



ORAU TEAM Dose Reconstruction Project for NIOSH

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ACRONYMS AND ABBREVIATIONS

ANL-W Argonne National Laboratory–West

CFA Central Facilities Area

DOE U.S. Department of Energy

EEOICPA Energy Employees Occupational Illness Compensation Program Act of 2000

INL Idaho National Laboratory

MDA minimum detectable activity

NIOSH National Institute for Occupational Safety and Health

POC probability of causation

TBD technical basis document

U.S.C. United States Code

§ section or sections

1.0 INTRODUCTION

Technical basis documents and site profile documents are not official determinations made by the National Institute for Occupational Safety and Health (NIOSH) but are rather general working documents that provide historic background information and guidance to assist in the preparation of dose reconstructions for particular sites or categories of sites. They will be revised in the event additional relevant information is obtained about the affected site(s). These documents may be used to assist NIOSH staff in the completion of the individual work required for each dose reconstruction.

In this document the word “facility” is used as a general term for an area, building, or group of buildings that served a specific purpose at a site. It does not necessarily connote an “atomic weapons employer facility” or a “Department of Energy [DOE] facility” as defined in the Energy Employees Occupational Illness Compensation Program Act [EEOICPA; 42 U.S.C. § 7384l(5) and (12)]. EEOICPA defines a DOE facility as “any building, structure, or premise, including the grounds upon which such building, structure, or premise is located ... in which operations are, or have been, conducted by, or on behalf of, the Department of Energy (except for buildings, structures, premises, grounds, or operations ... pertaining to the Naval Nuclear Propulsion Program)” [42 U.S.C. § 7384l(12)]. Accordingly, except for the exclusion for the Naval Nuclear Propulsion Program noted above, any facility that performs or performed DOE operations of any nature whatsoever is a DOE facility encompassed by EEOICPA.

For employees of DOE or its contractors with cancer, the DOE facility definition only determines eligibility for a dose reconstruction, which is a prerequisite to a compensation decision (except for members of the Special Exposure Cohort). The compensation decision for cancer claimants is based on a section of the statute entitled “Exposure in the Performance of Duty.” That provision [42 U.S.C. § 7384n(b)] says that an individual with cancer “shall be determined to have sustained that cancer in the performance of duty for purposes of the compensation program if, and only if, the cancer ... was at least as likely as not related to employment at the facility [where the employee worked], as determined in accordance with the POC [probability of causation¹] guidelines established under subsection (c) ...” [42 U.S.C. § 7384n(b)]. Neither the statute nor the probability of causation guidelines (nor the dose reconstruction regulation) define “performance of duty” for DOE employees with a covered cancer or restrict the “duty” to nuclear weapons work.

As noted above, the statute includes a definition of a DOE facility that excludes “buildings, structures, premises, grounds, or operations covered by Executive Order No. 12344, dated February 1, 1982 (42 U.S.C. 7158 note), pertaining to the Naval Nuclear Propulsion Program” [42 U.S.C. § 7384l(12)]. While this definition contains an exclusion with respect to the Naval Nuclear Propulsion Program, the section of EEOICPA that deals with the compensation decision for covered employees with cancer [i.e., 42 U.S.C. § 7384n(b), entitled “Exposure in the Performance of Duty”] does not contain such an exclusion. Therefore, the statute requires NIOSH to include all occupationally derived radiation exposures at covered facilities in its dose reconstructions for employees at DOE facilities, including radiation exposures related to the Naval Nuclear Propulsion Program. As a result, all internal and external dosimetry monitoring results are considered valid for use in dose reconstruction. No efforts are made to determine the eligibility of any fraction of total measured exposure for inclusion in dose reconstruction. NIOSH, however, does not consider the following exposures to be occupationally derived:

- Radiation from naturally occurring radon present in conventional structures
- Radiation from diagnostic X-rays received in the treatment of work-related injuries

¹ The U.S. Department of Labor is ultimately responsible under the EEOICPA for determining the POC.

This Site Profile documents historical practices at the Argonne National Laboratory–West (ANL-W) and provides information for the evaluation of both internal and external dosimetry data for unmonitored and monitored workers; the document can serve as a supplement to, or substitute for, individual monitoring data. This document provides a profile of ANL-W that contains technical basis information for the evaluation of the total occupational radiation dose for EEOICPA claimants.

1.1 PURPOSE

This Site Profile provides supporting technical data for the evaluation, with favorable to claimant assumptions, of the total radiation dose that can reasonably be associated with a worker's ANL-W occupational radiation exposure. This dose results from exposure to external and internal radiation sources in ANL-W facilities, from ANL-W occupationally required diagnostic X-ray examinations, and from exposure to onsite environmental releases. The discussions include doses that could have occurred while the worker was not monitored or that dosimetry programs could have missed. Since ANL-W began operations, the development of newer and more reliable scientific methods and protection measures has led to changes in radiation detection ability and recording practices. This Site Profile provides the methods to account for these changes.

The doses are evaluated using the NIOSH Interactive RadioEpidemiological Program and the Integrated Modules for Bioassay Analysis program. This document describes the uncertainty evaluation for ANL-W exposure and dose records, which is an integral component of the NIOSH approach to dose reconstruction.

1.2 SCOPE

The Site Profile consists of the latest revisions of this Introduction and five major technical basis documents (TBDs): Site Description, Occupational Medical Dose, Occupational Environmental Dose, Occupational Internal Dose, and Occupational External Dosimetry.

Site Description

The Site Description TBD (ORAUT 2004a) briefly describes the facilities and processes at ANL-W since the early 1950s. The ANL-W site is a part of the Idaho National Laboratory (INL) site. INL is about 50 miles west of Idaho Falls, Idaho, in the Arco desert and covers about 890 square miles. ANL-W developed and operated reactors at two locations: One south of the INL Central Facilities Area (CFA) and one presently at the east edge of the site. The present site is about 35 miles west of Idaho Falls and covers about 900 acres. The Site Description TBD provides information about the facilities at ANL-W and identifies unusual events.

Occupational Medical Dose

The Occupational Medical Dose TBD (ORAUT 2005b) provides information about the dose that individual workers received from X-rays required as a condition of employment. These X-rays included preemployment and chest X-rays during periodic physical exams. The frequency of required X-rays varied over time and as a function of worker age. Both the X-ray equipment and the techniques for taking X-rays have changed over the years covered by this TBD. These factors have been taken into account in determining the dose that a worker would have received from the X-ray. When there was a doubt about the technique used, favorable to claimant assumptions have been made to ensure that the dose is not underestimated. Important parameters include the tube current and voltage, exposure time, source-to-skin distance, and the view (posterior–anterior or lateral). This TBD provides the calculated doses to other exposed organs from the chest X-ray. The calculated dose accounts for the uncertainty associated with each of the parameters. Tables list the various organ doses for convenient reference by the dose reconstructors.

Occupational Environmental Dose

The Occupational Environmental Dose TBD (ORAUT 2004b) discusses the maximum dose to the whole body and organs that workers could have received when working outside the buildings at the ANL-W. This dose could be the result of inhalation of radioactive materials in the atmosphere, direct radiation from effluent plumes, and direct exposure to radionuclides that could have become incorporated into the soil.

The radionuclide concentrations at the ANL-W areas are based principally on measurements of stack effluents coupled with ground-level maximum annual average air concentrations from the National Oceanic and Atmospheric Administration. A screening process using dose conversion factors from the International Commission on Radiological Protection demonstrates that, of the 56 radionuclides on the annual effluent list, nine radionuclides (^{144}Ce , ^{131}I , ^{147}Pm , ^{238}Pu , $^{239/240}\text{Pu}$, ^{106}Ru , ^{89}Sr , ^{90}Sr , and ^{91}Y) contribute about 95% of the total internal dose. This TBD provides calculated annual intakes of these radionuclides based on standard breathing rates and exposure times.

Measurement of direct gamma values at the ANL-W facility fence provides annual external whole-body dose to workers from ambient radiation and from submersion in the annual radioactive material concentration.

Occupational Internal Dose

The Occupational Internal Dose TBD (ORAUT 2005a) discusses the internal dosimetry program at ANL-W.

This TBD contains a comprehensive default table to guide internal dose reconstruction in cases with minimal data. In addition, the TBD discusses the *in vivo* and *in vitro* minimum detectable activities (MDAs), the analytical methods, and the reporting protocols for the radionuclides at ANL-W. These parameters varied somewhat over the years for each of the radionuclides, but the capabilities were relatively consistent through the history of the site. The primary radionuclides of concern are those associated with spent high-enriched fuels: Mixed fission products, mixed activation products, plutonium (with a predominance of ^{238}Pu), americium, and uranium (both high-enriched and depleted).

This TBD describes information for reconstruction for workers with no confirmed intakes but who could have been exposed, in the early days, in circumstances in which monitoring did not occur, or for monitored readings below the detection limits. The document discusses methods for the evaluation of these potential doses and provides additional data for the evaluation of the worst-case scenario and for unmonitored workers.

Occupational External Dosimetry

The Occupational External Dosimetry TBD (ORAUT 2004c) discusses the program for measuring skin and whole-body doses to the workers. This document describes the dose reconstruction parameters, practices, and policies, and the dosimeter types and technology for measuring the dose from the different types of radiation. Discussion includes evaluation of doses measured from exposure to beta, gamma, and neutron radiation. Tables provide test results for various dosimeters exposed to different exposure geometries, radiation types, and energies. This TBD provides detailed discussion of sources of bias, workplace radiation field characteristics, responses of the different beta/gamma and neutron dosimeters in the workplace fields, and the adjustments to the recorded dose measured by these dosimeters during specific years.

This TBD discusses missed dose as a function of dosimeter type, year, and energy range. In addition, the document describes the use of the external dosimetry technical basis parameters to facilitate the efforts of the dose reconstructors.

1.3 ATTRIBUTIONS AND ANNOTATIONS

All information requiring identification was addressed via references integrated into the reference section of this document.

Norman Rohrig served as the initial Document Owner for this document. Mr. Rohrig was previously employed at INL, which shared boundaries with ANL-W and used the same dosimetry systems. His work involved management, direction, or implementation of radiation protection and/or health physics program policies, procedures, or practices in relation to atomic weapons activities at the site. This revision has been overseen by a new Document Owner, who is fully responsible for the content of this document, including all findings and conclusions. Mr. Rohrig continues to serve as a Site Expert for this document because he possesses or is aware of information relevant to reconstruction of radiation doses that were experienced by claimants who worked at the site. In all cases where such information or previous studies or writings are included or relied upon by the Document Owner, those materials are fully attributed to the source. Mr. Rohrig's Disclosure Statement is available at www.oraucoc.org.

REFERENCES

- ORAUT (Oak Ridge Associated Universities Team), 2004a, *Technical Basis Document for the Argonne National Laboratory - West – Site Description*, ORAUT-TKBS-0026-2, Rev. 00, Oak Ridge, Tennessee, September 9.
- ORAUT (Oak Ridge Associated Universities Team), 2004b, *Technical Basis Document for the Argonne National Laboratory - West – Occupational Environmental Dose*, ORAUT-TKBS-0026-4, Rev 00, Oak Ridge, Tennessee, September 30.
- ORAUT (Oak Ridge Associated Universities Team), 2004c, *Technical Basis Document for the Argonne National Laboratory - West – Occupational External Dosimetry*, ORAUT-TKBS-0026-6, Rev. 00, Oak Ridge, Tennessee, September 30.
- ORAUT (Oak Ridge Associated Universities Team), 2005a, *Technical Basis Document for the Argonne National Laboratory - West – Occupational Internal Dose*, ORAUT-TKBS-0026-5, Rev. 00, Oak Ridge, Tennessee, January 20.
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