adequacy, given the inherent difficulty of establishing routine tritium exposure and what internal residence times can be assumed.

For an SEC evaluation, the circumstances at Paducah Gaseous Diffusion plant exemplify how "missed dose" must be ascertained and evaluated. A number of sources of missed dose existed that made it less feasible to estimate individual worker doses, including:

- A lack of documentation. At Paducah, this included doses that were never recorded, may have been discarded, or records that could not be located after an extensive search.

- A failure to monitor the exposure. There were numerous examples at Paducah during the history of the plant where the potential for radiological exposure may have existed, but was not monitored, or not adequately monitored.

- A failure to recognize an opportunity for a radiological exposure. For example, at Paducah, it was assumed that nearly all uranium ingested or inhaled was soluble and quickly excreted from the body without harm or long-term effects. In fact, aerosols of insoluble uranium compounds were generated in a number of work areas.

- Lack of sensitivity of the radiation monitoring or bioassay techniques. For example, a worker who had been exposed to elevated airborne concentrations of "poorly soluble" uranium was given in vivo radiation monitoring and determined to be below standard detection limits for the site, when, in fact, the determined lung burden was equivalent to a "significant internal deposition" according to corporate radiation protection criteria.

- Movement of workers between job assignments and between facilities without any documentation or changes in dosimetry to reflect differences in radiation source terms. It was also obvious that, over time, buildings were used for different purposes and the potential for worker radiation exposure was not recognized.

The above contributory sources of inadequate, missing, or inaccurate dose records illustrates the need to systematically review the dosimetric history, operational practice, and management policy over the lifetime of the plant for which an SEC petition has been received, and to assure through sampling that this probing is thorough.

The checklist in Exhibit 3-2 is divided into three sections. The first two sections allow the auditor to review the information provided by the petitioner. The last section allows the auditor to review the work performed by NIOSH during the petition evaluations. The first section, "SEC eligibility criteria," presents the conditions which must be met, by law, in order to qualify as a member of the SEC. The second section, "Petition requirements," presents information which 42 CFR 83 states must be included in the petition in order to perform a complete evaluation. The third section, "Information gathered by NIOSH," is a list of sources described in 42 CFR 83 that

may be used by NIOSH during its evaluation. NIOSH is responsible for collecting all relevant information in order to accurately and fairly evaluate petitions for SEC. By definition, addition to the SEC depends on NIOSH's ability to do a dose reconstruction, therefore the auditor must be able to decide if NIOSH exhausted all of the information sources and elements that make up an accurate dose reconstruction. In most cases, performing an audit on an SEC petition evaluation must also involve an audit of the dose reconstruction (see the Dose Reconstruction Review Checklist).

These completed forms will be filed in hard copy and electronic form under our records management system, and auditable under our quality control/quality assurance program. All audit findings are documented on the forms, and traceable back to the auditor and the documents upon which the audit review was performed.

## Exhibit 3-2. SEC Petition Audit Report and Checklist

**SEC PETITION AUDIT REPORT**

Page____of____

| **Audit Number:** | **Petition Number:** | **Date:** |
|---|---|---|
| **Auditor(s):** | | |
| | | |
| **Audit Record Summary** (Describe below what records you examined, to whom you submitted them, the conclusions you arrived at, and how you arrived at them): | | |
| List of documents reviewed: | | |
| | | |
| | | |
| | | |
| List of new documents identified: (Attach a copy of all documents not included in the original administrative record to this report.) | | |
| | | |
| | | |
| | | |
| List of person(s) interviewed: (Attach a copy of the interview documentation to this report.) | | |
| | | |
| | | |
| | | |
| **Audit conclusions**: Agree/disagree (Note: Attach all audit checklists and supporting documents.) | Agree:_____(Initials) Additional comments should be entered in the 'Summary' below. | Disagree_____(Initials) If petition evaluation is rejected, complete next section. |
| Provide a summary discussion of the reasons for disagreeing with the petition evaluation: (Attach all calculations, notes, reports, etc., used in your conclusions.) | | |
| | | |
| | | |
| | | |
| General Comments: | | |
| | | |
| Signature of Auditor(s): | | |
| Area of Review: | | |
| Date: | | |

## Exhibit 3-2. SEC Petition Audit Report and Checklist (continued)

### SEC PETITION REVIEW CHECKLIST

| Audit Number: | Petition Number: | Date: | Page ___ of ___ |
|---|---|---|---|
| **Auditors/ Area of Review:** | | | |
| | | | |
| **Person(s) who performed SEC petition evaluation and/or dose reconstruction:** | | | |
| | | | |

| Description | Yes/No/NA | Comments | Initials |
|---|---|---|---|
| **SEC ELIGIBILITY CRITERIA**<br>Sentences or phases in quotations are items taken directly from 42 CFR 83.<br>Must be able to answer **yes** to one or more parts of the following questions in order to qualify for SEC. | | | |
| 1. Are the class of employees represented by the petition present or former employees of "Department of Energy (DOE), DOE contractor or subcontractor, or an Atomic Weapons Employer (AWE)"? | | | |
| 2. Is the petitioner: | | | |
| (a) a member of the class of employees? | | | |
| (b) "a surviving spouse, child, parent, grandchild or grandparent" of an employee? | | | |
| (c) "one or more labor organizations representing or formerly having represented DOE, DOE contractors, or subcontractors, or AWE employees"? | | | |
| (d) "one or more individuals or entities authorized in writing by one or more DOE, DOE contractor or subcontractor, or AWE employee"? | | | |
| 3. Have one or more members of the class of employees been diagnosed with one or more of the following cancers: | | | |
| (a) "Leukemia (other than chronic lymphocytic leukemia) provided that the onset of the disease was at least two years after initial occupational exposure"? | | | |
| (b) "Lung cancer (other than in situ lung cancer that is discovered during or after a post mortem exam"? | | | |
| (c) "Bone cancer"? | | | |
| (d) "Renal cancers"? | | | |
| (e) "The following diseases, provided onset was at least 5 years after first exposure: | | | |
| (i) "Multiple myeloma"? | | | |
| (ii) "Lymphomas (other then Hodgkin's Disease)"? | | | |

## Exhibit 3-2. SEC Petition Audit Report and Checklist (continued)

**SEC PETITION REVIEW CHECKLIST**
continued

| Description | Yes/No/NA | Comments | Initials |
|---|---|---|---|
| (iii) "Primary cancer of the: | | | |
| (A) Thyroid? | | | |
| (B) Male or female breast? | | | |
| (C) Esophagus? | | | |
| (D) Stomach? | | | |
| (E) Pharynx? | | | |
| (F) Small intestine? | | | |
| (G) Pancreas? | | | |
| (H) Bile ducts? | | | |
| (I) Gall bladder? | | | |
| (J) Salivary gland? | | | |
| (K) Urinary bladder? | | | |
| (L) Brain? | | | |
| (M) Colon? | | | |
| (N) Ovary? | | | |
| (O) Liver (except if cirrhosis or hepatitis B is indicated)"? | | | |
| 4. Has the petitioner provided proof of the cancer diagnosis (e.g., physician's letter, post-mortem exam results)? Note: Proof of diagnosis is not discussed in 42 CFR 83, but it may be important for the purposes of evaluation. | | | |
| **PETITION REQUIREMENTS**<br>Sentences or phases in quotations are items taken directly from 42 CFR 83.<br>Does the petition indicate or contain: | | | |
| 1. "The DOE or AWE facility at which the class worked"? | | | |
| 2. "The location or locations at the facility covered by the petition (e.g., building, technical area)?" | | | |
| 3. "The job titles and/or job duties of the class members?" | | | |
| 4. "The period of employment relevant to the petition?" | | | |
| 5. "Identification of an exposure incident that was unmonitored, unrecorded, or inadequately monitored or recorded?" Some examples include: | | | |
| (i) Records or confirmation from NIOSH or DOE that the exposure incident occurred? | | | |
| (ii) "Medical evidence that one or more members of the class may have incurred a high-level radiation dose from the incident, such as a depressed white blood cell count associated with radiation exposure or the application of chelation therapy"? | | | |
| (iii) "Confirmation by affidavit from two employees who witnessed the incident, providing this evidence is consistent with other information available to HHS?" | | | |

## Exhibit 3-2. SEC Petition Audit Report and Checklist (continued)

**SEC PETITION REVIEW CHECKLIST**
continued

| Description | Yes/No/NA | Comments | Initials |
|---|---|---|---|
| 6. "A description of the petitioner's basis for believing records and information available are inadequate to estimate the radiation doses incurred by members of the proposed class of employees with sufficient accuracy?" Some examples include: | | | |
| (i) "Documentation or statements provided by affidavit indicating that radiation exposures and doses to members of the proposed class were not monitored, either through personal or area monitoring"? | | | |
| (ii) "Documentation or statements provided by affidavit indicating that radiation monitoring records for members of the proposed class have been lost, falsified, or destroyed"? | | | |
| (iii) "A report published by a scientific government agency or published in a peer-reviewed scientific journal that identifies dosimetry and related information that are unavailable for estimating the radiation doses of employees"? | | | |
| **INFORMATION GATHERED BY NIOSH**<br>Sentences or phases in quotations are items taken directly from 42 CFR 83.<br>Does the administrative record contain information (or indicate attempts to obtain information) from the following sources? | | | |
| 1. Records and information from DOE and AWE facilities? | | | |
| 2. "Potential members of the class and their survivors?" | | | |
| 3. "Labor organizations who represent or represented employees at the facility during the relevant time period?" | | | |
| 4. "Managers, radiation safety officials, and other witnesses present during the relevant period at the facility"? | | | |
| 5. "NIOSH records from epidemiological research on DOE populations and records from dose reconstructions conducted under 42 CFR 82"? | | | |
| 6. "Records from research, dose reconstructions, medical screening programs, and other related activities conducted to evaluate the health and/or radiation exposures of employees of DOE, DOE contractors or subcontractors, and the AWEs"? | | | |

## Exhibit 3-2. SEC Petition Audit Report and Checklist (continued)

**SEC PETITION REVIEW CHECKLIST**
continued

| Description | Yes/No/NA | Comments | Initials |
|---|---|---|---|
| **TYPES OF INFORMATION USED IN DOSE RECONSTRUCTION**<br>Taken directly from 42 CFR 82.14.<br>This is simply a guideline. Each case is different and not all of the types of information listed below may be necessary. | | | |
| 1. "Subject and employment information:" | | | |
| (a) "gender" | | | |
| (b) "date of birth" | | | |
| (c) "DOE and/or AWE employment history: | | | |
| (i) job title held by year | | | |
| (ii) work location (site names, building numbers, technical areas, duration of relevant employment)" | | | |
| 2. "Worker monitoring data": | | | |
| (a) "external dosimetry data (film badge, TLD, neutron dosimeters)" | | | |
| (b) "pocket ionization chamber data" | | | |
| 3. "Internal dosimetry data:" | | | |
| (a) "urinalysis results" | | | |
| (b) "fecal sample results" | | | |
| (c) "in vivo measurements results" | | | |
| (d) "incident investigation reports" | | | |
| (e) "breath radon and/or thoron results" | | | |
| (f) "nasal smear results" | | | |
| (g) "external contamination measurements" | | | |
| (h) "other measurement results applicable to internal dosimetry" | | | |
| 4. "Monitoring program data" | | | |
| (a) "analytical methods used for bioassay analyses" | | | |
| (b) "performance characteristics of dosimeters for different radiation types" | | | |
| (c) "historical detection limits for bioassay samples and dosimeter badges" | | | |
| (d) "bioassay sample and dosimeter collection/exchange frequencies" | | | |
| (e) "documentation of record keeping practices used to record data and/or administratively assign dose" | | | |
| (f) "other information to characterize the monitoring program results" | | | |

## Exhibit 3-2. SEC Petition Audit Report and Checklist (continued)

**SEC PETITION REVIEW CHECKLIST**
continued

| Description | Yes/No/NA | Comments | Initials |
|---|---|---|---|
| 5. "Workplace monitoring data" | | | |
| (a) "surface contamination surveys" | | | |
| (b) "general area air sampling results" | | | |
| (c) "breathing zone air sampling results" | | | |
| (d) "radon and/or thoron monitoring results" | | | |
| (e) "area radiation survey measurements (beta, gamma and neutron)" | | | |
| (f) "fixed location dosimeter results (beta, gamma, and neutron)" | | | |
| (g) "other workplace monitoring results" | | | |
| 6. "Workplace characterization data" | | | |
| (a) "information on the external exposure environment: | | | |
| (i) radiation type (gamma, X-ray, proton, neutron, beta, other charged particles) | | | |
| (ii) radiation energy spectrum | | | |
| (iii) uniformity of exposure (whole body vs. partial body exposure) | | | |
| (iv) irradiation geometry" | | | |
| (b) "information on work-required medical screening x-rays" | | | |
| (c) "other information useful for characterizing workplace radiation exposures" | | | |
| 7. "Information characterizing internal exposures" | | | |
| (a) "radionuclides and associated chemical forms" | | | |
| (b) "results of particle size distribution studies" | | | |
| (c) "respiratory protection practices' | | | |
| (d) "other information useful for characterizing internal exposures" | | | |
| 8. "Process descriptions for each work location" | | | |
| (a) "general description of the process" | | | |
| (b) "characterization of the source term (radionuclide and its quantity)" | | | |
| (c) "extent of encapsulation" | | | |
| (d) "methods of containment" | | | |
| (e) "other information to assess potential for irradiation by source or airborne dispersion of radioactive material" | | | |

## 3.8 Special Topics

The following presents a list and brief description of special technical topics that our team will be prepared to address. Section 3.6 on Blind Dose Reconstruction also addresses many special topics, especially those related to internal dosimetry.

### 3.8.1 Special Attention to Historical Bioassays and Dose Reconstructions

Historic bioassay surveillance data in workers have been evaluated at times by dosimetrists and epidemiologists in order to reconstruct the extent of occupationally received past exposures to one or more internally absorbed radionuclide-contaminants. Before those early data could be employed in a meaningful interpretive manner, however, various essential defining characteristics should have been addressed. For example, how technically accurate and precise were the measurements, and to what extent were they representative of their associated exposure events? Within this basic concept, we will endeavor to determine the extent to which statistical confidence was attached to the archival surveillance data; consider any algorithm that may have been employed for translation of older information into more current representations of exposures; examine those programs for evaluating error terms which were attached to each of the individual bioassay values; and consider how the original sample collection protocols were considered for their effect on the final estimation of the time-course and magnitude of related exposure(s).

To accomplish these aims, the approach that will be taken in this review can be represented as falling into each of three major categories: (1) the statistical representation of analytical accuracy and precision, (2) those factors accounting for the sample collection variability, and (3) the biological considerations for estimating the physiological dose and significance. In the first category, it will be necessary to statistically propagate the uncertainties associated with each of the procedural steps (e.g., chemical and plating recoveries, detection efficiency, etc.), as well as to consider the myriad of other factors that make up the statistical counting error (e.g., background variability, sample size, counting time, etc.). In addition, other sources of uncertainty, such as the specificity of the analysis for the contaminant in question and individual analytical procedural steps (e.g., plating problems resulting in unwarranted alpha particle absorption), should be defined quantitatively. All of these considerations become particularly significant when procedures entailing no tracer isotope (as frequently encountered in some of the early methodologies) had been employed.

The second category that will be considered, i.e., the sample collection variability, includes factors such as the magnitude, time, and frequency of the bioassay sample collection (important, for example, to the extent defined by the changing pH of a standing urine sample, container–wall "plateout," magnitude of the "retention" parameter viz. effective half-life), as well as other time-related collection factors that are relevant to the exposure scenario.

Finally, attempts at quantifying the above considerations for final radiological dose calculation necessarily invokes knowledge of the physical absorption along with the uncertainties attached to the magnitude of each of the metabolic transfer factors and deposition parameters of the considered contaminant.

### 3.8.2 Use of Specific Values of the Human Respiratory Tract Model (HRTM) Parameters

A great deal of attention is currently being given to the appropriate choice of the absorption parameters in performing internal dose calculations. For example, though particle sizes have been considered important since the issuance of ICRP 30, concern regarding specific absorption parameters and their effect on bioassay is new. This issue is given particular attention in the recently published "Guide for the Practical Application of the ICRP Human Respiratory Tract Model," Annals of the ICRP, Supporting Guidance No. 3, Volume 32, No. 1-2, 2002, ISN 0146-6453, Pergamon Press, 2003.

In this document, guidance is given on applying the HRTM in situations that require specific information on the characterization of radioactive aerosols and gases, and on determining absorption rates from lungs to the blood. The information contained in this document is a very important update on the ICRP 66, 68,78, (56, 67, 69) series, and should be used in the interpretation of bioassay data and when it is desirable to obtain better dose assessments. Examples are given illustrating the application of the HRTM in a range of situations. The document analyzes how specific information on particle-size distribution, particle density, absorption to blood, nose or mouth breathing, and distribution of time between sleep, sitting, and light/heavy exercises affects the effective doses and the interpretation of bioassay measurements (urine, feces, lungs). In general, bioassay measurements change much more than effective doses, as the characteristics of the inhaled material change. So it may well be particularly important to use specific information to assess intakes from measurements on workers.

In the reconstruction of doses we may use material-related parameters that result in a better assessment of the dose. When particle-size distribution is unknown, and available data are not sufficient for determining the particle size, dose should be calculated using "dose per measured quantities" (urine excretion, feces excretion, lung, or body measurements). The quantity "dose/measured quantity" is more robust in relation to particle sizes than the quantity "intake/measured quantity," although they come from the same ICRP models and the former value is obtained by multiplying the last one by the quantity dose coefficient per unit intake. Specific absorption factors, describing the rate of absorption from lungs to blood, should be used for compounds described in this document and when a more refined dose reconstruction analysis is required.

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. Typically, this is likely to be the case when assessing doses retrospectively, i.e., when the intake has already taken place, or when intakes are currently taking place or are likely to take place in the near future.

In general, a "closer look" at absorption parameters generally reveals that the default values used to derive the generic dose conversion factors are overly conservative. This creates a dilemma for this project in that it is our intent to err on the side of the claimant. As such, our audits will identify such issues as they arise, solely for the purpose of providing a complete record of our review, but this does not necessarily mean that NIOSH was incorrect in using the more conservative default values in their assessments. In cases in which the reconstructed doses are

based on dose conversion factors that are clearly conservative based on the records, but the doses are still found to be low, we will provide documentation of this fact.

Sometimes the opposite occurs and the use of specific factors gives a higher dose than using default parameters. In the ICRP technical document, several examples are cited where the use of the specific absorption factors from lung to blood gives a higher dose than when assigning the default absorption type. All examples are related to effective doses, but the same applies with organ doses. In cases in which there is reason to believe that the physical and chemical composition of the inhaled or ingested material is such that the doses may be higher than reported, this finding will be reported and given special attention with regard to its implications not only to the dose reconstruction under investigation, but also to other related dose reconstructions.

### 3.8.3 Intercomparisons of Bioassay Results among Different Laboratories

Recent intercomparisons have revealed that different laboratories can obtain different estimates of intakes and doses when provided with the same bioassay data. In these exercises, in which the participants had largely used ICRP models, differences in dose assessments of up to five orders of magnitude had been reported. The differences were largely due to assumptions regarding absorption fractions and retention models. [IAEA, "Intercomparison and Biokinetic Model Validation of Radionuclide Intake Assessment," IAEA-TECDOC-1071, 1999; H. Doerfel, A. Andrasi, M.R. Bailey, A. Birchall., C.M. Castellani, C. Hurtgen, N. Jarvis, L. Johansson, B. LeGuen, G. Tarroni,. "Third European Intercomparison Exercise on Internal Dose Assessment: Results of a Research Pprogramme in the Framework of the EULEP/EURADOS Action Group," FZKA 6457, Forschungszentrum Karlsruhe, 2000.] Such findings are very disturbing, but indicate how much the choice made by the internal dosimetry expert on "reasonable assumptions" for missing information can affect the interpretation of bioassay results.

### 3.8.4 Dose per Unit Measurement for Dose Reconstruction

Graphs of committed effective dose per unit measured activity (in the body or in excreta) versus times after intake, as a function of lung absorption Type and AMAD, reveal "areas of invariance," i.e., time periods where the assessment of dose is relatively insensitive to assumptions made about lung absorption Types and AMAD. Thus, in dose-reconstruction analysis, when AMAD and/or lung absorption Types are not known or are poorly defined, the use of monitoring data, if available, in the period of time corresponding to the invariance area can minimize parameter uncertainties in modeling. The effective dose per unit measured activity also provides a tool to compare bioassay methods in relation to uncertainties in dose calculations as a function of differences in lung absorption parameters for specific compounds. These data are useful when choosing a bioassay method, when assigning a weight to multiple bioassay results, and when defining the uncertainties related to an unknown or poorly known lung absorption parameter.

### 3.8.5 Upcoming Developments with ICRP Internal Dosimetry

Though the current ICRP models have been adopted for use by NIOSH, ICRP is continually re-evaluating their recommendations and models. Dr. will keep the Board appraised of

these developments, so that they can be given appropriate consideration as the Board fulfills its mandate. New developments that are worth mentioning include:

- HAT - The new model for the Human Alimentary Tract, in substitution to the ICRP 30 GI Tract Model, is in its final draft. It is probably going to be released in early 2004. The new HAT model will be used in the future by ICRP in substitution for the ICRP 30 model.

- Publication of a new document, *Occupational Intakes of Radionuclides: Dose Assessment and Monitoring* (Revision of Publications 30, 54, 68, 78). The new document will contain revisions of the systemic models; most of the models will be recycling models for easier bioassay interpretation. Whenever information is available, physiologically based models will be recommended.

- In relation to inhalation, information relating to absorption rates from the lungs to the blood for important compounds will be recommended and other compounds will be assigned to the three absorptions: Types F, M, S. In addition, the gender-specific doses will be calculated using realistic computational models (phantoms), derived from medical images, with organ sizes consistent with the new reference person (ICRP 89, 2002).

- A review of individual monitoring methods and programs, as well as interpretation of bioassay results, will be given. A review of sources of uncertainty in the estimate of intakes and doses will be included. A technical document on Interpretation of Bioassay Monitoring will be published at the same time as the main document.

- The biokinetic models for radionuclide contaminated wounds, which are being developed by the National Council on Radiation Protection (NCRP), will be reviewed by the ICRP and possibly be adopted.

- A complete review of tritium compounds biokinetics is being performed and a complete review of radon dosimetry is expected in the near future.

### 3.8.6 Additional Issues Related to Internal Dose Reconstruction

The reconstruction of internal dose is frequently complex, highly individualized, and defined by variables that are largely unknown. Even when credible bioassay data exist, estimates of internal dose(s) may, nevertheless, require process knowledge and professional judgment regarding the applicability of standard dose models in terms of the assigned chemical form, solubility, exposure pathway(s) for a radio-contaminant, etc. Among the variables that may profoundly affect the uncertainty of internal dose estimates are the following:

- Time of Uptake. Whole-body counting (WBC) and/or in-vitro bioassay data are of limited value if the "day(s) of uptake" is not known. This uncertainty is particularly problematic if the WBC/bioassay is one that is termed routine (i.e., conducted annually/periodically or upon termination). To assist in narrowing the window of exposure to a most probable time period, the reviewer must consider

all available data that may include incident reports, radiation surveys, radiation work permits (RWPs), co-worker exposure data, etc.

- Individualize Parameters. Dose models generally are based on reference-person physiological and lifestyle parameters. For some radionuclides, individual-specific parameters may profoundly alter estimates of dose. For example, the amount of dietary intake of non-radioactive iodine inversely affects the blood-to-thyroid transfer fraction (i.e., $f_2$ value) of radioiodine. Because dietary intake of iodine varies greatly by geographic location as well as over time, $f_2$ values can reasonably be expected to vary from less than 0.2 to as much as 0.8 on the basis of dietary intakes. Equally, the uptake of iodine and its retention/excretions may also be affected by underlying thyroid conditions/pathologies.

- Use of Air Monitoring Data as Surrogate for Bioassay Data. When internal exposures are based on air-monitoring data, the largest source of uncertainty to a calculated dose comes from the difference in concentration(s) in air inhaled by the worker versus the air sampled. When air is sampled in close proximity to a specific worker (as is the case for breathing-zone apparatus), potential differences are minimized. Of concern, however, are air monitoring data that are based on hard-wired, permanently installed continuous air monitors (CAMs). For example, a glove-box worker exposed in close proximity to a pinhole release of plutonium may be breathing air concentration(s) that are one to two orders of magnitude higher than air concentration(s) sampled by the CAM that may be 20 to 30 feet removed from the source.

### 3.8.7 Selected Issues Related to External Dose Reconstruction

- Personnel Dosimeters/Field Survey Instruments. Contributing to the uncertainty of derived dose estimates based on personnel dosimeters (film/TLD) are many factors. For some factors, considerable data exist that allow for corrections to be made that minimize their contribution to uncertainty. For example, a substantial body of data exists that defines the energy dependence of various film emulsions used in personnel dosimeters over time.

  A major factor contributing to uncertainty of personnel dosimeter and field survey data is the method of their calibration conditions approximate to exposure conditions of the wearer. Common variables involving calibration include selection of the radiation source, source-to-dosimeter/instrument geometry, use of a phantom, etc. A significant but frequently poorly defined variable is the difference in source geometry between the calibration of the dosimeter/survey instrument and the radiation field to which a monitored individual was exposed. In many instances, this involves the calibration to a point source and the monitored exposure to a complex radiation field that may include (1) multiple independent sources, (2) an infinite planar source, (3) isotropic ($2\pi$) source, or (4) an instantaneous exposure (one side only) from a point source (i.e., prompt neutron/gamma exposure from a nuclear weapon test).

### 3.8.8 Selection of Reasonable Assumptions

Due to the importance of ensuring that assumptions used to estimate doses are fair, consistent, and scientifically grounded, a special topic that must be re-emphasized is the need to compare all available data (i.e., worker profile data, site profile data, work history interview, claimant documentation, etc.) and evaluate them for consistency and reasonableness. Data comparisons should not be limited to information available for an individual case, but when applicable, should also include comparisons between similar cases.

### 3.8.9 Auditor's Assessment of a Case Significantly Differs with NIOSH's Dose Reconstruction Results

There may be cases during the basic, advanced, or blind review where the auditor identifies new information or uncovers inappropriate/unreasonable assumptions, calculational errors, inconsistencies in data, etc., that will substantially increase the dose and potentially change the outcome of a denied claim. When it appears that the auditor's findings could result in a PC of greater than 50 percent, it is recommended that the auditor(s) have an opportunity to present this case to the Advisory Board for further review.

# 4.0 PERSONNEL, FACILITIES, AND EQUIPMENT

## 4.1 Personnel

Exhibit 4-1 presents an overview of the relevant experience of key members of the project team. Following Exhibit 4-1, biosketches are provided that describe the role of each key person on the project, his or her relevant project experience, and their availability to the project. Appendix A presents complete resumes for each member of the team. Though we have assigned specific responsibilities to each individual on the project, it is worth noting that most personnel have experience in several of the technical specialty areas required for this project. A specific number of hours proposed for each key person has not been given here, as there is no way to know this without knowing the tasks which might be issued under the contract. However, work hour allocations and schedules are provided for the sample tasks.

| Name, Title, Anticipated Level of Effort (key personnel only) | Educational Background | Years of Relevant | Rad, Chem. | Familiar with Specific DOE/AWE Facilities | Availability |
|---|---|---|---|---|---|
| **Key Personnel** | | | | | |
| *SC&A, Inc.* | | | | | |
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| Name, Title, Anticipated Level of Effort (key personnel only) | Educational Background | Years of Relevant | Rad. Chem. | Familiar with Specific DOE/AWE Facilities | Availability |
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| Name, Title, Anticipated Level of Effort (key personnel only) | Educational Background | Years of Relevant | Rad. Chem. | Familiar with Specific DOE/AWE Facilities | Availability |
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| Name, Title, Anticipated Level of Effort (key personnel only) | Educational Background | Years of Relevant Work Experience | | | Availability |
|---|---|---|---|---|---|
| | | | Rad. Chem. | Familiar with Specific DOE/AWE Facilities | |
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