



A Basic Overview of
OCCUPATIONAL RADIATION EXPOSURE
Monitoring, Analysis & Reporting

*Outreach & Awareness Series to
Advance the DOE Mission*



*Office of Health, Safety and Security
U.S. Department of Energy*

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Overview

One of the priorities of the Department of Energy (DOE) is to ensure a safe and secure workplace by integrating safety and security into every element of the Department's mission to safeguard employees, contractors, and subcontractors.

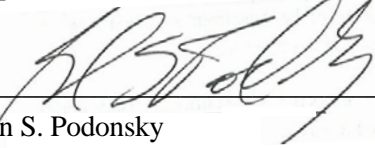
This pamphlet is developed as part of the Office of Health, Safety and Security's (HSS) outreach and awareness campaign to proactively advance safe execution of the DOE mission. It is intended to provide a short summary of two specific HSS programs that aid in the oversight of radiation protection activities at DOE.

Title 10, Code of Federal Regulations (C.F.R.), Part 835, *Occupational Radiation Protection*, establishes radiation protection standards, limits, and program requirements for protecting individuals from radiation resulting from the conduct of DOE activities. Radiation protection programs within DOE cover a large range of diverse programs and activities. This pamphlet focusses on two HSS activities that help ensure radiation exposures are accurately assessed and recorded, namely: 1) the quality and accuracy of occupational radiation exposure monitoring, and 2) the recording, reporting, analysis, and dissemination of the monitoring results.

The Department of Energy Laboratory Accreditation Program (DOELAP) is in place to ensure that radiation exposure monitoring at all DOE sites is precise and accurate, and conforms to national and international performance and quality assurance standards.

The DOE Radiation Exposure Monitoring Systems (REMS) program provides for the collection, analysis, and dissemination of occupational radiation exposure information. The annual REMS report is a valuable tool for managing radiological safety programs and for developing policies to protect individuals from occupational exposure to radiation. In tandem, these programs provide DOE management and workers an assurance that occupational radiation exposures are accurately measured, analyzed, and reported.

HSS strives to provide subject matter expertise and technical assistance related to occupational radiation exposure monitoring, analysis, and reporting. Please do not hesitate to contact us with any questions or need for assistance.



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Why are we concerned about exposure to radiation?

We are constantly exposed to radiation, whether from natural or man-made sources. Radiation consists of energy and particles that are given off by unstable atoms as part of a natural process to become stable or generate during the operation of high energy devices (e.g., accelerators). When we are exposed to radiation from the work we do, care is taken to protect against biological damage to the cells and DNA (genetic material) of our body, as well as risk of illness using engineered controls and by establishing regulatory controls. Fortunately, such risks are minimal at normal background radiation levels, at typical levels of medical exposure, and at occupational exposure levels allowed by regulations. HSS is responsible for establishing the regulatory requirements related to monitoring, assessing, reporting, and analyzing the radiation exposure to workers within the DOE Complex and to the public.

What are exposure limits?

Government agencies have established regulations that set limits for exposure to radiation and radioactive material based on extensive scientific research and recommendations from national and international scientific organizations. These limits are designed to protect individual workers, the public, and the environment, and are set at “acceptable” levels of risk similar to those for industrial activities (e.g., chemical, mining, transportation).

The key U.S. limit for occupational exposure to radiation is 5 rems/year (50 mSv/year),¹ while the exposure limit to minors and the general public is set at 100 mrem/year (1 mSv/year), as specified in 10 C.F.R. 835 and DOE O 458.1. DOE radiation

¹ The “System International” of units (SI system) for radiation measurement uses the “sievert” (Sv) for equivalent dose. (1 Sv=100 rems, 1 mSv = 100 mrem)

protection standards and exposure limits for workers are found in 10 C.F.R. 835, as shown in the table below.

In 2007, DOE revised the dosimetric quantities and units to reflect current international consensus values. Use of these quantities and units were required by July 2010.

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, which is the sum of the effective dose from external exposure and the committed effective dose from intakes.	TED (ED+CED) TOD (ED+CEqD)	5 rems
		Equivalent dose to the whole body from external exposures + committed equivalent dose to any organ or tissue (except for the skin and the lens of the eye). This is referred to as the total organ dose.	TOD (ED+CEqD)	50 rems
		Equivalent dose to the lens of the eye.	EqD-Eye	15 rems
		Equivalent dose to the skin or any extremity from external exposure + the committed equivalent dose to the skin or any extremity.	EqD (to the skin or any extremity) + CEqD (to the skin or any extremity)	50 rems
Declared pregnant workers**	835.206	Equivalent dose to the embryo/fetus from conception to birth.	EqD-Fetus	0.5 rem
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

* As amended, 6/8/2007

** Limit applies to the embryo/fetus.

For more information on 10 C.F.R. 835, visit the DOE HSS website at:

<http://www.hss.energy.gov/HealthSafety/WSHP/radiation/rule.html>

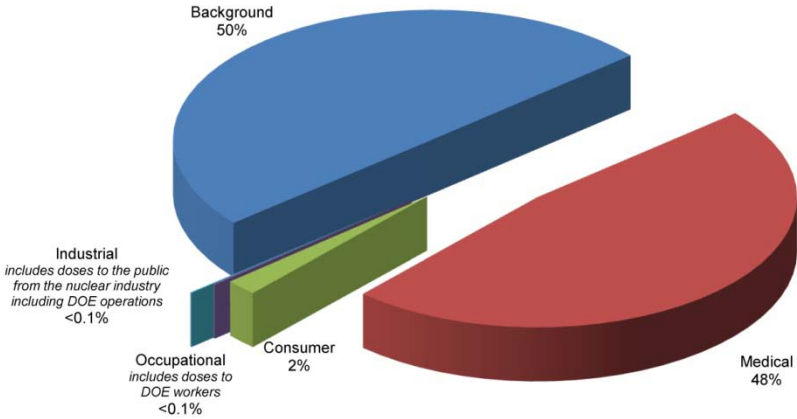
DOE radiation exposure in context

Comparing the DOE radiation exposure with other sources of radiation that we are exposed to in our daily lives provides an understanding of the radiation exposures to DOE workforce. In March 2009, the National Council on Radiation Protection and Measurements (NCRP) published report No. 160, *Ionizing Radiation Exposure of the Population of the United States*, which describes the doses to the U.S. population from all sources of ionizing radiation for 2006 (the most recent data available at the time the report was written). It also provides information on the variability of those doses from one individual to another. The NCRP reports the relative contributions to the U.S. population dose from naturally occurring sources (natural background), such as cosmic radiation from space; terrestrial radiation from radioactive materials in the earth; naturally radioactive materials ingested in food and in the air; medical sources from diagnostic procedures and treatments using radioactive pharmaceuticals and radiation-producing equipment; consumer products; and industrial, security, educational, and research activities. Both occupational and non-occupational doses are addressed.

The pie chart on the following page illustrates the relative contributions of these sources to the total radiation dose for the U.S. population in 2006. In that year, the effective dose per individual in the U.S. population was 620 mrem. The average dose to the largest part of the population is about half of the 620 mrems found in the total U.S. population. The largest segment of the population excludes those receiving doses from CT scans, stress tests or elevated worker doses. The annual dose for the somewhat smaller portion of the population receiving doses from medical diagnostics is over a rem. Doses to the public from industrial uses include nuclear power generation as well as DOE operations; doses to DOE workers from DOE operations are included in the category of occupational dose and are significantly below the regulatory occupational dose limit (5 rems).

Doses to the general public from DOE operations are insignificant, being less than 0.1% of the total radiation dose to the U.S. population.

Percent contribution of various sources of exposure to the total collective effective dose and the total effective dose per individual in the U.S. population for 2006.



Credit: Modification to image courtesy of National Council on Radiation Protection and Measurements

What are applicable requirements, guidance, and standards?

- **10 C.F.R. 835**, *Occupational Radiation Protection*, establishes radiation protection standards, limits, and program requirements for protecting individuals from ionizing radiation resulting from the conduct of DOE activities. Subpart I, “Reports to Individuals,” requires reporting of data to individuals monitored in accordance with 835.402.
- **10 C.F.R. 835.402 (b) and (d)**, “Individual Monitoring,” requires implementing external and internal dose monitoring programs that are accredited, or excepted from accreditation, in accordance with the DOELAP.
- **DOE Order 231.1-1B**, *Environment, Safety and Health Reporting*, requires reporting of the individual occupational radiation exposure data to the REMS repository.
- **REMS Reporting Guide**, provides details about the data format and schedule for reporting.
- **DOE Order 210.2A**, *DOE Corporate Operating Experience Program*, requires collection, analysis, and dissemination of performance indicators, such as occupational radiation exposure information.
- **DOE System of Records DOE-35**, *Personnel Radiation Exposure Records*, establishes requirements for routine use of the data.
- **DOE-STD-1111-98**, *DOE Laboratory Accreditation Program Administration*.
- **DOE-STD-1095-2011**, *DOE Laboratory Accreditation for External Dosimetry*.
- **DOE-STD-1112-98**, *DOE Laboratory Accreditation Program for Radiobioassay*.

What is DOELAP?

DOELAP sets quality assurance and performance standards to ensure occupational exposure to radiation is measured accurately and consistently. DOELAP is part of the overall radiation protection program that assures workers that their work environments are safe and gives them confidence that their radiation exposures are accurately measured.

DOELAP consists of both an External Dosimetry Accreditation Program and a Radiobioassay Accreditation Program. The accreditation processes involve onsite assessments of the DOE programs and performance testing. Performance testing is carried out by the Radiological and Environmental Sciences Laboratory (RESL), which is operated by the DOE Office of Nuclear Energy and located in Idaho. Performance testing determines a program's ability to meet accuracy and precision requirements, while the onsite assessment evaluates a program's quality assurance processes.

DOELAP is made up of assessors, oversight boards, RESL, and the DOELAP Administrator. Assessors are volunteers from the various DOE contractor dosimetry and radiobioassay programs who have been trained by RESL to perform these assessments. Oversight board members are also volunteers and are often the directors of DOE site programs or have had extensive dosimetry or radiobioassay experience. Performance test and assessment results are reviewed by the appropriate oversight board which then makes recommendations to the DOELAP Administrator regarding further accreditation. Finally, the DOELAP Administrator accredits those programs that successfully met all criteria.

DOELAP currently accredits external dosimetry programs at 21 DOE sites and radiobioassay programs at 18 of those sites. These programs monitor workforces that range from several dozen individuals to several thousand, and cover activities that include biological research, high-energy physics, nuclear weapon manufacturing, and the cleanup of former nuclear weapon production facilities.

Not all DOE sites conduct work that has the potential for breathing in or the ingestion of radioactive material. The three DOE sites that do not have radioassay programs are dedicated to particle accelerator research.

DOELAP also provides calibration sources through its phantom library. The calibration sources are provided to programs that use relatively large radiation detectors to identify and measure the amount of certain radioactive materials that may have been incorporated in an individual's body. The library, currently maintained and operated by RESL, has human body-like phantoms for loan to DOE sites, U.S. Nuclear Regulatory Commission (NRC) licensees, and state emergency response organizations. The phantoms are loaned at no cost other than shipping and insurance.

What are the basic elements of DOELAP?

1. Performance testing
2. Onsite assessment
3. Accreditation certification
4. Assessor training
5. Program development
6. Applied research in areas where technological shortfalls exist

What is the REMS program?

The DOE REMS program establishes a database for collection, analysis, and dissemination of data on occupational radiation exposures received at DOE sites. DOE and the U.S. NRC have a Protective Agreement (PA) to share radiation exposure data to allow both agencies to collect and maintain dose records of monitored individuals. Requests for prior dose records often pertain to worker exposures at both NRC and DOE facilities. For this reason, both agency databases are managed by Oak Ridge Associated Universities in Oak Ridge, TN.

The REMS database serves as the central repository of radiation exposure information for DOE. The database consists of individual occupational radiation exposure records for DOE workers from 1987 to the present. From 1969 to 1987, facilities were required to report only career radiation exposure records when the individual terminated employment. As part of a historical data collection effort, 13 major DOE sites voluntarily provided historical exposure data (about 4 million dose records) to the REMS database.

An annual analysis and explanation of observed trends in occupational exposure across DOE are provided in the *DOE Occupational Radiation Exposure Report*. Reports since 1974 are available at <http://www.hss.energy.gov/sesa/analysis/remes/annual.htm>.

What are the basic elements of the REMS program?

1. Data collection and management
2. Publish the annual Occupational Radiation Exposure Report
3. Data dissemination and guidance

What DOELAP and REMS resources are available?

Additional information on DOELAP is located at:

<http://www.hss.energy.gov/sesa/corporatesafety/doelap/>

1. DOELAP Regulatory Basis
2. DOELAP Program Administration
3. Phantom library
4. Application for accreditation

Additional information on REMS is located at:

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

1. Annual Occupational Radiation Exposure Reports since 1974
2. Statistical data since 1984
3. Applicable DOE Orders and instructions for the recordkeeping and reporting of occupational radiation exposure at DOE
4. Guidance on how to request dose data from DOE and other federal agencies
5. Guidance on how to report data to the REMS repository

Contact Information:

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10 C.F.R. 835

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