

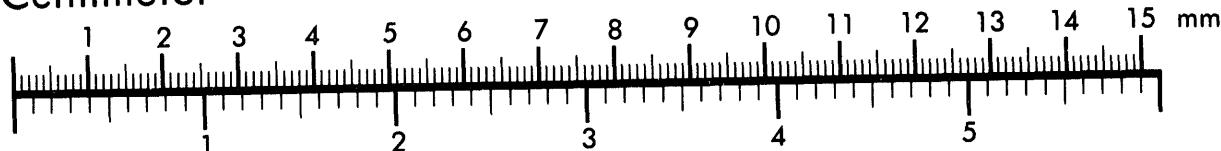


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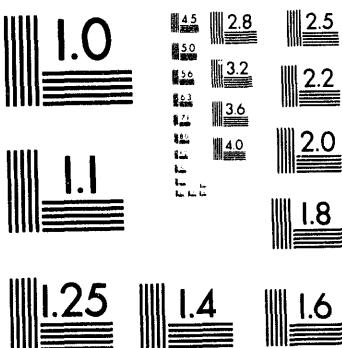
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Pacific Northwest Laboratory ALARA Report for Calendar Year 1993

S. L. Keller

July 1994

**Prepared for
the U.S. Department of Energy
under Contract DE-AC06-76RLO 1830**

**Pacific Northwest Laboratory
Richland, Washington 99352**

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SUMMARY

This report provides summary results of the Calendar Year (CY) 1993 As Low As Reasonably Achievable (ALARA) Program at the Pacific Northwest Laboratory (PNL)¹. This report includes information regarding whole-body exposures to radiation, and skin contaminations.

The collective whole-body radiation dose to employees during 1993 was 0.58 person-sievert (58 person-rem)². This dose was 11 percent lower than the projected dose of 0.65 person-sievert (65 person-rem). The Radiation Protection Section's Field Dosimetry Services group projected that no PNL employee's dose would exceed 0.02 sievert (2 rem) based on dosimeters processed during the year; no worker actually exceeded the limit by the end of CY 1993.

There were 15 reported cases of skin contamination for PNL employees during 1993. This number is 60 percent of the projected total of 25 cases. There were an additional 21 cases of personal-effects contamination to PNL staff: nine of these contamination events occurred at the 324 Building, nine occurred at the 325 Building, one occurred in the 327 Building, one occurred in the 3720 Building, and one occurred in the 326 Building.

Line management set numerous challenging and productive ALARA goals for their facilities. Appendix A describes the final status of the 1993 ALARA goals. Appendix B describes the radiological ALARA goals for 1994.

The Radiation Protection Section of the Laboratory Safety Department routinely perform audits of radiological ALARA requirements for specific facilities with significant potential for exposure. These ALARA audits are part of a comprehensive safety audit of the facility, designed to evaluate and improve total safety performance.

¹ The Pacific Northwest Laboratory is operated by Battelle Memorial Institute for the U.S. Department of Energy under Contract DE-AC06-76RLO 1830.

² The dosimetry records base the collective whole-body dose on dose to compliance-dosimeter-wearing PNL staff onsite only. All other data, discussions, conclusions, etc., in this report include both onsite and offsite information.

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I. INTRODUCTION

The concept of maintaining exposures to radiation as low as possible (ALAP) was first introduced formally in 1954 by the National Committee on Radiation Protection. DOE Order 5480.11, "Radiation Protection for Occupational Workers," establishes requirements for DOE contractor ALARA programs and references *Health Physics Manual of Good Practices for Reducing Radiation Exposures to Levels that are As Low As Reasonably Achievable* (ALARA), which describes possible elements of ALARA programs.

ALARA is a factor considered in all PNL projects. Chapter 1 of the DOE, *Radiological Control Manual*, provides guidance on PNL's radiological ALARA program. PNL trains all radiation workers in ALARA ideas and techniques. The purpose of this report is to summarize and document activities, accomplishments, and results of safety parameters involved in the ALARA Program during CY 1993.

The Radiological ALARA Program is administered by the PNL ALARA Coordinator of the Radiation Protection Section. The research and operational organizations develop ALARA goals; the ALARA Coordinator reviews these goals and tracks their progress throughout the year. The ALARA report displays CY 1993 radiological goals and their status in Appendix A; the CY 1994 radiological goals are in Appendix B. Line management implements the ALARA programs and Laboratory Safety and other organizations provide training and support.

II. RADIOLOGICAL ALARA

This section summarizes performance of the radiological ALARA Program at PNL. It includes information on radiation doses and skin contaminations and identifies the organizations with the highest doses.

Radiation Exposure

In CY 1993 staff members at PNL facilities on the Hanford Site who were monitored for compliance with DOE Order 5480.11 (i.e., multipurpose dosimeter wearers) received a total of 0.58 person-sievert (58 person-rem). At the beginning of the year, the ALARA Coordinator projected 0.65 person-sievert (65 person-rem), based on planned activities, primarily those in the 324 and 325 Buildings. The difference between projected and actual dose was 11 percent.

Exposure Trends

The ALARA Coordinator analyzed the distribution of doses among staff. Figure 1 shows the distribution of doses among the 1832 staff members who were monitored for compliance with DOE Order 5480.11. The average dose for this group during 1993 was 0.32 millisievert (32 millirem), compared to 0.34 millisievert (34 millirem) in 1992. The most frequently occurring dose for staff members during 1993 was 0 millisievert (0 millirem).

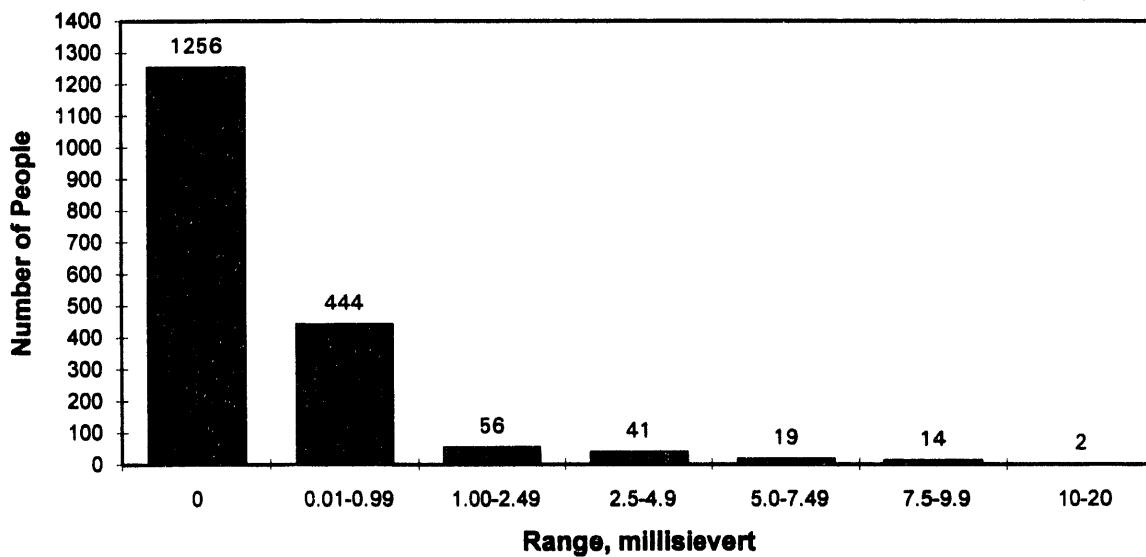


FIGURE 1. Dose Distribution for CY 1993

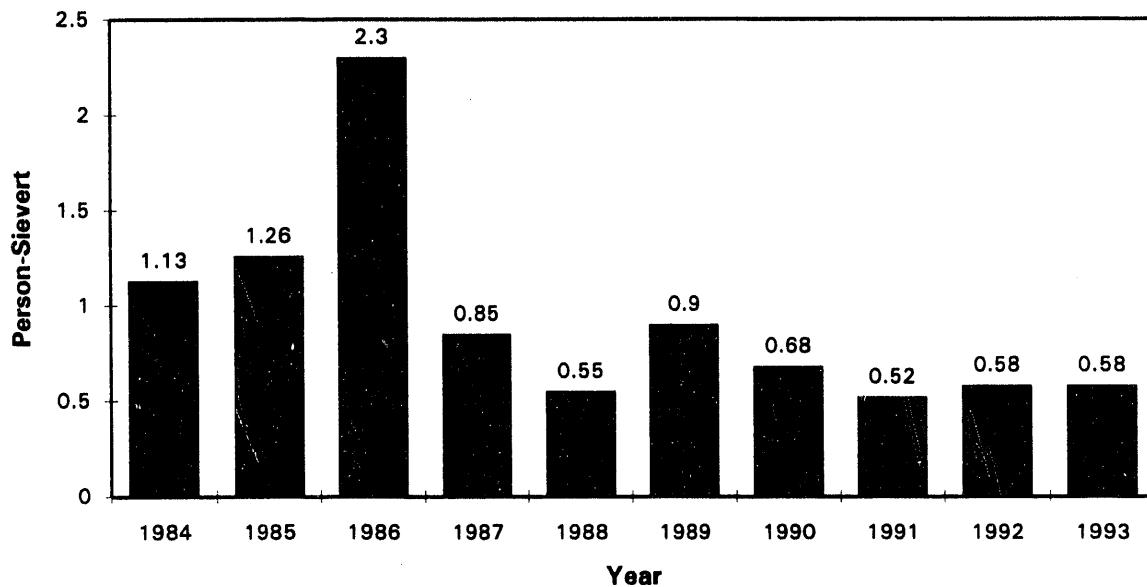


FIGURE 2. Annual Collective Whole-Body Dose for the Last 10 Years

Figure 2 shows the yearly trend in collective whole-body dose for PNL. The figure illustrates the correlation of collective dose to the major programs. The ALARA Coordinator relates the dose maximum in 1986 to the destructive examination phase of the steam generator project. The rise in collective dose in 1989 and 1990 was the result of the single-shell tank waste characterization. The

majority of the collective dose in 1991 through 1993 is attributed to the 325 Building A Annex clean-out, and clean-out activities in the 324 Building B hot cell. The ALARA Coordinator expects the collective dose for PNL to remain below 1 person-sievert (100 person-rem) over the next several years, unless significant program changes occur.

Figure 3 shows the yearly trend in total collective whole-body dose incurred by the five centers or directorates with the highest collective whole-body doses for the last three years. The Facilities and Operations Directorate accounted for approximately 38 percent, the Waste Technology Center accounted for 31 percent, and the Materials and Chemical Sciences accounted for 20 percent of the total CY 1993 PNL collective whole-body dose.

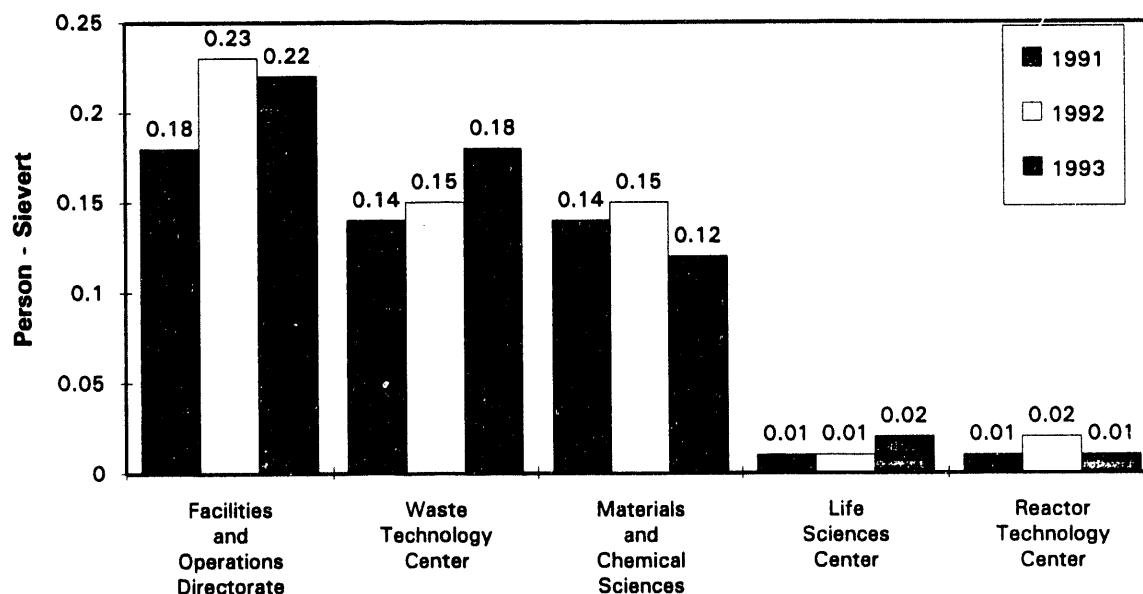


FIGURE 3. Collective Whole-Body Dose for 1990-1993 for the Five Highest Centers

Figure 4 shows the distribution of dose among PNL high dose organizations for 1993. The department incurring the highest collective dose was the Process Technology Department of the Waste Technology Center, which operates the majority of PNL's hot cell facilities, incurring 28 percent of the PNL collective dose. The Technical Services Department, Facilities and Operations Directorate received 17 percent of the PNL total. This dose results from support of the research and facility operations and maintenance. The Laboratory Safety Department, also of the Facilities and Operations Directorate, received approximately 17 percent of the PNL collective dose, the majority of which is due to routine activities of the Radiation Protection Technologists in support of the hot cell clean-out activities in the 324 and 325 Buildings. The Chemical Technology Department of the Materials and Chemical Sciences Center received 9 percent of the total. The Chemical Sciences Department of the Materials and Chemical Sciences Center received 6 percent of the total. The Materials Sciences Department had 5 percent of the total. The ALARA Coordinator attributes the majority of the dose for all of these departments to staff who work in the 324, 325 and 327 Buildings.

Observing the centers' and departments' trends of collective dose totals over the years indicates that the level of the collective dose relates directly to the number of projects involving work with radioactive

materials. A qualitative analysis of the 1993 overall collective dose totals for PNL has shown typical or expected values when compared with the recent years' totals (after 1986). The actual dose for 1993 was 11 percent lower than projected.

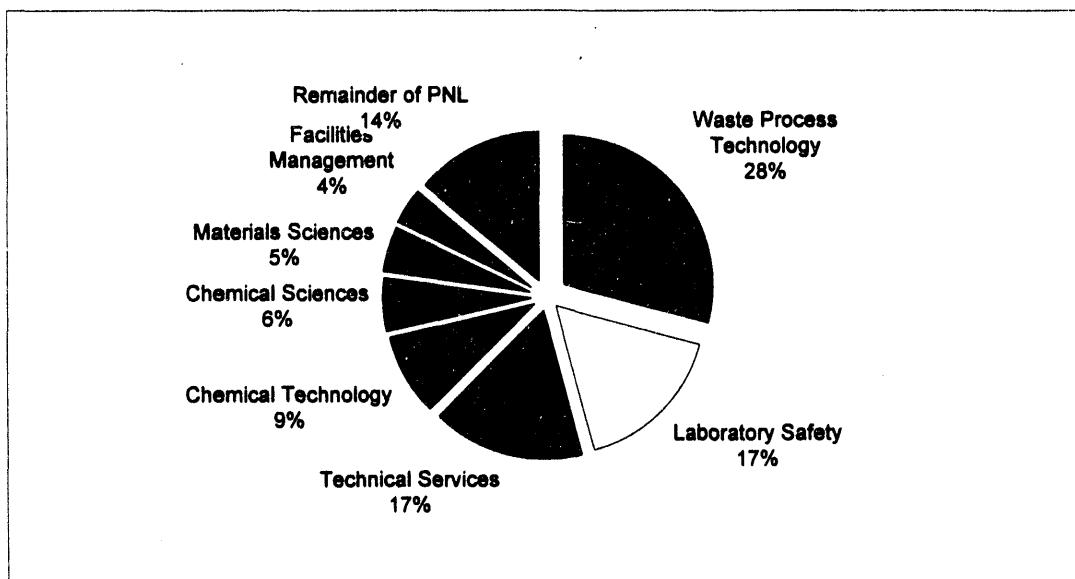


FIGURE 4. Distribution of Dose Among High-Dose Departments, 1993

Skin Contamination

In CY 1993, PNL staff had a total of 15 cases of skin contamination compared to an estimated number of 25 (Appendix D). Figure 5 shows the historical trend of yearly skin contaminations for the period 1990 to 1993. The stabilization of the number of skin contaminations is mostly due to heightened staff awareness, attention to detail while removing protective clothing, and a decrease of the use of personal clothing in contaminated and potentially contaminated areas.

An analysis of the available data indicates that the rate of the skin contaminations, as well as number of the skin contaminations, remained essentially constant in 1993 as compared to 1992. The number of entries into Radiologically Controlled Areas in all years is approximately 500,000.

Figure 6 provides a breakdown of skin-contamination cases by facility since 1990. Nine of the 1993 cases occurred in the 324 Building, and six occurred in the 325 Building. At the beginning of the year, the ALARA Coordinator projected 25 cases based on planned activities and historical trends.

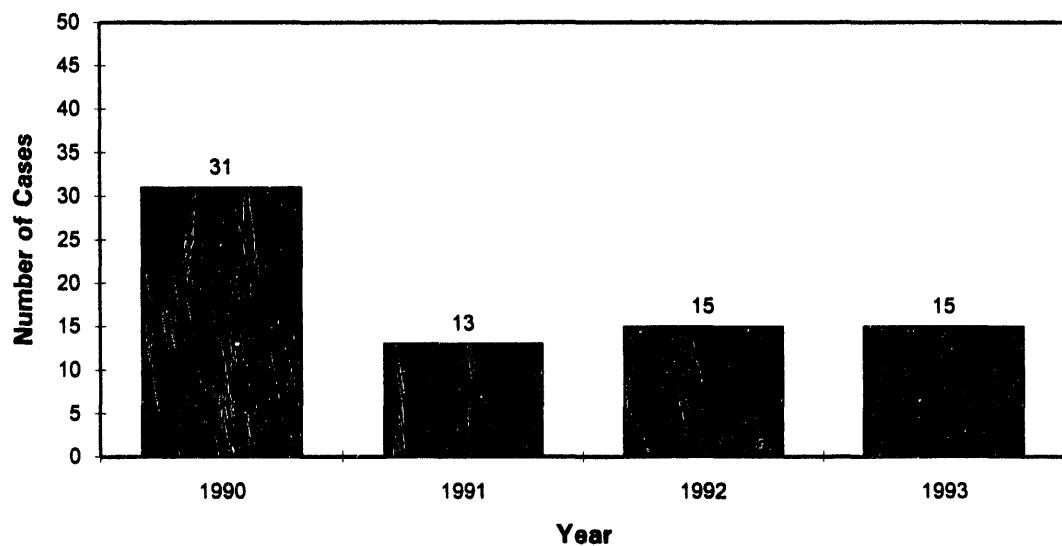


FIGURE 5. Annual Incidence of Skin Contaminations from 1990 through 1993

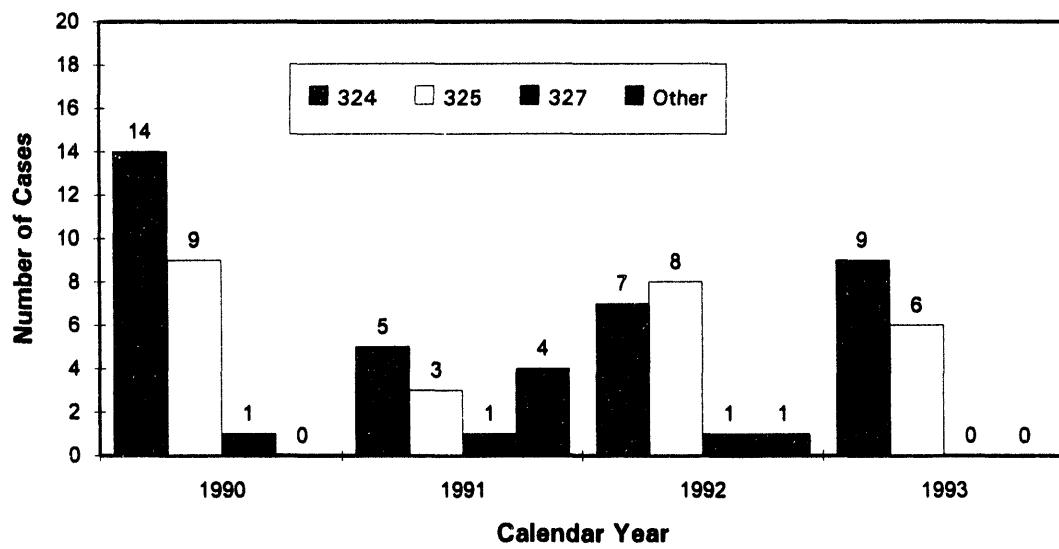


FIGURE 6. Annual Totals of Skin Contamination Cases by Year and Facility

III. REFERENCES

U.S. Department of Energy (DOE). 1992. "*Radiation Protection for Occupational Workers.*" DOE Order 5480.11.

U.S. Department of Energy (DOE). 1988. "*Health Physics Manual of Good Practices for Reducing Radiation Exposure to Levels that are As Low As Reasonably Achievable (ALARA).*" PNL-6577, Pacific Northwest Laboratory, Richland, Washington.

U.S. Department of Energy (DOE). 1990. "*Radiological Control Manual.*" DOE N 5480.6. Washington, D.C.

APPENDIX A

STATUS OF CALENDAR YEAR 1993 ALARA GOALS

The following organizations had ALARA goals for CY 1993: Waste Technology Center (WTC), Reactor Technology Center (RTC), Materials and Chemical Sciences Center (MCSC), and the Laboratory Safety Department (LS).

The majority of the CY 1993 ALARA goals were completed. Three goals were not completed due to circumstances beyond the control of the organization; two of these were put on hold and one was carried forward to 1994.

This appendix examines the goals individually, stating the goal number and a statement of the goal. The statement of the goal will be followed by a summary of final progress. The goals are numbered according to the organization working on the goal, the building where the work is being done, and a sequential number.

<u>Goal Number</u>	<u>Goal</u>	<u>Status</u>
306W-93-1	Reduce inventory of Uranium; reduce background radiation level.	Completed.
306W-93-2	Reduce amount of liquid radioactive waste in room 132; reduce unnecessary personnel dose.	Completed.
306W-93-3	Reduce probability of contamination from cracked flooring by replacing flooring.	This goal was put on hold.
325-93-1	Remove and dispose of Pu-contaminated glovebox; reduce dose rate and contamination hazard in room 410.	Completed.
325-93-2	Remove contamination hot spots from 325 Building A Annex floor; reduce dose hazard.	This goal was put on hold.
325-93-3	Design and fabricate shielded waste-handling system for Shielded Analytical Facility; reduce personnel dose.	Completed.
324-93-1	Design and install new track system for removal of waste from the 324 Building main hot cell airlock. Use of new track system will reduce time in the airlock and industrial hazards.	This goal was carried forward to 1994.
324-93-2	Design and fabricate remote decontamination viewing system for reduction of dose and contamination.	Completed.
324-93-3	Reduce volume of waste from analytical instrumentation.	Completed.

327-93-1	Identify and dispose of waste from 327 Building B and G-hot cells.	Completed.
327-93-2	Reduce personnel dose in 327 Building canyon room by removing painted-over contamination, etc.	Completed.
327-93-3	Reduce the use of the hazardous solvent 1,1,1-trichlorethane with non-hazardous substitute.	Completed.

APPENDIX B

RADIOLOGICAL ALARA GOALS FOR CALENDAR YEAR 1994

The Material and Chemical Sciences Center (MCSC) and Engineering Technology Center (ETC) have radiological ALARA goals. The ETC is a combination of last year's Reactor Technology Center (RTC) and the Waste Technology Center (WTC).

<u>Goal Number</u>	<u>Synopsis of Goal</u>
MCSC-306W-94-1	Improve contamination detection capabilities upon exiting from the depleted-uranium processing and machining areas through the installation of the intermediate personal-survey and clothing-change area at or near this work location. This goal will reduce the area of contamination by 100 square feet and reduce the machining-operations personnel contamination incidents.
MCSC-306W-94-2	Return 10,000 kg of depleted uranium to an Army sponsor. This action will allow the 306-W Building to become a non-nuclear facility and will reduce radiation readings in the building. This action will also reduce the radiation reading on the north wall from 4 mR/h to 2 mR/h.
MCSC-325-94-1	Review analytical chemistry laboratory (ACL) radioactive sample-storage locations to eliminate samples that are no longer required and to consolidate the number of storage areas in ACL space. This goal is expected to reduce radioactive-storage locations by one-third and collective dose by 10 percent.
MCSC-325-94-2	Remove and replace high efficiency particulate air (HEPA) filter on glovebox 38-A, Room 604. This goal will reduce the whole-body dose received by personnel working at the glovebox.
ETC-324-94-1	High-dose-rate waste containers will be shielded using concrete barrier blocks. The containers will be stored in a portion of the waste-storage enclosure that was constructed in FY 1993. This goal is expected to reduce staff collective dose by approximately 60 mrem/y.
ETC-324-94-2	A waste compactor will be installed in the radiochemical engineering cell airlock. Current plans are to compact all airlock wastes, such as those generated from cask handling or decontamination operations, into 30-gallon drums. These drums will then be removed from the airlock into 55-gallon shielded drums. This goal is expected to reduce the collective dose to waste handlers approximately 1 rem/y.
ETC-324-94-3	A new track and dollie system will be designed and fabricated to replace the current system. This goal will result in a collective exposure reduction for Hot Cell Operations staff approximately 1.2 rem/y.
ETC-324-94-4	Modify the pendant control on the 30/5-ton overhead bridge crane from a fixed position to a non-fixed (festooned) type. This goal will reduce collective PNL exposures by approximately 250 mrem/y.

ETC-324-94-5 Fabricate and install new step plugs to replace existing contaminated plugs. This goal is expected to reduce contamination incidents to the gallery from an average of 1.5 times per year to 0 times per year.

ETC-327-94-1 Reduce the easily dispersible contamination and radiation readings at transfer and equipment ports at F cell. Achievement of this goal will be assessed by performing radiation readings at the transfer and equipment ports before material transfers (>5 R/h). The expected reduction is from the present >5 R/h to < 1 R/h.

ETC-327-94-2 Reduce the radiation-dose-rate readings on the top of I cell by evaluating and moving the spent fuel stored in the cell and removing that which is not currently needed to support the on-going spent-fuel study. The expected reduction during transfers through the port is from the present >2 R/h to < 200 mr/h.

APPENDIX C

PROJECTIONS FOR CALENDAR YEAR 1994

The projections for CY 1994 are based on several sources. The primary source is the individual organization's estimate of collective dose based on planned activities. The ALARA Coordinator reviews these estimates and makes an independent appraisal of high-dose organizations, then combines the estimates into a PNL-wide collective dose estimate. Other sources taken into account are historical and recent trends in dose and contamination, as well as the year-to-date collective doses and contamination events. This estimate is relatively accurate because exposure rates for certain tasks is relatively well known, and extensive planning occurs before a new task is undertaken. An increase/decrease in exposure is expected for 1994 as the pace of hot cell clean-out activities increases, as well as several repairs to hot cell facilities.

The estimate for the expected number of skin contaminations is based on planned work in contamination areas, past trends, planned training, and expected effectiveness of protective clothing. This projection is subject to wide variations from year to year due to the relatively small number of events that occur and to unexpected sources of contamination. As the majority of the high-dose jobs are planned to occur in very high-contamination areas, the ALARA Coordinator projected the same number of skin contaminations as projected for 1993, despite the low number of actual skin contaminations.

Very few new or unexpected uptakes of radioactive materials have occurred at PNL in recent years; therefore, none are projected. The uptakes in past years have been either chronic uranium uptakes in the millirem range or offsite uptakes of tritium. No new uptakes are projected for CY 1994.

The Projections for CY 1994 are as follows:

0.65 person-Sievert (65 person-rem) collective whole-body dose.

25 skin contaminations.

APPENDIX D

SKIN CONTAMINATION CASES IN CALENDAR YEAR 1993

There were 15 cases of skin contamination of PNL staff at the Hanford Site in 1993, 60% of the projected 25 cases. Of these 15 cases, nine were in the 324 Building, six in the 325 building. The table below lists the skin contaminations in chronological order, the building where the contamination occurred, a brief description of the details of the event, a listed cause of the occurrence type, and occurrence date.

An occurrence classifier determined the severity and the cause of the event according to the guidance given by DOE Order 5000.3B. The occurrence classifiers determined that all skin contaminations in CY 1993 fit the category of "Off-Normal Occurrence." The Off-Normal Occurrence reports describe all skin contaminations in more detail and can be found in the Occurrence Reporting and Processing System (ORPS) database using the occurrence number listed below. Note: All occurrence numbers have the prefix RL-PNL.

In addition to the 15 skin-contamination events, there were 21 events involving personal-effects contamination.

<u>NUMBER</u>	<u>BLDG</u>	<u>DETAILS</u>	<u>TYPE</u>	<u>DATE</u>
324-1993-0002	324	Personnel contamination after work in fume hood in room 147. Staff member was wearing protective clothing and it is believed the protective clothing was contaminated before he put it on.	ONO	1/8/93
324-1993-0003	324	Personnel contamination during removal of rack in B cell. Entry into the cubicle, earlier the same day, allowed undetected spread of contamination.	ONO	1/29/93
324-1993-0004	324	Personnel contamination of right sole of shoe after work in the REC airlock event which was due to a rapid removal of protective clothing after an individual was escorted from the airlock with heat-prostration symptoms.	ONO	3/5/93
324-1993-0005	324	Personnel clothing contamination of PNL millwright. Source believed to be contaminated coveralls.	ONO	3/8/93

324-1993-0006	324	Personnel skin contamination on back of neck, found upon exit from the REC airlock. Source believed to be from condensate dripping from the doorframe at the exit of the airlock.	ONO	3/9/93
324-1993-0007	324	Personnel head and hair contamination. Event due to careless removal of protective respirator.	ONO	3/11/93
324-1993-0008	324	KEH personnel hair contamination. Event due to careless/untrained removal of protective clothing.	ONO	3/17/93
324-1993-0010	324	Personnel shoe contamination, after working in B-cell airlock. Source was unknown. Staff member was wearing proper protective clothing (bubble suit).	ONO	3/26/93
324-1993-0011	324	Personnel skin contamination, after support work to staff in a radiologically controlled area. Source is believed to have transferred from protective clothing to personal clothing.	ONO	3/29/93
324-1993-0013	324	Personnel clothing contamination after working in B-cell gallery. Two subsequent contamination events are included in the 10-day report. Source believed to be protective clothing from the laundry.	ONO	6/9/93
324-1993-0014	324	An RPT was found to have radioactive contamination on the little finger of his right hand. The cause was from handling electronic dosimeters before entering of the radiological area.	ONO	6/17/93
324-1993-0016	324	KEH shoe contamination after load test of 6-ton crane in B-cell airlock. Contamination occurred during careless undress.	ONO	6/28/93
324-1993-0018	324	Personnel clothing was contaminated. Staff member became contaminated when he came in contact with contaminated protective clothing from laundry.	ONO	8/10/93
324-1993-0020	324	Personnel skin was contaminated. Staff member perspired in a protective suit, which broke the tape seal around the neck area and allowed contamination to enter.	ONO	8/12/93
324-1993-0024	324	Shoe was contaminated. Staff member became contaminated after washing down the hot-cell airlock. Protective clothing and shoe covers worn. The source was unknown.	ONO	11/11/93
324-1993-0025	324	Skin contamination of wrist. Staff member became contaminated after installing conduit in the B-cell gallery. Source believed to have transferred from glove to wrist during careless undress.	ONO	11/19/93
324-1993-0026	324	Skin contamination was detected after a technician's exit from the hot-cell airlock. There was an RWP violation, in that only one pair of gloves was worn.	ONO	12/9/93

325-1993-0001	325	Personnel contamination of right chest area, after working in room 400. The source was unknown.	ONO	1/8/93
325-1993-0002	325	Personnel contamination of shoe after work in room 511. The source was unknown.	ONO	1/13/93
325-1993-0003	325	Personnel contamination of right hand after counting a sample in room 425. Contamination was due to loose contamination that fell off a contaminated counting plate.	ONO	1/27/93
325-1993-0004	325	Personnel contamination of heel of right shoe after maintenance work on evening shift. Source believed to be transferred from the static mat at the PCM to staff member's shoe.	ONO	2/2/93
325-1993-0005	325	Personnel contamination of right pant leg after exit survey. Source believed to be from contaminated labcoat.	ONO	2/12/93
325-1993-0006	325	Personnel contamination of right palm after exit survey. Source was traced to a pipette in room 313.	ONO	2/17/93
325-1993-0007	325	Personnel contamination of face, lip, and hair after decontamination solution splashed in her face.	ONO	3/3/93
325-1993-0010	325	Radioactive contamination found on right shoe of KEH construction worker. The source was unknown.	ONO	3/31/93
325-1993-0011	325	Radioactive contamination found on right hand of technician. Contamination acquired during analytical work, after using inadequate pipette. No gloves were worn.	ONO	4/7/93
325-1993-0012	325	Radioactive contamination found on hands of KEH construction worker, after work in room 302. Event caused by inadequate fixative coating over previous contamination in ductwork in the floor.	ONO	5/3/93
325-1993-0013	325	Radioactive contamination found on PNL staff member's shoe after working in a surface contamination area. Contamination was transferred from contaminated protective shoe covers.	ONO	5/10/93
325-1993-0015	325	Contamination of KEH staff member's shoe during construction work. Alpha particle was deeply imbedded on shoe and believed to have been present before entering the work area.	ONO	5/17/93
325-1993-0016	325	A technician was found to have a contaminated forefinger upon exit from room 400, which is a radiation area. The source is Sr-Y, which came from contaminated cabinetry used for laboratory equipment.	ONO	6/9/93

325-1993-0024	325	Personnel clothing contamination found after laboratory work. The source was unknown; the staff member was not working with radioactive samples and did not use a fume hood.	ONO	10/14/93
325-1993-0026	325	A staff member was found to have a contaminated sole of right shoe after exit from the 325 Building A Annex area. The source was unknown.	ONO	12/27/93
PNLBOPEM-1993-0003	327	The RLWS alarm sounded at the low-point drain line. Water was leaking from a previously sealed isolation valve. Shoes of two staff member's became contaminated in the investigation of the leak (100mr/hr).	ONO	1/25/93
PNLBOPER-1993-0013	326	Personal clothing contamination (non-PNL employee) after work in normal research and development activities. Contamination may be due to unbuttoned laboratory coat during work.	ONO	4/5/93
PNLBOPER-1993-0036	3720	Research and development technician found contamination on shoe sole. He had not been in any areas requiring shoe covers. Source was unknown and had decayed to non-detectable levels by the next day.	ONO	11/10/93

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A vertical stack of four abstract black and white shapes. The top shape is a rectangle divided into two vertical sections by a central vertical line. The second shape is a horizontal rectangle with a diagonal black line from the top-left corner to the bottom-right corner. The third shape is a large, thick, L-shaped block. The bottom shape is a large, thick, U-shaped block.

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