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ACRONYMS AND ABBREVIATIONS

ANL-E	Argonne National Laboratory-East
CP	Chicago Pile
EEOICPA	Energy Employees Occupational Illness Compensation Program Act of 2000, as amended
GeV	giga electron volt, 1 billion electron volts
MDA	minimum detectable activity
NIOSH	National Institute for Occupational Safety and Health
TBD	technical basis document
U.S.C.	United States Code

1.1 PURPOSE

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 in the event 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 [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 [probability of causation] 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. §Section 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 radiation exposures 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 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.

This site profile documents the history of the Argonne National Laboratory-East (ANL-E) site in Illinois in relation to radiation dosimetry. This information may be used to evaluate both internal and external dosimetry data for unmonitored and monitored workers and serve as a supplement to, or substitute for, individual monitoring data. This site profile provides supporting technical data to evaluate the total occupational radiation dose that can reasonably be associated with a worker's radiation exposure at ANL-E. This dose could be the result of exposure to external and internal radiation sources inside

ANL-E facilities, to ANL-E occupationally required diagnostic X-ray examinations, and to environmental releases while the worker was on the site but outside of the facilities. The discussions include doses that could have occurred while the worker was not monitored or that could have been missed.

Over the years since ANL-E began operation, more reliable scientific methods and protection measures have been developed for radiation detection, monitoring, dosimetry, and protection systems. This site profile discusses the methods needed to account for these changes. The doses are to be evaluated using the NIOSH Interactive RadioEpidemiological Program and the Integrated Modules for Bioassay Analysis software. Information on measurement uncertainties is an integral component of the NIOSH approach, and this document describes the uncertainty evaluation for ANL-E exposure and dose records.

1.2 SCOPE

This site profile is comprised of this Introduction and five major sections individually published as TBDs: Site Description, Occupational Medical Dose, Occupational Environmental Dose, Occupational Internal Dose, and Occupational External Dosimetry.

Site Description
The Site Description TBD (ORAUT 2006a) briefly describes the facilities and processes at ANL-E since 1946. The ANL-E site is in DuPage County, Illinois, about 25 miles southwest of downtown Chicago, and it covers about 1,500 acres.

ANL-E has been operated by the University of Chicago since it was founded on July 1, 1946. The laboratory's predecessor was the University of Chicago Metallurgical Laboratory, which developed and operated the first nuclear reactor, the Chicago Pile 1 (CP-1) under the West Stands of Stagg Field. The reactor first operated on December 2, 1942. In 1943, CP-1 was relocated to Site A at the Palos Park Reserve just southeast of the present site (originally known as Site D), and CP-1 was renamed as CP-2. The Chicago area site became known as ANL–E after the National Reactor Testing Station where the ANL-West is located (now the Idaho National Laboratory) was established. ANL-West has since become part of the Idaho National Laboratory.

ANL-E was responsible for many initial reactor designs located at other sites and was home to CP-3, CP-5, the Experimental Boiling Water Reactor, Janus, and some training reactors. ANL-E participated in developing techniques for fuel fabrication and reprocessing. Fundamental research was conducted much like at a university, with buildings for biology, chemistry, physics, chemical engineering, etc. Several modest accelerators preceded operation of the Zero Gradient Synchrotron, which accelerated protons to 12.5 GeV for high-energy physics. Currently operating accelerators include the Intense Pulsed Neutron Source, Argonne Tandem Linear Accelerator System, and the Advanced Photon Source.

The Site Description TBD provides information about the facilities and identifies unusual events that took place at ANL-E.

Occupational Medical Dose
The Occupational Medical Dose TBD (ORAUT 2005) provides information about the dose that individual workers received from X-rays that were required as a condition of employment. These included pre-employment and periodic chest X-rays during physical examinations. The frequency of required X-rays varied over time and as a function of the worker's age. Both the X-ray equipment and the techniques used for taking X-rays have changed over the years, and this document accounts for

these changes in determining the dose that a worker could have received from an X-ray at a particular time with particular equipment and techniques. Where there was doubt about the technique used, assumptions have been made to ensure that the dose has not been underestimated. Important parameters include the tube current and voltage, exposure time, source to skin distance, and the view (posterior–anterior or lateral). The doses to other organs exposed by chest X-rays have also been calculated. The uncertainty on the calculated dose takes into account the uncertainty associated with each of the parameters mentioned above. Tables list the doses received by the various organs in the body for convenient reference by the dose reconstructors.

Occupational Environmental Dose

The Occupational Environmental Dose TBD (ORAUT 2006b) discusses the maximum dose to the whole body and organs that workers could have received when outside the buildings at ANL-E from inhalation of radioactive materials in the atmosphere, from direct radiation from effluent plumes, and from direct exposure to radionuclides that may have become incorporated into the soil.

The radionuclide concentrations at ANL-E site areas are based principally on measurements of stack effluents coupled with ground-level maximum annual average air concentrations. Annual intakes of these radionuclides were calculated with standard breathing rates and exposure times. Annual external whole-body dose to workers from ambient radiation and from submersion in the annual radioactive material concentration is provided by the measurement of direct gamma values at the ANL-E facility with TLDs since 1972. Measurements were at the site boundary and near facilities believed to impact dose at the site boundary.

Occupational Internal Dose

The Occupational Internal Dose TBD (ORAUT 2006c) discusses the internal dosimetry program at ANL-E. This document contains a comprehensive default table to guide internal dose reconstruction in cases with minimal data. In addition, the document discusses the *in vitro* minimum detectable activities (MDAs), the analytical methods, and the reporting protocols for the radionuclides at ANL-E. As expected, these parameters varied somewhat over the years for each of the radionuclides evaluated, although the capabilities were relatively consistent throughout the history of the site. The primary radionuclides of concern are those associated with spent high-enriched fuels: mixed fission products (from a variety of reactor types), mixed activation products, plutonium (with a predominance of ^{238}Pu), americium, and uranium (both high-enriched and depleted). This document also discusses the *in vivo* MDAs, the analytical methods, and the reporting protocols for the X-ray and gamma-emitting radionuclides.

In addition, this document presents information for workers with no confirmed intakes but who could have been exposed in the early days when monitoring programs were not required and for workers with monitored readings below the detection limits. The document discusses methods for evaluating potential doses that fall in these categories 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 2006d) 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 technologies for measuring dose from different types of radiation. The discussion includes an 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. There are detailed discussions 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.

Missed dose is discussed 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.

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