



ORAU TEAM Dose Reconstruction Project for NIOSH

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<p>Subject Expert: Norman D. Rohrig</p>	
<p>Approval: <u>Signature on File</u> Approval Date: <u>11/29/2006</u> Daniel Mantooth, Document Owner</p>	
<p>Approval: <u>Signature on File</u> Approval Date: <u>11/29/2006</u> John M. Byrne, Task 3 Manager</p>	
<p>Concurrence: <u>Signature on File</u> Concurrence Date: <u>11/28/2006</u> Edward F. Maher, Task 5 Manager</p>	
<p>Concurrence: <u>Signature on File</u> Concurrence Date: <u>12/01/2006</u> Kate Kimpan, Project Director</p>	
<p>Approval: <u>Brant A. Ulsh Signature on File for</u> Approval Date: <u>12/13/2006</u> James W. Neton, Associate Director for Science</p>	

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PUBLICATION RECORD

EFFECTIVE DATE	REVISION NUMBER	DESCRIPTION
05/07/2004	00	New document for the INEEL Introduction. Incorporates responses to OCAS comments. First approved issue. Initiated by Norman D. Rohrig.
12/13/2006	01	Approved revision as a result of biennial review. Revised language in the Purpose section as required by NIOSH. Attribution and Annotation section added. Constitutes a total rewrite of document. Incorporates internal, NIOSH and DOL formal review comments. This revision results in no change to the assigned dose and no PER is required. Training required: As determined by the Task Manager. Initiated by Norman D. Rohrig.

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ACRONYMS AND ABBREVIATIONS

- CFA Central Facilities Area
- DOE U.S. Department of Energy
- EEOICPA Energy Employees Occupational Illness Compensation Program Act of 2000
- IMBA Integrated Modules for Bioassay Analysis (computer program)
- INL Idaho National Laboratory
- IREP Interactive RadioEpidemiological Program

- MDA minimum detectable activity
- mi mile

- NIOSH National Institute for Occupational Safety and Health

- POC probability of causation

- TAN Test Area North
- TBD technical basis document

- U.S.C. United States Code

- § Section or Sections

1 1.1 PURPOSE

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

8 In this document the word “facility” is used as a general term for an area, building, or group of
9 buildings that served a specific purpose at a site. It does not necessarily connote an “atomic weapons
10 employer facility” or a “Department of Energy [DOE] facility” as defined in the Energy Employees
11 Occupational Illness Compensation Program Act [EEOICPA; 42 U.S.C. § 7384l(5) and (12)].
12 EEOICPA defines a DOE facility as “any building, structure, or premise, including the grounds upon
13 which such building, structure, or premise is located ... in which operations are, or have been,
14 conducted by, or on behalf of, the Department of Energy (except for buildings, structures, premises,
15 grounds, or operations ... pertaining to the Naval Nuclear Propulsion Program)” [42 U.S.C. §
16 7384l(12)]. Accordingly, except for the exclusion for the Naval Nuclear Propulsion Program noted
17 above, any facility that performs or performed DOE operations of any nature whatsoever is a DOE
18 facility encompassed by EEOICPA.

19 For employees of DOE or its contractors with cancer, the DOE facility definition only determines
20 eligibility for a dose reconstruction, which is a prerequisite to a compensation decision (except for
21 members of the Special Exposure Cohort). The compensation decision for cancer claimants is based
22 on a section of the statute entitled “Exposure in the Performance of Duty.” That provision [42 U.S.C. §
23 7384n(b)] says that an individual with cancer “shall be determined to have sustained that cancer in the
24 performance of duty for purposes of the compensation program if, and only if, the cancer ... was at
25 least as likely as not related to employment at the facility [where the employee worked], as
26 determined in accordance with the POC [probability of causation¹] guidelines established under
27 subsection (c) ...” [42 U.S.C. § 7384n(b)]. Neither the statute nor the probability of causation
28 guidelines (nor the dose reconstruction regulation) define “performance of duty” for DOE employees
29 with a covered cancer or restrict the “duty” to nuclear weapons work.

30 As noted above, the statute includes a definition of a DOE facility that excludes “buildings, structures,
31 premises, grounds, or operations covered by Executive Order No. 12344, dated February 1, 1982
32 (42 U.S.C. 7158 note), pertaining to the Naval Nuclear Propulsion Program” [42 U.S.C. § 7384l(12)].
33 While this definition contains an exclusion with respect to the Naval Nuclear Propulsion Program, the
34 section of EEOICPA that deals with the compensation decision for covered employees with cancer
35 [i.e., 42 U.S.C. § 7384n(b), entitled “Exposure in the Performance of Duty”] does not contain such an
36 exclusion. Therefore, the statute requires NIOSH to include all occupationally derived radiation
37 exposures at covered facilities in its dose reconstructions for employees at DOE facilities, including
38 radiation exposures related to the Naval Nuclear Propulsion Program. As a result, all internal and
39 external dosimetry monitoring results are considered valid for use in dose reconstruction. No efforts
40 are made to determine the eligibility of any fraction of total measured exposure for inclusion in dose
41 reconstruction. NIOSH, however, does not consider the following exposures to be occupationally
42 derived:

- 43 • Radiation from naturally occurring radon present in conventional structures
- 44 • 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.

1 This Site Profile documents historical practices at the Idaho National Laboratory (INL) site and can be
2 used to evaluate internal and external dosimetry data for unmonitored and monitored workers and
3 serve as a supplement to individual monitoring data. This document provides a site profile of the INL
4 that contains technical basis information to be used to evaluate the total occupational radiation dose
5 for EEOICPA claimants.

6 This Site Profile can be a tool when performing dose reconstructions for INL workers. The Integrated
7 Modules for BioAssay Analysis (IMBA) computer code is a tool useful for internal dose calculations.
8 Information on measurement uncertainties is an integral component of the NIOSH approach. This
9 document describes how to evaluate uncertainty associated with INL exposure and dosimetry
10 records.

11 **1.2 SCOPE**

12 The Site Profile consists of six TBDs: This Introduction, Site Description, Occupational Medical Dose,
13 Occupational Environmental Dose, Occupational Internal Dose, and Occupational External Dosimetry.

14 **Site Description**

15 The Site Description TBD (ORAUT 2005) briefly describes the facilities and processes at INL since
16 the early 1950s. The INL site, located about 50 mi west of Idaho Falls in the Arco desert, covers
17 about 890 mi². Many additional offices and a few laboratories are in Idaho Falls, Idaho. Previous
18 names for the INL site were the National Reactor Testing Station (1949-1974), the Idaho National
19 Engineering Laboratory (1974-1997), and the Idaho National Engineering and Environmental
20 Laboratory (1997-2005).

21 The Central Facilities Area (CFA), formerly a Navy gunnery testing facility, now provides support
22 facilities, central services, and laboratories. Radioactive wastes from the site and from the Rocky
23 Flats Environmental Testing Station are handled and stored at the Radioactive Waste Management
24 Complex. Argonne National Laboratory-West developed and operated reactors at two locations:
25 1) south of CFA and 2) at the east edge of the site. High-enrichment uranium spent fuel was
26 reprocessed at the Idaho Chemical Processing Plant, and the resultant high-level waste was
27 processed there. The Test Reactor Area supported three large research reactors, several smaller
28 reactors, and several laboratories. Test Area North (TAN) was home to the Aircraft Nuclear
29 Propulsion Program. The Loss of Fluid Test program was later conducted there. Armor for the
30 U.S. Army is constructed at the Specific Manufacturing Capability facility at TAN. Reactor safety tests
31 were conducted at the Special Power Excursion Reactor Test facilities. The Army Reactor Area was
32 used to test reactors and was the site of an accident at Stationary Low-Power Reactor No. 1 (Horan &
33 Gammill 1963).

34 The site description TBD provides information about the facilities and identifies unusual events that
35 took place at INL facilities.

36 **Occupational Medical Dose**

37 The Occupational Medical Dose TBD (ORAUT 2004a) provides information about the dose that
38 individual workers received from X-rays that were required as a condition of employment. These
39 X-rays included chest X-rays taken during preemployment and during periodic physical exams. The
40 frequency of required X-rays varied over time and as a function of the worker's age. Both the X-ray
41 equipment and the techniques used for taking chest X-rays covered by this TBD have changed over
42 the years. These factors have been taken into account in determining the dose that a worker would
43 have received from the X-ray. When there was a doubt about the technique used, assumptions that
44 are favorable to claimants have been made to ensure that the dose has not been underestimated.

1 Important parameters include the tube current and voltage, exposure time, source-to-skin distance,
2 and view (posterior-anterior or lateral). Doses to other exposed organs from the chest X-ray have
3 been calculated. The uncertainty associated with the calculated dose takes into account the
4 uncertainty associated with each of the parameters mentioned above (ORAUT 2004a). Tables list
5 doses received by organs in the body for convenient reference by dose reconstructors.

6 **Occupational Environmental Dose**

7 The Occupational Environmental Dose TBD (ORAUT 2004b) is the maximum dose to the whole body
8 and body organs that workers could have received when working outside buildings at a given location
9 on INL from inhalation of radioactive materials in the atmosphere, from direct radiation from effluent
10 plumes, and from direct exposure to radionuclides and radiation sources that might have become
11 incorporated in the soil.

12 The radionuclide concentrations at INL areas are based principally on measurements of stack
13 effluents coupled with ground-level maximum annual average air concentrations provided by the
14 National Oceanic and Atmospheric Administration. Of the 56 radionuclides assigned to the annual
15 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) have been
16 demonstrated to contribute about 95% of the total internal dose by a screening process using dose
17 conversion factors from the International Commission on Radiological Protection (ORAUT 2004b).
18 Annual intakes of these radionuclides were calculated with standard breathing rates and exposure
19 times.

20 Annual external whole-body dose to workers from ambient radiation and from submersion in the
21 annual radioactive material concentration is provided by the measurement of direct gamma values at
22 the INL facility fences (ORAUT 2004b).

23 **Occupational Internal Dose**

24 The Occupational Internal Dose TBD (ORAUT 2006a) discusses the internal dosimetry program at
25 INL.

26 This TBD contains a comprehensive default table to guide internal dose reconstruction in cases with
27 minimal data. In addition, the TBD discusses *in vitro* minimum detectable activities (MDAs), analytical
28 methods, and reporting protocols for radionuclides at INL. As expected, these parameters varied
29 somewhat over the years for each of the radionuclides evaluated, although the capabilities were
30 relatively consistent through the history of the site. The primary radionuclides of concern are those
31 associated with spent high-enriched fuels – mixed fission products (from a variety of reactor types),
32 mixed activation products, plutonium (with a predominance of ^{238}Pu), americium, and uranium (high-
33 enriched and depleted) (ORAUT 2006a). This TBD discusses *in vivo* MDAs, analytical methods, and
34 reporting protocols for X- and gamma-ray emitting radionuclides.

35 This TBD presents information for workers who could have been exposed in the early days but had no
36 confirmed intakes. This could have occurred under circumstances in which monitoring programs were
37 not required, or when the monitored readings were below detection limits. The document discusses
38 methods for evaluating potential doses that fall in this category and provides additional data for the
39 evaluation of the worst-case scenario and for unmonitored workers.

40 **Occupational External Dosimetry**

41 The Occupational External Dosimetry TBD (ORAUT 2006b) discusses the program for measuring skin
42 and whole-body doses to workers. This document describes dose reconstruction parameters,
43 practices, and policies, and dosimeter types and technologies for measuring doses from different
44 types of radiation. Discussion includes evaluation of doses measured from exposure to beta, gamma,

1 and neutron radiation. Tables provide test results for various dosimeters exposed to different
2 exposure geometries, radiation types, and energies. Sources of bias, workplace radiation field
3 characteristics, responses of beta/gamma and neutron dosimeters in workplace fields, and
4 adjustments to the recorded dose measured by these dosimeters during specific years are discussed
5 in detail.

6 Missed dose is discussed as a function of dosimeter type, year, and energy range. In addition, the
7 document describes the use of external dosimetry technical basis parameters to facilitate the efforts of
8 dose reconstructors.

9 **1.3 ATTRIBUTIONS AND ANNOTATIONS**

10 None

11

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