EHSS

Office of Environment, Health, Safety and Security

U.S. Department of Energy

OCCUPATIONAL RADIATION EXPOSURE REPORT FOR CY 2021

This document is available on the U.S. Department of Energy
Radiation Exposure Monitoring System Program Web Site at:
https://energy.gov/ehss/occupational-radiation-exposure

U.S. Department of Energy
Occupational Radiation Exposure Report for Calendar Year 2021

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Prepared by:
Katharine McLellan
U.S. Department of Energy
Office of Environment, Health, Safety and Security (EHSS)

D.A. Hagemeyer
D.B. Holcomb
Oak Ridge Institute for Science and Education (ORISE)

Foreword

The *U.S. Department of Energy Occupational Radiation Exposure Report for Calendar Year 2021* presents the results of analyses of occupational radiation exposures at the Department of Energy (DOE), including the National Nuclear Security Administration (NNSA) operations, during calendar year 2021. This report includes occupational radiation exposure data for over 67,000 DOE Federal employees, contractors, and subcontractors as well as members of the public who have worked in or entered controlled areas monitored for exposure to radiation.

DOE publishes this annual report to provide DOE Management, Program Offices, workers, health physicists, and other stakeholders an evaluation of DOE-wide performance regarding compliance with Title 10 of the *Code of Federal Regulations* (CFR) Part 835, *Occupational Radiation Protection* (10 CFR 835) radiation exposure limits and adherence to as low as reasonably achievable principles.

This report provides a discussion regarding radiation protection and exposure reporting requirements as well as information and analyses regarding aggregate, individual, site, DOE Program, transient individuals, and a historical review of DOE exposure data. DOE continues to be diligent in protecting its workers and the public from exposure to radiation as proven by the results contained in this report.

As part of our continual improvement process, you, the reader, are encouraged to provide comments and suggestions regarding this report via the User Survey included at the end of this report.

TODD LAPOINTE
DIRECTOR FOR ENVIRONMENT,
HEALTH, SAFETY AND SECURITY

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LIST OF ABBREVIATIONS AND ACRONYMS

ACL	Administrative Control Level
AEC	U.S. Atomic Energy Commission
AEDE	Annual Effective Dose Equivalent
ALARA	As Low As Reasonably Achievable
AMWTP	Advanced Mixed Waste Treatment Project
ANL	Argonne National Laboratory
ATR	Advanced Test Reactor
BNL	Brookhaven National Laboratory
CEBAF	Continuous Electron Beam Accelerator Facility
CED	Committed Effective Dose
CEDE	Committed Effective Dose Equivalent
CEqD	Committed Equivalent Dose
CEqD-SK	Committed Equivalent Dose to the Skin
CFR	Code of Federal Regulations
CY	Calendar Year
DAC	Derived Air Concentration
DDE	Deep Dose Equivalent
DOE	U.S. Department of Energy
ED	Effective Dose
EqD	Equivalent Dose
EqD-Fetus	Equivalent Dose to the Fetus
EqD-ME	Equivalent Dose to the Skin of the Maximally Exposed Extremity
EqD-SKWB	Equivalent Dose to the Skin of the Whole Body
EqD-WB	Equivalent Dose to the Whole Body
EE	Office of Energy Efficiency and Renewable Energy
EHSS	Office of Environment, Health, Safety and Security
EM	Office of Environmental Management
EPA	U.S. Environmental Protection Agency
ERDA	Energy Research and Development Administration
ETEC	Energy Technology Engineering Center
ETTP	East Tennessee Technology Park
Fermilab	Fermi National Accelerator Laboratory
FTE	Full-Time Equivalent
ICP	Idaho Cleanup Project
ICRP	International Commission on Radiological Protection
INL	Idaho National Laboratory
KC-NSC	Kansas City National Security Campus
LANL	Los Alamos National Laboratory
LBNL	Lawrence Berkeley National Laboratory
LINAC	Linear Accelerator
LCLS	LINAC Coherent Light Source
LLNL	Lawrence Livermore National Laboratory
LM	Office of Legacy Management
MPPB	Main Plant Process Building
mSv	Millisievert

NCRP	National Council on Radiation Protection and Measurements
NE	Office of Nuclear Energy
NNSA	National Nuclear Security Administration
NNSS	Nevada National Security Site
NRC	U.S. Nuclear Regulatory Commission
NREL	National Renewable Energy Laboratory
NYSERDA	New York State Energy Research and Development Authority
O	Order
OEP	Operating Experience Program
ORISE	Oak Ridge Institute for Science and Education
ORNL	Oak Ridge National Laboratory
ORP	Office of River Protection
OST	Office of Secure Transportation
PGDP	Paducah Gaseous Diffusion Plant
PNNL	Pacific Northwest National Laboratory
PORTS	Portsmouth Gaseous Diffusion Plant
PPPL	Princeton Plasma Physics Laboratory
rem	Roentgen equivalent man
REMS	Radiation Exposure Monitoring System
Rh-102	Rhodium-102
Rh-102m	Rhodium-102m
SC	Office of Science
SLAC	SLAC National Accelerator Laboratory
SNM	Special Nuclear Material
SNL	Sandia National Laboratories
SPRU	Separations Process Research Unit
SPEAR3	Stanford Positron-Electron Asymmetric Ring
STD	Standard
Sv	Sievert
TED	Total Effective Dose
TJNAF	Thomas Jefferson National Accelerator Facility
TOD	Total Organ Dose
TRU	Transuranic
TSS	Transportation Safeguards System
U	Uranium
U-234	Uranium-234
UMTRA	Uranium Mill Tailings Remedial Action Project
USEC	United States Enrichment Corporation
WIPP	Waste Isolation Pilot Plant
WTP	Waste Treatment Plant
WVDP	West Valley Demonstration Project
Y-12	Y-12 National Security Complex

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Executive Summary

The U.S. Department of Energy (DOE) Office of Environment, Health, Safety and Security (EHSS) publishes annual occupational radiation exposure reports to provide DOE Management, Program Offices, workers, health physicists, and other stakeholders an evaluation of DOE-wide performance regarding compliance with Title 10 of the *Code of Federal Regulations* (CFR) Part 835, *Occupational Radiation Protection* (10 CFR 835) radiation exposure limits and adherence to as low as reasonably achievable (ALARA) principles.

This report presents the results of analyses of occupational radiation exposures at DOE operations, including the National Nuclear Security Administration (NNSA), during calendar year (CY) 2021. The report includes occupational radiation exposure information for over 67,000 DOE Federal employees, contractors, and subcontractors, and members of the public monitored for radiation exposure. The 98 DOE organizations that submitted radiation exposure reports in CY 2021 have been grouped into 34 sites. The information has been analyzed to provide a measure of DOE's performance in protecting workers and individuals who have entered controlled areas.

Individuals who have the potential to be exposed to radiation at a DOE facility are required to be monitored in accordance with 10 CFR 835, Subpart E. The exposure monitoring data are used to determine the radiation dose received by the individual, which is reported to DOE through the DOE Radiation Exposure Monitoring System (REMS) in accordance with DOE Order 231.1B, *Environment, Safety and Health Reporting*.

Unless otherwise specified, the term "dose" used in this report refers to the total effective dose (TED) and is measured in units of "rem" (derived from the phrase Roentgen equivalent man). The sievert (Sv) is the international unit of effective dose where 1 Sv is equal to 100 rem and 1 rem is, therefore, equal to 10 millisieverts (mSv). The TED is the summation of the effective dose from sources of radiation that are external and internal to the body. The committed effective dose (CED) is the dose resulting from radioactive material taken into the body and is commonly referred to as internal dose. The term "collective dose" is the sum of the individual doses received by a group of individuals and is shown in units of "person-rem."

Analysis of the collected exposure data for CY 2021 indicate that:

- DOE operations were compliant with regulatory radiation protection requirements as no exposures were reported to have exceeded the occupational dose limit of 5 rem (50 mSv) TED; and
- Only 25 percent of the monitored individuals received a measurable dose (a detectable dose greater than zero), and of those, the average measurable dose received was less than 1 percent of the 5 rem (50 mSv) TED limit.

In addition, from CY 2020 to CY 2021:

- The number of individuals with measurable dose decreased by less than 1 percent; however, the collective TED increased by 11 percent;
- The number of facilities citing the COVID-19 pandemic as limiting operational activities decreased from 62 percent to 53 percent;
- Collective CED (internal exposure to U-234) decreased by 23 percent to 43.8 person-rem (438 person-mSv); and
- Collective TED for transient individuals increased by 47 percent to 15.3 person-rem (153 person-mSv).

The collective dose at DOE facilities has decreased by 91 percent since CY 1986. This coincides with the end of the Cold War era, which shifted the DOE mission from weapons production to stabilization, waste management, and environmental remediation activities, along with the consolidation and remediation of facilities across the complex to meet the new mission.

In alignment with the change in mission, regulations and requirements have been modified (see Section 2) that reinforce DOE's focus on ALARA practices and risk reduction to lowering occupational radiation dose.

Over the past 5 years, only two monitored individuals, both at Los Alamos National Laboratory (LANL), received a dose above the 2 rem (20 mSv) TED administrative control level.

- In CY 2018, an individual received a TED of 3.8 rem (38 mSv) when a technician breached his glove while performing glovebox maintenance. A survey of the worker detected alpha contamination on two fingers of the worker's hand, and the results of a diagnostic bioassay confirmed that an intake had occurred.
- In CY 2020, an individual received a TED of 3.0 rem (30 mSv) after an airborne release. The individual received an internal dose during the incident in which skin contamination and positive nasal smears were detected. The source of the contamination was determined to be a breach in a glovebox glove.
- Details of these incidents are available in the occurrence reports NA-LASO-LANL-TA55-2018-0013 and NA--LASO-LANL-TA55-2020, respectively.

This report and other information regarding DOE occupational radiation exposure may be accessed at:

https://energy.gov/ehss/occupational-radiation-exposure

Introduction

The *U.S. Department of Energy Occupational Radiation Exposure Report for Calendar Year 2021* presents the results of analyses of occupational radiation exposures at Department of Energy (DOE), including the National Nuclear Security Administration (NNSA), operations during calendar year (CY) 2021. This report includes occupational radiation exposure information for DOE Federal employees, contractors, and subcontractors, and members of the public monitored for radiation exposure. The 98 DOE organizations that submitted radiation exposure reports for CY 2021 have been grouped into 34 sites.* The information has been analyzed and trended to provide a measure of DOE's performance in protecting workers and individuals who have entered controlled areas.

This report is published by the DOE Office of Environment, Health, Safety and Security (EHSS). The purpose of this report is to provide DOE Management, Program Offices, workers, health physicists, and other stakeholders an evaluation of DOE-wide performance regarding compliance with Title 10 of the *Code of Federal Regulations* (CFR) Part 835, *Occupational Radiation Protection* (10 CFR 835) radiation exposure limits and adherence to as low as reasonably achievable (ALARA) principles.

Individuals who have the potential to be exposed to radiation at a DOE facility are required to be monitored in accordance with 10 CFR 835, Subpart E. The exposure monitoring data are used to determine the radiation dose received by those individuals, which is reported to DOE in accordance with DOE Order (O) 231.1B, *Environment, Safety and Health Reporting*. Unless otherwise specified, the term "dose" used in this report refers to the total effective dose (TED) and is measured in units of "rem" (derived from the phrase Roentgen equivalent man). The TED is the summation of the effective dose from sources of radiation that are external and internal to the body. The committed effective dose (CED) is the dose resulting from radioactive material taken into the body and is commonly referred to as internal dose. The term "collective dose" is the sum of the individual doses received by a group of individuals and is shown in units of "person-rem."

1.1 Report Organization

This report is organized into nine sections. Section 1 describes the content and organization of this report. Section 2 discusses radiation protection, radiation dose limits, and reporting requirements. Section 3 presents the CY 2021 occupational dose data along with trends over the past 5 years and includes information and analyses regarding aggregate, individual, site, DOE Program, and transient individual exposure data; a historical review; and a DOE occurrence report review. Section 4 provides instructions to submit successful ALARA projects, and Section 5 discusses conclusions. Sections 6, 7, and 8 contain the report glossary, references and a user survey, respectively. Section 9 contains the Appendices which have additional detail and data associated with the information presented within the report.

1.2 Report Availability

This report, the appendices, and all other associated information are available on the DOE Radiation Exposure Monitoring System (REMS) web site at:

https://www.energy.gov/ehss/occupational-radiation-exposure

The REMS web site contains additional information on occupational radiation exposure, such as:

- Annual occupational radiation exposure reports and associated Appendices in pdf since CY 1974;
- Guidance on reporting radiation exposure information to the DOE REMS;
- Updated REMS-Online Query Tool;

* For the purposes of this report, the sites and facilities are grouped by geographic location. When reported separately, the data for individual facilities at the sites are provided separately. See Section 3.4 for more information.

- Guidance on how to request a dose history for an individual;
- Statistical data since CY 1987 for analysis;
- Applicable DOE orders and manuals for the recordkeeping and reporting of occupational radiation exposure at DOE;
- Occupational Exposure Dashboard—interactive data explorer;
- Ten Year Summary—graphical comprehensive overview of past 10 years of radiation exposure data; and
- ALARA activities at DOE.

Requests for access to the data files, or for individual dose records used to compile this report, as well as suggestions and comments, should be directed to:

Ms. Katharine McLellan
DOE REMS Program Manager
Office of Environment, Health, Safety and Security (EHSS)
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, D.C. 20585-1290
E-mail: katharine.mclellan@hq.doe.gov

Standards and Requirements

It is DOE's mission to provide a safe and healthy workplace for all DOE Federal employees, contractors, and subcontractors as well as members of the public that visit DOE facilities. To meet this mission, the EHSS establishes comprehensive and integrated programs for the protection of workers from hazards in the workplace, including ionizing radiation. The DOE standards for occupational radiation protection include radiation exposure limits to workers. In addition, DOE is required to maintain radiation exposures as far below the limits as is reasonable through application of the ALARA process, which incorporates pre-job planning, engineering controls, and worker training.

This section identifies the radiation protection standards and requirements applicable to DOE operations in CY 2021.

2.1 Radiation Protection Requirements

DOE radiation protection standards are based on Federal guidance for protection against occupational radiation exposure promulgated by the U.S. Environmental Protection Agency (EPA) in CY 1987 [1]. The guidance, initially implemented by DOE in CY 1989, was based on the CY 1977 recommendations of the International Commission on Radiological Protection (ICRP) Publication 26 [2] and the CY 1987 recommendations of the National Council on Radiation Protection and Measurements (NCRP) Publication 91 [3]. EPA recommends that internal dose be added to the external whole-body dose to determine the TED equivalent. The laws and requirements for occupational radiation protection pertaining to the information collected and presented in this report are summarized in *Exhibit 2-1*.

2.2 Radiation Dose Limits

Radiation dose limits are codified in 10 CFR 835, Sections 202, 206, 207, and 208 [4] and are summarized in *Exhibit 2-2*.

2.3 Reporting Requirements

DOE O 231.1B, *Environment, Safety and Health Reporting* [5] contains the requirements for reporting annual individual radiation exposure records to the REMS repository. Exposure records for the monitoring year are required to be reported by March 31 of the following calendar year. Specific instructions for preparing occupational exposure data for submittal to the REMS repository are contained in the REMS Data Reporting Guide [6] available online at:

https://www.energy.gov/ehss/downloads/radiation-exposure-monitoring-systems-data-reporting-guide

Exhibit 2-1: Regulations and Requirements Pertaining to the Collection and Reporting of Radiation Exposures.

Title	Date	Description
10 CFR 835, Occupational Radiation Protection [4]	Issued 12/14/93 Amended 11/4/98 Amended 6/8/07 Amended 4/13/11 Amended 8/11/17	Establishes radiation protection standards, exposure limits, and program requirements for protecting individuals from ionizing radiation that results from the conduct of DOE activities.
DOE O 231.1B, Environment, Safety and Health Reporting [5]	Approved 6/27/11 Amended 11/28/12	Requires the annual reporting of occupational radiation exposure records to the DOE REMS repository.
REMS Reporting Guide [6]	Issued 2/23/12	Specifies the current format and content of the reports required by DOE O 231.1B.

Exhibit 2-2: DOE Dose Limits from 10 CFR 835.

Personnel Category	Section of 10 CFR 835	Type of Exposure	Acronym	Annual Limit
General employees	835.202	Total effective dose. The sum of the effective dose (for external exposures) and the committed effective dose.	TED	5 rem (50 mSv)
		The sum of the equivalent dose to the whole body for external exposures and the committed equivalent dose to any organ or tissue other than the skin or the lens of the eye.	EqD-WB + CEqD (TOD)	50 rem (500 mSv)
		Equivalent dose to the lens of the eye	EqD-Eye	15 rem (150 mSv)
		The sum of the equivalent dose to the skin or to any extremity for external exposures and the committed equivalent dose to the skin or to any extremity	EqD-SkWB + CEqD-SK and EqD-ME + CEqD-SK	50 rem (500 mSv)
Declared pregnant workers*	835.206	The equivalent dose to the embryo/fetus from the period of conception to birth as a result of occupational exposure of a declared pregnant worker.	EqD-Fetus	0.500 rem (5 mSv) from the period of conception to birth
Minors	835.207	Total effective dose	TED	0.100 rem (1 mSv)
Members of the public in a controlled area	835.208	Total effective dose	TED	0.100 rem (1 mSv)

* Limit applies to the embryo/fetus.

2.4 Amendments to 10 CFR 835

In August 2006, DOE published a proposed amendment to 10 CFR 835 in the *Federal Register*, and, in June 2007, the amended rule was published. The amendment:

- Specified new dosimetric terminology and quantities based on ICRP 60/68 in place of ICRP 26/30;
- Specified ICRP 60 tissue weighting factors in place of ICRP 26 weighting factors;
- Specified ICRP 60 radiation weighting factors in place of ICRP 26 quality factors;
- Amended other parts of the regulation that changed as a result of adopting ICRP 60 dosimetry system;
- Used the ICRP 68 dose conversion factors to determine values for the derived air concentrations; and
- Adopted other changes intended to enhance radiation protection.

The amended rule became effective on July 9, 2007, and was required to be fully implemented by DOE sites by July 9, 2010. All terminology used in this annual report reflects that of the amendment. In addition, 10 CFR 835 was revised in April 2011 when Appendix C (Derived Air Concentration [DAC] for Workers) was updated. On August 11, 2017, Appendices C and E were amended. The amendment to Appendix C corrected the air immersion DAC for any single radionuclide not listed in the Appendix C table with a decay mode other than alpha emission or spontaneous fission and with radioactive half-life less than 2 hours, adjusted for an 8-hour workday. The amendment to Appendix E corrected the activity information of two radioisotopes of rhodium (Rh-102 and Rh-102m).

Occupational Radiation Dose at DOE

3.1 Analysis of the Data

The following key indicators are analyzed to identify and correlate parameters that impact occupational radiation doses at DOE:

- Number of records for monitored individuals;
- Individuals who received a measurable dose;
- Collective dose;
- Average measurable dose; and
- Dose distribution.

The analysis of key indicators for individual dose data includes:

- Doses exceeding the 5 rem (50 millisievert [mSv]) DOE regulatory limit; and
- Doses exceeding the 2 rem (20 mSv) DOE administrative control level (ACL).

Additional information is provided in this report concerning activities at sites contributing to most of the collective dose.

The data for prior years contained in this report are subject to change as sites may submit corrections for previous years as required by DOE O 231.1-1B(1)(b). Corrected or updated records received after the annual March 31 deadline are included in the following year's annual report.

3.2 Analysis of Aggregate Data

3.2.1 Number of Monitored Individuals

The data in the REMS repository are reported by each facility in the form of a record for a monitoring period for each individual. An individual may have been monitored more than once at the same facility (e.g., multiple short-term assignments) or may have been monitored at more than one facility during the year. This can result in more than one record for an individual during the year in the REMS repository. However, the impact of multiple records per person on the annual trends and aggregate analysis of the data in this report is not significant as it occurs consistently from year to year. An analysis of the number of individuals who are monitored at more than one location during the year is provided in Section 3.5, which supports this assertion. The term "number of monitored individuals" will be used herein with the understanding that it is determined by the number of records for monitored individuals.

3.2.2 Number of Individuals with Measurable Dose

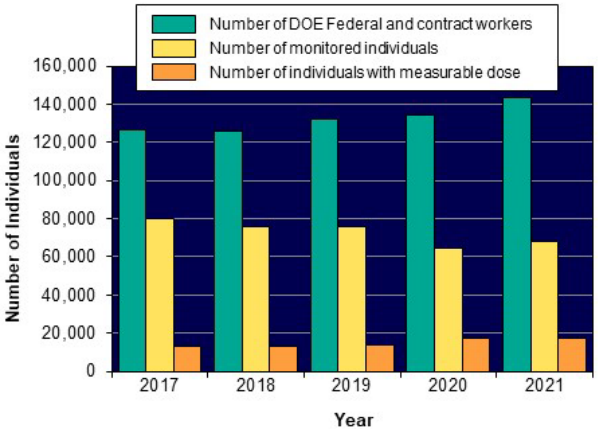
DOE uses the number of individuals with measurable dose to represent the exposed workforce size. In this context, "with measurable dose" means that a detectable value was reported for the individual.

Over the past 5-year period, measurable doses to all monitored individuals were well below the annual DOE regulatory limit of 5 rem (50 mSv) TED; however, one monitored individual received an annual TED of 3.8 rem (38 mSv) in CY 2018, and another individual received a single dose of 3.0 rem (30 mSv) TED in CY 2020. Both doses exceeded the 2 rem (20 mSv) DOE ACL.

Exhibit 3-1a and *Exhibit 3-1b* show the number of DOE Federal and contract workers, the total number of individuals monitored for radiation dose, the number of individuals with a measurable dose, and the relative percentages of individuals with measurable dose for the past 5 years. The number of DOE Federal and contract employees was calculated by dividing the total hours worked per year by the average number of work hours per year. It is, therefore, not a true count of individuals, but is a representation of the total size of the DOE workforce as full-time equivalents (FTEs) and is included here to compare it to the number of individuals monitored.

As shown in *Exhibit 3-1b*, the number of monitored individuals increased by 5 percent from a value of 64,694 in CY 2020 to a value of 67,773 in CY 2021. This is the second year in a row since individual records began being compiled in CY 1987 where the number of monitored individuals has been lower than 70,000.

Exhibit 3-1a: Monitoring of the DOE Workforce, CY 2017 – 2021.



For CY 2021, 47 percent of the DOE workforce was monitored for radiation dose, and 25 percent of monitored individuals received a measurable dose.

Exhibit 3-1b: Monitoring of the DOE Workforce, CY 2017 – 2021.

Year	DOE Federal & Contractor Workforce*	Number of Monitored Individuals	Percent of Monitored Individuals**	Number of Individuals with Measurable Dose	Percent of Individuals with Measurable Dose**
2017	126,268	79,906	63% ▲	13,019	16% ▲
2018	125,969	75,634	60% ▼	13,335	18% ▲
2019	131,895	76,143	58% ▼	13,824	18%
2020	134,059	64,694	48% ▼	17,252	27% ▲
2021	143,770	67,773	47% ▼	17,130	25% ▼
5-Year Average	**132,392**	**72,830**	**55%**	**14,912**	**20%**

* The number of DOE and contract workers was determined from the total annual work hours at DOE [7] converted to FTEs.
** Up arrows indicate an increase from the previous year's value. Down arrows indicate a decrease from the previous year's value.

The decrease is due to many DOE employees and contractors moving to a "work from home" status in response to the COVID-19 pandemic during CY 2020, therefore, not requiring radiation exposure monitoring.

The number of individuals with measurable dose decreased by less than 1 percent from a value of 17,252 in CY 2020 to a value of 17,130 in CY 2021. However, collective TED increased by 11 percent from 749.156 rem (7,491 mSv) in CY 2020 to 828.036 rem (8,280 mSv) in CY 2021.

This increase was because individuals that tend to receive measurable dose at DOE sites perform work in areas involving radioactive materials as part of DOE's core mission activities. These core mission activities continued during CY 2021 at most sites during the COVID-19 pandemic. Therefore, the number of individuals with the potential to receive a measurable dose did not decrease.

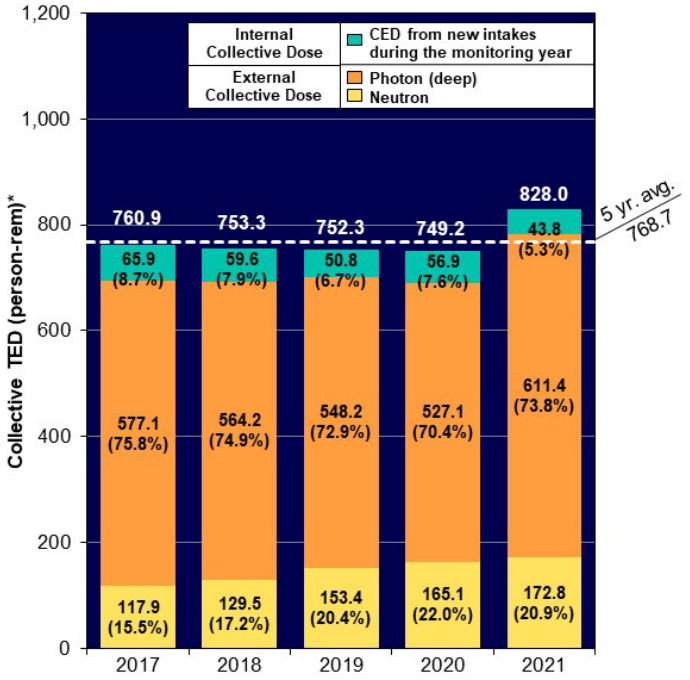
3.2.3 Collective Dose

The collective dose is the sum of the dose received by all individuals with a measurable dose and is measured in units of person-rem and person-mSv. DOE monitors the collective dose as one measure of the overall performance of radiation protection programs to keep individual exposures and collective exposures ALARA.

In this report, the term "collective dose" is also applied to various types of radiation dose, such as external or internal, and will be specified in conjunction with the term "collective" to clarify the intended meaning.

As shown in *Exhibit 3-2*, the collective TED increased at DOE by 11 percent from 749.156 person-rem 7,491 person-mSv) in CY 2020 to 828.036 person-rem (8,280 person-mSv) in CY 2021. The internal dose is based on the 50-year CED methodology.

Exhibit 3-2: Components of TED, CY 2017 – 2021.



The collective TED increased by 11% percent at DOE from CY 2020 to 2021.

The collective internal dose decreased by 23% percent from CY 2020 to 2021.

The collective neutron dose increased by 5 percent from CY 2020 to 2021.

The collective photon dose increased by 16 percent from CY 2020 to 2021.

Effective Dose from photons—the component of external dose from gamma or x-ray electromagnetic radiation (also includes energetic betas)

Effective dose from neutrons—the component of external dose from neutrons ejected from the nucleus of an atom during nuclear reactions

Internal dose—radiation dose resulting from radioactive material taken into the body

* The percentages in parentheses represent the percentage of each dose component to the collective TED.

Under this methodology, the cumulative dose received from the intake of radioactive material over the next 50 years is assigned to the individual as a one-time dose in the year of intake. In other words, the CED is the effective dose from radionuclides taken into the body during the reporting year integrated over the next 50 years.

The internal dose component of the collective TED decreased by 23 percent from 56.9 person-rem (569 person-mSv) in CY 2020 to 43.8 person-rem (438 person-mSv) in CY 2021, due to decreases at the Los Alamos National Laboratory (LANL) and Y-12 National Security Complex (Y-12). The collective photon dose increased by 16 percent from 527.1 person-rem (5,271 person-mSv) in CY 2020 to 611.4 person-rem (6,114 person-mSv) in CY 2021, due to increases at Idaho, LANL, and Savannah River Site.

The neutron component of the collective TED increased by 5 percent from 165.1 person-rem (1,651person-mSv) in CY 2020 to 172.8 person-rem (1,728 person-mSv) in CY 2021. The increase resulted primarily from increases in collective neutron dose at LANL.

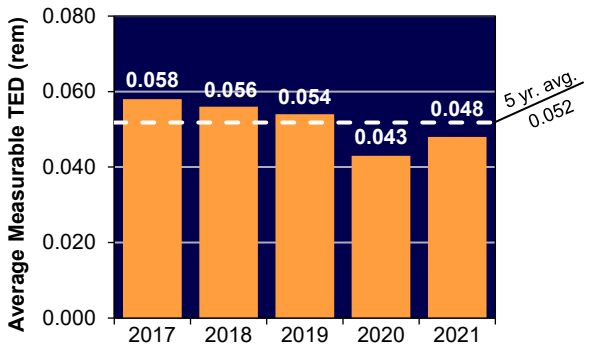
Five DOE sites contributed 89 percent of the collective TED in CY 2021. In descending order of collective TED, these were: LANL, Savannah River, Idaho, Oak Ridge, and Hanford. LANL, Savannah River, Idaho, and Hanford had increases in collective TED in CY 2021, while the change in collective TED at Oak Ridge was negligible. (See section 3.4.3.)

3.2.4 Average Measurable Dose

The average measurable dose to DOE monitored individuals, a key radiation dose indicator, is calculated by dividing the collective TED by the number of individuals with measurable dose. This is the average most commonly used by radiation exposure research organizations when examining trends and comparing doses received by individuals because it excludes those individuals that did not receive a measurable dose.

Exhibit 3-3 illustrates that the average measurable TED increased by 11 percent from 0.043 rem (0.430 mSv) in CY 2020 to 0.048 rem (0.480 mSv) in CY 2021.

Exhibit 3-3: Average Measurable TED, CY 2017 – 2021.



While the collective dose and average measurable dose serve as measures of the magnitude of the dose accrued by DOE monitored individuals, they do not depict the distribution of doses among the monitored individuals.

3.2.5 Dose Distribution

Exposure data are commonly analyzed in terms of dose intervals to depict the TED distribution among the monitored individuals. *Exhibit 3-4* shows the number of individuals in each of 11 different dose ranges. The number of individuals receiving doses above 0.100 rem (1 mSv) is included to show the number of individuals with doses above the monitoring threshold specified in 10 CFR 835.402(a) and (c) [4].

Even though the number of individuals monitored increased by 5 percent in CY 2021, *Exhibit 3-4* shows that the dose distribution in the 1.0-2.0 rem (10-20 mSv) range has remained nearly the same since CY 2018. In the past 5 years, only two individuals have received doses above 2.0 rem—one in CY 2018, and one in CY 2020.

Exhibit 3-5 presents the dose distribution of those individuals with measurable doses in terms of the percentage of individuals with measurable TED in each range. The doses received by the 89 percent of monitored individuals who received a measurable dose were below the required monitoring threshold of 0.100 rem (1 mSv) specified in 10 CFR 835.402 (a) and (c).

These results reflect DOE's conservative practice of monitoring more individuals than are required. This ensures adequate protection of the individual and that ALARA principles are being effectively implemented to reduce radiation exposure.

Exhibit 3-4: Distribution of TED by Dose Range, CY 2017 – 2021.

	TED Range (rem)*	2017	2018	2019	2020	2021
Number of Individuals in Each Dose Range	Less than measurable	66,887	62,299	62,319	47,442	50,643
	Measurable to 0.100	11,006	11,418	11,946	15,680	15,174
	0.100 – 0.250	1,397	1,336	1,311	1,158	1,376
	0.250 – 0.500	480	429	424	313	441
	0.500 – 0.750	102	97	90	67	97
	0.750 – 1.000	13	39	42	22	29
	1.0 – 2.0	21	15	11	11	13
	2.0 – 3.0					
	3.0 – 4.0		1		1	
	4.0 – 5.0					
	>5.0					
Total number of records for monitored individuals		79,906	75,634	76,143	64,694	67,773
Number with measurable dose		13,019	13,335	13,824	17,252	17,130
Number with dose >0.100 rem		2,013	1,917	1,878	1,572	1,956
Collective TED (person-rem)		760.859	753.322	752.315	749.156	828.036
Average measurable TED (rem)		0.058	0.056	0.054	0.043	0.048

* Individuals with doses equal to the dose value separating the dose ranges are included in the next higher dose range.

Exhibit 3-5: Percentage of Individuals with Measurable TED by Dose Range, CY 2017 – 2021.

	TED Range (rem)*	2017	2018	2019	2020	2021
Percentage of Individuals with Measurable TED	Measurable <0.100	84.54%	85.62%	86.41%	90.89%	88.58%
	0.100 – 0.250	10.73%	10.02%	9.48%	6.71%	8.03%
	0.250 – 0.500	3.69%	3.22%	3.07%	1.81%	2.57%
	0.500 – 0.750	0.78%	0.73%	0.65%	0.39%	0.57%
	0.750 – 1.000	0.10%	0.29%	0.30%	0.13%	0.17%
	1.0 – 2.0	0.16%	0.11%	0.08%	0.06%	0.08%
	2.0 – 3.0	0.00%	0.00%	0.00%	0.00%	0.00%
	>3.0	0.00%	0.01%	0.00%	0.01%	0.00%
% of monitored individuals with measurable dose		16%	18%	18%	27%	25%
% of monitored individuals with dose > 0.100 rem		3%	3%	2%	2%	3%

* Individuals with doses equal to the dose value separating the dose ranges are included in the next higher dose range.

3.3 Analysis of Individual Dose Data

The previous section's analysis is based on aggregate data for DOE. From both the individual and regulatory perspectives, it is important to examine the doses received by individuals in the elevated dose ranges to understand the circumstances that led to these exposures and reduce or eliminate these types of exposures in the future.

3.3.1 Doses in Excess of the Regulatory Limit

No individual was reported to have exceeded the TED regulatory limit (5 rem [50 mSv]) from CY 2017 – 2021.

In CY 2018, one individual exceeded the 10 CFR 835.202 total organ dose (TOD) limit of 50 rem (500 mSv) from a plutonium-238 intake at LANL, which resulted in a TOD to the bone surfaces of 118.5 rem (1,185 mSv). Details of the incident are available in the occurrence report NA--LASO-LANL-TA55-2018-0013.

Eighty-nine percent of monitored individuals who received a measurable dose in CY 2021, received doses below the required monitoring threshold of 0.100 rem (1 mSv) specified in 10 CFR 835.402 (a) and (c).

3.3.2 Doses in Excess of the DOE Administrative Control Level

DOE Standard (STD)-1098-2017, *Radiological Control* [8] establishes a 2 rem (20 mSv) ACL for TED per year per person for all DOE activities. The STD states that each DOE site should establish an annual facility ACL based on historical and projected exposures and that no individual should be allowed to exceed this value without prior facility management approval.

One individual was reported to have exceeded the TED ACL (2 rem [20 mSv]) in CY 2020.

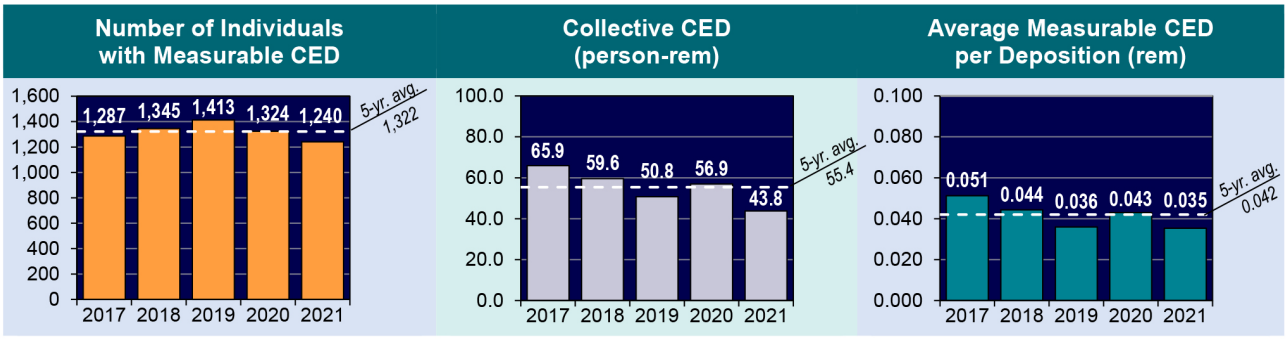
In June of CY 2020, skin contamination and positive nasal smears were detected on one employee after an airborne release at LANL's Plutonium Processing and Handling Facility. The source of the contamination was determined to be a breach in a glovebox glove. The individual received a CED of 2.4 rem (24 mSv) from Plutonium-238, resulting in a TED of 3.0 rem (30 mSv) for the year. Details of the incident are available in the occurrence report NA--LASO-LANL-TA55-2020.

3.3.3 Intakes of Radioactive Material

DOE tracks the number of radionuclide intakes as a performance measure in this report. DOE emphasizes the importance of implementing measures to avoid intakes and maintain doses as low as reasonable through the ALARA principle. Intakes involving certain radionuclides can take significant time to analyze and determine final dose. This can result in changes to prior year dose totals if the updates are received after the March 31 annual reporting deadline.

Exhibit 3-6 shows the number of individuals with measurable CED, collective CED, and average measurable CED for CY 2017 – 2021. The number of individuals with measurable CED decreased by 6 percent from 1,324 in CY 2020 to 1,240 in CY 2021, and the collective CED decreased by 23 percent. The average measurable CED decreased from 0.043 rem (0.430 mSv) in CY 2020 to 0.035 rem (0.350 mSv) in CY 2021 and remained below the 5-year average measurable CED.

Exhibit 3-6: Number of Individuals with Measurable CED, Collective CED, and Average Measurable CED, CY 2017 – 2021.



Note: The number of internal depositions represents the number of internal dose records with positive results reported for each individual.

Ninety-five percent of the collective CED in CY 2020 was from uranium intakes at Y-12 during the operation and management of Enriched Uranium Operations facilities at the site. Compared with external doses, few individuals at DOE receive measurable internal doses. Larger fluctuations may occur from year to year in the number of individuals and the collective CED compared to other components of TED.

Exhibit 3-7 shows the distribution of the CED from CY 2017 – 2021. The total number of individuals with measurable CED in each dose range is the sum of the number of individuals receiving a CED in the dose range. Individuals may have had more than one intake of radioactive material, but the site would report one CED value from these intakes.

Doses below 0.020 rem (0.200 mSv) are shown as a separate dose range, to show the large number of individuals in this low dose range.

The internal dose records indicate that the majority of the intakes resulted in very low doses.

In CY 2021, 54 percent of the internal dose records were for doses below 0.020 rem (0.200 mSv). Over the 5-year period, internal doses accounted for 7 percent of the collective TED; although only 9 percent of the individuals who received internal doses had estimated doses above the monitoring threshold (0.100 rem [1 mSv]) specified in 10 CFR 835.402(c) [4]. It is noted that the CED is a dose received over a 50-year period after the intake that is all credited to the individual in the year of intake, so the actual annual dose is lower.

3.3.4 Bioassay and Intake Summary Information

Exhibit 3-8 shows the breakdown of bioassay measurements by type and number of measurements. Bioassay and intake summary information are required to be reported under the REMS Reporting Guide [6].

During the past 5 years, "Urinalysis" has been reported as the most common method of bioassay measurement used to determine internal doses to the individuals.

The Paducah Gaseous Diffusion Plant had the largest percentage increase (52 percent) in the number of "Urinalysis" measurements in CY 2021, increasing from 1,053 in CY 2020 to 1,602 in CY 2021. Seventy-four percent of the "Urinalysis" measurements in CY 2021 were performed at four sites: Y-12, LANL, Savannah River Site, and Hanford Site.

The measurements reported as "In Vivo" include direct measurements of the radioactive material in the body of the monitored person. Examples of "In Vivo" measurements include whole-body counts and lung or thyroid counts. Three sites—Hanford Site, Savannah River Site, and Office of River Protection (ORP)—accounted for 85 percent of the "In Vivo" measurements.

Exhibit 3.8 also indicates the number of "Fecal" bioassay measurements taken. Y-12 accounted for 96 percent of the measurements in CY 2021.

Exhibit 3-9 shows the reported "Air Sampling" measurements, which are used to calculate the amount of airborne radioactive material taken into the body and the resultant internal dose.

Exhibit 3-7: Internal Dose Distribution from Intakes, CY 2017 – 2021.

Year	Number of Individuals with CED in the Ranges (rem)*											Total No. of Indiv.	Total Collective CED (person-rem)
	Meas. <0.020	0.020–0.100	0.100–0.250	0.250–0.500	0.500–0.750	0.750–1.000	1.0–2.0	2.0–3.0	3.0–4.0	4.0–5.0	>5.0		
2017	554	544	148	38	3	0	0	0	0	0	0	1,287	65.923
2018	629	559	141	14	1				1			1,345	59.556
2019	683	612	116	2	0	0	0	0	0	0	0	1,413	50.761
2020	583	592	142	6				1				1,324	56.923
2021	667	456	113	4	0	0	0	0	0	0	0	1,240	43.789

* Individuals with doses equal to the dose value separating the dose ranges are included in the next higher dose range.

Exhibit 3-8: Bioassay Measurements, CY 2017 – 2021.

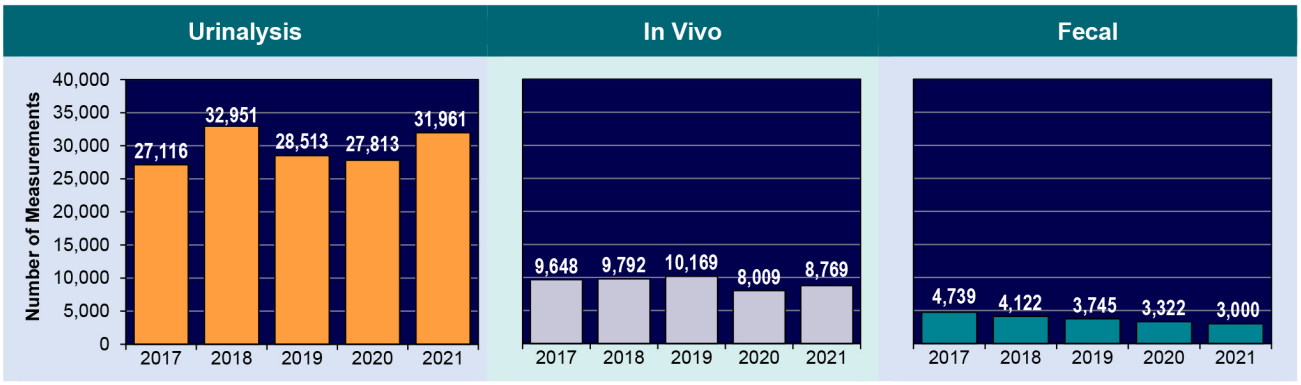
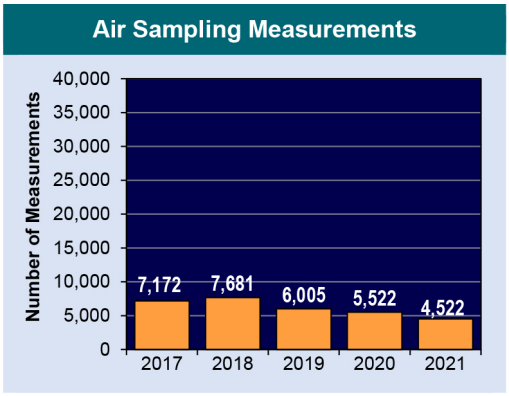


Exhibit 3-9: Air Sampling Measurements, CY 2017 – 2021.

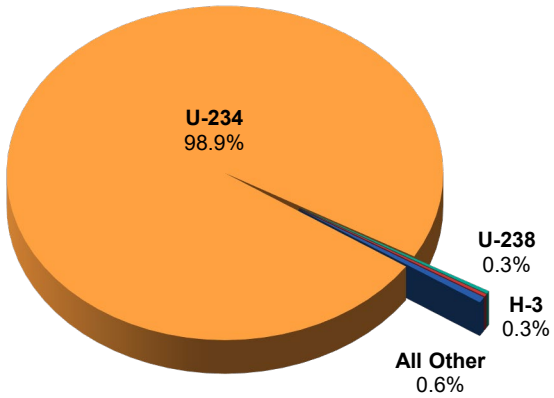


The values shown are based on the number of measurements taken and not the number of individuals monitored. Individuals may have measurements taken more than once during the year

Y-12 performed the largest number of bioassay and air sampling measurements combined, comprising 35 percent of the total measurements taken.

Exhibit 3-10 shows the breakdown of the collective CED by radionuclide for CY 2021. Uranium-234 (U-234) accounted for the largest percentage of the collective CED, with 99 percent of this dose accrued at Y-12.

Exhibit 3-10: Collective CED by Radionuclide from Internal Exposure, CY 2021.



"Air Sampling" accounted for 12 percent of the total measurements. Savannah River Site performed the largest number of air sampling measurements, comprising 99 percent of the total air measurements taken in CY 2021 (see *Exhibit 3-14* for additional information).

Appendix B contains additional information on intake data such as: Exhibits B-4, Internal Dose by Site; B-17, Internal Dose by Facility Type and Nuclide; B-19, Internal Dose by Labor Category; and B-21, Internal Dose Distribution by Site and Nuclide.

3.4 Analysis of Site Data

3.4.1 Collective TED by Site and Other Facilities

The collective TED values for CY 2019 – 2021 for the major DOE sites and operations/field offices are shown graphically in *Exhibit 3-11*. A list of the collective TED and number of individuals with measurable TED by DOE sites is shown in *Exhibit 3-12*. For the purposes of this report, the sites and facilities are grouped by geographic location as shown in these exhibits. When reported separately, the data for individual facilities at the sites are provided separately, such as at Hanford, Oak Ridge, and Savannah River. The data for Idaho is not provided separately and includes the Idaho National Laboratory (INL), Idaho Cleanup Project (ICP), and the Advanced Mixed Waste Treatment Project (AMWTP).

The collective TED increased by 11 percent from 749 person-rem (7,490 person-mSv) in CY 2020 to 828 person-rem (8,280 person-mSv) in CY 2021, with LANL, Savannah River, Idaho, Oak Ridge, and Hanford contributing 89 percent of the total DOE collective TED.

Exhibit 3-11: Collective TED by DOE Site for CY 2019 – 2021.

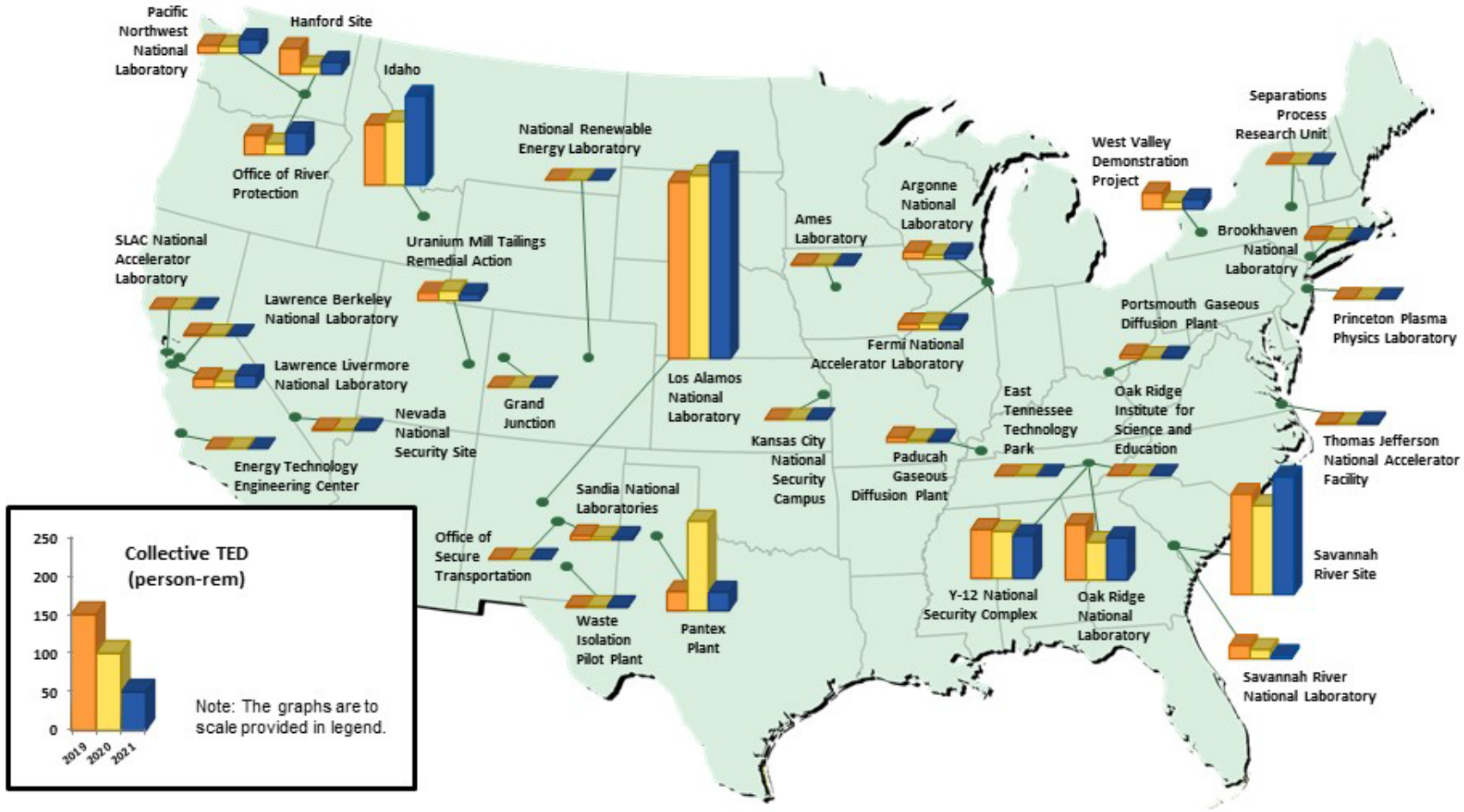


Exhibit 3-12: Collective TED and Number of Individuals with Measurable TED by DOE Site, CY 2019 – 2021.

Site	2019		2020		2021	
	Collective TED (person-rem)	Number with Meas. TED	Collective TED (person-rem)	Number with Meas. TED	Collective TED (person-rem)	Number with Meas. TED
Ames Laboratory	0.837	31	0.777	30	0.710	30
Argonne National Laboratory	8.650	83	4.609	65	6.385	96
Brookhaven National Laboratory	3.191	137	1.161	111	0.977	60
Energy Technology Engineering Center	0.009	2	0.045	8		
Fermi National Accelerator Laboratory	7.060	154	7.850	168	6.110	195
Grand Junction Site	0.041	13	0.043	14	0.158	28
Hanford:						
Hanford Site	32.673	822	9.797	485	15.128	534
Office of River Protection	24.153	671	13.291	461	27.476	706
Pacific Northwest National Laboratory	9.717	446	8.523	408	17.127	533
Hanford Totals:	66.543	1,939	31.611	1,354	59.731	1,773
Idaho	76.511	1,203	80.614	1,667	113.108	1,816
Kansas City National Security Campus	0.364	66	0.493	93	0.920	68
Lawrence Berkeley National Laboratory	1.810	23	0.834	14	0.511	12
Lawrence Livermore National Laboratory	11.003	153	7.494	128	14.933	155
Los Alamos National Laboratory	**224.472**	1,983	**232.736**	2,523	**303.186**	4,206
National Renewable Energy Laboratory	0.001	1	0.030	4	0.000	0
Nevada National Security Site	1.940	50	1.800	72	1.821	38
Oak Ridge:						
East Tennessee Technology Park	0.186	19	0.751	102	0.468	53
Oak Ridge Institute for Science and Education	0.237	22	0.000	0	0.025	2
Oak Ridge National Laboratory	70.245	539	47.666	610	53.455	976
Y-12 National Security Complex	61.751	1,665	59.591	1,428	54.186	1,436
Oak Ridge Totals:	132.419	2,245	108.008	2,140	108.134	2,467
Office of Secure Transportation	0.448	13	0.025	2	0.084	6
Paducah Gaseous Diffusion Plant	5.554	100	2.654	116	2.465	92
Pantex Plant	24.248	758	113.909	3,563	23.755	402
Portsmouth Gaseous Diffusion Plant	4.289	71	1.107	40	2.029	69
Princeton Plasma Physics Laboratory	0.391	72	0.234	54	0.222	42
Sandia National Laboratories	5.323	154	3.287	89	3.092	105
Savannah River:						
Savannah River National Laboratory	16.631	547	11.717	445	4.073	165
Savannah River Site	126.763	**3,651**	112.247	**4,220**	148.663	**4,965**
Savannah River Totals:	*143.394*	*4,198*	*123.964*	*4,665*	*152.736*	*5,130*
Separations Process Research Unit	0.029	2	0.000	0	0.012	1
SLAC National Accelerator Laboratory	0.206	11	0.146	2	0.000	0
Thomas Jefferson National Accelerator Facility	1.266	52	0.607	22	1.974	48
Uranium Mill Tailings Remedial Action Project	9.748	95	12.004	95	7.836	65
Waste Isolation Pilot Plant	1.113	54	1.130	67	1.283	78
West Valley Demonstration Project	20.459	139	8.868	112	12.145	108
Service Center Personnel *	0.996	22	3.116	34	3.719	40
Totals	**752.315**	**13,824**	**749.156**	**17,252**	**828.036**	**17,130**

Note: Bold and boxed values indicate the greatest value in each column.

* Includes personnel at National Energy Technology Laboratory (NETL), NNSA Albuquerque complex, Oak Ridge, and Waste Isolation Pilot Plant (WIPP) in addition to several smaller facilities not associated with a DOE site.

3.4.2 Changes by Site from CY 2020 to 2021

Exhibit 3-13 shows the collective TED, the number monitored, the number with a measurable TED, and the average measurable TED as well as the percentage change in these values from the previous year. Some of the largest percentage changes occurred at relatively small facilities where conditions may fluctuate from year to year due to changes in workload and tasks conducted.

Changes that have the most impact in the overall values at DOE typically occur at sites with large collective TED. For example, the collective TED at LANL increased from 232.736 person-rem (2,327 person-mSv) in CY 2020 to 303.186 person-rem (3,032 person-mSv) in CY 2021. (See section 3.4.3.)

Fourteen of the 34 DOE sites reported decreases in the collective TED from the CY 2020 values, and 20 of the 34 DOE sites reported increases in the collective TED from the CY 2020 values.

Eighteen of the 34 reporting sites experienced increases in the number of workers with a measurable TED from CY 2020 to 2021. The largest increase in total number of individuals with a measurable TED occurred at the LANL, with an increase of 1,682 individuals or 67 percent (see *Exhibit 3-14)*. The second largest increase in total number of individuals with a measurable TED occurred at Savannah River Site, with an increase of 745 individuals, or 18 percent.

Sixteen of the 34 reporting sites experienced decreases in the number of individuals with a measurable TED from CY 2020 to 2021. The largest decrease in the number of individuals receiving a measurable TED occurred at the Pantex Plant, with a decrease of 3,161 individuals, or 89 percent. A discussion of activities at the highest dose facilities is included in section 3.4.3.

3.4.3 Activities Significantly Contributing to Collective Dose in CY 2021

In an effort to identify the reasons for changes in the collective dose at DOE, the sites provided information on activities that significantly contributed to the collective dose for CY 2021 as instructed in the REMS Reporting Guide, Item 1. In *Exhibit 3-14*, these sites are presented in descending order of collective TED with a dotted line representing the site's 5-year average TED. Sites that have reported less than 5 person-rem (50 person-mSv) for CY 2021 can be found in *Exhibit 3-15*. Due to the low doses and small number of individuals with measurable dose, wider variation can occur from year to year.

Exhibit 3-14 Site Listing > 5 Person-Rem

Exhibit 3-15 Site Listing < 5 Person-Rem

Exhibit 3-13: Site Dose Data, CY 2021.

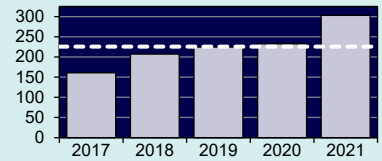
Site	2021							
	Collective TED (person-rem)	Percent Change from 2020	Number of Monitored Individuals	Percent Change from 2020	Number with Meas. TED	Percent Change from 2020	Avg. Meas. TED (person-rem)	Percent Change from 2020
Ames Laboratory	0.710	◊	133	◊	30	◊	0.024	◊
Argonne National Laboratory	6.385	39% ▲	1,668	9% ▲	96	48% ▲	0.067	-6% ▼
Brookhaven National Laboratory	0.977	◊	1,995	◊	60	◊	0.016	◊
Fermi National Accelerator Laboratory	6.110	-22% ▼	1,221	-4% ▼	195	16% ▲	0.031	-33% ▼
Grand Junction Site	0.158	◊	33	◊	28	◊	0.006	◊
Hanford:								
Hanford Site	15.128	54% ▲	4,045	17% ▲	534	10% ▲	0.028	40% ▲
Office of River Protection	27.476	107% ▲	3,414	**22%** ▲	706	53% ▲	0.039	35% ▲
Pacific Northwest National Laboratory	17.127	101% ▲	1,902	-2% ▼	533	31% ▲	0.032	54% ▲
Hanford Totals:	59.731	89% ▲	9,361	15% ▲	1,773	31% ▲	0.034	44% ▲
Idaho	113.108	40% ▲	6,156	14% ▲	1,816	9% ▲	0.062	29% ▲
Kansas City National Security Campus	0.920	◊	220	◊	68	◊	0.014	◊
Lawrence Berkeley National Laboratory	0.511	◊	838	◊	12	◊	0.043	◊
Lawrence Livermore National Laboratory	14.933	99% ▲	3,533	4% ▲	155	21% ▲	0.096	65% ▲
Los Alamos National Laboratory	**303.186**	30% ▲	**10,902**	15% ▲	4,206	67% ▲	0.072	-22% ▼
National Renewable Energy Laboratory	0.000	◊	7	◊	0	◊	◊	◊
Nevada National Security Site	1.821	1% ▲	731	-3% ▼	38	-47% ▼	0.048	**92%** ▲
Oak Ridge:								
East Tennessee Technology Park	0.468	◊	133	◊	53	◊	0.009	◊
Oak Ridge Institute for Science and Education	0.025	◊	48	◊	2	◊	0.013	◊
Oak Ridge National Laboratory	53.455	12% ▲	4,063	4% ▲	976	60% ▲	0.055	-30% ▼
Y-12 National Security Complex	54.186	-9% ▼	6,161	8% ▲	1,436	1% ▲	0.038	-10% ▼
Oak Ridge Totals:	108.134	0%	10,405	3% ▲	2,467	15% ▲	0.044	-13% ▼
Office of Secure Transportation	0.084	◊	337	◊	6	◊	0.014	◊
Paducah Gaseous Diffusion Plant	2.465	-7% ▼	1,503	8% ▲	92	-21% ▼	0.027	17% ▲
Pantex Plant	23.755	-79% ▼	3,422	-10% ▼	402	-89% ▼	0.059	85% ▲
Portsmouth Gaseous Diffusion Plant	2.029	83% ▲	2,267	5% ▲	69	73% ▲	0.029	6% ▲
Princeton Plasma Physics Laboratory	0.222	◊	358	◊	42	◊	0.005	◊
Sandia National Laboratories	3.092	-6% ▼	1,914	1% ▲	105	18% ▲	0.029	-20% ▼
Savannah River:								
Savannah River National Laboratory	4.073	-65% ▼	202	-68% ▼	165	-63% ▼	0.025	-6% ▼
Savannah River Site	148.663	32% ▲	6,495	0%	**4,965**	18% ▲	0.030	13% ▲
Savannah River Totals:	152.736	23% ▲	6,697	-6% ▼	5,130	10% ▲	0.030	12% ▲
Separations Process Research Unit	0.012	◊	8	◊	1	◊	0.012	◊
SLAC National Accelerator Laboratory	0.000	◊	1,589	◊	0	◊	◊	◊
Thomas Jefferson National Accelerator Facility	1.974	**225%** ▲	1,227	-7% ▼	48	**118%** ▲	0.041	49% ▲
Uranium Mill Tailings Remedial Action Project	7.836	-35% ▼	147	9% ▲	65	-32% ▼	**0.121**	-5% ▼
Waste Isolation Pilot Plant	1.283	14% ▲	423	6% ▲	78	16% ▲	0.016	-2% ▼
West Valley Demonstration Project	12.145	37% ▲	405	12% ▲	108	-4% ▼	0.112	42% ▲
Service Center Personnel*	3.719	**19%** ▲	273	-4% ▼	40	18% ▲	0.093	1% ▲
Totals	**828.036**	**11%** ▲	**67,773**	**5%** ▲	**17,130**	**-1%** ▼	**0.048**	**11%** ▲

Note: Bold and boxed values indicate the greatest value in each column.
◊ The percentage change from the previous year is not shown because it is not meaningful when the site collective dose is less than 1 person-rem (10 person-mSv).
* Includes personnel at NETL, NNSA Albuquerque complex, Oak Ridge, and WIPP in addition to several smaller facilities not associated with a DOE site.

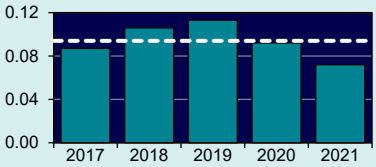
Exhibit 3-14: Activities Significantly Contributing to Collective TED in CY 2021, in Descending Order of Collective Dose.

Los Alamos National Laboratory (LANL)

Collective TED (person-rem)



Average Measurable TED (rem)



Site Description

LANL conducts radiological operations in active facilities, storage facilities, facilities with legacy radiological concerns, in addition to operations in inactive facilities and areas destined for decommissioning. Radiological activities include programmatic and production work; facility construction, modification, and maintenance; and research, development, and testing.

Activities Involving Radiation Exposure

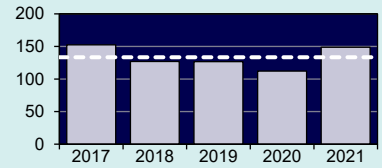
- Weapons manufacturing and related work at the TA-55 plutonium facility;
- Plutonium-238 work;
- Retrieval, repackaging, and shipping of radioactive waste; and
- Infrastructure support for radiological work and facility maintenance.

Changes in Dose

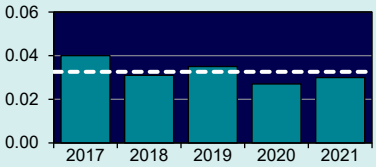
- A primary contributor to dose in CY 2021 was work with Pu-238, producing general purpose heat sources and other infrastructure support for radiological work at the TA-55 plutonium facility; and
- In CY 2021, there was an increase in work at TA-55, leading, to an increase in the number of personnel, and subsequently, an increase in collective dose.

Savannah River Site

Collective TED (person-rem)



Average Measurable TED (rem)



Site Description

Savannah River Site was constructed during the early 1950s to produce the basic materials used in the fabrication of nuclear weapons, primarily tritium and plutonium-239, in support of our nation's defense programs. Five reactors were built to produce these materials. Also built were several support facilities, including two chemical separations plants, a heavy water extraction plant, a nuclear fuel and target fabrication facility, a tritium extraction facility, and waste management facilities.

Activities Involving Radiation Exposure

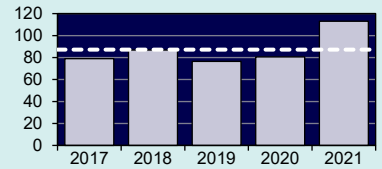
- Continued processing Canadian Target Residue Material;
- Finished decommissioning a former nuclear radiological facility;
- Post-closure care at closed reactor facilities; and
- Plutonium down blending.

Changes in Dose

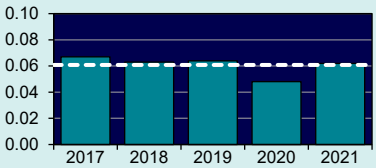
- CY 2021 dose increased in comparison with CY 2020 as workers safely removed failed vessels from the Hot Canyon; and
- Began process of deactivating 235-F.

Idaho

Collective TED (person-rem)



Average Measurable TED (rem)



Site Description

The primary focus of activities at the site is nuclear energy research and development at the Idaho National Laboratory. The DOE Idaho Operations Office oversees three major contracts to ensure that operations and research activities are carried out safely and in compliance with laws, regulations, and contract provisions. The Idaho Cleanup Project (ICP) focuses on addressing legacy wastes resulting from decades of widely varied work, including conventional weapons testing, government-owned research and power reactor development and testing, spent nuclear fuel reprocessing, laboratory research, and defense missions.

Activities Involving Radiation Exposure

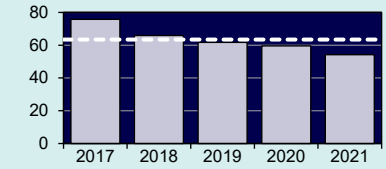
- Work at the Advanced Test Reactor (ATR) Complex, including experiment system operations, plant maintenance and modifications, routine ATR power and outage operations, and Research and Development Operations/Laboratory support;
- Activities at the Materials and Fuel Complex including maintenance and upgrades, treatment and storage for waste repackaging, benchtop and glovebox operations, decontamination efforts; and
- Waste handling, consolidation and shipment, decontamination work, and radiography operations.

Changes in Dose

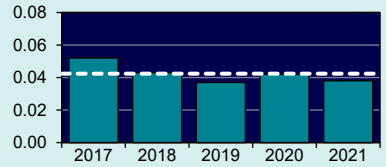
- Dose increased in CY 2021 with increased characterization of waste drums at CPP-659;
- Increased entries in the Integrated Fuel Storage Facility to repair canister lid clamps; and
- Completed several significant tasks in high dose rate areas.

Oak Ridge: Y-12 National Security Complex (Y-12)

Collective TED (person-rem)



Average Measurable TED (rem)



Site Description

Y-12 is one of four production facilities in the National Nuclear Security Agency (NNSA) Nuclear Security Enterprise. The facility's emphasis is the processing and storage of uranium and development of technologies associated with those activities. Y-12 maintains the safety, security, and effectiveness of the U.S. nuclear weapons stockpile and processes highly enriched uranium for the Naval Nuclear Propulsion Program.

Activities Involving Radiation Exposure

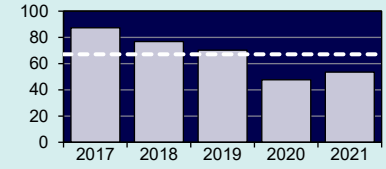
- Manufacture, processing, and storage of special nuclear materials;
- Characterization and hazardous waste removal at Y-12 Biology Complex; and
- Maintenance of equipment and facilities.

Changes in Dose

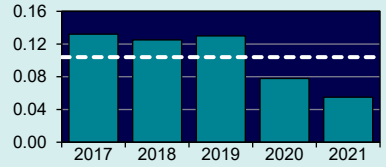
- In CY 2021, work was resumed after COVID-19 paused radiological work activities; and
- Continued cleaning activities.

Oak Ridge: Oak Ridge National Laboratory (ORNL)

Collective TED (person-rem)



Average Measurable TED (rem)



Site Description

ORNL is a multiprogramming science and technology laboratory. ORNL's mission is to deliver scientific discoveries and technical breakthroughs that will accelerate the development and deployment of solutions in clean energy and global security, and, in doing so, create economic opportunity for the nation. ORNL also performs other work for DOE, including isotope production, information management, and technical program management, and provides research and technical assistance to other organizations.

Activities Involving Radiation Exposure

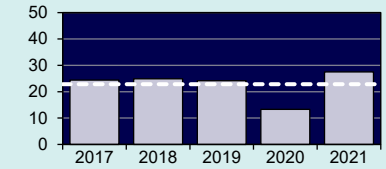
- Medical radioisotope production;
- Processing low-level and transuranic (TRU) waste at the TRU Waste Processing Center;
- Providing materials for National Aeronautics and Space Administration; and
- Facility maintenance.

Changes in Dose

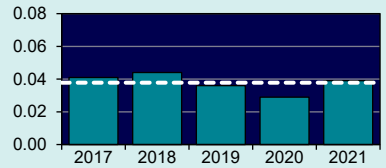
- The increase in monitored individuals along with increasing work activities after COVID-19 restrictions were relaxed resulted in an increase in the collective TED; and
- Decrease in the production of radioisotopes because of the restructuring of facility and work safety processes and fewer planned hot cell and manipulator maintenance projects resulted in a lower average measurable TED.

Hanford: Office of River Protection (ORP)

Collective TED (person-rem)



Average Measurable TED (rem)



Site Description

The ORP's mission is to retrieve and treat Hanford's waste and close the tank farms to protect the Columbia River. Chemical and radioactive waste, resulting from more than four decades of plutonium production, is currently stored in 177 large underground tanks. ORP is responsible for the retrieval, treatment, and disposal of this waste. The cornerstone of the tank waste cleanup project is the Waste Treatment Plant (WTP). The WTP will use a technology called vitrification to immobilize chemical and radioactive waste in an exceptionally sturdy form of glass to isolate it from the environment.

Activities Involving Radiation Exposure

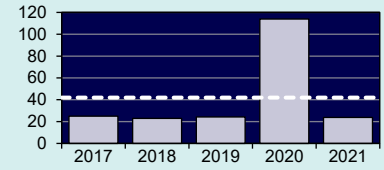
- Removal and transfer of waste from older single-shell tanks to newer double-shell tanks;
- Maintenance and support of the evaporator, which reduces the volume of stored liquid waste by concentrating radioactive waste solutions;
- Work at the 222-S laboratory; and
- Well logging activities using an AmBe source.

Changes in Dose

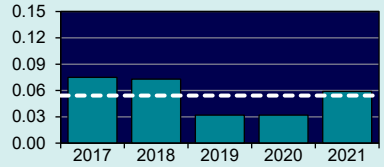
- The increase in collective TED was attributed to the resumption of operations in CY 2021 as compared with CY 2020 when radiological work was curtailed due to the COVID-19 pandemic.

Pantex Plant (Pantex)

Collective TED (person-rem)



Average Measurable TED (rem)



Site Description

Pantex is the nation's primary facility for the final assembly, disassembly, and maintenance of nuclear weapons. The last new nuclear weapon was completed in CY 1991. Since then, the plant has safely dismantled thousands of weapons retired from the stockpile by the military and placed the resulting plutonium pits in interim storage. Pantex has approximately 650 buildings, including specialized facilities in which maintenance, modification, disassembly, and assembly operations are conducted.

Activities Involving Radiation Exposure

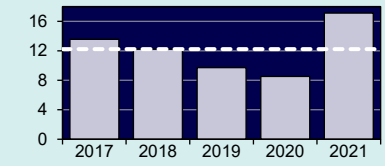
- Operations that expose individuals to large numbers of bare weapon pits containing significant quantities of special nuclear material (SNM); and
- Nuclear explosive assembly/disassembly operations, weapon dismantlement programs, life-extension programs, SNM Component Re-qualification, and SNM staging.

Changes in Dose

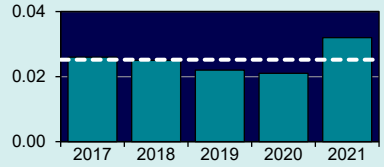
- In CY 2020, Pantex suffered a significant breakdown in dosimetry equipment that resulted in dosimeters being processed at an alternate site with additional estimates and calculations performed manually by Pantex personnel. All dose estimates were extremely conservative, elevating the dose results from CY 2020 to abnormally high levels; and
- The equipment issues have been addressed, and CY 2021 dose levels were similar to CY 2019 levels.

Hanford: Pacific Northwest National Laboratory (PNNL)

Collective TED (person-rem)



Average Measurable TED (rem)



Site Description

Located in Richland, Washington, PNNL is 1 of 10 national laboratories managed by DOE's Office of Science (SC). The laboratory provides the facilities, unique scientific equipment, and world-renowned scientists and engineers to strengthen U.S. scientific foundations through fundamental research and innovation. The lab also supports Hanford site cleanup efforts by performing scientific and technical evaluations and reviews and developing and advancing new technologies to address site cleanup challenges.

Activities Involving Radiation Exposure

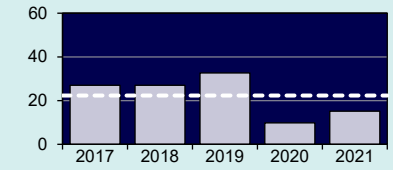
- Work at the Radiochemical Processing Laboratory;
- Radiation detection research; and
- Implementation of security measures for radiological materials of concern.

Changes in Dose

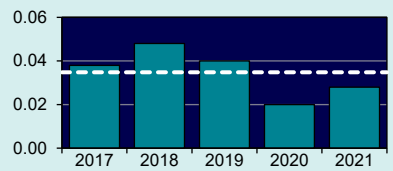
- Increased volume of elevated risk high-dose radiological work.

Hanford: Hanford Site

Collective TED (person-rem)



Average Measurable TED (rem)



Site Description

DOE's Hanford Site sits on 586 square miles in the desert of southeastern Washington State. The area is home to nine former nuclear reactors and their associated processing facilities that were built beginning in CY 1943. Hanford reactors produced plutonium from CY 1944 until 1987. Today, Hanford workers are involved in an environmental cleanup project and remediation of the site.

Activities Involving Radiation Exposure

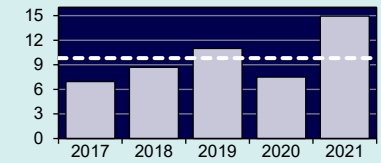
- Work activities at the plutonium finishing plant facility;
- Material handling and waste transfer; and
- Facility demolition and site remediation.

Changes in Dose

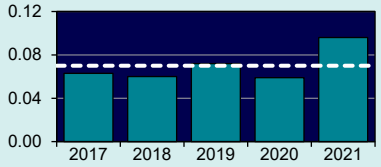
- The increase in collective TED was attributed to the resumption of operations in CY 2021 as compared with CY 2020 when radiological work was curtailed due to the COVID-19 pandemic.

Lawrence Livermore National Laboratory (LLNL)

Collective TED (person-rem)



Average Measurable TED (rem)



Site Description

LLNL is a DOE facility operated by the Lawrence Livermore National Security, LLC management team, which includes Bechtel, the University of California, BWX Technologies, Washington Group, and Battelle. The site serves as a national resource of scientific, technical, and engineering capability with a special focus on national security. LLNL's mission encompasses such areas as: strategic defense, energy, the environment, biomedicine, technology transfer, education, counterterrorism, and emergency response. The types of radioactive materials range from tritium to TRU; the quantities of each range from nanocuries (i.e., normal environmental background values) to kilocuries.

Activities Involving Radiation Exposure

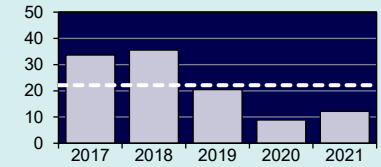
- Radiation-producing devices, such as x-ray machines, accelerators, and electron-beam welders; and
- Handling a wide range and quantity of radioactive materials.

Changes in Dose

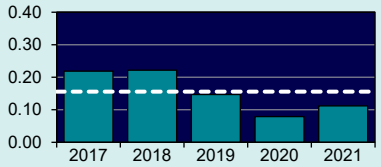
- Increased radiological work relative to that conducted during CY 2020 during the height of the COVID-19 pandemic, the number of individuals monitored increased, and a few individuals received relatively high dose.

West Valley Demonstration Project (WVDP)

Collective TED (person-rem)



Average Measurable TED (rem)



Site Description

WVDP is a unique operation within DOE and came into being through the WVDP Act of 1980. The Act requires DOE to be responsible for solidifying the high-level waste and disposing of waste created by the solidification and decommissioning of the facilities used in the process. The land and facilities are not owned by DOE; rather, the project premises are the property of the New York State Energy Research and Development Authority (NYSERDA) and represent only 200 acres of the larger Western New York Service Center, which is approximately 3,300 acres, also owned by NYSERDA. After DOE's responsibilities under the Act are complete, the Act requires that the premises be returned to New York State.

Activities Involving Radiation Exposure

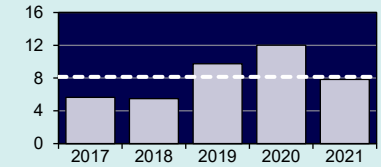
- Facility disposition;
- Deactivation work in the Main Plant Process Building (MPPB); and
- Radiological Control Technicians providing support for facility disposition activities.

Changes in Dose

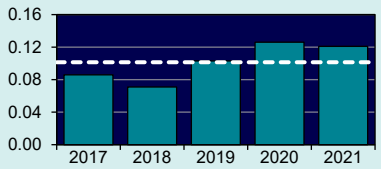
- Majority of dose was incurred during deactivation work in the MPPB; and
- Return to work following COVID-19 imposed restrictions and the performance of complex hands-on work in an area exhibiting very high radiation levels.

Uranium Mill Tailings Remedial Action Project (UMTRA)

Collective TED (person-rem)



Average Measurable TED (rem)



Site Description

The UMTRA site is located approximately 3 miles northwest of Moab in Grand County, Utah, and includes a former uranium-ore processing facility. The site encompasses 480 acres, of which approximately 130 acres are covered by a uranium mill tailings pile. The UMTRA Project ships four trainloads of tailings to the Crescent Junction Disposal Site each week. The trains contain 152 containers of approximately 34 tons each, or a total of 20,672 tons of tailings per week. Tailing shipments began in April 2009 and are expected to continue through CY 2034.

Activities Involving Radiation Exposure

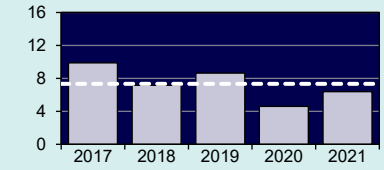
- Maintenance;
- Erosion control measures;
- Tailings excavation and conditioning;
- Loading tailings into containers and transporting to the rail beach;
- Ground water remediation; and
- Health and safety oversight.

Changes in Dose

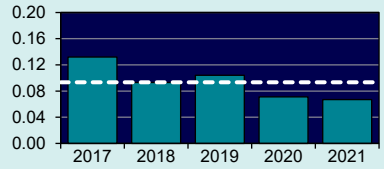
- Reduction in dose can be attributed to a 10 percent decrease in the quantity of tailings shipped.

Argonne National Laboratory (ANL)

Collective TED (person-rem)



Average Measurable TED (rem)



Site Description

ANL is one of DOE's largest national laboratories for scientific and engineering research. ANL's mission is to apply a unique mix of world-class science, engineering, and user facilities to deliver innovative research and technologies. The principal radiological facilities at the laboratory are the Advanced Photon Source, a superconducting heavy-ion linear accelerator (LINAC), a 22-MeV pulsed electron LINAC, and several other charged-particle accelerators.

Activities Involving Radiation Exposure

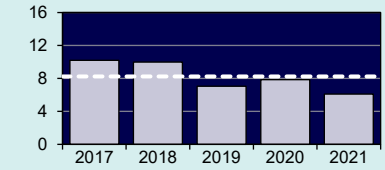
- Work supporting the lab's radiological facilities;
- Programmatic activities resulting primarily from research activities in the Irradiated Materials Laboratory; and
- Material handling, management, storage, and disposition activities associated with the Alpha Gamma Hot Cell Facility, the Waste Management Operations Facility, and the Radioactive Waste Storage Facility.

Changes in Dose

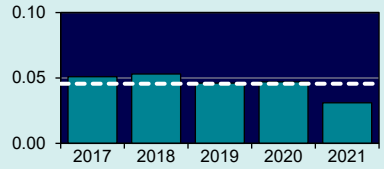
- Increased presence of workers on-site and work performed as the laboratory moves out of COVID-19 restrictions related to Minimum Safe Operations.

Fermi National Accelerator Laboratory (Fermilab)

Collective TED (person-rem)



Average Measurable TED (rem)



Site Description

Fermilab provides leadership and resources for qualified researchers to conduct basic research at the frontiers of high-energy particle physics and related disciplines. The primary features of the site include the accelerator complex and associated building infrastructure, an interconnected industrial cooling water system, a housing complex for visiting researchers, row crop agriculture, and natural areas in various states of restoration.

Activities Involving Radiation Exposure

- Upgrade and repair activities of the Fermilab accelerator complex;
- Installation of new NuMi target, upgrade of water piping, replacement of pre- and HEPA filters, ion pump replacement; and
- Management and disposal of radioactive waste.

Changes in Dose

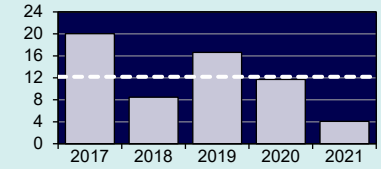
- Upgrade and repair activities of the accelerator complex; and
- The majority of dose to personnel resulted from work performed during the shutdown from June 27 to October 4 of CY 2021. Of the 157 planned jobs, 14 required ALARA plans, and completion of this work contributed significantly to the collective dose during the shutdown.

As seen in *Exhibit 3-11*, most of the collective TED is associated with just a few DOE sites. For sites with relatively low collective dose or with fewer monitored individuals, wider variation can occur from year to year. These year-to-year variations are often due to changes in funding or mission priorities that can significantly impact the relatively small amount of work involving radiation exposure. In CY 2021, 19 DOE sites reported less than 5 person-rem (50 person-mSv) collective TED for their respective site. One site, Energy Technology Engineering Center, ceased all work in radiological areas and is no longer monitoring personnel for occupational exposure. These sites and the activities contributing to collective TED can be found in *Exhibit 3-15*.

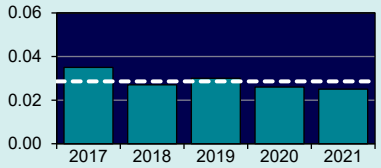
Exhibit 3-15: Activities Significantly Contributing to Collective TED in CY 2021, for Sites Reporting Less Than 5 Person-Rem, in Descending Order of Collective Dose.

Savannah River National Laboratory

Collective TED (person-rem)



Average Measurable TED (rem)



Site Description

Savannah River National Laboratory began reporting separately from the Savannah River Site effective CY 2016. The laboratory supports DOE in its environmental management and nuclear security missions and applies its expertise in nuclear chemical manufacturing to assist DOE in meeting its objectives in areas, such as nuclear waste cleanup and defense nonproliferation.

Activities Involving Radiation Exposure

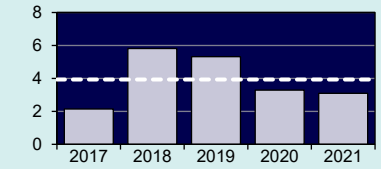
- Currently, most Savannah River National Laboratory programs support the Savannah River Site tritium mission. This includes applying hydrogen technologies used in processing tritium; extraction, purification, and storage of tritium; and
- Execution of the Mark-1A plutonium-244 recovery program.

Changes in Dose

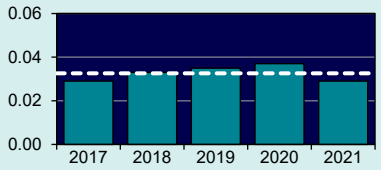
- Relocation of the laboratory's analytical laboratory facilities.

Sandia National Laboratories (SNL)

Collective TED (person-rem)



Average Measurable TED (rem)



Site Description

SNL's primary mission is ensuring the U.S. nuclear arsenal is safe, secure, and reliable, and can fully support our nation's deterrence policy. SNL is the engineering arm of the U.S. nuclear weapons enterprise. SNL's foundation is science-based engineering in which fundamental science, computer models, and unique experimental facilities come together so researchers can understand, predict, and verify weapon systems performance.

Activities Involving Radiation Exposure

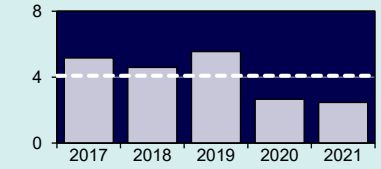
- Operation of a research reactor, gamma irradiation facility, hot cell facility, and several pulsed power accelerators;
- Conducting light laboratory work involving x-ray machines and tracer radionuclides; and
- Waste operations.

Changes in Dose

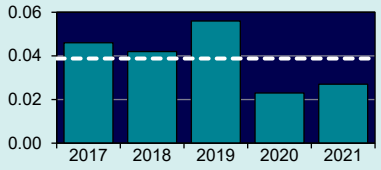
- CED increase is attributed to increased neutron generator production work performed by fewer individuals onsite due to the COVID-19 pandemic.

Paducah Gaseous Diffusion Plant (PGDP)

Collective TED (person-rem)



Average Measurable TED (rem)



Site Description

PGDP is located 3 miles south of the Ohio River and is 12 miles west of Paducah, Kentucky. The plant began enriching uranium in CY 1952, first for the nation's nuclear weapons program and then for nuclear fuel for commercial power plants. In CY 1994, the enrichment facilities were leased to United States Enrichment Corporation (USEC). In August 2013, USEC notified DOE that they were discontinuing enrichment operations and planning to de-lease the enrichment facilities.

Activities Involving Radiation Exposure

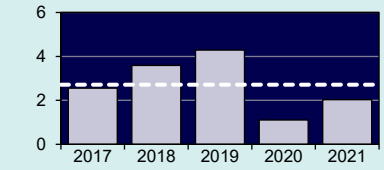
- Continued support of plant operations and maintenance of the Depleted Uranium Hexafluoride project as a nuclear facility;
- Environmental remediation and cleanup activities;
- Waste disposition; and
- Decontamination and decommissioning of inactive facilities.

Changes in Dose

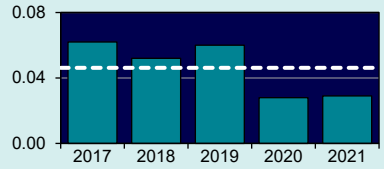
- Decrease in dose is attributed to primary work scope being performed in non-rad areas and having several employees teleworking due to COVID-19.

Portsmouth Gaseous Diffusion Plant (PORTS)

Collective TED (person-rem)



Average Measurable TED (rem)



Site Description

PORTS is located in Pike County, Ohio. PORTS was one of three large gaseous diffusion plants initially constructed to produce enriched uranium to support the nation's nuclear weapons program and later enrich uranium for commercial nuclear reactors. The plant has been shut down and is currently undergoing decontamination and decommissioning.

Activities Involving Radiation Exposure

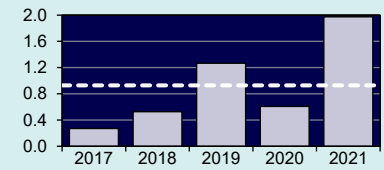
- Site deactivation, decommissioning, and demolition activities;
- Waste handling, processing, and shipment of uranium-bearing materials;
- Processing of uranium hexafluoride cylinders;
- Facility decontamination; and
- Uranium barter transfers.

Changes in Dose

- The plant began a gradual restart in late CY 2020 and into CY 2021. Work was subsequently returning to pre-COVID work levels.

Thomas Jefferson National Accelerator Facility (TJNAF)

Collective TED (person-rem)



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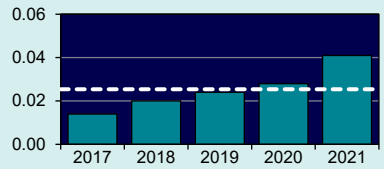


Site Description

TJNAF is one of 17 national laboratories funded by DOE. TJNAF's primary mission is to conduct basic research of the atom's nucleus using the unique particle accelerator known as the Continuous Electron Beam Accelerator Facility (CEBAF).

Activities Involving Radiation Exposure

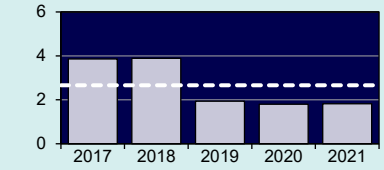
- Maintenance, modification, and repair of activated components associated with the CEBAF and other ancillary activities (e.g., transport, storage, and disposal of radioactive materials).

Changes in Dose

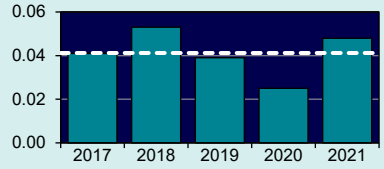
- Collective TED fluctuates up or down from year to year, depending on maintenance associated with unique experimental set-ups performed in radiological areas. In CY 2021, Hall A Dump reconfiguration accounted for most of the year's dose.

Nevada National Security Site (NNSS)

Collective TED (person-rem)



Average Measurable TED (rem)



Site Description

NNSS is located approximately 65 miles northwest of Las Vegas. It is a remote facility that covers approximately 1,375 square miles of land. NNSS has been the primary location for testing nuclear experiments in the continental United States since CY 1951.

Activities Involving Radiation Exposure

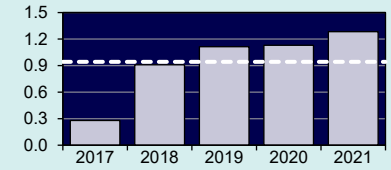
- Operation of low-level radioactive and mixed waste disposal facilities;
- Assembly and execution of subcritical experiments, confined critical experiments;
- Assembly/disassembly of special experiments;
- Operation of pulsed x-ray machines, linear accelerators, and neutron generators;
- Development, testing, and evaluation of radiation detectors;
- Surface cleanup and site characterization of contaminated land areas; and
- Managing environmental activity for the University of Nevada system.

Changes in Dose

- The increase in dose was attributed to the increase in activities associated with critical and special National Laboratories experiments and the increase in radiological work.

Waste Isolation Pilot Plant (WIPP)

Collective TED (person-rem)



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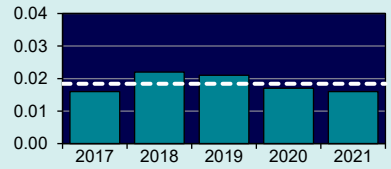


Site Description

WIPP is located in the Chihuahuan Desert near Carlsbad, New Mexico. This DOE facility safely disposes of the nation's defense-related transuranic (TRU) radioactive waste. WIPP began disposal operations in March 1999.

Activities Involving Radiation Exposure

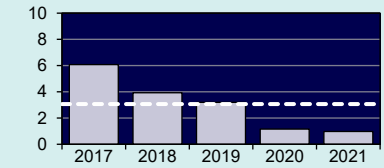
- Handling and processing of TRU waste for storage; and
- Managing long-term repository operations.

Changes in Dose

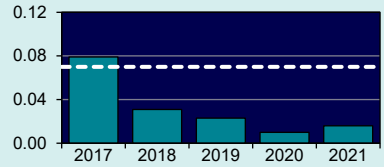
- All doses received were from routine activities associated with the disposal of TRU waste.

Brookhaven National Laboratory (BNL)

Collective TED (person-rem)



Average Measurable TED (rem)



Site Description

BNL conducts research in the physical, biomedical, and environmental sciences as well as in energy technologies and national security. BNL also builds and operates major scientific facilities that are available to university, industry, and government researchers.

Activities Involving Radiation Exposure

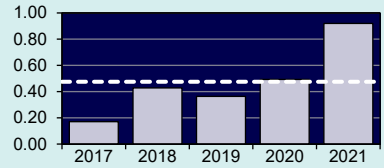
- Research involving nuclear and particle physics, accelerator science, and biological systems research;
- Facility maintenance and source replacement; and
- Support for the National Aeronautics and Space Administration Space Radiation Laboratory.

Changes in Dose

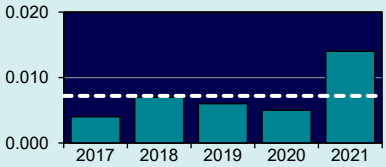
- The decrease in total dose was primarily due to restricted access to the BNL site and most of the personnel teleworking in response to the COVID-19 pandemic.

Kansas City National Security Campus (KC-NSC)

Collective TED (person-rem)



Average Measurable TED (rem)



Site Description

KC-NSC is responsible for manufacturing and procuring non-nuclear components for nuclear weapons, including electronic, mechanical, and engineered material components. It supports national laboratories, universities, and U.S. industry and is located in Kansas City, Missouri.

Activities Involving Radiation Exposure

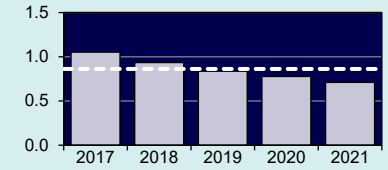
- Non-destructive testing, telemetry (neutron generators);
- Security operations, depleted uranium operations;
- Full production of weapons Life Extension Program; and
- Legacy part refurbishment and waste management.

Changes in Dose

- Increased production related to the B61-12 Life Extension Program.

Ames Laboratory

Collective TED (person-rem)



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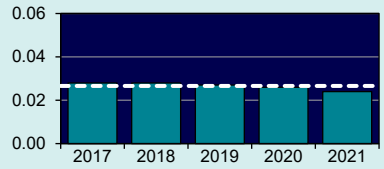


Site Description

Ames Laboratory is a government-owned, contractor-operated research facility of the DOE. For over 65 years, the Ames Laboratory has sought solutions to energy-related problems through the exploration of chemical, engineering, materials, mathematical, and physical sciences.

Activities Involving Radiation Exposure

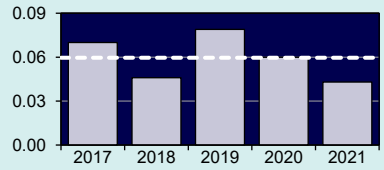
- Limited radioactive material work;
- Operation of 23 x-ray systems and 1 Mossbauer spectroscopy system; and
- Remediation of radiological legacy contamination is ongoing.

Changes in Dose

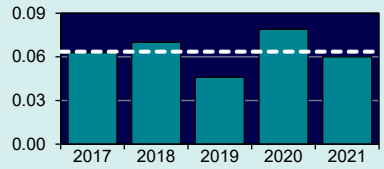
- Radiological activities returned to pre-COVID-19 levels around the middle of the monitoring period. The collective dose reflects normal routine operations and normal variations given the limited number of individuals with measurable dose and the very low doses.

Lawrence Berkeley National Laboratory (LBNL)

Collective TED (person-rem)



Average Measurable TED (rem)



Site Description

LBNL is a member of the national laboratory system supported by DOE through its Office of Science and is charged with conducting unclassified research across a wide range of scientific disciplines. LBNL employs approximately 4,200 scientists, engineers, support staff, and students.

Activities Involving Radiation Exposure

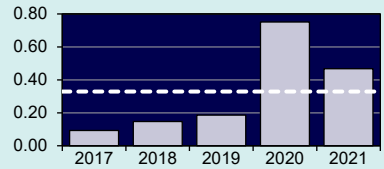
- Fluorine-18 research;
- Antineutrino research and experiments; and
- Site inventory of radioactive and nuclear material activities.

Changes in Dose

- The decrease in the collective TED was due to less dose to workers performing maintenance tasks at the 88-inch Cyclotron facility.

Oak Ridge: East Tennessee Technology Park (ETTP)

Collective TED (person-rem)



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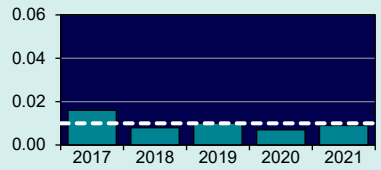


Site Description

ETTP was originally named the Oak Ridge Gaseous Diffusion Plant. As part of the Manhattan Project, the plant was designed to produce enriched uranium for use in atomic weapons operations during World War II. After the war, the plant was renamed the Oak Ridge K-25 Site and produced enriched uranium for the commercial nuclear power industry from CY 1945 to 1985. In CY 1987, DOE renamed the site ETTP and began a major environmental cleanup project with the long-term goal of converting ETTP into a private industrial park.

Activities Involving Radiation Exposure

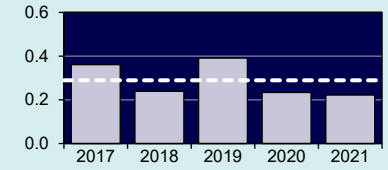
- Continuation of ongoing cleanup activities.

Changes in Dose

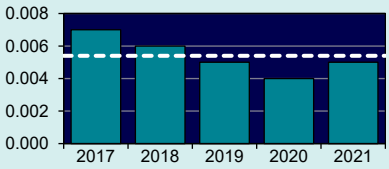
- Work focused on shifting to cleanup and demolition at the Oak Ridge National Laboratory.

Princeton Plasma Physics Laboratory (PPPL)

Collective TED (person-rem)



Average Measurable TED (rem)



Site Description

PPPL is a collaborative national center for fusion energy research. The laboratory advances the coupled fields of fusion energy and plasma physics research and enhances the scientific understanding and key innovations needed to realize fusion as an energy source for the world.

Activities Involving Radiation Exposure

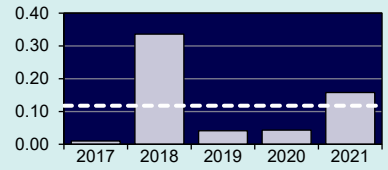
- Experimental and theoretical fusion research; and
- Plasma research and experiments involving radioactive sources and x-ray-generating devices.

Changes in Dose

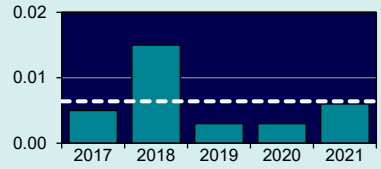
- The decrease in dose was attributed to COVID-19 decreased work duties.

Grand Junction Site

Collective TED (person-rem)



Average Measurable TED (rem)



Site Description

The Grand Junction Site was transferred to the Office of Legacy Management (LM) in CY 2003. Legacy Management manages the site according to a site-specific Long-Term Surveillance and Maintenance Plan.

Activities Involving Radiation Exposure

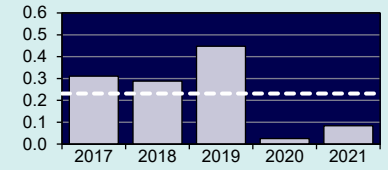
- Conducting annual sampling of groundwater and surface water;
- Validating the analytical data generated from the annual sampling event;
- Conducting an annual site inspection and preparing an inspection report;
- Inspecting abandoned mine sites; and
- Monitoring well maintenance.

Changes in Dose

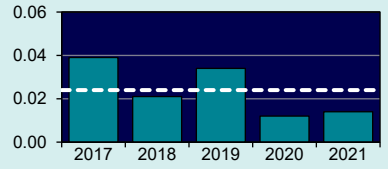
- All doses received were from routine field activities performed by Legacy Management personnel and were very low.

Office of Secure Transportation (OST)

Collective TED (person-rem)



Average Measurable TED (rem)



Site Description

OST is the NNSA organization tasked to provide secure ground transportation of nuclear weapons, special nuclear material (SNM), nuclear weapon components, and nuclear explosive-like assemblies. OST operates both secure ground transporters and Federal aircraft, which make up the Transportation Safeguards System (TSS). The TSS Federal Agent and vehicle maintenance facilities are located in Oak Ridge, Tennessee; Amarillo, Texas; and Albuquerque, New Mexico. The OST Administrative Headquarters are located at Kirtland Air Force Base in Albuquerque, New Mexico.

Activities Involving Radiation Exposure

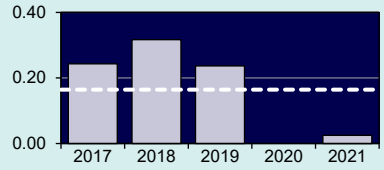
- Providing secure ground transportation of nuclear weapons, SNM, nuclear weapon components, and nuclear explosive-like assemblies; and
- Tracking and directing cargo loading revisions to minimize radiation exposure.

Changes in Dose

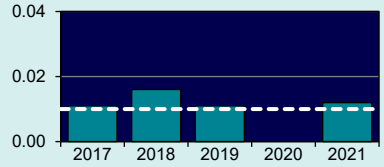
- Differences may be attributed to the small number of individuals (less than 10 for each year); and
- Due to COVID-19 impacts, the overall level of activity remained low.

Oak Ridge: Oak Ridge Institute for Science and Education (ORISE)

Collective TED (person-rem)



Average Measurable TED (rem)



Site Description

ORISE is a DOE institute focusing on scientific initiatives to research health risks from occupational hazards, assess environmental cleanup, respond to radiation medical emergencies, support national security and emergency preparedness, and educate the next generation of scientists.

Activities Involving Radiation Exposure

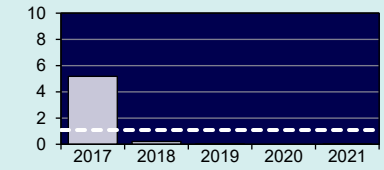
- Independent verification activities involving radiological surveys at sites undergoing decommissioning; and
- Environmental sample processing and radiological protection.

Changes in Dose

- Due to COVID-19 restrictions, little radiological site work was performed during the period.

Separations Process Research Unit (SPRU)

Collective TED (person-rem)



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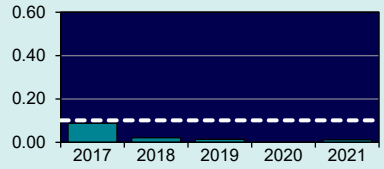


Site Description

SPRU is located at Knolls Atomic Power Laboratory based in upstate New York. Built in the 1940s, the buildings supported the SPRU mission to research the chemical process to extract plutonium from irradiated materials. Although the equipment was flushed and drained and bulk waste was removed following the shutdown of the facilities in CY 1953, residual materials are present in the tanks, buildings H2 and G2, and interconnecting pipe tunnels. The site is currently undergoing a variety of cleanup activities, including demolition, decontamination, and remediation.

Activities Involving Radiation Exposure

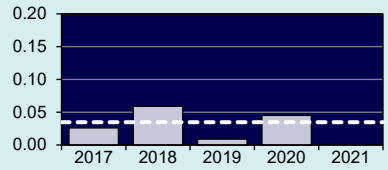
- Repackaging TRU waste;
- Processing and shipping low activity water and waste; and
- Surveillance and maintenance of site condition activities.

Changes in Dose

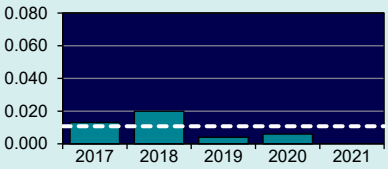
- Collective dose remained low due to maintaining proper as low as reasonably achievable controls during quarterly inspections of the TRU waste storage area.

Energy Technology Engineering Center (ETEC)

Collective TED (person-rem)



Average Measurable TED (rem)



Site Description

ETEC is located within Area IV of the Santa Susana Field Laboratory. The laboratory comprises four discrete operational areas with two adjacent undeveloped properties. In CY 1988, DOE decided to close the remaining ETEC operations. ETEC is currently in a safe shutdown mode, pending the completion of the Environmental Impact Statement.

Activities Involving Radiation Exposure

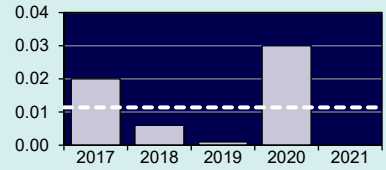
- Disposition of government property;
- Cleanup of facilities, demolition of facilities, and site restoration;
- Area IV is undergoing characterization for cleanup of the area; and
- Investigation and remediation of soil and groundwater.

Changes in Dose

- In CY 2021, ETEC eliminated personnel dosimeters due to no accessible radiological areas present onsite.

National Renewable Energy Laboratory (NREL)

Collective TED (person-rem)



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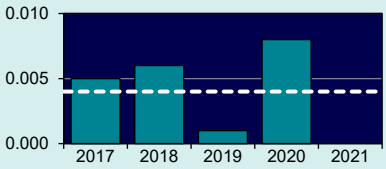


Site Description

NREL focuses on creative answers to today's energy challenges. From fundamental science and energy analysis to validating new products for the commercial market, NREL researchers are dedicated to transforming the way the world uses energy. With more than 35 years of successful innovation in energy efficiency and renewable energy, NREL discoveries provide sustainable alternatives for powering homes, businesses, and transportation systems.

Activities Involving Radiation Exposure

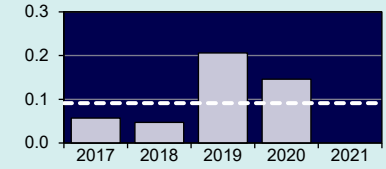
- Electron microscopy staining; and
- Operation of analytical and process equipment containing sealed sources.

Changes in Dose

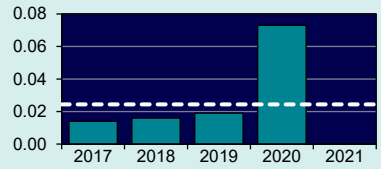
- Due to the small number of individuals with measurable dose, these small differences are within normal variations; and
- Site activity continued to be reduced due to COVID-19.

SLAC National Accelerator Laboratory (SLAC)

Collective TED (person-rem)



Average Measurable TED (rem)



Site Description

SLAC, which opened in CY 1962, is one of 10 DOE Office of Science laboratories and is operated by Stanford University on behalf of DOE. Originally a premier high-energy particle accelerator laboratory, SLAC has grown into a state-of-the-art photon science laboratory. SLAC's scientific mission has diversified from an original focus on particle physics and accelerator science to include cosmology, materials and environmental sciences, biology, chemistry, and alternative energy research.

Activities Involving Radiation Exposure

- Operation of the LINAC Coherent Light Source (LCLS) – the world's first hard x-ray free electron laser;
- Operation of the Stanford Synchrotron Radiation Lightsource – a pioneering synchrotron radiation facility; and
- Operation of the Stanford Positron-Electron Asymmetric Ring (SPEAR3), and a separate, shorter linear accelerator (LINAC), and a booster ring for injecting accelerated beams of electrons into SPEAR3.

Changes in Dose

- The CY 2021 collective TED of 0.0 is a reflection of the fact that no major radiological projects were conducted during CY 2021.

3.4.4 Summary by Program Office

DOE has divided the responsibility of managing its missions among specific program offices. A site may include facilities or project areas that perform work in support of the mission of multiple program offices. In these cases, the dose records are separated by the reporting organization and assigned to the corresponding program office. For this reason, some sites will have portions of the collective dose shown under more than one program office.

Exhibit 3-16 shows the collective TED, number of individuals with measurable TED, and the average measurable TED by DOE program office. NNSA and the Office of Environmental Management (EM) account for 82 percent of the collective TED (55 and 27 percent, respectively).

The primary sites contributing to the collective TED within EM are Savannah River Site and Idaho. For NNSA, the primary contributors are LANL, Savannah River Site, and Y-12.

A more detailed breakdown of the exposure information by site, program office, and contractor is included in the Appendices of this report.

Exhibit 3-16: Program Office Dose Data, CY 2021.

Program Office	Collective TED (person-rem)	Percent Change from 2020	Number with Meas. Dose (TED)	Percent Change from 2020	Avg. Meas. TED (rem)	Percent Change from 2020
Office of Energy Efficiency and Renewable Energy (EE)					**Total Monitored =**	**7***
National Renewable Energy Laboratory	0.000	◊	0	◊	0.000	◊
EE Totals	**0.000**	◊	**0**	◊	**0.000**	◊
Office of Environmental Management (EM)					**Total Monitored =**	**20,393***
East Tennessee Technology Park	0.468	◊	53	◊	0.009	◊
Hanford Site	15.128	54% ▲	534	10% ▲	0.028	40% ▲
Idaho (ICP, AMWTP and DOE IOO)	39.741	44% ▲	654	1% ▲	0.061	**43%** ▲
Los Alamos National Laboratory	2.391	82% ▲	112	**300%** ▲	0.021	-54% ▼
Nevada National Security Site	0.000	◊	0	◊	0.000	◊
Oak Ridge National Laboratory	14.310	**137%** ▲	631	129% ▲	0.023	4% ▲
Office of River Protection	27.476	107% ▲	706	53% ▲	0.039	35% ▲
Paducah Gaseous Diffusion Plant	2.465	-7% ▼	92	-21% ▼	0.027	17% ▲
Portsmouth Gaseous Diffusion Plant	2.029	83% ▲	69	73% ▲	0.029	6% ▲
Savannah River National Laboratory	4.073	-65% ▼	165	-63% ▼	0.025	-6% ▼
Savannah River Site	**94.058**	30% ▲	**3,149**	18% ▲	0.030	10% ▲
Separations Process Research Unit	0.012	◊	1	◊	0.012	◊
Service Center Personnel*	3.644	18% ▲	39	22% ▲	0.093	-3% ▼
Uranium Mill Tailings Remedial Action Project	7.836	-35% ▼	65	-32% ▼	**0.121**	-5% ▼
Waste Isolation Pilot Plant	1.283	14% ▲	78	16% ▲	0.016	-2% ▼
West Valley Demonstration Project	12.145	37% ▲	108	-4% ▼	0.112	42% ▲
EM Totals	**227.059**	**32%** ▲	**6,456**	**16%** ▲	**0.035**	**14%** ▲
Office of Fossil Entergy (FE)					**Total Monitored =**	**92***
Service Center Personnel*	0.000	◊	0	◊	0.000	◊
FE Totals	**0.000**	◊	**0**	◊	**0.000**	◊
Office of Legacy Management (LM)					**Total Monitored =**	**33***
Grand Junction Site	0.158	◊	28	◊	0.006	◊
LM Totals	**0.158**	◊	**28**	◊	**0.006**	◊
National Nuclear Security Administration (NNSA)					**Total Monitored =**	**29,306***
Kansas City National Security Campus	0.920	◊	68	◊	0.014	◊
Lawrence Livermore National Laboratory	14.933	**99%** ▲	155	21% ▲	**0.096**	65% ▲
Los Alamos National Laboratory	**300.795**	30% ▲	**4,094**	**64%** ▲	0.073	-21% ▼
Nevada National Security Site	1.821	1% ▲	38	-47% ▼	0.048	**92%** ▲
Office of Secure Transportation	0.084	◊	6	◊	0.014	◊
Pantex Plant	23.735	-79% ▼	401	-89% ▼	0.059	85% ▲
Sandia National Laboratories	3.092	-6% ▼	105	18% ▲	0.029	-20% ▼
Savannah River Site	54.605	37% ▲	1,816	17% ▲	0.030	18% ▲
Y-12 National Security Complex	54.186	-9% ▼	1,436	1% ▲	0.038	-10% ▼
NNSA Totals	**454.171**	**-1%** ▼	**8,119**	**-14%** ▼	**0.056**	**15%** ▲
Office of Nuclear Energy (NE)					**Total Monitored =**	**4,143***
Idaho National Laboratory	73.367	39% ▲	1,162	14% ▲	0.063	21% ▲
NE Totals	**73.367**	**39%** ▲	**1,162**	**14%** ▲	**0.063**	**21%** ▲
Office of Science (SC)					**Total Monitored =**	**13,792***
Ames Laboratory	0.710	◊	30	◊	0.024	◊
Argonne National Laboratory	6.385	39% ▲	96	48% ▲	0.067	-6% ▼
Brookhaven National Laboratory	0.977	◊	60	◊	0.016	◊
Fermi National Accelerator Laboratory	6.110	-22% ▼	195	16% ▲	0.031	-33% ▼
Lawrence Berkeley National Laboratory	0.511	◊	12	◊	0.043	◊
Oak Ridge Institute for Science and Education	0.025	◊	2	◊	0.013	◊
Oak Ridge National Laboratory	**39.145**	-6% ▼	345	3% ▲	**0.113**	-9% ▼
Pacific Northwest National Laboratory	17.127	101% ▲	**533**	31% ▲	0.032	**54%** ▲
Princeton Plasma Physics Laboratory	0.222	◊	42	◊	0.005	◊
SLAC National Accelerator Laboratory	0.000	◊	0	◊	0.000	◊
Thomas Jefferson National Accelerator Facility	1.974	**225%** ▲	48	**118%** ▲	0.041	49% ▲
SC Totals	**73.186**	**10%** ▲	**1,363**	**13%** ▲	**0.054**	**-2%** ▼

Note: Bold and boxed values indicate the greatest value in each category.

◊ The percentage change from the previous year is not shown because it is not meaningful when the site collective dose is less than 1 person-rem (10 person-mSv).

* Individuals who worked at more than one program office are represented within each grouping; therefore, the total monitored values will not match the annual number of individuals monitored.

3.5 Transient Individuals

For this report, a DOE site is defined as a geographic location. Transient individuals, or transients, are defined as individuals who are monitored at more than one DOE site during the calendar year and, therefore, had more than one monitoring record reported to the REMS repository. This section presents information on transient individuals to determine the extent to which individuals traveled from site to site and to examine the doses received by these individuals.

The tracking and analysis of transient individuals are important aspects of the REMS Program. While each site is responsible for monitoring individuals during their work at that site, the REMS Program collects dose records from all sites and verifies that individuals do not exceed regulatory limits by accruing doses at multiple facilities. Although the number of transient individuals and average doses have been low, the examination of these records remains an important function in assessing performance of DOE radiation protection programs.

Exhibit 3-17 shows the dose distribution and total number of transient individuals from CY 2017 to 2021. Over the past 5 years, the records of transient individuals have averaged almost 3 percent of the total records for all monitored individuals. These individuals received, on an average, 2.5 percent of the collective TED. The collective TED for transients increased from 10.37 person-rem (103.72 person-mSv) in CY 2020 to 15.29 person-rem (152.9 person-mSv) in CY 2021. The average measurable TED increased from 0.031 rem (0.310 mSv) in CY 2020 to 0.035 rem (0.350 mSv) in CY 2021. The 47 percent increase in the collective TED in CY 2021 is the result of the resumption of travel to pre-COVID-19 pandemic levels.

3.6 Historical Data

To provide historical context for radiation exposure data at DOE, it is useful to include information prior to the past 5 years. *Exhibit 3-18* and *Exhibit 3-19* show a summary of occupational exposures starting in CY 1974, when the Atomic Energy Commission (AEC) split into the U.S. Nuclear Regulatory Commission (NRC) and the Energy Research and Development Administration (ERDA), which subsequently became DOE. *Exhibit 3-18* and *Exhibit 3-19* show the collective dose, average measurable dose, and number of individuals with a measurable dose from CY 1974 to CY 2021. All three parameters decreased dramatically between CY 1986 and CY 1993 due to the shutdown of facilities within the weapons complex and the end of the Cold War era. After this time, the DOE mission shifted from weapons production to shutdown, stabilization, and decontamination and decommissioning activities.

Exhibit 3-17: Dose Distribution of Transient Individuals, CY 2017 – 2021.

	Dose Ranges (TED in rem)*	2017	2018	2019	2020	2021
Transients	Less than measurable	2,035	2,291	2,144	522	1,041
	Measurable <0.100	432	404	475	324	409
	0.100 – 0.250	24	23	31	12	16
	0.250 – 0.500	12	13	12	2	4
	0.500 – 0.750	3	1	2	0	1
	0.750 – 1.000	1	2	2	0	0
	1.0 – 2.0					1
	>2.0					
	Total number of individuals monitored**	2,507	2,734	2,666	860	1,472
	Number with measurable dose	472	443	522	338	431
	% with measurable dose	19%	16%	20%	39%	29%
	Collective TED (person-rem)	20.069	18.934	22.369	10.370	15.294
	Average measurable TED (rem)	0.043	0.043	0.043	0.031	0.035
All DOE	Total number of records for monitored individuals	79,906	75,634	76,143	64,694	67,773
	Number of individuals with measurable dose	13,019	13,335	13,824	17,252	17,130
	% of total monitored individuals who are transient	3.1%	3.6%	3.5%	1.3%	2.2%
	% of the number of individuals with measurable dose who are transient	3.6%	3.3%	3.8%	2.0%	2.5%

*Individuals with doses equal to the dose value separating the dose ranges are included in the next higher dose range.
** Total number of individuals represents the number of individuals monitored and not the number of records.

Exhibit 3-18: Collective Dose and Average Measurable Dose, CY 1974 – 2021.

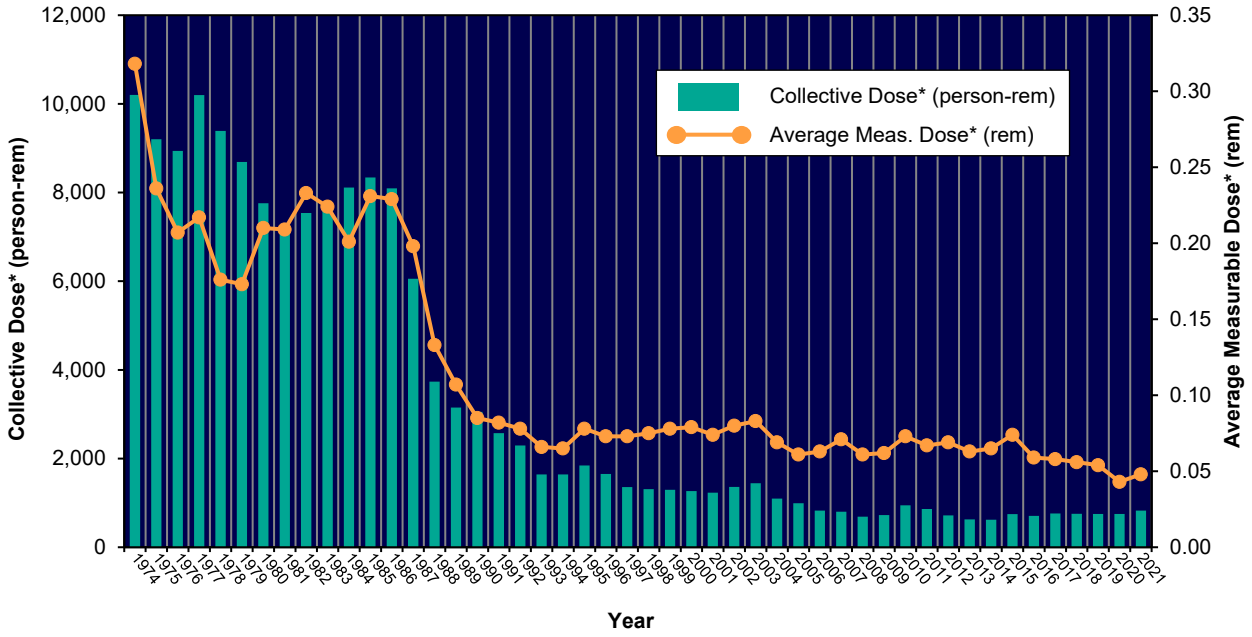
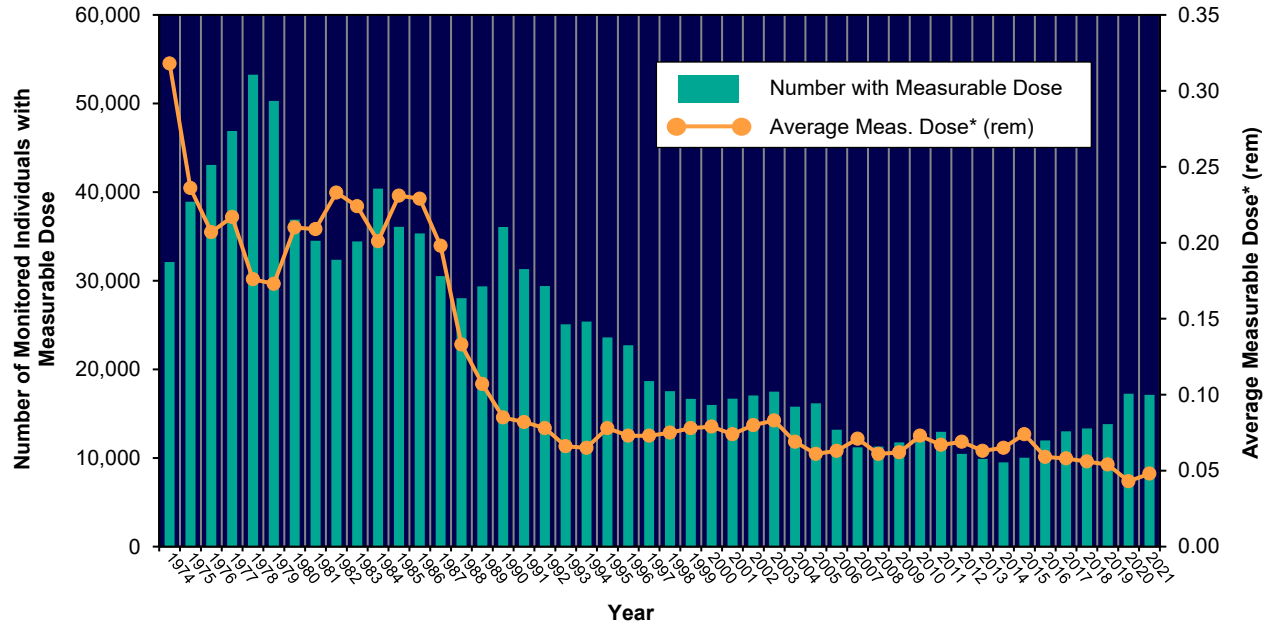


Exhibit 3-19: Number of Individuals with Measurable Dose and Average Measurable Dose, CY 1974 – 2021.



* COLLECTIVE DOSE

1974 – 1989	collective dose = Deep Dose Equivalent (DDE)
1990 – 1992	collective dose = DDE + Annual Effective Dose Equivalent (AEDE)
1993 – 2009	collective dose = DDE + Committed Effective Dose Equivalent (CEDE)
2010 – Present	collective dose = Effective Dose (from external sources) (ED) + Committed Effective Dose (CED)

AGENCIES

1946 – 1974	Atomic Energy Commission (AEC)
1974 – 1977	Energy Research and Development Administration (ERDA)
1977 – Present	Department of Energy (DOE)

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ALARA and Operating Experience Programs

Two DOE Office of Environment, Health, Safety and Security (EHSS) Programs that are closely related to the collection and analysis of occupational radiation exposure are the ALARA Program and the Operating Experience Program (OEP). A description of these programs is provided here as well as access information.

4.1 ALARA Program

Descriptions of ALARA activities that have shown promise in reducing the radiation exposure at DOE are collected for the purpose of sharing strategies and techniques among DOE radiation protection managers. Project descriptions are voluntarily submitted from the sites and are not independently verified or endorsed by DOE. Program and site offices and contractors who are interested in benchmarks of success and continuous improvement in the context of integrated safety management and quality are encouraged to provide input.

Descriptions of ALARA activities are provided on the DOE web site:

https://www.energy.gov/ehss/occupational-radiation-exposure-publications

Individual project descriptions may be submitted to EHSS through the REMS web site. The submissions should describe the process in sufficient detail to provide a basic understanding of the project, the radiological concerns, and the activities initiated to reduce dose. The web site provides a form to collect the following information about the project:

- Mission statement;
- Project description;
- Radiological concerns;
- Total collective dose for the project;
- Dose rate to exposed workers before and after exposure controls were implemented;
- Information on how the process implemented ALARA techniques in an innovative or unique manner;
- Estimated dose avoided;
- Project staff involved;
- Approximate cost of the ALARA effort;
- Impact on work processes, in person-hours if possible (may be negative or positive);
- Figures and/or photos of the project or equipment (electronic images if available); and
- Point of contact for follow-up by interested professionals.

The REMS web page for submitting ALARA project descriptions can be accessed on the internet at:

https://www.energy.gov/ehss/downloads/line-alara-project-submittal-form-report-alara-project-descriptions-rems

4.2 Operating Experience Program

DOE has a mature Operating Experience Program (OEP), which has been enhanced from the lessons learned program that was initially developed in CY 1994. The OEP is described in DOE O 210.2A, *DOE Corporate Operating Experience Program* [9].

The objectives of OEP are to institute a DOE-wide program for the management of operating experience to prevent adverse operating incidents and to expand the sharing of good work practices among DOE sites. The program provides a systematic review, identification, collection, screening, evaluation, and dissemination of operating experience from U.S. and foreign government agencies and industry, professional societies, trade associations, national academies, universities, and DOE and its contractors. DOE Headquarters takes corporate responsibility for identifying, analyzing, and sharing operating experience information. Operating experience/lessons

learned provided by DOE field sites optimize the knowledge gained by communicating through various products, including a corporate database.

DOE posts operating experience information and links to other operating experience resources on the internet to disseminate information so that DOE and external entities may improve the health and safety aspects of operations within their facilities, including reducing the number of accidents and injuries.

For further information contact:

Ms. Colette Broussard
Office of Environment, Health, Safety and Security (EHSS)
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, D.C. 20585-1290
E-mail: **colette.broussard@hq.doe.gov**

https://www.energy.gov/ehss/corporate-operating-experience-program

Conclusions

Analysis of the collected exposure data for CY 2021 indicate that:

- DOE operations were in compliance with regulatory radiation protection requirements as no exposures were reported to have exceeded the occupational dose limit of 5 rem (50 mSv) TED; and
- Only 25 percent of the monitored individuals received a measurable dose, and of those, the average measurable dose received was less than 1 percent of the 5 rem (50 mSv) TED limit.

In addition, from CY 2020 to CY 2021 the:

- The number of individuals with measurable dose decreased by less than 1 percent however, the collective TED increased by 11 percent.
- The number of facilities citing the COVID-19 pandemic as limiting operational activities decreased from 62 percent to 53 percent;
- Collective CED (internal exposure to U-234) decreased by 23 percent to 43.8 person-rem (438 person-mSv); and
- Collective TED for transient individuals increased by 47 percent to 15.3 person-rem (153 person-mSv).

The collective dose at DOE facilities has decreased by 91 percent since CY 1986. This coincides with the end of the Cold War era, which shifted the DOE mission from weapons production to stabilization, waste management, and environmental remediation activities, along with the consolidation and remediation of facilities across the complex to meet the new mission.

In alignment with the change in mission, regulations and requirements have been modified (see Section 2) that reinforce DOE's focus on ALARA practices and risk reduction to lowering occupational radiation dose.

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Glossary

Administrative Control Level (ACL)
A dose level that is established below the DOE dose limit to administratively control exposures. ACLs are multi-tiered, with increasing levels of authority required to approve a higher level of exposure.

As Low As Reasonably Achievable (ALARA)
The approach to radiation protection to manage and control exposures (both individual and collective) to the work force and to the general public to as low as is reasonable, taking into account social, technical, economic, practical, and public policy considerations. As used in this part, ALARA is not a dose limit but a process which has the objective of attaining doses as far below the applicable limits of this part as is reasonably achievable.
[10 CFR 835.2]

Average Measurable Dose
The dose obtained by dividing the collective dose by the number of individuals who received a measurable dose. This is the average most commonly used when examining trends and comparing doses received by individuals, because it reflects the exclusion of those individuals receiving a less than measurable dose. In this report, average measurable dose is calculated for total effective dose (TED) and committed effective dose (CED).

Bioassay Measurements
As presented in Section 3.3.4, the number of bioassay measurements is the number of measurements taken to determine the kinds, quantities, or concentrations of radioactive material in the human body, whether by direct measurement or by analysis and evaluation of materials excreted or removed from the human body. Types of bioassay include:

- In Vivo bioassay: From the Latin for "in one that is living," occurring within the living. The direct measurement of radioactive material in the human body. The number of in vivo measurements represents the number of measurements performed for all individuals during the year.
- Fecal bioassay: The evaluation of radioactive material excreted in feces from the human body. The number of fecal bioassay measurements is the number of fecal samples analyzed for all individuals during the year.
- Urinalysis bioassay: The evaluation of radioactive material excreted in urine from the human body. The number of urinalysis bioassay measurements is the number of fecal samples analyzed for all individuals during the year.

Collective Dose
The sum of doses to all individuals in a population for a period of time and is used whenever the dose may refer to more than one type of dose. In cases where the type of dose is specified, the term “collective” is followed by the type of dose, such as the TED, CED, or photon. In all cases, the population is the group of DOE individuals that were monitored for occupational radiation exposure, and the period of time is the monitoring year. Collective dose is expressed in units of person-rem.

Committed Effective Dose (CED) or (E_{50})
Means the sum of the committed equivalent doses to various tissues or organs in the body ($H_{T,50}$), each multiplied by the appropriate tissue weighting factor (w_T)—that is, $E_{50} = \Sigma w_T H_{T,50} + w_{Remainder} H_{Remainder,50}$. Where $w_{Remainder}$ is the tissue weighting factor assigned to the remainder organs and tissues and $H_{Remainder,50}$ is the committed equivalent dose to the remainder organs and tissues. Committed effective dose is expressed in units of rem (or Sv).
[10 CFR 835.2]

Committed Equivalent Dose (CEqD) or ($H_{T,50}$)
Means the equivalent dose calculated to be received by a tissue or organ over a 50-year period after the intake of a radionuclide into the body. It does not include contributions from radiation sources external to the body. Committed equivalent dose is expressed in units of rem (or Sv). [10 CFR 835.2]

Dose
A general term for absorbed dose, equivalent dose, effective dose, committed equivalent dose, committed effective dose, or total effective dose as defined in this part. [10 CFR 835.2]

Effective Dose
Means the summation of the products of the equivalent dose received by specified tissues or organs of the body (H_T) and the appropriate tissue weighting factor (w_T)—that is, $E = \Sigma w_T H_T$. It includes the dose from radiation sources internal and/or external to the body. For purposes of compliance with this part, equivalent dose to the whole body may be used as effective dose for external exposures. The effective dose is expressed in units of rem (or Sv). [10 CFR 835.2]

Equivalent Dose (EqD)
Means the product of average absorbed dose ($D_{T,R}$) in rad (or gray) in a tissue or organ (T) and a radiation (R) weighting factor (w_R). For external dose, the equivalent dose to the whole body is assessed at a depth of 1 cm in tissue; the equivalent dose to the lens of the eye is assessed at a depth of 0.3 cm in tissue, and the equivalent dose to the extremity and skin is assessed at a depth of 0.007 cm in tissue. Equivalent dose is expressed in units of rem (or Sv). [10 CFR 835.2]

Measurable Dose
A dose greater than zero rem (not including doses reported as "not detectable").

Member of the Public
Means an individual who is not a general employee. An individual is not a "member of the public" during any period in which the individual receives an occupational dose. [10 CFR 835.2] The definition of general employee is specified in 10 CFR 835.

Number of Individuals with Measurable Dose
The subset of all monitored individuals who receive a measurable dose (greater than the limit of detection for the monitoring system). Many personnel are monitored as a matter of prudence and may not receive a measurable dose. For this reason, the number of individuals with measurable dose is presented in this report as a more accurate indicator of the exposed workforce. The number of individuals represents the number of dose records reported. Some individuals may be counted more than once if multiple dose records are reported for the individual during the year.

Occupational Exposure
An individual's exposure to ionizing radiation (external and internal) as a result of that individual's work assignment. Occupational exposure does not include planned special exposures, exposure received as a medical patient, background radiation, or voluntary participation in medical research programs.

Person-rem
The unit of measurement used for the collective dose to all DOE Federal, contractor, and subcontractor employees.

Rem
A unit of dose derived from the phrase Roentgen equivalent man. The rem is equal to 0.010 Sv, which is the international unit of measurement for radiation exposure.

Total Effective Dose (TED)
Means the sum of the effective dose (for external exposures) and the committed effective dose. [10 CFR 835.2]

Total Organ Dose (TOD)
The sum of the equivalent dose to the whole body for external exposures and the committed equivalent dose to any organ or tissue other than the skin or the lens of the eye.

Transient Individual
As used in this report, a transient individual is an individual monitored for radiation exposure at more than one DOE site during the calendar year.

References

1. EPA (U.S. Environmental Protection Agency), 1987. "Radiation Protection Guidance to Federal Agencies for Occupational Exposure," *Federal Register* 52, No. 17, 2822; with corrections published in the *Federal Registers* of Friday, January 30, and Wednesday, February 4, 1987.

2. ICRP (International Commission on Radiological Protection), 1977. "Recommendations of the International Commission on Radiological Protection," ICRP Publication 26, *Annals of the ICRP, Vol. 1, No. 3* (Pergamon Press, New York).

3. NCRP (National Council on Radiation Protection and Measurements), 1987. "Recommendations on Limits for Exposure to Ionizing Radiation," NCRP 91; superseded by NCRP Report No. 116.

4. 10 CFR 835, 1998, "Occupational Radiation Protection." Rule; DOE *Federal Register*, November 4, 1998. Amended August 11, 2017.

5. DOE O 231.1B, 2011, "Environment, Safety and Health Reporting," June 27, 2011.

6. REMS Data Reporting Guide, issued February 23, 2012. Online at: https://www.energy.gov/ehss/downloads/radiation-exposure-monitoring-systems-data-reporting-guide.

7. Computerized Accident Incident Reporting System (CAIRS), "DOE and Contractor Injury and Illness Data by Year by Quarter" report. Online at: https://www.energy.gov/ehss/policy-guidance-reports/databases/computerized-accident-incident-reporting-system.

8. DOE Standard, DOE-STD-1098-2017, "Radiological Control," January 2017. Online at: https://www.standards.doe.gov/standards-documents/1000/1098-AStd-2017/@@images/file.

9. DOE O 210.2A, "DOE Corporate Operating Experience Program," April 8, 2011. Online at: https://www.directives.doe.gov/directives-documents/200-series/0210.2-BOrder-a/@@images/file.

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U.S. Department of Energy Occupational Radiation Exposure Report for Calendar Year 2021

DOE, striving to meet the needs of its stakeholders, is looking for suggestions on ways to improve the *U.S. Department of Energy Occupational Radiation Exposure Report for Calendar Year 2021*. **Your feedback is important**. Constructive feedback will ensure this report can continue to meet user needs. Please fill out the attached survey form and return it to:

Ms. Katharine McLellan
Office of Environment, Health, Safety and Security (EHSS)
DOE REMS Program Manager
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, D.C. 20585-1290
katharine.mclellan@hq.doe.gov
Fax: (301) 903-1257

Questions concerning this survey should be directed to Ms. McLellan at (202) 586-0183.

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   Name: _____

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	Not Useful				Very Useful
Please rate the usefulness of this report overall:	1	2	3	4	5

Please rate the usefulness of the analysis presented in the following sections:

Executive Summary	1	2	3	4	5
Analysis of Aggregate Data	1	2	3	4	5
Collective Dose	1	2	3	4	5
Average Measurable Dose	1	2	3	4	5
Dose Distribution	1	2	3	4	5
Analysis of Individual Dose Data	1	2	3	4	5
Doses in Excess of DOE limit (5 rem)	1	2	3	4	5
Doses in Excess of ACL limit (2 rem)	1	2	3	4	5
Intakes of Radioactive Material	1	2	3	4	5
Bioassay and Intake Summary Information	1	2	3	4	5
Analysis of Site Data	1	2	3	4	5
Collective TED by Site and Other Facilities	1	2	3	4	5
Activities Significantly Contributing to Collective Dose	1	2	3	4	5
Additional Site Descriptions	1	2	3	4	5
Summary by Program Office	1	2	3	4	5
Transient Individuals	1	2	3	4	5
Historical Data	1	2	3	4	5
ALARA Activities at DOE	1	2	3	4	5
Conclusions	1	2	3	4	5

Please rate the importance of the timeliness of the publication of this report as it relates to your professional need for the information on occupational radiation exposure at DOE:

	Not important				Critical
	1	2	3	4	5

Please provide any additional input or comments on this report.

Appendix A: DOE Reporting Sites and Reporting Codes

The following is a list of the Occupation Codes that are reported with each individual's dose record to the DOE Radiation Exposure Monitoring System (REMS) in accordance with Order 231.1B. Occupation Codes are grouped into Labor Categories for the purposes of analysis and summary in this report. The occupation codes are listed in the REMS Reporting Guide, Table G-7, and represent a subset of the occupations listed in the Department of Commerce's Standard Occupational Classification (SOC) Manual (1980).

Exhibit A-1: Labor Categories and Occupation Codes

Labor Category	Occupation Code	Occupation Name
Agriculture	562	Groundskeepers
	570	Forest Workers
	580	Misc. Agriculture
Construction/Repair	610	Mechanics/Repairers
	641	Masons
	642	Carpenters
	643	Electricians
	644	Painters
	645	Pipe Fitter
	650	Miners/Drillers
	660	Misc. Repair/Construction
Laborers	850	Handlers/Laborers/Helpers
Management	110	Manager - Administrator
	400	Sales
	450	Admin. Support and Clerical
Misc.	910	Military
	990	Miscellaneous
Production	681	Machinists
	682	Sheet Metal Workers
	690	Operators, Plant/System/Utility
	710	Machine Setup/Operators
	771	Welders and Solderers
	780	Misc. Precision/Production
Professional	160	Engineer
	170	Scientist
	184	Health Physicist
	200	Misc. Professional
	260	Doctors and Nurses
Service Workers	512	Firefighters
	513	Security Guards
	521	Food Service Employees

Exhibit A-1: Labor Categories and Occupation Codes		
Labor Category	**Occupation Code**	**Occupation Name**
	524	Janitors
	525	Misc. Service
Technicians	350	Technicians
	360	Health Technicians
	370	Engineering Technicians
	380	Science Technicians
	383	Radiation Monitors/Techs.
	390	Misc. Technicians
Transport Workers	820	Truck Drivers
	821	Bus Drivers
	825	Pilots
	830	Equipment Operators
	840	Misc. Transport
Unknown	001	Unknown

The following is a list of all organizations reporting to the DOE REMS from CY 2017–2021. The list provides the Site groupings used in this report as well as the organization reporting code and name.

Exhibit A-2: Organizations Reporting to DOE REMS, CY 2017–2021.							
Site	**Org. Code**	**Organization Name**	**2017**	**2018**	**2019**	**2020**	**2021**
Albuquerque	OST3100	Office of Secure Transportation	●	●	●	●	●
Ames Laboratory	1000503	Ames Laboratory (Iowa State)	●	●	●	●	●
Argonne National Laboratory (ANL)	1000703	Argonne National Laboratory	●	●	●	●	●
Brookhaven National Laboratory (BNL)	1001003	Brookhaven National Laboratory	●	●	●	●	●
DOE Headquarters	1504001	DOE Headquarters	●	●	●	●	●
Energy Technology Engineering Center	8002001	Cabrera Services	●	●	●	●	-
Fermi National Accelerator Lab. (FERMI)	1002503	Fermilab	●	●	●	●	●
Grand Junction Site	3260615	Navarro Research and Engineering	●	●	●	●	●
Hanford	4700805	Bechtel National Corporation	●	●	●	●	●
	4701001	DOE, Office of River Protection	●	●	●	●	●
	4702005	Wastren Advantage, Inc.	●	●	●	●	●
	4706104	Hanford Laboratory Management Integration	-	-	-	-	●
	4707104	Washington River Protection Solutions, LLC	●	●	●	●	●
	NA-2000	NNSA - Visitors	●	●	●	●	-
	NA-2100	NNSA - Management and Support Personnel	●	●	●	●	●
	NA-2101	NNSA - Mgmt. & Support Personnel: MELE Assoc.	●	●	●	●	●
	NA-2110	NNSA - North and South America	●	●	●	●	-
	NA-2120	NNSA - Europe, Africa and the Middle East	●	●	●	●	-
	7500503	Battelle - PNNL	●	●	●	●	●
	7500504	Battelle -PNNL- Subs	●	●	●	●	●
	7500521	Pacific Northwest Site Office	●	●	●	●	●
	7502504	HPMC Occupational Medical Services	●	●	●	●	●
	7504204	Hanford Mission Integration Solutions (HMIS)	-	-	-	-	●
	7504304	Central Plateau Cleanup Company	-	-	-	-	●

Exhibit A-2: Organizations Reporting to DOE REMS, CY 2017–2021.

Site	Org. Code	Organization Name	2017	2018	2019	2020	2021
	7505214	Mission Support Alliance (MSA)	●	●	●	●	●
	7505304	CH2M Hill Plateau Remediation Company	●	●	●	●	●
	7506001	DOE-Richland Field Office	●	●	●	●	●
Idaho	3004001	Idaho Field Office	●	●	●	●	●
	3005003	INL - BEA, LLC - Research	●	●	●	●	●
	3005004	INL - BEA, LLC - Services	●	●	●	●	●
	3005009	INL - BEA, LLC - Security	●	●	●	●	●
	3005012	INL - BEA, LLC - Production	●	●	●	●	●
	3006002	INL - Fluor- Projects	●	●	●	●	●
	3006004	ICP - Fluor - Subcontractors	●	●	●	●	●
	3006005	ICP - Fluor - Support	●	●	●	●	●
Kansas City National Security Campus	0531002	Honeywell FM & T	●	●	●	●	●
Lawrence Berkeley National Lab. (LBNL)	8003003	Lawrence Berkeley National Laboratory	●	●	●	●	●
Lawrence Livermore National Lab. (LLNL)	0580403	Lawrence Livermore National Laboratory	●	●	●	●	●
	0580414	LLNL - Service Subcontractors	-	-	-	-	●
	0580416	LLNL - Construction Subcontractors	-	●	●	●	-
	0580503	LLNL - Nevada	●	●	●	●	●
	0580701	LLNL - DOE Site Office	●	●	●	●	-
Los Alamos National Lab. (LANL)	0540001	NNSA Los Alamos Site Office	●	●	●	●	●
	0544003	Los Alamos National Laboratory	●	●	●	●	●
	0544006	Los Alamos National Lab Construction Subs	●	●	●	●	●
	0544809	Protection Technologies Los Alamos	●	-	-	-	-
	0544904	Johnson Controls, Inc.	●	●	-	-	-
	1530001	Newport News Nuclear BWXT Los Alamos (N3B)	-	●	●	●	●
National Renewable Energy Laboratory	2806003	National Renewable Energy Laboratory	●	●	●	●	●
Nevada National Security Site	0501001	NNSA Service Center	●	●	-	-	-
	0520001	NNSA Nevada Site Office	●	●	●	●	●
	0521104	MSTS - Livermore Operations	●	●	●	●	-
	0521204	MSTS - Las Vegas	●	●	●	●	●
	0521304	MSTS - Los Alamos	●	●	●	●	●
	0521314	NSTec - Sandia	●	-	●	-	-
	0521405	MSTS - NTS	●	●	●	●	●
	0521416	MSTS - NTS subcontractors	●	●	●	●	●
	0521503	MSTS - Special Tech. Lab	●	●	●	●	●
	0529004	Nevada	●	●	●	-	-
	0529009	Wackenhut Services Inc. - NV	●	●	●	●	●
	3505104	Navarro-Intera LLC	●	●	●	●	●
	3508004	Nye County Sheriff - NSTec	●	-	-	-	-
	3508703	SAIC - NV	●	-	-	-	-
	9708001	USGS - Yucca	●	●	-	-	-
Oak Ridge Site	4003602	UT-Battelle: ORNL-Isotek	●	●	-	-	-
	4004203	Oak Ridge Inst. For Science & Educ. (ORISE)	●	●	●	●	●
	4004602	Tru Waste Processing Center - ORNL	●	●	●	●	●
	4006002	UCOR - ETTP	●	●	●	●	●
	4006503	UT-Battelle - ORNL	●	●	●	●	●
	4006510	UCOR - ORNL	●	●	●	●	●

Exhibit A-2: Organizations Reporting to DOE REMS, CY 2017–2021.

Site	Org. Code	Organization Name	2017	2018	2019	2020	2021
	4007509	National Strategic Protective Services	●	●	-	-	-
	4008010	UCOR- Y-12	●	●	●	●	●
	4018102	CNS, LLC, Y-12	●	●	●	●	●
Paducah Gaseous Diff. Plant (PGDP)	4007002	Swift & Staley Team	●	●	●	●	●
	6203106	DUF6 Paducah Construction Subs - MACS	●	●	●	●	●
	6503304	Four Rivers Nuclear Partnership	●	●	●	●	●
Pantex Plant (PP)	0510001	CNS Pantex - NNSA and DOE Couriers	●	●	●	●	-
	0514004	Battelle - Pantex	●	●	●	●	●
	0515002	CNS Pantex	●	●	●	●	●
	0515006	CNS Pantex - Construction Subs	●	●	●	●	-
	0515009	CNS Pantex - Security	-	●	●	-	-
Portsmouth Gaseous Diff. Plant (PORTS)	6202106	Mid-America Conversion Services (MCS)	●	●	●	●	●
	6202204	Portsmouth Mission Alliance (PMA)	●	●	●	●	●
	6202304	Fluor B & W Portsmouth	●	●	●	●	●
Princeton Plasma Physics Laboratory	1005003	Princeton Plasma Physics Laboratory	●	●	●	●	●
Sandia National Laboratories (SNL)	0578003	Sandia National Laboratories	●	●	●	●	●
Savannah River	0595112	Tritium Extractopm Facility	●	●	●	●	●
	8500000	Savannah River Operations	-	-	-	-	●
	8500505	Bechtel Construction - SR	●	●	-	-	●
	8500516	Miscellaneous SRS Construction Subs	●	●	●	●	●
	8501042	SRR Operations	●	●	●	●	●
	8505501	Savannah River Field Office	●	●	●	●	●
	8505504	Misc. DOE Contractors - SR	●	●	●	●	●
	8505525	Savannah River Nuclear Solutions, Inc.	●	●	●	-	●
	8505526	SR Construction - Parsons Subcontractors	●	●	●	●	●
	8509003	Univ. of Georgia Ecology Laboratories	●	●	●	●	●
	8509509	Centerra - SR	●	●	●	●	●
	8511002	Savannah River Nuclear Solutions, Inc.	●	●	●	●	●
	8511003	Savannah River National Laboratory	●	●	●	●	-
	8511004	SRNS Service Subs	●	●	●	●	●
	8511005	SRNS Construction	●	●	●	●	●
	8511006	SRNS Construction Subs	●	●	●	●	●
	8512003	BSRA - SR National Laboratory	-	-	-	-	●
	8512004	BSRA - Service Subs	-	-	-	-	●
Separations Process Research Unit	1523016	NY SPRU	●	●	●	●	●
Service Center Personnel	0501001	NNSA Albuquerque Complex	●	●	●	●	-
	0701001	Carlsbad Field Office	●	●	●	●	●
	0702003	Los Alamos National Lab - WIPP	●	●	●	●	●
	1504001	DOE Headquarters	●	●	●	●	●
	2041001	NETL Morgantown	-	-	-	●	●
	2042001	NETL Pittsburgh	-	-	-	●	●
	2045001	NETL Albany	-	-	-	●	●
	4003602	Isotek (Bldg 3019)	●	●	●	●	●
SLAC National Accelerator Facility	8008003	Stanford Linear Accelerator Center	●	●	●	●	●

Exhibit A-2: Organizations Reporting to DOE REMS, CY 2017–2021.							
Site	**Org. Code**	**Organization Name**	**2017**	**2018**	**2019**	**2020**	**2021**
Thomas Jefferson National Accelerator Facility	1509503	Thomas Jefferson National Accelerator Facility	●	●	●	●	●
	1509521	Jefferson Laboratory - DOE Employees	●	●	●	-	●
Uranium Mill Tailings Remediation Action Project	3260645	Uranium Mill Tailings Remedial Action - Moab	●	●	●	●	●
Waste Isolation Pilot Plant	0701001	Carlsbad Field Office	●	●	-	-	-
	0702003	LANL - WIPP	●	●	-	-	-
	0703104	Washington TRU Solutions LLC-WIPP	●	●	●	●	●
	0703109	Santa Fe Protective Services - WIPP	●	●	●	●	●
	0703114	WTS Subcontractors - WIPP	●	●	●	●	●
West Valley Project	4539004	West Valley Nuclear Services, Inc. (WVNS)	●	●	●	●	●
Pittsburg Naval Reactor Office	6007504	PNR - BAPL & BPMI-P	●	●	●	●	●
	6008003	PNR - BAPL & BPMI-P	●	●	●	●	●
	6009003	Naval Reactors - Idaho	●	●	●	●	●
Schenectady Naval Reactor Office	9004003	Knolls Atomic Power Laboratory	-	●	●	●	●
	9005003	Knolls Atomic Power Laboratory	●	●	●	●	●
	9005004	Knolls Atomic Power Laboratory	-	●	●	●	●

The following is a list of Facility Type Codes reported to REMS in accordance with the REMS Reporting Guide. A facility type code is reported with each individual's dose record and indicates the facility type where the majority of the individual's dose was accrued during the monitoring year.

Exhibit A-3: Facility Type Codes.	
Facility Type Code	**Description**
10	Accelerator
21	Fuel/Uranium Enrichment
22	Fuel Fabrication
23	Fuel Processing
40	Maintenance and Support (Site-Wide)
50	Reactor
61	Research, General
62	Research, Fusion
70	Waste Processing/Mgmt.
80	Weapons Fab. and Testing
99	Other

Appendix B: Additional Data

Exhibit B-1: Site Dose Data, CY 2019.

Site	Collective TED (person-rem)	Percent Change – Coll. TED	Number with Meas. Dose	Percent Change - # with Meas. Dose	Avg. Meas. TED (rem)	Percent Change – Avg. Meas. TED	Percentage of Coll. TED above 0.500 rem	Percent Change – Coll. TED above 0.500 rem
Ames Laboratory	0.837	–	31	–	0.027	–	–	–
Argonne National Laboratory	8.650	21% ▲	83	8% ▲	0.104	12% ▲	**39%**	52% ▲
Brookhaven National Laboratory	3.191	-19% ▼	137	10% ▲	0.002	-26% ▼	–	–
Energy Technology Engineering Center	0.009	–	2	–	0.005	–	–	–
Fermi National Accelerator Laboratory	7.060	-29% ▼	154	-18% ▼	0.045	-14% ▼	–	–
Grand Junction Site	0.041	–	13	–	0.003	–	–	–
Hanford: Hanford Site	32.673	21% ▲	822	45% ▲	0.040	4% ▲	3%	-81% ▼
Hanford: Office of River Protection	24.153	-3% ▼	671	18% ▲	0.035	4% ▲	–	–
Hanford: Pacific Northwest National Laboratory	9.717	-21% ▼	446	-10% ▼	0.021	2% ▲	–	–
Idaho	76.511	-12% ▼	1,203	-12% ▼	0.063	6% ▲	3%	**129%** ▲
Kansas City National Security Campus	0.364	–	66	–	0.005	–	–	–
Lawrence Berkeley National Laboratory	1.810	78% ▲	23	5% ▲	0.078	**71%** ▲	–	–
Lawrence Livermore National Laboratory	11.003	27% ▲	153	6% ▲	0.072	20% ▲	14%	-3% ▼
Los Alamos National Laboratory	**224.472**	8% ▲	1,983	2% ▲	0.113	7% ▲	31%	9% ▲
National Renewable Energy Laboratory	0.001	–	1	–	0.001	–	–	–
Nevada National Security Site	1.940	-50% ▼	50	-32% ▼	0.039	-26% ▼	–	–
Oak Ridge: East Tennessee Technology Park	0.186	–	19	–	0.010	–	–	–
Oak Ridge: Oak Ridge Institute for Science and Education	0.237	–	22	–	0.011	–	–	–
Oak Ridge: Oak Ridge National Laboratory	70.245	-9% ▼	539	-12% ▼	0.130	4% ▲	29%	-12% ▼
Oak Ridge: Y–12 National Security Complex	61.751	-6% ▼	1,665	9% ▲	0.037	-14% ▼	–	–
Office of Secure Transportation	0.448	–	13	–	0.034	–	–	–
Paducah Gaseous Diffusion Plant	5.554	21% ▲	100	-9% ▼	0.055	33% ▲	–	–
Pantex Plant	24.248	6% ▲	758	1% ▲	0.032	-56% ▼	–	–
Portsmouth Gaseous Diffusion Plant	4.289	20% ▲	71	3% ▲	0.060	16% ▲	–	–
Princeton Plasma Physics Laboratory	0.391	–	72	–	0.005	–	–	–
Sandia National Laboratories	5.323	-9% ▼	154	-12% ▼	0.035	4% ▲	–	–
Savannah River National Lab	16.631	97% ▲	547	74% ▲	0.030	13% ▲	4%	–
Savannah River Site	126.763	-1% ▼	**3,651**	-11% ▼	0.035	12% ▲	1%	–
Separations Process Research Unit	0.029	–	2	–	0.015	–	–	–
SLAC National Accelerator Laboratory	0.206	–	11	–	0.019	–	–	–
Thomas Jefferson National Accelerator Facility	1.266	**141%** ▲	52	**100%** ▲	0.024	20% ▲	–	–
Uranium Mill Tailings Remedial Action Project	9.748	78% ▲	95	23% ▲	0.103	44% ▲	–	–
Waste Isolation Pilot Plant	1.113	22% ▲	54	29% ▲	0.021	-4% ▼	–	–
West Valley Demonstration Project	20.459	-42% ▼	139	-13% ▼	**0.147**	-34% ▼	11%	-77% ▼
Service Center Personnel*	0.996	–	22	–	0.045	–	–	–
Totals	**752.315**	**0%**	**13,824**	**4%** ▲	**0.054**	**-4%** ▼	**14%**	**-9%** ▼

Note: Boxed values (gray background) indicate the greatest value in each column.
* Includes personnel at NNSA Albuquerque complex, Oak Ridge, and WIPP, in addition to several smaller facilities not associated with a DOE site.

Exhibit B-2: Site Dose Data, CY 2020.

Site	Collective TED (person-rem)	Percent Change – Coll. TED	Number with Meas. Dose	Percent Change - # with Meas. Dose	Avg. Meas. TED (rem)	Percent Change – Avg. Meas. TED	Percentage of Coll. TED above 0.500 rem	Percent Change – Coll. TED above 0.500 rem
Ames Laboratory	0.777	–	30	–	0.026	–	–	–
Argonne National Laboratory	4.609	-47% ▼	65	-22% ▼	0.071	-32% ▼	–	–
Brookhaven National Laboratory	1.161	-64% ▼	111	-19% ▼	0.010	-55% ▼	–	–
Energy Technology Engineering Center	0.045	–	8	–	0.006	–	–	–
Fermi National Accelerator Laboratory	7.850	11% ▲	168	9% ▲	0.047	2% ▲	6%	–
Grand Junction Site	0.043	–	14	–	0.003	–	–	–
Hanford: Hanford Site	9.797	-70% ▼	485	-41% ▼	0.020	-49% ▼	–	–
Hanford: Office of River Protection	13.291	-45% ▼	461	-31% ▼	0.029	-20% ▼	–	–
Hanford: Pacific Northwest National Laboratory	8.523	-12% ▼	408	-9% ▼	0.021	-4% ▼	–	–
Idaho	80.614	5% ▲	1,667	39% ▲	0.048	-24% ▼	4%	**47% ▲**
Kansas City National Security Campus	0.493	–	93	–	0.005	–	–	–
Lawrence Berkeley National Laboratory	0.834	–	14	–	0.060	–	–	–
Lawrence Livermore National Laboratory	7.494	-32% ▼	128	-16% ▼	0.059	-19% ▼	14%	5% ▲
Los Alamos National Laboratory	**232.736**	4% ▲	2,523	27% ▲	0.092	-19% ▼	**25%**	-21% ▼
National Renewable Energy Laboratory	0.030	–	4	–	0.008	–	–	–
Nevada National Security Site	1.800	-7% ▼	72	44% ▲	0.025	-36% ▼	–	–
Oak Ridge: East Tennessee Technology Park	0.751	–	102	–	0.007	–	–	–
Oak Ridge: Oak Ridge Institute for Science and Education	–	–	–	–	–	–	–	–
Oak Ridge: Oak Ridge National Laboratory	47.666	-32% ▼	610	13% ▲	0.078	-40% ▼	**24%**	-19% ▼
Oak Ridge: Y–12 National Security Complex	59.591	-3% ▼	1,428	-14% ▼	0.042	13% ▲	–	–
Office of Secure Transportation	0.025	–	2	–	0.012	–	–	–
Paducah Gaseous Diffusion Plant	2.654	-52% ▼	116	16% ▲	0.023	-59% ▼	–	–
Pantex Plant	113.909	**370% ▲**	3,563	**370% ▲**	0.032	0%	–	–
Portsmouth Gaseous Diffusion Plant	1.107	-74% ▼	40	-44% ▼	0.028	-54% ▼	–	–
Princeton Plasma Physics Laboratory	0.234	–	54	–	0.004	–	–	–
Sandia National Laboratories	3.287	-38% ▼	89	-42% ▼	0.037	7% ▲	–	–
Savannah River National Lab	11.717	-30% ▼	445	-19% ▼	0.026	-13% ▼	–	–
Savannah River Site	112.247	-11% ▼	**4,220**	16% ▲	0.027	-23% ▼	–	–
Separations Process Research Unit	–	–	–	–	–	–	–	–
SLAC National Accelerator Laboratory	0.146	–	2	–	0.073	–	–	–
Thomas Jefferson National Accelerator Facility	0.607	–	22	–	0.028	–	–	–
Uranium Mill Tailings Remedial Action Project	12.004	23% ▲	95	0%	**0.126**	23% ▲	18%	–
Waste Isolation Pilot Plant	1.130	2% ▲	67	24% ▲	0.017	-18% ▼	–	–
West Valley Demonstration Project	8.868	-57% ▼	112	-19% ▼	0.079	-46% ▼	–	–
Service Center Personnel*	3.116	213% ▲	34	55% ▲	0.092	**102% ▲**	–	–
Totals	**749.156**	**0%**	**17,252**	**25% ▲**	**0.043**	**-20% ▼**	**10%**	**-26% ▼**

Note: Boxed values (gray background) indicate the greatest value in each column.
* Includes personnel at NETL, NNSA Albuquerque complex, Oak Ridge, and WIPP, in addition to several smaller facilities not associated with a DOE site.

Exhibit B-3: Site Dose Data, CY 2021.

Site	Collective TED (person-rem)	Percent Change – Coll. TED	Number with Meas. Dose	Percent Change - # with Meas. Dose	Avg. Meas. TED (rem)	Percent Change – Avg. Meas. TED	Percentage of Coll. TED above 0.500 rem	Percent Change – Coll. TED above 0.500 rem
Ames Laboratory	0.710	–	30	–	0.024	–	–	–
Argonne National Laboratory	6.385	39% ▲	96	48% ▲	0.067	-6% ▼	8%	–
Brookhaven National Laboratory	0.977	–	60	–	0.016	–	–	–
Fermi National Accelerator Laboratory	6.110	-22% ▼	195	16% ▲	0.031	-33% ▼	–	–
Grand Junction Site	0.158	–	28	–	0.006	–	–	–
Hanford: Hanford Site	15.128	54% ▲	534	10% ▲	0.028	40% ▲	–	–
Hanford: Office of River Protection	27.476	107% ▲	706	53% ▲	0.039	35% ▲	–	–
Hanford: Pacific Northwest National Laboratory	17.127	101% ▲	533	31% ▲	0.032	54% ▲	–	–
Idaho	113.108	40% ▲	1,816	9% ▲	0.062	29% ▲	11%	146% ▲
Kansas City National Security Campus	0.920	–	68	–	0.014	–	–	–
Lawrence Berkeley National Laboratory	0.511	–	12	–	0.043	–	–	–
Lawrence Livermore National Laboratory	14.933	99% ▲	155	21% ▲	0.096	65% ▲	**42%**	**197% ▲**
Los Alamos National Laboratory	**303.186**	30% ▲	4,206	67% ▲	0.072	-22% ▼	22%	-9% ▼
National Renewable Energy Laboratory	–	–	–	–	–	–	–	–
Nevada National Security Site	1.821	1% ▲	38	-47% ▼	0.048	**92% ▲**	–	–
Oak Ridge: East Tennessee Technology Park	0.468	–	53	–	0.009	–	–	–
Oak Ridge: Oak Ridge Institute for Science and Education	0.025	–	2	–	0.012	–	–	–
Oak Ridge: Oak Ridge National Laboratory	53.455	12% ▲	976	60% ▲	0.055	-30% ▼	18%	-26% ▼
Oak Ridge: Y-12 National Security Complex	54.186	-9% ▼	1,436	1% ▲	0.038	-10% ▼	–	–
Office of Secure Transportation	0.084	–	6	–	0.014	–	–	–
Paducah Gaseous Diffusion Plant	2.465	-7% ▼	92	-21% ▼	0.027	17% ▲	–	–
Pantex Plant	23.755	-79% ▼	402	-89% ▼	0.059	85% ▲	–	–
Portsmouth Gaseous Diffusion Plant	2.029	83% ▲	69	72% ▲	0.029	6% ▲	–	–
Princeton Plasma Physics Laboratory	0.222	–	42	–	0.005	–	–	–
Sandia National Laboratories	3.092	-6% ▼	105	18% ▲	0.029	-20% ▼	–	–
Savannah River National Lab	4.073	-65% ▼	165	-63% ▼	0.025	-6% ▼	–	–
Savannah River Site	148.663	32% ▲	**4,965**	18% ▲	0.030	13% ▲	–	–
Separations Process Research Unit	0.012	–	1	–	0.012	–	–	–
SLAC National Accelerator Laboratory	–	–	–	–	–	–	–	–
Thomas Jefferson National Accelerator Facility	1.974	**225% ▲**	48	**118% ▲**	0.041	49% ▲	–	–
Uranium Mill Tailings Remedial Action Project	7.836	-35% ▼	65	-32% ▼	**0.121**	-5% ▼	6%	-65% ▼
Waste Isolation Pilot Plant	1.283	14% ▲	78	16% ▲	0.016	-2% ▼	–	–
West Valley Demonstration Project	12.145	37% ▲	108	-4% ▼	0.112	42% ▲	–	–
Service Center Personnel*	3.719	19% ▲	40	18% ▲	0.093	1% ▲	–	–
Totals	**828.036**	**11% ▲**	**17,130**	**-1% ▼**	**0.048**	**11% ▲**	**12%**	**15% ▲**

Note: Boxed values (gray background) indicate the greatest value in each column.
* Includes personnel at NETL, NNSA Albuquerque complex, Oak Ridge, and WIPP, in addition to several smaller facilities not associated with a DOE site.

Exhibit B-4: Internal Dose by Site, CY 2019–2021.

Site	No. of Individuals with Measurable CED* 2019	No. of Individuals with Measurable CED* 2020	No. of Individuals with Measurable CED* 2021	Collective CED Dose (person-rem) 2019	Collective CED Dose (person-rem) 2020	Collective CED Dose (person-rem) 2021	Average Measurable CED 2019	Average Measurable CED 2020	Average Measurable CED 2021
Hanford: Hanford Site	2	–	–	0.003	–	–	0.002	–	–
Hanford: Pacific Northwest National Laboratory	4	1	–	0.006	0.014	–	0.002	0.014	–
Idaho	2	4	1	0.093	0.059	0.012	0.047	0.015	0.012
Lawrence Livermore National Laboratory	2	1	3	0.115	0.056	0.152	0.058	0.056	**0.051** ◄
Los Alamos National Laboratory	22	26	27	0.081	2.640	0.198	0.004	**0.102** ◄	0.007
Oak Ridge: Oak Ridge National Laboratory	1	–	2	0.010	–	0.082	0.010	–	0.041
Oak Ridge: Y–12 National Security Complex	**1,313** ◄	**1,222** ◄	**1,130** ◄	**48.104** ◄	**51.644** ◄	**41.680** ◄	0.037	0.042	0.037
Paducah Gaseous Diffusion Plant	3	5	14	0.044	0.096	0.257	0.015	0.019	0.018
Sandia National Laboratories	10	8	6	0.036	0.051	0.068	0.004	0.006	0.011
Savannah River Site	2	9	3	0.007	0.034	0.026	0.004	0.004	0.009
Uranium Mill Tailings Remedial Action Project	51	48	54	2.179	2.329	1.314	0.043	0.049	0.024
Service Center Personnel**	1	–	–	0.083	–	–	**0.083** ◄	–	–
Totals	**1,413**	**1,324**	**1,240**	**50.761**	**56.923**	**43.789**	**0.036**	**0.043**	**0.035**

Note: Boxed values (gray background) indicate the greatest value in each column.
* The number of internal depositions represents the number of internal dose records with positive results reported for each individual.
** Includes personnel at NETL, NNSA Albuquerque complex, Oak Ridge, and WIPP, in addition to several smaller facilities not associated with a DOE site.

Exhibit B-5: Neutron Dose Distribution by Site, CY 2021.

Site	No. Meas. Dose	Meas. < 0.100	0.100 – 0.250	0.250 – 0.500	0.500 – 0.750	0.750 – 1.00	1.0 – 2.0	> 2.0	Total Monitored*	No. of Individuals with Meas. Dose	% of Individuals with Meas. Dose	Collective Neutron Dose (person-rem)	Avg. Meas. Neutron Dose (rem)
Ames Laboratory	133	–	–	–	–	–	–	–	133	–	–	–	–
Argonne National Laboratory	1,668	–	–	–	–	–	–	–	1,668	–	–	–	–
Brookhaven National Laboratory	1,995	–	–	–	–	–	–	–	1,995	–	–	–	–
Fermi National Accelerator Laboratory	1,221	–	–	–	–	–	–	–	1,221	–	–	–	–
Grand Junction Site	33	–	–	–	–	–	–	–	33	–	–	–	–
Hanford: Hanford Site	3,850	195	–	–	–	–	–	–	4,045	195	5%	1.989	0.010
Hanford: Office of River Protection	3,401	13	–	–	–	–	–	–	3,414	13	0%	0.050	0.004
Hanford: Pacific Northwest National Laboratory	1,902	–	–	–	–	–	–	–	1,902				
Idaho	6,138	18	–	–	–	–	–	–	6,156	18	0%	0.560	0.031
Kansas City Security Campus	219	–	1	–	–	–	–	–	220	1	0%	0.120	0.120
Lawrence Berkeley National Laboratory	838	–	–	–	–	–	–	–	838				
Lawrence Livermore National Laboratory	3,471	52	4	2	2	2	–	–	3,533	62	2%	5.822	**0.094** ◀
Los Alamos National Laboratory	8,977	1,524	283	85	23	9	1	–	**10,902** ◀	**1,925** ◀	**18%** ◀	**134.723** ◀	0.070
National Renewable Energy Laboratory	7	–	–	–	–	–	–	–	7	–	–	–	–
Nevada National Security Site	729	2	–	–	–	–	–	–	731	2	0%	0.050	0.025
Oak Ridge: East Tennessee Technology Park	133	–	–	–	–	–	–	–	133	–	–	–	–
Oak Ridge: Oak Ridge Institute for Science and Education	48	–	–	–	–	–	–	–	48	–	–	–	–
Oak Ridge: Oak Ridge National Laboratory	3,942	84	25	11	1	–	–	–	4,063	121	3%	10.360	0.086
Oak Ridge: Y–12 National Security Complex	6,157	4	–	–	–	–	–	–	6,161	4	0%	0.154	0.038
Office of Secure Transportation	337	–	–	–	–	–	–	–	337	–	–	–	–
Paducah Gaseous Diffusion Plant	1,503	–	–	–	–	–	–	–	1,503	–	–	–	–
Pantex Plant	3,143	252	26	1	–	–	–	–	3,422	279	8%	12.620	0.045
Portsmouth Gaseous Diffusion Plant	2,262	5	–	–	–	–	–	–	2,267	5	0%	0.069	0.014
Princeton Plasma Physics Laboratory	358	–	–	–	–	–	–	–	358	–	–	–	–
Sandia National Laboratories	1,907	7	–	–	–	–	–	–	1,914	7	0%	0.163	0.023
Savannah River National Lab	202	–	–	–	–	–	–	–	202	–	–	–	–
Savannah River Site	6,381	98	15	1	–	–	–	–	6,495	114	2%	6.140	0.054
Separations Process Research Unit	8	–	–	–	–	–	–	–	8	–	–	–	–

Exhibit B-5: Neutron Dose Distribution by Site, CY 2021.

Site	No. Meas. Dose	Meas. < 0.100	0.100 – 0.250	0.250 – 0.500	0.500 – 0.750	0.750 – 1.00	1.0 – 2.0	> 2.0	Total Monitored*	No. of Individuals with Meas. Dose	% of Individuals with Meas. Dose	Collective Neutron Dose (person-rem)	Avg. Meas. Neutron Dose (rem)
SLAC National Accelerator Facility	1,589	–	–	–	–	–	–	–	1,589	–	–	–	–
Thomas Jefferson National Accelerator Facility	1,231	–	–	–	–	–	–	–	1,231	–	–	–	–
Uranium Mill Tailings Remediation Action Project	147	–	–	–	–	–	–	–	147	–	–	–	–
Waste Isolation Pilot Plant	423	–	–	–	–	–	–	–	423	–	–	–	–
West Valley Project	405	–	–	–	–	–	–	–	405	–	–	–	–
Service Center Personnel**	269	–	–	–	–	–	–	–	269	–	–	–	–
Totals	**65,027**	**2,254**	**354**	**100**	**26**	**11**	**1**	**0**	**67,773**	**2,746**	**4%**	**172.820**	**0.063**

Note: Boxed values (gray background) indicate the greatest value in each column.
*Represents the total number of monitoring records. The number of individuals specifically monitored for neutron radiation cannot be determined.
**Includes personnel at NETL, NNSA Albuquerque complex, Oak Ridge, and WIPP, in addition to several smaller facilities not associated with a DOE site.

Exhibit B-6a: Distribution of TED by Facility Type, CY 2019.

TOTAL EFFECTIVE DOSE (TED)
Number of Individuals Receiving Radiation Doses in Each Dose Range (rem)

Facility Type	Less than Meas.	Meas. To 0.100	0.100 – 0.250	0.250 – 0.500	0.500 – 0.750	0.750 – 1.000	1.0 – 2.0	2.0 – 3.0	3.0 – 4.0	4.0 – 5.0	>5.0	Total Monitored	Percent of Monitored with Meas. TED	No. with Meas. TED	Collective TED (Person-rem)	Avg. Meas. TED (rem)
Accelerator	7,863	431	45	11	1	–	–	–	–	–	–	8,351	6%	488	20.840	0.043
Fuel Processing	417	402	11	2	–	–	–	–	–	–	–	832	**50%** ◄	415	11.189	0.027
Fuel/Uranium Enrichment	2,823	79	10	1	–	–	–	–	–	–	–	2,913	3%	90	4.475	0.050
Maintenance and Support	5,446	977	78	16	–	–	–	–	–	–	–	6,517	16%	1,071	41.174	0.038
Other	5,273	788	65	14	2	–	–	–	–	–	–	6,142	14%	869	33.154	0.038
Reactor	127	23	5	1	–	–	–	–	–	–	–	156	19%	29	1.593	0.055
Research, Fusion	345	77	–	–	–	–	–	–	–	–	–	422	18%	77	0.467	0.006
Research, General	24,392	3,089	361	100	24	14	4	–	–	–	–	**27,984** ◄	13%	3,592	200.307	0.056
Waste Processing/Management	4,417	2,996	347	122	6	–	–	–	–	–	–	7,888	44%	3,471	174.997	0.050
Weapons Fabrication and Testing	11,216	3,084	389	157	57	28	7	–	–	–	–	14,938	25%	**3,722** ◄	**264.119** ◄	**0.071** ◄
Totals	**62,319**	**11,946**	**1,311**	**424**	**90**	**42**	**11**	**0**	**0**	**0**	**0**	**76,143**	**18%**	**13,824**	**752.315**	**0.054**

Note: Boxed values (gray background) indicate the greatest value in each column.

Exhibit B-6b: Distribution of TED by Facility Type, CY 2020.

TOTAL EFFECTIVE DOSE (TED)
Number of Individuals Receiving Radiation Doses in Each Dose Range (rem)

Facility Type	Less than Meas.	Meas. To 0.100	0.100 – 0.250	0.250 – 0.500	0.500 – 0.750	0.750 – 1.000	1.0 – 2.0	2.0 – 3.0	3.0 – 4.0	4.0 – 5.0	>5.0	Total Monitored	Percent of Monitored with Meas. TED	No. with Meas. TED	Collective TED (Person-rem)	Avg. Meas. TED (rem)
Accelerator	6,785	386	34	7	1	–	–	–	–	–	–	7,213	6%	428	16.819	0.039
Fuel Processing	238	385	9	1	–	–	–	–	–	–	–	633	**62%** ◀	395	11.052	0.028
Fuel/Uranium Enrichment	2,423	142	–	–	–	–	–	–	–	–	–	2,565	6%	142	1.858	0.013
Maintenance and Support	5,008	889	25	3	–	–	–	–	–	–	–	5,925	15%	917	23.633	0.026
Other	3,920	722	38	3	1	–	–	–	–	–	–	4,684	16%	764	23.608	0.031
Reactor	115	10	2	–	–	–	–	–	–	–	–	127	9%	12	0.497	0.041
Research, Fusion	366	54	–	1	–	–	–	–	–	–	–	421	13%	55	0.497	0.009
Research, General	17,882	3,815	318	92	15	4	3	–	–	–	–	**22,129** ◀	19%	4,247	190.094	0.045
Waste Processing/Management	4,266	3,635	164	46	5	–	–	–	–	–	–	8,116	47%	3,850	129.690	0.034
Weapons Fabrication and Testing	6,439	5,642	568	160	45	18	8	–	1	–	–	12,881	50%	**6,442** ◀	**351.408** ◀	**0.055** ◀
Totals	**47,442**	**15,680**	**1,158**	**313**	**67**	**22**	**11**	**0**	**1**	**0**	**0**	**64,694**	**27%**	**17,252**	**749.156**	**0.043**

Note: Boxed values (gray background) indicate the greatest value in each column.

Exhibit B-6c: Distribution of TED by Facility Type, CY 2021.

TOTAL EFFECTIVE DOSE (TED)
Number of Individuals Receiving Radiation Doses in Each Dose Range (rem)

Facility Type	Less than Meas.	Meas. To 0.100	0.100 – 0.250	0.250 – 0.500	0.500 – 0.750	0.750 – 1.000	1.0 – 2.0	2.0 – 3.0	3.0 – 4.0	4.0 – 5.0	>5.0	Total Monitored	Percent of Monitored with Meas. TED	No. with Meas. TED	Collective TED (Person-rem)	Avg. Meas. TED (rem)
Accelerator	6,191	553	18	8	3	–	–	–	–	–	–	6,773	9%	582	20.139	0.035
Fuel Processing	140	373	8	1	–	–	–	–	–	–	–	522	**73%** ◄	382	9.030	0.024
Fuel/Uranium Enrichment	2,278	120	2			–	–	–	–	–	–	2,400	5%	122	2.497	0.020
Maintenance and Support	5,648	914	39	8	2	–	–	–	–	–	–	6,611	15%	963	31.152	0.032
Other	4,439	1,062	70	9	1	–	–	–	–	–	–	5,581	20%	1,142	37.205	0.033
Reactor	116	15	2	–	–	–	–	–	–	–	–	133	13%	17	0.719	0.042
Research, Fusion	385	43	–	–	–	–	–	–	–	–	–	428	10%	43	0.253	0.006
Research, General	17,910	5,226	427	149	29	12	4	–	–	–	–	**23,757** ◄	25%	5,847	274.469	0.047
Waste Processing/Management	3,942	4,055	295	81	2	–	–	–	–	–	–	8,375	53%	4,433	168.990	0.038
Weapons Fabrication and Testing	9,594	2,813	515	185	60	17	9	–	–	–	–	13,193	27%	**3,599** ◄	**283.582** ◄	**0.079** ◄
Totals	**50,643**	**15,174**	**1,376**	**441**	**97**	**29**	**13**	**0**	**0**	**0**	**0**	**67,773**	**25%**	**17,130**	**828.036**	**0.048**

Note: Boxed values (gray background) indicate the greatest value in each column.

Exhibit B-7a: Collective TED by Site and Facility Type, CY 2019.

Site	Accelerator	Fuel/ Uranium Enrichment	Fuel Processing	Maintenance and Support	Reactor	Research, General	Research, Fusion	Waste Processing/ Management	Weapons Fabrication and Testing	Other	Totals
Ames Laboratory	–	–	–	–	–	0.837	–	–	–	–	0.837
Argonne National Laboratory	–	–	–	–	–	8.650	–	–	–	–	8.650
Brookhaven National Laboratory	2.720	–	–	0.392	–	–	–	0.079	–	–	3.191
Energy Technology Engineering Center	–	–	–	–	–	0.009	–	–	–	–	0.009
Fermi National Accelerator Laboratory	7.060	–	–	–	–	–	–	–	–	–	7.060
Grand Junction Site	–	–	–	–	–	–	–	–	–	0.041	0.041
Hanford: Hanford Site	–	–	–	**20.406** ◀	–	–	–	–	–	**12.267** ◀	32.673
Hanford: Office of River Protection	–	–	–	–	–	–	–	15.045	–	9.108	24.153
Hanford: Pacific Northwest National Laboratory	–	–	–	–	–	9.717	–	–	–	–	9.717
Idaho	–	–	–	–	–	**76.511** ◀	–	–	–	–	76.511
Kansas City National Security Campus	–	–	–	–	–	–	–	–	0.364	–	0.364
Lawrence Berkeley National Laboratory	–	–	–	–	–	1.810	–	–	–	–	1.810
Lawrence Livermore National Laboratory	–	–	–	1.573	–	9.430	–	–	–	–	11.003
Los Alamos National Laboratory	**8.749** ◀	–	–	6.245	–	24.333	–	4.278	**174.284** ◀	6.583	**224.472** ◀
National Renewable Energy Laboratory	–	–	–	–	–	0.001	–	–	–	–	0.001
Nevada National Security Site	–	–	–	1.940	–	–	–	–	–	–	1.940
Oak Ridge: East Tennessee Technology Park	–	0.186	–	–	–	–	–	–	–	–	0.186
Oak Ridge: Oak Ridge Institute for Science and Education	–	–	–	–	–	0.237	–	–	–	–	0.237
Oak Ridge: Oak Ridge National Laboratory	–	–	–	–	–	52.789	–	17.456	–	–	70.245
Oak Ridge: Y-12 National Security Complex	–	–	–	–	–	–	–	–	61.751	–	61.751
Office of Secure Transportation	–	–	–	–	–	–	–	–	0.448	–	0.448
Paducah Gaseous Diffusion Plant	–	–	–	–	–	0.044	–	5.510	–	–	5.554
Pantex Plant	–	–	–	–	–	–	–	–	24.248	–	24.248
Portsmouth Gaseous Diffusion Plant	–	**4.289** ◀	–	–	–	–	–	–	–	–	4.289
Princeton Plasma Physics Laboratory	–	–	–	–	–	–	**0.391** ◀	–	–	–	0.391
Sandia National Laboratories	0.839	–	–	0.224	**1.593** ◀	1.014	0.076	0.124	0.636	0.817	5.323
Savannah River National Laboratory	–	–	0.005	4.609	–	11.543	–	0.385	0.024	0.065	16.631
Savannah River Site	–	–	**11.184** ◀	5.762	–	3.382	–	**100.757** ◀	2.364	3.314	126.763
Separations Process Research Unit	–	–	–	–	–	–	–	0.029	–	–	0.029
SLAC National Accelerator Laboratory	0.206	–	–	–	–	–	–	–	–	–	0.996
Thomas Jefferson National Accelerator Facility	1.266	–	–	–	–	–	–	–	–	–	0.206
Uranium Mill Tailings Remedial Action Project	–	–	–	–	–	–	–	9.748	–	–	1.266
Waste Isolation Pilot Plant	–	–	–	–	–	–	–	1.113	–	–	9.748
West Valley Demonstration Project	–	–	–	–	–	–	–	20.459	–	–	1.113
Service Center Personnel*	–	–	–	0.023	–	–	–	0.014	–	0.959	20.459
Totals	**20.840**	**4.475**	**11.189**	**41.174**	**1.593**	**200.307**	**0.467**	**174.997**	**264.119**	**33.154**	**752.315**

Note: Boxed values (gray background) indicate the greatest value in each column.
* Includes personnel at NNSA Albuquerque complex, Oak Ridge, and WIPP.

Exhibit B-7b: Collective TED by Site and Facility Type, CY 2020.

Site	Accelerator	Fuel/ Uranium Enrichment	Fuel Processing	Maintenance and Support	Reactor	Research, General	Research, Fusion	Waste Processing/ Management	Weapons Fabrication and Testing	Other	Totals
Ames Laboratory	–	–	–	–	–	0.777	–	–	–	–	0.777
Argonne National Laboratory	0.246	–	–	0.383	–	2.047	–	1.851	–	0.082	4.609
Brookhaven National Laboratory	0.806	–	–	0.282	–	–	–	0.073	–	–	1.161
Energy Technology Engineering Center	–	–	–	–	–	0.045	–	–	–	–	0.045
Fermi National Accelerator Laboratory	**7.850** ◀	–	–	–	–	–	–	–	–	–	7.850
Grand Junction Site	–	–	–	–	–	–	–	–	–	0.043	0.043
Hanford: Hanford Site	–	–	–	**8.071** ◀	–	–	–	–	–	1.726	9.797
Hanford: Office of River Protection	–	–	–	0.015	–	–	–	8.099	–	5.177	13.291
Hanford: Pacific Northwest National Laboratory	–	–	–	–	–	8.523	–	–	–	–	8.523
Idaho	–	–	–	–	–	**80.614** ◀	–	–	–	–	80.614
Kansas City National Security Campus	–	–	–	–	–	–	–	–	0.493	–	0.493
Lawrence Berkeley National Laboratory	–	–	–	–	–	0.834	–	–	–	–	0.834
Lawrence Livermore National Laboratory	–	–	–	0.608	–	6.886	–	–	–	–	7.494
Los Alamos National Laboratory	6.819	–	–	4.231	–	31.775	–	6.981	**175.509** ◀	**7.421** ◀	**232.736** ◀
National Renewable Energy Laboratory	–	–	–	–	–	0.030	–	–	–	–	0.030
Nevada National Security Site	–	–	–	1.800	–	–	–	–	–	–	1.800
Oak Ridge: East Tennessee Technology Park	–	0.751	–	–	–	–	–	–	–	–	0.751
Oak Ridge: Oak Ridge Institute for Science and Education	–	–	–	–	–	–	–	–	–	–	–
Oak Ridge: Oak Ridge National Laboratory	–	–	–	–	–	45.162	–	2.504	–	–	47.666
Oak Ridge: Y-12 National Security Complex	–	–	–	–	–	–	–	–	59.591	–	59.591
Office of Secure Transportation	–	–	–	–	–	–	–	–	0.014	0.011	0.025
Paducah Gaseous Diffusion Plant	–	–	–	0.011	–	0.096	–	2.547	–	–	2.654
Pantex Plant	–	–	–	0.100	–	–	–	–	113.809	–	113.909
Portsmouth Gaseous Diffusion Plant	–	**1.107** ◀	–	–	–	–	–	–	–	–	1.107
Princeton Plasma Physics Laboratory	–	–	–	–	–	–	0.234	–	–	–	0.234
Sandia National Laboratories	0.345	–	–	0.787	**0.497** ◀	0.766	**0.263** ◀	0.271	0.143	0.215	3.287
Savannah River National Laboratory	–	–	0.104	2.575	–	8.679	–	0.169	0.183	0.007	11.717
Savannah River Site	–	–	**10.948** ◀	4.770	–	3.840	–	**85.193** ◀	1.666	5.830	112.247
Separations Process Research Unit	–	–	–	–	–	–	–	–	–	–	–
SLAC National Accelerator Laboratory	0.146	–	–	–	–	–	–	–	–	–	0.146
Thomas Jefferson National Accelerator Facility	0.607	–	–	–	–	–	–	–	–	–	0.607
Uranium Mill Tailings Remedial Action Project	–	–	–	–	–	–	–	12.004	–	–	12.004
Waste Isolation Pilot Plant	–	–	–	–	–	–	–	1.130	–	–	1.130
West Valley Demonstration Project	–	–	–	–	–	–	–	8.868	–	–	8.868
Service Center Personnel*	–	–	–	–	–	0.020	–	–	–	3.096	3.116
Totals	**16.819**	**1.858**	**11.052**	**23.633**	**0.497**	**190.094**	**0.497**	**129.690**	**351.408**	**23.608**	**749.156**

Note: Boxed values (gray background) indicate the greatest value in each column.
* Includes personnel at NETL, NNSA Albuquerque complex, Oak Ridge, and WIPP.

Exhibit B-7c: Collective TED by Site and Facility Type, CY 2021.

Site	Accelerator	Fuel/ Uranium Enrichment	Fuel Processing	Maintenance and Support	Reactor	Research, General	Research, Fusion	Waste Processing/ Management	Weapons Fabrication and Testing	Other	Totals
Ames Laboratory	–	–	–	–	–	0.710	–	–	–	–	0.710
Argonne National Laboratory	0.562	–	–	0.413	–	2.236	–	2.983	–	0.191	6.385
Brookhaven National Laboratory	0.761	–	–	0.181	–	–	–	0.035	–	–	0.977
Fermi National Accelerator Laboratory	6.110	–	–	–	–	–	–	–	–	–	6.110
Grand Junction Site	–	–	–	–	–	–	–	–	–	0.158	0.158
Hanford: Hanford Site	–	–	–	**12.680** ◀	–	–	–	–	–	2.448	15.128
Hanford: Office of River Protection	–	–	–	–	–	–	–	15.744	–	11.732	27.476
Hanford: Pacific Northwest National Laboratory	–	–	–	–	–	17.127	–	–	–	–	17.127
Idaho	–	–	–	–	–	**113.108** ◀	–	–	–	–	113.108
Kansas City National Security Campus	–	–	–	–	–	–	–	–	0.920	–	0.920
Lawrence Berkeley National Laboratory	–	–	–	–	–	0.511	–	–	–	–	0.511
Lawrence Livermore National Laboratory	–	–	–	1.924	–	13.009	–	–	–	–	14.933
Los Alamos National Laboratory	**10.158** ◀	–	–	9.365	–	58.609	–	8.897	**201.610** ◀	**14.547** ◀	**303.186** ◀
National Renewable Energy Laboratory	–	–	–	–	–	–	–	–	–	–	–
Nevada National Security Site	–	–	–	1.821	–	–	–	–	–	–	1.821
Oak Ridge: East Tennessee Technology Park	–	**0.468** ◀	–	–	–	–	–	–	–	–	0.468
Oak Ridge: Oak Ridge Institute for Science and Education	–	–	–	–	–	0.025	–	–	–	–	0.025
Oak Ridge: Oak Ridge National Laboratory	–	–	–	–	–	48.788	–	4.667	–	–	53.455
Oak Ridge: Y-12 National Security Complex	–	–	–	–	–	–	–	–	54.186	–	54.186
Office of Secure Transportation	–	–	–	–	–	–	–	–	0.084	–	0.084
Paducah Gaseous Diffusion Plant	–	–	–	–	–	0.257	–	2.208	–	–	2.465
Pantex Plant	–	–	–	0.020	–	–	–	–	23.735	–	23.755
Portsmouth Gaseous Diffusion Plant	–	**2.029**	–	–	–	–	–	–	–	–	2.029
Princeton Plasma Physics Laboratory	–	–	–	–	–	–	0.222	–	–	–	0.222
Sandia National Laboratories	0.574	–	–	0.161	**0.719** ◀	0.796	**0.031** ◀	0.049	0.173	0.589	3.092
Savannah River National Laboratory	–	–	0.006	0.079	–	3.823	–	0.088	0.025	0.052	4.073
Savannah River Site	–	–	**9.024** ◀	4.433	–	15.470	–	**113.023** ◀	2.849	3.864	148.663
Separations Process Research Unit	–	–	–	–	–	–	–	0.012	–	–	0.012
SLAC National Accelerator Laboratory	–	–	–	–	–	–	–	–	–	–	–
Thomas Jefferson National Accelerator Facility	1.974	–	–	–	–	–	–	–	–	–	1.974

Exhibit B-7c: Collective TED by Site and Facility Type, CY 2021.

Site	Accelerator	Fuel/ Uranium Enrichment	Fuel Processing	Maintenance and Support	Reactor	Research, General	Research, Fusion	Waste Processing/ Management	Weapons Fabrication and Testing	Other	Totals
Uranium Mill Tailings Remedial Action Project	–	–	–	–	–	–	–	7.836	–	–	7.836
Waste Isolation Pilot Plant	–	–	–	–	–	–	–	1.283	–	–	1.283
West Valley Demonstration Project	–	–	–	–	–	–	–	12.145	–	–	12.145
Service Center Personnel*	–	–	–	0.075	–	–	–	0.020	–	3.624	3.719
Totals	**20.139**	**2.497**	**9.030**	**31.152**	**0.719**	**274.469**	**0.253**	**168.990**	**283.582**	**37.205**	**828.036**

Note: Boxed values (gray background) indicate the greatest value in each column.
* Includes personnel at NETL, NNSA Albuquerque complex, Oak Ridge, and WIPP.

Exhibit B-8: Distribution of TED by Facility Type Listed in Descending Order of Average Measurable TED for Accelerator Facilities, CY 2021.

ACCELERATORS
Number of Individuals Receiving Radiation Doses in Each Dose Range (rem)

Site/Contractor	Less than Meas.	Meas. To 0.100	0.100 – 0.250	0.250 – 0.500	0.500 – 0.750	0.750 – 1.000	1.0 – 2.0	2.0 – 3.0	3.0 – 4.0	4.0 – 5.0	>5.0	Total Monitored	Percent of Monitored with Meas. TED	No. with Meas. TED	Collective TED (Person-rem)	Avg. Meas. TED (rem)
Argonne National Laboratory	349	12	–	1	–	–	–	–	–	–	–	362	4%	13	0.562	**0.043** ◀
Thomas Jefferson Natl. Accel. Facil.	1,179	41	6	1	–	–	–	–	–	–	–	1,227	4%	48	1.974	0.041
Los Alamos National Laboratory	310	250	6	2	3	–	–	–	–	–	–	571	**46%** ◀	**261** ◀	**10.158** ◀	0.039
Sandia National Laboratories	405	18	–	–	–	–	–	–	–	–	–	423	4%	18	0.574	0.032
Fermi National Accelerator Lab	1,026	185	6	4	–	–	–	–	–	–	–	1,221	16%	195	6.110	0.031
Brookhaven National Laboratory	1,327	47	–	–	–	–	–	–	–	–	–	1,374	3%	47	0.761	0.016
Central Plateau Cleanup Company	1	–	–	–	–	–	–	–	–	–	–	1	0%	–	0.000	0.000
N3B (LANL)	1	–	–	–	–	–	–	–	–	–	–	1	0%	–	0.000	0.000
SLAC National Accelerator Laboratory	1,589	–	–	–	–	–	–	–	–	–	–	**1,589** ◀	0%	–	0.000	0.000
Thomas Jefferson Site Office-DOE Employees	4	–	–	–	–	–	–	–	–	–	–	4	0%	–	0.000	0.000
Totals	**6,191**	**553**	**18**	**8**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**6,773**	**9%**	**582**	**20.139**	**0.035**

Note: Boxed values (gray background) indicate the greatest value in each column.

Exhibit B-9: Distribution of TED by Facility Type Listed in Descending Order of Average Measurable TED for Fuel Facilities, CY 2021.

FUEL FACILITIES
Number of Individuals Receiving Radiation Doses in Each Dose Range (rem)

Site/Contractor	Less than Meas.	Meas. To 0.100	0.100 – 0.250	0.250 – 0.500	0.500 – 0.750	0.750 – 1.000	1.0 – 2.0	2.0 – 3.0	3.0 – 4.0	4.0 – 5.0	>5.0	Total Monitored	Percent of Monitored with Meas. TED	No. with Meas. TED	Collective TED (Person-rem)	Avg. Meas. TED (rem)
ENRICHMENT																
Mid-America Conversion Services (MCS)	204	17	1	–	–	–	–	–	–	–	–	222	8%	18	**1.034** ◄	**0.057** ◄
Fluor/B&W - Portsmouth	1,858	45	1	–	–	–	–	–	–	–	–	**1,904** ◄	2%	46	0.935	0.020
Portsmouth Mission Alliance (PMA)	136	5	–	–	–	–	–	–	–	–	–	141	4%	5	0.060	0.012
URS/CH2MHill - Oak Ridge (UCOR): ETTP	80	53	–	–	–	–	–	–	–	–	–	133	**40%** ◄	**53** ◄	0.468	0.009
Totals	**2,278**	**120**	**2**	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**2,400**	**5%**	**122**	**2.497**	**0.020**
PROCESSING																
Savannah River Nuclear Solutions	116	316	8	1	–	–	–	–	–	–	–	**441** ◄	74%	**325** ◄	**8.200** ◄	**0.025** ◄
SRNS Construction	17	30	–	–	–	–	–	–	–	–	–	47	64%	30	0.503	0.017
SRS Tritium Facilities	1	3	–	–	–	–	–	–	–	–	–	4	75%	3	0.049	0.016
Savannah River Field Office	–	9	–	–	–	–	–	–	–	–	–	9	**100%** ◄	9	0.132	0.015
Centerra Services Inc. - SR	1	4	–	–	–	–	–	–	–	–	–	5	80%	4	0.061	0.015
SRNS Service Subs	4	7	–	–	–	–	–	–	–	–	–	11	64%	7	0.056	0.008
Battelle Savannah River Alliance BSRA	1	2	–	–	–	–	–	–	–	–	–	3	67%	2	0.016	0.008
SRR Operations	–	1	–	–	–	–	–	–	–	–	–	1	**100%** ◄	1	0.007	0.007
SRNL	–	1	–	–	–	–	–	–	–	–	–	1	**100%** ◄	1	0.006	0.006
Totals	**140**	**373**	**8**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**522**	**73%**	**382**	**9.030**	**0.024**

Note: Boxed values (gray background) indicate the greatest value in each column.

Exhibit B-10: Distribution of TED by Facility Type Listed in Descending Order of Average Measurable TED for Maintenance and Support, CY 2021.

MAINTENANCE AND SUPPORT
Number of Individuals Receiving Radiation Doses in Each Dose Range (rem)

Site/Contractor	Less than Meas.	Meas. To 0.100	0.100 – 0.250	0.250 – 0.500	0.500 – 0.750	0.750 – 1.000	1.0 – 2.0	2.0 – 3.0	3.0 – 4.0	4.0 – 5.0	>5.0	Total Monitored	Percent of Monitored with Meas. TED	No. with Meas. TED	Collective TED (Person-rem)	Avg. Meas. TED (rem)
Lawrence Livermore National Laboratory NV	96	8	1	–	2	–	–	–	–	–	–	107	10%	11	1.924	**0.175** ◄
DOE Headquarters	6	1	–	–	–	–	–	–	–	–	–	7	14%	1	0.075	0.075
MSTS - NTS	467	24	3	–	–	–	–	–	–	–	–	494	5%	27	1.376	0.051
Argonne National Laboratory	260	8	1	–	–	–	–	–	–	–	–	269	3%	9	0.413	0.046
Los Alamos National Laboratory	572	214	12	6	–	–	–	–	–	–	–	804	29%	232	9.328	0.040
MSTS - Las Vegas	122	10	1	–	–	–	–	–	–	–	–	133	8%	11	0.445	0.040
Central Plateau Cleanup Company	1,195	256	19	1	–	–	–	–	–	–	–	**1,471** ◄	19%	**276** ◄	**10.080** ◄	0.037
SRR Operations	1	26	1	–	–	–	–	–	–	–	–	28	96%	27	0.901	0.033
SRNS Construction	7	17	–	–	–	–	–	–	–	–	–	24	71%	17	0.365	0.021
Battelle - Pantex	19	1	–	–	–	–	–	–	–	–	–	20	5%	1	0.020	0.020
Savannah River Nuclear Solutions	91	136	–	–	–	–	–	–	–	–	–	227	60%	136	2.725	0.020
Brookhaven National Laboratory	581	10	–	–	–	–	–	–	–	–	–	591	2%	10	0.181	0.018
Univ. of Georgia Ecology Laboratory	9	18	–	–	–	–	–	–	–	–	–	27	67%	18	0.317	0.018
Hanford Mission Integration Solutions (HMIS)	1,159	156	1	1	–	–	–	–	–	–	–	1,317	12%	158	2.600	0.016
Sandia National Laboratories	352	10	–	–	–	–	–	–	–	–	–	362	3%	10	0.161	0.016
SRNL	1	5	–	–	–	–	–	–	–	–	–	6	83%	5	0.079	0.016
Savannah River Field Office	–	5	–	–	–	–	–	–	–	–	–	5	**100%** ◄	5	0.065	0.013
N3B	1	3	–	–	–	–	–	–	–	–	–	4	75%	3	0.037	0.012
SRNS Service Subs	2	5	–	–	–	–	–	–	–	–	–	7	71%	5	0.052	0.010
SRNS Construction Subs	1	1	–	–	–	–	–	–	–	–	–	2	50%	1	0.008	0.008
Batelle- PNNL	4	–	–	–	–	–	–	–	–	–	–	4	0%	–	0.000	0.000
CH2M Hill Plateau Remediation Company (CHPRC)	242	–	–	–	–	–	–	–	–	–	–	242	0%	–	0.000	0.000
DOE-Richland Field Office	4	–	–	–	–	–	–	–	–	–	–	4	0%	–	0.000	0.000
Hanford Laboratory Management Integration	1	–	–	–	–	–	–	–	–	–	–	1	0%	–	0.000	0.000
LLNL Service Subcontractors	1	–	–	–	–	–	–	–	–	–	–	1	0%	–	0.000	0.000
Los Alamos National Lab Construction Subs	5	–	–	–	–	–	–	–	–	–	–	5	0%	–	0.000	0.000
Mission Support Alliance	90	–	–	–	–	–	–	–	–	–	–	90	0%	–	0.000	0.000

Exhibit B-10: Distribution of TED by Facility Type Listed in Descending Order of Average Measurable TED for Maintenance and Support, CY 2021.

MAINTENANCE AND SUPPORT
Number of Individuals Receiving Radiation Doses in Each Dose Range (rem)

Site/Contractor	Less than Meas.	Meas. To 0.100	0.100 – 0.250	0.250 – 0.500	0.500 – 0.750	0.750 – 1.000	1.0 – 2.0	2.0 – 3.0	3.0 – 4.0	4.0 – 5.0	>5.0	Total Monitored	Percent of Monitored with Meas. TED	No. with Meas. TED	Collective TED (Person-rem)	Avg. Meas. TED (rem)
MSTS - Los Alamos	5	–	–	–	–	–	–	–	–	–	–	5	0%	–	0.000	0.000
MSTS - NTS subcontractors	30	–	–	–	–	–	–	–	–	–	–	30	0%	–	0.000	0.000
MSTS - Special Tech. Lab	7	–	–	–	–	–	–	–	–	–	–	7	0%	–	0.000	0.000
Navarro-Intera LLC	1	–	–	–	–	–	–	–	–	–	–	1	0%	–	0.000	0.000
NETL Pittsburgh	11	–	–	–	–	–	–	–	–	–	–	11	0%	–	0.000	0.000
NNSA Nevada Site Office	46	–	–	–	–	–	–	–	–	–	–	46	0%	–	0.000	0.000
Office of Secure Transportation	1	–	–	–	–	–	–	–	–	–	–	1	0%	–	0.000	0.000
Savannah River Operations	5	–	–	–	–	–	–	–	–	–	–	5	0%	–	0.000	0.000
Swift and Staley Team	233	–	–	–	–	–	–	–	–	–	–	233	0%	–	0.000	0.000
UT-Batelle ORNL	3	–	–	–	–	–	–	–	–	–	–	3	0%	–	0.000	0.000
Wackenhut Services Inc. - NV	15	–	–	–	–	–	–	–	–	–	–	15	0%	–	0.000	0.000
Washington River Protection Solutions LLC	2	–	–	–	–	–	–	–	–	–	–	2	0%	–	0.000	0.000
Totals	**5,648**	**914**	**39**	**8**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**6,611**	**15%**	**963**	**31.152**	**0.032**

Note: Boxed values (gray background) indicate the greatest value in each column.

Exhibit B-11: Distribution of TED by Facility Type Listed in Descending Order of Average Measurable TED for Reactor Facilities, CY 2021.

REACTOR FACILITIES
Number of Individuals Receiving Radiation Doses in Each Dose Range (rem)

Site/Contractor	Less than Meas.	Meas. To 0.100	0.100 – 0.250	0.250 – 0.500	0.500 – 0.750	0.750 – 1.000	1.0 – 2.0	2.0 – 3.0	3.0 – 4.0	4.0 – 5.0	>5.0	Total Monitored	Percent of Monitored with Meas. TED	No. with Meas. TED	Collective TED (Person-rem)	Avg. Meas. TED (rem)
Sandia National Laboratories	110	15	2	–	–	–	–	–	–	–	–	**127** ◀	**13%** ◀	**17** ◀	**0.719** ◀	**0.042** ◀
Brookhaven National Laboratory	6	–	–	–	–	–	–	–	–	–	–	6	0%	–	–	0.000
Totals	**116**	**15**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**133**	**13%**	**17**	**0.719**	**0.042**

Note: Boxed values (gray background) indicate the greatest value in each column.

Exhibit B-12: Distribution of TED by Facility Type Listed in Descending Order of Average Measurable TED for Research, General, CY 2021.

RESEARCH, GENERAL
Number of Individuals Receiving Radiation Doses in Each Dose Range (rem)

Site/Contractor	Less than Meas.	Meas. To 0.100	0.100 – 0.250	0.250 – 0.500	0.500 – 0.750	0.750 – 1.000	1.0 – 2.0	2.0 – 3.0	3.0 – 4.0	4.0 – 5.0	>5.0	Total Monitored	Percent of Monitored with Meas. TED	No. with Meas. TED	Collective TED (Person-rem)	Avg. Meas. TED (rem)
UT-Batelle ORNL	2,461	231	64	36	10	4	–	–	–	–	–	2,806	12%	345	39.145	**0.113** ◀
INL - BEA LLC - Research	139	33	2	2	2	1	–	–	–	–	–	179	22%	40	3.828	0.096
Lawrence Livermore National Laboratory	3,281	123	13	3	1	1	3	–	–	–	–	3,425	4%	144	13.009	0.090
INL - BEA LLC - Security	37	9	–	2	–	–	–	–	–	–	–	48	23%	11	0.901	0.082
ICP - Fluor - Support	36	11	1	1	–	–	–	–	–	–	–	49	27%	13	0.917	0.071
ICP - Fluor Service Subcontractors ICP/AMWTP	777	361	63	16	2	–	–	–	–	–	–	1,219	36%	442	27.198	0.062
INL - BEA LLC - Services	2,553	865	108	50	10	2	–	–	–	–	–	3,588	29%	1,035	**64.433** ◀	0.062
ICP - Fluor Projects (ICP and AMWTP)	410	148	37	2	1	–	–	–	–	–	–	598	31%	188	11.483	0.061
INL - BEA LLC - Production	252	68	5	2	1	–	–	–	–	–	–	328	23%	76	4.205	0.055
Argonne National Laboratory	870	43	5	1	–	–	–	–	–	–	–	919	5%	49	2.236	0.046
Lawrence Berkeley Laboratory	826	11	1	–	–	–	–	–	–	–	–	838	1%	12	0.511	0.043
Los Alamos National Laboratory	2,519	1,435	65	17	2	4	1	–	–	–	–	**4,043** ◀	38%	**1,524** ◀	57.428	0.038
Battelle Savannah River Alliance BSRA	29	277	25	1	–	–	–	–	–	–	–	332	91%	303	10.655	0.035
BATTELLE - PNNL	1,190	446	27	16	–	–	–	–	–	–	–	1,679	29%	489	16.629	0.034
Sandia National Laboratories	385	26	2	–	–	–	–	–	–	–	–	413	7%	28	0.796	0.028
SRNL	20	137	4	–	–	–	–	–	–	–	–	161	88%	141	3.823	0.027
Savannah River Field Office	1	8	–	–	–	–	–	–	–	–	–	9	89%	8	0.208	0.026
Ames Laboratory (Iowa State)	103	30	–	–	–	–	–	–	–	–	–	133	23%	30	0.710	0.024
N3B	82	19	–	–	–	–	–	–	–	–	–	101	19%	19	0.396	0.021
NNSA Los Alamos Site Office	31	41	–	–	–	–	–	–	–	–	–	72	57%	41	0.785	0.019
Savannah River Nuclear Solutions	30	98	1	–	–	–	–	–	–	–	–	129	77%	99	1.913	0.019
SRNS Construction	12	53	–	–	–	–	–	–	–	–	–	65	82%	53	1.000	0.019
Four Rivers Nuclear Partnership (FRNP)	944	14	–	–	–	–	–	–	–	–	–	958	1%	14	0.257	0.018
UCOR: ORNL	463	561	4	–	–	–	–	–	–	–	–	1,028	55%	565	9.643	0.017
BSRA-Service Subs	–	2	–	–	–	–	–	–	–	–	–	2	**100%** ◀	2	0.031	0.016
SRNS Service Subs	3	59	–	–	–	–	–	–	–	–	–	62	95%	59	0.922	0.016
Centerra Services Inc. - SR	9	54	–	–	–	–	–	–	–	–	–	63	86%	54	0.687	0.013
Idaho Field Office	136	11	–	–	–	–	–	–	–	–	–	147	7%	11	0.143	0.013

Exhibit B-12: Distribution of TED by Facility Type Listed in Descending Order of Average Measurable TED for Research, General, CY 2021.

RESEARCH, GENERAL
Number of Individuals Receiving Radiation Doses in Each Dose Range (rem)

Site/Contractor	Less than Meas.	Meas. To 0.100	0.100 – 0.250	0.250 – 0.500	0.500 – 0.750	0.750 – 1.000	1.0 – 2.0	2.0 – 3.0	3.0 – 4.0	4.0 – 5.0	>5.0	Total Monitored	Percent of Monitored with Meas. TED	No. with Meas. TED	Collective TED (Person-rem)	Avg. Meas. TED (rem)
Oak Ridge Institute for Science & Education	46	2	–	–	–	–	–	–	–	–	–	48	4%	2	0.025	0.013
Battelle -PNNL- Subs	162	32	–	–	–	–	–	–	–	–	–	194	16%	32	0.379	0.012
Pacific Northwest Site Office	13	12	–	–	–	–	–	–	–	–	–	25	48%	12	0.119	0.010
SRNS Construction Subs	1	5	–	–	–	–	–	–	–	–	–	6	83%	5	0.047	0.009
SRR Operations	–	1	–	–	–	–	–	–	–	–	–	1	**100%◄**	1	0.007	0.007
Brookhaven National Laboratory	1	–	–	–	–	–	–	–	–	–	–	1	0%	–	0.000	0.000
National Renewable Energy Laboratory	7	–	–	–	–	–	–	–	–	–	–	7	0%	–	0.000	0.000
NETL Albany	37	–	–	–	–	–	–	–	–	–	–	37	0%	–	0.000	0.000
NETL Morgantown	22	–	–	–	–	–	–	–	–	–	–	22	0%	–	0.000	0.000
NETL Pittsburgh	22	–	–	–	–	–	–	–	–	–	–	22	0%	–	0.000	0.000
Totals	**17,910**	**5,226**	**427**	**149**	**29**	**12**	**4**	**0**	**0**	**0**	**0**	**23,757**	**25%**	**5,847**	**274.469**	**0.047**

Note: Boxed values (gray background) indicate the greatest value in each column.

Exhibit B-13: Distribution of TED by Facility Type Listed in Descending Order of Average Measurable TED for Research, Fusion, CY 2021.

RESEARCH, FUSION
Number of Individuals Receiving Radiation Doses in Each Dose Range (rem)

Site/Contractor	Less than Meas.	Meas. To 0.100	0.100 – 0.250	0.250 – 0.500	0.500 – 0.750	0.750 – 1.000	1.0 – 2.0	2.0 – 3.0	3.0 – 4.0	4.0 – 5.0	>5.0	Total Monitored	Percent of Monitored with Meas. TED	No. with Meas. TED	Collective TED (Person-rem)	Avg. Meas. TED (rem)
Sandia National Laboratories	69	1	–	–	–	–	–	–	–	–	–	70	1%	1	**0.031◄**	**0.031◄**
Princeton Plasma Physics Laboratory	316	42	–	–	–	–	–	–	–	–	–	**358◄**	**12%◄**	**42◄**	0.222	0.005
Totals	**366**	**43**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**428**	**10%**	**43**	**0.253**	**0.006**

Note: Boxed values (gray background) indicate the greatest value in each column.

Exhibit B-14: Distribution of TED by Facility Type Listed in Descending Order of Average Measurable TED for Waste Processing, CY 2021.

WASTE PROCESSING
Number of Individuals Receiving Radiation Doses in Each Dose Range (rem)

Site/Contractor	Less than Meas.	Meas. To 0.100	0.100 – 0.250	0.250 – 0.500	0.500 – 0.750	0.750 – 1.000	1.0 – 2.0	2.0 – 3.0	3.0 – 4.0	4.0 – 5.0	>5.0	Total Monitored	Percent of Monitored with Meas. TED	No. with Meas. TED	Collective TED (Person-rem)	Avg. Meas. TED (rem)
Argonne National Laboratory	53	16	4	3	1	–	–	–	–	–	–	77	31%	24	2.983	**0.124** ◀
Northwind Portage - UMTRA Project - Moab	82	39	14	11	1	–	–	–	–	–	–	147	44%	65	7.836	0.121
West Valley Nuclear Services Inc.	297	70	15	23	–	–	–	–	–	–	–	405	27%	108	12.145	0.112
Tru Waste Processing Center - ORNL	160	50	12	4	–	–	–	–	–	–	–	226	29%	66	4.667	0.071
Parsons	–	1	–	–	–	–	–	–	–	–	–	1	**100%** ◀	1	0.054	0.054
Los Alamos National Laboratory	150	158	25	–	–	–	–	–	–	–	–	333	55%	183	8.897	0.049
Savannah River Nuclear Solutions	223	788	79	25	–	–	–	–	–	–	–	1,115	80%	892	36.830	0.041
Hanford Laboratory Management Integration	160	76	6	–	–	–	–	–	–	–	–	242	34%	82	2.974	0.036
SRR Operations	320	1,852	120	13	–	–	–	–	–	–	–	**2,305** ◀	86%	**1,985** ◀	**69.628** ◀	0.035
Washington River Protection Solutions LLC	1,596	381	17	2	–	–	–	–	–	–	–	1,996	20%	400	12.770	0.032
DUF6 Conversion Project - Paducah Subs	234	77	1	–	–	–	–	–	–	–	–	312	25%	78	2.208	0.028
Battelle Savannah River Alliance BSRA	3	4	–	–	–	–	–	–	–	–	–	7	57%	4	0.092	0.023
SRNS Construction Subs	–	1	–	–	–	–	–	–	–	–	–	1	**100%** ◀	1	0.020	0.020
SRNS Construction	83	75	2	–	–	–	–	–	–	–	–	160	48%	77	1.325	0.017
Washington TRU Solutions LLC-WIPP	312	73	–	–	–	–	–	–	–	–	–	385	19%	73	1.212	0.017
WTS Subcontractors - WIPP	33	4	–	–	–	–	–	–	–	–	–	37	11%	4	0.058	0.015
Centerra Services Inc. - SR	90	214	–	–	–	–	–	–	–	–	–	304	70%	214	3.013	0.014
Misc. DOE Contractors - SR	12	31	–	–	–	–	–	–	–	–	–	43	72%	31	0.432	0.014
Savannah River Field Office	12	30	–	–	–	–	–	–	–	–	–	42	71%	30	0.427	0.014
SRNS Service Subs	22	65	–	–	–	–	–	–	–	–	–	87	75%	65	0.902	0.014
Santa Fe Protective Services (WIPP)	–	1	–	–	–	–	–	–	–	–	–	1	**100%** ◀	1	0.013	0.013
Brookhaven National Laboratory	20	3	–	–	–	–	–	–	–	–	–	23	13%	3	0.035	0.012
Sandia National Laboratories	38	4	–	–	–	–	–	–	–	–	–	42	10%	4	0.049	0.012
SPRU-NY (Building remediation)	7	1	–	–	–	–	–	–	–	–	–	8	13%	1	0.012	0.012
SRNL	2	8	–	–	–	–	–	–	–	–	–	10	80%	8	0.088	0.011
Carlsbad Field Office	10	2	–	–	–	–	–	–	–	–	–	12	17%	2	0.020	0.010
SRR Service Subs	10	15	–	–	–	–	–	–	–	–	–	25	60%	15	0.152	0.010
Bechtel Construction - SR	1	3	–	–	–	–	–	–	–	–	–	4	75%	3	0.028	0.009

Exhibit B-14: Distribution of TED by Facility Type Listed in Descending Order of Average Measurable TED for Waste Processing, CY 2021.

WASTE PROCESSING
Number of Individuals Receiving Radiation Doses in Each Dose Range (rem)

Site/Contractor	Less than Meas.	Meas. To 0.100	0.100 – 0.250	0.250 – 0.500	0.500 – 0.750	0.750 – 1.000	1.0 – 2.0	2.0 – 3.0	3.0 – 4.0	4.0 – 5.0	>5.0	Total Monitored	Percent of Monitored with Meas. TED	No. with Meas. TED	Collective TED (Person-rem)	Avg. Meas. TED (rem)
Misc. S.R.S. Const. Subcontractors	3	6	–	–	–	–	–	–	–	–	–	9	67%	6	0.055	0.009
SRS Tritium Facilities	2	7	–	–	–	–	–	–	–	–	–	9	78%	7	0.065	0.009
Central Plateau Cleanup Company	1	–	–	–	–	–	–	–	–	–	–	1	0%	–	0.000	0.000
Los Alamos National Lab - WIPP	1	–	–	–	–	–	–	–	–	–	–	1	0%	–	0.000	0.000
N3B	3	–	–	–	–	–	–	–	–	–	–	3	0%	–	0.000	0.000
NNSA Los Alamos Site Office	1	–	–	–	–	–	–	–	–	–	–	1	0%	–	0.000	0.000
Parsons Subcontractors	1	–	–	–	–	–	–	–	–	–	–	1	0%	–	0.000	0.000
Totals	**3,942**	**4,055**	**295**	**81**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**8,375**	**53%**	**4,433**	**168.990**	**0.038**

Note: Boxed values (gray background) indicate the greatest value in each column.

Exhibit B-15: Distribution of TED by Facility Type Listed in Descending Order of Average Measurable TED for Weapons Fabrication, CY 2021.

WEAPONS FABRICATION
Number of Individuals Receiving Radiation Doses in Each Dose Range (rem)

Site/Contractor	Less than Meas.	Meas. To 0.100	0.100 – 0.250	0.250 – 0.500	0.500 – 0.750	0.750 – 1.000	1.0 – 2.0	2.0 – 3.0	3.0 – 4.0	4.0 – 5.0	>5.0	Total Monitored	Percent of Monitored with Meas. TED	No. with Meas. TED	Collective TED (Person-rem)	Avg. Meas. TED (rem)
Los Alamos National Laboratory	1,057	905	301	172	60	17	9	–	–	–	–	2,521	58%	**1,464** ◀	**201.509** ◀	**0.138** ◀
CNS, LLC - Pantex	3,001	322	70	9	–	–	–	–	–	–	–	3,402	12%	401	23.735	0.059
SRR Operations	–	1	–	–	–	–	–	–	–	–	–	1	**100%** ◀	1	0.047	0.047
CNS, LLC - Y-12	4,597	1,230	138	4	–	–	–	–	–	–	–	**5,969** ◀	23%	1,372	53.350	0.039
Sandia National Laboratories	147	11	–	–	–	–	–	–	–	–	–	158	7%	11	0.173	0.016
Savannah River Nuclear Solutions	23	12	–	–	–	–	–	–	–	–	–	35	34%	12	0.190	0.016
NNSA Los Alamos Site Office	2	3	–	–	–	–	–	–	–	–	–	5	60%	3	0.046	0.015
Savannah River Field Office	1	7	–	–	–	–	–	–	–	–	–	8	88%	7	0.104	0.015
Centerra Services Inc. - SR	2	2	–	–	–	–	–	–	–	–	–	4	50%	2	0.027	0.014
Kansas City National Security Campus	152	66	2	–	–	–	–	–	–	–	–	220	31%	68	0.920	0.014
Office of Secure Transportation	288	6	–	–	–	–	–	–	–	–	–	294	2%	6	0.084	0.014

Exhibit B-15: Distribution of TED by Facility Type Listed in Descending Order of Average Measurable TED for Weapons Fabrication, CY 2021.

WEAPONS FABRICATION
Number of Individuals Receiving Radiation Doses in Each Dose Range (rem)

Site/Contractor	Less than Meas.	Meas. To 0.100	0.100 – 0.250	0.250 – 0.500	0.500 – 0.750	0.750 – 1.000	1.0 – 2.0	2.0 – 3.0	3.0 – 4.0	4.0 – 5.0	>5.0	Total Monitored	Percent of Monitored with Meas. TED	No. with Meas. TED	Collective TED (Person-rem)	Avg. Meas. TED (rem)
SRS Tritium Facilities	149	161	3	–	–	–	–	–	–	–	–	313	52%	164	2.305	0.014
URS/CH2MHill - Oak Ridge (UCOR): Y-12	128	63	1	–	–	–	–	–	–	–	–	192	33%	64	0.836	0.013
SRNS Construction	24	14	–	–	–	–	–	–	–	–	–	38	37%	14	0.162	0.012
N3B	10	5	–	–	–	–	–	–	–	–	–	15	33%	5	0.055	0.011
SRNL	13	3	–	–	–	–	–	–	–	–	–	16	19%	3	0.025	0.008
Battelle Savannah River Alliance BSRA	–	1	–	–	–	–	–	–	–	–	–	1	**100%** ◀	1	0.007	0.007
SRNS Service Subs	–	1	–	–	–	–	–	–	–	–	–	1	**100%** ◀	1	0.007	0.007
Totals	**9,594**	**2,813**	**515**	**185**	**60**	**17**	**9**	**0**	**0**	**0**	**0**	**13,193**	**27%**	**3,599**	**283.582**	**0.079**

Note: Boxed values (gray background) indicate the greatest value in each column.

Exhibit B-16: Distribution of TED by Facility Type Listed in Descending Order of Average Measurable TED for Other, CY 2021.

OTHER
Number of Individuals Receiving Radiation Doses in Each Dose Range (rem)

Site/Contractor	Less than Meas.	Meas. To 0.100	0.100 – 0.250	0.250 – 0.500	0.500 – 0.750	0.750 – 1.000	1.0 – 2.0	2.0 – 3.0	3.0 – 4.0	4.0 – 5.0	>5.0	Total Monitored	Percent of Monitored with Meas. TED	No. with Meas. TED	Collective TED (Person-rem)	Avg. Meas. TED (rem)
Argonne National Laboratory	40	–	1	–	–	–	–	–	–	–	–	41	2%	1	0.191	**0.191** ◀
Isotek (Bldg 3019)	120	23	11	3	–	–	–	–	–	–	–	157	24%	37	3.624	0.098
Hanford Laboratory Management Integration	36	7	2	–	–	–	–	–	–	–	–	45	20%	9	0.618	0.069
CH2M Hill Plateau Remediation Company (CHPRC)	80	1	–	–	–	–	–	–	–	–	–	81	1%	1	0.055	0.055
Office of River Protection	81	5	1	–	–	–	–	–	–	–	–	87	7%	6	0.315	0.053
Washington River Protection Solutions LLC	448	174	25	4	–	–	–	–	–	–	–	651	31%	203	10.652	0.052
Sandia National Laboratories	303	15	1	–	–	–	–	–	–	–	–	319	5%	16	0.589	0.037
Los Alamos National Laboratory	1,647	353	22	2	1	–	–	–	–	–	–	**2,025** ◀	19%	**378** ◀	**12.447** ◀	0.033
SRNS Service Subs	17	25	3	–	–	–	–	–	–	–	–	45	62%	28	0.917	0.033
Bechtel National Corporation	334	1	–	–	–	–	–	–	–	–	–	335	0%	1	0.027	0.027
Central Plateau Cleanup Company	360	61	2	–	–	–	–	–	–	–	–	423	15%	63	1.569	0.025

Exhibit B-16: Distribution of TED by Facility Type Listed in Descending Order of Average Measurable TED for Other, CY 2021.

OTHER
Number of Individuals Receiving Radiation Doses in Each Dose Range (rem)

Site/Contractor	Less than Meas.	Meas. To 0.100	0.100 – 0.250	0.250 – 0.500	0.500 – 0.750	0.750 – 1.000	1.0 – 2.0	2.0 – 3.0	3.0 – 4.0	4.0 – 5.0	>5.0	Total Monitored	Percent of Monitored with Meas. TED	No. with Meas. TED	Collective TED (Person-rem)	Avg. Meas. TED (rem)
NNSA Los Alamos Site Office	29	8	–	–	–	–	–	–	–	–	–	37	22%	8	0.197	0.025
DOE-Richland Field Office	296	33	1	–	–	–	–	–	–	–	–	330	10%	34	0.801	0.024
Wastren Advantage, Inc.	50	5	–	–	–	–	–	–	–	–	–	55	9%	5	0.120	0.024
N3B	276	84	1	–	–	–	–	–	–	–	–	361	24%	85	1.903	0.022
Savannah River Field Office	5	4	–	–	–	–	–	–	–	–	–	9	44%	4	0.081	0.020
SRNS Construction Subs	1	3	–	–	–	–	–	–	–	–	–	4	75%	3	0.053	0.018
Centerra Services Inc. - SR	6	3	–	–	–	–	–	–	–	–	–	9	33%	3	0.042	0.014
SRR Operations	3	2	–	–	–	–	–	–	–	–	–	5	40%	2	0.027	0.014
Savannah River Nuclear Solutions	140	178	–	–	–	–	–	–	–	–	–	318	56%	178	2.328	0.013
Hanford Mission Integration Solutions (HMIS)	69	2	–	–	–	–	–	–	–	–	–	71	3%	2	0.023	0.012
SRR Service Subs	3	1	–	–	–	–	–	–	–	–	–	4	25%	1	0.012	0.012
SRNS Construction	27	30	–	–	–	–	–	–	–	–	–	57	53%	30	0.340	0.011
Univ. of Georgia Ecology Laboratory	–	1	–	–	–	–	–	–	–	–	–	1	**100%** ◄	1	0.011	0.011
Battelle Savannah River Alliance BSRA	5	8	–	–	–	–	–	–	–	–	–	13	62%	8	0.053	0.007
SRNL	1	7	–	–	–	–	–	–	–	–	–	8	88%	7	0.052	0.007
Navarro Research & Engineering	5	28	–	–	–	–	–	–	–	–	–	33	85%	28	0.158	0.006
HPMC Occupational Medical Services	7	–	–	–	–	–	–	–	–	–	–	7	0%	0	0.000	0.000
Mission Support Alliance	7	–	–	–	–	–	–	–	–	–	–	7	0%	0	0.000	0.000
Office of Secure Transportation	42	–	–	–	–	–	–	–	–	–	–	42	0%	0	0.000	0.000
SRS Tritium Facilities	1	–	–	–	–	–	–	–	–	–	–	1	0%	0	0.000	0.000
Totals	**4,439**	**1,062**	**70**	**9**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**5,581**	**20%**	**1,142**	**37.205**	**0.033**

Note: Boxed values (gray background) indicate the greatest value in each column.

Exhibit B-17: Internal Dose by Facility Type and Nuclide, CY 2019–2021.

Facility	Nuclide*	No. of Individuals with Measurable CED** 2019	No. of Individuals with Measurable CED** 2020	No. of Individuals with Measurable CED** 2021	Collective CED Dose (person-rem) 2019	Collective CED Dose (person-rem) 2020	Collective CED Dose (person-rem) 2021	Average Measurable CED (rem) 2019	Average Measurable CED (rem) 2020	Average Measurable CED (rem) 2021
Accelerator	Hydrogen-3	1	–	–	0.001	–	–	0.001	–	–
	Total	1	–	–	0.001	–	–	0.001	–	–
Fuel Fabrication	Total	–	–	–	–	–	–	–	–	–
Fuel Processing	Hydrogen-3	–	1	–	–	–	–	–	0.004	–
	Total	–	1	–	–	–	–	–	0.004	–
Fuel/Uranium Enrichment	Total	–	–	–	–	–	–	–	–	–
Maintenance and Support	Americium	1	–	–	0.002	–	–	0.002	–	–
	Hydrogen-3	1	–	1	0.004	–	–	0.004	–	0.003
	Other	2	3	1	0.002	0.007	0.014	0.001	0.002	0.014
	Plutonium	1	–	–	0.001	–	–	0.001	–	–
	Total	5	3	2	–	–	–	–	–	0.009
Other	Other	4	4	4	0.026	0.043	0.049	0.007	0.011	0.012
	Plutonium	–	–	1	–	–	–	–	–	**0.081** ◀
	Uranium	1	–	–	0.083	–	–	0.083	–	–
	Total	5	4	5	0.109	0.043	0.130	0.022	0.011	0.026
Reactor	Total	–	–	–	–	–	–	–	–	–
Research, Fusion	Total	–	–	–	–	–	–	–	–	–
Research, General	Americium	–	4	1	–	0.062	0.012	–	0.016	0.012
	Hydrogen-3	6	–	3	0.121	–	–	0.020	–	0.051
	Mixed	–	1	–	–	0.056	–	–	0.056	–
	Other	1	–	1	0.010	–	–	0.010	–	0.005
	Plutonium	2	2	–	0.093	0.019	–	0.047	0.010	–
	Uranium	9	10	20	0.056	0.106	0.293	0.006	0.011	0.015
	Total	18	17	25	0.280	0.243	0.462	0.016	0.014	0.018
Waste Processing/Mgmt.	Americium	–	–	1	–	–	–	–	–	0.068
	Other	4	–	–	0.008	–	–	0.002	–	–
	Uranium	51	48	54	2.179	2.329	1.314	0.043	0.049	0.024
	Total	55	48	55	2.187	2.329	1.382	0.040	0.049	0.025
Weapons Fab. and Testing	Hydrogen-3	16	20	21	0.071	0.067	0.096	0.004	0.003	0.005
	Mixed	6	–	7	0.093	–	–	0.016	–	0.058

Exhibit B-17: Internal Dose by Facility Type and Nuclide, CY 2019–2021.

Facility	Nuclide*	No. of Individuals with Measurable CED** 2019	No. of Individuals with Measurable CED** 2020	No. of Individuals with Measurable CED** 2021	Collective CED Dose (person-rem) 2019	Collective CED Dose (person-rem) 2020	Collective CED Dose (person-rem) 2021	Average Measurable CED (rem) 2019	Average Measurable CED (rem) 2020	Average Measurable CED (rem) 2021
	Other	–	1	–	–	0.001	–	–	0.001	–
	Plutonium	–	8	1	–	2.585	0.020	–	**0.323** ◀	0.020
	Uranium	**1,307** ◀	**1,222** ◀	**1,124** ◀	**48.011** ◀	**51.644** ◀	**41.278** ◀	**0.037** ◀	0.042	0.037
	Total	1,329	1,251	1,153	48.175	54.297	41.798	0.036	0.043	0.036
	Totals	**1,413**	**1,324**	**1,240**	**50.761**	**56.923**	**43.789**	**0.036**	**0.043**	**0.035**

Note: Boxed values (gray background) indicate the greatest value in each column.
*Intakes grouped by nuclide. Intakes involving multiple nuclides were grouped into "mixed." Nuclides where fewer than 10 individuals had intakes were grouped as "other."
**The number of internal depositions represents the number of internal dose records with positive results reported for each individual.

Exhibit B-18a: Distribution of TED by Labor Category, CY 2019.

TOTAL EFFECTIVE DOSE (TED)
Number of Individuals Receiving Radiation Doses in Each Dose Range (rem)

Site/Contractor	Less than Meas.	Meas. To 0.100	0.100 – 0.250	0.250 – 0.500	0.500 – 0.750	0.750 – 1.000	1.0 – 2.0	2.0 – 3.0	3.0 – 4.0	4.0 – 5.0	>5.0	Total Monitored	Percent of Monitored with Meas. TED	No. with Meas. TED	Collective TED (Person-rem)	Avg. Meas. TED (rem)
Agriculture	51	1	–	–	–	–	–	–	–	–	–	52	2%	1	0.010	0.010
Construction/Repair	3,364	1,521	181	56	3	–	–	–	–	–	–	5,125	34%	1,761	87.509	0.050
Laborers	1,041	350	48	19	1	–	–	–	–	–	–	1,459	29%	418	25.589	0.061
Management	5,533	1,170	46	9	–	–	–	–	–	–	–	6,758	18%	1,225	32.398	0.026
Miscellaneous	7,714	754	100	10	–	3	–	–	–	–	–	8,581	10%	867	39.188	0.045
Production	2,338	1,325	253	82	11	–	–	–	–	–	–	4,009	**42%** ◀	1,671	115.868	0.069
Professional/Scientists	17,898	3,328	208	62	12	7	1	–	–	–	–	**21,516** ◀	17%	**3,618** ◀	134.077	0.037
Service Workers	5,940	838	72	12	2	–	–	–	–	–	–	6,864	13%	924	35.171	0.038
Technicians	6,095	2,020	345	148	58	32	10	–	–	–	–	8,708	30%	2,613	**246.304** ◀	**0.094** ◀
Transport Workers	839	133	15	13	2	–	–	–	–	–	–	1,002	16%	163	11.900	0.073
Unknown	11,506	506	43	13	1	–	–	–	–	–	–	12,069	5%	563	24.301	0.043
Totals	**62,319**	**11,946**	**1,311**	**424**	**90**	**42**	**11**	**–**	**–**	**–**	**–**	**76,143**	**18%**	**13,824**	**752.315**	**0.054**

Note: Boxed values (gray background) indicate the greatest value in each column.

Exhibit B-18b: Distribution of TED by Labor Category, CY 2020.

TOTAL EFFECTIVE DOSE (TED)
Number of Individuals Receiving Radiation Doses in Each Dose Range (rem)

Site/Contractor	Less than Meas.	Meas. To 0.100	0.100 – 0.250	0.250 – 0.500	0.500 – 0.750	0.750 – 1.000	1.0 – 2.0	2.0 – 3.0	3.0 – 4.0	4.0 – 5.0	>5.0	Total Monitored	Percent of Monitored with Meas. TED	No. with Meas. TED	Collective TED (Person-rem)	Avg. Meas. TED (rem)
Agriculture	37	5	–	–	–	–	–	–	–	–	–	42	12%	5	0.043	0.009
Construction/Repair	3,178	1,809	136	25	2	–	–	–	–	–	–	5,150	38%	1,972	76.117	0.039
Laborers	993	392	44	4	–	–	–	–	–	–	–	1,433	31%	440	20.026	0.046
Management	4,570	1,646	51	8	1	–	–	–	–	–	–	6,276	27%	1,706	47.247	0.028
Miscellaneous	4,207	766	59	5	–	–	–	–	–	–	–	5,037	16%	830	28.397	0.034
Production	1,943	1,635	234	43	1	–	–	–	–	–	–	3,856	**50%** ◀	1,913	104.283	0.055
Professional/Scientists	15,281	4,385	224	50	11	6	2	–	–	–	–	**19,959** ◀	23%	**4,678** ◀	160.373	0.034
Service Workers	3,319	1,738	61	20	3	1	–	–	–	–	–	5,142	35%	1,823	53.999	0.030
Technicians	5,729	2,253	319	142	45	15	9	–	1	–	–	8,513	33%	2,784	**223.192** ◀	**0.080** ◀
Transport Workers	796	139	7	15	4	–	–	–	–	–	–	961	17%	165	12.661	0.077
Unknown	7,389	912	23	1	–	–	–	–	–	–	–	8,325	11%	936	22.818	0.024
Totals	**47,442**	**15,680**	**1,158**	**313**	**67**	**22**	**11**	**0**	**1**	**0**	**0**	**64,694**	**27%**	**17,252**	**749.156**	**0.043**

Note: Boxed values (gray background) indicate the greatest value in each column.

Exhibit B-18c: Distribution of TED by Labor Category, CY 2021.

TOTAL EFFECTIVE DOSE (TED)
Number of Individuals Receiving Radiation Doses in Each Dose Range (rem)

Site/Contractor	Less than Meas.	Meas. To 0.100	0.100 – 0.250	0.250 – 0.500	0.500 – 0.750	0.750 – 1.000	1.0 – 2.0	2.0 – 3.0	3.0 – 4.0	4.0 – 5.0	>5.0	Total Monitored	Percent of Monitored with Meas. TED	No. with Meas. TED	Collective TED (Person-rem)	Avg. Meas. TED (rem)
Agriculture	37	5	–	–	–	–	–	–	–	–	–	42	12%	5	0.043	0.009
Construction/Repair	3,178	1,809	136	25	2	–	–	–	–	–	–	5,150	38%	1,972	76.117	0.039
Laborers	993	392	44	4	–	–	–	–	–	–	–	1,433	31%	440	20.026	0.046
Management	4,570	1,646	51	8	1	–	–	–	–	–	–	6,276	27%	1,706	47.247	0.028
Miscellaneous	4,207	766	59	5	–	–	–	–	–	–	–	5,037	16%	830	28.397	0.034
Production	1,943	1,635	234	43	1	–	–	–	–	–	–	3,856	**50%** ◀	1,913	104.283	0.055
Professional/Scientists	15,281	4,385	224	50	11	6	2	–	–	–	–	**19,959** ◀	23%	**4,678** ◀	160.373	0.034
Service Workers	3,319	1,738	61	20	3	1	–	–	–	–	–	5,142	35%	1,823	53.999	0.030
Technicians	5,729	2,253	319	142	45	15	9	–	1	–	–	8,513	33%	2,784	**223.192** ◀	**0.080** ◀
Transport Workers	796	139	7	15	4	–	–	–	–	–	–	961	17%	165	12.661	0.077
Unknown	7,389	912	23	1	–	–	–	–	–	–	–	8,325	11%	936	22.818	0.024
Totals	**47,442**	**15,680**	**1,158**	**313**	**67**	**22**	**11**	**0**	**1**	**0**	**0**	**64,694**	**27%**	**17,252**	**749.156**	**0.043**

Note: Boxed values (gray background) indicate the greatest value in each column.

Exhibit B-19: Internal Dose by Labor Category, CY 2019–2021.

Labor Category	No. of Individuals with Measurable CED* 2019	No. of Individuals with Measurable CED* 2020	No. of Individuals with Measurable CED* 2021	Collective CED Dose (person-rem) 2019	Collective CED Dose (person-rem) 2020	Collective CED Dose (person-rem) 2021	Average Measurable CED (rem) 2019	Average Measurable CED (rem) 2020	Average Measurable CED (rem) 2021
Construction/Repair	314	268	273	11.624	11.935	9.181	0.037	0.045	0.034
Laborers	70	67	80	3.641	3.287	4.048	**0.052** ◄	**0.049** ◄	**0.051** ◄
Management	98	104	71	3.231	4.246	3.352	0.033	0.041	0.047
Miscellaneous	11	7	3	0.289	0.155	0.056	0.026	0.022	0.019
Production	**363** ◄	**357** ◄	**324** ◄	**14.619** ◄	**15.357** ◄	**12.022** ◄	0.040	0.043	0.037
Professional/Scientists	213	196	182	6.091	6.701	5.495	0.029	0.034	0.030
Service Workers	31	35	31	1.302	1.239	1.209	0.042	0.035	0.039
Technicians	111	119	120	3.660	6.618	3.857	0.033	0.056	0.032
Transport Workers	34	34	30	1.563	1.630	0.736	0.046	0.048	0.025
Unknown	168	137	126	4.741	5.755	3.833	0.028	0.042	0.030
Totals	**1,413**	**1,324**	**1,240**	**50.761**	**56.923**	**43.789**	**0.036**	**0.043**	**0.035**

Note: Boxed values (gray background) indicate the greatest value in each column.
*The number of internal depositions represents the number of internal dose records with positive results reported for each individual.

Exhibit B-20: Dose Distribution by Labor Category and Occupation, CY 2021.

Labor Category	Occupation	Less than Meas.	Meas. To 0.100	0.100 – 0.250	0.250 – 0.500	0.500 – 0.750	0.750 – 1.000	1.0 – 2.0	2.0 – 3.0	3.0 – 4.0	4.0 – 5.0	>5.0	Total Monitored	Percent of Monitored with Meas. TED	No. with Meas. TED	Collective TED (Person-rem)	Avg. Meas. TED (rem)
Agriculture	Groundskeepers	27	6	–	–	–	–	–	–	–	–	–	33	18%	6	0.098	0.016
	Misc. Agriculture	1	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–
Construction/Repair	Carpenters	275	196	30	5	3	–	–	–	–	–	–	509	46%	234	13.676	0.058
	Electricians	1,107	455	38	15	–	–	–	–	–	–	–	1,615	31%	508	21.368	0.042
	Masons	23	16	1	–	–	–	–	–	–	–	–	40	43%	17	0.518	0.030
	Mechanics/Repairers	464	265	15	3	–	1	–	–	–	–	–	748	38%	284	10.338	0.036
	Miners/Drillers	41	17	–	–	–	–	–	–	–	–	–	58	29%	17	0.257	0.015
	Misc. Repair/Construction	766	554	38	2	–	–	–	–	–	–	–	1,360	44%	594	18.968	0.032
	Painters	134	75	6	3		–	–	–	–	–	–	218	39%	84	3.653	0.043
	Pipe Fitter	358	291	45	15	3	–	–	–	–	–	–	712	**50%** ◀	354	22.312	0.063
Laborers	Handlers/Laborers/Helpers	1,090	481	57	10	1	–	–	–	–	–	–	1,639	33%	549	25.003	0.046
Management	Admin. Support & Clerical Sec.	512	95	1		–	–	–	–	–	–	–	608	16%	96	1.855	0.019
	Manager - Administrator	4,534	1,472	64	18	2	–	–	–	–	–	–	6,090	26%	1,556	49.397	0.032
	Sales	9	–	–	–	–	–	–	–	–	–	–	9	–	–	–	–
Miscellaneous	Military	31	1	–	–	–	–	–	–	–	–	–	32	3%	1	0.016	0.016
	Miscellaneous	4,325	1,179	85	18	1	–	–	–	–	–	–	5,608	23%	1,283	46.447	0.036
Production	Machine Setup/Operators	424	268	73	5	–	–	–	–	–	–	–	770	45%	346	21.922	0.063
	Machinists	108	27	3	4	5	–	–	–	–	–	–	147	27%	39	6.101	0.156
	Misc. Precision/Production	482	281	34	3	–	–	–	–	–	–	–	800	40%	318	14.424	0.045
	Operators, Plant/System/Util.	1,031	873	97	52	3	–	–	–	–	–	–	2,056	**50%** ◀	1,025	59.044	0.058
	Sheet Metal Workers	259	142	19	11	–	–	–	–	–	–	–	431	40%	172	11.084	0.064
	Welders and Solderers	24	7	–	–	–	–	–	–	–	–	–	32	25%	8	0.402	0.050
Professional/Scientists	Doctors and Nurses	9	–	–	–	–	–	–	–	–	–	–	9	–	–	–	–
	Engineer	5,659	1,338	98	12	6	2						7,115	20%	1,456	53.175	0.037
	Health Physicist	328	103	9	3	1	–	–	–	–	–	–	444	26%	116	5.656	0.049
	Misc. Professional	6,297	2,239	121	32	2	–	–	–	–	–	–	**8,691** ◀	28%	**2,394** ◀	75.800	0.032
	Scientist	3,605	687	39	16	1		3					4,351	17%	746	32.105	0.043
Service Workers	Firefighters	374	61	1	1	–	–	–	–	–	–	–	437	14%	63	1.410	0.022
	Food Service Employees	3	–	–	–	–	–	–	–	–	–	–	3	–	–	–	–
	Janitors	240	23	3	–	–	–	–	–	–	–	–	266	10%	26	0.954	0.037
	Misc. Service	2,316	778	100	39	10	2	–	–	–	–	–	3,245	29%	929	57.082	0.061
	Security Guards	1,000	364	4	–	–	–	–	–	–	–	–	1,368	27%	368	5.911	0.016
Technicians	Engineering Technicians	1,572	257	37	6	2	1	–	–	–	–	–	1,875	16%	303	16.607	0.055
	Health Technicians	132	37	6	1	–	–	–	–	–	–	–	176	25%	44	2.266	0.052
	Misc. Technicians	1,652	449	52	24	9	3	–	–	–	–	–	2,189	25%	537	34.720	0.065
	Radiation Monitors/Techs.	1,145	932	156	54	11	4	2	–	–	–	–	2,304	**50%** ◀	1,159	85.303	0.074
	Science Technicians	595	360	95	62	34	16	8	–	–	–	–	1,170	49%	575	**93.280** ◀	**0.162** ◀
	Technicians	908	181	12	9	1	–	–	–	–	–	–	1,111	18%	203	9.507	0.047
Transport Workers	Bus Drivers	1	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–
	Equipment Operators	120	75	8	6	1	–	–	–	–	–	–	210	43%	90	5.668	0.063
	Misc. Transport	328	19	–	–	–	–	–	–	–	–	–	347	5%	19	0.458	0.024
	Pilots	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	Truck Drivers	380	64	6	4	–	–	–	–	–	–	–	454	16%	74	3.935	0.053
Unknown	Unknown	7,954	506	23	7	1	–	–	–	–	–	–	8,491	6%	537	17.316	0.032
Totals		**50,643**	**15,174**	**1,376**	**441**	**97**	**29**	**13**	**0**	**0**	**0**	**0**	**67,773**	**25%**	**17,130**	**828.036**	**0.048**

Note: Boxed values (gray background) indicate the greatest value in each column.

Exhibit B-21: Internal Dose Distribution by Site and Nuclide, CY 2021.

Number of Individuals Receiving Radiation Doses in Each Dose Range (rem)

Site	Nuclide*	Meas. To 0.020	0.020 – 0.100	0.100 – 0.250	0.250 – 0.500	0.500 – 0.750	0.750 – 1.000	1.0 – 2.0	2.0 – 3.0	3.0 – 4.0	4.0 – 5.0	>5.0	Total Indiv. With Meas. CED	Collective CED (person-rem)	Avg. CED (rem)
Idaho	Americium	1	–	–	–	–	–	–	–	–	–	–	1	0.012	0.012
Lawrence Livermore National Laboratory	Hydrogen-3	1	2	–	–	–	–	–	–	–	–	–	3	0.152	0.051
Los Alamos National Laboratory	Uranium	6	–	–	–	–	–	–	–	–	–	–	6	0.024	0.004
Los Alamos National Laboratory	Plutonium	–	2	–	–	–	–	–	–	–	–	–	2	0.101	0.050
Los Alamos National Laboratory	Hydrogen-3	19	–	–	–	–	–	–	–	–	–	–	19	0.073	0.004
Oak Ridge: Oak Ridge National Laboratory	Uranium	1	–	–	–	–	–	–	–	–	–	–	1	0.014	0.014
Oak Ridge: Oak Ridge National Laboratory	Americium	–	1	–	–	–	–	–	–	–	–	–	1	0.068	**0.068** ◄
Oak Ridge: Y-12 National Security Complex	Uranium	583	426	110	4	–	–	–	–	–	–	–	**1,123** ◄	**41.276** ◄	0.037
Oak Ridge: Y-12 National Security Complex	Mixed	3	2	2	–	–	–	–	–	–	–	–	7	0.404	0.058
Paducah Gaseous Diffusion Plant	Uranium	10	4	–	–	–	–	–	–	–	–	–	14	0.257	0.018
Sandia National Laboratories	Other	6	–	–	–	–	–	–	–	–	–	–	6	0.068	0.011
Savannah River Site	Hydrogen-3	3	–	–	–	–	–	–	–	–	–	–	3	0.026	0.009
Uranium Mill Tailings Remedial Action Project	Uranium	34	19	1	–	–	–	–	–	–	–	–	54	1.314	0.024
Totals		**667**	**456**	**113**	**4**	–	–	–	–	–	–	–	**1,240**	**43.789**	**0.035**

Note: Boxed values (gray background) indicate the greatest value in each column.
*Intakes grouped by nuclide. Intakes involving multiple nuclides were grouped into "mixed." Nuclides where fewer than 10 individuals had intakes were grouped as "other."

Exhibit B-22: Extremity Dose Distribution by Site, CY 2021.

Site	No. Meas. Dose	Meas. to 0.100	0.100 – 1.0	1.0 – 5.0	5.0 – 10.0	10.0 – 20.0	20.0 – 30.0	Total Monitored*	No. with Meas.	No. Above Monitoring Threshold (5 rems)**	Collective Extremity Dose (person-rem)	Collective Extremity Dose (person-rem)	Avg. Meas. Extremity Dose (rem)
Ames Laboratory	45	87	1	–	–	–	–	–	133	88	–	2.762	0.031
Argonne National Laboratory	1,587	55	20	5	1	–	–	–	1,668	81	1	23.385	0.289
Brookhaven National Laboratory	1,975	15	4	1	–	–	–	–	1,995	20	–	2.877	0.144
Fermi National Accelerator Laboratory	1,210	11	–	–	–	–	–	–	1,221	11	–	0.320	0.029
Grand Junction Site	33	–	–	–	–	–	–	–	33	–	–	–	–
Hanford: Hanford Site	3,970	51	24	–	–	–	–	–	4,045	75	–	7.045	0.094
Hanford: Office of River Protection	2,857	279	263	15	–	–	–	–	3,414	557	–	119.787	0.215
Hanford: Pacific Northwest National Laboratory	1,343	482	62	15	–	–	–	–	1,902	559	–	60.394	0.108
Idaho National Laboratory	4,245	1,432	395	82	2	–	–	–	6,156	1,911	2	349.157	0.183
Kansas City National Security Plant	135	84	1	–	–	–	–	–	220	85	–	3.781	0.044
Lawrence Berkeley National Laboratory	797	20	18	2	1	–	–	–	838	41	1	17.902	0.437
Lawrence Livermore National Laboratory	3,489	20	17	7	–	–	–	–	3,533	44	–	21.748	0.494
Los Alamos National Laboratory	6,625	3,358	724	180	15	–	–	–	**10,902** ◀	**4,277** ◀	**15** ◀	**815.384** ◀	0.191
National Renewable Energy Laboratory	5	2	–	–	–	–	–	–	7	2	–	0.034	0.017
Nevada National Security Site	728	3	–	–	–	–	–	–	731	3	–	0.113	0.038
Oak Ridge: East Tennessee Technology Park	133	–	–	–	–	–	–	–	133	–	–	–	–
Oak Ridge: Oak Ridge Institute for Science and Education	48	–	–	–	–	–	–	–	48	–	–	–	–
Oak Ridge: Oak Ridge National Laboratory	3,898	60	60	34	10	1	–	–	4,063	165	11	175.053	**1.061** ◀
Oak Ridge: Y-12 National Security Complex	6,071	32	43	15	–	–	–	–	6,161	90		43.219	0.480
Office of Secure Transportation	337	–	–	–	–	–	–	–	337	–	–	–	–
Paducah Gaseous Diffusion Plant	1,503	–	–	–	–	–	–	–	1503	–	–	–	–
Pantex Plant	3,105	107	165	45	–	–	–	–	3,422	317	–	135.959	0.429
Portsmouth Gaseous Diffusion Plant	2,267	–	–	–	–	–	–	–	2,267	–	–	–	–
Princeton Plasma Physics Laboratory	358	–	–	–	–	–	–	–	358	–	–	–	–
Sandia National Laboratories	1,914	–	–	–	–	–	–	–	1,914	–	–	–	–

Exhibit B-22: Extremity Dose Distribution by Site, CY 2021.

Site	No. Meas. Dose	Meas. to 0.100	0.100 – 1.0	1.0 – 5.0	5.0 – 10.0	10.0 – 20.0	20.0 – 30.0	Total Monitored*	No. with Meas.	No. Above Monitoring Threshold (5 rems)**	Collective Extremity Dose (person-rem)	Collective Extremity Dose (person-rem)	Avg. Meas. Extremity Dose (rem)
Savannah River National Laboratory	169	19	13	1	–	–	–	–	202	33	–	6.106	0.185
Savannah River Site	5,617	404	422	44	8	–	–	–	6,495	878	8	299.33	0.341
Separations Process Research Unit	8	–	–	–	–	–	–	–	8	–	–	–	–
SLAC National Accelerator Laboratory	1,589	–	–	–	–	–	–	–	1,589	–	–	–	–
Thomas Jefferson National Accelerator Facility	1,231	–	–	–	–	–	–	–	1,231	–	–	–	–
Uranium Mill Tailings Remedial Action Project	147	–	–	–	–	–	–	–	147	–	–	–	–
Waste Isolation Pilot Plant	423	–	–	–	–	–	–	–	423	–	–	–	–
West Valley Demonstration Project	384	16	5	–	–	–	–	–	405	21	–	1.669	0.079
Service Center Personnel***	212	45	4	6	2	–	–	–	269	57	2	31.072	0.545
Totals	**58,458**	**6,582**	**2,241**	**452**	**39**	**1**	**–**	**–**	**67,773**	**9,315**	**40**	**2,117.097**	**0.227**

Note: Boxed values (gray background) indicate the greatest value in each column.

* Represents the total number of monitoring records. The number of individuals provided extremity monitoring cannot be determined.

** All extremity doses above 5 rems were for the upper extremities (hands and forearms). DOE annual limit for extremities is 50 rems. 10 CFR 835.402(a)(1)(ii) requires extremity monitoring for a shallow dose equivalent to the skin or extremity of 5 rems or more in a year.

*** Includes personnel at NETL, NNSA Albuquerque complex, Oak Ridge, and WIPP.

Prepared for the Office of Environment, Health, Safety and Security
by ORISE, P.O. Box 117 • Oak Ridge, TN 37831-0117