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PUBLICATION RECORD

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ACRONYMS AND ABBREVIATIONS

Ci	curie
DOE	U. S. Department of Energy
EEOICPA	Energy Employees Occupational Illness Compensation Program Act of 2000
LAMPF	Los Alamos Meson Physics Facility
LANL	Los Alamos National Laboratory
LASL	Los Alamos Scientific Laboratory
NIOSH	National Institute for Occupational Safety and Health
ORAU	Oak Ridge Associated Universities
OWR	Omega West Reactor
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 causation[1]] 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.

1.1 PURPOSE

This Site Profile describes the Los Alamos National Laboratory (LANL) site. Dose reconstructors can use the information in this Site Profile as a substitute for or supplement to worker exposure information to evaluate occupational radiation exposures.

This Site Profile consists of this Introduction and five technical basis documents (TBDs) with supporting tables and attachments. This Introduction provides a summary description of the five TBD sections: Site Description, Occupational Medical Dose, Occupational Environmental Dose, Occupational Internal Dose, and Occupational External Dosimetry.

1.2 SCOPE

The Site Description TBD (ORAUT 2004a) presents a brief description of the facilities and processes that have been used in the development of nuclear weapons since the early 1940s.

DOE owns LANL in northern New Mexico. From 1943 to 1981, the site was known as the Los Alamos Scientific Laboratory (LASL). The University of California has managed the laboratory since its establishment in 1943 as part of the Manhattan Project to create the first atomic weapons. LANL's responsibilities have expanded since then to include thermonuclear weapons design, high-explosives and ordnance development and testing, weapons safety, nuclear reactor research, waste disposal, waste incineration, chemistry, criticality experimentation, tritium handling, biophysics, and radiobiology.

From time to time, Los Alamos also performed special functions in its backup role to Hanford and the Rocky Flats Plant. For example, because of an accident at the Hanford Plutonium Finishing Plant in 1984, plutonium was sent in oxide form to Los Alamos for conversion to metal. In addition, Los Alamos served in a backup role for limited periods after major fires in plutonium facilities at Rocky Flats in 1957 and 1969. Today, LANL is the only remaining U.S. pit production facility.

Operations at Los Alamos have taken place in land divisions called technical areas (TAs). The current convention for describing locations at LANL is TA 3 66, where 3 is the area number and 66 is the building number. For TA 3, buildings are identified by letters (for example, TA 3-29 Building 29). Some buildings in TA 3 are identified as SM 66 for South Mesa Site.

The original main technical area (TA-1) processed plutonium and uranium for the World War II devices. TA-1 continued to build and test nuclear weapons critical assemblies on a limited scale until the late 1950s. Other radionuclides that were handled on a smaller scale in comparison with plutonium and uranium included americium, polonium, lanthanum, and barium. Starting in 1946, TA-21 (also known as DP West and DP East), which was built over several years, became the primary plutonium and uranium processing facilities. In 1978, plutonium and uranium operations were moved to TA-55 and, during the next several years, the DP sites underwent decontamination and decommissioning. The Chemistry and Metallurgy Research at TA-3 processed primarily plutonium, uranium, and americium.

Omega Site (TA-2) was used for critical assembly experiments and was the site of the water boiler reactors, Plutonium Fast Reactor [also known as Clementine (1946 to 1950)], Omega West Reactor (1956 to 1992), and other reactors for critical experiments that were later moved to TA-18 in 1947. Early reactors, which were built to confirm critical masses for fissionable materials and to study properties of fission and the behavior of the resultant neutrons, were the forerunners of a variety of reactors that were designed, and in some cases built and operated, at Los Alamos. While some of these reactors served as sources of neutrons for various nuclear research or for materials testing, other designs related to potential applications in power generation and propulsion of nuclear rockets into deep space. Some of the first significant steps towards controlled nuclear fusion as a power source were taken at Los Alamos, and the plasma thermocouple program explored methods for direct conversion of fission energy to electricity for potential application in spacecraft.

The Los Alamos Neutron Source Center, formerly known as the Los Alamos Meson Physics Facility (LAMPF), at TA-53 is the largest accelerator at LANL. This unit became operational in 1972 and still operates today. It has been used for a variety of purposes including production of medical isotopes and weapons research. For some periods, radioactive airborne emissions have accounted for the largest boundary doses from all of LANL operations. For example, 117,000 Ci of air activation products were released to the environment from LAMPF in 1978 (LASL 1979). Principal radionuclides that were released to the air include ^{41}Ar, ^{11}C, ^{13}N, and ^{15}O.

The Occupational Medical Dose TBD (ORAUT 2004b) provides information about the dose that individual workers received from X-rays that were required as a condition of employment. These X-rays included preemployment and annual chest X-rays during annual physical examinations. The frequency of required X-rays varied over time and also 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, assumptions favorable to claimants have been made to ensure the dose has not been underestimated. The parameters that have been investigated include the tube current and voltage, exposure time, filtration, source-to-skin distance, the view (posterior-anterior or lateral), and any other factor that could affect the dose the worker received.

The doses to other exposed organs from the chest X-ray have also been calculated. The doses take into account the uncertainty that is associated with each of the parameters that is mentioned above. The doses that were received by the various organs in the body are presented in tables for convenient reference by the dose reconstructors.

The Occupational Environmental Dose TBD (ORAUT 2004c) applies to workers who were not monitored for external or internal radiation exposure. The environmental dose is the dose workers received when working outside the buildings on the site from inhalation of radioactive materials in the air, direct radiation from plumes (immersion dose from radioactivity in the air), contact with radioactive particles on the skin, and from direct exposure to radionuclides that were incorporated in the soil.

Exposure to these sources can result in an internal dose to the whole body or body organs from inhalation of the radioactive materials or could result in a whole- or partial-body external dose from deposited radionuclides or submersion in the cloud of radioactive material.

The radionuclide concentrations within the TAs at LANL are based on the source terms that were developed from air-monitoring stations and release estimates. Screening analyses in Section 4 of the LANL site profile have demonstrated that the radionuclides ^{3}H, ^{131}I, ^{41}Ar, ^{238}Pu, ^{239}Pu, ^{232}Th, ^{235}U, ^{238}U, and ^{90}Sr contributed the greatest dose to site workers. Other radionuclides that were evaluated included ^{241}Am ^{11}C, ^{13}N, ^{15}O, ^{137}Cs. The solubility of several of these radionuclides is discussed in Sections 2, 4, and 5 of LANL site profile documents (ORAUT 2004a, 2004d, 2004e).

Intakes of radionuclides by workers were assumed to occur near the air-monitoring stations from which sampling data were taken to estimate air concentrations. These data can be found in Section

4.2 tables (e.g., Tables 4-1 and 4-2). Source emissions, screening results, and air concentrations are presented in Attachments A, B, C, and D to this TBD along with source term data and submersion doses.

The external dose to workers from the ambient radiation levels on site and from submersion in a cloud of radioactive material are also presented along with the skin dose from the ^{41}Ar.

The Occupational Internal Dose TBD (ORAUT 2004d) discusses the internal dosimetry program at LANL. At first, there was no bioassay program to determine the internal dose workers could have received. Starting in 1944, blood tests were performed after potential exposures. However, these blood tests were performed for blood count levels in relation to external radiation exposure rather than the radioactive content of the blood. Therefore, records of blood counts that were performed on an individual or mentioned in claimant interviews are not directly applicable to internal dose calculations. Many of the exposure histories and work records are not specific about the assigned work areas of individuals. However, when information about the work location is available, assumptions favorable to claimants have been made to provide the dose reconstructors with the ability to determine worker dose in these early periods. Section 5.2 discusses *in vitro* methods for specific radionuclides. Excreta bioassay methods for determining internal exposures were developed in late 1944 for plutonium (fully implemented in April 1945) and polonium, in 1949 for uranium, and in 1950 for tritium. Only workers with a significant potential for exposure were monitored. Although the number of monitored individuals has increased, not all individuals who work at LANL are currently monitored. A survey in 1986 estimated that approximately 350 persons had known burdens of plutonium.

Air samples, identifiable with the individual records, were performed beginning in 1944. These data along with coworker data can be used to estimate doses for unmonitored workers as deemed appropriate by the dose reconstructors.

As the state of the art of radiation detection progressed, whole-body counting for fission products was begun in 1955, chest counting was begun in 1970, and wound counting was performed beginning before 1967. Section 5.3 discusses the historical and current *in vivo* bioassay methods.

The bioassay program was developed and constantly improved over the years as technology progressed. Electronic databases were developed to maintain urinalysis records. This is discussed along with the various codes LANL used to identify the specific analyses. Much of the older monitoring data that are needed for LANL claims are not in a format that is easily retrieved. NIOSH and Oak Ridge Associated Universities (ORAU) Team members are currently developing a new bioassay database for all *in vitro* and *in vivo* results that will allow access to a complete set of records for all available data for a given claimant. Detailed information is provided in the database to assist the dose reconstructors in interpreting data they might encounter in worker records.

This TBD discusses the *in vitro* minimum detectable activities, the analytical methods, and the reporting protocols for the radionuclides that have been encountered at LANL. These aspects of the bioassay program varied over the years for each of the evaluated radionuclides (i.e., plutonium, americium, tritium, uranium, polonium, and fission products). Details of the monitoring techniques and programs are presented in this TBD.

Discussions are provided that present information on the specific radionuclides to which workers in each of the various facilities could have been exposed. Information is provided for the periods when processes changed as a result of improvements in the processing systems.

Interferences that might have been encountered in the collection and analysis of bioassay samples are discussed, as are the uncertainties in the bioassay measurements. Information is presented for workers with no confirmed intakes but who may have been exposed in the early days when the detection capability and sampling techniques were poor or there were missed samples. Methods for evaluation of potential doses that might fall in this category are presented. Additional data are provided for the evaluation of the worst-case scenario and for unmonitored workers.

Many tables are provided in this TBD to aid the dose reconstructor in evaluation of the potential doses workers received under all circumstances.

The Occupational External Dose TBD (ORAUT 2007) discusses the program for measurement of skin and whole-body doses to the workers. The methods for evaluation of external doses to workers have also evolved over the years as new techniques and equipment have been developed. Concepts in radiation protection have also changed. The dose reconstruction parameters, LANL practices and policies, and dosimeter types and technologies for measuring the dose from the different types of radiation are discussed in this section. Attention is given to the evaluation of doses that were measured from exposure to beta, gamma, and neutron radiation. Test results are tabulated for various dosimeters that were exposed to different exposure geometries and radiation energies.

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 that has been measured by these dosimeters during specific years are discussed in detail.

There are sources of potential dose that could be missed because of the limitations of dosimetry systems and the methods of reporting low doses. This missed dose is discussed as a function of facility location, dosimeter type, year, and energy range. Attachment A to this TBD 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.

REFERENCES

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