He responded as follows:

> *No. We do not have time allocated for this search.*

Specifically, for 1963–1972, three sets of logbooks contain data for composite (beta/gamma + tritium + neutron) doses, tritium dose only, and neutron dose only. These logbooks would be necessary to decompose the composite data to perform best estimate dose reconstruction. The availability of NTA data not provided in the claimant files was reinforced by the Radiological Records Manager during a meeting with Sam Glover (NIOSH), Elyse Thomas (ORAUT), Mark Griffin (Advisory Board), Brad Clawson (Advisory Board), and Kathryn Robertson-DeMers (SC&A).

SC&A provided a list of pertinent dosimetry records to NIOSH for consideration. In addition to the data sources identified in the site profile, History Associated Incorporated prepared site-specific guides to epidemiologic and health-related records at a number of sites including SRS. A list of records available at SRS is available through the DOE Office of Epidemiologic Studies Web site. This inventory of records includes the following (DOE 1995):

- *Densitometry Records (Personnel Monitoring Film Badge Data), 1952–1976, 1979, 1981–1984, Health Physics Section and Health Protection Department, E.I. du Pont de Nemours and Company….*

  Series Description: This record series contains personnel monitoring data for employees and visitors at the Savannah River Site. Data sheets and computer-generated reports provide exposure data collected from film badges, neutron pencils, and range ring dosimeters. Information includes employee name, payroll number, dosimeter number, health protection area, cycle or pull date, and readings. X-ray and gamma exposures, slow neutron exposures, and current and cumulative open window and shield dosimeter readings are given, usually in millirem. Calibration data includes densitometer, emulsion, code number, developer and reader name, developing temperature, and beta and gamma results in millirem.

- *Neutron Exposure Reports, 1971, Health Physics Section, E.I. du Pont de Nemours and Company….*

  Series Description: This series consists of neutron exposure reports and related correspondence. Information includes employee name, payroll number, thermoluminescent badge number, work area, cycle number, date badge was issued and returned, code number, and dose in millirems.

- *Dosimetry Logs, 1954–1978, Health Physics Section, E.I. du Pont de Nemours and Company…*

  Series Description: This series consists of logs that document the distribution of dosimeters and associated results. Dosimeters include finger rings, film badges, thermoluminescent dosimeters, thermoluminescent neutron dosimeters, and

"NTA" badges. Information includes frequency of dosimeter changes and readings, number distributed to certain areas, calibration data, and results for individual employees.

- *Neutron Dosimetry Data Logs, 1972–1982, 1986–1992, Health Physics Section, E.I. du Pont de Nemours and Company…*

  Series Description: This series consists of logs which record the assignment of thermoluminescent dosimeter (TLD) neutron badges to Savannah River Site employees. Information includes TLD badge number, name, social security or payroll number, supervisor's name and telephone number, date annealed and processed, and cycle number. There are separate sheets for temporary badges. Dates and locations are listed on each sheet. Readings are usually given in millirems. The series also includes Neutron Badges Indices listing the total number of badges issued, extra issues, badges read for cycle, controls, late badges, badges not used, and badges not returned.

- *Neutron Pencil Results (1952), Health Physics Section, E.I. du Pont de Nemours and Company…*

  Series Description: This series consists of lists recording neutron pencil dosimeter results. Information includes employee name, payroll number, neutron dose in millirems, pencil identification number, and reason why doses could not be determined from some pencils.

- *NTA Film Badge Inventory and Calibration Sheets, (1950–1962, 1964–1969)…*

  Series Description: This series consists of "NTA" film badge inventory and calibration sheets and memoranda regarding the "NTA" monitoring program. Information concerns the collection and processing of "NTA" film badges, procedures, suggested revisions to the program, areas where badges were collected, and the date received. "NTA" badge and payroll numbers are included. Some records include employee names, as well as other personnel information.

A review of several records storage transfer request forms from the Health Physics Section was conducted by Kathryn Robertson-DeMers (SC&A). Documents identified as containing neutron exposure information for the period of 1963–1972 are listed below:

- Transmittal dated December 29, 1971:

  NTA Film, 1962 through Cycle 8, 1967, Document #T2092
  NTA Film, Cycle 9, 1967 thru Cycle 6A, 1970, Document #T2091
  NTA Film, Cycle 6B, 1970 thru Cycle 9B 1971, Document #T2101

- Transmittal dated March 14, 1973:

  Neutron Data 1970 and 1971, Document #M440

The combination of sources above should provide a complete history for neutron dose from 1963–1972. NIOSH may want to consider performing a search of the site records database, especially as it pertains to information related to neutron exposure data for individuals. This additional source of data may be relevant to the assignment of neutron dose.

The Web site also lists other pertinent documents related to the SRS evaluation:

- Film Processing and Dosimeter Calibration Procedures (1954–1960)
- Daily Badge Processing Reports (1954–1957)
- Employee Radiation Exposure Record Cards (1964–1992)
- Construction Worker Exposures (1958–1959)
- Bioassay Analysis Reports (1979, 1981, 1989–1992)
- Bioassay and Dosimeter Data Sheets (1961–1972, 1975–1977, 1986–1988)
- Bioassay Logs (1953–1960, 1962–1989, 1991–1992, 1995)
- Bioassay Master Report (1975)
- Bioassay Monthly Reports (1982)
- Bioassay Program Records (1953–1954, 1992)
- Bioassay Results—Fission Products Induced Activity Reports (1965, 1967–1977, 1987–1989)
- Bioassay Sampling Cards (1954–1987)
- Contamination Cases Logbooks (ca. 1977–1992)
- Contamination Incident Reports (1951–1955, 1958, 1971–Current)
- In Vivo Count Results (1982–1983, 1985)
- Tritium Doses (1958–1972)
- Tritium Dosimetry Monthly Reports (1972–1976, 1979, 1981–1989, 1992–1993)
- Tritium Dosimetry Reports (1977–1979, 1983–1987, 1992–1993)
- Type A Occurrence Report (1979)
- Type C Occurrence Reports (1972–1981)
- Uranium Concentration Reports (1989–1990)
- Urinalysis Reports Strontium and Plutonium (1984–1990)

These records may assist NIOSH in its evaluation of the high-five approach, tritium, and incidents.

Completeness of HPAREH

Another issue relates to the fact that the HPAREH database does not contain data for all the workers for 1952 onward. It contains data for those that were monitored beginning in 1979 and afterwards. It also contains data for some (but not most) workers who worked during 1952–1978. This is important to realize when constructing a coworker model for assigning doses, such as OTIB-0032 (Merwin 2006) for beta/gamma doses and if a neutron coworker dose model is constructed in the future. The dose data from the earlier years (1952–1978) for a large population of workers should be included to create realistic year-by-year dose assignment tables for unmonitored workers. It is especially important to include these early years of dose data because doses during these early years most likely were greater than later years as radiation protection practices/knowledge improved.

NIOSH indicates that it presented the issue of what records from prior to 1979 were included in the HPAREH database to an SRS staff member, who replied in an email dated August 24, 2006. NIOSH has not provided the specific questions asked, making it difficult to understand the answer. An SRS staff member did, however, state the following in his response to NIOSH:

> *The latest version of HPAREH at SRS includes the complete dose history for more than 70% of the individuals ever monitored at SRS, and more than 70% of the cumulative collective worker doses delivered at SRS. It is important to note that SRS staff has never envisioned (or used) HPAREH as the only component of the official dose of record for any worker at SRS. The official dose of record includes all the forms of dose records available to us.*

As previously stated above, SRS believes that the most complete records at SRS from a population standpoint are the hardcopy records. Comment 5 above provides a detailed discussion of the limitations of HPAREH.

Multiple Dosimetry Data

A number of conditions can result in partial body exposures or portions of the body being exposed unevenly. SRS recognized this early in its operations and implemented a multiple dosimetry program. Multiple dosimeters were required where measurements showed nonuniform radiation fields (e.g., specific areas within the reactors required head monitoring, as the dose to the head was greater than that to the chest). The term "multiple badging" in this context refers to instances where workers wore more than one badge at the same time in order to capture doses to various parts of the body at risk of greater exposure more accurately than would be indicated by a single dosimeter worn at the pocket level. The TBD has not mentioned the multiple badging programs and how this information could be applied to assigning organ dose.

During site expert interviews, SC&A learned that multiple badge results are not routinely included in the personnel radiation exposure record and are not currently provided to NIOSH/ORAUT. The whole-body dose for an individual wearing multiple badges was assumed to be the highest recorded result on any of the badges. For example, if the results from four badges positioned over the body were 100 mrem, 200 mrem, 300 mrem and 400 mrem, the whole-body dose would be recorded as 400 mrem regardless of the position of the badge. In about 1992, the methodology for assigning whole-body dose from multiple badges changed. Each dosimeter was assigned an effective whole-body dose equivalent, and the resulting values were added to obtain the whole-body dose. In this case, weighting factors from ICRP 26, *Recommendations of the International on Radiation Protection*, are used (ICRP 1977). The whole-body dose is the only number that is documented in the individual's dosimetry file. All dosimeters worn were processed and results were recorded by area of the body. NIOSH/ORAUT should evaluate the results of multiple dosimeter processing by body position to determine whether partial-body exposures are an issue for specific organs and to evaluate whether the dose values provided by the multiple dosimetry are more claimant favorable. As individual files do not routinely include this information, a special request will be required.

4.14.2 Applicability to Revision 03

This comment is applicable to Revision 03 of the SRS TBD. Draft Revision 04-E (Scalsky 2006) provides no additional information to resolve this issue.

4.14.3 Summary of Overall NIOSH Response

Initially, NIOSH stated that the nature of this comment was unclear. It referred SC&A to the additional guidance in OCAS-TIB-006, *Interpretation of External Dosimetry Records at the Savannah River Site (SRS)* (Neton 2004), and OCAS-TIB-007, *Neutron Exposures at the Savannah River Site* (Neton 2003c), prepared following preparation of Section 5.0 in the SRS site profile in 2003. NIOSH examined the original SC&A review for clarification regarding logbooks.

NIOSH issued OCAS-PER-019, *The Effect of Additional Neutron Data from the Savannah River Site* (OCAS 2007). This program evaluation report indicated that SRS provided additional neutron data. NIOSH reevaluated 17 claims, including four noncompensable claims. No changes occurred in the POC. Previously unevaluated claims were completed with the new data.

4.14.4 Work Group Action

The following actions were identified in Work Group deliberations:

NIOSH Actions:

- Review neutron logbooks referenced in the August 22, 2006, meeting. The meeting minutes are available on the NIOSH Web site.
- Provide a response to the Board regarding the completeness of the HPAREH file used for the development of the external coworker model.
- Investigate the sources of information provided by SC&A.

4.14.5 Closure Status

Revisions 03 and draft Revision 04-E (Scalsky 2006) of the TBD lack an explanation of why the additional records are not being considered for dose reconstruction. SC&A provided NIOSH with an inventory of supplemental records that may be beneficial in dose reconstruction. Based on a review of OCAS-PER-019 (Allen 2007), SRS provided some additional neutron data. Whether these are the neutron logbook data mentioned above is unknown. To date, NIOSH has not discussed the exact nature of these data. NIOSH has made no effort to evaluate the completeness of the HPAREH file used in the development of the external coworker model. The integrity of the HPAREH file for use in coworker modeling is questionable given the absence of data for most workers terminating prior to 1979. Either the TBD or the external coworker dose procedure should develop and discuss a basis for its appropriateness. Furthermore, consideration should be given to multiple dosimetry results, which may provide valuable information on nonuniform exposures and may be of assistance in determining organ dose for some workers. For the above reasons, it is recommended that this overall finding remains open pending review of the NIOSH Work Group action items.

4.15 COMMENT 15: AMBIGUOUS DOSE RECONSTRUCTION DIRECTION

Well-developed technical documents are necessary to ensure that methods are effective and consistent. Applying consistent methodologies can provide continuity of assessment over time and across multiple facilities. The SRS TBD contains ambiguous instructions, inconsistencies, and unwarranted precision.

4.15.1 Issue Description

Dose reconstruction is a complex process even under the best circumstances. It is, therefore, imperative that supportive background information/data and specific instructions are presented in a logical manner that ensures understanding, process efficiency, and consistency among dose reconstructors. Many of the sections of the TBD, especially Chapter 4 related to internal dosimetry, are very difficult to understand and, together with the large array of TIBs and other OCAS/ORAUT procedures, create a virtually impenetrable, complex array of guidelines. This situation lends itself to inconsistencies in the way in which dose reconstructions are performed and makes it difficult to verify the reliability and reproducibility of the dose reconstructions. A major factor that limits the readability and, therefore, comprehensibility of Section 5.0 of the TBD is the mingling presentation of data that alternates between beta/photon and neutron dosimeters/dosimetry. Since reconstruction of beta/photon and neutron exposures requires two different methods, as well as IREP inputs, a more logical and comprehensible format would have separated these two major topics.

Quality assurance is an important part of maintaining a consistent and defensible dose reconstruction program. NIOSH/ORAUT should make the TBD transparent to the user and ensure that the various portions of the TBD are consistent with one another. Inconsistencies in the TBD and between the TBD and other procedures result in confusion and a potential misapplication of available dose reconstruction methods, and they should be corrected or explained. The issuance of complexwide TIBs designed to address specific issues such as glovebox work, tritium exposure, ambient environmental dose, and medical x-ray exposure among others has provided clarification. Procedures are used in conjunction with TIBs and site profiles to guide the dose reconstruction process. This provides more consistency in the process overall.

4.15.2 Applicability to Revision 03

These comments are applicable to Revision 03 of the TBD.

4.15.3 Summary of Overall NIOSH Response

A large number of TIBs have indeed been developed to address unique situations or very general, complexwide situations, all designed to address issues not easily covered in site profiles or to add efficiency to the POC evaluation process. Procedures are written, in part, to help ensure that the dose reconstructors consider all the various guidance documents. Site profiles, TIBs, and procedures are all essential aids to assist the dose reconstructors in performing their POC evaluations. Indeed, the lack of these documents would likely lead to less consistency and efficiency.

4.15.4 Work Group Action

There are no Work Group actions pending.

4.15.5 Closure Status

This issue is currently being addressed under a separate review task. The additions and updates to TIBs and procedures have clarified some of the ambiguity in the site profile. The use of site workbooks by dose reconstructors ensures that methods are consistent. The mingling of data causes confusion in the identification of dose reconstruction methodologies. Some improvement has been made in this area with the later revisions of the TBD. It is recommended that this issue be considered closed.

4.16 COMMENT 16: SPECIAL EXPOSURE CIRCUMSTANCES FOR SUBCONTRACTORS AND CONSTRUCTION WORKERS

The TBD does not currently include the special exposure circumstances for subcontractors and construction workers; however, NIOSH is aware of this issue. ORAUT-OTIB-0052 (Chew et al. 2006) was developed to provide dose reconstruction guidance for trade workers. SC&A is currently reviewing this procedure under Task 3.

4.16.1 Applicability to Revision 03

The trade worker section in Revision 03 of the TBD is reserved. NIOSH issued a generic TIB, ORAUT-OTIB-0052 (Chew et al. 2006), providing dose estimate parameters for construction workers, which includes consideration of SRS construction workers.

4.16.2 Summary of Overall NIOSH Response

No response was provided.

4.16.3 Work Group Action

This is no longer an issue and there is no Work Group action pending; therefore this issue is closed.

4.16.4 Summary

The issuance of ORAUT-OTIB-0052 (Chew et al. 2006) provides a mechanism for estimating construction worker doses. It has been included in the Task 3 procedure reviews and will not be discussed in this review. It is recommended that with the issuance of the construction worker procedure, this issue be considered closed and requires no further action. SC&A recommends that NIOSH finish the trade worker section in the SRS TBD for completeness.

5.0 OVERALL ADEQUACY OF THE SRS SITE PROFILE, REVISION 03, AS A BASIS FOR DOSE RECONSTRUCTION

The SC&A procedures call for both a "vertical" assessment of a site profile in terms of the adequacy and completeness of each particular element of the profile as well as a "horizontal" assessment of the extent to which the profile as a whole satisfies its intended purpose and scope. This section addresses the latter objective by evaluating (1) how, and to what extent, the site profile satisfies the five objectives defined by the Advisory Board for determining adequacy; (2) the usability of the site profile for its intended purpose (i.e., to provide a generalized technical resource for the dose reconstructor when individual dose records are unavailable), and (3) generic technical or policy issues that transcend any single site profile that need to be addressed by the Advisory Board and NIOSH.

5.1 SITE PROFILE IMPROVEMENTS

In general, Revision 03 of the TBD included minimal changes, including an analysis of the maximum plausible annual dose from the ingestion of foodstuffs at SRS. This issue was originally raised in a worker outreach meeting and integrated to respond to this comment. Draft Revision 04-E (Scalsky 2006) proposes additional improvements.

5.2 SATISFYING THE FIVE OBJECTIVES

The SC&A review procedures, as approved by the Advisory Board, require that each site profile be evaluated against five measures of adequacy—completeness of data sources, technical accuracy, adequacy of data, site profile consistency, and regulatory compliance. The SC&A finds that Revision 03 of the SRS site profile represents an adequate accounting of the primary internal issues related to plutonium, uranium, and tritium, as well as main external hazards. Revision 03 is not substantially different than Revision 02 and therefore only minimally resolved the 16 issues identified in the Revision 02 review. The primary changes made to Revision 03 included incorporation of internal review comments and inclusion of a model for the ingestion of foodstuffs. Therefore, Revision 03 of the SRS site profile falls short in fully characterizing a number of key underlying issues that are fundamental to guiding dose reconstruction. In some cases, these issues may impact other site profiles. Many of the issues involve a lack of sufficient conservatism in key assumptions or estimation approaches, or incomplete site data or analyses of these data.

SC&A is aware of NIOSH's ongoing efforts to develop and issue Revision 04-E (Scalsky 2006) of the SRS site profile and has acknowledged additional information intended for inclusion in that version. Likewise, additional guidance documents were being issued that, while not yet reflected in Revision 03 of the SRS site profile, would serve to mitigate some of the gaps and issues raised in this report. While Revision 04-E (Scalsky 2006) incorporates changes that will close a number of the comments, it remains a draft and has not been formally released. Therefore, this report continues to cite issues related to those intended improvements as "open" pending issuance of Revision 04-E (Scalsky 2006).

5.2.1 Objective 1: Completeness of Data Sources

Revision 03 of the TBD contains incomplete assessment and guidance on dose assignment pertaining to RU, Pu-242, transplutonium radionuclides, thorium, and U-233. The calculation of internal dose does not explicitly consider transuranic and fission product impurities in RU. Impurity concentrations are based on estimates made from waste stream data and appear to be at odds with the DOE 1985 Task Force review on RU (DOE 1985). A further investigation of the RU source term data should be completed to determine the upper bounds of impurity concentrations and resulting doses. Other assays, such as metallurgical analyses, may assist in determining concentrations and relative uncertainties in these values. Revision 03 does not address potential internal dose from U-233 (including impurities in uranium). Revision 04-E (Scalsky 2006) adds discussions on the assignment of dose from impurities in RU and from U-233; however, the document has not been formally released.

Revision 03 does not consider potential contributions from exposure plutonium containing higher levels of Pu-242, nor does it justify the absence of such a discussion. Proposed Revision 04-E (Scalsky 2006) discusses the production of Pu-242 during curium campaigns and provides information on the activity composition of the high Pu-242 mixture. The default assumption for plutonium remains at 10-year-old 12% plutonium.

SRS handled exotic radionuclides as a result of special production campaigns and source production ranging in quantities from fractions of a gram to kilograms during special campaigns. These radionuclides included transplutonium elements, Po-210, Co-60, Cf-252, Tm-170, Ir-192, Eu-152, and various isotopes of lanthanum (Reed et al. 2002). Many of these sources produced were encapsulated and therefore posed primarily an external hazard. Neptunium and curium were also processed for periods of time. Revision 03 of the TBD does not explicitly cover the potential dose from these radionuclides. The document gives inadequate or no consideration to potential exposures and missed dose from these radionuclides and does not discuss the implementation of monitoring techniques for these radionuclides.

Section 4.1.2 on bioassay was added in Revision 03, but the issues related to RU, Pu-242, transplutonium radionuclides, thorium and U-233 have not been adequately resolved. Several updates proposed for Revision 04-E (Scalsky 2006) of the TBD deal directly with exposure from these radionuclide sources. This will bridge some of the gaps found in previous versions of the TBD. It is recommended that issues related to exposure from RU, Pu-242, transplutonium radionuclides, U-233 and other exotic radionuclides remain open pending review of the yet-to-be-released Revision 04-E (Scalsky 2006) of the TBD and ORAUT-OTIB-0053 (ORAUT 2005).

SC&A maintains that some workers have sustained significant exposures that are relevant to their dose reconstruction but may not be captured by relying on the DOE exposure file and the CATI. Other sources besides dosimetry files exist at SRS that summarize incidents and provide supporting documentation. Databases identified may be specific to an area or operation, so a compilation of several sources may be necessary to capture site-wide incidents. The databases vary in the criteria for inclusion, giving a broader perspective on what constitutes an incident. Without a thorough reconciliation of the DOE exposure files against these separate incident data banks, NIOSH cannot be assured that all significant exposures from incidents are considered in relation to individual worker claims or in efficiency methods (e.g., high-five approach, coworker dose assignments). Dose reconstructors should be alerted to these situations. Based on record storage practices, redundant systems are necessary to develop a complete list of incidents. While the CATI provides some potential to identify incidents that may be missing from an individual's dose record, reliance on the CATI for this purpose places an inappropriate burden upon the worker or survivor to recall events and to recognize potential implications for the dose reconstruction.

Revision 03 gave no additional consideration to many potential unrecognized or unreported exposures from high-risk work activities. Proposed Revision 04-E (Scalsky 2006) includes discussions on potential dose from special campaigns involving U-233, thorium, and transplutonium radionuclides, and ORAUT-OTIB-0052 (Chew et al. 2006) addresses dose to construction workers. However, neither Revision 03 nor proposed Revision 04-E (Scalsky 2006) of the TBD includes information on decontamination and decommissioning, open burning of solvents, and other high-risk or unusual jobs. It is recommended that this issue remains open pending the completion of Work Group actions and release of proposed Revision 04-E (Scalsky 2006) of the site profile.

The completeness of the data used as a basis for the high-five approach is questionable. NIOSH has not reviewed all recorded inhalation intakes over the history of the site. The criteria for inclusion of individuals in the SRS intake file have changed over time, excluding some intakes from the file. Other sources of information such as the DPSP monthly reports, databanks and incident files, and visitor cards were not considered when identifying intakes. SC&A has presented numerous examples from these sources that likely meet the criteria for inclusion in the high-five approach and deserve further investigation. The general bioassay trend for Np-237 and Pu-239 from the individual high-five data and the DPSP monthly report data indicate that monthly report bioassay results were higher. In addition, some radionuclides were present at the site prior to the availability of bioassay techniques. It is recommended that several Work Group actions remain open, including clarification of the location of the SRS high-five bioassay data, review of the tank farm Fault Tree Data Bank, and completion of the revised high-five approach.

The issuance of ORAUT-OTIB-0052 (Chew et al. 2006) provides a mechanism for the estimation of construction worker doses. It has been included in the Task 3 procedure reviews and will not be discussed in this review. It is recommended that with the issuance of the construction worker procedure, this issue be considered closed and requires no further action. SC&A recommends that NIOSH complete the trade worker section in the SRS TBD for completeness.

5.2.2 Objective 2: Technical Accuracy

The method used to reconstruct doses to unmonitored outdoor workers due to airborne emissions employs an atmospheric dispersion model, assumptions, and a resuspension factor that do not appear to be claimant favorable and are not entirely appropriate for this class of problem. Revision 03 (Scalsky 2005) and proposed Revision 04-E (Scalsky 2006) provide no clarification on these issues. In its response to SC&A's finding, NIOSH maintains that the dispersion model has been adequately validated and is sufficiently conservative. It has not specifically addressed ground-level plumes from open-pan burning of contaminated solvents or from environmental spills and leaks in the TBD. Furthermore, it has not provided a written evaluation of the existing dispersion model focusing on episodic releases, as proposed by the Work Group.

The TBD lacks a basis for the use of a resuspension factor of 1×10^{-9} for resuspension of contaminated soil. Based on an SC&A review of the literature, it also appears that the TBD resuspension factor of 1×10^{-9} per meter may not be claimant favorable. Kennedy and Strenge (1992) reported resuspension factors from approximately 1×10^{-11} to 1×10^{-2} m^{-1}, which suggests that resuspension is a complex process of several parameters and that the specific conditions present at the time of measurement are critical. Based on recommended resuspension factors presented in the literature, an average value closer to 1×10^{-5} to 1×10^{-6} per meter would seem more appropriate for use in worker dose reconstruction, resulting in worker inhalation doses from resuspension that are 3 to 4 orders of magnitude greater than those derived in the site profile. The dust-loading approach should also be considered, using an average work-year dust loading on the order of perhaps 1 mg/m^3. It is recommended that, due to remaining issues associated with the atmospheric dispersion model, assumptions, and a resuspension factor, this overall finding remains open.

Revision 03 contains inadequate information regarding the assessment of dose from STCs. In June 2006, NIOSH proposed a methodology for the assignment of dose from STCs. Proposed SRS-specific guidance assigns dose from tritides based on surface contamination limits rather than production information and surveillance data, making the basis for assumptions weak, particularly in years when engineering controls were not as advanced as they are today. In April 2007, NIOSH released ORAUT-OTIB-0066 (LaBone 2007), which provides a bounding technique for the assignment of dose from intakes of OBTs and SMTs. NIOSH has provided a dose estimation methodology for STCs; however, it has not verified the timeframe and location where STCs were handled or the types and quantities of STCs handled at SRS. The bounding techniques, as proposed for SRS, cannot be effectively developed and applied without some basic understanding of the STCs handled, the quantities of material, the locations and time periods of potential exposure, and the physical behaviors of tritium compounds in the environment (e.g., conversion to HTO, formation of rust) to correctly characterize tritium exposure. Furthermore, NIOSH limited the application of this technique to 1975 to present. This conflicts with site expert statements that indicate that potential exposures occurred as far back as late 1950s. Given the large amount of tritium handled at SRS in various areas and the propensity of tritium to bind with organics and metals, it is reasonable to assume that STCs were present at SRS in some form prior to 1975. An evaluation of the adequacy of the dose estimation methodology cannot be completed without this key information; thus it is recommended that the issue remains open.

In-vivo bioassay monitoring results for thorium should be analyzed very carefully. Errors of two orders of magnitude can be made, depending on the material type, equilibrium assumptions, and time of measurement after intake. Urinalysis results should also require a very cautious analysis, including the influence of natural thorium in the diet.

Information in the revised TBD refers the dose reconstructor to ORAUT-OTIB-0001 (Brackett 2003), which describes the high-five approach. NIOSH indicated that it intends to update the high-five approach and base revised calculations on bioassay data rather than data in the SRS

IDR. This update was expected in December 2006 but has not been completed as of August 2007. Until the revision of this procedure is implemented and the TBD references the correct TIB, regulatory issues continue to be associated with the application of the high-five approach. Using the urinalysis as a basis for dose calculation will eliminate the use of intake data derived with ICRP 30 and allow for the exclusive use of ICRP 60 methodology or more current methods. Revision 03 (Scalsky 2005) and Revision 04-E (Scalsky 2006) still reference the 2003 version of ORAUT-OTIB-0001 (Brackett 2003) on maximizing internal dose. The updated approach along with any modifications to the TIB will be reviewed when provided by NIOSH.

Revisions 03 and 04-E reference ORAUT-OTIB-0001 (Brackett 2003), which continues to use both ICRP 30 and subsequently ICRP 66 as the method for assignment of internal dose. ORAUT-OTIB-0001 (Brackett 2003) justifies the use of intakes calculated with ICRP 30 methodologies rather than the most current ICRP methodology by comparing IRFs from ICRP 30 and ICRP 68. The ICRP 30 model does not produce intake values that are higher than those derived by the new ICRP models for a majority of the relevant radionuclides included in the hypothetical intake as maintained by NIOSH. The use of ICRP 30 methodology to calculate the intake, with a subsequent use of ICRP 68 models to calculate the dose, did not always result in the intended highest dose to an organ. Similarly, the appropriate solubility types between the two methodologies were not always paired consistently, resulting in discrepancies that were not claimant favorable.

The dose reconstructor is directed to use surrogate radionuclides for radionuclides absent from the IMBA code. In lieu of this, a more prudent approach to the absence of radionuclides is to use the dose coefficients provided in ICRP 2001 and employ a linear interpolation for the radionuclides that are not explicitly given. ORAUT-OTIB-0001 (Brackett 2003) should be updated to reflect these and other changes made to the high-five approach. The closure of this issue is pending the update of the high-five method using bioassay data and appropriate models. It is recommended that issues associated with the high-five approach remain open pending the release of the revised ORAUT-OTIB-0001 (Brackett 2003) and subsequent reflection in Revision 04-E (Scalsky 2006) of the TBD.

The issues associated with correction factors and uncertainties have not been satisfactorily resolved. It has not been demonstrated that the application of a DAF of 1.119 or 1.039 for both TLDs and film for 1952–1986, and an uncertainty of 30% without full consideration of laboratory, radiological, and environmental factors, is claimant favorable. The dosimeter calibration is based on an incident angle of zero degrees, which underestimates the actual field dose where incident angle is greater than zero. The correction factor applied to recorded dosimeter results is too low for photon energies from 30 to 250 keV, which is the default photon energy used.

Specific actions recommended by SC&A to achieve closure include the following:

- Provide detailed period/location film-specific DAFs for the period 1952–1970.
- Provide period/location TLD-specific DAFs for the period 1971–1986.
- Assess the impact of new DAFs on coworker data.

- Account for differences in incident angles between calibration and field use.
- Account for photon energies between 30 and 250 keV (the default photon energy used in calibration).
- Clarify the basis for applying a generic 30% uncertainty factor, and/or provide clear instructions for applying other appropriate uncertainty factors.

Revision 03 does not provide additional information to satisfactorily resolve issues associated with correction factors and uncertainties. The recent draft of Revision 04E (Scalsky 2006), which is not yet officially issued, contains a few changes to external dose reconstruction, but these additions do not satisfactorily address issues associated with correction factors and uncertainties; therefore, they are still applicable. None of the SRS site-specific workbooks and guides that SC&A has been able to locate provides further qualification for using the DAFs as recommended in the TBD (Scalsky 2006). The SRS documents that SC&A has been able to find do not deal specifically with uncertainties or adjustment factors. In addition, SC&A needs more bibliographic information to locate the “guide of 3/29/04” (as listed in the NIOSH response) and evaluate its applicability to this issue. It is recommended that for these reasons this issue remains open.

SC&A concurs that ORAUT-OTIB-0017 (Merwin 2005) provides suitable guidance for the assignment of shallow dose. This issue is closed.

The TBD prescribes two very different protocols for neutron dose reconstruction that correspond to pre- and post-1971 time periods. Prior to 1971, the uncertainty factors associated with the neutron-to-photon ratio are neither technically defensible nor likely to be claimant favorable. The TBD provides no compelling evidence to suggest that the TLND dosimeter offered significant improvements over NTA film. In brief, this suggests that both the TLND recorded neutron doses between 1971 and 1995 as well as the pre-1971 neutron doses (derived by neutron-to-photon ratios) suffer from a high degree of uncertainty and must be viewed with caution.

SC&A’s evaluation of Revision 03 (Scalsky 2005) did not reveal any changes concerning neutron dose reconstruction methodologies. SC&A believes that the use of the geometric mean and geometric standard deviation that describe the post-1971 neutron-to-photon ratio is neither technically defensible nor likely to be claimant favorable for a large fraction of potential claimants. Proposed Revision 04-E of the TBD (Scalsky 2006) provides some changes and clarifications to the applications of neutron-to-photon values for dose reconstruction. For likely noncompensible cases, the site profile recommends applying the 95^{th} percentile neutron-to-photon dose ratio to the recorded dose. SC&A recommends that the 95^{th} percentile neutron-to-photon values be used in all SRS dose reconstruction cases, not in just the likely noncompensable cases. There is currently no Work Group action pending, but it is recommended that this issue remain open pending the release of proposed Revision 04-E (Scalsky 2006).

5.2.3 Objective 3: Adequacy of Data

The adequacy of the F- and H-Area Tank Farm characterization in the TBD is questionable for use as dose reconstruction guidance. Data evaluation appears to be incomplete with regard to exposure conditions, radionuclides of concern, and uncertainty. This is particularly true for early periods of operation, where primary records involving key operations and incidents are lacking. The tank farm database, not currently evaluated by the TBD, can serve to determine what assumptions would be suitable in giving claimants who worked in the tank farms the benefit of the doubt in the face of considerable uncertainties. The lack of evaluation of primary data sources has left the TBD without a realistic way to estimate uncertainties. The potential for internal and external exposure to unmonitored workers in areas not designated as radiological control areas needs to be investigated. Revision 03 of the site profile made no changes in the discussion on the tank farms. Proposed Revision 04-E (Scalsky 2006) made only minimal changes, such as the inclusion of Cs-137 and Ru-106 in Table A-14. Default intakes for tank farms workers for different periods of time, including actinides, were added. This revision does not resolve all issues associated with the tank farms. It is recommended that this issue remain open pending completion of Work Group action items and release of the proposed Revision 04-E (Scalsky 2006).

An evaluation of the comprehensiveness of the early monitoring program should be completed for early workers to determine whether existing site profile methodologies bound their dose. This is especially important in the case of workers who were not monitored but were exposed to a radiological hazard. Without a single organization determining neutron dosimeter, bioassay requirements, and when special interpretations of film badges are required, there may have been inconsistencies in actual practices. The adequacy of the early monitoring program (i.e., who they monitored) will not be resolved by an inventory of records provided in claimant files. Furthermore, additional validation of the HPAREH database as the exclusive source for external coworker dose determination, given the incompleteness of early data, is necessary to demonstrate that these data are adequate for this use. It is recommended that this issue remain open pending NIOSH's completion of Work Group action items.

Revisions 03 and 04-E lack an explanation of why the additional records are not being considered for dose reconstruction. SC&A provided NIOSH with an inventory of supplemental records that may be beneficial in dose reconstruction. Based on a review of OCAS-PER-019 (OCAS 2007), NIOSH/ORAUT has received some additional neutron data from SRS. The exact nature of this data has not been discussed with SC&A to date. To SC&A's knowledge, no effort has been made by NIOSH/ORAUT to evaluate the completeness of the HPAREH file used in the development of the external coworker. The integrity of the HPAREH file for use in coworker modeling is questionable, since most of the workers terminating prior to 1979 are not included in the HPAREH. A basis for its appropriateness should be developed and discussed in either the TBD or the ORAUT-OTIB-0032 (Merwin 2006). Furthermore, consideration should be given to multiple dosimetry results, which may provide valuable information on nonuniform exposures and may be of assistance in determining organ dose for some workers. For the above reasons, it is recommended that this overall finding remain open pending review of the NIOSH Work Group action items.

5.2.4 Objective 4: Consistency among Site Profiles

The key assumptions in Revision 03 for medical, environmental, internal, and external dose remained the same as those from Revision 02. Section 3.0 of Revision 03 did include an annual dose from the ingestion of foodstuffs. Doses are calculated for the ingestion of 60 kilograms (wet mass) of food per year for Sr-90, Cs-137, Pu-238, Pu-239, and tritium. NIOSH/ORAUT has stated that ingestion is not usually considered at major DOE sites; however, it was considered for SRS and for worst-case internal dose assumptions at Hanford. Ingestion dose should not be applied selectively at one facility and ignored at another.

5.2.5 Objective 5: Regulatory Compliance

The TBD has effectively complied with the hierarchy of data required under 42 CFR Part 82 and its implementation guides with one notable exception. SC&A notes that SRS used ICRP 30 to determine the relative intakes used in the high-five hypothetical intake. This appears to conflict with 42 CFR 82.18(b), which states "NIOSH will calculate the dose to the organ or issue using the appropriate current metabolic models published by the ICRP."

5.3 USABILITY OF THE SITE PROFILE FOR ITS INTENDED PURPOSES

SC&A identified a number of issues in the SRS and other site profiles reviewed to date that, in some cases, represent potential generic policy issues that transcend any individual site profile. These issues may involve the interpretation of existing standards (e.g., oro-nasal breathing), how certain critical worker populations (e.g., construction workers and early workers) should be profiled for historic radiation exposure, and how exposure itself should be analyzed (e.g., the treatment of incidents and statistical treatment of dose distributions). SC&A previously defined these issues in its evaluation of Revision 02 of the SRS site profile. NIOSH has issued TIBs to address generic issues such as shallow dose assignment, dose to construction workers, exposure from highly insoluble plutonium, and exposure from STCs, all of which apply to dose reconstruction at SRS. Other common issues still remain, such as the dose from impurities in RU, dose to decontamination and decommissioning workers, and quality assurance of records provided for claimants by SRS.

5.3.1 Ambiguous Dose Reconstruction Direction

The ambiguity of the TBD is currently being addressed under a separate review task. The additions and updates to TIBs and procedures have clarified some of the ambiguity in the site profile. The use of site workbooks by dose reconstructors ensures that methods are consistent. The mingling of data causes confusion in the identification of dose reconstruction methodologies. The later revisions of the TBD have made some improvement in this area; therefore, it is recommended that this issue be considered closed.

5.3.2 Inconsistencies and Editorial Errors in the Site Profiles

NIOSH uses Equations 3-2 and 3-3 on pages 52–53 of the TBD to derive the atmospheric dispersion factors (i.e., X/Q values expressed in units of seconds per cubic meter) for ground-level and elevated releases, respectively. These equations appear to be in error because they result in large X/Q values. For example, using Equation 3-2, the ground-level X/Q at 1,000 meters downwind from the release point is derived as follows:

$$Y = 1.0146X - 1.8809$$

where Y = Atmospheric dispersion factor (s/m^3) and X = Distance from the source (meters).

Hence, at 1,000 meters, the X/Q value is as follows:

$$Y = 1.0146(1000) - 1.8809 = 1013$$

Since X/Q values are typically a small fraction of 1 (e.g., on the order of 0.001), it appears that the equation contains a typographical error. Perhaps the equation should be inverted, giving a value of 1/1013 or about 0.001. This is also the case for Equation 3-3.

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ATTACHMENT 1: NIOSH TECHNICAL DOCUMENTS CONSIDERED DURING THE REVIEW PROCESS

Technical Basis Documents:

- ORAUT-TKBS-0003, Savannah Rive Site, Revision 03, April 5, 2005 (Scalsky 2005).

Technical Support Documents:

- OCAS-PER-001, *Misinterpreted Dosimetry Records Resulting in an Underestimate of Missed Dose in SRS Dose Reconstruction*, Revision 0, Office of Compensation Analysis and Support, Cincinnati, Ohio, September 8, 2003. (Neton 2003a)

- OCAS-PER-002, *Error in Surrogate Organ Assignment Resulting in an Underestimate of X-ray Dose in SRS Dose Reconstructions*, Revision 0, Office of Compensation Analysis and Support, Cincinnati, Ohio, December 15, 2003. (Neton 2003b)

- OCAS-PER-0019, *The Effect of Additional Neutron Dose Data from the Savannah River Site*, Revision 0, Office of Compensation Analysis and Support, Cincinnati, Ohio, May 18, 2007. (Allen 2007)

- OCAS-TIB-006, *Interpretation of External Dosimetry Records at the Savannah River Site (SRS)*, Revision 1, Office of Compensation Analysis and Support, Cincinnati, Ohio, February 20, 2004. (Neton 2004)

- OCAS-TIB-007, *Neutron Exposures at the Savannah River Site*, Revision 0, Office of Compensation Analysis and Support, Cincinnati, Ohio, September 17, 2003. (Neton 2003c)

- ORAUT-OTIB-0001, *Technical Information Bulletin: Maximum Internal Dose Estimates for Savannah River Site (SRS) Claims*, *Revision 0*, Oak Ridge Associated Universities, Oak Ridge, Tennessee, July 15, 2003. (Brackett 2003)

- ORAUT-OTIB-0032, *External Coworker Dosimetry Data for the Savannah River Site*, Revision 0 PC-1, Oak Ridge Associated Universities, Oak Ridge, Tennessee, November 7, 2006. (Merwin 2006)

- ORAUT-OTIB-0006, Revision 02 (2003), *Technical Information Bulletin: Dose Reconstruction from Occupationally Related Diagnostic X-ray Procedures*, Oak Ridge Associated Universities, Oak Ridge, Tennessee. December 29, 2003. (Kathren et al. 2003)

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- ORAUT-OTIB-0017, Revision 00 (2005), *Technical Information Bulletin – Interpretation of Dosimetry Data for Assignment of Shallow Dose,* Oak Ridge Associated Universities, Oak Ridge, Tennessee, January 19, 2005. (Merwin 2005)

- ORAUT-OTIB-0066 (2007), Revision 00, *Calculation of Dose from Intakes of Special Tritium Compounds*, Oak Ridge Associated Universities, Oak Ridge, Tennessee, April 26, 2007. (LaBone 2007)

ATTACHMENT 2: WSMS DATABANK STATISTICS

SRS staff obtained a copy of the WSMS incident database. Because this database was lengthy and contained classified information, a review team was assembled to review the database at SRS from February 28 through March 1, 2007. The three objectives were to determine the contents of the database, compare entries in this database to those from the tank farm Fault Tree Databank, and determine its usefulness in dose reconstruction. The WSMS database contains 464,092 incidents, including many that do not relate to radiation exposure. SRS has expressed concern about having to review the entire database for classified material and has requested that the Work Group identify the particular incidents of interest. To accommodate uncleared members of SC&A, NIOSH, ORAUT, and the Work Group, incident counts by year, area code, and facility code have been provided. Counts for key equipment codes and operations codes associated with sample incidents retrieved from the database have also been provided. However, without the user manual, SC&A was unable to define many of the codes listed below.

Table A2-1. WSMS Incident Statistics by Year

Year	# of Incidents	Year	# of Incidents
1953	1	1980	18708
1954	107	1981	18600
1955	301	1982	18689
1956	415	1983	16879
1957	426	1984	18571
1958	390	1985	19745
1959	653	1986	25366
1960	597	1987	23944
1961	624	1988	20402
1962	752	1989	24538
1963	804	1990	27456
1964	1308	1991	36531
1965	1368	1992	31525
1966	1918	1993	31124
1967	2102	1994	32240
1968	1633	1995	28057
1969	1203	1996	5292
1970	1454	1997	38
1971	1971	1998	47
1972	2783	1999	80
1973	2578	2000	28
1974	3018	2001	10
1975	3571	2002	5
1976	5163	2003	19
1977	8831	2004	35
1978	9856	2005	5
1979	12324	2006	1

Table A2-2. WSMS Incident Statistics by Area Code

Area ID	Count	Area Code
19	6	V (ON SITE OTHER THAN IDENTIFIED AREAS)
15	22	R
20	22	W
17	33	T
10	52	L
13	64	P
21	76	Z
3	90	C
7	94	G
2	105	B
12	168	N
9	185	K
4	347	D
18	384	V
5	613	E
14	800	Q
16	1867	S
1	22131	A
11	27816	M
8	157644	H
6	251710	F

Table A2-3. WSMS Incident Statistics by Facility Code

Facility ID	Facility Code	Count
1	SA	1
2	A	3991
3	B	381
4	C	856
5	D	207
6	E	725
7	F	109
8	H	197
9	I	667
10	K	47
11	LA	45
12	LB	1335
13	LC	19
14	LD	330
15	LE	18855
16	LF	5
17	LG	292
18	LH	1
19	LI	36
20	LJ	1
21	LK	125
22	LL	1213
23	LM	241
24	LS	73
25	LT	4
26	LU	24
27	LV	21913
28	LW	46
29	LY	3
30	M	3
31	MC	49
32	MF	27447
33	O	1
34	Q	303
35	S	233
36	S0	25
37	SA	170555
38	SB	120668
39	SC	36473
40	SD	15970
41	SE	5503

Facility ID	Facility Code	Count
42	SG	2
43	SH	93
44	SI	7443
45	SJ	495
46	SK	119
47	SL	19454
48	SM	3365
49	SN	88
50	SO	183
51	SP	1048
52	SQ	28
53	SS	19
54	ST	13
55	SW	784
56	SX	486
57	SZ	355
58	T	151
59	W	43
60	WA	285
61	WB	27
62	WC	69
63	WD	3
64	WE	39
65	WG	117
66	WH	2256
67	WJ	302
68	WK	6
69	WL	13
70	WM	180
71	WO	17
72	WQ	2257
73	WR	631
74	WS	1589
75	WT	21964
76	WU	335
77	WV	18
78	WW	781
79	WX	13
80	WY	2
81	WZ	79
82	X	1

Table A2-4. WSMS Incident Statistics by Key Equipment Codes Related to Incidents Involving Radiation

Equipment ID	Equipment Code	Count
8	313-M (FABRICATION)	13352
62	ACCEPTANCE CRITERIA	4
63	ACCOUNTABILITY	667
70	ACTIVITY	2386
74	AIR EMMISSIONS	35
76	AIR REVERSAL	740
80	AIRBORNE ACTIVITY (772-F)	597
83	ALARM/HORN	33979
90	AMERICIUM	29
91	AMERICIUM, CURIUM, CALIFORNIUM	62
94	ANALYSIS	165
95	ANALYTICAL	1893
96	ANALYTICAL CELL	867
97	ANALYTICAL, 320-M	130
108	ASSAY/MONITOR ENRICHED URANIUM	7
163	BETA-GAMMA INCINERATOR	118
182	BIOASSAY AND/OR CHEST COUNT	263
183	BIOASSAY AND/OR CHEST COUNT (772-F)	33
190	BLOWER, FANS	11380
192	BODY EXPOSURE>2RAD/HR OR>1R/HR	186
205	BREATHING AIR	3237
212	BUILDING 232-H	67
213	BUILDING 234-H	43
214	BUILDING 235-H	3
215	BUILDING 238-H	2
216	BUILDING 249-H	2
219	BULDING 233-H	29
222	BURIAL GROUND	1600
225	CABINET	147
226	CABINET, ENTRY/EXIT OF MATERIAL	4386
230	CALIBRATION	3084
231	CALIBRATION SOURCE	495
232	CALIFIRNIUM FACILITY	53
297	CLEANING	541
302	CLOTHING CONTAMINATION (772-F)	738
337	CONDUCT OF OPERATIONS	344
345	CONTAMINATION	2123
346	CONTAMINATION PERSONAL CLOTHING/EFFECTS	395
347	CONTAMINATION, AIRBORNE	19160
348	CONTAMINATION, CLOTHING	4977
349	CONTAMINATION, FACILITY OR EQUIPMENT	29421
350	CONTAMINATION, NASAL	706
351	CONTAMINATION, SKIN	2475

Table A2-4. WSMS Incident Statistics by Key Equipment Codes Related to Incidents Involving Radiation

Equipment ID	Equipment Code	Count
355	CONTROL ROOM/CONTROL BOARD/PANEL BOARD	2190
368	CORE MACHINING	99
374	CORE, URANIUM	35
380	CRITICALITY POTENTIAL	2099
386	CURIE (0 TO 1E2)	75
387	CURIE (1E2 TO 1E3)	871
388	CURIE (1E3 TO 1E4)	79
389	CURIE (1E4 TO 1E5)	77
390	CURIE (1E5 TO 1E6)	75
391	CURIUM 242	8
392	CURIUM 244	10
398	DAMPER	925
407	DECONTAMINATION	1
418	DEMOLITION/DECOMMISION	8
419	DENITRATOR	54
466	DRUMS, CANS	979
469	DUCT	1220
476	DUST BAG	23
477	DUST COLLECTION	244
480	EFFLUENT TREATMENT FACILITY	377
496	ENRICHED URANIUM METAL RECEIVING, 321-M	68
497	ENRICHED URANIUM STORAGE	162
498	ENVIRONMENTAL PROTECTION AGENCY	1269
499	ENVIRONMENTAL RELEASE	2476
500	ENVIRONMETAL PROGRAMS, MISC. 300-AREA	1250
504	EQUIPMENT SEALS	416
506	ERRORS	1797
507	ERRORS, SUPERVISOR	882
509	ESTIMATED TOTAL EXPOSURE (772-F)	158
510	EU CONCENTRATE TANK	36
511	EU LOADOUT FACILITY	231
513	EVACUATION	482
517	EVAPORATOR (GENERAL)	176
535	FACILITY CONTAMINATION (772-F)	1762
548	FILTERS (GENERAL), SCREENS, STRAINER	9652
560	FIRE	2116
561	FIRE DETECTION AND SUPPRESSION	18059
562	FIRE EXTINGUISHER	13
563	FIRE WATCH	114
564	FIRE WATER SYSTEM	158
567	FIXED CONTAMINATION	184
582	FLUOROSCOPE	119
583	FLUOROSCOPE INSPECTION, 321-M	119
603	FULL BODY AND RESPIRATORY PROTECTION (772-F)	1291

Table A2-4. WSMS Incident Statistics by Key Equipment Codes Related to Incidents Involving Radiation

Equipment ID	Equipment Code	Count
604	FUMES	605
614	GANG VALVE	6713
614	GANG VALVE	6713
631	GLOVES	11839
632	GLOVES (772-F)	355
638	GROUND WATER	281
639	GROUNDWATER CLEANUP	684
654	HAZARDOUS WASTE	865
656	HEAT EXCHANGER/COOLER	819
662	HEPA FILTER	1163
675	HOOD OR RADIOBENCH (772-F)	552
676	HOOD/GLOVE BOX	541
681	HOSE	1693
691	HUT	1403
702	IDENTIFICATION, URANIUM SLUGS	34
709	IMPROPER STORAGE	799
710	IMPURITIES	782
714	INADEQUATE ADMINISTRATIVE CONTROL	392
715	INADEQUATE COMMUNICATION	1818
718	INADEQUATE MONITORING	37
719	INADEQUATE PROTECTIVE CLOTHING	805
726	INDUSTRIAL HYGIENE	102
730	INHALATION	6767
731	INJURY	36
734	INJURY, MEDICAL TREATMENT CASE	33
743	INSTALL, REPLACE (AND/OR REMOVE)	7841
744	INSTRUMENT AIR	3468
745	INSTRUMENT MALFUNCTION	68255
752	INTERLOCK	1316
760	INVENTORY	186
761	IODINE	155
762	IODINE REACTOR	1317
763	ION CHAMBER	8
764	ISOTOPE SEPARTION (GAS)	37
772	KANNE MONITOR	483
775	LABORATORY	631
786	LEAKS	37354
795	LIMIT EXCEEDED	1221
800	LIQUID EFFLUENT TREATMENT FACILITY (LETF)	674
801	LIQUID LEVEL	2485
819	LOSS	854
823	LOW LEVEL WASTE	190
844	MAINTENANCE ROOM/AREA	69
850	MASS SPECTROMETER	83

Table A2-4. WSMS Incident Statistics by Key Equipment Codes Related to Incidents Involving Radiation

Equipment ID	Equipment Code	Count
853	MATERIAL LOST	49
868	METER	186
872	MISC 300 AREA FACILITIES	5350
874	MISLABELED	974
877	MIXED WASTE	46
882	MONITORING	3591
890	NEPTUNIUM	261
891	NEPTUNIUM TUBE FABRICATION, 321-M	16
892	NEUTRON MONITOR	1578
893	NEUTRON TEST GAGE, 321-M	262
919	OPERATING ERROR	3255
920	OPERATIONAL SAFETY REQUIREMENT/TECH SAFETY REQUIREMENT	436
954	PERSONAL EXPOSURE	1656
955	PERSONNEL	4513
958	PERSONNEL EXPOSURE>20MR (772-F)	500
960	PERSONNEL RADIATION MONITOR	29
969	PIPE/LINES	6860
976	PLUGGAGE	42235
977	PLUTONIUM	1268
978	PLUTONIUM 238	13
979	PLUTONIUM STORAGE FACILITY	2284
997	PRECIPITATOR	6
992	PRE-EXTRUSION (U-AL LOGS), 321-M	148
1012	PROCEDURAL DIFFICULTY	3118
1013	PROCEDURAL VIOLATION	2986
1014	PROCEDURE, INADEQUATE	868
1016	PROCESS CONTAMINATION MONITOR (CAM, STORM WATER)	2315
1020	PROCESS MONITORS	80
1021	PROCESS RADIAITON MONITOR (VAMPS, ETC.)	627
1026	PROTECTIVE CLOTHING	2316
1029	PRSONNEL CONTAMINATION MONITOR	627
1036	PUNCTURE	321
1041	QUALITY CONTROL	427
1052	RADIATION	5
1053	RADIO BENCH	45
1054	RADIOACTIVE	1155
1055	RAIL/TRACK	305
1060	RDZ, RCA, RBA	137
1069	RECEIVING PU 238	9348
1093	RELEASE GUIDE	3
1105	RESPIRATORY PROTECTION	415
1116	RISER	16
1133	RUPTURED	1374
1134	RUTHENIUM	68

Table A2-4. WSMS Incident Statistics by Key Equipment Codes Related to Incidents Involving Radiation

Equipment ID	Equipment Code	Count
1139	SAFETY EQUIPMENT	270
1150	SAMPLING/SAMPLER	13369
1180	SEWER	795
1186	SHIELDING	76
1201	SKIN CONTAMINATION (772-F)	224
1209	SLUGS, URANIUM	37
1213	SMEARABLE CONTAMINATION	542
1225	SOLID BURNING	9
1228	SOLVENT BURNING	19
1243	SPILL	2850
1251	STACK	1936
1252	STACK MONITOR	365
1266	STEP OFF PAD	16
1280	STRUCTURAL COMPONENT	2173
1285	SUMP	18872
1288	SURVEILLANCE	750
1364	TARGET FABRICATION FACILITY	23
1368	TECHNICAL DIVISION (SRTC)	1849
1380	THERMAL PROCESSING PU 238	12
1385	THORIUM	137
1400	TRAINING	660
1417	TRANSPLUTONIUM	138
1426	TRITIUM OXIDE	2
1427	TRITIUM, D20	251
1428	TROUBLE ALARM/TROUBLE LIGHT	656
1454	UNCONTROLLED REACTION	483
1463	UPTAKE/ABSORPTION	15
1464	UPTAKE/INGESTION	13
1465	UPTAKE/INHALATION	397
1466	UPTAKE/INJECTION	74
1467	URANIUM	766
1476	VALVE FAILURE	26181
1479	VAULT	1555
1483	VENTILATION	4578
1484	VENTILATION (772-F)	2408
1486	VENTILATION, TANK	802
1489	VESSEL/TANK/CONTAINER	9386
1505	WASTE	2459
1508	WASTE DISPOSAL	2152
1509	WASTE DISPOSAL (772-F)	680
1528	WELL WATER	475
1529	WELLS	630
1535	X-RAY	74

Table A2-5. WSMS Incident Statistics by Key Operations Codes Related to Incidents Involving Radiation

Operation ID	Operation Description	Count
4	313-M SLUG FABRICATION OPERATIONS – 300 FACILITY	12209
5	320-M ROD ASSEMBLY OPERATIONS – 300 FACILITY	1702
6	321-M TUBULAR ASSEMBLY OPERATIONS – 300 FACILITY	4942
7	322-M SLUG & TUBULAR ASSEMBLY OPERATIONS – 300 FACILITY	7807
10	ACID RECOVERY	3171
11	ACTINIDE TARGET FABRICATION	791
12	ADJUSTMENT/ION EXCHANGE (NP-237)	2367
13	ADJUSTMENT/PRECIPITATION/FILTRATION (PU-38)	2898
15	ANION EXCHANGE COLUMN	8869
17	BASIN WATER CLEANUP/WATER OPERATIONS	476
18	BETA-GAMMA INCINERATOR	7
23	CABINETS	856
24	CASK OPERATIONS	612
28	CHEMICAL PREPARATION AND STORAGE	635
29	CHEMICAL STORAGE	3354
30	CHEMICAL TRANSFER FACILITY (CTF)	645
35	COMPRESSED GASES	7998
37	CONSTRUCTION	1513
39	CRANE AND HOIST OPERATIONS	18681
40	CRITICALITY	808
44	DENITRATOR, A-LINE	4861
51	ELECTRICAL	13830
53	ENVIRONMENTAL	4218
55	EVAPORATOR	3178
57	EXTENDED SLUDGE PROCESSING (ESP)	183
58	F.P. REMOVAL FROM EVAPORATOR CONDENSATE	18
59	FILTRATION	7722
61	FINISHING/PACKAGING/PU-238 OXIDE	418
64	FIRES	17567
67	FUEL AND TARGET OPERATIONS	529
69	FUEL STORAGE	230
71	GANG VALVE CORRIDOR	10306
73	GAS-TRITIUM DATABANK	2
79	HEALTH PROTECTION	4893
83	INSPECTIONS/TESTS	867
85	LABORATORY (TRITIUM FACILITY)	25
86	LAUNDRY	324
87	MECHANICAL OPERATIONS	573
88	MECHANICAL PROCESSES (IN CELL)	75
89	MISCELLANEOUS	34045
90	MPPF FINISHING AND HANDLING	27
91	MPPF PROCESS CONTROL	55
92	MPPF SEPARATION PROCESSES	92

Table A2-5. WSMS Incident Statistics by Key Operations Codes Related to Incidents Involving Radiation

Operation ID	Operation Description	Count
93	MPPF SOLUTION PREPARATION	51
95	NEW PRODUCTION REACTOR (NPR)	15
96	NEW SPECIAL RECOVERY	8351
104	OVERFLOWS	1048
110	PERSONNEL SAFETY	1314
114	PRECIPITATION/FILTRATION (NP-237)	3406
116	PROCESS CONTROL	1929
118	PROCESS OPER (TRITIUM)	81
119	PROCESS SAFETY	978
120	PRODUCT STORAGE AND ACCOUNTABILITY	737
123	QUALITY ASSURANCE	13
132	SAMPLE AISLE	11235
133	SAMPLING	1276
135	SECOND PRODUCT CYCLE	5810
136	SECOND URANIUM CYCLE	3186
142	SHIPPING/RECEIVING/STORAGE (NP-237)	333
144	SLAG AND CRUCIBLE	155
145	SOLIDS HANDLING, A-LINE	1654
147	SOLVENT WASHING	4378
148	SPECIAL RECOVERY	8577
150	STORAGE/BASIN OPERATIONS	659
153	TANK	5176
154	TANKS	353
155	THERMAL PROCESSES (NP-237)	221
169	UNCONTROLLED REACTIONS	311
176	VENTILATION	22447
180	WASTE – HAZARDOUS	831
181	WASTE – INTERMEDIATE LEVEL	110
182	WASTE – LOW LEVEL	188
183	WASTE – MIXED	64
185	WASTE – TRU	97
187	WASTE HANDLING	10002
188	WATER HANDLING FACILITIES	1083
189	WATER SYSTEMS	15884
190	WET CHEMISTRY (SCRAP RECOVERY, HBLINE)	3351

ATTACHMENT 3: RECOMMENDED CRITERIA FOR RETRIEVAL OF INCIDENTS FROM WSMS

As a result of the February 28–March 1, 2007, review of the data bank, the Work Group asked SC&A to provide the results of several queries run during the database review to obtain some general statistics on the database. Attachment 2 of this report summarizes the results. SC&A was asked to recommend criteria to the working group that would isolate the incidents of interest in the WSMS database. These criteria will be reviewed in a future Work Group meeting and modified by NIOSH, ORAUT, and the Work Group as necessary. Incidents are categorized by year, area, facility, source of information, equipment, and operations. It is recommended that the incidents retrieved first be limited by year and include incidents occurring prior to 1990. By 1990, incidents should have been filed regularly in the individual dose record. It is recommended that no restriction be placed on the area identification (ID) and the facility ID. Source ID, equipment ID, and operations ID, which are numerical values, can be used to focus the search to incidents involving radioactive material. The numerical values for each ID of interest are outlined below. Since the equipment ID and operations ID descriptions for an incident often contain text, it is suggested that these fields be searched for keywords. Suggested keywords are listed below. While visiting SRS, the review team printed more than 100 incidents from the database and cleared for release. SC&A chose the specific source ID, equipment ID, operations ID, and keywords based on the occurrence of the values and keywords in the 100 example incidents. In addition, if the ID did not occur in the incident record and it was clearly of interest (e.g., uptake/ingestion), the ID has been included below. These criteria constitute a preliminary recommendation for consideration by the Work Group in further meetings.

The following search terms are recommended to obtain records representative of the types of incidents of interest from the WSMS database.

Incidents occurring in 1990 or before

And,

Incidents where the equipment field contains the words uptake, intake, inhalation, ingestion, health protection, environment, contamination, uranium, neptunium, bioassay, chest count, americium, californium, curie, curium, fume, fire, limit exceeded, neutron, exposure, plutonium, thorium, tritium, stack, alarm, or x-ray.

Or,

Incidents where the operations field contains the words miscellaneous, health protection, special recovery, fires, or ventilation.

Or,

Incidents where Source ID equals 2, 12, 46, 47, 55, 61, 62, 63, 64, 69, 74, 76, 101, 112, 114, 121, 122, 123, 124, 126, 127, 130, 131, 145, 150, 156, 157, 160, 174, 176, 179, 182, 190, 191, 214, 225, 233, 248, 262, 263, 271, 277, 296, 309, 310, 321, 322, 323, 331, 341, 376, 380, 381, or 386.

Or,

Incidents where equipment ID equals 8, 62, 63, 70, 74, 76, 80, 83, 90, 91, 94–97, 108, 163, 182, 183, 190, 192, 205, 212, 213, 214, 215, 216, 219, 222, 225, 226, 230, 231, 232, 297, 302, 337, 345–351, 355, 368, 374, 380, 386–392, 398, 407, 418, 419, 466, 469, 476, 477, 480, 496–500, 504, 506, 507, 509, 510, 511, 513, 517, 535, 548, 560–564, 567, 582, 583, 603, 604, 614, 631, 632, 638, 639, 654, 656, 662, 675, 681, 691, 702, 709, 710, 714, 715, 718, 719, 726, 730, 731, 734, 743, 744, 745, 752, 760, 761, 762, 763, 764, 772, 775, 786, 795, 800, 801, 819, 823, 844, 850, 853, 868, 872, 874, 877, 882, 890, 891, 892, 893, 919, 920, 954, 955, 958, 960, 969, 976, 977, 978, 979, 992, 997, 1012, 1013, 1014, 1016, 1020, 1021, 1026, 1029, 1036, 1041, 1052, 1053, 1054, 1055, 1060, 1069, 1093, 1105, 1116, 1133, 1134, 1139, 1150, 1180, 1186, 1201, 1209, 1213, 1225, 1228, 1243, 1251, 1252, 1228, 1243, 1251, 1252, 1266, 1280, 1285, 1288, 1364, 1368, 1380, 1385, 1400, 1417, 1426, 1427, 1428, 1454, 1463, 1464, 1463, 1464, 1465, 1466, 1467, 1476, 1479, 1483, 1484, 1486, 1489, 1505, 1508, 1509, 1528, 1529, or 1535.

Or,

Incidents where operations ID equals 4, 5, 6, 7, 10, 11, 12, 13, 15, 17, 18, 23, 24, 28, 29, 30, 35, 37, 39, 40, 44, 51, 53, 55, 57, 58, 59, 61, 64, 67, 69, 71, 73, 79, 83, 85, 86, 87, 88, 89, 90, 91, 92, 93, 95, 96, 104, 110, 114, 116, 118, 119, 120, 123, 132, 133, 135, 136, 142, 144, 145, 147, 148, 150, 153, 154, 155, 169, 176, 180, 181, 182, 183, 184, 185, 187, 188, 189, or 190.