B Survivor Information — Complete Section B if you are a Survivor or representing a Survivor.

B.1 **Name of Survivor:**

First Name Middle Initial Last Name

B.2 **Social Security Number of Survivor:**

B.3 **Address of Survivor:**

Street Apt # P.O. Box

City State Zip Code

B.4 **Telephone Number of Survivor:**

B.5 **Email Address of Survivor:**

B.6 **Relationship to Employee:**

Go to Part C.

C Employee Information — Complete Section C UNLESS you are a labor organization.

C.1 **Name of Employee:**

First Name Middle Initial Last Name

C.2 **Former Name of Employee** (e.g., maiden name/legal name change/other):

Mr./Mrs./Ms. First Name Middle Initial Last Name

C.3 **Social Security Number of Employee:**

C.4 **Address of Employee (if living):**

Street

City State Zip Code

C.5 **Telephone Number of Employee:** ( )

C.6 **Email Address of Employee:**

C.7 **Employment Information Related to Petition:**

C.7a Employee Number (if known):

C.7b Dates of Employment: Start -43 End 44

C.7c Employer Name: Stone and Webster - Clinton Eng. Works

C.7d Work Site Location: OAK Ridge X-10 Plant and Y-12

C.7e Supervisor's Name: Unknown

E Proposed Definition of Employee Class Covered by Petition — Complete Section E.

E.1 **Name of DOE or AWE Facility:** Oak Ridge, TN. X-10 - Y-12

E.2 **Locations at the Facility relevant to this petition:**

All Locations

E.3 **List job titles and/or job duties of employees included in the class. In addition, you can list by name any individuals other than petitioners identified on this form who you believe should be included in this class:**

All Guards and Service Workers

E.4 **Employment Dates relevant to this petition:**

Start	1943	End	47
Start		End	
Start		End	

E.5 **Is the petition based on one or more unmonitored, unrecorded, or inadequately monitored or recorded exposure incidents?:** ☒ Yes ☐ No

If yes, provide the date(s) of the incident(s) and a complete description (attach additional pages as necessary):

told me that he had been informed of being exposed to Radiation on the Job.

I ask what he did at Oak Ridge, he said, I was a guard."

I was six years old when went to work at Oak Ridge. during my forty six years with him, he never talk about his Job.

He was "Sworn to Secrecy" and I Respect him for it

I have no Records, except, a data Card and Social Security Record.

Go to Part F.

Special Exposure Cohort Petition — Form B

F Basis for Proposing that Records and Information are Inadequate for Individual Dose — Complete Section F.

Complete **at least one** of the following entries in this section by checking the appropriate box and providing the required information related to the selection. You are not required to complete more than one entry.

F.1 ☑ I/We have attached either documents or statements provided by affidavit that indicate that radiation exposures and radiation doses potentially incurred by members of the proposed class, that relate to this petition, were not monitored, either through personal monitoring or through area monitoring.

(Attach documents and/or affidavits to the back of the petition form.)

Describe as completely as possible, to the extent it might be unclear, how the attached documentation and/or affidavit(s) indicate that potential radiation exposures were not monitored.

I have Enclosed A Document with information obtain from (DOE) THAT indicates THAT WAS NOT monitored for RADIATION exposure during his employment.

NIOSH - has determined THAT further research and ANLYSIS will NOT Produce A Level of Radiation dose resulting in a probability of Causation of 50% or greater

F.2 ☑ I/ We have attached either documents or statements provided by affidavit that indicate that radiation monitoring records for members of the proposed class have been lost, falsified, or destroyed; or that there is no information regarding monitoring, source, source term, or process from the site where the employees worked.

(Attach documents and/or affidavits to the back of the petition form.)

Describe as completely as possible, to the extent it might be unclear, how the attached documentation and/or affidavit(s) indicate that radiation monitoring records for members of the proposed class have been lost, altered illegally, or destroyed.

The workers hired during the early years of 1940-1947. Employers didn't know anything about What Radiation Could do to anyone, and Radiation Protection Standards were less strict.
Document # SCA-TR-TASK1-0013-Page 11 of 115 - Sept 29-2006

Part F is continued on the following page.

Name or Social Security Number of First Petitioner:

decision. Final determinations are made by the Department of Labor based on standards determined by EEOICPA and its implementing regulations.

Dose Reconstruction Overview

The Office of Compensation Analysis and Support has performed a dose reconstruction for in accordance with the applicable requirements of the Energy Employees Occupational Illness Compensation Progtam Act. Information provided by the Department of Labor (DOL) indicates that worked at the Oak Ridge National Laboratory (X-10) and Y-12 Plant from 1943, through 1944, and that he was diagnosed with cancer in 1964 and cancer in 1974. Although may have also worked at the Oak Ridge Gaseous Diffusion Plant (K-25), consideration of possible dose at that site was discounted for this dose reconstruction since K-25 did not begin operation until 1945.[9]

During his employment at X-10 and Y-12, was employed as a security inspector according to records received from the DOL and information provided during the telephone interview process. Based on the interview, probably worked checking the security at entrances and exits to buildings at X-10. Information obtained from the Department of Energy (DOE) indicates that he was not monitored for radiation exposure during his employment.

dose was 9.222 rem to the and 16.070 rem The dose was calculated only for these organs because of the specific types of cancer associated with this claim.

For the purposes of this dose reconstruction, radiation dose was overestimated using maximizing assumptions related to radiation exposure and intake, based on current science, documented experience, and relevant data. Even under these assumptions, NIOSH has determined that further research and analysis will not produce a level of radiation dose resulting in a probability of causation of 50% or greater. In accordance with 42 CFR § 82.10(k),[1] NIOSH has determined that sufficient research and analysis have been conducted to consider this dose reconstruction complete. Per the requirements of 42 CFR § 82.10(j),[1] only the dose incurred up to the point of cancer diagnosis was included in this dose reconstruction.

Information Used

The primary references used in this dose reconstruction were the ORAUT Technical Information Bulletins and Technical Basis Documents (see references). In instances in which specific information useful for estimating doses was lacking, parameters were selected that maximized the dose estimate.

In addition to the above information, the record of the computer assisted telephone interview was reviewed carefully by the dose reconstructor. The information provided was considered in the dose estimation process. Additional information on the evaluation of the interview is provided in subsequent sections of this report, as applicable.

Dose Estimate

External Dose

External dose is received from radiation originating outside the body and is typically measured by dosimetry worn on the body. Such radiation doses may have been delivered quickly (acute exposure) or slowly over the period of time that the employee was exposed (chronic exposure). External doses for individuals not monitored for radiation exposure were likely predominantly from on-site ambient photon radiation and occupational medical X-ray procedures.

Radiation Type, Energy, and Exposure Geometry

Due to the fact that was not monitored, the determination of radiation exposure geometry was not necessary for this reconstruction. For the purposes of estimating probability of causation, all on-site ambient photon doses and medical X-ray doses are assumed to be acute. Additionally, to maximize the probability of causation, the photon energy range was always assumed to be 30–250 keV.

On-Site Ambient Dose

Because was not monitored for ionizing radiation doses during his employment at X-10 and Y-12, on-site ambient doses were assessed as part of this reconstruction in accordance with the External Dose Reconstruction Implementation Guideline.[3] This accounts for any doses from stack releases or other radiation sources that may have been unmonitored at the site. The on-site ambient doses assigned were based on a comparison between the Technical Basis Document for Oak Ridge National Laboratory – Occupational Environmental Dose[7] and the Technical Basis Document for Y-12 National Security Complex – Occupational Environmental Dose.[8] The higher ambient dose was attributed to X-10 and the doses were doubled to ensure the final dose is maximized. This results in a total on-site ambient dose of 1.456 rem each to the bladder and prostate would not have been present in an environment providing doses this high due to the nature of his work as a security inspector.

Occupational Medical Dose

Although may not have been required to undergo medical X-ray procedures, the dose received from diagnostic X-ray procedures that may have been required as a condition of employment was also included in the overall dose to the bladder and prostate (using the bladder as a surrogate organ for the prostate).[10] Based on information in the Technical Basis Document for the Oak Ridge National Laboratory – Occupational Medical Dose[5] and the Technical Basis Document for the Y-12 National Security Complex – Occupational Medical Dose,[6] and an assumed annual X-ray each year of employment, a total X-ray dose of 0.065 rem was assigned to each cancer location. This X-ray dose is considered claimant favorable as it likely exceeds the true X-ray dose to the bladder and prostate. Additionally, a multiplication factor of 1.3 has been applied to ensure claimant favorability and to account for uncertainty.

Internal Dose

Internal dose is caused by radioactive materials that are taken into the body. A chronic intake is an intake of radioactive material that occurs over an extended period of time (typically weeks or longer). An acute intake is an intake of radioactive material that occurs over a short period of time (typically minutes to hours). Regardless of the rate at which the intake occurs, the internal dose received from radioactive materials having long half-lives occurs over an extended period of time and is, therefore, considered chronic. The internal dose to the prostate was determined by using the dose calculated for the colon. The internal dose to the prostate is to be determined using the highest dose calculated for any non-metabolic organ.[10] However, in this case, the dose to an organ that provides a larger dose (colon) than the highest dose to any non-metabolic organ was used.

Employment records for were reviewed and no records of bioassay monitoring results were found. Internal monitoring programs are applied to individuals who are likely to be exposed to radiation from internally-deposited radioactive material. Personnel who are not selected for internal dose monitoring programs are less likely to be exposed. However, to account for any incidental dose that may have been received but not documented, internal dose was assigned based on a hypothetical intake assuming an intake of 28 radionuclides. This results in an intake that greatly exceeds any possible actual intake by because this level of activity would be expected to be detectable by workplace indicators. Also, these nuclides would not all be found at the X-10 or Y-12 sites. The total internal dose assigned was 7.701 rem to the bladder and 14.549 rem to the prostate.

Assigned internal doses are based on the information provided in the Technical Information Bulletin: Maximum Internal Dose Estimates for Certain DOE Complex Claims[4] and the application of assumptions that maximize the dose to the applicable organ from the radionuclides present at a reactor site. These assumptions include assuming large intakes of uranium that did not likely occur. The dose calculated using the stated methodology is claimant favorable because of the low potential for intakes of radioactive material of the magnitude assumed in the dose calculation. This potential is considered low because o ob title (security inspector) and his relatively short period of employment at the sites.

Dose from Radiological Incidents

The record of the telephone interview was evaluated carefully by the dose reconstructor. It indicates that wore a badge but it was not certain if this was a dosimeter. It also states that eceived a letter stating that he was exposed to radiation and that he may develop bladder cancer in the future. To predict the development of a specific type of cancer in the future is not possible, and it is evident from the records that the badge was not a dosimeter, although it is possible that some monitoring records could not be recovered. Overestimating assumptions were applied in this dose reconstruction to ensure that the dose given in this dose reconstruction was greater than any actual radiation dose received by

No radiological incidents were documented in the telephone interview or the records supplied by the Department of Energy.

Uncertainty

Point estimates (constant values) were used for organ dose input into the NIOSH-Interactive RadioEpidemiological Program (NIOSH-IREP).

Possible Overestimate of Radiation Dose

There are a number of reasons to believe that this dose estimate represents a larger dose than true radiation dose received while working at X-10 and Y-12. The most important reasons for this include:

- Internal doses were estimated by using claimant-favorable assumptions regarding hypothetical intakes that were unlikely to have occurred. The actual internal doses received by would have been considerably smaller than those calculated using these assumptions.
- The actual doses to the bladder and prostate from occupational medical X-ray procedures are likely to be smaller than were calculated based on the maximizing assumptions used in this dose reconstruction.
- The external on-site ambient doses estimated for are likely much larger than any ambient doses that were unmonitored or unrecorded.

Summary

Although unmonitored for radiation exposur likely received on-site ambient radiation and occupational medical X-ray doses during his employment at the Oak Ridge National Laboratory (X-10) and the Y-12 Plant. Internal dose was also applied to account for potential unmonitored intakes of radioactive material. The total estimated dose to was 9.222 rem to the bladder and 16.070 rem to the prostate. The reported dose is a significant *overestimate* of occupational radiation dose which will support claim determination.

Attachment 1 contains the IREP dose reconstruction summary sheets that will be used by the Department of Labor to make the final probability of causation determination of the claim.

References

1. 42 CFR 82, *Methods for Radiation Dose Reconstruction Under the Energy Employees Occupational Illness Compensation Program Act of 2000*; Final Rule, Federal Register/Vol.67, No. 85/Thursday, May 2, 2002, p 22314.

2. 42 CFR 81, *Guidelines for Determining the Probability of Causation Under the Energy Employees Occupational Illness Compensation Program Act of 2000*; Final Rule, Federal Register/Vol.67, No. 85/Thursday, May 2, 2002, p 22296.

3. NIOSH, (2002) *External Dose Reconstruction Implementation Guideline, Rev 1*, OCAS-IG-001, National Institute for Occupational Safety and Health, Office of Compensation Analysis and Support, Cincinnati, Ohio.

4. ORAUT (Oak Ridge Associated Universities Team), ORAUT-OTIB-0002, *Technical Information Bulletin: Maximum Internal Dose Estimates for Certain DOE Complex Claims, Rev 01 PC-2*, May 7, 2004.

5. ORAUT (Oak Ridge Associated Universities Team), ORAUT-TKBS-0012-3, *Technical Basis Document for the Oak Ridge National Laboratory – Occupational Medical Dose, Rev 01*, October 29, 2004.

6. ORAUT (Oak Ridge Associated Universities Team), ORAUT-TKBS-0014-3, *Technical Basis Document for the Y-12 National Security Complex – Occupational Medical Dose, Rev 00 PC-3*, April 18, 2006.

7. ORAUT (Oak Ridge Associated Universities Team), ORAUT-TKBS-0012-4, *Technical Basis Document for the Oak Ridge National Laboratory – Occupational Environmental Dose, Rev 00*, May 7, 2004.

8. ORAUT (Oak Ridge Associated Universities Team), ORAUT-TKBS-0014-4, *Technical Basis Document for the Y-12 National Security Complex – Occupational Environmental Dose, Rev 00 PC-3*, October 11, 2005.

9. ORAUT (Oak Ridge Associated Universities Team), ORAUT-TKBS-0009-2, *Technical Basis Document for the K-25 Site – Site Description, Rev 00*, January 12, 2004.

10. ORAUT (Oak Ridge Associated Universities Team), ORAUT-OTIB-0005, *Technical Information Bulletin: Internal Dosimetry Organ, External Dosimetry Organ, and IREP Model Selection by ICD-9 Code, Rev 02 PC-1*, February 10, 2006.

The Occupational Environmental Dose TBD (Burns 2004b) appears to rely on emission and measurement data; however, it does not indicate the model used for calculations. The TBD generally discusses particle size; however, the actual particle size assumptions for assignment of internal dose have not been provided. No consideration has been given to the deficiencies in the stack and ambient air sampling systems; however, there is a heavy reliance on these systems to determine unmonitored worker dose. Exposures considered are limited to I-131, H-3 (starting 1967), Kr-85, Xe-133, and mixed fission products (MFPs) (optional), while diverse radionuclides were handled and potentially released at the site. There has been no consideration of potential doses from the release of large uranium particles. Overall, SC&A believes that further investigation into environmental source terms and pathways is needed.

The Occupational External Dose TBD (Burns and Mohrbacher 2004) may result in an underestimate of neutron dose. Neutron dose is determined from neutron track emulsion type A (NTA) film results and is modified with a correction factor. Some facility-specific neutron energy bands are provided; however, in some facilities, the entire spectrum is essentially below the practical 1-MeV detection limits of NTA film used in the workers' badges. From the information in current Occupational External Dose TBD, ORAUT-TKBS-0012-6 (Burns and Mohrbacher 2004), it is not obvious that the dose reconstructor has sufficient detailed correction factors/instructions available to correct for the unmonitored neutron doses resulting from neutrons with less than 1 MeV of energy at the numerous facilities at ORNL that produced neutron exposures through the years.

Information available for the dose reconstruction in the early years is limited, inadequate, and in some cases, not available. External monitoring for 1943–1944 was limited to the use of pocket ionization chambers (PICs), with some experimental badges worn. There is a lack of clear discussion on how these monitored and unmonitored doses are derived during this time period. Furthermore, the Occupational External Dose TBD (Burns and Mohrbacher 2004) questions the validity of these data. The monitoring practices for the years prior to 1951 required further investigation to determine if all exposed workers were monitored during this time period. In terms of internal exposure, there was an absence of routine internal monitoring until 1949. Early bioassay data was limited to plutonium and strontium, although other radionuclides were being handled even prior to 1949.

The Occupational Internal Dose TBD lacks guidance on how to assign dose to radionuclides other than transuranics, uranium, activation products, and fission products. As indicated by site experts, ORNL handled almost everything on the periodic table at one point or another. There has been no screening presented to demonstrate that the secondary radionuclides, particularly accelerator- and reactor-produced, are of no dose consequence to the workers. Although ORNL handled uranium and radium in the early years, no consideration was given to occupational radon exposure. Information was not provided on the activity fractions for plutonium and thorium. Activity fractions for plutonium provide critical information for the assessment of dose from americium as an impurity. Dose from non-traditional chemical forms of radionuclides, such as high-fired oxides and tritides, were not considered. Finally, an adequate rationale for assumption of Am-241 in the case of transplutonium bioassay rather than Cm-244 was not provided.

Public Burden Statement

Public reporting burden for this collection of information is estimated to average 300 minutes per response, including time for reviewing instructions, gathering the information needed, and completing the form. If you have any comments regarding the burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, send them to CDC Reports Clearance Officer, 1600 Clifton Road, MS-E-11, Atlanta GA, 30333; ATTN:PRA 0920-0639. Do not send the completed petition form to this address. Completed petitions are to be submitted to NIOSH at the address provided in these instructions. Persons are not required to respond to the information collected on this form unless it displays a currently valid OMB number.

Privacy Act Advisement

In accordance with the Privacy Act of 1974, as amended (5 U.S.C. § 552a), you are hereby notified of the following:

The Energy Employees Occupational Illness Compensation Program Act (42 U.S.C. §§ 7384-7385) (EEOICPA) authorizes the President to designate additional classes of employees to be included in the Special Exposure Cohort (SEC). EEOICPA authorizes HHS to implement its responsibilities with the assistance of the National Institute for Occupational Safety (NIOSH), an Institute of the Centers for Disease Control and Prevention. Information obtained by NIOSH in connection with petitions for including additional classes of employees in the SEC will be used to evaluate the petition and report findings to the Advisory Board on Radiation and Worker Health and HHS.

Records containing identifiable information become part of an existing NIOSH system of records under the Privacy Act, 09-20-147 "Occupational Health Epidemiological Studies and EEOICPA Program Records. HHS/CDC/NIOSH." These records are treated in a confidential manner, unless otherwise compelled by law. Disclosures that NIOSH may need to make for the processing of your petition or other purposes are listed below.

NIOSH may need to disclose personal identifying information to: (a) the Department of Energy, other federal agencies, other government or private entities and to private sector employers to permit these entities to retrieve records required by NIOSH; (b) identified witnesses as designated by NIOSH so that these individuals can provide information to assist with the evaluation of SEC petitions; (c) contractors assisting NIOSH; (d) collaborating researchers, under certain limited circumstances to conduct further investigations; (e) Federal, state and local agencies for law enforcement purposes; and (f) a Member of Congress or a Congressional staff member in response to a verified inquiry.

This notice applies to all forms and informational requests that you may receive from NIOSH in connection with the evaluation of an SEC petition.

Use of the NIOSH petition forms (A and B) is voluntary but your provision of information required by these forms is mandatory for the consideration of a petition, as specified under 42 CFR Part 83. Petitions that fail to provide required information may not be considered by HHS.

Name or Social Security Number of First Petitioner

Special Exposure Cohort Petition
under the Energy Employees Occupational Illness Compensation Act

U.S. Department of Health and Human Services
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

OMB Number: 0920-0639 Expires: 07/31/2010

Special Exposure Cohort Petition — Form B
JUN 23 2010

Appendix — Continuation Page

Continuation Page — Photocopy and complete as necessary.

Dear Sir /Madam;

I filed a claim in 2001.I don't thing they have given me a fair and accurate dose reconstruction. I know at this time- it was beginning of the program, and everything was new, but they should have more information now- on dose reconstruction. They have denied and denied my claim.

I don't think they have any records or On his data card his employer was- Stone/Webster. Stone / Webster constructed Y-12, Location of unit on the card looks like they have corrected and left blank. Contracting Agency- Was the Manhattan Dist.

DuPont - constructed X-10. I can't find anything that connects with X-10.
DOE has said that dad doesn't have enough work days for SEC, but could you help!!

Thank you! For reading this letter.

Attach to Form B if necessary.

Name or Social Security Number of First Petitio

The evidence shows that the employee worked at the X-10 in Oak Ridge, Tennessee, from 1943 to 1944. X-10 is not a designated SEC facility. The evidence of record does not show that you worked at another SEC location. Therefore, the employee does not qualify as a member of the SEC.

You meet the definition of a survivor under Part B of the Act. 42 U.S.C. § 7384s(e)(3)(A). However, a survivor is only entitled to compensation under Part B of the Act, if the employee would have been entitled to compensation under Part B of the Act, for an occupational illness.

Part B of the Energy Employees Occupational Illness Compensation Program Act established a compensation program to provide a lump sum payment and medical benefits as compensation to eligible covered employees who have been diagnosed with a specific occupational illness incurred as a result of their exposure to radiation, beryllium or silica while in the performance of duty for the DOE and certain of its vendors, contractors and subcontractors. 42 U.S.C. § 7384 *et seq.*

A cancer is considered to have been sustained in the performance of duty if it was at least as likely as not (a 50% or greater probability) related to radiation doses incurred while working at a DOE facility. 42 U.S.C. § 7384n(b), 42 C.F.R. Part 81 I.B. The dose reconstruction estimates were performed in accordance with the Act and the NIOSH regulations. 42 U.S.C. § 7384n(d), 42 C.F.R. § 82.10. The probability of causation calculation was completed in accordance with the Act, the implementing regulations, and NIOSH regulations. 42 U.S.C. § 7384n(c)(3), 20 C.F.R. § 30.213, 42 C.F.R. Part 81.

I conclude that you are not entitled to compensation because the calculation of "probability of causation" does not show that there is a 50% or greater likelihood that the employee's cancers were caused by radiation exposure received in the performance of duty at the X-10. 42 U.S.C. § 7384n(b). Therefore, your claim for survivor benefits for the employee's cancers under Part B of the Act is denied. 42 U.S.C. § 7384n(b).

Jacksonville, Florida

Jeana F. LaRock
Hearing Representative
njg

1.0 EXECUTIVE SUMMARY

This report provides the results of an independent audit conducted by S. Cohen and Associates (SC&A, Inc.) of the technical basis documents (TBDs) developed by the National Institute for Occupation Safety and Health (NIOSH) that make up the site profile for the Oak Ridge National Laboratory (ORNL). This audit was conducted during the period February 1, 2006–September 15, 2006, in support of the Advisory Board on Radiation and Worker Health (Advisory Board) in the latter's statutory responsibility under the Energy Employees Occupational Illness Compensation Program Act (EEOICPA) to conduct such reviews, and advise the Secretary of Health and Human Services on the "completeness and adequacy" of the EEOICPA program.

ORNL is located on the Oak Ridge Reservation, along with the Y-12 National Security Complex (Y-12) and the Oak Ridge Gaseous Diffusion Plant (K-25). The main laboratory area of ORNL is in Bethel Valley. Other ORNL research facilities are located at an adjacent site in Melton Valley and at the Y-12 Plant (DOE 1990). The Site Description TBD (Fleming 2006b, pp. 10–11) provides the following summary of the scope of the nuclear activities conducted at the ORNL:

> *Since its operations began in 1943, the mission of Oak Ridge National Laboratory (ORNL) has been to conduct research and development (R&D) and production missions in support of DOE and its predecessor agencies. Much of the earliest site work was devoted to the development and operation of the original plutonium production reactor and associated chemical separation facility to test the larger production reactors that were being built on the Hanford Site. The Graphite Reactor produced gram quantities of plutonium and later fission products [e.g., radioactive lanthanum (RaLa)]; other types of radioactive materials were separated in other site facilities. Waste control technologies during early site operations were in their infancy, and much of the current knowledge of transport of radionuclides in the environment was obtained during this time. The ability to detect, identify, and quantify radiation types and exposures were progressing along with new technologies being discovered in radioisotope production. Much of the information gained during the early years at ORNL was used for the design of future U.S. Atomic Energy Commission (AEC)/DOE facilities and detection systems. Waste radioactive material was released from early site operations as gaseous, liquid, and solid effluents with little or no pretreatment. Methods were later developed to capture many of the contaminants at their source and to reduce overall plant emissions. In some cases, this increased direct exposures to individuals in the immediate area and created locations in which incidents and spills occurred.*
>
> *During the more than 60 years of operations at the site, facilities have been constructed, operated, decontaminated, and decommissioned based on need.*

- *The operation of the Graphite Reactor for producing plutonium and other radioisotopes*
- *The development and refinement of chemical processes to separate plutonium, uranium, and thorium from irradiated fuel*
- *Chemical separation of RaLa from irradiated fuel slugs for use in implosion dynamics studies at Los Alamos National Laboratory*
- *Operation of facilities for the separation, packaging, and distribution of radioisotopes for government and commercial use*

In addition, ORNL developed new reactor technologies. The Laboratory tested different reactor designs (pool, pressurized-water, boiling-water, liquid-metal, gas-cooled) that were either scrapped or developed further elsewhere. Reactors operated at ORNL include the Low-Intensity Test Reactor (LITR), Critical Experiments Facility [CEF, at the Y-12 National Nuclear Security Complex (Y-12)], Bulk Shielding Reactor (BSR)/Pool Critical Assembly (PCA), Oak Ridge Research Reactor (ORR), Tower Shielding Reactor (TSR), Health Physics Research Reactor (HPRR), Homogeneous Reactor Experiment (HRE), Aircraft Nuclear Propulsion (ANP) Program, the High Flux Isotope Reactor (HFIR), and the Molten Salt Reactor Experiment (MSRE).

SC&A's review focused on the six TBDs that make up the ORNL site profile. These address introduction, site description, occupational internal dose, occupational external dose, occupational medical dose, and occupational environmental dose, as they pertain to historic radiation exposure of ORNL workers. These TBDs are dated from 2004–2006. As "living" documents, TBDs are constantly being revised as new information, experience, or issues arise. A complete list of the ORNL TBDs, as well as supporting documents, that were reviewed by SC&A is provided in Attachment 1.

SC&A's review process included a review of the TBDs, a visit to Oak Ridge, Tennessee, to conduct interviews with site experts and identify documents for data retrieval, reviews of retrieved ORNL and other historic records, and an exchange of questions and answers, in addition to TBD-specific conference calls, between SC&A and its NIOSH and Oak Ridge Associated Universities (ORAU) counterparts. The TBDs were evaluated for their completeness, technical accuracy, adequacy of data, compliance with stated objectives, and consistency with other site profiles, as stipulated in the *SC&A Standard Operating Procedure for Performing Site Profile Reviews* (SC&A 2004).

The Occupational Medical Dose TBD, ORAUT-TKBS-0012-3 (Fleming 2004), provides little documentation to support the assumed techniques, and protocols applied to calculate the dose, which is mainly derived from Cardarelli et al. 2002, are accurate. NIOSH believes that when no information is readily available about the energy spectrum, it is reasonable to use the assumptions for dose conversion factors (DCFs) that are presented in the Implementation Guide.

Issues presented in this report are sorted into the following categories, in accordance with SC&A's review procedures:

(1) Completeness of data sources
(2) Technical accuracy
(3) Adequacy of data
(4) Consistency among site profiles
(5) Regulatory compliance

Following the introduction and a description of the criteria and methods employed to perform the review, the report discusses the strengths of the TBD, followed by a description of the major issues identified during our review. The issues were carefully reviewed with respect to the five review criteria. Several of the issues were designated as primary findings, because they represent key deficiencies in the TBDs that need to be corrected, and which have the potential to substantially impact at least some dose reconstructions. Others have been designated "secondary findings" to both connote their importance for the technical adequacy and completeness of the site profile, and to indicate that they have been judged by SC&A to have relatively less influence on dose reconstruction or the ultimate significance of worker doses so estimated.

1.1 SUMMARY OF STENGTHS

Both the internal and external dose TBDs provided an extensive history of the internal and external monitoring program at ORNL. The NIOSH/ORAU team is aware of gaps in the TBDs, and has plans to investigate exposure to radon, americium as an impurity, and tritides. Recent revisions to the ORNL Site Description TBD captured a number of facilities that were missed in the original version of the site description, and provided further information on ORNL processes and operations. One benefit of this revision was the inclusion of all buildings mentioned by site experts as being missing from the original revision.

1.2 SUMMARY OF FINDINGS

Finding 1: Incomplete Dose Data for the Earlier Years. Information available for dose reconstruction in the early years is limited, inadequate, or in some cases, not available. External beta/gamma monitoring with film badges did not occur until June 1944, while routine neutron monitoring was not available until 1949. The neutron dose is reliant on application of a neutron-proton (n-p) ratio to the photon dose, yet the TBD questions the dose results from 1943–1944. Bioassay was not routinely available prior to 1949, and then only for a few radionuclides. Table 5A-2, page 39, of the Occupational Internal Dose TBD (Bollenbacher et al. 2006) provides minimum detectable activity (MDA) values that have been determined for gross alpha, gross beta, and 16 radionuclides found in urinalysis sampling, and gross alpha and 4 radionuclides found in fecal sampling. A method for identifying workers and assigning missed dose for those potentially exposed to all the assorted radionuclides for which MDAs have been determined (Table 5A-2, page 39) is lacking in this document. No consideration was given to early issues with significant beta exposures, which caused skin erythema. Consideration of dose from uranium particle releases and their subsequent deposition on the skin was not evaluated in the

TBD. For 1944–1947, the TBD relies on air sampling data; however, very little information is provided related to its collection and analysis. Further evaluation should be provided to make sure this approach is bounding for unmonitored acute and chronic intakes.

Finding 2: Inadequate Consideration of Missed Dose from Other Radionuclides. Although it acknowledges their existence, the Occupational Internal Dosimetry TBD ORAUT-TKBS-0012-5 (Bollenbacher et al. 2006) does not adequately address potential doses from secondary or so-called "exotic" radionuclides. The focus of the TBD is on "radionuclides likely to produce a measurable internal dose," including uranium, activation products, fission products, and transuranics. Numerous radionuclides were handled at ORNL ranging in quantities from fractions of a gram to kilograms. Radionuclides for which co-worker dose is assigned included strontium, uranium, plutonium, Am-241, Cs-137, Ce-144, and Ru-106 (Kennedy 2005). Potential exposures to reactor- and accelerator-produced radionuclides have not been adequately considered. The TBD does not try to ascertain when radionuclides were present, in what quantities they were handled, and whether there were suitable methods available for monitoring these radionuclides.

Finding 3: Problems with Neutron Doses. In view of several statements made in the Occupational External Dose TBD (Burns and Mohrbacher 2004), the use of NTA film to monitor neutron doses at ORNL raises several areas of concern. For example, page 23 of the TBD mentions that neutron energy spectra and neutron exposure data before the late 1980s is sparse, and that information is particularly lacking for many of the reactors that operated at ORNL early in its history. If n-p values are used instead of NTA dose records, these concerns are still valid, because using n-p values depend on a detailed knowledge of the gamma and neutron doses, and neutron energy spectra at each work location as a function of time.

Finding 4: Lack of Information Concerning Selection of Workers for Badging. The Occupational External Dose TBD (Burns and Mohrbacher 2004) does not provide sufficient details concerning who was badged and when, to ensure that workers were sufficiently monitored to allow for technically sound dose reconstruction. Page 11 of the TBD states that initially only employees required to work in restricted areas more than 3 days per week were issued beta-gamma monitoring, and that as late as 1956, there were no strict enforcement policies concerning the wearing of monitoring badges. Apparently, the workers that entered restricted areas only 1 or 2 days per week did not received badges or any dose of record. Table 6-2, page 16, of the TBD provides a list of the characteristics of dosimeters from 1944 to present worn by *radiation* workers at ORNL, but does not describe what defined a radiation worker. The TBD needs to further refine who was (and was not) monitored and how those selections were made in order to be able to determine the adequacy of the dose records.

Finding 5: Lack of Dose Assignment Procedure for Unmonitored Worker. The Occupational External Dose TBD (Burns and Mohrbacher 2004) does not provide a defined procedure to assign dose to unmonitored workers. Section 6.5.1 briefly mentions limits of detection (LOD) and provides Table 6-24, page 69, listing the LOD and exchange frequency as a function of time. However, this should only be applied to the dose missed by the dosimeter worn by a worker, not the dose missed because a worker was not badged. This applies to neutron as well as photon and beta doses. During these early years, an unmonitored worker could have received dose without management or the worker being fully aware of the hazards. The TBD needs to provide technically sound dose reconstruction procedures for assigning doses to unmonitored workers, especially in the early years (1943–1960s), when radiation hazards were not always recognized or effectively addressed.

Finding 6: Lack of Data Validation and Verification. The validation and verification of the data used in dose reconstruction has not adequately been completed. There are indications that additional bioassay data exist that are not reflected in the database obtained by ORAU for the calculation of MDAs. For example, we became aware that the ORNL has not fully consolidated all the occupational exposure records, indicating that some records may not be complete. Also, the completeness and accuracy of the external dosimetry data may require further verification to ensure field-recorded dose results were integrated into occupational exposure records (OERs). This adds to uncertainty of these data. Finally, the environmental air sampling data ratios used in the development of co-worker dose from Ru-106, Ce-144, and Cs-137 should be further justified.

Finding 7: The TBD Fails to Adequately Define and Assess Occupational Medical Exposure. The current medical exposure and dose guidelines, as presented in (Kathren 2003), go a long way in assuring that all occupational medical exposures are reasonably included in determining the overall dose estimations for claimants. Unfortunately, the interpretation to date by the contractor (ORAU) has not been applied too conservatively to be claimant favorable. The occupational medical dose TBD (Fleming 2006a) assumes an interpretation that also has been considered and applied at other sites, such as the Mound Plant and Los Alamos National Laboratory (LANL), Paducah, and Pinellas. To this extent, the assumption that medical procedures are limited to only one pre-employment chest x-ray and chest x-rays that are part of routine physical exams may substantially underestimate worker medical exposure when evaluating occupational medical exposure.

Finding 8: Techniques and Protocols Increase Uncertainty of DCFs listed in the TBD. The Occupational Medical Dose TBD (Fleming 2006a) provides little documentation to support the assumed techniques and protocols applied to calculate the dose, which is mainly derived from NCRP Report 102. The TBD states that a posterior-anterior (PA) chest x-ray was typically the only view taken. It is an undocumented assumption in the TBD that exams required only a PA view. SC&A has inquired whether definitive protocol existed to validate that chest exams possibly included PA views and lateral (LAT) views on a limited basis. NIOSH has acknowledged in other TBD reviews that the lack of verifiable protocols is a generic problem at many sites, has planned to search all available records, and will include pertinent records and references in any future revision of this section of the TBD. The Occupational Medical Dose TBD is also deficient in that little documentation exists to validate x-ray protocols, equipment maintenance, and upkeep records.

Finding 9: Frequency and Type of X-ray Exposure is Uncertain. The Occupational Medical Dose TBD in Section 3 provides no documentation or references to support the assumption that only a limited group of workers received annual x-ray exams after 1970. To the contrary, up until about 1985, most DOE sites performed chest x-rays almost on a voluntary basis. DOE medical program reviews documented during the early 1990s showed many sites still used chest radiography as a general screening exam. Most workers accepted chest x-rays, even though the job did not require it. Also, the assumption that workers in special exposure categories, such as beryllium workers, were given chest x-rays only as part of their routine physical is not well-documented and not consistent with special screening guidelines. The TBD applies no conservative assumption to cover such exams.

Finding 10: Inadequate Consideration of Environmental Dose from Radionuclides Other than I-131 and Tritium. The Occupational Environmental Dose TBD (Fleming 2006a) focuses on onsite airborne I-131 concentration, onsite airborne concentration of MFPs, onsite airborne concentrations of tritium, and onsite exposure rate data. Reactors' releases and waste farms data are not adequately considered.

In many ways, the TBDs have done a successful job in addressing a series of technical challenges. In other areas, the TBDs exhibit shortcomings that may influence some dose reconstructions in a substantial manner. Major issue areas include the following:

- Insufficient data for early worker dose reconstructions
- Inadequate consideration of missed dose from secondary radionuclides and radionuclide impurities
- Occupational exposure to radon is not fully addressed in the TBDs
- Insufficient characterization of the monitored workforce for beta/gamma and neutron monitoring
- Underestimation of neutron dose when using NTA file and in developing n-p ratios where the initial photon dose is not well characterized
- Lack of external dose assignment methodology for unmonitored workers
- Incomplete evaluation of medical x-ray exposures, especially in the early years
- Inadequate validation of source data used in dose reconstruction
- Concerns with reported deficiencies of air monitoring sampler locations at the site

SC&A believes that these important issues need to be effectively dealt with in any upcoming revisions to the ORNL site profile TBDs in order that more claimant-favorable dose reconstructions can be effectively conducted in areas where these data gaps exist.

The use of such maximized (or upper-bound) values, however, is limited to those instances where the resultant maximized doses yield POC values below 50%, which are not compensated. For this second category, the dose reconstructor needs only to ensure that all potential internal and external exposure pathways have been considered.

The obvious benefit of "worst-case" assumptions and the use of maximized doses in dose reconstruction is efficiency, which is achieved by the fact that maximized doses avoid the need for precise data and eliminates consideration for the uncertainty of the dose. Lastly, the use of bounding values in dose reconstruction minimizes any controversy regarding the decision not to compensate a claim.

Although simplistic in design, to satisfy this type of a dose reconstruction, the TBD must, at a minimum, provide information and data that clearly identify (1) all potential radionuclides, (2) all potential modes of exposure, and (3) upper limits for each contaminant and mode of exposure. Thus, for external exposures, maximum dose rates must be identified in time and space that correspond to a worker's employment period, work locations, and job assignment; similarly, in order to maximize internal exposures, highest air concentrations and surface contaminations must be identified.

Category 3: This represents the most complex and challenging dose reconstruction category. It consists of claims where the case cannot be dealt with under one of the two categories above. For instance, when a minimum dose estimate does not result in compensation, a next step is required to make a more complete estimate. Or when a "worst-case" dose estimate that has assumptions that may be physically implausible results in a POC greater than 50%, a more refined analysis is required. A more refined estimate may be required either to deny or to compensate. In such dose reconstructions, which may be represented as "reasonable," NIOSH has committed to resolve uncertainties in favor of the claimant. According to 42 CFR Part 82, NIOSH interprets "reasonable estimates" of radiation dose to mean the following:

> *. . . estimates calculated using a substantial basis of fact and the application of science-based, logical assumptions to supplement or interpret the factual basis.* ***Claimants will in no case be harmed by any level of uncertainty involved in their claims, since assumptions applied by NIOSH will consistently give the benefit of the doubt to claimants.*** [Emphasis added.]

In order to achieve the five objectives described above, SC&A reviewed each of the six TBDs, their supplemental attachments, and TIBs, giving due consideration to the three categories of dose reconstructions that the site profile is intended to support. The six ORNL TBDs provide well-organized information for the dose reconstructor when adequate data were available to do that comprehensively.

ORAUT-TKBS-0012-1, Rev. 00, *Technical Basis Document for Oak Ridge National Laboratory – Introduction* (Burns 2004a), explains the purpose and the scope of the site profile. SC&A was attentive to this section, because it explains the role of each TBD in support of the dose reconstruction process. During the course of its review, SC&A was cognizant of the fact that the site profile is not required by the EEOICPA or by 42 CFR Part 82, which implements the statute.

Site profiles were developed by NIOSH as a resource to the dose reconstructors for identifying site-specific practices, parameter values, and factors that are relevant to dose reconstruction. Based on information provided by NIOSH personnel, SC&A understands that site profiles are living documents, which are revised, refined, and supplemented with TIBs as required to help dose reconstructors. Site profiles are not intended to be prescriptive nor necessarily complete in terms of addressing every possible issue that may be relevant to a given dose reconstruction. Hence, the introduction helps in framing the scope of the site profile. As will be discussed later in this report, NIOSH may want to include additional qualifying information in the introduction to this and other site profiles describing the dose reconstruction issues that are not explicitly addressed by a given site profile.

ORAUT-TKBS-0012-2, Rev. 01, *Technical Basis Document for Oak Ridge National Laboratory – Site Description* (Fleming 2006b), is an extremely important document, because it provides a description of the facilities, processes, and historical information that serve as the underpinning for subsequent ORNL TBDs.

ORAUT-TKBS-0012-3, Rev. 01 PC-1, *Technical Basis Document for Oak Ridge National Laboratory – Occupational Medical Dose* (Fleming 2006a), provides an overview of the sources, types of exposure, and the frequency of exams that workers potentially received.

ORAUT-TKBS-0012-4, Rev. 00, *Technical Basis Document for Oak Ridge National Laboratory – Occupational Environmental Dose* (Burns 2004b), provides background information and guidance to dose reconstructors for reconstructing the doses to unmonitored workers outside of the facilities at the site who may have been exposed to routine and episodic (accidental) airborne emissions from these facilities.

ORAUT-TKBS-0012-5, Rev. 00 PC-1, *Technical Basis Document for Oak Ridge National Laboratory – Occupational Internal Dose* (Bollenbacher et al. 2006), presents background information and guidance to dose reconstructors for deriving occupational internal doses to workers.

ORAUT-TKBS-0012-6, Rev. 00, *Technical Basis Document for Oak Ridge National Laboratory – Occupational External Dose* (Burns and Mohrbacher 2004), presents background information and guidance to dose reconstructors for deriving occupational external doses to workers.

Site expert interviews were conducted from February 22– March 3, 2006, in Oak Ridge, Tennessee, with former and current ORNL employees; Bechtel-Jacobs, Inc., employees; and Department of Energy–Oak Ridge Operations Office oversight personnel. The purpose of these interviews was to receive first-hand accounts of past radiological control and personnel monitoring practices at ORNL, and better understand how operations were conducted. Interviewees were selected to represent a reasonable cross-section of production areas and job categories. References to specific site experts have been omitted for privacy reasons. The individuals were given the opportunity to review their interview summary for accuracy. This is an important safeguard against missing key issues or misinterpreting some vital piece of information. To ensure that classified information had not been included in the interview notes,

Energy Employees Occupational Illness Compensation Program

Facility List

There was one record found for the facility: Clinton Engineer Works (CEW) .

1 - Clinton Engineer Works (CEW)

Also Known As: Oak Ridge Area
Also Known As: Oak Ridge Reservation
State: Tennessee **Location:** Oak Ridge
Time Period: 1943-1949
Facility Type: Department of Energy

Facility Description: In 1943, as part of the Manhattan Engineer District, the US. Government purchased 59,000 acres 12 miles west of Knoxville, Tennessee because it needed a remote location to build production plants and laboratories to produce plutonium and enriched uranium for the atomic bomb project. This facility was known as the Clinton Engineer Works (CEW) and was referred to generally as Oak Ridge. The entire CEW was bounded by security fences from February 1943 through March 1949 Within the CEW, were the processing plants, known as Y-12, K-25 and X-10 (now ORNL) each of which had its own security fence (a fence within a fence) and has been designated separately for purposes of the EEOIPCA During this time, Roane Anderson Company managed, operated and maintained residences, apartment, dormitories, guest houses, barracks, hutments, trailers, restaurants, cafeterias, buses, roads, streets, sidewalks, garbage and sewage disposal, heating plants and more for the CEW. Roane did not, however, operate the processing plants and laboratories. The CEW gates came down in March 1949. This meant that people no longer needed a security clearance to enter the CEW, though clearances were still required to enter the plants and laboratories. The fences surrounding the processing plants also remained. It was also in 1949 that the privatization of what is today known as the City of Oak Ridge began.

CONTRACTOR: Roane Anderson

This page was last updated on June 04, 2008

The South Campus Facility was originally established in 1945 to study accidental irradiation of cattle during testing of the first atomic bomb near Alamogordo, New Mexico. The scope of this research soon included studies of the introduction and migration of radioisotopes in the food chain as well as other agricultural problems. The University of Tennessee Scarboro Operations Site once operated as a comparative animal research laboratory and an agricultural experiment station. The Scarboro Operations site was one of several government-owned facilities assigned to ORAU and ORISE in 1981

CONTRACTOR: Oak Ridge Associated Universities (1946-present)

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7 - Oak Ridge National Laboratory (X-10)

Also Known As: Clinton Laboratories
State: Tennessee **Location:** Oak Ridge
Time Period: 1943-present
Facility Type: Department of Energy

Facility Description: During the Manhattan project, the Oak Ridge National Laboratory (ORNL) site was used by the University of Chicago Metallurgical Laboratory to construct the first pile semiworks - a test plant that would move the plutonium product process from the research stage to large scale production. DuPont began construction of the test pile, the X-10 reactor in March 1943 and was ready for operations by January 1944. A research facility designated as the Clinton Laboratories was built during the war to support X-10 reactor activities and included chemistry, health and engineering divisions

After the war, the laboratory was transformed from a war production facility to a nuclear research center and changed its name to Oak Ridge National Laboratory in 1948. The Laboratory's research role in the development of nuclear weapons decreased over time, but the scope of its work expanded to include production of isotopes, fundamental hazardous and radioactive materials research, environmental research, and radioactive waste disposal.

Throughout the course of its operations, the potential for beryllium exposure existed at this site, due to beryllium use, residual contamination, and decontamination activities

CONTRACTORS: University of Chicago (1943-1945); Monsanto Chemical (1945-1947); Union Carbide and Carbon Corp. (1948-1984); Martin Marietta Energy Systems (1984-1994); Lockheed Martin Energy Research Corp. (1994-1998); UT Battelle (2000-present)

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8 - Office of Scientific and Technical Information (OSTI)

State: Tennessee **Location:** Oak Ridge
Time Period: 1957 - Present
Facility Type: Department of Energy

Facility Description: The Office of Scientific and Technical Information was created to serve as a federal government repository for all technical reports pertaining to the Department of Energy and its predecessor agencies.

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9 - S-50 Oak Ridge Thermal Diffusion Plant

State: Tennessee **Location:** Oak Ridge
Time Period: 1944-1951
Facility Type: Department of Energy

Facility Description: The S-50 Plant at Oak Ridge was constructed in 1944 to enrich uranium feed material for the Y-12 electromagnetic facility using a liquid thermal diffusion process. The process was originally developed at the Naval Research Laboratory in Washington, DC, and tested on a pilot plant level at the Philadelphia Naval Shipyard. Located near the K-25 gaseous diffusion facility, the S-50 Plant operated for a limited period during 1944-1945. The plant was closed in September 1945 because the thermal diffusion process was not as efficient as the gaseous diffusion.

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ATTACHMENT 1: NIOSH TECHNICAL DOCUMENTS CONSIDERED DURING THE REVIEW PROCESS

Technical Basis Documents

ORAUT-TKBS-0012-1, *Technical Basis Document for Oak Ridge National Laboratory – Introduction Rev. 00,* August 11, 2004 (Burns 2004a).

ORAUT-TKBS-0012-2, *Technical Basis Document for Oak Ridge National Laboratory – Site Description Rev. 01,* August 30, 2006 (Fleming 2006b).

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Technical Support Documents

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Prostate Cancer and Exposure to Ionizing Radiation

Summary: Evidence has been recorded of an connection between cancers of the prostate and exposure to ionizing radiation. This connection is supported by evidence from studies of nuclear workers in England who have been exposed to ionizing radiation. The National Research Council's, on the other hand, has determined that the prostate is relatively insensitive to ionizing radiation. Prostate cancer is not designated as a "specified" cancer under the Energy Employees Occupational Illness Compensation Program Act. Historically, prostate cancer incidence has been high for Los Alamos County while prostate cancer mortality has been low compared to other counties in the state. Prostate cancer incidence and mortality rates in Rio Arriba County were among the top third of New Mexico counties. Incidence means new cases of cancer, while mortality means deaths due to cancer.

What is Prostate Cancer?

The prostate is a gland in a man's reproductive system. The prostate is about the size of a walnut. It is located below the bladder. Cancer of the prostate occurs when cells of the prostate become abnormal and reproduce without control. Tumors of the prostate that are not cancer are common. (National Cancer Institute)

Findings of Human Health Research Studies

Human health research studies compare the patterns of disease among groups of people with different amounts of exposure to a suspected risk factor. Below are results reported from such studies of prostate cancer among people exposed to ionizing radiation.

All of these studies found increases and possible increases in prostate cancer among certain groups of exposed workers. Statistically significant is a term used to mean that the connection between the health outcome and the exposure was strong enough that it was unlikely to be due to chance. An asterisk (*) was placed by statistically significant findings. The research included incidence studies, which look at new cases of cancer. These can track health more quickly and accurately than mortality studies of deaths due to cancer.

Studies of Los Alamos National Laboratory (LANL) Workers

Research conducted of LANL workers provides the most direct evidence about possible relationships between a health problem and workplace exposures at LANL.

- In studies performed to date, no reported evidence of increased rates of prostate cancer in LANL employees.

Studies of Other Nuclear Workers in the United States

The next most relevant evidence comes from studies of workers in similar occupations with the same types of exposures. Listed below are studies that looked at prostate cancer and workplace exposures among nuclear workers in other parts of the United States.

- **Fernald, Ohio:** A possible increase in prostate cancer deaths was found in a study of 4,014 males who were employed between 1951 and 1989, and then followed through 1989.[1]

- **Lawrence Livermore, California:** A possible increased incidence of prostate cancer was seen in men employed between 1969 and 1980.[22]

- **Mallinckrodt, St. Louis, Missouri:** A possible increase in prostate cancer deaths was found in a study of 2,514 males employed in uranium processing between 1942 and 1966, followed-up through 1993. [2]

- **Oak Ridge, Tennessee:** A possible increase in prostate cancer deaths was found in a study of 8,375 males who were employed for at least 30 days between 1943 and 1972, and then followed through 1977. [50] Similar findings in 3,763 workers who were monitored for internal contamination, followed through 1984. [57]

- **Oak Ridge Y-12, Tennessee:** A possible increase in prostate cancer deaths was seen in a study of 7,043 males employed between 1947 and 1990, and then followed through 1990. [24]

- **Rocky Flats, Colorado:** A possible increase in prostate cancer deaths was found in a study of 5,413 males who were employed for at least two years between 1952 and 1979, and then followed through 1979. [28]

- **Savannah River Site, South Carolina:** A possible increase in prostate cancer deaths was seen among salaried employees and in white males employed before 1955. [44]

Studies of Other Nuclear Workers Worldwide

Below are studies of nuclear workers outside of the United States that looked at prostate cancer in connection with radiation exposures.

- **Atomic Energy of Canada:** A possible increase in prostate cancer deaths was found in a study of 8,977 men who were employed between 1956 and 1985. [46]

- **Atomic Weapons Establishment of the U.K.:** An increase in prostate cancer deaths was found in a study of 9,389 workers who were monitored for radiation while employed between 1951 and 1982, and then followed through 1982.[*] A possible increase in prostate cancer deaths was found in an analysis of the 3,742 workers who were monitored for internal radionuclides (This study assumed a 10 year latent period). [53]

- **Sellafield, England:** An increase in prostate cancer deaths was found in a study of radiation workers who were employed between 1947 and 1975, and then followed to 1992, when compared to non-radiation workers.[*] Also, an increase in deaths due to benign prostatic hyperplasia (BPH) was found in plutonium workers employed between 1947 and 1975, when compared to other radiation workers. [3*]

- **Atomic Energy Authority of the U.K.:** Risk of prostate cancer increased in men who were internally contaminated by tritium, chromium-51, iron-59, cobalt-60 or zinc-65.[*] Risk increased with length of time working in contaminated areas and increasing levels of contamination.[1 *+] A scientist commenting on this study pointed out that zinc-65 localizes in the prostate gland.[letters to BMJ re: Rooney #37, #44]

Studies of Other Ionizing Radiation Exposures

Studies among other groups of people who were not nuclear workers can also be significant as evidence of possible increases in prostate cancer among those who have been exposed to ionizing radiation. Most other research has been conducted of people exposed to atomic bombs.

- **Atomic Bomb Survivors:** In studies performed to date there is no reported evidence of increased rates of prostate cancer in A-bomb survivors.

Previous DOE Studies

Under the original 1990 memorandum of understanding NIOSH assumed responsibility for the management of a number of ongoing studies, then being conducted by four DOE contractors: Oak Ridge Associated Universities, which became the Oak Ridge Institute for Science and Education (ORISE); Los Alamos National Laboratory, Battelle Pacific Northwest Laboratory, and Hanford Environmental Health Foundation. Approximately 40 research efforts were itemized in the memorandum of understanding. Ten projects were performed by ORISE, five by Los Alamos National Laboratory, and five by Hanford Environmental Health Foundation and Battelle Pacific Northwest Laboratory were transferred for management by NIOSH. In most of these cases, the research efforts were well under way by the time of the implementation of the memorandum of understanding; therefore, NIOSH had minimal opportunity to provide scientific or technical input. NIOSH worked with these contractors to complete the studies summarized below:

I. OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION (ORISE)

The following studies were performed by investigators from the Center for Epidemiologic Research of ORISE, under the leadership of Donna Cragle, Ph.D. The analysis of the studies of two sites, X–10 and Y–12, were conducted by investigators from the University of North Carolina, as a subcontract to Oak Ridge Associated Universities.

Oak Ridge National Laboratory (X–10)

1. Manuscript: Wing S, Shy CM, Wood JL, Wolf S, Cragle DL, Frome EL [1991]. Mortality among workers at Oak Ridge National Laboratory. JAMA 265(11): 1397-1402.

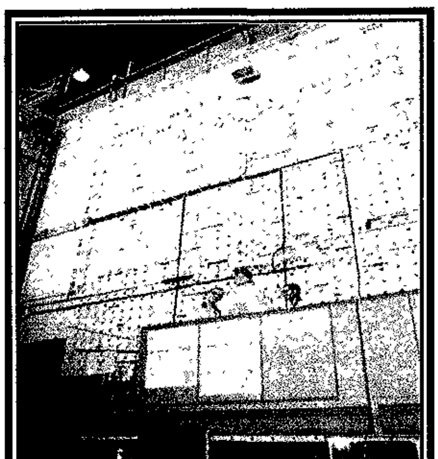
Summary: White males hired at the Oak Ridge National Laboratory between 1943 and 1972 were followed up for vital status through 1984 (N=8,318). Relatively low mortality compared with that in U.S. white males was observed for most causes of death. However, leukemia mortality was elevated in the total cohort (63% higher, 28 deaths) and in workers who had at some time been monitored for internal radionuclide contamination (123% higher, 16 deaths). External radiation with a 20-year exposure lag was related to all causes of death (2.68%, increase per 10 mSv), primarily due to an association with cancer mortality (4.94%, increase per 10 mSv).

investigation of followup status. Information about these workers was compared with consumer credit databases to determine the last date these workers were known to be alive. The results of this part of the study indicate that if these procedures had been applied to all workers with unknown vital status, about 90% of these workers would have been confirmed to be alive. About 5% of the total study population would have remained lost to followup.

Combined U.S. Cohorts (Hanford, Oak Ridge National Laboratory, Rocky Flats)

Manuscript: Gilbert ES, Cragle DL, Wiggs LD [1993]. Update analyses of combined mortality data on workers at the Hanford Site, Oak Ridge National Laboratory, and Rocky Flats Nuclear Weapons Plant. Radiation Res 136:408–421.

Summary: Combined analyses of mortality data for 44,943 workers from Hanford, Oak Ridge National Laboratory, (X–10), and Rocky Flats were undertaken to assess cancer risks associated with protracted low-dose exposure to ionizing radiation. Of 24 cancer sites evaluated, 12 showed positive correlations with radiation dose, and 12 showed negative correlations. Cancer of the esophagus, cancer of the larynx, and Hodgkin's disease showed statistically significant correlations with radiation dose, but these correlations were likely to have resulted from bias or chance fluctuations. Evidence of an increase in the excess relative risk with increasing age at risk was found for all cancer in both Hanford and Oak Ridge National Laboratory. Both populations showed significant correlations of all cancer with radiation dose among those 75 years and older. Although this age effect may have resulted from bias in the data, its presence suggests that summary risk estimates for nuclear workers be interpreted cautiously.



Oak Ridge Graphite Reactor, code-named "X-10," produced the world's first quantities of plutonium. *Oak Ridge Graphite Reactor Landmark, Oak Ridge National Laboratory, Tennessee. Date not provided. Photo courtesy of the U.S. Department of Energy.*

Table V: Parameter Estimates for the Main Effects Model for Mortality from Selected Cancer Causes of Death Among White Males (N = 67,197) Who Worked in Oak Ridge Between 1943 and 1984

Cause of Death (ICDA-8)	Observed Number	SMR	Facilities[a] X10	TEC	Y12	K25	MUL	LRT[b]	SES[c] (Monthly)	Length of Employment[c] (<1 Year)	Period Trend[d] (% per Year)
All Cancer	4,673	0.99	-18.9	-8 80	-6.0	-5.2	-4 2	6 5	-38 1 (6 2)[c]	16.3 (3.1)	0.58 (0.16)
Mouth and Pharynx (140-149)	117	0.80	-32 7	-29.7	-161.2	-28.4	-3.3	6.9	.	31.7 (19.4)	0.50 (0 99)
Digestive (150-159)	1,038	0.79	-17.8	-33 6	-31.7	-20.2	-36.4	5.2	-20.5 (12.1)	9.8 (6.5)	0.55 (0.32)
Esophagus (150)	93	0.83	-6.2	-30.9	-53.3	-3.3	-40.4	2.4	-97.9 (53.2)	26.6 (21.6)	-0.91 (1.08)
Stomach (151)	176	0.74	5.9	-23.9	-52.3	-22.0	-29.3	2.0	-88.2 (37.7)	-5 3 (15.9)	-0.22 (0.72)
Large Intestine (153)	344	0.80	-14 5	-38.0	-40 5	-19.1	-34 7	3.1	-0.7 (19.0)	2.3 (11.4)	1.01 (0.60)
Rectum (154)	78	0.55	-88.0	-74.0	-23.0	-50.8	-89 8	2.6	20 6 (40 4)	12.3 (23.7)	-0.96 (1.12)
Liver (155-156)	78	0.78	-108.6	-59.2	-39.0	-51.2	-58.0	1.8	63.2 (36 4)	47.4 (24 0)	1 46 (1.14)
Pancrease (157)	241	0.95	8.0	-21.4	-2.0	-14.5	-22.9	1.9	-51.6 (27.3)	22.2 (13.6)	0.92 (0.73)
Larynx (161)	62	0.88	-4.5	-82.7	6.3	-0 4	-52.4	8.6	-207.1 (99.6)	59.6 (27.0)	-0.18 (1.35)
Lung (162-163)	1,848	1.19	-34.8	10.5	15.4	9.4	13.1	21.6	-62.3 (11.1)	21 7 (4.9)	0.85 (0.28)
Bone (170)	25	1.22	-80.5	-4.5	.	45.6	3.0	5.3	7.6 (77.8)	11.3 (41.4)	-2.51 (1.94)
Skin (172-173)	80	0.96	-3.7	-0.3	-31.6	-18 6	22.0	2.1	-18.8 (39.0)	-35.0 (25.6)	2.80(1.29)
Prostate ([illegible])	319	1.01	[illegible]	8.8	[illegible]	[illegible]	[illegible]	2.6	-21.5 (22.7)	17.1 (11.8)	-0.08 (0.67)
Testes (186-187)	18	0.75	-10.3	22.0	.	3.9	-105.0	5.4	-74.8 (110.2)	-32.1 (49.0)	-0.46 (2.20)
Bladder ([illegible])	105	0.76	-108.0	-9.0	-56.7	-47.0	[illegible]	6.6	-21.5 (44.0)	9.9 (20.6)	-0.07 (1.05)
Kidney (189)	109	0.92	-41.7	-23.0	17 8	-21.3	-20.0	1.8	34.5 (31.3)	7.6 (20.6)	1.007 (1.08)
Brain, CNS (191-192)	51	1.10	15.4	-16.3	55.8	13.3	4.2	6.1	-43 9 (32.7)	20 2 (17.3)	-1.61 (0.79)
All Lymphatic (200-209)	418	0.93	9.7	4.2	-4.2	-3.6	0.6	0.8	4.4 (16.9)	-19.3 (10.6)	-0.52 (0.50)
Lympho/Reticulosarcoma (200)	82	0 92	-23.7	-14.8	50.3	20.1	-12.9	3.5	43.4 (33.6)	-35.0 (24.4)	1.15 (1.27)
Hodgkin's Disease (201)	39	0.77	-13.4	-5.5	-32.9	-28.9	-57.1	1.0	34 6 (51 1)	-22.2 (34 6)	0 04 (1.59)
Leukemia (204-207)	180	0.99	61.7	4.8	-64.5	0.7	13.3	10.7	-39.7 (27.9)	-10.1 (15.9)	-0 46 (0.74)
Other Lymphatic (202, 203, 208)	105	0.84	-92.8	8 2	71.9	-15.4	7.9	12.3	23.0 (34.3)	-27.0 (22.2)	-1.48 (1.16)

[a] The "facility" factor is used as the reference category so that the first five parameter estimates (column 4-8) are the natural logarithms of the SMRs in logarithmic percent (L%) units at the reference level of SES and length of employment at the midpoint (1965) of period of follow-up.

[b] LRT statistic is chi-square (with 4 degrees of freedom) for the null hypothesis of no difference in the facility effects adjusted for SES, length of employment, and period trend (values that exceed 9.49 are significant at .05 level)

[c] The reference category for SES is the non-monthly (vs. monthly) workers, and the reference level for length of employment is greater than one year. The parameter estimates for SES, and length of employment are log relative risks in L% units. These estimates can be compared with the null value zero using the SEs given in parentheses, or converted into estimates of relative risk

[d] The period trend describes the change in the SMR (percent per year) over the forty years of follow-up.

EXECUTIVE SUMMARY

Purpose We report the results and analysis of a one year needs assessment study evaluating whether a medical monitoring and risk communication program is justified for former and current workers at the Y-12 and Oak Ridge National Laboratory (ORNL).

Methods To complete this study, we used available exposure assessment data from paper records and electronic databases and reviewed all studies that have been completed at the plants. We also gathered "expert" former and current workers to conduct risk mapping sessions and focus groups to obtain in-depth information about the plants. We collected and analyzed responses to a questionnaire that was sent to a stratified random sample of 500 former Y-12 and ORNL workers. We obtained employee rosters and basic employment data, to the extent available, from the contractors and other institutions.

Findings Former and current Y-12 and ORNL workers have had significant exposure to pulmonary toxins (nickel, asbestos, beryllium, and acids), carcinogens (external and internal radiation, asbestos, beryllium, and cadmium), renal toxins (chlorinated solvents and lead), neurotoxins (mercury, solvents and lead), hepatotoxins (carbon tetrachloride and other solvents) and noise. Epidemiologic studies at Y-12 and ORNL show excess rates of selected diseases, including cancer and selected neurologic effects. Workers are concerned about the effects of previous exposures on their health and are very interested in a medical screening and education program. Former workers have good access to health care and engage in periodic health examinations. However, most do not believe that their primary care providers know much about the exposures that they had at Y-12 and ORNL. The focus groups and questionnaire responses also provided useful guidance about how to establish effective risk communication and medical surveillance programs.

The target population for a medical screening program among former and current Y-12 and ORNL workers is conservatively estimated to range from 12,000 to 20,000. This range requires refinement, but the roster with names and addresses that would allow initiation of screening is currently available.

Conclusion The findings of this needs assessment study support a targeted medical and cancer surveillance and education program. This conclusion is based on 1) the evidence that large numbers of workers have had significant exposures to detrimental agents, 2) the demonstration among Y-12 and ORNL workers of excess risk of cancer, selected neurologic effects and beryllium-related outcomes in epidemiologic studies, and 3) the need and desire expressed by former and current workers for a credible targeted program of medical surveillance and education. A health protection and risk communication program should center on workers at risk for 1) cancer, 2) chronic respiratory disease, including chronic obstructive lung disease and the pneumoconioses, 3) kidney, liver and neurologic disease, and 4) hearing loss. These conditions are amenable to early intervention, amelioration, and/or primary prevention. A risk communication delivered by a credible source will reduce uncertainty and distrust. After participation in the proposed screening program, former and current Y-12 and ORNL workers will have increased real knowledge about their personal health status, what is known about their risks, and how they can promote their own health. We believe that mounting such a program in Phase II will make a tangible contribution to the health of former and current Y-12 and ORNL workers.

Bibliographic Citation

Document	**For copies of Journal Articles**, please contact the Publisher or your local public or university library and refer to the information in the Resource Relation field. **For copies of other documents**, please see the Availability, Publisher, Research Organization, Resource Relation and/or Author (affiliation information) fields and/or Document Availability.
Title	Advances in dose reconstruction at Oak Ridge
Creator/Author	Hoffman, F.O. [SENES Oak Ridge, Inc., TN (United States)] ; Widner, T.E. [ChemRisk/McLaren Hart Environmental Services, Inc., Alameda, CA (United States)]
Publication Date	1996 Jun 01
OSTI Identifier	OSTI ID: 393995
Report Number(s)	CONF-9607135--
Other Number(s)	Journal ID: HLTPAO; ISSN 0017-9078; TRN: TRN: 96:005375-0084
Resource Type	Journal Article
Resource Relation	Journal Name: Health Physics; Journal Volume: 70; Journal Issue: Suppl.6; Conference: 41. Annual Meeting of the Health Physics Society, Seattle, WA (United States), 21-25 Jul 1996; Other Information: PBD: Jun 1996
Subject	56 BIOLOGY AND MEDICINE, APPLIED STUDIES ;05 NUCLEAR FUELS ;99 MATHEMATICS, COMPUTERS, INFORMATION SCIENCE, MANAGEMENT, LAW, MISCELLANEOUS; RADIOACTIVE EFFLUENTS; EMISSION; MERCURY; MAN; RADIATION DOSES; ENVIRONMENT; CONTAMINATION; POLYCHLORINATED BIPHENYLS; URANIUM; HISTORICAL ASPECTS; CLINCH RIVER; OAK RIDGE RESERVATION; PROBABILITY; DATA COMPILATION; NEOPLASMS; MONTE CARLO METHOD
Description/Abstract	The Oak Ridge Dose Reconstruction has seven tasks: (1) releases of radionuclides from X-10 radiolanthanum processing, (2) atmospheric and aquatic discharges of mercury from Y-12, (3) releases of PCB`s from all facilities, (4) aquatic releases of radionuclides from X-10 into the Clinch River, (5) a systematic search for classified and unclassified records of past releases (6) releases of uranium from all facilities, and (7) screening of contaminants and release events not previously evaluated in the study. The contaminants, exposure pathways, and release events requiring the most intensive analysis are identified first through screening level calculations and then through an iterative assessment approach based on a preliminary uncertainty analysis of more realistic sets of models and assumptions. Subjective probability distributions are developed for uncertain model components, reflecting the present state of knowledge about true but unknown values, and these uncertainties are propagated through to estimates of dose and health risk using Monte Carlo simulation. This procedure is effective in identifying the components of the dose reconstruction model of dominant importance. Efforts are focused on the review and improvement of the set of preliminary assumptions that may significantly impact the overall uncertainty in the final result. The results of the screening calculations and the preliminary uncertainty analysis are compared against established decision criteria to identify the need for resource re-allocation among tasks. To date, a 10{sup -4} life-time incidence of cancer incidence and a hazard index of one have been proposed as a decision criterion. Decisions about reallocation of resources among Tasks will be made by the Oak Ridge Health Agreement Steering Panel and the Tennessee Department of Health, which actively seek public involvement and participation.
Country of Publication	United States
Language	English
Format	Medium: X; Size: pp. 51-52
System Entry Date	2009 Dec 16

(8) CEL A Cancer Effect Level (CEL) is the lowest exposure level associated with the onset of carcinogenesis in experimental or epidemiologic studies. CELs are always considered serious effects.

(9) Chemical Form The nuclide, the chemical form (chloride, oxide, etc.) and the type of emission (alpha or beta particle and gamma ray) is indicated in this column.

(10) Reference The complete reference citation is given in chapter 10 of the profile.