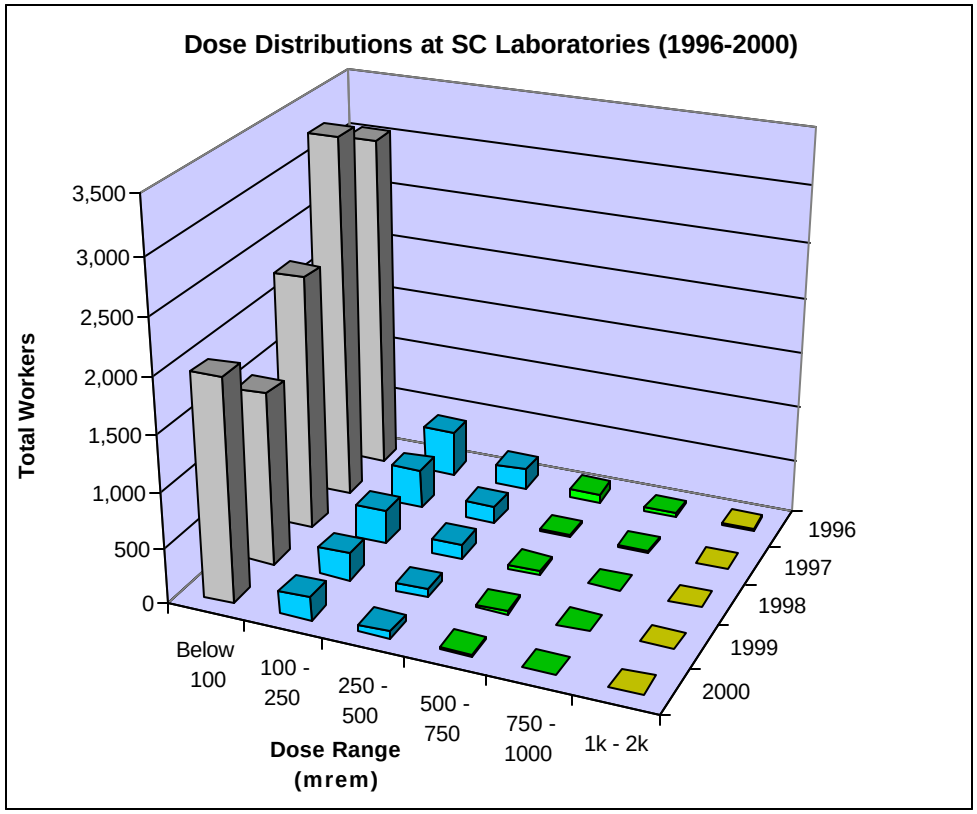
Occupational Radiation Exposure Profile for the Office of Science Laboratories 1996-2000



Office of Laboratory Operations
and Environment, Safety and Health (SC-83)
Office of Science
U.S. Department of Energy

Executive Summary

During the past 5 years, occupational radiation doses have dropped significantly at the eleven non-defense laboratories aligned with by the Office of Science (SC). The total collective dose to all workers has dropped more than 60 percent in the last 5 years--from 305 person-rem in 1996 to 115 person-rem in 2000. By comparison, the collective dose at all Department of Energy (DOE) laboratories has dropped just over 20 percent in the same period--from 1,651 person-rem in 1996 to 1,266 person-rem in 2001.

Most workers who were monitored for radiation exposure at SC laboratories received no measurable dose at all. Of those who did have a measurable dose, approximately 80 percent received less than 100 millirem per year, which is the threshold for requiring that a dosimeter be issued. More than 98 percent of those who had 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).

In 2000, there were only three individuals who had an annual dose exceeding 1,000 millirem, which is 20 percent of the DOE limit. All three individuals were technicians working at the Alpha-Gamma Hot Cell at Argonne National Laboratory - East, who work with analysis of irradiated fuel. The maximum dose was approximately 1,140 millirem, and ANL-E currently has a task force looking for opportunities to reduce the dose from this work.

Reportable occurrences for loss of control of radioactive material, spread of contamination, and personnel contamination are generally trending down or remaining at low levels at all SC laboratories for the past 5 years. There has been an upward trend in occurrences of personnel contamination at Oak Ridge, attributable to the new work for environmental restoration by Bechtel Jacobs, and replacement of the beryllium reflectors at the High Flux Isotope Reactor (HFIR).

Introduction

This report is intended to give managers a current assessment of the performance of the Office of Science laboratories with respect to radiological operations. It provides a 5-year retrospective look at occupational radiation exposures at the eleven Office of Science (SC) laboratories, including results for all Department of Energy (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 report does not include occupational doses from work funded by SC at other laboratories.

The 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://rems.eh.doe.gov/, and is also published annually in the DOE Occupational Radiation Exposure Report.

Excellence in Radiological Control

The Department of Energy strives to maintain radiation exposures to its workers 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 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, their average dose, and the group (or total collective) dose for all monitored individuals at all SC laboratories.

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 the higher doses that come close to approaching administrative control levels. For this reason, this report also includes a dose distribution, which shows the frequency distribution for the total number of exposed workers at selected ranges of dose.

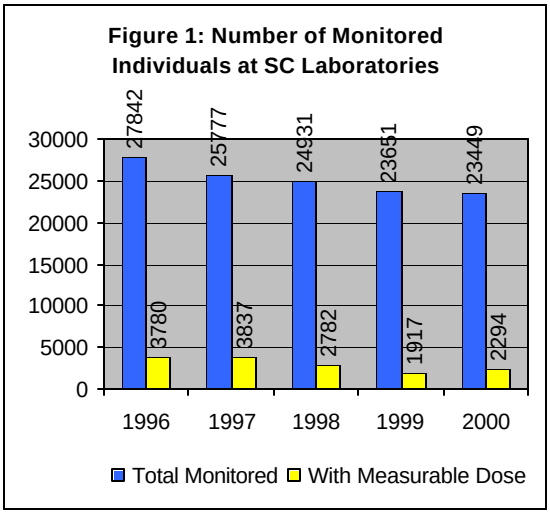
Another characteristic of a robust radiological safety program is that, for a constant workload, both individual and group doses should drop over time, as experience and lessons learned combine to improve radiological work practices. This analysis provides a 5-year retrospective of occupational radiation exposures, to evaluate where reductions have occurred. It is important to note here that an increase in dose is not necessarily undesirable; often it can be attributed to increased work activity rather than a decrease in radiation control practices.

Number of Monitored Individuals

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.

In practice, however, most sites prudently provide dosimetry in excess of this requirement, for reasons of administrative convenience, legal liability and security. While the total number of monitored individuals gives a good indication of the overall scope of the dosimetry program, it is not necessarily a good indicator of the actual exposed work force.

The number of monitored individuals at all SC laboratories has trended slightly down, from 27,842 in 1996 to 23,449 in 2000 (see Figure 1). However, only a fraction of those monitored actually received a measurable dose. The number of people with a measurable dose has dropped from 3,780 in 1996 to 2,294 in 2000.



All eleven SC laboratories had a decrease in the number of workers with a measurable dose since 1996. The laboratories with the largest total decrease were Brookhaven National Laboratory (1,018) and Pacific Northwest National Laboratory (188). Fermilab had a slight increase in 2000, as a result of work to reinstall the Collision Detector at Fermilab (CDF) and DZero particle detectors in the Tevatron tunnel.

Collective Dose

The collective dose, or total radiation dose, is the sum of all annual doses received by every individual with a measurable dose. It is typically measured in units of person-rem, and it includes doses to visitors, as well as DOE employees, contractors and subcontractors. The collective dose is monitored by DOE as one measure of the overall performance of radiation protection programs.

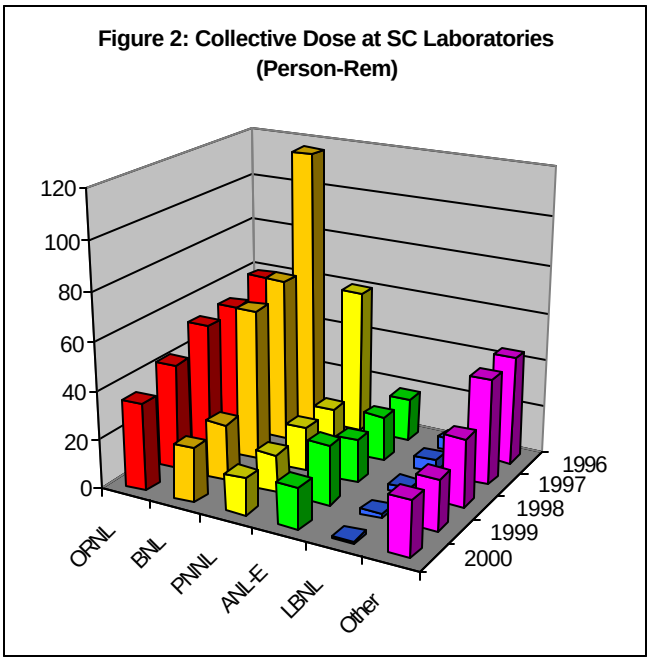
The collective dose from all SC laboratories has dropped during the last 5 years, from 305 person-rem in 1996 to 115 person-rem in 2000 (see Figure 2). The majority of the collective dose occurred at the four largest multi-program laboratories; Argonne National Laboratory-East (ANL-E), Brookhaven National Laboratory (BNL), Oak Ridge National Laboratory (ORNL), and Pacific Northwest National Laboratory (PNNL).

The largest reductions in total person-rem occurred at BNL and PNNL . The collective dose at BNL has dropped about 80 percent, from 117 person-rem in 1996 to 22 person-

rem in 2000. The drop is attributable to a major reduction in dose at the Alternating Gradient Synchrotron (AGS), and the shutdown of the High-Flux Beam Reactor and the Brookhaven Medical Research Reactor (BMRR). The collective dose at PNNL has dropped about 75 percent, from a high of 61 person-rem in 1997 to 15 person-rem in 2000, after the transition out of Buildings 324 and 327.

Oak Ridge National Laboratory (ORNL) has reduced their collective dose by about 40 percent, from 60 person-rem in 1996 to 36 person-rem in 2000. The major contributor to the collective dose at ORNL is the work at the High Flux Isotope Reactor (HFIR) and the Radiochemical Engineering Development Center (REDC). ORNL has an ALARA Engineering Group that proactively reviews any task that is predicted to have a collective total effective dose equivalent (TEDE) exceeding 300 person-millirem. Any task that predicts a collective TEDE greater than 1,000 person-millirem must also be reviewed by the Radiological Support Services Complex Leader. ORNL also has an Administrative Control Limit of 600 millirem for individual doses.

Figure 2: Collective Dose at SC Laboratories (Person-Rem)



Argonne National Laboratory-East (ANL-E) has dropped about 7 percent during the last 5 years, from 18.5 person-rem in 1996 to 17.2 person-rem in 2000. The collective dose increased to 25 person-rem in 1999, because of a decontamination and decommissioning operation at the CP-5 Reactor to remove the bioshield and pedestal. This work required the use of approximately 30 outside contractor personnel, whose dose was included in the site total. The collective dose decreased to 17 person-rem in 2000. Work at the Alpha Gamma Hot Cell Facility (AGHCF) is a major contributor to the dose at ANL-E.

The collective dose at Lawrence Berkeley National Laboratory (LBNL), has dropped by about 75 percent--from 4.6 person-rem in 1996 to 1.1 person-rem in 2000. LBNL has a number of policies within the framework of Integrated Safety Management (ISM) that have contributed to this reduction in dose. LBNL radiation safety professionals perform a 'walk down' on any operation that yields a dosimeter reading exceeding 50 millirem to any worker, looking for opportunities to reduce the dose. Also, the LBNL Radiation Safety Committee (RSC) meets quarterly, and the 'top ten' doses are presented and reviewed to ensure that the doses are commensurate with the work.

The collective dose from SC accelerator laboratories and single-purpose laboratories represented only a small fraction of the total. Of the three accelerator laboratories, SLAC and Fermilab have the largest collective dose. The collective dose at SLAC has dropped about 70 percent, from 19.3 person-rem in 1996 to 5 person-rem in 2000. Fermilab has reduced their collective dose about 24 percent, from 16.2 person-rem in 1996 to 12.3 person-rem in 2000.

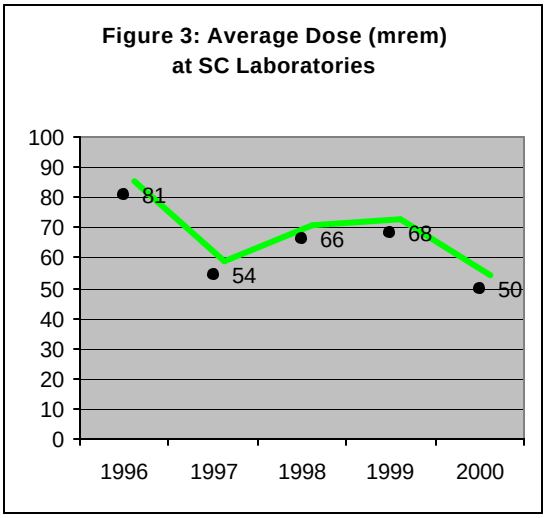
The collective dose at Thomas Jefferson National Accelerator Facility (TJNAF) has dropped from 2.9 person-rem in 1996 to 1.6 person-rem in 2000.

Princeton Plasma Physics Laboratory (PPPL) dropped from 6 person-rem in 1996 to 2.9 person-rem in 2000. The dominant occupational radionuclide exposure is from tritium, and the majority of the dose is from Decontamination and Decommissioning activities.

Both Ames and ORISE have maintained the smallest collective doses of any SC laboratory, running at less than 0.5 person-rem every year.

Average Measurable Dose

The average measurable dose is one of the five DOE-wide ISM effectiveness measures, and it is calculated by dividing the collective dose by the total number of individuals with a measurable dose. The average dose for all SC facilities has ranged from 81 millirem in 1996 to 50 millirem in 2000 (see Figure 3).



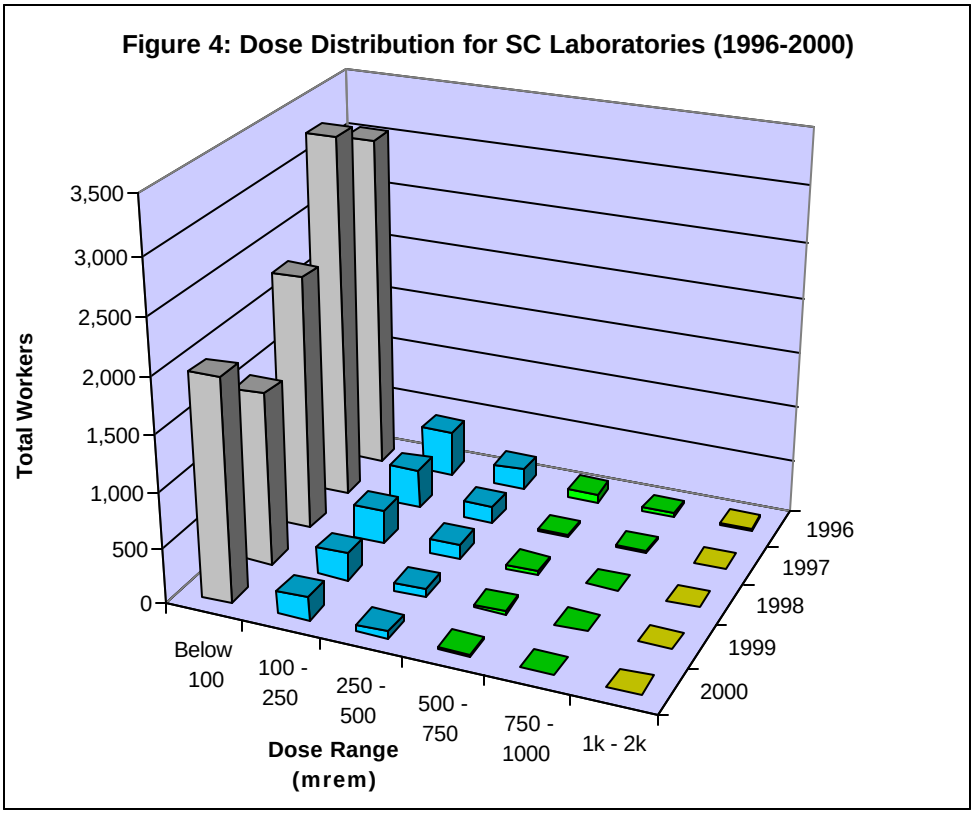
While the average measurable dose is one useful indicator for dose to workers (and visitors) at SC laboratories, it can produce artifacts which may be misunderstood if taken out of context. For example, the average dose can drop if each worker gets less dose, but the average can also drop if there is an overall increase in the number of workers who receive very low levels of measurable dose. The latter case 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 be of concern. In order to provide a more complete picture of radiation exposures, the following section presents exposure data as a frequency distribution, showing the number of workers at selected intervals of annual dose, with trends over the past 5 years.

Dose Distribution

Of all workers at SC laboratories 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 4). For the last 5 years, at least 80 percent of all workers at SC laboratories fell into this category. Also, for this same time period, more than 96 percent of all workers had a dose of less than 500 millirem per year, which is one-tenth of the annual limit of 5,000 millirem in 10 CFR 835.

There was an increase in the number of individuals with a dose below 100 millirem in the year 2000, which is attributable to an overall increase in work at several SC laboratories. For example, Fermilab began a campaign during this time to reinstall the CDF and DZero detectors in the Tevatron tunnel. Also, SLAC experienced an unexpectedly large number of small positive doses (most less than 10 millirem) for some workers who normally receive no measurable dose. The doses could not be attributed to any known exposures or quality control problems; as a result, a new dosimetry system is being used.



In 2000, there were only three individuals who had an annual dose exceeding 1,000 millirem (the maximum was 1140 millirem). All three were technicians working at the Alpha-Gamma Hot Cell at ANL-E, who worked with analysis of irradiated fuel. ANL-E currently has an ALARA task force working to reduce the dose from this work.

In 1999, there were five individuals with an annual dose exceeding 1 rem--one at Fermilab, two at ANL-East, and two at ORNL. The single dose exceeding 1 rem at Fermilab is believed to be an artifact, caused by the employee inadvertently leaving the dosimeter on top of a cabinet that contained a radiation source, used for conducting radiation damage studies on components of particle physics detectors. This dose was reported as an occurrence, and is documented in Occurrence Report CH-BA-FNAL-FERMILAB-2000-0003.

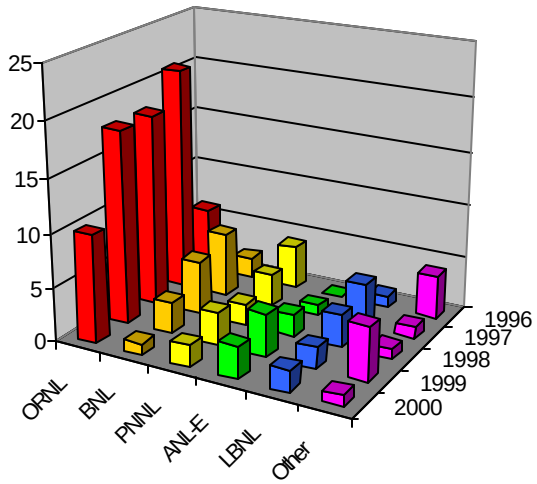
The two workers at ANL-East who exceeded 1 rem in 1999 were both technicians working with irradiated fuel at the Alpha-Gamma Hot Cell.

The two workers exceeding 1 rem at ORNL in 1999 were both Radiological Control Technicians (RCTs). One was at the Radiochemical Engineering Development Center (REDC), but an investigation revealed that the workplace exposure potential and nonoccupational exposure could not account for this amount of exposure. The other RCT was working with the Wastewater Triad Project at Building 7877, which involved out-of-tank evaporation and removal of cesium and strontium from liquid waste storage tanks, and the doses were attributed to the termination of the project when many nonroutine and maintenance activities occurred.

Contamination Occurrences

In addition to monitoring radiation exposure, sites are required to report unusual or off-normal occurrences involving loss of control of radioactive material, spread of radioactive contamination, or personnel contamination. While there are usually no significant dose consequences associated with these kinds of occurrences, an increase in the number of occurrences that is not attributable to a change in work activities may indicate a degradation in the effectiveness of radiological control programs.

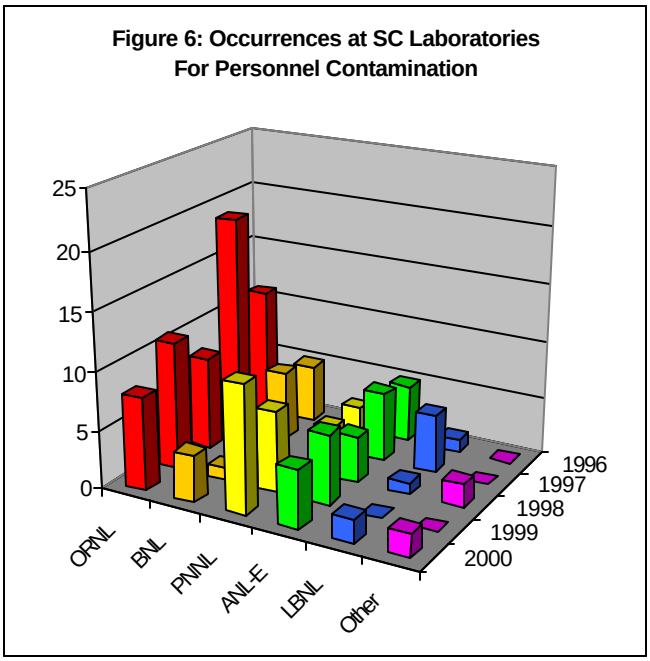
Figure 5: Occurrences at SC Laboratories For Loss of Control of Radioactive Material And Spread of Contamination



Occurrences of "Loss of Control of Radioactive Material and Spread of Contamination" were predominately at the five multi-program laboratories: ANL-E, BNL, LBNL, ORNL and PNNL (see Figure 5). The other laboratories had a combined total of only 12 occurrences during the last 5 years.

Overall, ORNL had the largest number of occurrences in this category, trending up between 1997 to 1999, and dropping back down in 2000. The number of occurrences at all other SC laboratories are either trending down or remaining stable at low levels. The increase in occurrences at ORNL between 1997-1999 is attributable in part to the turnover of environmental restoration and waste management work to a new contractor, Bechtel-Jacobs. Radiological surveys of facilities to be turned over to the new contractor identified several sources of legacy contamination on fixed surfaces and equipment.

Occurrences of "Personnel Contamination" were also predominately at the five SC multi-program laboratories. The other laboratories reported a combined total of four occurrences during the last 5 years (see Figure 6).



There was a recent upward trend in occurrences of personnel contamination at PNNL, which was investigated and traced to legacy contamination in overhead areas of the Radiochemical Processing Laboratory's 600 Annex. The contaminated areas have been mitigated, and the number of personnel contamination occurrences at PNNL is expected to drop in 2001.

Laboratory Profile Sheets

The following section has a one-page synopsis for each of the eleven SC laboratories, briefly discussing their radiological operations and a summary of the occupational radiation exposures for the past 5 years. Contractual performance measures for radiological control are also noted, including both dose and contamination control, as applicable.

The dose distribution tables are highlighted in color in order to make them easier to read, and to help facilitate comparison of one laboratory with another. The highlight colors are the same as those used in Figure 4, "Dose Distribution for SC Laboratories" (0-100 mrem is gray, 100-500 mrem is blue, 500-1000 mrem is green, and 1000-2000 mrem is yellow).

Ames Laboratory

In the year 2000, Ames had the lowest number of individuals with a measurable dose among all laboratories operated by the Office of Science. The total dose was the second lowest (0.311 person-rem), barely above that of the other single-purpose laboratory, Oak Ridge Institute for Science and Education (ORISE), which had 0.299 total person-rem. The average dose increased from 10 millirem to 77 millirem in 1999; the increase was traced to dosimeters being stored in close proximity to a radiation source after work hours. Storage practices were revised, and the average dose dropped from 77 millirem in 1999 to 24 millirem in 2000.

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 14 x-ray systems and approximately 70 trained x-ray workers. Radioactive materials work has been minimal over the past 5 years, with primary use consisting of sealed source materials and irradiated metals. No radioactive materials research activities were conducted during 2000. Ames Laboratory radiological activities are subject to a readiness review process and ALARA committee review as ISMS mechanisms.

Occupational Radiation Dose Distribution (1996-2000)

						Total Workers In Each Dose Range (mrem) >					
Year	**Total Workers Monitored**	**Total Workers With Dose**	**Total Person - mrem**	**Avg. Dose (mrem)**	**Total With No Dose**	**Below 100**	**100 - 250**	**250 - 500**	**500 - 750**	**750 - 1000**	**1k - 2k**
1996	112	7	120	17	105	7	0	0	0	0	0
1997	123	6	110	18	117	6	0	0	0	0	0
1998	113	2	20	10	111	2	0	0	0	0	0
1999	109	3	230	77	106	1	2	0	0	0	0
2000	122	13	311	24	109	13	0	0	0	0	0

Contractual 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 for CY 2001, 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 – East (ANL-E)

ANL-E had the third highest collective dose among all SC laboratories in 2000--BNL and ORNL were higher. During 1999, ANL-E had a decontamination and decommissioning operation at the CP-5 Reactor, to remove the bioshield and pedestal, which required the use of 30 outside contractor personnel. If the collective dose from this operation were subtracted, the average dose would drop from 131 millirem to 98 millirem. The Argonne Tandem Linac Accelerator System (ATLAS) contributes little to the collective dose (less than 0.1 person-rem for the last 5 years). The most significant dose contribution is from the Alpha-Gamma Hot Cell Facility (AGHCF).

In 2000, three individuals working at the AGHCF had an annual dose exceeding 1,000 millirem (the maximum dose received was approximately 1140 millirem). All three were technicians who work with analysis of irradiated fuel. The collective dose is projected to increase next year, because the AGHCF will be analyzing a higher number of samples, and the samples will be significantly more radioactive. There is currently an ALARA task force looking for opportunities to reduce the dose from this work.

Occupational Radiation Dose Distribution (1996-2000)

						Total Workers In Each Dose Range (mrem) >					
Year	Total Workers Monitored	Total Workers With Dose	Total Person - mrem	Avg. Dose (mrem)	Total With No Dose	Below 100	100 - 250	250 - 500	500 - 750	750 - 1000	1k - 2k
1996	3,077	202	18,516	92	2,875	160	27	10	0	2	3
1997	3,053	238	19,021	80	2,815	186	34	14	1	2	1
1998	2,938	182	17,715	97	2,756	127	40	11	1	2	1
1999	2,888	187	24,583	131	2,701	126	34	14	8	3	2
2000	2,824	183	17,244	94	2,641	140	27	8	5	0	3

Contractual Performance Measures for Radiological Control:

ANL-E has performance expectations for the laboratory collective dose equivalent to monitored individuals, and also for the number of radioactive contaminations and contaminated individuals. The contract provides that a joint committee of Argonne Group (ARG) and ANL representatives appointed by the ARG Manager and the ANL Radiological Control (RadCon) Managers, respectively, will review the occupational radiation protection performance measures quarterly and agree on adjustments to performance expectations as necessary to account for changes in scope of radiological work.

The collective TEDE performance expectation will be based on the combined ALARA goals for ANL-E and ANL-W, excluding Divisions whose goal is 0.5 person-rem or less, and excluding dose received at the New Brunswick Laboratory.

Brookhaven National Laboratory (BNL)

In 2000, BNL had the second highest collective dose of all laboratories managed by the Office of Science. The collective dose at BNL has dropped from 117 person-rem in 1996 to 22 person-rem in 2000. This decrease is attributable to a major reduction in dose at the Alternating Gradient Synchrotron (AGS), and the shutdown of the High-Flux Beam Reactor and the Brookhaven Medical Research Reactor (BMRR).

Approximately three-fourths of the collective dose at Brookhaven is from operation of the AGS, which is now used in conjunction with the Relativistic Heavy Ion Collider (RHIC), in addition to fixed target programs involving high-intensity protons or heavy ions. Until recently, repairing broken radioactive equipment was the major source of radiation exposure at AGS. The dose reductions at AGS are attributable to major improvements in accelerator equipment design, accelerator upgrades and an active ALARA program.

Occupational Radiation Dose Distribution (1996-2000)

						Total Workers In Each Dose Range (mrem) >					
Year	**Total Workers Monitored**	**Total Workers With Dose**	**Total Person - mrem**	**Avg. Dose (mrem)**	**Total With No Dose**	**Below 100**	**100 - 250**	**250 - 500**	**500 - 750**	**750 - 1000**	**1k - 2k**
1996	5,927	1,448	116,771	81	4,479	1,164	159	61	38	20	6
1997	5,984	1,463	68,948	47	4,521	1,274	117	56	14	2	0
1998	5,596	1,055	62,965	60	4,541	885	101	50	15	4	0
1999	5,653	521	23,371	45	5,132	453	59	7	2	0	0
2000	5,482	430	22,384	52	5,052	363	57	8	2	0	0

Contractual Performance Measures for Radiological Control:

BNL has a performance measure for ALARA collective dose goals. An Outstanding rating is awarded for under-running ALARA goals by more than 20 percent, and an Unsatisfactory rating for over-running by more than 40 percent.

There is another measure for the number of radioactive contaminations reportable under ORPS, which provides an Outstanding rating for four or fewer occurrences, and an Unsatisfactory rating for 17 or more.

Fermilab

The proton beam used at Fermilab has greater potential to produce prompt radiation and induced radioactivity than the electron beams used at Stanford Linear Accelerator Facility (SLAC) and Thomas Jefferson National Accelerator Facility (TJNAF). For this reason, Fermilab tends to have a higher collective dose than either SLAC or TJNAF. It is commendable that the ALARA program at Fermilab has managed to cut the collective dose in half since 1997, despite the increased intensity at which the accelerator now operates to better support the physics research program.

Most of the collective dose results from work around radioactivated equipment; when the accelerator is operating and this kind of work decreases, the collective dose drops. An extended shutdown of the accelerator occurred during 2000, to reinstall the Collision Detector at Fermilab (CDF) and DZero detectors in the Tevatron tunnel. As a result, there was an increase in both the collective dose and the number of individuals with a measurable dose.

One employee at Fermilab was assigned a dose of 1,240 millirem in 1999, but it is believed that this dose is an artifact, caused by inadvertently leaving the dosimeter on top of a cabinet that contained a radiation source. The dose was reported to the NTS and ORPS, and is documented in Occurrence Report CH-BA-FNAL-FERMILAB-2000-0003.

Occupational Radiation Dose Distribution (1996-2000)

						Total Workers In Each Dose Range (mrem) >					
Year	**Total Workers Monitored**	**Total Workers With Dose**	**Total Person - mrem**	**Avg. Dose (mrem)**	**Total With No Dose**	**Below 100**	**100 - 250**	**250 - 500**	**500 - 750**	**750 - 1000**	**1k - 2k**
1996	2,540	538	16,230	30	2,002	513	23	1	1	0	0
1997	2,365	859	24,970	29	1,506	822	29	6	2	0	0
1998	2,066	441	12,790	29	1,625	421	15	5	0	0	0
1999	1,051	227	8,740	39	824	211	13	2	0	0	1
2000	1,361	406	12,340	30	955	390	14	1	1	0	0

Contractual Performance Measures for Radiological Control:

Fermilab has a contractual performance measure for managing collective dose. The measure rates a collective dose of less than 18 person-rem as outstanding.

Lawrence Berkeley National Laboratory (LBNL)

LBNL ranks the lowest in both average measurable dose and collective dose of all the SC multi-program laboratories, and both dose measures are trending down. LBNL has a number of policies within the framework of ISM that contribute to maintaining occupational radiation doses as low as reasonably achievable (ALARA). LBNL 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, and the 'top ten' doses are reviewed to ensure that the doses are commensurate with the work performed. The RSC also evaluates dose trends for each building.

The collective dose from the 88-Inch Cyclotron has been reduced by 90 percent since 1998, (from 1.0 to 0.1 person-rem) and now contributes only 8 percent to the site total. LBNL has begun using CR-39 dosimetry in any areas with positive neutron readings on albedo dosimeters. The improved accuracy of CR-39 has helped reduce the magnitude of recorded neutron doses.

Occupational Radiation Dose Distribution (1996-2000)

						Total Workers In Each Dose Range (mrem) >					
Year	**Total Workers Monitored**	**Total Workers With Dose**	**Total Person - mrem**	**Avg. Dose (mrem)**	**Total With No Dose**	**Below 100**	**100 - 250**	**250 - 500**	**500 - 750**	**750 - 1000**	**1k - 2k**
1996	2,732	100	4,642	46	2,632	92	6	2	0	0	0
1997	1,879	128	5,247	41	1,751	117	9	2	0	0	0
1998	1,992	76	2,912	38	1,916	75	1	0	0	0	0
1999	1,781	46	1,822	40	1,735	41	5	0	0	0	0
2000	1,835	44	1,114	25	1,791	42	2	0	0	0	0

Contractual Performance Measures for Radiological Control:

LBNL has a performance measure for managing occupational radiation dose, which provides an Outstanding rating for no individual exposures in excess of 500 millirem without an increase in workload (unless authorized in writing by the Radiological Control Manager), plus the number of individual exposures exceeding 100 millirem is 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.

There is also a performance measure for unplanned radiation exposures and ORPS reportable occurrences of skin or personal clothing contamination. An Outstanding rating is provided 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).

Oak Ridge Institute for Science and Education (ORISE)

In 2000, ORISE had the lowest number of monitored employees, the lowest collective dose, and the lowest average dose for all laboratories managed by the Office of Science. For the last 5 years, ORISE has never had a dose exceeding 100 millirem. The only sources of radiological exposure are some sealed sources for calibration, and some analytical work for environmental samples.

Occupational Radiation Dose Distribution (1996-2000)

						Total Workers In Each Dose Range (mrem) >					
Year	**Total Workers Monitored**	**Total Workers With Dose**	**Total Person - mrem**	**Avg. Dose (mrem)**	**Total With No Dose**	**Below 100**	**100 - 250**	**250 - 500**	**500 - 750**	**750 - 1000**	**1k - 2k**
1996	61	16	350	22	45	16	0	0	0	0	0
1997	49	12	370	31	37	12	0	0	0	0	0
1998	55	1	20	20	54	1	0	0	0	0	0
1999	48	8	42	5	40	8	0	0	0	0	0
2000	94	58	299	5	36	58	0	0	0	0	0

Contractual Performance Measures for Radiological Control:

ORISE has a performance measure for worker radiation dose, to assess the effectiveness of the ORISE personnel exposure program and to document that an active As Low As Reasonably Achievable (ALARA) Program is in place. The average ORISE employee occupational dose is calculated by dividing the collective total effective dose equivalent (TEDE) for all monitored ORISE employees by the total number of employees with a measurable dose. A rating of Meets Expectation shall be assessed for the quarter if the average dose falls below 10 millirem, and a rating of Does Not Meet Expectation is assessed if the average exceeds 10 millirem.

Beginning in January 1999, ORISE began using the Luxel TLD with a threshold of 1.0 millirem, compared to the previously used K-100 TLD that had a threshold of 10.0 millirem. This increased TLD sensitivity has resulted in a statistically higher dose per individual.

Oak Ridge National Laboratory (ORNL)

ORNL ranked highest in both collective dose and average measurable dose among all laboratories managed by the Office of Science. The major contribution to the collective dose at ORNL is the work at the High Flux Isotope Reactor (HFIR) and the Radiochemical Engineering Development Center (REDC). The Holifield Radioactive Ion Beam Facility (HRIBF) and the Oak Ridge Electron Linear Accelerator (ORELA) contribute little to the collective dose (approximately 0.23 person-rem in 2000).

In 1999, two Radiological Control Technicians (RCTs) exceeded 1 rem at ORNL. One was at the Radiochemical Engineering Development Center (REDC), but an investigation revealed that the workplace exposure potential and nonoccupational exposure could not account for this amount of exposure. Typically RCT exposures at REDC are below the ORNL administrative control level of 600 millirem. The other RCT was working with the Wastewater Triad Project at Building 7877. The project involved out-of-tank evaporation and removal of cesium and strontium from liquid waste storage tanks.

Occupational Radiation Dose Distribution (1996-2000)

						Total Workers In Each Dose Range (mrem) >					
Year	**Total Workers Monitored**	**Total Workers With Dose**	**Total Person - mrem**	**Avg. Dose (mrem)**	**Total With No Dose**	**Below 100**	**100 - 250**	**250 - 500**	**500 - 750**	**750 - 1000**	**1k - 2k**
1996	7,266	597	60,137	101	6,669	429	103	44	14	4	3
1997	6,828	591	54,059	91	6,237	430	107	41	8	4	1
1998	6,388	527	53,005	101	5,861	389	79	43	10	3	3
1999	6,159	506	43,740	86	5,653	376	89	28	9	2	2
2000	5,954	371	35,848	97	5,583	258	77	27	8	1	0

Contractual Performance Measures for Radiological Control:

ORNL has performance measures for both worker radiation dose and radiological operations. The measure for worker radiation dose is based on the average measurable dose; ratings range from outstanding for 90 millirem or less, to marginal for more than 110 millirem.

The radiological operations measure is based on five factors; the number of radiological workers that exceed their ORNL ALARA goal by 5 percent, the number of radiological workers exceeding 30 percent of any dose limit in 10 CFR 835, and the number of occurrences for radiation exposure, personnel contamination, and loss of control of radioactive material or spread of contamination.

Pacific Northwest National Laboratory (PNNL)

PNNL ranked fourth highest in 2000 for collective dose among all laboratories managed by the Office of Science. PNNL had a big drop in the collective dose in 1997; in 1996, it was 61 person-rem, in 1997, 18 person-rem, and it has dropped slowly since. This significant drop resulted from the PNNL transition out of the 324 and 327 Buildings. At one time, 324 Building represented a major portion (more than 30 percent) of the Hanford Site collective dose.

Occupational Radiation Dose Distribution (1996-2000)

						Total Workers In Each Dose Range (mrem) >					
Year	**Total Workers Monitored**	**Total Workers With Dose**	**Total Person - mrem**	**Avg. Dose (mrem)**	**Total With No Dose**	**Below 100**	**100 - 250**	**250 - 500**	**500 - 750**	**750 - 1000**	**1k - 2k**
1996	1,951	362	60,771	168	1,589	230	50	46	19	6	11
1997	1,725	288	17,573	61	1,437	243	33	9	2	1	0
1998	1,718	263	18,289	70	1,455	205	43	11	4	0	0
1999	1,609	236	15,569	66	1,373	190	30	15	1	0	0
2000	1,396	174	15,378	88	1,222	133	20	18	3	0	0

Contractual Performance Measures for Radiological Control:

PNNL has performance measures for managing unplanned dose, spread of radioactive contamination, and loss of control of radioactive material, as part of their evaluation of the effectiveness of Integrated Safety Management. An "Unplanned Dose" is defined as any occupational dose exceeding the expected dose by a value of 100 millirem or more, or any single unplanned dose onsite to a minor, student, or member of the public that exceeds 50 millirem.

"Spread of Radioactive Contamination" is defined as the number of instances of uncontrolled unwanted (nonlegacy) spread of radioactive contamination, meeting the criteria of DOE M 232.1-1A, Section 9.3, Group 1D, Off-Normal Event, Items 1-4. "Loss of Control of Radioactive Material" is defined as the number of losses of accountability of a sealed or unsealed radioactive source that meets the criteria of DOE M 232.1-1A, Section 9.3, Group 1D, Off-Normal Event, Items 5 or 6.

An outstanding rating requires zero Unplanned Doses, three or fewer instances of Spread of Radioactive Contamination, and one or zero instances of Loss of Control of Radioactive Material.

Princeton Plasma Physics Laboratory (PPPL)

PPPL ranked fourth lowest for collective dose among all SC laboratories in 2000. The dominant occupational radionuclide exposure is from tritium, and the majority of the occupational dose is from Decontamination and Decommissioning activities.

Occupational Radiation Dose Distribution (1996-2000)

						Total Workers In Each Dose Range (mrem) >					
Year	**Total Workers Monitored**	**Total Workers With Dose**	**Total Person - mrem**	**Avg. Dose (mrem)**	**Total With No Dose**	**Below 100**	**100 - 250**	**250 - 500**	**500 - 750**	**750 - 1000**	**1k - 2k**
1996	424	104	6,023	58	320	84	14	5	1	0	0
1997	381	88	2,943	33	293	81	6	1	0	0	0
1998	275	35	1,080	31	240	33	2	0	0	0	0
1999	406	34	817	24	372	33	1	0	0	0	0
2000	466	59	2,941	50	407	51	8	0	0	0	0

Contractual Performance Measures for Radiological Control:

PPPL has performance measures for both collective dose and personnel contamination control. A Total Effective Dose Equivalent (TEDE) of 0 to 4 person-rem for routine operations, and 0 to 8 person-rem for Decontamination and Decommissioning, is rated as Outstanding.

A total of zero contamination events is rated as Outstanding. Contamination events are defined as the number of skin or clothing contamination events (excluding protective clothing contamination) in which workers or visitors are contaminated with radionuclides that meet or exceed the criteria in PPPL documents implementing DOE Order 232.1.

Stanford Linear Accelerator Center (SLAC)

SLAC had the second lowest average measurable dose of all accelerator laboratories managed by SC in 2000. The collective dose at SLAC was less than that of Fermilab, and more than that at TJNAF. Typically, visitors represent about two-thirds of the individuals who are monitored.

The majority of the worker dose comes from maintenance activities. SLAC's average dose rate increased in 1997, when it began replacement of original beamline equipment, which was slightly activated after 20 years of use. With the replacement complete in 2000, the average dose decreased to 12 mrem. Replacing the aged, activated equipment has helped reduce radiation exposures overall; the collective dose at SLAC has dropped every year for the last 5 years.

In 2000, SLAC experienced an unexpectedly large number of small positive doses (most less than 10 millirem) for some workers who normally receive no measurable dose. The results could not be attributed to any known exposures or quality control problems; as a result, a new dosimetry system is being used.

Occupational Radiation Dose Distribution (1996-2000)

						Total Workers In Each Dose Range (mrem) >					
Year	**Total Workers Monitored**	**Total Workers With Dose**	**Total Person - mrem**	**Avg. Dose (mrem)**	**Total With No Dose**	**Below 100**	**100 - 250**	**250 - 500**	**500 - 750**	**750 - 1000**	**1k - 2k**
1996	2,598	312	19,320	62	2,286	268	29	14	1	0	0
1997	2,069	117	14,175	121	1,952	79	20	15	1	2	0
1998	2,283	157	13,137	84	2,126	126	19	12	0	0	0
1999	2,493	104	10,192	98	2,389	78	17	7	2	0	0
2000	2,423	489	5,766	12	1,935	482	7	0	0	0	0

Contractual Performance Measures for Radiological Control:

SLAC has performance measures 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 nonradiological workers.

There is a second measure for compliance with occupational radiation dose limits in 10 CFR 835, with an Outstanding rating for no occupational doses to radiological workers in excess of 500 millirem, no general employee dose over 50 millirem, and a total collective dose less than 70 percent of the previous three-calendar-year running average.

Thomas Jefferson National Accelerator Facility (TJNAF)

TJNAF ranks lowest in both collective dose and average measurable dose of the three accelerator laboratories managed by the Office of Science. Approximately two-thirds of the monitored individuals at TJNAF are visitors.

TJNAF has a "Level of Concern" set at 60 millirem per quarter; any individual dose exceeding this level triggers an ALARA review.

Occupational Radiation Dose Distribution (1996-2000)

						Total Workers In Each Dose Range (mrem) >					
Year	**Total Workers Monitored**	**Total Workers With Dose**	**Total Person - mrem**	**Avg. Dose (mrem)**	**Total With No Dose**	**Below 100**	**100 - 250**	**250 - 500**	**500 - 750**	**750 - 1000**	**1k - 2k**
1996	1,154	94	2,880	31	1,060	90	4	0	0	0	0
1997	1,321	47	1,370	29	1,274	44	2	1	0	0	0
1998	1,507	43	1,039	24	1,464	42	1	0	0	0	0
1999	1,454	45	1,370	30	1,409	43	2	0	0	0	0
2000	1,492	67	1,616	24	1,425	66	1	0	0	0	0

Contractual Performance Measures for Radiological Control:

TJNAF had a performance measure for the number of reportable and recordable exposures to radiation as off-normal occurrences; this measure weights unusual occurrences by a factor of five.

There is also another measure requiring a peer review of the Radiological Control Program in even-numbered fiscal years.