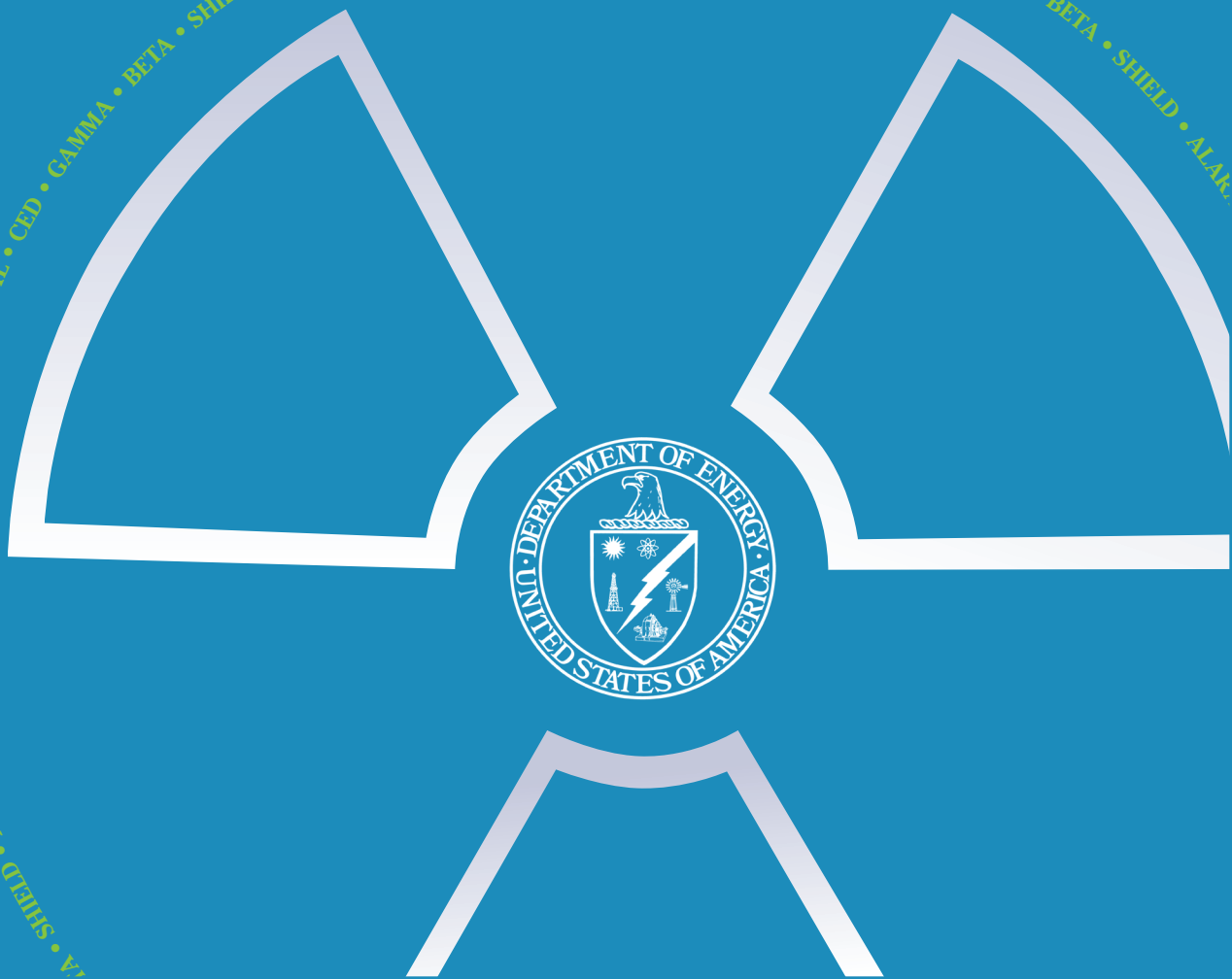
Mission Success

EHSS

Office of Environment, Health, Safety and Security

DOE 2013 Occupational Radiation Exposure

November 2014



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

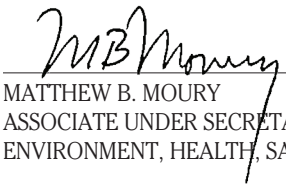
Foreword

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 (EHSS) 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 EHSS Office of 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 their 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 2013 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 ALARA process requirements, and an overview of the status of radiation exposures of the DOE workforce. In addition, this report serves as a risk management tool for managing 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 harmful effects of radiation.

The Radiation Exposure Monitoring System (REMS) program remains a key component of EHSS 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

This page intentionally left blank.

Contents
Table of Contents

LIST OF EXHIBITS

LIST OF ABBREVIATIONS AND ACRONYMS

ACL	Administrative Control Level
ALARA	As Low As Reasonably Achievable
AMWTP	Advanced Mixed Waste Treatment Project
ANL	Argonne National Laboratory
ARRA	American Recovery and Reinvestment Act
BNL	Brookhaven National Laboratory
CED	Committed Effective Dose
C.F.R.	Code of Federal Regulations
D&D	Decontamination and Decommissioning
DOE	U.S. Department of Energy
ED	Effective Dose
EHSS	Office of Environment, Health, Safety and Security
EM	Office of Environmental Management
EqD	Equivalent Dose
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
LATA	Los Alamos Technical Associates
LBNL	Lawrence Berkeley National Laboratory
LLNL	Lawrence Livermore National Laboratory
LLNS	Lawrence Livermore National Security, LLC
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
ORISE	Oak Ridge Institute for Science and Education
ORNL	Oak Ridge National Laboratory
ORP	Office of River Protection
ORPS	Occurrence Reporting and Processing System
PFP	Plutonium Finishing Plant
PGDP	Paducah Gaseous Diffusion Plant
PNNL	Pacific Northwest National Laboratory
PORTS	Portsmouth Gaseous Diffusion Plant
PPPL	Princeton Plasma Physics Laboratory
Pu	Plutonium
RCS	Radiological Control Standard
Rem	Roentgen equivalent in man
REMS	Radiation Exposure Monitoring System
RL	Richland Operations Office
SC	Office of Science
SLAC	SLAC National Accelerator Laboratory
SNL	Sandia National Laboratories

SPRU	Separations Process Research Unit
SRNS	Savannah River Nuclear Solutions
SRR	Savannah River Remediation
SRS	Savannah River Site
SST	Swift & Staley
Sv	Sievert
TED	Total Effective Dose
TJNAF	Thomas Jefferson National Accelerator Facility
TRU	Transuranic
U	Uranium
UMTRA	Uranium Mill Tailings Remediation Action Project
WIPP	Waste Isolation Pilot Plant
WVDP	West Valley Demonstration Project
Y-12	Y-12 National Security Complex

Summary
Executive Summary

The Office of Analysis within the U.S. Department of Energy (DOE) Office of Environment, Health, Safety and Security (EHSS) 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 2013 Occupational Radiation Exposure Report* provides an evaluation of DOE-wide performance regarding compliance with Title 10, Code of Federal Regulations (C.F.R.), Part 835, *Occupational Radiation Protection* dose limits and as low as reasonably achievable (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 five-year period, the occupational radiation exposure information has been analyzed in terms of aggregate data, dose to individuals, and dose by site.

As an indicator of the overall amount of radiation dose received during the conduct of operations at DOE, the report includes information on collective dose, which is the summation of all dose received by monitored individuals. Primarily in this report, "dose" refers to the Total Effective Dose (TED) and the collective TED is the summation of the TED reported for each monitored individual. 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 DOE collective TED decreased 12.8% from 2012 to 2013, 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 decreased by 9% from 2012 to 2013, as shown in *Exhibit ES-2*.

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

- The collective TED decreased 12.8% from 719 person-rems (7,190 person-millisieverts [mSv]) in 2012 to 627 person-rems (6,270 person-mSv) in 2013.
- The sites contributing to the majority of the collective TED were (in descending order of collective TED) Los Alamos, Oak Ridge, Savannah River, Hanford, and Idaho. These sites accounted for 81% of the collective TED at DOE in 2013.

Exhibit ES-1:
Collective TED (person-rem), 2009–2013.

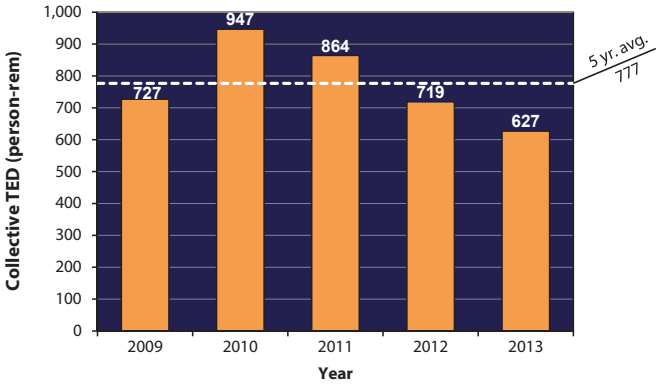
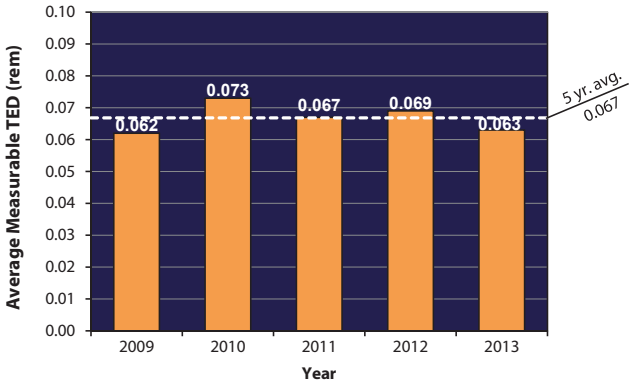


Exhibit ES-2:
Average Measurable TED (rem), 2009–2013.



- The collective TED decreased at four of the five sites with the largest collective TED. For these four sites, the decrease in collective TED in 2013 was attributed to a mid-year pause at LANL's TA-55 due to concerns with the criticality safety program; an overall decrease in radworker population throughout the Y-12 complex; and an approximate 2-month decrease in production work in preparation for the government shutdown during the sequestration in October 2013. At SRS, budget issues arose during the year and many projects were put on hold. In addition, Hanford experienced reductions in work due to budgetary constraints. Work at several Richland (RL) projects, including Transuranic (TRU) Retrieval, was reduced to a minimum safety status, and some work at the Plutonium Finishing Plant (PFP) was curtailed. The largest contributors to the Hanford (RL and Office of River Protection) dose activities were glove box removal at PFP, Tank Farm activities, decontamination and demolition of facilities on the river corridor and central plateau, and waste treatment, storage, and handling.

- The collective CED decreased by 13% from 50.3 person-rems (503 person-mSv) in 2012 to 44.0 person-rems (440 person-mSv) in 2013.

- Uranium-234 accounted for the largest percentage of the collective CED, with over 94% of this dose accrued at Y-12.

- The collective TED for transient workers decreased by 26% from 28.4 person-rems (284 person-mSv) in 2012 to 21.1 person-rems (211 person-mSv) in 2013.

Over the past five year period, 99.99% of the individuals receiving measurable TED have received doses below the 2 rems (20 mSv) TED administrative control level (ACL), which is well below the DOE regulatory limit of 5 rems (50 mSv) TED annually. The occupational radiation exposure records show that in 2013, DOE facilities continued to comply with DOE dose limits and ACLs, and worked to minimize exposure to individuals. No doses exceeded the DOE occupational dose limit of 5 rems TED in 2013 and no doses exceeded the DOE ACL of 2 rems TED.

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

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

Section One Introduction

1

Introduction

The *DOE 2013 Occupational Radiation Exposure Report* analyzes occupational radiation exposures at U.S. Department of Energy (DOE) facilities during 2013. 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 105 DOE organizations submitting radiation exposure reports for 2013 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 as appendices to this report (http://energy.gov/ehss/occupational-radiation-exposure). 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:

Ms. Nirmala Rao, Office of Analysis (AU-23)
DOE REMS Project Manager
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, D.C. 20585-1290
E-mail: nimi.rao@hq.doe.gov

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

- Annual occupational radiation exposure reports in portable document format (PDF) since 1974;
- Guidance on reporting radiation exposure information to the DOE Headquarters Radiation Exposure Monitoring System (REMS);
- 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; 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 2013 occupational radiation dose data along with trends over the past 5 years.
Section Four	Provides instructions to submit successful as low as reasonably achievable (ALARA) projects.
Section Five	Discusses conclusions.
Appendices	The appendices are offered in color on the DOE Radiation Exposure web site. 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.

This page intentionally left blank.

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 Office of Environment, Health, Safety and Security (EHSS) 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 2013. 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 2013 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, is 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]. This guidance recommends that internal dose be added to the external whole-body dose to determine the total effective dose equivalent (TEDE). Prior to this guidance, the external dose and internal dose were each limited separately. It should be noted that Title 10, Code of Federal Regulations (C.F.R.), Part 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 C.F.R. 835). Title 10 C.F.R. 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 C.F.R. 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

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

Title	Date	Description
10 C.F.R. 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 C.F.R. 835.

Personnel Category	Section of 10 C.F.R. 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.

annual individual radiation exposure records to the REMS repository. DOE Manual (M) 231.1-1A, *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 C.F.R. 835

In August 2006, DOE published a proposed amendment to 10 C.F.R. 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 C.F.R. 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 (50 millisievert [mSv]) DOE regulatory limit; and
- doses exceeding the 2 rems (20 mSv) DOE Administrative Control Level (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 workforce, 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 comprise less than 3% of the monitored workers; therefore, the multiple counting has minimal impact on the totals and averages presented in this report (see section 3.5). This is because of the conservative practice at some DOE facilities of providing 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 C.F.R. 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

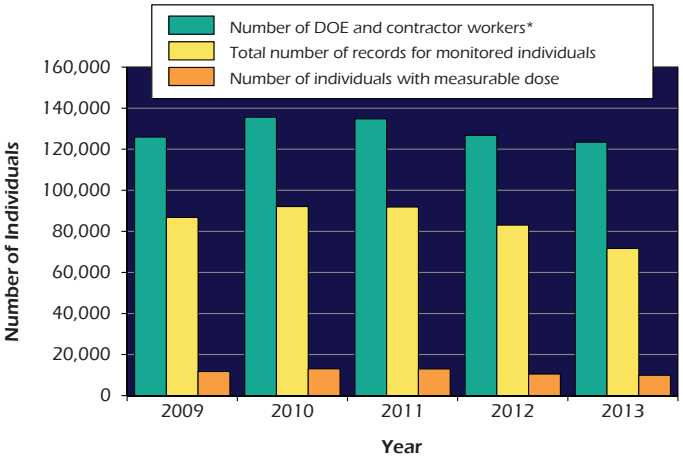
DOE uses the number of individuals receiving a measurable dose to represent the exposed workforce size. The number of individuals with a measurable dose includes all individuals that received a reported detectable dose.

Over the past 5-year period, 99.99% of the individuals receiving measurable total effective dose (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.

Twenty of the reporting sites experienced decreases in the number of workers with a measurable TED from 2012 to 2013. The largest decrease in total number of workers with a measurable TED occurred at the Savannah River site (SRS) with a decrease of 573 workers. Twelve of the reporting sites experienced increases in the number of workers with a measurable TED from 2012 to 2013. The largest increase in the number of workers receiving a measurable TED occurred at the Los Alamos National Laboratory (LANL). A discussion of activities at the highest dose facilities is included in Section 3.4.3.

Exhibit 3-1a:
Monitoring of the DOE Workforce, 2009–2013.



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

For 2013, 58% of the DOE workforce was monitored for radiation dose, and 14% of monitored individuals received a measurable dose.

Exhibit 3-1b:
Monitoring of the DOE Workforce, 2009–2013.

Year	DOE & Contractor Workforce	Number of Workers Monitored	Percent of Workers Monitored*	Number Monitored w/Measurable Dose	Percent Monitored w/Measurable Dose*
2009	125,933	86,768	69% ▲	11,761	14%
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	123,424	71,661	58% ▼	9,901	14% ▲
5-Year Average	**129,298**	**85,087**	**66%**	**11,627**	**14%**

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

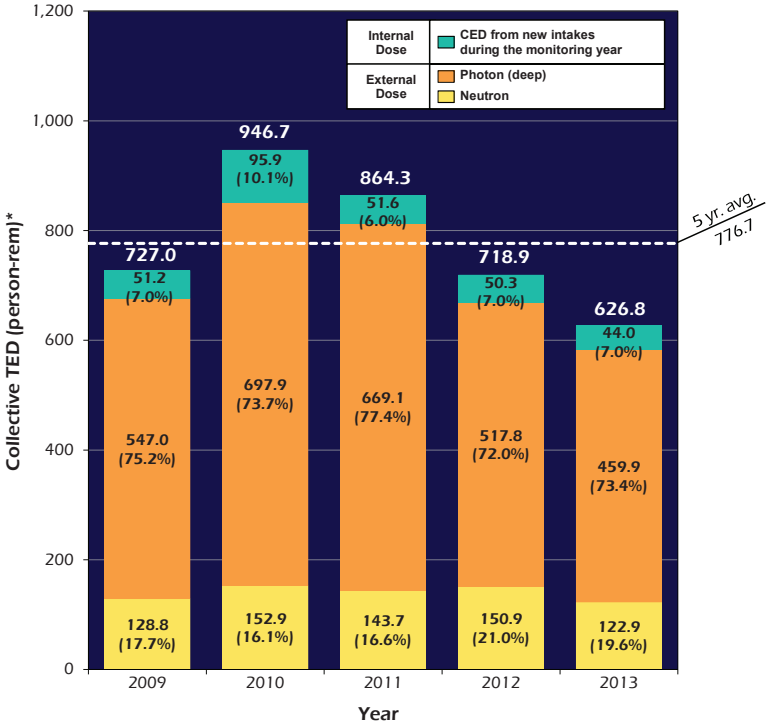
3.2.3 Collective Dose

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.

As shown in *Exhibit 3-2*, the collective TED decreased at DOE 12.8% from 718.9 person-rems (7,189 person mSv) in 2012 to 626.8 person-rems (6,268 person-mSv) in 2013.

The internal dose is based on the 50-year Committed Effective Dose (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 decreased by 13% from 50.3 person-rems (503 person mSv) in 2012 to 44.0 person-rems (440 person-mSv) in 2013. This observed drop in internal collective dose is due, in part, to an overall decrease in the number of individuals monitored for internal exposure during 2013 at Y-12. In addition, there was a substantial decrease in the internal exposure potential due to a planned orderly shutdown of work activities as a response to the government shutdown, which contributed to the decrease in collective CED in 2013. The collective

Exhibit 3-2:
Components of TED, 2009–2013.



The collective TED decreased by 13% at DOE from 2012 to 2013.

The collective internal dose decreased by 13% from 2012 to 2013.

Neutron dose decreased by 19% from 2012 to 2013.

Photon dose decreased by 11% from 2012 to 2013.

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.

photon dose decreased by 11% from 517.8 person-rems (5,178 person-mSv) in 2012 to 459.9 person-rems (4,599 person-mSv) in 2013.

The neutron component of the TED decreased by 19% from 150.9 person-rems (1,509 person-mSv) in 2012 to 122.9 person-rems (1,229 person-mSv) in 2013. This is because neutron exposures decreased proportionately to the overall reduction in dose at the Hanford Plutonum Finishing Plant (PFP).

Twenty of the DOE sites reported decreases in the collective TED from the 2012 values, while 12 of the DOE sites reported increases. The 5 sites that contributed most (81%) of the DOE collective TED in 2013 were (in descending order of collective TED): LANL – 22%; Oak Ridge – 20% (including East Tennessee Technology Park [ETTP], Y-12 National Security Complex [Y-12], Oak Ridge National Laboratory [ORNL], and Oak Ridge Institute for Science and Education [ORISE]); SRS – 14% (including Savannah River Nuclear Solutions [SRNS] and Savannah River Remediation [SRR]); Hanford – 13% (including the Hanford Site, Pacific Northwest National Laboratory [PNNL], and the Office of River Protection [ORP]); and Idaho Site – 11% (including the Idaho National Laboratory [INL], Idaho Cleanup Project [ICP] and the Advanced Mixed Waste Treatment Project [AMWTP]).

Four of these sites reported decreases in the collective TED in 2013 compared with 2012. The four sites in descending order of the percent reduction in collective TED are SRS (39% lower), Hanford (15% lower), Oak Ridge (10% lower), and LANL (1% lower).

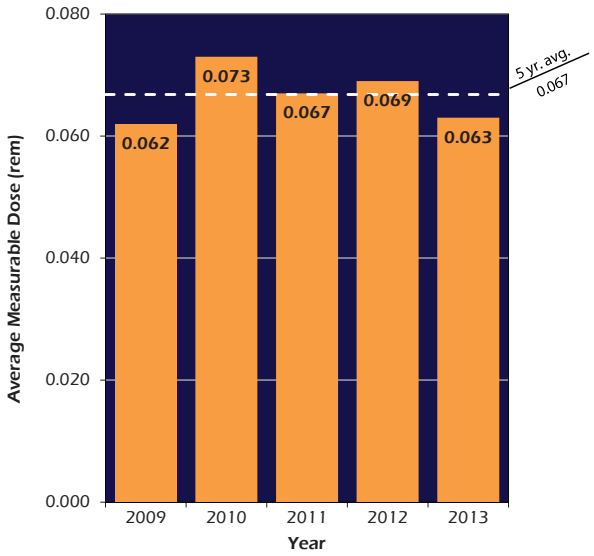
3.2.4 Average Measurable Dose

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 decreased by 9% from 0.069 rem (0.69 mSv) in 2012 to 0.063 rem (0.63 mSv) in 2013, slightly lower than the 5-year average. 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.

Exhibit 3-3:
Average Measurable TED, 2009–2013.



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 C.F.R. 835.402(a) and (c) [6].

Exhibit 3-4 shows that the dose (TED) distribution for 2013 was slightly lower in every range but the 0.750 to 1 rem range compared with the 2012 data. *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 the values remained relatively constant or lower, which is consistent with the overall decrease in the average measurable TED during 2013 as a result of reduced activities due to budgetary constraints and work suspension due to criticality safety concerns at TA-55 Plutonium Facility at LANL.

Exhibit 3-4:
Distribution of TED by Dose Range, 2009–2013.

TED Range (rem)		2009	2010	2011	2012	2013
Number of Individuals in Each Dose Range*	Less than measurable	75,007	79,057	78,892	72,582	61,760
	Measurable to 0.100	9,763	10,361	10,514	8,443	8,151
	0.100–0.250	1,398	1,857	1,736	1,360	1,245
	0.250–0.500	490	695	564	529	420
	0.500–0.750	72	101	99	87	48
	0.750–1.000	28	23	41	27	28
	1–2	10	9	11	15	9
	2–3					
	3–4					
	4–5					
	>5		1			
Total number of records for monitored individuals		86,768	92,104	91,857	83,043	71,661
Number with measurable dose		11,761	13,047	12,965	10,461	9,901
Number with dose >0.100 rem		1,998	2,686	2,451	2,018	1,750
% of individuals with measurable dose		14%	14%	14%	13%	14%
Collective TED (person-rems)		727.006	946.658	864.315	718.903	626.785
Average measurable TED (rem)		0.062	0.073	0.067	0.069	0.063

* 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, 2009 – 2013.

	TED Range (rem)	2009	2010	2011	2012	2013
Percentage of Individuals with Measurable TED*	Measurable <0.100	83.0%	79.4%	81.1%	80.7%	82.3%
	0.100–0.250	11.9%	14.2%	13.4%	13.0%	12.6%
	0.250–0.500	4.2%	5.3%	4.4%	5.1%	4.2%
	0.500–0.750	0.6%	0.8%	0.8%	0.8%	0.5%
	0.750–1.000	0.2%	0.2%	0.3%	0.3%	0.3%
	1–2	0.1%	0.1%	0.1%	0.1%	0.1%
	2–3	0.0%	<0.0%	0.0%	0.0%	0.0%
	>3	0.0%	<0.0%	0.0%	0.0%	0.0%

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, as well as a regulatory perspective, it is important to closely examine the doses received by individuals in the elevated dose ranges to thoroughly 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

Exhibit 3-6 shows the number of doses in excess of the TED regulatory limit (5 rems [50 mSv]) from 2009 through 2013.

No individual was reported to have exceeded 5 rems in 2013.

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 in 2013.

As shown in *Exhibit 3-6*, one individual has exceeded the 2 rems (20 mSv) ACL in the past 5 years. The same individual also exceeded the 5 rems (50 mSv) annual limit.

Exhibit 3-6:
Number of Individuals Exceeding 2 rems ACL and the 5 rems Annual Limit, 2009–2013.

Year	>2 rems	>5 rems
2009		
2010		1
2011		
2012		
2013		

In 2013, no individual received a TED in excess of 2 rems (20 mSv).

3.3.3 Intakes of Radioactive Material

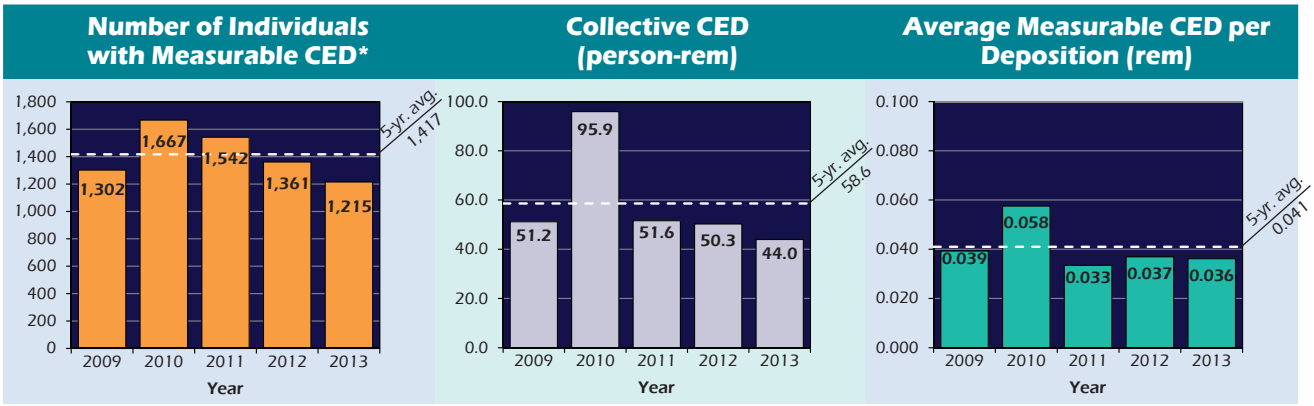
DOE tracks the number of intakes as a performance measure in the report. As shown in *Exhibit 3-7*, the highest dose from the single event that caused an exceedance of the ACL was the result of the intake of radionuclides. DOE emphasizes the importance of taking measures to avoid intakes and maintain doses as low as reasonable through the ALARA process.

Exhibit 3-8 shows the number of individuals with measurable CED, collective CED, and average measurable CED for 2009 to 2013. The number of individuals with measurable CED decreased by 11%

Exhibit 3-7:
Dose in Excess of DOE Administrative Control Levels, 2009–2013.

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
2009				None reported			
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			

Exhibit 3-8:
Number of Individuals with Measurable CED, Collective CED, and Average Measurable CED, 2009-2013



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

from 1,361 in 2012 to 1,215 in 2013, while the collective CED decreased by 13%. The average measurable CED decreased by 3% from 0.037 rem (0.37 mSv) in 2012 to 0.036 rem (0.36 mSv) in 2013.

Ninety-four percent of the collective CED in 2013 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 3-9 shows the distribution of the internal dose (CED) from 2009 to 2013. 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,

Exhibit 3-9:
Internal Dose Distribution from Intakes, 2009–2013.

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		
2009	707	456	118	16	4	1						1,302	51.162
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	671	430	106	5	2	1						1,215	43.966

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

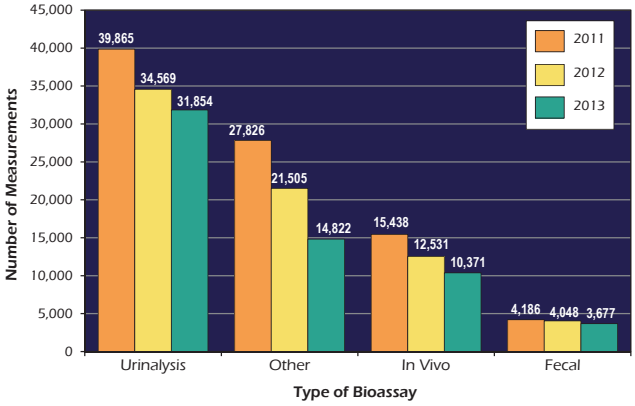
but these intakes result in one annual CED total per individual. Doses below 0.020 rem (0.20 mSv) are shown as a separate dose range, to show the large number of doses in this low dose range. The decrease in the number of individuals with measurable CED in 2013 is primarily due to the limited operations at Y-12.

The internal dose records indicate that the majority of the intakes result in very low doses. In 2013, 55% 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% of the collective TED, and only 9% of the individuals who received internal doses were above the monitoring threshold (0.1 person-rem [1 mSv]) specified in 10 C.F.R. 835.402(c) [6].

3.3.4 Bioassay and Intake Summary Information

For the monitoring year 2013, 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 3-10* 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 Other are for air samples taken in the workplace that 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.

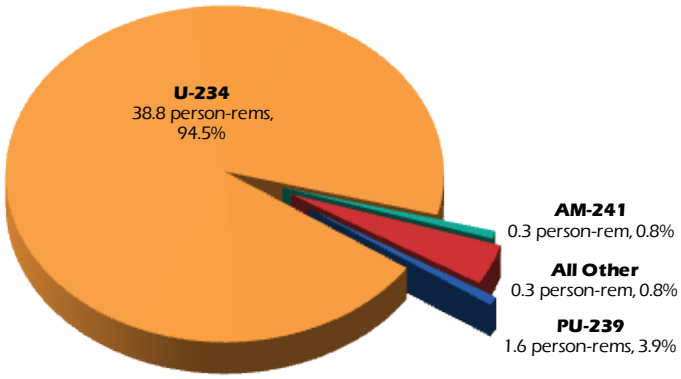
Exhibit 3-10:
Bioassay and Air Sampling Measurements, 2011-2013.



Sixty-five percent of the urinalysis measurements in 2013 were performed at four sites: Y-12, LANL, SRS and the Portsmouth Gaseous Diffusion Plant (PGDP). The majority of the bioassay measurements reported as Other were from air sampling and accounted for 24% of the total measurements. Nearly 42% of the In Vivo measurements were from Hanford. Hanford also performed the largest number of bioassay measurements overall, comprising 24% of the total measurements taken. PGDP had the largest percentage increase (94%) in the number of urinalysis measurements in 2013 and SRS reported the largest decrease (50%) in the number of Other measurements.

Exhibit 3-11 shows the breakdown of the collective CED by radionuclide for 2013. Uranium-234 (U-234) accounted for the largest percentage of the collective CED, with over 94% of this dose accrued at Y-12.

Exhibit 3-11:
Collective CED by Radionuclide, 2013.



3.4 Analysis of Site Data

3.4.1 Collective TED by Site and Other Facilities

The collective TED for 2011 through 2013 for the major DOE sites and operations/field offices are shown graphically in *Exhibit 3-12*. A list of the collective TED and number of individuals with measurable TED by DOE sites are shown in *Exhibit 3-13*. The collective TED decreased 12.8% from 719 person-rems (7,190 person-mSv) in 2012 to 627 person-rems (6,270 person-mSv) in 2013, with LANL; Oak Ridge sites (including ETTP, Y-12, ORNL, and ORISE); Savannah River (including SRNS and SRR); Hanford (including the Hanford Site, PNNL, and the ORP); and Idaho Site (including INL, ICP, and AMWTP) contributing 81% of the total DOE collective TED.

Exhibit 3-12:
Collective TED by DOE Site for 2011–2013.

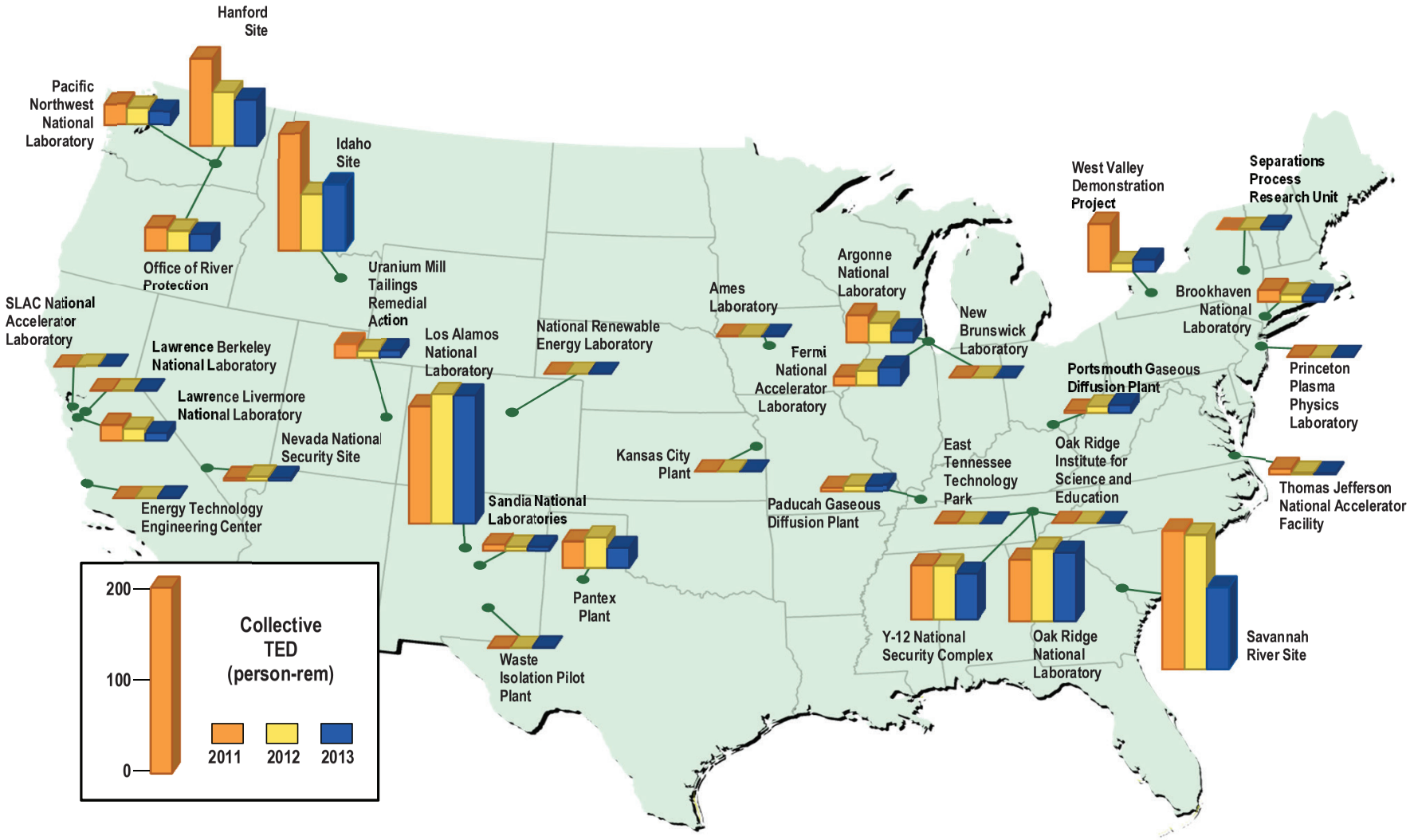


Exhibit 3-13:
Collective TED and Number of Individuals with Measurable TED by DOE Site, 2011–2013.

Site	2011		2012		2013	
	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	0.762	29	0.820	25	0.730	24
Argonne National Laboratory	29.552	177	21.212	122	13.017	74
Brookhaven National Laboratory	12.822	172	7.981	171	6.988	194
Energy Technology Engineering Center	0.139	47	0.227	55	0.479	57
Fermi National Accelerator Laboratory	10.090	155	15.980	207	19.750	175
Hanford:						
Hanford Site	94.691	1,479	58.349	926	50.081	715
Office of River Protection	25.308	496	21.528	413	18.228	448
Pacific Northwest National Laboratory	22.336	257	17.779	240	14.550	403
Idaho Site	127.162	2,391	61.292	1,257	71.752	1,438
Kansas City Plant	0.049	2	0.021	6	0.001	1
Lawrence Berkeley National Laboratory	0.759	13	0.497	10	0.623	9
Lawrence Livermore National Laboratory	16.979	116	13.037	131	8.475	103
Los Alamos National Laboratory	127.079	1,460	140.148	1,438	**138.734**	**1,703**
National Renewable Energy Laboratory	0.017	5	0.020	4	0.068	5
Nevada National Security Site	2.743	78	4.284	100	3.218	89
New Brunswick Laboratory	0.165	8	0.039	2	0.012	1
Oak Ridge:						
East Tennessee Technology Park	0.830	39	0.306	14	0.040	4
Oak Ridge Institute for Science and Education	0.211	82	0.124	23	0.083	6
Oak Ridge National Laboratory	66.727	729	78.790	763	74.531	642
Y-12 National Security Complex	59.055	1,537	58.643	1,413	49.727	1,337
Paducah Gaseous Diffusion Plant	4.038	78	5.984	113	6.450	92
Pantex Plant	28.947	311	33.118	339	21.829	330
Portsmouth Gaseous Diffusion Plant	2.279	47	7.092	135	8.634	102
Princeton Plasma Physics Laboratory	0.401	53	0.334	43	0.339	58
Sandia National Laboratories	6.913	126	4.315	122	4.335	123
Savannah River Site	**149.967**	**2,512**	**145.443**	**2,044**	88.536	1,471
Separations Process Research Unit	0.179	13	0.584	23	2.896	48
SLAC National Accelerator Laboratory	0.236	10	0.315	15	0.281	10
Thomas Jefferson National Accelerator Facility	6.245	57	1.963	85	1.503	48
Uranium Mill Tailings Remedial Action Project	15.000	191	7.673	87	7.407	55
Waste Isolation Pilot Plant	0.476	25	0.298	18	0.552	32
West Valley Demonstration Project	51.662	247	9.312	86	12.901	101
Service Center Personnel*	0.496	23	1.395	31	0.035	3
Totals	**864.315**	**12,965**	**718.903**	**10,461**	**626.785**	**9,901**

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 3-14:
Site Dose Data, 2013.

Site	2013							
	Collective TED (person-rem)	Percent Change from 2012	Number with Meas. Dose	Percent Change from 2012	Avg. Meas. TED (rem)	Percent Change from 2012	Percentage of Coll. TED above 0.500 rem	Percent Change from 2012
Ames Laboratory	0.730	◊	24	◊	0.030	◊		
Argonne National Laboratory	13.017	-39% ▼	74	-39% ▼	**0.176**	1% ▲	**61%**	17% ▲
Brookhaven National Laboratory	6.988	-12% ▼	194	13% ▲	0.036	-23% ▼		-100% ▼
Energy Technology Engineering Center	0.479	◊	57	◊	0.008	◊		
Fermi National Accelerator Laboratory	19.750	24% ▲	175	-15% ▼	0.113	46% ▲	8%	100% ▲
Hanford:								
Hanford Site	50.081	-14% ▼	715	-23% ▼	0.070	11% ▲	29%	**314%** ▲
Office of River Protection	18.228	-15% ▼	448	8% ▲	0.041	-22% ▼		
Pacific Northwest National Laboratory	14.550	-18% ▼	403	68% ▲	0.036	-51% ▼		-100% ▼
Idaho Site	71.752	17% ▲	1,438	14% ▲	0.050	2% ▲		
Kansas City Plant	0.001	◊	1	◊	0.001	◊		
Lawrence Berkeley National Laboratory	0.623	◊	9	◊	0.069	◊		
Lawrence Livermore National Laboratory	8.475	-35% ▼	103	-21% ▼	0.082	-17% ▼	28%	27% ▲
Los Alamos National Laboratory	**138.734**	-1% ▼	**1,703**	18% ▲	0.081	-16% ▼	15%	-56% ▼
National Renewable Energy Laboratory	0.068	◊	5	◊	0.014	◊		
Nevada National Security Site	3.218	-25% ▼	89	-11% ▼	0.036	-16% ▼		
New Brunswick Laboratory	0.012	◊	1	◊	0.012	◊		
Oak Ridge:								
East Tennessee Technology Park	0.040	◊	4	◊	0.010	◊		
Oak Ridge Institute for Science and Education	0.083	◊	6	◊	0.014	◊		
Oak Ridge National Laboratory	74.531	-5% ▼	642	-16% ▼	0.116	12% ▲	15%	0%
Y-12 National Security Complex	49.727	-15% ▼	1,337	-5% ▼	0.037	-10% ▼	1%	0%
Paducah Gaseous Diffusion Plant	6.450	8% ▲	92	-19% ▼	0.070	32% ▲		
Pantex Plant	21.829	-34% ▼	330	-3% ▼	0.066	-32% ▼		-100% ▼
Portsmouth Gaseous Diffusion Plant	8.634	22% ▲	102	-24% ▼	0.085	61% ▲		
Princeton Plasma Physics Laboratory	0.339	◊	58	◊	0.006	◊		
Sandia National Laboratories	4.335	0%	123	1% ▲	0.035	0%		
Savannah River Site	88.536	-39% ▼	1,471	-28% ▼	0.060	-15% ▼	4%	-20% ▼
Separations Process Research Unit	2.896	**396%** ▲	48	**109%** ▲	0.060	**138%** ▲		
SLAC National Accelerator Laboratory	0.281	◊	10	◊	0.028	◊		
Thomas Jefferson National Accelerator Facility	1.503	-23% ▼	48	-44% ▼	0.031	36% ▲		
Uranium Mill Tailings Remedial Action Project	7.407	-3% ▼	55	-37% ▼	0.135	53% ▲		
Waste Isolation Pilot Plant	0.552	◊	32	◊	0.017	◊		
West Valley Demonstration Project	12.901	39% ▲	101	17% ▲	0.128	18% ▲	4%	100% ▲
Service Center Personnel*	0.035	◊	3	◊	0.012	◊		
Totals	626.785	-13% ▼	9,901	-5% ▼	0.063	-8% ▼	10%	-22% ▼

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.

3.4.2 Changes by Site from 2012 to 2013

Exhibit 3-14 shows the collective TED, the number with a measurable TED, the average measurable TED, and the percentage of the collective TED delivered above 0.500 rem by site for 2013, 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. 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 2013.

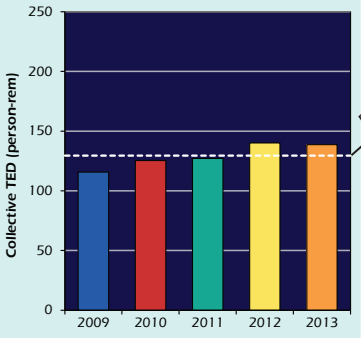
The percentage of the collective TED above 0.500 rem is an indicator of the distribution of dose to individuals. A smaller fraction of the monitored population received doses above 0.5 rem in 2013. See section 3.2.5 for more information on the characteristics of the distribution of doses to individuals above a certain dose value.

3.4.3 Activities Significantly Contributing to Collective Dose in 2013

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 2013. These sites, presented in descending order of collective TED (LANL, Oak Ridge, SRS, Hanford, and Idaho) each had a collective TED over 70 person-rems and were the top contributors to the collective TED in 2013. These sites comprised 81% of the total collective TED at DOE. Four sites reported decreases in the collective TED, which contributed to a 12.8% decrease in the DOE collective TED from 719 person-rems (7,190 person-mSv) in 2012 to 627 person-rems (6,270 person-mSv) in 2013. The sites significantly contributing to the collective TED in 2013 are shown in *Exhibit 3-15*, including a description of activities that affected the collective TED.

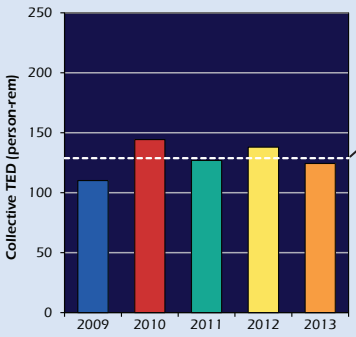
In addition to the information provided in *Exhibit 3-15*, 22 DOE sites reported a description of activities as it relates to occupational exposure, as requested in the REMS Reporting Guide, Item 1. The full text of these descriptions can be found in Section 3.4.4. In this section, explanations for increases and decreases in the collective dose at DOE sites ranging from improved ALARA to changes in decommissioning activities are discussed. Overall, the majority of sites experienced decreases in collective dose.

Exhibit 3-15 :
Activities Significantly Contributing to Collective TED in 2013 .

Los Alamos National Laboratory	**Percent Change***			**Description of Activities at the Site**
	2012-2013 (last yr.)	**2011-2013 (3 yr.)**	**2009-2013 (5 yr.)**	
	1.0% ↓	9.2% ↑	19.9% ↑	The 2013 collective TED at LANL was 138.734 person-rems. This is a 1% decrease from the previous year (140.148 person-rems). LANL monitored 9,078 individuals, and of these, 1,703 had measurable TED, an 18% increase from 2012 (see Exhibit 3-14 for more details). TA-55 Plutonium Facility operations accounted for the majority of occupational dose at LANL in 2013 - historically consistent for LANL. Occupational dose was accrued from manufacturing and related weapons work, Plutonium-238 (Pu-238) work and repackaging materials, as well as providing radiation control technicians (RCT) and other infrastructure support for radiological work and facility maintenance at TA-55. A primary contributor to dose was work with Pu-238, producing general purpose heat sources for use individually and in radioisotope thermoelectric generators. The top 25 doses at LANL in 2013 were accrued at TA-55. Doses at TA-55 would have been significantly higher due to planned programmatic work in all of these areas; however, most work was paused mid-year due to concerns 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 waste facilities at TA-50 and TA-54 – this work continued throughout 2013, commensurate with commitments to reduce onsite waste inventories. There was also a significant portion of LANL dose accrued by workers performing programmatic and maintenance work at the TA-53 Los Alamos Neutron Science Center, commensurate with associated radiological work. No individual received over 2 rems at LANL during 2013.

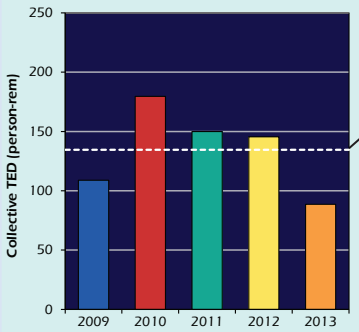
* Up arrows indicate an increase in change. Down arrows indicate a decrease in change.

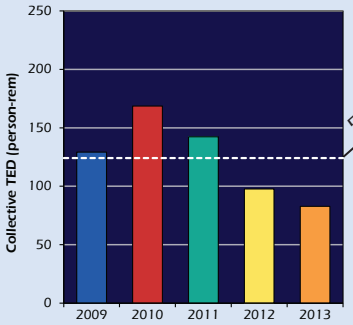
Exhibit 3-15 (Continued):
Activities Significantly Contributing to Collective TED in 2013.

Oak Ridge	Percent Change*			Description of Activities at the Site
	2012-2013 (last yr.)	2011-2013 (3 yr.)	2009-2013 (5 yr.)	
	9.8% ↓	1.9% ↓	12.9% ↑	The 2013 collective TED at all Oak Ridge Sites was 124.381 person-rems. **Y-12 National Security Complex (Y-12)** Over 5,318 individuals were monitored at Y-12 in 2013 (17% fewer than in 2012) and 1,337 individuals had measurable TED, a 5% decrease from 2012 (see Exhibit 3-14 for more details). The collective TED decreased 15% from 58.643 person-rems in 2012 to 49.727 person-rems in 2013. The collective effective dose decreased by 5% from 11.5 person-rems in 2012 to 10.9 person-rems in 2013. This decrease was mainly due to an overall decrease in radworker population throughout the complex and an approximate 2-month decrease in production work in preparation for the government shutdown during the sequestration in October 2013. In addition, one project involving a neutron generator contributed no measurable effective dose this year compared with 0.219 person-rem in 2012. The 2013 collective CED decreased 17% from 46.8 person-rems in 2012 to 38.8 person-rems in 2013. This observed drop in internal dose was due, in part, to an overall decrease in the number of individuals monitored for internal exposure during 2013. In addition, there was a substantial decrease in the internal exposure potential due to a planned orderly shutdown of work activities as a response to the government shutdown. The total extremity dose decreased 8% from 35.3 person-rems in 2012 to 32.3 person-rems in 2013. No individual exceeded 2 rems TED in 2013. **Oak Ridge National Laboratory (ORNL)** In 2013, ORNL reported 4,025 individuals, and of these, 642 individuals received a measurable TED (see Exhibit 3-14 for more details). This is a 16% decrease in the number of individuals with measurable TED compared with 2012. The collective TED for ORNL in 2013 was 74.531 person-rems. This represents a 5% decrease from 2012 (78.790 person-rems). During 2013, ORNL experienced an increase in work being performed at the Radiochemical Engineering Development Complex and an increase in radioactive specimen research being performed. The transuranic waste processing center (TWPC) reported a collective TED of 33.485 person-rems for 2013, a decrease of 4% from 2012 (34.778 person-rems). The Hot Cells Project at ORNL reported a collective TED of 2.500 person-rems for 2013, a 78% decrease compared with 2012 (11.449 person-rems). No individual exceeded 2 rems TED at ORNL during 2013. **Oak Ridge Institute for Science and Education (ORISE)** In 2013, ORISE reported 79 individuals, which included 6 individuals with measurable dose (a 74% decrease from 2012) (see Exhibit 3-13 for more details). The collective TED for the 2013 monitoring year was 0.083 person-rem, a 33% decrease from 2012 (0.124 person-rem). **East Tennessee Technology Park (ETTP)** In 2013, the DOE cleanup contractor monitored 627 individuals and 4 individuals had measurable TED (a 71% decrease from 2012) (see Exhibit 3-13 for more details). The 2013 collective TED was 0.040 person-rem, an 87% decrease from 2012 (0.306 person-rem). The major activities performed at DOE cleanup contractor-managed sites in 2013 consisted of environmental restoration work, decommission and decontamination of facilities, surveillance and maintenance tasks, stabilization of inactive facilities, and waste disposition. No individual exceeded 2 rems TED in 2013.

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

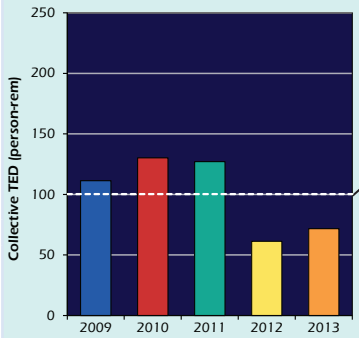
Exhibit 3-15 (Continued):
Activities Significantly Contributing to Collective TED in 2013.

Savannah River Site	Percent Change*			Description of Activities at the Site
	2012-2013 (last yr.)	2011-2013 (3 yr.)	2009-2013 (5 yr.)	
	39.1% ↓	41.0% ↓	18.7% ↓	The 2013 collective TED at SRS was 88.536 person-rems. This was 39% lower than 2012 (145.443 person-rems). The SRS collected records for 5,833 individuals in 2013, and 1,471 individuals had a measurable TED (see Exhibit 3-14 for more details). The number of individuals with measurable TED decreased by 28% from 2012 to 2013. This significant decrease was attributed to a host of budget issues that arose during the year. Many projects were put on hold throughout the year. The decrease was also due to many ALARA initiatives that were employed. The ALARA principles of time, distance and shielding were used in the recovery efforts from a suckback that occurred during a steam purge of Tank 8.3 instrumentation in H Canyon. Special tools and absorption media were used in the TRU waste remediation process. No individual exceeded 2 rems TED in 2013.

Hanford	Percent Change*			Description of Activities at the Site
	2012-2013 (last yr.)	2011-2013 (3 yr)	2009-2013 (5 yr)	
	15.2% ↓	41.8% ↓	35.8% ↓	The 2013 collective TED at Hanford was 82.859 person-rems. Overall, collective TED decreased by 15% from 2012 to 2013 at Hanford. The primary reason for this change was due to reductions in work due to budgetary constraints. Work at several RL projects, including TRU Retrieval, was reduced to a minimum safety status, and backshift work at the Plutonium Finishing Plant (PFP) was curtailed. Neutron exposures decreased proportionately to the overall reduction in dose at PFP. While the overall extremity exposure only increased by 3%, the PFP extremity dose increased 23%. This increase was a result of hands on work in HA-9A, a high mass glove box. The largest contributors to the Hanford (DOE-RL and DOE-ORP activities) dose were glove box removal at PFP (52%), Tank Farm activities (28%), decontamination and demolition of facilities on the river corridor and central plateau (10%), and waste treatment, storage and handling (6%). **Hanford Site** There were 4,256 individuals monitored at Hanford in 2013. Of these, 715 individuals had measurable TED, which is a 23% decrease from 2012 (see Exhibit 3-14 for more details). The TED decreased 14% from 58.349 person-rems in 2012 to 50.081 person-rems in 2013. No individual exceeded 2 rems TED in 2013. **The Office of River Protection (ORP)** In 2013, the ORP monitored 1,822 individuals, which included 448 individuals with measurable TED, an 8% increase from 2012 (see Exhibit 3-14 for more details). The 2013 collective TED decreased 15% from 21.528 person-rems in 2012 to 18.228 person-rems in 2013. No individual exceeded 2 rems TED in 2013. **Pacific Northwest National Laboratory (PNNL)** In 2013, PNNL monitored 2,269 individuals, and of these, 403 individuals had measurable TED, a 68% increase from 2012 (see Exhibit 3-14 for more details). The collective TED at PNNL in 2013 was 14.550 person-rems, an 18% decrease from the previous year (17.779 person-rems). The collective dose for 2013 compared with 2012 was much lower due to a reduction of elevated risk radiological work for the PNNL Shielded Facility Operations Group. There was much less high-activity source term work while performing post-irradiation examination activities for the Tritium Technology Program. No individual exceeded 2 rems TED in 2013.

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

Exhibit 3-15 (Continued):
Activities Significantly Contributing to Collective TED in 2013.

Idaho Site	Percent Change*			Description of Activities at the Site
	2012-2013 (last yr.)	2011-2013 (3 yr)	2009-2013 (5 yr)	
	↑ 17.1%	↓ 43.6%	↓ 35.5%	The 2013 collective TED at Idaho was 71.752 person-rems. **Idaho National Laboratory** In 2013, 3,400 individuals were monitored at the Idaho National Laboratory (INL), and of these, 854 individuals had measurable TED, a 12% increase from 2012. There was a collective TED of 35.711 person-rems in 2013. This represents a decrease of approximately 4% compared with 2012 (37.129 person-rems). The radiation exposure activities performed during 2013 at the INL Site included work at the Advanced Test Reactor (ATR) Complex, including experiment system operations, plant maintenance modifications, routine ATR power operations, and routine ATR outage operations. In addition, activities at the Materials and Fuel Complex included Homeland Security Radiation Dispersion Device training activities and Zero Power Physics Reactor fuel handling. At the Central Facilities Area (CFA) and Idaho Falls Facilities, training exercises continued for the Homeland Security/DTRA and radiation instrument calibrations and health physics instrumentation laboratory work was conducted at CFA-1618. No individual exceeded 2 rems TED in 2013. **Advanced Mixed Waste Treatment Project (AMWTP)** In 2013, there were 678 persons monitored at AMWTP, and of these, 320 individuals had measurable TED, representing a 92% increase from 2012. The collective TED in 2013 was 24.242 person-rems. This represents a 155% increase from 2012 (9.492 person-rems). The general increase in collective TED in 2013 can be attributed to accelerated waste processing operations to meet contractual obligations. In addition to the increased waste processing, the waste processed had a higher average exposure rate than processed waste in 2012. No individual exceeded 2 rems TED in 2013. **Idaho Cleanup Project (ICP)** The DOE contractor at ICP submitted 1,300 records, which included 245 individuals with measurable dose (a 21% decrease from 2012). The collective TED for 2013 was 11.515 person-rems. This represents a 20% decrease from 2012 (14.480 person-rems). ICP activities during 2013 leading to radiation exposure included the Accelerated Retrieval Project exposure activities (668 drums for targeted waste were processed); the Sludge Repackaging Project exposure activities (7,453 drums of waste were generated and 7,358 waste drums were shipped back to the Idaho Treatment Group [ITG]); and Idaho Nuclear Technology and Engineering Center nuclear materials disposal, including the maintenance of fuel handling equipment at the Integrated Fuel Storage Facility. In addition, decontamination and decommissioning (D&D) activities included the completion of sodium treatment of MFC-799 Day Tanks A and B and the sodium storage tank MFC-766 leg sodium contaminated pipe removal. The reason the 2013 dose was so much lower is completion of high dose rate jobs, including the characterization of the WL tanks and vault. No individual exceeded 2 rems TED in 2013. **Department of Energy Idaho Operations Office** The Department of Energy Idaho Operations Office monitored 204 individuals in 2013, and of those, 19 individuals had measurable TED (a 58% increase from the 12 individuals in 2012). The collective TED for 2013 was 0.284 person-rem, which is a 75% increase from 2012 (0.162 person-rem). The largest individual TED for the year was 0.029 rem. Monitored individuals were primarily involved with contractor oversight in areas with minimal potential for occupational radiation exposure. No individual exceeded 2 rems TED (all DOE personnel received less than 0.100 person-rem in 2013).

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

3.4.4 Additional Site Descriptions

The following descriptions were provided by the sites not previously included in *Exhibit 3-15*. 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 U.S. Department of Energy. For more than 60 years, the Ames Laboratory has sought solutions to energy-related problems through the exploration of chemical, engineering, materials, mathematical, and physical sciences.

There were 160 individuals monitored in 2013, and of these, 24 individuals had measurable TED, a 4% decrease from 2012. The collective TED was 0.730 person-rem in 2013, an 11% decrease from 2012. No individuals exceeded 2 rems TED for this monitoring year.

The use of X-ray devices and remediation of radiological legacy contamination were the primary paths of potential exposure in 2013. The laboratory has 18 X-ray systems and one spectroscopy system. Limited radioactive material research activities were conducted utilizing microgram quantities. In the past year, some laser ablation work using radioactive material, irradiated metals activities, and electro transport purification work were conducted.

The decrease in exposure from the value of the previous monitoring year may be due to the intrinsically safe engineering features of newer X-ray systems being introduced into the labs. Many of the new systems do not permit the bypassing of safety interlocks. Also the amount of radiation-related work was less in research areas, as well as facilities renovation work dealing with legacy contamination.

ANL

Argonne National Laboratory (ANL) is one of the U.S. Department of Energy'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 1,938 individuals monitored in 2013, and of these, 74 individuals had measurable TED, a 39% decrease from 2012. The collective TED for the monitoring year 2013 at Argonne National Laboratory was 13.017 person-rems, which represents a decrease of 39% from 2012. Collective TED at ANL has decreased by approximately 56% since 2011.

The significant decrease was achieved through challenging staff to place a concerted effort on evaluating a variety of ALARA approaches in the preplanning stages of work. In addition, some radiological-related work activities decreased from the previous year also resulting in an additional decrease in collective dose.

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 2,354 individuals monitored at BNL in 2013, and of these, 194 individuals had measurable TED, a 13% increase from 2012. The collective TED decreased by 12% from 7.981 person-rems in 2012 to 6.988 person-rems in 2013. The highest individual dose was 0.419 rem. No individual exceeded 2 person rems TED or exceeded any DOE occupational dose limit. The CED in 2013 was zero person-rem.

The decrease in total dose and extremely low bioassay dose was primarily due to minimal remediation activities at the BNL.

ETEC

The Energy Technology Engineering Center (ETEC) is located within area IV of the Santa Susana Field Laboratory (SSFL). The SSFL 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 146 individuals monitored at ETEC in 2013, and of these, 57 individuals had measurable TED, a 4% increase over 2012. The collective TED increased by 111% from 0.227 person-rem in 2012 to 0.479 person-rem in 2013. In 2013, all doses received at the organization were due to monitoring activities and tours of shutdown radiological facilities waiting for decommissioning and disposal.

No individual exceeded 2 rems TED for this monitoring year.

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 2013, Fermilab reported 1,259 monitored individuals, and of these, 175 individuals had measurable TED, a 15% decrease compared with 2012. During 2013, the collective TED was 19.750 person-rems, which is a 24% increase from 2012.

During 2013, 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 May 1, 2012, Fermilab began a major maintenance and development shutdown that lasted through June 2013, to prepare the accelerator and associated facilities for new experiments at much larger beam powers to support research at the Intensity Frontier.

The accelerator shutdown was also necessary to repair many accelerator components following the final years of operation of the Tevatron colliding beam program and the high intensity Neutrinos at the Main Injector (NuMI) beamline. Many of the changes made in this shutdown are also intended to improve operational reliability and hence, reduced maintenance needs in the future. Upgrades were performed in the linear accelerator (Linac), Booster, Recycler, Main Injector, and NuMI 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 2013, KCP reported 65 monitored individuals, and of these, 1 individual had measurable TED compared with 6 people with measurable TED in 2012. The collective TED was 0.001 person-rem, which represents a 95% decrease from 2012. The maximum TED received by an individual was 0.001 rem.

The only attributable fact that might have led to this lower level is reduced work load due to the facility being relocated. No individual 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 U.S. Department of Energy 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 2013 was 721, and of these, 9 individuals had measurable TED, a 10% decrease from 2012. The collective TED was 0.623 rem, a 25% increase from 2012.

The primary reason for this change was the increased number of the experiments performed in the Center for Functional Imaging (CFI). Eighty-one percent of the collective TED is the result of radiological activities at CFI, specifically those activities associated with new radiopharmaceutical (F-18/C-11) 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.

In 2013, 7,590 people were monitored at LLNL,and of these, 98 people had measurable TED, a 25% decrease from 2012. The collective TED for LLNL in 2013 was 8.358 person-rems, a 36% decrease from 2012. This was due to decreased operations in the plutonium facility and at LLNL. There were two people with internal uptakes accounting for 0.024 person-rem total CED.

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 2013, LLNL-Nevada monitored 170 individuals and 5 individuals had measurable TED, a 400% increase from the one individual in 2012. The collective TED for LLNL-Nevada was 0.117 person-rem, representing an increase of 516% from the 2012 value of 0.019 person-rem.

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 interlaboratory measurement evaluation programs.

In 2013, NBL monitored 42 individuals, and of these, 1 individual had measurable TED, a 50% decrease from 2012. The collective TED at NBL for 2013 was 0.012 person-rem. This represents a 69% decrease from 2012 (0.039 person-ream) 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. 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.

In 2013, NNSS monitored 3,100 people, and of these, 89 people had a measurable TED, an 11% decrease compared with 2012. The collective TED for 2013 at NNSS was 3.218 person-rems, which represents a 25% decrease in TED from 2012.

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 2013, NREL monitored 15 people, and of these, 5 people had a measurable TED, a 25% increase from 2012. The collective TED increased by 240% from 2012 (0.020 person-rem) to 2013 (0.068 person-rem).

Although, the monitoring showed a 240% increase in collective dose, overall the average dose at 0.014 rem (14 mrem) is low and the increase is primarily associated with decontamination activities.

No measurements exceeded the 2 rems TED.

PGDP

The Paducah Gaseous Diffusion Plant (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 delease the enrichment facilties.

In 2013, the PGDP monitored 973 individuals, which included 92 individuals with measurable TED, a 19% decrease compared with 2012. The overall collective TED for the PGDP was 6.450 person-rems, an 8% increase from 2012. The following description provides a breakdown of the various activities at this site.

The DOE remediation services contractor's exposure information for 2013 covers activities performed under the DOE contract and includes environmental remediation, facility decontamination, and final assessment of buildings and areas at the Paducah Site.

The collective TED for 2013 was zero person-rem. This represents a 100% decrease from the previous year. The primary reason for this change was decreased facility D&D operations at Paducah. The number of individuals exceeding 2 rems TED for 2013 was zero. There were no unusual events related to occupational radiation exposure at the Los Alamos Technical Associates (LATA) Kentucky facilities for 2013.

The DOE Uranium Hexafluoride (DUF_6) contractor's collective TED for 2013 was 6.161 person-rems. This represents an 11% increase from 2012. The primary reason for this change was increased operations at the Paducah DUF_6 Conversion Facility as the facility focuses on achieving designed flowrates. The number of individuals exceeding 2 rems TED for 2013 was zero. There were no unusual events related to occupational radiation exposure for 2013.

The DOE oversight contractor's collective TED for the 2013 monitoring year was 0.289 person-rem. This represents a 16% decrease from the value for the previous monitoring year. In 2013, the number of individuals with measurable TED decreased by 32% compared with 2012. The primary reason for this change was due to the number of monitored employees decreasing by 43% from the previous monitoring period. There was no change in the exposure levels for individuals performing normal work operations.

The number of individuals exceeding 2 rems TED for this monitoring year is 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 2013, Pantex monitored 3,107 individuals, and of these, 330 individuals had measurable TED, a 3% decrease from 2012. The TED to Pantex Plant workers in 2013 was 21.829 person-rems, which represents a 34% decrease from the total person-rem dose in 2012. No individual's dose exceeded their assigned administrative control level in 2013, with a maximum individual dose of 0.703 rem.

The primary reasons for the decreased population dose in 2013 were a turnover to a new work control software system and several facility safety upgrades. Consequently, the workload was lower in 2013.

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 D&D. In 2013, Portsmouth monitored 2,662 individuals, which included 102 people with measurable TED, a 24% decrease from 2012. The collective TED in 2013 at PORTS was 8.634 person-rems, a 22% increase compared with 2012. The following description provides a breakdown of the various activities at this site.

The DOE D&D contractor's exposure information for 2013 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 2013 was 2.994 person-rem.

The DOE Uranium Hexafluoride (DUF_6) contractor's collective TED for 2013 was 5.640 person-rems. The primary reason for this change was increased operations at the Paducah DUF_6 Conversion Facility as the facility focuses on achieving designed flowrates.

The number of individuals exceeding 2 rems TED for 2013 was zero.

PPPL

The U.S. Department of Energy'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 2013, data were submitted for 360 individuals, and of these, 58 individuals had measurable TED, a 35% increase compared with 2012 (43 individuals with measurable TED).

The primary reason for this increase was a dosimetry requirement change that increased the issuance of dosimeters, resulting in an increase in the number of measurable dosimetry results.

SLAC

SLAC National Accelerator Laboratory 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 (LINAC), 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 2013 report contained 2,327 records, which included 10 people with measurable TED, a 33% decrease compared with 2012. Collective TED in 2013 was 0.281 person-rem, an 11% decrease compared with 2012. No individual exceeded 2 person-rems TED or any DOE occupational dose limit during 2013 at SLAC.

This decrease was mainly associated with the operations of the newly constructed Facilities for the Accelerator Science and Experimental Test facility.

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 2013, SNL monitored 2,294 individuals, and of these, 123 individuals had measurable TED, a 1% increase from 2012. The 2013 collective TED for SNL was 4.335 person-rems, a less than 1% increase from 2012.

The slight increase is attributable to the SNL radiological operations of a research reactor, gamma irradiation facility, hot cell facility, and several pulsed-power accelerators; light laboratory work involving X-ray machines and use of tracer radionuclides; and waste operations.

SPRU

The Separations Process Research Unit (SPRU) is located at Knolls Atomic Power Laboratory (KAPL) 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 2013, SPRU monitored 248 individuals, and of these, 48 had measurable TED, a 109% increase compared with 2012. The collective TED for 2013 was 2.896 person-rem, a 396% increase from 2012.

The primary reason for this change was due to significant activity in the total Sludge Processing Operations. In addition, work was performed in the H2/G2 tunnel to remove process piping and install an isolation wall separating the H2 and G2 enclosures ventilation path.

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 2013, TJNAF monitored 1,378 individuals, which included 48 individuals with measurable TED, a 44% decrease from 2012. The 2013 collective TED for TJNAF was 1.503 person-rems, a decrease of 23% from 2012.

In general, 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 one trainload 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 2013, UMTRA monitored 113 individuals, which included 55 individuals with measurable TED, a 37% decrease from 2012. The collective TED for 2013 was 7.407 person-rems and represents a 3% decrease from 2012.

WIPP

The Waste Isolation Pilot Plant (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 2013, WIPP monitored 712 individuals, and of these, 32 individuals had measurable TED, a 78% increase compared with 2012. The collective TED for 2013 was 0.552 person-rem, which represents an 85% increase from 2012 (0.298 person-rem).

The primary reason for this change was due to increased shipment rates at WIPP. All doses received were from routine activities associated with the disposal of transuranic waste.

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 West Valley Demonstration Project 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 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 2013, WVDP monitored 320 individuals, and of these, 101 individuals had measurable TED, a 17% increase from 2012. The collective TED for 2013 was 12.901 person-rems, which represents a 39% increase from 2012.

The major contribution to dose in 2013 was waste operations activities, including waste processing, packaging, and shipping for disposal of radioactive waste previously produced during D&D projects.

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 3-16* 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 (43% and 36%, 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% of the collective TED at DOE.

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

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 3-17* shows the dose distribution and total number of transient individuals from 2009 to 2013. Over the past 5 years, the records of transient individuals have averaged 3% of the total records for all monitored individuals at DOE. These individuals received, on an average, 4% of the collective TED. The collective TED for transients decreased 26% from 28.4 person-rems (284 person-mSv) in 2012 to 21.1 person-rems (211 person-mSv) in 2013. The decrease of the transients' collective TED is greater than the overall decrease observed across the DOE complex from 2012 to 2013. The average measurable TED decreased 12% from 0.058 rem (0.58 mSv) in 2012 to 0.051 rem (0.51 mSv) in 2013. The decrease of the average measurable TED is a result of the 16% decrease in the number of transient individuals with measurable dose (492 in 2012 to 414 in 2013) and the 26% decrease of the collective TED and is greater than the decrease observed in the average measurable TED across the DOE complex. 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 EHSS 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 have been relatively low, the examination of these records remains an important function of EHSS in assessing performance of DOE worker health and safety programs.

Exhibit 3-16:
Program Office Dose Data, 2013.

Program Office	Collective TED (person-rem)	Percent Change from 2012	Number with Meas. Dose	Percent Change from 2012	Avg. Meas. TED (rem)	Percent Change from 2012
Office of Energy Efficiency and Renewable Energy (EE)					**Total Monitored =**	**15**
National Renewable Energy Laboratory	0.068	◊	5	◊	0.014	◊
EE Totals*	**0.068**	◊	**5**	◊	**0.014**	◊
Office of Environmental Management (EM)					**Total Monitored =**	**20,867**
East Tennessee Technology Park	0.040	◊	4	◊	0.010	◊
Energy Technology Engineering Center	0.479	◊	57	◊	0.008	◊
Hanford Site	50.081	-14% ▼	715	-23% ▼	0.070	11% ▲
Idaho Site (ICP and AMWTP)	39.779	32% ▲	679	2% ▲	0.059	29% ▲
Oak Ridge National Laboratory	35.985	-22% ▼	265	-15% ▼	**0.136**	-9% ▼
Office of River Protection	18.228	-15% ▼	448	8% ▲	0.041	-22% ▼
Paducah Gaseous Diffusion Plant	6.450	8% ▲	92	-19% ▼	0.070	32% ▲
Portsmouth Gaseous Diffusion Plant	8.634	22% ▲	102	-24% ▼	0.085	61% ▲
Savannah River Site	**88.536**	-39% ▼	**1,471**	-28% ▼	0.060	-15% ▼
Separations Process Research Unit	2.896	**396%** ▲	48	**109%** ▲	0.060	**138%** ▲
Service Center Personnel	0.035	◊	3	◊	0.012	◊
Uranium Mill Tailings Remedial Action Project	7.407	-3% ▼	55	-37% ▼	0.135	53% ▲
Waste Isolation Pilot Plant	0.552	◊	32	◊	0.017	◊
West Valley Demonstration Project	12.901	39% ▲	101	17% ▲	0.128	18% ▲
EM Totals*	**272.003**	**-19%** ▼	**4,072**	**-17%** ▼	**0.067**	**-2%** ▼
National Nuclear Security Administration (NNSA)					**Total Monitored =**	**30,354**
Kansas City Plant	0.001	◊	1	◊	0.001	◊
Lawrence Livermore National Laboratory	8.475	-35% ▼	103	-21% ▼	**0.082**	-17% ▼
Los Alamos National Laboratory	**138.734**	-1% ▼	**1,703**	**18%** ▲	0.081	-16% ▼
Nevada National Security Site	3.218	-25% ▼	89	-11% ▼	0.036	-15% ▼
Pantex Plant	21.829	-34% ▼	330	-3% ▼	0.066	-32% ▼
Sandia National Laboratories	4.335	**0%**	123	1% ▲	0.035	**0%**
Y-12 National Security Complex	49.727	-15% ▼	1,337	-5% ▼	0.037	-10% ▼
NNSA Totals*	**226.319**	**-11%** ▼	**3,686**	**4%** ▲	**0.061**	**-14%** ▼
Office of Nuclear Energy (NE)					**Total Monitored =**	**3,198**
Idaho National Laboratory	31.973	3% ▲	759	28% ▲	0.042	-20% ▼
NE Totals*	**31.973**	**3%** ▲	**759**	**28%** ▲	**0.042**	**-20%** ▼
Office of Science (SC)					**Total Monitored =**	**15,546**
Ames Laboratory	0.730	◊	24	◊	0.030	◊
Argonne National Laboratory	13.017	-39% ▼	74	-39% ▼	**0.176**	1% ▲
Brookhaven National Laboratory	6.988	-12% ▼	194	13% ▲	0.036	-23% ▼
Fermi National Accelerator Laboratory	19.750	**24%** ▲	175	-15% ▼	0.113	**46%** ▲
Lawrence Berkeley National Laboratory	0.623	◊	9	◊	0.069	◊
New Brunswick Laboratory	0.012	◊	1	◊	0.012	◊
Oak Ridge Institute for Science and Education	0.083	◊	6	◊	0.014	◊
Oak Ridge National Laboratory	**38.546**	18% ▲	377	-17% ▼	0.102	42% ▲
Pacific Northwest National Laboratory	14.550	-18% ▼	**403**	**68%** ▲	0.036	-51% ▼
Princeton Plasma Physics Laboratory	0.339	◊	58	◊	0.006	◊
SLAC National Accelerator Laboratory	0.281	◊	10	◊	0.028	◊
Thomas Jefferson National Accelerator Facility	1.503	-23% ▼	48	-44% ▼	0.031	36% ▲
SC Totals*	**96.422**	**-3%** ▼	**1,379**	**-1%** ▼	**0.070**	**-2%** ▼

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.

Exhibit 3-17:
Dose Distribution of Transient Workers, 2009–2013.

	Dose Ranges (TED in rem)	2009	2010	2011	2012	2013
Transients	Less than measurable	2,058	2,305	2,110	1,884	1,500
	measurable <0.100	523	489	497	418	373
	0.100–0.250	51	73	54	52	26
	0.250–0.500	20	23	11	19	14
	0.500–0.750		5	1	2	1
	0.750–1.000	3	2	3	1	
	1–2			2		
	Total number of individuals monitored*	2,655	2,897	2,678	2,376	1,914
	Number with measurable dose	597	592	568	492	414
	% with measurable dose	22%	20%	21%	21%	22%
	Collective TED (person-rem)	31.016	37.661	31.693	28.445	21.076
	Average measurable TED (rem)	0.052	0.064	0.056	0.058	0.051
All DOE	Total number of records for monitored individuals	86,768	92,104	91,857	83,043	71,661
	Number with measurable dose	11,761	13,047	12,965	10,461	9,901
	% of total monitored who are transient	3.1%	3.1%	2.9%	2.9%	2.7%
	% of the number with measurable dose who are transient	5.1%	4.5%	4.4%	4.7%	4.2%

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

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 3-18* and *Exhibit 3-19* 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 3-18* and *Exhibit 3-19* show the collective dose, average measurable dose, and number of workers with a measurable dose from 1974 to 2013. 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 2013.

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.

Exhibit 3-18:
Collective Dose and Average Measurable Dose, 1974–2013.

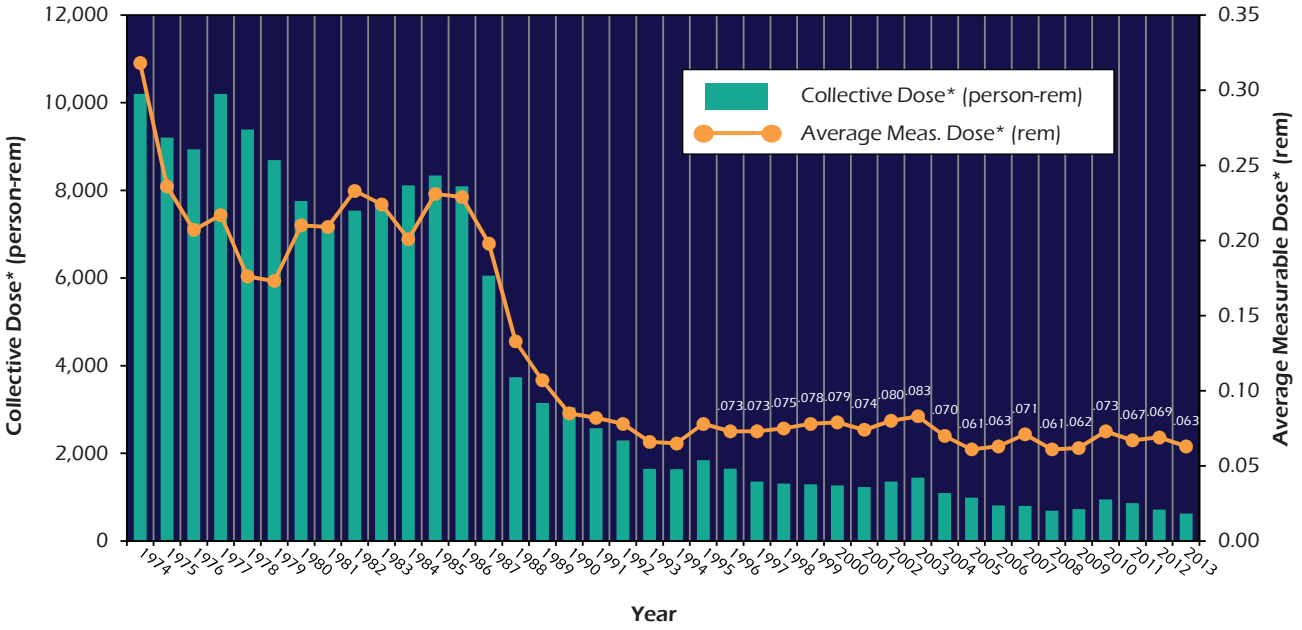
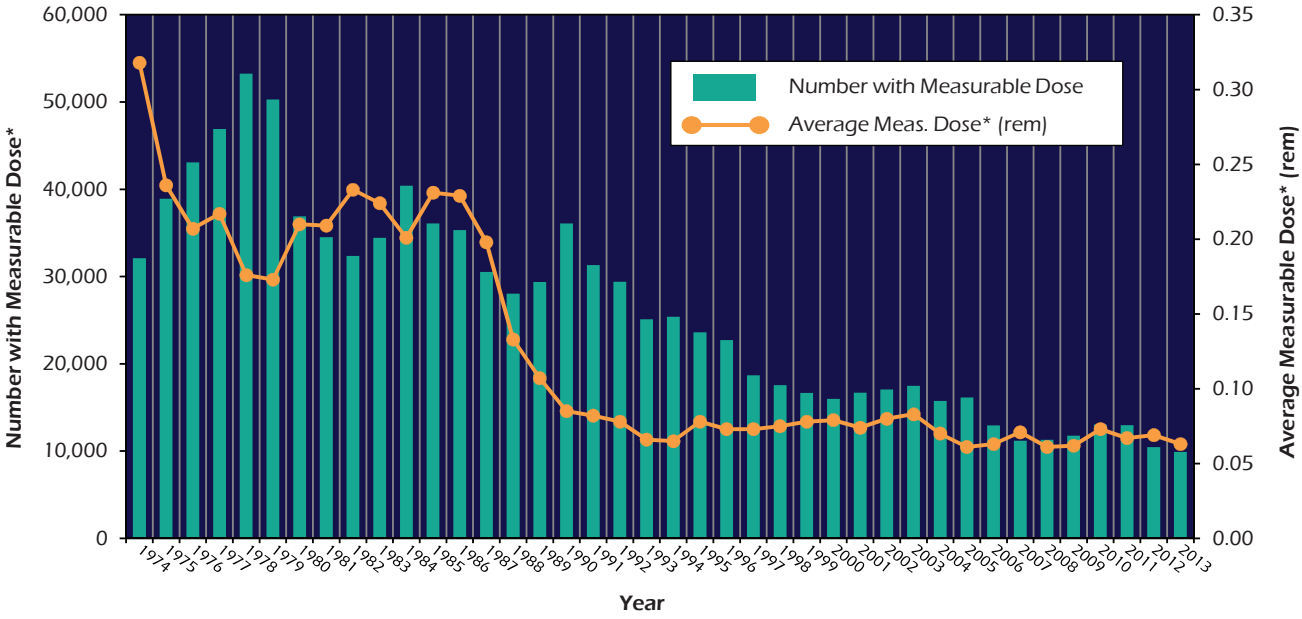


Exhibit 3-19:
Number of Workers with Measurable Dose and Average Measurable Dose, 1974–2013.



* 1974–1989 collective dose = DDE
1990–1992 collective dose = DDE + AEDE
1993–2009 collective dose = DDE + CEDE
2010–2013 collective dose = ED + CED

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

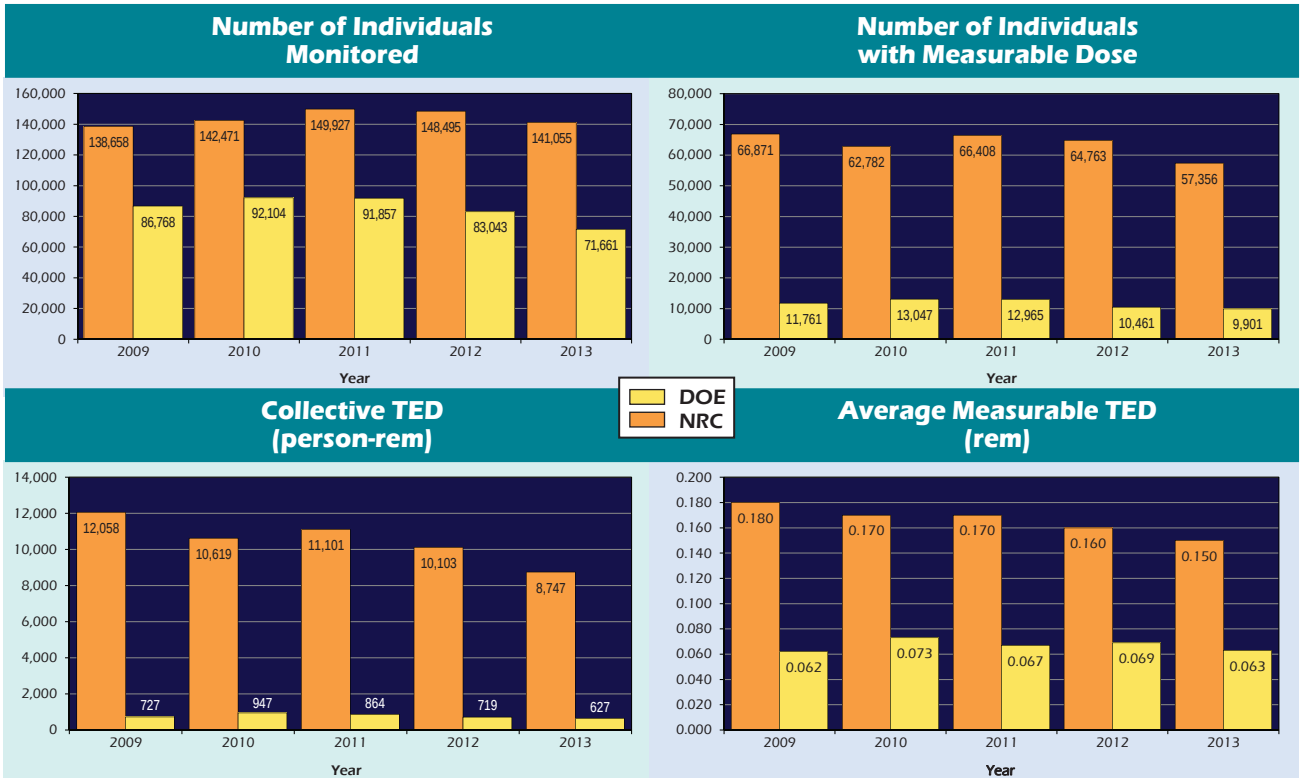
3.7 DOE Occupational Dose in Relation to Other Activities

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 2013 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 77% 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 3-20* cover the past 5 years (2009 to 2013). 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 17% of the NRC total for this time period. The percentages of DOE's collective dose (TED) and average measurable dose (TED) were 7% and 42% of the NRC totals, respectively.

Exhibit 3-20:
Comparison of Occupational Exposure for DOE and NRC, 2009 –2013.



Section Four
ALARA Activities at DOE

4

Descriptions of ALARA activities at DOE are provided on the EHSS 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 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 has been enhanced from 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 EHSS 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

This page intentionally left blank.

Section Five
Conclusions

5

Conclusions

The occupational radiation exposure records show that in 2013, DOE facilities continued to comply with DOE dose limits and ACL and worked to minimize exposure to individuals. Only 14% of the monitored workers received a measurable dose, and the average measurable dose received was less than 2% of the DOE limit. In 2013, the collective dose and the number of individuals with measurable dose decreased 12.8% and 5%, 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 92 person-rems from 2012 to 2013. This year marks the third time during the 5-year period that collective dose in the DOE complex decreased. Much of this can be attributed to budgetary constraints leading to a decline in production activities across the complex, continuing D&D progress with source term reduction, and the absence of any events that exceeded the 2 rems occupational exposure limit.

The collective dose at DOE facilities has experienced a dramatic (92%) 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:
2013 Radiation Exposure Summary.

- The collective TED decreased 12.8% from 719 person-rems (7,190 person-mSv) in 2012 to 627 person-rems (6,270 person-mSv) in 2013.
- Sites contributing significantly to collective TED were (in descending order of collective TED) Los Alamos, Oak Ridge, Savannah River, Hanford, and Idaho. These sites accounted for 81% of the collective TED at DOE in 2013.
- The collective TED decreased at four of the five sites with the largest collective TED. For these four sites, the decrease in collective TED in 2013 was attributed to a mid-year pause at LANL's TA-55 due to concerns with the criticality safety program; an overall decrease in radworker population throughout the Y-12 complex; and an approximate 2-month decrease in production work in preparation for the government shutdown during the sequestration in October 2013. At SRS, budget issues arose during the year and many projects were put on hold. In addition, Hanford experienced reductions in work due to budgetary constraints. Work at several Richland (RL) projects, including Transuranic (TRU) Retrieval,were reduced to a minimum safety status, and backshift work at the Plutonium Finishing Plant (PFP) was curtailed. The largest contributors to the Hanford (RL and ORP) dose activities were glove box removal at PFP, Tank Farm activities, decontamination and demolition of facilities on the river corridor and central plateau, and waste treatment, storage, and handling.
- The collective internal dose (CED) decreased by 13% between 2012 (50.253 person-rems) and 2013 (43.966 person-rems).
- Uranium-234 accounted for the largest percentage of the collective CED, with over 94% of this dose accrued at Y-12.
- The collective TED for transient workers decreased by 26% from 28.4 person-rems (284 person-mSv) in 2012 to 21.1 person-rems (211 person-mSv) in 2013.

This page intentionally left blank.

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.

American Recovery and Reinvestment Act (ARRA)
The ARRA of 2009 is an economic stimulus package signed into law on February 27, 2009.

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 total effective dose (TED) and committed effective dose (CED).

collective dose
The sum of the total annual effective dose equivalent or total effective dose values for all individuals in a specified population. 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 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 clean up of, the reactors and 100 – 400 areas at the reservation. Does not include ORP and PNNL.
>
> **Office of River Protection**
> Tank farm and liquid waste cleanup to protect the Columbia River.
>
> **Pacific Northwest National Laboratory**
> 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").

members of the public
Any individual not occupationally exposed to radiation or radioactive material, who either is not a DOE general employee or is an off duty DOE general employee. The definition of general employee is specified in 10 C.F.R. 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.

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 (AEDE) 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.

This page intentionally left blank.

References

References

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

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

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

4. ICRP (International Commission on Radiological Protection), 1991. "1990 Recommendations of the International Commission on Radiological Protection," ICRP Publication 60, *Annals of the ICRP, Vol. 21, Nos. 1-3* (Pergamon Press, New York).

5. ICRP (International Commission on Radiological Protection), 1994. "Dose Coefficients for Intakes of Radionuclides by Workers," ICRP Publication 68, *Annals of the ICRP, Vol. 24, No. 4* (Pergamon Press, New York).

6. 10 C.F.R. 835, 1998, "Occupational Radiation Protection." Rule; DOE *Federal Register,* November 4, 1998. Amended April 13, 2011.

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

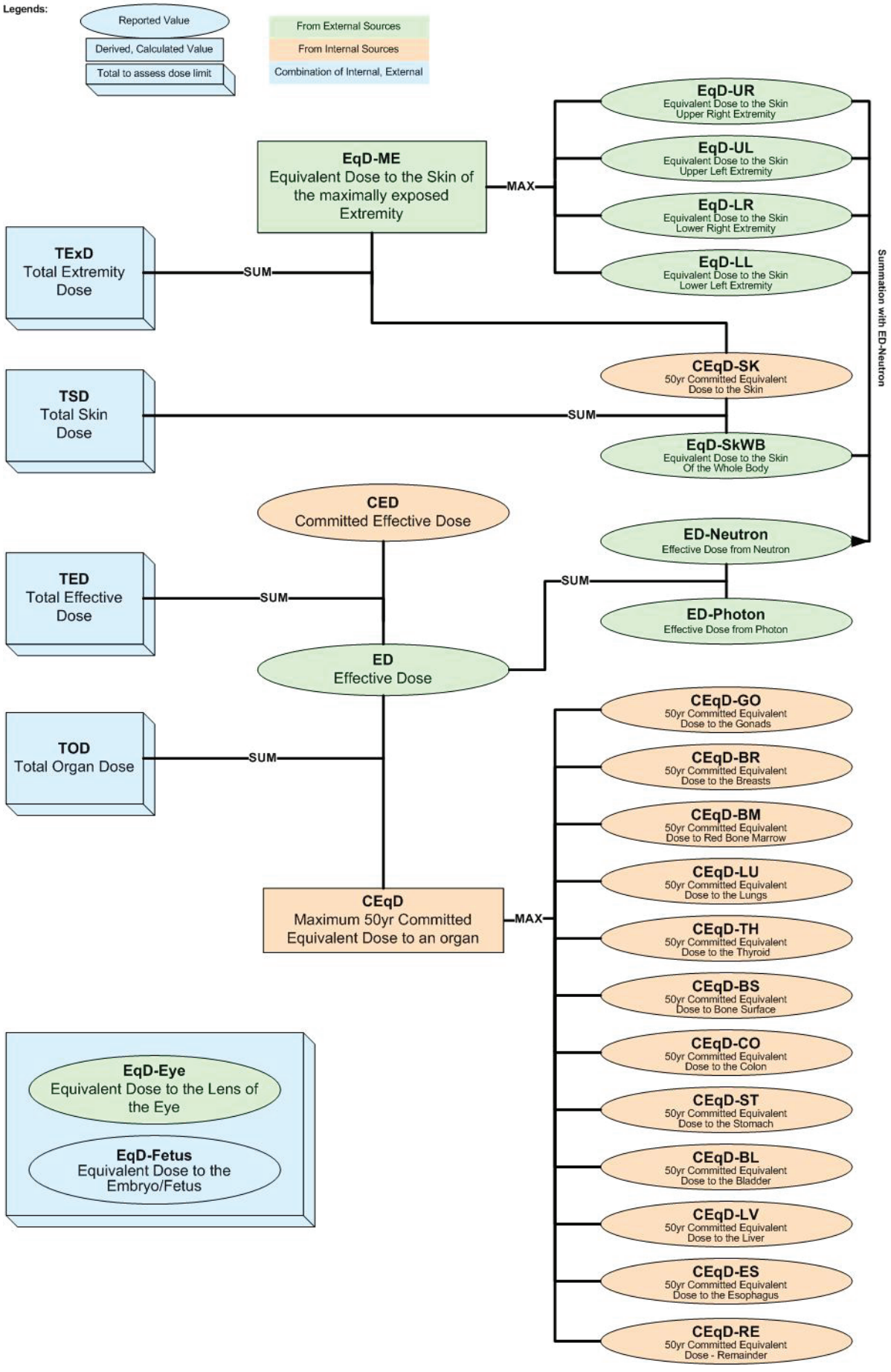
8. REMS Reporting Guide, issued February 23, 2012. Online at http://energy.gov/ehss/downloads/radiation-exposure-monitoring-systems-data-reporting-guide.

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

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 2013 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:

Ms. Nirmala Rao, Office of Analysis (AU-23)
DOE REMS Project Manager
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, D.C. 20585-1290
nimi.rao@hq.doe.gov
Fax: (301) 903-1257

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

1. Identification:

   Name: .....

   Title: .....

   Mailing Address: .....

   .....

   .....

   .....

2. Distribution:

   2.1 Do you wish to remain on the distribution for the report? _____ yes _____ no

   2.2 Do you wish to be added to the distribution? _____ yes _____ no

(continued on back)

Please circle one.

	Not Useful				Very Useful
Please rate the usefulness of this report overall:	1	2	3	4	5
Please rate the usefulness of the analysis presented in the following sections:					
Executive Summary	1	2	3	4	5
Analysis of Aggregate Data	1	2	3	4	5
Collective Dose	1	2	3	4	5
Average Measurable Dose	1	2	3	4	5
Dose Distribution	1	2	3	4	5
Analysis of Individual Dose Data	1	2	3	4	5
Doses in Excess of DOE limit (5 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:

Not important				Critical
1	2	3	4	5

Please provide any additional input or comments on the report.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

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