrapolation problem involved in spot sampling.

5-7-59: Page 78 – [Name's] re-sample (spot sample Mon. evening) was reported 20%.

5-8-59: Page 78 – [Name's] sample of 5-7 – 110%.

5-12-59: Page 79 – [Name] reports [Name's] re-sample of 5-8 at 20%.

5-21-59: Page 81 – [Name] notified me that [Name's] tools were found about 1,000 direct after being checked out of 81. These were sent back to 81 – No smear count found, direct was confirmed.

[Name] reported: [Name] 5/14 = 70%; [Name] ~ 5/14 = ~ 70%.
Their supervisor notified these men to resample.

[Name] reported very small Kimwipe fire during 3rd shift last night.

5-25-59: Page 82 – [Name's] re-sample of 5-22 reported @ 47% [Name] and [Name] given material for a Safety contract

5-16-59: Page 82 – Burned class waste – guard came down from gate 2 to observe he wrote report. [Name] reported [Name's] sample of 5-21 is 136%.

Spill in labs created slight degrees of hall contamination. [Name] reported at lunchtime that something must have happened since some shoes were found hot. Monitor was sent down and found hot areas plus all lab affected somewhat.

5-28-59: Page 83 – [Name's] resample of 5-27 was 75%

6-3-59: Page 83 – Discussion with [Name], [Name], and [Name] concerning contamination checkout of maintenance personnel. [Name] urine sample of 6-1 at 100% – told [Name].

6-10-59: Page 84 – [Name's] sample of 6-8 reported at 330% MPL. This information relayed to [Name]. Immediate overnight resample requested.

6-15-59: Page 84 – [Name] on loan to 76 for next two weeks. [Name's] overnite sample submitted 6-12-59 was reported at about 70%. Talked to [Name] about sampling needed for "C" contamination parts.

6-19-59: Page 85 – [Name's] Sample of 6/18 Reported at 685%.

6-22-59: Page 85 – [Name's] urine sample at 80%. Destroyed [Name's] permanent badge because of contamination. Notified [Name]. Guard person.

6-23-59: Page 85 – [Name's] resample about 50% – notified [Name] and [Name].

7-20-59: Page 89 – [Name] reported [Name's] sample 6-13 with an ave.1090 dpm and with very erratic results.

8-7-59: Page 93 – [Name] 212 dpm – 240% – notified [Name].

9-9-59: Page 101 – Badges found hot and destroyed:

[Name]	[Badge]	Perm & Exch.
[Name]	[Badge]	Perm & Exch
[Name]	[Badge]	Perm & Exch

Guard [Name] witnessed the badge destruction.

10-5-59: Page 103 – [Name] reported following 83 personnel with high urine results (sample submitted Oct. 1)

[Name]	1300 dpm	1480%
[Name]	217	247%
[Name]	1280	1450
[Name]	305	
[Name]	[illegible]	

10-9-59: Page 104 – [Name] reported resample results (submitted 10-7)

[Name]	273 dpm	310%
[Name]	150 dpm	170%

These people plus [Name] scheduled for resample over the weekend.

10-9-59: Page 104 – [Name] reported [Name] at 99 dpm (103%) report to [Name] (to be resampled)

10-9-59: Page 104 – [Name], [Name], [Name], and I had conference yesterday concerning the high urine counts. They have investigated and find no reason.

10-15-59: Page 105 – [Name] informs me that he consulted [Name] and has his permission to use either film badges on the exchange badge alone for wear in the Bldg. He told me to go ahead and work with [Name] in getting the situation taken care of.

10-16-59: Page 105–106 – [Name] reported at 124 dpm, sample …

10-27-59: Page 107 – [Name] reminded to submit urine sample. [Name] reminded to submit urine sample.

11-4-59: Page 108 – [Name] reported inadvertent exposure to [Name] letter written to [Name].

11-9-59: Page 108 – New exchange badge system instituted – perm badge not worn in ….

12-2-59: Page 111 – Talked to [Name] re possible use for hand and foot counter (He feels this might create more problems than it would solve.) Also discussed film badge use for 81 –

[Name] doesn't want to use film badges unless absolutely necessary – if other means for personnel exposure are available, he would rather not have to bother with the badges.)

12-18-59: Page 113 – [Name] spot sample after incident in 266 on Dec. 15 was reported at 409% MPL. [Name] sample of Dec. 14, 262%. [Name] sample of Dec. 10, 108%.

12-29-59: Page 115 –

Lab reports [Name] sample of 12-18 @ 128% (113 dpm)
Lab reports [Name] sample of 12-24 @ 82% (73 dpm)

1-5-60: Page 116 – [Name] discovered contamination of a major share of the floors in the backend of 91. [Name] sent down to assist about 10:30. Decontamination took remainder of the day. Recap of events led to fact that [Name] on PM shift 1–4 had opened an ice cream container of sample vials from 76 for shipment. Release of contam. was from this container. A check of [Name] when he came to work this PM showed significant personal contamination carried back in: face - 1500 cpm, hands - 1000, pants - 2500, shoes (top only) - 500 cpm. His lunch box was ~ 700 cpm and sandwich wrapping about 300 cpm. [Name] was decontam at 91 and med & his pants washed; money watch, wallet, etc., were decontam. His lunch was discarded. His car was checked (only steering wheel was contam. to 300 dpm).

1-7-60: Page 117 – Lab reports [Name] sample of 1-7 (exposure of 12-31 sample collected I-314) at 100 dpm/24 hr – 114%.

1-20-60: Page 118 – Repeat of test in [Name] lab conditions essentially the same – no sign exposure to other personnel.

1-28-60: Page 119 – Lab reported following sign. urine results – all received by lab the week of 1-18-69.

[Name] (Foundry) – 87% (resample 2-1 was 49%)
[Name] (P. Chem) – 99%
[Name] (P. Chem) – 80%
[Name] (P. Chem) – 90%
[Name] (P. Chem) – 57%
[Name] (?) – 58/60%
[Name] (Foundry) – 65? dpm – 72/77%
[Name] (83) – 82%
[Name] (83) – 28%

2-3-60: Page 121 – [Name] sample of 1-22 reported at 117 dpm – 133%.
[Name] resample of 1-28 reported at 119%
[Name] sample of 1-27 reported at 133%

2-5-60: Page 121 – [Name] sample of 1-29 reported at 135%
[Name] sample of 1-28 reported at 90%
[Name] sample of 2-2 reported at 33%.

2-10-60: Page 122 – [Name] sample of 2-8 – 69 dpm – 78%

2-16-60: Page 123 – Lab reported following urine results:

Results returned 2-15:
[Name] – 14 dpm – 16%
[Name] – 33 dpm – 40%
[Name] – 29 dpm – 33%

Resamples & Routine returned:
[Name] – 52 dpm – 59%
[Name] – 237 – 270%

2-17-60: Page 123 – Lab Results:

[Name]	2-8	162 dpm	184%
[Name]	2-8	80 dpm	91%
[Name]	2-8	83 dpm	94%

2-22-60: Page 124 – Lab reports:

[Name] (resample) – 52%
[Name] – 97%
[Name] – 154% (2-19-60)

2-23-60: Page 124 – Met with [Name], [Name], and [Name] to discuss HP position on chronic high urine excretions, such as [Name]. They feel no official HP recommendation to be made until 4 or 5 months repeated overexposures.

2-23-60: Page 124 – Met then with [Name], [Name], [Name] to discuss [Name] urine excretion. They wish to issue a letter to him stating that the condition seems to result from personal habits and asking that he exercise greater care.

2-24-60: Page 124 –

[Name] urine sample of 2-10 24 dpm – 27%
[Name] urine sample of 2-22 53 dpm – 60%

2-26-60: Page 124 – Lab reports:

[Name] sample of 2/26 @ 14 dpm or 15%
[Name] sample of 2/24 @ 70 dpm or 80%
[Name] sample of 2/22 @ 25 dpm or 28%.

3-1-60: Page 126 –

[Name] – urine sample of 2-26 was 14 dpm, 15%
[Name] – urine sample of 3-1 was 79 dpm, 90%.

3-10-60: Page 127 – Lab reported [Name] sample of 3-8 at 399 dpm/ 24 hr – 459%

3-11-60: Page 127 – Lab reported [Name] sample of 3-10 @ 108 dpm/ 24 hr – 123%
Lab reported [Name] sample of 3-10 @ 98 dpm/24 hr – 103%

3-14-60: Page 128 – Lab reported [Name] sample of 3-10 at 86 dpm – 90%?
Lab reported [Name] sample of 3-7 at 157 dpm 178%

3-16-60: Page 129 – Lab reported [Name] at 142 dpm/24 hr – 161% (sample of 3-11)

3-17-60: Page 129 – Lab reports:

[Name] sample of 3-11 at 126 dpm/24 hr – 143%
[Name] sample of 3-11 at 192 dpm/24 hr – 218%
[Name] sample of 3-14 at 10 dpm/24 hr – 11%
[Name] sample of 3-14 at 121 dpm/24 hr – 137%.

3-24-60: Page 130 – Lab reported:

[Name] – 3/14 – 134 dpm/24 hr – 152%
[Name] – 3/21 – 167 dpm/24 hr – 190%
[Name] – 3/21 – All spot samples were Bkgd

3-30-60: Page 130 – Lab reported:

[Name] – 3-24 – 140 dpm/24 hr
[Name] – 3-26 – 280 dpm (resample 4-1 was 61 dpm)
[Name] – 3-17 – 106 dpm (resample 4-1 was 18 dpm)
[Name] – 3-17 – 140

4-1-60: Page 131 – Lab reports:

[Name] sample of 3-21 @ 115 dpm/24 hr
[Name] sample of 3-25 @ 160
[Name] sample of 3-28 1st 6:30–12:30 @ 104 dpm/24 hr

2nd @ 43 ave = 74 dpm/24 hr
3-29 1st 6:30 @ 75
3-29 @ 69 ave = 72 dpm/24 hr
[Name] samples after contam accid 3-29-60; 1st 3 hr after acid 217 dpm/24 hr
Overnite after accid 57 dpm/24 hr

4-11-60: Page 133 – Lab reports:

[Name] resample of 4-1 was 61 dpm
[Name] resample of 4-1 was 18 dpm

4-20-60: Page 134 – Lab informs me that [Name] sample of 4-11 was 1st sample 30 dpm/ave = 22 dpm/24 hr; 2nd sample 14 dpm/ave

4-27-60: Page 135 – Lab reported [Name] samples:

March 31	Spot samples 1st 45 dpm/2nd 39/ave 42 dpm
April 4	Spot samples 1st 4 dpm/2nd 18/ave 11 dpm
April 11	Spot samples 1st 30/2nd 14/ave 22 dpm
April 18	Spot samples 1st 27/2nd 28/ave 28 dpm.

4-29-60: Page 135 – Lab reports:

[Name]	4-20	86 dpm/24 hr 78%
[Name]	4-20	124 dpm/24 hr
[Name]	4-20	116 dpm/24 hr 132%
[Name]	4-20	119 dpm/24 hr 135%
[Name]	4-20	65 dpm/24 hr 74%

5-6-60: Page 136 – [Name] reported [Name] and [Name] got extremely hot while removing rolls from 83 mill: 100,000 on face. Nostrils: [Name] 17 & 18 cpm, [Name] 32 & 41 cpm. Inside respirators were 2500 cpm.

7-1-60: Page 143 – [Name] asked for film badge coverage to replace exchange badges.

RFP Logbook 8/29/60–6/12/63 (Kittinger 1960)

3/2/61, Page 42 – [Name] talked to about 30–40 contractor people in cafeteria – they were offered urine sampling by their choice – [Name] said response seemed good. Further personal contam. problems w constr. Pers. All cleaned up OK.

3/8/61, Page 43 – Took list of people with no urine results for last 2 mo. to lab. Most were sampled but reporting delinquent. Lab however is not re-scheduling people who are high – also is not reporting samples that are not submitted when tagged. Talked to [Name] about problem.

3/8/61, Page 43 – Worked with [Name] on recommending action levels for Oy urine results. Checked calc. Decided to …100 dpm/24 hr as level indicating allowable lung level; 50 dpm for re-sample and 200 dpm for restriction from exp.

RFP Logbook 1962 Logbook Special Samples (RFP 1962)

1-2-62: Page 4 – [Name] Mouth and Nasal Swabs

(1) Mouth	All Pu	Low	36.5 c/m
(2) L Nostril	All Pu	High	135.66 c/m
(3) L Nostril	All Pu	Low	blank
(4) R Nostril	All Pu	Low	95.24 c/m
(5) R Nostril	All Pu	High	1502.99 c/m

1-8-62: Page 7 –
S-18 [Name] 12-9-61
(1) Skin from wound (spec 1. mg) 10:45 am 31.093 c/m
(2) Ca 0.3 mg Pu 2.690 c/m

1-30-62: Page 22- [Name]
Skin excision (ca-0.5 mg) 11,298 c/m at 30% Geo.

Page 37: 2-15-62 [Name] [Badge Number]
1.3 ug PU
179,000 d/m Not Quant. Transferred

3-13-62: Page 49 – S-178 Cadmium Air Sample (12 min 0.5 CFM)
Ashed in HO_3 first. Further ashing in muffle furnace.

4-23-62: Page 74 – [Name] Unknown source material
P.H.A. shows 85% U^{238} – 15% U^{234} by activity

Page 102: 7-17-62 Skin excision [Name] [Badge Number]
7-16-62 2,794 c/m PU with 4% Am

Page 125: 10-9-62 [Name] Special foreign body
[Badge Number] Ave. 50 min count 0.34
Reported by [Name] by phone to medical 10-9

Page 128: 10-15-62 [Name] 10-12-62
63,962 c/m .93 µgms
Pu 96.9% Run on RIDL 1 minute
Am 3.1%

Log Book W.D. Kittinger/R.M. Vogel (Kittinger and Vogel 1963)
Dates: 6-20-63 thru 10-27-67

9-23-63: Page 5 – They ([Name]) was advised by me and did notify [Name] [Badge Number] of his urine results

11-12-63: Page 7 – [Name] reported at 164 dpm/24hr for 10/3

12-9-63: Page 7 – High urine samples:

[Badge Number] [Name] 11-21 155 dpm/24hrs
[Badge Number] [Name] 11-13 192 (resample 12-11 was 5)

12-17-63: Page 7 – Urine sample – [Name] – 12-16 150 dpm/24hr

12-27-63: Page 7 – Urine sample results reported:

[Name] [Badge Number], 12-11, 77 dpm/24hr
[Name] (N/A), 12-11,120 dpm/24hr
[Name] 12-11,145 dpm/24hr
[Name] 12-13, 174 dpm/24hr
[Name] 12-13, 166 dpm/24hr
[Name] 12-13, 102 dpm/24hr

1-16-64: Page 8 –

[Name] resample results of 1-3-64 25 dpm/24hr
[Name] resample results of 1-3-64 25 dpm/24hr
[Name] resample results of 1-3-64 25 dpm/24hr

5-12-64: Page 12 – High Urine Results:

[Name] on 5/5 141 dpm/24hr
[Name] 5/6 121 dpm/24hr

2-17-66: Page 78 – Noted a few gamma exposures for Jan. 66 – Pen – 400 to 800 mostly 44 Bldg people.

6-21-66: Page 96 – Gamma alarm evac. at 200 PM. Good test. 72 people w/o film badges.

Logbook 8/1/63–3/18/68 (RFP 1963)

9/5/63: Page 6 –

[Name] – 18 of 30 urine samples show Americium

Rabbit positive plutonium
U-235 carry through in plutonium analysis

Logbook 3/3/64 – 9/4/64 (RFP 1964a)

3-12-64: Page 11 – Leaking bag incident at airlock (0345 hrs) [Name] [Badge Number] and [Name] [Badge Number] were requested to submit urinalysis samples.

3-15-64: Page 14 – [Name] cut finger on lead shield – monitored by [Name] Bkgd

3-20- 64: Page 19 – [Name] special urinalysis request
Film badge racks installed west entrance.

3-30-64: Page 29 – Puncture Wound – [Name] [Badge Number] distal and palm surface 2nd finger 1eft hand – bkgd – happened in hand

3-31-64: Page 30 – Urinalysis request for [Name] [Badge Number] due to personnel Contamination from opening waste bags in west. [Name] [Badge Number] Urinalysis Requested Np237 Spill (2 Spills) 99.5 %

4-23-64: Page 53 – Spec. for [Name] [Badge Number] Puncture through dry box glove76 Bldg initial 60.6 c/m = 0.11 ug 3rd 17.9 c/m 0.033 ug. Will return to medical for final 4-24-64.

4-27-64: Page 56 – [Name] received contamination hands from supposedly clean plastic gloves. Sent to medical for decontamination during lunch time. Back from medical at 1315.

4-30-64: Page 59 – Request special urine sample from [Name], [Name], [Name], [Name], after spill in… 166B_Am

5/1/64: Page 60 – Requested Special from [Name] for incident on 4-28-64.

6-1-64: Page 82 – Gamma Spect in [Name] [Badge Number] – puncture.
Boiler Operator burned left instep with steam. Nurse came down to Bldg. to dress wound.

6-12-64: Page 91 –

7/9/64: Page 110 – [Name] to Medical – 81 incident [Name] – Cut Finger.

7/16/64: Page 115 – Contamination incident at carbon box Rm 153 some time late on PM shift. 6-lab people working in area all contaminated. 1-Man suspected to have left plant possibly contaminated. No address or telephone number. I went to Boulder but I could not locate him.

7/21/64: Page 118 – Gamma spec on [Name] [Badge Number] wound. Had to be excised. Initial count 0.318 micrograms.

RFP Logbook 9/8/64–3/26/65 (RFP 1964b)

9-14-64: Page 15 – Possible personnel exposure to [Name] [Badge Number] working under leaking head tanks at batch box

9-22-64: Page 20 – [Name] [Badge Number] needs 2 new picture for his film badge old one 500 cpm.

1-8-65: Page 94 – [Name] [Badge Number] to medical for decontamination due to incident at L-6.

1-28-65: Page 109 – Incident of electronic techs bringing combo into H.P. area. Combo taken out of Rm 114 with contamination to greater than 100,000 c/m. Air hose used to blow out speaker – contamination spread throughout Rm 151. [Name] and [Name] sent to medical for decontamination and given special urine samples. Instruments from area should be monitored before they are brought into the shop. Practice of using air hose to blow dust from area instruments is a bad one, especially in the poorly ventilated shop area.

2/26/65: Page 131 – Exposure incident with [Name] in Rm. 187. Sent to medical for decontamination and to the body counter. Oxide sample and smears taken from the part that exposed him. Part number C-1049-07, A 1251 Part according to [Name] about 5 yrs. old.

Logbook 3/26/65 – 10/18/65 (RFP 1965a)

Page 3: 3-30-65 – Incident in rm. 180 on [Name]. Punctured bag containing oxide during canning operation body count requested – results negative special urine sample requested.

Page 31: 5-6-65 – Spill in 199 South and (sand, slog, crucible, lead all H.P. monitor in 71 Bldg. were put on the spill. Contamination extended from south end of 148 &149 up to the west exit door at 149. [Name] sent to medical for denominator (nose smears & 50 d/m) three monitors hold over 4 hr cover cleanup of contaminated area

Page 31: 5-6-65 – [Name] was sent to medical for decontamination of both hands. After treatment 100,000 c/m still remained. He was sent back to the building and rubber gloves were worn rest of night. A check on [Name] at end of shift still showed 75,000 c/m he was sent home with gloves and instruction on what to do. He is to report to Hp first thing when returning to work.

Page 35: 5-11-65 – [Name] [Badge Number] hands were checked at the start of the shift the bottom were <250 c/m.

Page 51: 6-4-65 – [Name] went to body counter due to incident in Rm 114

Page 59: 6-16-65 – Explosion – in room 153 Box #6 contamination spread over 300 Sq ft. up to and greater than 100,000 c/m. No problems with the contamination other than in room cleaned up immediately by [Name], [Name], [Name], [Name] urine samples requested for above mon.

Page 60: 6-17-65 – [Name] became contaminated while working in Lathe #768 the Inst. Were not working in his area at the time he was checking himself out thinking he was cold. He went into the locker room and ate two sandwiches. A check on [Name] later by monitor found him to be contaminated greater then 100,000 c/m on his hands and face. We checked his lunch bucket it was contaminated up to 25,000 c/m. his lunch was descended to hot waste and bucket decontaminated called [Name] then talked to [Name] about same 2 …samples were requested also 24 hr urine sample. [Name] was decontaminated at medical – no problems on this.

Page 61: 6-18-65 – Pocket dosimeter on [Name] 100mr for 12 hrs.

Pocket dosimeter – [Name] 200mr/12hr
[Name] 100mr/12hr

Page 72: 7-2-65 – Called [Name] about film badges being sent to foreman to be put in rack. Suggested that this was his people's job.

Page 76: 7-9-65 – [Name] to body Counter 8:30 Hrs.
[Name] to body counter 12:30/ hrs

Page 82: 7-19-65 – [Name] found contaminated at first of shift. He was working SR box. Day shift operator's name was obtained from [Name] and [Name]. It was [Name]s his locker was checked coveralls 1,500 c/m both sleeves 300c/m inside left sleeve, 400cm on locker door. [Name] was called took [Name] and went into [Name] home and checked No contamination was found on checking. Person 30,000 c/m was found on his left arm, 2,000 c/m on right wrist and 3,000 on left shoulder. He was asked to come back to the plant to be decontaminated. 10 gloves were changed 1 glove was washed. 20 ft floor to 8000 c/m.

Page 65: 8-6-65 – Lathe 724 contaminated. [Name] contaminated and sent to medical.

Page 103: 8-17-65 – [Name] to body counter
[Name] to body counter

Page 111: 8-26-65 – [Name] to medical hot hand and 500 c/m to 1000 c/m in his eye

Page 111: 8-26-65 – [Name] became contaminated while workers at R.R [location]. was removed he was sent home with 750c/m on the left side of his face. Face was too tender to do any more scrubbing.

Page 128: 9-21-65 – [Name] [Badge Number] received 2 small nitric acid burns on the back of his left wrist all contaminated removed except 50,000 c/m on burns arm was bandaged and was sent home. Overnight urine sample requested [Name] was asked to report to medical when he comes in tomorrow night.

Page 130: 9-23-65 – Spotted leak on 114 Fluor, controlled same [Name] & [Name] to medical and body counter called [Name], [Name] and [Name] (wasn't home)
[Name] and [Name] came out to plant.

Page 135: 9-29-65 – Maint on vaco lines over skull box, rm 149 Contamination was spread. [Name], 1785 sent from medical with 800 c/m on left Eye and 600 c/m on side of nose.

Page 145: 10-8-65 – Contaminated Incident in room 174 and 175 personnel involved [Name] [Badge Number], [Name] [Badge Number], [Name] [Badge Number] to body counter others [Name] [Badge Number], [Name] [Badge Number], [Name] [Badge Number], and [Name] was only one wearing a Resp.

Page 150: 10-14-65 – [Name] [Badge Number] sent home with 2,000 c/m on left hand after he had been to medical.

RFP Logbook 10/19/65–5/9/66 (RFP 1965b)

11/6/65: Page 17 – Gamma spec on [Name] [Badge Number] – First Count 20 µg – Final count before sewing up wound 4.6 µg – After sewing up wound 1.96 µg. Puncture wound on furnace #33, 76 Bldg.. Pu sliver on a tantalum funnel punctured him. [Name] called out to perform the excising. Continuous urine samples requested.

11-19-65: Page 28 – [Name] filling waste bag at incinerator the seam split. About 700 to 800 sq. ft. of floor contaminated from 3,000 c/m t0 100,000 c/m. [Name] did not have on a respirator when the incident happened. His face was spotty to 30,000 c/m; back of neck to 100,000 c/m under nose. 1,500 c/m nose swipes 126 d/m before washing, 6 d/m after washing. [Name] was completely decontaminated in the building. Head 13-26 to 3,000 c/m (100 pits) are decontaminated.

12-6-65: Page 39 – Talked to [Name] Re [Name] high film badge results.

12-9-65: Page 41 – Site gauge blew off at Tank 731. A pop off was heard at 0045 Hrs., but no one know what had occurred. About 0345 hrs hot booties were investigated and what had happened was discovered. Air sample A-8 was found to be 35,000 cpm. [Name] and [Name] issued special urine samples.

12-29-65: Page 57 – [Name] and [Name] went to medical at the end of PM shift for decontamination.

2-16-66: Page 93 – [Name] requested body count for [Name] [Badge Number]. Counted at 1130 on 2-16-66.

2-16-66: Page 93 – [Name] and [Name] came out at quitting time (~1615) from 147 B & C with up to 6,000 c/m on their hands and personal clothing. Both rooms checked OK, with the exception of the telephone 300 c/m. Desks were locked. Clothing Decontaminated.

2-24-66: Page 99 – K2 pressurized during MTC operations when a PV was being raised into K-1. Floor – ceiling and chem. line contaminated. MTCE Man [Name] [Badge Number] contaminated over most of his body. Released from medical with 2,000 c/m on his back and neck and 400 c/m on left side of face, chest, lower stomach, and R. knee. He was wearing a respirator at the time.

RFP Logbook 5/10/66–12/3/66 (RFP 1966a)

6/16/66: Page 27 – Rm. 148 – 0100 Fire and Pressurization of K-1 contamination confined immediate area. 250 sq. ft. B-16 head 10K c/m direct. Possible exposure and urine for [Name] [Badge Number] working at BBO.

7-11-66: Page 45 – Gamma spec [Name] [Badge Number] – 0.004 µg. Urine sample requested.

10-7-66: Page 112 – [Name] [Badge Number]. Glove failures 182 > 100K c/m. Nose, mouth, hair, sides of face, back of neck decontaminated to …c/m at nose and mouth – sent to body counter at 1220.

10-24-66: Page 124 – Explosion at the incinerator about 1720 hrs. Blew a window off the east side of the dry box. All of Rms 149, 148, 146, and 181 contaminated. Twelve people sent to medical and the body counter. Those body counted:

[Name] [Badge Number] x 12.

11-4-66: Page 133 – [Name] lost his Oct badge at badge change time. Asked [Name] to assign same dose vs. per mista.

12-1-66: Page 150 – Contaminated incident in 76 Bldg. South degreaser at 2135 hrs. [Name] [Badge Number] contaminated to 60K on face. Nose smear were 57 & 44 d/m. Decontamination completed at medical.

RFP Logbook 12/5/66–6/11/67 (RFP 1966b)

1/11/67: Page 26 – Gamma spec. on [Name] [Badge Number] – 1.29 µg. Dr. [Name] and [Name] were called. Medical action to be taken in the morning at 0800.

1/18/67: Page 31 – [Name] [Badge Number] sent to Bldg 22 for body count.

2/7/67: Page 45 – See Instructions for film badge study at the fluorinator. PMs and Mid please pick up film badges and record reading indicated.

2/19/67: Page 50 – Changed [Name] [Badge Number] film badges after his work on special Am project. Readings were 628 mr on the body badge and 874 mr on the wrist badge.

2/28/67: Page 60 – Talked to 2 groups of operators from Rm 114 about latest film badge list. All had high reading. Some quite concerned. Present were [Name], [Name], [Name], [Name], [Name], [Name] and [Name]. Explained how they can help control their own exposures by using shielding, distance, time and housekeeping.

3/6/67: Page 66 – Checked on film badge results for [Name] and [Name]. Reference future work with Cm in January.

3/11/67: Page 72 – 0650 hrs Possible inhalation of [Name] [Badge Number] from a glove failure at the R6 filters. Face 10K and arm 100K before washing after several washings in the decontamination room. Face 1K and arm 30K.

3/11/67: Page 72 – 0700 hrs Possible inhalation exposure of [Name] [Badge Number]. Top of head 50K and face 2K before washing. Source of the contamination is unknown. [Name] was on top of several boxes completing shutdown operations.

3/15/67: Page 75 – Started film study at 114 Fluorinator a 3 badge shield of micarda and Pb tape stationed in cabinet at box. 1 Control badge remain in block all times during the study. Operators – [Name] and [Name] each have a badge in the Block and will be worn only during bag cuts and material transfer outside of drybox. Attempting to establish amount of exposure other than working in drybox gloves.

5/23/67: Page 131 – Special film badges are to be worn by people involved with the Pu/Be Project. Regular film badges are not to be worn.

6/6/67: Page 141 – Talked to [Name] about his recent exposure. 781 mrem for month of April. His May exposure will be as high or higher (148 Fluorinator). Showed him the dose rate of 60 mR with shielding open 30 mR closed. Told him to spend as much time as possible out of the gloves and out of the fluor room. He was not aware that there should not be material stored on floor in room (pkg. of oxide). He is 20 years old. I estimate he will exceed this quarter tolerance by 2.5 times if he remains on the fluorinator.

Logbook 12/12/66 –12/31/68 (Kittinger 1966)

12-14-66: Page 1 – [Name] to notify Met Prod – 71 about exposure status of [Name], [Name], [Name], and [Name]. [Name] at ~ 2,000 mrem for Oct Nov; [Name], [Name] and [Name] all betw. 1,500 and 1,600.

12-23-66: Page 4 – Rec'd film badge results – investigation of [Name] ~1100 Nov exp. Showed he was assigned to fluorinator 71 Met Prod for 3 wks in Nov.

2-3-67: Page 12 – [Name] and I met with [Name], [Name], [Name], [Name], [Name], & [Name] to discuss the procedures relevant to body counting, wound counting, and urine sampling. Agreed that any detectable contam. about the nose and mouth area dictates body counting – set up procedures for more rapid scheduling. Also any would initially above background calls for special urine sampling. Also decided to furnish [Name] with a copy of the accident report – ordered 3 copy forms. Drafted letter to be sent to foreman explaining the procedures.

2-27-67: Page 18 – Notified by [Name] that [Name] & [Name] are now restricted from Pu work & that letters have been sent to their superv.

3-7-67: Page 19 – Notified [Name] that [Name] should be immed restricted from expos in March & that [Name] & [Name] should have expos. potential drastically reduced. Sent letter on 12 people to [Name].

3-9-67: Page 20 – In conv. with [Name], he stated [Name] neutron expos. on Feb badge was underevaluated.

3-10-67: Page 21 – Advised [Name] (after [Name] call) that [Name] neutron dose for Feb. is revised upward – he should be immed restricted. [Name] agreed.

3-17-67: Page 23 – Drafted letter to [Name] on background of over-exposures to [Name] & [Name]. Gave to [Name] for editing.

3-30-67: Page 26 – Met with [Name], [Name], & [Name] to formulate report to AEC on overexposures to [Name] & [Name].

3-31-67: Page 26 – Drafted answer to questions raised on overexposure report for [Name] & [Name]. Sent copy to [Name] for his comments.

4-3-67: Page 27 – [Name] reviewed and had [Name] review, both OKd, statements to be used on overexposure report.

4-4-67: Page 28 – Met w [Name], [Name] and [Name] to discuss neutron data from Mfg. Techs. Be-Pu runs. Data somewhat inconclusive. [Name] to meet with [Name] in afternoon. He is to indicate Pu-Be harder to shield than PuF_4 – that heel and salt from electro-ref. give up to 10 times more neuts than original mix – also to ask for better sampling next. Will ask for more runs.

4-11-67: Page 30 – Reported to [Name], high exposures reported by [Name]:

	Jan–Feb	Mar	Total
[Name]	1121	1435n + 604γ	3160
[Name]	1603	445 + 423	2971
[Name]	1338	1140 + 346	2824
[Name]	1513	854 + 365	2732
[Name]	2144		2971
[Name]	2553		2790
[Name]	2373		2610
[Name]	2761		2853
[Name]	2893		2906
[Name]	2484		2999
[Name]	2581		2591

4-19-67: Page 33 – Gave [Name] urine values for [Name] for past year – consistent positive – recommended he caution the man about resp. protection.

4-19-67: Page 33 – Rec'd two-wk pen. expos. for 71 fast recycle personnel. 7 were over 800 mrem. Wrote a letter to [Name] with details.

4-24-67: Page 35 – Rec'd word from [Name] that [Name] [Badge Number] was over 3 Rem for 1st quarter. Talked with [Name] & [Name] about his work assignments. He has been heavily involved in charge makeup using site returns.

4-26-67: Page 35 – [Name], [Name], & I met with [Name] to investigate cause for [Name] overexposure. They ([Name] & [Name]) have talked to [Name]. They feel major cause is the in operation of the belt conveyor for about two weeks in March while chainveyor was installed. I wrote description of cause, [Name] OKd, and sent to [Name].

4-27-67: Page 36 – [Name] of [Name] group was reported with a high hand exposure for March ~ 20,000 mrem. [Name] and the HP foreman to investigate.

7-24-67: Page 52 – Checked on overexposures to [Name], [Name], and [Name]. [Name] worked fluoride box prior to June to give him the bulk of exposure. [Name] worked Am box, Rm. 114. [Name] worked Line 3, Rm 114 – radiation readings and investigation with him do not support exposure. Wrist badge shows only 246 mrem, while body badge shows 2398 mrem.

8-28-67: Page 61 – Asked [Name] to recheck film badges for neuts of fluorinator operators:

	Reported at (mrem)	{Name] found (mrem)
[Name]	66	72
[Name]	25	329
[Name]	175	364

8-28-67: Page 61 – Last week asked for all foundry people working on ZPPR in 71 to be body counted. Gave [Name] a list:

[Name] x 5

Day:

[Name] x 5

PM:

[Name] x 6

To date [Name], [Name], and [Name] have been found with positive indications.

9-14-67: Page 64 – Asked [Name] to recheck neutron exposure for [Name] & [Name] who were assigned fluorinator operations – [Name] found they were evaluated about 130 mrem low. Also told [Name] I think gamma results are too low recently. He said he would check recency of calibration.

9-26-67: Page 67 – Received IBM sheets on film badge results. In tally with our 2 wk tabulations found we were low on several people because of late badge results we had not received. [Name] was one of these. As of Sept. 1 his quarter total was over 2,000 mrem. I called [Name] with this info. [Name] stated [Name] had been and still was on fluorinator work. [Name] said he would not move him now, but found later that he did. We were also low on 7 foundry people. In fact with 1st 2 weeks in Sept., [Name] is overexposed.

9-27-67: Page 67 – Consulted w [Name] and [Name] about radiation exposures resulting from ZPPR work plus site return work. Previously advised foundry to provide lead apron and use for bagout work both 76 & 71 ZPPR. They borrowed 2 aprons and requisitioned 6.

10-31-67: Page 75 – [Name] & his people – [Name] & his people are quite skeptical about film badge results. Oct results are abnormally high with little reason as far as production people are concerned. [Name] & I have talked about possibility that 60 keV being seen in Cd region & reported as hard radiation. Data on ZPPR people gives credence to this possibility. Talked with [Name] slightly – he does not feel this is happening.

11-9-67: Page 77 – Met with [Name], [Name], [Name], [Name], [Name], & [Name] to discuss evaluation of film badges. Finding confirmed that soft radiation finding way under Cd shield because of spacing in the badge. In some cases over evaluation is by a factor of 2. [Name] people to use correction factor until badges are modified. Full correction to be applied to 71 chem ops from Oct. 18.

12-7-67: Page 81 – [Name] reported extremely dark film badge for [Name] (Mfg engin) Supervision has checked with him and found no anomalous use. People doing similar work were [Name], [Name], & [Name].

12-15-67: Page 82 – Reported to [Name] that [Name] hand exposure as of Dec. 8 was 19,265 mr. Advised him to employ restrictions to avoid surpassing 25,000.

12-15-67: Page 83 – Reported to [Name] that [Name] hand exposure as of Dec. 8 was 19,265 mr. Advised him to employ restrictions to avoid surpassing 25,000.

12-15-67: Page 83 – Worked with [Name] to untangle meaning of yearly allowed pen column film badge sheet. This program is written incorrectly. It seems to show in some cases not what the annual limit is but rather how much can still be received – however stops at 5,000 level. [Name] is to have program rewritten.

3-19-68: Page 98 – On basis of Feb. film badge results, advised [Name] to take exposure restrictive measures for [Name] [Badge Number] & [Name] [Badge Number].

4-3-68: Page 101 – Small explosion in glove box in Rm 120-M – 3 men to body counter.

4-5-68: Page 102 – Met with [Name] & [Name] to give them advice on Step II hearing involving transfer of [Name] & [Name] to 44 because they were near 1250 level. Affirmed to them that H.P. believes 1250 mrem/quarter to be proper level to alter a man's job to effect exposure reduction.

5-7-68: Page 107 – Notified [Name] of 2-week exposure to [Name] 1275 mrem neutrons, ~250 mr gamma. Also gave him exposures to neutrons for all over 200 mrem – plus total exposures to [Name], [Name], and [Name].

6-4-68: Page 111 – Reported following prelim. results to [Name] for film badge period 5-17 through 28:

[Name] – 670 mr gamma
[Name] – 670 mrem neutrons
[Name] – 1079
[Name] – 715
[Name] – 828
[Name] – 768

6-18-68: Page 113 – Rec'd 771 film badge results – blank showed about 500 mrem neutrons – bulk of exposures are obviously too high. Checked with [Name] on any shift correlation. Inspected rack for storage practice. Appears that bulk of personnel use the rack. [Name] took the one-month blank for reading.

Also received a special film report on possible X-ray exposure to [Name]. His badge showed ~500 mrem neutrons. [Name] talked to him and discovered that [Name] has several 100 grams of Pu-Be stored in his area. Will check this out further with survey instrument.

6-19-69: Page 113 – From check of unused films, [Name] decided film contam. cause of problem in neutron exposures for 71 & 76 2-wk change. Consulted w/[Name], decided to make neutron dose assignment on basis of area survey info and work assignments. Used foreman's check of work assignments.

7-2-68: Page 116 – Assigned neutron doses to 71 personnel on basis of area exposure surveys and work assignment – due to contam. neutron film.

7-30-68: Page 119 – Met with [Name], [Name], & [Name] to agree on dose to be assigned to [Name] [Badge Number]. [Name] was involved in about 25 hr. of close work on a unit. Film badge was pulled & gave incredible result of ~150 mr. Assignment agreed to by all was on this basis:

	Dose rate	Time	Est. dose	Meas. dose*	Ratio	Assigned dose
[Name]	17	5 hr	85	59	0.69	
[Name]	80	25 hr	2000	?	0.69	1380

* Measured dose for [Name] was subsequent to [Name] exposure and was film unconfirmed by TLD. Submitted draft of letter to [Name] on recommendations for future short-type work for [Name] OK….

9-5-68: Page 126 – Notified [Name] of [Name] high expos., period 8/15–8/29 978 mrem.

9-6-68: Page 127 – Rec'd & passed on film badge runs for Fndry & chem. ops. 23 chem ops people over prorated quart. level (850) high is [Name] (?) over 2000.

9-20-68: Page 130 – Made special of [Name] badge from Sept 3 to Sept. 14. He received 383 mrem (125 γ, 258 neutron). I discovered yesterday from 2-wk badge change list that he had transferred to 776 Prod. Cont. Yesterday I discussed his exposure control w [Name] and pulled his badge to date. His quarterly total to yesterday is: 2124 to 8-29 and 383 from this special to 2507. I verbally recommended to [Name] that he be restricted from the area.

9-21-68: Page 131 – [Name] was rotated to 44 by Prod. Cont.

10-8-68: Page 134 – Incident in foundry – [Name] working in B-12 furnace box pulled off glove as he retracted his hand. Glove was held on by "O" ring – some contradictions as to whether inner plastic glove ring involved or not. High air contam. resulted in NW corner of 776. Body counted were: [Name], [Name], [Name], [Name], [Name], [Name].

10-14-68: Page 136 – Incident in Bldg 71 – waste barrel fire in 114 – contam. spread was general throughout 114, but fairly low level – 2 to 3k. About 10 people sent to body counter: [Name], [Name], [Name], [Name], [Name], [Name], [Name], [Name], [Name], [Name], [Name], and [Name]. All neg except [Name]. [Name] estimates him at about 1 lung burden based on a 1000 ppm estimate of ^{241}Am. [Name] & [Name] notified [Name] should be restricted from hot area pending further determinations. ([Name] reports 163 ppm ^{241}Am from smear sample of drum).

10-16-68: Page 137 – [Name] estimated at ~ 6 mplb – relayed info to [Name] & [Name]. [Name] is now working in 881. Checked w [Name]. This is not an acceptable location to us. Will inform [Name].

11-6-68: Page 140 – Explosion – K furnace 771 – blow out liquid from crit drains in fluorinator. Air contamination in immed. area 7100K c/m direct. Sent to body counter:
[Name] [Badge Number] x 9

Got nose swipes on these people. About 2400 ft^2 of area contaminated >100K cpm. Only [Name] showed positive count – to be studied.

11-18-68: Page 142 – 2 sheet metal men, [Name] & [Name] sent to body counter for potential inhalation exposures. Appear to have pulled lead tape from box counter to… given to the monitor ([Name]). Were not wearing respirators. [Name] neg. on body count. [Name] appears to be above 25 – will be recounted. 2nd count bkgd.

12-12-68: Page 147 – Called for badge change on following maint. people who worked on mill cleanout.

[Name] [Badge Number] x 10

Logbook 6/12/67–12/29/67 (RFP 1967)

6-29-67: Page 16 – Talked to …about [Name] on 148 Fluorinator judging from readings and study with neutrometers it would indicate 777 mrem of exposure in the past 4 days. Front of box without shielding 75 to 80 mrem – with shielding 35 mrem.

7-1-67: Page 18 – [Name] to medical at 1945 to decontam. hands. Storage went with him to check him out.

8-11-67: Page 49 – Talked to [Name], [Name], and [Name] about the gamma and neutron levels in Rm. 182. Too much storage in area – [Name] is running 65 mrem on dosimeter for today. He is at the mold coating box.

8-30-67: Page 62 – Gamma spec. on [Name] [Badge Number] Possible caustic burn on both knees.

9-25-67: Page 81 – Send [Name] and [Name] to body counter suspected exposures from holes in gloves. Both had contaminated face.

11-1-67: Page 110 – Gamma spect on [Name] [Badge Number]. Acid burn on left forearm. Contamination still present. Will make final count when burn woundd is cold.

11-1-67: Page 110 – [Name] [Badge Number] contaminated face from hole in glove-up to 4,000 c/m called – [Name] he will body count him on 11-2-67.

11-22-67: Page 125 – [Name] [Badge Number] told to report to the body counter at 0800 hrs Tuesday 11/28/67. Possible inhalation exposure Line 4 Rm. 114.

11-30-67: Page 129 – [Name] [Badge Number] will come in, 5 hr early for a body counter check for possible lung contamination.

12-20-67: Page 143 – Called [Name] regarding a possible inhalation exposure for [Name]. [Name] will report to the body counter tomorrow at 1515 hrs.

Logbook 1/2/68 – 7/5/68 (RFP 1968a)

1/12/68: Page 10 – Informed [Name] regarding the BB1. labeling. [Name] [Badge Number] alpha spec initial .48 ug time 0500 hrs. Dr. [Name] will examine the wound at 0800 this morning for further treatment. Wound had .20 ug after scrubbing and scraping. Wound was excised and final reading bkdg.

2/15/68: Page 38 – [Name] received 3 to 5 k c/m around his nose and mouth when a glove failed on A-9 Bldg. 76 at ~ 1820. Arranged with [Name] to have him body counted at 1530 on 2-16-68 (Notified [Name])

2/25/68: Page 45 – Spill at Line 14 during window change. [Name] and [Name] to Medical for decontam and alpha spec for [Name] only, because of 2 small existing sores on his left wrist. Urine samples requested and body count is to be arranged for 2-26-68. All maint. people in Bldg. put on decontam. of area. Area Contam. is principally east of Line 14 and east end of fluorinator room. 14 operators are being brought in 4 hrs early on 2-26-68 to complete cleanup operations. 2 monitors called in to cover ([Name], [Name]).

3/22/68: Page 66: [Name] [Badge Number] – urine sample requested. – There is a possibility his resp may have leaked. A body count will be arranged by [Name] or [Name] for Tues morn.

4/11/68: Page 81 – [Name] [Badge Number] to medical for gamma speck. Initial count 3.9 ug. Final 0.05 ug.

4/19/68: Page 87 – Talked to [Name] regarding exposures that might be experienced during the clean up of the fluorinator in Room 148. It was decided to put special body badges on [Name] [Badge Number] and [Name] [Badge Number] for Sat 4/20/68 and have them read immediately. 1st quarter readings for [Name] (694 Pen) ([Name] 481 Pen).

4/22/68: Page 89 – Special film badge results for Sat. work on 148 Fluorinator –

[Name]	205(n)	14 (photon)
[Name]	160(n)	15 (photon).

4/26/68: Page 93 – Gamma spect on [Name]. 0.028 ug was told to report to medical Mon. at 1480.

5/10/69: Page 105 – Got a special develop and reading on film badge for [Name] [Badge Number]. He has worked on 114 fluorinator shielding two days this week. Badge showed gamma=33 and n=180 – from May 3 thru May 9. Told [Name] not to use him today and sat for welding on 114 fluor.

5-28-68: Page 119 – Gamma Spec on [Name] [Badge Number]. Final net count was .003 ug. To report into medical tomorrow P.M. Bucket request was issued.

6-4-68: Page 123 – A sudden squall that blew in from the east spread contam. from the rabbit pen on to the people working there and into Bldg 03 itself contaminating the inside of the Bldg to 10,000 c/m. Lunch boxes in the Bldg were also contam. All lunches were discarded and lunches were furnished to them. [Name] street pants were contam. to 500 c/m. They were cleansed up with tape. Also [Name] car was generally contam to 300 and 400 c/m on both the inside and outside. It was driven into 74 Bldg. area and decontam. Operators were decontam. in Rm 169.

6-10-68: Page 127 – Reported to medical at 1600 to take gamma spec on [Name]. Dr. [Name] was there and it turns out that no burn was received as was at first reported. High level contam. did exist on thumb nail however and we were unable to reduce it to < 2000 c/m. Had medical put a rubber cover on his thumb and sent him home with 2000 c/m still on his thumb nail. Asked him to check back into H.P. tomorrow for another check and advise on what other action if any should be taken.

6/17/68: Page 132 – Possible inhalation exposure on [Name] [Badge Number] working at the "W" box. [Name] called for body counting at 2015 hrs. [Name] is not sure what caused the release that set off the continuous air monitor behind them. That sample greater than 100,000 c/m, B-15 > 100,000 c/m. [Name] [Badge Number] also in area and sent up for body count.

6/27/68: Page 140 – [Name] went thru glove on 181 cascades. Received >100,000 c/m on right forearm. Reduced to 2,000 c/m at medical. Ointment used on arm and spot where high level remained was bandaged. He was told to report to medical at 1530 tomorrow afternoon.

RFP Logbook 7/8/68–2/4/69 (RFP 1968b)

7/9/68: Page 2 – Scheduled [Name] for body count – Rm 185 incident 7/8/68.

7/11/68: Page 4 – Badge results on Mrf. Eng. Work the 12/8 Fluor results from 1 Jul to 10 Jul.

	Neutron	Gamma Body	Wrist
[Name] [Badge Number]	174	26	37
[Name] [Badge Number]	114	1	34
[Name] [Badge Number]	174	28	3
[Name] [Badge Number]	102	55	77
[Name] [Badge Number]	126	20	50
[Name] [Badge Number]	114	6	14

8/8/68: Page 26 – Scheduled [Name] [Badge Number] for body count at 0745 tomorrow morning. He was involved in spill at Line #30 on day shift.

8/21/68: Page 35 – Sent [Name] [Badge Number] to body counter. 114 Fluor. Incident.

8/22/68: Page 36 – Talked to [Name] about his two forgotten badges within a six-month period. The First "F" badge issued in this period was on 6-17-68 & he was working in the uranium area that week for [Name].

8/22/68: Page 36 – Scheduled [Name] [Badge Number] for body count on 8-23-68 at 1515. Urine and fecal samples requested.

9/13/68: Page 51: Incident at Line 13 & 14 resulted in the following people being sent to the body counter Monday 9-16-68 at 1500 hrs. [Name] [Badge Number], [Name] [Badge Number], and [Name] [Badge Number].

9-25-68: Page 60 – Incident at BBO end of PM shift. [Name] [Badge Number] told to report to body counter, (again) (9-25-68 at 1500 hrs). Scheduled with [Name].

10-16-68: Page 75 – Body count requested this AM for [Name] [Badge Number]. Possible inhalation.

10-18-68: Page 77 – Requested 5 special body and wrist badges from [Name] to be used on special project next week in Rms. 180E & F. Badges will be down Monday.

10-22-68: Page 79 – Special project with Am started in Rm 180E. Special film badges were sent down.

10-26-68: Page 83 – Small incident occurred at incinerator 1100 hrs when pipefitters were removing insulation from heat exchanger. 70 sq. ft. floor to 50,000 c/m. Slight personnel contamination to [Name], [Name], & and [Name]. Not wearing respirators. [Name] issued special urine requests for all 3.

11-6-68: Page 91 – Possible internal exposure from glove failure at Line 45 for [Name]. Body count 0700 1715 AM.

11-6-68: Page 91 – Chem line explosion and fire – body counting scheduled for [Name] [Badge Number]; [Name] [Badge Number]; [Name] [Badge Number]; [Name] [Badge Number]; [Name] [Badge Number]; [Name] [Badge Number]; [Name] [Badge Number]; [Name] [Badge Number].

11-13-68: Page 96 – Scheduled [Name] for body count – He was in Rm. 247 on 11-6-68 when the explosion occurred at K-1.

11-13-68: Page 96 – Sent film badges for [Name] (RCA Service Man) and [Name] [Badge Number] to [Name] for special developing. They were working on the electron microscope and may have been exposed to x-rays.

11-20-68: Page 101 – Body count requested for [Name] [Badge Number]. 7000 c/m around nose and mouth, chin, neck and hair. 40,000 c/m chest. Possible sources checked no source found. (All gloves Line 2, 2 orange tanks top Line 2, six shielded storage pots, N. enc 114 and two gloves on fluorinator all neg.)

12-11-68: Page 114 – 0001 Line 20 [Name] [Badge Number]. Adjusting air flow valve on sparge line. Needle released from valve allowing contaminated air to escape directly onto [Name] side of face contaminated to 2000 c/m. Left arm to 20,000 c/m. 100 sq. ft. floor to 20,000 c/m. Body counted 0700 this AM.

12-30-68: Page 126 – SA 114 Fluorinator – enlarging windows. 990 mrem neutron 8 mr γ. [Name] [Badge Number], [Name] [Badge Number], [Name] [Badge Number]. Restricted todays work only.

1-2-69: Page 128 – Asked dosimetry for special development of body badges because of involvement in S.A. at 114 Fluor last Mon. and Tues. For [Name] and [Name] (Sheelmetal).

1-3-69: Page 129 – [Name], [Name] [Badge Number] scheduled for body count at 0800. Nose swipes and material swipes taken and submitted to [Name]. On material swipe to [Name] for ppm Am analy.

1-3-69: Page 129 – Talked to [Name] about ex. exposures to [Name] [Badge Number] and [Name] [Badge Number]. Suggested he pull these two people off the job on 114A Fluor. and use two others. Inst. readings – Average of 100 mrem/hr – [Name] on job all day Tuesday and ½ day Thur and Tri. [Name] on job ½ day Tuesday – Thur and Fri.

1-3-69: Page 129 – Changed body badge films for [Name] [Badge Number] and [Name] [Badge Number]. Sent on film to dosimetry for development.

1-10-69: Page 134 – Incident at Line 2 – [Name] [Badge Number] and [Name] [Badge Number] scheduled for a body count. [Name] called at 0540 hrs. and he will be in by 0700 hrs. Nasal swabs taken and sent along to body counter.

1-14-69: Page 136 – Glove failure at Line 15 – [Name] [Badge Number] scheduled for a body count at 0700. [Name] called and he is coming in early. Smear to [Name] 1050 ppm Am.

1-23-69: Page 144 – Gamma spect. on [Name] pipefitter 76 Bldg. SCAB! Came off of old wound which was highly contaminated. Results were Neg. [Name] was also sent home from medical with a contaminated air and contaminated leg. This all came from S.A. job at 4 hl mill 76 Bldg. [Name] was the monitor. Arm was 4,000 c/m Leg 2,000 c/m when he went home.

Body count requested for [Name] [Badge Number]. See incident and possible exposure sheet. Will report to medical at 1500 hrs on 1-14-69.

1-27-69: Page 146 – Picked up ZPPR badge for special results.

1-27-69: Page 146 – Incident at Line 30 ~1800 hrs. Flange leaked going into top Line 30. Sprayed [Name] forehead and coveralls. Possible exposure reports for [Name] [Badge Number] and [Name] [Badge Number].

1-28-69: Page 147 – Scheduled [Name] [Badge Number] for body count @ 1530 1-29-69. Told me he was in area of spill at Line 30 1-27-69.

Logbook 2/5/69–9/3/69 (RFP 1969a)

2-5-69: Page 1 – [Name] and [Name] [Badge Number] scheduled for body count after 180 F incident. Nose swipes and smears sent to [Name] and 71 labs.

2-5-69: Page 1 – Count remaining from CA Job 249 on [Name] finger R.hand 1500 cm, 4th Finger 2,00c/m Elbow 500 c/m.

3-7-69: Page 23 – Body count on [Name] [Badge Number] – "B" box Incident RM 160

3-11-69: Page 25 – [Name] [Badge Number] became contaminated while working with tank farm-face-hand's greater than 100,00 c/m he was scheduled for body count (no work permit was issued for pre check of [Name])

4-23-69: Page 55 – [Name] and [Name] were sent up to body count from an incident at Button Breakout. [Name] had 4,000 c/m around nose

4-24-69: Page 56 – Might be a good idea to find out who the Am separators were that worked around lines 43 and 44 on 4-23-69 and maybe give them a pee bucket or schedule them for a body count due to the significance of the incident at line 43 on Pm shift 4-23-69 (see incident report) Air samples B-17, 18, and 19 were running 1,000,000 c/m and were running from 2K to 6K

4-24-69: Page 56 – [Name] I asked production to have [Name], [Name], and [Name] to come in for a body count because of the incident at the end of the Pm shift 4-23-69

4-24-69: Page 56 – [Name] sent up for body count – this was from incident at BBO, results negative

5-6-69: Page 66 – Body count for [Name] – possible inhalation. [Name] and [Name] came out – to do the counting.

5-9-69: Page 69 – Smoke reports coming out of stack at 1015 Hrs [Name] came in to find out if we are getting a air sample – referred her to site survey samples [Name] [Badge Number] sent to body counter @ 1000 for possible inhalation source believed to be hot pickup that he was emptying smears wee sent to pick

5-14-69: Page 72 – [Name] to medical to check decontaminating crew and shower stall approx 1.5 hrs

5-15-69: Page 73 – Body count for [Name] [Badge Number] contaminated from samples in room 166 A. She has to be recounted at 0745 on 5-16-69.

5-16-69: Page 74 – Called [Name] in 0240 to take body count on [Name] (guard doing fire patrol in 76 Bldg)

5-19-69: Page 75 – Fire at incinerator at 1930 hrs all of room 149 contaminated – one glove burned off line loss of vacuum in day bay big factor. Sent 6 mon to body counter.

[Name] [Badge Number] x 5

3-28-69: Page 38 – Body count requested for [Name] [Badge Number] 10K c/m on face Glove failure at line #2

4-10-69: Page 46 – Fire at K-2 Furnace (1800 hrs) 3 gloves burned off of line. 8 personnel sent to body count.

[Name] [Badge Number] x 8

Decontamination started immed. not completed on this shift. xx = some positive; xx fecal samples requested. [Name] did the counting 0700–2300. Sent material smear to [Name]. He told me on phone that he could analyze it.

4-11-69: Page 47 – Passed out fecal sample cards to personnel that were body counted from K-2 fire.

5-22-69: Page 78 – Body count requested for [Name] [Badge Number] and [Name] [Badge Number]. Both were involved in handling a plastic bag with a hole in it.

6-10-69: Page 90 – Body count requested for [Name] – Possible inhalation exposure – Incident at Line #16 – Sample for Am determination taken by [Name] and sent to 881 Bldg.

6-10-69: Page 90 – Sent [Name] to Body counter – he was contaminated around face (2,000 c/m – 4,000 c/m) source holes in glove.

6-16-69: Page 94 – Body count for [Name] for incident on 6-13-69.

6-17-69: Page 95 – TLDs being used on special Am job in Room 180F.

6-25-69: Page 101 – 2115 hrs criticality drain on line #30 ran over we only have cloth booties to use, material is running 146g/liter. At least 6 pr shoes contaminated to > 100 K. 3 chem. operators sent to medical for decontamination.

7-2-69: Page 106 – Body count requested for [Name] – [Name] and [Name] – incident in rm 182 ~ 1345 9 system pressurized)

7-2-69: Page 106 – [Name] [Badge Number] possible inhalation exposure Checked Bkg

7-3-69: Page 107 – Badged 14 fast recycle operators with special TLD badges for [Name].

7-11-69: Page 112 – [Name] [Badge Number] sent to body counter at 0715

7-14-69: Page 113 – [Name] to body count at 0715 – he was roding out the off gas line inline 17, glove failed causing the contamination.

7-14-69: Page 113 – Scheduled [Name] for a body count at {Name's] request would also like to schedule [Name], [Name], [Name], [Name] is to report back to body counter at 1600hrs, 7-15-69

7-15-69: Page 114 – [Name] to body counter at 1600 hrs PER request of [Name]

[Name] – To body counters 1800hrs
[Name] – body counter 1900hrs
[Name] – body counter 2000hrs

7-16-69: Page 115 – Body count scheduled on [Name] [Badge Number] bag broke open in the tunnel

7-24-69: Page 121 – [Name] and [Name] sent to body count at 0630 possible inhalation from spill at line 30

7-25-69: Page 122 – Arranged TLD badging for 71 foundry operations with [Name] (to be changed weekly)

7-29-69: Page 124 – [Name] requested a fecal sample from [Name] who is on the midnight shift West notified

7-30-69: Page 125 – [Name] to body count – High air samples on 7-24-69 am 146 no evidence of source or reason for same found.

7-30-69: Page 125 – [Name] and [Name] to body count – line 9 rm 114 portable drybox

7-31-69: Page 126 – [Name] – [Name] – [Name] – [Name] to go to body count at 0630 hrs.

7-31-69: Page 126 – [Name] [Badge Number] Bldg Serv. Sent to the body counter as a result of fire last night. He was bkg.

7-31-69: Page 126 – [Name] to body counter – Bkg.

8-4-69: Page 129 – Decontaminated in tunnel – and burning of oxide [Name] [Badge Number] to body count at 0715 possible resp leak. All decontaminators are wearing assault masks in tunnel as a result (Two much sweat.).

8-8-69: Page 133 – [Name] was down to discuss setting up a special γ-n survey for the week of 8-11-69. Talked with [Name] for proper location of 12 men – Special TLD's are in folder in my drawer.

8-11-69: Page 134 – Issued [Name] and [Name] TLD badges.

8-12-69: Page 135 – Issued special badges as per [Name] request.

8-15-69: Page 138 – [Name] sent to body counter. Bkg.

8-18-69: Page 139 – [Name] [Badge Number] sent to body count – 0730 – He was in the tunnel without resp on 8-17-69.

8-21-69: Page 142 – Issued [Name] and [Name] TLD badges.

8-26-69: Page 145 – Body count scheduled for [Name] [Badge Number]. He became contaminated while working on Line 4. To be counted at 0700.

8-27-69: Page 146 – Issued TLD badges to [Name] and [Name] (3 day exposure)

8-27-69: Page 147: Issued special badges to [Name] [Badge Number] and [Name] [Badge Number] working on Line 17.

9-2-69: Page 150 – [Name] [Badge Number] sent to body counter. Bkg.

RFP Logbook 8-13-69 to 8-28-69 (RFP 1969b)

8-14-69 (Midnight): Page 3 – [Name] hit his elbow on a can in the vault room when coming down a ladder. The skin was busted and [Name] went to Medical at 7:30 a.m.

8-14-69 (Midnight): Page 3 – [Name] noticed a small nick on his right thumb when he was being monitored out this a.m. He does not know when or how he did it. He was sent to Medical also….[Name] has a scab on his right knee and Medical asked to see him yesterday.

8-20-69: Page 12 – [Name] received small puncture on back of left hand. No contamination, medical applied bandage, cause was a small piece of wire.

8-20-69: Page 14 – [Name] to medical twice, cut finger both times.

8-23-69: Page 18 – [Name] to Medical – cut both knees – cold.

8-24-69: Page 19 – [Name] went to Medical – hit right thumb with screwdriver.
Medical cleaned and applied bandage. [Name] got the top of left thumb between crowbar and pot which he was removing in 154A. It broke the skin just under the nail causing bleeding. Medical cleaned and applied bandage.

Hammond Logbook 9/19/65–5/14/69 (Hammond 1965)

10/8/68: Page 137 – Pu (oxide) confirmed inhalation – several personnel, North Foundry, 776 [Name] [Badge Number] showed positive lung exposure; blood and urine taken.

5/12/69: Page 144 – Entry for 776 fire: "40 people through body counter at this time (1000hrs); 1 fecal request, only 40 urine buckets.

5/13/69: Page 145 – [Name] blood sample of 5/12 contained 3.08 dpm/22 ml; fecal sample also taken

RFP Logbook (4/3/68–9/15/71) (RFP 1968c)

April 7, 1970, page 47 –

Neutron dosimeters for SNAP – NASA

March 23, 1971, Page 58 –

PuFl and PuBe neutron reading problems
High exposure 771 – same old thing

776 Building Logbook [May 26 1969 June 16 1969] (RFP 1969c)

Page 65: 6-2-69 [Name] cut his thumb – was not contaminated – sent to Medical. He is OK.

RFP Logbook 6/16/69–8/28/69
Special Decontamination Crew Summer 1969 Fire (RFP 1969d)

6/17/69: Page 1 – [Name] [Badge Number], small laceration on left thumb between thumbnail and first knuckle. Take to medical at 2:55 M. HP test positive .005, cleaned to .003. No further medical required other than bandage. HP request urine sample. Object causing cut unknown.

6/21/69: Page 12 – [Name] [Badge Number] received small laceration on inside of right wrist. Left for medical at 2:15. Treated by medical and returned about 3:30 am. (urine sample requested).

7/69: Page 91 – For a period from 4/69 to 7/18/69 there were a total of 99 trips to medical as a result of wounds or contamination. Some individuals had multiple trips during this period. [not verbatim]

7/27/69: Page 110 – [Name] was sent to medical with a small scratch on the forefinger of his right hand it checked out OK.

7/27/69: Page 110 – [Name] went to medical at 5:45 AM with puncture wound in left index finger. The cause was a ceiling nail.

8/1/69: Page 122 – [Name] and [Name] to medical. Both contaminated.

RFP Logbook 9/4/69 – 3/3/70 (Foreman's HP Log Bldg 771) (RFP 1969e)

Page 5: 9-10-69 – [Name] sprayed with acid at Line 12 – Sent to Medical and body count requested.

Page 8: 9-15-69 – [Name] [Badge Number] and [Name] [Badge Number] were sent to body count by request of [Name], due to contam area at Line 17 that occurred last Friday PM's after window charge – Reminded [Name] that we have a PM man at Body Counter and he could pay for O.T. rather than wait three days after incident.

Page 13: 9-22-69 – [Name], [Name], and [Name] scheduled for body count, due to incident on Sat. nite. [Name] reported that all three men were Bkgd.

Page 14: 9-23-69 – [Name] called and said that [Name] would like to request urine samples for [Name] [Badge Number], [Name] [Badge Number] and [Name] [Badge Number] due to incident that occurred on Sat. nite 9-20-69.

Page 18: 9-26-69 –

Body Count for [Name] [Badge Number] Possible inhalation Line #11 – [Name].
[Name] [Badge Number] scheduled for Body Count – Line 13 Incident
[Name] [Badge Number] scheduled for Body Count – Line 13 Incident

Page 19: 9-27-69 – Gamma spec in 776 Bldg is not working properly. If gamma spec is needed use the one in Medical. Techs and [Name] notified.

Page 23: 10-2-69 – Body count scheduled for [Name] [Badge Number] and [Name] [Badge Number], because of incident at 500 tanks sight gage on 10-1-69.

Page 47: 10-30-69 – [Name] [Badge Number] to Medical for gamma spec. – Body Count & decontamination from incident at Line 5.

Page 69: 11-25-69 – [Name] called about [Name] pen. exposure for October checked it out and he was actually on several jobs in hot area. Will special his November badge for immediate results.

Sent [Name], [Name], and [Name] to the body counter because at a steam trap leak.

11-26-69: Page 70 – Informed [Name] to keep [Name] off of any hot jobs (penetrating) due to his high exposure during October (restrict until first of the year).

11-26-69: Page 70 – [Name] & [Name] scheduled for body count due to incident at Line 2 at 1030 on 11-25-69.

11-26-69: Page 70 – [Name] wants smear samples for body counts on [Name] (Steam Line Leak) and [Name] (Line 2).

12-10-69: Page 80 – [Name] [Badge Number] and [Name] [Badge Number] work about 30 mm in close contact with the pneumatic blower filter surface court on the filter. 383 mrem/hr neutron & 290 mrem/hr gamma. 3 ft readings 60 mrem/hr and 11 mr/hr gamma. Body count requested on both men because their faces became contaminated while removing S.A. hood.

12-12-69: Page 82 – [Name] [Badge Number] sent to medical for decontamination. Final count 1.5–2K on left forearm still remaining.

1-24-70: Page 116 – [Name] to body count at 1720 has relative sample in foreman's tray. [Name] to body count at 1950. Sample also in tray. [Name] to Medical at 1800 for decontamination.

2-17-70: Page 136 – [Name] sent to body counter, possible inhalation exposure from bag failure Line 44.

2-19-70: Page 138 – New special badge rack: these badges should only be issued by the foreman or by the monitors specifically asked to do so. They can be used for replacement badges on special studies. Lost badge replacement badges issued only at the request of the man's supervisor. (Paper work similar to lost security badge reports will be coming from [Name]). A returned (borrowed) badge should be hung backwards, and used only once. Special study badges will be picked up daily, at our request the whole rack will be replaced monthly. One of the BKG badges should go with each return to 123. Use log sheet provided, including only TLD number and the man number.

3-2-70: Page 147 –

Gamma spec. [Name] [Badge Number]
Gamma spec. (Recheck) [Name] [Badge Number] recommended he see Dr. [Name] regarding wound.
[Name] [Badge Number] sent to body counter. Possible count results (Border line). Recount tomorrow.

RFP Logbook_Sept _11_1969_Dec_26_1969 (RFP 1969f)

Page 1: 9-11-69 Asked that new people be provided film badges when they report to the job.

Kittinger's Log Book No. IV (Kittinger 1969)
1/2/69 – 3/28/72

1/8/69: Page 2 – Met w [Name], discussed lack of badge change for contractor personnel – many as old as Mar 68 issue. [Name] to correct this and place all workers in 76-77 on mo. change. Also discussed lack of credibility for neutron dose data. This seems to me to be much poorer data in the past 3 months even than before. [Name] will ask [Name] to again examine calibration and do comparative studies with Texas Nuclear. [Name] feels we need to abandon film and assign dose.

1/24/69: Page 7 – [Name] talked to [Name] about his 1139 mrem exposure in 1st 2-week period. [Name] claims no unusual work situations – was on fluorinator operations majority of the period. [Name] worked with him on this assignment.

1/29/69: Page 8 – [Name] reported urine sample from [Name] S & W man [Badge Number] was 3.8 dpm/24 hr. [Name] informed [Name] foreman that he should submit a re-sample because it appeared the lab had contaminated his sample. [Name] had suggested to [Name] that he submit the original sample not because [Name] had come to him concerned that he was receiving no sampling.

1/29/69: Page 9 – Discussed status of neutron dosimetry w [Name]. He reports from instrumentation meeting he just attended that other contractor having same problem – disparity between survey instr. readings & NTA film. They have no plans to solve this problem. [Name] also reported other installations using wrist badges only on very limited special issue basis. [Name] indicated Brookhaven (I think) feels some promise in neutron eval. from TLDs either enriched or depleted in 6Li.

3/5/69: Page 22 – Called [Name] about [Name] Jan. film badge result 580 mrem.

3/5/69: Page 22 – Rec'd 2 wk film badge results for 771 – 2 da late because 1 pers. meters tech. missing. – Called [Name] and gave him names and totals for all > 300 mrem. ~ 30 people.

3/6/69: Page 22 – Met w [Name] – requested shielding be installed for unit storage in Rm 217 of 779. Showed him copy of shielding recommended to [Name] in Sept. 68, copy of current survey, and dose sustained by [Name] at his desk (639 mrem) because of this unshielded storage. [Name] agreed to investigate shielding possibilities. I plan to follow up w letter & copy of most recent survey.

3/6/69: Page 22 – Asked [Name] to read [Name] Feb. badge as soon as possible. Got special badge for [Name]'s bank.

3/7/69: Page 23 – Rec'd Feb film results for [Name], 1170 mrem, 639 for [Name] gives total of 1809 mrem. Called [Name] Asking for help on getting shielding. Wrote letter to [Name] Asking for removal of units or shielding.

3/10/69: Page 23 – Rec'd 771 film badge results today – 1 wk late. Wrote letter to [Name]. 25 people above pro-rated.

4/3/69: Page 30 – High gamma ct from 2 dreams in 774 produced high pers. expos during last film badge period 3/13–3/27.

	Neutron	Gamma	Total
[Name]	20	435	455
[Name]	20	376	396
[Name]	24	531	555
[Name]	54	526	550

4/10/69: Page 32 – Met w [Name] to discuss my concern over inc. in positive urine results. For 5-mo period 43% of all samples run for Pu are positive. [Name] knows that a significant cross contam. problem exists in the lab and expects this to be corrected when new lab facility are occupied. He does not feel the impact of the sample contam. will be great since anomalous results are excluded from computer tape and since this situation should be corrected shortly. He promised to carefully examine the exposure history of any personnel before work restrictions are imposed.

4/11/69: Page 32 – 771 Incident at reduction line 149 last night (PM). Reduction reactor blew up and several gloves burned off the box. Eight indiv. were body counted. [Name], [Name], [Name], [Name], [Name], [Name], [Name], and [Name]. [Name] & [Name] showed positive counts about equal to last counts (1964 for [Name] and Jan 69 for [Name]). [Name] and [Name] were positive and possibly above perm lung burden. The 4 positives are to be recounted tonite and Mon. nite. All 8 were given cartons for fecal samples today. Am conc. judged to be 180 ppm.

4/18/69: Page 34 – Conferred w [Name] and he will act to delete 715 mrad pen and 719 mrem skin for [Name] [Badge Number]. This was recorded for a Sept. badge left on a smock and left hanging in the area until turning in in April.

4/24/69: Page 36 – [Name] counted again today – count level about same. Low ppm Am-241 on samples leaves question about whether positive lung count due to prior exposure. Relayed qualitative information of this nature to [Name]. Asked them to hold him out of the area until better definition is given – probably early next week.

6/24/69: Page 49 – Body counted from 779 incidents. [Name], [Name] [Badge Number], [Name] [Badge Number], [Name] [Badge Number], [Name] [Badge Number], [Name] [Badge Number].

7/1/69: Page 51 – [Name] reports sign. lung count for [Name] [Badge Number] – and [Name] [Badge Number] gut or liver. Told [Name] about these [Name] said he talked to [Name] about 774 conditions.

7/28/69: Page 58 – Informed [Name] of high June exposures to [Name] (707 mrem, 687 gamma) & [Name] (1142 mrem all gamma).

7/31/69: Page 60: Fire in 771 on last nite's PM shift – ~ 11 PM can of oxide from 776 got hot enough to ignite plastic and tape outside of can. Contam. was spread to ~11,000 ft2 of 771 plus the tunnel. A number of people from both PM and Mid shifts were sent to body counter (about 20).

8/14/69: Page 63 – [Name] [Badge Number] of S & W called relative to film badge issue. No…found men coming to 771 w '68 badges. Informed [Name] that neutron film not necessary, but concerned about old badges – called [Name] about this.

8/27/69: Page 67 – High levels of penetrating radiation from boxes in 777 west of dry room brought to attention of [Name] on B-26 & [Name] & [Name] today – Max reading at 1 foot is 80 mrem/hr. [Name] sent team in to inspect & re-distribute parts – plan to sent many to 771 as soon as possible – probably not before next Tuesday. Pulled 6 badges for special evaluation of doses. This matter brought up at [Name] meeting.

10/6/69: Page 74 – Called [Name] to see if he was aware of high doses to his people last 2 wk period. He felt this due to heavy work load & extended work week. Sent summary letter to [Name].

10/17/69: Page 75 – Notified [Name] about high exposure to [Name] – [Name] thinks due to film badge left at desk. Data does not support.

10/28/69: Page 77 – Discussed [Name] lung count w [Name] – asked him to get further study on this case. Suggested he be restricted if count is close to MPLB considering the assumptions made.

10/28/69: Page 77 – Notified [Name] that [Name] probably has at least 50% MPLB. Also told him we are not satisfied with venting of units in shed. [Name] to check on.

12/22/69: Page 87 – [Name] was exposed to an open port on X-ray diffraction unit in Rm 234, 779 Bldg. Film badge was pulled & showed very little exposure. Unit belongs to [Name]. I talked to [Name] – they have taped all of the unused ports shut for want of a long term solution.

3/24/70: Page 104 – In 776 – met w [Name], [Name], [Name], [Name], [Name] to discuss pen. rad exposure levels – largely resulting from improper spacing and line loading. All present agreed to correct problem. I indicated the other alternatives that would be used if problem isn't corrected.

(1) Shielding will be recalculated and installed.
(2) Areas above 2.5 mrem will be roped off and signs posted showing stay times per day.

4/20/70: Page 107 – Contam incident 777 from maint. operation – compressed air blown into plugged line outside glove box released contam. About 12,000 ft2 contam. to 25,000 cpm. Seven men sent to body counter. All negative.

6/10/70: Page 114 – Also notified [Name] of > 1343 mrem dose to [Name] [Badge Number] for same period. [Name] also to rotate him out.

6/24/70: Page 116 – Informed [Name], [Name], and [Name] of high hand exposures for April to 4 Assembly workers. 25 + Rem exposure to [Name], [Name], [Name], and [Name] were others. [Name] informed by [Name]. [Name] agreed to rotate out [Name] and [Name].

	April (Mar 15 to Apr 20)	Jan thru Mar	May–June
[Name]	25.724 Rem	7,505	1000
[Name]	17,794	1,172	
[Name]	8.004	1,799	
[Name]	8.964	2,455	

3/2/71: Page 139 – [Name] concerned about possible > MPLB exposure to [Name] on 2-23. Confirmed exposure probably occurred to low ppm Am mt'l – fresh oxide – however his wearing respire and low pers contam. levels do not confirm a high air contam. situation.

3/72: Page 146 – Dosimetry has changed hand-to-wrist ratio to 1.5 to 1 for all 771 operations except 241Am work where it will stay 2.5 to 1. Neutron wrist dosimetry now in effect at 771.

Hand-to-wrist ratio studies are underway again in 776 & 707. Ratio at present is 5 to 1.

RFP Logbook 1-26-70 to 10-26-70 (Foreman Log) (RFP 1970a)

Page 80: 5-13-70 Gamma spec on [Name] [Badge Number] – Bkg.

Page 81: 5-14-70 Gamma spec on [Name] [Badge Number] – Bkg.

Page 93: 5-27-70 Gamma spec. [Name] right hand Bkg.

Page 130: 9-24-70 Gamma spec on [Name] [Badge Number].

RFP Logbook 9-2-70 to 12-24-71 (Foreman's Log) (RFP 1970b)

Page 3: 9-22-70 [Name] sent to Medical for decontamination and a body count. Body count Bkg.

Page 7: 9-28-70 [Name] [Badge Number] Medical restricted him from contaminated areas. Sent him home 6 hours sick leave.

Page 9: 9-30-70 PM – left word that a number of gloves had holes on the south side of Line 41. We found contamination on the sides of the box 50K, on a spot check, the paint in the area had been stripped. In order to decontaminate this area, I feel we should have the floor painted and covered to avoid contaminating the bare concrete floor.

While making bad cuts on the north end of Line 3, acid ran out at the end of the bad causing an acid burn to [Name] forearm as well as contaminating the floor area. This happened at 0500. [Name] was rinsed off but was not taken to Medical until 0600 due the fact that we did not have a nurse on duty until 0600.

Page 11: 10-2-70 1930 hours acid leak tracking contaminated all over the floor in Rm. 114. [Name] [Badge Number] received an acid burn on his right shoulder and left leg. Gamma spec. Bkg. Body Count Bkg. [Name] [Badge Number] had acid has been bagged and should be watched until it is repaired.

Page 19: 10-10-70 Entire shift spend in decon at mist tank area behind Lines 13 & 14, on H-6 vacuum system – (4) people sent to Medical this shift for future decon – (2) came back bandaged from excessive decontamination.

Page 23: 10-13-70 Incident Line #2 at approximately 2000 hours.

Routine production was being performed on Line #2 when a fire broke out in #3 pot followed by two minor explosions. The explosion caused the box to pressurize and cause contamination to be released into the area from the crit drains. This area was not on respirators at time of occurrence. All personnel involved were scheduled for body count with all results being negative. See accident and incident reports.

Page 25: 10-15-70 MID GFNO At approximately 2140 hours, CAM at 2 and #3 were activated. Monitors responded immediately and located a ruptured steam valve coming off of a condensate trap – Respirators were put on as soon as CAM activated. Overhead from Line 3 west over Line 1 to West wall running from 5,000 c/m to 20,000 c/m – North from Line 3 into 114 storage area 2,000 c/m to 5,000 c/m of lateral surfaces and floor – South of Line 3 for approximately 20 feet overhead 10,000 c/m; floor 5,000 c/m to 15,000 c/m – East of Line 3, along the front of Line 4 -2,000 c/m – this was mostly tracking. In immediate area for about 100 square feet 100,000 c/m on floor and side of dry box. Only three operators were in the vicinity at the time incident occurred. Arrangements made to get them body counts. [Name] [Badge Number] – [Name] [Badge Number] and [Name] [Badge Number])….(Daytime) Most of day was spent deconing around Line #3. Area is all cold except in back of Line #3. Approximately 400 sq ft of floor cocooned. The rest of the floor in back is 30K (PM) [Name[to medical for gamma spec. Results 0.002 ug.

Page 29: 10-19-70 Some combustible material inside Line 37 caught fire causing one of the day box gloves to melt releasing small amount of contamination. [Name] was operating at the time. Fire was extinguished by [Name] and [Name] and glove changed. [Name] will be scheduled for body count 0730 10-19-70.

Page 33: 10-21-70 Sent [Name] to Medical for gamma spec – puncture right knee.

Page 35: 10-23-70 Sent [Name] (Painter) to Medical for gamma spec. – several old cuts on finger tip.

Page 41: 10-29-70 [Name] [Badge Number] sent to body counter.

Page 51: 11-8-70 Gamma spec for [Name] [Badge Number] First thing results Bkg. ([Name] – write up the accident sheet on this.)

Page 94: 12-19-70 Special badges used by people on Line 17 bagouts.

Page 101: 12-27-70 Gamma spec for [Name] [Badge Number] at 0530.

Page 118: 1-14-71 [Name] [Badge Number] went to Medical for gamma spec.
[Name] [Badge Number] to Medical for body count 2330 hours – possible exposure

Page 120: 1-15-71 Talked to all M.D. operations in the cafeteria on the proper procedure to wear the new TLD film badges.

Page 150: 2-13-71 Gamma spec on [Name] – Bkg.

RFP Logbook 2/15/71 to 7/23/71 (Kittinger 1971)

Page 2: 2-16-71 Took [Name] to medical for decon and gamma spec. on top of his head. Had an incident on line #2 – air lock operation.

Page 11: 2-4-71 [Name] – B-36 <1000% RCG.2000 c/m.

Page 12: 2-25-71 [Name] B-36 141 Nash pump vault 1175% RCG 3000 c/m.

Page 12: 2-26-71 Deconed on line 20.

Page 13: 2-26-71 [Name] 141 Mash pump vault 8000% RCG 20,000 c/m.

Page 18: 3-3-71 B36 Nash pump vault 2800% RCG 7000 c/m

B36 141 Nash Pump Vault 3100% RCG 4000 c/m.

Page 27: 3-13-71 Called [Name] out to body count [Name]. Contaminated while pulling a piece of tape off a pipe in the overhead at tank 218.

RFP Log July 24, 1971 to Jan 9 1972 (RFP 1971)

Page 105: 11/5/71 - Fire – Line 20 – Button Break out @ 1300. Handled by [Name], [Name] and [Name]. [Name] and [Name] to body counter. Platform and front of bay contaminated to 100 c/s. Heads OK.

RFP Log May 29 1972 to October 15, 1972 (Right side of logbook water damaged and faded – not readable) (RFP 1972a)

Page 15: 6-13-72 Do not send any PI a.m. samples to body count. Next week we will work out a safe handling and packaging procedure with [Name] – [Name].

RFP Logbook 10/16/72 to 3/25/73 (RFP 1972b)

1-27-72: Page 49 – Window change Line 10 – [Name] [Badge Number], and [Name] [Badge Number] body counted. Not wearing respirators because signs had been removed on Lines 15 & 16.

RFP Logbook 3/20/74 – 9/23/74 (RFP 1974)

Page 80: 6/8/1974 – Incident @ Line 3. Many gloves contaminated. Find out who worked Mids sat at Line 3 and body count them if they were contaminated Sat night.

Page 73: 6-17-74 – Liquid spill in line 1. Very high gamma readings. People cleaning will receive very high hand exposures.

Contamination Control Logbook_1982_1985 (RFP 1982)

2/21/82: Page 10 – Did have trouble in OY Leach – [Name] took care of it. Possible inhalation on [Name]. Called shift super and got a Body count for him approx. 0145.

Falk Logbooks (Falk 1967, Falk 1969)

Two Falk logbooks: Almost exclusively his personal calibration and neutron spectral measurements. However, some interesting historical takes on n/p measurements in specific facilities. He also mentions U-237 as a key constituent.

Individual specific data was not found in the following logbooks.

RFP Logbook Jan 10, 1972 to May 29, 1972 (Foreman Log)
RFP Logbook Apr 1987 to Sep 1987. Contamination Control Report Sheets
Rad Exposure Letter Log
Release History Unk 1956_72

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RFP 1957, *Log Book Bldg 771 Fire 1957*, Rocky Flats Plant, Dow Chemical Company, Golden, Colorado.

RFP 1962, *RFP Logbook 1962 Logbook Special Samples*, Rocky Flats Plant, Dow Chemical Company, Golden, Colorado, Bar Code No. 8419780.

RFP 1963, *RFP Logbook 8/1/63–3/18/68,* Rocky Flats Plant, Dow Chemical Company, Golden, Colorado.

RFP 1964a, *RFP Logbook 3/3/64 – 9/4/64*, Rocky Flats Plant, Dow Chemical Company, Golden, Colorado.

RFP 1964b, *RFP Logbook 9/8/64-3/26/65***,** Rocky Flats Plant, Dow Chemical Company, Golden, Colorado.

RFP 1965a, *Logbook 3/26/65-10/18/65,* Rocky Flats Plant, Dow Chemical Company, Golden, Colorado.

RFP 1965b, *RFP Logbook 10/19/65-5/9/66,* Rocky Flats Plant, Dow Chemical Company, Golden, Colorado.

RFP 1966a, *RFP Logbook 5/10/66-12/3/66*, Rocky Flats Plant, Dow Chemical Company, Golden, Colorado.

RFP 1966b, *Logbook 12/5/66-6/11/67*, Rocky Flats Plant, Dow Chemical Company, Golden, Colorado.

RFP 1967, *RFP Logbook 6/12/67-12/29/67*, Rocky Flats Plant, Dow Chemical Company, Golden, Colorado.

RFP 1968a, *RFP Logbook 1/2/68 – 7/5/68*, Rocky Flats Plant, Dow Chemical Company, Golden, Colorado.

RFP 1968b, *RFP Logbook 7/8/68 - 2/4/69,* Rocky Flats Plant, Dow Chemical Company, Golden, Colorado.

RFP 1968c, *RFP Logbook 4/3/68–9/15/71,* Rocky Flats Plant, Dow Chemical Company, Golden, Colorado.

RFP 1969a, *HP Log 2/5/69–9/3/69*, Rocky Flats Plant, Dow Chemical Company, Golden, Colorado.

RFP 1969b, *776 Students, Volume 2*, RFP Logbook 8-13-69 to 8-28-69, Rocky Flats Plant, Dow Chemical Company, Golden, Colorado.

RFP 1969c, *776 Building Logbook May 26 1969 to June 16 1969,* Rocky Flats Plant, Dow Chemical Company, Golden, Colorado.

RFP 1969d, *Special Decontamination Crew Logbook Summer 1969 Vol 1 and 2, 6/16/69–8/28/69,* Rocky Flats Plant, Dow Chemical Company, Golden, Colorado.

RFP 1969e, *Foreman's HP Log Bldg 771 9/4/69 to 3/3/70*, Rocky Flats Plant, Dow Chemical Company, Golden, Colorado.

RFP 1969f, *Decontamination 9/11/69 to 12/26/69 Logbook 776*, Rocky Flats Plant, Dow Chemical Company, Golden, Colorado.

RFP 1970a, *Foreman's Log 1/26/70 thru 10/26/70*, Rocky Flats Plant, Dow Chemical Company, Golden, Colorado.

RFP 1970b, *RFP Logbook 9-2-70 to 12-24-71 (Foreman's Log),* Rocky Flats Plant, Dow Chemical Company, Golden, Colorado.

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RFP 1972b, *Foreman's Log 10/16/72 to 3/25/73,* Rocky Flats Plant, Dow Chemical Company, Golden, Colorado.

RFP 1974, *Foreman Logbook 3/20/74 – 9/23/74***,** Rocky Flats Plant, Dow Chemical Company, Golden, Colorado.

RFP 1982, *Contamination Control Log,* Rocky Flats Plant, Rockwell International, Golden, Colorado, 1982–1985.

ATTACHMENT 15: LOGBOOK REFERENCES TO OTHER RADIONUCLIDES

Logbook 10/1/57–8/26/60 (Kittinger 1957)

12-10-57: Page 9 – At 3:45 [Name] called to report an inadvertent Co60 exposure to [Name] in Bldg. 81 Radiography. He explained that the source had not been rotated completely under the shielding and [Name] had not followed instruction in use of the cutie pie. [Name] brought the film badge in for evaluation.

11-3-58: Page 51 – [Name] conferred with me about high air count trend in 233. He agreed to a special sampling program for this room.

10-21-59: Page 106 – Ir-192 source received by radiography – checked outside of container.

1-21-60: Page 118 – [Name] and I met with [Name] and [Name] at their request to discuss problems that might be associated with Th processing. Advised them bare processing possible with care given to mesothorium …. + exposures.

6-1-60: Page 139 – Bldg. 83 made hot breakdown on steel clad Th ingots in the afternoon. Cans broke on both ingots. Special air samples and smears were taken. [Name] reported no Th on smears from 1st can that broke on a qual analysis.

RFP Logbook 6/20/63 thru 10/27/67 (Kittinger and Vogel 1963)

4-3-64: Page 11 – Survey fm 44 showed some Co60 contam – highest was 5500 dpm β from a cap used for pneumatic tube – 2 pigs and tubes also showed positive Co60

4-20-64: Page 11 – Conveyed to [Name] a request by [Name] that a permanent H3 sniffer be installed in 54 Bldg.

9-4-64: Page 20 – U233 Project postponed for 6 months.

3-24-65: Page 37 – Pit – No steamer – too cold (0 degrees) today. Thorium ingot in 83 Bldg. 80d/m, 75K direct.

4-27-65: Page 41 – Pit working on misc. Pu241 MPC Air 0.3 d/m/24hr RCG

4-28-65: Page 41 – Special project going well – first metal made early this AM

7-2-65: Page 50 – U233 Rc'd, unpacked, vented, repacked and shipped

8-23-65: Page 56 – U233 project started – thorium strike experiment in 86 started – handling procedures U.

9-17-65: Page 60 – Okayed 19, Np237 sample to 41 with HP surveillance and follow up.

10-12-65: Page 63 – [Name] Am project started – ADK

12-28-65: Page 71 – Started [Name] Pu project in 130….Talked to [Name] on 5mg Np237 sample to 41 – he will bring written request over – for our approval.

1-10-66: Page 72 – Np project – No HP problems.

2-2-66: Page 76 – Rc'd proposal from [Name] on Am and Pu in 142.

2-11-66: Page 77 – Okayed [Name] Np project in 228

2-14-66: Page 78 – [Name] brought 5 gm Np into Bldg for project

2-15-66: Page 78 – Np project – slightly messy – no big problems

3-2-66: Page 80 – Checked in the 98 tunnel for summers – recommend lock on 50 curie RaBe source.

3-7-66: Page 80 – [Name] started Np237 project in 44…

3-21-66: Page 83 – Talked to [Name] on Np foil job in 81, 265.

3-28-66: Page 84 – [Name] to start Np rerun (1200 ppm Pu-238). [Name] down to talk about Np project – 265.

5-2-66: Page 90 – [Name] project (Am) started.

5-3-66: Page 90 – Okayed [Name] Np fluoridation in G-12.

5-18-66: Page 92 – Cm project started in 71.

1-13-67: Page 120 – Thorium strike on 233 completed today.

5-3-67: Page 131 – Np project started – 81.

5-5-67: Page 131 – Slight Np spill in 264.

RFP Logbook 8/1/63–3/18/68 (RFP 1963)

8/27/63: Page 5 –

Microprojector reading more track 1.7 to 1
Identifying film by Am not successful
Gamm counting by direction.

Stan – Pu-238 source problem

11/14/63: Page 13 – [Name] – Fabrication of U-233

Logbook 3/26/65 – 10/18/65 (RFP 1965)

Page 8: 4-5-65 – U-233 mock run 201-630 DJC 900326-12 Charge 6.7 hr

Page 9: 4-5-65 – Charge for U-233 mock run 201-630 DJC 900326-12 6.7 hr today for [Name].

Page 33: 5-10-65 – U233 spill from PVC line (again) rm 114

RFP Logbook 12/5/66–6/11/67 (RFP 1966)

3/6/67: Page 66 – Checked on film badge results for [Name] and [Name]. Reference future work with Cm in January.

Logbook 12/12/66–12/31/68 (Kittinger 1966)

1-31-67: Page 11 – Worked with [Name] on specs. for special permission on radioactive mtl shipments. He agreed to exclude Am and Np from table showing criticality limits – to make separate table asking for quantity agreement only.

Logbook 2/5/69–9/3/69 (RFP 1969)

6-17-69: Page 95 – TLDs being used on special Am job in Room 180F.

RFP Logbook (4/3/68–9/15/71) (RFP 1968)

Sept 11, 1968, page 11:

Pu isotopic content
238Pu in 79 Building

October 30, 1968, page 17 – 236Pu running out.

April 9, 1969, page 31 – Am in waste barrels

April 7, 1970, page 47 –

Neutron dosimeters for SNAP – NASA
Am243 from NCAR

April 28, 1970: Page 49 – Americium release

RFP Logbook 9-2-70 to 12-24-71 (Foreman's Log) (RFP 1970)

Page 1: 9-22-70 – Checked tritium detector in Bldg. 54. Detector indicated an alarm condition. We had problems with the detector over the weekend also. It seems there is a short in the electrical.

Page 126: 1-21-71 – Special experiment involving a high neutron source of californium-252 in Rm. 174B, contractors are working in this area and in the area of neutron radiation that is roped off. This beam penetrates the device at the rate of 3815/rem [number not clear] neutron and 2 mr/hr gamma. All of this beam is roped off. [Name] of Delv contractors coordinator OK'd this arrangement.

RFP Logbook 2/15/71 to 7/23/71 (RFP 1971)

Page 29: 3-15-71 – There is not a tritium detector in 54 Building. Only empty tritium cylinders are stored there. [Name] does not want to set up the portable sniffer there because it is the only one we have. Security is going to discontinue clock counts in 54 Building until we get the detector back in service. Security will call HP if they do need to be in the building asking us to cover with the portable sniffer.

Contamination Control Logbook_1982_1985 (5/28/81–7/8/85) (Passmore 1982)

2-5-82: Page 16 – It was decided to discontinue the search for the thorium source that were inadvertently put into the landfill dump. 77 sources out of 300 were recovered.

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ATTACHMENT 16: DETAILED LOGBOOK ANALYSIS SUMMARY TABLES[4]

Table 16-1: Detailed External Dosimetry Logbook Comparison for Individuals with Hard Copy NDRP Information

ID	Date	Original Category	Cycle Date	Logbook Dose	NDRP Data Result	NDRP vs. Logbook	Hard Copy Result	Hard Copy vs. Logbook
2	4/11/1967	Total	1/1–12/31	2,906	2,910	C	2,906	E
4	6/18/1968	Neutron		500	All 1968 neutron doses < 30 mrem	N	92	N
9	5/7/1968	Gamma	4/18–5/3	250	252	C	1,782	C
9	5/7/1968	Neutron	4/18–5/3	1,275	1,275	E	1,782	C
13	4/11/1967	Gamma	3/1–4/1	365	367	C	2,385	C
13	4/11/1967	Neutron	3/1–4/1	854	854	E	2,385	C
14	9/26/1967		7/1–9/1	>2 Rem	Confirmed exposure in excess of 2,000 mrem	C	3,396	C
15	3/19/1968		12/29/67–3/4/68	1,102	1,103	C	1,341	C
22	8/28/1967	Neutron	7/28–8/18	329	329	E	2,353	C
29	7/30/1968	Neutron	n/a	1,380	Original neutron exposure through 7/24/68 is zero	N	1,551	C
33	4/11/1967	Total	1/1–4/1	2,971	2,973	C	2,971	E

C – Consistent
N – Inconsistent
E – Exact Match
In – Inconclusive

[4] SC&A-assigned identification numbers are used in lieu of NIOSH or RFP identification numbers to protect the privacy of the individuals.

Table 16-2: Detailed External Dosimetry Logbook Comparison
(Coworker Stat Date Used)

ID	Date	Original Category	Cycle Date	Dose	Coworker Stat Data Result	Coworker Stat vs. Logbook	Hard Copy Result	Hard Copy vs. Logbook
1	12/15/1967	Extremity	1/1–12/31	19,265	n/a	C	22,125	C
3	6/4/1968	Total	5/17–28/1968	1,079	0	N	1,748	C
5	3/19/1968			1,019	2,589	C	1,261	C
6	6/4/1968		5/17–28/1968	828	n/a	In	1,439	C
7	4/11/1967	Total		2,949	7,495	C	2,999	C
10	6/4/1968		5/17–28/1968	768	3,659	C	1,612	C
11	4/11/1967	Total		2,039	7,682	C	3,160	C
16	4/11/1967	Total		2,591	4,687	C	2,591	E
17	3/1/1969	Total		406	5,421	C	808	C
17	4/11/1967	Total		868	3,830	C	2,971	C
18	6/4/1968	Neutron	5/17–28/1968	670	n/a	In	1,375	C
19	8/28/1967	Total		364	n/a	In	2,783	C
23	6/4/1968	Gamma	5/17–28/1968	670	4,897	C	2,335	C
24	12/23/1966		5/9–12/31	1,100	3,365	C	1,659	C
26	6/4/1968		5/17–28/1968	715	n/a	In	1,542	C
27	9/20/1968	Total		383	5,659	C	2,506	C
30	4/11/1967	Total	1/1–6/5	1,486	3,977	C	2,824	C
32	4/11/1967	Total		2,853	5,357	C	2,853	E
34	4/11/1967	Total		2,610	n/a	In	2,610	E
35	4/11/1967	Total		2,790	n/a	In	2,790	E

C – Consistent
N – Inconsistent
E – Exact Match
In – Inconclusive

Table 16-3: Detailed Bioassay Logbook Comparison

ID	Logbook Date	Category	Logbook[1]	HIS-20	HIS-20 vs. Logbook	Hard Copy	Hard Copy vs. Logbook
1	1/4/1971	Plutonium	0.17	0.17	E	0.17	E
2	1/4/1971	Plutonium	0.06	0.06	E	0.06	E
3	1/22/1970	Americium	Bkgd	0	C	Bkgd	E
3	11/3/1961	EP/U	13	13	E	13	E
3	8/17/1967	Plutonium	Bkgd	0	E	Bkgd	E
4	2/9/1965	Plutonium	Bkgd	0.14	C	0.14	C
4	4/11/1969	Plutonium	0.2	0.2	E	0.2	E
5	1/23/1967	Plutonium	0.32	0.31	C	0.32	E
5	1/23/1967	Americium	Bkgd	0.08	C	Bkgd	C
6	1/4/1960	Plutonium	Bkgd	0	C	Bkgd	E
6	1/5/1961	Electroplating	Bkgd	0	C	Bkgd	E
7	12/19/1967	Gross Alpha	Bkgd	0	C	Bkgd	E
8	1/13/1961	Fluorimetry	Bkgd	0	C	Bkgd	E
9	5/21/1959	Electroplating	136% MPL	120	C	120	C
9	5/27/1959	Electroplating	75% MPL	66	C	66	C
9	3/11/1960	Electroplating	192	192	E	192	E
10	11/9/1961	Electroplating	Bkgd	0	C	Bkgd	E
11	1/6/1961	Fluorimetry	Bkgd	0	C	Bkgd	E
12	1/16/1964	Plutonium	0.28	0.28	C	0.28	E
12	4/11/1969	Plutonium	0.99	0.99	E	0.99	E
12	1/28/1971	Plutonium	0.75	0.75	E	0.75	E
12	2/11/1965	Plutonium	Bkgd	n/a	In	Bkgd	E
12	4/3/1967	Plutonium	0.64	n/a	In	0.64	E
13	1/5/1961	GA	Lost	n/a	In	Lost	C
14	1/10/1963	Plutonium	0.42	n/a	In	0.42	E
15	1/5/1961	Electroplating	7	0	C	Bkgd	C
16	8/31/1960	Electroplating	29	29	E	29	E
17	1/10/1963	Plutonium	Bkgd	0	C	Bkgd	E
18	2/5/1960	Fluorimetry	Bkgd	n/a	In	Bkgd	E
19	2/20/1964	Plutonium	Bkgd	0	C	Bkgd	E
19	3/14/1969	Plutonium	Bkgd	0	C	Bkgd	E
20	8/31/1960	Electroplating	16	n/a	In	16	E
21	1/26/1961	Alpha	Bkgd	0	C	Bkgd	E
22	1/8/1960	Electroplating	72	72	E	72	E
22	11/9/1961	EP/U	24	n/a	In	24	E
23	3/10/1960	Uranium	108	108	E	108	E
23	1/5/1961	Electroplating	17	17	E	17	E
24	1/10/1963	Plutonium	Bkgd	0	C	Bkgd	E
24	1/6/1961	Electroplating	15	n/a	In	n/a	In
25	1/13/1960	Electroplating	8.8	8.8	E	8.8	E
26	1/6/1961	Electroplating	6	0	C	6	E
27	3/5/1970	Americium	Bkgd	n/a	In	Bkgd	E
28	1/20/1960	GA	Bkgd	0	C	Bkgd	E
29	1/10/1963	Plutonium	Bkgd	0.14	C	Bkgd	E

Table 16-3: Detailed Bioassay Logbook Comparison

ID	Logbook Date	Category	Logbook[1]	HIS-20	HIS-20 vs. Logbook	Hard Copy	Hard Copy vs. Logbook
30	6/18/1959		685% MPL	n/a	In	603	C
30	12/14/1959		262% MPL	n/a	In	230	C
30	12/24/1959		82% MPL	n/a	In	71	C
30	2/19/1960	Electroplating	102	n/a	In	102	E
30	3/14/1960	Electroplating	121	n/a	In	121	E
30	4/25/1960	Electroplating	15	n/a	In	15	E
31	2/10/1961	Alpha	Bkgd	0	C	Bkgd	E
32	1/5/1961	Electroplating	12	12	E	12	E
33	6/17/1957	Blood	0.8	n/a	In	n/a	In
34	1/10/1963	Plutonium	Bkgd	n/a	In	Bkgd	E
35	11/16/1962	Electroplating	Bkgd	0	C	Bkgd	E
35	11/15/1965	Americium	Bkgd	0	C	Bkgd	E
35	4/26/1965	Plutonium	Bkgd	0	C	n/a	In
36	8/26/1960	Electroplating	11	n/a	In	11	E
37	1/6/1961	Electroplating	9	9	E	9	E
38	1/12/1961	Fluorimetry	Bkgd	n/a	In	Bkgd	E
39	4/3/1967	Plutonium	0.44	n/a	In	0.44	E
40	1/4/1971	Plutonium	0.42	0.42	E	0.42	E
41	4/10/1964	Plutonium	Bkgd	n/a	In	Bkgd	E
42	2/8/1965	Americium	Bkgd	n/a	In	Bkgd	E
43	6/18/1969	Americium	Bkgd	n/a	In	Bkgd	E
44	1/6/1961	Electroplating	22	22	E	22	E
45	2/8/1961	Alpha	Bkgd	0	C	Bkgd	E
46	2/3/1960	GA	Bkgd	0	C	Bkgd	E
47	2/26/1960	Fluorimetry	Bkgd	0	C	Bkgd	E
48	1/8/1960	Gross Alpha	Bkgd	0	C	Bkgd	E
49	1/27/1961	Alpha	Bkgd	0	C	Bkgd	E
50	5/14/1959	Uranium	~70% MPL	60	C	60	C
51	1/6/1961	Electroplating	11	n/a	In	11	E
51	11/13/1961	EP/U	33	n/a	In	33	E
52	11/15/1965	Americium	Bkgd	n/a	In	Bkgd	E
52	9/27/1967	Gross Alpha	Bkgd	n/a	In	Bkgd	E
53	1/13/1960	Fluorimetry	Bkgd	0	C	Bkgd	E
54	1/13/1969	Plutonium	0.23	0.23	E	0.23	E
55	1/12/1960	Plutonium	Bkgd	n/a	In	Bkgd	E
56	2/6/1961	Alpha	Bkgd	0	C	Bkgd	E
57	2/15/1962	Plutonium	13	n/a	In	13	E
58	11/18/1959		206%MPL	182	C	182	C
58	1/10/1960	Electroplating	29	n/a	In	29	E
59	11/21/1962	Plutonium	Bkgd	n/a	In	Bkgd	E
60	1/22/1960	Fluorimetry	Bkgd	n/a	In	Bkgd	E
61	1/20/1967	Americium	Bkgd	0	C	Bkgd	E
61	1/16/1964	Plutonium	14.4	14.4	E	14.4	E
61	2/5/1965	Americium	1	1	E	1	E

Table 16-3: Detailed Bioassay Logbook Comparison

ID	Logbook Date	Category	Logbook[1]	HIS-20	HIS-20 vs. Logbook	Hard Copy	Hard Copy vs. Logbook
61	1/20/1967	Plutonium	5.39	5.39	E	5.39	E
61	1/16/1969	Plutonium	8	8	E	8	E
61	4/14/1969	Plutonium	8.7	8.7	E	8.7	E
62	11/16/1962	Plutonium	Bkgd	0	C	Bkgd	E
62	8/11/1969	Americium	Bkgd	0	C	Bkgd	E
62	1/14/1970	Plutonium	Bkgd	0	C	Bkgd	E
62	1/14/1970	Uranium	Bkgd	0	C	Bkgd	E
62	3/16/1964	Plutonium	Bkgd	n/a	In	Bkgd	E
63	1/7/1960	Plutonium	Bkgd	0	E	Bkgd	E
63	1/10/1963	Plutonium	0.39	n/a	In	0.39	E
64	1/27/1965	Plutonium	Bkgd	n/a	In	n/a	In
65	4/20/1960	Electroplating	124	n/a	In	124	E
66	1/6/1961	Alpha	0.08	0	C	Bkgd	C
67	12/6/1962	Electroplating	Bkgd	n/a	In	Bkgd	E
68	11/8/1961	EP/U	10	n/a	In	10	E
69	11/16/1961	EP/U	20	20	E	20	E
69	1/13/1960	Electroplating	Bkgd	n/a	In	Bkgd	E
70	1/19/1961	Alpha	Bkgd	n/a	In	n/a	In
71	2/24/1960	Fluorimetry	Bkgd	0	C	Bkgd	E
71	1/25/1961	Fluorimetry	Bkgd	0	C	Bkgd	E
72	1/11/1960	Electroplating	Bkgd	0	C	Bkgd	E
73	1/15/1960	Plutonium	Bkgd	n/a	In	Bkgd	E
74	1/22/1967	Americium	Bkgd	n/a	In	Bkgd	E
74	11/22/1965	Americium	Bkgd	0.11	C	Bkgd	E
75	1/16/1969	Plutonium	0.29	0.29	E	0.29	E
75	5/10/1971	Plutonium	0.12	n/a	In	0.12	E
76	1/22/1960	Fluorimetry	Bkgd	n/a	In	Bkgd	E
77	11/16/1962	Electroplating	Bkgd	0	C	Bkgd	E
77	3/27/1967	Electroplating	Bkgd	0	C	Bkgd	E
77	2/14/1969	Plutonium	Bkgd	0.07	C	Bkgd	E
77	10/10/1969	Electroplating	Bkgd	n/a	In	n/a	In
78	1/3/1966	Plutonium	Bkgd	0.13	C	0.13	C
78	1/3/1966	Americium	Bkgd	0	C	Bkgd	E
78	3/5/1970	Americium	Bkgd	0	C	Bkgd	E
78	11/25/1962	Plutonium	0.51	n/a	In	0.51	E
78	1/10/1963	Plutonium	0.49	n/a	In	0.49	E
78	1/15/1964	Plutonium	0.29	0.37	N	0.37	N
79	3/29/1971	Plutonium	0.29	n/a	In	0.29	E
80	5/10/1971	Plutonium	Bkgd	n/a	In	Bkgd	E
81	2/19/1961		Bkgd	n/a	In	Bkgd	E
82	10/3/1958	Uranium	203% MPL	n/a	In	179	C
82	11/21/1962	Electroplating	Bkgd	n/a	In	Bkgd	E
83	11/21/1962	Plutonium	Bkgd	n/a	In	Bkgd	E
84	1/7/1960	Electroplating	14	14	E	14	E

Table 16-3: Detailed Bioassay Logbook Comparison

ID	Logbook Date	Category	Logbook[1]	HIS-20	HIS-20 vs. Logbook	Hard Copy	Hard Copy vs. Logbook
84	1/11/1961	Electroplating	14	14	E	14	E
84	2/15/1962	Plutonium	Bkgd	n/a	In	Bkgd	E
85	2/10/1961	Fluorimetry	Bkgd	0	C	Bkgd	E
86	8/29/1960	Electroplating	11	n/a	In	11	E
87	1/8/1960	Gross Alpha	Bkgd	0	C	Bkgd	E
88	1/13/1960	Plutonium	Bkgd	n/a	In	Bkgd	E
89	11/21/1962	Plutonium	Bkgd	n/a	In	Bkgd	E
90	1/19/1961	Alpha	Bkgd	0	C	Bkgd	E
91	1/8/1960	Fluorimetry	Bkgd	n/a	In	Bkgd	E
91	1/12/1961	Fluorimetry	Bkgd	n/a	In	Bkgd	E
92	11/21/1962	Plutonium	Bkgd	n/a	In	Bkgd	E
93	1/26/1965	Plutonium	0.35	0.35	E	0.35	E
94	5/21/1965	Americium	Bkgd	n/a	In	n/a	In
95	1/17/1964	Plutonium	Bkgd	0	C	Bkgd	E
95	1/5/1967	Americium	0.44	0.44	E	0.44	E
95	1/28/1971	Plutonium	0.03	0.03	E	0.03	E
96	1/26/1961	Fluorimetry	Bkgd	0	C	Bkgd	E
97	11/21/1962	Plutonium	Bkgd	0	C	Bkgd	E
98	1/18/1960		99% MPL	n/a	In	87	C
99	2/10/1961	Fluorimetry	Bkgd	0	C	Bkgd	E
100	1/6/1960	Gross Alpha	Bkgd	0	C	Bkgd	E
101	1/6/1960	Electroplating	Bkgd	0	C	Bkgd	E
102	11/21/1962	Electroplating	Bkgd	0	C	Bkgd	E
102	8/17/1967	Plutonium	Bkgd	0	C	Bkgd	E
102	3/11/1970	Plutonium	Bkgd	0	C	Bkgd	E
102	1/14/1970	Plutonium	0.38	0.38	E	0.38	E
102	1/2/1964	Plutonium	Lost	n/a	In	Lost	E
102	1/3/1966	Plutonium	Bkgd	0.07	C	Bkgd	E
103	1/6/1960	Gross Alpha	Bkgd	0	C	Bkgd	E
104	1/14/1960	GA	Bkgd	0	C	Bkgd	E
105	3/21/1960	Electroplating	115	115	E	115	E
106	11/21/1962	Plutonium	Bkgd	n/a	In	Bkgd	E
107	1/20/1967	Americium	Bkgd	0	C	Bkgd	E
107	1/10/1963	Plutonium	0.98	0.98	E	0.98	E
107	7/21/1964	Plutonium	7.67	7.67	E	7.67	E
107	6/2/1967	Plutonium	1.43	1.43	E	n/a	In
107	1/29/1971	Plutonium	0.45	n/a	In	0.45	E
107	1/29/1971	Electroplating	Bkgd	n/a	In	Bkgd	E
108	1/7/1960	Plutonium	Bkgd	n/a	In	Bkgd	E
109	1/6/1960	Plutonium	Bkgd	n/a	In	Bkgd	E
110	2/3/1960	GA	Bkgd	0	C	Bkgd	E
111	12/23/1969	Americium	Bkgd	0	C	Bkgd	E
111	3/11/1970	Plutonium	0.2	0.2	E	0.2	E
111	4/3/1967	Plutonium	0.29	n/a	In	0.29	E

Table 16-3: Detailed Bioassay Logbook Comparison

ID	Logbook Date	Category	Logbook[1]	HIS-20	HIS-20 vs. Logbook	Hard Copy	Hard Copy vs. Logbook
112	11/25/1969	Americium	Bkgd	0	C	Bkgd	E
112	2/3/1970	Americium	Bkgd	0	C	Bkgd	E
113	1/5/1961	Fluorimetry	Bkgd	n/a	In	Bdgd	E
113	5/21/1965	Americium	Bkgd	n/a	In	Bkgd	E
114	2/25/1967	Electroplating	Bkgd	n/a	In	Bkgd	E
115	2/17/1970	Plutonium	Bkgd	0	C	Bkgd	E
115	3/13/1970	Plutonium	0.21	0.21	E	0.21	E
116	2/11/1960	Fluorimetry	Bkgd	n/a	In	Bkgd	E
117	5/11/1971	Plutonium	Bkgd	n/a	In	Bkgd	E
118	11/21/1962	Plutonium	Bkgd	0	C	Bkgd	E
119	12/27/1962	Electroplating	Bkgd	0	C	Bkgd	E
120	2/17/1965	Gross Alpha	Bkgd	0	C	Bkgd	E
121	1/16/1969	Plutonium	Bkgd	n/a	In	Bkgd	E
122	1/8/1960	Plutonium	Bkgd	0	C	Bkgd	E
123	1/15/1960	GA	Bkgd	n/a	In	Bkgd	E
124	4/20/1960	Electroplating	116	n/a	In	116	E
124	5/4/1960	Electroplating	11	n/a	In	11	E
124	9/2/1960	Electroplating	16	n/a	In	16	E
125	1/15/1960	Plutonium	Bkgd	n/a	In	Bkgd	E
126	11/17/1961	EP/U	Bkgd	n/a	In	Bkgd	E
127	8/29/1960	Electroplating	Bkgd	0	C	Bkgd	E
128	8/30/1971	Americium	4	4	C	4	E
128	8/24/1971	Plutonium	127	127.3	E	127	E
128	8/30/1971	Plutonium	86	n/a	In	86	E
129	1/10/1963	Plutonium	Bkgd	n/a	In	Bkgd	E
130	8/7/1959		212	n/a	In	212	E
130	8/26/1960	Electroplating	9	n/a	In	9	E
131	8/30/1960	Electroplating	32	32	E	32	E
131	10/6/1959		1300	n/a	In	1300	E
132	2/12/1960	Fluorimetry	Bkgd	0	C	Bkgd	E
133	6/1/1967	Electroplating	Bkgd	0	C	Bkgd	E
133	11/21/1967	Electroplating	Bkgd	0	C	Bkgd	E
134	2/3/1970	Americium	Bkgd	0	C	Bkgd	C
134	12/24/1962	Electroplating	Bkgd	0	C	Bkgd	E
134	1/20/1967	Americium	0.33	0.33	E	0.33	E
134	1/20/1967	Plutonium	Bkgd	n/a	In	Bkgd	E
135	1/21/1960	Plutonium	Bkgd	n/a	In	Bkgd	E
136	2/21/1964	Plutonium	0.37	0.47	N	0.47	N
137	8/26/1960	Electroplating	26	26	E	26	E
137	11/9/1961	Electroplating	21	21	E	21	E
138	2/3/1961	Fluorimetry	Bkgd	n/a	In	Bkgd	E
139	2/15/1962	Plutonium	29	n/a	In	29	C
139	1/13/1960	Electroplating	14	n/a	In	14	E
140	2/20/1964	Plutonium	Bkgd	n/a	In	0.23	N

Table 16-3: Detailed Bioassay Logbook Comparison

ID	Logbook Date	Category	Logbook[1]	HIS-20	HIS-20 vs. Logbook	Hard Copy	Hard Copy vs. Logbook
141	1/20/1967	Plutonium	Bkgd	0	C	Bkgd	E
141	3/11/1970	Plutonium	0.29	0.29	E	0.29	E
141	11/21/1962	Plutonium	0.31	n/a	In	0.31	E
142	4/28/1959	Uranium	~50% MPL	36	C	36	C
143	1/18/1960		72% MPL	n/a	In	n/a	In
144	2/15/1965	Gross Alpha	Bkgd	0	C	Bkgd	E
144	12/20/1967	Gross Alpha	Bkgd	0	C	Bkgd	E
144	10/18/1965	Americium	0.24	0.24	E	0.24	E
145	2/15/1962	Plutonium	44	n/a	In	44	E
146	11/9/1961	EP/U	14	n/a	In	14	E
147	12/14/1967	Gross Alpha	Bkgd	0	C	Bkgd	E
148	3/29/1971	Plutonium	0.09	n/a	In	0.09	E
148	5/10/1971	Plutonium	0.006	n/a	In	0.06	N

[1] Results were compiled from the urinalysis logbooks.
C – Consistent
N – Inconsistent
E – Exact Match
In – Inconclusive
n/a – Not Available

Table 16-4: Detailed In-Vivo Count Comparison between Logbook Data and Health Physics Files

ID	Logbook Date	In Vivo Count in Hard Copy Record[1]	Comment
149	11/1/1967	Yes	Positive
150	11/6/1968	Yes	Bkgd
151	11/6/1968	Inconclusive	HP file unavailable
152	6/4/1965	Yes	Positive
152	10/14/1968	Yes	Bkgd
153	10/8/1968	Yes	Bkgd
154	10/14/1968	Yes	Bkgd
155	10/14/1968	Yes	1.4 MPLB
156	10/14/1968	Yes	Bkgd
157	10/8/1968	Yes	36% MPLB
158	6/17/1968	Yes	Bkgd/Pos
158	10/14/1968	Yes	Bkgd
159	11/6/1968	Yes	Bkgd
160	3/18/1969	Yes	Bkgd
160	10/14/1968	No	Incident w/ Request for In Vivo Count but no count available
161	10/8/1968	Yes	Left Lung Pos
162	10/14/1968	Yes	Bkgd
163	9/25/1969	Yes	Bkgd; Skin Contamination Incident
164	10/14/1968	Yes	Bkgd
165	5/22/1969	Yes	Bkgd
166	10/24/1966	Yes	Am Positive
167	10/8/1968	Inconclusive	HP file unavailable
168	12/10/1969	Yes	Bkgd; Count date 12/11/69
169	11/6/1968	Yes	Bkgd; Count date 11/7/68
170	11/6/1968	Yes	Bkgd; Count date 11/7/68
171	11/6/1968	Yes	<2-sigma
172	10/14/1968	Yes	Bkgd
173	9/15/1969	Yes	Bkgd
174	11/6/1968	Yes	~23% MPLB
175	10/8/1968	Yes	>20; Multiple followup counts, 10/9/68, 1.92 MPLB
176	10/14/1968	Yes	Bkgd
177	10/8/1968	Yes	>2 sigma
178	11/6/1968	Yes	Bkgd; Count date 11/7/68
179	10/14/1968	Yes	Bkgd
179	10/2/1969	Yes	Bkgd
180		Inconclusive	HP file unavailable
181	11/6/1968	Yes	Bkgd; Count date 11/11/68
182	11/18/1968	Inconclusive	HP file unavailable

[1] Inconclusive indicates the hard copy dosimetry file was not available for review.

Table 16-5: Qualitative Comparisons between Logbook Data and Health Physics Files

ID	Description of Logbook Entry	Date of Logbook Entry	Result	Incident or Wound Count Report	Skin Contamination Report	Dosimetry Investigation Report
143	Urine Submitted	3/12/1964	3/1/64 Sample: Bkgd	n/a	n/a	n/a
141	Urine Request	9/23/1969	9/25/69 Sample: 0.17 dpm/24 hr	n/a	n/a	n/a
183	Wound Count	7/1/1969		Yes	n/a	n/a
184	Wound Count	1/13/1967		Yes	n/a	n/a
185	Wound Count	4/24/1969		Yes	n/a	n/a
186	Wound Count	2/16/1967	0.006 ug	Yes	n/a	n/a
187	Wound Count	3/9/1967	3.25 ug	Yes	n/a	n/a
188	Wound Count	12/15/1966		Yes	n/a	n/a
189	Skin Contamination	5/8/1967	n/a	n/a	Yes	n/a
190	Skin Contamination	5/8/1967	n/a	n/a	Yes	n/a
190	Skin Contamination	5/12/1967	n/a	n/a	Yes	n/a
191	Contamination	5/25/1967	n/a	n/a	Yes	n/a
192	Skin Contamination	5/8/1967	n/a	n/a	Yes	n/a
193	Skin Contamination	5/8/1967	n/a	n/a	Yes	n/a
194	Skin Contamination	5/8/1967	n/a	n/a	Yes	n/a
195	Contaminated Badge	1/20/58	n/a	n/a	n/a	No
196	Contaminated Badge	9/22/1964	n/a	n/a	n/a	No
20	Dose Adjustment	3/7/1967	3400	n/a	n/a	No
20	Dose Adjustment	3/10/1967	3400	n/a	n/a	No
31	Dose Adjustment	9/14/1967	1341	n/a	n/a	No
197	Incident	6/25/1967	n/a	No	n/a	n/a
198	Incident	1/18/1974	n/a	No	n/a	n/a
199	Incident	4/20/1964	n/a	No	n/a	n/a

Table 16-5: Qualitative Comparisons between Logbook Data and Health Physics Files

ID	Description of Logbook Entry	Date of Logbook Entry	Result	Incident or Wound Count Report	Skin Contamination Report	Dosimetry Investigation Report
200	Incident	11/7/1968	n/a	Yes	n/a	n/a
201	Incident	11/6/1968	n/a	Yes	n/a	n/a
202	Incident	11/6/1968	n/a	Yes	n/a	n/a
203	Incident	11/6/1968	n/a	Yes	n/a	n/a
204	Incident	11/6/1968	n/a	Yes	n/a	n/a
205	Incident	11/6/1968	n/a	Yes	n/a	n/a
206	Incident	11/6/1968	n/a	Yes	n/a	n/a
207	Incident	11/6/1968	n/a	Yes	n/a	n/a
208	Incident	4/16/1969	n/a	Yes	n/a	n/a

n/a = not applicable

Table 16-6: Overexposure Comparisons between Logbook Data and Health Physics Files

ID	Description of Logbook Entry	Date of Logbook Entry	Exposure Period	Result (mrem)	Logbook vs. Hard Copy Record	Comment
25	Overexposed Film	12/7/1967	Q4/T	566	In	Inconclusive. No additional information is located in the HP file.
8	Overexposure	7/24/1967	Q3/T	2122	C	Overexposure 6/16-7/3 Confirmed
28	Overexposure	9/26/1967	Q3/T	3783	C	Exposure in excess of 3.0 Rem/qtr
20	Overexposure	3/17/1967	Q1/T	3400	C	Exposure in excess of 3.0 Rem/qtr
21	Overexposure	3/17/1967	Q1/T	3166	C	Exposure in excess of 3.0 Rem/qtr
12	Overexposure	4/24/1967	Q1	3239	C	Exposure in excess of 3.0 Rem/qtr

C - consistent; In – Inconclusive; T = total; Q1 = First Quarter; Q2 = Second Quarter; Q3 = Third Quarter; Q4 = Fourth Quarter

Table 16-7: Comparison of Recently Identified Individual Specific Logbook Data with HIS-20

ID	Logbook Date	Category	Logbook dpm/sample	HIS-20	Match
301	1/11/1966	Pu/Fecal	71	n/a	M
302	2/17/1966	Pu/Fecal	5.7	n/a	M
303	5/19/1966	Pu/Fecal	7.6	n/a	M
304	10/7/1969	Pu/Fecal	123	n/a	M
305	10/7/1969	Am/Fecal	22	n/a	M
306	1/12/1966	Pu/Fecal	100	n/a	M
307	11/10/1965	Pu/Urine	10.2	10.2	E
308	10/31/1971	Pu/Urine	734	734	E
309	10/31/1971	Am/Urine	5.68	5.68	E
310	5/11/1967	Pu/Urine	86.5	87	C
311	5/11/1967	Am/Urine	2.22	2.2	C
312	1/14/1954	Urine	1.7	n/a	M
313	1/20/1954	Urine	2.7	n/a	M
314	1/20/1954	Urine	4.9	0	N
315	1/21/1954	Urine	3.4	n/a	M
316	1/2/1963	Pu/Urine	0	n/a	M
317	1/9/1963	Pu/Urine	0	0	E
318	1/10/1963	Pu/Urine	0	n/a	M
319	1/14/1963	Pu/Urine	0.32	0.32	E
320	9/7/1972	Pu/Urine	12.5	n/a	M
321	7/26/1973	Am/Urine	<det	n/a	M
322	7/27/1972	Pu/Urine	29.5	29.5	E
323	12/11/1963	Am/Urine	7.97	n/a	M
324	12/23/1963	Am/Urine	0.6	n/a	M
325	12/19/1963	Am/Urine	0.25	0.25	E
326	12/13/1963	Am/Urine	0.33	n/a	M
327	12/16/1963	Am/Urine	0.5	0.5	E

C – Consistent
N – Inconsistent
E – Exact Match
M – Missing
n/a – Not Available

ATTACHMENT 17: RECORDS RETRIEVALS FOR DATA INTEGRITY REVIEW

On February 13, 2006, Legacy Management provided a list of 452 records sets retrieved from the Denver Federal Records Center from January 31, 2006, thru August 31, 2006. The inventory included 142 individual health physics files, 36 safety concern files, dosimetry information, and field RadCon information. The individual health physics files are not listed in this attachment, as they include Privacy Act Information. The individual health physics files were used for internal dosimetry, external dosimetry, and data integrity investigations. Safety concerns are listed separately from technical documents and procedures, logbooks, and other data. Table 17-2 contains the records sets retrieved by SC&A for review during the March 12–16, 2007, site visit. These records were selected from among the list provided by Legacy Management, NIOSH/ORAUT records search results, and SC&A records search results.

Table 17-1. Safety Concerns Retrieved as a Part of the 452 Boxes Retrieved from the Denver Federal Records Center[5]

Accession Number	Box No.	Requester	Description of Contents	Review By SC&A
434-03-0349	1	NIOSH/ORAUT	JCUSC Safety Concern # 1990-169	Yes
434-03-0349	3	NIOSH/ORAUT	JCUSC Safety Concern # Safety Concern # 1991-262	Yes
434-03-0344	2	NIOSH/ORAUT	JCUSC Safety Concern # Safety Concern # 1992-036	Yes
434-03-0344	2	NIOSH/ORAUT	JCUSC Safety Concern # 1992-048	Yes
434-03-0345	1	NIOSH/ORAUT	JCUSC Safety Concern # 1993-124	Yes
434-03-0346	1	NIOSH/ORAUT	JCUSC Safety Concern # 1994-072	Yes
434-03-0346	1	NIOSH/ORAUT	JCUSC Safety Concern # 1994-079	Yes
434-03-0346	1	NIOSH/ORAUT	JCUSC Safety Concern # 1994-080	Yes
434-03-0346	1	NIOSH/ORAUT	JCUSC Safety Concern # 1994-081	Yes
434-03-0346	2	NIOSH/ORAUT	JCUSC Safety Concern # 1994-245	Yes
434-03-0346	1	NIOSH/ORAUT	JCUSC Safety Concern # 1994-79	Yes
434-03-0346	1	NIOSH/ORAUT	JCUSC Safety Concern # 1994-80	Yes
434-03-0346	1	NIOSH/ORAUT	JCUSC Safety Concern # 1994-81	Yes
434-03-0347	1	NIOSH/ORAUT	JCUSC Safety Concern # 1995-077	Yes
434-03-0348	1	NIOSH/ORAUT	JCUSC Safety Concern # 1996-182	Yes
434-02-0432	2	NIOSH/ORAUT	JCUSC Safety Concern # 1997-163	Yes
434-02-0432	2	NIOSH/ORAUT	JCUSC Safety Concern # 1997-176	Yes
434-05-1143	2	NIOSH/ORAUT	JCUSC Safety Concern # 1998-073	Yes
434-05-1143	3	NIOSH/ORAUT	JCUSC Safety Concern # 1999-023	Yes
434-05-1143	4	NIOSH/ORAUT	JCUSC Safety Concern # 2000-075	Yes
434-03-0356	1	NIOSH/ORAUT	JCUSC Safety Concern # 71-4	Yes
434-03-0355	1	NIOSH/ORAUT	JCUSC Safety Concern # 75-34	Yes
434-03-0354	1	NIOSH/ORAUT	JCUSC Safety Concern # 84-19	Yes
434-03-0354	1	NIOSH/ORAUT	JCUSC Safety Concern # 85-109	Yes
434-03-0353	1	NIOSH/ORAUT	JCUSC Safety Concern # 85-137	Yes
434-03-0353	1	NIOSH/ORAUT	JCUSC Safety Concern # 86-13	Yes
434-03-0353	1	NIOSH/ORAUT	JCUSC Safety Concern # 86-161	Yes
434-03-0353	1	NIOSH/ORAUT	JCUSC Safety Concern # 86-169	Yes
434-03-0353	1	NIOSH/ORAUT	JCUSC Safety Concern # 86-186	Yes
434-03-0352	1	NIOSH/ORAUT	JCUSC Safety Concern # 87-005	Yes
434-03-0352	1	NIOSH/ORAUT	JCUSC Safety Concern # 87-038	Yes
434-03-0253	1	NIOSH/ORAUT	JCUSC Safety Concern # 87-206	Yes
434-03-0351	1	NIOSH/ORAUT	JCUSC Safety Concern # 89-148	Yes
434-03-0351	2	NIOSH/ORAUT	JCUSC Safety Concern # 89-167	Yes
434-03-0351	2	NIOSH/ORAUT	JCUSC Safety Concern # 89-214	Yes
434-03-0351	2	NIOSH/ORAUT	JCUSC Safety Concern # 89-259	Yes

[5] The accession, microfilm, box, receipt and barcode numbers in the table represent numbers assigned by Legacy Management for retrieval of archived records. These numbers are associated with a particular record (e.g., logbooks, reports, folders, photos, videos) or a group of records and do not identify particular individuals.

Table 17-2. Records Sets Reviewed by SC&A March 12–16, 2007[6]

Accession No./ Microfilm No.	Box	Unique Receipt(s) No.	Bar Code	Description	SC&A Review Comments	Personal Monitoring Data Included
434-00-0280	1	33618		Radiation Monitoring Protection/ Book #1-8 RCT Log Book Daily Operations Log (Buildings 400–800, 444, 865, 883)	All RCT logs contain entries re: surveys performed, respirator checks, instrument tests, etc. No rad data or issues apparent.	No
434-03-0787	1	34130	8526485	Radiation Monitoring Protection// 24 Books Foreman Log Books Bldg 771 (1957–1975)	Usual operational entries in foreman logbooks; nothing of note. **Kittinger 111 logbook has two references to individual exposure values, one a list of high exposures (mrem pene) for Jan-Mar 66; other is adjusted assigned dose for "misreading" badge.**	Minimal
434-96-0105	563/796	37563		881 Hillside Jennisen Construction Health and Safety Logbook No 1-5/881 Hillside Jennison Construction Co URIE Environmental Health Inc Logbook	This logbook contains field health and safety information for Jennison Construction Company.	No
		37766	21600	Decon Log Book	Logbook consists of area decontamination activities.	No
		37795	22027	Decon Health and Safety Logbook	Logbook consists of area decontamination activities.	No
		38223	853134	Radiation Monitoring Surveys//Contamination Control Log Books Foreman Log Books (1977-1981)	Logbooks primarily contain information related to contamination surveys, personnel contamination, notations of body counts and potential intakes, contamination spread incidents, decontamination activities, SAAM results and alarms, respiratory protection posting and deposting, and daily activities.	No
		38226	8011442	Contamination Control Logbooks/Building 707	Logbook primarily contain information related to contamination surveys, personnel contamination, notations of body counts and potential intakes, contamination spread incidents, decontamination activities, SAAM results and alarms, respiratory protection posting and deposting, and daily activities.	No

[6] The receipt and barcode number in the table represent numbers assigned by Legacy Management for retrieval of archived records. These numbers are associated with a particular record (e.g., logbooks, reports, folders, photos, videos) or a group of records and do not identify particular individuals.

Table 17-2. Records Sets Reviewed by SC&A March 12–16, 2007[6]

Accession No./ Microfilm No.	Box	Unique Receipt(s) No.	Bar Code	Description	SC&A Review Comments	Personal Monitoring Data Included
		38226	8043045	Radiation Monitoring Protection /// 2/27/89 - 7/9/89 Contamination Control Report Book // 7/10/89 - 11/18/89 Contamination Control Report Book // 8/26/90 - 11/15/90 Contamination Control Report Book // 1/16/91 - 4/28/91 CC Log Book // 4/28/91 - 8/7/91 CC Log Book // 7/2/91 - 10/7/91 CC Log Book // 8/7/91 - 9/28/91 CC Log Book // 9/28/91 - 1/8/92 CC Log Book // 1/8/92 - 3/4/92 CC Log Book // 6/14/92 - 9/22/92 CC Log Book // 9/22/92 - 1/1/93 CC Log Book // 4/11/93 - 1/23/93 CC Log Book // 7/23/93 - 1/31/94 CC Log Book // 4/22/94 - 11/3/94 CC Log Book // 9/5/94 - 4/21/94 CC Log Book (1989-1993)	Logbooks primarily contain information related to contamination surveys, personnel contamination, notations of body counts and potential intakes, contamination spread incidents, decontamination activities, SAAM results and alarms, respiratory protection posting and deposting, and daily activities.	No
		38263	8215382	Radiation Monitoring Protection / Book #5 RCT Log Book Daily Operations (Bldg 400–800) Area (1993–1996)	Logbook primarily includes contamination and radiation survey information, SAAM checks, radiation alarm responses, air sampling data, decontamination information, job coverage, incident information and daily activities.	Minimal
		38263	8215379	Radiation Monitoring Protection / Book #2 RCT Log Book Daily Operations Log (Building 883)	Logbook primarily includes contamination and radiation survey information, SAAM checks, radiation alarm responses, air sampling data, decontamination information, job coverage, incident information and daily activities.	Minimal
		38263	8215380	Radiation Monitoring Protection / Book #3 RCT Log Book Daily Operations (Bldg 400–800) (1993–1996)	Logbook primarily includes contamination and radiation survey information, SAAM checks, radiation alarm responses, air sampling data, decontamination information, job coverage, incident information and daily activities.	Minimal
		38263	8215381	Radiation Monitoring Protection / Book #4 RCT Log Book Daily Operations Log (Bldg 865) (1993–1996)	Logbook primarily includes contamination and radiation survey information, SAAM checks, radiation alarm responses, air sampling data, decontamination information, job coverage, incident information and daily activities.	Minimal

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Accession No./ Microfilm No.	Box	Unique Receipt(s) No.	Bar Code	Description	SC&A Review Comments	Personal Monitoring Data Included
		38263	8215383	Radiation Monitoring Protection / Book#6 RCT Log Book Daily Operations Log (400–800) Area (1993–1996)	Logbook primarily includes contamination and radiation survey information, SAAM checks, radiation alarm responses, air sampling data, decontamination information, job coverage, incident information and daily activities.	Minimal
		38263	8215384	Radiation Monitoring Protection / Book#7 RCT Log Book Daily Operations (Building 444) (1993–1996)	Logbook primarily includes contamination and radiation survey information, SAAM checks, radiation alarm responses, air sampling data, decontamination information, job coverage, incident information and daily activities.	Minimal
		38264	8215385	Radiation Monitoring Protection / Book#8; RCT Log Book Daily Operations (Building 444) (1993–1996)	Logbook primarily includes contamination and radiation survey information, SAAM checks, radiation alarm responses, air sampling data, decontamination information, job coverage, incident information and daily activities.	Minimal
		38265	8255556	Radiation Monitoring Protection / Folder 2 Log Book, Decon Room 779	Activities occurring in the 779 decontamination room.	No
		38265	8526748	Radiation Monitoring Protection // 16 Books Contamination Control RPT Log Books 1982 1986 1985 1987 1986 1988 1990 AND 1989 Building 771 (1971–1990)	Logbooks primarily contain information related to contamination surveys, personnel contamination, notations of body counts and potential intakes, contamination spread incidents, decontamination activities, SAAM results and alarms, respiratory protection posting and deposting, and daily activities.	No
		38265	8526485	Radiation Monitoring Protection // 24 Books Foreman Log Books Bldg 771 (1957–1975)	Foreman's Logbooks primarily contains information on work schedules and daily activities.	No

Table 17-2. Records Sets Reviewed by SC&A March 12–16, 2007[6]

Accession No./ Microfilm No.	Box	Unique Receipt(s) No.	Bar Code	Description	SC&A Review Comments	Personal Monitoring Data Included
		38265	8526749	Radiation Monitoring Protection // 6 Books Contamination Control RPT Foreman's Log Books 1971 1976 1983 TO 1984 1985 AND 1987 Bldg 771 (1971–1990)	Contamination Control logbooks primarily contain information related to contamination surveys, personnel contamination, notations of body counts and potential intakes, contamination spread incidents, decontamination activities, SAAM results and alarms, respiratory protection posting and deposting, and daily activities.	Minimal
		38266	8562766	Radiation Monitoring Protection // 2 Foreman Log Books 776-777 6/15/1970 thru 2/17/1975 (1969–1976)	Foreman's Logbooks primarily contains information on work schedules and daily activities.	No
		40983	8568031	Terminated Personnel Radiation Records // Specials TLD Badge March thru June 1974	**Dosimetry processing sheets by month and quarter for 1974. Results are linkable to employees by badge number. These sheets are the same as the dosimetry processing sheets found on the O-drive for other years.**	Yes
		42324	8722942	Radiation Monitoring Protection // Folder 8 RCT Log Book 07/06/1987 thru 10/01/1997 B444	Logbooks primarily include contamination and radiation survey information, SAAM checks, radiation alarm responses, air sampling data, decontamination information, job coverage, incident information and daily activities.	Minimal
		55673		Radiation Monitoring Protection / LogBook	This includes field radiological control monitoring information and daily activities.	No
434-03-1041	1	62098		Radiation Monitoring Protection // Folder 2 - 7 Area Decontamination Daily Log Book 5/21/69 thru 10/14/71	Logbook consists of area decontamination activities.	No
		62098		Radiation Monitoring Protection // 2 Foreman Log Books 776-777 6/15/1970 thru 2/17/1975	Foreman's Logbooks primarily contains information on work schedules and daily activities.	No
		62098		Radiation Monitoring Protection // 24 Books Foreman Books Bldg 771	Foreman's Logbooks primarily contains information on work schedules and daily activities.	No
		62098		Radiation Monitoring Protection // 3 771 S. A. Log Books 06/24/1970 thru 04/02/1975	This logbook lists supplied air jobs.	No

Table 17-2. Records Sets Reviewed by SC&A March 12–16, 2007[6]

Accession No./ Microfilm No.	Box	Unique Receipt(s) No.	Bar Code	Description	SC&A Review Comments	Personal Monitoring Data Included
434-05-0699	1	68340		Medical or Health Research Project Case Files // Historical Health Physics and Internal Dosimetry Collection / / Folder 1 - 5, 7-8 Daily Log Books Wound Count Log Book/ / Folder 6 Daily Log Books Data Log Book 01/01/1972 THRU 12/31/1977/ Folder 9 Daily Log Books Lung Counter Room A and B - Calibration Log Book 08/01/1974 Thru 03/16/1982 / Folder 10 Daily Log Book Lung Counter Room A B and C - Source Check Log Book 05/16/1973 Thru 02/12/1982/ / Folder 11 Daily Log Books Eberline SRM-200 Wound Counters - Performance Check Log Book 03/24/1998 Thru 07/08/2003// Folder 13 Daily Log Books Dosimetry Log Book 10/30/1967 Thru 07/30/1971/Folder 14 Daily Log Books Roger Falks Dosimetry Log Book 01/01/1967 THRU 05/02/1969/Folder 15 Daily Log Books Roger Falks Dosimetry Log Book 08/28/1969 thru 07/25/1972/ / Folder 16 Dialy Log Books Operational Log Book - Rocky Flats Whole Body Counter (Backgrounds) 01/07/1964 thru 07/27/1964/ / Folder 17 Daily Log Books Project Notebook for the Rocky Flats Total Body Counter 06/07/1962 thru 06/11/1962// Folder 18 Daily Log Books Homer Otto 1000 Log Book 07/07/1964 thru 12/30/1964/ / Folder 19 Daily Log Books LLL Phantom Calibration Study Log Book 04/26/1979 thru 07/19/1979	LLL phantom calibration study measurements. HOMER OTTO phantom calib measurements. 1-2 pages on initial installation of WBC, w/ calibration data. Roger Falk's various logbooks containing early neutron dosimetry work, including process and area measurements, including neutron energies. Other "dosimetry" logs are simply personnel and program status entries. Equipment performance checks: Eberline wound counter. Source checks and calibration for lung counter. Calibration for wound counter. **Wound count logbooks for 11/7/74-9/28/81: Numerous entries for named workers (w/ badge nos) for abrasions, acid burns, lacerations, and punctures with cpm; number of recounts.**	Yes

Table 17-2. Records Sets Reviewed by SC&A March 12–16, 2007[6]

Accession No./ Microfilm No.	Box	Unique Receipt(s) No.	Bar Code	Description	SC&A Review Comments	Personal Monitoring Data Included
434-05-0699	2/16	68341		Medical or Health Research Project Case Files// Historical Health Physics and Internal Dosimetry Collection/ / Folder 3 Log Book Kittinger Log Book Number 4 01/02/1968 thru 03/28/1972/ Folder 4 Log Book Staff Logbook 05/28/1981 thru 07/08/1985/	Contains useful rad program entries, but no specific rad dose records info relevant to ongoing evaluation of completeness or badging policy issues. Reference to "lack of contractor badge change for contractor personnel with many as old as Mar 68 issuance; John to correct this and place all workers in 76, 77 on monthly change." Staff LogBook likewise. Kittinger log provides some limited individual data by name, e.g., for high neutron and gamma readings (3/13-3/27/69).	Minimal
434-05-0699	12	68351		Contamination Control LogBooks / Building 707	The log book contained radiological monitoring data related to contamination monitoring and decontamination.	No
		68351		321-72-101 - Special Dose Measurements Using TLD 07/01/1972 thru 08/21/1972 / 321-72-103 - Special Dose Measurements Using TLD 08/01/1972 thru 09/08/1972 / 321-72-104 - Special Dose Measurements Using TLD 09/01/1972 thru 10/09/1972	**Product and Health Physics Research Service Report, Special Dose Measurements Using TLD, Technical Report; The box containing these documents also had information on dosimetry and environmental studies, dose rates, tritium bioassay data, information on individuals in the transuranic registry.**	Yes
		68351		Special Dose Measurements Using TLD	Product and Health Physics Research Service Report, Special Dose Measurements Using TLD, Technical Report	No
	321-72-103	68351		Product and Health Physics Research Service Report, Special TLD Measurements Using TLD, Technical Document	Technical documents related to the TLD program.	No
	321-72-104	68351		Product and Health Physics Research Service Report, Special TLD Measurements Using TLD, Technical Document	Technical documents related to the TLD program.	No
434-02-0378		00-0151-35		Uranium	Folder contained general information on uranium and thorium.	No
434-02-0378		00-0151-35		Thorium	Folder containing general information on thorium.	No

Table 17-2. Records Sets Reviewed by SC&A March 12–16, 2007[6]

Accession No./ Microfilm No.	Box	Unique Receipt(s) No.	Bar Code	Description	SC&A Review Comments	Personal Monitoring Data Included
434-05-0578		05-0015-2		Medical or Health Research Project Case Files - RF.005.006 Thorium Use At Rocky Flats (CDPHE)	Mixon farm white paper (no name) that has since been attributed to Bob Bistline. Already have.	No
		10459	8020515	Radiation Monitoring Surveys/ Logbook	This includes field radiological control monitoring information and daily activities.	No
		10459	8020516	Radiation Monitoring Surveys/ Logbook	This includes field radiological control monitoring information and daily activities.	No
		10459	8020517	Radiation Monitoring Surveys/ Logbook	This includes field radiological control monitoring information and daily activities.	No
		10460	8019780	Radiation Monitoring Surveys / Rockwell International Radiation Monitoring Contamination Control Report (Logbook)	Logbook primarily contain information related to contamination surveys, personnel contamination, notations of body counts and potential intakes, contamination spread incidents, decontamination activities, SAAM alarms, tritium alarms, respiratory protection posting and deposting, and daily activities. There are several references to a tritium lab.	Minimal
		10460	8019781	Radiation Monitoring Surveys / Rockwell Internation Radiation Monitoring Contamination Control Report (Logbook)	This logbook contained radiological monitoring data, descriptions of daily tasks and incident information.	No
		11501	8036490	Radiation Monitoring Protection/Logbook	LCO Surveillance Survey, Underline and Aisleway Survey, Gamma-Neutron Survey, Air-lock Criticality Drain Surey, Special Surveys, Tank Survey, Glove Box Survey, Hot-Cold Contamination Control Survey, Exhaust Screens Survey	No

Table 17-2. Records Sets Reviewed by SC&A March 12–16, 2007[6]

Accession No./ Microfilm No.	Box	Unique Receipt(s) No.	Bar Code	Description	SC&A Review Comments	Personal Monitoring Data Included
		16509	8045306	Radiation Monitoring Protection / 1/17/92 TO 7/14/94 Contamination Control Data Logger Bld 559 // 2/21/94 TO 10/3/94 Contamination Control Data Logger BLD 559 // 6/15/91 To 1/16/92 Rpt Log Book // 5/31/91 to 1/6/92 CC Log Book Bld 559 // 1/21/91 to 5/12/91 CC Log Book Bld 559 // 6/21/90 to 1/18/91 CC Log Book // 7/13/92 to 3/23/93 RCT Log Book // 7/14/92 to 1/19/93 RCT Log Book // 7/22/94 to 5/24/95 RCT Log Book Bld 559 // 3/16/94 to 9/10/94 Supervisors Log // 9/12/94 to 4/4/95 Supervisors Log Book Bld 559 // 4/5/95 to 10/31/95 Supervisors Log	Included are several contamination control logbooks, RPT logbooks, RPT Foreman's logbooks, and wupervisor Logbooks. There logbooks were maintained at Building 559 but included entries for Building 561 also. The contents of the logbooks included contamination surveys, instrument check results, air sampling checks (including SAAMS), daily tasks completed, decontamination activities, and incidents (including personnel contamination incidents). SAAM alarms were frequently mentioned. There was also mention of posting and downposting areas including respiratory protection required postings. There were several entries with employee specific data relating to wound counts, injuries and badge contamination. In the 9/12/94 to 4/4/95 supervisor log there were several instances noted where TLDs were pulled as a result of violation of radiation protection requirements. There is job-specific DAC information. Related to this there are multiple references to sending personnel to internal dosimetry. One logbook contained the instructions for maintaining a field logbook. Log entries were to include routine production, maintenance jobs, decon jobs, routine surveys, contamination control duties, hallway check out, emergencies, radiological incident and accident reporting and any other duties that fall under the ROI.	Moderate Amount
434-03-1035	4	16951	8562707	Radiation Monitoring Surveys // Log Books (C R Johnson) For Buildings 707 779	Scanned 8 logs and found only operational entries; one reference to "quarterly" compilations of TLD results.	No

Table 17-2. Records Sets Reviewed by SC&A March 12–16, 2007[6]

Accession No./ Microfilm No.	Box	Unique Receipt(s) No.	Bar Code	Description	SC&A Review Comments	Personal Monitoring Data Included
		18948	8043046	Radiation Monitoring Protection /// 8/10/93 - 4/8/94 Foreman Log Books // 8/31/93 - 6/2/93 Foreman Log Books // 6/2/92 - 11/1/93 Foreman Log Books // 7/25/75 - 9/24/82 Supplied Air Log Book // 4/23/86 - 12/30/86 Supplied Air Log Book // 11/7/89 - 7/3/90 Supplied Air Log Book // 9/23/85 - 12/8/89 Supplied Air Log Book // 1/23/91 - 5/15/91 Data Logger Books // 5/15/91 - 7/2/91 Data Logger Books // 10/8/91 - 12/1/91 Data Logger Books // 12/1/91 - 1/22/92 Data Logger Books // 4/29/92 - 8/8/92 Data Logger Books // 8/8/92 - 11/19/91 Data Logger Books // 11/18/92 - 1/1/93 Data Logger Books // 1/10/93 - 2/27/93 Data Logger Books // 2/27/93 - 4/22/93 Data Logger Books // 1/22/92 - 4/29/92 Data Logger Books	This includes field radiological control monitoring information and daily activities including information on supplied air jobs.	No
		18949	8043047	Radiation Monitoring Protection /// 10/30/82 - 10/19/84 Foreman's Log Book // 8/14/85 - 5/31/86 Foreman's Log Book // 10/1/87 - 4/4/87 Foreman's Log Book // 8/25/88 - 11/18/89 Foreman's Log Book // 4/5/88 - 8/25/88 Foreman's Log Book // 11/28/89 - 6/10/90 Foreman's Log Book // 6/11/90 - 9/28/90 Foreman's Log Book // 9/28/90 - 1/8/91 Foreman's Log Book // 11/30/90 - 1/20/91 Foreman's Log Book // 1/8/91 - 4/26/91 Foreman's Log Book // 4/26/91 - 8/14/91 Foreman's Log Book // 6/17/91 - 8/10/93 Foreman's Log Book // 8/15/91 - 10/3/91 Foreman's Log Book // 10/4/91 - 2 /19/92 Foreman's Log Book	All foreman logs reviewed without any notable entries.	No

Table 17-2. Records Sets Reviewed by SC&A March 12–16, 2007[6]

Accession No./ Microfilm No.	Box	Unique Receipt(s) No.	Bar Code	Description	SC&A Review Comments	Personal Monitoring Data Included
		18950	8043045	Radiation Monitoring Protection /// 2/27/89 - 7/9/89 Contamination Control Report Book // 7/10/89 - 11/18/89 Contamination Control Report Book // 8/26/90 - 11/15/90 Contamination Control Report Book // 1/16/91 - 4/28/91 CC Log Book // 4/28/91 - 8/7/91 CC Log Book // 7/2/91 - 10/7/91 CC Log Book // 8/7/91 - 9/28/91 CC Log Book // 9/28/91 - 1/8/92 CC Log Book // 1/8/92 - 3/4/92 CC Log Book // 6/14/92 - 9/22/92 CC Log Book // 9/22/92 - 1/1/93 CC Log Book // 4/11/93 - 1/23/93 CC Log Book // 7/23/93 - 1/31/94 CC Log Book // 4/22/94 - 11/3/94 CC Log Book // 9/5/94 - 4/21/94 CC Log Book	Logbooks primarily contain information related to contamination surveys, personnel contamination, notations of body counts and potential intakes, contamination spread incidents, decontamination activities, SAAM results and alarms, respiratory protection posting and deposting, and daily activities.	No
		19158	8036489	Radiation Monitoring Protection / Logbook	This includes field radiological control monitoring information and daily activities for RPTs assigned to Plantsite responsibilities.	No
		19158	8036491	Radiation Monitoring Protection / Logbook	This is a contamination control logbook (plantsite) including field radiological control monitoring information and daily activities.	No
		19158	8036492	Radiation Monitoring Protection / Logbook	This includes field radiological control monitoring information and daily activities for RPTs assigned to Plantsite responsibilities. There are references to wound counts and personnel contamination.	Minimal
		19158	8036493	Radiation Monitoring Protection / Logbook	Building 559 Radiological Operations logbook including explanation of daily activities, notation of SAAM alarms, information on incidents, and contamination survey data.	Minimal
		19160	8036595	Radiation Monitoring Protection / Logbook	Building Support RPT's Log (1989). This field logbook only contains 36 pages of information on radiological monitoring and daily activities. The rest is blank.	No
		19160	8036596	Radiation Monitoring Protection / Logbook	This RPT Logbook containing field radiological control monitoring information and daily activities. Instructions for maintaining a logbook were also included. The instructions	No

Table 17-2. Records Sets Reviewed by SC&A March 12–16, 2007[6]

Accession No./ Microfilm No.	Box	Unique Receipt(s) No.	Bar Code	Description	SC&A Review Comments	Personal Monitoring Data Included
					indicate that RPTs are to log routine production, maintenance jobs, decontamination jobs, routine surveys, contamination control duties, emergencies, and radiological incidents.	
		19160	8036597	Radiation Monitoring Protection / Logbook	788 Pond Logbook containing radiological operations data. There was mention of an individual receiving a substantial wound. RPTs were required follow the individual to a local hospital to conduct a contamination survey.	Minimal
		19160	8036598	Radiation Monitoring Protection / Logbook	The RPTs Daily Logbook for Building 881 and 883 primarily include contamination and radiation survey information, SAAM checks, radiation alarm responses, air sampling data, decontamination information, job coverage, incident information and daily activities. There was reference made to the use of Thorium Acetylacetonate in the laboratory.	No
		19160	8036599	Radiation Monitoring Protection / Logbook	This logbook had little information as it covered only a few days.	No
		19161	8036387	Radiation Monitoring Protection / Logbook Plantsite	Logbook primarily includes contamination and radiation survey information, SAAM checks, radiation alarm responses, air sampling data, decontamination information, job coverage, incident information and daily activities.	No
		19161	8036388	Radiation Monitoring Protection / Logbook Plantsite	Logbook primarily includes contamination and radiation survey information, SAAM checks, radiation alarm responses, air sampling data, decontamination information, job coverage, incident information and daily activities.	No
		19161	8036389	Radiation Monitoring Protection / Logbook Plantsite	Logbook primarily includes contamination and radiation survey information, SAAM checks, radiation alarm responses, air sampling data, decontamination information, job coverage, incident information and daily activities.	No

Table 17-2. Records Sets Reviewed by SC&A March 12–16, 2007[6]

Accession No./ Microfilm No.	Box	Unique Receipt(s) No.	Bar Code	Description	SC&A Review Comments	Personal Monitoring Data Included
		19161	8036390	Radiation Monitoring Protection / Logbook Plantsite	Logbook primarily includes contamination and radiation survey information, SAAM checks, radiation alarm responses, air sampling data, decontamination information, job coverage, incident information and daily activities.	No
		19161	8036391	Radiation Monitoring Protection / Logbook Plantsite	Logbook primarily includes contamination and radiation survey information, SAAM checks, radiation alarm responses, air sampling data, decontamination information, job coverage, incident information and daily activities.	No
		19161	8036392	Radiation Monitoring Protection / Logbook Plantsite	Logbook primarily includes contamination and radiation survey information, SAAM checks, radiation alarm responses, air sampling data, decontamination information, job coverage, incident information and daily activities.	No
		19162	8036671	Radiation Monitoring Protection / Logbook	This logbook consists of survey data, air sampling data, instrument performance check logs, and daily activities from the plantsite. The logbook makes reference to radon air sampling in containment tents.	No
		19162	8036672	Radiation Monitoring Protection / Logbook	Radiation Monitoring Logbook covering Buildings 664, 778, 750 Pad, 904, and the Pond Area. The contents included descriptions of daily activities, survey data including a survey conducted at the Bloomfield Warehouse, and information on incidents. There is limited information with personal identifiers.	Minimal
		19162	8036673	Radiation Monitoring Protection / Logbook	This record set contained Radiation Monitoring Tracking Sheets and other survey information.	No
		19162	8036674	Radiation Monitoring Protection / Logbook	This includes field radiological control monitoring information and daily activities.	No
		19162	8036675	Radiation Monitoring Protection / Logbook	This includes field radiological control monitoring information and daily activities.	No
		19162	8036679	Radiation Monitoring Protection / Logbook	This includes field radiological control monitoring information and daily activities.	No

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Accession No./ Microfilm No.	Box	Unique Receipt(s) No.	Bar Code	Description	SC&A Review Comments	Personal Monitoring Data Included
		19162	8036680	Radiation Monitoring Protection / Logbook	The logbook discussed radiological operations conducted in Building 881, Rooms 121, 144, 163, 165, and 297. The contents included descriptions of daily activities, survey data, , and information on incidents. There was reference to J.A. Jones conducting borehole sampling in B-297. The logbook noted that contamination was found in the ductwork. There is a reference to six J.A. Jones workers being sent to medical due to inhalation of fumes (no names provided).	Minimal
		19162	8036681	Radiation Monitoring Protection / Logbook	This includes field radiological control monitoring information and daily activities.	No
		19162	8036682	Radiation Monitoring Protection / Logbook	This logbook is a description of the various maintenance activities done in Building 771 over the stated time period.	No
		19171	8038071	Radiation Monitoring Protection / Logbook	This includes field radiological control monitoring information and daily activities.	No
		19171	8038072	Radiation Monitoring Protection / Logbook	This includes field radiological control monitoring information and daily activities.	No
		19171	8038073	Radiation Monitoring Protection / Logbook	This is the 881 P.M. Shift Logbook compiled by manager P.M. shift and midshift.	No
		19172	8036747	Radiation Monitoring Protection / Logbook	This includes field radiological control monitoring information and daily activities.	No
		19172	8036748	Radiation Monitoring Protection / Logbook	This includes field radiological control monitoring information and daily activities.	No
		19172	8036749	Radiation Monitoring Protection / Logbook	This includes field radiological control monitoring information and daily activities.	No
		19172	8036750	Radiation Monitoring Protection / Logbook	This includes field radiological control monitoring information and daily activities.	No
		19173	8036509	Radiation Monitoring Protection / Logbook	This includes field radiological control monitoring information and daily activities.	No
		19173	8036510	Radiation Monitoring Protection / Logbook	This includes field radiological control monitoring information and daily activities.	No

Table 17-2. Records Sets Reviewed by SC&A March 12–16, 2007[6]

Accession No./ Microfilm No.	Box	Unique Receipt(s) No.	Bar Code	Description	SC&A Review Comments	Personal Monitoring Data Included
		19173	8036511	Radiation Monitoring Protection / Logbook	This includes field radiological control monitoring information and daily activities.	No
		19174	8036529	Radiation Monitoring Protection / Logbooks	This includes field radiological control monitoring information and daily activities.	No
		19175	8036677	Radiation Monitoring Protection / Logbook	Source Receiving and Shipping Log with dpm values, calibration date and recalibration date. Covers receipt and shipping for Building 371, 707, 771, 776, and 881.	No
		19175	8036678	Radiation Monitoring Protection / Logbook	This includes field radiological control monitoring information and daily activities.	No
		19175	8036676	Radiation Monitoring Protection / B881 Logbook	The Log Book Tritium Results 1975-1985 Building 881 contains radiological survey and air sampling date for tritium.	No
		19195	8036683	Radiation Monitoring Protection / Logbook	This includes field radiological control monitoring information and daily activities.	No
		19195	8036684	Radiation Monitoring Protection / Logbook	This includes field radiological control monitoring information and daily activities.	No
		19195	8036685	Radiation Monitoring Protection / Logbook	This includes field radiological control monitoring information and daily activities.	No
		19195	8036686	Radiation Monitoring Protection / Logbook	This includes field radiological control monitoring information and daily activities.	No
		19195	8036687	Radiation Monitoring Protection / Logbook	Logbook primarily include contamination and radiation survey information, SAAM checks, radiation alarm responses, air sampling data, decontamination information, job coverage, incident information and daily activities. There are multiple regarding individuals being sent to medical for decontamination or to the body counter.	Minimal

Table 17-2. Records Sets Reviewed by SC&A March 12–16, 2007[6]

Accession No./ Microfilm No.	Box	Unique Receipt(s) No.	Bar Code	Description	SC&A Review Comments	Personal Monitoring Data Included
		19195	8036688	Radiation Monitoring Protection / Logbook	Rockwell International Radiation Monitoring Rocky Flats Plant Contamination Control containing information related to contamination surveys, personnel contamination, notations of body counts and potential intakes, contamination spread incidents, decontamination activities, SAAM results and alarms, respiratory protection posting and deposting, and daily activities. This covers the plutonium area (e.g., Bldg 707, 776, etc.)	Minimal
434-97-0168		31252	8063527	Radiation Monitoring Protection / B991 Contamination Control Logbook	RCT entries re: contamination surveys, equipment tests. Etc. No "rich" rad data.	No
434-00-0280	1	33618	8215379	Radiation Monitoring Protection / BOOK#2 RCT Log Book Daily Operations Log (Building 883)	Logbooks primarily include contamination and radiation survey information, SAAM checks, radiation alarm responses, air sampling data, decontamination information, job coverage, incident information and daily activities.	Minimal
434-00-0269	1	33655	8259851	Radiation Monitoring Protection / Folder 1 RCT Log Book Bldg 904 Pad	Logbooks primarily include contamination and radiation survey information, SAAM checks, radiation alarm responses, air sampling data, decontamination information, job coverage, incident information and daily activities.	No
434-02-0960	1	34142	8419774	Radiation Monitoring Protection // Historical Records Transmittal/ Personnel Radiation History Files Health Physics Log Books 2/60, 5/63 Visitor Film Badge 4/61-6/63 Air and Smear Samples CY 1962 Site Survey Results CY 1959-60, 1962 Pu/Urine Re Box Originally Located at FRC Under Accession 430-80-0011 This Box was Contaminated Copied by an RCT on 5-2-2002 and Re-entered Under RTI 32 Folder 1 Log Book Site Survey 1959 thru 1960	Series of foreman logs for 1960-62; nothing notable. Extensive site survey measurements for 1959-1960.	No

Table 17-2. Records Sets Reviewed by SC&A March 12–16, 2007[6]

Accession No./ Microfilm No.	Box	Unique Receipt(s) No.	Bar Code	Description	SC&A Review Comments	Personal Monitoring Data Included
434-02-0960	1	34142	8419775	Radiation Monitoring Protection // Historical Records Transmittal/Personnel Radiation History Files Health Physics Log Books 2/60, 5/63 Visitor Film Badge 4/61-6/63 Air and Smear Samples CY 1962 Site Survey Results CY 1959-60, 1962 Pu/Urine Re Box Originally Located at FRC Under Accession 430-80-0011 This Box Was Contamination Copied by an RCT on 5-2-2002 and Re-Entered Under RTI 32 Folders 2 and 3 Log Book Production Area Log HP 2-18-1960 thru 6-24-1961	Production logs contain daily operational status info; no dose-related data.	No
434-02-0960	1	34142	8419776	Radiation Monitoring Protection // Historical Records Transmittal/Personnel Radiation History Files Health Physics Log Books 2/60, 5/63 Visitor Film Badge 4/61-6/63 Air and Smear Samples CY 1962 Site Survey Results CY 1959-60, 1962 PU/URINE Re Box Originally Located at FRC Under Accession 430-80-0011 This Box was Contaminated Copied by an RCT on 5-2-2002 and re-entered under RTI 32 Folder 4 Log Book 4-25-1960 thru 6-26-1961	**Logs contain daily programmatic status items, air and smear sample results, and some infrequent references to "positive" urinalysis results with name and reading indicated.**	Yes
434-02-0960	1	34142	8419777	Radiation Monitoring Protection // Historical Records Transmittal/Personnel Radiation History Files Health Physics Log Books 2/60, 5/63 Visitor Film Badge 4/61-6/63 Air and Smear Samples CY 1962 Site Survey Results CY 1959-60, 1962 Pu/Urine Re Box Originally Located at FRC Under Accession 430-80-0011 This Box was Contaminated Copied by an RCT on 5-2-2002 and Re-entered Under RTI 32Folders 5 and 6 Shift Log Books 4-19-1960 thru 1-23-1962	Shift Logbooks contain daily operational status info; no dose data of relevance.	No

Table 17-2. Records Sets Reviewed by SC&A March 12–16, 2007[6]

Accession No./ Microfilm No.	Box	Unique Receipt(s) No.	Bar Code	Description	SC&A Review Comments	Personal Monitoring Data Included
434-02-0960	1	34142	8419778	Radiation Monitoring Protection // Historical Records Transmittal/Personnel Radiation History Files Health Physics Log Books 2/60, 5/63 Visitor Film Badge 4/61-6/63 Air and Smear Samples CY 1962 Site Survey Results CY 1959-60, 1962 Pu/Urine Re Box Originally Located at FRC Under Accession 430-80-0011 This Box was Contaminated Copied by an RCT on 5-2-2002 and Re-entered Under RTI 32 Folders 7 and 8 Log Book 6-27-1961 thru 10-15-1962	Logs contain daily programmatic status items, air and smear sample results, and some infrequent references to "positive" urinalysis results with name and reading indicated, as well as indications of individual wound monitoring done.	Yes
434-02-0960	1	34142	8419779	Radiation Monitoring Protection // Historical Records Transmittal/Personnel Radiation History Files Health Physics Log Books 2/60, 5/63 Visitor Film Badge 4/61-6/63 Air and Smear Samples CY 1962 Site Survey Results CY 1959-60, 1962 Pu/Urine Re Box Originally Located at FRC Under Accession 430-80-0011 This Box was Contaminated Copied by an RCT on 5-2-2002 and Re-entered Under RTI 32Folder 9 Log Book 4-14-1961 thru 12-1-1962	**Extensive individual urine counts for workers by name and badge no., 4/14/61-12/1/62.**	Yes
434-02-0960	1	34142	8419780	Radiation Monitoring Protection // Historical Records Transmittal/Personnel Radiation History Files Health Physics Log Books 2/60, 5/63 Visitor Film Badge 4/61-6/63 Air and Smear Samples CY 1962 Site Survey Results CY 1959-60, 1962 Pu/Urine Re Box Originally Located at FRC Under Accession 430-80-0011 This Box was Contaminated Copied by an RCT on 5-2-2002 And Re-entered Under RTI 32Folder 10 Log Book 1962 Special 12-28-1961 thru 12-6-1962, Special 1962.	**Special 1962 log has daily cc smears and air sampling data, and some individual data (mouth, nose swab measurements), all for Bldg 81.**	Yes

Table 17-2. Records Sets Reviewed by SC&A March 12–16, 2007[6]

Accession No./ Microfilm No.	Box	Unique Receipt(s) No.	Bar Code	Description	SC&A Review Comments	Personal Monitoring Data Included
434-02-0960	1	34142	8419781	Radiation Monitoring Protection // Historical Records Transmittal/Personnel Radiation History Files Health Physics Log Books 2/60, 5/63 Visitor Film Badge 4/61-6/63 Air and Smear Samples CY 1962 Site Survey Results CY 1959-60, 1962 Pu/Urine Re Box Originally Located at FRC Under Accession 430-80-0011 This Box was Contaminated Copied by an RCT on 5-2-2002 And Re-entered Under RTI 32Folder 11 Log Book EP Electroplating 1962 1-2-1962 thru 12-31-1962	**Extensive individual urine counts (electroplating) for workers by name and badge no., 1/2/62-12/31/62.**	Yes
434-02-0960	1	34142	8419782	Radiation Monitoring Protection // Historical Records Transmittal/Personnel Radiation History Files Health Physics Log Books 2/60, 5/63 Visitor Film Badge 4/61-6/63 Air and Smear Samples CY 1962 Site Survey Results CY 1959-60, 1962 Pu/Urine Re Box Originally Located at FRC Under Accession 430-80-0011 This Box was Contaminated Copied by an RCT on 5-2-2002 And Re-entered Under RTI 32Folder 12 Log Book Site Survey 1962	Site survey logs contain area surveys and water sample results in gross and net cpm.	No
434-02-0960	1	34142	8419783	Radiation Monitoring Protection // Historical Records Transmittal/Personnel Radiation History Files Health Physics Log Books 2/60, 5/63 Visitor Film Badge 4/61-6/63 Air and Smear Samples CY 1962 Site Survey Results CY 1959-60, 1962 Pu/Urine Re Box Originally Located at FRC Under Accession 430-80-0011 This Box was Contaminated Copied by an RCT on 5-2-2002 And Re-entered Under RTI 32Folder 13 Log Book Lab Analysis 11-1-1962 thru 1-14-1963	**Extensive individual urine counts for workers by name and badge no., 11/1/62-1/14/63.**	Yes

Table 17-2. Records Sets Reviewed by SC&A March 12–16, 2007[6]

Accession No./ Microfilm No.	Box	Unique Receipt(s) No.	Bar Code	Description	SC&A Review Comments	Personal Monitoring Data Included
434-02-0960	1	34142	8419784	Radiation Monitoring Protection // Historical Records Transmittal/Personnel Radiation History Files Health Physics Log Books 2/60, 5/63 Visitor Film Badge 4/61-6/63 Air and Smear Samples CY 1962 Site Survey Results CY 1959-60, 1962 Pu/Urine Re Box Originally Located at FRC Under Accession 430-80-0011 This Box was Contaminated Copied by an RCT on 5-2-2002 And Re-entered Under RTI 32Folder 14 Log Book Visitor Film Badge Log Bldg 776 4-2-1961 thru 6-11-1963	**Visitor Film Badge log contains names, dates, and badge nos. assigned.**	Yes
434-02-0960	1	34142	8419785	Radiation Monitoring Protection // Historical Records Transmittal/Personnel Radiation History Files Health Physics Log Books 2/60, 5/63 Visitor Film Badge 4/61-6/63 Air and Smear Samples CY 1962 Site Survey Results CY 1959-60, 1962 Pu/Urine Re Box Originally Located at FRC Under Accession 430-80-0011 This Box was Contaminated Copied by an RCT on 5-2-2002 And Re-entered Under RTI 32Folder 15 Log Book Plutonium 1-1-1963 thru 9-24-1963	**Pu log for 1/1/63-9/24/63 contains extensive individual urine counts by name and badge no.**	Yes
434-02-0960	1	34142	8419786	Radiation Monitoring Protection // Historical Records Transmittal/Personnel Radiation History Files Health Physics Log Books 2/60, 5/63 Visitor Film Badge 4/61-6/63 Air and Smear Samples CY 1962 Site Survey Results CY 1959-60, 1962 Pu/Urine Re Box Originally Located at FRC Under Accession 430-80-0011 This Box was Contaminated Copied by an RCT on 5-2-2002 And Re-entered Under RTI 32Folder 16 Log Book Special 1963 1-3-1963 thru 1-3-1964	**"Special" 1963 log contains bldg and air surveys/cc smears for 1963 (mostly bldg. 81) , gross counts/min.; as well as 771 Pu bioassay (blood and urine) and wound eval. for named workers (w/ badge nos.). Pu logs for 1/1/63 to 9/24/63 contain individual data for urine samples.**	Yes

Table 17-2. Records Sets Reviewed by SC&A March 12–16, 2007[6]

Accession No./ Microfilm No.	Box	Unique Receipt(s) No.	Bar Code	Description	SC&A Review Comments	Personal Monitoring Data Included
434-02-0960	1	34142	8419787	Radiation Monitoring Protection // Historical Records Transmittal/Personnel Radiation History Files Health Physics Log Books 2/60, 5/63 Visitor Film Badge 4/61-6/63 Air and Smear Samples CY 1962 Site Survey Results CY 1959-60, 1962 Pu/Urine Re Box Originally Located at FRC Under Accession 430-80-0011 This Box was Contaminated Copied by an RCT on 5-2-2002 And Re-entered Under RTI 32Folder 17 Log Book Hotman 1964	**"Hot man" special bioassays (cpm), urine and blood, for late 1963-1964, Am.; by name and date/time (numerous repeats).**	Yes
430-80-0015		34144	8930435	Internal Dosimetry Logbooks // Special Analysis Logbook 1966-1969 (SR90 PO210 NP237 H3 TH) / Logbook 8/1963 - 3/1968 / Logbook 4/1968 - 9/1971 / Logbook Bldg 771 Fire 1957 / Stan Hammond Logbook 1965 / CSU Dog Study 3 Logbooks 1969 / Fluormeter Results 1962 / Hot Man Urine Sample Results 1962 1972 / Gross Alpha Urine Results 1962 1963 / Plutonium Surveys and Smears 1962 1963 / Miscellaneous Other Logbooks	**"Hot man" Book #1 Logbook containing special urine, fecal, and blood bioassays (cpm, dpm) for americium intakes for CY1963 and 1965; names and badge nos. Americium urine bioassay results for CY1963. "Hot man" Book #2 Logbook containing special urine and organ-specific bioassay sample results (cpm, dpm) for Pu and Am, and others (Cm-244, Pu-236, u-232). Several individuals followed for months. Special Analysis logs (1966for individual exposures to Sr-90, Po-210, Np-237, and H-3 by name and "man number." Balance of logs primarily Pu surveys, smears, gross alpha counts.**	Yes
434-98-0167		40448	8112886	Radiation Monitoring Protection / FILE #1; RAD OPS Logbook	This includes field radiological control monitoring information and daily activities.	No
434-98-0167		40448	8112887	Radiation Monitoring Protection / FILE #2; RAD OPS Logbook	This includes field radiological control monitoring information and daily activities.	No
434-98-0167		40449	8112876	Radiation Monitoring Protection / FILE #1; RAD OPS Logbook	This includes field radiological control monitoring information and daily activities.	No
434-98-0167		40449	8112877	Radiation Monitoring Protection / FILE #2; RAD OPS Logbook	This includes field radiological control monitoring information and daily activities.	No
434-98-0167		40449	8112878	Radiation Monitoring Protection / FILE #3; RAD OPS Logbook	This includes field radiological control monitoring information and daily activities.	No

Table 17-2. Records Sets Reviewed by SC&A March 12–16, 2007[6]

Accession No./ Microfilm No.	Box	Unique Receipt(s) No.	Bar Code	Description	SC&A Review Comments	Personal Monitoring Data Included
434-98-0167		40449	8112879	Radiation Monitoring Protection / FILE #4; RAD OPS Logbook	This includes field radiological control monitoring information and daily activities.	No
434-98-0167		40449	8112880	Radiation Monitoring Protection / FILE #5; RAD OPS Logbook	This includes field radiological control monitoring information and daily activities.	No
434-98-0167		40449	8112881	Radiation Monitoring Protection / FILE #6; RAD OPS Logbook	This includes field radiological control monitoring information and daily activities.	No
434-98-0167		40449	8112882	Radiation Monitoring Protection / FILE #7; RAD OPS Logbook	This includes field radiological control monitoring information and daily activities.	No
434-98-0167		40449	8112883	Radiation Monitoring Protection / FILE #8; RAD OPS Logbook	This includes field radiological control monitoring information and daily activities.	No
434-98-0167		40449	8112884	Radiation Monitoring Protection / FILE #9; RAD OPS Logbook	This includes field radiological control monitoring information and daily activities.	No
434-98-0167		40449	8112885	Radiation Monitoring Protection / FILE #10; RAD OPS Logbook	This includes field radiological control monitoring information and daily activities.	No
434-02-0748	1	43047	8418216	Radiation Monitoring Protection // Folders 1 thru 17 Contamination Control Logs 2-17-1982 thru 2-17-90 (Non-Inclusive)	Logbook primarily contain information related to contamination surveys, personnel contamination, notations of body counts and potential intakes, contamination spread incidents, decontamination activities, SAAM results and alarms, respiratory protection posting and deposting, and daily activities.	No
434-00-0138	1	46471	8255556	Radiation Monitoring Protection / Folder 2 Log Book, Decon Room 779	One page of contamination surveys of workers (not named)	No
434-03-1041	1	62098	85262777	Radiation Monitoring Protection // Folder 7 Log Book 777 Clean-up 05/21/1969 thru 12/08/1969	Nothing of note. All operational.	No
434-03-0568	5	62500	853134	Radiation Monitoring Surveys // Contamination Control Log Books Foreman Log Books	Various foreman logs for 1973-1981; no notable entries.	No
434-03-1042	1	62600	8562766	Radiation Monitoring Protection // 2 Foreman Log Books 776-777 6/15/1970 thru 2/17/1975	All operational entries; no particular high exposures cited. Mostly supervisory notes.	No
434-04-0088	23	63815	8593746	Building Operating Records // Folder 20 Foreman Log Building 776 05/18/1988 thru 09/05/1990	Foreman's Logbooks primarily contains information on work schedules and daily activities.	No
434-05-0680	2	69169	8722942	Radiation Monitoring Protection // Folder 8 RCT	Operational entries.	No

Table 17-2. Records Sets Reviewed by SC&A March 12–16, 2007[6]

Accession No./ Microfilm No.	Box	Unique Receipt(s) No.	Bar Code	Description	SC&A Review Comments	Personal Monitoring Data Included
				Log Book 07/06/1987 thru 10/01/1997 B444		
434-80-0003		73736	8930472	Radiation Monitoring Surveys // Surveys (Gamma-Neutron Contamination Cold Area and Equipment) for Buildings Non Pu Area 07/01/1978 thru 12/31/1978 / Surveys (Gamma-Neutron Contamination Cold Area and Equipment) for Buildings Non Pu Area 8/1975 / Air Contamination Experience Monthly Reports 01/01/1979 thru 12/31/1979 / Plant Incident Reports 01/01/1976 thru 12/31/1976 / Check List for Supplied Air Operation Building 776 01/01/1977 thru 12/31/1977 / Foreman's Logbooks BUILDING 776 02/01/1975 thru 10/31/1977 / Size Reduction Logbook 12/01/1973 thru 08/31/1977 / Addendum to Monthly Progress Reports 1/1962 / Monthly Progress Reports 1/1962 Buildings 71 74 76 77 / Report on Uranium Processing Areas 1/1962	This includes field radiological control monitoring information and daily activities.	No
434-80-0003		73736	8930472	Radiation Monitoring Surveys // Surveys (Gamma-Neutron Contamination Cold Area and Equipment) for Buildings Non Pu Area 07/01/1978 thru 12/31/1978 / Surveys (Gamma-Neutron Contamination Cold Area and Equipment) for Buildings Non Pu Area 8/1975 / Air Contamination Experience Monthly Reports 01/01/1979 thru 12/31/1979 / Plant Incident Reports 01/01/1976 thru 12/31/1976 / Check List for Supplied Air Operation Building 776 01/01/1977 thru 12/31/1977 / Foreman's Logbooks BUILDING 776 02/01/1975 thru 10/31/1977 / Size Reduction Logbook 12/01/1973 thru 08/31/1977 / Addendum to Monthly Progress Reports 1/1962 / Monthly Progress Reports 1/1962 Buildings 71 74 76 77 / Report on Uranium Processing Areas 1/1962	**Incidents report (1976–1979) contains contamination incidents in 707, 771 and 776.. by level and location of contamination, and individuals (by name) involved and subsequent WBC or other followup personnel monitoring results.** Monthly progress reports contain 881 and 444 contamination surveys: in general,considerable surface contamination; little airborne measured. Relatively high frequency of contaminated wounds cited (for 1963, 1,270 wounds reported, with 347 positive contaminated, with 174 with radioactive material remaining after debridement. Monthly progress reports useful for providing maximum and average penetrating dose levels by building and worker category.	Yes

Table 17-2. Records Sets Reviewed by SC&A March 12–16, 2007[6]

Accession No./ Microfilm No.	Box	Unique Receipt(s) No.	Bar Code	Description	SC&A Review Comments	Personal Monitoring Data Included
434-06-0331		74268	8856991	Building Operation Records // Folder 1 Radiological Engineering Logbooks (2 Logbooks) T690B 10/22/1991 thru 04/21/1994	This includes field radiological control monitoring information and daily activities.	No
434-06-0331		74268	8856991	Building Operating Records // Folder 1 Radiological Engineering Logbooks (2 Logbooks) T690B 10/22/1991 thru 04/21/1994	Daily entries re: reviews conducted, applicable requirements, status of audits, meetings. Etc. No identified rad data of use.	No
		SA1215		Historical Records Transmittal/Product and Health Physics Research Records/Box 1/1 Fire File from Bldg 776 Fire 5/11/69/2. Contributory Information/ 2-2 Fire Department/ 2-3 Health Physics/ 2-4 Nuclear Safety/ 2-5 Testimony of Call-INS/Interviews/Testimonies	Not located at the Legacy Management Facility - Classified	Unk
		SA1869		Historical Records Transmittal/Product and Health Physics Research Records/Box 1/1 Fire File from Bldg 776 Fire 5/11/69	Not located at the Legacy Management Facility - Classified	Unk
434-03-0531	2	SC1738	8526752	Radiation Monitoring Protection // IIR Log Book 1/1/1988 thru 12/31/1988 Bldg 771	Just notification status with dates. Only one page.	No
434-03-0531	2	SC1738	8526754	Radiation Monitoring Protection // Tritium Log Book 1/1/1986 thru 12/31/1986 Bldg 771	Couple of pages of tritium smear sample results for 771 by location.	No
434-03-0531	2	SC1738	8526759	Radiation Monitoring Protection // 5 Books Shift Log Books 1989 to 1990 1987 to 1988 1982 to 1983 1984 to 1985 1985 to 1986 Bldg 771	Operational daily entries related to monitoring by RCTs.	No
434-03-0531	2	SC1738	8526762	Radiation Monitoring Protection // SEA Log Book 1980 Bldg 771	Contains entries for "Supplied Air Log" for non-Pu areas by name/date -- check out equipt.	No
434-03-0531	2	SC1738	8526763	Radiation Monitoring Protection // 3 Books Monitoring Log Books 1984 to 1985 Bldg 771	Counts of number of workers monitored and number contaminated. Daily entries on workplace monitoring, including alarms, contamination, etc.	Minimal
434-03-0531	1	SC1740	8526748	Radiation Monitoring Protection // 16 Books Contamination Control RPT Log Books 1982 1986 1985 1987 1986 1988 1990 and 1989 Bldg 771	Nothing of note. Operational entries.	No

Table 17-2. Records Sets Reviewed by SC&A March 12–16, 2007[6]

Accession No./ Microfilm No.	Box	Unique Receipt(s) No.	Bar Code	Description	SC&A Review Comments	Personal Monitoring Data Included
434-03-0531	1	SC1740	8526749	Radiation Monitoring Protection // 6 Books Contamination Control RPT Foremans Log Books 1971 1976 1983 TO 1984 1985 and 1987 Bldg 771	Nothing of note. Operational entries.	No
434-03-0574	47	SE7283	8522915	Radiation Monitoring Surveys // Log Book Bldg 559 9/1/1990 thru 9/30/1990	"Resumption" of operations surveys with limited logbook entries. Nothing notable.	No
434-03-0574	55	SE7709	8523011	Radiation Monitoring Surveys // Log Book Bldg 371 1/1/1984 thru 12/31/1986	Daily sampling survey status info.	No
434-03-0532		SE7720	8523108	Radiation Monitoring Surveys // Logbooks 1 thru 7 Bldg Unknown (Site) 1984 thru 8/31/1989	Limited operational-related entries.	No
434-03-0790	2	SE8916	8526511	Radiation Monitoring Protection // Radio Assay Log Book Daily Samples Bldg 881 10/14/1987	Contains raw daily sample counts for various areas 460, 444, 865, 889, 883, 881, 771, 707.	No

ATTACHMENT 18: ROCKY FLATS PLANT DATA INTEGRITY EXAMPLE RESPONSE

SC&A's evaluation and responses provided below are to the responses provided by NIOSH/ORAUT to data integrity and other concerns raised in the Rocky Flats petition; the Advisory Board meeting in Denver, Colorado, on April 26–27, 2006; and interviews with petitioners, advocates, and former workers. The summary of the concerns, along with the entire NIOSH/ORAUT evaluation, is provided below for reference. The responses provided by SC&A are not limited to the issues raised in the concerns, but may encompass SC&A's own concerns regarding the comments. This is especially true if issues relate to other findings raised in this report. The topics raised by the commenter were not limited to data integrity issues, but covered a diverse set of topics. Personal identifiers were removed from the response to protect the identity of individuals. The claimant status originally reported by NIOSH is included; however, this information is not used directly for this evaluation. SC&A based its comments on the original affidavit or information provided in transcripts.

EXAMPLE 1

Source: SEC Petition 00030, Part B, page 14

Claimant Status: POC greater than 50%, underestimate

Concern: *Fire on 9/11/57, Building 771, spread of contamination throughout building and contamination released in Building 771*

NIOSH Response: The individual submitting the affidavit is a claimant, and his dose reconstruction has been completed. It is clear that contamination incidents occurred throughout the operating history of Rocky Flats. As this dose reconstruction demonstrates, the doses resulting from such incidents can be estimated. Doses from internally deposited radionuclides are estimated from bioassay results, and external doses are measured using film badges or TLDs.

SC&A Response: On September 11, 1957, a fire was discovered in a Plexiglas glovebox in a development laboratory in Building 771. Plutonium casting residues self-ignited and ignited the plexiglass wall of the glovebox. Several kilograms of plutonium were involved. The fire spread through the glovebox ventilation system, two stages of the absolute filters, and into the main exhaust system. Because of backpressure in the exhaust system, contamination was spread throughout most of the building. An operator was working with a can with 1,500 g of plutonium and a bath of carbon tetrachloride. He left the area and when he came back, the chips were burning. He tried to relocate it to an appropriate area, but accidentally dropped it into the carbon tetrafluoride bath. An air sampler 15 feet from the explosion accumulated 11 ug of plutonium. Other samples were much less and concentrations in the office area did not exceed the Recommended Concentration Guide (RCG). The room was evacuated except for three operating personnel who first unsuccessfully tried to cover the opening in the box (Piltingsrud 1966). This affidavit is providing information on one of what can be considered the five major incidents that occurred at RFP. The affidavit is primarily providing information that should be considered.

NIOSH/ORAUT should verify that those involved in fighting the fire, decontaminating and replacing equipment, and demolition of the building in later years were appropriately monitored.

There is no issue defined in this affidavit that requires a response.

EXAMPLE 2

Source: SEC Petition 00030, Part B, page 16

Claimant Status: Non-claimant

Concern: *10/15/65 Fire in Glovebox 752 in Building 776/777, 25 people received internal depositions, some as high as 30 times the maximum allowable lung dose, which equated to 480 nanocuries. 25 of these people were restricted from Pu work areas, by Jan. 1967, 14 people had their restriction lifted.*

NIOSH Response: Summary of information from Report of Investigation of Fire in Building 76-77 on October 15, 1965: Fifteen of 83 people counted received significant radiation exposure —greater than 0.008 microcuries in the lung. All personnel leaving Building 776 were requested to shower. Those leaving Building 777 with skin contamination were requested to shower. Decontamination was with soap and water. Twenty employees were sent to Medical for further decon and/or whole-body counting and possible DTPA treatment. Body counting was recommended for personnel who were highly contaminated and/or known to be in a location near the fire. Fifteen employees within the general area of the fire received inhalation exposures resulting in depositions of 0.008 to 0.17 microcuries in the lung. [End of summary]

It is clear that contamination incidents occurred throughout the operating history of Rocky Flats. The doses resulting from such incidents can be estimated. Doses from internally deposited radionuclides are estimated from bioassay results, and external doses are measured using film badges or TLDs.

SC&A Response: On October 15, 1965, a fire in a plutonium fabrication plant resulted in a large-scale spread of plutonium oxide. Maintenance was attempting to unplug an oil coolant line on a lathe, and plutonium metal caught fire. The fire occurred outside a glovebox in a 70,000 sq. ft. production area. Air sample results ranged from $>10^{-6}$ uc/cc down to 10^{-12} uc/cc at the most remote locations. About 400 employees were working in the room at the time. Many did not have time to don their respirator with the rapid contamination spread. Initially, those with nose and mouth contamination were counted. In subsequent days, additional positive lung counts were identified. As a result, the decision was made to count all 400 personnel that were in the building at the time of the fire. As reported, 25 individuals were found to have enough plutonium in their lungs to deliver a dose of at least 15 rem per year (Piltingsrud 1966).
The 1965 fire involved "high-fired" plutonium oxide with a submicron particle size (Piltingsrud 1966), measured at 0.32 micron. The names of the 25 individuals with positive depositions of plutonium can be found in *Files on the Five Major Incidents at the Rocky Flats Plant* (Plott 1986). Although those 400 individuals working in the room received lung counts immediately after the incident, it is uncertain whether bioassay sampling was conducted for these individuals.

It is also unclear if the employees were periodically evaluated to identify intakes from high-fired oxide that may show up years later. This affidavit is providing information on one of the five major incidents that occurred at RFP that should be considered in dose reconstructions, especially with the known presence of high-fired oxide**.**

There is no issue defined in this affidavit that requires a response.

EXAMPLE 3

Source: SEC Petition 00030, Part B, page 20

Claimant Status: Non-claimants

Concern: *Air sample on 10/16/00 was out of calibration in Building 771 Room 186 Tent. Eleven people gave fecal samples, all had exposures, 3 had exceeded dose limits. It was shown that there had been an acute inhalation, an acute ingestion and an acute inhalation. Kept out of Pu areas for a period of time. Concern is for future health.*

NIOSH Response: The CAM was out of calibration; however, it was determined that the CAM was working properly.

Summary of information from the RF Citizens Advisory Board Minutes of Work Session held May 17, 2001, available at: http://www.rfcab.org/ Minutes/5-17-01.html: Eleven workers received unexplained uptakes in Building 771. Ten of those workers had an exposure in the range of 6–60 mrem. The other worker had a dose slightly higher than 100 mrem. Another 46 individuals volunteered for exposure tests, 28 had a dose above decision level ranging up to 55 mrem. A team was then established to investigate the source of the exposures; the investigation was completed in March 2001. It was determined that the exposures most likely were caused by low levels of airborne Pu from rad work activities over time, and exacerbated by D&D activities. Immediately following the incident, work in the affected tent area was suspended, and overall work was curtailed in Building 771. Additional samples were requested, and respirator cleaning, testing, training, and use were assessed. An extensive contamination survey of Building 771 was performed, and additional containment was placed on gloveboxes awaiting size reduction. Some of the corrective actions recommended by the report include the increased use of respiratory protection for D&D and waste handling activities, and improved control of potential airborne radioactivity areas, lessons learned, train RCT's, to other projects and to train site RCTs on lessons learned; increase the ventilation or air flow in Building 771; provide independent radiological protection assessments; improve the facility's air monitoring program; establish independent review of D&D tent design and ventilation; and evaluate the site's calculation of potential intake factors. The room 186 tent was disassembled and disposed as waste. The number of radiological protection staff was increased, and equipment, gloveboxes, etc., being used in activities were surveyed weekly for contamination. In addition, baseline contamination surveys in overhead spaces were performed. [End of summary.]

While this was an important event, this is not an SEC issue as NIOSH dose reconstructions at Rocky Flats rely on direct personnel monitoring, rather than air monitoring. Bioassay and whole-body counts were initiated for the individuals involved, and intakes were detected in some cases. This data could be used by NIOSH for dose reconstruction.

SC&A Response: Eleven individuals were asked to submit fecal samples when an air sampler in the area was determined to be out of calibration. Acute and chronic intakes were discovered in all eleven of the individuals. Engineering controls were in place for the job, but failed. Although this raises questions regarding the quality of the air-sampling program, the individuals in this case received bioassay sampling. Assuming workers performing the same or similar jobs were on routine bioassay programs, intakes would likely be caught.

Concurrence with NIOSH/ORAUT that this is not an SEC issue.

EXAMPLE 4

Source: SEC Petition 00030, Part B, pages 22–30; (see also Example 25)

Claimant Status: Dose reconstruction has not yet been completed.

Concern 1: *Dose records are inadequate for administrative employees located in Building 371.*

NIOSH Response: From the early 1990s forward, the policy at Rocky Flats and throughout the DOE weapons complex was that external dosimetry was only required for employees with the potential to receive greater than 100 mrem/yr. This assessment was based on the job function as well as the measured dose rates for individual work areas. The concerns expressed in this affidavit and supporting material primarily relate to disagreements the employee has with assumed parameter values (primarily occupancy factors) used by the site in assessing whether she should have been monitored. While this is an important issue, and may be germane to how unmonitored dose is assigned in her dose reconstruction, NIOSH believes that these issues do not have SEC implications. At worst, in the case of an unmonitored worker who had the potential for significant radiation exposure, NIOSH could estimate unmonitored dose based on coworker data.

SC&A Response: NIOSH/ORAUT has several methods for assigning missed dose to workers. This includes assignment of dose based in the minimum detectable dose of the dosimeter and the number of exchange periods, or in case of potential for exposure they can apply a coworker model. The validity of the external coworker model is discussed further in Section 4.0 of this report. Decontamination and Decommissioning workers are discussed in Section 8.0 of this report. The criteria used by RFP to monitor workers during any period of time should be fully evaluated to determine if inadequacies exist in how monitoring was determined.

Concurrence with NIOSH/ORAUT that this is not an SEC issue.

Concern 2: *Zeros that should read as extremely high doses.*

NIOSH Response: On SEC Petition 00030, Part B, page 23, it is stated “At minimum, six of the missing doses were for instances when my report came back “no data available”, and coincidentally, these doses are associated to times I worked inside of a vault for inventory or performed other high-dose activities. On September 10, 2004, a nuclear researcher at Rocky Flats informed me that, "If the films were too dark to read due to high exposure, zeros were assigned for those badge readings. I recall some high doses that are not included in my provided records." This appears to form the basis for the concern expressed on page 24 that there are "zeros that should appear as extremely high doses." The "no data available" dose reports the employee refers to are the periodic dosimetry reports issued to supervisors following each badge exchange cycle. These reports were sometimes posted and signed or initialed by the employees. The entry "no current data available" indicates when a badge wasn't available for reading at the time the report had to be issued due to any of several possible reasons, including (1) the badge was not exchanged on schedule, but rather retained by the employee for an additional badge wear cycle (2) the dosimetry department was not able to complete the badge reading due to workload, (3) a problem with the badge necessitating a dose reconstruction/ investigation. The entry "no data available" or "no current data available" has never been observed by NIOSH in any worker's radiation file, which contains the dose of record and is the data used for dose reconstruction. Rather this entry has only been observed on the supervisor's reports, which are not used for dose reconstruction. A blank or zero could indicate a period when a badge wasn't returned at the scheduled badge exchange, but was rather retained by the worker for an additional badge exchange cycle. In this situation, all dose recorded on the badge was recorded in one badge exchange cycle, and a blank appeared in the record for the other exchange cycle. A zero entry in the dosimetry records could also indicate that there was no positive dose recorded on the badge. Whenever a blank or zero appears in the dosimetry record, missed dose is assigned.

The employee states that she was told by a nuclear researcher that films too dark to read were assigned zero dose. First it must be noted that the issue of films that were too dark to read would only apply during the period when film badges were in use at Rocky Flats. The site transitioned from films to thermoluminescent dosimeters (TLDs) in the 1969–1971 timeframe. This employee worked at Rocky Flats beginning in 1983; therefore, all of her external dosimetry would have used TLDs rather than films. The issue of film darkening would not be relevant for this employee. However, since she mentions the nuclear researcher, NIOSH contacted this researcher on August 9, 2006. His services have been engaged by SC&A in support of their activities related to the Rocky Flats SEC petition, and numerous public comments indicate that he is a source widely trusted by the petitioners and workers. He stated that the assignment of doses in situations when film badges were too dark to read was determined by investigations/ dose reconstructions. It was not the practice to arbitrarily assign zero doses in these situations.

SC&A Response: The concerns raised in the affidavit can be summarized in the following statement.

> *A recorded dose of zero was assigned when there was exposure to extremely high doses. The worker's job scope involved hands on processing of plutonium. The worker was required to initial her dose record biweekly. At a minimum, six of the missing doses were for instances when the report came back "no data available" and coincidently this corresponded to work inside the vault area and other high dose activities. The individual was informed by RFP health physics staff that if the films were too dark to be read, a value of zero was recorded (USTW 2005).*

Issues regarding the dosimeter results not reflecting the field exposure conditions have been raised many times during the course of this review. Several explanations have been offered by NIOSH/ORAUT. NIOSH/ORAUT stated in *21 March 2006 SC&A Comments and NIOSH Responses* (NIOSH 2006):

> *Pre-1964: A blank indicates a period when the worker was not monitored. This situation will be dealt with by applying unmonitored dose using coworker data (for radiation workers), or by applying ambient environmental dose (non-radiation workers). A zero indicates a monitored period when there was no positive recorded dose. This situation will be dealt with by applying missed dose.*

For the years 1964 and after, NIOSH states:

> *1964 and after: A blank or zero could indicate a period when a badge wasn't returned at the scheduled badge exchange, but was rather retained by the worker for an additional badge exchange cycle. In this situation, all dose recorded on the badge was recorded in one badge exchange cycle, and a blank appeared in the record for the other exchange cycle. A zero entry in the dosimetry records could also indicate that there was no positive dose recorded on the badge. In any case, whenever a blank or zero appears in the dosimetry record, missed dose is assigned.*

Individuals indicated that they were diligent about turning in their dosimeters. When an individual did not turn in a dosimeter on time, a letter was issued to the employee and a copy was put in their dosimetry file. There were times when badges were turned in late, but this cannot explain all "no data available" or unusual dosimeter results. Review of results from the dosimeter processing logsheets indicates that notations were made when a badge was not turned in. This is easily verifiable for years where dosimetry processing logbooks are available. There has been no apparent attempt by NIOSH/ORAUT to validate whether individuals raising this issue actually kept their badge for an extra exchange cycle. Furthermore, they have chosen to excuse secondary dosimetry results that may serve as a supplemental source of data to validate whether exposure occurred. Some external dosimetry logbooks also indicated when there were missing crystals or other issues with the badge. Again, these could be used to verify that the "no data available" was the result of a damaged dosimeter.

The explanation may certainly explain some situations where workers recollect seeing "no data available," but it could not explain all the situations where workers note significant discrepancies between dosimeters and field exposure conditions.

NIOSH/ORAUT response is incomplete. An adequate explanation has not been offered.

<u>Concern 3</u>: *Accuracy of the dose readings due to the lead shielding provided by the lead aprons worn for bag cuts.*

NIOSH Response: Lead aprons were available and used for a limited number of tasks at RFP. For most years, workers were instructed to wear badges under the lead apron to measure dose to the torso. In 1992, this was changed to instruct workers to wear the dosimeter outside the lead apron to better measure the dose to the head, neck, and arms. Field studies to determine the dosimeter response in both locations were performed. The results of these studies were used to develop bias corrections to use for dose reconstructions. The use of lead aprons does not preclude sufficiently accurate dose reconstruction. As a result, NIOSH concludes this issue does not have SEC implications.

SC&A Response: Field studies conducted by RFP have allowed NIOSH to develop external dose correction factors for conditions where lead aprons were worn by workers. Dose correction factors are to be incorporated into the RFP External Dose TBD (Langsted 2007). Further discussion of whether the dose correction factor is adequate for unshielded portions of the body should be addressed in the site profile review.

Concurrence with NIOSH/ORAUT that this is not an SEC issue.

Concern 4: *The significant dose that was not recognized during her salaried years as technical support with her office areas located within feet of the production area.*

NIOSH Response: As in point number 1 above, the primary concern here is the decision by the site not to assign external dosimetry for this worker during a portion of her employment during which it was judged that she did not have the potential to receive 100 mrem/yr or greater. During the years she was unmonitored, the site did not assign external dose. In its dose reconstructions, NIOSH considers and assigns unmonitored dose, as appropriate. There is nothing in the evidence presented here that would prevent NIOSH from calculating unmonitored dose in this situation. On the contrary, the supporting material provides the results of work area surveys and occupancy factors, which could inform the calculation of unmonitored dose. Therefore, NIOSH concludes that while this issue is important, it does not have SEC implications.

SC&A Response: There were situations where personnel were not expected to receive exposure; however, service areas (e.g., cafeteria, security posts, Health Physics offices) were on the other side of the wall from processes. For example, the cafeteria in Building 771 was located on the other side of the wall from the "Old Plutonium Production" line. This created low dose rates in the service areas, as there was not sufficient shielding. Health Physics conducted background studies and area-monitoring data is available to validate the appropriateness of the missed dose assignments used in dose reconstruction.

Concurrence with NIOSH/ORAUT that this is not an SEC issue.

Concern 5: *Dose adjusted for 40-hour workweek rather than actual work time of 45+ hours.*

NIOSH Response: The length of the workweek would only impact dose estimates derived using source-term calculation. At RFP, NIOSH is using individual dosimetry results in a great majority of dose reconstruction. For situations where dosimetry is not available or is inadequate, NIOSH may rely on coworker data. Furthermore, if source term calculations were relied upon, the length of the workweek could be adjusted in a claimant-favorable manner.

SC&A Response: To summarize the concern raised, the area dosimetry showed measurable dose in the electric shop (2,844 mrem/yr), the planners' office (2,120 mrem/yr), and the women's locker room (284 mrem/yr). Radiological Engineers documented an occupancy factor of 1/16 of the workday. This was not an accurate assumption, and actual work time exceeded 40 hours per week. The area dosimetry program is often used to define boundaries where workers are likely to require monitoring. NIOSH/ORAUT should further evaluate who was monitored versus who should have been monitored. Also, the background numbers provided above serve as data validation points for missed dose calculations.

Concurrence with NIOSH/ORAUT that this is not an SEC issue.

Concern 6: *Methodology used to determine her dose.*

NIOSH Response: This concern deals primarily with the methodology used to calculate doses from potential exposure to high-fired plutonium oxides. NIOSH has detailed the methodology it will use in such situations in ORAUT-OTIB-0049. Potential exposure to high-fired oxides does not prevent NIOSH from conducting dose reconstructions of sufficient accuracy.

SC&A Response: The underlying issue here is the potential implications of high-fired oxide to dose reconstruction. A technical information bulletin, ORAUT-OTIB-0049, has been developed by ORAUT to determine dose as a result of intakes from highly insoluble plutonium. A detailed assessment of the RFP high-fired oxide issue is discussed in detail in Section 3.0.

With the release of ORAUT-OTIB-0049 (ORAUT 2007b), NIOSH/ORAUT defined the scope for application of their highly insoluble plutonium.

> *Plutonium oxide (especially the high-fired variety) is one of the most insoluble forms of plutonium (ICRP 1994, personal discussion with C.W. Sill) typically encountered in the workplace. However, it is not feasible to exclude the possibility that soluble forms of plutonium might become more insoluble over time (La bone, T.R. and W.M. Findley 1999; J.C. Moody, G.N. Stradling, and A.R. Britcher 1994). Therefore, the TIB is assumed to apply if the form of the plutonium is not known. This is used as an additional possibility of material type; all possibilities are calculated and the type resulting in the largest dose is applied to be favorable to the claimant.*

In the *NIOSH Response to SC&A Draft Report on Data Integrity*, NIOSH stated that they had addressed this issue in a December 19, 2006, e-mail between NIOSH and SC&A. In response to "Where have you documented which workers will be assessed according to ORAUT-OTIB-0049," NIOSH provided the following answer (NIOSH 2007).

> *OTIB-49 is now being finalized. Once it is signed, we will initiate a Program Evaluation Report to revisit completed claims with a POC<50% to see which*

> *should be revised in accordance with the new OTIB. In practice, the claims with the greatest potential to be revised are noncomp lung cases, because assuming super S solubility is claimant-favorable in these situations. Claims completed after OTIB-49 comes into force will be completed in accordance with the OTIB.*

This response indicates that noncompensable lung cancer cases will be revisited. SC&A recommends that NIOSH/ORAUT consider those exposed in other fires (e.g., 1969 fire, Tunnel fire) and during high temperature plutonium processing. Decontamination and Decommissioning workers are also at risk when they come in contact with residual material, especially in areas that only became accessible during the demolition of buildings and equipment. Although this is not an SEC issue, a more clearly defined scope in terms of the RFP worker categories may assist dose reconstructors in defining individuals potentially exposed to high-fired oxides.

Concurrence with NIOSH/ORAUT that this is not an SEC issue.

EXAMPLE 5

Source: SEC Petition 00030, Part B, page 32; (see also Example 34)

Claimant Status: Non-claimant

Concern 1: *Inaccurate Exposure Records: Missing records in 1982-1983, when working high dose job.*

NIOSH Response: The affidavit in the petition (USTW 2005, Part B, p. 32) states the following:

> *In 1982–1983 Loading nuclear material into the Stacker Retriever in Building 371, 6 quarter out of 8, there is no data available for my dose. This work had very high dose. Up to 8 R/hr. Operators assigned were routinely rotated, due to the high dose, but as a Radiological Control Technician I was not.*

A summary of this employee's dosimetry for the years surrounding the time in question (worker concerned about 1982–1983, surrounding years are 1979–1986) can be found in the rad file on pages 87–89 (time period mentioned by the worker in ***bold italics***):

Period	Penetrating dose (mrem)
1q 79	140
2q 79	0
3q 79	0
4q 79	0
1q 80	56
2q 80	205
3q 80	14
4q 80	88

Period	Penetrating dose (mrem)
1q 81	51
2q 81	0
3q 81	0
4q 81	0
1q 82	***0***
2q 82	***39***
3q 82	***0***
4q 82	***28***
1q 83	***34***
2q 83	***0***
3q 83	***0***
4q 83	***6***
1q 84	5
2q 84	0
3q 84	29
4q 84	25
1q 85	0
2q 85	133
3q 85	206
4q 85	123
1q 86	102
2q 86	132
3q 86	109
4q 86	79

The main concern expressed by the worker was that there were no data available for his dose in 1982–1983. The worker was in fact monitored during the time period in question. The results from the years 1979–1986 show recorded doses varying from 0 to 206 mrem/quarter. Within this time period, the doses in 1979 and 1982–1984 were comparatively lower, and the years 1980 and 1985–1986 comparatively higher.

The worker expressed some concern that the data were missing during a time he was working in an area that reportedly had dose rates as high as 8 R/hr. The area in question is a large, warehouse-like room where pits were stored. The stacker/retriever mentioned in the affidavit was a piece of equipment resembling a robotic forklift. Pits or other items were placed on the stacker/retriever, which then placed the items into the storage area. The reason a robotic stacker/retriever was necessary was that the storage area was maintained in an inert atmosphere (argon gas). Workers could not enter this area, as this would have been quickly fatal. The only place a radiation field as high as 8 R/hr would have existed in this area was inside the storage area, which was inaccessible to workers. It is very plausible that the entire area would have been posted at 8 R/hour in case of an emergency to inform responders on the maximum dose rates that could be present. Dose rates in areas accessible by workers would have been much lower. As NIOSH has repeatedly discussed, areas were posted with the maximum possible dose rates, and such postings were not intended to be representative of dose rates actually experienced by workers. This is an example of just such a situation. It is easy to understand how a worker in the field could have the impression that he was receiving a high dose (based on postings of maximum dose rates) and be perplexed when his dosimetry results did not reflect this.

<u>SC&A Response</u>: Further discussion with the individual making the comment indicated he was not referring to the absence of the data from his file, but the little or no dose he received while working on this project.

SC&A has reviewed the analysis put together by NIOSH. A summary of this employee's dosimetry for the years surrounding the time in question (worker concerned about 1982–1983, surrounding years are 1979–1986) can be found in the rad file on pages 87–89 (time period mentioned by the worker in ***bold italics***):

Period	NIOSH Determined Penetrating dose (mrem)	Penetrating Dose (mrem) Per Hardcopy Record
1q 79	140	56
2q 79	0	205
3q 79	0	14
4q 79	0	88
1q 80	56	51
2q 80	205	0
3q 80	14	0
4q 80	88	0
1q 81	51	0
2q 81	0	39
3q 81	0	0
4q 81	0	28
1q 82	***0***	***34***
2q 82	***39***	***0***
3q 82	***0***	***0***
4q 82	***28***	***6***
1q 83	***34***	***5***
2q 83	***0***	***0***
3q 83	***0***	***29***
4q 83	***6***	***25***
1q 84	5	0
2q 84	0	33
3q 84	29	206
4q 84	25	123
1q 85	0	102
2q 85	133	132
3q 85	206	109
4q 85	123	79
1q 86	102	118
2q 86	132	162

Period	NIOSH Determined Penetrating dose (mrem)	Penetrating Dose (mrem) Per Hardcopy Record
3q 86	109	97
4q 86	79	107

Note that the NIOSH results vary from those observed by SC&A in the hardcopy files. It appears as though NIOSH shifted its values by a year.

NIOSH/ORAUT in their response to the SC&A draft data integrity example report indicated that they are more capable of interpreting the concerns raised than the individual who wrote the affidavit stating that the individual clearly stated he was concerned about the missing data. In conversations with the individual involved, he was asked why he felt there were no doses for six out of eight quarters in 1982 and 1983, when there were numeric values in his record. He clarified his statements in the affidavit. When the individual originally received his data, the fields for the six quarters in question had no readings. During the 1990s, the doses were apparently changed to zeros or single-digit doses. The concern expressed in the affidavit is not the physical absence of results, but rather the apparent underestimate of exposure given his involvement in the Stacker Retriever job. He also offered an explanation for why it was possible to receive exposure when working outside the storage vault. The Stacker Retriever area was a portion of the 371 building where components and other material were stored on pallets in a safe configuration. There was a small room adjacent to the storage area with a table where materials were hand fed into the retriever system. This required direct handling of components and other materials. Although one cannot enter the storage area, they could receive exposure when loading and unloading the system.

The *Technical Basis for Rocky Flats Plant – Occupational External Exposure* (Langsted 2007) indicates that RFP apparently recorded doses down to zero. If this individual were standing in a radiation field of 8 R/hr for 1 minute, the exposure would be 133 mR, as measured by a field instrument. This exceeds a typical minimum detectable dose. Since contact and 1-foot readings are taken on an intermittent basis, it is reasonable to assume an individual could spend one minute in an area at or approaching the maximum radiation field during the day. Any additional time would increase the accumulated dose. Even the 34 mrem in the first quarter of 1982 seems trivial compared to what might be expected. A technical explanation for this disparity has not been provided.

NIOSH indicated that areas were posted with the maximum possible dose rates, and such postings were not intended to be representative of dose rates actually experienced by workers. They have assumed that the individuals communicating the concerns simply "have the impression that he was receiving a high dose (based on postings of maximum dose rates)." This employee worked as a Radiation Monitor in the Plutonium Area. His responsibilities included coverage of jobs on various lines. He worked with Experimental Operators who handled non-traditional radionuclides and radionuclide mixtures. He was also exposed to tritium, but no monitoring data were available. What NIOSH has not taken into consideration is that many of those raising concerns regarding the accuracy of dosimeters were cognizant of the dose rates, as they had radiation instruments in their hand. Individuals raising these concerns were, indeed, aware of the radiological conditions around them.

NIOSH/ORAUT response is incomplete. An adequate explanation has not been offered.

Note: The individual's doses as provided in the original Data Integrity Example report incorrectly represented the doses in the Health Physics file. Later responses from NIOSH/ORAUT have included corrected results.

Concern 2: *Inaccurate Exposure Records: Contamination incident – lung count determined to be false positive.*

NIOSH Response: The affidavit in the petition states:

> *In either 1987 or 1988, an incident in Building 771 Room 114 Line 2 a glovebox bag came off. I was contaminated from head to toe and there was ten to the sixth contamination on my full-face respirator. There was no fecal sample taken but my lung count was positive. I was told that it was a statistical high and was recounted in another room. I was told that I had not received an inhalation. 8 years later, I was given a dose for this incident.*

This worker's radiation file does not contain an incident report exactly matching this description in the years 1987–1988. However, there is a description of a possible inhalation incident that occurred on March 3, 1986, found on pages 218–220 of the radiation file that bears some resemblance to the description provided in the affidavit. This incident occurred in Building 771, Room 114 Box 2 (pg. 219), and no dose was assigned for this incident based on bioassay and whole-body count results, which is consistent with the worker's description. Contamination on the body or clothing of an employee can affect the results of lung counts. It is consistent with known practices at Rocky Flats (and other sites across the DOE complex) that if an initial body count indicated a positive result, the worker would have been asked to shower and/or change clothes to ensure that the presence of external contamination was not causing a false positive result. This appears to be the case for the 1986 incident, as there are two body counts recorded on March 3. 1986, the first of which was positive, and the second was negative – in agreement with the affidavit. The expected 90-day recount, which was scheduled after suspected contamination incidents, is also recorded (June 26, 1986) and was negative.

However, there are also some discrepancies between the worker's description of the incident he is concerned about and the information on the March 3, 1986, incident in the file. The most obvious discrepancy is the date, (worker concerned about an incident "in either 1987 or 1988," while the incident in the file occurred in 1986). The worker's description indicates that no fecal samples were taken, but the description of the 1986 incident provides results of fecal samples.

The bottom line is that there is not an exact match between the description in the affidavit and any incident report in the worker's rad file. However, there is an incident recorded in the file that occurred in the right location at **approximately** the right time.

SC&A Response: Assuming the site used a detection level at the 95% confidence level, it is expected that there would be a false positive rate of 5%. In these conditions, a follow-up count would likely occur at a higher sensitivity (e.g., different type of count, longer count, more sensitive instrument, etc.) At the detection level, when a positive is observed either the result is accepted or the individual is counted again to gain better sensitivity. For cases where individuals have bioassay doses at or below the detection level, NIOSH determines the dose by using the urinalysis data, which were available in this case.

Concurrence with NIOSH/ORAUT that this is not an SEC issue.

Concern 3: *Inaccurate Exposure Records: Positive fecal samples in 2000.*

NIOSH Response: The affidavit in the petition states:

> *In 2000, I voluntarily gave 3 fecal samples and they came back positive. I was not involved in any incidents. I was actually on restriction because of back surgery and was only in a Radiological Area for 2 months before the samples. This was the first time I ever gave a fecal sample voluntarily or involuntarily in my entire career.*

A detailed review of the rad file for previous fecal samples was not performed; however, it is noted that the worker's rad file shows fecal samples taken on March 4, 1986, as a result of the previously described incident (pg. 220). There is indication of other fecal samples taken on October 29, 1982 (page 257) and in August 1995 (page 52). This does not agree with the worker's statement that the fecal samples given in 2000 were the first of his career. Pages 50–70 of 268 in the rad file describe the fecal samples taken in December 2000, and mentioned in the affidavit. Two of the three samples showed detectable levels of Pu, and an extensive internal dosimetry dose assessment was performed.

NIOSH concludes that there is nothing presented in this affidavit that would compromise our ability to perform dose reconstructions of sufficient accuracy.

SC&A Response: It is difficult for an employee to forget submitting a fecal sample. NIOSH/ORAUT limited their evaluation to the Health Physics file. The bioassay logs for this time period should be checked to evaluate whether data are available from this source. Files have been identified for some workers that were incomplete so verification by a second source is prudent. A detailed analysis of Health Physics file completeness is provided in Section 9.0.

NIOSH response is incomplete.

EXAMPLE 6

Source: SEC Petition 00030, Part B, pages 34–35 (see also Example 32)

Claimant Status: Non-claimant

Concern 1: *High-fired oxides*

NIOSH Response: NIOSH agrees that there is evidence of high-fired Pu oxides at the Rocky Flats Plant. The presence of such materials does not, however, affect the feasibility of dose reconstructions. ORAUT-OTIB-0049 describes the methodology NIOSH will use in dose reconstructions potentially involving super S plutonium.

SC&A Response: See response to 4-6.

Concurrence with NIOSH/ORAUT that this is not an SEC issue.

Concern 2: *No bioassays taken when a furnace in Building 776 (Molten Salts Building) was loaded, heated and over pressurized causing it to vent to the atmosphere in the room where personnel were without respiratory protection.*

NIOSH Response: This incident is difficult to evaluate, as no approximate timeframe is given. It is not clear from the affidavit whether the employee was actually involved in the incident described, or whether he is relating an incident that involved other employees. If the employees involved were on a routine bioassay/whole-body counting schedule, then intakes resulting from such incidents may have been detected through those measurements, even if no special bioassays were taken at the time. However, it would be odd for no special bioassays or whole-body counts to be taken in the event of a potential contamination incident, as this individual's radiation file, and the radiation files of other individuals NIOSH has examined, contain many examples of whole-body counts and bioassays performed as a result of similar incidents. Not enough information has been provided to determine whether such bioassays/whole-body counts were taken.

SC&A Response:

Concurrence with NIOSH/ORAUT that this is not an SEC issue.

Concern 3: *Injury due to metal in the leg, resulting in direct blood uptake of high-fired oxides.*

NIOSH Response: According to this person's radiation file, a wound to the leg happened in September of 1969. The wound count found no contamination of this wound. This would argue against an intake.

SC&A Response:

Concurrence with NIOSH/ORAUT that this is not an SEC issue.

Concern 4: *No data available and darkened badges.*

NIOSH Response: Entries of "no data available" indicate instances when either the badge was not turned in at the scheduled badge exchange, or the badge was turned in but there was a problem with the dosimetry badge. Investigations of such problems sometimes delayed the reporting of a worker's dose so that it was unavailable at the time the dosimetry reports for that cycle were issued. In this situation, "no data available" would appear in the dosimetry report issued to supervisors until the investigation was complete. These entries are not found in individual worker's radiation file that is used by NIOSH for dose reconstruction. Upon completion of the investigation, the measured or assigned dose would then be recorded in the worker's dosimetry record. Depending on the timeframe, the results of these investigations were documented in the worker's Health Physics file, and may or may not have been communicated to the employee at that time.

It is well known that films can also be blackened by exposure to light. In most cases, film blackening due to light contamination can be distinguished from blackening due to exposure to ionizing radiation. Extreme environmental conditions such as exposure to high temperatures can cause film fogging (Kathren 1966, pp. 61–63; Brodsky and Kathren 1963, pp. 453–461).

If a badge was blackened due to light contamination, or exposure to high temperatures, it is likely that an investigation would have been conducted to determine the appropriate dose.

SC&A Response: This is another example of a situation where exposure conditions were high, yet badge results were zero. The general response provided by NIOSH is that impossible or high counts would be the result of exposure to light or high temperatures, and that an investigation would have been conducted to determine the appropriate dose. It so happens that the examples of overexposed or suspicious badge readings coincide with situations where individuals were working on high exposure jobs. A discussion of dosimetry investigations can be found in Section 5.2 of the review report.

Concern 5: *No enforcement for proper storage/placement for TLDs.*

NIOSH Response: A concern has been raised that some dosimeter control badges were stored in areas of elevated radiation prior to 1977. Such a situation could result in the personnel dosimeters being over-corrected for background radiation. To remedy such a problem, NIOSH would adjust the ambient environmental dose NIOSH assigns during dose reconstruction. However, substantial research on this topic does not support the general concern.

From the start of RFP radiological operations until January 1976, it appears that dosimeter background was determined from either laboratory blanks or control dosimeters stored on the storage boards with the dosimeters. There was some discussion that, in that period, storage boards may have been moved to lower dose locations because the background dose from the facility was unacceptably elevated. To evaluate this issue, records review and interview programs were initiated. Approximately 18 boxes of external dosimetry program records were reviewed. These records included weekly and monthly status reports from the 1950s, 1960s, and 1970s, and some technical documents generated during that period. Approximately 500 pages of documents were identified as potentially relevant to this issue. No evidence of an identified high background radiation level was found. No evidence of action to reduce storage board background was found. Interviews were conducted with four retired dosimetry program managers. Each of these individuals was asked if they recalled this issue or actions taken in response to such a problem. None of the four recalled storage board background as a problem. Most recalled that elevated storage background was not significant and did not affect the dosimetry results. From this review, it is concluded that elevated ambient levels of external radiation were not a problem at Rocky Flats during the 1951–1976 time period. From 1977 to February 2000, a plant-wide standard background was subtracted. For dosimeters collected from March 2000 through 2003, badge storage background dosimeter results were used. These background dosimeter results were averaged over a five-quarter rolling period. The initial results of this process indicated a background that is a 14% increase over the calculated site average (standard deviation = 16%).

If the employee's dosimeter were stored in a location where it was exposed to radiation, this exposure would cause his dosimeter badge to register additional dose that he didn't actually receive. The NIOSH dose reconstruction would incorporate this overestimate of his dose, benefiting his claim under EEOICPA.

SC&A Response: Workers are concerned about the background subtracted from badges and how this was influenced by the storage location. The radiation background at the Dosimeter Exchange Board was monitored by a TLD placed in the rack along with those worn by personnel. The methodology used for background subtraction has varied over time. Lagerquist (1975) indicated, effective January 1986, that the total background subtracted from dosimeters would be environmental background (0.34 mRem/day) with instrument background. TLD operating procedures in 1983 also indicated that the total background subtracted was determined from environment and instrument background (RI 1983). The *Background Subtraction Methodology Study* was conducted the second quarter of 1999 at locations across the site. This study indicated that using a location-specific background may create potential problems because the dosimeters were not always stored at the assigned location. Furthermore, the study indicated subtracting backgrounds by location will generally reduce the reported dose (Klueber and Savitz 1999). A TLD background subtraction based on whether the location of the storage area was in a hard-walled or non-hard walled building was implemented (RMRS 1999). In 2001, the actual TLD element residual signal together with a time-dependent and location-dependent background, results in a TLD specific background, which is subtracted from the personal dosimeter (RFETS 2001). Methods for background subtraction prior to 1976 were not located. The concern here is whether the location-specific background level is appropriate for background subtraction. Based on documentation reviewed, the location-specific background was not used until 1999. In 1999, studies were conducted and a revised methodology was implemented. The study included background level data by location. These data could be used to adjust dosimeter results as appropriate.

Concurrence with NIOSH/ORAUT that this is not an SEC issue.

EXAMPLE 7

Source: SEC Petition 00030, Part B, page 37

Claimant Status: Non-claimant

Concern: *This is a letter requested by the petitioner for information on how internal dose assessment methodologies changed over the years.*

<u>NIOSH Response</u>: The referenced letter describes the methodologies the site used to assign internal doses based on bioassay measurements. The first step in calculation of internal doses at Rocky Flats involved bioassay and/or whole-body counting. From these results, the methods used to calculate such quantities such as annual effective dose equivalent, committed effective dose equivalent, systemic burden, etc., have indeed evolved over time, as described in the letter included in the petition. However, it is important to understand that NIOSH does not rely on any of these subsequent calculations, but rather directly uses the bioassay/whole-body count results in dose reconstruction. Therefore, while the methods used at Rocky Flats to calculate these derivative dose quantities evolved in concert with the methods recommended by expert bodies such as the International Commission on Radiological Protection, these changes would not affect the way NIOSH conducts dose reconstructions. Therefore, the evolution of methods to calculate internal dose used by the site would not prevent NIOSH from conducting dose reconstructions of sufficient accuracy.

Limits of detection for bioassay and whole-body counting also improved over the years, allowing for the detection of even smaller uptakes, and these improvements are reflected in NIOSH dose reconstructions.

<u>SC&A Response</u>: This letter describes the basis for the calculation of internal dose over the history of Rocky Flats primarily describing the use of systemic burden, Annual Effective Dose Equivalent, and Committed Effective Dose Equivalent. The letter simply establishes which models were used to determine internal dose.

There is no issue defined in this affidavit that requires a response.

EXAMPLE 8

<u>Source</u>: SEC Petition 00030, Part B (3 affidavits)

<u>Claimant Status</u>: Non-claimants

<u>Concern 1</u>: *Work Practices: High-fired oxides* (USTW 2005, 1st affidavit, Part B, pp. 39–41)

<u>NIOSH Response</u>: NIOSH agrees that there is evidence of high-fired Pu oxides at the Rocky Flats Plant. The presence of such materials does not, however, affect the feasibility of dose reconstructions. ORAUT-OTIB-0049 describes the methodology NIOSH will use in the dose reconstructions potentially involving Super S plutonium.

<u>SC&A Response</u>: See response to 4-6.

Concurrence with NIOSH/ORAUT that this is not an SEC issue.

<u>Concerns 2 and 3</u>: *(2) Radiation exposures and doses have gone undetected, i.e., employees routinely removed lead-lined or water shielded glove port covers, did not put covers back on, then employees would sit in chairs with heads near open glove ports, dosimeter worn on chest, head exposure went unmonitored; (3) Removing cans of material and placing them under their* *arms or between their legs with no shielding.* (USTW 2005: Part A, p. 53, and 2nd affidavit, Part B, pp. 47–49)

NIOSH Response: The general concern expressed by the petitioner is that parts of workers' bodies might have been exposed to more radiation than their badge indicated because of shielding of the badge and heterogeneity in the radiation field. Concern 2 addresses work at gloveboxes where parts of a worker's body may have been in front of a gloveport, while their badge was not in front of a port. This is an understandable concern, however a brief discussion of the characteristics of the radiation fields in such situations may help alleviate this concern. If the radiation fields emanating through a gloveport were indeed similar to a cylinder with a sharp edge, in other words a direct beam, it would be a concern if parts of the body were in the beam while the badge is shielded. However, the creation of a directed beam requires a discreet source surrounded by deep shielding arranged in a gun-barrel type of configuration. This is not the type of arrangement experienced in a typical glovebox, where the field emanating from a port is more accurately characterized as conical with very soft edges due to scattering. The field experienced by a worker at a glovebox would be homogenized even more by the worker's movement, and by radiation received from other gloveboxes in the line and in the room. Further consideration of this issue is given in OCAS-TIB-0010, *Best Estimate External Dose Reconstruction for Glovebox Workers*.

Regarding Concern 3, NIOSH is aware that there are geometry issues which merit consideration in calculating doses to some extremities. Where there may be special exposure geometries, NIOSH has the ability to include geometrical correction factors to account for this on a case-by-case basis; therefore, this issue does not preclude sufficiently accurate dose reconstruction. As a result, NIOSH contends that this issue does not have SEC implications.

SC&A Response (Comment 2): There are two distinct issues outlined in the affidavit. First, radiation exposures and doses have gone uncaptured due to the variety of engineering controls, poor work practices, and procedural deficiencies. For example, employees routinely removed lead-lined or water shielded glove port covers, did not put covers back on, then employees would sit in chairs with heads near open glove ports, dosimeter worn on chest, head exposure went unmonitored. Second, unshielded exposure occurred when workers would remove the product cans and place them under their arms or between their legs where the apron did not provide shielding. While working overhead, the pelvic region of the body received exposure from open glove ports.

With respect to uncaptured dose from glovebox work, NIOSH has developed OCAS-TIB-0010, which provides a correction factor for glovebox workers. However, this document does not give any indication of when to apply these correction factors (i.e., How do you know someone worked in a glovebox?) Studies conducted by Health Physics related to wearing the dosimeter outside and inside lead aprons can be used for the development of correction factors. Consideration of these data would assist in determining whether an appropriate bias correction factor can be applied to uncovered portions of the body. Separate consideration would have to be given to shallow exposure. **Concurrence with NIOSH/ORAUT.**

SC&A Response (Comment 3): The response does not address the concern related to partial body exposure.

NIOSH response is incomplete.

Concern 4: *Lead aprons and not clear where to wear dosimeter (under or over apron).* (USTW 2005: Part A, p. 53, and 2nd affidavit, Part B, pp. 47–49)

NIOSH Response: Lead aprons were available and used for a limited number of tasks at RFP. For most years, workers were instructed to wear badges under the lead apron to measure dose to the torso. In 1992, this was changed to instruct workers to wear the dosimeter outside the lead apron to better measure the dose to the head, neck, and arms. Field studies to determine the dosimeter response in both locations were performed. The results of these studies were used to develop bias corrections to use for dose reconstructions. The use of lead aprons does not preclude sufficiently accurate dose reconstruction.

SC&A Response: See Response 4-3.

Concurrence with NIOSH/ORAUT that this is not an SEC issue.

Concern 5: *Workers working several feet apart and some were wearing lead aprons and some were not.* (USTW 2005: Part A, p. 53, and 2nd affidavit, Part B, pp. 47–49)

NIOSH Response: As long as each worker was individually monitored, it is not clear how some workers wearing protective equipment such as lead aprons, and other workers not wearing such equipment would adversely impact NIOSH's ability to conduct dose reconstructions of sufficient accuracy. Each individual's dosimetry result would be used for dose reconstruction. In situations where a worker is unmonitored or there is some reason to suspect the accuracy of the monitoring, NIOSH does use coworker data. However, NIOSH does not assign the dose from one individual coworker to an unmonitored individual. Rather, NIOSH typically assigns a claimant-favorable estimate (50th or 95th percentile of all workers monitored at the site for the time period in question). It is NIOSH's understanding that the site conducted dose reconstructions in a similar fashion—the dose to assign to an individual was reconstructed by examining the results of all coworkers on the same job and either an average or maximum dose from the group was assigned as appropriate. As noted in the affidavit, individual worker's doses can vary, even if they are in the same area or working on the same job, due to differences in protective equipment, time spent in the radiation field, distance from the radiation source, and intervening shielding. This is exactly the reason that in general, concerns that an individual's dose was lower than expected based on the doses of some other individuals on the same job does not provide compelling evidence of data integrity problems.

SC&A Response:

Concurrence with NIOSH/ORAUT that this is not an SEC issue.

Concern 6: *Furtive job tasks, no special monitoring, working with high-fired oxide contaminates. Work evolution undocumented, therefore, no nasal smears, or bioassays and no monitoring for dose beyond TLD.* (USTW 2005, 2nd affidavit, Part B, pages 47–49)

NIOSH Response: The petition refers to "furtive" job tasks where jobs were performed "outside the bounds of normal work controls with no airborne contamination monitoring and with no special worker monitoring." An example is given of a radiation control technician performing such a job in an area with high-fired oxides, and "no nasal smears or bioassays were conducted and no monitoring for dose beyond TLD was conducted." While such practices could constitute a regulatory compliance violation, no evidence is provided that such occurrences would prevent dose reconstruction of sufficient accuracy. Radiation control technicians and other radiation workers would be expected to be on routine bioassay schedules so any intakes, whether as a result of normal work assignments or the described "furtive" jobs, would be reflected in the bioassay results. Similarly, external doses received during the conduct of these jobs would be reflected by the external dosimetry issued to radiation workers. As a result, NIOSH can conduct dose reconstructions of sufficient accuracy and this issue therefore does not have SEC implications.

SC&A Response: Assuming the employee was adequately monitored via urinalysis, this would not present an issue with dose reconstruction. If, however, the bioassay monitoring was incomplete, this would impact internal dose reconstruction, and may impact coworker dose. If intakes during short, furtive, and hence, unrecorded jobs were missed and no bioassay was done, the problem of estimating internal dose due to soluble (e.g., tritium) and moderately soluble forms of radionuclides would need to be addressed. **Concurrence with a qualifier.**

Concern 7: *Health Effects: Harmed by exposure to radiation, effects of synergism of exposure.* (This affidavit did not provide additional information.) (USTW 2005, 3rd affidavit, Part B, p. 51–52)

NIOSH Response: For the purpose of the SEC evaluation of this petition under the requirements of the EEOICPA, Part B (currently being administered by the Department of Labor), and 42 CFR Part 83, NIOSH considers the feasibility of estimating radiation doses with sufficient accuracy. If radiation doses cannot be estimated with sufficient accuracy, then NIOSH also considers whether such radiation doses may have endangered the health of members of the class of employees. Neither the feasibility of radiation dose reconstruction nor the associated determination of health endangerment involves the effects of smoking or exposure to toxic chemicals. The effects of smoking (for lung/respiratory tract cancers) are considered by the Department of Labor (DOL) in the evaluation of probability of causation for employees who receive a dose reconstruction from NIOSH. DOL also considers the exposure of a worker to the combination of toxic chemicals and radiation under Part E of EEOICPA.

SC&A Response: The synergistic effects of exposure to chemical and radiological hazards are considered under Part E of the EEOICPA. Mixed exposures are not covered under the provisions of Subpart C. Since synergistic exposures are not defined under Subpart C, this concern should be directed to the Department of Labor under the provisions of Subpart E. **Concurrence with NIOSH/ORAUT that this is not an SEC issue.**

EXAMPLE 9

Source: SEC Petition 00030, Part B (2 affidavits)

Claimant Status: Non-claimant

Concern 1: *Employees dealt with high-fired oxides, high penetrating radiation exposure (burn out lines).* (USTW 2005, Part B, pp. 497–498)

NIOSH Response: NIOSH agrees that there is evidence of high-fired Pu oxides at the Rocky Flats Plant. The presence of such materials does not, however, affect the feasibility of dose reconstructions. ORAUT-OTIB-0049 describes the methodology NIOSH will use in dose reconstructions potentially involving Super S plutonium.

SC&A Response: The concern involved employees working in areas with very high penetrating radiation exposures. Workers referred to these areas as the burnout lines. It was not uncommon to have airborne excursions. Selective Alpha Air Monitors (SAAMs) were used to warn workers of a release; however, at the time of the alarm workers were typically without respiratory protection. Assuming the individual was on a routine bioassay-monitoring program, the inoperability of the SAAMs, although a poor practice, would not prevent dose reconstruction. Refer to Example and Section 3.0 for a discussion on high-fired oxide. There is no specific mention of the burnout lines in the NIOSH/ORAUT response.

NIOSH/ORAUT response is incomplete.

Concern 2: *Description of lung counting capabilities over time (no lung counting from 1952–1964 and they were seldom used from 1964–1968).* (USTW 2005, Part B, pp. 497–498)

NIOSH Response: Lung counting capabilities did change and evolve over time at Rocky Flats. The existence and availability of bioassay monitoring (including urinalysis) at Rocky Flats from the beginning of operations permits the reconstruction of internal doses with sufficient accuracy. Specific descriptions of the methodology and corrections applied to internal dose reconstruction are included in the Rocky Flats Internal Dosimetry TBD (ORAUT 2007a) and in supporting Technical Information Bulletins.

SC&A Response: Simply provides information on the dosimetry program.

There is no issue defined in this affidavit that requires a response.

Concern 3: *Discussion of dosimeter badge and the change it went through over the years.* (USTW 2005, Part B, pp. 497–498)

NIOSH Response: As was the case for lung-counting capabilities described above, external dosimetry did change and evolve over time at Rocky Flats. The existence and availability of film badge and TLD monitoring data at Rocky Flats from the beginning of operations permits the reconstruction of external doses with sufficient accuracy. Specific descriptions of the methodology and corrections applied to external dose reconstruction are included in the Rocky Flats External Dosimetry TBD and in supporting Technical Information Bulletins.

SC&A Response: Simply provides information on the dosimetry program.

There is no issue defined in this affidavit that requires a response.

Concern 4: *Presence of body oils and hair on chips.* (USTW 2005, Part B, pp. 497–498)

NIOSH Response: Oil or dirt contamination on a crystal could burn as the crystal was heated and give an artificially high result for that crystal. This result, when compared with the readings from the other crystals in the dosimeter, would have indicated whether the dosimeter had been exposed to contamination. A dose could be estimated from the readings from the remaining crystals.

Anomalous TLD results were investigated using, and the procedures for doing so were formalized in 4-J88-RDE-0053, *TLD Data Investigation and Abbreviated External Dose Reconstruction*, and 4-J98-RDE-0071, *Extended External Dose Reconstruction*. The results of these investigations were documented in the worker's Health Physics file, and may or may not have been communicated to the employee at that time. Since anomalous readings were investigated, NIOSH contends that occasions where badges were contaminated and therefore gave anomalously high readings does not prevent NIOSH from performing dose reconstructions of sufficient accuracy.

SC&A Response:

(1) Crystals were cleaned with alcohol, which facilitated removal of oil and dirt from the crystal.

Concurrence with NIOSH/ORAUT that this is not an SEC issue.

(2) In addition to raising issues concerning oil and hair on TLD crystals, the commenter also raised concerns regarding inconsistent practices with employee dosimetry that resulted in missing or inaccurate information.

NIOSH/ORAUT response is incomplete.

Concern 5: *Lost crystals.* (USTW 2005, Part B, pp. 497–498)

NIOSH Response: It is possible that these crystals were read before they were dropped, but some crystals could have been dropped before being read. Systems were in place to interpret a badge with a missing crystal, and badges contained duplicate crystals. In these cases, a dose could be estimated from the readings from the remaining crystals. These situations were investigated, and the procedures for doing so were formalized in 4-J88-RDE-0053, *TLD Data Investigation and Abbreviated External Dose Reconstruction*, and 4-J98-RDE-0071, *Extended External Dose Reconstruction*. The results of these investigations were documented in the worker's Health Physics file, and may or may not have been communicated to the employee at that time. Since instances where badges were missing crystals were investigated, NIOSH concludes that this issue does not prevent NIOSH from performing dose reconstructions of sufficient accuracy.

SC&A Response: This is another example of a situation where exposure conditions were high yet badge results were zero. The general response provided by NIOSH is that high counts would be the result of exposure to light or high temperatures, and that an investigation would have been conducted to determine the appropriate dose. It so happens that the examples of overexposed or suspicious badge readings coincide with situations where individuals were working on high exposure jobs. A discussion of dosimetry investigations can be found in Section 5.2 of this SC&A review report.

NIOSH/ORAUT response is incomplete. An adequate explanation has not been offered.

Concern 6: *Lower level of exposure over time.* (USTW 2005, Part B, pp. 497–498)

NIOSH Response: This issue does not have SEC implications; therefore, no response is required for this item.

SC&A Response: The concern is related to under reporting of lower level of exposure over time. From 1951 through 1992, RFP reported dose down to zero. In 1993, a minimum reported dose of 10 mrem was adopted. This would indicate individuals were monitored and had dosimetry results. NIOSH/ORAUT also compensates for minimum reported dose with the assignment of missed doses for dosimeters reading zero.

Concurrence with NIOSH/ORAUT that this is not an SEC issue.

Concern 7: *Use of zeros.* (USTW 2005, Part B, pp. 497–498)

NIOSH Response: The concern expressed is that "Investigations into unusual dosimetry results frequently resulted in the assignment of zero when the investigator was unable to determine the cause of the exposure." Should the results of an investigation indicate that the most likely dose experienced by a worker was zero, it is entirely plausible that this value would be assigned. The petition presents no specific examples of where this was done inappropriately. NIOSH would have to examine this on a case-by-case basis, but is not presently aware of any examples of inappropriate assignment of zero dose.

SC&A Response: The commenter is concerned that investigations into dosimetry results frequently resulted in the assignment of a zero dose when the investigator was unable to determine the cause of the exposure. A detailed discussion of the dosimetry investigation is addressed in Section 5.2 of this SC&A review report.

NIOSH/ORAUT response is incomplete. An adequate explanation has not been offered.

Concern 8: *Radiological Incident Reports from 1998–2003 for Buildings 707, 771, 776, 777, and 779.* (USTW 2005, Part B, pp. 269–496)

NIOSH Response: NIOSH grants that incidents occurred during the history of Rocky Flats. However, the occurrence of such incidents does not prevent NIOSH from conducting dose reconstructions with sufficient accuracy.

SC&A Response: Radiological Incident Reports from 1998–2003 for Buildings 707, 771, 776, 777, and 779 where provided as examples of non-routine events. There was a concern expressed that the TBD did not capture incidents or events past 1976. This is a site profile review issue.

Concurrence with NIOSH/ORAUT that this is not an SEC issue.

EXAMPLE 10

Source: SEC Petition 00030, Part B pages 54–267

Claimant Status: Non-claimant

Concern: *Transmittal of Past Events between 1952 and 1988.* (NOTE: Some of these events are not radiological events.)

NIOSH Response: Many of the events listed in this section are not radiological events. This is a section that provides events that happened between 1952 and 1988. NIOSH grants that incidents occurred during the history of Rocky Flats. However, the occurrence of such incidents does not prevent NIOSH from conducting dose reconstructions with sufficient accuracy.

SC&A Response: This letter provided a listing of occurrences that have occurred at RFETS from 1952 to 1988. Hundreds of Radiological, Industrial Safety, Nuclear Safety, and other reportable incidents are listed. This information could inform the dose reconstruction process, but is not an SEC issue.

There is no issue defined in this affidavit that requires a response.

EXAMPLE 11

Source: SEC Petition 00030, Part B, page 500; Cindy Shubert

Claimant Status: Non-claimant

Concerns 1 and 2: *(1) Lost and/or damaged crystals, resulting in crystals never evaluated for dose because they had fallen on the floor; (2) Reused crystals that had fallen to the floor.*

NIOSH Response: Some crystals could have been dropped before being read. Systems were in place to interpret a badge with a missing crystal, and badges contained duplicate crystals (Figure 11-1). In these cases, a dose could be estimated from the readings from the remaining crystals. These situations were investigated, and the procedures for doing so were formalized in 4-J88-RDE-0053, *TLD Data Investigation and Abbreviated External Dose Reconstruction*, and 4-J98-RDE-0071, *Extended External Dose Reconstruction*. The results of these investigations were documented in the worker's Health Physics file, and may or may not have been communicated to the employee at that time. Since instances where badges were missing crystals were investigated, NIOSH contends that this issue does not prevent NIOSH from performing dose reconstructions of sufficient accuracy. At the time of reading, badges were sometimes missing crystals or contained damaged or contaminated crystals. The duplicate crystals contained in the badges could be used to calculate a dose when badges were missing crystals. The principle upon which TLDs operate is based on the crystals emitting flashes of light as they are heated in a known proportion to how much radiation they were exposed to. Once crystals are heated through the reading process, they are reset to zero and ready for re-use. If there was a problem with individual crystals, a reading can frequently be obtained by other crystals in the dosimeter. If the crystal had been broken when it fell on the floor, the total light output from the crystal might be affected, depending on the size of the remaining crystal read. If only a small fraction of the crystal could be recovered, the light output would probably be reduced due to the missing TLD material. If the reading was comparable to the expected pattern for that dosimeter, the reading probably would have been used. If the reading was much lower than the others, the other crystal readings would have been used to determine the dose.[7]

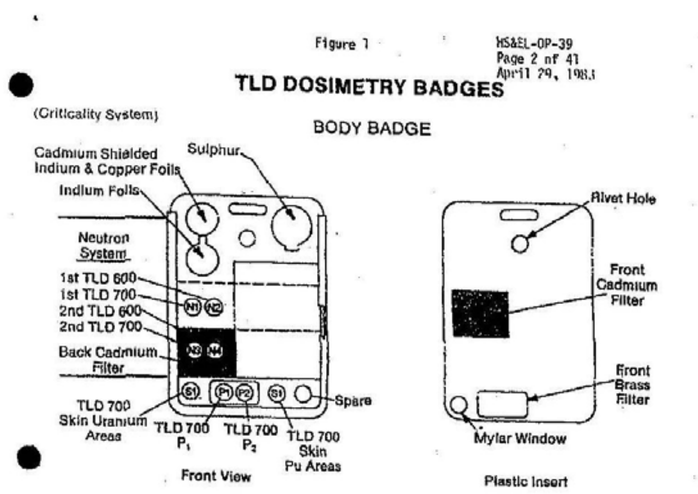

Figure 11-1:TLD Badges

SC&A Response (Comment 1):

NIOSH/ORAUT is correct that redundant crystals can be used to determine dose, assuming they are not compromised themselves. In cases where the redundancy of the crystals is not available (e.g., all crystals are missing), a typical method of determining dose would be to conduct an investigation into the potential exposure of an individual. These investigations common outline

[7] Personal communication from Steve Baker, NIOSH, July 14, 2006.

how the dose of record was arrived at. NIOSH states that systems were in place to address these situations. Former RFP RadCon personnel have acknowledged that dosimetry investigations were not document until a formalized procedure was put in place. As a result of the absence of documented results on such investigations, this makes proving that each case was evaluated and interpreted impossible. Cases involving lost or damaged crystal should have resulted in an investigation of potential exposure. A detailed discussion of the dosimetry investigation is addressed in Section 5.2 of this SC&A review report.

NIOSH/ORAUT response is incomplete. An adequate explanation has not been offered.

SC&A Response (Comment 2): Refer to Response to Example 11, Concern 1.

NIOSH/ORAUT response is incomplete. An adequate explanation has not been offered.

Concern 3: *Several instances when a crystal was being read, the foreman of the group would advise the dosimeter worker that the dose shown was too high to possible be correct, and the worker was advised to change or delete the reading.*

NIOSH Response: In instances when a particular crystal gave implausible results (one previously noted scenario is contamination on badges which yield spurious light signals when the crystal is heated through the reading cycle), it is indeed possible that the supervisor would doubt the results of the crystal and would instead rely on the readings from the other crystals in the badge, as described above.

SC&A Response: Refer to Response to Example 11, Concern 1.

NIOSH/ORAUT response is incomplete. An adequate explanation has not been offered.

Concern 4: *Crystals soaked in alcohol, for unknown reasons, prior to being read.*

NIOSH Response: The purpose of the alcohol rinse was to clean the crystals, i.e., to remove potential contamination from the crystals (Link and Pennock 1983)

SC&A Response: Since thermolumescent dosimeters operate on the principles of luminescence caused as a result of heat, alcohol is unlikely to affect the reading of the TLD.

Concurrence with NIOSH/ORAUT that this is not an SEC issue.

EXAMPLE 12

Source: SEC Petition 00030, Part B, page 501

Claimant Status: Non-claimant

Concern 1: *Often times when the Thermo Luminescent Dosimeter was being read (which was done by a high heating process) the instrument failed and no readings were available.*

<u>NIOSH Response</u>: The assumption is that this refers to the Harshaw TLDs and deals with a situation where a valid reading could not be obtained for one or more TLD crystal(s) in a dosimeter, which may have been caused by a problem with the dosimeter or with the Harshaw reader. If one crystal could not be read, information from the other crystals in that dosimeter could be (and were) used to estimate the dose. If multiple crystals failed so that a dose could not be determined from the dosimeter, a request was made for the building Radiation Protection personnel (Operational Health Physicists) to perform a dose reconstruction.

<u>SC&A Response</u>: Refer to Response to Example 11, Concern 1.

NIOSH/ORAUT response is incomplete. An adequate explanation has not been offered.

<u>Concern 2</u>: *Once these TLDs were heated to a certain temperature, they came out zeroed, so essentially no dose could accurately be reconstructed. When I asked Steve Baker how he handled that, he told me that he applied a "Fudge Factor" to assess dose.*

<u>NIOSH Response</u>: The principle upon which TLDs operate is based on the crystals emitting flashes of light as they are heated in a known proportion to how much radiation they were exposed to. Once crystals are heated through the reading process, they are indeed reset to zero and ready for re-use. There is no need to reconstruct dose, because a directly measured dose has been read from the TLD—that is the purpose of heating the crystals. If there is a problem with individual crystals, a reading can frequently be obtained by other crystals in the dosimeter.

<u>SC&A Response</u>: The issue was not specifically addressed.

NIOSH/ORAUT response is incomplete.

<u>Concern 3</u>: *Often times the crystals were dropped on the floor and broken, so that only a small piece of the crystal was counted.*

<u>NIOSH Response</u>: Impacting a crystal has no effect on its light output. If there is a problem with individual crystals (breakage, etc.), a reading can frequently be obtained by other crystals in the dosimeter.

<u>SC&A Response</u>: Refer to Response to Example 11, Concern 1.

NIOSH/ORAUT response is incomplete. An adequate explanation has not been offered.

<u>Concern 4</u>: *My medical restriction from the Rocky Flats Occupational Medical Department clearly restricted me from being around Ethel [sic] Alcohol, which the company ignored, when they assigned me to Dosimetry.*

<u>NIOSH Response</u>: Compliance/noncompliance with a restriction on ethyl alcohol exposure, while important for the employee involved, would not have any impact on NIOSH's ability to conduct radiation dose reconstruction, and is therefore not an SEC issue.

SC&A Response: 42 CFR 83, *Procedure for Designating Classes of Employees as Members of a Special Exposure Cohort Under the Energy Employees Occupational Illness Compensation Program Act of 2000*, specifically indicates that Health and Human Services (HHS) is not authorized to consider health risks other than exposure to radiation. The process of adding classes to an SEC is governed under Subpart C of the EEOICPA. Subpart E of the EEOICPA covers DOE contractor and subcontractor employees who develop an illness as a result of exposure to a toxic substance (including cancers caused by radiation, beryllium illness, and chronic silicosis) as a DOE contractor or subcontractor employee, and uranium miners, millers, and ore transporters. Exposures to chemicals in the pond are not relevant to the SEC petition process outlined in Subpart C, but may be covered under Subpart E. SC&A concurs with the NIOSH assessment that exposure to toxic chemicals does not affect the ability to perform radiation dose reconstruction.

Concurrence with NIOSH/ORAUT that this in not an SEC issue.

EXAMPLE 13

Source: SEC Petition 00030, Part B, pages 503–506

Claimant Status: POC greater than 50%, underestimate, external

Concern 1: *Th strikes, (1958–1959) eye site impaired, no record of this incident*

NIOSH Response: There are no records of any eye incidents in this employee's file. A thorium strike was an operation performed at Rocky Flats to remove thorium from U-233. As such, an incident report would not be expected unless there were some accidents during this operation. These thorium strikes are very well documented, and this employee was monitored both externally (pages 63–110 of his rad file) and through bioassay (pages 39–62 of his rad file) throughout his employment at Rocky Flats. This data was available and used for completion of his dose reconstruction.

SC&A Response: Although the issue here is related to site impairment, the volatilization of thorium during strikes should be given some consideration when determining internal dose. This is especially the case when limited bioassay data exists for the worker population.

Concurrence with NIOSH/ORAUT that this in not an SEC issue.

Concern 2: *Incidents were not documented*

NIOSH Response: Incidents were reported only if they had the potential to result in an uptake. A review of this worker's radiation file reveals that there are several incident reports (pages 6–10, 145–150, 168–169, and 174–178), spanning the years of concern in this affidavit. NIOSH grants that it is not always possible to tie an intake to a particular incident. Routine or special request bioassay would detect intakes that may have resulted from unreported incidents. The entire point of the routine bioassay programs is to monitor for intakes that may not be recognized at the time of occurrence and to ensure that internal doses from all intakes are kept below regulatory limits.

SC&A Response:

Concurrence with NIOSH/ORAUT that this is not an SEC issue.

EXAMPLE 14

Source: SEC Petition 00030, Part B, pages 507–521

Claimant Status: POC less than 50%, best estimate

Concerns 1 and 2: *(1) Exposure to contamination, Pu, incidents, alarms going off; (2) Pu can't be detected by reconstruction of dose, incidents, and undetected amounts of Pu in system.*

NIOSH Response: Incidents were reported if they necessitated sending the employee to the Medical Department. If a contamination incident could be successfully addressed on the floor, an incident report may not have been filed. NIOSH grants that it is not always possible to tie an intake to a particular incident. Routine or special request bioassay would detect intakes that may have resulted from unreported incidents. The entire point of the routine bioassay programs is to monitor for intakes that may not be recognized at the time of occurrence and to ensure that internal doses from all intakes are kept below regulatory limits. This worker's radiation file was reviewed and it contains numerous incident reports, including every incident report submitted in support of this affidavit, plus numerous others. Some measurement results showed an activity greater than the level of detection, and internal intakes were assigned. All of this data was available and considered in the dose reconstruction.

SC&A Response (Comment 1): Assuming the employee was adequately monitored via urinalysis, this would not present an issue with dose reconstruction. If, however, the bioassay monitoring was incomplete, this would impact internal dose reconstruction.

Concurrence with a qualifier.

SC&A Response (Comment 2): Assuming the employee was adequately monitored via urinalysis, this would not present an issue with dose reconstruction. If, however, the bioassay monitoring was incomplete notably in relation to incidents, this would impact internal dose reconstruction, and may impact coworker dose.

Concurrence with a qualifier.

Concern 3: *Skin contamination on face, hands, and neck to 100,000 cpm.*

NIOSH Response: This employee's record does show skin contamination to 100,000 cpm in February 1963. As a result, a urine sample was taken on February 25, 1963, which came up positive for Pu. A body burden was assigned (page 86). This information was available and was considered in the dose reconstruction. This employee also participated in the routine bioassay program designed to detect intakes of radionuclides from all sources (including inhalation and wounds) over the course of his employment.

SC&A Response:

Concurrence with NIOSH/ORAUT that this is not an SEC issue.

Concern 4: *Moving drums, involved in fire in Building 771, also the 1969 fire in Building 776. He was exposed to a lot of radiation and was told not to go into Building 80 any more, however, HP thought is was necessary that he return to Building 80, even though his film badge was over the limit for exposure. He used a half-mask respirator.*

NIOSH Response: This employee was monitored for external dose throughout his employment at Rocky Flats. This information was considered in his dose reconstruction. In addition, potential missed external dose was assigned. This employee was also monitored for internal plutonium exposure and uranium intakes. Results were applied in assignment for a claimant-favorable internal dose.

SC&A Response (Comment 4): Although the individual was sent into the area even though he exceeded the limit for exposure, he was monitored for this period of time.

Concurrence with NIOSH/ORAUT that this is not an SEC issue.

SC&A Response (Comment 4b): An additional concern was raised in the affidavit. The employee became a Radiation Monitor and was involved in the 1969 fire in Building 776. He was one of the first monitors to arrive. Firemen were sent into the fire area in air packs had to be constantly changed due to contamination. Monitoring and decontamination of fire personnel was conducted with a half face respirator.

NIOSH/ORAUT response is incomplete.

Concern 5: *Employees were exposed to many chemicals and metals.*

NIOSH Response: For the purpose of the SEC evaluation of this petition under the requirements of the EEOICPA, Part B (currently being administered by the Department of Labor), and 42 CFR Part 83, NIOSH considers the feasibility of estimating radiation doses with sufficient accuracy. DOL considers the exposure of a worker to the combination of toxic chemicals and radiation under Part E of EEOICPA.

SC&A Response: The effects of exposure to chemicals are considered under Part E of the EEOICPA. Since chemical exposures are not defined under Subpart C, this concern should be directed to the Department of Labor under the provisions of Subpart E.

Concurrence with NIOSH/ORAUT that this is not an SEC issue.

EXAMPLE 15

Source: SEC Petition 00030, Part B, page 522; (see also Example 27)

Claimant Status: POC less than 50%, overestimate

Concern 1: *Dose reconstruction will not provide all the exposure due to problems of not collecting all the data.*

NIOSH Response: The affidavit describes concerns that contamination incidents that were handled on the floor and did not result in an incident report would not be reflected in the dose reconstruction. However, this employee was monitored both externally and through bioassay throughout his employment at Rocky Flats. External dose resulting from the incidents described would be reflected in film badge or TLD results, and any intakes resulting from the incidents would be reflected in bioassay results. These are the primary sources of data used by NIOSH for dose reconstruction.

SC&A Response: Assuming the employee was adequately monitored via urinalysis, this would not present an issue with dose reconstruction. If, however, the bioassay monitoring was incomplete, this would impact internal dose reconstruction.

Concurrence with a qualifier.

Concern 2: *Contamination was washed off and not always reported and did not show up on the TLD.*

NIOSH Response: Incidents were not always reported. NIOSH grants that it is not always possible to tie an intake to a particular incident. Routine or special request bioassay would detect intakes that may have resulted from unreported incidents. The entire point of the routine bioassay programs is to monitor for intakes that may not be recognized at the time of occurrence and to ensure that internal doses from all intakes are kept below regulatory limits.

SC&A Response: Assuming the employee was adequately monitored via urinalysis, this would not present an issue with dose reconstruction. If, however, the bioassay monitoring was incomplete, this would impact internal dose reconstruction.

Concurrence with a qualifier.

Concern 3: *In Building 771, TLDs were worn when going into the inner area of the facility and posted on the wall when not in the inner facility.*

NIOSH Response: Building 771 was set up such that one entered into a general office area and one would proceed to the radiological area. When going into the inner facility, which was posted as a radiological area, then TLDs were required. These TLDs were kept in the outer area. However, when in the outer area, TLDs were optional. General TLDs were posted throughout the outer area and read routinely.

SC&A Response: Refer to Response to Example 4, Comment 4.

Concurrence with NIOSH/ORAUT that this is not an SEC issue.

EXAMPLE 16

Source: SEC Petition 00030, Part B, page 524

Claimant Status: Non-claimant

Concern 1: *No current data available.*

NIOSH Response: Entries of "no current data available" indicate instances when either the badge was not turned in at the scheduled badge exchange, or the badge was turned in but there was a problem with the dosimetry badge. Investigations of such problems sometimes delayed the reporting of a worker's dose so that it was unavailable at the time the dosimetry reports for that cycle were issued. In this situation, "no current data available" would appear in the dosimetry report until the investigation was complete. Upon completion of the investigation, the assigned dose would then be substituted into the worker's dosimetry record. The results of these investigations were documented in the worker's Health Physics file, and may or may not have been communicated to the employee at that time. Anomalous TLD results were investigated, and the procedures for doing so were formalized in 4-J88-RDE-0053, *TLD Data Investigation and Abbreviated External Dose Reconstruction*, and 4-J98-RDE-0071, *Extended External Dose Reconstruction*. Since anomalous readings were investigated, NIOSH contends that the presence of "no current data available" entries in and recorded in the worker's records does not prevent NIOSH from performing dose reconstructions of sufficient accuracy. Therefore NIOSH concludes that this issue does not have SEC implications.

SC&A Response: Refer to Response to Example 4, Comment 2.

NIOSH/ORAUT response is incomplete. An adequate explanation has not been offered.

Concern 2: *Chemicals in pond, worked at Solar Ponds from 1983–1989.*

NIOSH Response: For the purpose of the SEC evaluation of this petition under the requirements of the EEOICPA, Part B (currently being administered by the Department of Labor), and 42 CFR Part 83, NIOSH considers the feasibility of estimating radiation doses with sufficient accuracy. If radiation doses cannot be estimated with sufficient accuracy, then NIOSH also considers whether such radiation doses may have endangered the health of members of the class of employees. DOL also considers the exposure of a worker to the combination of toxic chemicals and radiation under Part E of EEOICPA.

SC&A Response:

Concurrence with NIOSH/ORAUT that this is not an SEC issue.

Concern 3: *Lung burden, management says it was from work in Building 771, but this worker thinks it is strange why his lung count was clean from 771 productions.*

NIOSH Response: This worker's radiation file was examined. His affidavit says he started work at the solar ponds in April 1983. According to documentation in the file, he actually started work at the solar ponds on May 20, 1985 (page 136). This discrepancy may be due to trying to recall exact work locations and job assignments some 20 years after the fact. The radiation file contains extensive urinalysis and whole-body count results. The whole-body counts started yielding positive results for plutonium in November 1988, and they were very close to the limit of detection. The worker also had positive plutonium urinalysis results close to the limit of detection as early as 1984 when he was still working in Building 771.

Urinalysis techniques directly measure the plutonium content in urine, while whole-body counts measure the radiation emitted by Am^{241}, the daughter of Pu, which grows in with a half-life of approximately 14 years. Slightly positive urinalysis results in 1984 and slightly positive whole-body counts showing up approximately four years later when Am^{241} grows in to detectable levels are entirely consistent with an intake of Pu occurring in the latter days of the worker's assignment to Building 771, as concluded by the site in its investigation.

SC&A Response: There is a possibility that an initial lung count can be negative, but with the increased concentration of Am-241 over time, it may show positive at a later time. This would be dependent on the initial concentration of Am-241/Pu-241 in the inhaled material, the sensitivity of instruments used for the count, the count time and technique, and the amount of the intake. Urinalysis techniques directly measure the plutonium content in urine, while whole-body counts measure the radiation emitted by Am-241, the daughter of Pu, which grows in with a half-life of approximately 14 years.

Concurrence with NIOSH/ORAUT that this is not an SEC issue.

EXAMPLE 17

Source: SEC Petition 00030, Part B, pages 526–534

Claimant Status: Non-claimant

Concern: *Fecal sample one year after incident and the results dosimetry received back were refused.*

NIOSH Response: This employee submitted bioassay samples upon learning an area he worked in was contaminated (T-690 trailer). The Analytical Laboratory had experienced an extended down time, so the fecal samples were sent to a subcontractor laboratory for analysis. The results from the subcontractor laboratory did not meet all the acceptance criteria by Radiological Health; therefore, the results were not used as valid data. This employee was given the opportunity to resubmit samples. NIOSH is currently conducting additional evaluation of this example.

SC&A Response: Assuming the employee was adequately monitored via urinalysis, this would not present an issue with dose reconstruction. If, however, the bioassay monitoring was incomplete, this would impact internal dose reconstruction.

Concurrence with a qualifier.

EXAMPLE 18

Source: SEC Petition 00030, Part B, pages 535–537

Claimant Status: POC less than 50%, overestimate

Concerns 1 and 2: *(1) Did not wear protective equipment, other than white coveralls, in Building 444, stated his TLD readings were always within the limits that were acceptable; (2) Never wore a ½ mask when storing or handling parts or at any time.*

NIOSH Response: Building 444 was a depleted uranium facility. The concern expressed by the worker seems to be that personnel protection devices (especially respirators) were not required in situations where he feels they should have been. While this concern has obvious safety implications, NIOSH reconstructions of internal dose are based primarily on bioassay results. The dose reconstructions NIOSH performs take no account of possible reductions in uptake potential provided by respiratory protection. Therefore, failure to wear respiratory protection would not compromise NIOSH's ability to conduct dose reconstructions with sufficient accuracy.

SC&A Response (Comment 1a): The issue communicated in Example 18-1 really composed two issues. The first related to protective clothing worn in Buildings 444 and 883.

Concurrence with NIOSH/ORAUT that this is not an SEC issue.

SC&A Response (Comment 1b): In this case, the worker is concerned about the accuracy of the TLD system in detecting radiation exposures. His responsibilities took him to areas where radiation levels were high. This is another concern relating to the disparity between dosimeters and field exposure conditions.

NIOSH/ORAUT response is incomplete.

SC&A Response (Comment 2): Assuming the employee was adequately monitored via urinalysis, this would not present an issue with dose reconstruction. If, however, the bioassay monitoring was incomplete, this would impact internal dose reconstruction.

Concurrence with a qualifier.

Concern 3: *Eat and drink in work area.*

NIOSH Response: Eating in radiation areas and/or carrying contamination with them to break rooms might conceivably result in an ingestion intake of radioactive materials. These types of situations are easily handled in dose reconstruction. Regardless of methods of intake (ingestion, inhalation, wounds, etc) such intakes would be monitored through bioassay. When starting from bioassay results, it is almost universally claimant favorable to assume that any radionuclides detected in urine (for example) were the result of inhalation intakes. Such an assumption usually results in higher organ doses than if ingestion is assumed. If a situation were encountered where both inhalation and ingestion were possible routes of intake, and ingestion was the claimant-favorable assumption, the IMBA software NIOSH uses to calculate internal doses is entirely capable of calculating doses from ingestion intakes. Therefore, NIOSH concludes that this issue does not have SEC implications.

SC&A Response:

Concurrence with NIOSH/ORAUT that this is not an SEC issue.

EXAMPLE 19

Source: SEC Petition 00030, Part B, pages 538–539

Claimant Status: POC greater than 50%, underestimate

Concern 1: *Wearing dosimetry badges under lead aprons.*

NIOSH Response: Lead aprons were available and used for a limited number of tasks at RFP. For most years, workers were instructed to wear badges under the lead apron to measure dose to the torso. In 1992, this was changed to instruct workers to wear the dosimeter outside the lead apron to better measure the dose to the head, neck, and arms. Field studies to determine the dosimeter response in both locations were performed. The results of these studies were used to develop bias corrections to use for dose reconstructions. The use of lead aprons does not preclude sufficiently accurate dose reconstruction.

SC&A Response: See Response 4, Comment 3.

Concurrence with NIOSH/ORAUT that this is not an SEC issue.

Concern 2: *Film badge readings did not match job duties, suggested that management played with numbers to keep techs working in high radiation areas. Employee was aware of the high exposure because he wore a chirper.*

NIOSH Response: Because no specific dates were given regarding the film badge readings and the job duties, it is not possible to evaluate this specific concern. The early "chirpers" were just that—an audible signal to get a "feel" for workers when they entered higher fields of radiation. The badges continued to be the "legal" record of dose. Later, for the work that could be dose-limiting the new generation digital dosimeters were used to monitor on a real-time basis the dose accumulation on a daily or more frequent basis, with an audit chirp rate also. They were used for qualitative controls, with the personnel dosimeter being the formal dose of record. Workers not familiar with the dosimetry or the control procedure intricacies could get the impression that the dosimeters were faulty. For example, for a short-term job the chirp rate could be elevated, with the remainder of the day at lower chirp rates, and the high chirp rate period could be the primary recollection because it was unusual, dramatic, etc. This affidavit does not present any evidence that "management played with numbers to keep techs working in high radiation areas," nor is NIOSH aware of any such evidence.

SC&A Response:

Because the workers' dosimeter readings did not match their job duties, there are allegations that management may have manipulated the dose results to keep individuals working. The employee states he was aware of the high exposure because he wore a chirper. Chirpers were used during high-dose rate jobs to provide real-time radiation exposure information. Depending on the particular model of chirper, it is possible for the unit to significantly over-respond to low-energy x-rays. On the other hand, some of the units will miss photons with energies less than 50 keV. Similar issues would be seen with a pocket dosimeter. The specifics of the chirpers and other secondary dosimetry used would have to be evaluated for the specific radiation field of concern. In "side-by-side" dosimeter studies, results within 50%–100% of one another would be considered in agreement. NIOSH/ORAUT does not provide a plausible explanation for why the dosimeter readings did not match the individual's job duties due to lack of information provided in the affidavit. Furthermore, investigations into why such discrepancies seem to occur between dosimetry and alternate data such as secondary dosimetry or survey data and stay time would help resolve the disparities that have been identified. Data of this type could serve to validate the magnitude of dose received by the worker.

NIOSH/ORAUT response is incomplete. An adequate explanation has not been offered.

Concern 3: *Lose protective clothing when leaving work area due to radon gas. (Building 991)*

NIOSH Response: Radon daughter products and their interference with contamination monitoring are a problem everywhere (especially in the basement areas of many homes). Concrete buildings (and particularly in areas of low ventilation flows) are also subject to significant radon/daughter activity during barometric pressure lows. A whole generation of more sophisticated air monitors, personnel monitors, etc., grew up to deal with this problem specifically.

As personnel monitors were developed with greater sensitivity, radon daughter activity buildup, especially on synthetic (high static charge buildup) clothing, flags, etc., was a real problem. For some period of time, clothing was confiscated overnight to wait for decay until alpha/beta ratio techniques, short-term decay evaluations, and then alpha spectrum analyses could clear the clothing in a more expeditious manner.

In the later years, the RCTs took tape presses of contamination and let it decay, or they just decayed the item to see if it was radon, and the PCM-2s and the CAMs had radon discrimination capabilities built into them. Radon from the building materials was considered part of background and was not included in occupational dose. The bottom line is that detection of radon and its daughter products was a well-known issue at Rocky Flats and elsewhere, and does not prevent NIOSH from conducting dose reconstructions of sufficient accuracy.

SC&A Response: There has been no occupational source of radon discovered to date.

Concurrence with NIOSH/ORAUT that this is not an SEC issue.

EXAMPLE 20

Source: SEC Petition 00030, Part B, page 540

Claimant Status: Non-claimant

Concern: *In 1957 he was in explosion that shattered the enclosure from the mixing tube which contained Pu Nitrate and 50% hydrogen peroxide. The explosion blew the safety glasses off his face and he doesn't know what happened to his film badge. He had 12 body burdens in chest area as of 2003.*

NIOSH Response: This affidavit describes a very serious and well-known incident that occurred at Rocky Flats. This incident resulted in extensive external and internal contamination of two individuals – [Name] (the author of the affidavit in the petition), and [Name]. Mr. [Name] is a NIOSH claimant. This incident is specifically discussed in *The Past 30 Years at Rocky Flats*, E.A. Putzier, November 1982 (pp. 41–44). The radiation file for Mr. [Name] contains extensive documentation of the investigations that were conducted regarding the 1957 incident in Building 71. Multiple reports were written soon after the incident as the investigation progressed. Several of these documents provide summaries of the urine bioassay analyses that were performed in the investigations. In addition, Mr. [Name's] radiation file contains a Radiation Exposure Summary prepared June 14, 1972 (pages 66–84), which provides analytical results of urine bioassays performed from 1957 through 1972. The numbers of urine bioassays for Pu that are available for dose reconstruction are noted below:

Urine Bioassay for Pu	
Year	**No. of Results**
1957	125
1958	68
1959	12
1960	9
1961	10
1962	9
1963	10
1964	81
1965	5
1966	3
1967	5

Urine Bioassay for Pu	
Year	**No. of Results**
1968	4
1969	4
1970	3
1971	6
1972	2

The 1972 Radiation Exposure Summary for Mr. [Name] also provides external radiation results (1954 through 1971) for Skin, Penetrating, and Wrist.

The number of fecal samples for the years 1957–1964 is listed below:

Fecal analysis	
Year	**No. of Results**
1957	31
1958	17
1959	2
1961	2
1962	1
1963	2
1964	36

In addition, 46 blood samples were taken in 1957.

There were certainly incidents throughout the operational history of the Rocky Flats plant, and this is one of the most serious. However, the occurrence of such incidents does not prevent NIOSH from conducting dose reconstructions of sufficient accuracy. This incident is very well documented and supporting bioassay measurements are available, which would be used by NIOSH in dose reconstructions.

SC&A Response: Page 540 contained a list of incidents from the 1980s rather than an affidavit. It is uncertain whether the page reference is correct. The incident above occurred on Friday, June 14, 1957 in Room 146, Building 777. An explosion occurred during a plutonium peroxide precipitation and filtration operation. The excessive pressure due to rapid decomposition of hydrogen peroxide caused a glass vial to scatter and the subsequent "blowing off" of a panel on the dry box enclosure. There was approximately one kilogram of Pu in the vessel prior to the explosion. At the time of the explosion, seven individuals were in the room. Five of the seven received varying levels of radioactive contamination. Two employees were next to the platform when the explosion occurred. They did not immediately put on their respirators and received lacerations to the face. The two men received extensive sampling as a result of this incident (Plott 1986, Piltingsrud 1966). An entire logbook of bioassay results (e.g., blood, fecal, urine) is available starting immediately after the accident and for some time after. Contamination spread throughout half of the room. Air samples in the room showed concentrations ranging from 100 to 45,000 times the Plant Working Level. Twenty percent of the air samples in the other parts of the building revealed concentration above the Plant Working Level (Plott 1986, Piltingsrud 1966). An incident of this magnitude not only has implications for the workers directly involved, but also for workers involved in the clean-up and demolition. The individuals directly involved were well monitored and data are readily available for dose reconstruction.

Concurrence with NIOSH/ORAUT that this is not an SEC issue.

EXAMPLE 21

Source: Conversation with [Name] April 17, 2006, April 12 Matrix Item Comment 9, Action Item 7; [Name]

Claimant Status: Non-claimant

Concern: *Mr.* [Name] *gave the name of an individual (*[Name]*) who, upon termination of employment, had given exit bioassay samples and a whole-body count. The urine sample showed an elevated level of Pu.*

NIOSH Response: Kaiser-Hill convened an expert panel (including individuals who did not work at the Rocky Flats Site) to investigate this situation. After considering several possible intake scenarios, which were concluded to be implausible, the expert panel concluded:

- The Team considers the likelihood of external contamination of the sample prior to entering the Kaiser-Hill formal chain of custody to be credible.

- The Team considered removal of one or more instrument check sources from the plant site as easily accomplished. The Team concluded that deliberate contamination of the urine and fecal samples from an instrument check source was plausible and could be accomplished with little or no risk to the person doing the tampering and no risk to the public at large.

There was no conclusion that dosimetry personnel had falsified the dosimetry results in this case. In fact, the expert panel concluded, "…Kaiser-Hill has implemented a very effective program for determining the cause of the anomalous, high urine bioassay results. The Team felt that Kaiser-Hill had been very thorough and complete in their approach to this unexpected occurrence." Rather than being an example of a data integrity issue, this supports the integrity of the bioassay program at Rocky Flats, and shows an example that unexpected bioassay results were thoroughly investigated.

SC&A Response: SC&A was not privy to the documented conversation notes, so it is difficult to assess the actual concern.

Inconclusive.

EXAMPLE 22

Source: Conversation with [Name] April 17, 2006

Claimant Status: POC greater than 50%, underestimate, part of external dose

Concern: *Blackened neutron badges*

NIOSH Response: As described in the *Neutron Dose Reconstruction Project Protocol* (ORISE 2005, p.16), exposure to relatively high doses of gamma radiation (500–1000 mrem) can cause a film to be fogged and cause difficulty in reading the neutron badge. However, a review of this individual's dosimetry results indicates that the highest gamma dose received from the beginning of employment through the end of 1969 was approximately 430 mrem. Gamma fogging would not be expected to have been a problem for this individual's neutron badges, and there is no notation to that effect in his dosimetry record or in the NDRP data for this individual.

Although NIOSH has located no evidence that this particular individual had a problem with blackened film badges, it is well known that films can also be blackened by exposure to light. In most cases, film blackening due to light contamination can be distinguished from blackening due to exposure to ionizing radiation. Extreme environmental conditions such as exposure to high temperatures can cause film fogging (Kathren 1966, pp. 61–63; Brodsky and Kathren 1963, pp. 453–461).

If a badge was blackened due to light contamination, or exposure to high temperatures, it is possible that an investigation would have concluded that the appropriate dose was low or zero.

SC&A Response: SC&A was not privy to the documented conversation notes, so it is difficult to assess the actual concern.

Inconclusive.

EXAMPLE 23

Source: Questions from [Name] from February 27, 2606, Working Session (addressed in April 5, 2006, Working Board Matrix); [Name] (see also Example 31)

Claimant Status: Non-claimant

General Comment: NIOSH previously addressed the concern below, based on what was thought to be the correct incident. The evaluation appears below for completeness. However, NIOSH has since learned that it did not investigate the correct incident. NIOSH held a conference call with [the EE] on Thursday, August 24, 2006, to address the correct incident. The issue is addressed in Example 31, Concern 4.

Concern: *How are you addressing the fact that when a person received an abnormal or unexpectedly high dose and an internal investigation could not identify the source, the person* *received a 0 for dose. I know this to be true because it happened to me when I was pregnant in the 1999/2000 timeframe. My dosimeter showed a high reading for ionizing radiation. And an investigation was conducted and the reviewers could not find the source so they decided NOT to follow conduct of operations which says you have to trust your indicators (in this case my dosimeter) and decided to enter a 0 for my exposure. I am sure there are hundreds of examples like this. So now my dose record is inaccurate and there is obviously no way to reconstruct it accurately since they failed to do so at the time.*

NIOSH Response: NIOSH would need to review the investigation report to comment on the issue raised above. Based on experience, however, we can say that there are a number of reasons why a dosimeter could provide an erroneously elevated value. For example, the presence of solvents and detergents on the badge can produce light output that appears to be a large radiation dose. Each anomalously high reading needs to be evaluated by the radiation protection program and documented in the worker's exposure file on a case-by-case basis. To ensure that workers are not overexposed in the field, conduct of operations practice does dictate that one trusts the real-time radiation indicators. This practice, however, is not necessarily applicable when a worker is no longer in the potentially hazardous environment and a scientific investigation of a potentially malfunctioning device is being conducted.

Recently, NIOSH has accessed the dosimetry files for this individual and located an extended external dose reconstruction report, which describes the incident in question (Figure 23-1). This report concludes the following:

> [The EE] *became separated from her dosimeter while in the Building 371 RBA, thereby necessitating this extended dose reconstruction. She forgot to remove it from her anti-C clothing while doffing at the Room 3408 step off pad.* [The EE] *was on a tour with the two listed coworkers and was separated from her dosimeter for approximately 30 minutes.* [The EE] *is being assigned the zero dose listed on page one for the time she was without her dosimeter. This dose is equal to the dose received by the listed coworkers who were with her on the entire tour.*

The petitioner provided no evidence that this investigation was in error. NIOSH contends that this incident does not constitute deliberate falsification of data.

SC&A Response:

SC&A obtained a copy of the EE's radiation exposure file and examined the external dosimetry information, including external exposure investigation reports. She wore a dosimeter and had both in-vivo and in-vitro bioassay available in her file. She was restricted from high radiation work on [date], and [date]. Her Declaration of Pregnancy on [date], was withdrawn on [date] (Her child was born on [date].

Both *Official* and *Unofficial* dosimeter results were listed on the *Dosimetry History by Individual* printout. The *Occupational Radiation Exposure Records File Folder Checklist* from her dosimetry file indicates an *Extended Dose Reconstruction (EDR)* was done on October 28, 1998.

A "Dose Assessment" was completed on May 16, 2000, and August 15, 2000. There is an *Extended External Dose Reconstruction Form* in her dosimetry file for May 16, 2001. This may represent the calculated dose listed on May 2, 2001. No dosimetry investigation forms were available in her personal dosimetry file for September 29, 1997, and September 28, 1998, where she also had a calculated dose listed. NIOSH has apparently located these and can trace the 54 millirem beta dose investigation as the one the EE was referring to. The EE raised a question regarding completeness of claimant records, since it took an extraordinary effort and two separate requests to recover the relevant data from her records. The above situation is an example of where an unusual result was obtained and an investigation was conducted to determine the likely exposure. Similar situations would be expected with other unusual badge results such as over-exposures.

It is recommended that NIOSH/ORAUT perform some validation on monitoring records received for claimants from RFP. All records may not always be readily available in the individual health physics files.

Concurrence with NIOSH/ORAUT that this is not an SEC issue.

EXTENDED EXTERNAL
DOSE RECONSTRUCTION

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EXTENDED EXTERNAL DOSE RECONSTRUCTION FORM

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Section 1: PERSONNEL DATA

Name: [redacted] Health Physics ID No: [redacted]
Social Security Number: [redacted] Building: T117A Ext/DP: x6285 / 3574
Department: K-H. Communications Job Classification: [redacted]
Supervisor: [redacted] Supervisor Ext/DP: x5099 / 3554

Section 2: DOSIMETER

Case No: C999999 IDB Name: P010101
802 TLD: 2999999 809 TLD: 9999999 813 TLD: N/A
[√] Whole Body [ ] Wrist [ ] Other
Anneal Date: 5/2/01 Activity Date: 5/2/01
Issue Date: 5/2/01 Return Date: 5/2/01
Assign Date: 5/2/01 Read Date: 5/2/01
Reason for Dose Reconstruction: Separated from dosimeter while in RBA (see RIR 01-200)

Section 9: DOSE EQUIVALENT ASSIGNMENT

Final Dose Results	Neutron	Gamma	Deep	Skin	Extremity	Lens of Eye
(mrem)	0	0	0	0	N/A	0

Type of Record [√] New [ ] Modify

Section 11: SIGNATURES

Letter Sent		[redacted]	5/16/01
Employee Signature	Date	Ext. Do[redacted]etry Staff Designee	Date
[redacted]	5/24/01	[redacted]	
Ext. Dosimetry Staff review	Date	Data Entry, Rad. Records	Date
[redacted]	6/5/01		
Manager, Radiological Health	Date		

Figure 23-1: Extended External Dose Reconstruction (page 1 of 3)

EXTENDED EXTERNAL
DOSE RECONSTRUCTION

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Section 5: EXTERNAL DOSE RECONSTRUCTION CHECKLIST

1. Did the individual access any area and/or perform work that requires a dosimeter?
[√] Yes [ ] No If yes, document circumstances.
[ ] N/A [ ] Unknown
In the Building 371 RBA separated from her dosimeter for 30 minutes
2. Was the individual wearing required dosimetry?
[ ] Yes [√] No If no, explain circumstances.
[ ] N/A [ ] Unknown

3. Did the individual receive any medical treatment during the period in question that involved nuclear medicine?
[ ] Yes [ ] No If yes, document circumstances.
[√] N/A [ ] Unknown

4. Did the individual store his/her dosimeter at the assigned storage location?
[√] Yes [ ] No If no, explain circumstances.
[ ] N/A [ ] Unknown
Building T117A storage board

Section 6: OTHER EMPLOYEES REQUIRED TO BE INTERVIEWED

Name	Health Physics ID
N/A	

Section 7: DOSE EQUIVALENT OF INDIVIDUAL'S COWORKERS

(All dose equivalents in mrem)

Name	HP ID	Wear Period	Neutron	Gamma	Deep	Skin	Ext	LOE
[redacted]	[redacted]	05/02/01-05/09/01	0	0	0	0	N/A	0
[redacted]	[redacted]	05/02/01-05/09/01	0	0	0	0	N/A	0
N/A								
Highest dose equivalent among coworkers:			0	0	0	0	N/A	0

Figure 23-1: Extended External Dose Reconstruction (page 2 of 3)

EXTENDED EXTERNAL DOSE RECONSTRUCTION

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Section 3: EXTERNAL DOSE RECONSTRUCTION ANALYSIS

Investigator: [redacted] HP ID No. [redacted] Date: 5/4/01

Was the employee interviewed? [√] Yes [ ] No

If yes, the interview was: [√] Telephone [ ] In Person [ ] Other

Section 4: EMPLOYEE COMMENTS

Section 8: DISCUSSION / COMMENTS

[redacted] became separated from her dosimeter while in the Building 371 RBA, thereby necessitating this extended dose reconstruction. She forgot to remove it from her anti-C clothing while doffing at the Room 3408 step off pad. [redacted] was on a tour with the two listed coworkers and was separated from her dosimeter for approximately 30 minutes. [redacted] is being assigned the zero dose listed on page one for the time she was without her dosimeter. This dose is equal to the dose received by the listed coworkers who were with her on the entire tour.

Section 10: RECORD INFORMATION and NOTIFICATION

Supporting Documentation Attached? [√] YES [ ] NO
Radiological Engineering Notification Required? [ ] YES [√] NO
Method of Notification
[ ] Writing: Internal Correspondence No:
[ ] Telephone: Date & Time:
Person Notified:

Figure 23-1: Extended External Dose Reconstruction (page 3 of 3)

EXAMPLE 24

Source: Advisory Board Public Comment Meeting (April 26, 2006, pages 350–358)

Claimant Status: POC less than 50%, overestimate, internal and external

General Comment: The EE worked as an industrial engineering technician and material control specialist from December 1, 1958, through February 28, 1986,. Primary exposure would have been photons and electrons with some potential for neutrons. The year 1958 was prorated for the one month he did work. The original dose reconstruction (2004) was reworked in 2006 due to the following:

- Change of particle size from 5 microns to 1 micron
- Neutron Dose contained in the RF NDRP
- Dose reconstruction did not consider the contribution from low-energy photons in the dose estimate to the colon.

The original dose reconstruction estimated 47.296 rem (overestimate); the 2006 dose reconstruction estimated 20.205 rem (overestimate), which is greater than his recorded occupational dose of 6.447 rem.

Concern 1: *Accuracy of Dose Reconstruction: States the dose assigned for dose reconstruction was for a time when not working at RFP. Assigned values for 1956 and 1957, but did not start working at RFP until December 1, 1958. (Employee dates: December 1, 1958–February 28, 1987)*

NIOSH Response: Neutron and gamma dosimetry data were noted in the Department of Energy dosimetry files for one badge cycle in 1956. It was not clear that this dosimetry result belonged to Mr. [Name], however the additional dose outside the DOL verified employment date was included in Mr. [Name's] dose reconstruction to be claimant favorable. The dose reconstruction accurately reflected the verified period of employment. Similarly, the NDRP provided detail to allow assignment for reported neutron zeros from 1956–1970 and all reported zeros that were not changed to a positive dose were used in the dose reconstruction to be claimant favorable.

SC&A Response: The existence of dose in the NDRP prior to the individual's employment leads to questions on the quality of this data. There is a heavy reliance on this data to assign neutron doses, so it is important to establish the quality of this data source. NIOSH did not respond to the individual's concerns regarding the correctness of the NDRP.

Concern 2: *Questions whether urinalysis was not reported/available from 1968–1971, but was available from 1975–1985. Shows zeros, especially in early years when he was a clerk/packer.*

NIOSH Response: It is not unusual for workers to be on varying bioassay schedules throughout their career, which can reflect changes in job duties and resultant potential for uptake of radioactive materials. Mr. [Name's] external dose measurements from this period are also relatively low, which is consistent with his bioassay history. It must also be noted that in the early years, the limits of detection for bioassay techniques were higher than in later years, making it more likely to see limits less than the limit of detection reported. To account for any incidental dose that may have been received but not documented, internal dose was assigned in Mr. [Name's] dose reconstruction based on a hypothetical intake assuming an intake of 12 radionuclides (including plutonium, americium, and uranium). This results in an intake that greatly exceeds any actual intake by the Mr. [Name], because this level of activity would be expected to be detectable by workplace indicators and would result in chronic bioassay and whole-body count results in excess of those reported. Additionally, these nuclides would not all be found in a single location on site.

SC&A Response: There is also a gap in the bioassay data from January 17, 1967–April 28, 1972. Bioassay results do exist prior to and after this period of time. There is no indication of work restriction in the Health Physics file. Detailed information on job responsibilities and work location is not available. There is also no information on why bioassay sampling was discontinued.

Inconclusive.

Concern 3: *On his dying bed he said that records were accidentally on purpose destroyed at the Federal Center in Denver.*

NIOSH Response: NIOSH is not aware of any evidence that records it would use for dose reconstruction at Rocky Flats were inappropriately destroyed. Some records, such as original personal dosimetry records, are governed by DOE records retention policies. Other records are not covered by such policies. Further analysis of this concern is not possible without additional details regarding what types of records are at issue.

SC&A Response: The individual is no longer alive and cannot be consulted for further clarification.

Inconclusive

Concern 4: *What building was used in his dose reconstruction?*

NIOSH Response: The dose records show that the employee worked in several different buildings during his employment at RFP, including 881, 444, 901, 991, and 776. The site profile for Rocky Flats only discusses the major buildings at the Rocky Flats site. It is not intended to be a comprehensive listing of all buildings. Mr. [Name's] dose reconstruction, as well as those of other claimants from Rocky Flats, is based primarily on personal bioassay and external dosimetry results, rather than source term calculations that may be influenced by work location.

SC&A Response: Assuming the employee was adequately monitored for the radionuclides in their work area, this would not present an issue with dose reconstruction. If, however, the internal or external monitoring was incomplete or inadequate, this would impact dose reconstruction. **Concurrence with a qualifier.**

Concern 5: *No dose assigned during 1970 strike.*

NIOSH Response: The reconstruction of [Name's] dose was based on his external dosimetry data provided by the DOE. These results show no recorded dose in 1970. No evidence has been presented to show that this is in error.

SC&A Response: There is clearly missing dose in the first two quarters of 1970. This individual worked a portion of his time in the non-plutonium areas, based on a review of his work history. As a result, he may have been considered a non-plutonium worker in the period of time when non-plutonium area badges were not read. More detail on issues regarding 1969 and 1970 exposure gaps is found in Section 4.0.

Inconclusive.

Concern 6: *Records show that this person had 316 incidents of exposure, with 15 incidents taking place in years before he was employed at RFP.*

NIOSH Response: The reference here is apparently to the number of lines in the IREP input file (316), some of which occur before the period of verified employment for the claimant-favorable reasons discussed above.

SC&A Response:

Concurrence with NIOSH/ORAUT that this is not an SEC issue.

EXAMPLE 25

Source: Advisory Board Public Comment Meeting (ABRWH 2006a, pp. 367–372) (see also Example 4)

Claimant Status: Dose reconstruction has not yet been completed.

General Comment: Many of the concerns expressed by this individual in the public comment session reiterate concerns expressed by this individual in the SEC petition, and examined in Example 4. These concerns will not be restated here.

Concern 1: *Inaccurate, incomplete and blatantly fraudulent records.*

NIOSH Response: The employee cites "no data available" dosimetry results, zeroes when she was working in high rad areas, darkened badges being assigned zero dose, and wearing badges under lead aprons as the basis for her contention that "the records used for the dose reconstruction are inaccurate, incomplete, and blatantly fraudulent). The reader is directed to Example 4 for a complete consideration of these issues.

NIOSH is not aware of blatantly fraudulent Rocky Flats DOE dosimetry monitoring data/records, and no evidence of fraud is included in this public testimony.

SC&A Response: The comment does not provide sufficient information to determine whether records were incomplete or inaccurate.

Inconclusive

The more pressing issue expressed by the worker was the lack of exposure when the employee worked in high radiation areas such as the vault. NIOSH/ORAUT have not provided an adequate explanation for the disparity between dosimeter results and exposure to high dose rate fields.

NIOSH response is incomplete.

Concern 2: *Surrounded by Pu production processing lines. She had a 360 degree of exposure.*

NIOSH Response: The Rocky Flats External Dosimetry TBD addresses assignment of dose relating to 360-degree exposure issues. This situation does not prevent NIOSH from performing dose reconstructions of sufficient accuracy.

SC&A Response: The TBD does address exposure geometry and angular dependence of the dosimetry system. This discusses the variation in response by the dosimeter as it is exposed from different directions. In this case, the worker is not referring to the angle of exposure on the badge, but the existence of source terms surrounding an individual. Although the laboratory response to various incident angles on the dosimeter is discussed, no response to exposure from multiple sources (e.g., plutonium in boxes behind, to the side and/or in front of the worker at the same time) has been provided.

NIOSH/ORAUT response is incomplete.

Concern 3: *Office adjacent to an abandoned americium line. Adjusted dose of 826 mrem for the year (2,000 hours), but she worked 45+ hours a week. In addition, she feels that the numbers are fraudulent and were manipulated to meet the corporate bonus structure. She did not have a badge at this time, because she was considered administrative personnel.*

NIOSH Response: Similar to the concerns expressed and examined in Example 4, this issue deals with the justification used by the site in deciding that this employee did not require external dosimetry. The issue of proper assignment of unmonitored dose is most appropriately considered in the context of the individual dose reconstruction. There is no indication here that NIOSH could not calculate unmonitored dose with sufficient accuracy as appropriate. On the contrary, the supporting materials accompanying this affidavit provide area surveys and other data that could be informative for such a calculation. The length of the workweek would only impact dose estimates derived using source-term calculation. Furthermore, if source term calculations were relied upon, the length of the workweek could be adjusted in a claimant-favorable manner. At Rocky Flats, NIOSH is using individual dosimetry results in a great majority of dose reconstructions. For situations where dosimetry is not available or is inadequate, NIOSH may rely on coworker data. Coworker data is developed for whole-body dose recorded on film badges or TLDs. The whole-body dose equal to a claimant-favorable percentile of doses recorded for the monitored population is assigned as a whole-body dose to the unmonitored individual.

No evidence of fraud was provided either in this affidavit or in the public comment made by this individual. NIOSH is not aware of blatantly fraudulent Rocky Flats dosimetry monitoring data/records.

SC&A Response: NIOSH/ORAUT has several methods for assigning missed dose to workers. This includes assignment of dose based on the minimum detectable dose of the dosimeter and the number of exchange periods, or in case of potential for exposure they can apply a coworker model. The validity of the external coworker model is discussed further in Section 4.0 of this report. Decontamination and Decommissioning workers are discussed in Section 8.0 of this report. The criteria used by RFP to monitor workers during any period of time should be fully evaluated to determine if inadequacies exist in how monitoring was determined.

Concurrence with NIOSH/ORAUT that this is not an SEC issue.

EXAMPLE 26

Source: Advisory Board Public Comment Meeting (ABRWH 2006a, pp. 386–393)

Claimant Status: POC less than 50%

Concern 1: *Record keeping virtually non-existent.*

NIOSH Response: [Name's] employment dates are from January 11, 1982, through September 30, 2001. His records show that he has dosimetry data for all of his years of employment.

SC&A Response: The affidavit indicates record keeping was virtually non-existent and the records that may aid a worker's claim (e.g., dosimetry logs, radiation control logs, etc.) cannot be found or do not exist. Multiple dosimetry logs, contamination control logs, Radiation Protection Technician (RPT) logs, and Foreman's logs have been located and reviewed. These logbooks have some value, but do not always contain individual names. A review of logbook data was conducted by SC&A and is discussed in detail in Section 5.3. Completeness of records is also discussed in this report.

Inconclusive.

Concern 2: *Routine exposures not recorded, workers exposed to unrecorded radiation, unusual results disregarded.*

NIOSH Response: Routine exposures were monitored by the external dosimetry program. Unusual results were not disregarded, but rather were investigated to determine whether or not there was a problem with the dosimeter and to determine an appropriate assigned dose. The conduct of dose investigations is described in Procedures RDE-0053 and RDE-0071. During the latter years of Mr. [Name's] employment, it was DOE policy to monitor only those employees with a potential to receive greater than 100 mrem in a year. This potential was judged on several factors, including historic dosimetry results for individual employees, job duties and work locations, and survey results of work locations.

SC&A Response: It is unclear from the comment whether the individual was concerned about receiving unmonitored exposure, or whether the primary concern is that unusual results were disregarded. In their response, NIOSH/ORAUT indicate that unusual results were investigated to determine whether or not there was a problem with the dosimeter. They were also used to determine appropriate assigned dose. This individual was employed during a time period where no formal dosimetry investigation procedures have been identified. Assuming the employee was adequately monitored, this would not present an issue with dose reconstruction. If, however, the internal or external bioassay monitoring was incomplete, this would impact dose reconstruction.

Inconclusive.

Concern 3: *Dose reconstructions based on averages for the areas or the buildings. Dose reconstruction does not always consider the dose received by an individual working in a high dose rate job.*

NIOSH Response: Dose reconstructions in general, and [Name's] dose reconstruction in particular, are not based on average dose rates in an area. Dose reconstructions are based on personal dosimetry results, which reflect the actual exposure conditions experienced by the individual employee. In situations of unmonitored exposures, dose reconstructions can sometimes be based on a claimant-favorable estimate of dose derived from the distribution of all workers monitored at the site (e.g., the 95th percentile value). This accounts for the possibility that a particular unmonitored employee might have received a higher than average dose.

SC&A Response: The worker is correct that job responsibilities are not adequately taken into consideration when assigning a missed dose. This is particularly relevant to the assignment of coworker doses. NIOSH routinely uses averages where dose records are not available when performing a best-estimate dose reconstruction.

Inconclusive.

Concern 4: *The handout that this employee distributed at the meeting states, "The denial was based on dose reconstruction and my lack of being able to provide specific additional info." (letter dated June 10, 2005).*

NIOSH Response: The letter dated June 10, 2005, is the Notice of Recommended Decision from DOL. It states, "Based on the dose reconstruction performed by NIOSH, the probability of causation (the likelihood that the cancer was caused by radiation exposure incurred by the employee while working at the Rocky Flats Plant) was calculated for the lung cancer. The probability of causation values were determined using the upper 99 percent credibility limit, which helps minimize the possibility of denying claims to employees with cancer likely to have been caused by occupational radiation exposures. It was shown that [Name's] lung cancer does not meet the "at least as likely as not" (a 50% or greater probability) threshold required under

Part B of the EEOICPA that the cancer was caused by radiation doses incurred while employed at the Rocky Flats Plant." The denial of Mr. [Name's] claim was not based on his inability to provide specific additional information. However, the letter also describes the procedures to be followed if the claimant wishes to object to the recommended decision. It states, "Your objections MUST clearly state the reasons for your disagreement and indicate the specific findings of fact and/or conclusions of law with which you disagree, including objections to any dose reconstruction performed. If you want an informal oral hearing on your objections, at which you will be given the opportunity to present both oral testimony and written evidence in support of your claim, you MUST request a hearing when you file your objections."

SC&A Response: The determination of POC is not relevant to the SEC process. However, the availability of data is relevant. There is significant concern among workers that the burden of proof regarding radiation exposure and employment is put on their shoulders although it is more difficult for them to access records. The petitioners are clearly at a disadvantage when trying to gain access to records to support their claims. This not only applies to RFP but to other sites and should be addressed on a complex-wide basis.

Inconclusive.

EXAMPLE 27

Source: Advisory Board Meeting (ABRWH 2006b, pp. 114–120)(See Also Example 15)

Claimant Status: POC less than 50%, over estimate from dosimetry records

Concern 1: *Never wore TLDs in office areas, then 5 or 6 years (later?) there was radiation exposure in the office areas.*

NIOSH Response: In the 1980s and very early 1990s, employees kept their dosimeters in their possession and took them home since their security ID was incorporated into the dosimeter holder. In 1990–1992 timeframe, the ID and dosimeter were separated and badge boards were established in multiple facilities as a means of better controlling the background, conditions of storage, and accountability of the dosimeters. People were free to pick up and wear their dosimeter all day, even if they were not in a radiation area. They were only asked to return their badges to the boards at the end of their shift. This was the case during this EE's employment period (1995–2000). It is not clear from the worker's concern whether the working conditions in the office areas in question were constant and whether dose-rates would be expected to be constant over the years. It is not clear that the radiation exposure was present in the office areas during the time he worked there without his TLD. It was the policy at Rocky Flats that dosimetry was required only for employees expected to receive greater than 100 mrem per year. This was determined in part by periodic surveys of specific work areas. The reason for repeating the surveys on a periodic basis was to ensure that estimates of exposure potential were current, and not based on working conditions that had changed. To account for doses workers might have received when working in areas with dose rates low enough that monitoring was not required, NIOSH can assign environmental and/or unmonitored dose, as appropriate.

SC&A Response: Several concerns have been raised regarding exposure in production buildings outside the immediate production area. Area dosimetry data even as late as 2000 indicates that dose could be received by workers who did not enter the processing areas. NIOSH could assign coworker doses to these individuals, making dose reconstruction possible.

Concurrence with NIOSH/ORAUT that this is not an SEC issue.

Concern 2: *Inaccurate records regarding exposure and types of exposure.*

NIOSH Response: This individual is concerned that, "…the paperwork is incorrect in terms of where some of these people got their exposure, what types of exposure there are in different areas in the facility when you walk through that you can get a higher level exposure" (ABRWH 2006b, p. 118). NIOSH is not aware of any systematic inaccuracies in Rocky Flats dosimetry records. The TLDs and film badges used at Rocky Flats provide an integrative measure of total external radiation exposure experienced during the wear cycle. With certain well-known limitations (like gamma fogging of NTA films or fogging of film badges by light exposure, etc.) these dosimetry badges are expected to reliably record total radiation exposure in all areas and typical working conditions at the Rocky Flats Plant.

SC&A Response: The comment does not provide sufficient information to determine whether a systemic problem exists.

Inconclusive.

Concern 3: *In several rooms where alarms went off.*

NIOSH Response: The incidents described (alarms going off, removal of contaminated clothing) were considered in this individual's dose reconstruction. Doses from internally deposited radionuclides are estimated from bioassay results, and external doses are measured using film badges or TLDs. Therefore NIOSH concludes that this issue does not have SEC implications.

SC&A Response: Assuming the employee was adequately monitored via urinalysis, this would not present an issue with dose reconstruction. If, however, the bioassay monitoring was incomplete, this would impact internal dose reconstruction. **Concurrence with a qualifier.**

EXAMPLE 28

Source: Advisory Board Public Comment Meeting (ABRWH 2006a, pp. 431–433)

Claimant Status: Dose reconstruction has not yet been completed.

Concern: *Worked in Building 71, injured working in a glovebox with glass (puncture wound), no immune system.*

NIOSH Response: NIOSH grants that incidents occurred during the history of Rocky Flats. Intakes of radioactive materials received from such incidents would be monitored by bioassay. External doses received in incidents would be monitored by film badges or TLDs (depending on the time period). The incident described is reported in this individual's radiation file. The occurrence of such incidents does not prevent NIOSH from conducting dose reconstructions with sufficient accuracy. Therefore, NIOSH concludes that this issue does not have SEC implications.

SC&A Response: During the individual's tenure at RFP, he received a puncture wound from plutonium contaminated glass while working in a glovebox. The individual's doctor informed him he had no immune system. Since non-cancer medical conditions are not defined under Subpart C, this concern should be directed to the Department of Labor. The non-cancer medical conditions are considered under Part E of the EEOICPA. **Concurrence with NIOSH/ORAUT that this is not an SEC issue.**

EXAMPLE 29

Source: Advisory Board Public Comment Meeting (ABRWH 2006a, pp. 394–399)

Claimant Status: POC less than 50%, overestimate

Concern: *Tore down the area where they had the fire in '69***,** *Tore down G-mod in Building 707 (Be room), exposed to radioactive dust from production era during demolition.*

NIOSH Response: This individual was monitored both with external dosimetry and by bioassay during his employment at Rocky Flats. Exposures above the limits of detection would be expected to be reflected in the dosimetry results; therefore, NIOSH concludes that exposure to this material would not prevent dose reconstruction of sufficient accuracy and this is not an SEC issue.

SC&A Response: The concern raised here brings up a question regarding the potential for D & D workers to be exposed to high-fired oxides created as a result of the 1969 fire. In determining who to apply ORAUT-OTIB-0049 to, this should be considered. **Concurrence with NIOSH/ORAUT that this is not an SEC issue.**

EXAMPLE 30

Source: Advisory Board Public Comment Meeting (ABRWH 2006a, pp. 404–424)

Claimant Status: POC less than 50%, overestimate based on dosimetry records (non-production worker)

Concern 1: *Specific concerns regarding being in areas where she did not have dosimetry.*

NIOSH Response: Several examples of when this individual believes she was or could have received unmonitored exposure were presented. She states that these situations were completely ignored in the NIOSH dose reconstruction. Since no dates were provided for these events, it is not possible to know whether she was monitored during the described events. However, the events listed were reported in the CATI interview and were taken into account for the dose reconstruction. There is no evidence that this individual actually did receive unmonitored dose; however, the possibility is, in fact, accounted for and a claimant-favorable estimate of unmonitored dose was assigned and discussed in her dose reconstruction report.

SC&A Response: Refer to the Response for Example 4, Concern 4.

Concurrence with NIOSH/ORAUT that this is not an SEC issue.

Concern 2: *Contamination areas painted over with normal paint, then states that any worker would have been exposed to radiation.*

NIOSH Response: Purple paint was used as a fixative to prevent the spread of surface contamination. Its presence does not necessarily signify that TLDs should have been worn in the area. This would depend on whether the exposure potential exceeded 100 mrem/yr.

SC&A Response: A fixed contamination area would not necessarily result in significant external exposure. Potential exposure would also be dependent on the proximity of individuals to the area. No field monitoring data such as radiation and contamination surveys are available to ascertain the extent of the potential exposure. The individual toured areas where other workers wore protective clothing without dosimetry. This particular individual was intermittently monitored for internal and external exposure while at RFP. A missed dose assignment would likely have to be assigned in this case. **Concurrence with NIOSH/ORAUT that this is not an SEC issue.**

Concern 3: *While visiting Pantex there was a tritium release and Pantex made sure to issue her a dosimeter. The NIOSH report did not include the Pantex dosimetry report.*

NIOSH Response: The records from Pantex were considered in this individual's dose reconstruction and the dosimetry report shows that there was no recorded dose during her visit to Pantex.

SC&A Response: Monitoring data from other DOE sites where individuals visited may or may not be included in the Health Physics file. Some sites did not routinely provide the home facility with exposure results. NIOSH must first be aware of other sites an individual visited and request this data prior to including it in the dose reconstruction. This is a question not routinely asked as a part of the CATI process. This issue has broad implications and should be addressed on a complex-wide basis.

Concurrence with NIOSH/ORAUT that this is not an SEC issue.

Concern 4: The individual was c*oncerned about being exposed to Super Class Y material.*

NIOSH Response: NIOSH has detailed the approach to be used in dose reconstructions where there is potential exposure to Super Y Pu. This is found in ORAUT-OTIB-0049.

SC&A Response: See SC&A Response to Example 4, Concern 6.

Concurrence with NIOSH/ORAUT that this is not an SEC issue.

EXAMPLE 31

Source: Advisory Board Meeting (ABRWH 2006b, pp. 95–114); (see also Example 23)

Claimant Status: Non-claimant

Concern 1: *As of February 15, 2005, could dose be accurately reconstructed?*

NIOSH Response: NIOSH has established that it has access to sufficient information to accurately reconstruct radiation dose incurred by any member of the class and to estimate radiation doses more precisely than a maximum dose estimate. NIOSH relies primarily upon personal dosimetry worn by individual employees for reconstructing dose. The need for using coworker data is minimal at Rocky Flats; however when it is required and appropriate, NIOSH can assign a claimant-favorable estimate from coworker data (e.g., 95th percentile of all monitored workers). NIOSH contends we can accurately reconstruct dose for all members of the class throughout the history of the site.

SC&A Response: **NIOSH** has an evaluation report stating that they believe they can accurately reconstruct dose. SC&A has reviewed this evaluation and provided comments. The final determination of whether dose reconstruction is feasible must be decided by the Advisory Board.

Inconclusive.

Concern 2: *Concern about the 6 cases cited in ER, then applied to 9,537 people…not a good population to be basing assumptions from.*

NIOSH Response: The evaluation report discusses the seven bases of the petition, as given to NIOSH by the petitioner. In addition, the evaluation report also discusses nine specific incidents, as stated in the petition in the form of affidavits. This document discusses those nine incidents, plus many others, in detail.

SC&A Response: It is unclear exactly which six cases are being referenced. As a part of the petition review, NIOSH evaluated the pedigree of the RFP data that may be the source of this comment. The CEDR cohort contained 6 data files for the 9,537 individuals in the cohort.

Inconclusive.

Concern 3: *NDA folks carried cans of Pu under their arms, but the dosimeter is not measuring the dose.*

NIOSH Response: NIOSH is aware that there are geometry issues which merit consideration in calculating doses to some extremities. Where there may be special exposure geometries, NIOSH has the ability to include geometrical correction factors to account for this on a case-by-case basis, therefore this issue does not preclude sufficiently accurate dose reconstruction. As a result, NIOSH contends that this issue does not have SEC implications.

SC&A Response: In this particular case, the worker is referring to portions of the body that were not protected when lead aprons were worn. Field studies conducted by RFP have allowed NIOSH to develop external dose correction factors for conditions where lead aprons were worn by workers. Dose correction factors are to be incorporated into the RFP External Dose TBD (Langsted 2007). Further discussion of whether the dose correction factor is adequate should be addressed in the site profile review.

Concurrence with NIOSH/ORAUT that this is not an SEC issue.

Concern 4: *Dose reconstruction done on this employee because her dosimeter showed an abnormally high reading and the dosimetry department did an investigation and asked her to remember all the places she had been for the previous 6 months, then a zero was entered on her dose record. (not talking about the incident where she left her TLD in her coveralls, which ended up in the laundry basket. This incident is discussed in Example 23.)*

NIOSH Response: Two interviews have been conducted with [the EE]. The notes from both interviews are below.

Notes from brief interview with [the EE], former Rocky Flats employee, conducted on April 27, 2006, by Arjun Makhijani and Hans Behling:

Background: [Name]'s job designation was Communications Professional; work included taking tour groups through all site facilities, including all plutonium and uranium facilities. Notes are not verbatim. The conversational style is retained to give a flavor of the interview. Draft sent to [Name] on April 29, 2006, at [e-mail address] for permission to use her name in the interview requested of [Name], who spoke on behalf of the petitioners on April 27, 2006, during Rocky Flats portion of the meeting of the Advisory Board on Radiation and Worker Health in Denver, Colorado. Corrected interview returned to SC&A by [Name] on May 5, 2006. Permission to use her name in this interview and to review her dose record granted by [Name] in an e-mail of May 5, 2006.

[START OF INTERVIEW]
Arjun: I am interested in looking into this instance of zeroing out a dose result because it is an example relating to someone who is not a claimant and does not expect to be a claimant. I also want to look into it because of your statement that NIOSH did not look at the data you wanted them to look at.

[Interviewee]: NIOSH investigated the wrong incident. I was referring to a different one. The incident I was referring to was in about 1999 or 2000, but may have been 1998 or as late as 2001. I was called into dosimetry because they had an issue with my dose for the quarter. They needed

to do a dose reconstruction because they could not ascertain why I would have high dose. I think it was the beta dose but I don't know.

Hans: It may have been a dose resolution rather than a dose reconstruction. A dose resolution concerns a discrepancy that you couldn't resolve and needs investigation. The Panasonic TLD that was in use in the 1999–2000 period in question had several elements. If one reading, such as the beta dose not match and is aberrant, it may be rewritten in as zero. The reading of the badge is completely automated. It should be possible to detect if there was a legitimate reason for changing the reading to zero.

[Interviewee]: They did an investigation and I had to fill out papers showing where I had been for that period of time. The investigation was quite a bit of time after the quarter in question. It was hard for me to recall the details of where I had been. To the best of my recollection I had been in a lot of plutonium buildings and 886, the uranium criticality laboratory. The buildings were 779, 771, 776, 777, 371, and 886. And they [dosimetry department] determined that they could not figure out where the dose reading came from and they gave me a zero. The dose involved was 80-some millirem. It wasn't very high and I wasn't worried about it.

Arjun: Did you get a written report?

[Interviewee]: I don't recall.

Arjun: Were you pregnant at time?

[Interviewee]: My son was born on [date]. I declared my pregnancy in the fourth month. I do not recall for certain whether the timeframe overlaps with when I was pregnant or not.

Hans: You want to get the raw data as developed by the processor. You want all the raw reads and you can see if there is or is not a legitimate basis for the read. The regulatory limit for pregnant women is 500 mrem. Then there is an administrative limit. That may be lower. Some places have a zero limit for pregnant women. In every facility there is a pregnancy policy. Do you have a copy?

[Interviewee]: At Rocky Flats you had to declare pregnancy. It was not a mandatory exclusion from rad work; the policy excluded just high rad work.

Arjun: I will likely need a release from you to ask DOE for your dose records.

[Interviewee]: Send me the form and I'll sign it. You can look into my dosimetry records.

Arjun: Thanks. Either Kathy DeMers or I will get back to you.
[END OF INTERVIEW]

Notes from the second interview:

Conference Call Notes
Interview with [Name]
August 24, 2006, 2:30 pm – 4:00 pm ET

Subject: Concern over inaccurate records not only in her file, but other workers as well.

Attendees: Brant Ulsh, Steve Baker, Craig Little, Karin Jessen, Bob Meyer, Joe Fitzgerald, Kathy Behling, Hans Behling, Kathy DeMers, Mark Griffon, Arjun Makhijani, [Name]

Brant introduced the concern from an e-mail sent to OCAS on February 28, 2006 that read:

> *How are you addressing the fact that when a person received an abnormal or unexpectedly high dose and an internal investigation could not identify the source, the person received a 0 for dose. I know this to be true because it happened to me when I was pregnant in the 1999/2000 timeframe. My dosimeter showed a high reading for ionizing radiation. And an investigation was conducted and the reviewers could not find the source so they decided NOT to follow conduct of operations which says you have to trust your indicators (in this case my dosimeter) and decided to enter a 0 for my exposure. I am sure there are hundreds of examples like this. So now my dose record is inaccurate and there is obviously no way to reconstruct it accurately since they failed to do so at the time.*

Brant discussed the notes from the interview with Arjun Makhijani and Hans Behling with [Name] at the Advisory Board Meeting on April 27, 2006.

Craig Little stated that he had a short conversation with [Name] at the Advisory Board Meeting on April 27, 2006.

[Name]'s specific issue is the time frame between 1998 and 2001. Brant reviewed [Name]'s records from the Part 1 and Part 2 (e-mail dated August 23, 2006, titled Rad files for call tomorrow). Information discussed included the declaration of pregnancy on [date]; 1998 54 mrem shallow dose (March 30, 1998–June 22, 1998 badge cycle), and the 11 mrem in 2000.

[Name] asked about how deep and shallow dose is determined, Brant explained how the TLD works.

Hans was concerned about the series of entries regarding the dates of the Declaration of Pregnancy [date] and the dose assessment completed on November 8, 1999, and the badge cycled entered on September 28, 1999. He stated there was no incident report that matches what [Name] was stating. Hans discussed what the policy should have been. It was pointed out that her Declaration of Pregnancy data closely coincided with the ending of a quarter and the subsequent badge exchange. After reviewing the records, and noting that there was an embryo assessment at the appropriate time, Hans stated that the proper protocol was followed and that this issue was closed in his mind. Hans came to this conclusion near the end of the call. He is still a little concerned that there are some things missing from her file, specifically, the Declaration of Pregnancy form and any potential paperwork having to do with following the investigation procedure. We followed the paper trail and all the paper work is in order for [Name]'s pregnancy. [Name] pointed out that she continued to go into the back areas during her pregnancy and that she did sign a waiver to do so.

[Name] said at the Denver Advisory Board Meeting that she was involved in three incidents over the course of her career. Brant listed three possible incidents from [Name]'s rad file:

(1) The laundry issue, which is not the issue that [Name] has been referring to (not the issue she is concerned about)

(2) The special fecal sample that was requested in December 1999 (not the issue she is concerned about)

(3) The beta dose in 1998, which is the issue we discussed.

Brant led the group through a systematic review of [Name]'s file and we predominantly discussed #3 which includes information in her rad files on pages 11, 12 in part 2. Steve Baker explained the meaning of the 4 different elements of the beta/gamma dosimeter (802 dosimeter) and what they measured (element 1= beta, element 2 = beta and gamma, element 3, 4 = gamma) and the 2 dosimeters (802 and 809 -neutron) that were used at the time. It was pointed out that the badge cycle from March 30, 1998–June 22, 1998, matches [Name]'s concern regarding her beta dose (54 mrem). [Name] did mention that she was in the U criticality lab with a film crew about this time. In addition, there was a tank being drained. She mentioned these as 2 possible scenarios for getting a beta dose. Discussion also included steps that were taken to retrace [Name]'s steps to learn the source of the beta exposure. The paperwork that was done to retrace these steps are not in [Name]'s rad file, i.e., the investigation report. However, it was suggested that an investigation report may not have been filled out because it was decided to use the 54 mrem in her dose record. Steve Baker suggested that a procedure existed that required trying to track down the source of exposure if exposure was above 50 mrem. If a cause could not be determined regarding an exposure over 50 mrem, then the actual reading would stand (in this case, the 54 mrem). Steve/Brant will locate this procedure. Steve also noted that as RFP got closer to closure, the procedures changed. [Name]'s concern was lack of documentation of the process. This lack of report in her files is [Name]'s concern regarding inaccurate records across the worker population. She was just using herself as an example. [Name] thinks a dose reconstruction was done, since they were investigating why she got the 54 mrem. Mark also mentioned that the general concern was over the inaccurate records.

Discussion also took place regarding the issue date of the badges. Steve Baker explained that it usually took about 3–4 weeks to get the badges ready to ship to the field, which explains the issue date of February 26, 1998, and the exchange date of March 30, 1998. The paper work does not give an indication of when the badge is actually shipped out to the field.

Hans stated that it was a compliment to the RFP program that they would try to investigate such a small dose of 80 mrem [in this case 80 mrem is used because [Name] had stated 80 mrem was a small dose and she wasn't worried about it (see interview notes with Arjun, Hans, and Name].

[Name] asked if random auditing had been done to see if other files are complete. Brant replied that no, there was no random audit, but we have examined all the examples given in the Petition.

Kathy DeMers stated that she had sent files to other people to determine if anything was missing from their files. The concerns that had been stated were zeros in the reports and people don't believe the zeros. Brant stated this was a concern that has been repeated.

The conference call ended at 4 pm with the action items of Brant sending the procedure (see above) to the call participants, and Brant stated that he would consult with the team to see if there was any other place we could check for an investigation report corresponding to the 1998 badge reading.
[END OF INTERVIEW]

NOTE: NIOSH investigated further into [Name]'s rad file and has retrieved her Declaration of Pregnancy [Year] and a dose investigation for the [Year] badge read (shown below).

In an e-mail message dated August 28, 2006, Ms. *[Name]* has agreed that the 1998 badge read is the correct incident, but expressed concern that all of her records were not retrieved from the beginning. The completeness of the records supplied to NIOSH by the DOE is certainly a valid issue; however it should be noted that the records were present in her file but overlooked as they were in a separate envelope. In the absence of the additional records, NIOSH would simply have correctly assigned the dose recorded in her records. The additional records would not have affected the dose reconstruction that would have been performed, had she been a claimant.

<u>SC&A Response</u>: This provides an example of a situation where a dosimetry investigation was completed and documented.

Concurrence with NIOSH/ORAUT that this is not an SEC issue.

EXAMPLE 32

<u>Source</u>: Advisory Board Meeting (ABRWH 2006b, pp. 134–140)

<u>Claimant Status</u>: Non-claimant

Concern 1: *Record keeping, original records including personal records of exposure, surveys of radiation and contamination areas, dumped in the landfill. In addition, this employee is sure there is contamination in the landfill, from the records.*

<u>NIOSH Response</u>: NIOSH is continuing the investigation into this issue, and it will be discussed separately.

<u>SC&A Response</u>: NIOSH completed the investigation and found the evidence to be inconclusive. Concurrence that the investigation is inconclusive.

Concern 2: *Lead aprons and badges worn underneath the aprons.*

NIOSH Response: Lead aprons were available and used for a limited number of tasks at RFP. For most years, workers were instructed to wear badges under the lead apron to measure dose to the torso. In 1992, this was changed to instruct workers to wear the dosimeter outside the lead apron to better measure the dose to the head, neck, and arms. Field studies to determine the dosimeter response in both locations were performed. The results of these studies were used to develop bias corrections to use for dose reconstructions. The use of lead aprons does not preclude sufficiently accurate dose reconstruction. As a result, NIOSH concludes this issue does not have SEC implications.

SC&A Response: See Response for Example 4, Concern 3.

Concurrence with NIOSH/ORAUT that this is not an SEC issue.

Concern 3: *Lifetime exposure of 113 rem, requested radiation records, but got medical records. He has not yet received his radiation records.*

NIOSH Response: This individual was monitored both with external dosimetry and by bioassay during his employment at Rocky Flats. Exposures above the limits of detection would be expected to be reflected in the dosimetry results; therefore NIOSH concludes this would not prevent dose reconstruction of sufficient accuracy and this is not an SEC issue.

SC&A Response: In subsequent discussions with this individual, he indicated he had received his radiation record for RFP.

Concurrence with NIOSH/ORAUT that this is not an SEC issue.

EXAMPLE 33

Source: Advisory Board Meeting (ABRWH 2006b, pp. 121–134)

Claimant Status: Non claimant

Concern 1: *No gamma shielding on most dry boxes. Shielding started in about 1968.*

NIOSH Response: The lack of shielding on dry boxes would not prevent NIOSH from conducting dose reconstructions with sufficient accuracy. The presence or absence of shielding on dry boxes would not affect the performance of external dosimeters (film or TLDs), which is the primary source of data NIOSH relies on to perform external dose reconstruction.

SC&A Response: Assuming the employee was adequately monitored for the radionuclides in their work area, this would not present an issue with dose reconstruction. If, however, the external monitoring was incomplete or inadequate, this would impact dose reconstruction, and may impact the coworker analysis.

Concurrence with a qualifier.

Concern 2: *Building 771, Rm 114, Line 1, you could go from extreme neutron field to an extreme gamma field (Line 1 was the Am box).*

NIOSH Response: Employees at Rocky Flats were monitored for both neutron and gamma radiation. NIOSH relies primarily upon personal dosimetry worn by individual employees for reconstructing external dose. The need for using coworker data is minimal at Rocky Flats; however when it is required and appropriate, NIOSH can assign a claimant-favorable estimate from coworker data (e.g., 95th percentile of all monitored workers).

SC&A Response: A more accurate characterization of the monitoring at RFP was that some employees were monitored for neutron and gamma radiation.

The comment simply provides information.

There is no issue defined in this affidavit that requires a response.

Concern 3: *Has a 36-rem body burden that he suspects is a product of high-fired oxide.*

NIOSH Response: This employee was extensively monitored for internal uptake of plutonium, both through bioassay and lung counting. NIOSH had detailed the methods that will be used to reconstruct internal dose due to high-fired Pu (ORAUT-OTIB-0049). Possible exposure to this form of Pu will not prevent NIOSH from conducting dose reconstructions of sufficient accuracy.

SC&A Response: See response to Example 4, Comment 6. **NIOSH response is incomplete.**

Concern 4: *Occurrences of black badges.*

NIOSH Response: This phenomenon was primarily an issue with neutron films. As described in the *Neutron Dose Reconstruction Project Protocol* (p.16), exposure to relatively high doses of gamma radiation (500–1,000 mrem) can cause a film to be fogged and cause difficulty in reading the neutron badge. It is well known that films can also be blackened by exposure to light. In most cases, film blackening due to light contamination can be distinguished from blackening due to exposure to ionizing radiation. Extreme environmental conditions such as exposure to high temperatures can cause film fogging (Kathren 1966, pp. 61–63; Brodsky and Kathren 1963, pp. 453–461). If a badge was blackened due to light contamination, or exposure to high temperatures, it is possible that an investigation would have concluded that the appropriate dose was low or zero.

SC&A Response: NIOSH assumes that film was blackened as a result of environmental conditions such as heat and light. No consideration has been given to the possibility that badges were actually over-exposed. Furthermore, NIOSH has not presented documentation of dosimetry investigations completed to determine the actual dose.

NIOSH/ORAUT response is incomplete. An adequate explanation has not been offered.

<u>Concern 5</u>: [The EE] *said the U.S. had about 100 tons of Pu and there could be 3 tons at RFP that don't show up on inventory records.*

<u>NIOSH Response</u>: The plausibility of a loss of 3 tons of Pu at Rocky Flats is questionable; however this is not germane to NIOSH's ability to conduct dose reconstructions of sufficient accuracy. NIOSH relies upon personal dosimetry and bioassay measurements to conduct dose reconstructions, not on material balances.

<u>SC&A Response</u>: The fact that plutonium was not appropriately inventoried is not relevant to the ability to conduct dose reconstruction.

Concurrence with NIOSH/ORAUT that this is not an SEC issue.

<u>Concern 6</u>: The individual is c*oncerned about exposures to beryllium, solvents and chemicals.*

<u>NIOSH Response</u>: NIOSH dose reconstructions deal only with exposure to ionizing radiation. Exposure to Be and other hazardous and/or toxic chemicals is handled under other parts of the compensation program.

<u>SC&A Response</u>: The effects of exposure to chemicals are considered under Part E of the EEOICPA. Since chemical exposures are not defined under Subpart C, this concern should be directed to the Department of Labor under the provisions of Subpart E.

Concurrence with NIOSH/ORAUT that this is not an SEC issue.

<u>Concern 7</u>: *Building 771 was closed in the spring of 1968 due to Zipper. Zipper burned everyone out.*

<u>NIOSH Response</u>: It is well known that the ZPPR project resulted in relatively high external doses to the personnel involved. However, there is no indication that these exposures were inadequately monitored. As long as these exposures were accurately monitored, and NIOSH is aware of no evidence to the contrary, dose reconstructions can be performed with sufficient accuracy.

<u>SC&A Response</u>: The ZPPR project did result in high external exposures, which is evident in the number of individuals exceeding dose limits in the 1967 and 1968 time period. As long as individuals were adequately monitored, wore their badges, and dosimeter abnormalities were appropriately investigated and documented, this would not preclude dose reconstruction. If these conditions are not met, this would impact external dose reconstruction. Furthermore, if this data were used in the coworker model, the reliability of the coworker data would be in question and require further evaluation.

Concurrence with a qualifier.

EXAMPLE 34

<u>Source</u>: USTW 2005, Part A, p. 47 (unspecified individual), and Part B, p. 32 (Name); Advisory Board Working Group Matrix (April 5, 2006, Item 10) (see also Example 5)

<u>Claimant Status</u>: Non-claimant

<u>Concern</u>: Bioassays were redone or individuals were recounted when the readings were high and subsequent results were declared as having no exposure or false positives. Both examples have other complex features.

<u>NIOSH Response</u>: Verifying an intake suggested by a positive bioassay result is in compliance with Rocky Flats procedure PRO-1171-RDI-5106, which states "An intake is considered confirmed if one follow-up sample shows detectable levels of activity (not associated with background or previously identified intakes) following a workplace indicator which exceeds actions levels <u>or</u> following a routine bioassay sample above the decision level."

It should also be noted that NIOSH receives raw bioassay data from the site, including results that the site has determined to be false positives. Conversations with dose reconstructors indicated that no bioassay results are excluded, even if the site determined that it was a false positive (in fact, no one had any recollection of this ever occurring, though we did not perform an exhaustive search of completed dose reconstructions).

<u>SC&A Response</u>: Assuming the site used a detection level at the 95% level, it is expected that there would be a false positive rate of 5%. In these conditions, a follow-up sample or count should have been conducted and would likely occur at a higher sensitivity (e.g., different type of count, longer count, more sensitive instrument, etc.) At the detection level for both bioassay and in-vivo counting, when a positive is observed, either the result is accepted or the individual is resampled or counted again to gain better sensitivity. For cases where individuals had bioassay samples at or below the detection level, NIOSH/ORAUT would use any positive urinalysis results to calculate the dose. Follow-up bioassay sampling is a common practice when an bioassay sample comes up positive. A site-specific policy determines where there is a confirmed uptake. At some sites a confirmed uptake is considered two positive bioassay results consecutively, or two positive bioassay samples out of three. Field indicators such as a SAAM alarm or personnel contamination, especially on the face, are also considered in evaluating positive bioassay samples. Upon receipt of the claimant file, the raw bioassay results can be re-evaluated based on NIOSH's own criteria.

Concurrence with NIOSH/ORAUT that this is not an SEC issue.

EXAMPLE 35

<u>Source</u>: Advisory Board Public Comment Meeting (ABRWH 2006a, pp. 341–349)

<u>Claimant Status</u>: Non-claimant, no cancer

Concern 1: *"readings" were +/- 75% on paperwork.*

NIOSH Response: To account for uncertainty in dosimetry readings, additional uncertainty factors are applied to the reported dose using ORAUT-OTIB-0027, *Supplementary External Dose Information for Rocky Flats*, Table 4-2. NIOSH dose reconstructions explicitly consider the uncertainty associated with external dosimetry. This issue does not have SEC implications.

SC&A Response: It is difficult to ascertain where the worker is referring to uncertainty factors in the dose reconstruction process or in RFP records.

Inconclusive.

Concern 2: *Two incidents involving journey machinist: (1) working on downdraft table in Building 777, he said it should have been a glovebox situation, as soon as the component came to the end of the procedure of the machining process, it leaked, alarms,…donned respirator, nasal smear taken; (2) Building 776, jagged piece of metal in pendant, called DOE representative, who came out within 30 min. Claims there is no documentation.*

NIOSH Response: It is clear that contamination incidents occurred throughout the operating history of Rocky Flats. The doses resulting from such incidents can be estimated. Doses from internally deposited radionuclides are estimated from bioassay results, and external doses are measured using film badges or TLDs. It is not clear that the occurrence described as a jagged piece of metal in pendant constitutes an incident where the employee was exposed to radiation in an unplanned and uncontrolled manner. This issue does not have SEC implications.

SC&A Response: Further conversations with the employee indicated that this was considered an intentional act and should have resulted in a criminal investigation such as that conducted by the FBI when gloves were intentionally slit. The concern regarding this incident is that appropriate investigations may not have been conducted and documented in all cases. The concern here is that incidents occurred, and were not documented. Subsequently appropriate follow-up monitoring did not happen. There are also issues associated with the completeness of individual files used to do dose reconstruction.

Inconclusive.

Concern 3: *Termination paperwork bioassay reports: yellow line shows an erasure and a rewrite of U-235, says it should be D-38.*

NIOSH Response: The form in question is the standard DOE termination report. It was common that these forms were filled out by clerks in the Radiological Records group based on information in the worker's health physics file. The clerk had to interpret the data in the worker's record to fill out the DOE form. Mr. [Name] is correct in his observation that the material should have been stated as depleted uranium and not U-235, since he was a machinist mainly in Building 444, the main area for DU operations. The DOE termination report is a very broad summary and is not used for NIOSH project dose reconstruction. Clerical errors did happen. NIOSH concludes that this issue does not have SEC implications.

SC&A Response: Doses were modified for several reasons over the operational history of RFP. The first and most obvious reason was an entry mistake. Adjustments were made to a large population of workers for 1968 due to a computer error. Corrections were made to exposure records because the dose was not being totaled for 1976 and prior years in the site dosimetry database. One cannot determine from the information provided whether this was a case of falsification of records or a recording error. In the analysis of uranium dose, NIOSH/ORAUT would assume U-234 to maximize the dose from an intake of uranium.

Concurrence with NIOSH/ORAUT that this is not an SEC issue.

Concern 4: *Told to put badge inside pocket on certain jobs so he did not contaminate the badge.*

NIOSH Response: Placing a badge in a pocket does not significantly affect the badge reading. The practice of putting a badge in a pocket to avoid contaminating the badge does not preclude sufficiently accurate dose reconstruction. As a result, this issue does not have SEC implications.

SC&A Response: Placing the badge in a pocket or wrapping badges in plastic were common industry practice to protect dosimeters from contamination. The shielding provided by the clothing would have little impact on the detection of neutrons and photons. Where this would make a difference is in the assessment of skin dose. This does not have SEC implications but should be addressed in revisions to the site profile. **Concurrence with NIOSH/ORAUT that this is not an SEC issue.**

EXAMPLE 36

Source: Advisory Board Public Comment Meeting (ABRWH 2006a, pp. 358–367)

Claimant Status: Non-claimant

Concern 1: *Reconstructing dose for Th workers, if it can't be done for Y-12, how can it be done for RFP?*

NIOSH Response: The Th-228 present at RFP was not in high enough quantities to contribute significantly to internal dose potential. This issue will be discussed separately.

SC&A Response: A detailed analysis of potential dose from thorium and other radionuclides is provided under Section 6.0, the Internal Dose section of this report.

Inconclusive.

Concern 2: *Results of zeros*

NIOSH Response: A blank or zero could indicate a period when a badge wasn't returned at the scheduled badge exchange, but was rather retained by the worker for an additional badge exchange cycle. A zero entry in the dosimetry records could also indicate that there was no positive dose recorded on the badge. Whenever a blank or zero appears in the dosimetry record, missed dose is assigned.

SC&A Response: Missed dose is assigned in cases where the record lists a zero dose. In cases where an individual had little or no exposure this would be a reasonable method for assigning dose. In the case there was a potential for exposure, this approach would not always bound the dose. There is some ambiguity in the exact nature of the concern.

Concern 3: *1969 data gap*

NIOSH Response: NIOSH indicated that they have reviewed the records of 600 claimants and determined that 138 have records that appear to be incomplete for 1969. NIOSH will provide the following documents related to the 1969 fire: (1) log book for the time of the fire, and (2) Incident report(s) for the fire. NIOSH has retrieved raw records for the time period and is in the process of comparing these with the database. SC&A to provide a logbook from the time of the fire (being transmitted).

This issue will be discussed separately.

SC&A Response: Several logbooks have been provided to NIOSH/ORAUT that cover the time period of the 1969 fire. NIOSH has developed many hypotheses for why data gaps exist in the 1969 data and how they will address these gaps. A more detailed discussion of this issue is provided in Section 4.0 of the review. **Inconclusive.**

EXAMPLE 37

Source: Advisory Board Public Comment Meeting (ABRWH 2006a, pp. 372–377)

Claimant Status: Non-claimant

Concern 1: *Beryllium exposure*

NIOSH Response: The subject of this SEC evaluation is to determine if it is feasible to reconstruct radiation doses. Possible exposure to beryllium does not have SEC implications.

SC&A Response: The effects of exposure to chemicals are considered under Part E of the EEOICPA. Since chemical exposures are not defined under Subpart C, this concern should be directed to the Department of Labor under the provisions of Subpart E.

Concurrence with NIOSH/ORAUT that this is not an SEC issue.

Concern 2: *Work in respirators and procedures kept changing. DAC levels were exceeded and no requirement to do bioassay or fecal samples.*

NIOSH Response: The procedures and methodologies did change over time to reflect the current work being completed during the D&D phase. The level of protection used in various circumstances and situations will change with the job description. It is puzzling that this worker asserts that no bioassay or fecal sampling was required. Bioassays were required and fecal samples were required when the worker reached a certain number of DAC-hours, based on his lapel sampler. However, this was only a trigger for bioassay over and above that required for routine bioassay monitoring. This worker was extensively monitored for internal exposure, as noted in Table 18-1 below:

Table 18-1: Bioassay Monitoring Results

Sample Date	Sample Type	Analyte
1-26-88	Lung	Am-241/Pu, Th-234/U-238
12-14-88	Lung	Am-241/Pu, Th-234/U-238
3-3-89	Lung	Am-241/Pu, Th-234/U-238
6-9-89	Lung	Am-241/Pu, Th-234/U-238
5-4-92	Routine fecal	Pu-238, Pu-239
6-20-94	Routine urine (failed QC)	U-234, U-235, U-238
8-3-94	Routine urine	U-234, U-235, U-238
10-26-95	Lung	U-235, U-238, Am-241
11-29-95	Routine urine	U-234, U-235, U-238
6-27-96	Routine urine	U-234, U-235, U-238, Pu-239/240
9-12-96	Routine nasal	
10-3-96	Routine urine	Pu-239
10-31-96	Lung	U-235, U-238, Am-241
9-22-97	Routine urine	Pu-239/240
8-30-98	Routine urine (failed QC)	Pu-239/240
9-14-98	Lung	U-235, U-238, Am-241
2-2-99	Routine urine	Pu-239/240
1-18-00	Nasal/mouth	
1-23-00	Routine urine	U-233/234, U-235, U-238, Pu-239/240
7-19-00	Lung	U-235, U-238, Am-241
1-21-01	Routine urine	U-233/234, U-235, U-238, Pu-239/240
12-17-01	Lung	U-235, U-238, Am-241
5-5-02	Routine urine	Pu-239/240
5-16-02	Nasal/mouth	
5-20-02	Nasal/mouth	
4-15-03	Lung	U-235, U-238, Am-241
4-20-03	Routine urine	Pu-239/240
6-28-04	Nasal/mouth	

Due to the availability of bioassay and lung counting, NIOSH concludes that this is not an SEC issue.

<u>SC&A Response</u>: Assuming the employee was adequately monitored via urinalysis, this would not present an issue with dose reconstruction. If, however, the bioassay monitoring was incomplete, this would impact internal dose reconstruction.

<u>Concern 3</u>: *Several examples given regarding working situations and use of protective equipment.*

<u>NIOSH Response</u>: The concern expressed by the worker seems to be that personnel protection devices (especially respirators) were not required in situations where they should have been.

While this concern has obvious safety implications, NIOSH reconstructions of internal dose are based primarily on bioassay results. The usage or failure to use respirators would not affect NIOSH's ability to conduct dose reconstructions of sufficient accuracy; therefore this issue does not have SEC implications.

SC&A Response:

Concurrence with NIOSH/ORAUT that this is not an SEC issue.

EXAMPLE 38

Source: Advisory Board Public Comment Meeting (ABRWH 2006a, pp. 377–378)

Claimant Status: Non-claimant

Concern: *Lead apron and badge issue.*

NIOSH Response: Lead aprons were available and used for a limited number of tasks at RFP. For most years, workers were instructed to wear badges under the lead apron to measure dose to the torso. In 1992, this was changed to instruct workers to wear the dosimeter outside the lead apron to better measure the dose to the head, neck, and arms. Field studies to determine the dosimeter response in both locations were performed. The results of these studies were used to develop bias corrections to use for dose reconstructions. The use of lead aprons does not preclude sufficiently accurate dose reconstruction. As a result, NIOSH concludes this issue does not have SEC implications.

SC&A Response: On the surface, this appears to be another concern relating to the positioning of the dosimetry with respect to the lead apron. In this case, the comment also includes some indication that there was an exposure problem with wearing two aprons. Although the first aspect has been adequately addressed by NIOSH, the second has not. Analysis has been provided by NIOSH/ORAUT for wraparound lead aprons. It is uncertain whether wearing two aprons would result in the same response as wearing a wraparound apron. Although NIOSH/ORAUT has not explicitly dealt with special exposure scenarios from wearing two lead aprons, this would not constitute an SEC issue.

Concurrence with NIOSH/ORAUT that this is not an SEC issue.

EXAMPLE 39

Source: Advisory Board Public Comment Meeting (ABRWH 2006a, pp. 378–380)

Claimant Status: Non-claimant

Concern 1: *Dosimetry readings were zero.*

<u>NIOSH Response</u>: A blank or zero could indicate a period when a badge wasn't returned at the scheduled badge exchange, but was rather retained by the worker for an additional badge exchange cycle. In this situation, all dose recorded on the badge was recorded in one badge exchange cycle, and a blank appeared in the record for the other exchange cycle. A zero entry in the dosimetry records could also indicate that there was no positive dose recorded on the badge. Whenever a blank or zero appears in the dosimetry record, missed dose is assigned.

<u>SC&A Response</u>: NIOSH has concluded that blank or zero results were the result of a retained dosimeter for an extra cycle, or that no positive exposure occurred. Missed dose would be assigned to zero dose results. In this case, it is not clear from the statement whether the individual is referring to production areas or administrative areas within production buildings. In the former case, the missed dose methodology may not be appropriate. **Inconclusive.**

<u>Concern 2</u>: *Worked 60+ hours some weeks.*

<u>NIOSH Response</u>: The length of the workweek would only impact dose estimates derived using source-term calculation. Furthermore, if source term calculations were relied upon, the length of the workweek could be adjusted in a claimant-favorable manner. At Rocky Flats, NIOSH is using individual dosimetry results in a great majority of dose reconstructions. For situations where dosimetry is not available or is inadequate, NIOSH may rely on coworker data. Coworker data is developed for whole-body dose recorded on film badges or TLDs. The whole-body dose equal to a claimant-favorable percentile of doses recorded for the monitored population is assigned as a whole-body dose to the unmonitored individual.

<u>SC&A Response</u>: Bioassay data or coworker data are used for dose reconstruction, which are not impacted by the length of the workweek. NIOSH/ORAUT has recently proposed to use air sampling data to determine internal dose from thorium. The length of exposure becomes pertinent when using air-sampling data. Information regarding hours worked per week is requested during the individual interview. Dose reconstructors are supposed to take this into consideration when determining dose in this manner.

Concurrence with NIOSH/ORAUT that this is not an SEC issue.

EXAMPLE 40

<u>Source</u>: Advisory Board Public Comment Meeting (ABRWH 2006a, pp. 428–430)

<u>Claimant Status</u>: Non-claimant

<u>Concern 1</u>: *No bioassays in high radiation areas.*

<u>NIOSH Response</u>: Depending on the area, bioassays are not necessarily needed when entering a high radiation area. External dosimetry would be appropriate for this type of area.

<u>SC&A Response</u>: Bioassay samples are not used to determine radiation exposure, but are used to determine if radioactive material has entered the body such as in an airborne release. It is unclear whether the individual is referring to a "High Radiation Area" or a "High Contamination Area." **Inconclusive.**

Concern 2: *No bioassay on a man whose mask was so hot it had to be shipped in high-level waste.*

NIOSH Response: In situations where a respirator was contaminated and a possible intake was indicated, it would be expected that lung counting and/or bioassay would have been appropriate. If the employee was on routine bioassay, any intakes resulting from such an occurrence could be estimated; however without specific details, this situation cannot be evaluated.

SC&A Response: The threshold for special bioassay and its impact on dose reconstruction is the underlying issue here. NIOSH has indicated that missed intakes would be detected in a routine monitoring program at the later date. This would be dependent on the material to which the individual was exposed. **Inconclusive.**

Concern 3: *Sanded on BE with no downdrafts and no respirators.*

NIOSH Response: The purpose of the SEC evaluation report is to determine if it is feasible to estimate with sufficient accuracy the radiation dose. This issue therefore does not have SEC implications.

SC&A Response: The effects of exposure to chemicals are considered under Part E of the EEOICPA. Since chemical exposures are not defined under Subpart C, this concern should be directed to the Department of Labor under the provisions of Subpart E.

Concurrence with NIOSH/ORAUT that this is not an SEC issue.

EXAMPLE 41

Source: Advisory Board Public Comment Meeting (ABRWH 2006a, pp. 434–436)

Claimant Status: Non-claimant

Concern: Records destroyed many years ago by Dow.

NIOSH Response: NIOSH is not aware of any evidence that records it would use for dose reconstruction at Rocky Flats were inappropriately destroyed. Some records, such as original personal dosimetry records, are governed by DOE records retention policies. Other records are not covered by such policies. Further analysis of this concern is not possible without additional details regarding what types of records are at issue.

SC&A Response: There is not enough information provided in the comment to make a definitive determination.

Inconclusive.

EXAMPLE A-1

"There was a campaign where Am 241 was purified and sold...operators who were very good at this operation were rarely rotated from the process and received zero counts from their dosimetry badges, and were told by the dosimetry personnel that those high counts were 'impossible' for buildings on the hot side...In fact, operators' counts were "zeroed out" at the end of the fiscal year. Therefore, operators started each new year with zero counts from the dosimetry department." (ABRWH 2006a, pg. 364)

NIOSH Response: SC&A's assertion that NIOSH did not respond to this issue is in error. This general issue was addressed in Examples 4-2, 9-7, 12-2, 24-2, 36-2, and 39-1 in the Data Integrity Examples dated August 25, 2006. No specific individuals were identified in the concern; therefore this specific situation could not be evaluated by NIOSH. SC&A's response to this issue states, "This is another example of a situation where exposure conditions were high yet badge results were zero." Presumably, this conclusion is based on an analysis of documentary evidence, however no supporting evidence is provided. NIOSH would be very interested in reviewing SC&A's analysis of this specific situation. (See comments from the following matrices: 2/27/06, p. 2, 7/26/06 p. 4, 10/31/06 p.4 and 7, also see the Status of Rocky Flats NIOSH Action Items, April 20, 2006, p. 9).

SC&A Response: An individual is allowed to receive a particular amount of radiation within a defined period (e.g., quarterly or annually). They start each period out with zero exposure. For example, if an individual is allowed 5 Rem in a year, the balance of his/her dose will go to zero on the first day of the year. The goal is to maintain exposure within a limit for that set period of time. This amount of exposure is what he/she has available for that period. DOE currently limits the amount of radiation one can receive, but it does not regulate the rate at which you receive radiation. This means that an individual could theoretically receive 5 rem on December 31 and legally receive 5 rem on January 1. Up until the implementation of the current radiation protection regulations, an additional lifetime limit of 5 (N-18), where N is age, was also used. Once this level was exceeded, the individual was not allowed to receive additional dose for the remainder of their life.

This comment provides another example of a situation where exposure conditions were high yet badge results were zero. The general explanation provided by NIOSH/ORAUT is that in all the situations raised about questionable badge results there were environmental factors or there was a misunderstanding on the part of the worker. Furthermore, there is a lack of documentation describing how doses were arrived at when unusual dosimeter results occurred. NIOSH/ORAUT should evaluate cases with unusual badge results in a systematic manner and verify unrecorded exposures were not occurring. It so happens that the examples of overexposed or suspicious badge readings often coincide with situations where individuals were working on high-exposure jobs. A discussion of dosimetry investigations and blackened badges can be found in Sections 5.2 and 5.6 of the review report, respectively.

EXAMPLE A-2

Incompleteness of records is not an isolated case. One worker was missing data from the period of 1964 to 1969. He distinctly remembers receiving four body counts. The records also do not include the decontamination received after the 1965 fire (ABRWH 2006a, pg. 352).

NIOSH Response: There is a record of this individual's involvement in the 1965 fire (pg. 99) in his rad file. Chest counts are recorded in his file for October 18, 1965 (page 97), December 30, 1965 (page 96), January 8, 1970 (page 95), September 24, 1973 (page 94), and five other counts between 1975 and 1990. There is external dosimetry in every year between 1964 and 1968. There is no recorded external dosimetry in 1969. Observations from the worker's radiation file do not appear to agree with the expressed concern; however SC&A's response indicates, "There is a completeness issue with respect to this individual's medical and radiological file…" Presumably this conclusion is based on an analysis of documentary evidence, however no supporting evidence is provided. NIOSH would be very interested in reviewing SC&A's analysis of this specific situation.

SC&A Response: NIOSH/ORAUT is correct in stating that the worker has bioassay data for the years 1964 through 1968. There are no results for 1969 and all quarterly doses in 1970 are 0. There is a Health Physics Report of Accident or Possible Exposure for October 15, 1965, when the fire occurred which notes that the individual was scheduled for a whole-body count. Although it notes the air contamination in the area, it does not provide information on personal contamination levels, nor does it mention decontamination. Fecal sampling was also completed shortly after this event. The individual relayed to SC&A that following his involvement in the 1965 incident, he had to be decontaminated several times as a result of extensive contamination. The concern raised by the individual is that the decontamination effort he underwent is absent from his health physics file. There is a completeness issue with respect to this individual's medical and radiological file. Although records are missing the key data to perform dose reconstruction, the bioassay data, are available.

As previously mentioned, SC&A encourages NIOSH/ORAUT to complete an assessment of the records they are receiving for claimants and ensure what they are provided is complete.

Concurrence with NIOSH/ORAUT that this is not an SEC issue.

EXAMPLE A-3

Two employees were instructed by management to leave their badges in the rack or desk drawer while doing their time studies and audits in hot areas. Auditors were not issued protective clothing while conducting audits in hot areas (ABRWH 2006a, pg. 354).

NIOSH Response: NIOSH agrees that there is not enough information to evaluate this specific situation. However, NIOSH did discuss this general issue in its presentation of the Evaluation Report at the Advisory Board meeting in Denver on April 27, 2006 (ABRWH 2006b, pp. 77–84), and concluded that it is very unlikely that such a situation would have an adverse systemic impact on NIOSH's ability to conduct dose reconstruction with sufficient accuracy.

SC&A Response: There is not enough information provided to establish whether this was a systemic problem.

Inconclusive.

EXAMPLE A-4

If the badge exceeded the authorized limit for the period, production employees would be disciplined. In addition, they would not be "No response.eligible for overtime." As a result, some of the operators didn't wear their dosimeters all the time, or put them in the back pocket of their coveralls to avoid disciplinary actions (ABRWH 2006a, pg. 354).

NIOSH Response: NIOSH agrees that there is not enough information to evaluate this specific situation. However, NIOSH did discuss this general issue in its presentation of the Evaluation Report at the Advisory Board meeting in Denver on April 27, 2006 (ABRWH 2006b, pp. 77–84), and concluded that it is very unlikely that such a situation would have an adverse systemic impact on NIOSH's ability to conduct dose reconstruction with sufficient accuracy.

SC&A Response: There is not enough information provided to establish whether this was a systemic problem.

Inconclusive.

EXAMPLE A-5

Two chemical operators with many years experience in the Building 771 process area left their positions to work in the dosimetry department. The dosimetry person training them told them if badges returned readings higher than a certain number they were instructed to give the operator zero counts, or no current data available (ABRWH 2006a, pg. 355).

NIOSH Response: NIOSH agrees that there is not enough information to evaluate this specific situation. However, the issue of Supervisor's Reports showing "No Current Data Available" has been extensively considered by NIOSH, SC&A, and the Working Group, as was the concern that workers' were simply assigned a zero dose when their badges showed high readings.

SC&A Response: There is not enough information provided to establish whether this was a systemic problem.

Inconclusive.

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ATTACHMENT 19: POTENTIAL THORIUM INTAKE AT RFP

1.0 SUMMARY

Primarily from MBA inventory records, several other documents, and interviews with responsible program managers it is clear that thorium was in the Rocky Flats plant facilities in kg quantities for a period of 19 years with maximum inventory quantities in each year in the range of 1 to 249 kg (4 years at or just over 100 kg, 4 years from 165 to 249 kg and 10 years from 1 to 49 kg). For perspective, 250 Kg is relatively small compared to the Y-12 experience, where 100s of MTTh were processed. Recorded lung counts at Y-12 indicated that >50% of the workers had lung burdens <1mg (the recorded minimum level). The primary use for thorium was thorium parts manufacture at the Rocky Flats Plant (RFP) from natural thorium metal stock for use as weapons parts and mockups.

Table 1. Thorium Use at RFP

Plant Location	Use Description	Time Period	Amounts of Thorium Handled in Each Use	Form	NUREG-1400 Max. Q Values
881	Fabrication of metal weapons parts from natural Th and Th alloys—machining, shearing, grinding	1956–1993	1–6 kg	Metal	600 gm/unit maximum
881, 771	Fabrication of Th substitute R&D components in lieu of more expensive Pu or HEU	1956–1993	<500 gm (Aggregate 7 kg) quantities	Metal, oxides, nitrates	5–50 gm
Analytical Labs	Analytical procedures and development programs	1952–1993	<500 gm	Nitrates, oxides, etc.	5–10 gm
Various	Use of Th oxide as a mold-coating compound in limited experiments—never on a production scale	Unknown	Unknown assume 100 gm quantities	Th oxide	100 gm

MBA records were rounded to nearest 500 gm quantities, i.e. <500 recorded as zero and >500 gm recorded as 1 K

As indicated in the table above, there were a number of uses for thorium in small quantities. The larger individual metal parts were in the 3 to 5 kg size (10 kg being the maximum credible size). The stock parts were "trimmed and lightly machined" with waste in the range of <10%. Only the wastes from the metal forms would be prone to air dispersal and fit the NUREG-1400 or Regulatory Guide 8.25 description of "Q quantity of radioactive material being processed in a year in unsealed or loose form." The emphasis on unencapsulated was intended to exclude large solid parts.

Those categories of thorium use at RFP as listed in Table 1 included all products that were brought in as thorium. There was another source of thorium that came into the plant as a contaminant of an experimental uranium weapons project. The possible use of U-233 as the fissile component of nuclear weapons brought trace quantities of U-232 with the material in initial levels up to 50 ppm. Th-228 is the first daughter of U-232 in a chain with high-energy gamma emissions, which raise the radiation levels from the metal parts to impractical levels on a period characteristic of the 1.9-year half-life. This made it necessary to perform a chemical removal ("strike") of the Th-228 from the aged U-233 weapons material. The maximum quantities of uranium involved in a chemical extraction was approximately 20 Kg and would include in the range of 1 gm of U-232 with possibly a few mgm of Th-228. The strike was performed in a glovebox operation under high radiological safety surveillance and control. The Th-228 was immediately packaged as waste and disposed. This experimental project was carried on as special work order tasks during the middle 1950s to mid 1960s (Bistline 1976).

2.0 THORIUM BIOSSAY AT RFP

Unlike uranium, little of the thorium inhaled or ingested is excreted in urine. Therefore, fecal bioassay is the method generally used where worker exposures are in the range of permissible concentrations. Though there is recorded information related to the development of thorium urinalyses and several urine results in the 1960 time period, there are no data available to indicate that thorium isotopes were part of the routine bioassay program. There are no data to suggest that fecal bioassay was used routinely at the RFP to assess radionuclide intakes. Lung counting was used at other DOE sites for thorium lung deposition determination, although RFP lung counting in the energy ranges of interest was for Th-234, a daughter of U-238, used for uranium deposition analysis.

3.0 NATURAL THORIUM (TH-232 AND ITS DECAY PRODUCTS)

Thorium is an element that consists primarily of four naturally occurring radionuclides Th-232, Th-234, Th-230, and Th-228). Thorium-228 is a decay product of Th-232. Thorium-234 and Th-230 are decay products of U-238. There are no stable isotopes of thorium. Thorium-232 constitutes nearly 100 percent by weight of natural thorium. The half-life and specific activity of Th-232 are 1.41E10 years and 4.04E3 Bq/g (1.09E-7 Ci/g), respectively. The components of the Th-232 decay series are shown in Table 1.

Thorium is generally found in nature in equilibrium with its decay products because its longest-lived decay product (Ra-228) has a half-life of only 5.75 years. In contrast, the decay products of U-238 have much longer half-lives so are not always in equilibrium with the parent in nature. When natural thorium is chemically separated from its decay products, the resulting mix of isotopes includes Th-232, Th-228, Th-234, and Th-230. The relative concentrations of Th-234 and Th-230 depend on the concentration of U in the material from which the thorium was separated. Thorium-234 has a relatively short half-life (24 days) and will decay out within a relatively short period of time regardless of its initial concentration. Thorium-228 will be present at the same activity concentration as the parent Th-232. The nuclides below Th-228 in the decay series all have short half-lives and will build in to equilibrium with the Th-228 in a short period of time, i.e., less than one month.

The specific activity of Th-232 is 4.04 E3 Bq/g (4.04E6 Bq/kg). Because Ra-224 and Ac-228 do not contribute significantly to the dose (less than 10%) the ingrowth of these two nuclides is of little importance in calculating total internal doses. (However, it should be noted that due to the Ac-228 gamma radiation, external doses build up over time as the Ra-228 builds up.)

4 0 DOSE FROM INHALATION OF THORIUM METAL

4.1 Thorium Dose Coefficients

Potential radiation doses were calculated for workers engaged in work with thorium, the major exposure potential being to machining metal assuming aged thorium (complete equilibrium including Ra-228 and Ac-228). The calculation also assumed no Th-230 present in isotopic mixture, since it is a decay product of uranium. Because of its much shorter half-life, Th-230 would contribute only a negligible fraction of the mass but, depending on its concentration, could contribute to the dose. Rn-220 (Th) and its very short-lived decay products Po-216 and Tl-208 were not included in the analysis due to the gaseous nature of Th. The International Commission on Radiological Protection (ICRP) dose coefficients for Th-232 and its decay products used in the dose estimation are given in Table 2.

4.2 Estimated Particle Size and Solubility

The ICRP recommends the use of dose coefficients for 5.0 µm Activity Median Aerodynamic Diameter (AMAD) particle sizes for occupational inhalation dose calculations. However, physical particle diameters for metallurgical dusts and fumes can range from 0.001 µm to 100 µm (Hinds, 1982). It should be noted that the Aerodynamic Diameter (AD) is a function of the diameter, density, and shape of particles. The AD determines the behavior of small particles. Thorium dust particles generated by machining the metallic form would have a greater AD than the physical diameter due to the density of the thorium. Lacking specific information on the particle sizes potentially at RFP, the most conservative values, based on deposition fractions, were used in the dose calculation.

International Commission on Radiological Protection Publication 66 (ICRP 1994) provides a table of deposition fractions for various particle sizes (Table 3). The ICRP dose coefficients for workers are calculated based on deposition of 5.0 µm AMAD particles. For the purpose of this dose calculation, the dose coefficients were adjusted by the ratio of the maximum alveolar deposition to the deposition at 5.0 µm. The maximum ratio for the alveolar/interstitial (AI) region is 9.0. The adjusted dose coefficients are shown in Table 2.

Because metallic thorium was processed it was assumed to have been insoluble, i.e., ICRP Class S or 10 CFR 20 Class Y.

4.3 Estimated Thorium Intake

The potential thorium intake was estimated based on the procedure described in NUREG 1400, Air Sampling in the Workplace (NRC 1993). The purpose of NUREG-1400 is to establish a guide that will conservatively indicate the need for an air-monitoring program. The variables are chosen in such a way as to always result in a high value.

NUREG 1400 suggests calculating the potential intake of radionuclides by workers using the following equation:

$$I = Q \times 10^{-6} \times R \times C \times D$$

where:

I = estimated annual intake
Q = total quantity of "unsealed or loose" material handled in a year for a given work location
R = release fraction
C = confinement factor
D = dispersibility

The typical release fraction for solids (e.g., uranium pellets) is given as 1E-3 in NUREG 1400. The confinement factor for a well-ventilated hood is 0.1. The dispersibility factor for cutting or grinding is given as 10. Therefore, the estimated annual intake for a solid material, such as thorium metal, being cut or ground in a hood would be as follows:

I = Q x 1E-6 x 1E-3 x 1E-1 x 10 = Q x 1E-9

In lieu of site-specific information it was assumed that each thorium model weighed 6 kg and that one large part was processed for each of 10 months for a total of 60 kg of natural thorium per year. It is further estimated that the unsealed or loose contaminants from large metal parts is 10% or less.

The specific activity of Th-232 is 4.04E6 Bq/kg. The total activity of unsealed or loose thorium processed per year would be as follows:

Q = 4.04E6 Bq/kg x 6 kg = 2.4E7 Bq

The estimated annual intake, based on the modifying factors used above would be 2.4E-2 Bq.

4.4 Summary of Estimated Doses

For a reference point the committed equivalent and effective doses were calculated based upon the estimated intakes. These potential doses to individual workers, assuming the estimated annual intake of Th-232 was 2.4E-2 Bq, were calculated under the above stated assumptions, assuming a particle size adjustment of 9, Class S thorium, Class M radium, and Class F lead as follows:

Effective dose – 9E-5 rem, (<1 mrem)
Bone dose – 4E-4 rem, (0.4 mrem)
Lung dose – 7 E-4 rem, (0.7 mrem)

Other uses and operations involving thorium at RFP are listed in Table 1. The highest calculated potential internal intakes result from the fabrication of large metal weapons parts for which intakes are estimated above. Smaller quantities assumed for most of the other uses and operations are offset by the thorium being in the form of powders or other more dispersible materials, but still resulting in fractional mrem estimated doses.

4.4.1 Th-228 Strike Estimated Dose

The thorium strike removal of Th-228 is different in nature from the thorium that came into the plant as thorium materials, since this source of thorium-228 came into the plant as a contaminant of U-233. However, during the chemical separation of the thorium plus daughters from the U-233/232 a significant radiological hazard existed, primarily from external radiation. As indicated below, the maximum curie amount of Th-228 estimated from a 20 kg U-233 process with 50 ppm U-232 was approximately 10 Ci. Measured radiation from this activity could be as high as 10s of rem/hr from gamma radiation of high energies (up to 2.6 Mev) during the separation processes (Kirchner and Freiberg 1965).

The internal intake potential can be calculated also, using the NUREG-1400 general approach. The operations were (1) short-lived, (2) performed in high confinement gloveboxes designed for production Pu operations, and (3) the separated Th-228 plus daughters were immediately encapsulated and stored/shipped to the disposal site in Idaho.

$$I = Q \times 10^{-6} \times R \times C \times D$$

where:

I = estimated annual intake
Q = total quantity of "unsealed or loose" material handled in a year for a given work location
R = release fraction
C = confinement factor
D = dispersibility

The typical release fraction for liquids is given as 1E-2 in NUREG 1400. The confinement factor for a glove box is given as 1E-2. Plutonium gloveboxes in which the U-233 was processed, operate with confinement factors in excess of 3E-7 (two in-line HEPA filters) – assume 3E-4. The dispersibility factor for liquids is chosen as 1. Therefore, assuming (1) 20 kg of U-233 with 50 ppm U-232, (2) 1 gm U-232 (50 ppm U-232 = approximately 20 Ci), and (3) approximately 10 Ci (3.7E+11 Bq) Th-228, the estimated annual intake for Th-228 in this maximum processed amount in a contained liquid in a glove box would be as follows:

$$I = Q \times 1E{-}6 \times 1E{-}2 \times 3E{-}4 \times 1 = Q \times 3E{-}12$$
$$= 3.7E{+}11 \text{ Bq} \times 3E{-}12 = 1.11 \text{ Bq}$$

The potential doses to individual workers, assuming the estimated annual intake of Th-228 of 1.11 Bq, were calculated under the above stated assumptions, assuming a particle size adjustment of 9, Class S thorium, Class M radium, and Class F lead, the calculated annual doses were as follows:

Effective dose – 3E-3 rem (3 mrem)
Bone dose – 3E-2 rem (30 mrem)
Lung dose – 3E-2 rem (30 mrem)

Table 2: Thorium-232 Decay Series Table 3: Th-232 Dose Coefficients (ICRP 2001)

Nuclide	Atomic Number	Mode of Decay	Energy (MeV) (percent) [emissions greater than 10% only]	Half-life	Decay Product
Th-232	90	Alpha	3.95 (23) 4.01 (76.8)	1.41E10 y	Ra-228
Ra-228	88	Beta	0.039 (100)	5.75 y	Ac-228
Ac-228	89	Beta Gamma	1.17 (32) 1.74 (12) 0.338 (11.4) 0.911 (27.7) 0.969 (16.6)	6.13 h	Th-228
Th-228	90	Alpha	5.34 (26.7) 5.42 (72.4)	1.91 y	Ra-224
Ra-224	88	Alpha	5.69 (95.1)	3.66 d	Rn-220
Rn-220	86	Alpha	6.29 (99)	55.6 s	Po-216
Po-216	84	Alpha	6.78 (100)	0.15 s	Pb-212
Pb-212	82	Beta Gamma	0.334 (85.1) 0.239 (44.6)	10.64 h	Bi-212
Bi-212 (64.1 %)	83	Alpha Gamma	6.05 (25) 6.09 (10) 0.727 (11.8)	60.55 m	Tl-208
Tl-208	81	Beta Gamma	1.28 (25) 1.52 (21) 1.80 (50) 0.511(21.6) 0.583 (85.8) 0.860 (12) 2.614 (100)	3.07 m	Pb-208
Bi-212 (35.9 %)	83	Beta	1.59 (8) 2.25 (48.4)	305 ns	Pb-208 stable

Table 3: Th-232 Dose Coefficients (ICRP 2001)

Nuclide	Inhalation Dose Coefficient (Sv/Bq)					
	Effective		Bone Surface		Lungs	
	Class M	Class S	Class M	Class S	Class M	Class S
Th-232	2.9E-5	1.2E-5	1.5E-3	1.4E-4	1.6E-5	7.7E-5
Ra-228	1.7E-6		3.6E-5		6.2E-6	
Ac-228	1.2E-8	1.2E-8	4.9E-8	7.9E-8	1.7E-7	8.0E-8
Th-228	2.2E-5	2.5E-5	2.8E-4	1.2E-5	1.3E-4	2.1E-4
Ra-224	2.4E-6		9.5E-7		2.0E-5	
Pb-212 (Class F)	3.3E-8		1.0E-7		8.1E-9	
Bi-212	3.9E-8		2.6E-11		2.0E-7	

Note: Short-lived decay products of ^{220}Rn are not included in this table.

Table 4: Deposition Fractions As a Function of Particle Size
(From Table F.1 ICRP Publication 66)

Respiratory tract region	Maximum fractional deposition	Particle Size at Max. Dep. (µm AMTD)	Fractional Deposition at 5 µm	Ratio of max. dep. To dep. At 5 µ
ET1	4.5E-1	0.0006	3.5E-1	1.3
ET2	4.4E-1	0.0006	4.1E-1	1.1
BB	4.2E-2	0.002	1.1E-2	3.9
Bb	1.3E-1	0.005	5.3E-3	25
AI	5.0E-1	0.02	4.5E-2	9.0
Total	9.9E-1	0.0006	8.3E-1	

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ATTACHMENT 20: SUMMARY OF THORIUM HANDLING AT RFP

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December 21, 2006

EXECUTIVE SUMMARY

The use of thorium at Rocky Flats is a topic of continuing interest to the Rocky Flats Working Group. In response, NIOSH and the ORAU Team have conducted an extensive investigation into this topic, and have previously presented interim reports to the Working Group. This document summarizes all of the data we have assembled from reviews of classified and unclassified documentation and interviews with several Rocky Flats workers, as well as source term calculations. This investigation has come to the following conclusions:

(1) Thorium metalworking was never a major and/or production scale operation at Rocky Flats, and involved a maximum of a dozen individuals. An experimental metal forming project with three 80 kg ingots was conducted on eight working days between May and September 1960. The thorium used on this project represented the bulk of the thorium inventory ever present at Rocky Flats (240 kg). This project was monitored (air monitoring and limited confirmatory urinalysis) and controlled by health physics personnel. A detailed timeline has been assembled from source documentation and health physics field logbooks. There was no indication of any intakes of thorium, and maximum credible intake calculations result in doses of no consequence.

(2) There were some instances when Rocky Flats received pre-formed parts containing thorium from Oak Ridge to use in weapons mockups. No chemistry or metallurgy was performed on these parts at Rocky Flats, and there was no potential for significant intakes. This conclusion was drawn using reported air concentrations from a documented series of surveys of uranium metal working production operations. From this data the maximum thorium concentrations were calculated, resulting in minimal intakes given the short times of each project. This use of thorium, together with the analytical procedures described next, represented the bulk of the total number of activities involving thorium at Rocky Flats.

(3) There were numerous analytical procedures involving trace quantities of thorium. The potential for intake of thorium from these procedures was trivial, due to the minute quantities present, coupled with the standard radiological controls in place.

(4) There were some parts manufacturing involving U^{233} at Rocky Flats. The uranium metal involved contained trace quantities of U^{232}. One of the daughter products of U^{232} is Th^{228}. Due to the high external exposure levels, the thorium and daughters were removed from the U^{233} in a "thorium strike" prior to processing the uranium metal. These projects received extra attention from the health physics group due to the external exposure hazard as well as the potential internal hazard of the Th^{228} and daughters.

(5) The thorium used in the machining project in 1960 came from W.R. Grace and Co. The thorium used in the weapons mockups and in analytical procedures came from Oak Ridge. There is no evidence that any thorium was received at Rocky Flats from the Dow Madison Site.

(6) The search for and definition of all uses of thorium at Rocky Flats discovered a possible trivial use of thorium in experimental, short-term mold coating compound.

The bases for these conclusions are detailed in the body of the report, and consist of unclassified reports, an unclassified extract of a classified report, material balance account ledgers, monthly progress reports from the Chemistry Lab & Personnel Meters, Site Survey, and Chemistry Research and Development groups, health physics field logbooks, and interviews with former Rocky Flats and Dow Madison workers. In total, hundreds of man-hours have been dedicated to addressing the Working Group's and SC&A's concerns on this issue, and the results presented here represent all of the data we have been able to locate and review. NIOSH continues to conclude that the thorium handling operations at Rocky Flats were limited in scope, well monitored and documented, resulted in trivial potential doses, and do not represent an SEC issue.

INTRODUCTION

The use of thorium at Rocky Flats is a topic of continuing interest to the Rocky Flats Working Group. It is included in the latest Rocky Flats Issues Matrix, dated October 31, 2006 (comments 29 and 35). NIOSH has worked with the Records Management staff at the Mountain View records facility to identify and retrieve available documentation on thorium handling activities at Rocky Flats. The following keywords were used to cast as wide a net as possible: Thorium, Th-232, and Th-232. In addition, several more specific searches were conducted to pursue various relevant avenues of investigation. In total, nine searches of the Rocky Flats records have been conducted on the following dates in 2006: May 2, May 4, June 5, June 8, July 6, November 8, November 13, November 16, and December 18. NIOSH has also worked with the staff at the Denver Federal Records Center to locate and redact classified material related to this subject. This included sending a team of technical staff with security clearances to search for, review and evaluate this material at the repository on two separate occasions.

Previous NIOSH reports on this topic have included a source term calculation demonstrating no significant uptake potential for the thorium activities at Rocky Flats (title – Potential Thorium Intake at RFP, authored by Bryce Rich), and responses to comments by SC&A. This was discussed at the November 6, 2006 meeting of the Rocky Flats Working Group and there have also been email exchanges on this topic since that meeting. The purpose of this document is to consolidate all of the information NIOSH currently has available on the use of thorium at Rocky Flats. This information consists of several reference documents, the previously mentioned source term calculations (revised as suggested at the November 6 Working Group meeting), interviews with eight former workers with knowledge of thorium activities at Rocky Flats and with a former Dow Madison worker, health physics field logbooks, and monthly progress reports from several groups at Rocky Flats.

II) Activities involving thorium at Rocky Flats:

There were a limited number of activities involving thorium at Rocky Flats.(1-8) These included(1) a limited project in 1960 to fabricate metal parts,(9) the use of pre-formed thorium metal parts as stand-ins in weapons mock-ups, the removal of Th^{228} from U^{233} metal (thorium strikes), small-scale and short term investigation of the use a mold-coating containing thorium oxide, and the use of small amounts of thorium compounds in analytical procedures.

IIA) Fabrication of thorium metal parts:

Thorium metal working was never a major and/or production scale operation at Rocky Flats, and involved a maximum of a dozen individuals according to information provided by a former worker(3). This is confirmed by the health physics field logbook covering these operations, which lists 11 workers by name as participating in a small thorium project in 1960.(10) The metal working operations were performed on the equipment used for enriched uranium operations (shrouded/hooded machines).(3,11) This was special order work (*i.e.* infrequent, not continuous, and additional health and safety coverage).(3,5,7,8) Nevertheless, in terms of the amount of thorium used in an individual investigation, this single project represented the principal use of thorium at Rocky Flats.(1)

Three thorium ingots were sent to Rocky Flats from W.R. Grace and Company,(9) and these ingots were processed in Building 83 and 31 in 1960 (10,12-14). The first ingot was nuclear grade thorium, and the other two were alloy grade thorium.(9) Each of the three ingots weighed approximately 80 kg.(9) The purpose of this experiment was to develop techniques for forming thorium metal and/or thorium alloys into desired shapes from ingots of a size of approximately 12”x12”x3”, using rolling of the ingot to a thickness of 0.44”. The ingots were placed in 16 gauge cans for containment and forming control. The cans were removed following steps in the thickness reduction rolling process and the ingots were recanned for all of the rolling steps except the final bare cold roll step. Contamination releases occurred during the removal of the cans, but were anticipated, planned and controlled. The final step was press forming into the desired shape.

A detailed account of this project has been assembled from source documentation(9) and health physics field logbooks:(10,14)

(1) Ingots 1 (nuclear grade) and 2 (alloy) were canned in heavy, 16 gauge, mild steel cans on May 18, 1960. Special air and surface contamination samples were collected for radiological controls.

(2) The canned ingots (1 and 2) were hot rolled on June 1, 1960. This rolling was successful and the cans maintained their integrity. Special air samples and smears were taken during these operations. Receipt of six thorium ingot smears is noted in the monthly progress reports for the Chemistry Laboratory & Personnel Meters group.(15,16) A qualitative analysis detected no thorium on the smears.(14)

(3) Cold rolling was conducted on ingots 1 and 2 on June 3, 1960. The ingots were first cold rolled in their cans, but the welds on the cans began to fail. The cans were then removed by shearing. It was noted that this shearing generated dust. The ingots were then cold rolled, uncanned and annealed. At this point, there was insufficient metal for part forming from ingot 2 because of problems with the metal becoming brittle and cracking. Specimens were taken from ingot 2, and the remainder was scrapped. Air samples and smears were taken during these operations.

(4) Ingot 1 (nuclear grade) forming by canned hot and cold rolling plus the uncanned cold rolling was successful in spite of cold rolling can failure, and the ingot was pressed into the desired shape, followed by machining to final shape on June 8, 1960.

(5) An entry in the health physics field logbook on June 27, 1960 estimated that the total time spent monitoring this thorium project thus far was 25 hours.

(6) Ingot 3 (alloy) was canned on September 13, 1960.

(7) On September 21 and 22, 1960, hot rolling of ingot 3 was attempted. The can ruptured during the hot rolling and the operation was terminated. The can was flame cut, and air samples were taken. It was noted that the flame cutting used on ingot 3 was preferable to shearing for removing the cans. There were eight individuals (identified by name in the health physics logbook) involved in this operation.

(8) The broken ingot was pulled from the can on September 29, 1960. Ingot 3 was then scrapped. Urine samples were requested for this operation. There were four individuals (identified by name in the health physics logbook) involved in this operation, one of whom had also been involved in the activities on September 22, 1960.

Air and surface contamination was monitored for each of these operation steps and urine samples were collected for confirmatory data. No detectable urine activity was observed and maximum intakes using air activity data was not of consequence. Field monitoring data did not justify a call for in vivo monitoring.

The potential health hazards of handling thorium were well recognized, even as early as 1952.[5,17-20] Furthermore, relevant controls and protection procedures were apparently employed when handling thorium. Dr. Robert Bistline states "handling of the metal was in accordance with specific procedures of our Health Science and other appropriate advisory or control groups."[1] This probably would have entailed the use of respirators, though this has not been explicitly accounted for in the source term calculations NIOSH has performed.

This detailed account of this thorium project allows a precise estimate of the amount of time spent on these operations. Each of these canning, rolling, decanning, shearing, etching, forming and machining steps was of short duration of 2 hours or less. Thorium handling occurred on four days between May 18, 1960 and June 8, 1960 and involved two of the three thorium ingots. These operations totaled approximately 25 hours.[14] The total number of personnel involved was 12 or so workers for the entire project.[3,10] Monthly progress reports from the Site Survey group note the results of thorium air samples taken during rolling and other operations. These results are qualitatively described as indicating, "low levels of air borne contamination,"(12) and quantitatively as, "One sample during rolling was 105% MPL. Other samples taken on this and other operations averaged 32% MPL, all based on the MPL for thorium of 4.4 dpm/m^3." (13) There were additional operations on four more days in September, 1960 involving the third ingot. Since only one ingot was handled on these last four days compared to two ingots on the first four days, an estimate of 13 hours of handling in September 1960 is reasonable. The conservatism of this estimate is also supported by the fact that operations on ingot 3 were terminated during hot rolling of the canned ingot. Cold rolling of the bare ingot was not performed on ingot 3.(9)

Based on this information, this project involved approximately eight hours of cold rolling of bare thorium metal (on June 3, 1960) with an air concentration of 4.62 dpm/m^3, and approximately 30 hours of other operations with an air concentration of 1.41 dpm/m^3. Oak Ridge National Laboratory's DCAL code, which was used in the calculations for ICRP 68,(21) was used to generate annual organ equivalent dose coefficients for inhalation of Th^{228} and Th^{232}. These data were then used to calculate maximum annual organ doses for this project. The highest annual organ dose for any organ was 62 mrem for the ET1 compartment of the respiratory system. This calculation includes several conservative assumptions, including (1) no account was taken for use of respirators, though this would clearly be the practice at Rocky Flats in situations where there was potential for generation of airborne contamination (2) for simplicity, it was assumed that a worker was involved in all phases of the project, though this was clearly not the case,(10,14) and would therefore have been exposed to the maximum number of hours of airborne contamination (3) Th^{232} was assumed to be in equilibrium with Th^{228}, which results in a maximized organ dose, even though this may not have been the case if the thorium ingots were freshly manufactured. Even with all of these maximizing assumptions, the resulting organ dose is small.

It is known that urinalysis for thorium was not performed routinely at Rocky Flats.(22) However, Rocky Flats began investigating thorium urinalysis methods as early as January, 1960,(23) in advance of the thorium metal fabrication project described above. A colorimetric method developed by the New York Operations Office – Health and Safety Laboratory was selected for limited use to support this project. This technique was described as specific to thorium, with a detection limit of 0.2 µg/L.(23) Development work was performed in February,(24) March,(25) and April(26) 1960. Thorium urinalyses were received and results were reported by the chemistry laboratory for 18 samples between June and November, 1960,(16,27-31) This number of samples is consistent with the low number of employees (perhaps up to a dozen) involved in this project, as detailed to NIOSH by site experts.(3,7) The format of these monthly progress reports is such that urinalyses with significant result for the subject month are listed with the name of the employee. Negative results are not listed by name. None of these progress reports list any positive thorium urinalysis results, nor are any positive thorium urinalysis results mentioned in the health physics logbook. Primarily through a review of the radiation files for individuals identified in the health physics logbooks(10,14) as having been involved in this thorium project, NIOSH has located three individual Th urinalyses results received by the chemistry laboratory around the time of these operations (two received by the lab on June 6, and one received by the lab on July 1, 1960). This is an indication that these special thorium urinalysis results were placed in the worker's radiation files. These results would be considered in dose reconstruction. All of the results were background.

NIOSH has also located urinalysis results analyzed for thorium for two Rocky Flats workers not involved in thorium handling at Rocky Flats. In the case of the first worker, notations in monthly progress reports from the Chemistry Lab and Personnel Meters section from 1958(32-34) refer to four urine samples from one employee analyzed for thorium. A review of this individual's radiation file revealed a report on this situation, which concluded that this individual had a two year exposure to thorium ore concentrate prior to employment at Rocky Flats, and that he was working in a cold area of the plant. No exposure to thorium at Rocky Flats was identified or suggested. In the case of the second worker, an unusual spectrum was noted in the worker's chest count. Two urinalysis samples were analyzed for thorium for this worker, and these results are noted in the monthly progress reports from the Industrial Hygiene and Bioassay section(35) as "below significant level" and in the worker's radiation file as background. These results are also reflected in a logbook of special urinalyses covering the relevant time period.(36) The worker's radiation file also contains a report by Dr. Robert Bistline on this situation, which described a number of chest counts following up on the original "strange" count. Dr. Bistline's report gave the preliminary conclusion that the spectrum observed was a result of external contamination with depleted uranium. No exposure to thorium at Rocky Flats was identified or suggested. No other bioassay samples analyzed for thorium are mentioned in the monthly progress/status reports from the bioassay group, recorded in the special analyses logbooks, or mentioned in any other documentation located by NIOSH/ORAU.

It was reported by [a site expert] that though the experimental use of thorium work at Rocky was highly classified, it was well-known to specific responsible H&S professionals and followed closely. A conscious decision was made that, based upon the extent of thorium use and the field monitoring data (air, surface, urinalysis and personnel contamination monitoring/surveys), there was no justification for calibration and initiation of whole body counting for thorium.

IIB) Use of thorium substitute R&D components in lieu of more expensive Pu or HEU

Rocky Flats received thorium metal from Oak Ridge as pre-formed parts for use in weapons mockups. Light polishing was done at Rocky Flats(2,3,8) to assure the required fit in the mockup. No chemistry or metallurgy was performed on these parts at Rocky Flats. Due to the physical characteristics of these pre-formed parts, the small quantities involved, and the absence of handling procedures which would be expected to generate airborne thorium, there was no potential for significant uptake of thorium metal from this use of thorium at Rocky Flats.

IIC) Thorium strikes on U^{233}metal

Thorium strikes were performed to remove Th^{228} and its daughters from U^{233} (uranyl nitrate or uranium oxide feed) between 1965 and 1982.(2,3,11,37-40) Recovered uranium wastes from these operations were shipped to Lawrence Livermore Laboratory or Oak Ridge, and other waste products were shipped to Idaho for burial.(39) The presence of U^{232} and its daughters as contaminants presented a significant and well-recognized external radiation hazard,(2,11,38,39) and therefore attracted extra attention from health physics(5,20) in addition to concern for exposure potential from the Th^{228} and daughters. The U^{232} concentration in the U^{233} processed in 1965 contained up to approximately 50 ppm U^{232},[38,39] while that processed in 1976-77 contained only 7-8 ppm U^{232}.[39]

The strikes usually involved gram to kg quantities of U^{233}, however a strike was done on approximately 20 kg of U^{233} in the mid-1960s.[11] Uranium processing began in Building 771, where the thorium and daughters were removed in high containment process facilities. The high external exposure generating thorium wastes were handled in the glovebox facilities of Building 771, packaged, and sent to waste disposal in Idaho. The conversion of uranium to metal and metal parts was performed in Building 881, where elaborate precautions were taken in order to process this material.[11] The machine tools used were heavily shrouded with plastic, and [Name] recalled that there was no trouble in containing the alpha radioactivity. This is supported by entries in the health physics field logbook from the time, which notes the U^{233} campaign, but notes no unusual occurrences or exposures.[20]

IID) Use of small quantities of thorium in analytical procedures and as a mold coating

The use of thorium in analytical procedures has been described as numerous, but involving small (gram or less) quantities.[1,2] Accounts of several small, laboratory procedures have been located in progress reports related to research and development. One experiment conducted in 1969 dealt with separating trace (µg) quantities of uranium and thorium from solutions of neptunium.[41] Another experiment in 1970 dealt with the determination of low concentrations [($5x10^{-6}$ - $3.4x10^{-4}$ M) = (0.07 - 5 ppm)] of thorium impurities in plutonium.[42] There were a few laboratory experiments conducted in 1975 to convert thorium oxide to thorium metal.[43] The purpose of these experiments was to prepare thorium metal foils to be used as targets for particle accelerator experiments at Oak Ridge. These experiments used small quantities (35-100 g) of high purity thorium oxide. This material had been purified in the calutrons at Oak Ridge to remove the thorium daughters prior to shipment to Rocky Flats.

Casting was mentioned in one reference document,[8] and the author was interviewed to discuss this.[4] The "casting" of thorium mentioned in this report was associated with the development of a special high temperature arc furnace. Since the temperature sensors available at the time were not calibrated to record temperatures at these extremes, a small amount of thorium was used for calibration. The melting point of thorium was well established (1750 degrees C) and provided a calibration point at this temperature. The small amount (few grams) was not left in the crucible, but poured into a "casting". Casting of thorium parts was not done at Rocky Flats.[4]

A mold-coating compound containing thoria (thorium oxide) may have been used experimentally for a brief period. This operation was limited in scope, and never approached production scale.[1,2] None of the site experts interviewed by NIOSH could recall this use of thorium. The molding performed at Rocky Flats was mostly with weapons grade materials the goal of which was high purity, therefore the amount of thorium in any mold coating would have had to be kept small to avoid possible contamination of the plutonium and/or uranium. Using a maximum estimate of 75 grams per mold of thorium would be $1/10^{th}$ of the amount of plutonium. This may have been one of the reasons thorium was not used routinely as a mold coating in the production program. The time of exposures would have been brief (if at all, since the plutonium molding was done in a glove box) – in the few minutes range. The exposure potential quantities were derived using the following assumptions (1) molds used were primarily for plutonium metals and some uranium metals. For the weapons materials (Pu and VHEU), the quantity in any one part (mold) had to be minimized for criticality control considerations, therefore the molded quantities could be no more than a kilogram, producing a <5 inch diameter spherical metal button; (2) using the densities in g/cm^3 for plutonium (19.82), uranium (18.7), and thorium oxide (11.5), a kilogram of plutonium in a sphere would be 50.5 cm^3, with a radius of 2.3 cm. (3) the thickness of the coating would be ≤1 mm (source: http://www.tdcoating.com/td_glossary_terms2.htm#c, Thermal Diffusion (TD) Center, 2020 15th St., Columbus, IN 47201, Metallurgical Terms for the Coating and Heat Treating Industries, Glossary of Terms – Coatings) (4) thus the surface of a 2.3 cm radius sphere is 66 cm^2 and with 1 mm thick coating yielding a volume of 6.6 cm^3 (maximum) of thorium oxide could be used for a maximum quantity of 6.6 x <11.5 = approximately 75 gm. This is consistent with the 100 gm proposed in the source term calculation in Section VI.

III) Scale of thorium handling activities at Rocky Flats and implications for dose reconstruction:

It is clear from documentary evidence(1,2,8,11) and from interviews with former workers(3-6,44,45) that thorium activities at Rocky Flats were minor, and involved few workers (a dozen, at most).(3,40) With the exception of analytic procedures involving very small quantities of thorium, activities involving thorium at Rocky Flats were few and sporadic, as they were special order work.(3,5,7,8) Because of the nonroutine nature of the material and jobs, these activities attracted extra attention from health physics.(5,20) There is no indication that any significant thorium intakes ever occurred at Rocky Flats(6,20) as evidenced by air and surface monitoring plus urinalyses performed for confirmatory purposes.

Furthermore, as discussed at the November 6, 2006 meeting of the Rocky Flats Working Group, the chances of an undocumented thorium intake affecting the compensability of any claim are exceedingly remote. A very conservative estimate of the number of workers employed at Rocky Flats between 1952 and 1989 is 16,303.(46) Note that this estimate excludes any worker with employment of less than six months, and any workers for whom vital status, birth and hire dates were unavailable at the time of the study, and any worker with employment beginning after 1989 therefore it is most certainly an underestimate. The only realistic possibility of an undocumented thorium intake having a significant impact on any dose reconstruction would occur in a best estimate lung cancer case with a probability of causation of <50%. As of November 3, 2006, there were 1158 Rocky Flats cases received by NIOSH for dose reconstruction, of which there were 34 lung cases with a probability of causation of <50%. None of these cases was a best estimate, therefore there is no identified claim for which thorium could reasonably be expected to have a significant impact. Even granting that a case could exist, the odds of encountering a claim from a worker who handled thorium at Rocky Flats are less than 12/16,303 = 7.4×10^{-4}. The chances of this same worker being a best estimate lung case with a probability of causation <50% is (7.4×10^{-4}) x (<1/16,303). This is less than 4.5×10^{-8}.

IV) Quantities of thorium at Rocky Flats:

The quantities of thorium present at the Rocky Flats Plant varied from zero to 249 kg in a given month. This was verified by the NIOSH/ORAU team through a review of classified Material Balance Account ledgers, other documents,(1,2) and interviews with responsible program personnel. Thorium was present at Rocky Flats plant facilities in kg quantities for a period of 19 years with maximum inventory quantities in each year in the range of 1 to 249 kg (four years at or just over 100 kg, four years from 165 to 249 kg and ten years from one to 49 kg). Note that this is maximum inventory, and should not be confused with the quantity of material actually processed. The quantity of thorium handled at Rocky Flats was described by workers as "minor-trace level,"(4) and "trace quantities."(6) Seven former workers were interviewed and asked if there were significant quantities of thorium, and would they have knowledge of its presence. All seven workers were unanimous in stating that significant quantities of thorium were not present, and they would have known about it if it were.(5,6,44,45,47-49) These workers included individuals who served on the Operating Board (which approved all processes at Rocky Flats),(47) the Shipment Receiving Authorization Committee (which reviewed all incoming shipments of radioactive material),(5) and the worker responsible for the operation of the lung counter and as such, was intimately familiar with all "exotic" radionuclides present at Rocky Flats.(6)

V) Sources of Thorium Handled at Rocky Flats:

In terms of the number of activities handling thorium at Rocky Flats, the most significant source of thorium was Oak Ridge, largely as pre-formed parts,(3) but also a small quantity (grams) of high purity thorium oxide.(43) In addition, Rocky Flats received three ingots of thorium metal from W.R. Grace and Company for the 240 kg project in 1960,(9) which represented the bulk of the thorium handled at Rocky Flats.

The possibility of frequent and regular rail shipment of large quantities (tons) of thorium metal to Rocky Flats from the Dow Madison Site has been raised by SC&A and by petitioners involved with a SEC petition for the Dow Madison Site. A review of transcripts of the interviews of Dow Madison workers upon which this question is based(50-52) reveals that the Dow Madison workers were clearly speaking of shipments of magnesium alloy, of which thorium is a minor component (up to three percent according to the workers). NIOSH further verified this with a followup interview of the worker who spoke of shipments of material between the Dow Madison Site and Rocky Flats. In this followup interview,(53) the worker recalled frequent shipments to Rocky Flats, and he stated unambiguously that the material was magnesium alloy, not thorium metal. He did not recall the Madison Site ever shipping pure thorium metal to Rocky Flats or anywhere else. The extent of the exchange of radioactive materials between Rocky Flats and Dow Madison, if any, was also discussed with a former worker who served on the Shipment Receiving Authorization Committee at Rocky Flats (which reviewed all incoming shipments of radioactive material).(5) This individual did not recall any shipments of thorium between the two sites, and was clearly in a position to be aware of such shipments. At NIOSH's request, Records Management personnel at the Mountain View facility conducted a search of Rocky Flats records on November 16, 2006, for anything relating to the Dow Madison Site. No contract or any other documents related to a relationship between Dow Madison and Rocky Flats was located. The FUSRAP documents related to the Dow Madison Site were also reviewed. These documents clearly state that the handling of thorium at the Dow Madison Site was unrelated to AEC work, and was conducted under a separate license from the Illinois Department of Nuclear Safety.[54,55] NIOSH has found no evidence that shipments of thorium metal from Dow Madison to Rocky Flats took place. Furthermore, the receipt of large quantities of thorium metal from Dow Madison, or anywhere else, would be contrary to several documents noted in this report,[1,2,8] the Material Balance Account ledgers, and information provided by several former Rocky Flats workers.[3-6,44,45,47-49]

VI) Source Term Calculations:

As indicated above thorium was present and handled at Rocky Flats primarily in short duration special projects in a general research and development mode. Quantities were relatively small in the gram to 250 kg levels. Few personnel were involved, the tasks involved unusual isotopes and exposure potential, thus attracted heightened attention and controls. The tasks were well monitored for air, personnel, and surface contamination, and included urine samples for verification of low exposure potential from the field monitoring data. However, thorium was recognized as unusual in metabolic characteristics, thus urine analysis was not only technologically difficult in the early years, but was recognized as questionable in terms providing the means of definitive quantitative intake analysis.

For this reason the following intake analyses are provided to demonstrate "bounding" of the internal dose potential from the major identified internal sources. Where available, bioassay data is preferred for dose reconstruction. When only field monitoring data (primarily air sampling data) is available, this can be used with appropriate conservative assumptions to derive the maximum bounding dose. The bounding assumptions outlined in NUREG-1400 can be used to derive intake and/or confirm the estimates provided by data based analyses.

VIA) Fabrication of thorium metal parts from three 80 kg ingots:

This project involved approximately eight hours of cold rolling of bare thorium metal (on June 3, 1960) with an air concentration of 4.62 dpm/m^3, and approximately 30 hours of other operations with an air concentration of 1.41 dpm/m^3, which translates to an intake of approximately 3 Bq. Oak Ridge National Laboratory's DCAL code, which was used in the calculations for ICRP 68,[21] was used to generate annual organ equivalent dose coefficients for inhalation of Th^{228} and Th^{232}. These data were then used to calculate maximum annual organ doses for this project. The highest annual organ dose for any organ was 62 mrem for the ET1 compartment of the respiratory system. This calculation includes several conservative assumptions, including (1) no account was taken for use of respirators, though this would clearly be the practice at Rocky Flats in situations where there was potential for generation of airborne contamination (2) for simplicity, it was assumed that a worker was involved in all phases of the project, though this was clearly not the case,[10,14] and would therefore have been exposed to the maximum number of hours of airborne contamination (3) Th^{232} was assumed to be in equilibrium with Th^{228}, which results in a maximized organ dose, even though this may not have been the case if the thorium ingots were freshly manufactured. Even with all of these maximizing assumptions, the resulting organ dose is small.

On 22 September 1960 the failed thorium metal ingot 3 can was cut open with a torch, presumably to identify the condition of the ingot after the hot rolling step and failed can. The radiological control program was evidenced by a series of four air samples that were collected for 50 and 70 minutes on two samplers and for 2 hours on the other two samplers. The samples were counted three times, the last being a one-month delay count. The activity was approx. 50% long lived with maximum concentration at 62 dpm/m^3 (which was a BZ sample) and the other samplers recording at 3 to 8 dpm/m^3. Based upon standing procedures and practice and the degree of recorded surface and air activity monitoring, it is reasonable to assume the use of respiratory protection. However, without respiratory protection a calculated intake of 1 Bq is derived, which would translate to a CDE of 14 mrem bs and 8 mrem lung. First year annual dose is 0.1 mrem bone surfaces and 2 mrem lung dose, with the 20 year dose at 2 mrem bone surfaces and 0.1 mrem lung.

Thus, using data from both a general report and the specific data from the one can opening excellent agreement is demonstrated as 1 Bq from the single can uncaning task and 3 Bq intake from 30 hrs of work with all three of the ingots. The calculated doses, using different software programs also shows consistency of resultant dose – as less than 100 mrem to any organ.

VIB) Use of thorium substitute R&D components in lieu of more expensive Pu or HEU:

VI B 1) Use of NUREG 1400 assumptions in the absence of bioassay data

Initial research revealed the typical operations and the approximate quantities of thorium used with no specific monitoring data available. One approach to estimate the potential thorium intake is based on the procedure described in NUREG 1400.(56) The purpose of NUREG-1400 is to establish a guide that will conservatively indicate the need for an air monitoring program. The variables are chosen in such a way as to always result in high values of air activity. NUREG 1400 suggests calculating the potential intake of radionuclides by workers using the following equation:

$$I = Q \times 10^{-6} \times R \times C \times D$$

where:

I = estimated annual intake
Q = total quantity of "unsealed or loose" material handled in a year for a given work location
R = release fraction
C = confinement factor
D = dispersibility

The typical release fraction for solids (*e.g.*, uranium pellets) is given as 1E-3 in NUREG 1400. The confinement factor for a well-ventilated hood is 0.1. The dispersibility factor for cutting or grinding is given as 10. Therefore, the estimated annual intake for a solid material, such as thorium metal, being cut or ground in a hood would be as follows:

$$I = Q \times 1E\text{-}6 \times 1E\text{-}3 \times 1E\text{-}1 \times 10 = Q \times 1E\text{-}9$$

In lieu of site-specific information it was assumed that each thorium model weighed 6 kg (which is a major overestimate, representing the maximum credible amount) and that one large part was processed for each of 10 months for a total of 60 kg of natural thorium per year (thus further compounding the conservatism). It is further estimated that the unsealed or loose contaminants from the prefabricated, large metal parts, which were only slightly modified to fit, is 10% or less, hence the Q value of 6 kg is used. For perspective the surface area of a large block of thorium has a surface area in the range of 1E+5 times less than 10% of that amount as waste reduced to 5 µm particles.

The specific activity of Th^{232} is 4.04E6 Bq/kg. The total activity of unsealed or loose thorium processed per year would be as follows:

Q = 4.04E6 Bq/kg x 6 kg = 2.4E7 Bq

The estimated annual intake, based on the modifying factors used above would be 2.4E-2 Bq. For a reference point the committed equivalent and effective doses were calculated based upon the estimated intakes. These potential doses to individual workers, assuming the estimated annual intake of ^{232}Th was 2.4E-2 Bq, were calculated under the above stated assumptions, Class S thorium

Effective dose – 9E-5 rem, (<1 mrem)
Bone dose – 4E-4 rem, (0.4 mrem)
Lung dose – 7 E-4 rem, (0.7 mrem)

VI B 2) Intake estimate by comparing uranium machining and/or grinding air activity with possible Th releases:

A study of air activity measured from similar machining and/or grinding operations was conducted to validate the estimate derived using NUREG-1400 approach. Thus an extensive study by scientists of the AEC Health and Safety Laboratory prior to 1958(57) was referenced which presents air sampling data from a number of facilities in which a variety of processes were used in the early 1960s time period for processing of uranium. This study was with uranium being processed in large quantities for extended time period of production operations and present a much greater contamination release potential than the light machining or grinding of relatively small pieces of thorium metal during relatively short time periods, but can be used in a high bounding comparison. The releases from similar processes, *i.e.* milling, grinding, etc. on uranium as compared to thorium is also conservative/bounding based upon the differences in the physical characteristics. The melting point for uranium metal is 1,690°C and for thorium metal 1,845°C. The boiling point is 3,500°C for uranium and 5,200°C for thorium. Thus values derived for thorium air activity based upon the direct comparison with uranium results below will be higher than those anticipated for thorium.

The air activity levels for the machining and grinding operations, which were performed on the uranium metal parts, were converted to mass concentrations, which were then converted to thorium activity concentrations. This is based upon the assumption that equal mass quantities of thorium to those of uranium would be released. Since thorium metal, oxides and hydroxides are considered insoluble, solubility class S dose conversion factors were used.

Since the work with thorium metal parts was performed on equipment designed for enriched uranium at the Rocky facilities, the machines were shrouded/hooded and were considered in the "vented" category listed in the reference study.

Table 1. Calculation of CDE and Annual DE Dose in mrem

Operation	dpm/m3U	µgU/m3	dpm/m3Th	hr/yr	Bq intake	mrem CDE	DE mrem 1st yr	DE mrem 20th yr
Machining	50	64	16	10	3.1	44 bs	0.25 bs	6.5 bs
						24 lung	5 lung	0.3 lung
Grinding	200	257	63	10	12.6	176 bs	1.0 bs	27 bs
						97 lung	21 lung	1.6 lung

Key: bs = bone surfaces, lung = lung as the organ of reference. For reference the annual dose equivalent in mrem is given for the 1st year after intake and the 20th. CDE = Cumulative dose equivalent is derived by multiplication of the intake by the dose conversion factor from ICRP 68 in Table 3.

Based upon a conservative bounding of the doses based upon assumed intakes from comparative air sampling data, organ dose does not appear to be limiting, even though intakes using this comparison analyses is a couple orders of magnitude larger than that calculated using NUREG-1400.

VIC) – Thorium strikes on U^{233}:

The thorium strike removal of Th^{228} is different in nature from the thorium that came into the plant as thorium metal, since this source of Th^{228} came into the plant as a contaminant of U^{233}. However, during the chemical separation of the thorium plus daughters from the $U^{232/233}$ a significant radiological hazard existed, primarily from external radiation. The maximum activity of Th^{228} estimated from a 20 kg U^{233} process with 50 ppm U^{232} was approximately 10 Ci. Measured dose rates from this activity could be as high as tens of rem/hr from gamma radiation of high energies (up to 2.6 Mev) during the separation processes.[38] The internal intake potential can be calculated also, using the NUREG-1400 general approach. The operations were (1) short-lived, (2) performed in high confinement glove boxes designed for production Pu operations, and (3) the separated Th^{228} plus daughters were immediately encapsulated and stored/shipped to the disposal site in Idaho.

$I = Q \times 10^{-6} \times R \times C \times D$

where:

I = estimated annual intake
Q = total quantity of "unsealed or loose" material handled in a year for a given work location.
R = release fraction
C = confinement factor

D = dispersibility

The typical release fraction for liquids is given as 1E-2 in NUREG 1400. The confinement factor for a glove box is given as 1E-2. Pu glove boxes in which the U-233 was processed, operate with confinement factors in excess of 3E-7 (two in-line HEPA filters) – assume 3E-4. The dispersibility factor for liquids is chosen as 1. Therefore, assuming (1) 20 kg of U^{233} with 50 ppm U^{232}, (2) 1 gm U^{232} (50 ppm U^{232} = approximately 20 Ci), and (3) approximately 10 Ci (3.7E+11 Bq) Th^{228}, the estimated annual intake for Th^{228} in this maximum processed amount in a contained liquid in a glove box would be as follows:

I = Q x 1E-6 x 1E-2 x 3E-4 x 1 = Q x 3E-12

= 3.7E+11 Bq x 3E-12 = 1.11 Bq

The potential doses to individual workers, assuming the estimated annual intake of Th^{228} of 1.11 Bq, were calculated under the above stated assumptions, Class S thorium, Class M radium, and Class F lead, the calculated annual doses were as follows:

Effective dose – 3E-3 rem, (3 mrem)
Bone dose – 3E-2 rem, (30 mrem)
Lung dose – 3E-2 rem, (30 mrem)

The previous comparison between conservative values above resulted in a value above the NUREG-1400 estimate. In this case the Th^{228} extraction with daughters is so grossly overestimated both in terms of total quantity of isotope present and in the demonstrated confinement of the glove box process facilities in which the extraction and waste handling was performed, that the NUREG-1400 estimate is not deemed overly conservative. Air activity that would result in 100 Bq intake would have been cause for a significant release with the subsequent detail in the health physics logs we have reviewed.

VID) Use of small quantities of thorum in analytical procedures and as a mold coating:

Thorium oxide might have been used as a mold-coating compound in limited experiments.[(1)] The site experts we interviewed had no specific memory of the experimental use of the mold coating, but did remember that it was experimental and was used in a limited manner and never made it to production or routine use. The time of exposures were very brief (if at all, since the Pu molding was done in a glove box) – in the few minutes range. The exposure potential quantities were derived using the following assumptions:

(1) Molds used were primarily for Pu metals and some U metals. The molded quantities could be no more than a kg, producing a <5"diameter spherical metal button.

(2) Using the densities in g/cm^3 for Pu – 19.82, U – 18.7, and Th – 11.5, a kg of Pu in a sphere would be 50.5 cm^3, with a radius of 2.3 cm.

(3) The thickness of the coating would be ≤1 mm (source: http://www.tdcoating.com/td_glossary_terms.htm, Metallurgical Terms for the Coating and Heat Treating Industries, "Coating – Thernal Diffusion (TD) Center, 2020 15th St., Columbus, IN 47201, Metalurgical Terms for the Coating and Heat Treating Industries, Glossary of Terms).

(4) Thus the surface of a 2.3 cm radius sphere is 66 cm^2 and with 1mm thick coating a volume of 6.6 cm^3 (maximum) of thorium oxide could be used for a gm quantity of 6.6 x <11.5 = approx. 75 gm. Consistent with the 100 gm default.

Thus, using NUREG-1400 approach for any operation, including analytical laboratory processes, with a release fraction (R) of 0.01, including a confinement factor (C) of 1, a dispersibility factor (D) of 10 and a Q of <100 grams (4E+5 Bq), the intake would be 4E-2 Bq. Clearly, with the factors maximized any quantity <100 grams would result in potential intake of <0.04 Bq and truly inconsequential internal dose.

VII) Conclusion

Several conclusions can be drawn from the preceding evidence. First, it is clear that thorium operations at Rocky Flats were limited in scope, and involved quantities of thorium that were trivial in comparison to the quantities of plutonium and uranium processed at Rocky Flats. The quantity of thorium at Rocky Flats was also trivial in comparison to other AEC/DOE sites like Y-12, which processed a large fraction of the thorium used in the DOE complex, and Fernald, which also served as a primary DOE complex supplier and as the thorium repository for the DOE for the period post 1979. The only operation at Rocky Flats that involved even a moderate quantity of thorium occurred on eight workdays in 1960. A very detailed account of this project has been determined. This project involved few workers, whose identities are known, and the project was monitored by sampling for airborne thorium and through limited thorium urinalysis. NIOSH continues to conclude that the thorium handling operations at Rocky Flats were limited in scope, well monitored and documented, resulted in trivial potential doses, and do not represent an SEC issue.

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ATTACHMENT 21: SC&A MEMORANDUM TO THE ROCKY FLATS WORKING GROUP "THORIUM-232 AND OTHER 'EXOTIC' RADIONUCLIDES AT ROCKY FLATS"

Date: October 27, 2006

To: Working Group on the Rocky Flats SEC
From: Joe Fitzgerald
Subject: Thorium-232 and other "exotic" radionuclides at Rocky Flats – review of NIOSH papers

This memorandum provides a review of the NIOSH paper *Potential Thorium Intake at RFP* (no date, hereafter NIOSH 2006)), which proposes a method to estimate Th-232 doses as well as doses during the strike removal of Th-228 from U-233 at Rocky Flats. It also briefly reviews NIOSH's paper *Comments in Response to SC&A 'Additional Issues' Rocky Flats and Other Radionuclides* (no date, hereafter NIOSH 2006a).

A. THORIUM-232

NIOSH's paper *Potential Thorium Intake at RFP* is a response to SC&A's raising the issue of how intakes of Th-232 were going to be estimated.

NIOSH had stated during Working Group meetings concerned with the Rocky Flats SEC that there were gross alpha urinalysis data that could be conservatively interpreted to assume the worst-case radionuclide at Rocky Flats (i.e., that delivering the highest dose to the organ in question) when the radionuclide to which an employee was exposed was not known. However, NIOSH did not provide any example that actually connected an individual with a potential for thorium exposure with a gross alpha bioassay sample that could be interpreted in the suggested manner. NIOSH 2006 does not pursue this approach. Rather, it estimates Th-232 and Th-228 intakes by estimating a source term and then using an approach set forth in NUREG-1400,[8] which is a Nuclear Regulatory Commission guidance document for determining whether air monitoring is needed in a facility processing nuclear materials.

1. Th-232 Source Term

NIOSH uses an estimate of 6 kilograms of Th-232 processed per month for 10 months to estimate annual intake. The dates for this work are given as 1956 to 1993. No data on frequency of processing are provided, but NIOSH does provide the following data on Th-232 stocks:

> *Primarily from MBA inventory records, several other documents, and interviews with responsible program managers it is clear that thorium was in the Rocky Flats plant facilities in kg quantities for a period of 19 years with maximum*

[8] E.E. Hickey et al., *Air Sampling in the Workplace*, NUREG-1400, Final Report, Office of Nuclear Regulatory Research, Nuclear Regulatory Commission, Washington, D.C., September 1993.

inventory quantities in each year in the range of 1 to 249 kg (4 years at or just over 100 kg, 4 years from 165 to 249 kg and 10 years from 1 to 49 kg).

These data are not sufficient to definitively determine whether the NIOSH estimate of 6 kilograms per use and 10 times per year is claimant favorable. This is because the source term is a flow (amount processed per year), but the data quote above are stocks. Without information of how much Th-232 was being shipped in and out in various periods, SC&A cannot verify NIOSH's assumption regarding source term.

SC&A has not done a review of the classified Rocky Flats MBA inventory records. Such a review may be needed to ensure that the available thorium production records are complete.[9] We accept NIOSH's characterization of the Rocky Flats source term so far as amounts processed are concerned for the purposes of this review. For thorium metalworking, NIOSH assumed 6 kilograms per month for ten months as the amount that was processed. However, the source term may need verification for completeness of available documentation.

2. NUREG-1400

NUREG-1400 was written to provide guidance regarding workplace air monitoring to meet the requirements of 10 CFR 20, the NRC's regulation where Allowable Limits of Intake and Derived Air Concentrations of various radionuclides are specified. It details how air samplers are to be located and how the accuracy of air sampling methods may be improved. NUREG-1400 is a modern document (1993); it was not written for the purpose of dose reconstruction. For instance, it assumes that "a worker is not likely to have an intake I_p exceeding 10^{-6} of the material being handled…" However, this assumes that "normal precautions are taken."[10]

The workplaces of the Atomic Energy Commission during the 1960s and 1960s frequently did not have what one would have considered as "normal precautions" in the 1990s. For instance, thorium metal processing at Fernald in the 1950s and 1960s generated dust that were as high as hundreds of times the maximum allowable limit of 70 dpm/m^3.[11] Dust levels ranged from a few times MAC to several hundred times MAC. Peak measurements were thousands of times the maximum allowable concentration. The highest *average* exposure recorded in 1955 was

[9] Caution with regard to thorium production data is warranted. During the Y-12 SEC Working Group meetings, NIOSH initially indicated that thorium production was quite small, but a subsequent investigation by NIOSH showed that large quantities were, in fact, processed there in the SEC period. Thorium-232 production data in the Fernald TBD are incomplete (SC&A TBD, review, forthcoming). Further, according to NIOSH's Fernald Site Profile, many thorium production and other documents for Fernald were lost or destroyed. *Technical Basis Document for the Fernald Environmental Management Project – Occupational Internal Dose,* ORAUT-TKBS-0017-5, National Institute for Occupational Safety and Health, May 28, 2004; p. 18.

[10] NUREG-1400, p. 1.2

[11] There are many documents evaluating dust levels in Fernald thorium processing operations including metal working operations. Some references are: P.B. Klevin to W.B. Harris, *Health Hazards in Thorium Processing*, March 5, 1954; K.N. Ross to J.E. Carvitti, "Air Dust Evaluation of Thorium Furnace Operations," November 14, 1960; K.N. Ross to R.H. Starkey, "Air Dust Evaluation of Reverter – Plant 8," February 28, 1966; R. H. Starkey to C. R. Chapman, "Problems Associated with Thorium Processing – Plant 8," National Lead Company of Ohio, October 1, 1968; R. H. Starkey to C. R. Chapman, "Air Dust Re-Evaluation of the Thorium Furnace – Plant 6," National Lead Company of Ohio, March 26, 1963. A more detailed description will be provided in SC&A's review of the NIOSH Fernald Site Profile.

353 MAC. This would produce a committed dose to the bone surface of more than 5 rem in just 5 minutes of exposure. The peak level measured at Fernald in that same year was about 3,500 MAC. At this level, the committed dose to the bone surface would be more than 10 rem in just one minute.[12]

High levels of thorium dust were also prevalent in the early period at other sites for which there are data. In summary, from data available for Fernald and other facilities processing thorium in the early nuclear era, it would appear that what would be regarded as "normal precautions" were not the norm at the time.

NIOSH 2006 states that the levels of thorium production at Rocky Flats were far lower than they were at Y-12; by extension this would also apply to Fernald. However, thorium metal was machined at Rocky Flats to make large parts for nuclear weapon mock-ups. It is possible, therefore, that levels of local dust therefore may have been high. As SC&A has pointed out before, the level of production will affect population exposure (all other things being equal), but cannot be used as a basis for assuming low individual exposure. Individual exposure depends on very localized dust and ventilation conditions, production techniques, industrial hygiene methods, such as the use of hoods, and the layout of equipment and facilities. For instance, the dust levels during the pilot production phase in 1951 at Bethlehem Steel were much higher than in the large-scale production phase, because the process during the latter phase was much improved relative to the former.

Rocky Flats also operated an incinerator for recovery of fissile materials from 1958 to 1988 (Rocky Flats TBD, Vol. 2, p. 37). It is not clear whether this was used for thorium recovery. Incinerator loading and unloading operations in the early years at Fernald were among the dustiest thorium operations. SC&A's review of the Rocky Flats TBD pointed out that NIOSH had not analyzed incinerator fires and incidents (SCA-TR-TASK1-0008, December 2005, p. 92). While that discussion was in the context of plutonium exposures, it would also need to be raised in the context of exposure to other radionuclides, if the incinerator was used for recovering them.

In the absence of air monitoring data for thorium and thorium bioassay data, there is no way to calibrate the appropriateness of the use of NUREG-1400 for estimating intakes. SC&A notes that NIOSH's estimated annual intake of 2.4E-2 Bq of Th-232 is extremely small compared to any historical thorium production data from the 1950s and 1960s or even the 1970s. When Th-228 in equilibrium is taken into account, the intake estimated by NIOSH would be 4.8E-2 Bq/year. The data compiled by SC&A in the course of the review of the Fernald TBD (to be published shortly) indicate that a concentration of 1 MAC would be at the lower end of what was experienced in production areas. The intake of Th-232 in equilibrium with Th-228 in a single hour at 1 MAC would be almost 30 times the NIOSH estimate for the entire year.

SC&A concludes that, even assuming that thorium production operations overall took place over only a few days in the entire year, the disparity between the cleaner documented conditions at

[12] The thorium data for Fernald in this paragraph are from a W.B. Harris to Merril Eisenbud communication, "Thorium at Fernald," April 17, 1956. An equilibrium mixture of Th-232 and Th-228 has been assumed in the calculations in this section.

other sites and the NIOSH intake estimate would be three orders of magnitude or more. If the conditions at Rocky Flats for thorium production in the 1950s and 1960s were moderately comparable to the dust levels documented for Fernald or Simonds, the disparity would be much bigger. It is important to remember in this context that high puff dust levels for very short periods of time – of a few minutes or less – could produce doses greatly in excess of the NIOSH annual intake estimate. For instance, a puff of 100 MAC would produce an intake of 4.8E-2 Bq of a Th-232/Th-228 mixture in just over one second.

Another way to look at the proposed intake rate is to consider what it implies for mass loading during the working time. Assume that the entire 60 kilograms was processed in a single 8-hour day and that the breathing rate was 1.2 m^3/hour. These assumptions would yield a high estimate of air concentration, corresponding to NIOSH's assumptions. The air concentration of Th-232, expressed in terms of mass, corresponding to the NIOSH intake amounts to only about 0.6μg/m^3. For comparison, 1 MAC, defined as 70 dpm/m^3 in the 1950s and 1960s (mixture of Th-232 and Th-228), amounts to about 140 micrograms/m^3. The NIOSH estimate is almost 500 times smaller, or just over 0.002 MAC. This appears to be an incredible estimate in light of working conditions that have been documented at other sites for thorium processing.

In another comparison, the U.S. standard for PM_{10} (24 hour average) is 150 μg/m^3.[13] The Th-232 levels at Rocky Flats would be almost 250 times cleaner than the current EPA PM_{10} standard. As another point of reference, urban background air in European cities measures at 12 to 89 μg/m^3, annual average.[14] Indeed, 0.6μg/m^3 is much cleaner than a national park. For instance, the PM_{10} level between 1993 and 1995 in Great Basin National Park was 6.5μg/m^3.[15]

If the intake of 2.4E-2 Bq, or about 6 micrograms, of Th-232 is assumed to occur over a longer time, for instance, a week's equivalent of work, then the above comparisons would be even more stark.

In view of the above, the use of NUREG-1400 would have to be supported by considerable data from the site showing the conditions at Rocky Flats during thorium processing, especially metalworking. As it stands, the NIOSH analysis is not supported by such data. However, if such data were available, it would render the use of NUREG-1400 moot, since on-site air concentrations could be directly used to estimate Th-232 intakes.

3. Factors Used in NUREG-1400 to Estimate Intake

NUREG-1400 uses several factors to obtain an estimate intake for the purpose of determining whether air monitoring is needed in the workplace. As discussed above, the most basic factor is described as a

> *rule of thumb that, when normal precautions are taken, a worker is not likely to have an intake I_p exceeding 10^{-6} of the material being handled….*

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[13] EPA, National Ambient Air Quality Standards, on the web at http://www.epa.gov/air/criteria.html

[14] Technical Working Group on Particles, European Commission, *Ambient Air Pollution by Particulate Matter: Position Paper*, April 8, 1997, on the web at http://ec.europa.eu/environment/air/pdf/pp_pm.pdf

[15] Great Basin Online, http://www.nps.gov/archive/grba/aerosol.htm.

The Brodsky fraction of 10^{-6} in workplace situations was estimated for volatile radionuclides like iodine-131 or tritium as HTO.[16] According to Stephen McGuire of the NRC:

> *For worker dose inside buildings, Brodsky also found 10^{-6} to be a valid fraction. However, the measurements supporting the conclusion were based on iodine, which is very volatile. He provided no data on non-volatile materials. NUREG-1400 expanded the Brodsky proposal to non-volatiles. Considering that there are similarities in the mechanisms of how materials are suspended and become airborne in both accidents and in workplace activities, it is reasonable that the airborne fractions should not be totally dissimilar. This was supported by some other data including a thesis by Scott Pennington at Georgetown Univeristy [sic], who looked at uranium processing and found that a fraction of 10^{-9} provided a good fit with the data (10^{-6} x 0.001).* [17]

SC&A has not reviewed Pennington's thesis, but suggests that such a review by NOSH might be useful, should NIOSH wish to continue to pursue the use of NUREG-1400 for Rocky Flats thorium-232 dose reconstruction. Specifically, the dust conditions at the facilities studied by Pennington should be compared to those historically prevailing in thorium production in the AEC complex and at AWEs. Further, a study of dust levels versus throughput at multi-kilogram levels of machining thorium metal would also be very useful.

SC&A notes that a 10^{-6} intake fraction for volatile materials, sometimes called a "Magic Number" (as applied by Brodsky), used inside buildings, cannot be considered as anything more than a "rule of thumb" for an annual average, even for industrial hygiene purposes in modern facilities. As noted above, intense short-term puff releases under circumstances that have prevailed at other AEC and AWE facilities could easily create situations where intake in a short period of time greatly exceeds that estimated by an annual average rule of thumb. Hence, for work that was episodic, annual average considerations do not appear to be appropriate unless their use can be demonstrated to be claimant favorable by comparison with air concentration data from similar conditions and processes.

Because the Brodsky paper suggested 10^{-6} for volatile radionuclides, NUREG-1400 suggests a further reduction of intake by a factor of one thousand for solids that are subjected to processing and yet another reduction by a factor of ten for good ventilation. It also suggests multiplying the intake by ten for if cutting and grinding operations are involved.

NIOSH has provided no data to show that the specific workplaces that were used to machine Th-232 were well ventilated; hence it is unclear if a reduction of intake by a factor of ten due to this factor is justified. Further, NUREG-1400 does not provide any example of metal working

[16] A. Brodsky, "Resuspension Factors and Probabilities of Intake of Material in Process (Or 'Is 10-6 a Magic Number in Health Physics?')," Health Physics, Vol. 39, December 1980, pp. 992-1000.

[17] SC&A was unable to locate the *Health Physics* paper cited in the online archives of the journal (HP. Vol. 39, pp. 992-1000). The content of the paper as described above is surmised from e-mail correspondence sent by Stephen McGuire of the Nuclear Regulatory Commission in response to a query about the paper on the RadSafe website. See www.vanderbilt.edu/radsafe/9801/msg00587.html, dated 23 January 1998.

operations in its estimates of intake. The reduction of intake by a factor of 1,000 is illustrated with the use of sintered uranium fuel pellets and the dispersion factor 10 is suggested for the same process.[18] Grinding sintered uranium fuel pellets, which are ceramics, can be expected to have considerably different characteristics than machining actinide metals. Fume generation would not be expected in the former, but could occur in the latter, especially in the absence of the use of cooling fluids on the piece being machined. Hence, if factors such as those suggested for the processing of solids are to be used in estimating intakes for the purpose of dose reconstruction, an actual comparison of the processes and materials is necessary. NIOSH has provided no analysis showing that a comparable situation existed between the examples provided in NUREG-1400 and thorium metal processing at Rocky Flats. Such an analysis is would appear to be required by 42 CFR 82, according to which the benefit of the doubt should be given to the claimant in the presence of uncertainty.

Finally, NIOSH reduced the source term by a factor of ten above and beyond that used in NUREG-1400 in its example of uranium fuel pellet grinding. NIOSH assumes that total metal processed into parts as 60 kilograms per year (p. 4). But instead of using this as the source term, NIOSH reduced it by a factor of ten:

> *It is further estimated that the unsealed or loose contaminants from large metal parts is 10% or less. (p. 4)*

NIOSH states that "waste" form thorium machining was less than 10% (NIOSH 2006, p. 2), but does not provide any reference for this assertion. Using this reasoning, instead of taking the annual amount processed as 60 kilograms in the NUREG-1400 equation, NIOSH reduced the amount processed to 6 kilograms per year. NIOSH then applied all the other factors discussed above, which together amount to a factor of 10^{-9}. In effect, NIOSH is actually using a factor of 10^{-10} on the actual amount processed to estimate the intake. This appears contrary to the way NUREG-1400 treats the example of fuel pellet grinding.

Uranium fuel pellets are also massive objects from the dust point of view, in that they are not loose contaminants. They are unsealed; so was the thorium metal that was being machined. Only a small fraction of the fuel pellet would become loose material as a result of grinding and a part of that would become airborne. NUREG-1400 applies the factor of 0.001 to the total weight of uranium fuel pellets processed annually. It does not use an additional factor of ten to reduce the source term and it does not argue that the source term should be reduce because only a part of the fuel pellet becomes loose material. While the analogy with thorium metal, as noted above, is not readily applicable without further analysis to the fraction by which 10^{-6} should be reduced, it is sufficiently applicable in terms of the similarity of being massive relative to "loose" material. NIOSH appears to have misapplied NUREG-1400 to reduce the source term by a factor of ten.

[18] NUREG-1400, p. 1.3.

4. Rocky Flats Thorium-232 Bioassay Data

NIOSH 2006 makes the following statement regarding Rocky Flats thorium data:

> *Unlike uranium, little of the thorium inhaled or ingested is excreted in urine. Therefore, fecal bioassay is the method generally used where worker exposures are in the range of permissible concentrations. Though there is recorded information related to the development of thorium urinalyses and several urine results in the 1960 time period, there are no data available to indicate that thorium isotopes were part of the routine bioassay program. There are no data to suggest that fecal bioassay was used routinely at the RFP to assess radionuclide intakes. Lung counting was used at other DOE sites for thorium lung deposition determination, although Rocky lung counting in the energy ranges of interest was for Th-234 a daughter of U-238, used for uranium deposition analysis.*

This implies that there are some records for both thorium urinalysis and thorium fecal analysis. Granting that fecal data may not have been used to evaluate thorium intakes at Rocky Flats, such data may still provide some indication whether the orders of magnitude of intake estimated by NIOSH using NUREG-1400 are in the right ballpark. Further, if there are any urinalysis results that are above the detection limit of the time, this would be very significant for the very reason that "*little of the thorium inhaled or ingested is excreted in urine*." Hence, SC&A recommends that NIOSH should analyze all of the available thorium bioassay data in the context of its analysis using NUREG-1400.

5. Conclusion as regards the Use of NUREG-1400

NIOSH has not provided an analysis that would enable a determination of the applicability and claimant favorability of the use of NUREG-1400 for Rocky Flats workers. Historical data from other sites, especially regarding short-term concentrations of thorium in workplace air, suggest that the NIOSH estimate of Th-232 intake of 2.4E-2 Bq per year could be orders of magnitude too low, though this cannot be firmly established in absence of any data from Rocky Flats itself. Some Rocky Flats thorium-232 air concentration data appear to be necessary to establish the validity of the NIOSH approach. In the alternative, it is possible that some of the bioassay data might provide a useful indicator as to whether the analysis is correct to within a few orders of magnitude. NIOSH's paper, "Potential Thorium Intake at RFP" does not provide any such data. NIOSH should use all available bioassay data (fecal and urine) to attempt to validate its approach.

6. Gross Alpha Bioassay Data

A check of the HIS-20 database shows that there is a considerable gross alpha bioassay database for Rocky Flats. It is unclear why this database has not been used to estimate intakes, as proposed earlier, since 42 CFR 82 favors the use of personal monitoring data over all others in dose reconstruction. An explanation of why this source of data is not being used would be helpful. SC&A notes that the completeness or adequacy of the gross alpha data for such purposes has not yet been evaluated.

7. Thorium-228

Comments similar to those above would apply to application of NUREG-1400 to the Th-228 strike section of NIOSH 2006. SC&A notes that the source term of 10 curies for Th-228 is low by about a factor of 2.2 if Th-228 is assumed to be in equilibrium with U-232, under the assumptions in the paper (20 kg. U-233, with 50 ppm U-232).

8. Comparison with Y-12

NIOSH is required to be equitable and consistent across sites in its approach to dose reconstruction. A comparable situation for thorium-232, though at higher production levels, existed at Y-12, in that there were essentially no bioassay or air monitoring data for thorium-232 workers. NIOSH proposed an SEC for those workers (1948-1957 period) and the Advisory Board accepted NIOSH's recommendation. That SEC has now been granted.

The use of NUREG-1400 at Rocky Flats would raise the question of why an SEC was granted to Y-12, when NUREG-1400 could just as well have been applied there. Note that the quantity of production is not a restraint on the applicability of NUREG-1400. The example in NUREG-1400 discussed above was for a production of 100,000 kilograms of fuel pellet at a grinding station. Hence, the scale of production at Y-12 would not have been an issue in the use of NUREG-1400 for Y-12.

NIOSH's appeal to the smaller scale of production at Rocky Flats relative to Y-12 in using NUREG-1400 at Rocky Flats requires a quantitative demonstration that that smaller scale of production resulted in air concentrations that were orders of magnitude lower than those at other facilities. Further, as noted above, machining of pieces of thorium metal weighing several kilograms each should not be assumed to create lower dust levels than larger annual throughputs. This may apply to population exposure (all other things being equal) but would not to individual exposure. Further, as noted above, NIOSH would still have to demonstrate that NUREG-1400 provides the appropriate tools for that job and that its intake estimates are credible and comparable to other facilities processing thorium under similar conditions.

B. OTHER RADIONUCLIDES

NIOSH 2006a (*Comments in Response to SC&A 'Additional Issues' Rocky Flats and Other Radionuclides*) covers the following radionuclides, in addition to providing some materials accounting data for thorium as well:

- Am-241
- U-233
- HEU and DU
- Cm-244
- Np-237
- Tritium

NIOSH 2006a, itself, does not provide any assessment of dose reconstruction feasibility or approach, but rather points to data and production processes for various radionuclides in a rather general way. SC&A notes that NIOSH 2006a has no references, making it impossible to verify the statements in it. The document contains general statements about the way Rocky Flats monitored the workplace environment as well as worker exposure:

> *A comprehensive radiological protection program was in place from the start of operations and continued through the history of the plant for the primary purpose of protection of workers, members of the public and the facilities. For internal intake and exposure control this included 1) extensive use of engineered containment/confinement barriers, i.e. glove boxes and transfer lines, work place air flow control, effluent filtration and continuous monitoring, etc. etc., 2) Continuous air monitors (CAM's) for immediate identification of episodic releases as well as long term average retrospective concentration documentation, 3) continuous area air samplers, which extended the historical detection limit of ambient air concentrations to < hundredths of MPC levels, 4) routine and continuing surface contamination surveys, 5) routine and continuing personnel contamination surveys at control boundaries and frequently during work with the materials, 6) personnel protection clothing (which was worn in control area boundaries in which measurable levels of contamination were known to exist and/or in which the potential of release was present) and respiratory protection as necessary, 7) personnel routine bioassay – both in vitro and in vivo – for personnel with the potential of intakes and the need for specific sampling.*
>
> *A number of accidental releases occurred through the years, including a major fire in the 776 complex, all of which resulted in a legacy of residual plant contamination and personnel exposure potential. In support of these conditions and with the primary objective of controlling and minimizing personnel internal and external dose a staff of over a hundred full time field RCTs, the professional radiological engineering, health physics, dosimetry, analytical laboratories, and management staffs were provided. It was a major program and had the responsibility of addressing all radiological hazards. Documentation of this program was extensive, including logbooks, internal and external dose records, bioassay records, etc. Retrieval of this extensive database continues.*

SC&A is unclear as to what the above means in the context of the radionuclides discussed in the paper. The statements in the context of the above list of radionuclides might imply that there was intensive monitoring for each of them. However, since no references are provided, SC&A was unable to verify the claims as they relate to the radionuclides in question. SC&A did check the HIS-20 internal monitoring database in order to assess which radionuclides in the above list had monitoring data.

1. Americium-241

SC&A verified that there are bioassay data for Am-241 beginning in 1963. However, a check of several thousand Am-241 records indicated that monitoring was relatively sparse in 1963 and increased progressively until 1967, when data are far more plentiful than in prior years. Whether this reflects a greater number of workers, or a ramping up of the monitoring program that missed many workers in the first few years of the monitoring program is unclear. SC&A did not do a complete check of the records (there are ~150,000 for Am-241), hence this conclusion is not definitive. However, the results indicate the need for a more detailed look as to whether there are significant gaps in the Am-241 bioassay coverage data in the first few years. It may be possible to complement Am-241 data for the early years with gross alpha data. However, as noted above, the adequacy of that data for such use has not yet been evaluated.

2. Uranium-233

There are uranium bioassay data, including some U-232 data. The contamination of U-233 with Th-228 is discussed above, since NIOSH proposes to use NUREG-1400 to address the issue.

3. Highly Enriched Uranium and Depleted Uranium

The uranium bioassay data are in radioactivity units, allowing for appropriate interpretation of the results. There are also data by uranium isotope.

4. Curium-244

Some bioassay data are available, according to NIOSH 2006a (p. 3). However, none were noticed in the HIS-20 database. NIOSH should provide the bioassay data in order to establish that its conclusions regarding curium-244 are valid. As presented, these conclusions are:

> *Very few workers were involved; the project was short-lived and conducted in high integrity containment facilities. A few bioassay samples were taken to validate and document that the potential exposures are not appreciable. For most of the process, the Cm was present as trace levels in the Pu parts.*

5. Neptunium-237

NIOSH 2006a provides Np-237 inventory data (a few kilograms at most) and states that "[s]mall quantities of Np-237 have been processed at RFP since 1962." This processing was done on a batch basis and there were a variety of processes to which the Np-237 was subjected. NIOSH 2006a states that there were some bioassay samples, but none were found in the HIS-20 database. Since there are no references and no data in the HIS-20 database, SC&A was unable to verify NIOSH's conclusion that "there is no documented evidence that Np constituted a source of recorded exposure…." (p. 4). However, SC&A notes that the absence of documentation does not mean an absence of exposure and suggests that whatever bioassay data might have been collected be retrieved, since Np was processed in a variety of ways at Rocky Flats. The lower specific activity of Np-237 relative to the plutonium-239, mentioned in NIOSH 2006a, is not germane when Np-237 was processed is by itself (rather than co-processed with Pu).

6. Tritium

No urinalysis data point was found in the HIS-20 database for tritium in the production period (i.e., up to and including 1989). The earliest samples date from August 6, 1998, when there were several samples. No bioassay data for the incidents in the production period were found, though NIOSH 2006a implies that there were such incidents:

> *Tritium was present at RFP during brief periods of time as a contaminant and/or component of weapons. Inadvertent releases occurred, which required radiological safety action, including environmental sampling, worker bioassay sample analyses, etc.* (p. 2).

It is unclear how NIOSH proposes to reconstruct tritium doses.

7. Conclusions Regarding Other Radionuclides

Am-241 and the various isotopes of uranium have a large database of bioassay records. However, records for Am-241 in the first few years (1963 to 1966) of monitoring may be sparser than in later years and may need supplementation.

NIOSH has not provided any bioassay or air monitoring data to underpin its claims regarding neptunium-237 and curium-244. The situation with regard to Np-237, in particular, warrants further investigation due to the variety of processes to which it was subjected.

There are no production period bioassay data in the HIS-20 database for tritium. The data gap extends up to August 1998, which is well into the decommissioning period. It is unclear if there are any tritium data or records for incidents, such as those cited by NIOSH (NIOSH 2006a, p.2). NIOSH has not suggested any dose reconstruction method for tritium. Based on the available information, it is unclear to SC&A how NIOSH proposes to reconstruct tritium doses prior to 1998.

ATTACHMENT 22: NIOSH EVALUATION OF SC&A'S THORIUM-232 AND OTHER "EXOTIC" RADIONUCLIDES AT ROCKY FLATS – REVIEW OF NIOSH PAPERS

November 3, 2006

SC&A Comment 1:

This memorandum provides a review of the NIOSH paper *Potential Thorium Intake at RFP* (no date, hereafter NIOSH 2006)), which proposes a method to estimate Th-232 doses as well as doses during the strike removal of Th-228 from U-233 at Rocky Flats.

NIOSH Evaluation 1:

The comment does not accurately reflect the purpose of the referenced NIOSH document. That document did not "propose a method to estimate Th-232 doses as well as doses during the strike removal of Th-228 from U-233 at Rocky Flats". Rather, it detailed a rationale for establishing the maximum credible intake and demonstrating that maximum possible organ doses were trivial.

SC&A Comment 2:

NIOSH had stated during Working Group meetings concerned with the Rocky Flats SEC that there were gross alpha urinalysis data that could be conservatively interpreted to assume the worst-case radionuclide at Rocky Flats (i.e., that delivering the highest dose to the organ in question) when the radionuclide to which an employee was exposed was not known. However, NIOSH did not provide any example that actually connected an individual with a potential for thorium exposure with a gross alpha bioassay sample that could be interpreted in the suggested manner. NIOSH 2006 does not pursue this approach. Rather, it estimates Th-232 and Th-228 intakes by estimating a source term and then using an approach set forth in NUREG-1400

NIOSH Evaluation 2:

NIOSH initially postulated that gross alpha bioassay results could be used to estimate Am^{241} exposures if no Am-specific bioassay was performed (5 April 2006 Comment responses.doc). NIOSH did not suggest using gross alpha bioassay results for estimating Th intakes. As stated in Section 2.0 of the document "Potential Thorium Intake at RFP", fecal bioassay is the method generally used to reconstruct intake values, where worker exposures are in the range of permissible concentrations. NIOSH has not located any data to suggest that routine or special bioassay for thorium was performed at Rocky Flats. NIOSH has recently located an extensive thorium lung count database for thorium workers at Fernald during the operational period of the early 1960s to the late 1990s, which will be used to more accurately bound the thorium intake of workers and provide another means of bounding and more accurately estimating the intake during the early years in which no bioassay data is available beyond air monitoring data at Fernald.

NIOSH is not proposing using NUREG-1400 to estimate Th intakes. Rather, NIOSH uses NUREG-1400 to demonstrate that there were no credible intake scenarios for thorium which could have resulted in organ doses higher than a few mrem at Rocky Flats.

SC&A Comment 3:

NIOSH uses an estimate of 6 kilograms of Th-232 processed per month for 10 months to estimate annual intake. The dates for this work are given as 1956 to 1993. No data on frequency of processing are provided, but NIOSH does provide the following data on Th-232 stocks:

> *Primarily from MBA inventory records, several other documents, and interviews with responsible program managers it is clear that thorium was in the Rocky Flats plant facilities in kg quantities for a period of 19 years with maximum inventory quantities in each year in the range of 1 to 249 kg (4 years at or just over 100 kg, 4 years from 165 to 249 kg and 10 years from 1 to 49 kg).*

These data are not sufficient to definitively determine whether the NIOSH estimate of 6 kilograms per use and 10 times per year is claimant favorable. This is because the source term is a flow (amount processed per year), but the data quote above are stocks. Without information of how much Th-232 was being shipped in and out in various periods, SC&A cannot verify NIOSH's assumption regarding source term.

SC&A has not done a review of the classified Rocky Flats MBA inventory records. Such a review may be needed to ensure that the available thorium production records are complete

NIOSH Evaluation 3:

The reported inventory records indicate the maximum possible process flows. The specific material flow quantities in the detail suggested are classified. The estimates are made to maximize the credible dose potential. We leave it to the Working Group's discretion whether to ask SC&A to review these documents.

SC&A Comment 4:

Caution with regard to thorium production data is warranted. During the Y-12 SEC Working Group meetings, NIOSH initially indicated that thorium production was quite small, but a subsequent investigation by NIOSH showed that large quantities were, in fact, processed there in the SEC period. Thorium-232 production data in the Fernald TBD are incomplete (SC&A TBD, review, forthcoming). Further, according to NIOSH's Fernald Site Profile, many thorium production and other documents for Fernald were lost or destroyed.

NIOSH Evaluation 4:

Caution is also warranted when comparing data from other facilities to Rocky Flats. This would only be appropriate if the types of operations were similar. Fernald was a production facility for a total of 19 years, processing >2000 MT and served as the DOE Th repository until the decommissioning. Y-12 was a Th production facility, processing quantities in the many hundreds of MT. Rocky Flats was neither, *i.e.* there were only special projects and/or R/D efforts. Based on a comprehensive review of materials accountability ledgers, Rocky Flats had a maximum of 249 kg of thorium present in 1961 only. A running inventory showed that for years 1960, 1965, 1966, 1967, 1968, 1969, and 1970 total plant inventory show a range of 103 to 179 kg. For all other years thorium inventory were less than 50 kg and records were kept at the 1 kg quantity. In terms of pure quantities of associated Th materials, Rocky exposure potentials would be a factor of much less than 0.001 compared to Y-12 or Fernald. Rocky Flats utilized materials and parts manufactured at Y-12 in models and weapons mock-ups ([NAME], personal communication, June 26, 2006). No chemistry or production of Th metal occurred at Rocky Flats. On occasion the parts received from Y-12 were lightly trimmed to achieve a good fit in the model. SC&A has presented no evidence or rationale that the Th operations at Fernald or Y-12 can be appropriately applied to Rocky Flats. Without such evidence, we conclude that this comparison is not valid.

SC&A Comment 5:

NUREG-1400 is a modern document (1993); it was not written for the purpose of dose reconstruction.

NIOSH Evaluation 5:

NIOSH recognizes the primary function of NUREG-1400 and is not proposing using it for Th dose reconstruction. NUREG-1400 presents a widely accepted methodology useful for bounding analyses. Thus, NIOSH uses NUREG-1400 to bound the credible intake scenarios for thorium at Rocky Flats. This is judged to be adequately claimant favorable, since the assumptions of NUREG-1400 are extraordinarily conservative for the purpose of establishing the need for an air-monitoring program.

SC&A Comment 6:

For instance, it [NUREG-1400] assumes that "a worker is not likely to have an intake I_p exceeding 10^{-6} of the material being handled…" However, this assumes that "normal precautions are taken."

The workplaces of the Atomic Energy Commission during the 1960s and 1960s frequently did not have what one would have considered as "normal precautions" in the 1990s.

NIOSH Evaluation 6:

The phrase, "normal precautions" is not defined in NUREG-1400, nor does SC&A provide such a definition. At Rocky Flats, the occasional light trimming of pre-formed parts received from Y-12 was conducted in shrouded/hooded machines and was conducted as a "special project" with added attention of health and safety professionals. This would seem to constitute controls and attention above that considered "normal precautions". SC&A has provided no evidence that NUREG-1400 would be inappropriate for the extremely limited Th handling at Rocky Flats.

SC&A Comment 7:

…thorium metal processing at Fernald in the 1950s and 1960s generated dust that were as high as hundreds of times the maximum allowable limit of 70 dpm/m Dust levels ranged from a few times MAC to several hundred times MAC. Peak measurements were thousands of times the maximum allowable concentration. The highest *average* exposure recorded in 1955 was 353 MAC. This would produce a committed dose to the bone surface of more than 5 rem in just five minutes of exposure. The peak level measured at Fernald in that same year was about 3,500 MAC. At this level, the committed dose to the bone surface would be more than 10 rem in just one minute.

High levels of thorium dust were also prevalent in the early period at other sites for which there are data. In sum, from data available for Fernald and other facilities processing thorium in the early nuclear era, it would appear that what would be regarded as "normal precautions" were not the norm at the time.

NIOSH Evaluation 7:

Fernald performed Th production and repository functions. However recorded air activity does not translate directly to intake/deposition, as indicated by an extensive lung count database for Fernald. Also, Rocky Flats was not a Th production facility, rather the Site utilized parts manufactured at Y-12 in models and weapons mock-ups ([NAME], personal communication, June 26, 2006). On occasion, the parts received from Y-12 were lightly trimmed to achieve a good fit in the model. SC&A has presented no evidence or rationale that the Th operations at Fernald can be appropriately applied to Rocky Flats. Without such evidence, we conclude that this comparison is invalid.

SC&A has referenced (W.B. Harris to Merril Eisenbud communication, "Thorium at Fernald," April 17, 1956) from Fernald. The Fernald document contains informal summary information about the dust levels measured during pre-April 1956 thorium operations (the thorium plant was shut down in December of 1955). The processes involved in the thorium plant during this time frame were: a wet purifying step, a derby production, sawing the derbies into 2" squares, welding the squares into long electrodes, and arc melting with consumable electrodes.

During the period of high production rate "several average exposures exceeding 15,000 micrograms per cubic meter" occurred, with the highest average being 50,000 micrograms per cubic meter. "Individual sample results ran up as high as 1/2 gram per cubic meter." To correct this, production rates were dropped, and "most of the exposures were below 200 micrograms per cubic meter, with some as high as 500, but the bad spots which previously had been at 50,000 were now reduced to an average exposure of 10,000." So, based on these Fernald numbers SC&A has alleged, "Peak measurements were thousands of times the maximum allowable concentration. The highest *average* exposure recorded in 1955 was 353 MAC. This would produce a committed dose to the bone surface of more than 5 rem in just five minutes of exposure. The peak level measured at Fernald in that same year was about 3,500 MAC. At this level, the committed dose to the bone surface would be more than 10 rem in just one minute. Footnote: The thorium data for Fernald in this paragraph are from a W.B. Harris to Merril

Eisenbud communication, "Thorium at Fernald," April 17, 1956. An equilibrium mixture of Th-232 and Th-228 has been assumed in the calculations in this section".

SC&A's calculation is seriously in error. It overestimates even the *committed, 50 year dose* by a factor of about 11 (note that NIOSH dose reconstructions use annual organ doses, rather than 50 year committed doses). The highest result: 0.5 grams per cubic meter x Th-232 specific activity of 1.1 E-07 Ci/gram = 5.5 E -08 Ci Th-232 per cubic meter = 55,000 pCi/m^3. Then to convert to Bq/cubic meter: 55000 pci / 27 pci/Bq = 2037 Bq/m^3* 60dpm / Bq = 122,222 dpm/m^3. Then to convert to MAC: 122222 dpm per cubic meter / 70 dpm/cubic meter per MAC = 1746 MAC. Since the Th-232 is in equilibrium with Th-228, we have another 1746 MAC of Th-228; therefore, 1746 * 2 =~ 3500 MAC. To test SC&A's bone surface dose estimate of 10 rem committed from a 1 minute intake of 3500 MAC air (245,000 dpm/cubic meter), assume a light breather 1.2 m^3/hour for 1 minute = 0.02 cubic meters of air inhaled = an intake of 4900 dpm.

Assuming that half of this 4900 dpm intake was Th-232 and the other half was Th-228, we get a bone surface dose (as calculated in IMBA) of 3.81 rem (0.13 rem committed to the bone surface from Th-228, and 3.68 rem* committed to the bone surface from Th-232). However, the bone surface dose calculated in IMBA for Th-232 overestimates the actual bone surface dose by a little more than a factor of 5 (due primarily to the overestimating simplification of where the thorium-232 progeny are deposited). IMBA assumes that the progeny are deposited on the bone surface rather than throughout the bone matrix. So, the 3.81 rem / 5 = 0.736 rem bone surface dose from Th-232.

So SC&A's 1 minute intake = 10 rem to the bone surface is incorrect (for more reasons than those listed here). Correct calculations indicate 1 minute of unprotected exposure to the 3500 maximum allowable concentration yields 0.866 rem *over 50 years*. (0.736 + 0.13 rem). In addition (and very important), even during the early years of operation it was required practice to wear respiratory protection and particularly during episodic periods such as those used as example above. Even a half face respirator properly fitted and breathing through a HEPA filter would provide 99.97% minimum protection factor or 3E-4 factor reduction.

SC&A Comment 8:

NIOSH 2006 states that the levels of thorium production at Rocky Flats were far lower than they were at Y-12; by extension this would also apply to Fernald. However, thorium metal was machined at Rocky Flats to make large parts for nuclear weapon mock-ups. It is possible, therefore, that levels of local dust therefore may have been high. As SC&A has pointed out before, the level of production will affect population exposure (all other things being equal), but cannot be used as a basis for assuming low individual exposure. Individual exposure depends on very localized dust and ventilation conditions, production techniques, industrial hygiene methods, such as the use of hoods, and the layout of equipment and facilities.

NIOSH Evaluation 8:

The comment is inaccurate. NIOSH has not stated that "the levels of thorium production at Rocky Flats were far lower than they were at Y-12". There were no Th production activities *per* *se* at Rocky Flats. Rocky Flats utilized parts manufactured at Y-12 in models and weapons mock-ups ([NAME], personal communication, June 26, 2006). No chemistry or production of Th metal occurred at Rocky Flats. Rather, on occasion, the metal parts received from Y-12 were lightly trimmed to achieve a good fit in the model. Minimal rolling and shearing are reported on small metal parts.

In reference to SC&A's assertion that "the level of production will affect population exposure (all other things being equal), but cannot be used as a basis for assuming low individual exposure", NIOSH notes that NUREG-1400 references [Brodsky, A., Resuspension factors and probabilities of intake of material in process (or "is 10^{-6} a magic number in health physics?", *Health Physics*, 36(6): 992-1000. 1980] as the source of the conclusion that "a worker is not likely to have an intake I_p exceeding 10^{-6} of the material being handled…". In fact, Brodsky 1980 explicitly states, "…the following probabilities (or fractional amounts) may be assumed to usually remain $<10^{-6}$…the fractional amount of radioactivity placed into process in routine operations *that will enter the body of any worker*, averaged over an extended period (e.g. 1 yr)" (emphasis added).

SC&A Comment 9:

…the dust levels during the pilot production phase in 1951 at Bethlehem Steel were much higher than in the large-scale production phase, because the process during the latter phase was much improved relative to the former.

NIOSH Evaluation 9:

Bethlehem Steel was a production steel mill with little "containment" for the process equipment and materials. Rocky Flats use of thorium was primarily in R/D applications with an elevated attention by health and safety and other support staff because of the uniqueness. Relatively small amounts of materials were used, the work performed on the materials were simple and basically performed in and on equipment and facilities designed for containment of other radioactive material, i.e. uranium. It is not clear to NIOSH how the two facilities are in any way comparable.

SC&A Comment 10:

Rocky Flats also operated an incinerator for recovery of fissile materials from 1958 to 1988 (Rocky Flats TBD, Vol. 2, p. 37). It is not clear whether this was used for thorium recovery. Incinerator loading and unloading operations in the early years at Fernald were among the dustiest thorium operations. SC&A's review of the Rocky Flats TBD pointed out that NIOSH had not analyzed incinerator fires and incidents (SCA-TR- TASK1-0008, December 2005, p. 92). While that discussion was in the context of plutonium exposures, it would also need to be raised in the context of exposure to other radionuclides, if the incinerator was used for recovering them.

NIOSH Evaluation 10:

SC&A has presented no evidence that any Th wastes were incinerated at Rocky Flats. In fact, the thorium scrap generated in Rocky Flats' handling of thorium metal were packaged and shipped back to Y-12 ([NAME], personal communication, June 26, 2006). A very limited amount of combustibles was generated and shipped to INL.

SC&A Comment 11:

In the absence of air monitoring data for thorium and thorium bioassay data, there is no way to calibrate the appropriateness of the use of NUREG-1400 for estimating intakes.

NIOSH Evaluation 11:

The meaning of "calibrate the appropriateness of the use of NUREG-1400" is unclear, however, NIOSH is not proposing to use this document to estimate thorium intakes. Rather, NIOSH uses NUREG-1400 to demonstrate that there were no credible intake scenarios for thorium which could have resulted in organ doses of any significance at Rocky Flats. NIOSH is not aware of any requirement for air monitoring or bioassay data for the use of NUREG-1400. It was reported by the responsible professional interviewees that air monitoring was performed on all these operations. The air monitoring did not signal the need for further bioassay. The air monitoring data is not available as clearly identified as associated with the thorium operations, since they were counted for gross alpha activity. In fact, if thorium air monitoring associated with the projects or bioassay existed, the use of NUREG-1400 would not be necessary. NUREG-1400 presents a method of evaluating the need for an air-monitoring program. This use of the document simply is the utilization of an approved method of estimating maximum potential intakes thus justifying monitoring programs. The assumptions and approach is extraordinarily conservative and was used in this context to demonstrate that the reason for the lack of other data or recorded incidents was due to the low potential for intakes.

SC&A Comment 12:

SC&A notes that NIOSH's estimated annual intake of 2.4E-2 Bq of Th-232 is extremely small compared to any historical thorium production data from the 1950s and 1960s or even the 1970s.

NIOSH Evaluation 12:

Rocky Flats is not a thorium production facility. The primary use of the thorium metal parts received from Y-12 was weapons mock-ups, lightly trimmed to achieve a good fit. SC&A has presented no evidence or rationale that the comparison of thorium production data is appropriate.

SC&A Comment 13:

When Th-228 in equilibrium is taken into account, the intake estimated by NIOSH would be 4.8E-2 Bq/year. The data compiled by SC&A in the course of the review of the Fernald TBD (to be published shortly) indicate that a concentration of 1 MAC would be at the lower end of what was experienced in production areas. The intake of Th-232 in equilibrium with Th-228 in a single hour at 1 MAC would be almost 30 times the NIOSH estimate for the entire year.

NIOSH Evaluation 13:

Fernald thorium applications were production and warehousing hundreds of MT of Th compounds and materials. Rocky Flats utilized parts manufactured at Y-12 in models and weapons mock-ups ([NAME], personal communication, June 26, 2006). No chemistry or production of Th metal occurred at Rocky Flats. Rather, the primary work was with parts received from Y-12 were lightly trimmed to achieve a good fit in the model. SC&A has presented no evidence or rationale that the Th operations at Fernald can be appropriately applied to Rocky Flats. Without such evidence, we conclude that this comparison is invalid.

SC&A Comment 14:

SC&A concludes that, even assuming that thorium production operations overall took place over only a few days in the entire year, the disparity between the cleaner documented conditions at other sites and the NIOSH intake estimate would be three orders of magnitude or more. If the conditions at Rocky Flats for thorium production in the 1950s and 1960s were moderately comparable to the dust levels documented for Fernald or Simonds, the disparity would be much bigger. It is important to remember in this context that high puff dust levels for very short periods of time – of a few minutes or less – could produce doses greatly in excess of the NIOSH annual intake estimate. For instance, a puff of 100 MAC would produce an intake of 4.8E-2 Bq of a Th-232/Th-228 mixture in just over one second.

NIOSH Evaluation 14:

There were no thorium production activities at Rocky Flats. There is no reasonable basis for comparison in this context. Fernald thorium applications were production and repository. Simonds Saw and Steel was a steel mill. Rocky Flats utilized parts manufactured at Y-12 in models and weapons mock-ups ([NAME], personal communication, June 26, 2006). No chemistry or production of Th metal occurred at Rocky Flats. Rather, on occasion, the parts received from Y-12 were lightly trimmed to achieve a good fit in the model. SC&A has presented no evidence or rationale that the Th operations at Fernald or the steel production activities at Simonds can be appropriately applied to Rocky Flats. Without such evidence, we conclude that this comparison is invalid.

SC&A Comment 15:

Another way to look at the proposed intake rate is to consider what it implies for mass loading during the working time. Assume that the entire 60 kilograms was processed in a single 8-hour day and that the breathing rate was 1.2 m^3/hour. These assumptions would yield a high estimate of air concentration, corresponding to NIOSH's assumptions. The air concentration of Th-232, expressed in terms of mass, corresponding to the NIOSH intake amounts to only about 0.6μg/m^3. For comparison, 1 MAC, defined as 70 dpm/m^3 in the 1950s and 1960s (mixture of Th-232 and Th-228), amounts to about 140 micrograms/m^3. The NIOSH estimate is almost 500 times smaller, or just over 0.002 MAC. This appears to be an incredible estimate in light of working conditions that have been documented at other sites for thorium processing.

NIOSH Evaluation 15:

Again, Rocky Flats was not a thorium processing facility. SC&A has presented no evidence that data from such facilities can appropriately be applied to Rocky Flats.

SC&A Comment 16:

In another comparison, the U.S. standard for PM_{10} (24 hour average) is 150 µg/m. The Th-232 levels at Rocky Flats would be almost 250 times cleaner than the current EPA PM_{10} standard. As another point of reference, urban background air in European cities measures at 12 to 89 $\mu g/m^3$, annual average. Indeed, 0.6$\mu g/m^3$ is much cleaner than a national park. For instance, the PM_{10} level between 1993 and 1995 in Great Basin National Park was 6.5µg/m.

If the intake of 2.4E-2 Bq, or about 6 micrograms, of Th-232 is assumed to occur over a longer time, for instance, a week's equivalent of work, then the above comparisons would be even more stark.

NIOSH Evaluation 16:

SC&A appears to be asserting that all airborne particulate loading at Rocky Flats is due to thorium processing. This doesn't make intuitive sense. It is unclear to NIOSH how indoor airborne concentrations of radioactive material generated by light trimming inside a shrouded hood can be compared to ambient dust loading in outside air in a national park in Nevada or in urban air in unnamed European cities. We would be interested in hearing SC&A's rationale for why such comparisons are appropriate.

SC&A Comment 17:

In view of the above, the use of NUREG-1400 would have to be supported by considerable data from the site showing the conditions at Rocky Flats during thorium processing, especially metal working. As it stands, the NIOSH analysis is not supported by such data. However, if such data were available, it would render the use of NUREG-1400 moot, since on-site air concentrations could be directly used to estimate Th-232 intakes.

NIOSH Evaluation 17:

The Comment seems to provide two contradictory conclusions. It is correctly noted that the existence of thorium air monitoring data or bioassay could render the use of NUREG-1400 unnecessary. NIOSH concurs. However, SC&A's basis for predicating the use of NUREG-1400 on the existence of such data is not clear. NIOSH finds no such requirements in NUREG-1400 itself. In a functioning and comprehensive radiation safety program, nothing detected is a "good thing" and did not signal the need for reports and explanations other than for engineering reports related to the success of the project.

SC&A Comment 18:

NUREG-1400 uses several factors to obtain an estimate intake for the purpose of determining whether air monitoring is needed in the workplace. As discussed above, the most basic factor is described as a

> *rule of thumb that, when normal precautions are taken, a worker is not likely to have an intake I_p exceeding 10^{-6} of the material being handled….*

The Brodsky fraction of 10^{-6} in workplace situations was estimated for volatile radionuclides like iodine-131 or tritium as HTO. According to Stephen McGuire of the NRC:

> *For worker dose inside buildings, Brodsky also found 10^{-6} to be a valid fraction. However, the measurements supporting the conclusion were based on iodine, which is very volatile. He provided no data on non-volatile materials. NUREG-1400 expanded the Brodsky proposal to non-volatiles. Considering that there are similarities in the mechanisms of how materials are suspended and become airborne in both accidents and in workplace activities, it is reasonable that the airborne fractions should not be totally dissimilar. This was supported by some other data including a thesis by Scott Pennington at Georgetown Univeristy [sic], who looked at uranium processing and found that a fraction of 10^{-9} provided a good fit with the data (10^{-6} x 0.001).*

SC&A has not reviewed Pennington's thesis, but suggests that such a review by NIOSH might be useful, should NIOSH wish to continue to pursue the use of NUREG-1400 for Rocky Flats thorium-232 dose reconstruction. Specifically, the dust conditions at the facilities studied by Pennington should be compared to those historically prevailing in thorium production in the AEC complex and at AWEs. Further, a study of dust levels versus throughput at multi-kilogram levels of machining thorium metal would also be very useful.

NIOSH Evaluation 18:

Both NUREG-1400 and Brodsky 1980 propose an intake fraction of 10^{-6} as a screening value to ensure conservatism. NIOSH has also not reviewed Pennington's thesis, however NIOSH notes that this document, as quoted by SC&A, appears to observe a value three orders of magnitude lower. If this is accurate, it supports the use of 10^{-6} as a screening value, and reinforces the conservatism of NIOSH's analysis.

NUREG-1400 is a widely accepted standard which has been extensively peer reviewed and used as a reliable reference. NIOSH is not prepared to commit to re-reviewing peer reviewed guidance documents promulgated by other agencies or expert bodies. We are also not convinced that reviewing a thesis that we neither cited nor used in our analysis is a wise use of resources. SC&A proposes that NIOSH compare the dust conditions at the facilities studied by Pennington to those historically prevailing in thorium production in the AEC complex and at AWEs, however NIOSH must again note that Rocky Flats was not a thorium production facility. Therefore, the suggested comparison would not be meaningful.

SC&A Comment 19:

SC&A notes that a 10^{-6} intake fraction for volatile materials, sometimes called a "Magic Number" (as applied by Brodsky), used inside buildings, cannot be considered as anything more than a "rule of thumb" for an annual average, even for industrial hygiene purposes in modern facilities. As noted above, intense short-term puff releases under circumstances that have prevailed at other AEC and AWE facilities could easily create situations where intake in a short period of time greatly exceeds that estimated by an annual average rule of thumb. Hence, for work that was episodic, annual average considerations do not appear to be appropriate unless their use can be demonstrated to be claimant favorable by comparison with air concentration data from similar conditions and processes.

NIOSH Evaluation 19:

NIOSH does not agree with SC&A's assertion that a value of 10^{-6} for an intake fraction "cannot be considered as anything more than a "rule of thumb" for an annual average, even for industrial hygiene purposes in modern facilities" and is somehow inappropriate for use in AEC, DOE, or AWE facilities. In fact, NUREG-1400 states,

> *…**based on observations and experience with a wide range of facilities, equipment, and processes**, Brodsky has concluded that the fractional amount of radioactive material inhaled by a worker is generally less than one millionth (10^{-6}) of the amount of radioactive material processed (Brodsky 1980)*. (Emphasis added.)

NUREG-1400 is a widely accepted standard which has been extensively peer reviewed and used as a reliable reference. SC&A has presented no evidence that the use of an intake fraction of 10^{-6}, as specified in NUREG-1400, is inappropriate for the minimal thorium handling operations at Rocky Flats. Again, the use of NUREG-1400 is not intended to provide quantitative intake estimates for use in dose reconstruction. It represents an upper limit "bounding" of intake potential, using widely recognized factors for assuring very conservative estimates. NUREG-1400 stipulates that the factors apply to dispersible materials. Even uranium fuel pellets are relatively small in relationship to a 6 kg thorium part, the surface area to volume of which does not compare with fuel pellets.

SC&A Comment 20:

Because the Brodsky paper suggested 10^{-6} for volatile radionuclides, NUREG-1400 suggests a further reduction of intake by a factor of one thousand for solids that are subjected to processing and yet another reduction by a factor of ten for good ventilation. It also suggests multiplying the intake by ten for if cutting and grinding operations are involved.

NIOSH Evaluation 20:

SC&A's characterization of Brodsky 1980 is inaccurate. While Brodsky did observe an intake fraction of 10^{-6} for HTO, that document also states, "Since many tritiated compounds, in particular HTO, have been considered to be more susceptible to volatility or release of radioactive material, it would also appear safe to use 10^{-6} as a reasonably conservative generic estimate of the maximum fractional amount of plant throughput that gets into one employee via inhalation". Brodsky's practical field observations did not limit the application of an input fraction value of 10^{-6}, as SC&A suggests. On the contrary, that study concluded that since HTO is at the upper limit of volatility of radioactive compounds, it should provide a bounding estimate value likely to exceed that observed for other radioactive compounds.

SC&A Comment 21:

NIOSH has provided no data to show that the specific workplaces that were used to machine Th-232 were well ventilated; hence it is unclear if a reduction of intake by a factor of ten due to this factor is justified.

NIOSH Evaluation 21:

The light trimming of Th parts was performed using the same equipment used for EU (i.e. shrouded/hooded machines) in Building 81 ([NAME], personal communication, June 26, 2006). These hoods were ventilated and provided the confinement characteristic of laboratory hoods.

SC&A Comment 22:

NUREG-1400 does not provide any example of metal working operations in its estimates of intake. The reduction of intake by a factor of 1,000 is illustrated with the use of sintered uranium fuel pellets and the dispersion factor 10 is suggested for the same process. Grinding sintered uranium fuel pellets, which are ceramics, can be expected to have considerably different characteristics than machining actinide metals. Fume generation would not be expected in the former, but could occur in the latter, especially in the absence of the use of cooling fluids on the piece being machined. Hence, if factors such as those suggested for the processing of solids are to be used in estimating intakes for the purpose of dose reconstruction, an actual comparison of the processes and materials is necessary. NIOSH has provided no analysis showing that a comparable situation existed between the examples provided in NUREG-1400 and thorium metal processing at Rocky Flats. Such an analysis is would appear to be required by 42 CFR 82, according to which the benefit of the doubt should be given to the claimant in the presence of uncertainty.

NIOSH Evaluation 22:

NUREG-1400 does indeed provide an example of sintered fuel pellets. However, Table 1.1 of NUREG-1400 lists a release fraction of 0.001 for "Solids, e.g. uranium fuel pellets, *cobalt, or iridium metal*" (emphasis added). The application of the release fraction is based on the physical form of the material. Both uranium fuel pellets and thorium metal are solids. NUREG-1400 does not limit its application only to ceramics. SC&A speculates that cooling fluid was not used in the Th handling activities at Rocky Flats, which could lead to fume generation, however no evidence is provided that cooling fluid was not used. This would not be consistent with basic metal handling procedures. Furthermore, NUREG-1400 does not advise against its application if there is the possibility of fume generation. Presumably, the same potential for fume generation would exist for operations involving cobalt or iridium metal, which is explicitly listed in NUREG-1400.

Again, NIOSH must point out that we are not proposing to "estimate (sic) intakes for the purpose of dose reconstruction." Rather, NIOSH uses NUREG-1400 to demonstrate that there were no credible intake scenarios for thorium that could have resulted in organ doses of any significance at Rocky Flats.

SC&A Comment 23:

NIOSH reduced the source term by a factor of ten above and beyond that used in NUREG-1400 in its example of uranium fuel pellet grinding. NIOSH assumes that total metal processed into parts as 60 kilograms per year (p. 4). But instead of using this as the source term, NIOSH reduced it by a factor of ten:

> *It is further estimated that the unsealed or loose contaminants from large metal parts is 10% or less. (p. 4)*

NIOSH states that "waste" form thorium machining was less than 10% (NIOSH 2006, p. 2), but does not provide any reference for this assertion. Using this reasoning, instead of taking the annual amount processed as 60 kilograms in the NUREG-1400 equation, NIOSH reduced the amount processed to 6 kilograms per year. NIOSH then applied all the other factors discussed above, which together amount to a factor of 10^{-9}. In effect, NIOSH is actually using a factor of 10^{-10} on the actual amount processed to estimate the intake. This appears contrary to the way NUREG-1400 treats the example of fuel pellet grinding.

Uranium fuel pellets are also massive objects from the dust point of view, in that they are not loose contaminants. They are unsealed; so was the thorium metal that was being machined. Only a small fraction of the fuel pellet would become loose material as a result of grinding and a part of that would become airborne. NUREG-1400 applies the factor of 0.001 to the total weight of uranium fuel pellets processed annually. It does not use an additional factor of ten to reduce the source term and it does not argue that the source term should be reduce because only a part of the fuel pellet becomes loose material. While the analogy with thorium metal, as noted above, is not readily applicable without further analysis to the fraction by which 10^{-6} should be reduced, it is sufficiently applicable in terms of the similarity of being massive relative to "loose" material. NIOSH appears to have misapplied NUREG-1400 to reduce the source term by a factor of ten.

NIOSH Evaluation 23:

It is intuitively obvious that the amount of unencapsulated material available to become airborne is dependent on the area of the surfaces being cut or ground. It was our conservative, professional judgment and verified by interviews that <10% of the total mass of the pre-formed Th metal part would be available as waste with the potential to become airborne. It should be obvious that starting with a mass of 60 kg and lightly trimming a pre-formed part (with a relatively low surface area to mass ratio) would have the potential to generate far less airborne contamination than starting with the same 60 kg and machining it into small fuel pellets (with relatively high surface area to mass ratio) and then tumbling the pellets in the refining process. In actuality, this estimate of the unencapsulated fraction is probably unrealistic – it would probably be far lower. There is some support for this assumption in our interview with ([NAME], personal communication, June 26, 2006), in which it is stated that gram quantities of waste were packaged and shipped back to Oak Ridge or Nevada. Considering that the starting mass was kg quantities, and the waste mass was gram quantities, a more realistic unencapsulated fraction would be on the order of 0.001. However to ensure conservatism, a value of only 0.1 was used.

SC&A Comment 24:

NIOSH 2006 makes the following statement regarding Rocky Flats thorium data:

> *Unlike uranium, little of the thorium inhaled or ingested is excreted in urine. Therefore, fecal bioassay is the method generally used where worker exposures are in the range of permissible concentrations. Though there is recorded information related to the development of thorium urinalyses and several urine results in the 1960 time period, there are no data available to indicate that thorium isotopes were part of the routine bioassay program. There are no data to suggest that fecal bioassay was used routinely at the RFP to assess radionuclide intakes. Lung counting was used at other DOE sites for thorium lung deposition determination, although Rocky lung counting in the energy ranges of interest was for Th-234 a daughter of U-238, used for uranium deposition analysis.*

This implies that there are some records for both thorium urinalysis and thorium fecal analysis. Granting that fecal data may not have been used to evaluate thorium intakes at Rocky Flats, such data may still provide some indication whether the orders of magnitude of intake estimated by NIOSH using NUREG-1400 are in the right ballpark. Further, if there are any urinalysis results that are above the detection limit of the time, this would be very significant for the very reason that "*little of the thorium inhaled or ingested is excreted in urine*." Hence, SC&A recommends that NIOSH should analyze all of the available thorium bioassay data in the context of its analysis using NUREG-1400.

NIOSH Evaluation 24:

NIOSH is aware of one employee who gave a limited number of urine sample in the 1950s and 1960s. It was determined that this employee had previously worked at a mill, where he may have picked up a Th burden. This employee was not involved in handling Th at Rocky Flats. It is also mentioned (Hammond, S.E. August monthly progress report - Industrial Hygiene and Bioassay, September 9, 1966) that there were two thorium urinalysis samples collected in August, 1966, with results that were reported as "Below significant level". These results are shown in the Special Analysis logbook, which has been provided to SC&A on the O-drive.

SC&A Comment 25:

NIOSH has not provided an analysis that would enable a determination of the applicability and claimant favorability of the use of NUREG-1400 for Rocky Flats workers. Historical data from other sites, especially regarding short-term concentrations of thorium in workplace air, suggest that the NIOSH estimate of Th-232 intake of 2.4E-2 Bq per year could be orders of magnitude too low, though this cannot be firmly established in absence of any data from Rocky Flats itself. Some Rocky Flats thorium-232 air concentration data appear to be necessary to establish the validity of the NIOSH approach.

NIOSH Evaluation 25:

As discussed in evaluations of previous comments, SC&A has presented no compelling rationale for concluding that the NUREG-1400 approach is somehow inappropriate for use at Rocky Flats. The purpose of NUREG-1400 is to determine whether air sampling is required in facilities that handle radioactive materials, and if so to provide guidance on how such sampling should be conducted. Rocky Flats is a facility that handled radioactive materials – exactly the type of facility NUREG-1400 covers. SC&A's comparisons of the minimal handling of a few kg of pre-formed Th metal parts at Rocky Flats to the production of tons of Th metal at Y-12, and the storage of warehouses full of Th compounds at Fernald are invalid. As noted in previous comments, if Th air data from Rocky Flats existed, there would be no need to use the NUREG-1400 approach, so SC&A's insistence that such data are required to apply NUREG-1400 are both illogical and not supported by NUREG-1400 itself.

SC&A Comment 26:

In the alternative, it is possible that some of the bioassay data might provide a useful indicator as to whether the analysis is correct to within a few orders of magnitude. NIOSH's paper, "Potential Thorium Intake at RFP" does not provide any such data. NIOSH should use all available bioassay data (fecal and urine) to attempt to validate its approach.

NIOSH Evaluation 26:

The only Th data from Rocky Flats NIOSH is aware of related to one individual not involved in Th handling activities at Rocky Flats. This individual was eventually determined to have worked at a mill prior to his employment at Rocky Flats, which was the likely source of any burden he may have incurred. The data SC&A is requesting does not exist, to the best of our knowledge, with the exception of two Th samples listed in the Special Analysis Logbook.

SC&A Comment 27:

A check of the HIS-20 database shows that there is a considerable gross alpha bioassay database for Rocky Flats. It is unclear why this database has not been used to estimate intakes, as proposed earlier, since 42 CFR 82 favors the use of personal monitoring data over all others in dose reconstruction. An explanation of why this source of data is not being used would be helpful. SC&A notes that the completeness or adequacy of the gross alpha data for such purposes has not yet been evaluated.

NIOSH Evaluation 27:

There is indeed a considerable body of gross alpha bioassay results. However, NIOSH never proposed to use these results to estimate Th intakes. We did briefly consider this approach for Am, before it was discovered that there was minimal exposure potential for Am prior to about 1963, when Rocky Flats began widespread use of Am-specific bioassay. As stated in Section 2.0 of the document "Potential Thorium Intake at RFP", fecal bioassay is the method generally used where worker exposures are in the range of permissible concentrations. NIOSH has not located any data to suggest that routine or special bioassay for thorium was performed at Rocky Flats. This is consistent with the lack of a credible intake scenario for Th at Rocky Flats.

SC&A Comment 28:

Comments similar to those above would apply to application of NUREG-1400 to the Th-228 strike section of NIOSH 2006. SC&A notes that the source term of 10 curies for Th-228 is low by about a factor of 2.2 if Th-228 is assumed to be in equilibrium with U-232, under the assumptions in the paper (20 kg. U-233, with 50 ppm U-232).

NIOSH Evaluation 28:

We have responded to SC&A's comments above and have similar confidence in the utility of NUREG-1400 in demonstrating the lack of a credible intake scenario for the Th strike operations. At 50 ppm U-232 there would be approximately 1 g of U-232 in 20 kg of U-233. Specific activity of U-232 (72 yr $t_{1/2}$) is 21 Ci/g or approximately 20 Ci. Assuming equilibrium of Th-228 with U-232, there would be 20 Ci of Th-228. This is a conservative estimation, since Th-228 would build in with a 1.9 yr $t_{1/2}$ and probably not be in full equilibrium since the last strike. The 10 Ci was used to illustrate that at 2 years post initial uranium preparation there would still be 10 Ci of Th-228 plus daughters – providing the driving need for periodic strikes to remove the thorium.

SC&A Comment 29:

NIOSH is required to be equitable and consistent across sites in its approach to dose reconstruction. A comparable situation for thorium-232, though at higher production levels, existed at Y-12, in that there were essentially no bioassay or air monitoring data for thorium-232 workers. NIOSH proposed an SEC for those workers (1948-1957 period) and the Advisory Board accepted NIOSH's recommendation. That SEC has now been granted.

The use of NUREG-1400 at Rocky Flats would raise the question of why an SEC was granted to Y-12, when NUREG-1400 could just as well have been applied there. Note that the quantity of production is not a restraint on the applicability of NUREG-1400. The example in NUREG-1400 discussed above was for a production of 100,000 kilograms of fuel pellet at a grinding station. Hence, the scale of production at Y-12 would not have been an issue in the use of NUREG-1400 for Y-12.

NIOSH Evaluation 29:

SC&A's assertion that a comparable situation for Th^{232} existed between Y-12 and Rocky Flats is not accurate. Y-12 was a Th production facility. Rocky Flats utilized parts manufactured at Y-12 in models and weapons mock-ups ([NAME], personal communication, June 26, 2006). No chemistry or production of Th metal occurred at Rocky Flats. Rather, on occasion, the parts received from Y-12 were lightly trimmed to achieve a good fit in the model. SC&A has presented no evidence or rationale that the Th operations at Y-12 can be appropriately applied to Rocky Flats. Without such evidence, we conclude that this comparison is invalid. There were no credible intake scenarios for thorium which could have resulted in organ doses of any significance at Rocky Flats.

SC&A Comment 30:

NIOSH's appeal to the smaller scale of production at Rocky Flats relative to Y-12 in using NUREG-1400 at Rocky Flats requires a quantitative demonstration that that smaller scale of production resulted in air concentrations that were orders of magnitude lower than those at other facilities.

NIOSH Evaluation 30:

NUREG-1400 was applied to the Y-12 situation for the laboratory settings. NIOSH is not appealing to the smaller scale of the operations at Rocky Flats as a reason why it is applicable at Rocky and not at Y-12. There is a fundamental difference between the occasional light trimming of pre-formed Th metal parts that occurred at Rocky Flats and the production of tons of thorium at Y-12. However, the quantities, the form of the materials, and the required handling/manipulation were so different that comparisons between the Th activites that occurred at the two facilities cannot be directly made.

SC&A Comment 31:

Further, as noted above, machining of pieces of thorium metal weighing several kilograms each should not be assumed to create lower dust levels than larger annual throughputs. This may apply to population exposure (all other things being equal) but would not to individual exposure.

NIOSH Evaluation 31:

This comment appears to be a restatement of the objection raised by SC&A in comment 7. As noted in our evaluation of that comment, SC&A's calculation is in error. It overestimates even the *committed, 50-year dose* by a factor of about 11 (note that NIOSH dose reconstructions use annual organ doses, rather than 50 year committed doses). It is intuitively obvious that higher throughput operations will create higher integrated (over time) intake potentials, all other things being equal. This same logic does not apply to peak instantaneous concentrations, and NIOSH is not asserting this. NUREG-1400 references Brodsky 1980 as the source of the release fraction discussion. Brodsky 1980 explicitly states, "…the following probabilities (or fractional amounts) may be assumed to usually remain $<10^{-6}$…the fractional amount of radioactivity placed into process in routine operations *that will enter the body of any worker*, averaged over an extended period (e.g. 1 yr)" (emphasis added).

SC&A Comment 32:

Further, as noted above, NIOSH would still have to demonstrate that NUREG-1400 provides the appropriate tools for that job and that its intake estimates are credible and comparable to other facilities processing thorium under similar conditions.

NIOSH Evaluation 32:

SC&A has presented no compelling rationale for concluding that the NUREG-1400 approach is somehow inappropriate for use at Rocky Flats. The purpose of NUREG-1400 is to determine whether air sampling is required in facilities that handle radioactive materials, and if so to provide guidance on how such sampling should be conducted. Rocky Flats is a facility that handled radioactive materials – exactly the type of facility NUREG-1400 covers. SC&A's comparisons of the minimal handling of a few kg of pre-formed Th metal parts at Rocky Flats to the production of tons of Th metal at Y-12, and the storage of warehouses full of powdered Th compounds at Fernald are invalid.

SC&A Comment 33:

SC&A verified that there are bioassay data for Am-241 beginning in 1963. However, a check of several thousand Am-241 records indicated that monitoring was relatively sparse in 1963 and increased progressively until 1967, when data are far more plentiful than in prior years. Whether this reflects a greater number of workers, or a ramping up of the monitoring program that missed many workers in the first few years of the monitoring program is unclear. SC&A did not do a complete check of the records (there are ~150,000 for Am-241), hence this conclusion is not definitive. However, the results indicate the need for a more detailed look as to whether there are significant gaps in the Am-241 bioassay coverage data in the first few years. It may be possible to complement Am-241 data for the early years with gross alpha data. However, as noted above, the adequacy of that data for such use has not yet been evaluated.

NIOSH Evaluation 33:

Presumably, SC&A is referring to the number of Am bioassay results in HIS20. By our count, there are 475 Am bioassay results in 1963, 1299 results in 1964, 1227 results in 1965, 1406 in 1966, and 2939 results in 1967. This is consistent with Rocky Flats beginning to handle Pu (with ingrown Am) from weapons returned from the field beginning in 1963. SC&A has presented no evidence that there are gaps in Am monitoring, nor is NIOSH aware of any gaps.

SC&A Comment 34:

There are uranium bioassay data, including some U-232 data. The contamination of U-233 with Th-228 is discussed above, since NIOSH proposes to use NUREG-1400 to address the issue.

NIOSH Evaluation 34:

NIOSH has responded to the comments on the Th strikes above.

SC&A Comment 35:

The uranium bioassay data are in radioactivity units, allowing for appropriate interpretation of the results. There are also data by uranium isotope.

NIOSH Evaluation 35:

NIOSH concurs with this comment.

SC&A Comment 36:

Some bioassay data are available, according to NIOSH 2006a (p. 3). However, none were noticed in the HIS-20 database. NIOSH should provide the bioassay data in order to establish that its conclusions regarding curium-244 are valid. As presented, these conclusions are:

> *Very few workers were involved; the project was short-lived and conducted in high integrity containment facilities. A few bioassay samples were taken to validate and document that the potential exposures are not appreciable. For most of the process, the Cm was present as trace levels in the Pu parts.*

NIOSH Evaluation 36:

NIOSH concurs that there are no bioassay data in the HIS-20 database for Cm. HIS20 contains bioassay results for plutonium, uranium, americium – the primary radionuclides of concern at Rocky Flats, and for gross alpha. There are nine Cm bioassays noted in the monthly progress reports from the IH and Bioassay group (Hammond, S.E. October monthly progress report - Industrial Hygiene and Bioassay, November 9, 1966, and Hammond, S.E. November monthly progress report - Industrial Hygiene and Bioassay, December 8, 1966). These results are confirmed in the Special Analysis Logbook which has been provided to SC&A and the Working Group on the O drive, and which gives results for nine Cm bioassays from nine individuals (one sample each). None of these individuals are NIOSH claimants. This small sample population further supports NIOSH's previous statement that very few workers were involved and the project was short-lived. In fact, in our interview with [INTERVIEWEE], who was directly involved in the Cm operations, [INTERVIEWEE] stated that only he and one other person were directly involved in converting the Cm to a metal. There were undoubtedly have been a very limited number of other support personnel (HPs, etc.), and this is entirely consistent with the population of bioassay samples mentioned in the progress reports, and recorded in the Special Analysis logbooks.

SC&A Comment 37:

NIOSH 2006a provides Np-237 inventory data (a few kilograms at most) and states that "[s]mall quantities of Np-237 have been processed at RFP since 1962." This processing was done on a batch basis and there was a variety of processes to which the Np-237 was subjected. NIOSH 2006a states that there were some bioassay samples, but none were found in the HIS-20 database. Since there are no references and no data in the HIS-20 database, SC&A was unable to verify NIOSH's conclusion that "there is no documented evidence that Np constituted a source of recorded exposure…." (p. 4). However, SC&A notes that the absence of documentation does not mean an absence of exposure and suggests that whatever bioassay data might have been collected be retrieved, since Np was processed in a variety of ways at Rocky Flats. The lower specific activity of Np-237 relative to the plutonium-239, mentioned in NIOSH 2006a, is not germane when Np-237 was processed is by itself (rather than co-processed with Pu).

NIOSH Evaluation 37:

NIOSH concurs that there are no bioassay data in the HIS-20 database for Np. HIS20 contains bioassay results for plutonium, uranium, americium – the primary radionuclides of concern at Rocky Flats, and for gross alpha. References have been added to the subject NIOSH evaluation of the potential for intakes of Np at Rocky Flats in response to this comment. The lower specific activity of Np^{237} compared to Pu is germane because the primary use of Np at Rocky Flats was as a tracer blended into Pu to support a few specific weapons tests at the Nevada Test Site.

SC&A Comment 38:

No urinalysis data point was found in the HIS-20 database for tritium in the production period (i.e., up to and including 1989). The earliest samples date from August 6, 1998, when there were several samples. No bioassay data for the incidents in the production period were found, though NIOSH 2006a implies that there were such incidents:

> *Tritium was present at RFP during brief periods of time as a contaminant and/or component of weapons. Inadvertent releases occurred, which required radiological safety action, including environmental sampling, worker bioassay sample analyses, etc.* (p. 2).

It is unclear how NIOSH proposes to reconstruct tritium doses.

NIOSH Evaluation 38:

NIOSH concurs that there are no production period bioassay data in the HIS-20 database for tritium. HIS20 contains bioassay results for plutonium, uranium, americium – the primary radionuclides of concern at Rocky Flats, and for gross alpha. Tritium bioassay results are included in the individual claimants' radiation files, and these results are used to reconstruct tritium doses, as appropriate.

SC&A Comment 39:

Am-241 and the various isotopes of uranium have a large database of bioassay records. However, records for Am-241 in the first few years (1963 to 1966) of monitoring may be sparser than in later years and may need supplementation.

NIOSH Evaluation 39:

Presumably, SC&A is referring to the Am bioassay results in HIS20. For the years SC&A references above, there are 475 results for 1963, 1299 results for 1964, 11227 results for 1965, and 1406 results for 1966. This is consistent with Rocky Flats beginning to receive Pu (with ingrown Am) from weapons returned from the field beginning in 1963. SC&A has presented no evidence that there are any gaps in Am monitoring, nor is NIOSH aware of any gaps.

SC&A Comment 40:

NIOSH has not provided any bioassay or air monitoring data to underpin its claims regarding neptunium-237 and curium-244. The situation with regard to Np-237, in particular, warrants further investigation due to the variety of processes to which it was subjected.

NIOSH Evaluation 40:

The comment is incorrect. The limited number of bioassay results available for Np and Cm have been provided to SC&A and the Working Group in the Special Analysis Logbook on the O drive. The low results support NIOSH's evaluation that there is no credible intake potential for these radionuclides at Rocky Flats. The low numbers of results for these radionuclides supports NIOSH's assertion that there were very few people involved in these operations.

SC&A Comment 41:

There are no production period bioassay data in the HIS-20 database for tritium. The data gap extends up to August 1998, which is well into the decommissioning period. It is unclear if there are any tritium data or records for incidents, such as those cited by NIOSH (NIOSH 2006a, p.2). NIOSH has not suggested any dose reconstruction method for tritium. Based on the available information, it is unclear to SC&A how NIOSH proposes to reconstruct tritium doses prior to 1998.

NIOSH Evaluation 41:

NIOSH concurs that there are no production period bioassay data in the HIS-20 database for tritium. HIS20 contains bioassay results for plutonium, uranium, americium – the primary radionuclides of concern at Rocky Flats, and for gross alpha. Tritium bioassay results are included in the individual claimants' radiation files, and these results will be used to reconstruct tritium doses, as appropriate.

ATTACHMENT 23: NIOSH EVALUATION OF SC&A'S DRAFT REPORT ON OTHER RADIONUCLIDES (THORIUM)

February 28, 2007

BACKGROUND

On December 26, 2006, NIOSH issued a report on applications involving thorium at Rocky Flats. SC&A issued a draft evaluation of NIOSH's report on January 11, 2007. SC&A's evaluation covered other radionuclides, including Am^{241}, U^{233}, Cm^{244}, Np^{237}, and H^3, which were dealt with in previous exchanges between NIOSH and SC&A, however only in the case of thorium have NIOSH and SC&A so far been unable to reach consensus. It is NIOSH's understanding that there is agreement that the other listed radionuclides do not present SEC issues at Rocky Flats.

In its January 11, 2007, report, SC&A expressed numerous concerns regarding with NIOSH's evaluation of thorium use at Rocky Flats. This current document is another attempt to address SC&A's concerns in the hope that NIOSH and SC&A can reach concurrence on this issue.

This report contains several sections:

(1) NIOSH's point-by-point response to concerns expressed in SC&A's January 11, 2007, report.

(2) Interviews on thorium machining/trimming at Rocky Flats

(3) Interviews on use of magnesium-thorium alloy at Rocky Flats

(4) NUREG 1400 validation

(5) Revised calculations of bounding organ doses for applications involving preformed thorium parts at Rocky Flats

(6) Estimated dose during welding and grinding with thoriated-tungsten electrodes

CONCLUSIONS

The primary concerns expressed by SC&A, which were repeated over many comments in their January 11, 2007, report, were as follows:

(1) SC&A stated that NUREG-1400 has not been demonstrated to be a valid approach for bounding thorium doses at Rocky Flats. NIOSH disagrees, and has presented examples in this document that demonstrate that NUREG-1400 does indeed produce bounding estimates.

(2) SC&A stated that new information is continually emerging which demonstrates that thorium operations were far more significant than previously represented. NIOSH disagrees. The amount of thorium handled at Rocky Flats has been captured in NIOSH's previous source term calculations based on Materials Balance and Inventory ledgers. Additional levels of detail have been presented in response to SC&A's and the working group's concerns, however this new information supports NIOSH's original conclusion that there is no evidence of significant thorium intakes at Rocky Flats.

(3) SC&A stated that two new source terms (ingots from W.R. Grace, and magnesium-thorium alloy from Dow Madison) have been recently discovered. NIOSH disagrees. The ingots from W.R. Grace are reflected in the Materials Balance and Inventory ledgers that were the basis for NIOSH's previous source term estimates. The weight of the evidence does not suggest that magnesium-thorium alloy was received at Rocky Flats from Dow Madison, and the working group declined to request followup on this issue at its January 26, 2007, meeting. It is NIOSH's understanding that barring new evidence, the magnesium-thorium alloy issue is closed.

(4) SC&A has stated that documents related to thorium may have been destroyed at Rocky Flats, therefore the thorium source term may be incompletely defined. NIOSH notes that no evidence of such destruction has been presented by SC&A or discovered by NIOSH. NIOSH stands by our source term estimates based on the Materials Balance and Inventory ledgers.

SECTION 1: EVALUATION OF SC&A COMMENTS

SC&A Comment 1:

It should be noted that a significant amount of work done by NIOSH on issues relating to other radionuclides was based on review of classified documents. SC&A pointed this out to the working group. SC&A did not undertake any classified reviews as none were authorized by the Board. This is noted, when relevant, in the following discussion for clarity and as a statement of fact, where there is a material review issue involved.

NIOSH Evaluation 1:

As stated in NIOSH's December 27, 2006, report:

> *The bases for these conclusions are detailed in the body of the report, and consist of unclassified reports, an unclassified extract of a classified report, material balance account ledgers, monthly progress reports from the Chemistry Lab & Personnel Meters, Site Survey, and Chemistry Research and Development groups, health physics field logbooks, and interviews with former Rocky Flats and Dow Madison workers.*

The only classified documentation used by NIOSH in the evaluation of the thorium issue was the Materials Balance and Inventory ledgers containing information about thorium. These ledgers have now been redacted and are available at:

> *O:\Document Review\AB Document Review\Rocky Flats\NIOSH responses to SCA draft reports\Other radionuclides*

Therefore, all of the information NIOSH has relied on in its evaluation of the thorium issue is now available in an unclassified format.

SC&A Comment 2:

In its October 2006 paper on the subject (Attachment 19), NIOSH provided data on thorium-232-related work at Rocky Flats. The main source term for potential thorium air contamination was stated as "Fabrication of metal weapons parts from natural Th and Th alloys – machining, shearing, grinding" (Table 1, p. 1). NIOSH has stated that the parts from Oak Ridge were "trimmed and lightly machine" at Rocky Flats (Attachment 19, p. 2). The maximum amount of thorium-232 in such metal parts was estimated at 60 kilograms per year, with a potential for "unsealed or loose contaminants from large metal parts is 10% or less," (p. 4), yielding a source term of at most 6 kilograms per year. NIOSH then applied NUREG-1400, a Nuclear Regulatory Guidance document, to this source term to develop an estimate of potential intake for thorium-232 exposure at Rocky Flats (see below for NUREG-1400 discussion).

NIOSH Evaluation 2:

SC&A appears to be conflating two different thorium operations (1) fabrication of metal weapons parts from natural Th and Th alloys – machining, shearing, grinding, and (2) fabrication of Th substitute R&D components in lieu of more expensive Pu or HEU. These two activities are considered separately in all of NIOSH's previous reports on this topic. The first operation was the 1960 ingot operation. The second operation dealt with the preformed parts received mainly from Oak Ridge.

SC&A Comment 3:

Thorium-232-related documents had been destroyed at DOE's Fernald plant in the 1970s. The question arose, therefore, as to whether this had been a wider policy or whether the examined documents represented a complete review of the thorium work at Rocky Flats. Further, a closer examination of thorium documents at Y-12 had yielded data indicating far more thorium processing than NIOSH initially believed. SC&A therefore sought some clarity as to the completeness of the thorium source term data, that were central to NIOSH's conclusion that upper bound doses were very low – so low in fact that they could be ignored (since they were less than 1 millirem in the worst case). (Working Group Meeting, November 6, 2006, transcript, pp. 213-214)

NIOSH Evaluation 3:

NIOSH is not evaluating SC&A's assertion that, "Thorium-232-related documents had been destroyed at DOE's Fernald plant in the 1970s" in this document because it has no direct bearing on the Rocky Flats SEC petition. Similarly, NIOSH is not commenting on SC&A's assertion that "Further, a closer examination of thorium documents at Y-12 had yielded data indicating far more thorium processing than NIOSH initially believed". NIOSH's December 27, 2006, report gives very detailed references, which allows the working group to decide whether the documents, logbooks, and interviews with numerous site experts comprises a sufficiently comprehensive body of evidence to inform their consideration of thorium use at Rocky Flats. Furthermore, detailed redacted Materials Balance and Inventory ledgers have now been provided that support NIOSH's statements regarding the quantities of thorium present at Rocky Flats. In response to SC&A's repeated assertions that thorium documents may have been destroyed at Rocky Flats, NIOSH has repeatedly expressed an interest in seeing the evidence that has led SC&A to this conclusion. To date, none has been provided. SC&A has yet to explain how significant quantities of thorium have gone undetected when (1) the primary source documentation NIOSH relied upon was the detailed Material Balance and Inventory ledgers, (2) every former worker NIOSH consulted, including one currently retained by SC&A, has stated that there were never any major operations with thorium at Rocky Flats, and (3) the extensive documentation referenced in NIOSH's December 26, 2006, report was unanimous in stating that there were never any major operations with thorium at Rocky Flats.

SC&A Comment 4:

A 1976 Rocky Flats assessment of thorium (initiated due to a complaint from a Rocky Flats neighbor that was judged to be without merit in reference to potential harm from thorium) indicated that cumulative "Normal Operating Losses" amounted to 32 kilograms of thorium-232 (Bistline 1976, p. 2). SC&A raised the question as to whether this estimate of cumulative normal operating losses was compatible with the NIOSH assertion that thorium metal processing was limited to very light work to smooth out irregularities in some parts that did not fit.

NIOSH Evaluation 4:

NIOSH is not asserting that "thorium metal processing was limited to very light work to smooth out irregularities in some parts that did not fit". Speaking of the use of preformed Th parts received primarily from Y-12, NIOSH's December 27, 2006, report clarified that "This use of thorium, together with the analytical procedures described next, represented the bulk of the total number of activities involving thorium at Rocky Flats." The NIOSH report also stated regarding the 1960 thorium ingot operation "The thorium used on this project represented the bulk of the thorium inventory ever present at Rocky Flats (240 kg)". SC&A appears to be conflating these two operations. It is not clear why the reference to a cumulative total of 32 kg Normal Operating Losses indicates operations beyond those discussed in NIOSH's December 27, 2006, report, especially when the 1960 Th ingot operation itself resulted in two of the 80 kg ingots being scrapped. The Normal Operating Losses are tracked on the Materials Balance and Inventory ledgers used by NIOSH in calculating the thorium source term.

SC&A Comment 5:

NIOSH has since revisited the source term question with regard to the amount of thorium metal processed. In its December 27, 2006, report, NIOSH stated that three thorium metal parts, each weighing about 80 kilograms, were rolled from 12"x12"x 3" ingots to metal bars between May and September 1960, with a total working time of 25 hours. Canning of the ingots in mild steel was also done. Only 12 workers are said to have been involved. There was an incident during hot rolling of the third ingot in September 1960 and the ingot was cut with a torch and eventually scrapped (see Attachment 20). This was new information about thorium processing presented in the December 27, 2006, report (Attachment 20). While this new information did not change NIOSH's October 2006 estimate of the maximum inventory of thorium-232 at Rocky Flats in any year (Attachment 19), it did increase the maximum amount estimated to be processed in any year from ~60 kilograms (plus small amounts in various processes) to 240 kilograms for canning and rolling, up to 60 kilograms for light machining of thorium metal from Oak Ridge, plus small amounts of other thorium uses.

NIOSH Evaluation 5:

A couple of minor clarifications are in order regarding the NIOSH report on thorium dated December 27, 2006:

(1) NIOSH did not state that the thorium was "rolled from 12"x12"x 3" ingots to metal bars." Rather, NIOSH described the project as:

The purpose of this experiment was to develop techniques for forming thorium metal and/or thorium alloys into desired shapes from ingots of a size of approximately 12"x12"x3", using rolling of the ingot to a thickness of 0.44 inches. The ingots were placed in 16 gauge cans for containment and forming control. The cans were removed following steps in the thickness reduction rolling process and the ingots were recanned for all of the rolling steps except the final bare cold roll step. Contamination releases occurred during the removal of the cans, but were anticipated, planned and controlled. The final step was press forming into the desired shape.

(2) The total time spent processing the *first two* ingots was 25 hours according to the health physics logbook describing this project. NIOSH estimated another 13 hours were involved in processing the third ingot (which is a probable overestimate), giving a total processing time for the project of approximately 38 hours;

(3) The total number of workers involved in this project was *12 or so*;

(4) It is not clear what definition SC&A is giving to the term "incident" in relation to the handling of the third ingot. As described in NIOSH's December 27, 2006, report, "On September 21 and 22, 1960, hot rolling of ingot 3 was attempted. The can ruptured during the hot rolling and the operation was terminated. The can was flame cut, and air samples were taken." There is no indication that there were any uptakes of thorium resulting from this project.

SC&A Comment 6:

In its December 27, 2006, report, NIOSH also reviewed whether Rocky Flats received thorium from the Dow Madison plant and concluded that no pure thorium shipments occurred between these two sites. However, NIOSH also found that magnesium alloy containing up to three percent thorium was shipped from Dow Madison to Rocky Flats:

> *A review of transcripts of the interviews of Dow Madison workers upon which this question is based (1,2,3) reveals that the Dow Madison workers were clearly speaking of shipments of magnesium alloy, of which thorium is a minor component (up to three percent according to the workers). NIOSH further verified this with a follow-up interview of the worker who spoke of shipments of material between the Dow Madison Site and Rocky Flats. In this follow-up interview (1), the worker recalled frequent shipments to Rocky Flats, and he stated unambiguously that the material was magnesium alloy, not thorium metal. He did not recall the Madison Site ever shipping pure thorium metal to Rocky Flats or anywhere else.* [Attachment 20, p. 7]

The December 27, 2006, NIOSH report does not explore the amounts of alloy that were shipped, or whether the alloys were processed in a way that could have exposure potential. During the January 9, 2007, working group teleconference call, NIOSH stated that the worker interviewed on this topic remembered that alloys were shipped by the truckload. The frequency of such shipments is unknown. SC&A notes here that a single truckload with ~10 metric tons of 3% thorium alloy would contain 300 kilograms of thorium. This material is not included in the Rocky Flats thorium inventory records. Yet, it could exceed the amounts that NIOSH has discussed to date. It is unknown at the time of this writing (January 9, 2007) whether and how this material was processed. NIOSH is investigating the issue. (A reference to the January 9, 2007, working group call transcript will be added for this paragraph when the transcript becomes available.)

NIOSH Evaluation 6:

The belief that there were regular and frequent shipments of thorium between the Dow Madison Site and Rocky flats was based on a misinterpretation of the interview transcripts referenced above by parties involved in the Dow Madison Site, who transmitted this misinterpretation to SC&A. This misinterpretation was pointed out in NIOSH's December 27, 2006, report, however SC&A's questions about the possibility of such shipments persisted. Therefore, NIOSH further verified the statements of the Dow Madison worker in a followup interview, as described above. In contrast to SC&A's comment above, NIOSH did not verify that shipments of magnesium alloy took place between the Dow Madison facility and Rocky Flats. Rather, NIOSH confirmed that the Dow Madison worker was speaking of magnesium alloy rather than pure thorium. NIOSH explicitly stated that we did not have any independent information as of the January 9, 2007, working group meeting regarding whether or not any such shipments of magnesium alloy took place. This was also reiterated during a conference call with SC&A on January 16, 2007, and at the working group meeting on January 26, 2007.

It was requested by the working group at the January 9, 2007, meeting that NIOSH conduct interviews with site experts from Rocky Flats regarding the degree of exchange of magnesium alloy between Rocky Flats and the Dow Madison site, if any. The four site experts subsequently interviewed were unanimous in their view that there were not large quantities of magnesium alloy used at Rocky Flats, and none of the interviewees remembered shipments of such material between Dow Madison Site and Rocky Flats. The one use of Mg alloy remembered was the pennants in the conveyor line in Building 776, which involved possibly a few hundred pounds of alloy at most. It was not clear whether or not this magnesium alloy contained thorium. It was also stated that the pennants were fabricated offsite by an outside vendor. The results of these interviews were presented to the working group and SC&A at the January 26, 2007, working group meeting and are presented in Section 3 of this report. At this meeting, the working group declined to request further followup actions on this issue. It is NIOSH's understanding that barring further evidence, this issue is closed.

SC&A Comment 7:

SC&A lacks confidence that NIOSH's December 27, 2006, report is the last word on this SEC-related issue.

NIOSH Evaluation 7:

While NIOSH does not grant that thorium use at Rocky Flats is an "SEC-related issue", NIOSH also lacks confidence that the December 27 report is the last word on this issue (as the current document itself demonstrates). As SC&A has noted earlier in this section, the course of the working group's inquiries into this topic have been complex and extensive, and SC&A's presentation of concerns has been iterative. As long as the working group has remaining questions and SC&A continues to refine and repeat previously stated concerns and present new concerns, NIOSH must reserve the ability to pursue new lines of inquiry and to provide additional level of detail as requested to address these issues. NIOSH also notes that while our efforts to obtain and review documentation that speaks to thorium use at Rocky Flats have been extensive, it is not possible to state that every piece of extant evidence has been secured. As in all other matters, NIOSH must maintain the ability to revise our thinking should new evidence be located, though we have no indication that such additional evidence exists.

However, the extensive level of detail requested by the working group on matters related to thorium use at Rocky Flats has provided a large body of evidence that supports the position expressed by NIOSH in our April 7, 2006, evaluation report,

> *Beginning in 1952, thorium was used on site in quantities small enough that effluents were not routinely analyzed for Th. Thorium quantities varied from as little as none to as much as 238 kilograms (kg) in a given month. The principle use was fabrication of metal parts from natural thorium metal (Th-232) and from various thorium alloys. Thorium oxide might have been used as a mold-coating compound in limited experiments. Thorium compounds were used in analytical procedures. In addition, twice between 1964 and 1969, thorium "strikes" were performed to remove gamma-emitting Th-228 from U-233 metal needed for fabrication of test devices. The strikes involved a fluoride precipitation and filtration process using natural thorium. Photon radiation from Th-228 decay products would have been monitored by standard gamma dosimetry badges in use at the plant. In addition, thorium was used as a stand-in for plutonium or uranium components in development programs.*

And further:

> *None of these other radionuclides were present at Rocky Flats in high enough quantities to contribute significantly to internal dose potential.*

Note that even as early as the evaluation report, the "fabrication of metal parts from natural thorium metal (Th-232) and from various thorium alloys" is discussed separately from "In addition, thorium was used as a stand-in for plutonium or uranium components in development programs." In the ten months since the presentation of NIOSH's evaluation report, SC&A has presented no evidence that significant thorium intakes ever occurred at Rocky Flats. On the other hand, NIOSH has presented extensive evidence that no such intakes occurred.

NIOSH's position that no thorium intakes occurred at Rocky Flats has been constant. On the other hand, SC&A has at various times, postulated that:

(1) Thorium-related documents at Rocky Flats may have been destroyed.

(2) Thorium production data from Rocky Flats may be incomplete because according to SC&A, this data was incomplete for Fernald and Y-12.

(3) NUREG-1400 is somehow inapplicable at Rocky Flats.

(4) Thorium intake potentials at Rocky Flats might be high because they were high at Fernald and Y-12.

(5) Dust levels at Bethlehem Steel indicate that airborne thorium levels might be high at Rocky Flats.

(6) The incinerator at Rocky Flats may have been used for thorium recovery.

(7) NIOSH's estimate of potential airborne thorium levels at Rocky Flats is too low based on a comparison to current EPA PM_{10} standards.

(8) NIOSH's estimate of potential airborne thorium levels at Rocky Flats is too low based on a comparison to PM_{10} levels between 1993 and 1995 in Great Basin National Park

(9) NIOSH's estimate of potential airborne thorium levels at Rocky Flats is too low based on a comparison to urban background air in European cities.

(10) Truckloads or trainloads of thorium metal or Mg alloy containing thorium may have been shipped to Rocky Flats from the Dow Madison site.

(11) Rocky Flats might have handled quantities of thorium larger than 240 kg because it had the capability of doing so.

Responding to SC&A's many questions on this issue has required significant levels of resources from NIOSH and the ORAU Team. None of these postulates has yet proven to be true, in spite of extensive efforts by NIOSH to investigate thorium issues at Rocky Flats. NIOSH respects the prerogative of the working group to consider questions raised by SC&A and request investigation by NIOSH. However, NIOSH does not see how the provision of the resulting detailed information, which supports NIOSH's original position that no significant thorium intakes occurred at Rocky Flats, in any way casts doubt on the completeness of our evaluation.

SC&A Comment 8:

NIOSH's earlier confidence that the thorium source term and upper bound intake estimates (see below) were properly described in the paper discussed at the November 6, 2006, meeting (Attachment 19) are shown to be incorrect by new processing information NIOSH's December 27, 2006, report. The continual emergence of new information in response to questions leaves a residual uncertainty as to whether there are other parts of the source term that have not yet come to light.

NIOSH Evaluation 8:

NIOSH strongly disagrees with this characterization. The hypothetical machining of small quantities of thorium was explicitly included in the earliest drafts of our response on this issue, and were discussed separately as early as the April 7, 2006, evaluation report. Some details have been discovered in response to questions by the working group on this issue, but the basic conclusion – no significant thorium intakes – has remained constant. The emergence of additional detail has confirmed, rather than contradicted NIOSH's original position. NIOSH's source term estimates have been based on Material Balance and Inventory ledgers, which were originally classified but have now been redacted. It is not accurate to say that the description of the source term in NIOSH's previous reports is incorrect because the December 27 report discussed the ingot operation in 1960 in great detail. The thorium ingots used in this operation are reflected in the source term estimates NIOSH calculated from the Material Balance and Inventory ledgers. The primary information in this source term calculation was the quantity of thorium. It was not originally considered important to provide a detailed listing of the points of origination of the thorium present at Rocky Flats, and NIOSH had some reservation about providing such detailed information as the inventories were still classified. When the primary reference describing the ingot operation was redacted, NIOSH provided additional detail regarding this operation, however, again, NIOSH's previous source term calculations accounted for this operation. Despite NIOSH's repeated requests to review the evidence upon which SC&A is basing this assertion, SC&A has yet to show any evidence for or explain how significant thorium operations have gone undetected when (1) the primary source documentation NIOSH relied upon was the detailed Material Balance and Inventory ledgers, (2) every former worker NIOSH consulted, including one currently retained by SC&A, has stated that there were never any major operations with thorium at Rocky Flats, and (3) the extensive documentation referenced in NIOSH's December 26, 2006, report was unanimous in stating that there were never any major operations with thorium at Rocky Flats.

SC&A Comment 9:

Further intensive work has revealed that earlier (October 2006) NIOSH assertions regarding the largest amount of thorium metal processed in any one year were incorrect.

NIOSH Evaluation 9:

In response to SC&A's unwillingness to accept NIOSH's bounding source term calculation based on a summary of the inventory sheets, NIOSH has now had the Materials Balance and Inventory sheets redacted and has provided these. NIOSH's previous bounding source term calculation was 60 kg per year for the years 1956-1993, for a total of 2220 kg. In fact, as evidenced on the redacted ledgers, only two shipments (57 kg and 55 kg) of preformed thorium parts were received directly from Y-12 in 1965, and additional shipments of parts produced at Y-12 and sent to Rocky Flats via the Lawrence Lab in 1962 (16 kg), and 1965 (3 receipts of 16 kg each), for a total receipt of preformed parts produced at Y-12 over the history of Rocky Flats of 176 kg. This demonstrates that NIOSH's bounding source term calculation overestimated the actual source term by a factor of almost 13. The annual estimates of amount of finished parts handled at Rocky Flats, calculated as the sum of the monthly results of [(beginning inventory) + (receipts) – (ending inventory)] reveals that the highest annual source term was 54 kg in 1965. Therefore, NIOSH's previous estimate of the source term for this operation of 60 kg was indeed bounding.

It is true that the amount of thorium handled in the 1960 ingot operation (240 kg) exceeded NIOSH's original estimate of 60 kg processed in any one year. However, SC&A fails to consider that NIOSH's original bounding estimate applied the 60 kg estimate to every year between 1956 and 1993, resulting in a total bounding estimate of 2220 kg, which overestimates the amount received in 1960 by a factor of almost 10. Also, as described in NIOSH's December 27, 2006, report, NIOSH is not proposing to use NUREG-1400 to bound the doses from the ingot operation, as air monitoring and bioassay data make this unnecessary.

These calculations reflect throughput (material received and subsequently sent offsite), and demonstrate conclusively that NIOSH's original annual source term of 60 kg was indeed bounding for the operations involving preformed parts.

SC&A Comment 10:

New and far more major metal processing activities have been revealed by the new NIOSH research. SC&A had been of the opinion that "light" work of the nature described by NIOSH during the November 6, 2006, working group meeting did not appear to be compatible with the description of thorium work at Rocky Flats in Bistline 1976, which states:

> ***The major Rocky Flats use of thorium has involved the fabrication of metal parts. Such fabrication has involved natural Thorium metal as well as the various alloys of Thorium with other metals*** *specified by our customers…* ***It should be emphasized that this has been the principal role of Thorium at Rocky Flats.*** [Emphasis added.]

NIOSH Evaluation 10:

The importance of the emphasis added by SC&A to the quote from Bistline 1976 ("specified by our customers" and "this has been the principal role") is unclear to NIOSH. However, NIOSH notes that we have previously responded to the first emphasized quote by explaining that "The customers for whom Rocky Flats performed limited thorium activities were other DOE sites (most notably Oak Ridge), as described by several site experts and reference documents" (email from Brant Ulsh to Joe Fitzgerald, 11-29-06).

SC&A appears to be conflating two different thorium operations (1) fabrication of metal weapons parts from natural thorium and thorium alloys – machining, shearing, grinding, and (2) fabrication of thorium substitute R&D components in lieu of more expensive Pu or HEU. These two activities are considered separately in all of NIOSH's previous reports on this topic. Speaking of the 1960 thorium ingot operation NIOSH's December 27, 2006, report stated, "The thorium used on this project represented the bulk of the thorium inventory ever present at Rocky Flats (240 kg)". SC&A's characterization of the thorium ingot operation (fabrication of metal parts from natural thorium and thorium alloys) as "new and far more major metal processing activities" is not accurate. It is not new, as it has been listed in all of NIOSH's previous reports on this topic although far more detail was available and presented in NIOSH's December 27, 2006, report. A project consisting of processing three 80 kg ingots over approximately 38 hours on eight working days in 1960 can hardly be characterized as a major operation, especially in comparison to the tons of plutonium and uranium processed at Rocky Flats, or in comparison to the tons of thorium material processed and/or stored at other DOE facilities (e.g., Y-12, Fernald).

Speaking of the use of preformed thorium parts received from Oak Ridge, the December 27, 2006, NIOSH report stated, "This use of thorium, together with the analytical procedures described next, represented the bulk of the total number of activities involving thorium at Rocky Flats."

SC&A Comment 11:

Given that 240 kilograms of thorium were canned and rolled (with the hot rolling of the last 80 being unsuccessful) in a total of 25 hours of work by at most a dozen people, Rocky Flats clearly had the capability to handle considerably larger amounts of thorium (without exceeding the idea that the thorium was a "minor" material there).

NIOSH Evaluation 11:

As stated in response comment 5 in this report, the total time spent processing the *first two* ingots was 25 hours according to the health physics logbook describing this project. NIOSH estimated another 13 hours were involved in processing the third ingot (which is a probable overestimate), giving a total processing time for the project of approximately 38 hours.

Since the thorium metal was processed on the same equipment used to process enriched uranium at Rocky Flats, and Rocky Flats processed larger amounts of enriched uranium, NIOSH would agree in principle that Rocky Flats had the capability to handle larger amounts of thorium. However, there is no indication that Rocky Flats did in fact process large amounts of thorium. On the other hand, there is considerable evidence that only small amounts of thorium were processed at Rocky Flats. Despite NIOSH's repeated requests to review the evidence upon which SC&A is basing this assertion, SC&A has yet to show any evidence for or explain how significant thorium operations have gone undetected when (1) the primary source documentation NIOSH relied upon was the detailed Material Balance and Inventory ledgers, (2) every former worker NIOSH consulted, including one currently retained by SC&A, has stated that there were never any major operations with thorium at Rocky Flats, and (3) the extensive documentation referenced in NIOSH's December 26, 2006, report was unanimous in stating that there were never any major operations with thorium at Rocky Flats.

SC&A Comment 12:

A new source for thorium metal supply to Rocky Flats was discovered – the ingots in question came from W.R. Grace and not from Oak Ridge. This is also compatible with the 1976 description quoted above, since Oak Ridge parts did not undergo significant manufacturing work at Rocky Flats, according to NIOSH.

NIOSH Evaluation 12:

A reference cited in NIOSH's December 26, 2006, report gives the source of the three thorium ingots processed in 1960 at W.R. Grace. This additional level of detail did not conflict with NIOSH's previous reports. NIOSH has previously stated that the preformed parts used in weapons mockups were received from Oak Ridge. The NIOSH reports previous to the December 27, 2006, report were silent on the source of the metal used in the fabrication of parts from natural thorium and alloys (the ingot operation). It is not clear to NIOSH why the determination of the points of origin of the thorium ingots would constitute an SEC issue. This does not change the maximum thorium inventory numbers cited by NIOSH. These were based on the Materials Balance and Inventory ledgers, and those ledgers reflect the thorium used in the 1960 ingot operation.

SC&A Comment 13:

A new source term for thorium was discovered in the form of shipments in the form of magnesium-thorium alloy from Dow Madison. The scale of these shipments is unknown, but as discussed above it is possible that the amount of thorium could be comparable to, and possibly even greater than, the scale of other thorium-related inventories at Rocky Flats. It is unknown at this time what was done with this alloy. NIOSH is investigating the issue, following the working group discussion during the January 9, 2007, teleconference call.

NIOSH Evaluation 13:

SC&A's conclusion that a new source term has been discovered consisting of magnesium alloy from Dow Madison is premature. Two Dow Madison workers have stated that they recalled such shipments. Four Rocky Flats workers have stated that they have no recollection of such shipments, and would have been in a position to know of them if they occurred. No independent documentary evidence (*e.g.* shipping records or inventories) has been presented by SC&A, parties interested in the Dow Madison site, or located by NIOSH as of this writing to suggest that such shipments took place. Magnesium-thorium alloy was used "almost exclusively in aircraft parts, particularly parts for aircraft engines" (NUREG-1717). While this is not conclusive, the known uses of Mg-Th alloy do not seem compatible with the mission of Rocky Flats. The Rocky Flats working group declined to request further followup on this issue in the January 26, 2007, meeting. It is NIOSH's understanding that barring new evidence, this issue is closed.

SC&A Comment 14:

Thorium-related documents have been destroyed at Fernald. Some documents at Rocky Flats have also been destroyed. These facts also raise questions about completeness of data regarding thorium processing.

NIOSH Evaluation 14:

NIOSH is not evaluating SC&A's assertion that, "Thorium-related documents have been destroyed at Fernald" in this document because it has no direct bearing on the Rocky Flats SEC petition. NIOSH's December 27, 2006, report gives very detailed references, which allows the working group to decide whether the documents, logbooks, and interviews with numerous site experts comprises a sufficiently comprehensive body of evidence to inform their consideration of thorium use at Rocky Flats. Despite NIOSH's repeated requests to review the evidence upon which SC&A is basing this assertion, SC&A has yet to show any evidence for or explain how significant thorium operations have gone undetected when (1) the primary source documentation NIOSH relied upon was the detailed Material Balance and Inventory ledgers, (2) every former worker NIOSH consulted, including one currently retained by SC&A, has stated that there were never any major operations with thorium at Rocky Flats, and (3) the extensive documentation referenced in NIOSH's December 26, 2006, report was unanimous in stating that there were never any major operations with thorium at Rocky Flats.

SC&A Comment 15:

The new NIOSH findings came to light about eight months after NIOSH completed its evaluation report, more than one year after SC&A raised the issue of thorium-related dose reconstruction in its TBD review SC&A Rocky Flats TBD review, p. 53), and after many questions were raised about the thorium issue during the arduous process of discussion of the ER. The magnitude of the new revelations regarding thorium metal working processes as well as two previously undisclosed and undiscovered sources of thorium supply to Rocky Flats is uncomfortably reminiscent of the discussions at Y-12, where repeated questions raised about data relating to thorium yielded a final source term picture that was very different from the initial assertions.

NIOSH Evaluation 15:

SC&A has again mischaracterized the additional detail provided in NIOSH's December 27, 2006, report as "new NIOSH findings". This provision of this additional detail, which is consistent with NIOSH's previous discussions of this issue, has no resemblance whatsoever to SC&A's description of the course of events at Y-12. NIOSH's position on thorium, as originally presented in our April 27, 2006, evaluation report, has been constant:

> *Beginning in 1952, thorium was used on site in quantities small enough that effluents were not routinely analyzed for Th. Thorium quantities varied from as little as none to as much as 238 kilograms (kg) in a given month. The principle use was fabrication of metal parts from natural thorium metal (Th-232) and from various thorium alloys. Thorium oxide might have been used as a mold-coating compound in limited experiments. Thorium compounds were used in analytical procedures. In addition, twice between 1964 and 1969, thorium "strikes" were performed to remove gamma-emitting Th-228 from U-233 metal needed for fabrication of test devices. The strikes involved a fluoride precipitation and filtration process using natural thorium. Photon radiation from Th-228 decay*

> *products would have been monitored by standard gamma dosimetry badges in use at the plant. In addition, thorium was used as a stand-in for plutonium or uranium components in development programs.*

And further:

> *None of these other radionuclides were present at Rocky Flats in high enough quantities to contribute significantly to internal dose potential.*

Despite NIOSH's repeated requests to review the evidence upon which SC&A is basing the assertion that there may be significant undiscovered thorium operations at Rocky Flats, SC&A has yet to show any evidence for or explain how significant thorium operations have gone undetected when (1) the primary source documentation NIOSH relied upon was the detailed Material Balance and Inventory ledgers, (2) every former worker NIOSH consulted, including one currently retained by SC&A, has stated that there were never any major operations with thorium at Rocky Flats, and (3) the extensive documentation referenced in NIOSH's December 26, 2006, report was unanimous in stating that there were never any major operations with thorium at Rocky Flats.

Presumably, SC&A's reference to "two previously undisclosed and undiscovered sources of thorium supply to Rocky Flats" refers to the three ingots supplied by W.R. Grace for the 1960 operation, and to Mg alloy from the Dow Madison site. NIOSH has previously stated that the preformed parts used in weapons mockups were received from Oak Ridge. The NIOSH reports previous to the December 27, 2006, report were silent on the source of the metal used in the fabrication of parts from natural thorium and alloys (the ingot operation). It is not clear to NIOSH why the determination of the source of the thorium ingots would constitute an SEC issue. This does not change the maximum thorium inventory numbers cited by NIOSH.

SC&A's conclusion that a new source term has been discovered consisting of magnesium alloy from Dow Madison is premature. Two Dow Madison workers have stated that they recalled such shipments. Four Rocky Flats workers have stated that they have no recollection of such shipments, and would have been in a position to know of them if they occurred. No independent documentary evidence (*e.g.* shipping records or inventories) has been presented by SC&A, parties interested in the Dow Madison site, or located by NIOSH as of this writing to suggest that such shipments took place. Magnesium-thorium alloy was used "almost exclusively in aircraft parts, particularly parts for aircraft engines" (NUREG-1717). While this is not conclusive, the known uses of Mg-Th alloy do not seem compatible with the mission of Rocky Flats. The Rocky Flats working group declined to request further followup on this issue in the January 26, 2007, meeting. It is NIOSH's understanding that barring new evidence, this issue is closed.

SC&A Comment 16:

Further, NIOSH's analytical approach relies on material stocks, which do not reveal how much was actually processed in any one year. SC&A agrees with NIOSH that there is documentation indicating that the largest stock of thorium-232 at Rocky Flats at any time appears to have been ~250 kilograms (excluding any quantities present in magnesium-thorium alloy). Therefore, SC&A would also agree that, by this criterion of material stocks, thorium-232 was a minor material at Rocky Flats, relative to plutonium and uranium. It also appears to have been processed sporadically.

However, the data on the stocks of thorium do not allow any conclusions as to the amounts processed in any one year, which could, in theory, be much larger or smaller than the maximum stock in any given year.

NIOSH Evaluation 16:

In an effort to reach consensus with SC&A on this issue, NIOSH has obtained redacted Material Balance and Inventory ledgers for thorium, which are available at:
The only classified documentation used by NIOSH in the evaluation of the thorium issue was the Materials Balance and Inventory ledgers containing information about thorium. These ledgers have now been redacted and are available at:

> *O:\Document Review\AB Document Review\Rocky Flats\NIOSH responses to SCA draft reports\Other radionuclides*

These ledgers conclusively demonstrate that NIOSH's previous analyses presented a bounding overestimate of the thorium source term.

NIOSH's previous bounding source term calculation was 60 kg per year for the years 1956-1993, for a total of 2220 kg. In fact, as evidenced on the redacted inventory sheets, only two shipments (57 kg and 55 kg) of preformed thorium parts were received directly from Y-12 in 1965, and additional shipments of parts produced at Y-12 were sent to Rocky Flats via the Lawrence Lab in 1962 (16 kg), and 1965 (3 receipts of 16 kg each), for a total receipt of preformed parts produced at Y-12 over the history of Rocky Flats of 176 kg. This demonstrates that NIOSH's bounding source term calculation overestimated the actual source term by a factor of almost 13. The annual estimates of amount of finished parts handled at Rocky Flats, calculated as the sum of the monthly results of [(beginning inventory) + (receipts) – (ending inventory)] reveals that the highest annual source term for the preformed parts was 54 kg in 1965. Also, as described in NIOSH's December 27, 2006, report, NIOSH is not proposing to use NUREG-1400 to bound the doses from the ingot operation, as air monitoring and bioassay data make this unnecessary.

SC&A Comment 17:

Examination of logbooks and monthly reports by NIOSH in the latest phase of its thorium investigation had yielded data on the processing of three 80-kilogram ingots from W.R. Grace and Company. Based on an initial review, SC&A also would agree with NIOSH that the processing of the three thorium ingots appears to have been well-documented (though it should be noted that SC&A has not yet had an opportunity to examine the source documents in detail). But this does not settle the issue of whether the most recent NIOSH review represents a complete picture of thorium metal processing at Rocky Flats.

NIOSH Evaluation 17:

The evaluation NIOSH presented in the December 27, 2006, report is thoroughly documented and an extensive references section was provided (57 individual references) and stated:

> *The bases for these conclusions are detailed in the body of the report, and consist of unclassified reports, an unclassified extract of a classified report, material balance account ledgers, monthly progress reports from the Chemistry Lab & Personnel Meters, Site Survey, and Chemistry Research and Development groups, health physics field logbooks, and interviews with former Rocky Flats and Dow Madison workers. In total, hundreds of man-hours have been dedicated to addressing the Working Group's and SC&A's concerns on this issue, and the results presented here represent all of the data we have been able to locate and review.*

These many interviews, reports, and logbooks present a consistent picture of thorium use at Rocky Flats, and led NIOSH to continue to conclude, as we have since our evaluation report,

> *that the thorium handling operations at Rocky Flats were limited in scope, well monitored and documented, resulted in trivial potential doses, and do not represent an SEC issue.*

Despite NIOSH's repeated requests to review the evidence upon which SC&A is basing the assertion that there may be significant undiscovered thorium operations at Rocky Flats, SC&A has yet to show any evidence for or explain how significant thorium operations have gone undetected when (1) the primary source documentation NIOSH relied upon was the detailed Material Balance and Inventory ledgers, (2) every former worker NIOSH consulted, including one currently retained by SC&A, has stated that there were never any major operations with thorium at Rocky Flats, and (3) the extensive documentation referenced in NIOSH's December 26, 2006, report was unanimous in stating that there were never any major operations with thorium at Rocky Flats.

SC&A Comment 18:

New components of the thorium source term have emerged in research done by NIOSH in response to questions raised by SC&A and the working group. This new source term information does not relate one way or another to NIOSH's ability to reconstruct dose if more historic thorium processing is uncovered. However, SC&A lacks confidence that the thorium-232 metal source term is necessarily complete due to the various factors stated above. It is to be noted SC&A has not carried out an independent review of this source term, which SC&A has pointed out would involve a classified investigation.

NIOSH Evaluation 18:

Presumably, SC&A's reference to "new components of the thorium source term" refers to the three ingots supplied by W.R. Grace for the 1960 operation, and to Mg alloy from the Dow Madison site. NIOSH has previously stated that the preformed parts used in weapons mockups were received from Oak Ridge. The NIOSH reports previous to the December 27, 2006, report were silent on the source of the metal used in the fabrication of parts from natural thorium and alloys (the ingot operation). It is not clear to NIOSH why the determination of the source of the thorium ingots would constitute an SEC issue. This does not change the maximum thorium inventory numbers cited by NIOSH.

SC&A's conclusion that a new source term has been discovered consisting of magnesium alloy from Dow Madison is premature. Two Dow Madison workers have stated that they recalled such shipments. Four Rocky Flats workers have stated that they have no recollection of such shipments, and would have been in a position to know of them if they occurred. No independent documentary evidence (*e.g.* shipping records or inventories) has been presented by SC&A, parties interested in the Dow Madison site, or located by NIOSH as of this writing to suggest that such shipments took place. Magnesium-thorium alloy was used "almost exclusively in aircraft parts, particularly parts for aircraft engines". While this is not conclusive, the known uses of Mg-Th alloy do not seem compatible with the mission of Rocky Flats. The Rocky Flats working group declined to request further followup on this issue at its January 26, 2007, meeting. It is NIOSH's understanding that barring new evidence, this issue is closed.

SC&A has stated that it "lacks confidence that the thorium-232 metal source term is necessarily complete". While details of the origination point of some of the thorium present onsite have recently come to light, this does not affect the source term NIOSH used in its previous bounding analyses. Despite NIOSH's repeated requests to review the evidence upon which SC&A is basing the assertion that there may be significant undiscovered thorium operations at Rocky Flats, SC&A has yet to show any evidence for or explain how significant thorium operations have gone undetected when (1) the primary source documentation NIOSH relied upon was the detailed Material Balance and Inventory ledgers, (2) every former worker NIOSH consulted, including one currently retained by SC&A, has stated that there were never any major operations with thorium at Rocky Flats, and (3) the extensive documentation referenced in NIOSH's December 26, 2006, report was unanimous in stating that there were never any major operations with thorium at Rocky Flats.

With the provision of redacted Materials Balance and Inventory ledgers, all of the evidence NIOSH has relied upon in its evaluation of the thorium issue is now available in an unclassified form.

SC&A Comment 19:

No quantitative data are available so far in NIOSH reports on the amounts of thorium contained in the magnesium-thorium alloy shipped from Dow Madison to Rocky Flats. A worker description that the alloy was shipped by the truckload indicates that the amounts may have been substantial. NIOSH has not presented an analysis indicating how dose from exposure to this allow would be reconstructed if any processing was done at Rocky Flats. Implications of magnesium alloyed with thorium for NIOSH's ability to dose reconstruction are unknown at this time since the scope of the source term and knowledge about processing remains unknown (see below for some preliminary remarks on this topic).

NIOSH Evaluation 19:

SC&A's conclusion that magnesium-thorium alloy was shipped to Rocky Flats from Dow Madison is premature. Two Dow Madison workers have stated that they recalled such shipments. Four Rocky Flats workers have stated that they have no recollection of such shipments, and would have been in a position to know of them if they occurred. No independent documentary evidence (*e.g.* shipping records or inventories) has been presented by SC&A, parties interested in the Dow Madison site, or located by NIOSH as of this writing to suggest that such shipments took place. Magnesium-thorium alloy was used "almost exclusively in aircraft parts, particularly parts for aircraft engines" (NUREG-1717). While this is not conclusive, the known uses of Mg-Th alloy do not seem compatible with the mission of Rocky Flats. The Rocky Flats working group declined to request further followup on this issue at its January 26, 2007, meeting.

SC&A Comment 20:

NIOSH has not so far presented data for the machining of parts from Oak Ridge that would be comparable to the data available for the ingot operations conducted in 1960 for the thorium metal received from W.R. Grace and Company. The December 27, 2006, paper (Attachment 20) is not clear on whether NIOSH intends to rely on NUREG-1400 or whether it intends to use some uranium air concentration data on machining and grinding from other sites presented in the paper.

NIOSH Evaluation 20:

It is not at all clear that any machining on these preformed parts was ever performed at Rocky Flats as the interviews with five former Rocky Flats workers indicated that they had no recollection of any such operation (Section 2). Therefore, it is logical that no data comparable to the ingot operation (which clearly occurred) would exist for machining of preformed thorium parts (which most likely didn't occur). If such data does exist, which is unlikely, NIOSH has not discovered it in the many detailed searches we have conducted to date.

As detailed in NIOSH's December 26, 2006, report, NUREG-1400 methodology has been used to demonstrate that there were no significant intakes from handling of preformed thorium parts at Rocky Flats.

SC&A Comment 21:

SC&A has expressed some skepticism regarding the very low doses derived from the application of NUREG-1400 to the situation at hand (Attachment 21). At the November 6, 2006, meeting, NIOSH asserted that the intakes and doses estimated were bounding estimates. NIOSH further stated that the 10% estimate for loose material was conservative, given that only light machining occurred on some components. SC&A agreed that the time of processing might have been short due to the limited work, but that the bounding nature of the estimate claimed by NIOSH needed to be established in a more reliable fashion related to metal working operations. NIOSH agreed to examine some metal working processes, including centerless grinding to evaluate whether the proposed application of NUREG-1400 was bounding. November 6, 2006, working group meeting transcript, pp. 219-220.) NIOSH's December 27, 2006, paper provides some analysis of this issue.

The committed and effective doses estimated for light machining of 60 kilograms of thorium parts per year, using a 10% loose material factor, Type S thorium, and the application of NUREG-1400 according to NIOSH's interpretation, were:

> *Effective dose – 9E-5 rem, (<1 mrem)*
> *Bone dose – 4E-4 rem, (0.4 mrem)*
> *Lung dose – 7 E-4 rem, (0.7 mrem)* [Attachment 20, p. 11]

For comparison actual operations, NIOSH used the following approach:

> *A study of air activity measured from similar machining and/or grinding operations was conducted to validate the estimate derived using NUREG-1400 approach. Thus an extensive study by scientists of the AEC Health and Safety Laboratory prior to 1958 (1) was referenced which presents air sampling data from a number of facilities in which a variety of processes were used in the early 1960s time period for processing of uranium. This study was with uranium being processed in large quantities for extended time period of production operations and present a much greater contamination release potential than the light machining or grinding of relatively small pieces of thorium metal during relatively short time periods, but can be used in a high bounding comparison. The releases from similar processes, i.e. milling, grinding, etc. on uranium as compared to thorium is also conservative/bounding based upon the differences in the physical characteristics. The melting point for uranium metal is 1690 C and for thorium metal 1845 C. The boiling point is 3500 C for uranium and 5200 C for thorium. Thus values derived for thorium air activity based upon the direct comparison with uranium results below will be higher than those anticipated for thorium.*
>
> *The air activity levels for the machining and grinding operations, which were performed on the uranium metal parts, were converted to mass concentrations, which were then converted to thorium activity concentrations. This is based upon the assumption that equal mass quantities of thorium to those of uranium would be released. Since thorium metal, oxides and hydroxides are considered insoluble, solubility class S dose conversion factors were used.*
>
> *Since the work with thorium metal parts was performed on equipment designed for enriched uranium at the Rocky facilities, the machines were shrouded/hooded and were considered in the "vented" category listed in the reference study.* [Attachment 20, p. 12]

The results obtained are shown in the table below, which is reproduced from the NIOSH report for convenience:

Table 6-2. Calculation of CDE and annual DE Dose in mrem

Operation	dpm/m3U	µgU/m3	dpm/m3Th	hr/yr	Bq intake	mrem	DE mrem	
						CDE	1st yr	20th yr
Machining	50	64	16	10	3.1	44 bs	0.25 bs	6.5 bs
						24 lung	5 lung	0.3 lung
Grinding	200	257	63	10	12.6	176 bs	1.0 bs	27 bs
						97 lung	21 lung	1.6 lung

Key: bs = bone surfaces, lung = lung as the organ of reference. For reference the annual dose equivalent in mrem is given for the 1st year after intake and the 20th. CDE = Cumulative dose equivalent is derived by multiplication of the intake by the dose conversion factor from ICRP 68 in Table 3.

Source: This is a reproduction of Table 6-1 in the NIOSH December 27, 2006, paper (see Attachment 20).

From this analysis, NIOSH concluded as follows:

> *Based upon a conservative bounding of the doses based upon assumed intakes from comparative air sampling data, organ dose does not appear to be limiting, even though intakes using this comparison analyses is a couple orders of magnitude larger than that calculated using NUREG 1400.* [p. 12]

SC&A is unclear as to the meaning of the phrase "does not appear to be limiting" in the above context. But it is clear that the intakes estimated from actual production operations are much greater ("a couple orders of magnitude larger") than those obtained using NUREG-1400. SC&A concludes that the use of NUREG-1400 is clearly not bounding according to this check performed by NIOSH.

NIOSH Evaluation 21:

While NIOSH continues to believe that the reduction in source term to account for the minimal machining hypothesized for the preformed parts is justified, we have removed this reduction from the revised calculations presented in Section 5 of this report in an effort to reach consensus with SC&A on this issue.

While NIOSH disagrees with some of the points raised in the comment above in relation to the uranium grinding converted to thorium activity approach, this argument is no longer relevant. As suggested by SC&A (see Comment 25), and agreed by NIOSH, it is preferable to consider operations that directly involved thorium. NIOSH has presented two such comparisons in Section 4 of this report, including the thorium operations at Simonds Saw and Steel (as suggested by SC&A) and the Rocky Flats ingot operation. Both examples demonstrate that NUREG-1400 is bounding.

The phrase "does not appear to be limiting" referred to the low estimates of committed doses to the bone surfaces and lungs observed in the uranium grinding comparison. The point was that both approaches (NUREG-1400 and uranium grinding converted to thorium activity) predicted extremely low committed doses, and therefore were not of consequence. This point seems to have been lost in all of the discussion about whether or not NUREG-1400 is bounding or whether the uranium grinding approach renders NUREG-1400 nonbounding.

SC&A Comment 22:

Further, during the November 6, 2006, working group meeting, NIOSH claimed that (i) NUREG-1400 was designed to be "grossly conservative" and (ii) the light machining operations carried out at Rocky Flats, without chemical processing or involvement of powders would result in an estimate that was "bounding on the high side." (November 6, 2006, working group meeting transcript, pp. 215–216.). Compared to these claims, the bone surface dose estimate provided by the examination of operational processes by NIOSH in its December 27, 2006, paper is well over two orders of magnitude greater for some organs than the claim made by NIOSH in its October 2006 paper and at the November 6, 2006, working group meeting (committed dose comparisons).

NIOSH Evaluation 22:

It is true that the committed dose estimates calculated from the uranium grinding operations converted to thorium activities arrived at higher doses than those predicted using NUREG-1400 for hypothetical light machining of preformed thorium parts. However, SC&A does not take into account the large uncertainties associated with such an approach. The higher predictions of a very uncertain comparison do not, in and of themselves, render NUREG-1400 nonbounding, only not as conservative as the uranium grinding converted to thorium approach.

As suggested by SC&A (see Comment 25), and agreed by NIOSH, it is preferable to consider operations that directly involved thorium. NIOSH has presented two such comparisons in Section 4 of this report, including the thorium operations at Simonds Saw and Steel (as suggested by SC&A) and the Rocky Flats ingot operation. Both examples demonstrate that NUREG-1400 is bounding.

SC&A Comment 23:

Moreover, SC&A does not concur that the approach taken by NIOSH above in examining uranium operations is bounding for Rocky Flats thorium operations. Light machining would reduce the time for an operation, but not necessarily the dust generated during the machining. The small amount of time for light machining does not provide any element of conservatism in NIOSH's calculations. Moreover, NIOSH has already taken the small amount of time per year into account in its estimate derived from operational processes by assuming that these are in operation for only 10 hours per year (Attachment 20, Table 1, reproduced above as Table 6-2). Similarly, NIOSH used data from vented operations in its operational dose estimate. This may correspond to realistic conditions for thorium processing at Rocky Flats, but it does not provide an element of conservatism that could lead to a description of the intake result as bounding.

NIOSH Evaluation 23:

As suggested by SC&A (see Comment 25), and agreed by NIOSH, it is preferable to consider operations that directly involved thorium. NIOSH has presented two such comparisons in Section 4 of this report, including the thorium operations at Simonds Saw and Steel (as suggested by SC&A) and the Rocky Flats ingot operation. Both examples demonstrate that NUREG-1400 is bounding.

NIOSH must also point out that the estimate of 10 hours of machining per year for the preformed thorium parts is a gross overestimate meant to be bounding. The most important basis for this statement is that it is unlikely that any machining at all occurred with these preformed parts, as detailed in the interviews in Section 2 of this report. Furthermore, even if some light polishing was performed, it is unlikely that it would have involved an hour on each of 10 parts assumed in NIOSH's previous calculation.

SC&A Comment 24:

Further, the relative melting point and boiling points of thorium and uranium are not very relevant to the problem of air concentrations in this context. Machining would create oxidation processes that would result in solid oxides becoming air borne, in addition to fine solid metal particles. The centerless grinding daily averages cited in the paper referenced by NIOSH are between 50 and 300 dpm/m^3. Since this is a range of daily *averages*, it would not be claimant favorable to use a value of less than 300 dpm/m^3 (NIOSH used 200 dpm/m^3). Given that NIOSH assumes a small number of workers who did the job over short periods of time, the use of averages may not be claimant favorable, since 42 CFR 83 requires that a suitably bounding dose be developed for all members of the class.

NIOSH Evaluation 24:

While NIOSH disagrees with some of the points raised in the comment above, this argument is no longer relevant. As suggested by SC&A (see Comment 25), and agreed by NIOSH, it is preferable to consider operations that directly involved thorium. NIOSH has presented two such comparisons in Section 4 of this report, including the thorium operations at Simonds Saw and Steel (as suggested by SC&A) and the Rocky Flats ingot operation. Both examples demonstrate that NUREG-1400 is bounding.

SC&A Comment 25:

Finally, there is a large amount of data from other facilities, including from thorium operations that NIOSH might have referenced, so it is not clear that the comparison provided is definitive enough to sustain a claim of conservatism in the result. (SC&A has not attempted to verify the details of NIOSH's calculations, since these are not relevant to the SEC-related question).

NIOSH Evaluation 25:

NIOSH agrees with SC&A's suggestion to compare the predicted intakes from NUREG-1400 to those directly involving thorium. NIOSH believes that this type of calculation is more directly comparable, and involves far fewer uncertainties than the comparison to uranium machining operations discussed and requested in a previous working group meeting.

As suggested by SC&A in a conference call on January 16, 2007, NIOSH has performed a comparison of observed intakes (using well characterized source term, processing time, and measured air concentrations) for Simonds Saw and Steel. Furthermore, NIOSH also performed a validation comparison for the 1960 thorium ingot operation at Rocky Flats. Both examples demonstrate that NUREG-1400 is bounding, as described in Section 4 of this report.

SC&A Comment 26:

NUREG-1400 does not provide a bounding approach to estimation of thorium doses from machining operations relating to the 6-kilogram pieces machined on occasion at Rocky Flats. NIOSH has not yet established an approach to dose reconstruction relating to these operations that meets the criteria for estimation of dose with sufficient accuracy under 42 CFR 83 for these operations. This is not to say that such an approach could not be established (with the proviso of a firm source term) using data from Rocky Flats and other facilities for comparable operations. This may be possible. SC&A's finding is that the methods proposed by NIOSH to date do not meet the test required by dose reconstruction with sufficient accuracy 42 CFR 83.

NIOSH Evaluation 26:

SC&A continues to insist that the use of NUREG-1400 be validated by comparing predicted results to those observed for operations involving thorium similar to those at Rocky Flats. It is NIOSH's previously stated and currently held position that there is no such requirement stated in NUREG-1400. Furthermore, the validity of this approach is widely recognized and accepted in the regulatory community. No convincing evidence has been presented that it would be somehow inapplicable to the very limited thorium operations at Rocky Flats. However, in an effort to reach consensus with SC&A on this issue, NIOSH has performed two comparisons to satisfy SC&A's concerns (Section 4). One comparison uses data from another facility, and one uses data from Rocky Flats, as suggested in the comment. Both comparisons verify that NUREG-1400 is bounding.

SC&A Comment 27:

During the January 9, 2007, working group teleconference call NIOSH stated that a worker interview indicated that magnesium-thorium alloy may have been shipped by the truckload from Dow Madison to Rocky Flats. SC&A did a very preliminary review whether the processing or use of such material might have implications for dose reconstruction.

The Nuclear Regulatory Commission produced a detailed assessment of circumstances in which by-product and source materials might be exempted from regulation (*Systematic Radiological Assessment of Exemptions for Source and Byproduct Materials*, NUREG-1717, June 2001). NUREG-1717 includes dose assessments that indicate that doses from metal-thorium alloys could produce doses that are in excess of those estimated by NIOSH using NUREG-1400 for pure thorium.

NIOSH Evaluation 27:

Most importantly, there is no conclusive evidence that Mg-Th alloy was present in significant quantities at Rocky Flats, let alone that "physical, or metallurgical treatment or processing" of Mg-Th alloy occurred at the site. Two Dow Madison workers have stated that they recalled such shipments. Four Rocky Flats workers have stated that they have no recollection of such shipments, and would have been in a position to know of them if they occurred. No independent documentary evidence (*e.g.* shipping records or inventories) has been presented by SC&A, parties interested in the Dow Madison site, or located by NIOSH as of this writing to suggest that such shipments took place. Magnesium-thorium alloy was used "almost exclusively in aircraft parts, particularly parts for aircraft engines" (NUREG-1717). While this is not conclusive, the known uses of Mg-Th alloy do not seem compatible with the mission of Rocky Flats. At the January 26, 2007, meeting, the working group declined to request further followup actions on this issue. It is NIOSH's understanding that barring further evidence, this issue is closed.

NUREG-1717 contains an example for an aircraft engine maintenance worker. In keeping with the purpose of this document (conservatively determine whether an exemption from regulation is warranted), this example makes several extremely conservative assumptions including (1) the thorium in the alloy is 10 years old (2) the source term assumed was a large (75 kg) casting and 10 smaller (1.6 kg each) castings (3) the average distance between the source terms and the worker was assumed to be 50 cm, and (4) the worker was assumed to spend 40 h/yr in proximity to the smaller castings, and 1000 h/yr in proximity to the large casting. Even under these conservative assumptions, which may be appropriate for a bounding analysis for an airline maintenance worker, the annual external dose equivalent was only 50 mrem. SC&A has not explained why they feel this example would be applicable to Rocky Flats.

SC&A's comparison of the external dose from the above example to the internal dose calculated by NIOSH for light machining is not appropriate. No evidence has been presented or discovered that suggests workers handling thorium metal at Rocky Flats would have received unmonitored external exposures. Furthermore, there is no evidence of any operations with thorium metal which would have required proximity to the source for anything approaching 1000 h/yr, and no evidence has yet been discovered of any operations at all with Mg-Th alloy at Rocky Flats.

SC&A Comment 28:

In the case of tungsten-thorium welding rods with 4% thorium, NUREG-1717 cites a German study whose findings were as follows:

> *Ludwig et al. (1999) reported that in a room with volume of about 100 m3, and without any ventilation or suction system, 35 electrodes (45 by weight thorium) were ground in 15 minutes. Their graph indicates an activity concentration for 232Th during the grinding of about 180 mBq/m3 (5×10_6 _Ci/m3) with the airborne activity concentration decreasing soon after the end of grinding. The only case from the Ludwig et al. (1999) study that involved local exhaust ventilation indicated a reduction factor of 100.*

> *The study estimated levels of 232Th intakes for welders from less than 0.1 to 144 Bq/yr (<2.7×10_3 to 3.9 nCi/yr) during welding and from 0.02 to 30.2 Bq/yr (5.4×10_4 to 0.82 nCi/yr) during grinding. In six cases the estimated total intake was estimated to exceed the annual limit for intake to the public of thorium in oxide form, as derived from ICRP Publication 71 (ICRP 71), based on the projections from limited sample data. Four of the six cases involved welders, working with alternating current, where the main exposure was caused by the welding process. The other two welders used direct current welding with the grinding causing the estimated intake to exceed the intake limit.* [NUREG-1717, p. 3-105]

It is to be noted that an intake at the high end of the cited range, 144 Bq of Th-232, would produce a committed bone surface dose of ~30 rem, if Type M solubility is assumed. This is almost five orders of magnitude greater than the bone surface dose calculated for the light machining of thorium using NUREG-1400. For Type S the committed dose would be ~4 rem, about four orders of magnitude greater than the dose that NIOSH calculated for light machining.

NIOSH Evaluation 28:

The appropriate solubility type for thorium dioxide is Type S, not type M, therefore SC&A's calculation of 30 rem committed to the bone surface is inappropriate and a gross overestimate.

Ludwig et al. (1999) states that "A welder can normally grind an electrode within about 1 minute and he has to grind electrodes only a few times per work day. Because of this low grinding frequency the sampled activity on the filter was expected to be below the detection limit of the filter analysis. On account of this problem, many electrodes were ground in close succession for these samples."

The survey conducted by Ludwig et al. (1999) of 26 welding shops indicated an average of one instance of grinding one electrode per hour of welding, with a range from 0.33 to 4.4 per hour. The instance of grinding of 35 electrodes in 15 minutes within an unventilated room of volume 100 m^3, was not done for the purpose of measuring a representative air concentration to which welders might be exposed; rather is was an experimental setup designed to observe the rate of decrease in airborne ^{232}Th concentration. The investigators couldn't measure this very well if they only sharpened one electrode, as the activity would be too low to detect. Therefore, to take the concentration derived from this contrived situation, and assume it provides representative air concentrations to which welders might be exposed during grinding each electrode is inappropriate.

Earlier in their manuscript, the Ludwig *et al.* indicate that although they "sought to determine the airborne thorium activity concentration during grinding and welding under realistic working conditions….the grinding frequency was atypical – it was increased to provide detectable quantities of thorium on sampling filters.." Therefore, they acknowledge that the measured air concentrations during grinding were not realistic – yet they don't make any corrections to their measured values when they calculate intakes associated with grinding. They further do not attempt to correct their intake calculations for respirable particles associated with grinding, yet other studies indicate the respirable fraction may be 60% or significantly lower.

Regarding their estimated intakes during welding, for each welder, Ludwig *et al*. multiplied the activity concentration they measured in the breathing zone of the welder by the annual working time the individual reported in which welding and welding-related work (such as preparation) took place. Thus, they assumed that each welder was exposed to the air concentration associated with their measurement on that day for the number of hours the welder estimated he was involved in welding or welding-related activities. This is completely unreasonable and inappropriate – the geometric mean air concentration of the 26 measurements they made during welding (both AC and DC) was 0.9 mBq/m^3, yet they assigned this one welder an intake based on a measured breathing zone concentration of 90.9 mBq/m^3. The geometric mean air concentration associated with AC welding from their work was 4.3 mBq/m^3. The welder in question was doing AC welding using 2% thoriated rods at the time, but that does not mean he always is involved in that type of welding. Their survey of time spent in welding activities did not provide that information. Furthermore, it is not reasonable to assume the welder was welding during the entire number of hours per year he estimated he was involved in welding or welding-related activities.

It is critical to recognize that thoriated welding electrodes were designed for DC welding of steel, nickel alloys, and most alloys other than aluminum or magnesium. They maintain a sharpened tip configuration during welding. They are not normally used with AC welding because it is difficult to maintain the balled end, which is desirable with AC welding (of materials such as aluminum). Many of the recent studies evaluating exposures to welders acknowledge that this is the case. More details are provided in Section 6 of this report.

SC&A Comment 29:

NUREG-1717 also explicitly discusses magnesium-thorium alloy:

> *In 10 CFR 40.13(c)(4), persons who receive, possess, use, or transfer any finished product or part fabricated of, or containing, tungsten- or magnesium-thorium alloys are exempted from licensing requirements for source material, provided the thorium content of the alloy does not exceed 4% by weight. The exemption does not authorize the chemical, physical, or metallurgical treatment or processing of any such finished product or part. An exemption for thoriated tungsten containing not more than 3% by weight of thorium, and without any other conditions on treatment or processing of the material, was first established on March 15, 1949 (14 FR 1156). The exemption in its present form was proposed on September 7, 1960 (25 FR 8619), and issued as a final rule on January 14, 1961 (26 FR 284).* [NUREG-1717, Section 3.16]

Note that under present day standards, in force since 1961, the "physical, or metallurgical treatment or processing" of magnesium-thorium alloys is not exempt from regulation. Even when alloy is not processed, the annual external doses alone in NUREG-1717 are far greater than the effective dose calculated bu NIOSH for light machining. NUREG -1717 estimates that average annual external dose to a maintenance worker handling and working on aircraft parts EDE for 1040 hours per year to be about 50 mrem (p. 3-243).

NIOSH Evaluation 29:

Most importantly, there is no conclusive evidence that Mg-Th alloy was present in significant quantities at Rocky Flats, let alone that "physical, or metallurgical treatment or processing" of Mg-Th alloy occurred at the site. One Dow Madison worker has stated that he recalled such shipments. Four Rocky Flats workers have stated that they have no recollection of such shipments, and would have been in a position to know of them if they occurred. No independent documentary evidence (*e.g.* shipping records or inventories) has been presented by SC&A, parties interested in the Dow Madison site, or located by NIOSH as of this writing to suggest that such shipments took place. Magnesium-thorium alloy was used "almost exclusively in aircraft parts, particularly parts for aircraft engines" (NUREG-1717). While this is not conclusive, the known uses of Mg-Th alloy do not seem compatible with the mission of Rocky Flats.

The example referenced from NUREG-1717 makes several extremely conservative assumptions including (1) the thorium in the alloy is 10 years old (2) the source term assumed was a large (75 kg) casting and 10 smaller (1.6 kg each) castings (3) the average distance between the source terms and the worker was assumed to be 50 cm, and (4) the worker was assumed to spend 40 h/yr in proximity to the smaller castings, and 1000 h/yr in proximity to the large casting. Even under these conservative assumptions, which may be appropriate for a bounding analysis for an airline maintenance worker (as in the NUREG-1717 example), the annual external dose equivalent was only 50 mrem. SC&A has not explained why they feel this example would be applicable to Rocky Flats.

SC&A's comparison of the external dose from the above example to the internal dose calculated by NIOSH for light machining is not appropriate. No evidence has been presented or discovered that suggests workers handling thorium metal at Rocky Flats would have received unmonitored external exposures.

SC&A Comment 30:

It is clear from NUREG-1717 and the other considerations presented above that knowledge of the approximate quantities, periods, and processing status of the magnesium-thorium alloy is needed before any reliable conclusions can arrived at regarding doses to Rocky Flats workers from this material.

NIOSH Evaluation 30:

SC&A's conclusion that magnesium alloy was received at Rocky Flats from Dow Madison is premature. One Dow Madison worker has stated that he recalled such shipments. Four Rocky Flats workers have stated that they have no recollection of such shipments, and would have been in a position to know of them if they occurred. No independent documentary evidence (*e.g.* shipping records or inventories) has been presented by SC&A, parties interested in the Dow Madison site, or located by NIOSH as of this writing to suggest that such shipments took place.

Magnesium-thorium alloy was used "almost exclusively in aircraft parts, particularly parts for aircraft engines" (NUREG-1717). While this is not conclusive, the known uses of Mg-Th alloy do not seem compatible with the mission of Rocky Flats.

NIOSH does not concur that anything in NUREG-1717 suggests that Mg-Th alloy presents an SEC issue at Rocky Flats.

SC&A Comment 31:

There were also other thorium operations at Rocky Flats. Some of these involved less that 500 grams of material. Such uses of thorium were regarded as small and were not reported in materials accounting records. Such uses of less than 500 grams included (Bistline 1976, p. 1 and pp. 3-4):

- Coating molds with thorium oxide;
- Use "in analytical procedures…as well as in development programs… [on numerous occasions…."]
- Use of thorium "as a stand-in or replacements for the more expensive Uranium or Plutonium components in certain phases of development programs. Usually these needs involved small amounts of material, but it nevertheless involved handling Thorium. This type of operation occurred frequently in the past and is occurring at the present time. Each individual use is too small for record keeping but, in the aggregate, it would approach 7 kg of Thorium in a variety of forms at the present moment."

The term "in the aggregate" in the last bullet point appears to refer to all then-current thorium development programs during 1976; however, SC&A notes that the statement is ambiguous and may refer to a cumulative amount of thorium use in development applications.

NIOSH implicitly proposes to use NUREG-1400 for these small uses as well. In its October 2006 paper on thorium intakes, NIOSH stated:

> *Other uses and operations involving thorium at RFP are listed in Table 1. The highest calculated potential internal intakes result from the fabrication of large metal weapons parts for which intakes are estimated above. Smaller quantities assumed for most of the other uses and operations are offset by the thorium being in the form of powders or other more dispersible materials, but still resulting in fractional mrem estimated doses.* [Attachment 19, p.5]

However, the argument that doses would be in the "fractional mrem" has not been well established. The source term for these small uses is not individually documented in material control records due to the then-prevailing policy regarding thorium accounts.

NIOSH Evaluation 31:

The comment is not correct in stating that that the material used in these small applications is not reflected on the Material Balance and Inventory ledgers. While it is the purpose of these ledgers to account for the thorium inventory, it is not the purpose of the ledger to detail each individual use of thorium. However, the sitewide inventory of $Th(NO_3)_4$, and ThO_2 is explicitly included in the ledgers.

The December 1967 Material Balance and Inventory ledger notes a material unaccounted for total of 7 kg, and states, "This represents 7 kg consumed by the Analytical Laboratories over a period of years. Thorium nitrate is utilized as a titrating reagent in the analysis of fluorine." Therefore, this 7 kg MUF represents a cumulative total as of that time. As stated in NIOSH's December 26, 2006, report, the smaller quantities in these analytical uses (*e.g.* 7 kg in total over a number of years in this example, as opposed to 60 kg for the handling of preformed thorium metal parts) is offset by the increase in the release fraction for thorium nitrate (0.1 for liquids) compared to that for thorium metal (0.01). Therefore, the resulting NUREG-1400 calculations would yield bounding doses similar to those calculated for the preformed parts (fractions of a mrem for the calculation in the December 26, 2006, report, and a few mrem for the revised calculations presented in Section 5 of this report).

SC&A Comment 32:

It should be noted that the higher dose conversion factors for thorium for some organs make one gram of thorium-232 radiologically comparable to a far larger amount of uranium (~100 times larger in case of bone surface dose, in the worst-case, for the same solubility, using dose conversion factors for committed dose in Federal Guidance Report 13 as the basis for the comparison). Hence, small amounts of thorium-232 would represent doses that would correspond to those delivered by much larger amounts of uranium for bone surface and several other organs. Further, given that NIOSH has not established that NUREG-1400 yields a bounding dose – on the contrary the one test against operational air concentrations for machining operations yielded a contrary result.

NIOSH Evaluation 32:

The comparison presented in SC&A's comment is inappropriate. The organ dose conversion factor is only one parameter to consider when calculating the potential organ doses associated with a given intake of different radioactive materials. It is not correct to state "small amounts of thorium-232 would represent doses that would correspond to those delivered by much larger amounts of uranium for bone surface and several other organs" based solely on a consideration of the organ dose conversion factor. One also has to consider, among other factors, (1) the chemical form of the radionuclide being considered and the associated solubility, (2) the radioisotope being considered (not specified for uranium in SC&A's comparison above) (3) the timeframe under consideration (committed dose is not used for dose reconstructions in this program – annual organ doses are). One also has to consider the actual potential for uptake. The potential for an uptake of thorium at Rocky Flats was trivial compared to the potential for an uptake of depleted or enriched uranium, due to the lack of significant operations for thorium compared to the very significant level of operations with uranium.

SC&A Comment 33:

NIOSH stated during the January 9, 2007, call that the cumulative amounts from small uses are in the material accounts. Hence, it may be possible to establish a source term for these small uses. However, given that the use of NUREG-1400 to Rocky Flats thorium operations has not been demonstrated to be in conformity with 42 CFR 83 in the one case in which a comparison was done with operational processes, it is not clear how NIOSH would proceed to estimate doses from the repeated small uses of thorium.

Small uses of thorium-232, each less than 500 grams, were not part of Rocky Flats materials accounts. In view of the inapplicability of NUREG-1400 to Rocky Flats thorium doses under 42 CFR 83, discussed above, it is unclear how NIOSH will estimate doses from the many occasions when thorium was used in small quantities.

NIOSH Evaluation 33:

The comment is not correct. Small quantities of thorium compounds (thorium nitrate, oxide, and fluoride) used in the referenced analytical procedures are accounted for on the Material Balance and Inventory ledgers as being received at Rocky Flats and issued to R&D. If the material was distributed onsite in quantities <500 grams, each individual distribution would not be expected to appear on the inventories for each building.

Some specific individual analytical procedures were described in NIOSH's December 27, 2006, report. Rocky Flats also used thorium nitrate as a titrating reagent in the analysis of fluorine. The accounting of each analytical procedure involving small quantities of thorium is not a reasonable standard, and has not been required in the evaluation of any other SEC petition. It is not clear to NIOSH how such uses of small quantities of thorium compounds in analytical procedures presents a significant exposure hazard such that it constitutes an SEC issue.

NIOSH also does not concur with SC&A that it is a "given that the use of NUREG-1400 to Rocky Flats thorium operations has not been demonstrated to be in conformity with 42 CFR 83" as described elsewhere in this document".

SC&A Comment 34:

The problem regarding Th-228 contamination of U-233, which arose from presence of trace U-232 (50 ppm) in the U-233, is more complex. Rocky Flats conducted operations to remove the Th-228 from U-233 prior to processing of the latter according to customer requirements ("thorium-228 strikes on uranium-233"). NIOSH proposes to use NUREG-1400 to provide an upper bound estimate for intakes of Th-228 during such operations. Its evaluation of the matter in its December 27, 2006, report states:

> *The previous comparison between conservative values above resulted in a value above the NUREG-1400 estimate. In this case the Th^{228} extraction with daughters is so grossly overestimated both in terms of total quantity of isotope present and in the demonstrated confinement of the glove box process facilities in which the*

> *extraction and waste handling was performed, that the NUREG-1400 estimate is not deemed overly conservative. Air activity that would result in 100 Bq intake would have been cause for a significant release with the subsequent detail in the health physics logs we have reviewed.* [Attachment 20, p. 13]

This is a confusing conclusion. For instance, if NUREG-1400 is not deemed overly conservative" then how is it to be characterized? SC&A asked NIOSH for a clarification and received the following response on December 29, 2006, via an e-mail from Brant Ulsh:

> *Joe [Fitzgerald] et al:*
>
> *The following elaboration was provided by Bryce Rich. I hope this clarifies things, but let me know if you have additional questions:*
>
> *Using the NUREG-1400 approach, we used a confinement factor of 3E-4 (99.7% filtering efficiency of typical HEPA filters for 0.3 micron particles – the least well filtered particle size) instead of the 0.01 used for typical evaluations for the original purposes of the report.*
>
> *10 Ci of Th-228 is used, but is an overestimate of quantity, since the amount of U-233 is maximized at 20 kg (one time at this level) and 2 years for ingrowth of Th-228 is assumed to achieve 50% equilibrium.*
>
> *This resulted in a calculated potential intake of 1 Bq.*
>
> *If we had used the ratio of 100:1 (measured:NUREG-1400) estimates derived in the previous thorium metal parts machining example and upgraded this estimate by a factor of 100, i.e. 100 Bq intake, this would have meant a release of >100 MPC/MPL (3E-10 uCi/cc) air concentrations for 8 hours and no respirators. Considering the routine monitoring capability in Bldg. 771 at the time this would have alarmed all the CAMs immediately and been the cause of a major incident with reports, urine sampling, surface surveys, cleanup, etc.*
>
> *This was a "special" project with high gamma-emitting radioisotopes. They had a lot of attention by HP professionals and technicians. The 100 Bq intake release didn't happen. Glove box releases happened due to accidents, glove failures, etc. – not routine releases.*
>
> *For this reason, using the NUREG-1400 estimating technique was deemed adequate as used and did not predict a major release.*

Even if one accepts without further documentation that air concentrations corresponding to an intake of 100 Bq would cause alarms to go off, it is unclear, why the intake may not have been 5 Bq or 10 Bq or some other number less than 100 Bq but more than 1 Bq. Therefore NIOSH's reasoning does not demonstrate that the intake estimate of 1 Bq is reasonably bounding.

NIOSH Evaluation 34:

The discussion regarding a 100 Bq release was simply to bolster the case for NIOSH using a confinement factor of 3E-4 for the Rocky Flats high integrity gloveboxes, rather than the 0.01 default in NUREG-1400. Had the default confinement factor been used instead of the more realistic but still conservative value used by NIOSH, the resulting predicted air concentrations would have been high enough to alarm the CAMs in Building 771. It must be emphasized that this was but one supporting argument for this confinement factor. The most compelling argument is that the gloveboxes were equipped with two in-line high efficiency HEPA filters, and no accident conditions (*e.g.* glove punctures, seal failures, etc.) were noted in the documentation describing the thorium strikes. Under normal operating conditions, such as those during the thorium strikes, the value of 3E-4 for the confinement factor for the high integrity gloveboxes is justified. The estimate of 1 Bq was based on NUREG-1400 calculations, not on the argument that a 100 Bq release was not possible.

SC&A Comment 35:

Further, NIOSH's reasoning depends on assumptions about monitoring that was operative at the time of Th-228 strikes and is based on general statements about the integrity of and care taken in monitoring. SEC affidavits have, on the contrary, claimed that furtive work practices were ordered and that such unauthorized activities were carried out. In this context, acceptance of a general statement such as the one above, without reference to the specific process in consideration, amounts to endorsing one point of view over the other and placing the burden of proof regarding Th-228 strikes on the petitioners. It is, of course, for the Board to consider, whether and to what degree, this is appropriate.

NIOSH Evaluation 35:

The comment is incorrect. NIOSH did not rely on "assumptions about monitoring that was operative at the time of Th-228 strikes and is based on general statements about the integrity of and care taken in monitoring". Rather, as described in our December 27, 2006, report, NIOSH relied on six documents (including reports explicitly describing the thorium strikes, health physics logbooks, etc.) as well as three interviews with site experts with direct knowledge of the thorium strikes. The concern about "furtive" job tasks performed outside the bounds of normal work practices was expressed in Part B of the SEC petition (pdf page 48), and were not related to thorium strikes. The implication of SC&A's comment above is that there were "furtive" thorium strikes. No evidence has been presented to substantiate this, nor was this claim raised in the SEC petition. This is the first time SC&A has implied this. Such an occurrence would be at odds with the documentation and site expert statements NIOSH has assembled, and NIOSH would be very interested in reviewing SC&A's evidence that furtive thorium strikes occurred.

SC&A Comment 36:

Finally, the comparison of the application of NUREG-1400 to operational processes above indicates that at least in some circumstances, the use of NUREG-1400 could lead to significant underestimates of intake. Therefore, NUREG-1400 cannot be reasonably regarded as yielding estimates of "sufficient accuracy" under 42 CFR 83 unless a specific demonstration is made that 1 Bq is a bounding estimate. NIOSH has not done this in its analysis. NIOSH's assertion that operations lasted for a short period of time is not really relevant to the application of NUREG-1400. Whether the routine operations are done over 250 days or a single day is not relevant to NUREG-1400. The relevant consideration in NUREG-1400 is that the equation should be applied over operations and times where air concentrations can reasonably be averaged. NUREG-1400 discusses intakes over an annual average, but does not require processes to be operating all the time.

NIOSH Evaluation 36:

NIOSH does not agree with SC&A's continued insistence that NUREG-1400 must be validated by comparing predicted results to those observed for operations involving thorium similar to those at Rocky Flats. It is NIOSH's previously stated and currently held position that there is no such requirement stated in NUREG-1400. Furthermore, the validity of this approach is widely recognized and accepted in the regulatory community. No convincing evidence has been presented that it would be somehow inapplicable to the very limited thorium operations at Rocky Flats. However, in an effort to reach consensus with SC&A on this issue, NIOSH has performed two comparisons to satisfy SC&A's concerns. These comparisons are discussed in detail in Section 4 of this report.

NIOSH also does not agree that NUREG-1400 has been shown to produce results that are not bounding. The estimates NIOSH previously presented derived from uranium operations yielded higher estimates than the NUREG-1400 calculations for light machining of thorium parts, however the uncertainties on the uranium analysis are quite large and are also quite conservative. For example, the dose calculated from the uranium air concentration approach was directly dependent on the exposure time assumed. NIOSH's calculation assumed 10 hours/year, which is a gross overestimate of the time it might have taken to lightly polish 60 kg of thorium over the course of a year. In contrast, the examples presented in Section 4 deal directly with thorium, so no extrapolation from uranium operations is necessary. They also deal with a well-defined source term, a well-defined processing time, and measured air activities. These examples demonstrate that NUREG-1400 is indeed bounding compared to calculated intakes based on real thorium operations, one of which occurred at Rocky Flats (1960 ingot operation).

SC&A Comment 37:

NIOSH has provided no analysis to show that NUREG-1400 provides a bounding estimate for dose in the case of Th-228 strikes that would be appropriate under 42 CFR 83. Specifically, SC&A does not concur with NIOSH that its reasoning regarding a 100 Bq intake being essentially impossible demonstrates that a 1 Bq intake estimate is a reasonable upper bound estimate. SC&A concludes that NIOSH's estimates for intakes during thorium-228 strikes using NUREG-1400 do not meet the test of dose estimates with sufficient accuracy under 42 CFR 83. NIOSH has not presented any operational data for this process that would allow such estimates.

NIOSH Evaluation 37:

NIOSH disagrees that NUREG-1400 is somehow inapplicable at Rocky Flats. Even though NIOSH disagrees that a validation of NUREG-1400 is required, NIOSH has provided such an analysis in Section 4 of this report. This analysis demonstrates that NUREG-1400 does indeed produce bounding estimates. As noted in NIOSH's previous reports, the thorium strikes were extensively documented both in reports dealing explicitly with the operations, and in health physics logbooks. There is no indication in any of the references that indicates that there was any release associated with the thorium strikes. On the contrary, the references detail very carefully monitored operation with no detectable releases. Furthermore, these operations were conducted in high integrity gloveboxes. No releases are expected from such gloveboxes under normal operating conditions. Releases would have been possible in the case of glove punctures or bag cuts, however there is no indication whatsoever that these conditions occurred. NIOSH stands by our analysis presented in our December 26, 2006, report that estimated bounding doses of 30 mrem to the bone and lung for thorium strikes.

SECTION 2: INTERVIEWS ON THORIUM MACHINING/TRIMMING AT ROCKY FLATS

Telephone interviews conducted January 16th and 17th with five former Rocky Flats personnel and all were asked the following questions:

(1) When did you start and how long did you work at Rocky Flats?

(2) What were your responsibilities?

(3) What can you tell us about the machining and or trimming of thorium parts at Rocky Flats?

[INTERVIEWEE]
Started in [date] as a chemical operator. Was involved with rolling, forming, and machining operations at Buildings 776, 881, and 883. Was General Foreman of building 444 from [date] to [date]. In building 444 he was responsible for all rolling, forming and machining operations. During his tenure at Building 444 there was only beryllium and depleted uranium being machined. He was also involved with R&D and "special orders" and would have known if thorium was being machined. He clearly stated that to the best of his recall, there was no machining or trimming of thorium metal. When asked if there was hypothetically thorium machining done at RF how that would have been accomplished? He said all radioactive/pyrophoric metal with resultant turnings or chip would be been covered by a water-based oil emulsion. This would have minimized dispersion of chip and minimized potential fires.

[INTERVIEWEE]
Started in [date] and worked [x] years at Rocky Flats until. He left Rocky Flat for [x] years beginning in [date] to attend Iowa State University and Ames laboratory to get his masters degree. His master's thesis was "" He is currently a consultant to LANL on machine production and gauging for new pit production and still holds an active "Q" clearance. While at Rocky Flats he was the lead engineer for "non-traditional" machining. His responsibilities were R&D on machining techniques like electrochemical and electrical discharge machining. He clearly stated that in his position he never saw a piece of thorium metal at Rocky Flats. He said if he knew that some thorium was present, he would have gone to look because of his interest. His primary work in Building 881, which he stated went "cold" in 1965. When asked what would be meant by "light machining" he stated at Rocky Flats that would have been no more than removal of 10 mils or less of material. He has excellent recall of R&D machining activities at Rocky Flats.

[INTERVIEWEE]
Started in [date] worked [x] years until [date]. He was the liaison between R&D and production in the uranium facilities (883, 881, 444). Did not recall any machining of thorium. When asked what would be meant by "light machining", he clearly stated that "it would be the minimal removal of material 30 mils of less and gram quantities removed". He also said that if there were significant quantities thorium present, he would have known about it and would have remembered.

[INTERVIEWEE]
Started in [date] at Hanford and came to Rocky Flats in [date] as a machinist. He worked for [x] years at Rocky Flats. He was a supervisor and a General Foreman for production and in became the Superintendent and Director of Production Operations. In He was the Deputy General Manager for Production. He had no recall that any machining of thorium metal took place at Rocky Flats.

[INTERVIEWEE]
Started in June [year] and worked at Rocky Flats until [date] as machinist in the R&D area. He also had no recall of any machining of thorium at Rocky Flats.

Summary of conclusion with regards to machining of thorium parts at Rocky Flats.
The ChemRisk Task 3/4 report clearly states that "There was light production of thorium parts in Building 881 in the 1950s to early 1960s. The report also states the "The major use has been fabrication of metal parts from natural thorium" and was also used as a "stand in" for the more expensive U or Pu components in various phases of development programs. It is not clear from the report itself whether "light production of thorium parts" refers to the ingot operation in 1960, or to some machining on the preformed Th metal parts received primarily from Y-12. The interviews above suggest the former, as none of the workers interviewed recalls any machining of thorium parts. If "light machining" of the preformed parts did indeed take place, it would have used a water-based oil emulsion cutting oil and at most 30 mils or less of material removed.

SECTION 3: INTERVIEWS ON USE OF MAGNESIUM-THORIUM ALLOY AT ROCKY FLATS

Telephone interviews conducted January 9th and 10th with four former Rocky Flats personnel and all were asked the following questions:

(1) How long did you work at Rocky Flats?

(2) What were your responsibilities?

(3) What can you tell us about the use of Magnesium alloy at Rocky Flats?

(4) If there were significant quantities of Magnesium alloy (more than a few kilograms), would you have knowledge of it's presence at Rocky Flats?

[INTERVIEWEE]
Started in [date]. Came from LASL as a manager to start developing plutonium processes. Worked at Rocky Flats for [x] years. He was a senior manager and a member of the Operating Board. The Operating Board had responsibility to approve all processes at Rocky Flats. He said that the conveyor system in Building 776 box line used magnesium for reduction in weight and strength stability. He had no recall of significant quantities or other use of magnesium alloy at Rocky Flats. He said that if there were significant quantities present, he would have known about it. He said that there was no magnesium alloy used in any processes for development or fabrication of weapons components. He said that pure magnesium salts were used in some of the chemical process, primarily for reduction of metal.

[INTERVIEWEE]
Started in [date] and worked [x] years until. He held many management responsibilities including Health Physics unit leader, and Manager of Plant Facilities, Construction and Support. He has excellent recall of operations and activities at Rocky Flats.

He clearly remembered that only the pennants in the conveyor system were made of magnesium alloy. The conveyor was constructed of stainless steel. He said that the conveyor system and pennants were fabricated and installed by an outside vendor. He was one of the first persons back into Building 776 after the May 11, 1969 fire. He clearly remembered that only few pennants were no longer present. He estimates that each pennant weighs no more than 4 pounds and there were about 10 to 15 pennants missing, primarily from Box B-4 in the North line. All others were present. There were about a hundred or so pennants in the box line. The entire box line was removed and sent as waste to Idaho.

He also said that there was no magnesium alloy used in any processes for development or fabrication of weapons components and if there were significant quantities present, he would have known about it.

[INTERVIEWEE]
Started in [date] and worked [x] years until. He has continued until closure as a consultant to Rocky Flats. Was Director of Plutonium Operations, Manager of Chemistry Technology, and Chemistry R&D. From [year] he served on the Shipment Receiving Authorization Committee that was responsible to reviewing all incoming radioactive shipments to Rocky Flats. There was a form that needed to be signed by the committee before anything (radioactive) was shipped to Rocky Flats.

He did not remember exactly what the conveyor system was made of but he did remember the pennants that held/hold the parts on the conveyor were a special alloy. He recalled that he had to complete and file a special record for the waste recovered after the 1969 fire to account for any fire hazard in the waste being sent to Idaho. He thinks it was magnesium. Most important point from [INTERVIEWEE] is that there was no magnesium alloy used in any processes for development or fabrication of weapons components. He also said the conveyor system and pennants would have been an outside vendor fabrication. He said that it would have been highly unlikely that RF would have purchased the magnesium alloy from Dow Madison and provided it to the vendor as government furnished equipment (GFE). He also acknowledged the use of magnesium salts in metal reduction processes.

He also said that if there were significant quantities of magnesium present at Rocky Flats, he would have known about it. He emphasized that because of the high degree of concern for fire potential any materials used at Rocky were reviewed and approved by the fire department prior to use. He stated that he would have known about any use of potentially flammable structural materials.

He added that the weapons component specifications at Rocky Flats were very precise and any materials used were carefully evaluated for possible effect on the neutronic properties of the weapons components. [INTERVIEWEE] had excellent recall and knowledgeable of activities and operations at Rocky Flats.

[INTERVIEWEE]
Started in [date] and worked for [x] years at Rocky Flats. He was a chemist and a supervisor for building 771. He did recall that the conveyor line in B776 had some magnesium alloy and some it did burn in the May 11, 1968 fire. When asked for an estimate of the quantity of magnesium alloy in the box line he said maybe a few hundred pounds at most because “it goes a long way”. He said that if there were significant quantities magnesium alloy present, he would have known about it. He said that there was no magnesium alloy used in any processes for development or fabrication of weapons components.

SECTION 4: NUREG-1400 VALIDATION

SC&A has insisted that the use of NUREG-1400 be validated by comparing predicted results to those observed for operations involving thorium similar to those at Rocky Flats. It is NIOSH's previously stated and currently held position that there is no such requirement stated in NUREG-1400. Furthermore, the validity of this approach is widely recognized and accepted in the regulatory community. No convincing evidence has been presented that it would be somehow inapplicable to the very limited thorium operations at Rocky Flats. However, in an effort to reach consensus with SC&A on this issue, NIOSH has performed two comparisons to satisfy SC&A's concerns.

This section considers actual thorium operations, including Simonds Saw and Steel, as suggested by SC&A (see Comment 25) in a conference call on January 16, 2007. The Simonds example has the following advantages:

(1) Operations involving thorium, so no conversion from uranium is required
(2) A discrete source term
(3) A discrete processing time
(4) Measured air activity measurements

To perform this comparison, NIOSH first calculated the *observed* intake estimate based on the measured air concentrations and the specified exposure time. This observed intake was then compared to the intake *predicted* by NUREG-1400 using the specified quantity of thorium. The ratio of predicted to observed intakes was 1.6, demonstrating that NUREG-1400 was indeed bounding in this example.

NIOSH also performed a similar comparison for the 1960 ingot operation at Rocky Flats, which had the same four advantages as those listed above for Simonds Saw and Steel. It is critical to stress that NIOSH's conclusion that no significant intakes occurred from this operation is based on the measured air concentrations and limited bioassays, as well as the detailed descriptions of this operation as discussed in our December 26, 2006, report. The current comparison is being performed only as a validation of NUREG 1400. The ratio of predicted to observed intakes for this comparison was 2.6, again demonstrating that the NUREG-1400 approach is bounding.

Details of these comparisons follow below.

EXAMPLE 1

Simonds Saw and Steel Thorium Billet Rolling and Processing:

- 8500 lbs of thorium ingots were rolled on November 25, 1952 [Belmore, F.M. (1952) Thorium Rolling - Simonds Saw & Steel Company]

- An extensive air activity survey was performed of this operation (Klevin and Weinstein 1953)

NUREG 1400 Results:

- Intake I = Q (1E-6)(R)(C)(D)

- Release Fraction R = 0.001 as the physical form was "Solids, e.g., uranium fuel pellets, cobalt, or iridium metal"

- Confinement Factor C = 1 since "for this rolling all of the 93 thorium billets processed were rolled in an unventilated 10" Bar Mill located southwest of the larger mill [Klevin, P.B. and Weinstein, M. S. (1953) Simonds Saw and Steel Company occupational exposure to thorium. Simonds-13. Industrial Hygiene Branch Health and Safety Division, New York USAEC Operations Office Industrial Hygiene Branch Health and Safety Division, New York USAEC Operations Office.]

- Dispersibility D = 10 since "A dispersibility factor of 10 can be applied to the calculation if cutting, grinding, heating, or chemical reaction of materials are performed.

- Q = 8500 lbs x 454 gms/lb x 2.2E-7 Ci/gm = 0.85 Ci

- Intake I = 0.85 Ci (1E-6) (1E-3) (1) (10) 3.7E+10 Bq/Ci = 315 Bq

Air Sample Measurement Results:

Source of data was [Klevin, P.B. and Weinstein, M. S. (1953) Simonds Saw and Steel Company occupational exposure to thorium. Simonds-13. Industrial Hygiene Branch Health and Safety Division, New York USAEC Operations Office Industrial Hygiene Branch Health and Safety Division, New York USAEC Operations Office.]

- 20 employees were monitored as each performed their several functions, recording their exposures at each task for the entire 7-hour period of the operation.

- For purposes of this survey 70 dpm/m^3 was used as the maximum allowed air concentration (MAC)

- The maximum exposure to two workers was 40 x MAC = 2800 dpm/m^3 time weighted average for the entire 7-hour shift.

- The average weighted exposure was 1030 dpm/m^3. For purposes of this comparison, the maximum exposure to any individual worker was used. This is a significant overestimate of the average worker's exposure, and was chosen to demonstrate a bounding estimate.

- At least 50% of the radioactivity collected on air filters during high temperature thorium processing is due to the more volatile radium daughters (Ra-224 and others) (Albert 1966, Lowery 1960). Thus the reported air sample results were assumed to be 50% (by activity) from Th^{232}.

Measured Intake based on air sampling data:

I = 2800 dpm/m^3 (1.2 m^3/hour) 0.0167 Bq/dpm (7hours) = 392 Bq total activity
= 196 Bq thorium Activity

Comment:

This was a very detailed and documented survey with all the mass flows and the air sampling results identified by individual recorded. Using the maximum exposed worker(s) (2) the intakes are overestimated by the NUREG-1400 approach by a factor of 1.6.

EXAMPLE 2

Rocky Flats decanning of an 80 kg ingot of thorium metal:

- Three 80 kg ingots were received as 3” x 12” x 12” thorium metal. The ingots were canned in heavy (16 gauge) mild steel and rolled for reduction in thickness.

- On 22 September 1960, one ingot was removed from the can following rolling and extrusion to approximately 25” dimensions by use of a flame cutting torch.

- The operation lasted for approximately 2 hours from start to finish with four air samples that were collected for 50 and 70 minutes on two samplers and for 2 hours on the other two samplers. The samples were counted three times, the last being one month delay count. The activity was approx. 50% long lived with maximum concentration at 62 dpm/m^3 (which was a BZ sample) and the other samplers recording at 3 to 8 dpm/m^3.

NUREG-1400 Results:

I = Q (1E-6) R C D

Q = 80 kg x 2.2E-4 Ci/kg = 0.0176 Ci
R = 1E-3
C = 1
D = 10

I = 0.0176 Ci x 3.7E+10 Bq/Ci x 1E-6 x 1E-3 x 1 x 10 = 6.5 Bq

Air Sample Measurement Results:

I = 62 dpm/m^3 x 1.2 m^3/hour x 2 hour x 0.0167 Bq/dpm = 2.5 Bq

Comments:

This was a very detailed and documented survey with all the mass flows and the air sampling results identified. Using the maximum exposed worker by the maximum recorded air sample result taken in the breathing zone, the intakes are approximately a factor of 2.6 conservative for the 1400 approach compared to the measured air monitoring results.

SECTION 5: REVISED CALCULATIONS OF BOUNDING ORGAN DOSES FOR APPLICATIONS INVOLVING PREFORMED THORIUM PARTS AT ROCKY FLATS

NUREG 1400 suggests calculating the maximum potential intake of radionuclides by workers using the following equation:

$$I = Q \times 10^{-6} \times R \times C \times D$$

where:

I = estimated annual intake
Q = total quantity of "unsealed or loose" material handled in a year for a given work location
R = release fraction
C = confinement factor
D = dispersibility

The typical release fraction for solids (*e.g.*, uranium pellets) is given as 1E-3 in NUREG-1400. The confinement factor for a well-ventilated hood is 0.1. The dispersibility factor for cutting or grinding is given as 10. Therefore, the estimated annual intake for a solid material, such as thorium metal, being cut or ground in a hood would be as follows:

I = Q x 1E-6 x 1E-3 x 1E-1 x 10 = Q x 1E-9

NIOSH's previous bounding estimate for this type of operation used a source term of 60 kg per year. This is indeed bounding, as the maximum annual thorium inventory for this application (use of preformed thorium parts as stand-ins for the more expensive U or Pu in weapons models) was 54 kg in 1965 as shown by the redacted Materials Balance and Inventory sheets for thorium.

NIOSH's previous estimates reduced the 60 kg source term by a factor of 10 to account for the fact that these are relatively large, preformed parts and the application assumed was very light machining or polishing. NIOSH still is of the opinion that this was appropriate, however SC&A has disagreed with this source term reduction. In an effort to reach consensus on this issue, NIOSH's current calculation does not take account of this source term reduction. Therefore, the source term assumed in the current calculation is the full 60 kg.

The specific activity of ^{232}Th is 4.04E6 Bq/kg. The total activity of unsealed or loose thorium processed per year would be as follows:

Q = 4.04E6 Bq/kg x 60 kg = 2.4E8 Bq

The estimated annual intake, based on the modifying factors used above would be 2.4E-1 Bq.

For a reference point the committed equivalent and effective doses were calculated based upon the estimated intakes. These potential doses to individual workers, assuming the estimated annual intake of ^{232}Th was 2.4E-1 Bq, were calculated under the above stated assumptions, Class S thorium.

Bone dose – 4E-3 rem, (4 mrem)
Lung dose – 7 E-3 rem, (7 mrem)

This dose estimate is bounding for the following reasons:

(1) There is no compelling evidence that any machining at all occurred with these preformed parts. Five former workers interviewed have no recollection of such activities. The only mention of thorium machining is found in the ChemRisk Task 3&4 report and Bistline, 1976. Both of these documents most likely refer to the ingot operation in 1960.

(2) It is based on NUREG-1400 methodology, which has been shown to overestimate actual observed thorium intakes (based on measured air concentrations) both at Simonds Saw and Steel, and for the 1960 ingot operation at Rocky Flats. NUREG-1400 is bounding by design, in accordance with its purpose to conservatively estimate the need for air monitoring.

(3) The source term used (60 kg), overestimates the highest amount of thorium handled as preformed parts (54 kg in 1965) by 10%.

As suggested and discussed previously by the working group, NIOSH, and SC&A, NIOSH's December 26, 2006, report also performed an analysis based on measured air activities of uranium generated by machining and grinding. These uranium masses were assumed for thorium operations, and were then converted to thorium air activities. An exposure time was assumed to generate an estimated organ dose. This approach produced an estimated bone dose a couple orders of magnitude higher than the NIOSH's previous NUREG-1400 based calculation for light machining of preformed parts. SC&A has expressed discomfort with this result, and has indicated on this basis that NUREG-1400 is not bounding. NIOSH is of the opinion that considering the uncertainties involved, this latter conclusion was not appropriate. For example, the dose calculated from the uranium air concentration approach was directly dependent on the exposure time assumed. NIOSH's calculation assumed 10 hours/year, which is a gross overestimate of the time it might have taken to lightly polish 60 kg of thorium over the course of a year. In contrast, the examples presented in this section deal directly with thorium, so no extrapolation from uranium operations is necessary. They also deal with a well-defined source term, a well-defined processing time, and measured air activities. These examples demonstrate that NUREG-1400 is indeed bounding compared to calculated intakes based on real thorium operations.

SECTION 6: ESTIMATED DOSE DURING WELDING AND GRINDING WITH THORIATED-TUNGSTEN ELECTRODES

Tungsten inert-gas (TIG) arc welding is a common welding process used for stainless steel, nickel alloys, and light metals, such as aluminum and magnesium (Gäfvert et al. 2003). Although most TIG welding machines are used in automated processes, not requiring the continuous presence of an operator, a significant amount of manual TIG welding also is conducted (Schneider et al. 2001).

Electrodes used in TIG are made of tungsten or a tungsten alloy. Thorium oxide alloy electrodes were designed for direct current (DC) applications, to improve arc stability and arc-starting. Pure tungsten electrodes are normally used with alternating current (AC) welding (Gäfvert et al. 2003). According to the American Welding Society *Recommended Practices for Gas Tungsten Arc Welding* publication, "thoriated tungsten electrodes are not normally used with AC welding because it is difficult to maintain the balled end, which is desirable with AC welding, without splitting the electrode".

The addition of thorium to a tungsten electrode began in about 1951 (Jankovic et al. 1999). In 1980, Buckley et al. reported that approximately 85% to 88% of the tungsten electrodes manufactured at that time were thoriated, and the thorium content ranged from 0.35% to 2.2%. The industry standard is nominally 1 to 2% by weight of ThO_2 (NRC 2001), although the weight percent can range up to 4% by weight (Ludwig et al. 1999). According to Gäfvert et al. (2003), the most common electrodes are those containing 2% ThO_2. The only radiologically important isotopes in thoriated electrodes are ^{232}Th, ^{230}Th, and ^{228}Th. Using alpha spectrometry, Ludwig et al. (1999) investigated the isotopic ratio of thoriated electrodes in a survey of workplaces, and indicated that the ^{230}Th:^{232}Th ratio was clearly less than 0.20. The ^{228}Th:^{232}Th activity depends on the time after chemical separation, and can range from 0.4 to 1.0, according to Ludwig et al. (1999).

The U.S. Nuclear Regulatory Commission exempts the receipt, possession, use, or transfer of any quantity of thorium contained in welding electrodes from licensing requirements (10 CFR 40.13 *Unimportant Quantities of Source Material*). According to Schneider et al. (2001), the initial exemption applicable to welding electrodes was issued as a final rule in 1961, based on the belief stated in the *Federal Register* that "exemption would not result in an unreasonable hazard to life or property".

The only significant route of radiation exposure to thorium in electrodes is inhalation. Thorium is released in an aerosol form during welding, despite the fact that these electrodes are considered to be nonconsumable. Furthermore, grinding of electrodes to sharpen the tip causes thorium to be emitted in a partially respirable form. Air concentrations of thorium associated with use of the thoriated electrodes have been evaluated in recent years by a number of researchers (Crim and Bradley 1995; Jankovic et al. 1999; Ludwig et al. 1999; and Gäfvert et al. 2003). Breslin and Harris, in 1952, first attempted to characterize the breathing zone and vicinity air concentrations during the welding operations, which included grinding. The more recent studies attempted to characterize air concentrations (both breathing zone and area air concentrations) attributable to welding and those attributable to grinding separately.

Doses associated with welding. In a U.S. Nuclear Regulatory Commission report (NUREG-1717, Schneider et al. 2001), the results of ^{232}Th air concentration measurements associated with TIG welding using thoriated electrodes through 1999 were reviewed. For the arc welding process itself, the two documents cited (which provided breathing zone and vicinity air concentration measurements) were Jankovic et al. (1999) and Ludwig et al. (1999). Jankovic et al. (1999) only made measurements during DC welding using 2% thoriated electrodes under various ventilation conditions; Ludwig et al. (1999) made measurements in 26 different shops in Germany during both DC and AC welding using 2% or 4% thoriated electrodes under various ventilation conditions. Jankovic et al. (1999) found a geometric mean air concentration of 0.15 mBq/m^3 for 15 measurements. Ludwig et al (1999) found a geometric mean air concentration of 0.9 mBq/m^3, although this latter study included results for AC welding. Excluding the AC results, the Ludwig et al.'s geometric mean air concentration would be 0.3 mBq/m^3, which is more in line with the Jankovic et al. study.

Two more recent studies were published in 2003. In a study by Gäfvert et al. (2003), 60% of the breathing zone measurements were made for welding under "real working conditions" and 40% for welding under more extreme conditions (using only 4% thoriated rods for AC welding, conditions not considered representative of a real working situation). Gäfvert et al. (2003) found an overall geometric mean air concentration of 2.1 mBq/m^3, but a geometric mean concentration of 0.9 mBq/m^3 for the 60% that represented real working conditions (which included both DC and AC welding). Saito et al. (2003) reported, for what appears to be a very limited sample number (one for each type of welding), a ^{232}Th breathing zone air concentration (respirable) of 0.132 mBq/m^3 for DC welding with 2% thoriated electrodes, and a respirable breathing zone concentration of 8.14 mBq/m^3 for AC welding with 2% thoriated electrodes. The geometric mean of Saito el al.'s two values is 1.0 mBq/m^3.

Based on the information in these studies, a geometric mean breathing zone air concentration of 1.0 mBq/m^3 appears to be a reasonable, but somewhat conservative, estimate of the breathing zone air concentration to which a fulltime welder might be exposed during arc welding. This value is approximately three times higher than it would be if the data for AC welding with thoriated electrodes, which is not a normal use of such electrodes, were excluded. Furthermore, a fair percentage of the reported air concentrations were at the limits of detection, such that the air concentrations are likely lower in those cases. Also, this value assumes the measurements only reflect respirable particle sizes. Assuming a fulltime welder spends 1,000 hr/yr actively involved in welding activities (Schneider et al. 2001, Ludwig et al. 1999) a mean intake of 1.2 Bq/yr of ^{232}Th. This is estimated based on an inhalation rate of 1.2 m^3/hr.

The ICRP (2001) 50-year committed bone dose factors for inhalation of Type S (thorium in oxide form) ^{232}Th, ^{230}Th, and ^{228}Th are 2.6 x 10^{-4}, 2.6 x 10^{-4}, and 2.2 x 10^{-5} Sv/Bq. The ICRP (2001) committed lung dose factors for inhalation of Type S ^{232}Th, ^{230}Th, and ^{228}Th are 1.5 x 10^{-4}, 7.0 x 10^{-5}, and 3.0 x 10^{-4} Sv/Bq. These dose factors assume a 1 µm AMAD, recognizing reported values range below and above that value (Schneider et al. 2001). .Assuming that ^{228}Th is approximately equal to the ^{232}Th activity of the welding fumes, and that ^{230}Th is 20% of the ^{232}Th activity, a mean bone dose of 0.4 mSv/yr (40 mrem/yr), and a mean lung dose of 0.6 mSv/yr (60 mrem/yr). These are upper bound organ dose estimates because (1) they include air concentrations associated with use of thoriated electrodes in AC welding applications, for which they were not designed and not normally used; (2) they do not consider what fraction of the airborne ^{232}Th is respirable, as it has not been reported; and (3) they are based on detection limits in several cases, when the actual concentration was actually not detectable. More reasonable estimates would consider DC welding only, in which case an estimated intake of 0.36 Bq/yr would be based on an average air concentration of 0.3 mBq/m^3 (the average of the DC results for the four studies), and would be on the order of 0.12 mSv/yr (12 mrem/yr) to bone and 18 mSv/yr (18 mrem/yr) to lungs.

Doses associated with Grinding. In NUREG-1717 (Schneider et al. 2001), results of air concentration measurements associated with grinding (sharpening) of thoriated electrodes were also reviewed. In that report, two groups of individuals who may grind electrodes were considered—welders who typically grind electrodes only a few times per day for their own use, and "dedicated grinders," who sharpen electrodes in support of many welders. This latter group, although recognized as not representative of a common situation, was identified on the basis of observations by Sinclair and Thind (1992), who reported seeing two workers at a construction site grinding as many as 250 electrodes per day.

According to Ludwig et al. (1999) and Gäfvert et al. (2003), it normally takes less than a minute to grind an electrode, and the procedure is carried out a few times every working day. Crim and Bradley (1995) suggest that one electrode may be used for several weeks, but of course this depends on the frequency of use. The work by Ludwig et al., in their survey of 26 European welding shops, indicated an average of one instance of grinding per working hour (defined as the time devoted to welding and welding-related work). Thus, if a welder spends an average of 1,000 hours per year welding, he would be grinding approximately 1,000 minutes per year, or 17 hours per year.

Unfortunately, in order to gather detectable amount of activity on a filter during grinding operations, some researchers found it necessary to grind for a much longer time period (6 minutes – Crim and Bradley, 15 minutes – Ludwig et al., 10 minutes – Saito et al.). Thus, air concentrations derived in this manner are not representative of, and are likely to exceed, those existing in a more realistic situation (Gäfvert et al., 2003). It is not clear how Jankovic et al. addressed this problem, but Gäfvert et al., (2003) exposed a collection filter to 20 one-minute grinding sessions prior to analyzing the filter, allowing aerosol particle in the air time to settle between sessions.

Based on a review of the measurements made by Crim and Bradley (1995), Ludwig et al. (1999), and Jankovic et al. (1999), an average airborne activity for grinding of 85 mBq/m^3 was derived by Schneider et al. (2001). It should be noted that this is likely to overestimate the breathing zone concentration during grinding operations for the following reasons. First, the Crim and Bradley work (mean of 23 mBq/m^3) and the Ludwig et al. work (mean of 180 mBq/m^3) measured air concentrations during grinding of multiple electrodes simultaneously for extended periods of time, in order to obtain detectable quantities of ^{232}Th on their samplers. Second, it appears that the mean individual study values used to derive the overall mean of 85 mBq/m^3 represent the total sampled airborne concentration of ^{232}Th, rather than the respirable fraction. For the grinding operation, the non-respirable fraction can be significant. The Crim and Bradley (1995) study found that in the breathing zone of welders during grinding, the respirable fraction could not be detected with a detection limit of 0.01 Bq/m^3, yet the total ^{232}Th (reported as thorium, but it is assumed that they measured ^{232}Th since the used nuclear activation analysis) was measured at 0.07 Bq/m^3. Although Ludwig et al. (1999) refer to the "inhalable" ^{232}Th, it is not clear if they are referring to respirable size, or just airborne ^{232}Th. Jankovic et al. (1999) state that 60% of the measured airborne ^{232}Th is respirable, but the total ^{232}Th from that study (mean of 52 mBq/m^3) was used to derive the overall mean of 85 Bq/m^3 (Schneider et al. 2001).

Gäfvert et al. (2003) reported a significantly lower air concentration (geometric mean of 2.2 mBq/m^3) during grinding operations, in part because they only reported the respirable fraction, and in part because their data collection was done under conditions more representative of the realistic conditions under which grinding occurs, where single electrodes are ground for around one minute, and aerosol particles settle out before additional grinding occurs. Saito et al. (2003) reported one measurement of breathing zone concentrations for electrode sharpening (grinding), with the result being 41 mBq/m^3 for the respirable fraction. Again, however, the Saito et al. measurement was done under unrealistic conditions, where grinding was performed continuously for 10 minutes.

From the foregoing discussion, it is reasonable to expect that the mean air concentration, in the breathing zone during grinding operations, is less than 10 Bq/m^3. However, due to the limited number of measurements under realistic conditions, it is prudent to adopt an estimate that is very likely to overestimate the concentration. Taking the average of the means reported in the studies relied on in NUREG-1717 (Schneider et al. 2001), and considering the more recent Gäfvert et al. (2003) and Saito et al. (2003) studies, an arithmetic average concentration during grinding operations is derived here to be 60 mBq/m^3. Assuming the grinding operation occurs once per hour for one minute, and the welder spends 1,000 hr per year involved in actual welding activities, a total yearly intake of 1.2 Bq/yr is estimated, assuming an inhalation rate of 1.2 m^3/hr, which is coincidentally the same as the ^{232}Th intake for 1,000 hours of inhalation of welding fumes.

For grinding operations, it is assumed that 1 μm AMAD describes the respirable particle size distribution, consistent with that reported by Ludwig et al. (1999) and assumed by Schneider et al. 2001). It should be noted, however, that Jankovic (1999), believes an AMAD of 5 μm is more appropriate. The ICRP (2001) 50-year committed bone dose factors for inhalation of Type S (thorium in oxide form) ^{232}Th, ^{230}Th, and ^{228}Th are 2.6 x 10^{-4}, 2.6 x 10^{-4}, and 2.2 x 10^{-5} Sv/Bq. The ICRP (2001) committed lung dose factors for inhalation of Type S ^{232}Th, ^{230}Th, and ^{228}Th are 1.5 x 10^{-4}, 7.0 x 10^{-5}, and 3.0 x 10^{-4} Sv/Bq. .Assuming that ^{228}Th is approximately equal to the ^{232}Th activity of the welding fumes, and that ^{230}Th is 20% of the ^{232}Th activity, a mean bone dose of 0.4 mSv/yr (40 mrem/yr), and a mean lung dose of 0.6 mSv/year (60 mrem/yr). These are considered upper bound dose estimates largely because they are based on measurements made when multiple electrodes were sharpened in close succession over periods of time exceeding those normally characteristic of the grinding activity, in order to obtain measurable radioactivity on sampling media. However, they also are overestimates because many of the results were not corrected for respirability. More reasonable estimates would use an air concentration closer to that obtained by Gäfvert et al. (2003), such as 10 mBq/m^3, resulting in a bone dose of 0.07 mSv/yr (7 mrem/yr) and a lung dose of 0.1 mSv/yr (10 mrem/yr).

Doses to nonwelders in the vicinity. The only two recent researchers to address this issue directly were Ludwig et al. (1999) and Saito et al. (2003). In the Ludwig et al. study, ^{232}Th intakes at distances ranging from 1.5 to 4 m from the welding or grinding site were apparently evaluated, but individual air concentration measurement results were not reported. Ludwig et al. provided some intake numbers, but did not support them with any of the critical assumptions used in deriving these intakes, such as exposure times. They did observe, however, that emissions of dust from grinding sites, and of fumes from welding sites, are "spatially rather restricted", and therefore put forth the assumption that the annual inhalable activity at neighboring work sites is "well below" the annual inhalation activity at a grinding or welding station. Saito et al. (2003) made two measurements of "workshop background", by sampling air over 10 m from the welding and electrode sharpening (grinding) areas. They reported a geometric mean total (respirable plus non-respirable) ^{232}Th air concentration of 0.058 mBq/m^3, which is 3 times lower than the reported total ^{232}Th concentration associated with DC welding, but 3300 times lower than the reported total ^{232}Th concentration associated with electrode sharpening. This latter observation regarding electrode sharpening is not unexpected due to the larger particle size associated with that operation, and thus the more rapid decrease in concentration with distance. Considering the estimated doses for welding and grinding operations, exposure of nonwelders in the vicinity of welder operations would not be expected to receive significant doses.

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ATTACHMENT 24: INTERVIEW REGARDING POSSIBLE SHIPMENTS OF ALLOY FROM DOW MADISON TO ROCKY FLATS

This interview took place on February 8, 2007, in Mason, Ohio. The interviewee was provided with a copy of this interview summary and incorporated his comments on March 8, 2007. Arjun Makhijani and U. Hans Behling of SC&A participated in this interview.

Arjun explained the interview procedure.

Arjun: Do I have your permission to use your name in this interview.

[Interviewee]: Oh yes. You can use it any time.

Arjun: I will make draft notes and send them to you for correction. This interview concerns SC&A's work on Rocky Flats. Tell me where you worked and what you did.

[Interviewee]: I worked for Dow Chemical in Madison, Illinois, from [date]. I worked on all jobs but my main one was crate builder. We made crates and skids and also I loaded trucks for 12 years.

Arjun: When was that 12-year period?

[Interviewee]: That was from 1963 to about 1975. They had what you call out of class overtime. I worked on all the other jobs except roller and craneman in the roller mill.

Hans [pointing to a long list of jobs handed to him by [Interviewee]]: Did you do all these jobs?

[Interviewee]: Yes. Sometimes the jobs I did changed from one week to the next.

Arjun: What did they do in the roller mill and what materials did they handle?

[Interviewee]: They rolled slabs down. We got the slabs from casting. We ran aluminum and mag—that is magnesium-thorium alloy—when I say mag, I mean the alloy with the thorium that was in with it. We ran anywhere from ought-4 {0.004 inches, a little thicker than paper) to 8 in. I am not sure how we found out that thorium was radioactive when the rest of the plant (people in extrusion and casting) did not know it. The people who worked in the mill knew that thorium was radioactive, but extrusion and casting...

Arjun: Tell me about the extrusion and casting departments.

[Interviewee]: Very little metal came in from outside. Everything came to us from castings.

Arjun: What kinds of raw materials did the plant receive?

[Interviewee]: We got aluminum and mag. The raw materials went to the casting department where the metal was made. They cast billets and slabs. Slabs are rectangular one foot by 48 in, 82 to 86 in long. It depends. There are different types. The billets are long cylindrical rods. Then everything that came from casting either went to extrusion or over to the rolling mill.

Arjun: What was the final product?

[Interviewee]: In the rolling mill it was all sheet or plate or coils. It was all flat. *[Interviewee] shows pictures of the flat plate from a catalog, and also pictures of slabs and billets.]* Each pass of the slab, it is reduced by half-an-inch. It has to go through many passes. For coils, they take it down to 3/8 inch for instance. The metal has to be heated before rolling.

The billets did not go to the mill. They went to the extrusion department where they were extruded into the finished shapes that the customers wanted. There were many complex finished shapes. They handled thorium alloy in extrusion, but they did not know that thorium was radioactive.

When I went by the heavy press, I was told we have been running this for 2 months—it's a special alloy for the government. I said "well it's radioactive." The boss said, we are not pushing radioactive material.

Arjun: Did you ship the plate or did you manufacture things from the plate at Dow Madison?

[Interviewee]: From the rolling mill, the flat plates and coils were shipped out.

Arjun: Was this all mag? Were there other alloys?

[Interviewee]: Yes there were. They had a number of alloys that are listed in this catalog—they did the same alloys back then as well. *[Shows the catalog.]*

Arjun: Was magnesium-thorium alloy the only thorium alloy they made?

[Interviewee]: It wasn't the only alloy with magnesium, but there was only one thorium alloy—magnesium-thorium.

Arjun: Did you pack the material and load the trucks?

[Interviewee]: I made the crates, but the packers put the metal in the crates. Every sheet of metal had a lot number on it, a government spec on it, and a government order number on it.

Hans: Did you do QA?

[Interviewee]: The spec lab was in casting where they sampled the material.

Arjun: Where all did you ship this stuff? Do you remember?

[Interviewee]: It went to Martin Marietta, Lockheed, Hughes Aircraft, Hughes, Bell Helicopter, and there was an outfit in Kansas—I can't think of the name, maybe it was in Wichita—and Rocky Flats.

Arjun: How many shipments did you do per month of mag in all?

[Interviewee]: We ran about 4 million pounds a month of the alloy in the rolling mill and 12 million of aluminum.

Arjun: Where did the bulk of the mag go? Was it to companies doing work for the Department of Defense?

[Interviewee]: Yes.

Arjun: What about shipments to Rocky Flats?

[Interviewee]: Rocky Flats got about four trucks a month—that would be about 36,000 to 40,000 per truckload. Not necessarily four trucks every single month – but as an approximate idea of the number of shipments.

Arjun: Rocky Flats got four truckloads of magnesium-thorium alloy per month? Are you sure of that?

[Interviewee]: Yes, at least four. The total amount per truckload depended on the thickness of the product. There was an instruction not to put film within 20 feet of the package.

Arjun: Did the trucks have other things, too, besides mag?

[Interviewee]: It might have a mixture of mag products—sheet and plate of different sizes. We might have 10 or 12 skids with material of different sizes.

Arjun: What was the reason for the caution about the film? Were you shipping film as well?

[Interviewee]: No. It was all mag. The caution about film was the sticker that was put on the skid and the sides of the package.

Arjun: Were there handling instructions for the mag?

[Interviewee]: No. When we asked about it, they would come out with a Geiger counter and say "See, no reading. You could lay on this for a thousand years and get no dose." But they were using the wrong Geiger counter.

Arjun: When did the shipments to Rocky start?

[Interviewee]: They were going on when I started [date provided]. Then get bumped out of shipping and went to the shear crew in the same department.

Arjun: Shipping to Rocky Flats wasn't a new activity after you started work there?

[Interviewee]: No.

Arjun: How long did the shipments to Rocky Flats go on?

[Interviewee]: When I left shipping in [mid-1970 range], they were still shipping it out to Rocky Flats. After that I don't know about where product was shipped.

Arjun: Are your sure that the trucks loaded for Rocky Flats were not dropping off material at multiple locations along the way, for instance, St. Louis?

[Interviewee]: There may have been some instances like that, but usually you load up for a single customer. If there was more than one customer, the truck was loaded specially, to indicate different customers. Most of the shipments were in open top trucks.

Hans: Were there any police or security escorts?

[Interviewee]: No.

Arjun: When you loaded the trucks, what kind of paperwork was done?

[Interviewee]: We pulled the weight stickers off and gave them to production control, which took all the plate tickets. Weight tickets had gross, net, and a ticket number.

Arjun: There must have been a shipping manifest.

[Interviewee]: We did not have that. The truck drivers got that in the stores. Most of the trucks were B-MACK and Anderson trucks.

Arjun: Were they semis?

[Interviewee]: Yes, they were 40-foot trailers—eighteen wheelers. That type was easy for us to load.

Arjun: What do you think happened to the shipping records?

[Interviewee]: [Name] got in there and he destroyed most of them. He was the CEO of magnesium-electron, I think it is called now.

Arjun: So it is no longer Dow Madison?

[Interviewee]: It went from Dow Chemical to Phelps Dodge to Conalco to SCI.

Arjun: Do you know what they did with the mag at Rocky Flats?

[Interviewee]: No. I can tell you a story about the mag we shipped to Martin Marietta. I asked a guy once and he said "what do you want to know for?" He was from the FBI. He said it was classified.

Arjun: Did you ship it anywhere else in the nuclear weapons complex, like Hanford or Los Alamos.

[Interviewee]: We shipped metal to Los Alamos.

Arjun: Where is Los Alamos?

[Interviewee]: New Mexico?

Arjun: Yes.

[Interviewee]: It seems like there was another one somewhere, too. Seems like it was up in Aberdeen, Maryland.

Arjun: That would be part of the Department of Defense. Was there any other thorium alloy that you made or just mag?

[Interviewee]: So far as I know just mag.

Arjun: You did not make tungsten-thorium welding rods?

[Interviewee]: No.

Arjun: Do you have the name of the storekeeper or the records keeper?

[Interviewee]: There was a shipping foreman. He would call in the trucks. The individual was at Rocky Flats also prior to being a shipping foreman at Dow Madison. He has testified on some of this stuff and has given an affidavit. He is one of the old affidavits. They taped him on camera. I will send you his phone numbers.

Arjun: What about the material that came back?

[Interviewee]: I don't know what all kinds of material came back, but there were sheets and plate. The sheets would be weighed and it might sit by the track well (though it came back by truck) for weeks; then it would go to casting. A couple of guys I knew would be sitting there waiting for the plate to come back, it would be weighed and it went straight to casting. Some of the returned plate had drill marks in it, some had slots in it.

Hans: I would call that runaround scrap.

[Interviewee]: On the heavy plate that was returned, it would not be wrapped. It would be on a skid on a cardboard box. It would say "Returned from Rocky Flats" on a piece of paper taped on to the metal.

Arjun: You remember it saying Rocky Flats?

[Interviewee]: Yes.

Arjun: Did you get returns from other places?

[Interviewee]: We got returns from almost every place we shipped. They [Dow Madison] expected 8% scrap back.

Arjun: So most of it was used wherever it went?

[Interviewee]: Yes.

Arjun: Is [a former fellow worker] around?

[Interviewee]: No. He died in 2001.

Arjun: Is there any top management person we could interview about records and shipments?

[Interviewee]: There is [manager named]. He was Plant Manager and he was breaking in [former worker].

Arjun: When did they stop making thorium magnesium alloy at Dow Madison?

[Interviewee]: The last product was in 1998. When they had the cleanup in 2000, there were several dozen slabs that were there that disappeared.

Arjun: Was there a storekeeper? Do you remember a name?

[Interviewee]: Yes, [name provided]. I can get her contact information for you.

Hans: Were there DOT records for radioactive material shipments?

[Interviewee]: The thorium alloys were HK31, HK61, HM21, and HM 31.

Arjun: There must have been carbon copies of the records. I'm also looking for more names of people.

[Interviewee]: When they came to clean up [in 2000], they discarded boxes of materials and even samples of materials. They destroyed records of materials that went into planes that would be needed in case of problems. The certification of the plane parts was destroyed. I can give you the contact information for [former worker]: [telephone number provided]. That is the plant telephone number. He is the CEO of the plant.

There is [fellow worker] who was in shipping, and [fellow worker] who also worked in shipping.

Hans: You guys never saw any dosimetry records?

[Interviewee]: No. We were given badges one time when the government people came in.

Hans: Were they AEC?

[Interviewee]: All we knew was that it was government people. Afterwards they took our badges and put them in a bucket where they sat for two weeks, and then they dumped them in the dumpster.

Hans: To your knowledge they were never processed?

[Interviewee]: No.

Arjun: Thanks so much for the interview. I'll mail you the draft for corrections.

ATTACHMENT 25: HYPOTHETICAL INTERNAL DOSE CASES 4, 5, AND 6

Review of Internal Dose Reconstruction Examples

CASE 4: HYPOTHETICAL COWORKER ASSIGNMENT FOR UNMONITORED URANIUM WORKER

The dose reconstruction example case, described below, is an example of one of the problems of the proposed coworker model for RFP. The zeros resulting from the period the worker was monitored were treated as below the detection level and not below reporting level. This dual treatment has to be resolved, before a meaningful model is proposed.

Selection Criteria

- Hypothetical Radiation Worker: worked in 881 from 1956 through 1966 and was exposed to uranium
- Monitor: 1960 through 1966 all results below the detection level

Cancer Description

Kidney (ICD-9 189.2)

NIOSH Approach-Summary

Missed uranium dose was assessed for years with bioassay data (no positive data). For years with no monitoring data, uranium coworker dose was assigned.

Internal dose monitoring records for radionuclides were reviewed. All measurement results for the EE showed an activity below the level of detection. The EE was only monitored for uranium from 1960 through 1966. However, the EE had potential for uranium exposure from 1956 through 1959, during which time the EE was not monitored. Therefore, the EE's uranium exposure will be based on coworker data (ORAUT-OTIB-0038) from 1956 through 1959, and for 1960 through 1966, the EE's uranium exposure will be based on the EE's bioassay detection limit. For the missed dose, a chronic intake rate was assumed using half the minimum detection activity (MDA) (ORAUT-TKBS-0011-5) for that radionuclide and assigned as the mode dose, with the maximum dose being twice the mode dose.

Radionuclide	Solubility	Basis	MDA	Intake Rate
Uranium (1956 – 1959)	S	Coworker	n/a	937 dpm/d
Uranium (1960 – 1963)	S	Urine	9.4 dpm/24 h	1135 dpm/d
Uranium (1964 – 1966)	S	Urine	31 dpm/24 h	3783.6 dpm/d

REVIEW OF NIOSH APPROACH

(1) The EE had a potential for uranium exposure from 1956 through 1959, but he was not monitored. The dose for this period was based on a coworker model that used the 50th percentile to calculate the intake. As a result, the calculated intake rate corresponded to less than one-half of the theoretical reporting level for uranium in urine. This is not claimant favorable. There is no scientific reason to use this coworker model to calculate the workers dose.

(2) There is no scientifically valid reason to assign missed doses based on one-half the MDA for the median conditions. In the Occupational Internal Dose TBD (ORAUT-TKBS-0011-5), the MDAs for the median and extreme conditions were calculated for the period 1952–1971, based on results from the logs. Variations in the number of extreme conditions produced different values of MDA. For uranium, there is about a five-fold difference between the MDA for the median and extreme conditions.

In general, the MDA for urine analysis is not a unique value. It will generally vary from sample to sample. The calculation of each sample MDA is based on a normal distribution of activities. The median MDA for all samples is a nonparametric value, and thus, half the median detection limit (half the MDA) does not have any statistical meaning.

CASE 5: HYPOTHETICAL ASSIGNMENT FOR INGESTION OF DEPLETED URANIUM

Selection Criteria

- Hypothetical Radiation Worker: worked in 444 from 1966 through 1969 and was exposed to depleted uranium
- Monitor: 1966 through 1969 all results below the detection level

Cancer Description

Colon (ICD-9 153.9)

Employment (Rocky Flats Plant)

Start: 1966
End: 1969

Approach

Hypothetical incident where a worker ingested depleted uranium and had a reported positive urinalysis bioassay data.

Work History

NOCTS: Radiation Monitor
DOB: 1930, Diagnosis Date: 2000

Dosimetry Data: Uranium urinalysis data for 1966 through 1969. No in-vivo data available.

Data Summary

Date	Sample Type	Nuclide	Result	MDA	Units
2/1/1966	Urine	U	0	31	d/m/24hr
6/6/1966	Urine	U	0	31	d/m/24hr
10/9/1966	Urine	U	0	31	d/m/24hr
2/11/1967	Urine	U	0	31	d/m/24hr
6/16/1967	Urine	U	0	31	d/m/24hr
10/19/1967	Urine	U	0	31	d/m/24hr
2/21/1968	Urine	U	37	31	d/m/24hr
6/25/1968	Urine	U	0	31	d/m/24hr
10/28/1968	Urine	U	0	31	d/m/24hr
3/2/1969	Urine	U	0	31	d/m/24hr
7/5/1969	Urine	U	0	31	d/m/24hr
11/7/1969	Urine	U	0	31	d/m/24hr

Probability of Causation (POC)

The probably of causation is based on the dose from fitted ingestion intake only. The POC does not include any potential inhalation, environmental, or external dose.

Colon (0.71%)

Narrative

The EE worked as a radiation monitor in Building 444 according to records provided by the Department of Labor, Department of Energy, and the telephone interview. His primary exposure would have been to depleted uranium. The internal doses are based on those of the colon (ORAUT-OTIB-0005).

A computer code, the Integrated Modules for Bioassay Analysis (IMBA), was used to estimate intakes of radioactive material and the subsequent annual organ doses. The IMBA Expert OCAS-Edition was used for this dose reconstruction. The ICRP 66 lung model with default aerosol characteristics was assumed, in conjunction with ICRP 68 metabolic models. It should be emphasized that intake dates, scenarios, and intake levels were based upon mathematical models and do not necessarily prove that such intakes occurred on the given dates. These dates and scenarios provide an acceptable explanation of exposure and dose based upon the bioassay data provided. This approach is in accordance with the provisions of the Radiation Dose Reconstruction Rule (42 CFR 82) and guidance in the NIOSH *Internal Dose Reconstruction Implementation Guideline* (OCAS-IG-002).

Internal dose monitoring records for radionuclides were reviewed. **One measurement result for the EE showed an activity above the level of detection five days after an ingestion incident** [emphasis added]. The EE's uranium exposure was determined based on uranium bioassay data. The uranium solubility was chosen based on the most claimant-favorable parameter, since all forms of uranium were present (ORAUT-TKBS-0011-5. For this claim, "insoluble" was determined to be the most claimant-favorable solubility type.

Radionuclide	Solubility	Basis	MDA	Intake Rate
Depleted Uranium	Insoluble	Urine	31 dpm/24 h	1,227,900 dpm

Summary

The total assigned dose to the kidney was 0.067 rem based on the approach described in this evaluation and is considered a claimant-favorability estimate for internal dose.

If the facts surrounding this dose reconstruction change (e.g., the date of diagnosis is modified, an additional covered cancer is diagnosed, or additional covered employment is identified), the efficiency measures used to reconstruct the dose may not be applicable. In this case, if the facts were to change, the dose reconstructed could be lower than that reported using this process.

Review of Case

(1) SC&A reviewed the procedures followed by NIOSH to calculate the intake and dose for the hypothetical incident where a worker ingested depleted uranium and had a reported positive urinalysis bioassay data 5 days after the ingestion. In addition, SC&A recalculated the intake and doses due to this hypothetical incident, using alternative software to IMBA. SC&A has concluded that the intake and dose calculated by NIOSH are correct, for a single intake associated with an ingestion exposure.

(2) However, NIOSH has considered that all other monitoring results, recorded as zero (below detection limits), were associated with zero exposures. SC&A considers that this approach is not claimant favorable. In Example Case 4, a missed dose based on the MDA was calculated for all monitoring results below detection limits. The missed dose, calculated using continuous intake by inhalation, in this example gives an additional dose to the colon one order of magnitude higher then the accidental ingestion intake. The missed dose was not considered by NIOSH in this case.

(3) The scenario of exposure used by NIOSH is not necessarily claimant favorable. Missed dose associated with continuous exposure through inhalation should have been calculated, with an additional ingestion exposure. The hypothesis of a continuous intake to calculate missed doses is, in general, used by NIOSH. A clear definition provided to

the dose reconstructor should be made by NIOSH, in order to avoid different procedures applied in similar cases, as occurred in example Case 4 and Case 5.

CASE 6: HYPOTHETICAL SUPER TYPE S MATERIAL ASSIGNMENT FOR MONITORED PLUTONIUM WORKER WITH NO CHEST COUNTS AND POSITIVE URINALYSIS RESULTS

Selection Criteria

- Hypothetical Radiation Monitor: worked 1961 through 1969 in 771, 776, and 707, and was exposed to fresh plutonium (100 ppm Am-241) with positive urinalysis results in 1963 and 1964
- OCAS Whitepaper, *Approach to Dose Reconstruction for Super Type S Material (March 21, 2006)*, was applied to four scenarios: Lung Cancer, GI Tract Cancer (colon), Systemic Metabolic Cancer (Liver), and Systemic Non-Metabolic Cancer (Prostate)

Cancer Description

Colon (ICD-9 153.9)
Liver (ICD-9 155.2)
Lung (ICD-9 162)
Prostate (ICD-9 185)

Employment (Rocky Flats Plant)

Start: 1961
End: 1969

Approach

A fit was made to the positive bioassay data. In situations where data was not sufficient to determine a best fit, a chronic intake was assumed.

Work History

NOCTS :	Radiation Monitor DOB: 1931, Diagnosis Date: 2000 Former Smoker
Dosimetry Data:	Urinalysis data for all years of employment. No in-vivo data available.

Data Summary

Date	Sample Type	Nuclide	Result	MDA	Units
5/1/1963	Urine	PU	0	0.44	d/m/24hr

Date	Sample Type	Nuclide	Result	MDA	Units
5/10/1963	Urine	PU	0.89	0.44	d/m/24hr
5/12/1963	Urine	PU	0.56	0.44	d/m/24hr
6/13/1963	Urine	PU	0	0.44	d/m/24hr
8/16/1963	Urine	PU	0	0.44	d/m/24hr
10/23/1963	Urine	PU	0	0.44	d/m/24hr
1/25/1964	Urine	PU	0	0.54	d/m/24hr
4/24/1964	Urine	PU	0	0.54	d/m/24hr
7/1/1964	Urine	PU	0	0.54	d/m/24hr
8/12/1964	Urine	PU	0	0.54	d/m/24hr
9/24/1964	Urine	PU	0.56	0.54	d/m/24hr
11/18/1964	Urine	PU	0	0.54	d/m/24hr

*All other results are reported as below the MDA.

Probability of Causation (POC)

These POCs are based on the dose from fresh plutonium weapons-grade mixture fitted intakes only. These POCs do not include missed internal, environmental, or any external dose.

Colon (9.66%)
Liver (97.29%)
Lung (99.34%)
Prostate (3.29%)

Narrative

The EE worked as a radiation monitor in Buildings 707, 771, 776, and 779 according to records provided by the Department of Labor, Department of Energy, and the telephone interview. His primary exposure would have been to plutonium. The external dose to the prostate and associated organ dose conversion factors in this evaluation are based on those of the heart wall.

A computer code, the Integrated Modules for Bioassay Analysis (IMBA), was used to estimate intakes of radioactive material and the subsequent annual organ doses. The IMBA Expert OCAS-Edition was used for this dose reconstruction. The ICRP 66 lung model with default aerosol characteristics was assumed, in conjunction with ICRP 68 metabolic models. It should be emphasized that intake dates, scenarios, and intake levels were based upon mathematical models and do not necessarily prove that such intakes occurred on the given dates. These dates and scenarios provide an acceptable explanation of exposure and dose based upon the bioassay data provided. This approach is in accordance with the provisions of the Radiation Dose Reconstruction Rule (42 CFR 82) and guidance in the NIOSH Internal Dose Reconstruction Implementation Guideline.

Internal dose monitoring records for radionuclides were reviewed. Three measurement results for the EE showed an activity greater than the level of detection; two consecutive results in 1963 and one in 1964. To account for potential intakes for the EE, two internal intakes were assigned: an acute intake on May 6, 1963, and a chronic intake from August 13, 1964–September 24,

1964. The May 6, 1963, intake date was based on a fit between the projected excretion rates and both of the EE's following bioassay sample results. The September 24, 1964, sample could fit any number of possible acute intake dates as a single, therefore a chronic intake was assumed from the day after previous negative sample (August, 13, 1964) to the positive results (September 24, 1964). These intakes were assessed assuming a solubility of Super Type S. This was done by assessing the intake based on Type S absorption, and adjustment factors were applied to accurately reflect the longer clearance time from the lung and the potential bias in intake due to lower urinary output per unit intake. The intake rates of the various radionuclide components (Pu-238, Pu-239, Pu-241, and Am-241) were based on the plutonium mixture (ORAUT-TKBS-0011-5) of fresh weapons-grade plutonium (100 ppm Am-241).

Summary

The total assigned fitted dose to the colon (2.290 rem), liver (249 rem), lung (3,980 rem), and the prostate (1.840 rem) based on the approach described in this evaluation is considered a reasonable overestimate, erring on the side of claimant-favorability for potential fitted internal dose.

If the facts surrounding this dose reconstruction change (e.g., the date of diagnosis is modified, an additional covered cancer is diagnosed, or additional covered employment is identified), the efficiency measures used to reconstruct the dose may not be applicable. In this case, if the facts were to change, the dose reconstructed could be lower than that reported using this process.

Review of Case

(1) SC&A reviewed the procedures followed by NIOSH to calculate the intake and dose for the Pu contamination that resulted in 3 positive urinalysis bioassay results. SC&A recalculated the intake and doses due to this hypothetical incident, using alternative software to IMBA. SC&A results using the alternative software (AIDE) were similar to the ones obtained by NIOSH, when the same scenario was assumed. SC&A has concluded that the intake and dose calculated by NIOSH are correct, given the hypothesis assumed by NIOSH: missed internal, environmental, or any external dose were not included and chronic intake was assumed from the day after previous negative sample (August 13, 1964) to the positive results (September 24, 1964).

(2) The scenario of exposure used by NIOSH for the 1964 positive urine result is not claimant friendly. If instead of a continuous intake, an intake in the middle of monitoring interval was assumed, as recommended in ICRP Publication 78, the total dose to the lung in year 2000 would be about 1.8 the dose calculated using the continuous intake. The same applies to the other organs.

(3) This example shows that the HF Pu model is claimant favorable to cancers of the liver and of the lung, which are main deposition organs for Pu.

ATTACHMENT 26: ORAUT-OTIB-0038 WHITE PAPER AND MEETING MINUTES

White Paper—Rocky Flats Plant Internal Coworker ORAUT-OTIB-0038

This white paper is intended to address some of the questions that arose during the Rocky Flats working group meeting on August 31, 2006. This white paper addresses only the calculational techniques used in the TIB; it does not address the database.

The participants discussed several issues that are best separated into individual topics. The topics addressed here are:

(1) Z-score plot approach to determining distribution parameters
(2) Censored data handling
(3) Why MDA doesn't matter
(4) Linear substitution approach to censored data

Z-Score Plot

The z-score plot approach to determining the parameters of a distribution follows some basic steps. First, the data are sorted by the value of the result. The probability of each data point is then determined using the equation (r-0.5)/n, where r is the ranked order of the data point and n is the number of data points in the entire set. For example, the sixth highest point of a distribution with 11 data points would have a probability of (6-0.5)/11 = 0.5

Next, the z-score of each data point is determined using the probability. The z-score is the number of standard deviations from the mean of the normal distribution that the probability represents. Some familiar values for these are 0, representing the mean, and 1, representing 1 standard deviation above the mean or the 84th percentile. The Excel function NORMSINV is used to find this value.

For a normal distribution, the value of any point on the curve (Y) is equal to the mean (u) plus the z-score (Z) times the standard deviation (Sig), or

Y = u + Z*Sig

The mean and the standard deviation are constants for a given distribution. The previous steps have determined the different Y and Z that exist for each data point. The equation resembles the standard equation for a straight line, with u representing the Y-intercept and Sig representing the slope. Therefore, plotting each data point with Z on the x-axis and Y on the y-axis will theoretically produce a straight line if the data represent a normal distribution. A linear regression analysis provides the slope and Y-intercept and, thus, the mean and standard deviation. Any goodness-of-fit parameter provides a measure of the goodness-of-fit to the assumption that the distribution is normally distributed. The data were obtained using Crystal Ball. An assumption of a normal distribution with a mean of 0 and a standard deviation were entered and the forecast values extracted. The results of the z-score plot show a calculated mean of 0.04 (compared to a true 0) and a standard deviation of 1.009 (compared to a true 1.0).

For a lognormal distribution, the value of any point on the curve (Y) is equal to the geometric mean (GM) times the geometric standard deviation (GSD) raised to the Z^{th} power:

$$Y = GM * GSD^{z}$$

If the natural log of both sides of the equation is taken, the equation transforms to:

$$Ln(Y) = ln(GM) + Z*ln(GSD)$$

In this case, the GM and the GSD (and in turn the natural log of these) are constants. If the value of each data point is log transformed by simply determining the natural log of the value, the log-transformed data can be plotted (on the y-axis) with the z-score value on the x-axis, and the data will again theoretically form a straight line. In this case, the Y-intercept is the natural log of the GM, and the slope is the natural log of the GSD. Data for this example were obtained in the same manner as the data for the normal distribution example. The parameters used in this case were a GM of 1 and a GSD of 2. The results of the z-score plot show a calculated GM of 1.03 (compared to a true 1.0) and a GSD of 1.98 (compared to a true 2.0).

Censored Data

In the two previous examples, all the data were available. However, the technique can easily be used when some of the data are censored. Censored data are any data for which the actual value is not recorded. Examples would be values reported as <MDA, or <X (where X is some number), or even values reported as zero by procedure, when the actual result is below some procedural number.

When censored data are included in a data set, the same Z-score plot technique can be used to determine the parameters of the distribution. All the steps are followed as before, except the plot includes only the uncensored data. The effect is to fit the uncensored tail of the distribution. The uncensored data must still be used to provide the proper probability and z-score. For this example, a recording level of 4.0 was used, so that all values below 4.0 were assumed to be reported as "<RL" (less than the reporting level). This resulted in only 25 of the 1,000 data points being uncensored. The results of the z-score plot show a calculated GM of 1.18 (compared to a true 1.0) and a GSD of 1.89 (compared to a true 2.0).

MDA

The detection limit of a single sample (the MDA) is not important to the determination of the distribution parameters. The MDA is essentially defined as the value at which there is only a 5% chance that the true value is below the critical level. The critical level is defined as the value at which there is only a 5% chance that the true value is not above background. When multiple samples of the same distribution are available, this concept is no longer relevant. Indeed, by definition, if 100 blank samples were analyzed, the critical value can be defined as the 95^{th}

percentile of the distribution of these observations. The very act of defining a confidence level of a blank sample (95^{th} percentile, for example) dictates that there is a distribution and that the parameters of that distribution can be determined.

Linear Substitution Approach to Censored Data

The situation has occurred in which a set of samples has a high percentage of censored values. The set also has some uncensored values recorded below the censoring level. This can occur when special situations dictate recording the actual value even though it is below the administrative reporting level. For ease of discussion, this paper will refer to these values as "low recorded values."

There are several possible approaches to addressing this type of data set:

(1) The low recorded values can be ignored.

(2) The low recorded values can be sorted above the censored values.

(3) The low recorded values can be sorted below the censored values.

(4) The values can be placed at a probability that is consistent with the assumed distribution type.

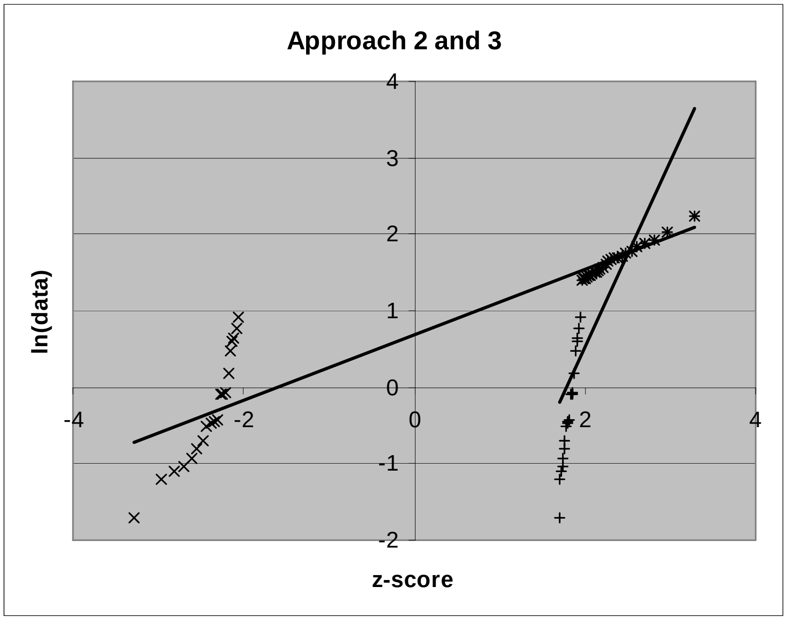
(5) The values can be placed at a probability that assumes the censored values are linearly distributed between the censored level and zero.

(6) All censored values can be replaced with a substitute value equal to half the censoring level.

To explore these options, the lognormal data set from the example above was again used. The first 20 results of the Crystal Ball analysis were selected as the low recorded values (all of these were below 4.0). These samples, plus the 25 samples greater than 4.0, were assumed to be recorded "as read." The remaining samples were assumed to be recorded as "<RL."

Approach 1 can be used if the number of values below the censored level is small compared to the number of uncensored values. This is a judgment call that requires a good basis prior to ignored recorded results. This approach by definition will result in the same analysis as the "censored" example above.

Approaches 2 through 5 place these values within the censored values. It is unrealistic to believe that the censored values all have a true value that is above the highest or below the lowest low recorded value. It is much more likely that the censored data have true values at various levels between the censoring level and zero. Therefore, approaches 2 and 3 are likely unrealistic but can produce bounding estimates. The figure below shows this graphically.



Both approaches must still account for data above the censoring level; these data can be seen on the right-hand side of the graph. The difference in approaches is the z-score assigned to the low recorded values. This assignment affects the slope and intercept of the regression (represented in the figure with a straight line). Since the regression line will likely go through these data, these data can be viewed as "locking in" the right-hand side of the regression line. With the right-hand side "locked," the regression line with the smaller slope (approach 3) should cross the 0 and 1 values of the x-axis at a higher value than the line of the higher slope. Since the point where the regression line crosses the 0 values of the x-axis determines the GM and the slope determines the GSD, approach 3 should normally be more favorable than approach 2.

Approach 4 may appear to be the most reasonable approach. However, to use this approach, the data must be placed in a lognormal distribution. To do that, the distribution parameters must be known or assumed. Since the parameters are not known, the distribution parameters must be assumed. This leads to a situation where the z-scores are based on an assumption of the parameters that are then to be determined using these z-scores. The appropriateness of this is clearly questionable. It is also difficult to conceive of an approach to assuming the GM and GSD without first analyzing the other uncensored data. If that is the case, further examination of the low recorded values adds nothing to the analysis.

Approach 5, like approach 4, substitutes values for the censored results. Again, the range of values is between zero and the reporting level. However, in this case, the data are not assumed to result in a lognormal distribution. Instead, the data are assumed to be distributed throughout the range, with an unknown distribution. In those situations, it is appropriate to assume only that the values are evenly distributed throughout the range.

The appropriateness of that assumption can be judged only on the basis of the true distribution. In the case of urine samples, it can be shown that data often follow a lognormal distribution. With that realization, it is clear that a lognormal distribution will result in few samples near the high end of the range and many more below the half point of the range. The uniform distribution, on the other hand, gives equal probability to each value. In fact, one of the basic properties of a lognormal distribution is that the median value is less than half the value represented by the middle of the range of values (range based on a confidence interval). Meanwhile, by definition, the median value of a uniform distribution is the value equal to the middle of the range. This implies that substituting a uniform distribution will be more favorable than substituting a lognormal distribution for these values.

Approach 6 is sometimes recommended for handling censored data. This approach simply substitutes a value equal to half the censored range. For example, a value of 2 would be substituted for all the values recorded as <4.0. For a data set with a high percentage of censored data, this approach tends to result in a GM nearly equal to the assumed substitution value.

Summary

Approach 1 is exactly the same as the "censored" example, so was not duplicated. Approach 4 was not analyzed, because the analysis requires an additional convention as to what distribution parameters are to be assumed. The table below shows the GM, GSD, 84th percentile, and R-squared values associated with each approach.

	GM	GSD	84th	R-squared
True distribution	1	2	2	N/A
Full distribution	1.030629	1.982555	2.043279	0.9986
Censored	1.17898	1.886369	2.223991	0.9935
Approach 2	0.013437	11.23879	0.151011	0.6235
Approach 3	1.987525	1.529636	3.040191	0.8648
Approach 5	1.504458	2.496756	3.756265	0.8485
Approach 6	2.007976	1.117258	2.243428	0.2286

As discussed in this paper, approaches 2 and 3 tend to represent extremes, with the GM being nearly 0 and nearly 2 for a distribution that has an actual GM of 1.0. Approach 6 tends to produce a GM nearly equal to the substitution value assumed (2.0); thus, the result is essentially determined by the initial assumption. Approach 1 gives a good representation of the underlying distribution, while approach 5 is favorable if the distribution is truly lognormal. In this case, this favorable approach leads to a GM of 1.5 versus 1.17 if the low recorded values were simply ignored.

SC&A Review of the Internal Coworker Model, ORAUT-OTIB-0038

Issues regarding the derivation and application of ORAUT-OTIB-0038, *Rocky Flats Plant Internal Co-Worker Model*, were raised when it was released and discussed at the August 31, 2006, Advisory Board working group meeting. These SC&A issues revolved around the following:[19]

- Applicability of median MDA vs. extreme condition MDA vs. reporting levels:

SC&A had determined that a large percentage of bioassay results for plutonium from 1953–1966 were below the reporting level. Median MDAs after 1962 were higher than the reporting level. This raised the questions of how meaningful those median MDAs were, and how the data below these thresholds should be applied in the coworker model.

- Reliability of the database:

  A large number of zeros are recorded in the HIS-20 database, raising questions about database reliability and NIOSH's approach of substituting a linear distribution between zero and the reporting level for the zeros, as indicated in ORAUT-OTIB-0038:

  > *Furthermore, the linear distribution has an average equal to half of the reporting value, consistent with the general dose reconstruction practice of assigning half of the lower limit of detection for missed dose calculations. Consequently, substituting a linear distribution for these zero entries appears reasonable.* (Arno et al. 2006)

  SC&A believed that the basis for this assumption was not clear.

- Whether monitored individuals represent those with highest exposure potential:

  SC&A questioned the NIOSH evaluation report conclusions that "in general, participation in a bioassay program involves workers who have the largest potential for exposure" and that "it is unlikely that an unmonitored worker would have received a larger dose than the most highly exposed monitored worker at a site" (NIOSH 2006a). The concern was how the coworker model could be derived without establishing the number of workers in specific work locations and the number monitored in each area. SC&A also questioned how an assumed lognormal distribution could be fitted to the available data without knowing statistically whether the sampled worker population is representative of the target population of interest.

In response to these and other issues raised, NIOSH developed its *White Paper—Rocky Flats Plant Internal Coworker ORAUT-OTIB-0038* (Allen 2006a) for further discussion and resolution. The white paper, written by David Allen of NIOSH, addressed four topical issues:

[19] As categorized in an October 31, 2006, e-mail from Dave Allen, NIOSH.

(1) Z-score plot approach to determining distribution parameters
(2) Censored data handling
(3) Why MDA doesn't matter
(4) Linear substitution approach to censored data

In reply to this white paper, SC&A provided point-by-point feedback to NIOSH. In general, SC&A accepted NIOSH's explanation for how the z-score plot was obtained and the censored data were handled but continued to question the reliability of the measurement results in relation to the MDA. With respect to the linear substitution approach, SC&A did not agree with the basis described for adoption of this approach. In particular, SC&A found that:

> *The reporting level is not a lower limit of detection. Actually it is below the median MDA and thus it is a value of doubtful meaning in terms of measurement of real activity. The assignment of half of the lower detection limit (half the MDA) is also not scientifically justifiable. The lower limit of detection (MDA) for urine analysis is not a unique value. It will generally vary from sample to sample. The calculation of each sample MDA is based on a normal distribution of activities. The median MDA for all samples is a nonparametric value, and thus half the median detection limit (half the MDA) does not have any statistical meaning. In the same way, the reporting level is a nonparametric value, unrelated to the real capacity of distinguishing between real measurement results and background or noise counts. In the same way, half the reporting level is not a scientifically statistically meaningful value and cannot be used to justify a procedure.*

In response, Dave Allen observed that ORAUT-OTIB-0038 "stops at a point that a distribution of monitored workers is defined...how that distribution is used is outside of the scope of the OTIB" (Allen 2006a). With SC&A agreement that the application of the TIB is the more relevant SEC issue, an issue-specific conference call on December 6, 2006, to address the three remaining issues. The minutes of this discussion are provided in this attachment.

In summary, NIOSH noted that its intent was to apply the 95th percentile distribution for unmonitored workers and that this approach was deemed sufficiently favorable to claimants, based on experience at Bethlehem Steel and other sites. SC&A questioned whether this approach was sufficiently conservative, because of data points apparently higher than those encompassed by the 95th distribution (i.e., SC&A asked why NIOSH did not use higher percentile distributions, such as the 99th). The discussion revealed that the RFP dose file had been updated, and some of these higher dose values may have been dropped (because they were linked to isolated incidents and, therefore, not representative). Additional discussion regarding the representativeness of the database (including the likely most-exposed workers) and its completeness (HIS-20 vs. CER) resolved those issues to the satisfaction of the working group.

In conclusion, SC&A accepts the NIOSH position that it is possible to derive a surrogate exposure model for the unmonitored worker, based on the distribution of internal doses received by the monitored workers at RFP. However the unmonitored workers' dose should be based on a percentile equal to or higher than the 95th percentile of the distribution, as stated by NIOSH in the December 6, 2006, conference call. While this is clearly a "site profile" issue, ORAUT-OTIB-0038 should be modified accordingly. In this context, concerns about the uncertainties associated with the MDA values and the applicability of a linear distribution to substitute censored data are no longer significant. It would be clearer if the paragraphs in ORAUT-OTIB-0038 on linear substitution are removed (they were not applied for Pu, in any case).

References

Allen, D. 2006a, *White Paper—Rocky Flats Plant Internal Co-worker ORAUT-OTIB-0038*, National Institute for Occupational Safety and Health, September 10, 2006.

Arno, M, R.N. Cherry and J.C. Lochamy 2006, *Internal Co-worker Dose Data for the Rocky Flats Environmental Technology Site*, ORAUT-OTIB-0038, Oak Ridge Associated Universities, Oak Ridge, Tennessee.

NIOSH (National Institute for Occupational Safety and Health) 2006a, *SEC Petition Evaluation Report, Petition SEC-00030*, Office of Compensation and Analysis Support, Cincinnati, Ohio, April 7, 2006. Report Submittal Date: April 7, 2006.

Draft Minutes
Issue-Specific Conference Call: ORAUT-OTIB-0038, Internal Coworker Approach

Call held: December 6, 2006; 2 pm

Attendees:

- NIOSH: Brant Ulsh, Jim Neton
- ORAU: Liz Bracket
- Advisory Board: Mark Griffon, Wanda Munn, Mike Gibson
- SC&A: Joe Fitzgerald, Joyce Lipzstein

Brant started the call by indicating that the internal dose coworker model (ORAUT-OTIB-0038) was being extended to include the D&D era (1990–2005), with a draft now in internal NIOSH review. This extension, based on urinalysis data in HIS-20, will provide projected intakes by year. NIOSH views this extension as responsive to the matrix issue regarding D&D.

It was noted that a companion review compiled by Gene Potter is based on a query of the HIS-20 database regarding dose distributions experienced by "top tier" contractors vs. subcontractors. The purpose is to compare the dose distribution for both groups to see if there is any statistically significant difference attributable to differing monitoring policies or practices. The "top-tier" group consists of 10–15 major operating contractors, while the subcontractor data come from 209 lower tier companies. NIOSH indicated that it had found virtually no difference in the dose distributions of both groups.

Brant further noted that this extended TIB coworker model has been developed for plutonium, at present, and will include uranium in its final draft version.

Following the D&D discussion, Joe Fitzgerald provided some background on the ORAUT-OTIB-0038 issue, noting that SC&A originally had concerns regarding ORAUT-OTIB-0038 and its technical basis but, through exchanges with Dave Allen, had concluded that the issue is really how the TIB is applied to bridge gaps in Rocky Flats dose data. At that time, Dave interpreted SC&A's remaining concerns as (from Dave Allen's October 31, 2006, e-mail):

(1) Application of median MDA vs. extreme condition MDA vs. reporting level

(2) Reliability of the database

(3) Rejection of the hypothesis that the monitored individuals represent the individuals with the highest potential for exposure

Joe asked Joyce to elaborate on these issues. Joyce indicated that in her view, there was no demonstration that the exposure of unmonitored workers is less than that of monitored workers. Jim Neton countered that it was unlikely that unmonitored workers would have received a dose greater than that of monitored workers on site.

Joyce went on to state that the coworker model was based on a "generalized" dose distribution that assumes that everyone would fit somewhere on the distribution. However, it is necessary to know where unmonitored workers fit on the dose distribution curve. This is difficult, because the location of the workers, or what kind of work they were doing, is unknown (if a dose distribution were done by job or building, there would not be the same concern, because the fit would be better). As an illustration, Joyce pointed to 1965 bioassay results, where a 50th percentile dose would be at 0.09 dpm; 84th percentile at 0.5 dpm; 95th percentile at 1,100 dpm; and the 99th percentile at 17,000 dpm. It was felt that NIOSH, by using the 50th percentile distribution, was using a less claimant-favorable dose reconstruction approach for unmonitored workers.

Joyce elaborated that there are 13 results above 17,000 dpm (99th percentile), too large a number to be ignored. Overall, NIOSH needs to demonstrate that unmonitored workers would fall on the low end of the dose distribution to warrant the approach evinced in ORAUT-OTIB-0038. Joyce noted that in her RFP research, she found (and cited examples of) historic instances where unexpectedly high internal results were recorded and later substantiated by followup sampling.

Jim, in response, explained that NIOSH intends to apply the 95th percentile distribution for unmonitored workers who were engaged in work activities that should have been monitored. This approach was derived from the Bethlehem Steel experience, and in that situation, SC&A was an advocate for this policy. Joyce interjected that she sees for RFP a big difference between the distribution results at the 95th percentile versus the 99th percentile; if that is the case, she questioned why NIOSH would use the 95th percentile.

Jim noted that it may be clearer to see this coworker concept as a "surrogate exposure model" rather than as a "coworker model"; that is, with respect to who was monitored, there are three possibilities:

(1) Monitoring was performed only for the highest exposed.
(2) Monitoring distribution included both the highest and lowest exposed.
(3) Only the lowest exposed were monitored.

He noted that there would be a problem only if RFP monitored the lowest exposed workers (the third possibility), which is unlikely, given feedback from interviews with workers and passages in logbooks.

He also noted that he agrees that there were incidents that may have resulted in high intakes, but they were not routine.

Joyce referenced the July–September 1965 data in terms of what she saw as a discrepancy in how the coworker model would fit; i.e., as the dose distribution increases, the curve is no longer straight, but curves upwards. NIOSH remarked that such fluctuations would be expected beyond the 95th percentile, which is another reason to use the 95th percentile distribution as opposed to, say, the 99th.

Liz Brackett subsequently questioned which data Joyce was citing for 1965 and noted that she had different values (Mark agreed that his values were also inconsistent with Joyce's). In her data file for that period, Liz indicated that she found no dose result greater than 120.8 dpm (Joyce had cited 580 dpm at the 95th percentile distribution, with the largest single result being 9,180 dpm).

Jim further observed that too much emphasis seems to be placed on the statistical distribution versus the parametric fit of the data. He believes the focus should be on whether analysts are confident that the data fit the historic worker exposure experience, not whether the distribution chosen envelops all of the doses. What NIOSH should be looking for is a "plausible upper bound."

He acknowledged the concern regarding lumping exposure distributions for different buildings and jobs together but indicated that to do otherwise would be impractical. By applying the 95th percentile distribution, one can cover the "waterfront" for chronic exposure. The highest exposures tend to be driven by events and short-term exposure situations, not by routine exposures.

Joyce continued to express concern over the inclusion of a large number of zeros in the distribution, as opposed to positive values and remarked on the need to be claimant favorable.

Jim countered that there is no clear rationale for assuming that unmonitored workers are among the higher exposed workers. NIOSH's position in this regard is that being claimant favorable means that given two equally plausible alternatives, NIOSH is committed to picking the one that benefits claimants. However, these alternatives (i.e., either unmonitored workers' exposures are higher than 95% of those of the monitored workers or they are not higher than 95% of those of the monitored workers) are not equally plausible. It is not plausible that unmonitored workers' exposures are higher than 95% of those of the monitored workers. One cannot have 100% certainty in a statistical model; one needs to decide the appropriate confidence level. This means choosing the statistical boundary that gives confidence that a "plausible upper bound" has been defined, based on available data.

In closing the discussion, Jim observed that the question of what confidence level (e.g., 95th vs. 99th) is appropriate is a broader policy issue than the question of ORAUT-OTIB-0038 for RFP. Mark agreed with Jim that while this may indeed be a broader issue, it did not appear to rise to the level of SEC significance for RFP.

On the question of the overall adequacy of the internal coworker model, Mark said that NIOSH's position regarding the reliability of HIS-20 seems to have shifted over the past several months, culminating in NIOSH's HIS-20 vs. CER analysis which provided a table showing large differences in the number of data points between the two databases. Brant countered that the SEC evaluation report and other documents acknowledge the limitations of HIS-20. In particular, he noted that the evaluation report discusses that data for workers who terminated before data were uploaded into the electronic database (sometime in the 1970s, but Brant couldn't recall the exact year) were not captured. Subsequently, the workers who were part of the long-term medical monitoring program (i.e., those with known or suspected large uptakes) were restored to the electronic database. If anything, this would bias the coworker data to the high side, though NIOSH's evaluation showed that the uptakes predicted by CEDR and by HIS-20 were very similar and no systematic bias was evident. Don Stewart of ORAU added that, in his opinion, there seemed to be a greater need for coworker data for external dose estimation rather than internal dose estimation.

Joyce then raised the question of the reliability of the data in terms of the MDA values used, noting the disparity in MDA values used as a basis for the coworker distributions. Jim, in turn, noted that the MDA issue had been dropped from the SEC dialogue, because the selection of the MDA (or reporting level) value simply was the point where data would be censored and would have little impact on the overall distribution itself. He noted that the appropriate Pu MDA to be applied for RFP is still unresolved, and that for some of the years in question, the reporting level was higher than the MDA. This question is more of a technical one, rather than one that bears on the feasibility of dose reconstruction. While the MDA issue may have some relevance at the 50th percentile distribution, it essentially goes away at the 95th percentile.

With respect to the planned extension of ORAUT-OTIB-0038 for D&D, Joyce questions why urinalysis data are being applied, rather than the presumably more sensitive WBC measurements. Following some discussion of the issue, Jim noted that while WBC could be more sensitive than urinalysis data, he believes that most workers in the D&D era would have had complete bioassays in any case, thus negating the need for many coworker assignments. It was also noted that post-1993, urinalysis data had become more sensitive than WBCs, because the MDAs for urinalysis had dropped considerably by that time.

In conclusion, the participants agreed that there did not seem to be any remaining SEC questions regarding ORAUT-OTIB-0038, other than the need to review the extension. They reached agreement on the following commitments:

(1) NIOSH owes the work group and SC&A:

- The extended ORAUT-OTIB-038 that includes the D&D era
- The Potter piece for plutonium (top-tier contractors vs. subs), with like treatment for uranium

(2) Joyce and Liz will attempt to reconcile their respective dose data spreadsheets.

ATTACHMENT 27: ANALYSIS OF TERMINATION BIOASSAY RESULTS FOR ROCKY FLATS DURING THE SHUTDOWN AND D&D ERA (1990–2005)

December 18, 2006

The purpose of this analysis was to compare the termination urine results for top-tier contractors (top tier) and subcontractors, where the term "top tier" refers to either the M&O contractor (1990 to mid-1995) or the integrating contractor team (mid 1995 to 2005). If the results are deemed to be comparable, it is an indication that the coworker study developed for Rocky Flats can be reasonably used for subcontractors during the shutdown and D&D era.

Urinalysis data were obtained from [Name] who performed the queries on the HIS-20 database. Since termination urine samples are not uniquely identified in the database, a criterion of any urine sample taken within plus or minus 60 days of the termination date in HIS-20 was selected. Many employees opted to use their last routine bioassay as their termination and this may have been outside of the 60-day window. The choice is documented in their records but was not available for this analysis. Also, it should be noted that the preferred method of termination bioassay in the later years of the site was by lung counting. In lung counting, the results were available immediately and any follow-up could normally be done before the individual left the site. On the other hand, urine samples were run with a "routine" priority to obtain the best minimum detectable activity, and turnaround times from shipment to results were usually around 30 days.

Approximately 8,100 results for all isotopes were retrieved from HIS-20. The results were divided into top tier and subcontractors. The following company names were used as the top tier.

- DOE-ROCKY FLATS FIELD OFFICE
- DYNCORP COLORADO
- DYNCORP I&ET
- EG&G INC. ROCKY FLATS PLANT
- KAISER-HILL COMPANY, L.L.C.
- KAISER-HILL RFETS
- RF CLOSURE SITE SERVICES, LLC
- RMRS CORPORATE
- ROCKY MT REMEDIATION SRV
- SAFE SITES OF COLORADO, L.L.C.
- WACKENHUT SERVICES, L.L.C.

There were 209 separate company names, which were used as the subcontractor population. However, some of these were variations on the same name, as seen for Kaiser-Hill in the list of top tier contractors.

After dividing the urine results into top tier and subcontractors, invalid results were removed from the population to be analyzed. Three criteria were used.

- Results with an "I" (invalid) in the "V" field
- Results with any character other than 0, 1 or blank in the "I" field
- Results with an error that was 0 or blank

The results were then screened for duplicate entries. A result was removed as a duplicate if all of the fields but the date(s) were the same (e.g. same person, sample number, volume, result, etc.).

If volume results were available (as they were for most results in this time period), the results were normalized by volume to 1400 mL per day. Otherwise the results were assumed to be 24-hour samples.

The population of subcontractors was further subdivided into companies that were directly involved in D&D activities and others. The following company names were used as the D&D population:

- BARTLETT SERV INC
- BARTLETT SERVICES, INC.
- DEMCO, INC
- DEMCO, INC.
- DENVER WEST REMEDIATION
- E2 CONSULTING ENGINEERS, INC.
- E2 CONSULTING
- ENVIROCON
- ENVIROMETALS
- ENVIRONMENTAL CHEM
- ENVIRONMENTAL CHEMICAL
- FOSTER WHEELER ENVIRONM
- GASH ELECTRIC
- GASH ELECTRIC COMPANY
- J A JONES CONSTRUCTION
- LOS ALAMOS TECH ASSOC
- LOS ALAMOS TECH OFFICE
- LOS ALAMOS TECHNICAL ASSOCIATE
- MACTEC
- MACTEC
- MANUFACTURING SCIENCES CORPORA
- MARQUES CONSTRUCTORS INC
- MARQUEZ CONTRACTORS
- PM TECH, INC
- PM TECH
- RESEARCH THECHOLOGY GROUP

- RESOURCE TECH GROUP
- RESOURCES TECHNOLOGY GRP, INC.
- SAIC INTERNATIONAL
- TENERA ROCKY FLATS
- TENERA\9341
- TIERRA ENVIRONMENTAL CONS
- URS CORPORATION
- URS GROUP
- WASHINGTON GROUP INTL.
- WASHINGTON GROUP INT'L
- WILLIAMS POWER CORP
- WILLIAMS POWER CORP
- WILLIAMS SERVICE GROUP
- WOODWARD CLYDE CONSULTANTS

Plutonium-239/240 (Pu-239/240) and each of the uranium isotopes (U-234, U-235, and U-238) were analyzed separately. The three populations considered (top tier, subcontractors, and D&D subcontractors) were compared for each isotope. The results are as follows:

	All Sub-contractors	**D&D Sub-contractors**	**Top Tier Contractors**
U-234 (dpm/day)			
50th Percentile	0.008	0.008	0.012
95th Percentile	0.164	0.150	0.275
Number of results	458	273	610
U-235 (dpm/day)			
50th Percentile	0.0	0.0	0.0005
95th Percentile	0.0302	0.0187	0.0326
Number of results	445	266	475
U-238 (dpm/day)			
50th Percentile	0.007	0.006	0.010
95th Percentile	0.128	0.148	0.190
Number of results	458	272	611
Pu-239/240 (dpm/day)			
50th Percentile	-0.0001	-0.0001	0.0
95th Percentile	0.015	0.007	0.041
Number of results	1384	856	2428

At the 50th and 95th percentiles, the results for the subcontractors and D&D subcontractors were less than the results for the top-tier contractors. Therefore, the coworker study developed for Rocky Flats can be reasonably used for subcontractors.

It may seem surprising to some that the results for the D&D population were lower. However, it is important to remember that the steelworkers (part of the top-tier) did most of the contaminated equipment removal; and the buildings were only turned over to subcontractors after contamination levels had been reduced. Furthermore, for plutonium, the top percentiles are populated with workers who had historical intakes, which occurred mostly before 1990. Some of these workers did retire or otherwise seek employment with a subcontractor, but most did not. For uranium, most of the results in the top percentiles were due to exposure to natural uranium in the environment, particularly from private water wells. Although not enough information was gathered in this study to draw a firm conclusion, it is likely that fewer of the D&D subcontract workers resided in the mountain communities on well water than did the longer-term top-tier employees.

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Comment #	Issue Description	NIOSH Response	SC&A Response
1	It is clear from RFETS procedures during the D&D era that individuals were placed on routine bioassay when a determination was made that a potential existed for receiving 100 mrem CEDE in radiological control areas. However, the definition used for who would be actually bioassayed was fairly tight: "Only those who are Rad Worker II or RCT qualified with a current respiratory fit and have entered an airborne or radiological contaminated area in the previous 12 months are considered to be likely, under typical conditions, to have the potential to receive an intake of material which could result in a CEDE of 100 mrem or greater."	At the start of D&D era, routine bioassay was based solely on rad worker II training. Many employees received this training only because they might occasionally visit a contaminated area. Some never did. The requirement for a current respirator fit was added in an attempt to sample the real hands-on workers. After the implementation of HIS-20 (~1997), the requirement for actual entries into a Pu area was added. Routine uranium bioassay was initially based on building assignment. It was then changed to sampling everyone in the routine program for both Pu and U. Finally, only people designated to be most at risk were sampled. The term "fairly tight" is misleading since this was still a large program. Under the final criteria (cited in comment #1), the site averaged over 2500 routine urine samples per year, until the last two years when most of the employees were terminating the site. Even with the sampling of the highest risk workers, there were only few confirmed intakes from routine bioassay. SC&A is speculating without basis that sampling a larger population of workers under less risk would have turned up unknown intakes. The primary means of detecting intakes in the workplace was through the workplace indicator program and follow-up with more sensitive special bioassay sampling. All workers, subcontractors and visitors, regardless of whether they were on a routine bioassay program, were subject to the provision of the workplace indicator program and special follow-up bioassay sampling in the event that a potential for an intake of radioactive material existed based on those workplace indicators. In addition, any worker could, for any reason, request a bioassay sample anytime they felt one may be warranted. These programs worked in concert with the routine bioassay program and the internal dosimetry monitoring program must be considered in its entirety when determining if the necessary employees were sampled.	This quoted definition from RFETS procedures was provided as only an observation without the implications that NIOSH attributes to it (it had been understood by SC&A from past working group discussions on the topic that being a Rad Worker II trained worker was the only criterion for routine bioassay). The "speculation" on SC&A's part that is cited by NIOSH in this response has no basis as it was not our intention to make the point, directly or indirectly, that is being challenged here. One issue that is not addressed are the D&D workers that were working in areas considered to be "cold" and then later found by monitoring to be contaminated with legacy radiological contamination. Some of those workers are no longer onsite and may have been among those that did not submit termination bioassays and were not Rad Worker II or respirator qualified at the time and, therefore, never bioassay monitored under the Routine Bioassay monitoring program. For how many workers did these circumstances apply and how would dose estimation be addressed?

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Comment #	Issue Description	NIOSH Response	SC&A Response
2	The determination of 100 mrem potential often was based on DAC hour projections, which in turn, were based on DAC hour tracking of workplaces with radiological material present. The appropriateness and completeness of bioassay monitoring of D&D workers, therefore, is strongly linked to how well D&D worksites were characterized for exposure potential and to what extent D&D workers who were exposed, but did not qualify for routine bioassay, were monitored for whatever intakes may have occurred (e.g., via termination bioassays, which were required for Rad Worker II qualified individuals or anyone who had ever worked with radioactive materials at the site).	We disagree with the statement "The determination of 100 mrem potential often was based on DAC hour projections, which in turn, were based on DAC hour tracking of workplaces with radiological material present." The actual criteria were given in comment #1. The only characterization of the workplace necessary for the program was the identification of potential airborne radioactivity areas and contamination areas. These areas required Rad Worker II training for entrance (DOE Radcon Manual, Article 335). As with most DOE sites, the tendency was to over-post these areas, so as not to have to continually expend rad safety manpower to post and de-post them. In some cases (e.g. Building 776) the physical layout with large open areas required over-posting since airborne areas could not be physically separated, and all personnel in the area were required to wear respiratory protection regardless of whether it was actually required in a location of the open area.	While it is clear that Rad Worker II designation became the basis for routine bioassay monitoring, it is not clear how that definition reconciles with the requirements in RFP's internal dosimetry procedures for the early 1990s. For example, 1992 procedures for the Routine Bioassay Monitoring Program indicated that: Individuals routinely performing work in RCAs where the time-weighted monthly average (TWMA) of the air sample results is 0.10 of the DAC or greater, or the maximum value of an air sample result is greater than 0.30 DAC, are required to participate in routine individual monitoring program for that radionuclide. It also is clear that that designation was based on a presumption of an exposure potential to the individual that could lead to a dose of 100 mrem/year or more. From NIOSH's description, there would have been at least two types of D&D workers from a monitoring standpoint: 1) Rad Worker II trained workers who would be bioassay routinely and would be able to work in RCAs and assumed to receive potential annual doses at or in excess of 100 mrem CEDE ; and 2) workers who were not Rad Worker II trained but would be assumed to be exposed to sources of radiation less than

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Comment #	Issue Description	NIOSH Response	SC&A Response
			100 mrem/year. SC&A's interest in the context of this issue is how these two worker categories were arrived at (individual risk assessment, DAC hour tracking, etc.?), and to what extent was the required routine bioassays (for Rad Worker II workers), termination bioassays (for non-bioassayed workers), and workplace indicator /special bioassays (for both) performed?
3	Two key audit findings from the documentation provided raise questions, in this context, regarding this issue of appropriateness and completeness:	See below	
3a	The 1997 audit found that a "technology shortfall exists with the routine bioassay program's ability to detect a gradual accumulation of intakes from low concentrations of plutonium airborne radioactive material that would result in a CEDE of 100 mrem (i.e., accumulation of 40 DAC-hours)." The audit further finds that the site had not established a technical basis for what work areas should include DAC hour tracking. That procedures did not address the tracking of DAC-hours accumulated by individuals in airborne radiation areas. That only specific jobs were included. Finally, that DAC-hour tracking and accumulation was not accomplished for personnel working	Refers to 4.12.2 on page 15 of 17 of "1997_Internal_Dosimetry_ Assessment_8694883_pages.pdf." This audit "observation" merely states the obvious, i.e., routine bioassay could not detect 100 mrem CEDE intakes of Pu regardless of whether they are acute or chronic. All DOE sites faced the same issue as is clearly explained in the introduction to Section 4.12.3. The primary means of detecting intakes of regulatory significance (i.e., 100 mrem) was through the workplace indicator program and early fecal sampling. Higher level potential intakes also were followed with urine and lung counting. Throughout the D&D era, the most likely outcome of sampling by this very sensitive technique was a determination of "no intake." The next most prevalent outcome was a dose of less than 100 mrem CEDE. The exceptions were well-documented cases in the dose records for the individuals affected. The DAC-hour program was eventually improved and doses were assigned from DAC-hours when they were accumulated over a relatively long period of time. In such cases, the interpretation of fecal bioassay results becomes	This issue speaks to how RFETS work areas with airborne contamination were evaluated and included in DAC-hour tracking. It does not, in any way, advance a need for dose assessment for "intakes outside of the airborne areas" as asserted in the NIOSH response. The 1997 audit finding in raising a measurement technology shortfall, also notes the cited shortcomings in how the site characterized and tracked areas with airborne contamination, all issues relevant to whether D&D workers may have received dose – dose that may have been missed in existing monitoring programs due to technology limitations or because of shortcomings in DAC hour tracking. Another question is to what extent could workers have received

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Comment #	Issue Description	NIOSH Response	SC&A Response
	multiple jobs within a building or across the plant site. [Assessment Report, Assessment No. 97-0111-KH, Internal Dosimetry Program, October 1997] From all of this, it is apparent that there may have been missed internal dose due to chronic exposures and inadequate DAC-hour tracking and workplace surveillance as a basis for bioassay.	strongly dependent on the scenario assumed. However, DAC-hours were not assigned for occupancy outside of airborne radioactivity areas. There is no logical basis for SC&A to conclude that higher intakes were possible outside of the airborne areas. Hypothetically an individual could be present just outside an airborne radioactivity area for 2000 hours/year in a concentration of 9.99% (i.e., less than 10%) of a DAC and could receive 500 mrem. This conservative, but unrealistic, dose is less than would be assigned under maximizing assumptions used by dose reconstructors for years without routine bioassay.	undetected exposures prior to 1997 when these technological shortcomings were discovered and accounted for? Whether this potential missed dose here is enveloped by the "maximizing assumptions" being used by dose reconstructors is yet another issue that needs to be addressed further
3b	The 2000 audit found at a steady decrease in the proportion of terminating workers who provided a final bioassay sample. In 1999, only 75% of RFETS employees and 62% of "lower-tiered" subcontractors were given terminal bioassays. [Assessment of the Rocky Flats Environmental Technology Site's Internal Dosimetry Program, Assessment No. FY00-114-KH, July 2000] Therefore, for those who were exposed to potential intakes because their work areas were not surveyed adequately (as noted above), or who did not meet the narrow definition for inclusion in the bioassay program, it appears there would not have been a reliable "backstop" provided by the termination bioassay program.	Refers to Section 3.3.1, page 9 of 11 of "KaiserHill_2000_ Assessment_RFETS_Internal_Dosimetry_Program_Vol_1_ 8694886_pages.pdf." 100% compliance with the termination bioassay requirement was not achieved and indeed is not possible at any DOE site. The vast majority (close to 100%) of termination bioassay samples were less than the decision level (i.e., not different than background) or consistent with known intakes. Workers who didn't submit samples will have maximizing assumptions applied, if appropriate, so this does not appear to be an SEC issue. Again, we disagree that anything presented by SC&A or in the audit findings indicates that "areas were not surveyed adequately." Nor do we agree that people were not included in the program that should have been. We can agree that some people left the site without receiving a termination bioassay, as was the case at every DOE site. However, those individual's would have been subject to the workplace indicator program and follow-up with the more sensitive special bioassay sampling should there have been any indication that an intake may have occurred.	The dose distributions cited, while reassuring to hear about, need to be provided for SC&A review. These should include the mentioned cross comparison between positive terminal bioassays and known intakes. Given the relatively higher lack of compliance by lower level subcontractors to requirements such as terminal bioassays, would it be appropriate to assume that the dose distributions are the same? How can an assumption be made about the appropriateness of an upper bound maximizing assumption for an employee whose internal exposure is unknown (other than applying a dose distribution that may or may not appropriate?)? If ultimate reliance is being placed on the real-time "workplace indicator program and follow-up," SC&A needs to have records provided that document the performance of those programs and what followup bioassays were conducted.

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Comment #	Issue Description	NIOSH Response	SC&A Response
			SC&A does not agree with the statement, "nor do we agree that people were not included in the program that should have been." This may or may not be true for for D&D workers after the technology shortfalls were discovered, but does not necessarily cover those that terminated and were not monitored prior to discovery of these issues.
4	The 2004 audit found that while the above noncompliance with termination bioassays had improved, there were still 31 subcontractor companies with 97 employees who had not complied with the termination bioassay requirement. It was further noted in this audit that a reduction in health physicists and rad techs had "negatively impacted" monitoring and compliance for terminating bioassay requirement. [Rocky Flats Environmental Technology Site, Internal Dosimetry Program, Assessment Report, FY04-111-KHAP, March 25, 2004].	Refers to Section 3.1, pages 10 and 11 of 28 of "Internal dosimetry audit report 2004.pdf." The termination bioassay issue was discussed in the response to comment 3. The "negative impact" statement was taken out of context. The report goes on to say that the negative impact was "specifically the generation of quarterly summary reports." Sufficient personnel were available to outprocess the personnel reporting to dosimetry, including administration of the termination bioassay program.	SC&A's comment is directed at the prevalence of noncompliance with the terminal bioassay program as late as 2004 (the final stages of D&D). The coverage of subcontractors in the RFETS bioassay program remains a concern; as noted in an radiation protection program audit conducted DOE's Defense Board in late-1993: "the DNFSB staff did not find that the subcontractors were included in the plants [ALARA] program and it was not clear that bioassays for subcontractors were thoroughly managed. With respect to issue of the "negative" impact cited in the audit, SC&A accepts NIOSH's explanation.
5	The 2004 audit also noted that a number of workers were not "on HIS-20." That "there may be individuals, which are in HIS-20 because they previously worked in a facility that used HIS-20, but are not currently using HIS-20. If these employees become delinquent [in providing bioassay samples], they are locked out of HIS-20, but their	Refers to Section 3.3, pages 13 of 28 of "Internal dosimetry audit report 2004.pdf." This audit finding is poorly worded. All employees issued a TLD badge were included in the HIS-20 database. However, not all areas of the Site were covered by HIS-20 access-control terminals, including many low-risk areas. This is what is being referred to by the auditor. Plutonium areas were covered until near the end when the next bioassay most employees received would be their termination sample or termination lung count. All employees were asked to outprocess through dosimetry and every subcontractor had	SC&A accepts the additional explanation and perspective offered by the NIOSH response.

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Comment #	Issue Description	NIOSH Response	SC&A Response
	manager may not be notified of the issue." [Rocky Flats Environmental Technology Site, Internal Dosimetry Program, Assessment Report, FY04-111-KHAP, March 25, 2004]. From this and other statements provided in the 2004 audit, it appears that with the influx of D&D subcontractors, many were not included in HIS-20, making a comparison of contractor or training rosters with that database problematic.	dosimetry included on their outprocessing checklist. This included employees who had never been issued a TLD badge. Some of these employees opted for termination sample or lung count even though they had never been in a rad area. The issue of the difficulty in the comparison of training rosters to people actually bioassayed is discussed in the response to comment #6, below.	
6	Given the shortcomings outlined above by the site's own audits, coupled with the working group's previously identified concerns regarding whether the D&D bioassay program was sufficiently adequate and complete to support dose reconstruction, we disagree with the comment made in the September 15th email that the provision of the aforementioned RFETS bioassay procedures and audits will suffice in response to this issue. It is even more imperative in light of the findings above to compare the Rad Worker II roster with individual bioassay records for validation purposes.	The "shortcomings" are addressed separately, above. While the request to compare the rad worker II-trained employees to bioassay records seems straightforward, in fact it would be quite complex. There is no rad worker II training roster *per se*. The program worked like this. When it had been one year since each employee's last Pu urine bioassay, the bioassay database queried the training records database to determine the training and respirator-fit status. If the training and respirator-fit status were current, it then queried the HIS-20 database to see if an entry had been made in the previous 12 months. Since site closure, these databases exit in some form, but are not able to communicate as they did when the site was operational. Basically, to do what is being requested, one would have to start with a list of employees and look them up in three systems. For each employee a matrix of the dates of entry into the program, rad worker II training dates, respirator fit dates, HIS-20 entry dates, termination date(s), and bioassay sample dates would have to be set up. Where bioassays appeared to be missing, a memo field would have to be examined. This field might contain such information as, "employee on short-term disability; no sample until return." The hardcopy file might also have to be recalled to determine the exact cause of a failure to submit a	SC&A's comment is directed at the NIOSH conclusion that the various D&D-era bioassay procedures and self-audits were sufficient to address the work group concerns raised regarding dose estimation for D&D workers. It remains our conclusion that not only are these documents inadequate to answer questions surrounding the adequacy and completeness or radiation records associated with D&D activities at RFP, they actually raise additional ones as cited above (e.g., lack of terminal bioassays, lack of integration of lower tier subcontractors into bioassay program, proper basis for Rad Worker II training, etc.) that are not sufficiently addressed in NIOSH's response. NIOSH's conclusion that it is too difficult to validate routine bioassays were conducted for Rad Worker II workers performing D&D needs to be

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Comment #	Issue Description	NIOSH Response	SC&A Response
		sample. Currently, no one on the ORAU/NIOSH side has access to all of the necessary records systems, and we would have to rely on resources from DOE Legacy Management. The return on this investment of time and energy would be a determination that some high percentage of people received bioassay samples on schedule.	further evaluated by the working group. The conclusion that, *a priori,* it would not be justified to do so, in any case, because it is already predictable by NIOSH that "some high percentage of people received bioassay samples on schedule" is speculative and non-evaluative for purposes of a review in the SEC context.
7	It would seem that if these data inadequacies are substantiated, at the very least, some consideration may need to be given to coworker modeling for D&D workers. We look forward to discussing these issues with the workgroup and NIOSH in the context of the ongoing workgroup deliberations.	NIOSH does not concur that any inadequacies which would have relevance to dose reconstruction have been substantiated. NIOSH also notes that the radiation protection protection programs were at their most mature state in the DOELAP era, which coincided with D&D activities at Rocky Flats. We are open to discussing the merits of expanding OTIB-038 (Rocky Flats Internal Coworker data) to cover the D&D era, however this is a TBD/DR issue, rather than an SEC issue.	SC&A, consistent with the existing work group action item, believes that sufficient questions exist regarding the adequacy and completeness of routine bioassay for D&D workers, particularly lower-tier subcontractors, to warrant validation via a cross comparison of bioassay records with a sampling of subcontractor D&D workers. The provision of the dose distributions for terminal bioassays cited by NIOSH in their response should also be provided for review. NIOSH should brief the working group in more detail regarding the state of records for Rad Worker II individuals, routine and special bioassay records, and the feasibility of conducting cross comparisons. NIOSH should also detail how the "workplace indicator program and followup" was conducted and how results were included in the dose of record. [it should be noted that these dosimetry programs were not characterized in the context of D&D activities in the site profile or SEC evaluation]. In this context, other questions that need

Rocky Flats Matrix Item #33 Comments—SC&A Response to NIOSH Comments Regarding D&D

Comment #	Issue Description	NIOSH Response	SC&A Response
			to be answered on a factual and evaluative basis: How sensitive were the workplace indicators? What workplace indicators were used in non-radiological control areas where latency contamination might be stumbled into during D&D? Can the missed dose from such exposures be estimated and maximized by NIOSH for quantification by dose reconstructors?

ATTACHMENT 28: SC&A SAMPLE OF NOCTS CLAIMS FOR ROCKY FLATS COMPLETENESS ANALYSIS

A sample of claims is required to assess the coverage and completeness of the data used for evaluating claims and for estimating doses to coworker claimants. It is expected that the completeness of the available data for claimants first employed at Rocky Flats prior to 1964 may differ from those employed later, due to adoption of universal testing programs in that year. A stratified sample design was selected, resulting in proportional sample representation for the two groups of claimants: Group A, comprising all claimants first employed at Rocky Flats prior to 1/1/1964; and Group B, with claimants first employed at Rocky Flats on or after January 1, 1964.

The NOCTS database was accessed to create a sampling frame consisting of all RFP claimants as of December 7, 2006. A database containing the 1,159 RFP claims was assembled in the Excel workbook *D:\Documents and Settings\hchmelynski\My Documents\RockyFlats6-RFdate-Wave3Sample.xls*. The data were entered on separate worksheets named for each status of claim, i.e., *Active-167*, *Pulled-17*, *GT50-302*, and *LT50-673*, where the number following the hyphen denotes the number of claims on each worksheet. A special query was conducted to identify the date of first employment at RFP for these claimants. These data are located in the *Jobs* spreadsheet of the workbook, sorted by Claim ID and beginning year of the employment period. Lookup functions were used to identify the date of first employment at RFP for each claim. This procedure failed to identify the date of first employment at RFP for approximately 10% of the claims. These claims were examined manually to determine the date of first employment. The entire employment history for these claims was added to the database.

A sampling frame was prepared and downloaded to the PC file *Rocky Flats-Combined (No Pulled).xls*. All claims identified as "Pulled" were removed from the sampling frame at this stage. The remaining claims were separated into the two strata (Group A and Group B, defined above) based on the date of first employment at RFP. The two strata are contained on worksheets *A* and *B* on the workbook, with 479 claims in Group A and 651 in Group B. In the first two waves of the sample, a small pilot sample of n_1=4 claims (Wave 1) was selected. That was followed by a larger random sample of n_2=8 claims (Wave 2). These claims were removed from the Wave 3 sampling frame.

The final and largest sample (Wave 3 with n_3=20) was designed to provide a balanced overall sample with proportional representation of the two strata. The details for this calculation are shown in Table 1. The population is divided 42.4% and 57.6% between Group A and Group B. Given a total sample size of 32=4+8+20 claims in all three waves, a proportional sample would contain 14 claims in Group A and 18 in Group B. Waves 1 and 2 contained 4 claims in Group A and 8 in Group B. Hence, 10 samples are required from each stratum in Wave 3 to complete the proportional sample design.

The 10 sample claims were selected from each group by assigning a random number between 0 and 1 to each claim in column B using the Excel *Rand()* function, followed by conversion to fixed values. Each group was then sorted by the random key in order from smallest to largest. The first 10 claims in each sorted group were selected as the sample.

Table 1. Wave 3 Sample Design

Date of First Employment at Rocky Flats	Time Period	Number of Claims in Population	Percentage of Claims in Population	Target Number of Claims in Combined Wave1+Wave2+Wave 3 Sample*	Number of Claims Previously Selected in Wave 1+Wave 2	Number of Claims to be Selected for Wave 3
Before 1964	Period A	479	42.4%	14	4	10
1964 and after	Period B	651	57.6%	18	8	10
	Total	1,130	100.0%	32	12	20

* Based on proportional allocation to the two time periods for combined Wave 1 + Wave 2 + Wave 3 samples.
Source: Rocky Flats - Wave 3 Sampling Plan.xl

ATTACHMENT 29: SC&A INTERVIEW WITH RFP SITE EXPERT ON DECEMBER 6, 2006

Interviewee: RFP Site Expert
NIOSH/ORAU: Brant Ulsh, Jennifer Hoff, Karin Jessen
Advisory Board: Mark Griffon
SC&A: Arjun Makhijani, Ron Buchanan, Kathy Robertson-DeMers, John Mauro

Notes of this SC&A interview with a Rocky Flats Plant Site Expert are not verbatim. Conversational style has been retained to give a flavor of the discussions.

Arjun: There seem to be gaps in external dosimetry data in the early years for among employees with potential for high exposure. In your review of the records, did you come across such gaps? The gaps seem concentrated in the 1950s. This is from a preliminary analysis of the data that we have been doing.

Interviewee: I am not sure that these are real gaps. In some cases if a worker was highly exposed he would be transferred from a highly exposed area into a cold area, where he would then be not monitored. That is one possibility. One of the things we observed was that people in building 81 were not regularly monitored because they were under the guidelines of 10 percent of the tolerance limit.

The determination of the neutron-to-photon ratios from the Neutron Dose Reconstruction Project (NDRP) only included results from Buildings 771, 776, 777, and 991. Buildings 44 and 81 were not included in the analysis.

If one wants to discern whether the gaps are real or not, they must look at the employee job history. They basically look at the employee's job title and see where the worker was assigned. Practice was not to monitor for external doses if the expected dose rates were less that 10% of the limit.

Arjun: Are the dose rates documented somewhere?

Interviewee: The NDRP searched extensively for the archived dose rate surveys in the 1950s and 1960s and did not find them. I would not expect that the documentation would be retained. The practice in the Cold War was not to write things down that could have gotten into the wrong hands.

Arjun: On the contrary, it has been my impression that DOE policy was to write things down.

Interviewee: Not in the 1950s. We have found very little documentation from the 1950s. [Note: This statement is supported on page 101 of Ed Putzier's memoirs, "The Past 30 Years at Rocky Flats Plant," where he presented his view of management's philosophy regarding documentation in the early years.]

Arjun: Then how do you know the things you have asserted regarding radiological conditions for workers who were not badged?

Interviewee: I have talked to people who were there in the Radiation Protection program when researching external dosimetry in the 1950s for the NDRP.

Kathy: Were people always reassigned to uranium area when they were restricted, or could they be sent to other areas?

Interviewee: They were reassigned based on what type of work they were suited for and where work was available. RFP formed a Work Assignment Committee (circa 1970), which was responsible for finding a suitable sport for workers on restriction. In the early years, they were frequently assigned to uranium areas. Ed Putzier discusses this in his memoirs.

Brant: The name of the document is "Past 30 Years at Rocky Flats."

Interviewee: It is on the Site Research Database.

Interviewee: How do we establish that workers were doing the work assigned according to job title?

Interviewee: We have worker history records.

Jennifer: The employment history cards are in NOCTS.

Interviewee: It is not 100 percent. There are cards missing for some people. The worker's job titles were on the cards. The worker's department is also listed on the card. It is not always easy to discern the building or work location from the card. I would be willing to help Ron to interpret the information on the cards for the cases he is reviewing, if needed.

Arjun: I'd like to ask about the neutron-to-photon ratios in two parts. First about the 1951 to 1957 data. You did not have neutron data for the 700 series buildings for that period.

Interviewee: The neutron data until 1957 is all from Building 91.

Arjun: Did you find gaps in the photon or neutron data?

Interviewee: I did not examine gamma data to be able to answer that. As for neutron data, there were about 10 or 20 people who were issued glass plate neutron dosimeters, which were processed by Los Alamos. Most of the 1950s to mid-1958 is a gap for the neutron data.

Arjun: How do we know that the persons issued the dosimeters were the ones most at risk?

Interviewee: I am not sure how they were selected. They would have been selected by Health Physics management at the time. I believe it had to do with the final assembly of the unit in Building 91.

Arjun: How many workers were there in Building 91 who did this kind of job? Just as an order of magnitude estimate.

Interviewee: I don't know.

Kathy: Were there disassembly people?

Interviewee: I am not sure there was any disassembly at the time. I would guess that was in the late 1950s and 1960s

Brant: Site returns came back in 1963 -- I think that is the year.

Ron: When I did the analysis of missing data on the 20 cases, the missing periods were usually at the beginning of the employment period. Is there some reason for that? Were they trainees? Did they work their way up to being badged.

Interviewee: They may have started work in a non-radiation area or in a lower job classification. Rocky Flats was a coveted place to work. What I have observed and known to have happened was that anyone would apply for a low-level job, such as Janitor, and work their way up into better positions as he proved himself. I don't know if it happened in the cases that you looked at.

Arjun: When we looked at Y-12, SC&A found that in the 1950s the management did try to find and monitor people most at risk. Sometimes they were successful and sometimes not. As a result, in some cases people who were monitored had high doses and in some cases it turned out later on that the workers were not well monitored in situations of high exposure potential. How do we know that this did not happen at Rocky Flats?

Interviewee: I am not sure you are going to find whether they were properly monitored. But you can find job titles and make a judgment about whether they were at risk.

Arjun: How do you know that they were not at risk if you don't have radiation dose rates?

Interviewee: One has to put trust in the professionalism of the people like [Name] and his staff.

Arjun: On the one hand, some workers have said that doses in high radiation areas were not well recorded. On the other, we don't have documentation of radiation rates in the 1950s. Are we in a situation of choosing whose statements we are going to put our faith in as the basis for the decision in that period, since there are no documents?

Interviewee: The policy of not badging workers with exposure potential less than 10% of the tolerance limit was implemented by a staff of professional Health Physicists. [Note: I have not found documentation of that policy. However, the policy is consistent the U.S. Atomic Energy Commission AEC Manual, "Chapter 0524 Standards for Radiation Protection," Section 1.B.4. Monitoring Requirements. "These requirements are applicable if the individual is likely to receive a dose or commitment in any calendar quarter in excess of 10 percent of the quarterly standards in A., above, due to: a. external radiation – personnel monitoring equipment for each individual.”]

Arjun: Let’s go back to the neutron doses. There were no neutron measurements for the 700 series building for 1951 to 1957. You back calculated those doses from 1958 and 1959 years.

Interviewee: Yes. It was for Building 71 mainly. There were also Building 76 and 77, but they were later. One of them was built in 1956 and 1957 and operational in late 1957. Building 71 was the Pu processing building. Chemical and metal operations were in Building 71.

Arjun: We found gaps in worker records that are classified as highly exposed. What does that mean for neutron to photon ratios?

Interviewee: It does not relate to neutron to photon ratios. You have to determine when they became at risk of becoming highly exposed. They may not have been at high risk in the initial stage. If they worked in a plutonium-related building in the 1950s and 1960s, any real gaps would be addressed by the NDRP.

Arjun: Did you find gamma dose gaps in people whose records you were using to estimate n/p ratios?

Interviewee: I did not scrutinize the gamma records. We captured all the gamma dose records from Pu-related buildings.

Arjun: Do you know of workers whose records had gaps?

Interviewee: I do not make any warranty that the gamma records are complete. I am not going to say that we have scrutinized the gamma data.

Arjun: Have you scrutinized neutron data and are they complete?

Interviewee: Oh yes, we have scrutinized the neutron data. There were some missing records. We captured all the worksheets that had been archived. I am not going to say we have a 100 percent capture. We have captured the data that were archived.

Arjun: What fraction of the working months were archived and captured?

Interviewee: We don’t know what fraction of the worksheets was actually captured. The missing data may be one or two percent.

Arjun: So this may mean that for n/p rations, there may be some data possibly missing in the numerator and denominator.

Interviewee: We used only paired sets of neutron and gamma doses to determine the n/p ratios. We used the photon and neutron data sets for the monitoring periods. That is a very important concept.

Arjun: What is your personal explanation for the gaps in the HIS-20 and CEDR databases?

Interviewee: I don't know much about the CEDR records. HIS-20 was a canned database implemented for access control. They uploaded the records form the Health Sciences database. There was a problem that the demographics for the plant did not include listings for workers who had terminated prior to 1977 and were not part of the benefits program. Therefore, it is not a complete database. So one has to be cognizant of the fact that it may not contain all of the old data. The best records are still in the worker's Health Physics files.

Arjun: Was there cohort badging in the early years (through the early 1960s)?

Interviewee: I do not believe Rocky Flats did cohort badging.

Arjun: Is there a way to way to verify that the workers thought to be at low risk were actually at low risk?

Interviewee: I don't know if there is any data to verify that. One can interview the appropriate health physics staff from Rocky Flats about that for the plutonium areas.

Arjun: So there people in the Pu areas who were thought to be not at risk.

Interviewee: You would have to ask the appropriate health physics staff from Rocky Flats that. I have not observed that. But then I am just looking at old data sheets.

Mark: When did the 10% policy change? Did they start badging everyone at some point and then there was another shift?

Interviewee: I am not sure when they backed off the 10 percent tolerance limit. It seems like early 1960s would be reasonable. They backed off tolerance limits for bioassay too in 1960 or 1961.

Brant: After the last working group meeting I asked Jim Langsted to put together a write-up on badging policies.

Arjun: At the last Working Group meeting we were told that subcontractors were normally not monitored but were given badges when they went into radiological areas. What were the criteria for badging these routinely non-badged workers, when they were given badges? Is there documentation of the policy?

Interviewee: I don't have a really good answer to the problem of the completeness problem for subcontractors. But Ed Putzier said in his memoir that they did not allow contractors in hot areas until the practice was loosened up in the late 1960s. Ed also references the HP guide that sets out the monitoring practices and we have captured that as part of our document capture. It stated the contractors would not be monitored externally unless they were going into a work area where the dose rate was more than 0.2 mrem per hour. So they were not monitored if they were in areas with rates less than that. This was both in the 1967 version and 1970 version. That was the plant policy in place at least starting in 1967.

Arjun: Do we know about the policy before that?

Interviewee: I don't what the policy was before that.

Arjun: It seems there was a policy from 1969 onward of not reading badges of some workers deemed to be at low risk of exposure. How long did this continue? Is there documentation of the starting and ending dates for this policy? How was low exposure potential determined?

Interviewee: I've read only the same report you did. I don't know but may be only for that year.

Arjun: It took me by surprise that there was a policy about badges that were worn but not read.

Interviewee: It took me by surprise too.

Mark: Let's wait on Jim Langsted's report to see what it says about badging policy and we can go form there.

[Arjun leaves the call]

Kathy: Can you define what is meant by the A, B, C, and D Plant?

Interviewee: Plant A (Building 44) was the depleted uranium facility. Plant B (Building 81) handled enriched uranium. Plant C was composed of the plutonium processing areas. Plant D (Building 91) was responsible for Shipping and Receiving and final assembly.

Kathy: Do you know when the thorium bioassay program began at RFP?

Interviewee: I have no information concerning that. Bryce Rich and Mel Chew were researching this issue.

Kathy: How was thorium used at RFP?

Interviewee: Again, ask Bryce Rich and Mel Chew about this.

Kathy: Do you know what Sr/Y may have been used for at RFP?

Interviewee: As far as I know, the only Sr/Y at RFP was in sealed sources used for calibration.

Kathy: In terms of gross alpha bioassay, was there any radiochemical separations done which may have eliminated thorium from the sample?

Interviewee: As far as I know, no separations were done; therefore all the alpha emitters would be present.

Kathy: There were gaps or nulls in some of the dose records, and zeros for the computer generated records for 1969. There is clearly a gap in the external monitoring for this year. Do you have any insight on this?

Interviewee: I have no special insights on this topic. Jim Langsted has done research on this and would be the individual to ask.

Kathy: Do you know why doses were significantly lower in 1970 Quarters 1 and 2?

Interviewee: Quarter 3 of 1970 was the strike. There was a decrease in plutonium production after the fire. This may have caused a drop in external exposure, especially for workers previously assigned to Building 776/777. [Note: Plutonium metal operations were disrupted after the fire until Building 707 became fully operational. Building 707 had engineered shielding and modularization to lower dose rates at work locations.]