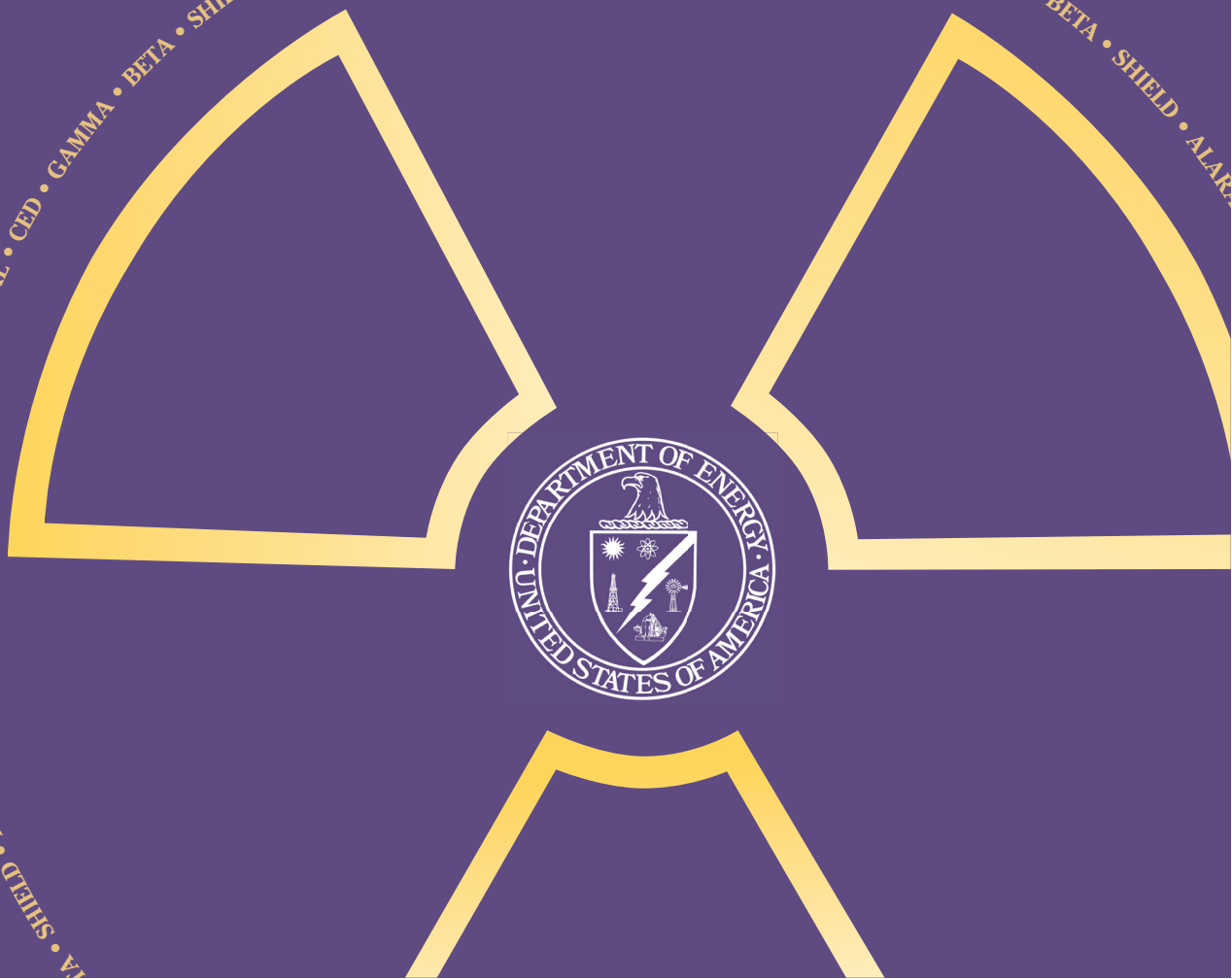
Office of Environment, Health, Safety and Security

DOE 2014 Occupational Radiation Exposure

September 2015



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

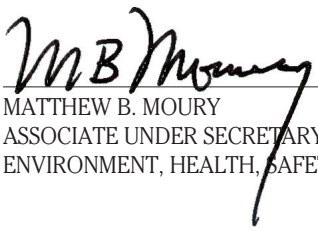
Foreword

Foreword

It is the responsibility of the U.S. Department of Energy (DOE) to protect the health and safety of DOE employees, contractors, and subcontractors. The Office of Environment, Health, Safety and Security (AU) provides the corporate-level leadership and strategic vision necessary to establish clear expectations for health, safety, environment, and security programs. In support of this mission, the AU Office of Environment, Safety, & Health (ES&H) Reporting and Analysis collects, analyzes, and disseminates data and performance indicators, such as occupational radiation exposure information.

To protect workers from the adverse health effects of radiation, a key safety focus for DOE is to maintain radiation exposures to below administrative control levels (ACL) and DOE radiation dose limits, and to further reduce these exposures through the as low as reasonably achievable (ALARA) process. The annual *DOE 2014 Occupational Radiation Exposure Report* provides an evaluation of DOE-wide performance regarding compliance with Title 10, Code of Federal Regulations, Part 835, *Occupational Radiation Protection* dose limits and an overview of the status of radiation exposures of the DOE workforce. In addition, this report serves as a risk management tool for radiological safety programs, and provides useful information to DOE organizations, epidemiologists, researchers, and national and international agencies involved in developing policies to protect workers and members of the public from the harmful effects of radiation.

The Radiation Exposure Monitoring System (REMS) program remains a key component of AU evaluation and analysis to inform management and stakeholders of the continued vigilance and success of the DOE sites in minimizing radiation exposure to workers. One of the objectives of this report is to provide useful, accurate, and complete information to DOE and the public. As part of a continuing improvement process, we would appreciate your response to the User Survey included at the end of this report.



MATTHEW B. MOURY
ASSOCIATE UNDER SECRETARY FOR
ENVIRONMENT, HEALTH, SAFETY AND SECURITY

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LIST OF EXHIBITS

LIST OF ABBREVIATIONS AND ACRONYMS

ACL	Administrative Control Level
AEC	Atomic Energy Commission
AEDE	Annual Effective Dose Equivalent
ALARA	As Low As Reasonably Achievable
AMWTP	Advanced Mixed Waste Treatment Project
ATR	Advanced Test Reactor
AU	Office of Environment, Health, Safety and Security
BNL	Brookhaven National Laboratory
CED	Committed Effective Dose
CEDE	Committed Effective Dose Equivalent
CEqD	Committed Equivalent Dose
CFI	Center for Functional Imaging
CFR	Code of Federal Regulations
D&D	Decontamination and Decommissioning
DDE	Deep Dose Equivalent
DOE	U.S. Department of Energy
DUF_6	Depleted Uranium Hexafluoride
ED	Effective Dose
EM	Office of Environmental Management
EqD	Equivalent Dose
ERDA	Energy Research and Development Administration
ES&H	Environment, Safety, & Health
ETEC	Energy Technology Engineering Center
ETTP	East Tennessee Technology Park
FACET	Facility for Advanced Accelerator Experimental Tests
Fermilab	Fermi National Accelerator Laboratory
ICP	Idaho Cleanup Project
ICRP	International Commission on Radiological Protection
INL	Idaho National Laboratory
KCP	Kansas City Plant
LANL	Los Alamos National Laboratory
LBNL	Lawrence Berkeley National Laboratory
LLNL	Lawrence Livermore National Laboratory
mSv	Millisievert
NBL	New Brunswick Laboratory
NNSA	National Nuclear Security Administration
NNSS	Nevada National Security Site, formally known as Nevada Test Site (NTS)
NRC	U.S. Nuclear Regulatory Commission
NREL	National Renewable Energy Laboratory
NYSERDA	New York State Energy Research and Development Authority
ORISE	Oak Ridge Institute for Science and Education
ORNL	Oak Ridge National Laboratory
ORP	Office of River Protection
ORPS	Occurrence Reporting and Processing System
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
Pu-238	Plutonium-238

RCS	Radiological Control Standard
rem	Roentgen equivalent in man
REMS	Radiation Exposure Monitoring System
RF	Radio Frequency
RL	Richland Operations Office
SLAC	SLAC National Accelerator Laboratory
SNL	Sandia National Laboratories
SPEAR3	Stanford Positron-Electron Asymmetric Ring
SPRU	Separations Process Research Unit
SRNS	Savannah River Nuclear Solutions
SRR	Savannah River Remediation
SRS	Savannah River Site
Sv	Sievert
TED	Total Effective Dose
TEqD	Total Equivalent Dose
TJNAF	Thomas Jefferson National Accelerator Facility
U-234	Uranium-234
UMTRA	Uranium Mill Tailings Remediation Action Project
USEC	United States Enrichment Corporation
WIPP	Waste Isolation Pilot Plant
WVDP	West Valley Demonstration Project
Y-12	Y-12 National Security Complex

Executive Summary

The Office of ES&H Reporting and Analysis within the DOE AU publishes the annual *DOE Occupational Radiation Exposure Report* to provide an overview of the status of radiation protection practices at DOE (including the National Nuclear Security Administration [NNSA]). The *DOE 2014 Occupational Radiation Exposure Report* provides an evaluation of DOE-wide performance regarding compliance with Title 10, Code of Federal Regulations (CFR), Part 835, *Occupational Radiation Protection* dose limits and ALARA process requirements. In addition, the report provides data to DOE organizations responsible for developing policies for protection of individuals from the adverse health effects of radiation. The report provides a summary and an analysis of occupational radiation exposure information from the monitoring of individuals involved in DOE activities. Over the past 5-year period, the occupational radiation exposure information has been analyzed in terms of dose to individuals, dose by site, and aggregate data.

Analysis of individual dose data includes an examination of:

- Doses exceeding the 5 rems (50 millisievert [mSv]) DOE regulatory limit; and
- Doses exceeding the 2 rems (20 mSv) DOE Administrative Control Level (ACL).

As an indicator of the overall amount of radiation dose received during the conduct of work activities at DOE, the report includes information on collective dose (aggregate data). The collective dose is the sum of the doses received by all individuals with a measurable dose and is measured in units of person-rem. The term "rem" stands for the roentgen equivalent in man. The collective dose values are also shown in person-millisievert (mSv). In this report, “dose” refers to the Total Effective Dose (TED) and the collective TED is the summation of the TED reported for all monitored individuals. The TED is comprised of the effective dose (ED) from external sources, which includes neutron and photon radiation, and the internal committed effective dose (CED), which results from the intake of radioactive material into the body. The total DOE collective TED was about the same as the previous year, it decreased 1 percent from 2013 to 2014, as shown in *Exhibit ES-1*.

Another primary indicator of the level of radiation exposure covered in this report is the average measurable dose, which normalizes the collective dose over the population of workers who actually received a measurable dose. The average measurable TED increased by 3 percent from 2013 to 2014, as shown in *Exhibit ES-2*.

The report contains information and analysis that can be summarized as follows:

- No doses exceeded the DOE occupational dose limit of 5 rems TED in 2014 and no doses exceeded the DOE ACL of 2 rems TED.

Exhibit ES-1:
Collective TED (person-rem), 2010–2014.

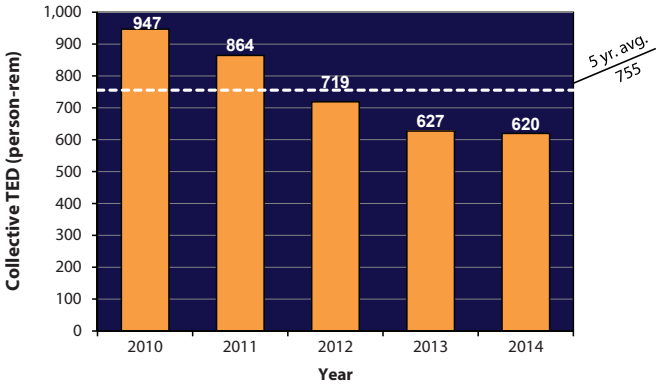
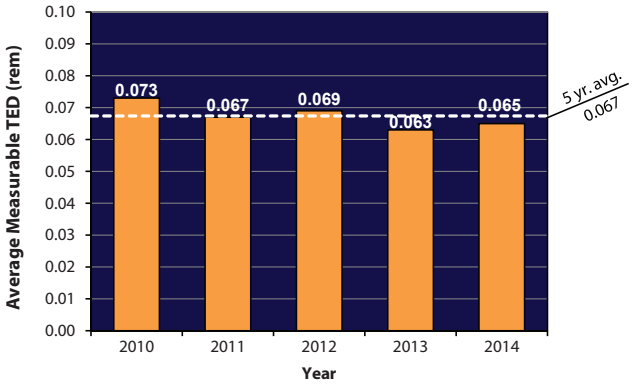


Exhibit ES-2:
Average Measurable TED (rem), 2010–2014.



- The collective TED decreased 1 percent from 627 person-rems (6,270 person-millisieverts [mSv]) in 2013 to 620 person-rems (6,200 person-mSv) in 2014.

- The sites contributing to the majority of the collective TED were (in descending order of collective TED) Oak Ridge, Los Alamos, Savannah River, Idaho, and Hanford. These sites accounted for 77 percent of the collective TED at DOE in 2014.

- The collective TED decreased at two of the five sites with the largest collective TED; i.e., Los Alamos National Laboratory (LANL) and Hanford. At LANL the decrease in collective TED in 2014 was attributed to curtailing work with solid waste in early 2014 due to the contamination release event at Waste Isolation Pilot Plant (WIPP) and its relation to LANL waste packaging. In addition, most programmatic work was not resumed from the 2013 pause associated with the criticality safety program at LANL's TA-55. At Hanford, the primary reasons for the decrease in collective TED was a change in the work scope at DOE-Richland Operations Office (RL) to include more work involving heavy equipment, which increased the distance between workers and source terms, and the implementation of long-length tools at DOE-Office of River Protection (ORP). Due to changes in funding, several DOE-RL projects continued to operate at minimal levels. The change in work scope also included the packaging and handling of the waste packages during the seal-out activities until placed in shielded hardened containers.

- Uranium-234 (U-234) accounted for the largest percentage of the collective CED (internal exposure), with over 98 percent of this dose accrued at Y-12.

- The collective CED (internal exposure) increased by 21 percent from 44.6 person-rems (446 person-mSv) in 2013 to 53.9 person-rems (539 person-mSv) in 2014, in part due to the increase of work activities in 2014 at Y-12 National Security Complex (Y-12) following the government sequestration and reduced activities in 2013.

- The collective TED for transient workers, individuals monitored at more than one DOE site, increased by 2 percent from 21.1 person-rems (211 person-mSv) in 2013 to 21.5 person-rems (215 person-mSv) in 2014.

Over the past 5 year period, 99.99 percent of the individuals receiving measurable TED have received doses below the 2 rems (20 mSv) TED ACL, which is well below the DOE regulatory limit of 5 rems (50 mSv) TED annually. The occupational radiation exposure records show that in 2014, DOE facilities continued to comply with DOE dose limits and ACLs and worked to minimize exposure to individuals.

To access this report and other information on occupational radiation exposure at DOE, visit the DOE AU web site at:

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

Section One Introduction

1

The *DOE 2014 Occupational Radiation Exposure Report* presents the results of analyses of occupational radiation exposures at DOE facilities during 2014. This report includes occupational radiation exposure information for all DOE employees, contractors, and subcontractors, as well as members of the public in controlled areas that are monitored for exposure to radiation. The 96 DOE organizations submitting radiation exposure reports for 2014 have been grouped into 32 sites. This information has been analyzed and trends over time are presented to provide a measure of DOE's performance in protecting its workers from radiation.

1.1 Report Organization

This report is organized into the five sections listed below. Additional supporting technical information, tables of data, and additional items are available on the DOE web site for Information on Occupational Radiation Exposure (http://energy.gov/ehss/occupational-radiation-exposure) and as appendices to this report. A User Survey form is included at the end of this report and users are encouraged to provide feedback to improve this report.

1.2 Report Availability

This report is available online and may be downloaded from:

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

Requests for additional copies of this report, 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:

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Visit the DOE web site for more information on occupational radiation exposure, such as the following:

- Annual occupational radiation exposure reports in PDF since 1974;
- Guidance on reporting radiation exposure information to the DOE Headquarters REMS;
- New improved query tool;
- Guidance on how to request a dose history for an individual;
- Statistical data since 1987 for analysis;
- Applicable DOE orders and manuals for the recordkeeping and reporting of occupational radiation exposure at DOE;
- Occupational Exposure Dashboard - new interactive data explorer;
- Ten Year Summary - new graphical comprehensive overview of past 10 years of radiation exposure data; and
- ALARA activities at DOE.

Section One	Describes the content and organization of this report.
Section Two	Discusses the radiation protection and dose reporting requirements.
Section Three	Presents the 2014 occupational radiation dose data along with trends over the past 5 years.
Section Four	Provides instructions to submit successful ALARA projects. A detailed ALARA Activity summary is provided on the DOE Radiation Exposure web site once the final report is published. Please visit http://energy.gov/ehss/occupational-radiation-exposure and select Annual Reports to review.
Section Five	Discusses conclusions.
Appendices	The appendices are offered in color on the DOE Radiation Exposure web site once the final report is published. Please visit http://energy.gov/ehss/occupational-radiation-exposure and select Annual Reports to review. The appendices provide a comprehensive breakdown of dose by field office and site, as well as distributions by facility type and occupation, type of dose, and internal dose by radionuclide.

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Section Two
Standards and Requirements

2

Standards and Requirements

One of DOE's primary objectives is to provide a safe and healthy workplace for all employees and contractors. To meet this objective, the DOE AU establishes comprehensive and integrated programs for the protection of workers from hazards in the workplace, including ionizing radiation. The basic DOE standards for occupational radiation protection include radiation dose limits that establish maximum permissible doses to workers. In addition to the requirement that radiation doses not exceed these limits, contractors and subcontractors are required to maintain exposures as far below the limits as is reasonable through application of the ALARA process.

This section discusses the radiation protection standards and requirements in effect for 2014. For more information on past requirements, visit the DOE web site for DOE Directives, Delegations, and Requirements at https://www.directives.doe.gov/. See the Archives section under the Directives menu for historical references.

2.1 Radiation Protection Requirements

DOE radiation protection standards in effect at the beginning of 2014 were originally based on Federal guidance for protection against occupational radiation exposure promulgated by the U.S. Environmental Protection Agency in 1987 [1]. This guidance, initially implemented by DOE in 1989, was based on the 1977 recommendations of the International Commission on Radiological Protection (ICRP) Publication 26 [2] and the 1987 recommendations of the National Council on Radiation Protection and Measurements Publication 91 [3]. The EPA guidance recommends that internal dose be added to the external whole-body dose to determine the total effective dose equivalent. Prior to this guidance, the external dose and internal dose were each limited separately. It should be noted that Title 10 CFR 835, *Occupational Radiation Protection* was revised in June 2007, with full implementation required by July 2010. The revision adopted ICRP Publications 60 [4] and 68 [5] dosimetric quantities and units (see section 2.4, Amendments to 10 CFR 835). Title 10 CFR 835 was further revised in April 2011 when Appendix C was updated. 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 835.202, 206, 207, and 208 [6] and are summarized in *Exhibit 2-2*.

2.3 Reporting Requirements

On June 27, 2011, DOE Order (O) 231.1A was updated and reissued as DOE O 231.1B, *Environment, Safety and Health Reporting* [7], which contains the requirements for reporting annual individual radiation exposure records to the REMS repository. DOE Manual 231.1-1A,

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

Title	Date	Description
10 CFR 835, *Occupational Radiation Protection* [6]	Issued 12/14/93 Amended 11/4/98 Amended 6/8/07 Amended 4/13/11	Establishes radiation protection standards, limits, and program requirements for protecting individuals from ionizing radiation that results from the conduct of DOE activities.
DOE Order 231.1B, *Environment, Safety and Health Reporting* [7]	Approved 6/27/11	Requires the annual reporting of occupational radiation exposure records to the DOE REMS repository.
REMS Reporting Guide [8]	Issued 2/23/12	Specifies the current format and content of the reports required by DOE Order 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 rems
		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 rems
		Equivalent Dose to the Lens of the Eye	EqD-Eye	15 rems
		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 to the maximally exposed extremity + CEqD-SK	50 rems
Declared pregnant workers*	835.206	Total equivalent dose	TEqD	0.5 rem per gestation period
Minors	835.207	Total effective dose	TED	0.1 rem
Members of the public in a controlled area	835.208	Total effective dose	TED	0.1 rem

*Limit applies to the embryo/fetus.

Environment, Safety, and Health Reporting Manual, has been cancelled and specific instructions for preparing occupational exposure data for submittal to the REMS repository are contained in the REMS Reporting Guide available online at: http://energy.gov/ehss/downloads/radiation-exposure-monitoring-systems-data-reporting-guide [8].

2.4 Amendment 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 (DACs); 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. Because all sites began complying with the new requirements during 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 for Workers) was updated.

Section Three
Occupational Radiation Dose at DOE

3

3.1 Analysis of the Data

Certain key indicators are useful when evaluating occupational radiation exposures received at DOE facilities. The key indicators are analyzed to identify and correlate parameters having an impact on radiation dose at DOE.

Key indicators for the analysis of aggregate data are the following:

- number of records for monitored individuals;
- individuals with measurable dose;
- collective dose;
- average measurable dose; and
- dose distribution.

Analysis of individual dose data includes an examination of:

- doses exceeding the 5 rems (50mSv) DOE regulatory limit; and
- doses exceeding the 2 rems (20 mSv) DOE ACL.

Additional information is provided in this report concerning activities at sites contributing to the majority of the collective dose. The data for prior years contained in this report are subject to change because sites may submit corrections or additions for previous years.

3.2 Analysis of Aggregate Data

3.2.1 Number of Records for Monitored Individuals

The number of records for monitored individuals represents the size of the DOE workforce monitored for radiation dose. The number of records for monitored individuals is not the same as the number of individuals in the workforce that are monitored, as it could include the same individual more than once. The number represents the sum of all records for monitored individuals, including all DOE employees, contractors, and subcontractors, as well as members of the public in controlled areas that are monitored for exposure to radiation. Individuals that have more than one record due to being monitored at more than one site (transient individuals) comprise less than 4 percent of the monitored workers; therefore, the multiple counting has minimal impact on the totals and averages presented in this report (see section 3.5 for a discussion on total doses received by transient workers monitored at more than one site). Some DOE facilities provide radiation dose monitoring to individuals for reasons other than the potential for exposure to radiation and/or radioactive materials exceeding the monitoring thresholds specified in 10 CFR 835.402. Many individuals are monitored for reasons such as security, administrative convenience, and legal liability. Some sites offer monitoring for any individual who requests monitoring, independent of the potential for exposure. For this reason, the number of records for workers who receive a measurable dose best represents the exposed workforce.

3.2.2 Number of Records for Individuals with Measurable Dose

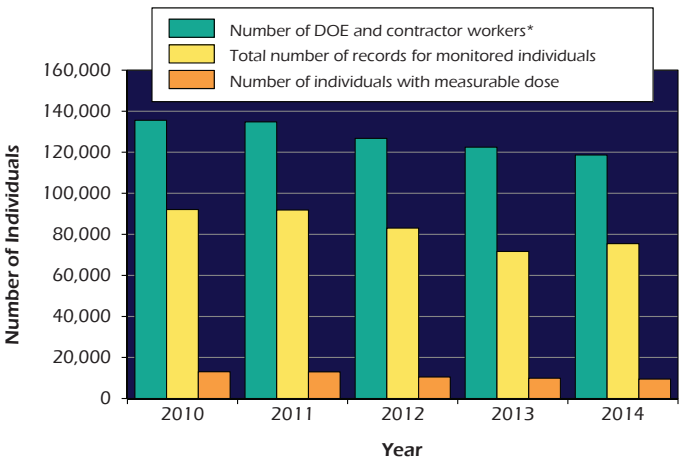
DOE uses the number of individuals receiving a measurable dose (number of records of monitored individuals with a detectable dose) to represent the exposed workforce size.

Over the past 5-year period, 99.99 percent of the individuals receiving measurable TED have received doses below the 2 rems (20 mSv) TED ACL, which is well below the DOE regulatory limit of 5 rems (50 mSv) TED.

Exhibit 3-1a and *Exhibit 3-1b* show the number of DOE and contractor workers, the total number of workers monitored for radiation dose, the number of individuals with a measurable dose, and the relative percentages for the past 5 years.

Fifteen of the reporting sites experienced decreases in the number of workers with a measurable TED from 2013 to 2014. The largest decrease in total number of workers with a measurable TED occurred at LANL with a decrease of 302 workers. Seventeen of the reporting sites experienced increases in the number of workers with a measurable TED from 2013 to 2014. The largest increase in the number of workers receiving a measurable TED occurred at the Savannah River Site (SRS) with an increase of 113 workers. A discussion of activities at the highest dose facilities is included in section 3.4.3.

Exhibit 3-1a:
Monitoring of the DOE Workforce, 2010–2014.



*The number of DOE and contractor workers was determined from the total annual work hours at DOE [9] converted to full-time equivalents.

For 2014, 64% of the DOE workforce was monitored for radiation dose, and 13% of monitored individuals received a measurable dose.

Exhibit 3-1b:
Monitoring of the DOE Workforce, 2010–2014.

Year	DOE & Contractor Workforce	Number of Workers Monitored	Percent of Workers Monitored*	Number Monitored w/Measurable Dose	Percent Monitored w/Measurable Dose*
2010	135,566	92,104	68% ▼	13,047	14%
2011	134,790	91,857	68% ▼	12,965	14%
2012	126,776	83,043	66% ▼	10,461	13% ▼
2013	122,494	71,662	59% ▼	9,902	14% ▲
2014	118,656	75,448	64% ▲	9,501	13% ▼
5-Year Average	**127,656**	**82,823**	**65%**	**11,175**	**13%**

* Up arrows indicate an increase from the previous year's value. Down arrows indicate a decrease from the previous year's value.

3.2.3 Collective Dose

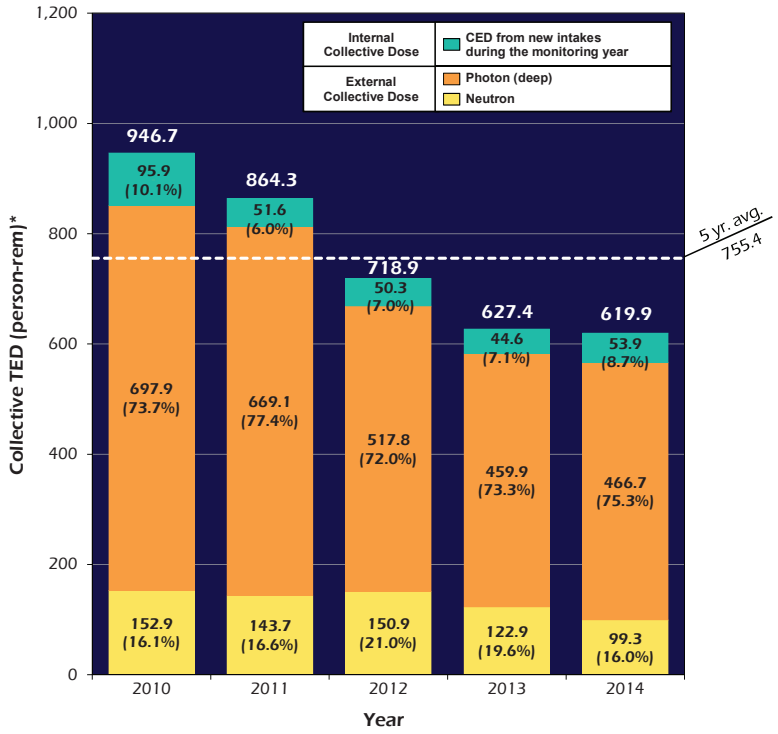
The collective dose is the sum of the dose received by all individuals with a measurable dose and is measured in units of person-rem and person-mSv. As used in this report, the collective dose is a measure of the overall occupational radiation exposure at DOE facilities and includes the dose to all DOE employees, contractors, and subcontractors, as well as members of the public in controlled areas that are monitored for exposure to radiation. 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 decreased at DOE by 1 percent from 627.4 person-rems (6,274 person-mSv) in 2013 to 619.9 person-rems (6,199 person-mSv) in 2014.

The internal dose is based on the 50-year CED methodology. 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 increased by 21 percent from 44.6 person-rems (446 person-mSv) in 2013 to 53.9 person-rems (539 person-mSv) in 2014. This increase is due, in part, to the increase of work activities in 2014 at Y-12 following the government sequestration and reduced activities in 2013. The collective photon

Exhibit 3-2:
Components of TED, 2010–2014.



The collective TED decreased by 1% at DOE from 2013 to 2014.

The collective internal dose increased by 21% from 2013 to 2014.

The collective neutron dose decreased by 19% from 2013 to 2014.

The collective photon dose increased by 1% from 2013 to 2014.

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.

dose increased by 1 percent from 459.9 person-rems (4,599 person-mSv) in 2013 to 466.7 person-rems (4,667 person-mSv) in 2014.

The neutron component of the collective TED decreased by 19 percent from 122.9 person-rems (1,229 person-mSv) in 2013 to 99.3 person-rems (993 person-mSv) in 2014. This is because neutron exposures decreased by 21 percent at LANL due to the curtailment of waste handling operations, and a decrease of 35 percent occurred at Oak Ridge National Laboratory (ORNL) due to a reduction of work performed at the radiochemical engineering development complex.

Ten DOE sites reported decreases in the collective TED from the 2013 values, while 22 DOE sites reported increases.

The five sites that contributed most (77 percent) of the DOE collective TED in 2014 were (in descending order of collective TED): Oak Ridge – 21 percent (including East Tennessee Technology Park [ETTP], Y-12, ORNL, and Oak Ridge Institute for Science and Education [ORISE]); LANL – 15 percent; SRS – 15 percent (including Savannah River Nuclear Solutions [SRNS] and Savannah River Remediation [SRR]); Idaho Site – 14 percent (including the Idaho National Laboratory [INL], Idaho Cleanup Project [ICP] and the Advanced Mixed Waste Treatment Project [AMWTP]); and Hanford – 11 percent (including the Hanford Site, Pacific Northwest National Laboratory [PNNL], and ORP).

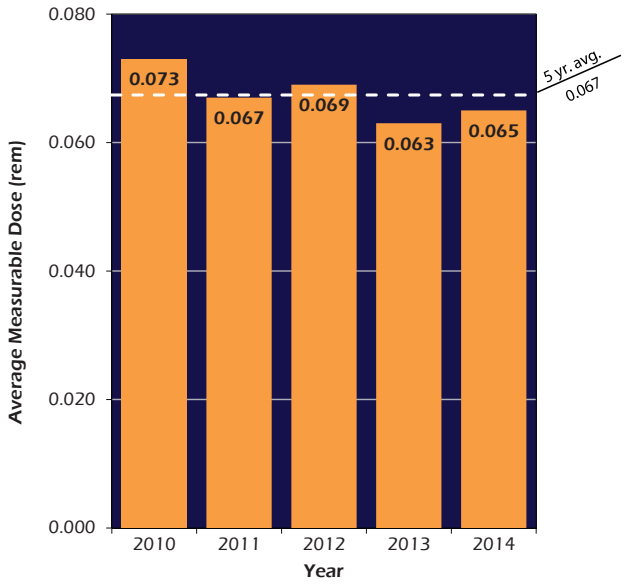
Two of these sites reported decreases in the collective TED in 2014 compared with 2013 and three sites reported increases. The two sites in descending order of the percent reduction in collective TED are LANL (31 percent lower) and Hanford (15 percent lower). The three sites in descending order of the percent increase in collective TED are Idaho (20 percent higher), Oak Ridge (5 percent higher), and SRS (5 percent higher).

3.2.4 Average Measurable Dose

The average measurable dose (TED) to DOE workers, a key radiation dose indicator, is calculated by dividing the collective dose (in this case, TED) by the number of individuals with measurable dose for TED. This is the average most commonly used in this and other reports when examining trends and comparing doses received by workers, because it reflects the exclusion of those individuals receiving a less than measurable dose.

The average measurable TED is shown in *Exhibit 3-3*. The average measurable TED increased by 3 percent from 0.063 rem (0.63 mSv) in 2013 to 0.065 rem (0.65 mSv) in 2014, slightly lower than the 5-year average.

Exhibit 3-3:
Average Measurable TED, 2010–2014.



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

3.2.5 Dose Distribution

Exposure data are commonly analyzed in terms of dose intervals to depict the dose (TED) distribution among the worker population. *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) [6].

Exhibit 3-4 shows that the dose (TED) distribution for 2014 was slightly lower in three ranges compared with the 2013 data. Ninety-nine percent of the individuals monitored had doses less than 0.25 rem (2.5 mSv). *Exhibit 3-5* presents the dose distribution in terms of the percentage of individuals with measurable TED in each range. The percentages shown in this manner assist in revealing changes in the distribution from year to year. It shows that three of the percentages increased while three decreased.

Exhibit 3-4:
Distribution of TED by Dose Range, 2010–2014.

	TED Range (rem)	2010	2011	2012	2013	2014
Number of Individuals in Each Dose Range*	Less than measurable	79,057	78,892	72,582	61,760	65,947
	Measurable to 0.100	10,361	10,514	8,443	8,150	7,708
	0.100–0.250	1,857	1,736	1,360	1,246	1,256
	0.250–0.500	695	564	529	421	444
	0.500–0.750	101	99	87	48	72
	0.750–1.000	23	41	27	28	15
	1–2	9	11	15	9	6
	2–3					
	3–4					
	4–5					
	>5	1				
Total number of records for monitored individuals		92,104	91,857	83,043	71,662	75,448
Number with measurable dose		13,047	12,965	10,461	9,902	9,501
Number with dose >0.100 rem		2,686	2,451	2,018	1,752	1,793
% of individuals with measurable dose		14%	14%	13%	14%	13%
Collective TED (person-rems)		946.658	864.315	718.903	627.361	619.896
Average measurable TED (rem)		0.073	0.067	0.069	0.063	0.065

* 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, 2010 – 2014.

	TED Range (rem)	2010	2011	2012	2013	2014
Percentage of Individuals with Measurable TED*	Measurable <0.100	79.41%	81.10%	80.71%	82.31%	81.13%
	0.100–0.250	14.23%	13.39%	13.00%	12.58%	13.22%
	0.250–0.500	5.33%	4.35%	5.06%	4.25%	4.67%
	0.500–0.750	0.77%	0.76%	0.83%	0.48%	0.76%
	0.750–1.000	0.18%	0.32%	0.26%	0.28%	0.16%
	1–2	0.07%	0.08%	0.14%	0.09%	0.06%
	2–3	0.00%	0.00%	0.00%	0.00%	0.00%
	>3	0.01%	0.00%	0.00%	0.00%	0.00%

Note: In 2010, one individual received an exposure in excess of the DOE annual limits. See section 3.3.2.
* 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 analysis is based on aggregate data for DOE. From an individual worker perspective and a regulatory perspective, it is important to examine the doses received by individuals in the elevated dose ranges to understand the circumstances leading to these doses in the workplace and to better manage, or where practical, avoid these doses in the future. The following sections focus on doses received by individuals that were in excess of the DOE limit (5 rems [50 mSv] TED) and the DOE recommended ACL (2 rems [20 mSv] TED).

3.3.1 Doses in Excess of DOE Limit

One individual exceeded the TED regulatory limit (5 rems [50 mSv]) in 2010 (see Occurrence Reporting and Processing System [ORPS] report EM-SR-SRNS-CPWM-2010-0008).

No individual was reported to have exceeded 5 rems TED from 2011 through 2014.

3.3.2 Doses in Excess of Administrative Control Level

The Radiological Control Standard (RCS) [10] recommends a 2 rems (20 mSv) ACL for TED per year per person for all DOE activities. Prior to allowing an individual to exceed this level, approval from the appropriate Secretarial officer or designee should be received. The RCS recommends that each DOE site establish its own more restrictive ACL that would require contractor management approval to be exceeded.

No individual exceeded 2 rems TED in 2014.

One individual exceeded the 2 rems (20 mSv) ACL in the past 5 years. The same individual also exceeded the 5 rems (50 mSv) annual limit.

3.3.3 Intakes of Radioactive Material

DOE tracks the number of intakes as a performance measure in the report. As shown in *Exhibit 3-6*, the highest dose from the single event that caused an exceedance of the ACL (and also the DOE limit as noted above) was the result of the intake of radionuclides (see ORPS report EM-SR-SRNS-CPWM-2010-0008). DOE emphasizes the importance of taking measures to avoid intakes and maintain doses as low as reasonable through the ALARA process.

Exhibit 3-7 shows the number of individuals with measurable CED, collective CED, and average measurable CED for 2010 to 2014. The number of individuals with measurable CED decreased by 2 percent from 1,221 in 2013 to 1,198 in 2014, while the collective CED increased by 21 percent. The average measurable CED increased by 22 percent from 0.037 rem (0.37 mSv) in 2013 to 0.045 rem (0.45 mSv) in 2014 and is slightly above the 5-year average measurable CED.

Ninety-eight percent of the collective CED in 2014 was from uranium intakes at Y-12 during the operation and management of Enriched Uranium Operations facilities at the site. Compared with external dose, relatively few workers at DOE receive measurable internal dose, so larger fluctuations may occur from year to year in the number of workers and collective CED than for other components of TED.

Exhibit 3-6:
Dose in Excess of DOE Administrative Control Levels, 2010–2014.

Year	Total Effective Dose (TED) (External + Internal Dose) (rem)	Effective Dose (ED) from External Sources (rem)	Committed Effective Dose (CED) from Intakes (rem)	Committed Equivalent Dose (CEqD) from Intakes (rem)	Intake Nuclides	Facility Types	Site
2010	31.618	0.029	31.589	1,043.190	Pu-238	Transuranic (TRU) Waste Remediation Facility	SRS
2011				None reported			
2012				None reported			
2013				None reported			
2014				None reported			

Exhibit 3-7:
Number of Individuals with Measurable CED, Collective CED, and Average Measurable CED, 2010-2014

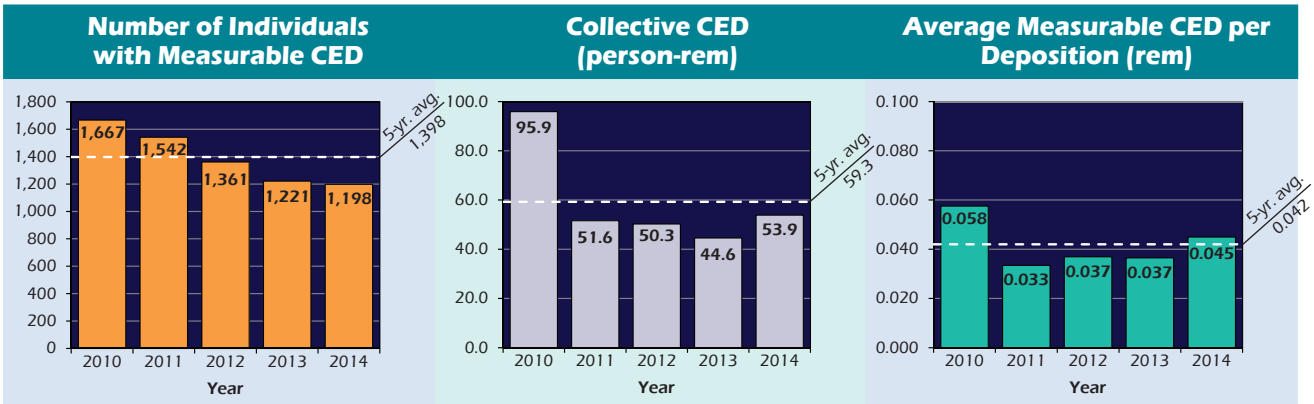


Exhibit 3-8 shows the distribution of the internal dose (CED) from 2010 to 2014. The total number of individuals with measurable CED in each dose range is the sum of the number of individuals receiving an internal dose (CED) in the dose range. Individuals may have had more than one intake of radioactive material, but these intakes result in one annual CED total per individual. Doses below 0.020 rem (0.20 mSv) are shown as a separate dose range, to show the large number of doses in this low dose range. The decrease in the number of individuals with measurable CED in 2014 is primarily due to the overall limited operations at LANL. (See *Exhibit 3-14* about operations at LANL).

The internal dose records indicate that the majority of the intakes result in very low doses. In 2014, 47 percent of the internal dose records were for doses below 0.020 rem (0.20 mSv). Over the 5-year period, internal doses accounted for 8 percent of the collective TED, and only 10 percent of the individuals who received internal doses had estimated doses above the monitoring threshold (0.1 person-rem [1 mSv]) specified in 10 CFR 835.402(c) [6].

Exhibit 3-8:
Internal Dose Distribution from Intakes, 2010–2014.

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		
2010	895	612	137	19	1	1	1				1	1,667	95.928
2011	886	535	107	12	1		1					1,542	51.601
2012	737	481	125	17	1							1,361	50.253
2013	668	438	107	5	2	1						1,221	44.600
2014	565	478	139	14	2							1,198	53.875

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

3.3.4 Bioassay and Intake Summary Information

For the monitoring year 2014, bioassay and intake summary information was required to be reported under the REMS Reporting Guide [8]. During the past 3 years, urinalysis has been reported as the most common method of bioassay measurement used to determine internal doses to the individuals. *Exhibit 3-9* shows the breakdown of bioassay measurements by measurement type and number of measurements. The measurements reported under 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. The measurements reported in air samples are used to calculate the amount of airborne radioactive material taken into the body and the resultant internal dose. Note that the numbers 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.

Sixty-seven percent of the urinalysis measurements in 2014 were performed at four sites: Y-12, LANL, SRS and the Portsmouth Gaseous Diffusion Plant (PGDP). The majority of the measurements reported as Air Sampling accounted for 14 percent of the total measurements. Nearly 25 percent of the In Vivo measurements were from Savannah River.

Y-12 performed the largest number of bioassay measurements overall, comprising 23 percent of the total measurements taken. WIPP had the largest percentage increase (523 percent) in the number of urinalysis measurements in 2014 (see section 3.4.4 for additional information) and SRS reported the largest decrease (70 percent) in the number of Air Sampling measurements.

Exhibit 3-9:
Bioassay and Air Sampling Measurements, 2012-2014.

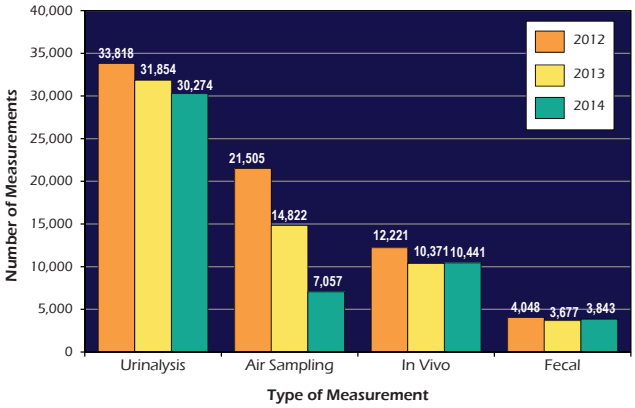
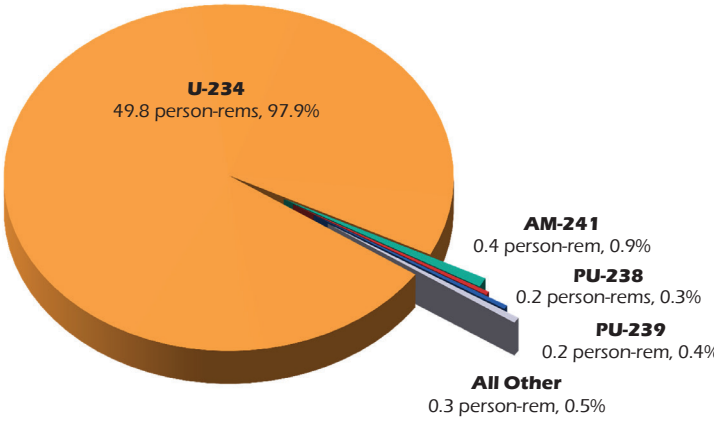


Exhibit 3-10 shows the breakdown of the collective CED by radionuclide for 2014. U-234 accounted for the largest percentage of the collective CED, with over 98 percent of this dose accrued at Y-12. It is worth noting that the collective CED per radionuclide for *Exhibit 3-10*, which is based on intake summaries, does not equal the collective CED found in *Exhibit 3-8*, which is based on individual dose records.

Exhibit 3-10:
Collective CED by Radionuclide from Internal Exposure, 2014.



3.4 Analysis of Site Data

3.4.1 Collective TED by Site and Other Facilities

The collective TED for 2012 through 2014 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 are shown in *Exhibit 3-12*. The collective TED decreased 1 percent from 627 person-rems (6,270 person-mSv) in 2013 to 620 person-rems (6,200 person-mSv) in 2014, with Oak Ridge sites (including ETTP, Y-12, ORNL, and ORISE); LANL; Savannah River Site (including SRNS and SRR); Idaho Site (including INL, ICP, and AMWTP); and Hanford (including the Hanford Site, PNNL, and ORP); contributing 77 percent of the total DOE collective TED.

3.4.2 Changes by Site from 2013 to 2014

Exhibit 3-13 shows the collective TED, 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 fluctuations in workload and tasks conducted.

Exhibit 3-11:
Collective TED by DOE Site for 2012–2014.

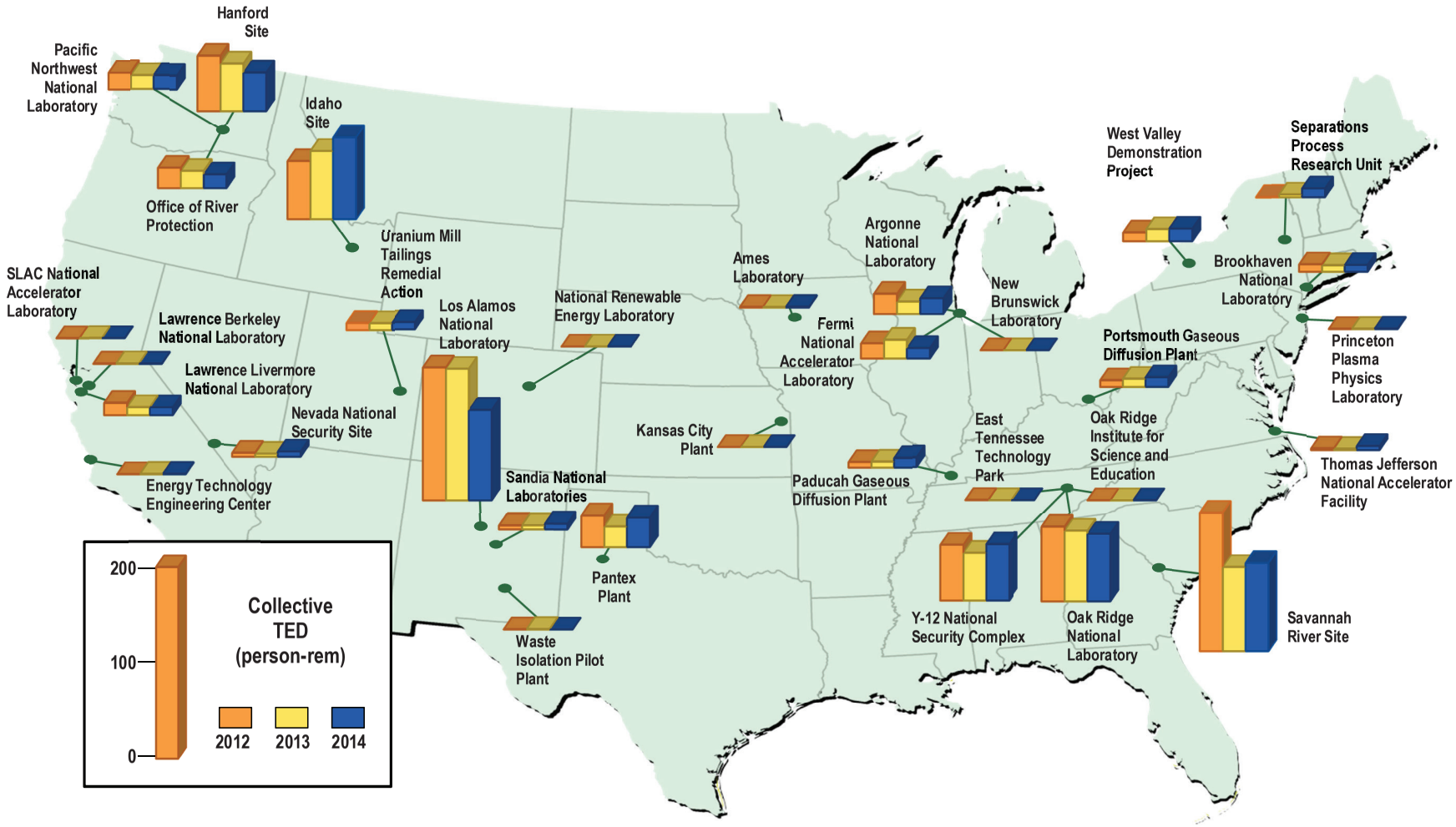


Exhibit 3-12:
Collective TED and Number of Individuals with Measurable TED by DOE Site, 2012–2014.

Site	2012		2013		2014	
	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	0.820	25	0.730	24	0.873	33
Argonne National Laboratory	21.212	122	13.091	74	16.492	84
Brookhaven National Laboratory	7.981	171	6.988	194	7.282	129
Energy Technology Engineering Center	0.227	55	0.479	57	0.489	69
Fermi National Accelerator Laboratory	15.980	207	19.750	175	11.070	193
Hanford:						
Hanford Site	58.349	926	50.081	715	40.715	659
Office of River Protection	21.528	413	18.228	448	14.653	412
Pacific Northwest National Laboratory	17.779	240	14.550	403	14.634	479
Idaho Site	61.292	1,257	71.814	1,437	86.202	1,174
Kansas City Plant	0.021	6	0.001	1	0.022	11
Lawrence Berkeley National Laboratory	0.497	10	0.623	9	0.463	8
Lawrence Livermore National Laboratory	13.037	131	8.475	103	8.353	108
Los Alamos National Laboratory	140.148	1,438	**138.734**	**1,703**	**95.436**	1,401
National Renewable Energy Laboratory	0.020	4	0.068	5	0.107	7
Nevada National Security Site	4.284	100	3.218	89	5.638	116
New Brunswick Laboratory	0.039	2	0.012	1	0.023	2
Oak Ridge:						
East Tennessee Technology Park	0.306	14	0.040	4	0.004	1
Oak Ridge Institute for Science and Education	0.124	23	0.083	6	0.210	23
Oak Ridge National Laboratory	78.790	763	74.531	642	71.304	618
Y-12 National Security Complex	58.643	1,413	50.136	1,337	59.296	1,326
Paducah Gaseous Diffusion Plant	5.984	113	6.450	92	10.306	139
Pantex Plant	33.118	339	21.829	330	31.084	305
Portsmouth Gaseous Diffusion Plant	7.092	135	8.634	102	10.302	95
Princeton Plasma Physics Laboratory	0.334	43	0.339	58	0.693	123
Sandia National Laboratories	4.315	122	4.335	123	6.072	93
Savannah River Site	**145.443**	**2,044**	88.536	1,471	92.820	**1,584**
Separations Process Research Unit	0.584	23	2.927	50	9.338	76
SLAC National Accelerator Laboratory	0.315	15	0.281	10	0.246	9
Thomas Jefferson National Accelerator Facility	1.963	85	1.503	48	4.452	42
Uranium Mill Tailings Remedial Action Project	7.673	87	7.407	55	7.756	61
Waste Isolation Pilot Plant	0.298	18	0.552	32	0.034	3
West Valley Demonstration Project	9.312	86	12.901	101	13.424	112
Service Center Personnel*	1.395	31	0.035	3	0.103	6
Totals	**718.903**	**10,461**	**627.361**	**9,902**	**619.896**	**9,501**

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

* Includes personnel at National Nuclear Security Administration (NNSA) Albuquerque complex and Oak Ridge in addition to several smaller facilities not associated with a DOE site.

Exhibit 3-13:
Site Dose Data, 2014.

Site	2014					
	Collective TED (person-rem)	Percent Change from 2013	Number with Meas. Dose	Percent Change from 2013	Avg. Meas. TED (rem)	Percent Change from 2013
Ames Laboratory	0.873	◊	33	◊	0.026	◊
Argonne National Laboratory	16.492	26% ▲	84	14% ▲	**0.196**	11% ▲
Brookhaven National Laboratory	7.282	4% ▲	129	-34% ▼	0.056	57% ▲
Energy Technology Engineering Center	0.489	◊	69	◊	0.007	◊
Fermi National Accelerator Laboratory	11.070	-44% ▼	193	10% ▲	0.057	-49% ▼
Hanford:						
Hanford Site	40.715	-19% ▼	659	-8% ▼	0.062	-12% ▼
Office of River Protection	14.653	-20% ▼	412	-8% ▼	0.036	-13% ▼
Pacific Northwest National Laboratory	14.634	1% ▲	479	19% ▲	0.031	-15% ▼
Idaho Site	86.202	20% ▲	1,174	-18% ▼	0.073	47% ▲
Kansas City Plant	0.022	◊	11	◊	0.002	◊
Lawrence Berkeley National Laboratory	0.463	◊	8	◊	0.058	◊
Lawrence Livermore National Laboratory	8.353	-1% ▼	108	5% ▲	0.077	-6% ▼
Los Alamos National Laboratory	**95.436**	-31% ▼	1,401	-18% ▼	0.068	-16% ▼
National Renewable Energy Laboratory	0.107	◊	7	◊	0.015	◊
Nevada National Security Site	5.638	75% ▲	116	30% ▲	0.049	34% ▲
New Brunswick Laboratory	0.023	◊	2	◊	0.012	◊
Oak Ridge:						
East Tennessee Technology Park	0.004	◊	1	◊	0.004	◊
Oak Ridge Institute for Science and Education	0.210	◊	23	◊	0.009	◊
Oak Ridge National Laboratory	71.304	-4% ▼	618	-4% ▼	0.115	-1% ▼
Y-12 National Security Complex	59.296	18% ▲	1,326	-1% ▼	0.045	19% ▲
Paducah Gaseous Diffusion Plant	10.306	60% ▲	139	51% ▲	0.074	6% ▲
Pantex Plant	31.084	42% ▲	305	-8% ▼	0.102	54% ▲
Portsmouth Gaseous Diffusion Plant	10.302	19% ▲	95	-7% ▼	0.108	28% ▲
Princeton Plasma Physics Laboratory	0.693	◊	123	◊	0.006	◊
Sandia National Laboratories	6.072	40% ▲	93	-24% ▼	0.065	85% ▲
Savannah River Site	92.820	5% ▲	**1,584**	8% ▲	0.059	-3% ▼
Separations Process Research Unit	9.338	**219%** ▲	76	**52%** ▲	0.123	110% ▲
SLAC National Accelerator Laboratory	0.246	◊	9	◊	0.027	◊
Thomas Jefferson National Accelerator Facility	4.452	196% ▲	42	-13% ▼	0.106	**239%** ▲
Uranium Mill Tailings Remedial Action Project	7.756	5% ▲	61	11% ▲	0.127	-6% ▼
Waste Isolation Pilot Plant	0.034	◊	3	◊	0.011	◊
West Valley Demonstration Project	13.424	4% ▲	112	11% ▲	0.120	-6% ▼
Service Center Personnel*	0.103	◊	6	◊	0.017	◊
Totals	**619.896**	**-1%** ▼	**9,501**	**-4%** ▼	**0.065**	**3%** ▲

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). Please see section 3.4.3.1 for more information.
* Includes personnel at NNSA Albuquerque complex and Oak Ridge in addition to several smaller facilities not associated with a DOE site.

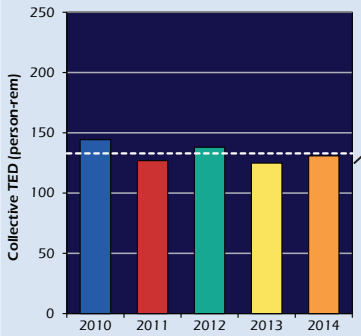
The changes that had the most impact in the overall values at DOE occurred at sites with a relatively large collective TED in addition to a large percentage change, such as LANL in 2014.

3.4.3 Activities Significantly Contributing to Collective Dose in 2014

In an effort to identify the reasons for changes in the collective dose at DOE, all of the larger sites were contacted to provide information on activities that significantly contributed to the collective dose for 2014. These sites, presented in descending order of collective TED (Oak Ridge, LANL, SRS, Idaho, and Hanford) each had a collective TED over 70 person-rems and were the top contributors to the collective TED in 2014. These sites comprised 77 percent of the total collective TED at DOE. Two sites reported decreases in the collective TED, which contributed to a 1 percent decrease in the DOE collective TED from 627 person-rems (6,270 person-mSv) in 2013 to 620 person-rems (6,200 person-mSv) in 2014. The sites significantly contributing to the collective TED in 2014 are shown in *Exhibit 3-14*, including a description of activities that affected the collective TED.

In addition to the information provided in *Exhibit 3-14*, 22 DOE sites reported a description of activities as it relates to occupational exposure, as requested in the REMS Reporting Guide, Item 1. The full text of these descriptions can be found in section 3.4.4. In this section, explanations for increases and decreases in the collective dose at DOE sites ranging from improvements in implementing the ALARA process to changes in decommissioning activities are discussed. Overall, the majority of sites experienced minimal increases in collective dose.

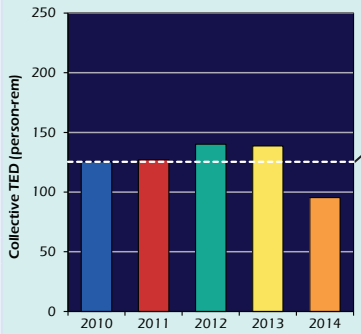
Exhibit 3-14:
Activities Significantly Contributing to Collective TED in 2014.

Oak Ridge	Percent Change*			Description of Activities at the Site
	2013-2014 (last yr.)	2012-2014 (3 yr.)	2010-2014 (5 yr.)	
	4.8% ↑	5.1% ↓	9.3% ↓	The 2014 collective TED at all Oak Ridge Sites was 130.814 person-rems, a 4.8 percent increase compared with 2013 (124.79 person-rems). **Y-12 National Security Complex (Y-12)** During 2014, Y-12 reported monitoring 5,789 individuals (9 percent more than in 2013) and 1,326 individuals had measurable TED, a less than 1 percent decrease from 2013 (see Exhibit 3-13 for more details). The collective TED increased 18 percent from 50.136 person-rems in 2013 to 59.296 person-rems in 2014. This increase in collective TED is primarily due to the increase in internal exposure potential as part of the increased activity required to recover from the actions associated with the 2013 government sequestration. The collective committed effective dose increased by 25 percent from 39.2 person-rems in 2013 to 49.0 person-rems in 2014. This increase in CED is due, in part, to the increase of work activities in 2014 at Y-12 following the government sequestration and reduced activities in 2013. No individual exceeded 2 rems TED in 2014. **Oak Ridge National Laboratory (ORNL)** In 2014, ORNL reported monitoring 3,850 individuals, and 618 individuals received a measurable TED (see Exhibit 3-13 for more details). This is a 4 percent decrease in the number of individuals with measurable TED compared with 2013. The collective TED for ORNL in 2014 was 71.304 person-rems. This represents a 4 percent decrease from 2013 (74.531 person-rems). During 2014, ORNL saw a decrease in exposure due to a decrease in work being performed at the Radiochemical Engineering Development Complex. The transuranic waste processing center reported a collective TED of 37.300 person-rems for 2014, an increase of 11 percent from 2013 (33.485 person-rems). No individual exceeded 2 rems TED at ORNL during 2014.

* Up arrows indicate an increase in change. Down arrows indicate a decrease in change.

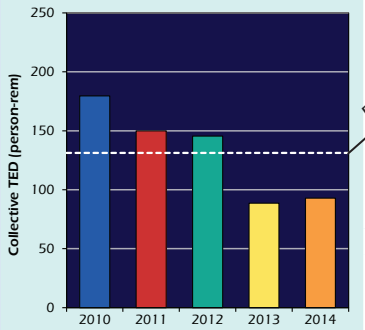
Exhibit 3-14 (Continued):
Activities Significantly Contributing to Collective TED in 2014.

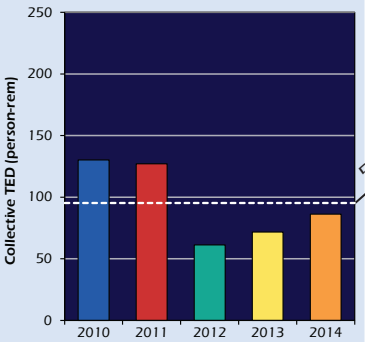
Oak Ridge	Percent Change*			Description of Activities at the Site
	2013-2014 (last yr.)	2012-2014 (3 yr.)	2010-2014 (5 yr.)	
				Oak Ridge Institute for Science and Education (ORISE) In 2014, ORISE reported 132 individuals, which included 23 individuals with measurable dose (see Exhibit 3-12 for more details). The collective TED for the 2014 monitoring year was 0.210 person-rem, an increase from 2013 (0.083 person-rem). **East Tennessee Technology Park (ETTP)** In 2014, the DOE cleanup contractor monitored 605 individuals and 1 individual had measurable TED (see Exhibit 3-12 for more details). The 2014 collective TED was 0.004 person-rem, a decrease from 2013 (0.040 person-rem). The major activities performed at DOE cleanup contractor managed sites in 2014 consisted of environmental restoration work, decontamination and demolition of facilities, surveillance and maintenance tasks, stabilization of inactive facilities, and waste disposition. No individual exceeded 2 rems TED in 2014.

Los Alamos National Laboratory	Percent Change*			Description of Activities at the Site
	2013-2014 (last yr.)	2012-2014 (3 yr.)	2010-2014 (5 yr.)	
	31.2% ↓	31.9% ↓	23.9% ↓	The 2014 collective TED at LANL was 95.436 person-rems. This is a 31 percent decrease from the previous year (138.734 person-rems). LANL monitored 9,042 individuals, and of these, 1,401 had measurable TED, an 18 percent decrease from 2013 (see Exhibit 3-13 for more details). TA-55 Plutonium Facility operations accounted for the majority of occupational dose at LANL in 2014, which is historically consistent for LANL. Occupational dose was accrued from weapons manufacturing and related work, Plutonium-238 (Pu-238) work, repackaging materials, and providing radiological control technician training and other infrastructure support for radiological work and facility maintenance at TA-55. The top 25 doses at LANL in 2014 were accrued at TA-55. A primary contributor to dose in 2014 was work with Pu-238, producing general purpose heat sources for use individually and in radioisotope thermoelectric generators. Doses at TA-55 would have been significantly higher in the balance of these areas; however, most programmatic work was not resumed from the 2013 pause associated with the criticality safety program. In addition to TA-55 operations, a significant portion of LANL dose was accrued by workers performing retrieval, repackaging, and shipping of radioactive solid waste at LANL facilities TA-50 and TA-54. Work with solid waste was curtailed early in 2014 due to the radioactive material release event at the Waste Isolation Pilot Plant and its relation to LANL waste packaging. (See Occurrence Report EM-CBFO—NWP-WIPP.) There was also a significant portion of LANL dose accrued by workers commensurate with programmatic and maintenance work at the TA-53 Los Alamos Neutron Science Center. Although CED at LANL decreased ten-fold from 2013 to 2014, seventeen intakes were experienced throughout 2014. These included two plutonium intakes (one identified through routine bioassay and one associated with decontamination activities (ORPS event NA-LASO-LANL-TA55-2014-0003), twelve uranium intakes from critical assembly operations at the Nevada National Security Site (ORPS event NA-NVSO-LANV-DAF-2014-0002), and three low-level tritium intakes consistent with routine operations. No individual received over 2 rems at LANL during 2014.

* Up arrows indicate an increase in change. Down arrows indicate a decrease in change.

Exhibit 3-14 (Continued):
Activities Significantly Contributing to Collective TED in 2014.

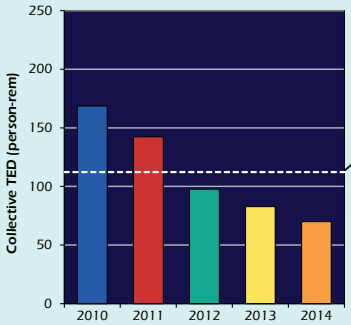
Savannah River Site	Percent Change*			Description of Activities at the Site
	2013-2014 (last yr.)	2012-2014 (3 yr.)	2010-2014 (5 yr.)	
	↑ 4.8%	↓ 36.2%	↓ 48.3%	The 2014 collective TED at SRS was 92.820 person-rems. This was 4.8 percent higher than 2013 (88.536 person-rems). The SRS collected records for 6,091 individuals in 2014, and 1,584 individuals had a measurable TED (see Exhibit 3-13 for more details). The number of individuals with measurable TED increased by 8 percent from 2013 to 2014. This increase was attributed to completing projects like the SRNL Cell Window replacements, such that dose to the workers was ALARA. In addition, the tungsten tote carrier system was implemented to replace the doorstop system for transporting high radiation samples. No individual exceeded 2 rems TED in 2014.

Idaho Site	Percent Change*			Description of Activities at the Site
	2013-2014 (last yr.)	2012-2014 (3 yr.)	2010-2014 (5 yr.)	
	↑ 20.0%	↑ 40.6%	↓ 33.8%	The 2014 collective TED at Idaho was 86.202 person-rems, a 20% increase compared with 71.814 person-rems in 2013. **Idaho National Laboratory** In 2014, 3,863 individuals were monitored at INL, and of these, 589 individuals had measurable TED, a 31 percent decrease from 2013. There was a collective TED of 36.162 person-rems in 2014. This represents an increase of 1 percent compared with 2013 (35.658 person-rems). The radiation exposure activities performed during 2014 at the INL Site included work at the Advanced Test Reactor (ATR) Complex, including experiment system operations, plant maintenance modifications, routine ATR power operations, routine ATR outage operations, and Research and Development Operations/Laboratory Support. In addition, activities at the Materials and Fuel Complex included homeland security radionuclide extractions; fuel receipt, shipments, examination, separations, and testing; sodium bearing waste treatment; waste load out and equipment upgrades, radiochemistry separations, irradiation-assisted stress testing, routine operations and Zero Power Physics Reactor fuel handling. At the Central Facilities Area, Transient Reactor Test (TREAT) reactor and Idaho Falls Facilities, training exercises increased for the Homeland Security/DTRA and radiation instrument calibrations and health physics instrumentation laboratory work was conducted. Experiments and clean-up of radioactive materials were conducted as well. No individual exceeded 2 rems TED in 2014. **Advanced Mixed Waste Treatment Project (AMWTP)** In 2014, there were 885 persons monitored at AMWTP, and of these, 218 individuals had measurable TED, representing a 32 percent decrease from 2013. The collective TED in 2014 was 14.860 person-rems. This represents a 39 percent decrease from 2013 (24.412 person-rems). The radiation exposure activities performed during 2014 at the AMWTP Site included work in support of removal of transuranic (TRU) waste from the DOE's Idaho Operations area. These activities included TRU waste retrieval, waste characterization, waste handling, maintenance, and shipment of TRU waste. No significant unplanned radiological concerns were encountered in 2014. The general decrease in collective TED in 2014 can be attributed to processing waste with a lower external exposure rate and setting challenging ALARA goals. ALARA goals were met by requiring personnel to wear electronic dosimeters to help identify areas of higher exposure rates and controlling activities to decrease worker exposure. No individual exceeded 2 rems TED in 2014.

* Up arrows indicate an increase in change. Down arrows indicate a decrease in change.

Exhibit 3-14 (Continued):
Activities Significantly Contributing to Collective TED in 2014.

Idaho Site	Percent Change*			Description of Activities at the Site
	2013-2014 (last yr.)	2012-2014 (3 yr.)	2010-2014 (5 yr.)	
				Idaho Cleanup Project (ICP) The DOE contractor at ICP submitted 1,321 records, which included 354 individuals with measurable dose (a 44 percent increase from 2013). The collective TED for 2014 was 34.972 person-rems. This represents a 204 percent increase from 2013 (11.515 person-rems). ICP activities during 2014 leading to radiation exposure included Waste Management, Nuclear Material Disposal (NMD), Balance of Plant (BOP), Battelle Energy Alliance, LLC (BEA), and the Accelerated Retrieval Project (ARP) (drums for targeted waste were processed); and the Sludge Repackaging Project (SRP) (drums of waste were generated) exposure activities. The large increase in dose received was due to the Waste Management group starting the Sodium Distillation System (SDS) process in the 3rd quarter. The majority of the dose received during the SDS process was due to cleaning of the slide gate and maintenance personnel replacing, installing, and removing SDS equipment. In addition, waste containers that were processed in 2014 had higher radiation levels than those processed in 2013. In addition, the ARP and SRP projects contributed to an increase in personnel dose due to drums being processed in the ARP VIII facility and the completion of the SRP where the drums had higher radiation levels. No individual exceeded 2 rems TED in 2014. **Department of Energy Idaho Operations Office** The Department of Energy Idaho Operations Office monitored 207 individuals in 2014, and of those, 13 individuals had measurable TED (a 32 percent decrease from the 19 individuals in 2013). The collective TED for 2014 was 0.208 person-rem, which is a decrease from 2013 (0.284 person-rem). The largest individual TED for the year was 0.031 rem. No individual exceeded 2 rems TED in 2014.

Hanford	Percent Change*			Description of Activities at the Site
	2013-2014 (last yr.)	2012-2014 (3 yr.)	2010-2014 (5 yr.)	
	15.5% ↓	28.3% ↓	58.5% ↓	The 2014 collective TED at Hanford was 70.046 person-rems, a 15.5 percent decrease compared with 2013 (82.859 person-rems). At Hanford, the primary reasons for the decrease in collective TED was a change in the work scope at DOE-RL to include more work involving heavy equipment which increased the distance between workers and source terms and the implementation of long-length tools at DOE-ORP. Due to changes in funding, several DOE-RL projects continued to operate at minimal levels. The change in work scope also included the packaging and handling of the waste packages during the seal-out activities until placed in shielded hardened containers. The overall extremity exposure at Hanford increased by 4.8 percent. The DOE-RL extremity dose increased 26.2 percent due to the change in work scope at Plutonium Finishing Plant. The changed work scope was primarily dismantling components, pipes, and systems from within the gloveboxes. The DOE-ORP extremity dose decreased by 30.4 percent. This reduction can be attributed to a reduction in force and the utilization of long-length tools at the single shell tanks retrieval and closure. **Hanford Site** There were 4,177 individuals monitored at Hanford in 2014. Of these, 659 individuals had measurable TED, which is an 8 percent decrease from 2013 (see Exhibit 3-13 for more details). The TED decreased 19 percent from 50.081 person-rems in 2013 to 40.715 person-rems in 2014. No individual exceeded 2 rems TED in 2014.

* Up arrows indicate an increase in change. Down arrows indicate a decrease in change.

Hanford	Percent Change*			Description of Activities at the Site
	2013-2014 (last yr.)	2012-2014 (3 yr.)	2010-2014 (5 yr.)	
				The Office of River Protection (ORP) In 2014, ORP monitored 2,039 individuals, which included 412 individuals with measurable TED, an 8 percent decrease from 2013 (see Exhibit 3-13 for more details). The 2014 collective TED decreased 20 percent from 18.228 person-rems in 2013 to 14.653 person-rems in 2014. No individual exceeded 2 rems TED in 2014. **Pacific Northwest National Laboratory (PNNL)** In 2014, PNNL monitored 2,409 individuals, and of these, 479 individuals had measurable TED, a 19 percent increase from 2013 (see Exhibit 3-13 for more details). The collective TED at PNNL in 2014 was 14.634 person-rems, a less than 1 percent increase from the previous year (14.550 person-rems). The collective dose for 2014 compared with 2013 was slightly higher due to the radiological work for the PNNL Applied Materials Science, Chemical Engineering and Applied Nuclear Science and Technology work scope. No individual exceeded 2 rems TED in 2014.

3.4.4 Additional Site Descriptions

The following descriptions were provided by the sites not previously included in *Exhibit 3-14*. The REMS Reporting Guide, Item 1, specifies that the sites should provide a description of activities conducted at the site as it relates to the collective radiation exposure received.

Ames

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.

There were 162 individuals monitored in 2014, and of these, 33 individuals had measurable TED, a 38 percent increase from 2013. The collective TED was 0.873 person-rem in 2014, which is a small increase from 2013. No individuals exceeded 2 rems TED for this monitoring year.

The use of X-ray devices and remediation of radiological legacy contamination are the primary paths of potential exposure. The Laboratory has 22 X-ray systems and one Mossbauer spectroscopy system. Limited radioactive material research activities are conducted utilizing microgram quantities.

ANL

Argonne National Laboratory is one of the DOE's largest national laboratories for scientific and engineering research. The lab's mission is to apply a unique mix of world-class science, engineering, and user facilities to deliver innovative research and technologies.

There were 1,894 individuals monitored in 2014, and of these, 84 individuals had measurable TED, a 14 percent increase from 2013. The collective TED was 16.492 person-rems in 2014, which is a 26 percent increase from 2013. No individuals exceeded 2 rems TED for this monitoring year.

This increase can be attributed to additional work activity by the laboratory to characterize and remove legacy radioactive material throughout many radiological facilities on site. In addition, the work activity related to the Alpha Gamma Hot Cell Facility de-inventory project successfully resulted in down-grading the AGHCF from a Hazard Category 2 nuclear facility to a Hazard Category 3 nuclear facility.

BNL

Brookhaven National Laboratory (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 available to university, industry, and government researchers.

There were 2,630 individuals monitored in 2014, and of these, 129 individuals had measurable TED, a 34 percent decrease from 2013. The collective TED was 7.282 person-rems in 2014, which is a 4 percent increase from 2013. No individuals exceeded 2 rems TED for this monitoring year.

The increase in collective TED was primarily due to installation of the Raster beam line and C line disassembly activities at the BNL. The highest individual dose was 0.371 rem.

ETEC

The Energy Technology Engineering Center (ETEC) is located within area IV of the Santa Susana Field Laboratory. The Laboratory is comprised of four discrete operational areas with two adjacent undeveloped properties. In 1988, DOE decided to close the remaining ETEC operations. With the closing of DOE operations, the focus turned to the disposition of government property, cleanup of facilities, the investigation and remediation of soil and groundwater, demolition of facilities, and site restoration. Area IV is undergoing characterization for cleanup of the area. ETEC is currently in a safe shutdown mode, pending the completion of the Environmental Impact Statement.

There were 129 individuals monitored in 2014, and of these, 69 individuals had measurable TED, a 21 percent increase from 2013. The collective TED was 0.489 person-rem in 2014, which is a slight increase from 2013. No individuals exceeded 2 rems TED for this monitoring year.

All doses received at the organization are due to monitoring activities and conducting tours of shutdown radiological facilities waiting for decommissioning and disposal. Minor variations of individual doses are indicated because the recorded exposures are low (near to background levels).

Fermilab

Fermi National Accelerator Laboratory (Fermilab) advances the understanding of the fundamental nature of matter and energy by providing leadership and resources for qualified researchers to conduct basic research at the frontiers of high-energy physics and related disciplines.

In 2014, Fermilab reported 1,272 monitored individuals, and of these, 193 individuals had measurable TED, a 10 percent increase compared with 2013. During 2014, the collective TED was 11.070 person-rems, which is a 44 percent decrease from 2013.

During 2014, the primary activities at Fermilab that resulted in occupational radiation exposures were upgrade and repair activities of the Fermilab accelerator. Nearly all radiation doses to personnel were due to exposures to items activated by the accelerated beams. On September 5, 2014, Fermilab began a maintenance and upgrade shutdown to prepare the accelerator and associated facilities for new experiments at much larger beam powers to support the current and future research at the laboratory. The vast majority of the work performed during this shutdown was also intended to improve operational reliability and, hence, reduced maintenance needs in the future. This included upgrades in booster, recycler, main injector, and neutrinos at main injector areas.

KCP

The NNSA Kansas City Plant (KCP) is responsible for manufacturing and procuring nonnuclear 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.

In 2014, KCP reported 72 monitored individuals, and of these, 11 individuals had measurable TED compared with 1 person with measurable TED in 2013. The collective TED was very low, 0.022 person-rem in 2014 and 0.001 person-rem in 2013. No individuals exceeded 2 rems TED for this monitoring year.

LBNL

Lawrence Berkeley National Lab (LBNL) is a member of the national laboratory system supported by the DOE through its Office of Science and is charged with conducting unclassified research across a wide range of scientific disciplines. Located on a 200-acre site, Berkeley Lab employs approximately 4,200 scientists, engineers, support staff, and students.

The total number of employees monitored for radiation exposure at LBNL in 2014 was 699, and of these, 8 individuals had measurable TED, a 1 percent decrease from 2013. The collective TED was 0.463 rem, a small decrease from 2013.

The primary reason for this change was to start using improved engineering controls and improved protocols in the Center for Functional Imaging (CFI). Eighty-five percent of the collective TED is the result of radiological activities at CFI, specifically those activities associated with new radiopharmaceutical development.

No individual exceeded 2 rems TED for this monitoring year.

LLNL

Lawrence Livermore National Laboratory (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, counter-terrorism, and emergency response. Support of these operations requires the use of a wide range of radiation-producing devices (e.g., x-ray machines, accelerators, electron-beam welders) and radioactive material. The types of radioactive materials range from tritium to transuranics; the quantities range from nanocuries (i.e., normal environmental background values) to kilocuries.

The combined total number of employees monitored for radiation exposure at LLNL (which includes LLNL and LLNL-Nevada) in 2014 was 9,956, and of these, 108 individuals had measurable TED, a 5 percent increase from 2013. The collective TED was 8.353 rems, a 1 percent decrease from 2013.

In 2014, 9,768 people were monitored at LLNL, and of these, 100 people had measurable TED, a 2 percent increase from 2013. The collective TED for LLNL in 2014 was 7.562 person-rems, a 10 percent decrease from 2013. This was due to decreased operations in the plutonium facility and at LLNL. There were two people with internal uptakes accounting for 0.026 person-rem total CED. No individual exceeded 2 rems TED for this monitoring year.

LLNL-Nevada is a DOE facility that serves as a national resource of scientific, technical, and engineering capability with a special focus on national security.

For 2014, LLNL-Nevada monitored 188 individuals and 8 individuals had measurable TED, a 60 percent increase from 2013. The collective TED for LLNL-Nevada was 0.791 person-rem compared with 0.117 in 2013. There were three people with internal uptakes accounting for 0.182 person-rem total CED. No individual exceeded 2 rems TED for this monitoring year.

NBL

The New Brunswick Laboratory (NBL) is a Government-owned, Government-operated center of excellence in the measurement science of nuclear materials. Specific operations involving radioactive material include destructive and nondestructive measurements of nuclear materials including plutonium and uranium. Additionally, NBL conducts research to develop improved measurement technology applied to nuclear materials and management of inter-laboratory measurement evaluation programs.

In 2014, NBL monitored 34 individuals, and of these, 2 individuals had measurable TED, a 100 percent increase from 2013. The collective TED at NBL for 2014 was 0.023 person-rem which is an increase from 2013 (0.012 person-rem) and is attributed to the annual physical inventory of nuclear material.

NNSS

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

In 2014, NNSS monitored 2,788 people, and of these, 116 people had a measurable TED, a 30 percent increase compared with 2013. The collective TED for 2014 at NNSS was 5.638 person-rems, which represents a 75 percent increase in TED from 2013.

The assembly/disassembly of special experiments and an ongoing project with radiological material resulted in the increase. Other current activities include operating 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 and neutron generators; accelerator experiments; development, testing, and evaluation of radiation detectors; emergency response training; surface cleanup and site characterization of contaminated land areas; environmental activity by the University of Nevada system; and non-nuclear test operations such as controlled spills of hazardous materials.

NREL

The National Renewable Energy Laboratory (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.

In 2014, NREL monitored 16 people, and of these, 7 people had a measurable TED, a 40 percent increase from 2013. The collective TED increased by 57 percent from 2013 (0.068 person-rem) to 2014 (0.107 person-rem).

The primary reason for this change was due to an increase in work involving radiation exposure, particularly decontamination of a laboratory used for radionuclide work. No measurements exceeded the 2 rems TED.

PGDP

PGDP is located 3 miles south of the Ohio River and is 12 miles west of Paducah, Kentucky. The plant began enriching uranium in 1952, first for the nation's nuclear weapons program and then for nuclear fuel for commercial power plants. In 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.

In 2014, the PGDP monitored 1,517 individuals, which included 139 individuals with measurable TED, a 51 percent increase compared with 2013. The overall collective TED for the PGDP was 10.306 person-rems, a 60 percent increase from 2013. The following description provides a breakdown of the various activities at this site.

The DOE remediation services contractor's exposure information for 2014 covers activities performed under the DOE contract scope for environmental remediation, facility decontamination, and final assessment of buildings and areas at the Paducah Site.

The collective TED for 2014 was 0.082 person-rem. This represents a slight increase from the zero person-rem reported for 2013. The primary reason for this change was due to facility decontamination and decommissioning operations at Paducah. The number of individuals exceeding 2 rems TED for 2014 was zero. There were no unusual events related to occupational radiation exposure at the Los Alamos Technical Associates Kentucky facilities for 2014.

The Depleted Uranium Hexafluoride (DUF_6) contractor's collective TED for 2014 was 10.02 person-rems. This represents a 63 percent increase from 2013. The primary reason for this change was increased operations at the Paducah DUF_6 Conversion Facility. The number of individuals exceeding 2 rems TED for 2014 was zero. There were no unusual events related to occupational radiation exposure for 2014.

The DOE oversight contractor's collective TED for the 2014 monitoring year was 0.152 person-rem. This represents a 47 percent decrease from the value for the previous monitoring year. In 2014, the number of individuals with measurable TED increased by 129 percent compared with 2013. The primary reason for this change was due to a change in work scope for certain individuals from the previous monitoring period. However, despite increasing the number of monitored individuals by 49 percent, the contractor was able to apply ALARA principles to all operations involving potential personnel exposure to ionizing radiation from areas where operations are conducted.

The DOE Paducah Deactivation Project contractor's collective TED for the 2014 monitoring year was 0.052 person-rem and included 8 individuals with measurable TED.

The number of individuals exceeding 2 rems TED for this monitoring year was zero.

Pantex

The DOE/NNSA Pantex Plant is the nation's only facility for assembly and disassembly of nuclear explosives. The operations that contribute the majority of the dose to Pantex Plant workers are operations that expose them to large numbers of bare weapon pits (the pits contain significant quantities of Special Nuclear Materials). These operations include nuclear explosive assembly/disassembly operations, weapon dismantlement programs, life-extension programs, Special Nuclear Material Component Re-qualification, and Special Nuclear Material staging.

In 2014, Pantex monitored 3,278 individuals, and of these, 305 individuals had measurable TED, an 8 percent decrease from 2013. The TED to Pantex Plant workers in 2014 was 31.084 person-rems, which represents a 42 percent increase from the total person-rem dose in 2013. No individual's dose exceeded their assigned administrative control level in 2014, with a maximum individual dose of 0.613 rem.

The primary reason for the increased dose in 2014 was that in 2013 several facility safety upgrades prevented Pantex from completing all the planned production activities. In 2014, a turnover to a new work control software system was completed and several additional facility safety upgrades were finished. However, the impact on production was not as great as in 2013 and Pantex was able to finish all scheduled work and even deliver more units in key programs in 2014.

PORTS

The Portsmouth Gaseous Diffusion Plant (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 enriched uranium used by commercial nuclear reactors. The plant is shut down and currently undergoing decontamination and decommissioning (D&D). In 2014, Portsmouth monitored 2,450 individuals, which included 95 people with measurable TED, a 7 percent decrease from 2013. The collective TED in 2014 at PORTS was 10.302 person-rems, a 19 percent increase compared with 2013. The following description provides a breakdown of the various activities at this site.

The DOE D&D contractor's exposure information for 2014 covers activities performed under the DOE contract and includes environmental remediation, facility decontamination, and uranium barter transfers at the Portsmouth Site. The collective TED for 2014 was 3.555 person-rems, a 19 percent increase compared with 2013. The number of individuals with measurable TED decreased by 24 percent in 2014 (39) compared with 2013 (51). This increase was primarily due to two contributing factors. The Barter Project production flow remained nearly constant from 2013, but the project began receiving return cylinders that contained product heels, which contributed to an increase dose. In addition, a drum over pack and shipping project initiated and began significant production in the X-744G facility.

The DUF_6 contractor's collective TED for 2014 was 6.747 person-rems, a 20 percent increase compared with 2013. The number of individuals with measurable TED increased by 10 percent in 2014 (56) compared with 2013 (51). Increases in collective TED for the monitoring year were nearly entirely based on increases in production goals and increased operations. Production goals for this monitoring period for Portsmouth were increased from 8,199 metric tons per year in 2013 to 12,344 metric tons in 2014 (an increase of roughly 50 percent).

The number of individuals exceeding 2 rems TED for 2014 was zero.

PPPL

The DOE's Princeton Plasma Physics Laboratory (PPPL) is a collaborative national center for fusion energy research. The Laboratory advances the coupled fields of fusion energy and plasma physics research and with collaborators is developing the scientific understanding and key innovations needed to realize fusion as an energy source for the world.

In 2014, data were submitted for 361 individuals, and of these, 123 individuals had measurable TED, a 112 percent increase compared with 2013 (58 individuals with measurable TED). The collective TED increased by 104 percent from 2013 (0.339 person-rem) to 2014 (0.693 person-rem).

The primary reason for this change is a result of more PPPL badged individuals involved in the final phases of the new NSTX upgrade project. More than twice the normal number of personnel worked in areas of extremely low radiation fields due to activation, and therefore, many more individuals received single digit mrem doses that would normally not have received any exposure. Additionally, PPPL personnel conducted two shift or extended shift operations during the final phases of the upgrade project, so their normal doses were in some cases doubled. These doses, however, are typically in the single digit mrem numbers in a given quarter. There are also a few individuals whose results are still being investigated as possible environmental exposures due to home building materials and geographic locations prone to high levels of Radon. PPPL does not require individuals to leave their dosimeters on-site when they leave for the day.

SLAC

SLAC National Accelerator Laboratory (SLAC) is one of 10 Department of Energy (DOE) Office of Science laboratories and is operated by Stanford University on behalf of the DOE. Since its opening in 1962, SLAC has been helping create the future. SLAC built the world's longest particle accelerator and discovered some of the fundamental building blocks of matter.

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. The main instrument of research is the 3.2-km linear accelerator, which can generate high-intensity beams of electrons and positrons up to 50 GeV. New research areas and projects at SLAC have often evolved as the offspring of the original linear accelerator and storage rings. Originally from a premier accelerator laboratory, SLAC has grown into a state-of-the-art photon science laboratory. Sections of the linear accelerator that defined the lab and its mission in its formative years are still driving electron beams today as the high-energy backbone of two cutting-edge facilities.

The construction of the new Facility for Advanced Accelerator Experimental Tests (FACET) was completed in mid-2012 to study plasma acceleration, using short, intense pulses of electrons and positrons to create an acceleration source called a plasma wakefield accelerator. FACET beams at SLAC have been operated since June 2012.

The 2014 report contained 2,147 records, which included 9 people with measurable TED, a 10 percent decrease compared with 2013. Collective TED in 2014 was 0.246 person-rem, a 12 percent decrease compared with 2013. This decrease is attributed to the reductions in radiological entries (or workloads) into various radiological control areas compared with 2013. No individual exceeded 2 person-rems TED or any DOE occupational dose limit during 2014 at SLAC.

There is also an active program in the development of accelerators, radio frequency (RF) power sources, detectors, and new sources and instrumentation for synchrotron radiation research. Another facility, Stanford Synchrotron Radiation Lightsource, has a smaller storage ring, the Stanford Positron-Electron Asymmetric Ring (SPEAR3), and a separate, shorter linear accelerator and a booster ring for injecting accelerated beams of electrons into SPEAR3. The Klystron Test Laboratory manufactures all the klystrons used in SLAC accelerators, as well as novel structures and components for future accelerators; it supports RF operations of SLAC accelerators; and it operates a 70-MeV X-band research accelerator and laser facility capable of producing subpicosecond beam bunches.

SNL

Sandia National Laboratories (SNL) radiological operations include operation of a research reactor, gamma irradiation facility, hot cell facility, and several accelerators; light laboratory work involving x-ray machines and use of tracer radionuclides; and waste operations.

In 2014, SNL monitored 2,290 individuals, and of these, 93 individuals had measurable TED, a 24 percent decrease from 2013. The total collective TED reported was 6.072 person-rems. This total includes dose for SNL members of the workforce, SNL visitors, as well as the DOE Office of Secure Transportation (OST). The 2014 collective TED for SNL was 5.935 person-rems (a 17 percent increase) and 0.137 person-rem was attributed to OST.

This increase is attributed to ongoing material disposition campaigns at the Auxiliary Hot Cell Facility and experiments at the Annular Core Research Reactor.

SPRU

The Separations Process Research Unit (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 equipment was flushed and drained and bulk waste was removed following the shutdown of the facilities in 1953, residual materials are present in the tanks, buildings H2 and G2, and interconnecting pipe tunnels.

In 2014, SPRU monitored 188 individuals, and of these, 76 had measurable TED, a 52 percent increase compared with 2013. The collective TED for 2014 was 9.338 person-rems, a 319 percent increase from 2013.

The focus of project activities in 2014 included completion of the Sludge Removal and Solidification Project and the G2 and H2 Building Characterization and D&D activities. The activities that resulted in the major person-rem contribution were the Characterization and D&D of the G2 & H2 Buildings and Hot Cells, as well as the shipping of higher activity piping, equipment, and debris removed from the Hot Cells. Surveillance and maintenance activities were continued to maintain site conditions. Process and shipment of low activity water and shipment of low activity debris also contributed to the increase. No individuals exceeded 2 rems TED for this monitoring year.

TJNAF

Thomas Jefferson National Accelerator Facility (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.

In 2014, TJNAF monitored 1,348 individuals, which included 42 individuals with measurable TED, a 13 percent decrease from 2013. The 2014 collective TED for TJNAF was 4.452 person-rems, an increase of 196 percent from 2013. No individual exceeded 2 rems TED for this monitoring year.

In general, this increase of collective TED is attributed to maintenance, modification, and repair to activated components associated with the Continuous Electron Beam Accelerator Facility and other ancillary activities (e.g., transport, storage, and disposal of radioactive materials). Typically, collective TED fluctuates up or down from year to year depending on maintenance associated with unique experimental set-ups performed in radiation areas.

UMTRA

The Uranium Mill Tailings Remediation Action Project (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 two trainloads of tailings each day. The trains have up to 36 railcars, each holding four lidded containers, for a total of about 5,000 tons of tailings per shipment. Tailing shipments began in April 2009 and are expected to continue through 2025.

In 2014, UMTRA monitored 127 individuals, which included 61 individuals with measurable TED, an 11 percent increase from 2013. The collective TED for 2014 was 7.756 person-rems and represents a 5 percent increase from 2013. This increase is attributed to the first full year of radon monitoring and an expanded number of workers that were monitored for radon in 2014.

WIPP

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

In 2014, WIPP monitored 810 individuals, and of these, 3 individuals had measurable TED, a 91 percent decrease compared with 2013. The collective TED for 2014 was 0.034 person-rem, which represents a decrease from 2013 (0.552 person-rem).

The primary reason for this decrease was due to a contamination event in the WIPP underground. On February 14, 2014, a radiation alarm was received from a continuous air monitor in the underground. There were no employees working underground at the time. Site surveys and personnel surveys were negative for radiological contamination. The preliminary analysis of underground exhaust filter samples indicated the presence of plutonium-239 and americium-241. Access to the underground continued to be restricted through 2014 pending the development of a recovery plan. No radioactive waste has been processed at the facility since the event. (See Occurrence Report EM-CBFO-NWP-WIPP-2014-0002)

No individuals exceeded 2 rems TED for this monitoring year.

WVDP

The West Valley Demonstration Project (WVDP) is a unique operation within DOE. It came into being through the WVDP Act of 1980. The Act requires that the Department is 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 the Department. 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.

In 2014, WVDP monitored 336 individuals, and of these, 112 individuals had measurable TED, an 11 percent increase from 2013. The collective TED for 2014 was 13.424 person-rems, which represents a 4 percent increase from 2013.

The major project contributing to dose was Facility Disposition's D&D work in the Liquid Waste Cell and Extraction Cell #1 (6 person-rems). The High Level Waste crew picked up just over 4 person-rems preparing the Equipment Decontamination Room and the Chemical Process Cell Crane Room for future high-level waste canister movements. Waste Operation's activities accounted for the majority of the remaining dose supporting waste packaging and movements on site with approximately 2 person-rems.

3.4.5 Summary by Program Office

DOE has divided the responsibility of managing its missions among specific program offices. The various DOE sites support different missions and therefore fall under the authority and management of the corresponding program offices. It should be noted that several sites undertake work supporting multiple program offices. However, each site has a lead program office and is not required to report radiation exposure by program office, so the exact contribution from each program office cannot be determined. In these instances, the site is shown under one program office but may have significant portions of the dose from work done in support of other program offices. *Exhibit 3-15* shows the number of individuals with measurable TED, the collective TED, and the average measurable TED by DOE program office. The Office of Environmental Management (EM) and the NNSA account for the largest percentages of the collective TED (46 and 33 percent, respectively). The mission of EM is to complete the safe cleanup of the environmental legacy brought about from five decades of nuclear weapons development and government-sponsored nuclear energy research. NNSA is responsible for the management and security of the nation's nuclear weapons, nuclear nonproliferation, and naval reactor programs, as well as responding to radiological emergencies and the transportation of nuclear weapons and special nuclear materials. In general, the missions of EM and NNSA require more interaction with and activities involving radioactive materials. These offices account for 79 percent of the collective TED at DOE.

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

Exhibit 3-15:
Program Office Dose Data, 2014.

Program Office	Collective TED (person-rem)	Percent Change from 2013	Number with Meas. Dose	Percent Change from 2013	Avg. Meas. TED (rem)	Percent Change from 2013
Office of Energy Efficiency and Renewable Energy (EE)					Total Monitored =	16**
National Renewable Energy Laboratory	0.107	◊	7	◊	0.015	◊
EE Totals*	**0.107**	◊	**7**	◊	**0.015**	◊
Office of Environmental Management (EM)					Total Monitored =	21,577**
East Tennessee Technology Park	0.004	◊	1	◊	0.004	◊
Energy Technology Engineering Center	0.489	◊	69	◊	0.007	◊
Hanford Site	40.715	-19% ▼	659	-8% ▼	0.062	-12% ▼
Idaho Site (ICP, AMWTP and DOE IOO)	50.040	26% ▲	585	-14% ▼	0.086	46% ▲
Nevada National Security Site	0.060	◊	2	◊	0.030	◊
Oak Ridge National Laboratory	37.300	4% ▲	223	-16% ▼	**0.167**	23% ▲
Office of River Protection	14.653	-20% ▼	412	-8% ▼	0.036	-13% ▼
Paducah Gaseous Diffusion Plant	10.306	60% ▲	139	51% ▲	0.075	7% ▲
Portsmouth Gaseous Diffusion Plant	10.302	19% ▲	95	-7% ▼	0.108	28% ▲
Savannah River Site	**92.820**	5% ▲	**1,584**	8% ▲	0.059	-3% ▼
Separations Process Research Unit	9.338	**219%** ▲	76	**52%** ▲	0.123	**110%** ▲
Service Center Personnel	0.070	◊	5	◊	0.014	◊
Uranium Mill Tailings Remedial Action Project	7.756	5% ▲	61	11% ▲	0.127	-6% ▼
Waste Isolation Pilot Plant	0.034	◊	3	◊	0.011	◊
West Valley Demonstration Project	13.424	4% ▲	112	11% ▲	0.120	-6% ▼
EM Totals*	**287.311**	**6%** ▲	**4,026**	**-1%** ▼	**0.071**	**7%** ▲
National Nuclear Security Administration (NNSA)					Total Monitored =	32,959**
Kansas City Plant	0.022	◊	11	◊	0.002	◊
Lawrence Livermore National Laboratory	8.353	-1% ▼	108	5% ▲	0.077	-6% ▼
Los Alamos National Laboratory	**95.436**	-31% ▼	**1,401**	-18% ▼	0.068	-16% ▼
Nevada National Security Site	5.578	**75%** ▲	114	**30%** ▲	0.049	35% ▲
Pantex Plant	31.084	42% ▲	305	-8% ▼	**0.102**	54% ▲
Sandia National Laboratories	6.072	40% ▲	93	-24% ▼	0.065	**85%** ▲
Y-12 National Security Complex	59.296	18% ▲	1,326	-1% ▼	0.045	19% ▲
NNSA Totals*	**205.841**	**-9%** ▼	**3,358**	**-9%** ▼	**0.061**	**0%**
Office of Nuclear Energy (NE)					Total Monitored =	3,861**
Idaho National Laboratory	36.162	13% ▲	589	-22% ▼	0.061	45% ▲
NE Totals*	**36.162**	**13%** ▲	**589**	**-22%** ▼	**0.061**	**45%** ▲
Office of Science (SC)					Total Monitored =	16,876**
Ames Laboratory	0.873	◊	33	◊	0.026	◊
Argonne National Laboratory	16.492	26% ▲	84	14% ▲	**0.196**	11% ▲
Brookhaven National Laboratory	7.282	4% ▲	129	-34% ▼	0.056	57% ▲
Fermi National Accelerator Laboratory	11.070	-44% ▼	193	10% ▲	0.057	-49% ▼
Lawrence Berkeley National Laboratory	0.463	◊	8	◊	0.058	◊
New Brunswick Laboratory	0.023	◊	2	◊	0.012	◊
Oak Ridge Institute for Science and Education	0.210	◊	23	◊	0.009	◊
Oak Ridge National Laboratory	**34.004**	-12% ▼	395	5% ▲	0.086	-16% ▼
Pacific Northwest National Laboratory	14.634	1% ▲	**479**	**19%** ▲	0.031	-15% ▼
Princeton Plasma Physics Laboratory	0.693	◊	123	◊	0.006	◊
Service Center Personnel	0.033	◊	1	◊	0.033	◊
SLAC National Accelerator Laboratory	0.246	◊	9	◊	0.027	◊
Thomas Jefferson National Accelerator Facility	4.452	**196%** ▲	42	-13% ▼	0.106	**239%** ▲
SC Totals*	**90.475**	**-6%** ▼	**1,521**	**10%** ▲	**0.059**	**-15%** ▼

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). Please see section 3.4.3.1 for more information.

* The collective TED totals are calculated from the dose records that are reported in millirem while the values shown are rounded to the nearest tenth of a rem.

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

A more detailed breakdown of the exposure information by site, program office, and contractor is available at http://energy.gov/ehss/occupational-radiation-exposure in the Appendices section of the Annual Report.

3.5 Transient Individuals

Transient individuals, or transients, are defined as individuals who are monitored at more than one DOE site during the calendar year. For the purpose of this report, a DOE site is defined as a geographic location. During the year, some individuals performed work at multiple sites and, therefore, had more than one monitoring record reported to the repository. In addition, some individuals transferred from one site to another. 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. *Exhibit 3-16* shows the dose distribution and total number of transient individuals from 2010 to 2014. Over the past 5 years, the records of transient individuals have averaged 3 percent of the total records for all monitored individuals at DOE. These individuals received, on an average, 4 percent of the collective TED. The collective TED for transients increased 2 percent from 21.1 person-rems (211 person-mSv) in 2013 to 21.5 person-rems (215 person-mSv) in 2014. The average measurable TED decreased 4 percent from 0.051 rem (0.51 mSv) in 2013 to 0.049 rem (0.49 mSv) in 2014. The decrease of the average measurable TED is a result of the 7 percent increase in the number of transient individuals with measurable dose (412 in 2013 to 440 in 2014) and the 2 percent increase of the collective TED. Since 1993, the percentages have remained relatively constant but are decreasing slightly as DOE has become extensively involved in D&D activities and other types of operations.

The tracking and analysis of transient workers are important aspects of the AU REMS project. While each site is responsible for monitoring individuals during their work at that site, the REMS project 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 has been relatively low, the examination of these records remains an important function of AU in assessing performance of DOE worker health and safety programs.

3.6 Historical Data

3.6.1 Prior Years

In order to analyze recent radiation exposure data in the context of the history of radiation exposure at DOE, it is useful to include information prior to the past 5 years as presented in this report. For this reason, *Exhibit 3-17* and *Exhibit 3-18* are presented to show a summary of occupational exposures back to 1974, when the Atomic Energy Commission split into the U.S. Nuclear Regulatory Commission (NRC) and the Energy Research and Development Administration, which subsequently became DOE. *Exhibit 3-17* and *Exhibit 3-18* show the collective dose, average measurable dose, and number of workers with a measurable dose from 1974 to 2014.

Exhibit 3-16:
Dose Distribution of Transient Workers, 2010–2014.

	Dose Ranges (TED in rem)	2010	2011	2012	2013	2014
Transients	Less than measurable	2,309	2,121	1,898	1,517	2,217
	measurable <0.100	490	499	419	371	386
	0.100–0.250	73	54	52	26	41
	0.250–0.500	23	11	19	14	12
	0.500–0.750	5	1	2	1	
	0.750–1.000	2	3	1		1
	1–2		2			
	Total number of individuals monitored*	2,902	2,691	2,391	1,929	2,657
	Number with measurable dose	593	570	493	412	440
	% with measurable dose	20%	21%	21%	21%	17%
	Collective TED (person-rem)	37.682	31.785	28.472	21.053	21.535
	Average measurable TED (rem)	0.064	0.056	0.058	0.051	0.049
All DOE	Total number of records for monitored individuals	92,104	91,857	83,043	71,662	75,448
	Number with measurable dose	13,047	12,965	10,461	9,902	9,501
	% of total monitored who are transient	3.2%	2.9%	2.9%	2.7%	3.5%
	% of the number with measurable dose who are transient	4.5%	4.4%	4.7%	4.2%	4.6%

* Total number of individuals represents the number of individuals monitored and not the number of records.

Exhibit 3-17:
Collective Dose and Average Measurable Dose, 1974–2014.

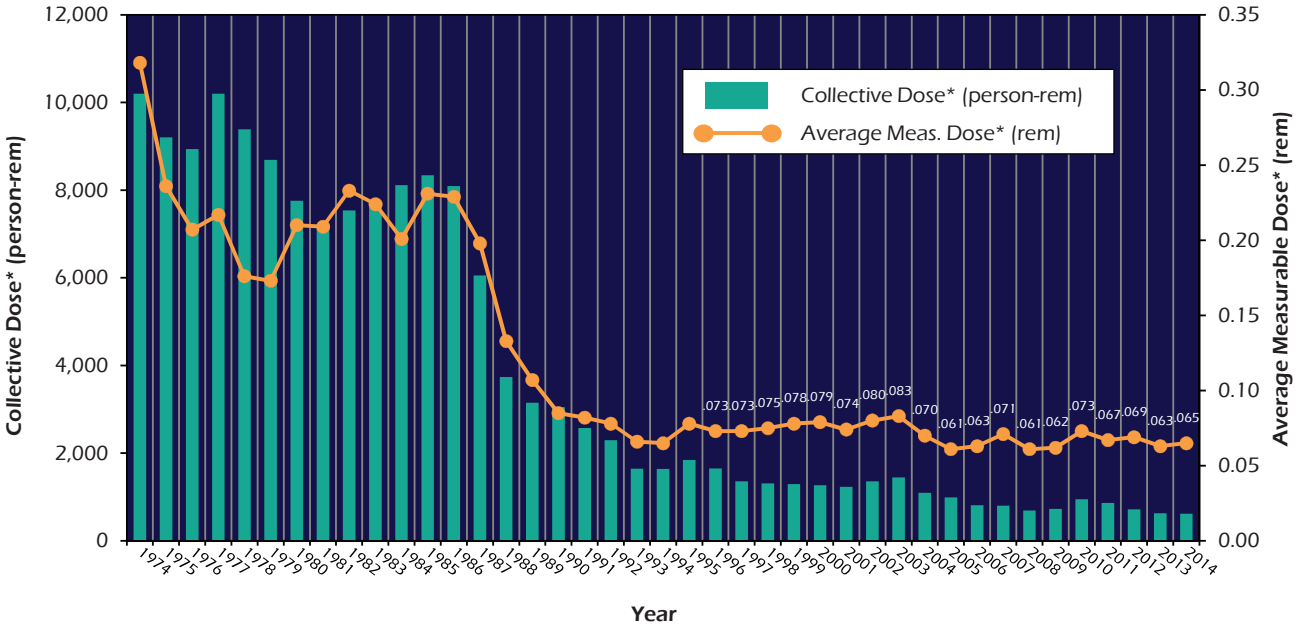
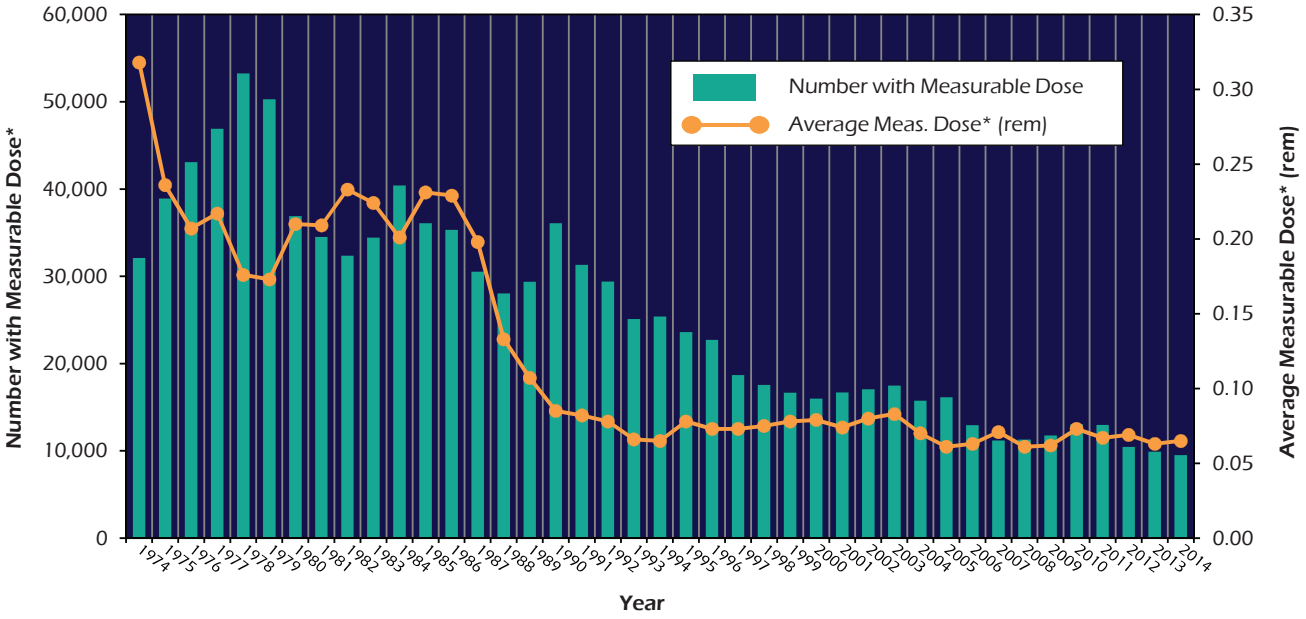


Exhibit 3-18:
Number of Workers with Measurable Dose and Average Measurable Dose, 1974–2014.



* 1974–1989 collective dose = DDE
1990–1992 collective dose = DDE + AEDE
1993–2009 collective dose = DDE + CEDE
2010–2014 collective dose = ED + CED

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

As can be seen from the graphs, all three parameters decreased dramatically between 1986 and 1993. The main reasons for this large decrease were the shutdown of facilities within the weapons complex and the end of the Cold War era, which shifted the DOE mission from weapons production to shutdown, stabilization, and D&D activities.

3.6.2 Historical Data Collection

In section 3.7 of the 2000 and 2001 annual reports on occupational exposure, information was presented on historical data that had been collected to date. Sites were requested by DOE to voluntarily provide historical exposure data, and many sites have subsequently responded. No additional sites reported historical data during the year 2014.

Sites that have not yet reported historical dose records are encouraged to contact Ms. Nirmala Rao at DOE (see section 1.2) to obtain further information on reporting these records. This is a request to voluntarily report historical data (records prior to 1987) that are available in electronic form or in whatever format that is most convenient for the site. The data will be stored as reported in REMS, and wherever possible, data will be extracted and loaded into the REMS database for analysis and retrieval. For detailed analysis, read section 3.7 of the 2000 report.

Sites that have voluntarily reported historical data are as follows:

- Fernald Environmental Management Project;
- Hanford Site;
- Idaho National Laboratory;
- Kansas City Plant;
- Lawrence Berkeley National Laboratory;
- Lawrence Livermore National Laboratory;
- Nevada National Security Site;
- Oak Ridge K-25 Site;
- Pantex Plant;
- Portsmouth Gaseous Diffusion Plant;
- Rocky Flats Environmental Technology Site;
- Sandia National Laboratories; and
- Savannah River Site.

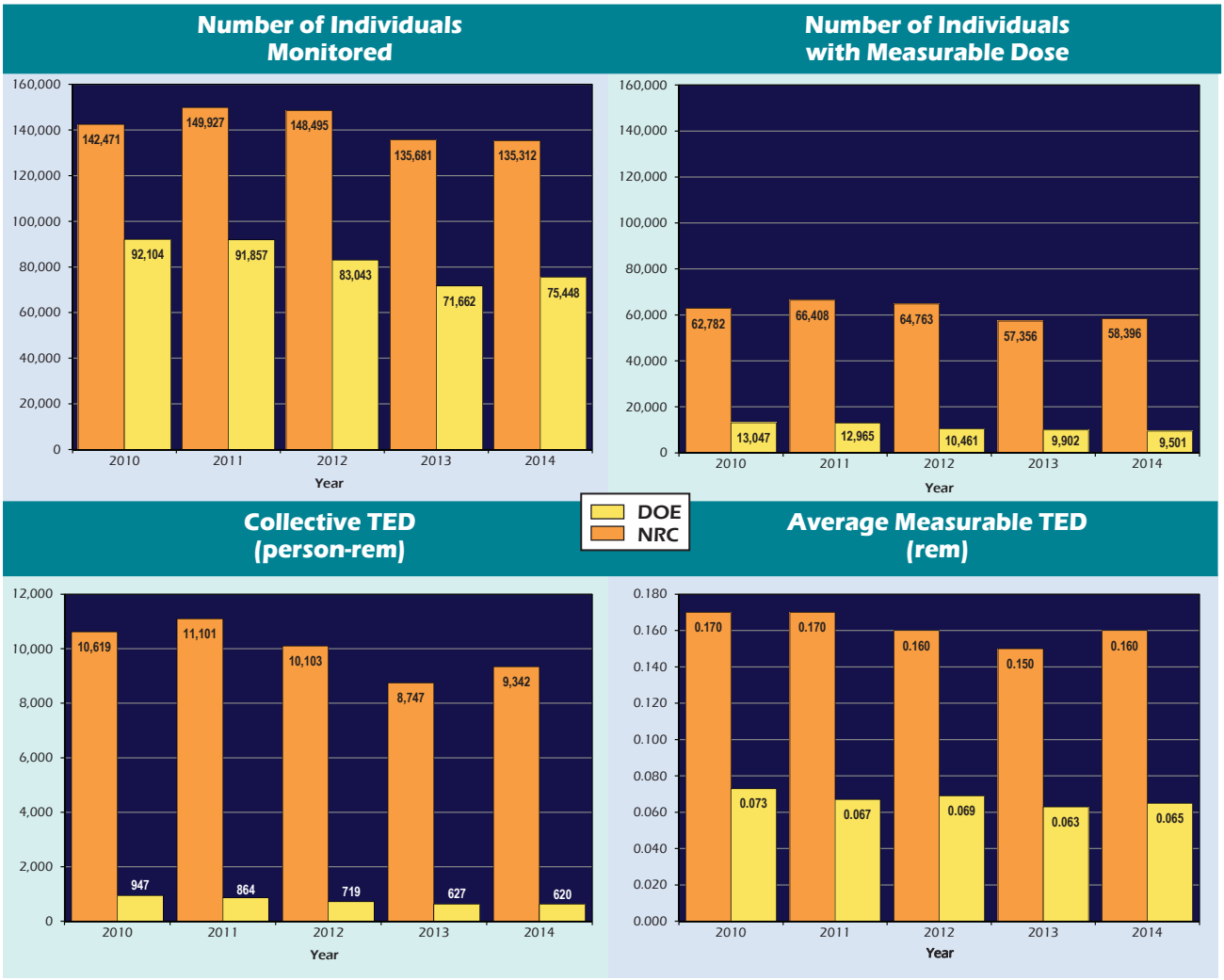
3.7 DOE Occupational Dose in Relation to Other Activities

3.7.1 Activities Regulated by the U.S. Nuclear Regulatory Commission

In the *DOE Occupational Radiation Exposure Report 1992-1994*, DOE occupational radiation exposure was shown in relation to other industrial and governmental endeavors in order to gain an understanding of the relative scale of the radiation exposure at DOE operations compared with other activities. The 2014 report includes the DOE occupational exposure in relation to activities regulated by the NRC. It should be noted that the purpose of this information is simply to put the DOE radiation exposure in context with other endeavors that involve radiation exposure. A direct comparison is not appropriate due to the differences in the missions of DOE and NRC. While the mission of DOE is broad in scope and includes activities from energy research to national defense, NRC licensed activities are dominated by radiation exposure received at commercial nuclear power plants. Reactor operations account for approximately 76 percent of the collective TED, while industrial radiographers, manufacturers, and distributors of radiopharmaceuticals; independent spent fuel storage installations; and fuel cycle licensees comprise the remainder.

The DOE and NRC occupational exposure data shown in *Exhibit 3-19* cover the past 5 years (2010 to 2014). While the number of workers monitored at NRC and DOE are relatively comparable over the past 5 years, the number of individuals with a measurable dose at DOE was 18 percent of the NRC total for this time period. The percentages of DOE's collective dose (TED) and average measurable dose (TED) were 8 percent and 42 percent of the NRC totals, respectively.

Exhibit 3-19:
Comparison of Occupational Exposure for DOE and NRC, 2010 –2014.



Section Four
ALARA Activities at DOE

4

Descriptions of ALARA activities at DOE are provided on the AU web site for the purposes of sharing strategies and techniques that have shown promise in the reduction of radiation exposure and to facilitate the dissemination among DOE radiation protection managers and others interested in these project descriptions. Readers should be aware that the 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.

4.1 Submitting ALARA Project Descriptions for Future Annual Reports

Individual project descriptions may be submitted to the DOE Office of ES&H Reporting and Analysis through the REMS web site. The submittals 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:

http://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, which expands and enhances upon the lessons learned program that was initially developed in 1994. The current DOE operating experience program is described in DOE O 210.2A, *DOE Corporate Operating Experience Program* [11]. The objective is 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 purpose is to provide 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, combined with the operating experience/lessons learned provided by DOE field sites, and optimizes the knowledge gained and shared with others through various products, including a corporate database.

DOE posts operating experience information and links to other operating experience resources on the Internet. DOE uses the Internet to openly disseminate such information so that not only DOE but also other external entities will have a source of information to improve the health and safety aspects of operations within their facilities, including reducing the number of accidents and injuries.

The specific operating experience web site address may be subject to change. Information services can be accessed through the DOE AU web site as follows :

http://energy.gov/ehss/corporate-operating-experience-program

1000 Independence Avenue, SW
Washington, D.C. 20585-1290

E-mail: Ashley.Ruocco@hq.doe.gov

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Section Five
Conclusions

5

Conclusions

The occupational radiation exposure records show that in 2014, DOE facilities continued to comply with DOE dose limits and ACL and worked to minimize exposure to individuals. Only 13 percent of the monitored workers received a measurable dose, and the average measurable dose received was less than 2 percent of the DOE limit. In 2014, the collective dose and the number of individuals with measurable dose decreased 1 and 4 percent, respectively. These decreases in the dose and number of individuals with measurable dose were the result of decreased activities involving radioactive materials, particularly at the DOE sites that comprise the majority of DOE collective dose. See *Exhibit 5-1* below for summary data.

Over the past 5 years, the collective dose and the size of the monitored workforce have remained at fairly stable levels. The collective TED for all DOE facilities was reduced by 7 person-rems from 2013 to 2014. This year marks the fourth time during the 5-year period that collective dose in the DOE complex decreased. Much of the decrease in collective dose has been attributed to a decrease in production activities as a result of budget reductions, continuing D&D progress in reducing the radioactive source term, and effective work planning and ALARA programs.

The collective dose at DOE facilities has experienced a dramatic (93 percent) decrease since 1986. This decrease 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. It is notable that as DOE has become more involved in the new mission, collective and average doses have been relatively low. Also, during this time period, regulations have improved with an increased focus on ALARA practices and risk reduction.

Exhibit 5-1:
2014 Radiation Exposure Summary.

- The collective TED was about the same showing a 1% decrease from 627 person-rems (6,270 person-mSv) in 2013 to 620 person-rems (6,200 person-mSv) in 2014.
- Sites contributing significantly to collective TED were (in descending order of collective TED) Oak Ridge, LANL, Savannah River, Idaho, and Hanford. These sites accounted for 77% of the collective TED at DOE in 2014.
- The collective TED decreased at two of the five sites with the largest collective TED. For these two sites, the decrease in collective TED in 2014 was attributed to curtailing work with solid waste at LANL in early 2014 due to the contamination release event at WIPP and its relation to LANL waste packaging. In addition, most programmatic work was not resumed from the 2013 pause associated with the criticality safety program at LANL's TA-55. At Hanford, the primary reasons for the decrease in collective TED was a change in the work scope at DOE-RL to include more work involving heavy equipment, which increased the distance between workers and source terms and the implementation of long-length tools at DOE-ORP. Due to changes in funding, several DOE-RL projects continued to operate at minimal levels. The change in work scope also included the packaging and handling of the waste packages during the seal-out activities until placed in shielded hardened containers.
- The collective internal dose (CED) increased by 21% between 2013 (44.600 person-rems) and 2014 (53.875 person-rems), in part due to the increase of work activities in 2014 at Y-12 following the government sequestration and reduced activities in 2013.
- U-234 accounted for the largest percentage of the collective CED, with over 98% of this dose accrued at Y-12.
- The collective TED for transient workers increased by 2% from 21.1 person-rems (211 person-mSv) in 2013 to 21.5 person-rems (215 person-mSv) in 2014.

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Glossary

Glossary

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

ALARA
Acronym for "as low as is reasonably achievable," which is the approach to radiation protection to manage and control exposures (both individual and collective) to the workforce and the general public to as low as is reasonable, taking into account social, technical, economic, practical, and public policy considerations. ALARA is not a dose limit but a process with the objective of attaining doses as far below the applicable limits as is reasonably achievable.

average measurable dose
Dose obtained by dividing the collective dose by the number of individuals who received a measurable dose. This is the average most commonly used in this and other reports when examining trends and comparing doses received by workers, because it reflects the exclusion of those individuals receiving a less than measurable dose. In this report, average measurable dose is calculated for TED and CED.

collective dose
As used in this report, the term "collective dose" is the sum of doses to all individuals in a population for a period of time. The general term "collective dose" 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 workers 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) (H_E,50)
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) (i.e., $H_E,50 = w_T H_T,50$). CED is expressed in units of rem.

committed equivalent dose (CEqD) (H_T,50)
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. CEqD is expressed in units of rem.

DOE site
A geographic location operated under the authority of the DOE.

ED
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, Effective dose = $\Sigma\, w_T H_T$. 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 rems (or Sievert [Sv]).

equivalent dose (EqD)
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 EqD to the whole body is assessed at a depth of 1 cm in tissue; the EqD to the lens of the eye is assessed at a depth of 0.3 cm in tissue; and the EqD to the extremity and skin is assessed at a depth of 0.007 cm in tissue. The mathematical term is H_T, while the abbreviation EqD is used in this report and in the REMS reporting requirements for this data element. EqD is expressed in units of rem (or Sv).

exposure
Occupational exposure means 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.

Hanford
This term is used to describe the entire reservation and all activities at this geographic location. It includes all cleanup activities at the reactors at the "Hanford Site," ORP, and PNNL. This term is used when we are *including* Hanford Site, ORP, and PNNL.

Hanford Site
All activities at, and cleanup of, the reactors and 100 – 400 areas at the reservation. Does not include ORP and PNNL.

Office of River Protection (ORP)
Tank farm and liquid waste cleanup to protect the Columbia River.

Pacific Northwest National Laboratory (PNNL)
The national laboratory involved in a broad range of scientific research.

measurable dose
A dose greater than zero rems (not including doses reported as "not detectable").

member of the public
Any individual not occupationally exposed to radiation or radioactive material, which either is not a DOE general employee or is an off duty DOE general employee. 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 dose
Occupational dose is an individual's ionizing radiation dose (external and internal) as a result of that individual's work assignment. Occupational exposure does not include doses received as a medical patient or doses resulting from background radiation or participation as a subject in medical research programs.

person-rem
The unit of measurement used for the collective dose to all DOE employees, contractors and subcontractors.

rem
The acronym for roentgen equivalent in man. The rem is equal to 0.01 sievert, which is the international unit of measurement for radiation exposure.

total effective dose (TED)
The sum of the ED from external sources and the CED from intakes of radionuclides during the monitoring period. The internal dose component of TED changed from the annual effective dose equivalent to the CEDE in 1993 and from CEDE to CED in 2007.

total number of records for monitored individuals
All individuals who are monitored and reported to the DOE Headquarters database system. This includes DOE employees, contractors, subcontractors, and members of the public monitored during a visit to a DOE site. 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.

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
An individual who is monitored at more than one DOE site during the calendar year.

urinalysis
The technique of determining the amount of radioactive material in the urine excreted from the body.

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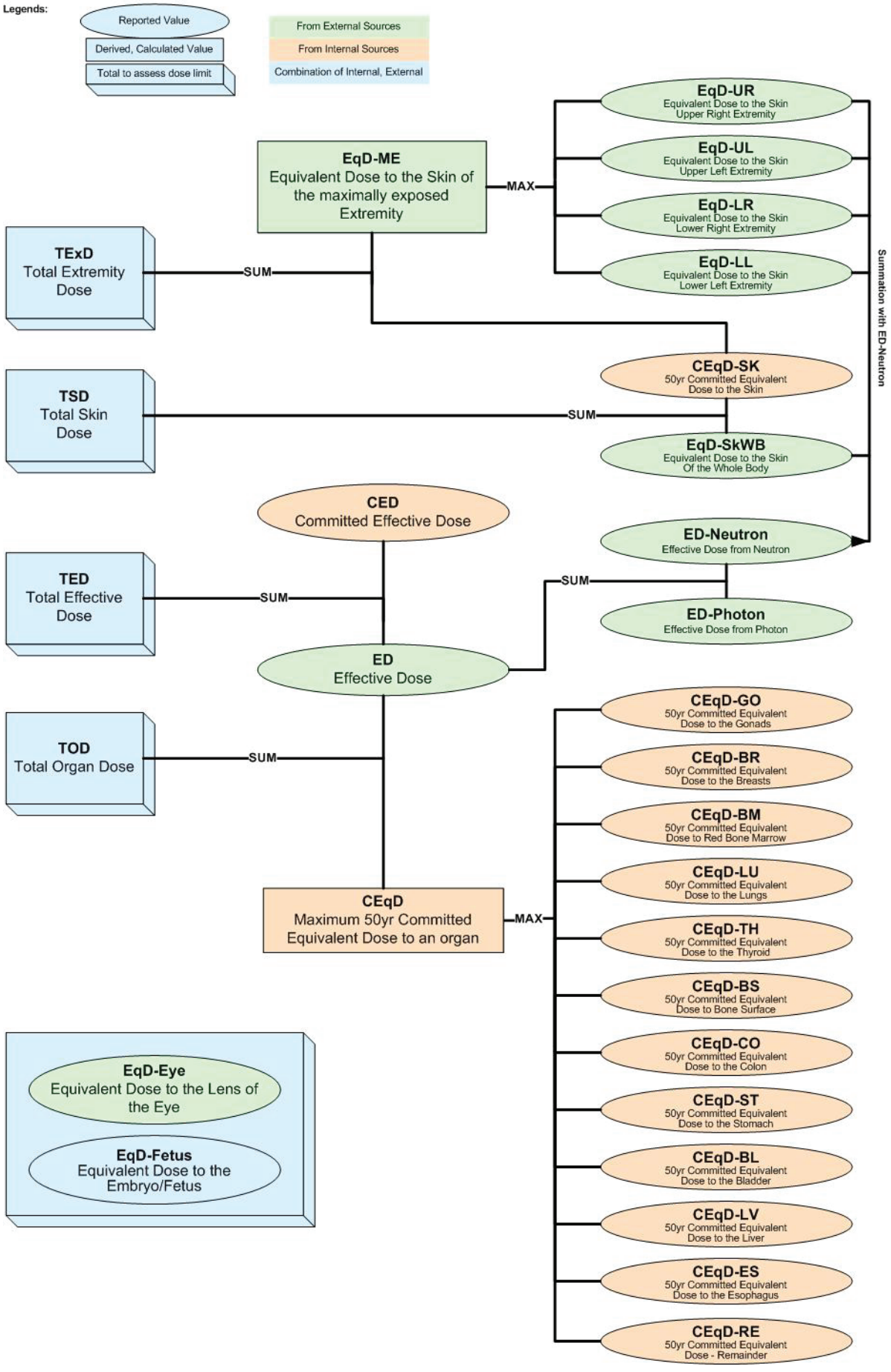
10. DOE Standard, DOE-STD-1098-99 (change notice 1), "*Radiological Control,*" May 2009.

11. DOE O 210.2A, "DOE Corporate Operating Experience Program," April 8, 2011.

DOE Radiation Exposure Management System (REMS)
Dose Abbreviations, Definitions, and Relationships



User Survey

DOE Occupational Radiation Exposure Report
User Survey

DOE, striving to meet the needs of its stakeholders, is looking for suggestions on ways to improve the *DOE 2014 Occupational Radiation Exposure Report*. **Your feedback is important**. Constructive feedback will ensure the report can continue to meet user needs. Please fill out the attached survey form and return it to:

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Questions concerning this survey should be directed to Ms. Rao at (301) 903-2297.

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Executive Summary	1	2	3	4	5
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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 rems)	1	2	3	4	5
Doses in Excess of ACL limit (2 rems)	1	2	3	4	5
Intakes of Radioactive Material	1	2	3	4	5
Analysis of Site Data	1	2	3	4	5
Collective Dose by Site	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
DOE Occupational Dose in Relation to Other Activities	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:

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Please provide any additional input or comments on the report.

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