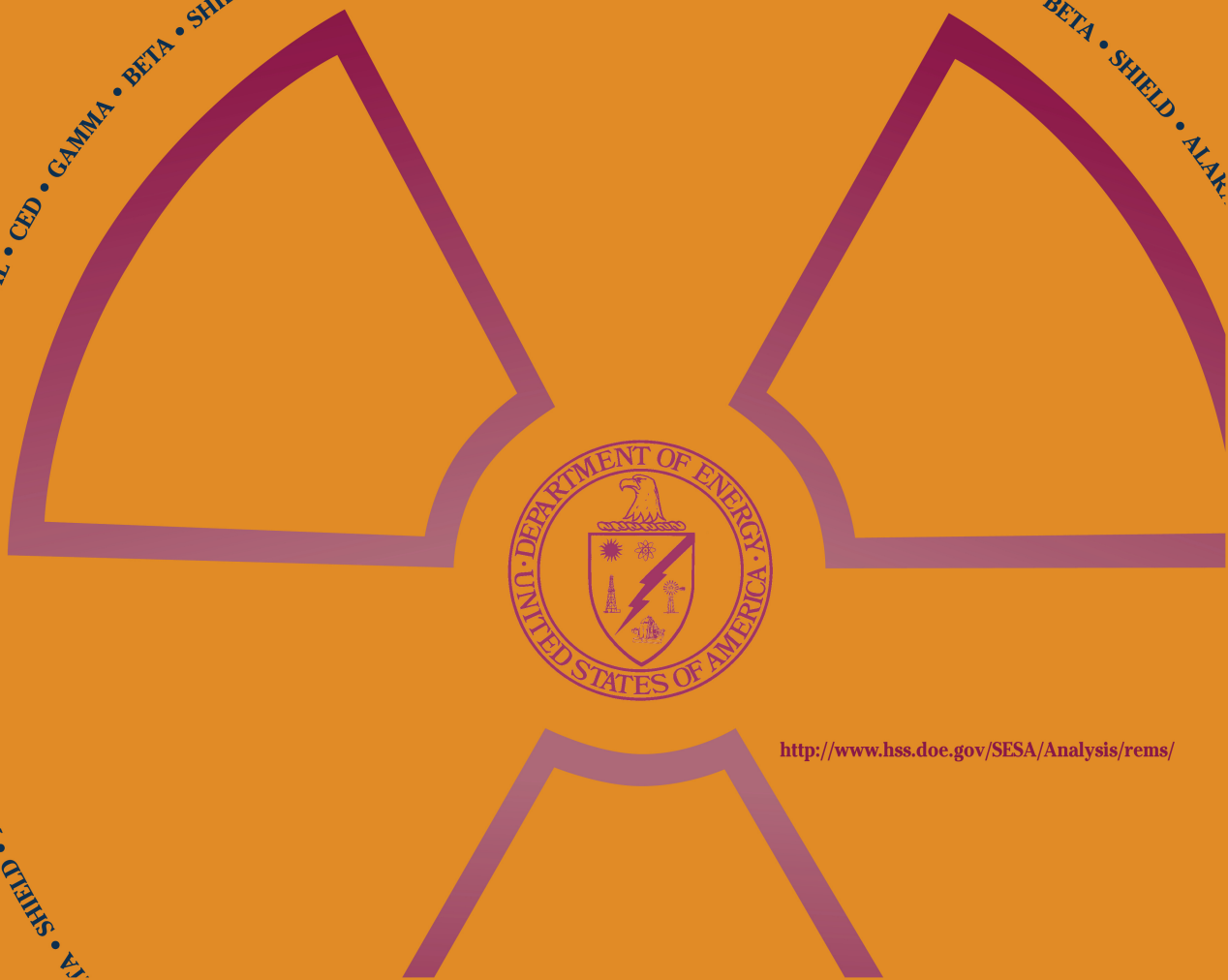
HSS
Office of Health, Safety and Security

DOE 2011 Occupational Radiation Exposure

December 2012



http://www.hss.doe.gov/SESA/Analysis/rems/

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REMS Program Web Site at:
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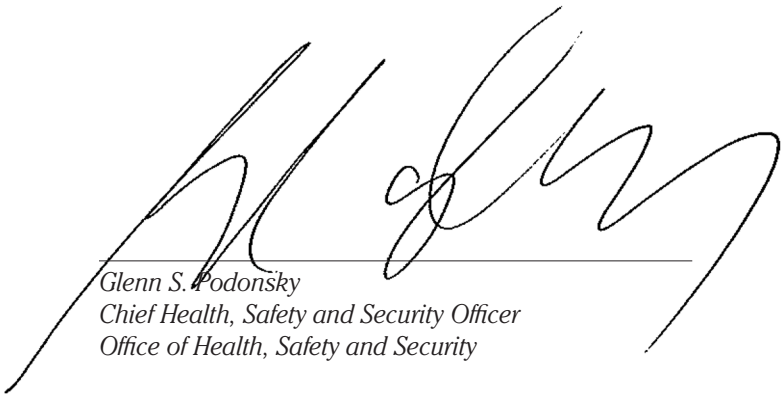
Foreword

Foreword

A core value of the U.S. Department of Energy (DOE) is to ensure the health and safety of DOE employees, contractors, and subcontractors. The Office of Health, Safety and Security (HSS) provides the corporate-level leadership and strategic vision necessary to establish clear expectations for, and provide oversight and enforcement regarding health, safety, environment, and security programs. In support of this mission, the HSS Office of Analysis provides for the collection, analysis, and dissemination of data and performance indicators, such as occupational radiation exposure information.

A key safety focus for DOE is to maintain worker radiation exposures below administrative control levels (ACL) and DOE radiation dose limits and to further reduce these exposures to levels that are "as low as reasonably achievable (ALARA)." The annual *DOE 2011 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 individuals from harmful effects of radiation.

The Radiation Exposure Monitoring System (REMS) program remains a key component of HSS oversight 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.



Glenn S. Podonsky
Chief Health, Safety and Security Officer
Office of Health, Safety and Security

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LIST OF EXHIBITS

LIST OF ACRONYMS

ACL	Administrative Control Level
ALARA	As Low As Reasonably Achievable
AMWTP	Advanced Mixed Waste Treatment Project
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
ED	Effective Dose
EqD	Equivalent Dose
DOE	U.S. Department of Energy
EM	Office of Environmental Management
ETTP	East Tennessee Technology Park
FACET	Facilities for Accelerator Science and Experimental Test
Fermilab	Fermi National Accelerator Laboratory
HSS	Office of Health, Safety and Security
ICP	Idaho Cleanup Project
ICRP	International Commission on Radiological Protection
INL	Idaho National Laboratory
LANL	Los Alamos National Laboratory
LATA	Los Alamos Technical Associates
LLNL	Lawrence Livermore National Laboratory
LLNS	Lawrence Livermore National Security, LLC
mSv	Millisievert
NBL	New Brunswick Laboratory
NNSA	National Nuclear Security Administration
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
PNNL	Pacific Northwest National Laboratory
Pu	Plutonium
RCS	Radiological Control Standard
REMS	Radiation Exposure Monitoring System
SC	Office of Science
SLAC	SLAC National Accelerator Laboratory
SNL	Sandia National Laboratories
SRNS	Savannah River Nuclear Solutions
SRR	Savannah River Remediation
SRS	Savannah River Site
SST	Swift & Staley
Sv	Sieverts
TED	Total Effective Dose
TJNAF	Thomas Jefferson National Accelerator Facility
TRU	Transuranic
UMTRA	Uranium Mill Tailings Remediation Action Project
WIPP	Waste Isolation Pilot Plant
Y-12	Y-12 National Security Complex
ZPPR	Zero Power Physics Reactor or Zero Power Plutonium Reactor

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Summary
Executive Summary

The U.S. Department of Energy (DOE) Office of Analysis within the Office of Health, Safety and Security (HSS) 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 2011 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. The occupational radiation exposure information is analyzed in terms of aggregate data, dose to individuals, and dose by site over the past five years.

It should be noted that was revised as of June 2007, with full implementation required by July 2010. All sites have now transitioned, and therefore this report reflects the changes in dose terminology and dose assessment methodology required by the revision to 10 C.F.R. 835.

As an indicator of the overall amount of radiation dose received during the conduct of operations at DOE, the report includes information on collective total effective dose (TED). 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 collective ED from photon exposure decreased by 4% between 2010 and 2011, while the neutron dose and internal dose components of the collective TED decreased by 6% and 47%, respectively. Over the past 10-year period, 99.99% of the individuals receiving measurable TED have received doses below the 2 rems (20 millisievert [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 2011, DOE facilities continued to comply with DOE dose limits and ACLs and worked to minimize exposure to individuals. The DOE collective TED decreased by 9% from 2010 to 2011, as shown in *Exhibit ES-1*. 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 2011 was attributed to the implementation of handheld X-ray devices to accurately identify prohibited waste items at the Savannah River Site (SRS); improvements in the planning of drum movements and better configuration in waste storage areas; increased worker awareness of the location of elevated exposure rate areas by utilizing electronic dosimeters; and programs that encouraged the workers to track their own dose at Idaho.

Exhibit ES-1:
Collective TED (person-rem), 2007–2011.

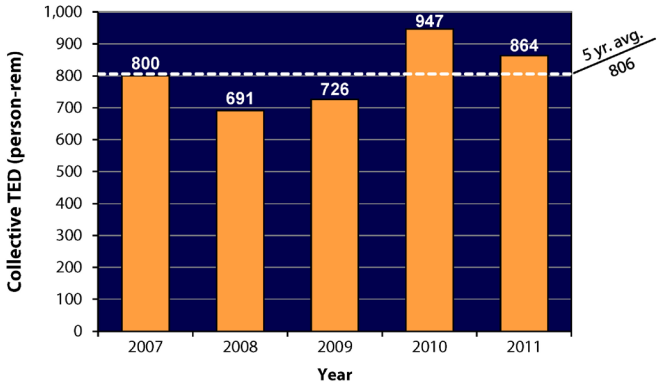
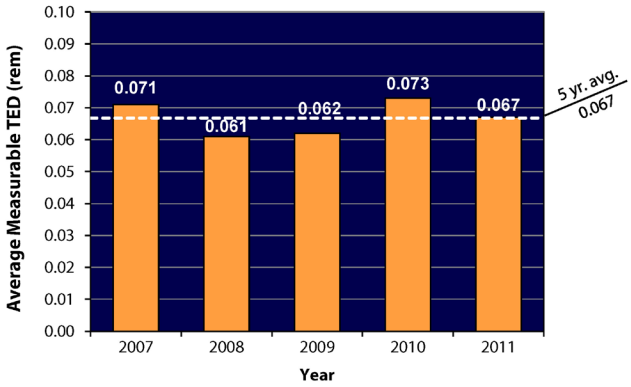


Exhibit ES-2:
Average Measurable TED (rem), 2007–2011.



Some sites experienced a decrease in the number of workers with measurable dose due to a reduction in work attributes associated with the American Recovery and Reinvestment Act (ARRA); those sites include Hanford Site, Oak Ridge National Laboratory (ORNL), and SRS. Overall, from 2010 to 2011, there was less than a 1% decrease in the number of workers with measurable dose. However, due to a slight decrease (less than 1%) in both the DOE workforce and monitored workers, the ratio of workers with measurable doses to monitored workers remained the same at 14%.

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 8% from 2010 to 2011, as shown in *Exhibit ES-2*. The number of individuals who received a measurable TED also decreased by nearly 1%.

Additional analyses show that the dose distribution in 2011 is similar to the distribution in 2010.

In 2011, only 14% of the monitored workers received a measurable TED and the average measurable TED, 0.067 rem, was less than 2% of the DOE limit. From 2010 to 2011, the collective TED and the number of individuals with measurable TED decreased by 9% and 1%, respectively. These decreases in the dose and number of individuals were the result of decreased activities involving radioactive materials, particularly at the DOE sites that comprise the majority of DOE collective dose.

Over the past 7 years, the collective dose and the size of the monitored workforce have remained at fairly stable levels. After 3 years of increases in the collective dose and the number of individuals with measurable dose, there was a decrease in both in 2011. This is attributable to the decrease in activities of decommissioning and waste processing at several of the larger DOE sites. While ARRA projects initially contributed to an increase in collective dose throughout the DOE complex, the completion of many of these projects is partially responsible for the decrease of collective dose and measurable records in 2011. No reported doses exceeded the DOE occupational limit of 5 rems TED in 2011 and no reported 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 HSS web site at:

http://www.hss.doe.gov/SESA/Analysis/rems/

Section One Introduction

The *DOE 2011 Occupational Radiation Exposure Report* analyzes occupational radiation exposures at U.S. Department of Energy (DOE) facilities during 2011. This report includes occupational radiation exposure information for all DOE employees, contractors, and subcontractors, as well as members of the public in controlled areas who are monitored for exposure to radiation. The 107 DOE organizations submitting radiation exposure reports for 2011 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://www.hss.doe.gov/SESA/Analysis/rems). 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://www.hss.doe.gov/SESA/Analysis/rems/

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

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

- Annual occupational radiation exposure reports in PDF files 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 2011 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 now offered in color on the DOE Radiation Exposure web site. Please visit **http://www.hss.doe.gov/SESA/Analysis/rems/** and select Annual Reports to review. The appendices provide a comprehensive breakdown of dose by operations office and site, as well as distributions by facility type and occupation, type of dose, and internal dose by radionuclide.

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Section Two
Standards and Requirements

2

Standards and Requirements

One of DOE's primary objectives is to provide a safe and healthy workplace for all employees and contractors. To meet this objective, the DOE Office of Health, Safety and Security (HSS) 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 which 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 at ALARA levels.

This section discusses the radiation protection standards and requirements in effect for 2011. For more information on past requirements, visit the DOE web site for DOE Directives, Delegations, and Requirements at https://www.directives.doe.gov/. See Archives section under the Directives menu for historical references.

2.1 Radiation Protection Requirements

DOE radiation protection standards in effect at the beginning of 2011 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 *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, Amendment to 10 C.F.R. 835). 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 [7]. DOE Manual (M) 231.1-1A, *Environment, Safety, and Health Reporting Manual*, has been cancelled and the reporting requirements from the manual have been moved to the online REMS Reporting Guide at http://www.hss.doe.gov/sesa/Analysis/rems/REMS_Reporting_Guide.pdf. [8]

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	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	TED	5 rems
		The sum of the effective dose to the whole body for external exposures and the committed equivalent dose to the maximally exposed organ or tissue other than the skin or the lens of the eye (Total Organ Dose)	ED+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 effective dose	TED	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.

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 final 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 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, the monitoring year 2011 is the first year where all sites are required to report under the Amendment to 10 C.F.R. 835. Therefore all terminology used in this annual report reflects that of the Amendment.

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), as specified in DOE STD 1098-2008 Radiological Control.

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 work force 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. Individuals that have more than one record due to being monitored at more than one site comprise only 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.

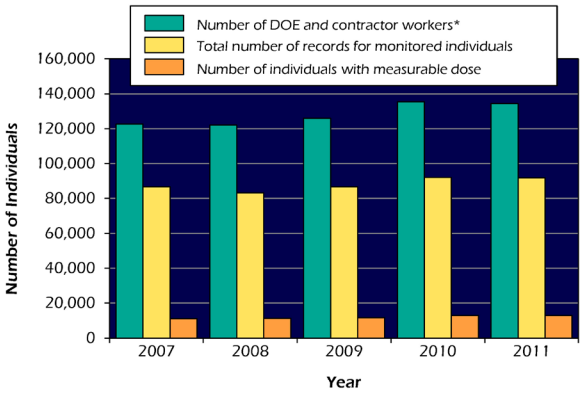
3.2.2 Number of Records for Individuals with Measurable Dose

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 any individual with a reported detectable dose greater than zero total effective dose (TED).

Over the past 10-year period, 99.99% of the individuals receiving measurable TED have received doses below the 2 rems (20 mSv) TED ACL, which is well below the DOE regulatory limit of 5 rems (50 mSv) TED.

Exhibits 3-1a and *3-1b* show the number of DOE and contractor workers, the total number of workers

Exhibit 3-1a:
Monitoring of the DOE Workforce, 2007–2011.



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

For 2011, 68% 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, 2007–2011.

Year	DOE & Contractor Workforce	Number of Workers Monitored	Percent of Workers Monitored*	Number Monitored w/Measurable Dose	Percent Monitored w/Measurable Dose*
2007	122,666	86,667	71%▼	11,198	13%▼
2008	122,082	83,235	68%▼	11,296	14%▲
2009	125,933	86,694	69%▲	11,757	14%
2010	135,414	92,066	68%▼	13,039	14%
2011	134,370	91,839	68%	12,957	14%
5-Year Average	**128,093**	**88,100**	**69%**	**12,049**	**14%**

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

monitored for radiation dose, the number of individuals with a measurable dose, and the relative percentages for the past 5 years.

Over the past 5 years, the percentage of individuals monitored for radiation exposure has remained within 3% of the 5-year average; the percentage of monitored individuals receiving any measurable radiation dose each year has been within 1% of the 5-year average.

Twenty-four of the reporting sites experienced decreases in the number of workers with a measurable TED from 2010 to 2011. The largest decrease in total number of workers with a measurable TED occurred at the Hanford Site. Eight of the reporting sites experienced increases in the number of workers with a measurable TED from 2010 to 2011. The largest increase in the number of workers receiving a measurable TED occurred at the Idaho National Laboratory (INL). A discussion of activities at the highest dose facilities is included in Section 3.4.3.

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 (person-sievert [Sv]). 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 who are monitored during a visit to a DOE facility. DOE monitors the collective dose as one measure of the overall performance of radiation protection programs to keep individual exposures and collective exposures ALARA.

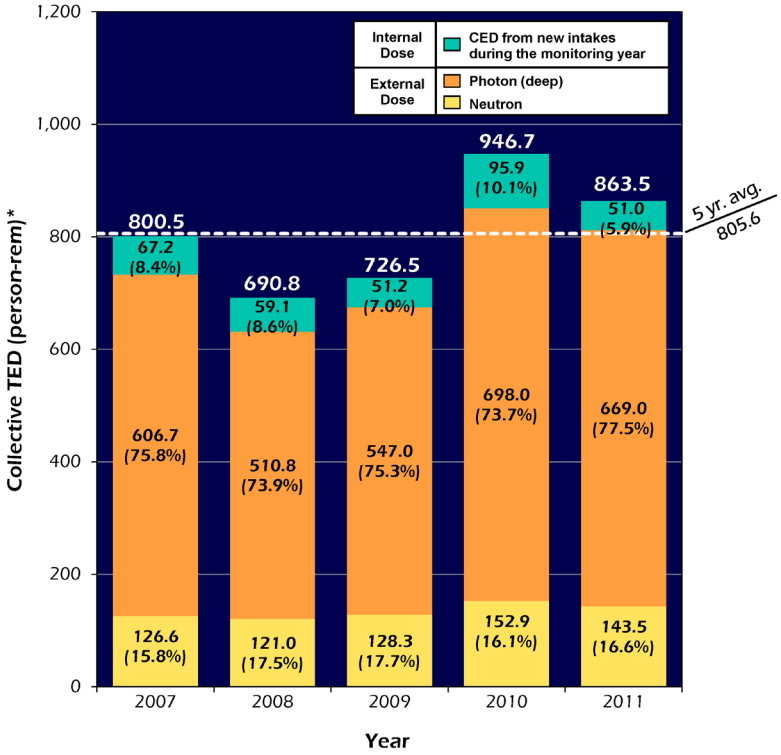
As shown in *Exhibit 3-2*, the collective TED decreased at DOE by 9% from 946.7 person-rems (9,467 person-mSv) in 2010 to 863.5 person-rems (8,635 person-mSv) in 2011.

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. The internal dose component of the collective TED decreased by 47% from 95.9 person-rems (959 person mSv) in 2010 to 51.0 person-rems (510 person-mSv) in 2011. The primary reason for the decrease in the collective CED is that there were no reported intakes in 2011 of the magnitude of the 32 rem CED at the Savannah River Site (SRS) in 2010. The collective photon dose decreased by 4% from 698 person-rems (6,980 person-mSv) in 2010 to 669 person-rems (6,690 person-mSv) in 2011.

The neutron component of the TED decreased by 6% from 153 person-rems (1,530 person-mSv) in 2010 to 144 person-rems (1,440 person-mSv) in 2011.

Twenty-one of the DOE sites reported decreases in the collective TED from the 2010 values, while 11 of the DOE sites reported increases. The five sites that contributed most (78%) of the DOE collective TED in 2011 were (in descending order of collective TED for 2011) SRS – 17% (including Savannah River Nuclear Solutions [SRNS] and Savannah River Remediation [SRR]); Hanford – 16% (including the Hanford Site, Pacific Northwest National Laboratory [PNNL], and the Office of River Protection [ORP]); Los Alamos National Laboratory (LANL) – 15%; Idaho – 15% (including INL and Idaho Cleanup Project

Exhibit 3-2:
Components of TED, 2007–2011.



The collective TED decreased by 9% at DOE from 2010 to 2011.

The collective internal dose decreased by 47% from 2010 to 2011.

Neutron dose decreased by 6% from 2010 to 2011.

Photon dose decreased by 4% from 2010 to 2011.

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.

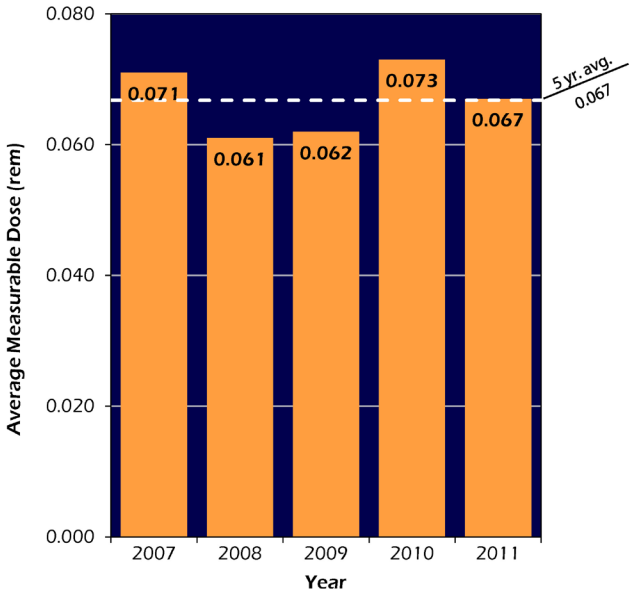
[ICP]); and Oak Ridge – 15% (including East Tennessee Technology Park [ETTP], Y-12 National Security Complex [Y-12], Oak Ridge National Laboratory [ORNL], and Oak Ridge Institute for Science and Education [ORISE]). Four of these sites reported decreases in the collective TED in 2011 compared with 2010.

3.2.4 Average Measurable Dose

The average measurable dose to DOE workers, a key radiation dose indicator, is calculated by dividing the collective dose (i.e., TED or CED) by the number of individuals with a measurable dose for each dose type.

The average measurable TED is shown in *Exhibit 3-3*. The average measurable TED decreased by 8% from 0.073 rem (0.73 mSv) in 2010 to 0.067 rem (0.67 mSv) in 2011, matching 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, 2007–2011.



3.2.5 Dose Distribution

Exposure data are commonly analyzed in terms of dose intervals to depict the dose 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 distribution for 2011 was slightly lower in five ranges compared with the 2010 data. Ninety-nine percent of the individuals monitored had doses less than 0.25 rem (2.5 mSv). *Exhibit 3-5* presents the dose distribution in terms of the percentage of individuals with measurable TED in each range. The percentages shown in this manner assist in revealing changes in the distribution from year to year. It shows that the values remain relatively constant with the exception of 2010. The percentages above 0.100 rem increased in 2010, which is consistent with the overall increase in the collective TED and average measurable TED during 2010 as a result of the increased activities funded under American Recovery and Reinvestment Act (ARRA). As these activities subsided during 2011, the percentages decreased in the dose ranges between 0.100 rem and 0.500 rem.

Exhibit 3-4:
Distribution of TED by Dose Range, 2007–2011.

	TED Range (rem)	2007	2008	2009	2010	2011
Number of Individuals in Each Dose Range*	Less than measurable	75,469	71,939	74,937	79,027	78,882
	Measurable to 0.100	9,048	9,348	9,760	10,352	10,507
	0.100–0.250	1,428	1,427	1,398	1,858	1,735
	0.250–0.500	518	421	490	695	564
	0.500–0.750	147	73	71	101	99
	0.750–1.000	34	20	28	23	41
	1–2	21	6	10	9	11
	2–3	1	1			
	3–4					
	4–5					
	>5	1			1	
Total number of records for monitored individuals		86,667	83,235	86,694	92,066	91,839
Number with measurable dose		11,198	11,296	11,757	13,039	12,957
Number with dose >0.100 rem		2,150	1,948	1,997	2,687	2,450
% of individuals with measurable dose		13%	14%	14%	14%	14%
Collective TED (person-rems)		800.463	690.780	726.477	946.749	863.528
Average measurable TED (rem)		0.071	0.061	0.062	0.073	0.067

* 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, 2007 – 2011.

	TED Range (rem)	2007	2008	2009	2010	2011
Percentage of Individuals with Measurable TED*	Measurable <0.100	80.8%	82.8%	83.0%	79.4%	81.1%
	0.100–0.250	12.8%	12.6%	11.9%	14.2%	13.4%
	0.250–0.500	4.6%	3.7%	4.2%	5.3%	4.4%
	0.500–0.750	1.3%	0.6%	0.6%	0.8%	0.8%
	0.750–1.000	0.3%	0.2%	0.2%	0.2%	0.3%
	1–2	0.2%	0.1%	0.1%	0.1%	0.1%
	2–3	0.01%	0.01%	0.0%	0.0%	0.0%
	>3	0.009%	0.0%	0.0%	0.01%	0.0%

* 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 and 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 2007 through 2011. One individual received a TED in excess of 5 rems (50 mSv) in 2007 from an intake of plutonium at LANL. (See Occurrence Reporting and Processing System [ORPS] report NA-LASO-LANL-CMR-2007-0002)

In 2010, one individual received a TED in excess of 5 rems (50 mSv). For more information on this event, see the Type B Accident Investigation Board Report "Employee Puncture Wound at the F-TRU Waste Remediation Facility", June 14, 2010 and the Preliminary Notice of Violation, NEA-2011-02, issued to SRNS July 22, 2011. The Type B Accident Investigation Board Report is publicly available and the URL is: http://www.hss.doe.gov/sesa/corporatesafety/aip/docs/accidents/typeb/FINAL_Type_B_Report_F-TRU_Puncture_Wound_2010.pdf On June 14, 2010, after performing can puncture operations during transuranic (TRU) remediation activities, an operator was placing the survey flag into the can and received a puncture wound to the right index finger resulting in a CED of 31.6 rems from an intake of plutonium (Pu)-238. (See ORPS report EM-SR-SRNS-CPWM-2010-0008)

No individual was reported to have exceeded 5 rems in 2011.

Exhibit 3-6:
Number of Individuals Exceeding 2 rems ACL and the 5 rems Annual Limit, 2007–2011.

Year	>2 rems	>5 rems
2007	1	1
2008	1	
2009		
2010		1
2011		

In 2011, no individual received a TED in excess of 2 rems (20 mSv).

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 2011.

As shown in *Exhibit 3-6*, four individuals have exceeded the 2 rems (20 mSv) ACL in the past 5 years. Two of the four individuals also exceeded the 5 rems (50 mSv) annual limit.

3.3.3 Internal Depositions of Radioactive Material

As shown in *Exhibit 3-7*, some of the highest doses to individuals have been the result of intakes of radioactive material. For this reason, DOE tracks the number of intakes as a performance measure in this report. DOE emphasizes the importance of taking measures to avoid intakes and maintain doses ALARA.

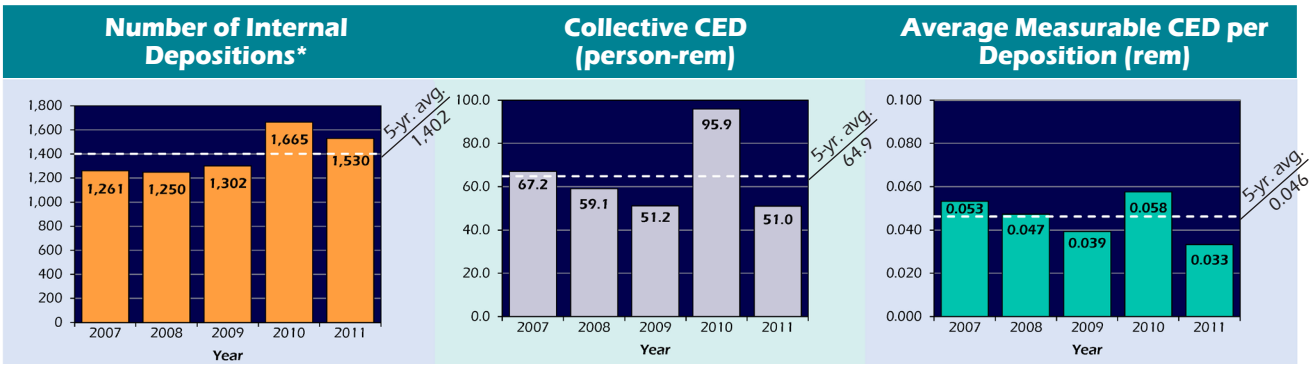
Exhibit 3-8 shows the number of internal depositions of radioactive material (an indicator of worker intakes), collective CED, and average measurable CED for 2007 to 2011. The number of internal depositions decreased by 8% from 1,665 in 2010 to 1,530 in 2011, while the collective CED decreased by 47%. The average measurable CED decreased by 43% from 0.058 rem (0.58 mSv) in 2010 to 0.033 rem (0.33 mSv) in 2011.

Ninety percent of the collective CED in 2011 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 receive measurable internal dose, so

Exhibit 3-7:
Dose in Excess of DOE Administrative Control Levels, 2007–2011.

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
2007	7.530	0.000	7.530	129.850	Pu-238, Pu-239	Research, General	LANL
2008	2.106	0.286	1.820	60.325	Pu-238, Pu-239	TA-55 Facility	LANL
2009	None reported						
2010	31.618	0.029	31.589	1,043.190	Pu-238	Transuranic (TRU) Waste Remediation Facility	SRS
2011	None reported						

Exhibit 3-8:
Number of Internal Depositions, Collective CED, and Average Measurable CED, 2007–2011.



* The number of internal depositions represents the number of internal dose records with positive results reported for each individual. Individuals may have multiple intakes in a year and, therefore, may be counted more than once.

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 from 2007 to 2011. The total number of individuals with intakes in each dose range is the sum of all records of intake in the subject dose range. Individuals with multiple intakes during the year may be counted more than once. 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 2011 is primarily due to the decrease of individuals receiving less than 0.100 rem (1 mSv).

The internal dose records indicate that the majority of the intakes result in very low doses. In 2011, 58% of the internal dose records were for doses below 0.020 rem (0.20 mSv). Over the 5-year period, internal doses from intakes accounted for 8% of the collective TED, and 11% 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].

On November 8, 2011, workers at the INL Materials and Fuels Complex Zero Power Physics Reactor (ZPPR) Facility operated by Battelle Energy Alliance (BEA) were packaging plutonium reactor fuel plates. Upon opening one of the storage containers, the workers discovered a plutonium fuel plate wrapped in plastic and tape. When the workers attempted to remove the wrapping material, an uncontrolled release of radioactive contaminants occurred, resulting in the contamination of 16 workers and the facility. The official dose assessments for the

Exhibit 3-9:
Internal Dose Distribution from Intakes, 2007–2011.

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		
2007	631	451	151	22	3	1	1				1	1,261	67.168
2008	616	471	133	25	2	2	1					1,250	59.062
2009	707	456	118	16	4	1						1,302	51.162
2010	894	611	137	19	1	1	1				1	1,665	95.886
2011	882	528	106	12	1		1					1,530	51.012

* Individuals with doses equal to the dose value separating the dose ranges are included in the next higher dose range.
** Individuals may have multiple intakes in a year and, therefore, may be counted more than once.

intakes of americium and plutonium were finalized as of November 26, 2012, for 15 of the monitored individuals. The highest committed effective dose equivalent for a worker was 1.5 rems. The highest committed dose equivalent to bone surfaces (the most highly irradiated single organ or tissue) was 16.5 rems. These doses are below the ACL and regulatory limits. The data presented in this report includes these finalized dose values.

An accident investigation was conducted in accordance with the requirements of DOE O 225.1B, Accident Investigations, and an investigation report, Plutonium Contamination in the ZPPR Facility at the INL, November 8, 2011, was released in January 2012. See also the ORPS report NE-ID-BEA-ZPPR-2011-0001.

3.3.4 Bioassay and Intake Summary Information

For the monitoring year 2011, 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. 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.

Fifty-nine percent of the urinalysis measurements in 2011 were performed at three sites: Y-12, Hanford, and SRS. The majority of the bioassay measurements reported as "Other" were from air sampling and account for 32% of the measurements. Over half of the in vivo measurements were from Hanford. Y-12 performs the largest number of bioassay measurements overall, comprising 27% of the total measurements taken. The largest increases in the number of urinalysis measurements occurred at Lawrence Livermore National Laboratory (LLNL) and the Paducah Gaseous Diffusion Plant, while Hanford reported the largest total increase in the number of "Other" measurements.

Exhibit 3-10:
Bioassay and Air Sampling Measurements, 2009-2011.

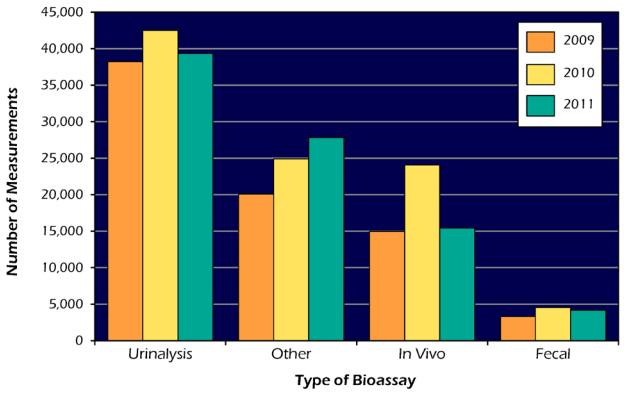
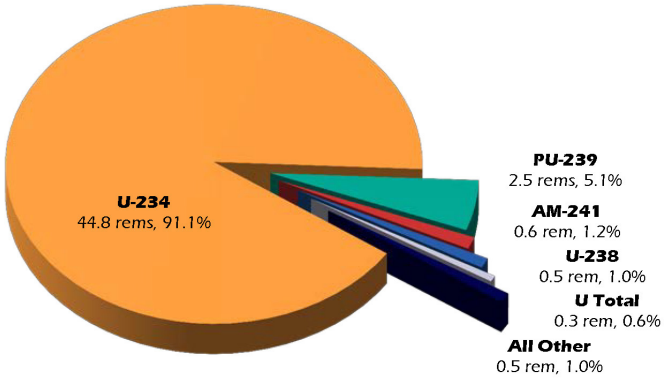


Exhibit 3-11 shows the breakdown of the collective CED by radionuclide for 2011. Uranium-234 accounts for the largest percentage of the collective CED, with over 97% of this dose accrued at Y-12.

Exhibit 3-11:
Collective CED by Radionuclide, 2011.



3.4 Analysis of Site Data

3.4.1 Collective TED by Site and Other Facilities

The collective TED for 2009 through 2011 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 is shown in *Exhibit 3-13*. The collective TED decreased by 9% from 947 person-rems (9,470 person-mSv) in 2010 to 864 person-rems (8,640 person-mSv) in 2011, with Savannah River (including SRNS and Savannah River Remediation [SRR]), Hanford (including the Hanford Site, PNNL, and the ORP), LANL, Idaho (including INL and ICP) and Oak Ridge sites (including ETTP, Y-12, ORNL, and ORISE) contributing 78% of the total DOE collective TED.

3.4.2 Changes by Site from 2010 to 2011

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 2011, 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 Savannah River in 2011.

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 2011. 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 2011

In an effort to identify the reasons for changes in the collective dose at DOE, several of the larger sites were contacted to provide information on activities that significantly contributed to the collective dose for 2011. These sites (SRS, Hanford, LANL, INL, and Oak Ridge) each had a collective TED over 100 person-rems and were the top contributors to the collective TED in 2011. These sites comprised 78% of the total collective TED at DOE. Four sites reported decreases in the collective TED, which contributed to a 9% decrease in the DOE collective TED from 947 person-rems (9,470 person-mSv) in 2010 to 864 person-rems (8,640 person-mSv) in 2011. The sites significantly contributing to the collective TED in 2011 are shown in *Exhibit 3-15*, including a description of activities that affected the collective TED.

3.4.3.1 Further Detail on Activities Significantly Contributing to Collective Dose in 2011

In addition to the information provided in *Exhibit 3-15*, several of the DOE sites provided further information on operations conducted during the monitoring year. 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. The following descriptions are excerpts from the transmittal letters from DOE sites in 2011.

Argonne National Laboratory

The collective TED for the monitoring year 2011 at Argonne National Laboratory is 29.420 person-rems, down from 31.170 person-rems the previous year, resulting in a decrease of 5.6%. The decrease was due to efficiencies in work methods and increased efforts to keep doses ALARA within the Alpha Gamma Hot Cell Facility. No individuals exceeded 2 rems TED this monitoring year.

Exhibit 3-12:
Collective TED by DOE Site for 2009–2011.

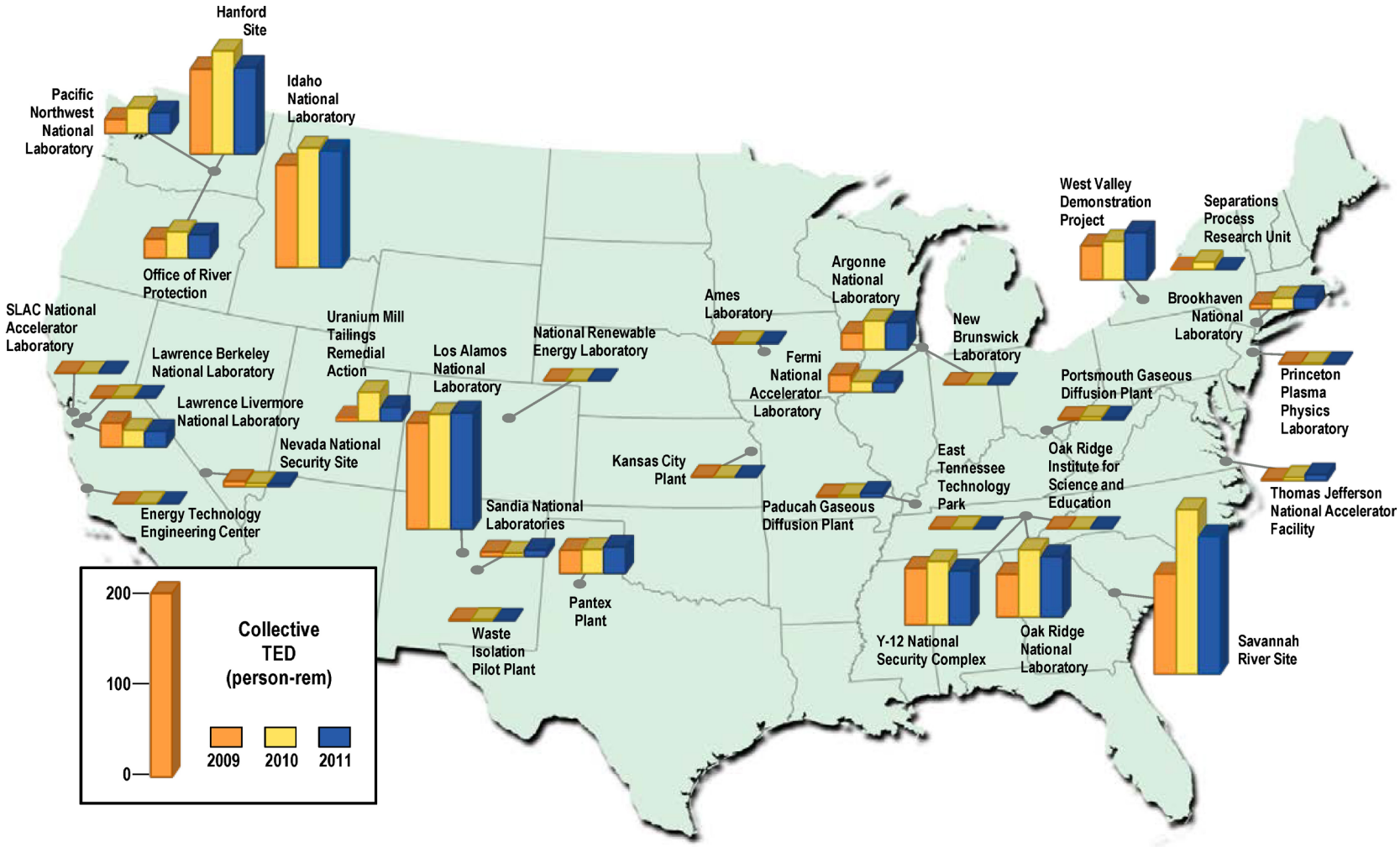


Exhibit 3-13:
Collective TED and Number of Individuals with Measurable TED by DOE Site, 2009–2011.

Site	2009		2010		2011	
	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	0.717	31	0.907	32	0.762	29
Argonne National Laboratory	17.610	137	31.170	177	29.420	176
Brookhaven National Laboratory	5.191	180	11.529	214	12.822	172
Energy Technology Engineering Center	0.125	43	0.292	54	0.139	47
Fermi National Accelerator Laboratory	18.750	243	11.220	169	10.090	155
Hanford:						
Hanford Site	93.149	1,633	112.522	1,673	94.691	1,479
Office of River Protection	20.639	346	28.522	535	25.308	496
Pacific Northwest National Laboratory	15.326	242	27.500	280	22.336	257
Idaho National Laboratory	111.326	1,808	130.278	1,890	126.612	2,385
Kansas City Plant	0.525	10	0.046	10	0.049	2
Lawrence Berkeley National Laboratory	0.613	14	1.097	16	0.759	13
Lawrence Livermore National Laboratory	25.993	182	18.214	144	16.979	116
Los Alamos National Laboratory	**115.733**	1,392	125.389	1,335	127.056	1,459
National Renewable Energy Laboratory	0.029	5	0.022	3	0.017	5
Nevada National Security Site	5.519	86	3.288	84	2.743	78
New Brunswick Laboratory	0.059	3	0.037	3	0.165	8
Oak Ridge:						
East Tennessee Technology Park	0.851	33	1.187	43	0.830	39
Oak Ridge Institute for Science and Education	0.231	62	0.114	56	0.211	82
Oak Ridge National Laboratory	46.654	655	73.468	726	66.252	714
Y-12 National Security Complex	61.882	1,379	69.516	1,635	59.055	1,537
Paducah Gaseous Diffusion Plant	1.151	79	1.884	90	4.038	78
Pantex Plant	25.158	302	26.131	303	28.947	311
Portsmouth Gaseous Diffusion Plant	1.540	32	2.960	63	2.279	47
Princeton Plasma Physics Laboratory	0.786	101	0.663	79	0.401	53
Sandia National Laboratories	4.871	131	3.564	81	6.913	126
Savannah River Site	108.902	**2,185**	**179.572**	**2,587**	**149.967**	**2,512**
Separations Process Research Unit	0.288	10	7.850	74	0.179	13
SLAC National Accelerator Laboratory	0.169	6	0.053	4	0.236	10
Thomas Jefferson National Accelerator Facility	0.690	27	3.111	67	6.245	57
Uranium Mill Tailings Remedial Action Project	3.624	92	31.497	237	15.000	191
Waste Isolation Pilot Plant	0.909	68	1.199	62	0.476	25
West Valley Demonstration Project	36.985	230	41.873	308	51.662	247
Service Center Personnel*	0.482	10	0.074	5	0.889	38
Totals	**726.477**	**11,757**	**946.749**	**13,039**	**863.528**	**12,957**

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

* Includes service center personnel from Albuquerque and Oak Ridge in addition to several smaller facilities not associated with a DOE site.

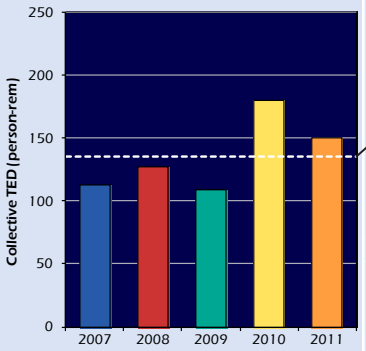
Exhibit 3-14:
Site Dose Data, 2011.

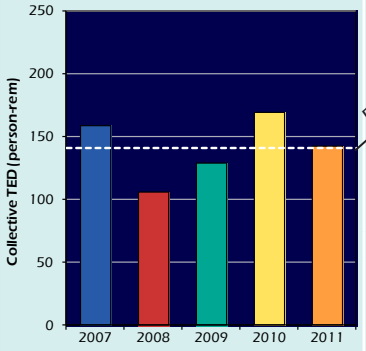
Site	2011 Collective TED (person-rem)	Percent Change from 2010	Number with Meas. Dose	Percent Change from 2010	Avg. Meas. TED (rem)	Percent Change from 2010	Percentage of Coll. TED above 0.500 rem	Percent Change from 2010
Ames Laboratory	0.762		29		0.026			
Argonne National Laboratory	29.420	-6% ▼	176	-1% ▼	0.167	-5% ▼	49%	-5% ▼
Brookhaven National Laboratory	12.822	11% ▲	172	-20% ▼	0.075	38% ▲	23%	300% ▲
Energy Technology Engineering Center	0.139		47		0.003			
Fermi National Accelerator Laboratory	10.090	-10% ▼	155	-8% ▼	0.065	-2% ▼		
Hanford:								
Hanford Site	94.691	-16% ▼	1,479	-12% ▼	0.064	-5% ▼		-100% ▼
Office of River Protection	25.308	-11% ▼	496	-7% ▼	0.051	-4% ▼	2%	100% ▲
Pacific Northwest National Laboratory	22.336	-19% ▼	257	-8% ▼	0.087	-12% ▼	22%	-52% ▼
Idaho National Laboratory	126.612	-3% ▼	2,385	26% ▲	0.053	-23% ▼	10%	75% ▲
Kansas City Plant	0.049		2		0.025			
Lawrence Berkeley National Laboratory	0.759		13		0.058			
Lawrence Livermore National Laboratory	16.979	-7% ▼	116	-19% ▼	0.146	16% ▲	**52%**	15% ▲
Los Alamos National Laboratory	127.056	1% ▲	1,459	9% ▲	0.087	-7% ▼	21%	-9% ▼
National Renewable Energy Laboratory	0.017		5		0.003			
Nevada National Security Site	2.743	-17% ▼	78	-7% ▼	0.035	-10% ▼		
New Brunswick Laboratory	0.165		8		0.021			
Oak Ridge:								
East Tennessee Technology Park	0.830		39		0.021			
Oak Ridge Institute for Science and Education	0.211		82		0.003			
Oak Ridge National Laboratory	66.252	-10% ▼	714	-2% ▼	0.093	-8% ▼	7%	-27% ▼
Y-12 National Security Complex	59.055	-15% ▼	1,537	-6% ▼	0.038	-10% ▼	1%	-80% ▼
Paducah Gaseous Diffusion Plant	4.038	**114%** ▲	78	-13% ▼	0.052	**147%** ▲		
Pantex Plant	28.947	11% ▲	311	3% ▲	0.093	8% ▲	6%	100% ▲
Portsmouth Gaseous Diffusion Plant	2.279	-23% ▼	47	-25% ▼	0.048	3% ▲		
Princeton Plasma Physics Laboratory	0.401		53		0.008			
Sandia National Laboratories	6.913	94% ▲	126	**56%** ▲	0.055	25% ▲		
Savannah River Site	**149.967**	-16% ▼	**2,512**	-3% ▼	0.060	-14% ▼	6%	-69% ▼
Separations Process Research Unit	0.179		13		0.014			
SLAC National Accelerator Laboratory	0.236		10		0.024			
Thomas Jefferson National Accelerator Facility	6.245	101% ▲	57	-15% ▼	0.110	136% ▲	37%	100% ▲
Uranium Mill Tailings Remedial Action Project	15.000	-52% ▼	191	-19% ▼	0.079	-41% ▼		
Waste Isolation Pilot Plant	0.476		25		0.019			
West Valley Demonstration Project	51.662	23% ▲	247	-20% ▼	**0.209**	54% ▲	36%	**442%** ▲
Service Center Personnel*	0.889		38		0.023	58% ▲		
Totals	**863.528**	**-9%** ▼	**12,957**	**-1%** ▼	**0.067**	**-8%** ▼	**12%**	**-4%** ▼

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 service center personnel from Albuquerque and Oak Ridge in addition to several smaller facilities not associated with a DOE site.

Exhibit 3-15 :
Activities Significantly Contributing to Collective TED in 2011.

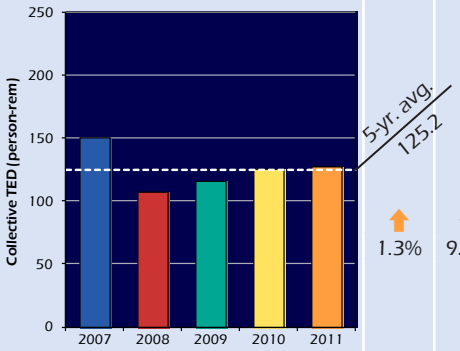
Savannah River Site	Percent Change* 2010-2011 (last yr.)	Percent Change* 2009-2011 (3 yr.)	Percent Change* 2007-2011 (5 yr.)	Description of Activities at the Site
	16.5% ↓	37.7% ↑	33.5% ↑	The Savannah River Site (SRS) was constructed during the early 1950s to produce the basic materials used in the fabrication of nuclear weapons, primarily tritium and plutonium-239, in support of our nation's defense programs. Five reactors were built to produce these materials. Also built were a number of support facilities including two chemical separations plants, a heavy water extraction plant, a nuclear fuel and target fabrication facility, a tritium extraction facility and waste management facilities. The SRS collected records for 7,888 individuals in 2011, and 2,512 people had a measurable total effective dose (TED). The number of individuals with measurable TED decreased by 3% from 2010. The collective TED was 149.967 person-rems, 16% lower than 2010. No individual exceeded 2 rems TED for 2011. An increase in dose at SRS in 2010 was primarily the result of a puncture wound. The decrease in dose for 2011 was due to the reduced amount of work scope in the American Recovery and Reinvestment Act (ARRA) and the implementation of handheld X-Ray devices in Solid Waste to accurately identify prohibited waste items, which reduced the amount of rework. K-Area realized an increase in dose due to Radio Frequency Tamper Indicating Devices (RFTID) failures & battery changes and an extensive International Atomic Energy Agency (IAEA) visit. The Savannah River Remediation (SRR) experienced an increase in dose at Saltstone and the Defense Waste Processing Facility (DWPF) due to equipment conditions and emergent repairs while F and H Tank Farms saw a decrease in dose due to work scope changes and increased ALARA practices.

Hanford	Percent Change* 2010-2011 (last yr.)	Percent Change* 2009-2011 (3 yr.)	Percent Change* 2007-2011 (5 yr.)	Description of Activities at the Site
	15.6% ↓	10.2% ↑	9.9% ↓	**Hanford Site** The United States Department of Energy's (DOE's) Hanford Site sits on 586-square-miles in the desert of southeastern Washington State. The area is home to nine former nuclear reactors and their associated processing facilities that were built beginning in 1943. Hanford reactors produced plutonium from 1944 until 1987. Today, Hanford workers are involved in an environmental cleanup project and remediation of the site. There were 1,479 individuals with measurable TED at Hanford in 2011, which is a 12% decrease from 2010. The TED decreased 16% from 112.522 person-rems in 2010 to 94.691 in 2011. No individual exceeded 2 rems TED in 2011. **The Office of River Protection (ORP)** The DOE ORP mission is to retrieve and treat Hanford's waste and close the tank farms to protect the Columbia River. The chemical and radioactive waste is currently stored in 171 large underground tanks. ORP and its contractors are removing and transferring this waste from the older single-shell tanks to the newer double-shell tanks. This transfer of waste is to reduce the environmental risk posed by the older tanks. The cornerstone of the tank waste cleanup project is the Waste Treatment Plant (WTP). The WTP will use a technology called vitrification to immobilize chemical and radioactive waste in an exceptionally sturdy form of glass to isolate it from the environment. The ORP had an 11% decrease in collective TED from 28.522 person-rems in 2010 to 25.308 person-rems in 2011. This same location also showed a 7% decrease in the number of individuals with measurable TED. No individual exceeded 2 rems TED in 2011.

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

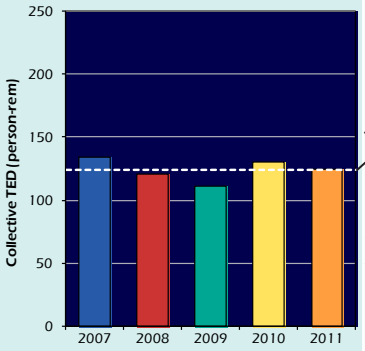
Exhibit 3-15 (Continued):
Activities Significantly Contributing to Collective TED in 2011.

Hanford	Percent Change*			Description of Activities at the Site
	2010-2011 (last yr.)	2009-2011 (3 yr.)	2007-2011 (5 yr.)	
				Pacific Northwest National Laboratory (PNNL) Located in Richland, Washington, PNNL is one of 10 national laboratories managed by DOE's Office of Science (SC). The laboratory provides the facilities, unique scientific equipment, and world-renowned scientists and engineers to strengthen U.S. scientific foundations through fundamental research and innovation. Approximately 4,900 people are employed at PNNL. In addition to the Richland campus, PNNL operates a marine research facility in Sequim, Washington, and satellite offices in Seattle and Tacoma, Washington, Portland, Oregon, and Washington, D.C. The collective TED at PNNL in 2011 was 22.336, a 19% decrease from the previous year. PNNL also had an 8% decrease in the number of individuals with measurable TED. The primary reason for the decrease at all three sites was reduction in ARRA work activities. Neutron exposures decreased proportionately to the overall reduction in dose. The largest contributors to exposure at the Hanford site were decontamination activities at the Plutonium Finishing Plant (37%), Tank Farm activities (19%), work activities at PNNL (16%), decontamination and demolition of various facilities on the river corridor and central plateau (14%), and transuranic (TRU) retrieval and other Waste and Fuels operations (14%). No individual exceeded 2 rems TED in 2011.

Los Alamos National Laboratory	Percent Change*			Description of Activities at the Site
	2010-2011 (last yr.)	2009-2011 (3 yr.)	2007-2011 (5 yr.)	
	↑ 1.3%	↑ 9.8%	↓ 15.6%	Los Alamos National Laboratory (LANL) conducts radiological operations in active facilities, storage facilities, facilities with legacy radiological concerns, and inactive facilities and areas destined for decommissioning. Radiological activities include programmatic and production work; facility construction, modification, and maintenance; and research, development, and testing. LANL had 1,459 people with measurable TED, a 9% increase from 2010. Collective TED at LANL in 2011 was 127.056 person-rems, which is virtually unchanged from last year (1% increase). Internal dose, committed effective dose (CED), was reported as 0.909 person-rem. The two highest individual doses (just over 1 rem) were accrued by workers performing plutonium glove box work at TA-55; these doses were tracked and controlled rigorously by line management and the LANL Institutional Radiation Safety Committee. Internal doses reflect a combination of routine tritium doses from LANL tritium operations and low-level intakes of uranium and plutonium. The top four internal doses were uranium doses accumulated over the year; the highest cumulative dose was 0.361 rem. TA-55 Plutonium Facility operations accounted for the majority of occupational dose at LANL in 2011, which is historically consistent for LANL. Occupational dose was accrued from manufacturing and related weapons work, Pu-238 work, repackaging materials, and providing Radiation Control Technician (RCT) and other infrastructure support for radiological work and facility maintenance at TA-55. In addition to TA-55 operations, significant portions of LANL dose were accrued by workers performing retrieval, repackaging, and shipping of radioactive solid waste at LANL waste facilities at TA-50 and TA-54 and workers performing programmatic and maintenance work at the TA-53 Los Alamos Neutron Science Center. No individual received over 2 rems at LANL during 2011.

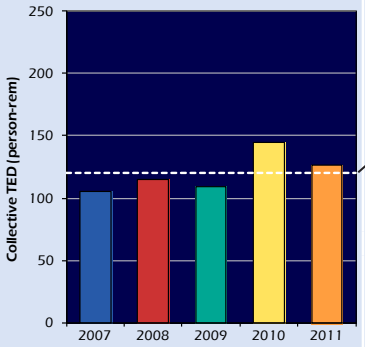
* Up arrows indicate an increase in change. Down arrows indicate a decrease in change.

Exhibit 3-15 (Continued):
Activities Significantly Contributing to Collective TED in 2011.

Idaho National Laboratory	Percent Change*			Description of Activities at the Site
	2010-2011 (last yr.)	2009-2011 (3 yr.)	2007-2011 (5 yr.)	
	2.8% ↓	13.7% ↑	5.6% ↓	**Idaho National Laboratory - Battelle Energy Alliance (BEA)** The radiation exposure activities performed by BEA during 2011 at the INL Site included work at the Advanced Test Reactor, the Materials and Fuel Complex, and the Central and Idaho Falls Facilities. BEA monitored 3,785 individuals in 2011. There was a collective TED of 51.430 person-rems in 2011. This represents an increase of approximately 7% compared with 2010. On November 8, 2011, workers at the INL Materials and Fuels Complex Zero Power Physics Reactor (ZPPR) Facility operated by Battelle Energy Alliance (BEA) were packaging plutonium reactor fuel plates. Upon opening one of the storage containers, the workers discovered a plutonium fuel plate wrapped in plastic and tape. When the workers attempted to remove the wrapping material, an uncontrolled release of radioactive contaminants occurred, resulting in the contamination of 16 workers and the facility. The official dose assessments for the intakes of americium and plutonium were finalized as of November 26, 2012, for 15 of the monitored individuals. The highest committed effective dose equivalent for a worker was 1.5 rems. The highest committed dose equivalent to bone surfaces (the most highly irradiated single organ or tissue) was 16.5 rems. These doses are below the ACL and regulatory limits. The data presented in this report includes these finalized dose values. (see section 3.3.3) An accident investigation was conducted in accordance with the requirements of DOE O 225.1B, Accident Investigations, and an investigation report, Plutonium Contamination in the ZPPR Facility at the INL, November 8, 2011, was released in January 2012. See also the ORPS report NE-ID-BEA-ZPPR-2011-0001. No individual exceeded 2 rems TED. **Advanced Mixed Waste Treatment Project (AMWTP)** AMWTP work activities, performed by Bechtel BWXT Idaho and Idaho Treatment Group, in 2011 continued the direct support of the 1995 Idaho/U.S. Navy/U.S. DOE Settlement Agreement requiring the removal of transuranic waste from the DOE's Idaho Operations area. The primary work activities at the AMWTP that contributed to workforce dose included TRU waste retrieval from burial, waste characterization, and waste handling operations in support of shipment of transuranic and by-product waste materials from Idaho to the DOE's Waste Isolation Pilot Plant (WIPP) facility and other commercial disposal sites. No significant radiological concerns were encountered in 2011. In 2011 there were 1,594 persons monitored. The collective TED was 20.400 person-rems. This represents a 16.2% decrease from 2010. This decrease in collective TED can be attributed to improvements in the planning of drum movements and better configuration in waste storage areas (higher dose rate drums were placed further from workers). Additionally, workers were made aware of the location of elevated exposure rate areas by utilizing electronic dosimeters and programs that encouraged the workers to track their own dose during the day. No individual exceeded 2 rems TED in 2011. **Idaho Cleanup Project (ICP)** ICP activities performed by CH2M-WG, LLC, during 2011 leading to radiation exposure included waste management activities, Advanced Test Reactor Complex decontamination and decommissioning (D&D) activities, Accelerated Retrieval Project (ARP) exposure activities, Materials and Fuels Complex D&D activities, and Idaho Nuclear Technology and Engineering Center (INTEC) nuclear materials disposal. CH2M-WG Idaho, LLC submitted 1,815 records. The collective TED for 2011 was 52.875 person-rems. This represents a 7% decrease from 2010 (56.768 person-rems). No individual exceeded 2 rems TED.

* 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 2011.

Oak Ridge	Percent Change*			Description of Activities at the Site
	2010-2011 (last yr.)	2009-2011 (3 yr.)	2007-2011 (5 yr.)	
	12.4% ↓	15.3% ↑	19.6% ↑	**Y-12 National Security Complex (Y-12)** Y-12 is one of four production facilities in the National Nuclear Security Administration's Nuclear Security Enterprise. The facility's emphasis is the processing and storage of uranium and development of technologies associated with those activities. Decades of precision machining experience make Y-12 a production facility with capabilities unequaled nationwide. Y-12 maintains the safety, security and effectiveness of the U.S. nuclear weapons stockpile and provides safe and effective nuclear propulsion systems for the U.S. Navy. Over 6,000 individuals were monitored at the Y-12 National Security Complex in 2011. The collective TED decreased 15% from 69.516 person-rems in 2010 to 59.055 person-rems in 2011. The 2011 collective CED decreased 22% from 57.232 person-rems in 2010 to 44.594 person-rems in 2011. ALARA efforts resulted in a reduction in the airborne radioactivity concentrations, and material types processed in some areas were more soluble than in previous years. The total extremity dose increased 64% from 23.986 person-rems in 2010 to 39.225 person-rems in 2011. This increase was due to disposition of legacy material and consolidation of material at the site. No individual exceeded 2 rems TED in 2011. **Oak Ridge National Laboratory (ORNL)** ORNL is a multiprogram science and technology laboratory managed for the DOE by UT-Battelle, LLC. ORNL's mission is to deliver scientific discoveries and technical breakthroughs that will accelerate the development and deployment of solutions in clean energy and global security, and in doing so create economic opportunity for the nation. ORNL also performs other work for the DOE, including isotope production, information management, and technical program management, and provides research and technical assistance to other organizations. In 2011, ORNL reported a 2% decrease in the number of individuals with measurable TED compared with 2010. The collective TED for ORNL in 2011 was 66.252 person-rems. This represents a 10% decrease from 2010 (73.468 person-rems). During 2011, ORNL saw a decrease in isotope processing and maintenance activities at the High Flux Isotope Reactor (HFIR) and the Spatial Neutron Source (SNS). No individual exceeded 2 rems TED at ORNL during 2011. **Oak Ridge Institute for Science and Education (ORISE)** ORISE is a DOE institute focusing on scientific initiatives to research health risks from occupational hazards, assess environmental cleanup, respond to radiation medical emergencies, support national security and emergency preparedness, and educate the next generation of scientists. In 2011, ORISE reported 82 individuals with measurable dose. The collective TED for the monitoring year was 0.211 person-rem. This represents an 85% increase from 2010. The primary reason for this change was due to increased radiological work and additional staffing that received a measurable TED. No individual exceeded 2 rems TED in 2011. **East Tennessee Technology Park (ETTP)** URS/CH2M Oak Ridge, LLC (UCOR) is the DOE's cleanup contractor for the DOE Oak Ridge Reservation, primarily focused on cleanup of the ETTP (the former Oak Ridge K-25 Site).

* 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 2011.

Oak Ridge	Percent Change*			Description of Activities at the Site
	2010-2011 (last yr.)	2009-2011 (3 yr.)	2007-2011 (5 yr.)	
				The major activities performed at UCOR managed sites in 2011 consisted of environmental restoration work, decommission and decontamination of facilities, surveillance and maintenance tasks, stabilization of inactive facilities and demolition of facilities. The increase in collective TED for 2011 as compared to 2010 is primarily attributed to removal of a legacy waste tank and remediation of surrounding contaminated soils. The decrease in total neutron dose for 2011 compared to 2010 reflects a decrease in waste operations work at ORNL. The increase in CED for 2011 compared to 2010 is associated with invasive work activities performed within K-25 prior to demolition activities. There were no unusual events related to occupational radiation exposure at UCOR facilities for 2011. No individual exceeded 2 rems TED in 2011.

Brookhaven National Laboratory

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. Brookhaven is operated and managed for DOE's Office of Science (SC) by Brookhaven Science Associates, a limited-liability company founded by Stony Brook University, the largest academic user of Laboratory facilities, and Battelle, a nonprofit, applied science and technology organization.

There were 172 people with measurable TED at BNL in 2011. The collective TED increased by 11% from 11.529 person-rems in 2010 to 12.822 person-rems in 2011. The highest individual dose was 0.856 rem. No individual exceeded 2 person rems TED or exceeded any DOE occupational dose limit. The CED was 0.001 person-rem, and the equivalent dose from external sources of radiation was 12.821 person-rems.

Energy Technology Engineering Center

The Energy Technology Engineering Center is currently in a safe shutdown mode, pending the completion of the Environmental Impact Statement. In 2011, few people received any significant radiation exposure dose from the DOE operations, with 13% decrease in the number of individuals with measurable TED. The number of people monitored in 2011 was about 5% less than that in 2010. This number also can vary from year to year, depending on the number of visitors and/or contractors that come to the site.

The collective TED decreased by 52% from 0.292 person-rem in 2010 to 0.139 person-rem in 2011. No individual exceeded 2 rems TED.

Fermi National Accelerator Laboratory

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 2011, Fermilab reported an 8% decrease in the number of people with measurable TED (155) compared with 2010 (169). During 2011, the collective TED was 10.090 person-rems. This is approximately a 10% decrease from 2010. This decrease was due to no major shutdowns of the accelerators complex. Major shutdowns of the accelerators were avoided due to the permanent shutdown of the Tevatron in September 2011.

Kansas City Plant

The collective TED for the 68 individuals monitored at the Kansas City Plant in 2011 was 0.049 person-rem, representing a 6.5% increase from 2010.

The majority of this dose (0.046 person-rem) was one individual that was involved in a special project involving portable flash x-ray units.

Lawrence Livermore National Laboratory/Lawrence Livermore National Laboratory-Nevada

LLNL is a DOE facility operated by the Lawrence Livermore National Security, LLC (LLNS) management team, which includes Bechtel, the University of California, BWX Technologies, Washington Group, and Battelle. The site serves as a national resource of scientific, technical, and engineering capability with a special focus on national security. LLNL's mission encompasses such areas as strategic defense, energy, the environment, biomedicine, technology transfer, education, counter-terrorism, and emergency response. Support of these operations requires the use of a wide range of radiation-producing devices (e.g., x-ray machines, accelerators, electron-beam welders) and radioactive material. The types of radioactive materials range from tritium to transuranics; the quantities range from nanocuries (i.e., normal environmental background values) to kilocuries.

The collective TED for LLNL overall in 2011 was 16.979 person-rems. For the non-Nevada facilities, the 2011 collective TED was 16.851 person-rems. This reflects a 6% decrease from the 2010 collective TED of 18.017 person-rems and is due to decreased operations in the Plutonium Facility and at LLNL. However, over half (52%) of the collective TED was above 0.500 rem. In 2011, 7,668 people were monitored, and 115 people had measurable TED. There were 18 people with internal uptakes accounting for 0.030 person-rem total collective CED.

LLNL-Nevada is a DOE facility operated by the LLNS management team, which includes Bechtel, the University of California, BWX Technologies, Washington Group, and Battelle. For 2011, LLNL-Nevada had a collective TED of 0.104 person-rem, representing an approximate decrease of 69% from 2010. Two-hundred thirteen people were monitored, but only 1 person had a measurable dose.

National Renewable Energy Laboratory

The National Renewable Energy Laboratory (NREL) decreased the collective TED by 23% in 2011. The NREL staff that was involved in x-ray generating device work increased in size, while individual exposure time decreased due to more users using the same number of machines.

New Brunswick Laboratory

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. Research to develop improved measurement technology applied to nuclear materials and management of interlaboratory measurement evaluation programs also have the potential to lead to ionizing radiation exposure.

The collective TED at NBL for 2011 was 0.165 person-rem. This represents a more than four-fold increase from the value for 2010 (0.037 person-rem). The primary reason for this increase was due to preparation for restart of plutonium laboratory operations. Plutonium operations have been shut down since December 2004, with little to no activity taking place in the laboratory areas. During 2011, material in the plutonium laboratories was collected, moved, and consolidated over several months.

Paducah Gaseous Diffusion Plant

The overall collective TED for the Paducah Gaseous Diffusion Plant in 2011 was 4.038 person-rems. The following discription provides a breakdown of the various activities at this site.

Los Alamos Technical Associates (LATA) Kentucky
The exposure information for 2011 covers LATA Kentucky activities performed under the DOE contract. Its scope consists of environmental remediation, facility decontamination, and final assessment of buildings and areas at the Paducah Site.

The collective TED for 2011 was 0.506 person-rem. This represents a 73% increase from the previous year. The primary reason for this change was increased facility decontamination and decommissioning (D&D) operations at Paducah. There were no unusual events related to occupational radiation exposure at LATA Kentucky facilities for 2011.

Uranium Disposition Services/Babcock & Wilcox Conversion Service, LLC
The collective TED for 2011 was 3.480 person-rems. This represents a 185% increase from 2010. The primary reason for this change was increased startup operations at the Paducah Uranium Hexafluoride Conversion Facility.

Swift & Staley (SST)
The collective TED for 2011 was 0.051 person-rem. This represents a 94% decrease from 2010. This decrease is attributed to several factors. SST applies the ALARA process to all operations involving potential personnel exposure to ionizing radiation or releases of radioactive

material from sites or facilities where SST conducts operations for DOE. SST is successful in reducing exposure using ALARA principles. In addition, SST no longer provides dosimetry for Uranium Disposition Services, which was the primary contributor to SST's personnel exposure.

Pantex Plant

The DOE/National Nuclear Security Administration (NNSA) Pantex Plant is the nation's only facility for assembly and disassembly of nuclear explosives. The collective TED for the Pantex Plant in 2011 was 28.947 person-rems, which resulted in an 11% increase in the collective TED. The 2011 activities that contributed the majority of dose to the Pantex Plant workers were operations that exposed 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.

Sandia National Laboratories

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

SNL reported twice as many people with measurable TED in 2011 (126) compared with 2010 (59). The 2011 collective TED for SNL was 6.913 person-rems, which represents a two-fold increase in site collective TED from 2010. These increases can be attributed to Auxiliary Hot Cell Facility TRU waste processing and Annular Core Research Reactor special irradiation projects conducted throughout 2011.

Separations Process Research Unit

Project activities in 2011 included the surveillance and maintenance activities to maintain site condition, the processing and shipment of low activity water, shipping of low activity soil, deconning in the sludge processing tent, and tenting the G2 and H2 buildings in preparation for demolition activities. This report contained 226 records, and 13 people had measurable TED. Collective TED was 0.179 person-rem for 2011, representing a 98% decrease in TED from 2010. The primary reason for this decrease was that demolition activities were halted at the end of September 2010.

SLAC National Accelerator Laboratory

The SLAC National Accelerator Laboratory (SLAC) program centers around experimental and theoretical research in elementary particle physics using accelerated electron beams and a broad program of research in atomic and solid-state physics, chemistry, and biology using synchrotron radiation from accelerated electron beams. The main instrument of research is the 3.2-km linear accelerator, which can generate high-intensity beams of electrons and positrons up to 50 GeV. The Klystron Test Laboratory manufactures all the klystrons used in SLAC accelerators, as well as novel structures and components for future accelerators; it supports low-level and high-level radio frequency operations of SLAC accelerators, and it operates a 70-MeV X-band research accelerator and laser facility capable of producing subpicosecond beam bunches.

The construction of the new Facilities for Accelerator Science and Experimental Test (FACET) was completed in mid 2011 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 2011.

The 2011 report contained 2,491 records, including 10 people with measurable TED. No individual exceeded 2 person-rems TED or any DOE occupational dose limit during 2011 at SLAC. Compared with the 2010 collective TED (0.053 person-rem), the 2011 collective TED (0.236 person-rem) was about four times higher. This increase is mainly associated with the operations of the newly constructed FACET facility and the construction of Building 28 (near the SLAC Klystron Gallery).

Thomas Jefferson National Accelerator Facility

Thomas Jefferson National Accelerator Facility (TJNAF) is one of 17 national laboratories funded by the DOE. TJNAF also receives support from the City of Newport News and the Commonwealth of Virginia. 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 2011, 1,682 individuals were monitored, and 57 individuals had reportable doses. The collective TED for 2011 was 6.245 person-rems. No individual dose exceeded the TJNAF ACL of 1 rem. The highest measurable TED was 0.730 rem.

The collective TED at TJNAF doubled from 3.111 person-rems in 2010 to 6.245 person-rems in 2011. The increase in TED was due to the specific conditions associated with the Q-weak experiment that took place in Hall C. This experiment used the highest sustained beam current ever achieved at TJNAF. The combination of high current and unexpected beam loss led to both high levels of activation and failure of beam line components. As a result, multiple repairs and maintenance work occurred within high radiation areas.

Uranium Mill Tailings Remediation Action Project – Moab

The Uranium Mill Tailings Remediation Action Project (UMTRA) site is located approximately 3 miles northwest of Moab in Grand County, Utah, and includes the former Atlas Minerals Corporation (Atlas) 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.

The collective TED for the UMTRA Project in 2011 was 15 person-rems, a 52% decrease from 2010. The primary reason for this decrease was a 50% reduction in the work force in July 2011.

Waste Isolation Pilot Plant

The Waste Isolation Pilot Plant (WIPP), located in the Chihuahuan Desert near Carlsbad, New Mexico, is a DOE facility managed by Washington TRU Solutions. The facility safely disposes of the nation's defense-related transuranic radioactive waste. WIPP began disposal operations in March 1999.

Twenty-five people had measurable TED at WIPP in 2011, a 60% decrease from 2010. The collective TED for 2011 was 0.476 person-rem. This also represents a 60% decrease from 2010. The primary reason for this decrease was due to changes in the amount of radioactive material contained in the waste processed. All doses received were from routine activities associated with the disposal of transuranic waste. There were no individuals exceeding 2 rems TED for this monitoring year.

West Valley Demonstration Project

Two projects involving low-dose jobs in 2011 required dosimetry monitoring of personnel . These were the installation of the tank and vault drying system in the waste tank farm and the installation of the permeable treatment wall. This resulted in a relative increase in the number of workers with no measurable TED. The increase of 23% collective TED (51.662 person-rems) in 2011 was due to an increase in D&D activity over 2010.

3.4.4 Summary by Program Office

DOE has divided the responsibility of managing its missions among specific program offices. The various DOE sites support different functions and therefore fall under the authority and management of separate program offices. It should be noted that several of the DOE sites undertake work supporting multiple program offices. However, those sites have a lead program office and are 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 (53% and 28%, respectively). The mission of the 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 and activities involving radioactive materials. These offices account for over 81% of the collective TED at DOE.

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

Exhibit 3-16:
Program Office Dose Data, 2011.

Program Office	Collective TED (person-rem)	Percent Change from 2010	Number with Meas. Dose	Percent Change from 2010	Avg. Meas. TED (rem)	Percent Change from 2010
Office of Energy Efficiency and Renewable Energy (EE)					**Total Monitored = 14**	
National Renewable Energy Laboratory	0.017		5		0.003	
EE Totals*	**0.017**		**5**		**0.003**	
Office of Environmental Management (EM)					**Total Monitored = 30,636**	
East Tennessee Technology Park	0.830		39		0.021	
Energy Technology Engineering Center	0.139		47		0.003	
Hanford Site	94.691	-16% ▼	1,479	-12% ▼	0.064	-5% ▼
Idaho National Laboratory	83.079	1% ▲	1,336	**38%** ▲	0.062	-26% ▼
Oak Ridge National Laboratory	30.404	-20% ▼	263	-4% ▼	0.116	-16% ▼
Office of River Protection	25.308	-11% ▼	496	-7% ▼	0.051	-4% ▼
Paducah Gaseous Diffusion Plant	4.038	**114%** ▲	78	-13% ▼	0.052	**147%** ▲
Portsmouth Gaseous Diffusion Plant	2.279	-23% ▼	47	-25% ▼	0.048	3% ▲
Savannah River Site	**149.967**	-16% ▼	**2,512**	-3% ▼	0.060	-14% ▼
Separations Process Research Unit	0.179		13		0.014	
Service Center Personnel*	0.830		35		0.024	
Uranium Mill Tailings Remedial Action Project	15.000	-52% ▼	191	-19% ▼	0.079	-41% ▼
Waste Isolation Pilot Plant	0.476		25		0.019	
West Valley Demonstration Project	51.662	23% ▲	247	-20% ▼	**0.209**	54% ▲
EM Totals*	**458.882**	**-13%** ▼	**6,808**	**-2%** ▼	**0.067**	**-11%** ▼
National Nuclear Security Administration (NNSA)					**Total Monitored = 33,951**	
Kansas City Plant	0.049		2		0.025	
Lawrence Livermore National Laboratory	16.979	-7% ▼	116	-19% ▼	**0.146**	16% ▲
Los Alamos National Laboratory	**127.056**	1% ▲	1,459	9% ▲	0.087	-7% ▼
Nevada National Security Site	2.743	-17% ▼	78	-7% ▼	0.035	-10% ▼
Pantex Plant	28.947	11% ▲	311	3% ▲	0.093	8% ▲
Sandia National Laboratories	6.913	**94%** ▲	126	**56%** ▲	0.055	**25%** ▲
Y-12 National Security Complex	59.055	-15% ▼	**1,537**	**-6%** ▼	0.038	**-10%** ▼
NNSA Totals*	**241.742**	**-2%** ▼	**3,629**	**1%** ▼	**0.067**	**-3%** ▼
Office of Nuclear Energy, Science and Technology (NE)					**Total Monitored = 3,002**	
Idaho National Laboratory	43.533	-10% ▼	1,049	14% ▲	0.041	-21% ▼
NE Totals*	**43.533**	**-10%** ▼	**1,049**	**14%** ▲	**0.041**	**-21%** ▼
Office of Science (SC)					**Total Monitored = 24,182**	
Ames Laboratory	0.762		29		0.026	
Argonne National Laboratory	29.420	-6% ▼	176	-1% ▼	**0.167**	-5% ▼
Brookhaven National Laboratory	12.822	11% ▲	172	-20% ▼	0.075	38% ▲
Fermi National Accelerator Laboratory	10.090	-10% ▼	155	-8% ▼	0.065	-2% ▼
Lawrence Berkeley National Laboratory	0.759		13		0.058	
New Brunswick Laboratory	0.165		8		0.021	
Oak Ridge Institute for Science and Education	0.211		82		0.003	
Oak Ridge National Laboratory	**35.848**	1% ▲	**451**	**0%**	0.079	1% ▲
Pacific Northwest National Laboratory	22.336	-19% ▼	257	-8% ▼	0.087	-12% ▼
Princeton Plasma Physics Laboratory	0.401		53		0.008	
Service Center Personnel*	0.059		3		0.020	
SLAC National Accelerator Laboratory	0.236		10		0.024	
Thomas Jefferson National Accelerator Facility	6.245	**101%** ▲	57	-15% ▼	0.110	**136%** ▲
SC Totals*	**119.354**	**-3%** ▼	**1,466**	**-5%** ▼	**0.081**	**3%** ▲

Note: Bold and boxed values indicate the greatest value in each column. The percentage change from the previous year is not shown because it is not meaningful when the site collective dose is less than 1 person-rem (10 person-mSv). Please see section 3.4.3.1 for more information.

A more detailed breakdown of the exposure information by site, program office, and contractor is available at http://www.hss.doe.gov/SESA/Analysis/rems/ 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 2007 to 2011. 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 by 16% from 37.8 person-rems (378 person-mSv) in 2010 to 31.7 person-rems (317 person-mSv) in 2011. The average measurable TED decreased 13% from 0.064 rem (0.64 mSv) in 2010 to 0.056 rem (0.56 mSv) in 2011. These decreases are consistent with the overall decreases observed across the DOE complex from 2010 to 2011 and represent a decrease in work performed involving radiation exposure. Since 1993, the percentages have remained relatively constant, even though 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 HSS 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 dose at multiple facilities. Although the number of transient individuals and average dose have been relatively low, the examination of these records remains an important function of HSS in ensuring individual worker health and safety.

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, *Exhibits 3-18* and *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

Exhibit 3-17:
Dose Distribution of Transient Workers, 2007–2011.

	Dose Ranges (TED in rem)	2007	2008	2009	2010	2011
Transients	Less than measurable	2,353	2,088	2,055	2,337	2,151
	measurable <0.100	408	424	523	487	498
	0.100–0.250	52	43	51	74	54
	0.250–0.500	8	9	20	23	11
	0.500–0.750				5	1
	0.750–1.000	1	1	3	2	3
	1–2					2
	Total number of individuals monitored*	2,822	2,565	2,652	2,928	2,720
	Number with measurable dose	469	477	597	591	569
	% with measurable dose	17%	19%	23%	20%	21%
	Collective TED (person-rem)	23.670	21.261	31.016	37.797	31.749
	Average measurable TED (rem)	0.050	0.045	0.052	0.064	0.056
All DOE	"Total number of records for monitored individuals"	86,667	83,235	86,694	92,066	91,839
	Number with measurable dose	11,198	11,296	11,757	13,039	12,957
	% of total monitored who are transient	3.3%	3.1%	3.1%	3.2%	3.0%
	"% of the number with measurable dose who are transient"	4.2%	4.2%	5.1%	4.5%	4.4%

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

Exhibit 3-18:
Collective Dose and Average Measurable Dose, 1974–2011.

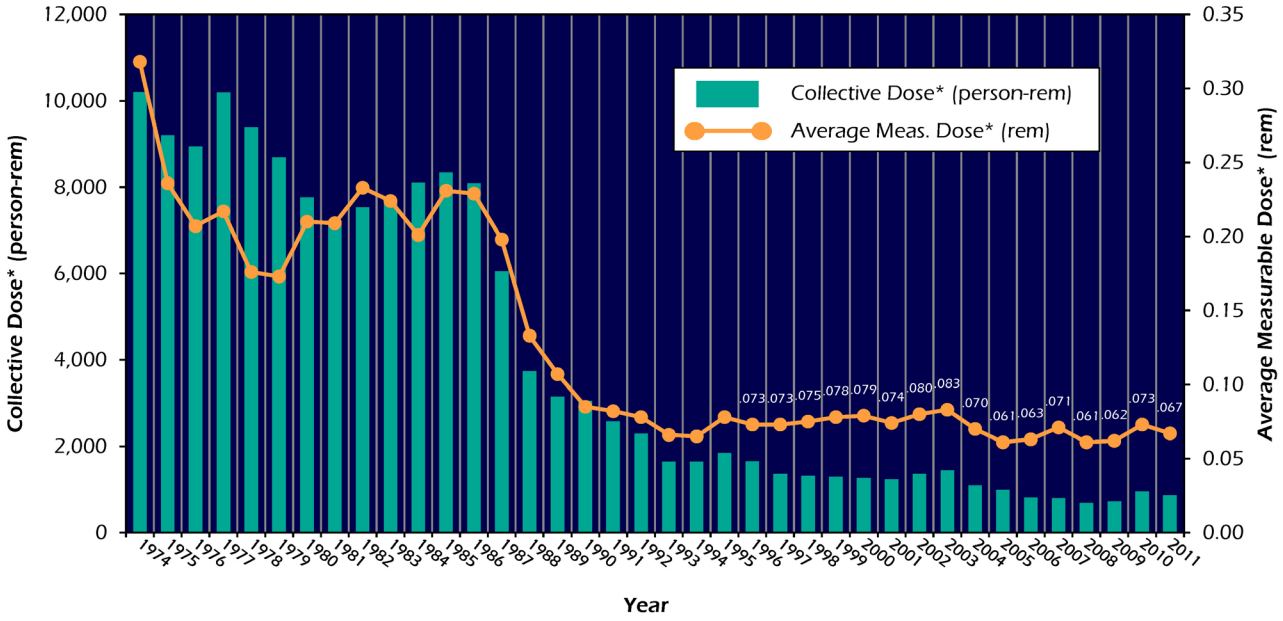
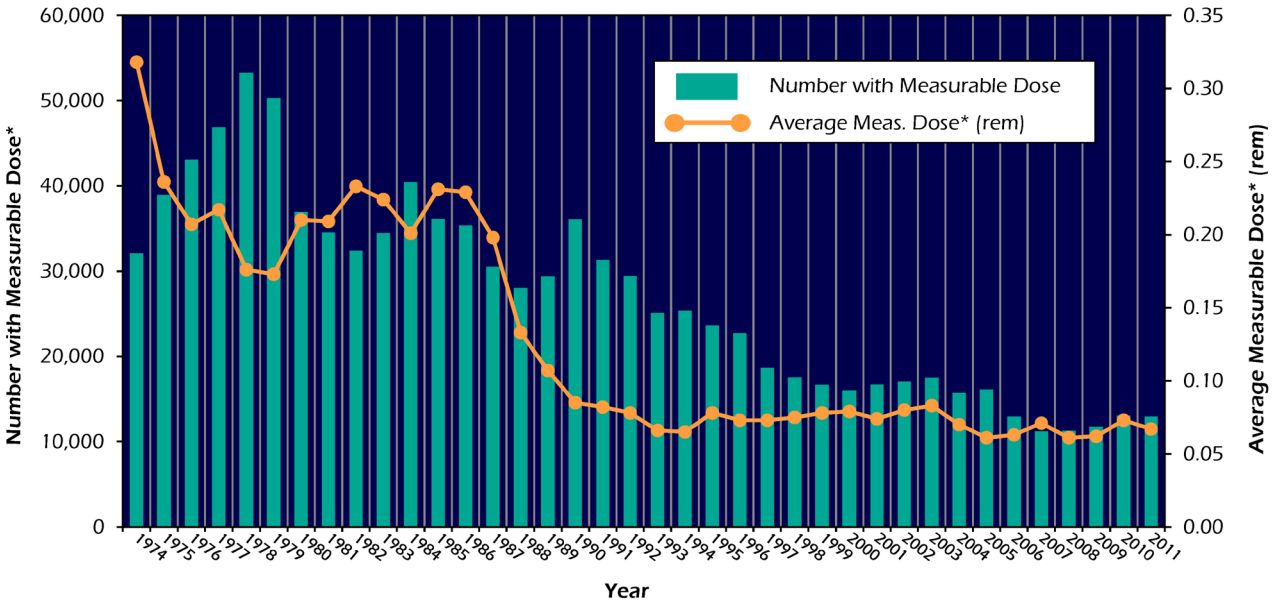


Exhibit 3-19:
Number of Workers with Measurable Dose and Average Measurable Dose, 1974–2011.



* 1974–1989 collective dose = DDE
1990–1992 collective dose = DDE + AEDE
1993–2010 collective dose = DDE + CEDE
2011 collective dose = ED + CED

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

and Development Administration, which subsequently became DOE. *Exhibits 3-18* and *3-19* show the collective dose, average measurable dose, and number of workers with a measurable dose from 1974 to 2011. 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 have reported historical data during the year 2011.

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

Sites that have voluntarily reported historical data are as follows:

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

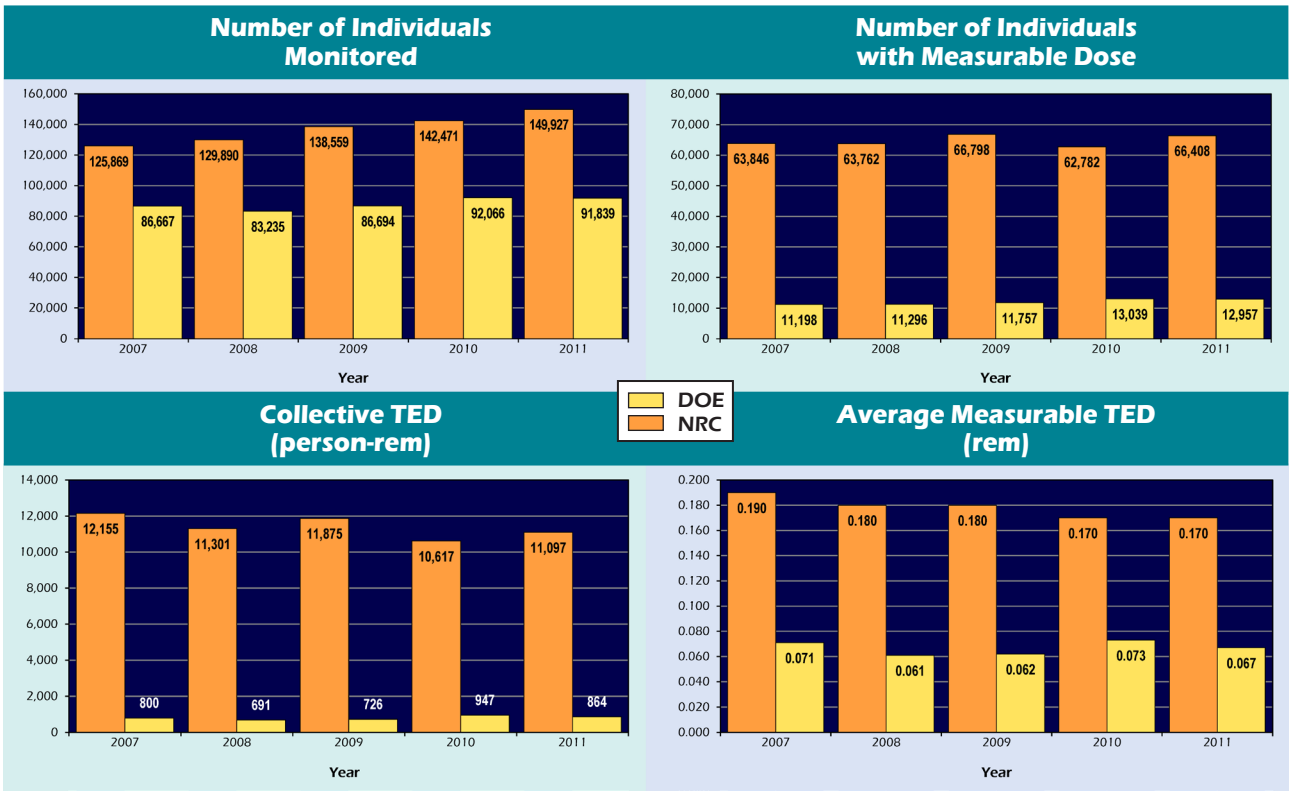
3.7 DOE Occupational Dose in Relation to Other Activities

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

In the *DOE Occupational Radiation Exposure Report 1992-1994*, DOE occupational radiation exposure was shown in relation to other industrial and governmental endeavors in order to gain an understanding of the relative scale of the radiation exposure at DOE operations to other activities. The 2011 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 79% 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 (2007 to 2011). 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 20% of the NRC total for this time period. The percentages of DOE's collective dose (TED) and average measurable dose (TED) were 8% and 39% of the NRC totals, respectively.

Exhibit 3-20:
Comparison of Occupational Exposure for DOE and NRC, 2007 –2011.



Section Four

4 ALARA Activities at DOE

Descriptions of ALARA activities at DOE are provided on the HSS 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://www.hss.doe.gov/SESA/Analysis/rems/rems/ALARA.cfm

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. The 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, 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 HSS web site as follows:

http://www.hss.doe.gov/SESA/Analysis/II/

1000 Independence Avenue, SW

Washington, D.C. 20585-1290

E-mail: nimi.rao@hq.doe.gov

Section Five
Conclusions

5

Conclusions

The occupational radiation exposure records show that in 2011, DOE facilities continued to comply with DOE dose limits and ACLs and worked to minimize exposure to individuals. Only 14% of the monitored workers received a measurable dose and the average measurable dose was less than 2% of the DOE limit. In 2011, the collective dose and the number of individuals with measurable dose decreased by 9% and 1%, respectively. These decreases in the dose and number of individuals 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 10 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 84 person-rems from 2010 to 2011. This year marks the first time since 2008 that collective dose in the DOE complex decreased. Much of this can be attributed to a decline in ARRA activities and the absence of events that exceeded the 2 rems occupational exposure limit.

The collective dose at DOE facilities has experienced a dramatic (90%) 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:
2011 Radiation Exposure Summary.

- The collective TED decreased 9% from 947 person-rems (9,470 person-mSv) in 2010 to 864 person-rems (8,640 person-mSv) in 2011.
- Sites contributing significantly to collective TED were (in descending order of collective TED) Savannah River, Hanford, Los Alamos, Idaho, and Oak Ridge. These sites accounted for 78% of the collective TED at DOE in 2011.
- The decrease in dose seen at four of the top five DOE sites was attributed to a variety of causes. The implementation of handheld x-ray devices to accurately identify prohibited waste items reduced the amount of rework at SRS. Improvements in the planning of drum movements and better configuration in waste storage areas and increased worker awareness of the location of elevated exposure rate areas helped decrease exposure at Idaho. Both Savannah River and Hanford saw decreases in collective TED due to a reduction in ARRA activities.
- Sites attributed much of the decrease in collective dose to the winding down of ARRA activities and the completion of several large projects in 2011.
- The collective internal dose (CED) decreased by 47% between 2010 and 2011.
- Uranium-234 accounted for the largest percentage of the collective CED, with over 97% of this dose accrued at Y-12.
- The collective TED for transient workers decreased by 16% from 37.8 person-rems (378 person-mSv) in 2010 to 31.7 person-rems (317 person-mSv) in 2011.

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Glossary

Glossary

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

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

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. Average measurable dose is calculated for total effective dose (TED), effective dose (ED), neutron dose, extremity dose, and other types of dose.

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.

CR
See SR.

ED
The summation of the products of the ED received by specified tissues or organs of the body (H_T) and the appropriate tissue weighting factor (w_T)—that is, $E = \Sigma w_T H_T$. It includes the dose from radiation sources internal and/or external to the body.

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).

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

exposure
As used in this report, exposure refers to individuals subjected to, or in the presence of, radioactive materials that may or may not result in occupational radiation dose.

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.

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
An individual's ionizing radiation dose (external and internal) as a result of that individual's work assignment. Occupational dose 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.

SR (formerly CR)
SR is defined by United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) as the ratio of the annual collective dose delivered at individual doses exceeding a specified dose value to the collective dose. UNSCEAR uses a subscript to denote the dose value (in mSv) used in the calculation of the ratio. Therefore, SR_{15} would be the ratio of the annual collective dose delivered at individual doses exceeding 1.5 rems (15 mSv) to the total annual collective dose.

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 ED to the whole body for external exposures and the committed equivalent dose to the maximally exposed organ or tissue other than the skin or the lens of the eye.

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

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

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References

References

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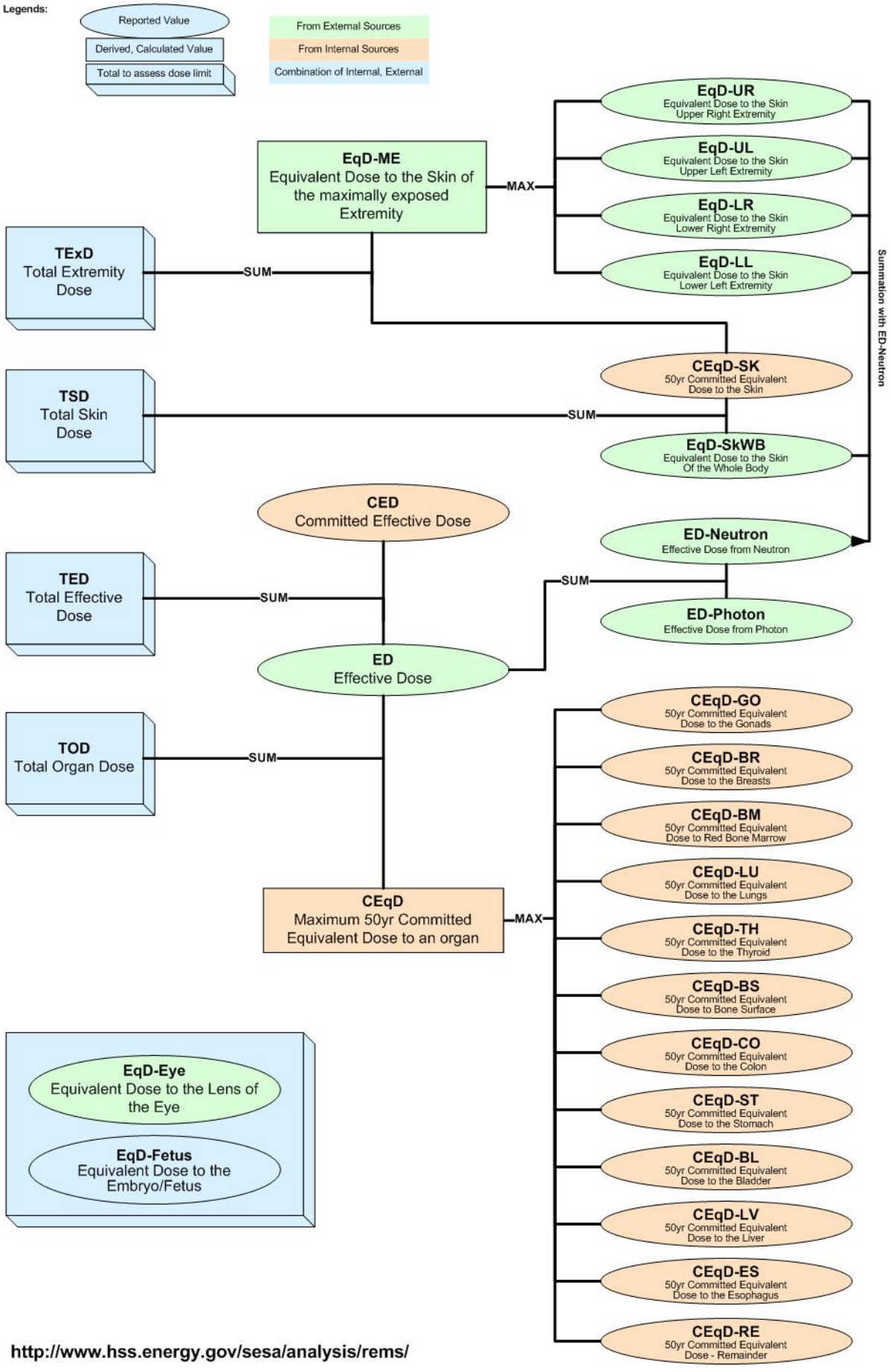
9. Computerized Accident and Incident Reporting System (CAIRS), "DOE and Contractor Injury and Illness Data by Year by Quarter" report. Online at http://www.hss.doe.gov/sesa/analysis/cairs/cairs/home.htm.

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



http://www.hss.energy.gov/sesa/analysis/rems/

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 2011 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 (HS-24)
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

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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 above 2 rems ACL	1	2	3	4	5
Doses in Excess of 5 rems	1	2	3	4	5
Internal Depositions 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
Description of Activities Related to Dose	1	2	3	4	5
Historical Data	1	2	3	4	5
ALARA Activities at DOE	1	2	3	4	5
Conclusions	1	2	3	4	5

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

Not important				Critical
1	2	3	4	5

Please provide any additional input or comments on the report.

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