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☐ New ☒ Total Rewrite ☐ Revision ☐ Page Change

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

PUBLICATION RECORD

EFFECTIVE DATE	REVISION NUMBER	DESCRIPTION
06/28/2005	00	Technical basis document for the Weldon Spring Plant – Introduction. Incorporates internal review comments, responses to NIOSH comments, and an additional change per a NIOSH comment. First approved issue. Training is not required. Initiated by Robert Meyer.
06/30/2008	00 PC-1	Approved page change revision initiated to eliminate reference to a user's guide on page 10 in Section 1.2, which was never published due to a change in policy. Added an Attributions and Annotations Section on page 10, updated NIOSH required language on page 5 in Section 1.1, and ORAU team references on pages 8 and 11. Now uses term, "favorable to claimant" on pages 6, 9, and 10 in Sections 1.1 and 1.2. No sections were deleted. Incorporates formal internal review comments. No changes were needed as a result of NIOSH formal review. Training required: As determined by the Task Manager. Initiated by Melton H. Chew. Approval: Signature on File for 06/11/2008 Melton H. Chew, Document Owner Signature on File 06/11/2008 John M. Byrne, Task 3 Manager Signature on File 06/11/2008 Edward F. Maher, Task 5 Manager Signature on File 06/13/2008 Kate Kimpan, Project Director Signature on File 06/30/2008 James W. Neton, Associate Director for Science
05/24/2013	01	Revision implemented according to guidance from ORAUT-PROC-0031, Rev. 04. Section 1.1: Replaced introductory text with updated template language. Added Section 1.1.1, "Purpose," and changed heading from "Site Profile Description" to "Scope" for Section 1.1.2. Minor technical editing conducted for Section 1.2. Deleted repetitious details and results that appear in subsequent sections of the Site Profile from Sections 1.3 through 1.6. Updated the Acronyms and Abbreviations and the References sections. No sections were deleted. No changes occurred as a result of formal internal review. Incorporates formal NIOSH review comments. Constitutes a total rewrite of the document. Training required: As determined by the Objective Manager. Initiated by David P. Harrison.

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ACRONYMS AND ABBREVIATIONS

AEC	U.S. Atomic Energy Commission
CFR	Code of Federal Regulations
DOE	U.S. Department of Energy
DOL	U.S. Department of Labor
EEOICPA	Energy Employees Occupational Illness Compensation Program Act of 2000
NIOSH	National Institute for Occupational Safety and Health
ORAU	Oak Ridge Associated Universities
POC	probability of causation
TBD	technical basis document
U.S.C.	United States Code
WSCP	Weldon Spring Chemical Plant
WSP	Weldon Spring Plant
WSQ	Weldon Spring Quarry
WSRP	Weldon Spring Raffinate Pits
§	section or sections

1.1 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 historical background information and guidance to assist in 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 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, 42 C.F.R. Pt. 82) restrict the "performance of duty" referred to in 42 U S. C. § 7384n(b) to nuclear weapons work (NIOSH 2010).

The statute also 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 excludes Naval Nuclear Propulsion Facilities from being covered under the Act, 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 occupational radiation exposures are considered valid for inclusion in a 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 (NIOSH 2010):

- Background radiation, including radiation from naturally occurring radon present in conventional structures

[1] The U.S. Department of Labor (DOL) is ultimately responsible under the EEOICPA for determining the POC.

- Radiation from X-rays received in the diagnosis of injuries or illnesses or for therapeutic reasons

1.1.1 Purpose

The purpose of this TBD is to introduce the Weldon Spring Plant (WSP) Site Profile, which contains technical basis information for the evaluation of the total occupational dose for EEOICPA claimants who were employed at WSP.

1.1.2 Scope

The Site Profile consists of this Introduction and five major TBDs: Site Description, Occupational Medical Dose, Occupational Environmental Dose, Occupational Internal Dosimetry, and Occupational External Dosimetry. Some of these have attachments that provide critical data for dose reconstructors.

1.2 SITE DESCRIPTION

The WSP Site Description TBD (ORAUT 2013a) discusses facilities and processes that were used in the processing of uranium concentrates and other uranium compounds from 1957 through 1966. WSP operations played an important role in the development of U.S. nuclear weapons. These operations focused on processing uranium and thorium from feed stocks to metal and intermediate products for use at other facilities. This TBD contains documentation to assist in the evaluation of worker dose from WSP operations and processes.

Site History and Operations
In April 1941, the War Department acquired 17,232 acres surrounding what is now the Weldon Spring Chemical Plant (WSCP) as the site for an explosives production facility known as the Weldon Spring Ordnance Works. By 1949, the ordnance works had been shut down and all but about 2,000 acres had been transferred to the State of Missouri and the University of Missouri.

In 1956, approximately 220 acres of the former Ordnance Works were transferred to the U.S. Atomic Energy Commission (AEC) for construction and operation of a Feed Materials Plant (the WSCP) to process uranium and thorium ore concentrates; this plant operated from 1957 through 1966. This Site Profile refers to the raffinate pits that were originally part of the WSCP as the Weldon Spring Raffinate Pits (WSRP) because they were managed separately in the postoperational period. In 1958, a 9-acre quarry site was transferred to the AEC; this is referred to as the Weldon Spring Quarry (WSQ).

In August 1967, the WSCP was returned to U.S. Army control for construction of an herbicide production facility. However, the AEC retained custody of the WSQ and the WSRP. In 1985, DOE (an AEC successor agency) regained responsibility for the WSCP and began site characterization and remediation. The quarry was placed on the National Priorities List in 1987; the listing was expanded to include the chemical plant area and associated waste storage areas in 1989.

Before remediation, there were four periods of the WSP site and WSCP history:

1. Plant acquisition and development from 1954 to 1957,
2. Operations from 1957 to 1966,
3. Initial cleanup from 1967 to 1969, and
4. Maintenance from 1969 to 1985.

The periods of concern for this Site Profile are those during which DOE and its predecessor agencies (AEC until 1975 and the Energy Research and Development Administration until 1979) had

contractors at some or all of the WSP sites and facilities. These include the operations period (1957 through 1966) and the monitoring and remediation periods (1975 to present). The monitoring period, from 1975 through 1984, applies only to the WSRP and WSQ because DOE did not assume control of the WSCP until 1985. Part 2 of this Site Profile contains a more detailed description of these activities.

During its operation by the Uranium Division of Mallinckrodt Chemical Works from 1957 to 1966, the WSCP processed four types of nuclear material (DOE 1986, pp. 13–14):

- Natural uranium was received as ore concentrates that were refined to extract the uranium, which was converted to various compounds and metal forms and shipped off the site. The processing of natural uranium was a continuous operation during the life of the Plant.

- Uranium depleted in the ^{235}U isotope below its natural isotopic abundance ratio was received and processed on an intermittent basis. This form of uranium was used primarily in product development activities and flow sheet improvements. Its use was confined primarily to pilot plant activities.

- Uranium enriched to 1% or less ^{235}U by weight was received and processed on an intermittent basis. This form of uranium was typically received in scrap metal or residues. The uranium contents were recovered, processed to various chemical forms, and shipped off the site.

- Natural thorium was typically received in either a nitrate or oxide form and processed on an intermittent batch basis in the refinery and oxide production and firing systems.

1.3 OCCUPATIONAL MEDICAL DOSE

The WSP Occupational Medical Dose TBD (ORAUT 2013b) provides information about doses individual workers received from X-rays that were required as a condition of employment. Available information about the X-ray examination frequency, equipment, and techniques is provided in Part 3 of this Site Profile. The TBD provides calculated organ dose estimates from occupational X-ray examinations that were administered at WSP from 1955 through 1966 (pre-1970), 1970 to 1985, and after 1985 using default dose estimates from ORAUT-OTIB-0006, *Dose Reconstruction from Occupational Medical X-Ray Procedures* (ORAUT 2011). Doses to other exposed organs from chest X-ray examinations have been calculated. The calculated doses take into account the uncertainty associated with machine type, examination frequency, and job classification. The TBD presents doses to organs in the body in tabular form for more convenient reference by dose reconstructors.

1.4 OCCUPATIONAL ENVIRONMENTAL DOSE

The WSP Occupational Environmental Dose TBD (ORAUT 2013c) considers doses that workers received while on the site but outside buildings; these typically result from inhalation of or direct exposure to radioactive materials in the air and from direct exposure to radionuclides in the soil.

Part 4 of this Site Profile contains information necessary to estimate internal environmental dose and includes sections that discuss the radionuclides of concern, source terms (release rates) for radionuclides potentially significant to internal environmental dose, and available air (particulate radionuclides and radon) and external ambient monitoring data. These doses have been reported for the WSRP, WSCP, and WSQ areas in remedial investigations that supported the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) process and in site-wide annual reports, and as a result of other radiological surveys. Airborne particulate and radon concentration data, normalized concentrations of radionuclides in soil, and estimated site-wide maximum annual inhalation intakes and ambient onsite dose at WSP are provided.

1.5 OCCUPATIONAL INTERNAL DOSIMETRY

The WSP Occupational Internal Dosimetry TBD (ORAUT 2013d) discusses the internal dosimetry program and develops estimates of potential intakes in accordance with OCAS-IG-002, *Internal Dose Reconstruction Implementation Guideline* (NIOSH 2002). Internal radiation dose is the dose to a worker from deposition of radionuclides in the body. Such deposition can occur as a result of inhalation of radionuclides in airborne dust, incidental ingestion of radionuclides, and intake through intact skin or wounds.

Information on the source term for dosimetrically significant radionuclides at WSP, *in vitro* and *in vivo* measurements, air monitoring, and an assessment of radionuclide intakes are presented in Part 5 of this Site Profile. Details for solubility classification, absorption type, and particle size are also presented. Available WSP data include *in vitro* data for uranium and *in vivo* data for thorium. Descriptions of the routine and special sampling programs, reporting levels, minimal detectable activities, interferences and uncertainties, reporting formats and codes, and work group (cost center or job title) information are discussed. Extensive air monitoring was conducted during the operational period and summary results of a series of dust studies are presented in tables for use by the dose reconstructors. Intake data are presented in tabular form for all periods.

1.6 OCCUPATIONAL EXTERNAL DOSIMETRY

The WSP Occupational External Dosimetry TBD (ORAUT 2013e) describes methods and concepts for measuring occupational external dose to workers in accordance with OCAS-IG-001, *External Dose Reconstruction Implementation Guideline* (NIOSH 2007). This TBD provides technical data that dose reconstructors can use to evaluate, with favorable to claimant assumptions, external occupational doses that can reasonably be associated with worker radiation exposures.

Part 6 of this Site Profile provides an overview of external dosimetry, information to interpret external dosimetry records, and a review of site administrative practices for recorded beta (skin) and gamma (deep) doses. Available information for badge assignment and exchange frequencies for the WSP is presented. Data tables are provided for workplace radiation fields at WSP including average gamma and beta dose, default photon energy distribution for WSP materials, and energy distribution by WSP building or area. The minimal neutron exposure potential at WSP is addressed. Dose conversion factors, potential maximum annual missed dose, and minimum dosimeter detection limits are tabulated for both photons and electrons. Other topics include dose record discrepancy guidance and favorable to the claimant instructions for missing entries in the records. Details are presented for calibration practices, uncertainty for film and thermoluminescent dosimetry systems, guidance for zero readings, unmonitored energy ranges, and angular dependence.

1.7 ATTRIBUTIONS AND ANNOTATIONS

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

REFERENCES

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