Document Title: Lawrence Livermore National Laboratory - Introduction	Document Number: ORAUT-TKBS-0035-1 Revision: 00 Effective Date: 07/18/2005 Type of Document: TBD Supersedes: None

Subject Expert: Jay J. Maisler

Document Owner

Approval:	Signature on File Jay J. Maisler, TBD Team Leader	Approval Date:	06/23/2005
Approval:	Signature on File Judson L. Kenoyer, Task 3 Manager	Approval Date:	06/23/2005
Concurrence:	Signature on File Richard E. Toohey, Project Director	Concurrence Date:	06/23/2005
Approval:	Signature on File James W. Neton, Associate Director for Science	Approval Date:	07/18/2005

☒ New ☐ Total Rewrite ☐ Revision ☐ Page Change

DOCUMENTS MARKED AS A TOTAL REWRITE, REVISION, OR PAGE CHANGE REPLACE THE PRIOR REVISION. PLEASE DISCARD / DESTROY ALL COPIES OF THE PRIOR REVISION.

PUBLICATION RECORD

EFFECTIVE DATE	REVISION NUMBER	DESCRIPTION
06/02/2005	00-A	New technical basis document for the Lawrence Livermore National Laboratory – Site Profile. Initiated by Jay J. Maisler.
06/03/2005	00-B	Incorporates changes resulting from internal review comments. Initiated by Jay J. Maisler.
06/20/2005	00-C	Incorporates changes resulting for OCAS review comments. Initiated by Jay J. Maisler.
07/18/2005	00	First approved issue. No training required. Initiated by Jay J. Maisler.

TABLE OF CONTENTS

ACRONYMS AND ABBREVIATIONS

EEOICPA	Energy Employees Occupational Illness Compensation Program Act of 2000
IMBA	Integrated Modules for Bioassay Analysis
IREP	Interactive RadioEpidemiological Program
LLNL	Lawrence Livermore National Laboratory
NIOSH	National Institute for Occupational Safety and Health
TBD	Technical Basis Document
U.S.C.	United States Code

1.1 INTRODUCTION

Technical basis documents (TBDs) and Site Profile documents are general working documents that provide guidance concerning the preparation of dose reconstructions at particular sites or categories of sites. They will be revised when additional relevant information is obtained about the affected site(s). These documents may be used to assist the National Institute for Occupational Safety and Health (NIOSH) 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 facility" as defined in the Energy Employees Occupational Illness Compensation Program Act of 2000 (EEOICPA; 42 U.S.C. § 7384l (5) and (12)).

This Site Profile documents historical practices at the Lawrence Livermore National Laboratory (LLNL) and provides information for the evaluation of internal and external dosimetry data for unmonitored and monitored workers; it can serve as a supplement to, or substitute for, individual monitoring data.

1.2 PURPOSE

This Site Profile provides technical basis information to be used to evaluate the total occupational radiation dose that can reasonably be associated with a worker's radiation exposure at LLNL. This dose results from exposure to external and internal radiation sources in LLNL facilities, to occupationally required diagnostic X-ray examinations, and to onsite environmental releases. This Site Profile includes methods for estimating doses that may have occurred while an employee was not monitored or inadequately monitored, or were missed due to analytical detection limits or incomplete or missing monitoring records (i.e., missed dose). Over the years LLNL has implemented new and more reliable scientific methods and protection measures. This Site Profile identifies these methods and measures.

Dose reconstructors use the NIOSH Interactive RadioEpidemiological Program (IREP) and the Integrated Modules for Bioassay Analysis (IMBA) computer program to evaluate radiation doses. Information on measurement uncertainties is an integral component of the NIOSH approach. This Site Profile describes how to evaluate uncertainty associated with LLNL exposure and dosimetry records, which is an integral component of the NIOSH approach to dose reconstruction.

1.3 SCOPE

The Site Profile consists of this Introduction and five major TBDs: Site Description, Occupational Medical Dose, Occupational Environmental Dose, Occupational Internal Dose, and Occupational External Dose.

1.3.1 Site Description

The Site Description TBD (ORAU 2005a) describes major LLNL facilities and operations. LLNL was founded in 1952 on the site of a closed U.S. Naval Air Station. It was originally known as the University of California Radiation Laboratory at Livermore, and later as the Lawrence Radiation Laboratory at Livermore. LLNL consists of two sites, the main Laboratory site, which is a densely populated mile-and-a-half square area in Livermore, California, and the 11-square-mile Explosive Test Site near Tracy, California, which is known as Site 300.

In the beginning, the Laboratory's single mission dealt with thermonuclear weapons development. Over the years, the mission has expanded to include diverse scientific and engineering research activities, but has focused primarily on research, development, and testing of the nuclear weapons life cycle and related tasks.

1.3.2 Occupational Medical Dose

The Occupational Medical Dose TBD (ORAU 2005b) provides information about the dose individual workers received from X-rays required as a condition of employment. Beginning in 1952, Health Services Department clinicians at LLNL prescribed chest X-ray examinations. From 1952 until about 1993, baseline X-rays were required for all preemployment evaluations. Apart from the preemployment baseline posterior-anterior chest X-rays, LLNL apparently did not mandate routine examinations on a regular basis for employees. LLNL apparently introduced chest films for beryllium and asbestos workers in the 1980s with a frequency dependent on the age and exposure of the individual (Noonan 2002).

ORAU (2005b) develops claimant-favorable estimates of doses from occupational medical X-rays to the lungs and other organs of the body. These doses, determined for chest examinations during different periods, are based on the operating parameters of the machines and the conditions of exposure, insofar as these are known.

1.3.3 Occupational Environmental Dose

The Occupational Environmental Dose TBD (ORAU 2005c) applies to unmonitored workers, namely LLNL employees who did not wear external dosimetry or who were not monitored for internal exposures. At LLNL, everyone, including administrative personnel, wore some type of external radiation dosimetry beginning in March 1958 (Nolan 1958). To provide the basis for estimating the environmental dose for years when monitoring did not occur or was not sufficient to apply to coworkers, this TBD provides annual intakes and ambient external dose from 1952 (1955 for Site 300) to 2001 (the last year with publicly available data).

Inhalation of environmental radionuclides results in internal dose to the whole body or body organs. The TBD analysis determined the internal dose for workers outside the facilities from air concentrations resulting from releases from stacks and individual building releases. Unmonitored workers might have been exposed to occupational doses internally from onsite releases to the air.

The TBD preparers reviewed site environmental reports for data that would be useful in reconstructing ambient radiation levels. Ambient radiation dose rates include natural background radiation and sources at the facility.

1.3.4 Occupational Internal Dose

The Occupational Internal Dose TBD (ORAU 2005d) describes the internal dosimetry program at LLNL. Workers handled a variety of radionuclides as part of their routine tasks. The key elements in the source term are plutonium and tritium, although others were in use at various times and in various forms.

Prior to the early 1960s, the only methodology used to monitor LLNL employees for intakes of radionuclides was urine bioassay, with the primary focus on excreted tritium. It is not clear when bioassay monitoring first began, but it continues to the present for plutonium, americium, uranium, mixed fission products, a variety of tracer radionuclides, iodine, and tritium (Mansfield 2000). Air

monitoring in workplaces and in the breathing zones of employees has been a common surveillance method. However, LLNL apparently did not use the data acquired from the air monitoring program to prepare the dose of record for employees; these data are not readily associated with individual exposures.

In vivo methodologies began on an investigational basis in 1964, with capabilities focused on high-energy (i.e., greater-than-200-keV) gamma emitters. In the 1970s, LLNL attempted to detect low-energy photon emitters (i.e., 60-keV gammas from the decay of ^{241}Am and plutonium L-shell X-rays). To this day, LLNL can provide a broad spectrum of *in vivo* counting services with varying degrees of detectability (Mansfield 2000).

From at least the late 1980s (and possibly before), LLNL based the setting of action levels on the amount of radionuclide excreted or detected in the whole body (Mansfield 1989). Later, it based the assessment of intakes and even doses on *in vivo* and *in vitro* monitoring results, using computer programs developed in-house (Mansfield 2000). *In vivo* and *in vitro* analysis data records and associated interpretations from the 1960s appear to be retrievable.

A review of in-house procedures used to assess the concentration of radioactivity in urine indicates that quality control steps were an integral part of the process (LLNL 1979). For example, duplicates were consistently run, and comparisons of results to "known quantities" were a critical step. Therefore, dose reconstructors can consider the *in vitro* results from in-house processing generally reliable. However, interpretation of those results can be difficult, primarily because LLNL might not have taken the contribution of environmental radioactivity (i.e., uranium, thorium) into account and, because samples might have been collected at work (i.e., "in-field" tritium analyses, Monday morning urines), cross-contamination could be an issue.

1.3.5 Occupational External Dose

The Occupational External Dose TBD (ORAU 2005e) describes the program for measuring skin and whole-body doses to workers from sources that were external to the body. LLNL workers were exposed to radiation from a variety of radioactive materials and radiation-producing machines. In addition, many worked at the Nevada Test Site or were involved with other weapons tests from which they could have received radiation exposures. Personnel dosimeter records are generally available for all periods at LLNL for workers with the potential for occupational radiation exposure. The operations and radiation safety staff routinely reviewed dosimeter results for compliance with control limits and investigated doses approaching annual or quarterly dose limits. As noted above, beginning in March 1958 all individuals entering the site received external dosimetry devices (e.g., film badges or thermoluminescent dosimeters).

REFERENCES

LLNL (Lawrence Livermore National Laboratory), 1979, *Radiochemical Procedures for Bioassay*, Report No. M-104, Livermore, California.

Mansfield, W. G., 1989, *Health and Safety Manual - LLNL Internal Dosimetry Program Manual*, Supplement 33.10, Lawrence Livermore National Laboratory, Livermore, California.

Mansfield, W. G. and A. R. Wood-Zika, 2000, *Technical Basis Manual for Internal Dosimetry*, UCRL-MA-147534, Lawrence Livermore National Laboratory, Livermore, California.

Nolan, W. E., 1958, "Progress Report on Film Badge Program," memorandum to D. C. Sewell, November 13, 1958, Lawrence Livermore National Laboratory, Livermore, California.

Noonan, K., 2002, "NIOSH Request for Description of X-ray Protocols," cover memorandum, May 17, Lawrence Livermore National Laboratory, Livermore, California.

ORAU (Oak Ridge Associated Universities), 2005a, *Technical Basis Document for Lawrence Livermore National Laboratory – Site Description*, ORAUT-TKBS-0035-2, Oak Ridge, Tennessee.

ORAU (Oak Ridge Associated Universities), 2005b, *Technical Basis Document for Lawrence Livermore National Laboratory – Occupational Medical Dose*, ORAUT-TKBS-0035-3, Oak Ridge, Tennessee.

ORAU (Oak Ridge Associated Universities), 2005c, *Technical Basis Document for Lawrence Livermore National Laboratory – Occupational Environmental Dose*, ORAUT-TKBS-0035-4, Oak Ridge, Tennessee.

ORAU (Oak Ridge Associated Universities), 2005d, *Technical Basis Document for Lawrence Livermore National Laboratory – Occupational Internal Dose*, ORAUT-TKBS-0035-5, Oak Ridge, Tennessee.

ORAU (Oak Ridge Associated Universities), 2005e, Technical Basis Document for Lawrence Livermore National Laboratory – Occupational External Dose, ORAUT-TKBS-0035-6, Oak Ridge, Tennessee.