



# DOE Radiation Exposure Monitoring System (REMS) Data Update

**Nimi Rao**

Office of Analysis (AU-23)

Office of Environmental Protection, Sustainability Support, and Corporate Safety Analysis  
Office of Environment, Health, Safety and Security (AU)

**Derek Hagemeyer**

ORAU

Health Physics Society

59<sup>th</sup> Annual Meeting

July 13-17, 2014 Baltimore, Maryland





## Purpose



- REMS Products and services
- Present the 2013 draft data for DOE occupational radiation exposure
  - Compare to last year and last 5 years
  - Discuss trends and overview
- Overview of E-Products

**Note: 2013 Data is preliminary and subject to change.**

***Data for previous years have been published  
and are available on the REMS web site***



## Relationship to NRC



- In 1996-1997, an Inter-agency Agreement was established between DOE and NRC to re-design REMS
- Currently there is a Protective Agreement in place to allow information sharing between DOE and NRC.
- Both databases share the same server and managed by ORAU
  - Project Manager at ORAU: Derek Hagemeyer



# REMS Products And Services



- REMS is the central repository of occupational radiation exposures for all DOE and DOE contractor workers
- Annual Report
- Web Page:  
<http://energy.gov/ehss/occupational-radiation-exposure>
- E-products currently under development
  - Dashboard- E Report
  - Ten Year Overview



# Acronyms

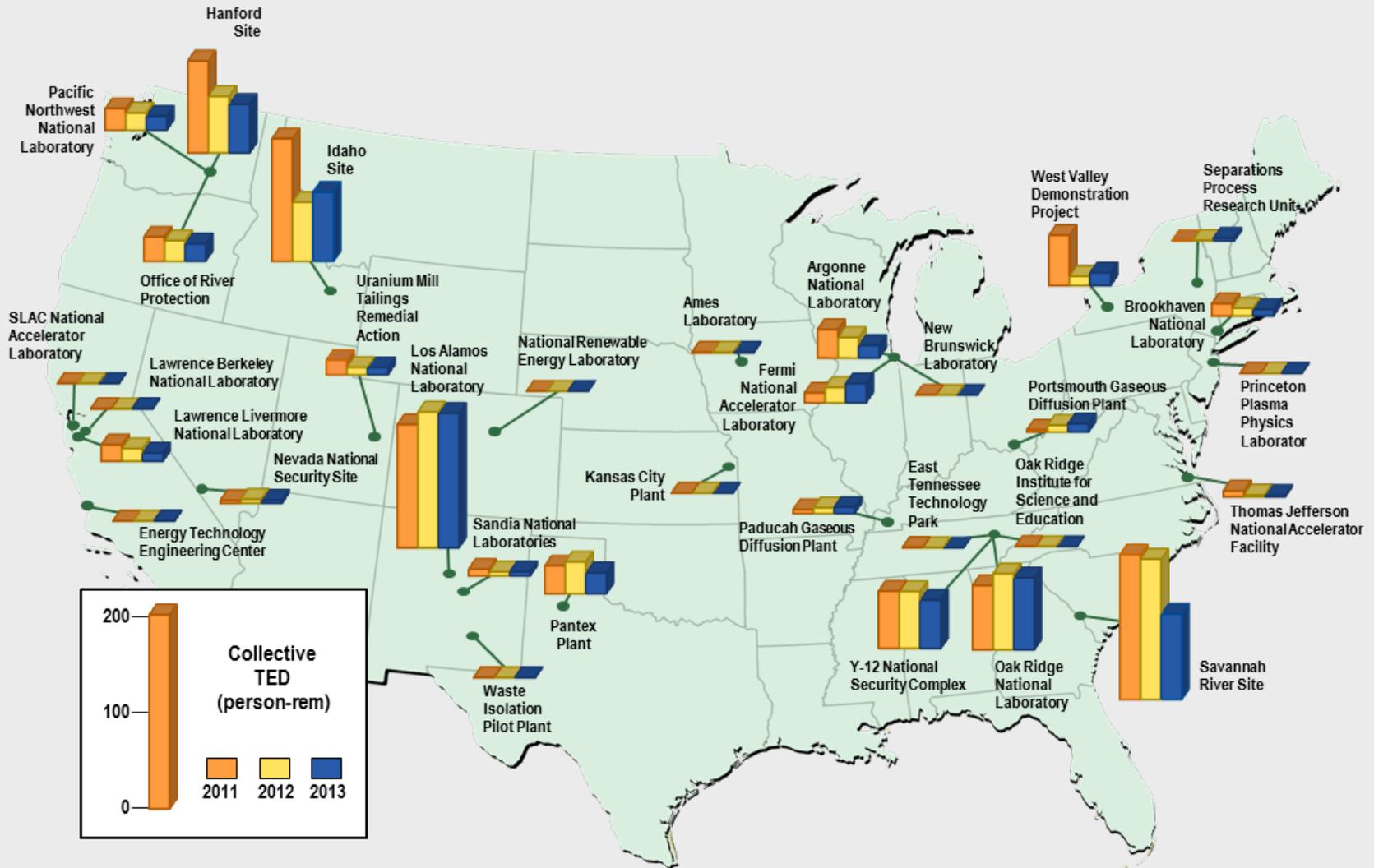


AEC	Atomic Energy Commission	EqD-SkWB	Equivalent Dose to the Skin of the Whole Body
AEDE	Annual Effective Dose Equivalent	EqD-UL	Equivalent Dose to the Skin Upper Left Extremity
ARRA	American Recovery and Reinvestment Act of 2009	EqD-UR	Equivalent Dose to the Skin Upper Right Extremity
CED	Committed Effective Dose	ERDA	Energy Research and Development Administration
CEDE	Committed Effective Dose Equivalent	HSS	Office of Health, Safety and Security
CEqD	Committed Equivalent Dose	ORAU	Oak Ridge Associated Universities
CEqD-SK	Committed Equivalent Dose to the Skin	REMS	Radiation Exposure Monitoring System
DDE	Deep Dose Equivalent	TED	Total Effective Dose
DOE	Department of Energy	TExD	Total Extremity Dose
ED	Effective Dose	TOD	Total Organ Dose
EqD-Eye	Equivalent Dose to the Lens of the Eye	TRU	Transuranic
EqD-LL	Equivalent Dose to the Skin Lower Left Extremity	TSD	Total Skin Dose
EqD-LR	Equivalent Dose to the Skin Lower Right Extremity		

Gray text indicates older terminology no longer used.



# Collective TED by DOE Site for 2011–2013





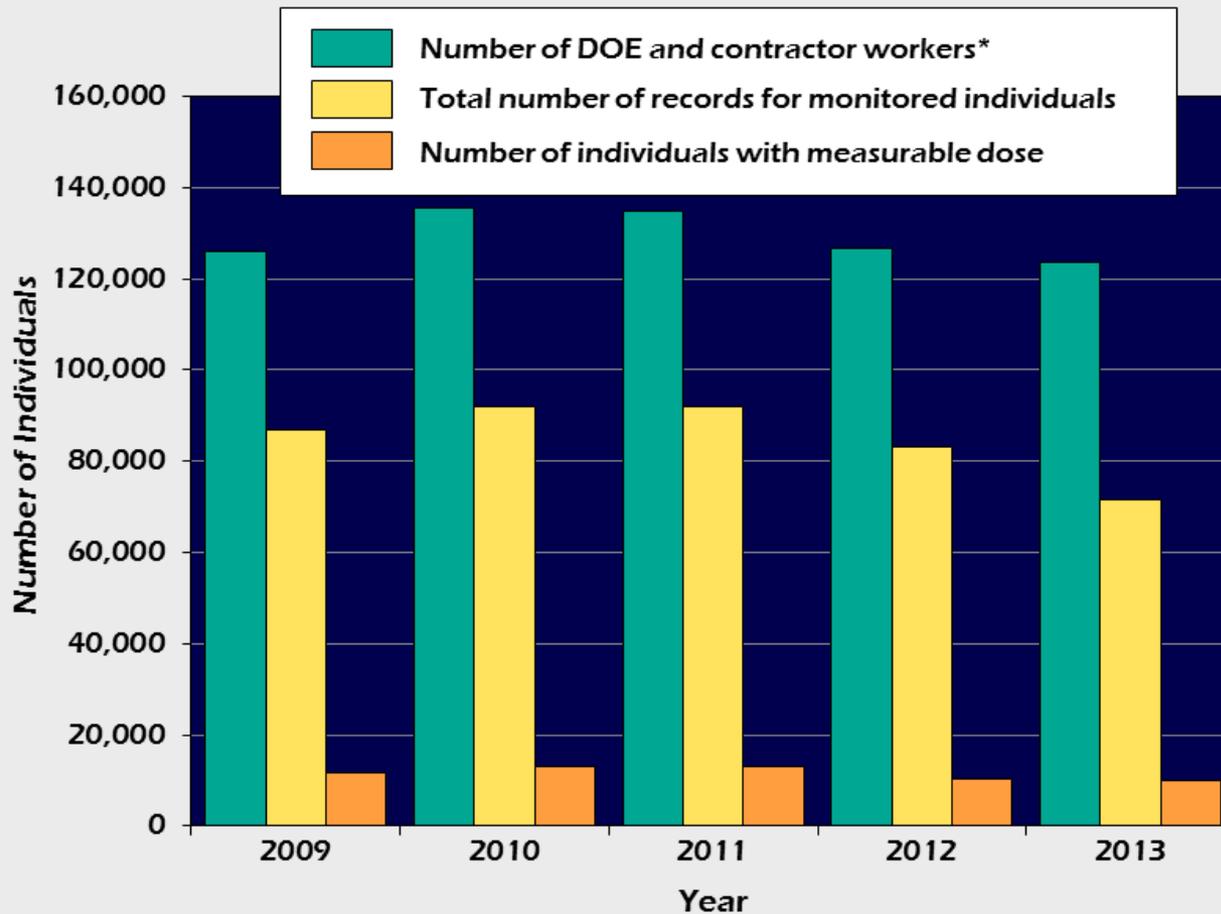
# Current Laws and Requirements Pertaining to Recording and Reporting Occupational Exposure to REMS



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



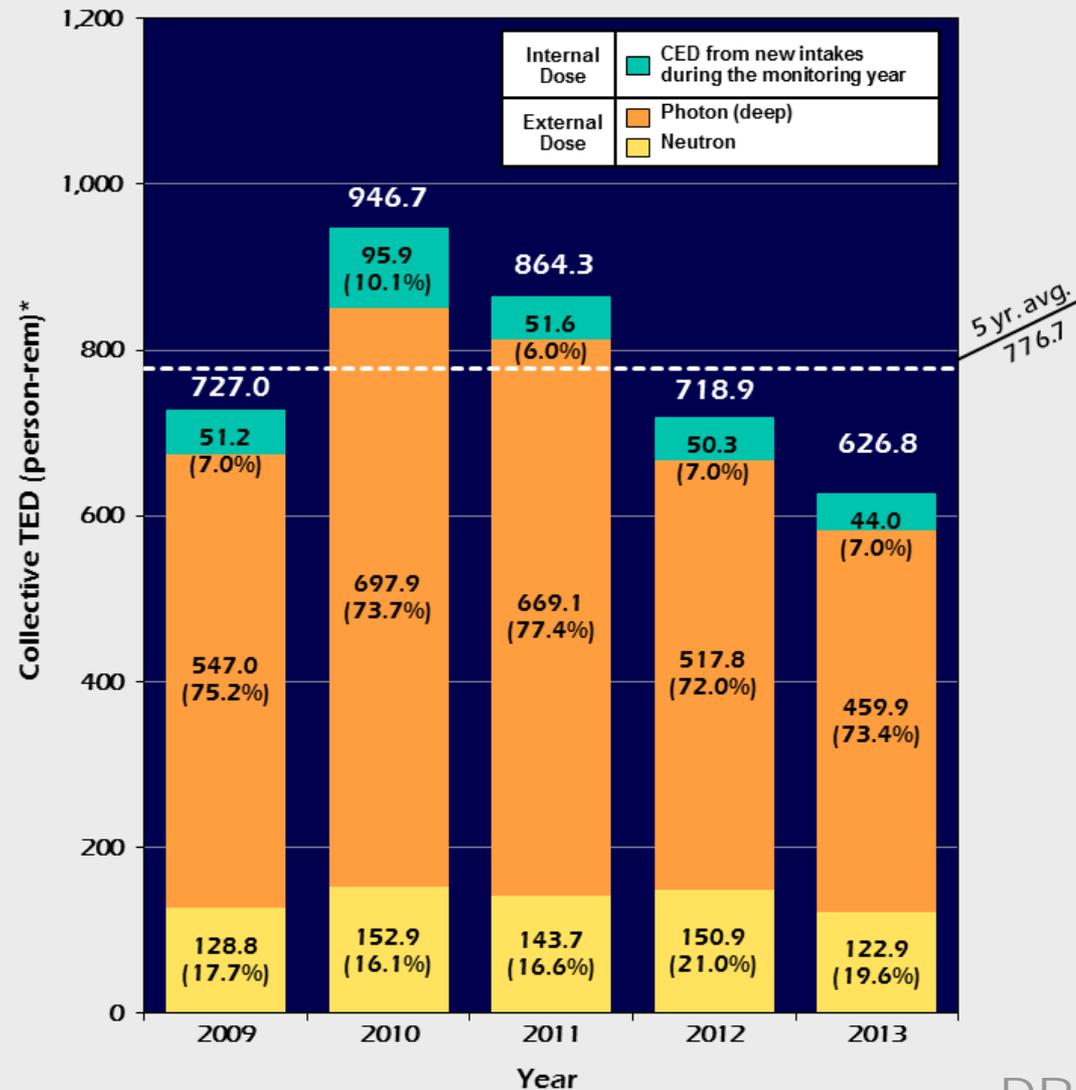
# Monitoring of the DOE Workforce, 2009–2013



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



# Components of TED, 2009–2013

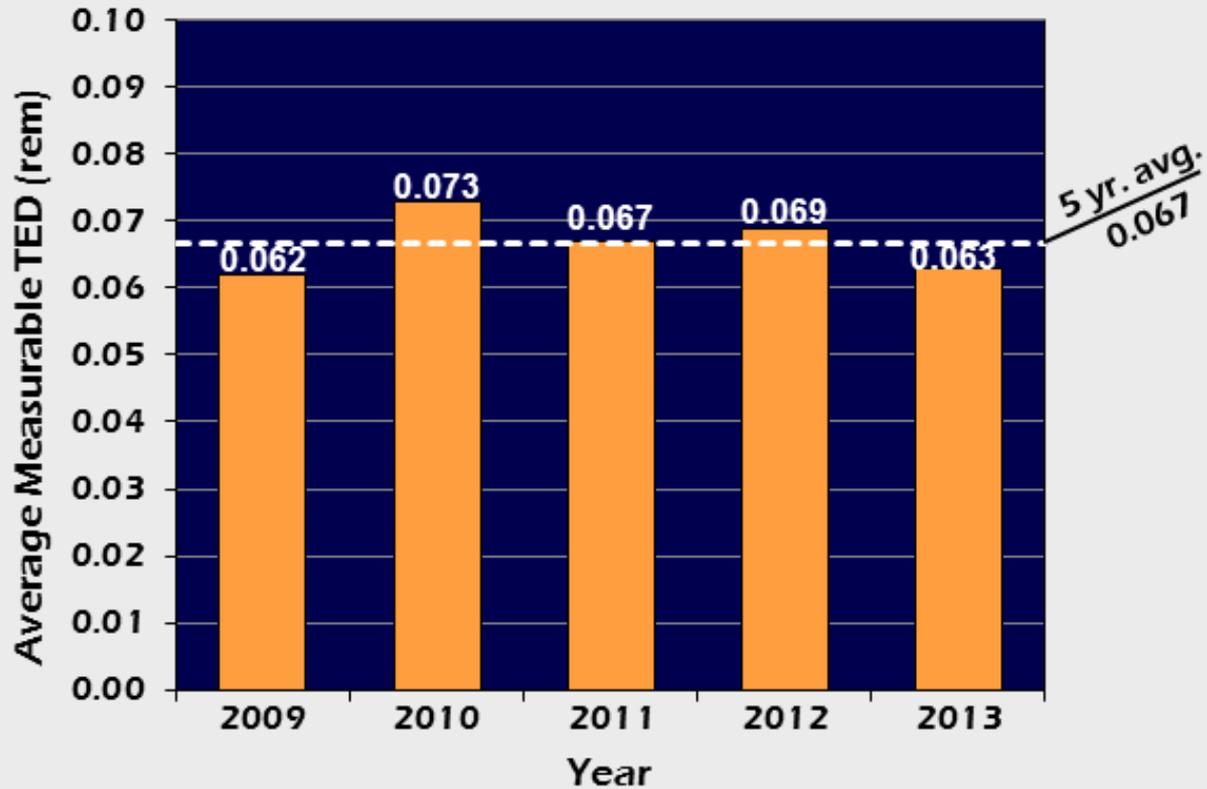


\* The percentages in parentheses represent the percentage of each dose component to the collective TED.

DRAFT DATA  
as of 5/07/14



# Average Measurable TED, 2009–2013





# Distribution of TED by Dose Range, 2009–2013



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

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



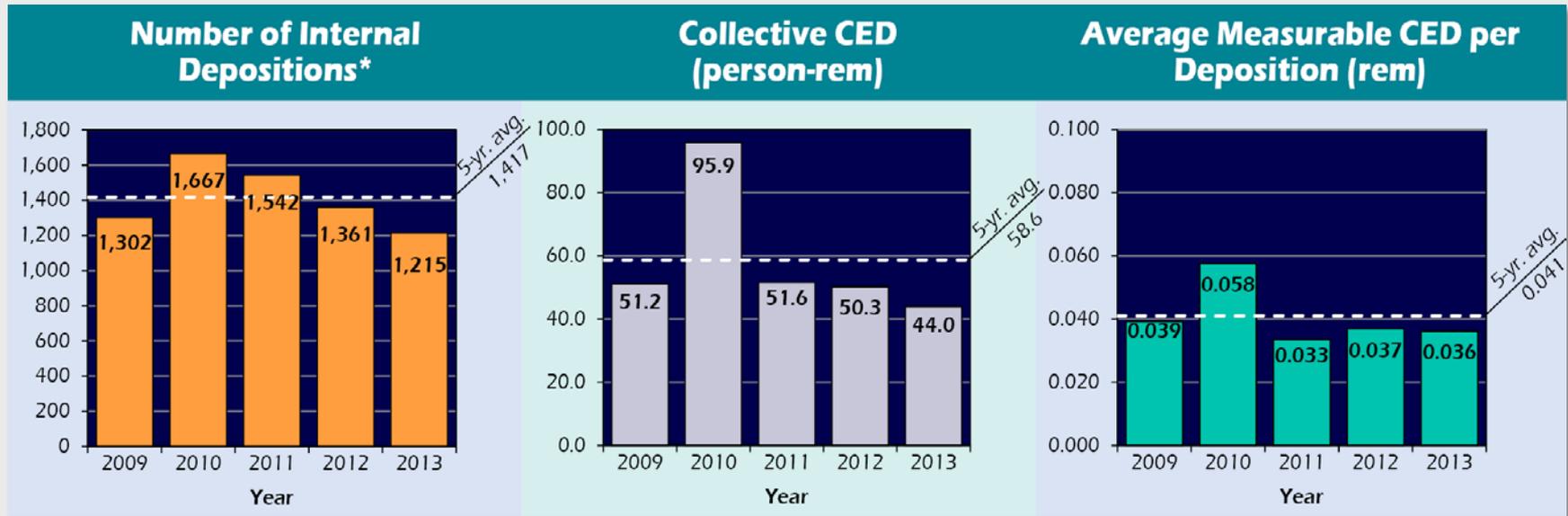
# Doses in Excess of DOE Limit, 2009–2013



Year	Total Effective Dose (TED) (External + Internal Dose) (rem)	Effective Dose (ED) from External Sources (rem)	Committed Effective Dose (CED) from Intakes (rem)	Committed Equivalent Dose (CEqD) from Intakes (rem)	Intake Nuclides	Facility Types	Site
2009	_____	_____	_____	None reported	_____	_____	_____
2010	31.618	0.029	31.589	1,043.190	Pu-238	Transuranic (TRU) Waste Remediation Facility	SRS
2011	_____	_____	_____	None reported	_____	_____	_____
2012	_____	_____	_____	None reported	_____	_____	_____
2013	_____	_____	_____	None reported	_____	_____	_____



# Number of Internal Depositions, Collective CED, and Average Measurable CED, 2009–2013



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



# Internal Dose Distribution from Intakes, 2009–2013



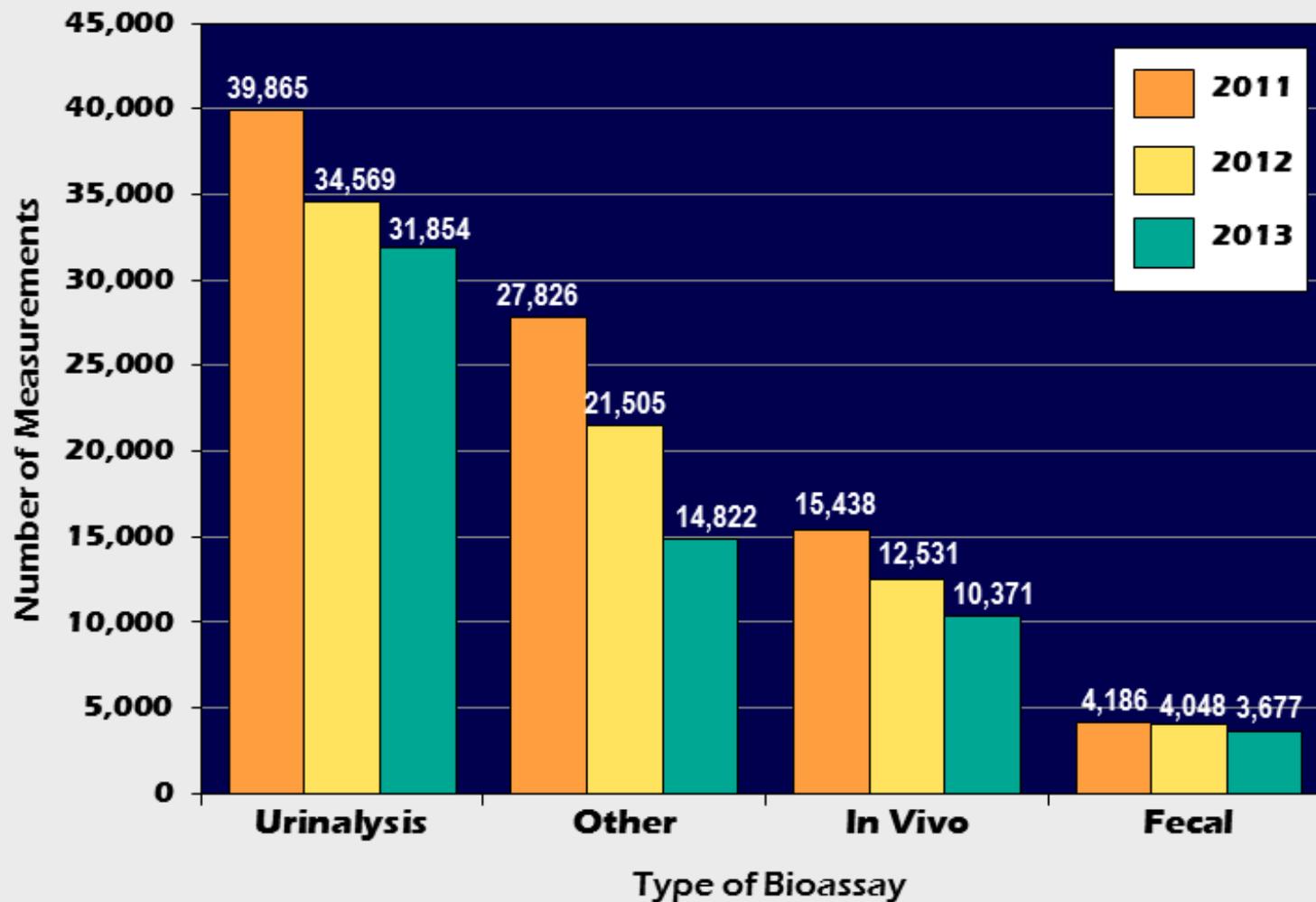
Year	Number of Individuals with CED in the Ranges (rem)*											Total No. of Indiv.**	Total Collective CED (person-rem)
	Meas. <0.020	0.020-0.100	0.100-0.250	0.250-0.500	0.500-0.750	0.750-1.000	1.0-2.0	2.0-3.0	3.0-4.0	4.0-5.0	>5.0		
2009	707	456	118	16	4	1						1,302	51.162
2010	895	612	137	19	1	1	1				1	1,667	95.928
2011	886	535	107	12	1		1					1,542	51.601
2012	737	481	125	17	1							1,361	50.253
2013	671	430	106	5	2	1						1,215	43.966

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

\*\* Individuals may have multiple intakes in a year and, therefore, may be counted more than once.

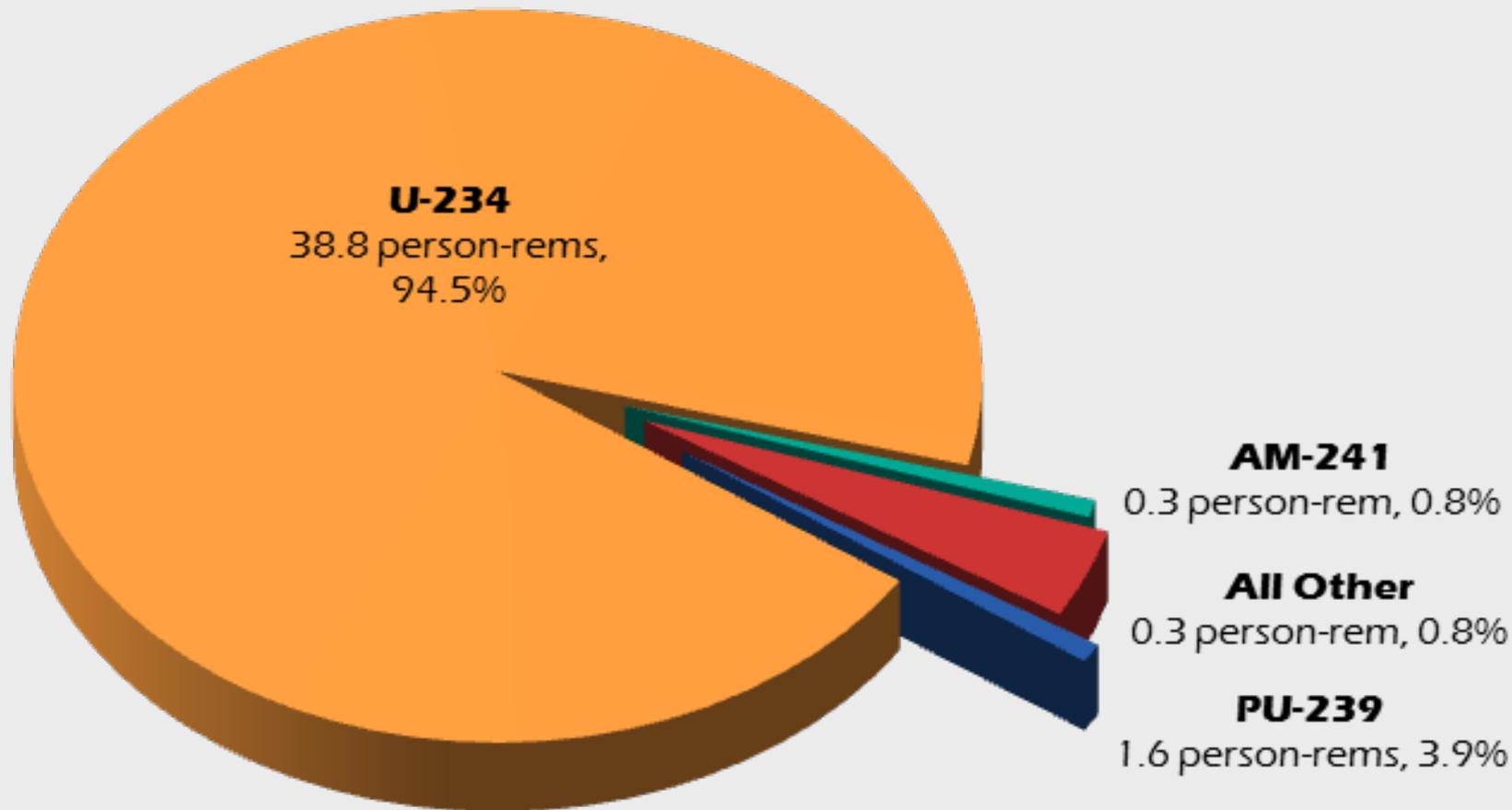


# Bioassay Measurements, 2011-2013



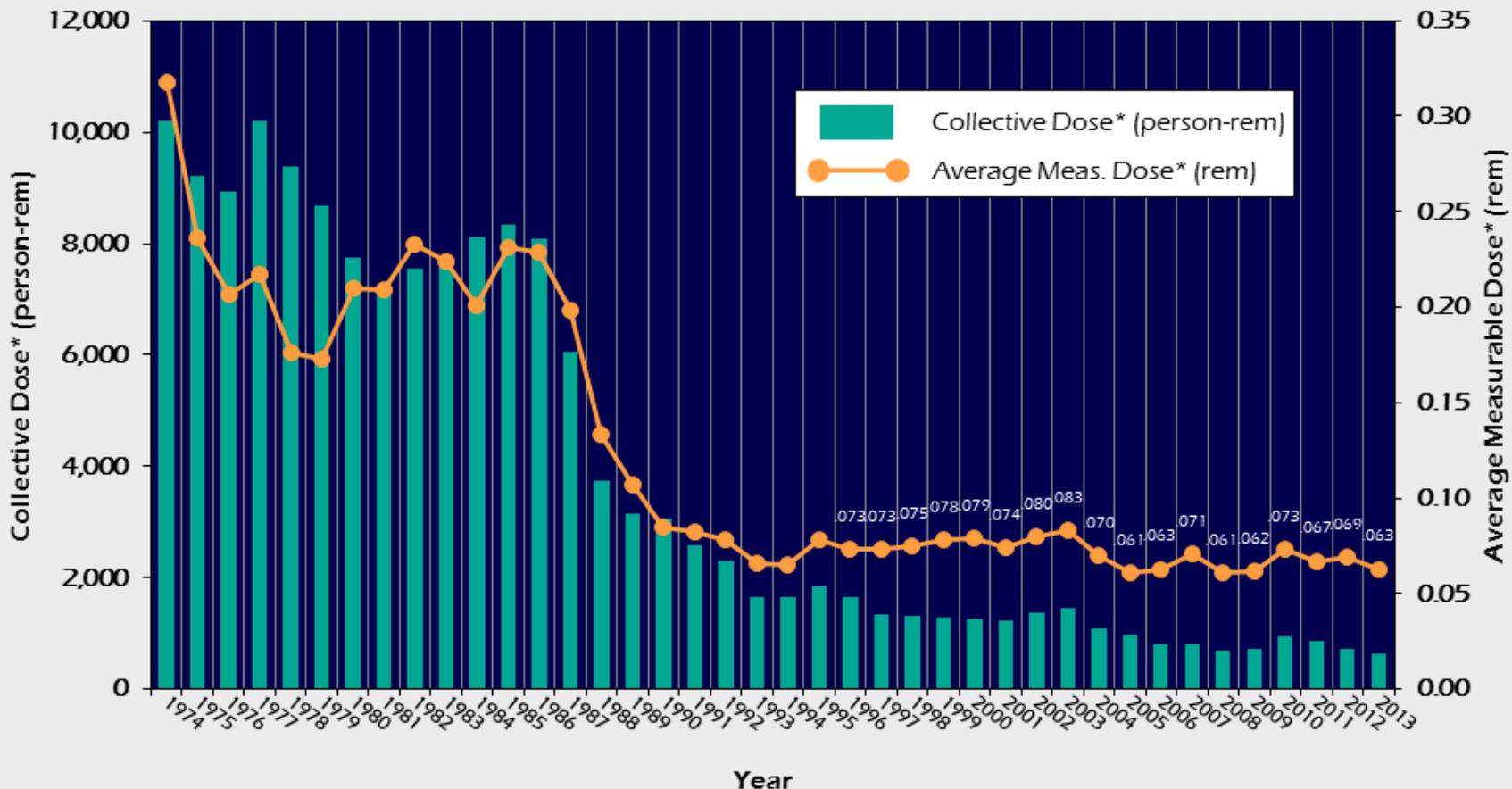


# Collective CED by Radionuclide, 2013





# Collective Dose and Average Measurable Dose, 1974–2013



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

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



## Conclusions



- The average measurable TED and the dose distribution have remained consistent over the past 5 years, and the collective TED has decreased in 2013 for the third year in a row.
- The decrease in collective TED during 2013, is primarily due to:
  - Budgetary constraints**
  - A decrease in production work to accommodate the government shutdown during the sequestration in October 2013**
  - Criticality safety program pause at LANL**



## E-Products



- DOE has initiated an effort to develop several electronic digital products or “e-products” to allow for interactive analysis and dissemination of information.
- Two products been developed to date:
  - [Dashboard](#)
  - [10 Year Overview](#)
- These e-products are draft and currently under review at the Office of Analysis for further development



## Contact



Nimi Rao, DOE AU-23  
Nimi.Rao@hq.doe.gov  
301-903-2297

Derek Hagemeyer, ORAU  
derek.hagemeyer@orau.org  
865-241-3615



End



# DOE Dose Limits from 10 CFR 835



Personnel Category	Section of 10 C.F.R. 835	Type of Exposure	Acronym	Annual Limit
General employees	835.202	Total effective dose. The sum of the effective dose (for external exposures) and the committed effective dose.	TED	5 rems
		The sum of the equivalent dose to the whole body for external exposures and the committed equivalent dose to any organ or tissue other than the skin or the lens of the eye.	EqD-WB + CEqD (TOD)	50 rems
		Equivalent Dose to the Lens of the Eye	EqD-Eye	15 rems
		The sum of the equivalent dose to the skin or to any extremity for external exposures and the committed equivalent dose to the skin or to any extremity	EqD-SkWB + CEqD-SK and EqD to the maximally exposed extremity + CEqD-SK	50 rems
Declared pregnant workers*	835.206	Total equivalent dose	TEqD	0.5 rem per gestation period
Minors	835.207	Total effective dose	TED	0.1 rem
Members of the public in a controlled area	835.208	Total effective dose	TED	0.1 rem

\*Limit applies to the embryo/fetus.