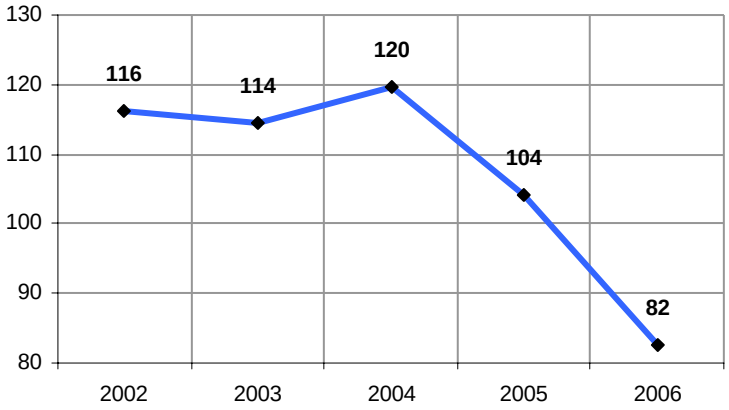
Radiological Control Profile for the Office of Science Laboratories 2002-2006

Collective Dose from all SC Laboratories (Person-Rem)



Office of Safety, Security and Infrastructure (SC-31)
Office of Science
U.S. Department of Energy

This page intentionally left blank.

This page intentionally left blank.

Executive Summary

Looking back at the trend over the past five years, the collective dose from all Office of Science (SC) laboratories has dropped by about 29 percent overall, from 116 person-rem in 2002 to 82 person-rem in 2006. By comparison, the collective dose at all Department of Energy (DOE) laboratories dropped by about 40 percent in the same period, from 1,360 to 813 person-rem.

During 2006, the collective occupational radiation dose for all SC laboratories dropped by about 21 percent to 82 person-rem, down from 104 person-rem in 2005. A large part of this decrease was at Argonne National Laboratory (ANL), where the collective dose dropped from 17 person-rem in 2005 to 9.5 person-rem in 2006. The decrease is attributable to less programmatic work at nuclear facilities such as the Alpha Gamma Hot Cell Facility (AGHCF), as a result of efforts to address nuclear safety issues identified by the DOE Office of Assessment. Another large decrease was at Stanford Linear Accelerator Center (SLAC), where the collective dose dropped to 3.0 person-rem in 2006, down 71 percent from 10.4 person-rem the previous year. The decrease in collective dose was attributable to a corresponding decrease in maintenance activities where activated accelerator components are present.

In 2006, Fermilab conducted a major 12 week shutdown for upgrades, maintenance and repair work, which brought the collective dose up to 25.7 person-rem for the year. For comparison, the collective dose was 16.1 person-rem in 2005, when there were no major shutdowns. Dose trending studies by Fermilab indicate that the collective dose for 2006 was well within the expected range for a year in which a major shutdown occurred, such as was done in 2003.

In 2006, for the second year in a row, there were no workers with an annual dose exceeding 1,000 millirem. In 2004, there were two workers in this category, both at the AGHCF at ANL.

Most workers who were monitored for radiation exposure at SC laboratories received no measurable dose at all. Of those who did, more than 80 percent received less than 100 millirem per year (the threshold for when a dosimeter must be issued). More than 99 percent of those with a measurable dose received an annual dose under 500 millirem, which is one-tenth of the DOE annual limit of 5,000 millirem (5 rem).

Reportable occurrences for personnel contamination, loss of control of radioactive material, spread of contamination or unplanned radiation exposures do not show any clear trend, although they generally correspond to the amount of work performed. Off-site doses to members of the public from releases of radionuclides to the environment are all well within regulatory limits.

Note: New Brunswick Laboratory (NBL) became part of the Office of Science in 2006, and is included in this annual report for the first time.

Introduction

This is a current assessment of the performance of SC laboratories with respect to radiological control. It provides a five-year retrospective look at occupational radiation exposures and radionuclide releases to the environment at all SC laboratories, including results for all DOE employees, contractors, subcontractors, and visitors. The scope of the report includes occupational doses for all workers at each facility and is not limited to just those funded by SC.

The occupational exposure data in this report is taken from the DOE Radiation Exposure Monitoring System (REMS), which serves as the central repository of radiation exposure information for DOE Headquarters. The REMS data is available on the web at http://www.hss.energy.gov/csa/analysis/rems/rems/ri.htm and is also published annually in the *DOE Occupational Radiation Exposure Report*.

Excellence in Radiological Control

The Department strives to maintain radiation exposures to its workers and the public below administrative control levels and regulatory limits and to further reduce these exposures to levels that are "As Low As Reasonably Achievable" (ALARA). The ALARA methodology considers both individual and group doses and involves a cost/benefit analysis that considers social, technical, economic, practical, and public policy aspects of the overall goal of dose reduction.

To evaluate how well ALARA is being implemented for workers at SC laboratories, it is necessary to look at several different measures of occupational dose. The analysis in this report considers the total number of individuals who are monitored for dose, the number of those who actually receive a measurable dose, the collective dose for all monitored individuals, and the average dose.

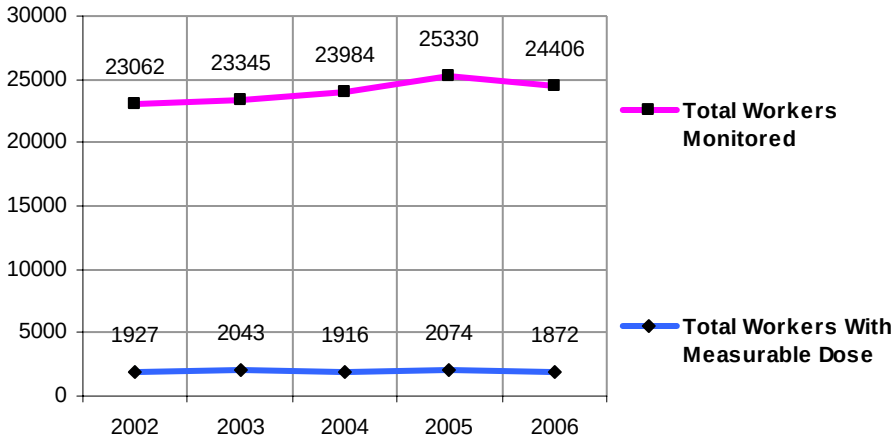
One characteristic of a good ALARA program is that the majority of worker dose should be at relatively low levels, with only a small percentage of workers receiving doses approaching administrative control levels. For this reason, this report also includes a frequency distribution for the total number of exposed workers at selected ranges of dose.

Another characteristic of a robust radiological safety program is that, for a constant workload, both individual and group doses should drop over time, as experience and lessons learned combine to improve radiological work practices. This analysis provides a five-year retrospective of occupational and environmental radiation exposures to evaluate where reductions have occurred. It is important to note that an increase in dose does not necessarily indicate a problem if it can be attributed to increased work activity rather than a decrease in radiation control practices.

Number of Monitored Workers

The total number of monitored workers at all SC laboratories has increased slightly, from 23,062 in 2002 to 24,406 in 2006 (see Figure 1.) However, only a fraction of those monitored actually received a measurable dose. The number of workers with a measurable dose decreased slightly from 1,927 in 2002 to 1,872 in 2006.

Figure 1: Number of Monitored Workers at SC Laboratories

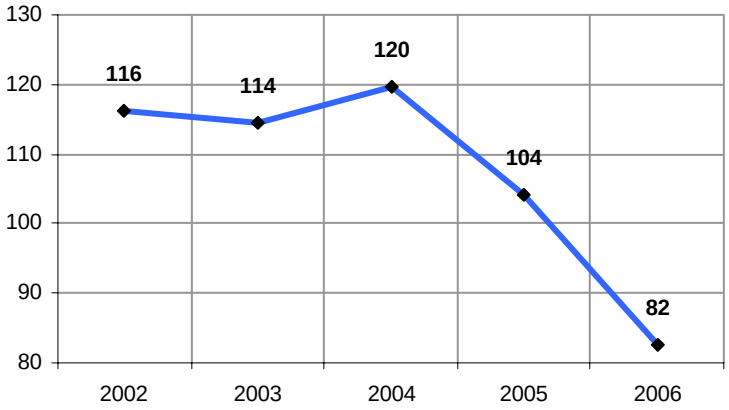


Personnel dosimetry is required for DOE workers who are likely to receive a dose greater than 100 millirem per year. Also, visitors are monitored at half that limit (50 millirem per year) if they are members of the public and not employees.

Collective Occupational Dose

Looking back at the trend over the past five years, the collective dose from all SC laboratories has dropped by about 29 percent overall, from 116 person-rem in 2002 to 82 person-rem in 2006 (see Figure 2.) By comparison, the collective dose at all Department of Energy (DOE) laboratories dropped by about 40 percent in the same period, from 1,360 to 813 person-rem.

Figure 2: Collective Dose from all SC laboratories (Person-Rem)



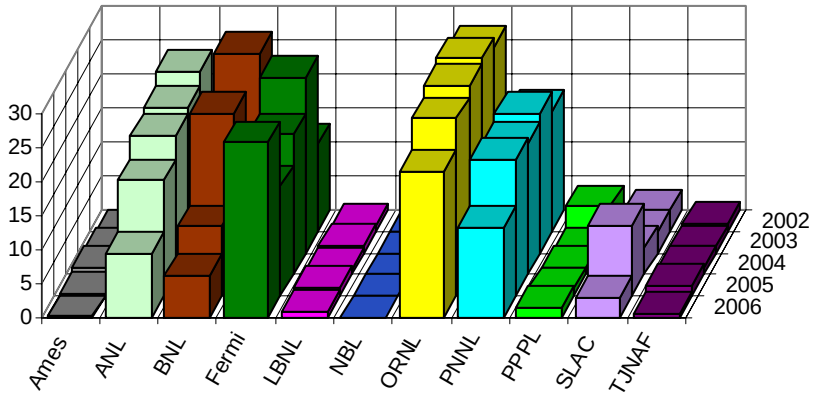
During 2006, the collective occupational radiation dose for all SC laboratories dropped by about 21 percent to 82 person-rem, down from 104 person-rem in 2005. A large part of this decrease was at Argonne National Laboratory (ANL), where the collective dose dropped from 17 person-rem in 2005 to 9.5 person-rem in 2006 (see Figure 3). The decrease is attributable to less programmatic work at nuclear facilities such as the Alpha Gamma Hot Cell Facility (AGHCF), as a result of efforts to address nuclear safety issues identified by the DOE Office of Assessment. A major dose contributor in 2006 was the Intense Pulsed Neutron Source, during maintenance on the accelerator.

Another large decrease was at Stanford Linear Accelerator Center (SLAC), where the collective dose dropped to 3.0 person-rem in 2006, down 71 percent from 10.4 person-rem the previous year. The decrease in collective dose was attributable to a corresponding decrease in maintenance activities conducted inside Radiological Control Areas where activated accelerator components are present.

In 2006, Fermilab conducted a major 12 week shutdown for upgrades, maintenance and repair work, which brought the collective dose up to 25.7 person-rem for the year. For comparison, the collective dose was 16.1 person-rem in 2005, when there were no major shutdowns. Dose trending studies by Fermilab indicate that the collective dose for 2006 was well within the expected range for a year in which a major shutdown occurred, such as was done in 2003. All of the shutdown tasks were necessary to achieve the challenging goals of the physics research program, while at the same time were aimed at reducing beam losses, which is an essential ingredient in improving performance and increasing deliverable proton intensities. Reducing beam losses also reduces

radioactivation of beam line components and potential radiation dose to personnel who must maintain the accelerators in the future.

Figure 3: Collective Dose at SC Laboratories (Person-Rem)



Year	Ames	ANL	BNL	Fermi	LBNL	NBL	ORNL	PNNL	PPPL	SLAC	TJNAF
2002	0.076	23.560	26.244	12.790	0.895	0.000	27.046	17.690	3.707	3.075	1.113
2003	0.448	21.379	12.183	25.670	1.037	0.045	28.591	20.407	0.552	3.127	0.992
2004	1.152	20.514	23.678	20.570	0.739	0.035	27.675	19.340	0.972	3.916	1.074
2005	0.339	16.984	10.216	16.130	1.180	0.160	26.122	20.073	1.164	10.370	1.519
2006	0.182	9.526	6.107	25.740	0.937	0.085	21.493	13.272	1.544	3.046	0.536

In 2006, the collective dose at Pacific Northwest National Laboratory (PNNL) was 13 person-rem, down significantly from 20 person-rem the previous year. More than 75% percent of the collective dose is from operations at the Radiochemical Processing Laboratory (RPL). The PNNL collective dose was significantly below the anticipated level of 19 person-rem for 2006, primarily because of dose reductions realized in the Tritium Target Program-Post Irradiation Examination activities in the RPL, deferred Shielded Facilities Operations work, and less than anticipated transitional activities with high activity sources and radioactive material.

At Oak Ridge National Laboratory (ORNL) the collective dose dropped to 21 person-rem in 2006, down 18 percent from 26 person-rem the previous year. The major contribution to the collective dose at ORNL is the work at the Radiochemical Engineering Development Center and the High Flux Isotope Reactor. The collective dose at ORNL will remain a challenge because of future projects and activities, including the consolidation of hot cell facilities, continued cleanup of legacy radioactive materials, and the operation of the Spallation Neutron Source.

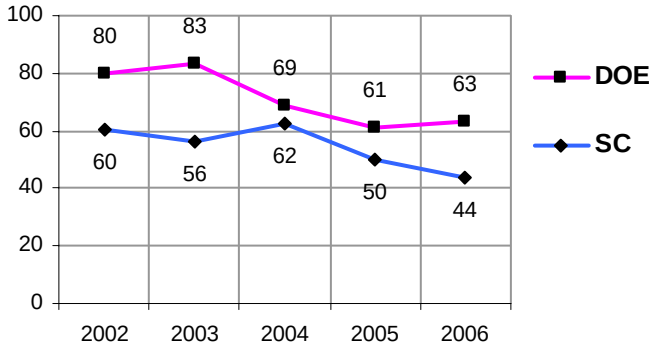
In 2006, the collective dose at Brookhaven National Laboratory (BNL) dropped to 6.1 person-rem, down 40 percent from 10.2 person-rem in 2005. The reduction in dose is mainly attributed to a decrease in high dose work activities at the Environmental Restoration Projects (ERP). While a lot of the ERP work will be done remotely, the dose

is expected to increase in August 2008 when the graphite pile removal begins at the Brookhaven Graphite Research Reactor.

Average Measurable Occupational Dose

The average measurable dose for all SC facilities has ranged between 44 to 62 millirem during the last five years. By comparison, the average measurable dose for all DOE sites has ranged between 61 to 83 millirem (see Figure 4).

Figure 4: Average Measurable Dose - DOE and SC compared (mrem/yr)



The average measurable dose is calculated by dividing the collective dose by the total number of individuals with a measurable dose. While the average measurable dose is one useful indicator for dose to workers (and visitors) at SC laboratories, it can be misunderstood if taken out of context. For example, the average measurable dose can drop if there is an overall increase in the number of workers who receive very low levels of measurable dose. This may give a mistaken impression that doses are dropping, when in fact they are rising.

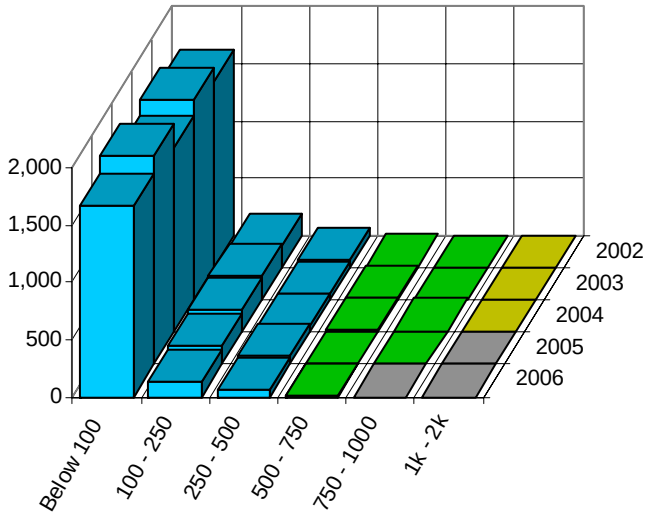
Also, since the average is calculated by dividing by the total number of workers with a measurable dose, the average may not be very sensitive to increases in dose to small numbers of workers, which may also be of concern.

In order to provide a more complete picture of radiation exposures, the following section presents a frequency distribution showing the number of workers at selected intervals of annual dose with trends over the past five years.

Occupational Dose Distribution

Of all SC laboratory workers who receive a measurable dose, the majority received an annual dose of less than 100 millirem, which is the DOE threshold for requiring dosimetry (see Figure 5). For the last five years, at least 80 percent of all workers at SC laboratories fell into this category.

Figure 5: Dose Distribution for SC Laboratories: Total Number of Workers in Each Dose Range



Dose Range (millirem/year)

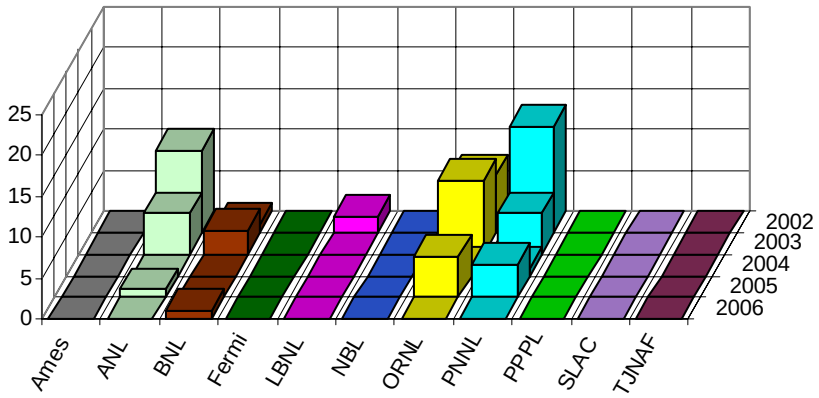
Year	Below 100	100 - 250	250 - 500	500 - 750	750 - 1000	1k - 2k
2002	1,629	201	73	12	6	6
2003	1,744	212	65	17	4	1
2004	1,615	204	64	17	14	2
2005	1,823	164	72	12	3	0
2006	1,671	138	57	6	0	0

In 2006, for the second year in a row, there were no workers with an annual dose exceeding 1,000 millirem. In 2004, there were two workers in this category, both at the AGHCF at ANL.

Personnel Contamination

There was one reported occurrence of personnel contamination in 2006. Over the past five years, there were 68 occurrences, as compared to 576 for all of DOE. These occurrences were predominately at the multi-program laboratories (see Figure 6). These occurrences do not show any clear trend, although they generally correspond to the amount of work performed.

Figure 6: Occurrences at SC Laboratories for Personnel Contamination



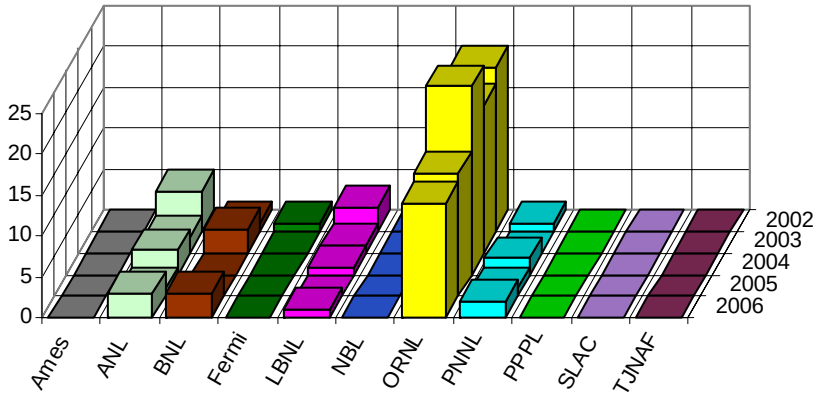
Year	Ames	ANL	BNL	Fermi	LBNL	NBL	ORNL	PNNL	PPPL	SLAC	TJNAF
2002	0	10	1	0	2	0	7	13	0	0	0
2003	0	5	3	0	0	0	9	5	0	0	0
2004	0	0	0	0	0	0	1	1	0	0	0
2005	0	1	0	0	0	0	5	4	0	0	0
2006	0	0	1	0	0	0	0	0	0	0	0

Although occurrences of personnel contamination do not cause any significant dose, they are tracked as a performance indicator for conduct of operations. An increase in the number of personnel contaminations may indicate a degradation in radiological control practices, if not otherwise attributable to a change in work activities. The threshold for reporting personnel contamination occurrences was raised in mid-2003, which generally decreased the total number reported, as compared to previous years.

Loss of Control of Radioactive Material and Spread of Contamination

In 2006, there were 23 reported occurrences for loss of control of radioactive material and spread of contamination. Over the past five years, there were 124 occurrences, as compared to 790 for all of DOE. These occurrences were predominately at ORNL, which are mostly due to the legacy contamination found during movement of personnel from old buildings to newer facilities (see Figure 7).

Figure 7: Occurrences at SC Laboratories for Loss of Control of Radioactive Material and Spread of Contamination



Year	Ames	ANL	BNL	Fermi	LBNL	NBL	ORNL	PNNL	PPPL	SLAC	TJNAF
2002	0	5	1	1	3	0	20	1	0	0	0
2003	0	2	3	0	1	0	18	0	0	0	0
2004	0	3	0	0	1	0	23	2	0	0	0
2005	0	1	0	0	0	0	15	1	0	0	0
2006	0	3	3	0	1	0	14	2	0	0	0

Like personnel contamination, these occurrences do not cause any significant dose, but are used as a performance indicator for conduct of operations. The threshold for reporting these contamination occurrences was raised in mid-2003, which generally decreased the total number reported, as compared to previous years.

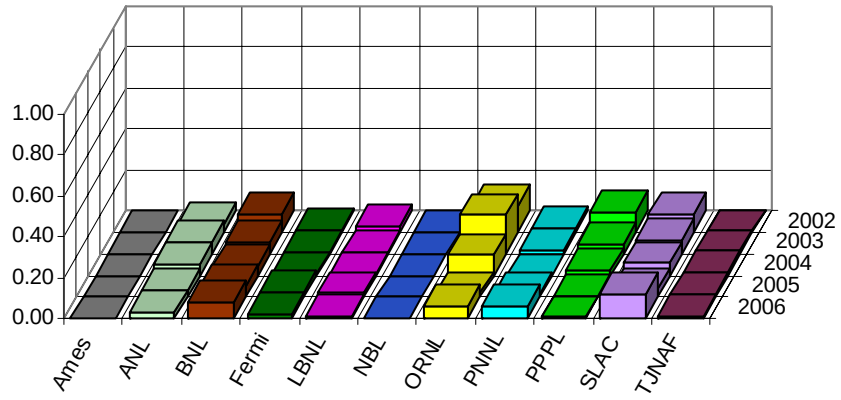
Unplanned Radiation Exposures

There were no occurrences of unplanned radiation exposures at SC laboratories in 2006. During the past five years, there was only one of these types of occurrences at SC laboratories, as compared to 50 for all of DOE.

Environmental Releases of Radionuclides

All DOE facilities are required to demonstrate to the Environmental Protection Agency (EPA) that radionuclides released to air do not cause a dose greater than 10 millirem per year to any member of the public. This standard is found in the National Emission Standards for Hazardous Air Pollutants (NESHAPS) standard 40 CFR 61, Subpart H. This dose of 10 millirem per year is too small to measure because of the much higher natural background radiation (around 300 millirem per year) and must be calculated annually, using EPA-approved computer codes.

Figure 8: NESHAPS dose at SC Laboratories (mrem/yr)



Year	Ames	ANL	BNL	Fermi	LBNL	NBL*	ORNL	PNNL	PPPL	SLAC	TJNAF
2002	0.000	0.039	0.086	0.008	0.030	0.000	0.130	0.023	0.100	0.085	0.007
2003	0.000	0.057	0.060	0.007	0.010	0.000	0.189	0.021	0.047	0.070	0.013
2004	0.000	0.054	0.044	0.008	0.010	0.000	0.100	0.000	0.029	0.060	0.019
2005	0.000	0.034	0.053	0.022	0.019	0.000	0.020	0.017	0.007	0.040	0.014
2006	0.000	0.029	0.081	0.025	0.013	0.000	0.060	0.065	0.008	0.120	0.010

** The NESHAPS dose for NBL is included in the total for ANL.*

Over the past five years, the dose to the maximally exposed individual has remained substantially less than one millirem per year at all SC laboratories (see Figure 8). In 2006, the largest dose was at SLAC (0.120 millirem, or 1.2 percent of the limit).

In addition to complying with the NESHAPS standard for releases to air, DOE facilities must also comply with the DOE dose limit of 100 millirem per year for members of the public from all pathways (DOE O 5400.5, *Radiation Protection of the Public and the Environment*). Important pathways which are evaluated include releases to both groundwater and surface waters (e.g., drinking water, eating fish, swimming, wading, and shoreline use). Off-site doses to members of the public from releases of radionuclides to the environment are all well within regulatory limits.

Laboratory Profiles

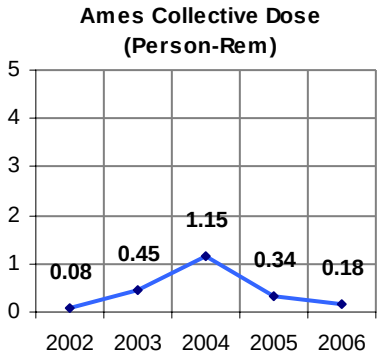
The following section is one-page synopses for each of the SC laboratories, briefly discussing their radiological operations and a summary of the occupational radiation doses for the past five years. Performance measures for radiological control are also noted, including both dose and contamination control, as applicable.

The occupational dose distribution tables are highlighted in color for easier reading and to help facilitate comparison of one laboratory with another. The highlight colors for the dose distributions are the same as those used in Figure 5, "Dose Distribution for SC Laboratories", where 0-500 mrem is blue, 500-1000 mrem is green, and 1000-2000 mrem is yellow.

Ames Laboratory (Ames)

Radiological Control Profile

In 2006, the collective dose at Ames Laboratory dropped to 0.18 person-rem, down from 0.34 person-rem the previous year. There were only eight workers who had a measurable dose, and all of the measurable doses were less than 100 millirem.



The radiological work at Ames includes use of x-ray devices, remediation of legacy contamination, stewardship of radioactive materials, and intermittent research involving small amounts of radioactive materials. There are currently 17 x-ray systems and approximately 90 trained x-ray workers.

Radioactive materials work has been minimal over the past five years, with primary use consisting of sealed source materials and irradiated metals. Ames Laboratory radiological activities are subject to a readiness review process and ALARA committee review.

Occupational Radiation Dose Distribution 2002-2006

Year	Total Workers In Each Dose Range (mrem): Below 100	100- 250	250- 500	500- 750	750- 1000	1k- 2k
2002	9	0	0	0	0	0
2003	21	0	0	0	0	0
2004	40	0	0	0	0	0
2005	14	0	0	0	0	0
2006	8	0	0	0	0	0

Performance Measures for Radiological Control

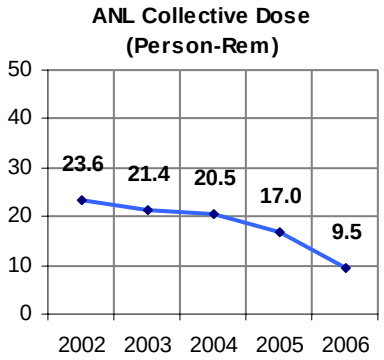
Ames uses the average total effective dose equivalent (TEDE) to measure the effectiveness of management commitments to ALARA. The rating is based on the average TEDE per person who received a measurable dose, as follows:

Outstanding = less than 30 millirem
Excellent = 30-42 millirem
Good = more than 42 and less than 79 millirem
Marginal = between 79-91 millirem
Unsatisfactory = more than 91 millirem

Argonne National Laboratory (ANL)

Radiological Control Profile

The collective dose at ANL dropped to 9.5 person-rem in 2006, down 44 percent from 17 person-rem the previous year. For the second year in a row, there were no workers with an annual dose exceeding 750 millirem.



A major dose contributor in 2006 was the Intense Pulsed Neutron Source. The dose was accrued primarily during periods of maintenance on the accelerator. In past years the Alpha Gamma Hot Cell Facility (AGHCF) has been the principal dose contributor. Less programmatic work was done at nuclear facilities such as AGHCF during the year as a result of efforts to address nuclear safety issues identified by the DOE Office of Assessment.

Occupational Radiation Dose Distribution 2002-2006

Year	Total Workers In Each Dose Range (mrem): Below 100	100- 250	250- 500	500- 750	750- 1000	1k- 2k
2002	180	35	10	1	1	6
2003	159	51	18	3	0	0
2004	122	28	12	3	5	2
2005	222	27	14	4	0	0
2006	129	23	5	1	0	0

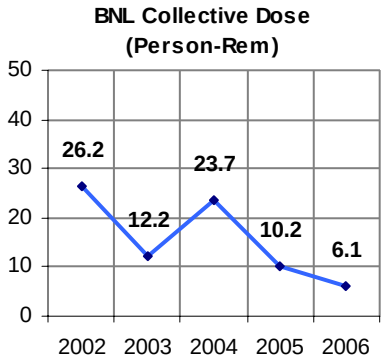
Performance Measures for Radiological Control

Performance expectations for the Laboratory include the collective dose equivalent to monitored individuals, an index based on the number of radioactive contaminations and contaminated individuals, and other radiological measures. The contract provides that a joint committee of Argonne Site Office (ASO) and ANL representatives will review the occupational radiation protection performance measures quarterly and agree on adjustments to performance expectations as necessary to account for changes in the scope of radiological work. A new leading performance indicator replaced collective dose equivalent in October 2006. It is based on the number of ALARA reviews conducted and extra credit is given for improvements in the management of radiation exposures.

Brookhaven National Laboratory (BNL)

Radiological Control Profile

In 2006, the collective dose at BNL dropped to 6.1 person-rem, down 40 percent from 10.2 person-rem in 2005. There were no workers with a dose exceeding 500 mrem, for the second year in a row.



The reduction in dose is mainly attributed to a decrease in high dose work activities at the Environmental Restoration Projects (ERP). While a lot of the ERP work will be done remotely, the dose is expected to increase in August 2008 when the graphite pile removal begins at the Brookhaven Graphite Research Reactor.

Occupational Radiation Dose Distribution 2002-2006

Year	Total Workers In Each Dose Range (mrem): Below 100	100- 250	250- 500	500- 750	750- 1000	1k- 2k
2002	368	48	15	5	3	0
2003	273	29	3	1	0	0
2004	246	36	8	5	6	0
2005	189	16	11	0	0	0
2006	130	15	2	0	0	0

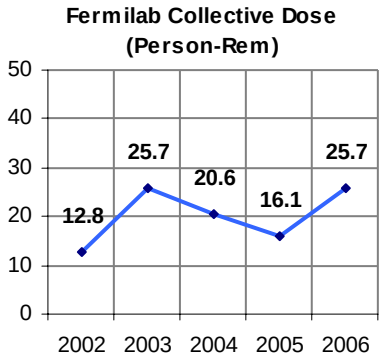
Performance Measures for Radiological Control

The performance measures define an effective ALARA program as comprised of dose goals and administrative control levels that are challenging and consider both historical exposures and planned operations; supportive of changes to those goals when operating assumptions change; communicates ALARA initiatives that help to optimize radiological exposures, and ensures dose is shared among all qualified workers.

Fermi National Accelerator Laboratory (Fermilab)

Radiological Control Profile

In 2006, Fermilab conducted a major 12 week shutdown for upgrades, maintenance and repair work, which brought the collective dose up to 25.7 person-rem for the year. For comparison, the collective dose was 16.1 person-rem in 2005, when there were no major shutdowns. Dose trending studies by Fermilab indicate that the collective dose for 2006 was well within the expected range for a year in which a major shutdown occurred, such as was done in 2003.



The 12 week shutdown included upgrades and component replacement in the Booster, replacement of the Main Injector Quadrupole Magnet and repairing leaks in the Neutrinos at the Main Injector (NuMI) horns. All of the shutdown tasks were necessary to achieve the challenging goals of the physics research program, while at the same time were aimed at reducing beam losses, which is an essential ingredient in improving performance and increasing deliverable proton intensities. Reducing beam losses also reduces radioactivation of beam line components and potential radiation dose to personnel who must maintain the accelerators in the future. The work during the shutdown was performed by workers who were fully trained in radiological work procedures and were thoroughly briefed in the specifics of each job task.

Occupational Radiation Dose Distribution 2002-2006

Year	Total Workers In Each Dose Range (mrem): Below 100	100- 250	250- 500	500- 750	750- 1000	1k- 2k
2002	363	21	5	0	0	0
2003	556	43	10	3	0	0
2004	451	34	13	0	0	0
2005	385	29	11	0	0	0
2006	720	36	19	1	0	0

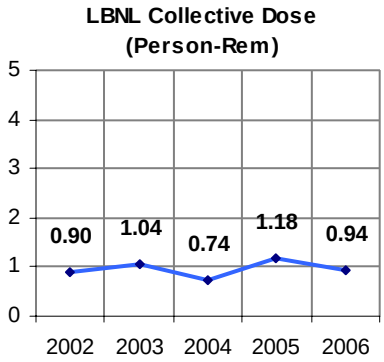
Performance Measures for Radiological Control

The ES&H Section Radiation Protection Group led formal reviews to identify both significant innovations recently made and opportunities for further improvement. For this measure, an identified innovation or opportunity for improvement that credibly can improve the control of radiation exposures is considered to be "significant." The measure was evaluated based on the number of reviews conducted and the number of significant actions identified and documented. In 2006, an adjectival rating of "Outstanding" was achieved for this measure.

Lawrence Berkeley National Laboratory (LBNL)

Radiological Control Profile

In 2006, LBNL had a collective dose of 0.94 person-rem, down 21 percent from 1.18 person-rem the previous year. There was only one worker with a dose exceeding 100 millirem, and there were no workers with a dose exceeding 250 millirem.



Radiological work includes research in life sciences and physical sciences involving small amounts of radioactive materials, operation of the Advanced Light Source and 88-inch Cyclotron, and closure activities at the former Bevatron accelerator. Radiopharmaceutical development and functional imaging with positron emission tomography represent areas of growth in radiological work.

The Laboratory has a number of policies within the framework of Integrated Safety Management that contribute to maintaining occupational radiation doses ALARA. Radiation safety professionals perform a "walk down" on any operation that yields a dosimeter reading exceeding 50 millirem to any worker. Also, the LBNL Radiation Safety Committee (RSC) meets quarterly, evaluates dose trends for each building, and reviews the "top 5" worker doses ensure that the doses are commensurate with the work.

Occupational Radiation Dose Distribution 2002-2006

Year	Total Workers In Each Dose Range (mrem): Below 100	100- 250	250- 500	500- 750	750- 1000	1k- 2k
2002	32	1	0	0	0	0
2003	17	2	1	0	0	0
2004	17	1	0	0	0	0
2005	19	3	0	0	0	0
2006	15	1	0	0	0	0

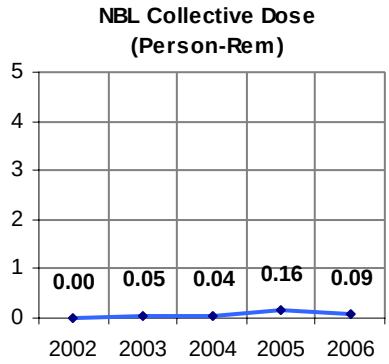
Performance Measures for Radiological Control

An Outstanding rating requires that the number of individual exposures exceeding 100 millirem must be less than or equal to the control level of 10, plus the average individual positive dose is less than the control level of 50 millirem, all without an increase in workload. The LBNL performance measure for reportable occurrences of personnel contamination provides an Outstanding rating for a weighted number of contaminated individuals less than or equal to 4.0 (with unusual occurrences having a weighting factor of 1.5, and off-normal at 1.0). The performance measure for control of radioactive material and spread of contamination provides an Outstanding rating for 2.0 or less weighted occurrences. Unusual occurrences use a weighted factor of 1.5 and off-normals 1.0.

New Brunswick Laboratory (NBL)

Radiological Control Profile

Note: NBL became part of the Office of Science in 2006, and is included in this annual report for the first time.



In 2006, the collective dose at NBL remained very low at 0.08 person-rem, down from 0.16 person-rem the previous year. There were no individuals with an annual dose exceeding 100 millirem. In 1997, there was one individual at NBL with a dose that exceeded 100 millirem, and no individuals have exceeded that value since that time.

The laboratory's mission deals with handling and use of various nuclear materials. This work is the sole source of radiation exposure to laboratory staff. This work has historically been conducted using ALARA principles.

Occupational Radiation Dose Distribution 2002-2006

Year	Total Workers In Each Dose Range (mrem): Below 100	100- 250	250- 500	500- 750	750- 1000	1k- 2k
2002	0	0	0	0	0	0
2003	2	0	0	0	0	0
2004	1	0	0	0	0	0
2005	4	0	0	0	0	0
2006	2	0	0	0	0	0

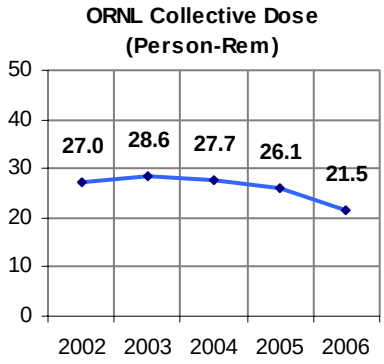
Performance Measures for Radiological Control

Due to the low exposure levels at NBL, the primary performance measure used by the laboratory is total person-mrem received.

Oak Ridge National Laboratory (ORNL)

Radiological Control Profile

In 2006, the collective dose at ORNL dropped to 21 person-rem, down 18 percent from 26 person-rem the previous year. For the first time since 2002, there were no workers with a dose exceeding 750 millirem.



The major contribution to the collective dose at ORNL is the work at the Radiochemical Engineering Development Center and the High Flux Isotope Reactor. The collective dose at ORNL will remain a challenge because of future projects and activities, including the consolidation of hot cell facilities, continued cleanup of legacy radioactive materials, and the operation of the Spallation Neutron Source. There is an ALARA Steering Committee and an ALARA Working Committee which discuss ongoing projects and share lessons learned on dose reductions. ALARA awards are routinely presented to employees who develop methods of reducing dose for particular jobs.

Occupational Radiation Dose Distribution 2002-2006

Year	Total Workers In Each Dose Range (mrem): Below 100	100- 250	250- 500	500- 750	750- 1000	1k- 2k
2002	273	55	22	4	0	0
2003	296	52	22	4	0	1
2004	262	55	19	3	3	0
2005	294	47	21	2	1	0
2006	239	37	17	4	0	0

Performance Measures for Radiological Control

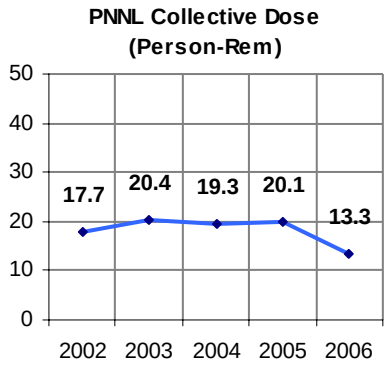
Performance measures are in place for both worker radiation dose and radiological control. The measures include:

- No unplanned dose.
- Average measurable dose to workers for individuals with measurable dose is less than the dose allowable to the public; i.e., less than 100 millirem.
- Effective radiological and chemical contamination control.

Pacific Northwest National Laboratory (PNNL)

Radiological Control Profile

In 2006, the collective dose at PNNL was 13 person-rem, down significantly from 20 person-rem the previous year. For the first time since 2002, there were no workers with a dose exceeding 500 millirem.



More than 75% percent of the collective dose is from operations at the Radiochemical Processing Laboratory (RPL). The PNNL collective dose was significantly below the anticipated level of 19 person-rem for 2006, primarily because of dose reductions realized in the Tritium Target Program-Post Irradiation Examination activities in the RPL, deferred Shielded Facilities Operations work scope, and less than anticipated transitional activities with high activity sources and radioactive material. The amount of radiological work, as measured by the number of RWP entries, also decreased in 2006 (20,802 RWP entries in 2006 vs. 24,323 in 2005) and dose per entry was lower (0.64 mrem per entry in 2006 vs. 0.83 mrem per entry in 2005).

Occupational Radiation Dose Distribution 2002-2006

Year	Total Workers In Each Dose Range (mrem): Below 100	100- 250	250- 500	500- 750	750- 1000	1k- 2k
2002	168	21	19	2	2	0
2003	166	31	11	6	4	0
2004	170	41	12	6	0	0
2005	141	30	15	6	2	0
2006	144	24	14	0	0	0

Performance Measures for Radiological Control

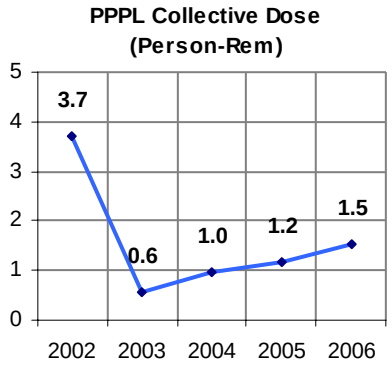
The PNNL radiological control management system continues to demonstrate mature performance through effective use of self assessments and Radiological Problem Report (RPR) and ALARA Tracking and Trending. This provides performance feedback to line organizations driving continuous improvement in radiological control performance though a maturing corrective action management system which tracks actions to completion. Review of the RPR/ALARA tracking and trending data identified general improvements in contamination control which has resulted in an overall decrease in the number of RPRs (normalized to the amount of radiological work performed). The laboratory completed improvements in the radioactive source control program by developing a single laboratory-wide inventory system for all sealed sources during FY06 in response to issues identified during a self assessment. Results from programmatic assessments performed in FY06 indicated stable or improved performance in all areas assessed.

Princeton Plasma Physics Laboratory (PPPL)

Radiological Control Profile

The collective dose at PPPL was 1.5 person-rem in 2006, up slightly from 1.2 person-rem in 2005. There were no workers with a dose that exceeded 100 millirem.

Most of the dose received on site is due to activated components in the vicinity of the National Compact Stellarator Experiment Coil Winding Facility. This area contains components and materials that were activated during Tokamak Fusion Test Reactor operations.



Occupational Radiation Dose Distribution 2002-2006

Year	Total Workers In Each Dose Range (mrem): Below 100	100- 250	250- 500	500- 750	750- 1000	1k- 2k
2002	130	15	0	0	0	0
2003	110	0	0	0	0	0
2004	123	0	0	0	0	0
2005	136	0	0	0	0	0
2006	155	0	0	0	0	0

Performance Measures for Radiological Control

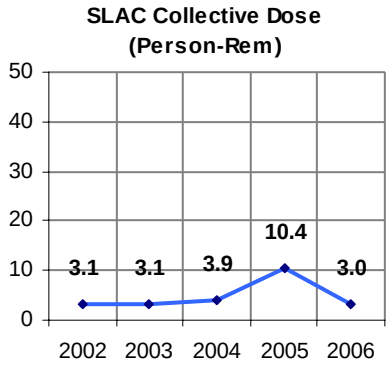
Performance measures are in place for collective dose. A TEDE that is 15 percent below the annual radiological goal established per the PPPL ALARA Plan is rated as Outstanding.

Stanford Linear Accelerator Center (SLAC)

Radiological Control Profile

The collective dose at SLAC dropped to 3.0 person-rem in 2006, down 71 percent from 10.4 person-rem the previous year. There were only two workers who had an annual dose that exceeded 100 millirem.

The decrease in collective dose was attributable to a corresponding decrease in maintenance activities conducted inside Radiological Control Areas where activated accelerator components are present.



Occupational Radiation Dose Distribution 2002-2006

Year	Total Workers In Each Dose Range (mrem): Below 100	100- 250	250- 500	500- 750	750- 1000	1k- 2k
2002	76	1	2	0	0	0
2003	106	3	0	0	0	0
2004	141	8	0	0	0	0
2005	349	10	0	0	0	0
2006	100	2	0	0	0	0

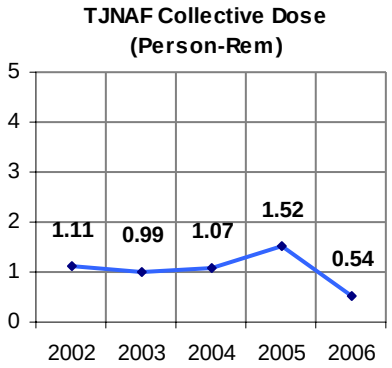
Performance Measures for Radiological Control

Performance measures are in place for unplanned radiation exposures and personnel contamination control. An Outstanding rating requires no occurrences of ORPS-reportable radiation doses or contamination. An unplanned radiation exposure includes a dose in excess of 100 millirem/year to non-radiological workers.

Thomas Jefferson National Accelerator Facility (TJNAF)

Radiological Control Profile

The collective dose at TJNAF decreased to 0.54 person-rem in 2006, down 65 percent from 1.52 person-rem the previous year. There were no workers with a dose exceeding 100 millirem. The decrease in collective dose is attributable to completion of maintenance, repairs, and disassembly associated with a unique experimental set up involving separated electron and photon beams in one of the high power experimental halls in the Continuous Electron Beam Accelerator Facility.



There is an Exposure Alert Level of 250 millirem per year; any individual dose exceeding this level triggers an ALARA review. Additionally, any individual who receives a total dose exceeding 120 mrem in a six month period, either through Thermo Luminscent Dosimeter (TLD) badge readings, or Self Reading Pocket Dosimeter (SRPD) readings is placed on a monthly TLD badge frequency for the remainder of the monitoring year. This enables closer monitoring for individuals who may be approaching administrative alert levels.

Occupational Radiation Dose Distribution 2002-2006

Year	Total Workers In Each Dose Range (mrem): Below 100	100- 250	250- 500	500- 750	750- 1000	1k- 2k
2002	30	4	0	0	0	0
2003	38	1	0	0	0	0
2004	42	1	0	0	0	0
2005	70	2	0	0	0	0
2006	29	0	0	0	0	0

Performance Measures for Radiological Control

The Performance Evaluation and Measurement Plan (PEMP) incentivizes the percentage of pre and post Radiation Work Permit (RWP) reviews that are conducted by a Radiological Engineer, when the projected cumulative dose for the RWP exceeds 100 mrem. Performance on the accounting of Sealed Radioactive Sources is measured for those subject to 10 CFR 835.1201, as well as Sealed Radioactive Sources that are not subject to the rule.

Another measure requires the conduct of a comprehensive peer review of the Radiological Control Program at least once every three years. The conduct of the peer review must utilize Criteria and Approach Documents, and meet a 45 day turn-around for corrective action plan generation to satisfy the B+ performance expectations.