PNL--8361

DE93 002511

Pacific Northwest Laboratory ALARA Report for CY 1991

G. M. Ceffalo

September 1992

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

Pacific Northwest Laboratory
Richland, Washington 99352

SUMMARY

This report provides summary results of the CY 1991 As Low As Reasonably Achievable (ALARA) Program at the Pacific Northwest Laboratory (PNL).[a] This report includes information regarding whole-body exposures to radiation, skin contaminations, and the nonradiological ALARA program.

The collective whole-body radiation dose to employees during 1991 was 0.52 person-sievert (52 person-rem).[b] This dose was 74% of the projected dose of 0.70 person-sievert (70 person-rem), and a significant reduction from the 1990 collective dose of 0.68 person sievert (68 person-rem). The dosimetry section projected that one PNL employee's dose would exceed 0.02 sievert (2 rem) based on dosimeters processed during the year, but no worker actually exceeded 0.02 sievert (2 rem) by the end of CY 1991.

There were 13 reported cases of skin contamination for PNL employees during 1991. This number is 43% of the projected total of 30 cases. Five of these cases (38%) occurred at the 324 Building.

Line management made progress during 1991 on the implementation of ALARA as evidenced by the development of challenging and productive ALARA goals by the operational organizations. Line management completed all goals that could be completed through the efforts of the organizations involved. Appendix A describes the final status of the 1991 ALARA goals. Appendix B describes the radiological ALARA goals for 1992.

The Occupational and Radiological Safety and Radiation Protection sections of the Laboratory Safety Department perform audits of radiological ALARA requirements routinely for specific facilities with significant potential for causing exposures. These

---

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

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

ALARA audits are part of a comprehensive safety audit of the facility, designed to evaluate and improve total safety performance.

The injury accident rates indicate that PNL protected staff members and the public from unacceptable exposure to nonradiological hazards. The motor vehicle accident and loss rates increased slightly, but only two reportable motor vehicle accidents occurred in 1991. There was one PNL fire in 1991 that resulted in damage. Starting in 1988, the Industrial Health and Safety Group of the Laboratory Safety Department began publishing accident data and rates for each center on a quarterly basis, allowing management to monitor safety performance parameters in their organization.

CONTENTS

FIGURES

TABLES

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 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. Section 10.0 of PNL-MA-6, Radiation Protection, provides information 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 1991.

At PNL, applying the ALARA philosophy is not limited to nuclear and radiological hazards; PNL applies the ALARA concept to a wide variety of hazards, including exposure to hazardous chemicals and physical hazards (lasers, noise, etc.). Line management makes exposures to chemicals ALARA by substituting less hazardous chemicals, using engineering controls such as ventilation or containment, and using administrative controls and personal protective equipment. Laboratory management reduces exposure to physical hazards such as lasers or rotating equipment by separating people from the hazard through the use of timing, distancing or shielding and/or guarding. PNL-MA-43, Industrial Hygiene, Occupational Safety and Fire Protection Programs, is the PNL document controlling such work.

The Occupational and Radiological Safety Section of the Laboratory Safety Department administers the ALARA Program through the PNL ALARA Coordinator. 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 goals and their status in Appendix A; the CY 1992 radiological goals are in Appendix B. Line management implements the ALARA programs with training in many topics being provided for their staff by Laboratory Safety and other organizations.

II. RADIOLOGICAL ALARA

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

Radiation Exposure

Staff members at PNL facilities on the Hanford Site monitored for compliance with DOE 5480.11 (i.e., multipurpose dosimeter wearers) received a total of 0.52 person-sievert (52 person-rem) in CY 1991. At the beginning of the year, the ALARA Coordinator projected 0.70 person-sievert (70 person-rem), based on planned activities, primarily those in the 324 and 325 Buildings.

Exposure Trends

The ALARA Coordinator analyzed the distribution of doses among the staff. Figure 1 shows the distribution of doses among staff members monitored for compliance with DOE 5480.11 (multipurpose dosimeter wearers). The most frequently occurring dose for staff members during 1991 was 0 millisievert (0 millirem). The average dose for this group during 1991 was 0.35 millisievert (35 millirem), compared to 0.44 millisievert (44 millirem) in 1990.

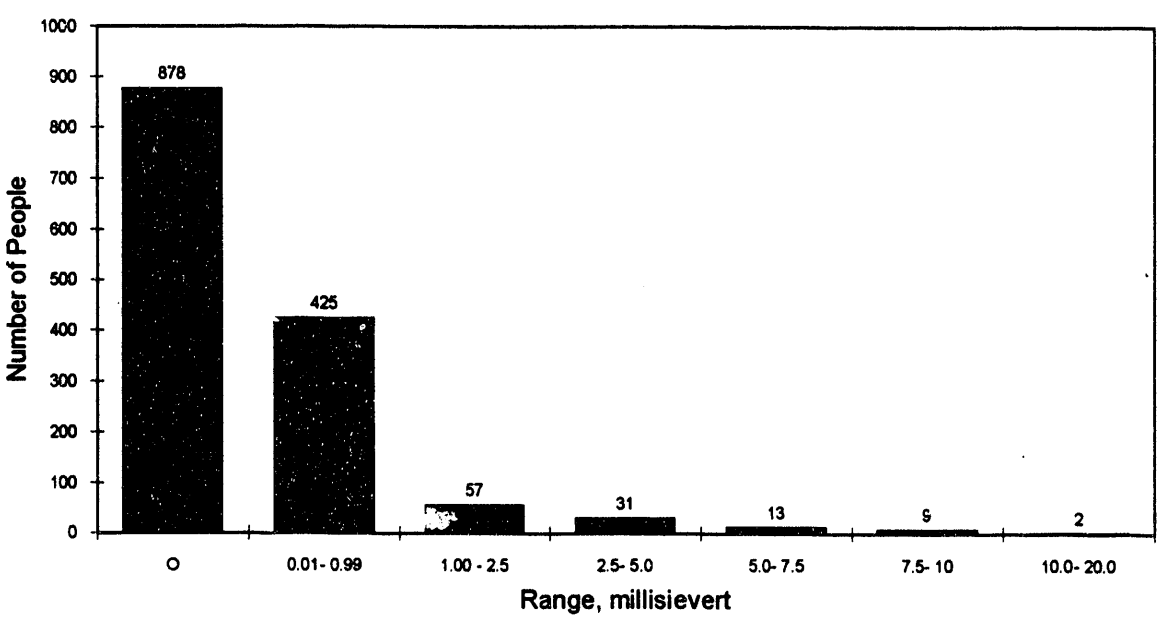

FIGURE 1. Dose Distribution for CY 1991

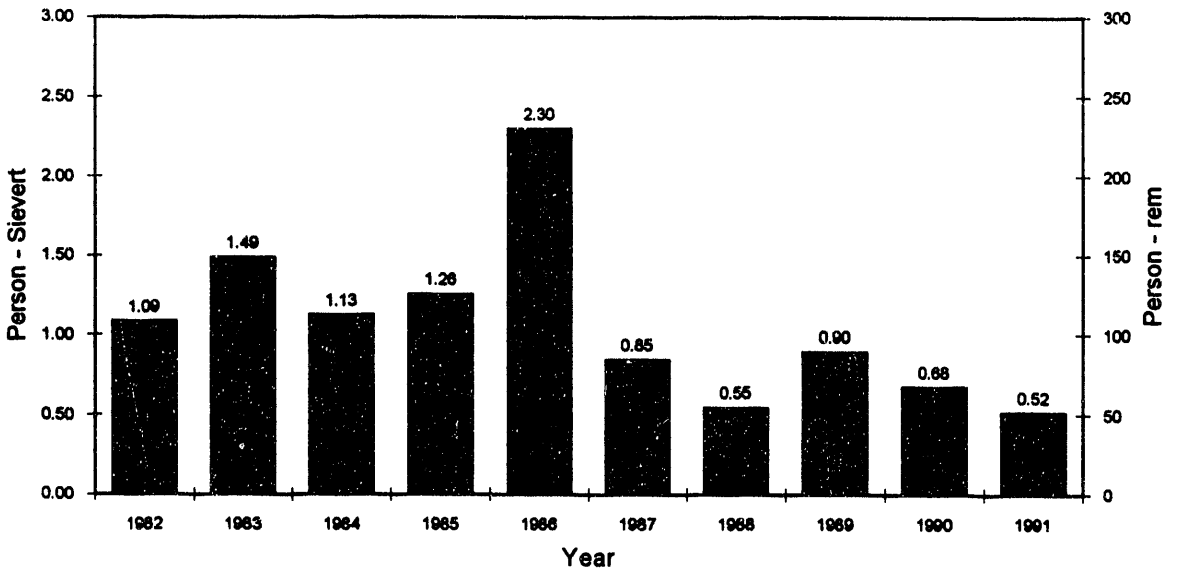

FIGURE 2. Annual Collective Whole-Body Dose for the Last 10 Years

Figure 2 shows the yearly trend in collective whole-body dose for PNL. The figure illustrates the dependence of collective dose on 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 1989-1990 was due to the single-shell tank waste characterization. Figure 2 also shows the general trend toward lower doses at PNL, some of which is independent of major projects. 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 six centers or directorates with the highest collective whole-body doses for the last 4 years. The Facilities and Operations Directorate accounted for approximately 34% of the total CY 1991 PNL collective whole-body dose. The Material and Chemical Sciences and Waste Technology Centers accounted for the majority of the balance of the total dose, incurring approximately 28% each.

Most centers decreased their doses relative to their 1990 totals, with the exception of Waste Technology, Material and Chemical Sciences and Earth and Environmental Sciences. The increase in collective dose of the Waste Technology Center is due to the transfer of all of the Reactor Technology hot cell operations to

Waste Technology. The collective dose of Reactor Technology decreased a corresponding amount. The Earth and Environmental Sciences Center collective dose increased slightly, from 980 mrem to 1190 mrem, which the ALARA coordinator does not consider statistically significant.

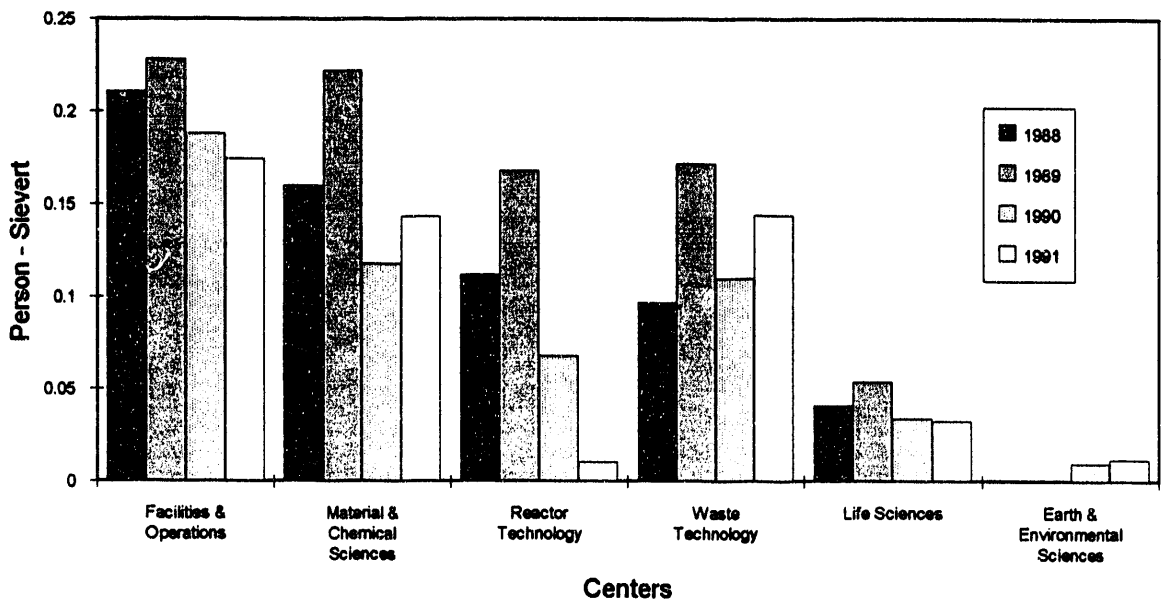

FIGURE 3. Collective Whole-Body Dose for 1988-1991 for the 6 Highest Centers and Directorates

Factors that may have improved the dose totals were the accomplishment of many ALARA goals (see Appendix A, "Status of CY 1991 ALARA Goals"), conducting pre-job ALARA meetings and the change in the relative total work load of the centers. The Laboratory Safety Department and Technical Services Department in the Facilities and Operations Directorate have reduced their doses due to these reasons, despite unavoidable routine tasks such as radiation protection surveys and facilities maintenance and repair. The Health Physics Department of the Life Sciences Center has remained consistent at its present low dose level over the past few years, mostly due to the unavoidable routine requirements of their primary job: radiation detector and dosimeter calibrations.

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 23% of the PNL collective dose. The Laboratory Safety Department of the Facilities and Operations Directorate received approximately

17% of the PNL collective dose, the majority of which is due to routine activities of the Radiation Protection Technologists. This dose is due to support of the research and facility operations and maintenance. The Technical Services Department, also of the Facilities and Operations Directorate, received 11% of the PNL total, for similar reasons. The Materials Science Department and Analytical Chemistry Laboratory of Materials and Chemical Sciences Center had 14% and 7% of the total PNL dose. The dosimetry reports attribute the majority of the doses for all of these departments to work in the 324, 327 and 325 Buildings. The Health Physics Department of the Life Sciences Center contributed 4% of the PNL collective dose (see Figure 4). As with their respective centers, most departments showed decreases in total doses during 1991.

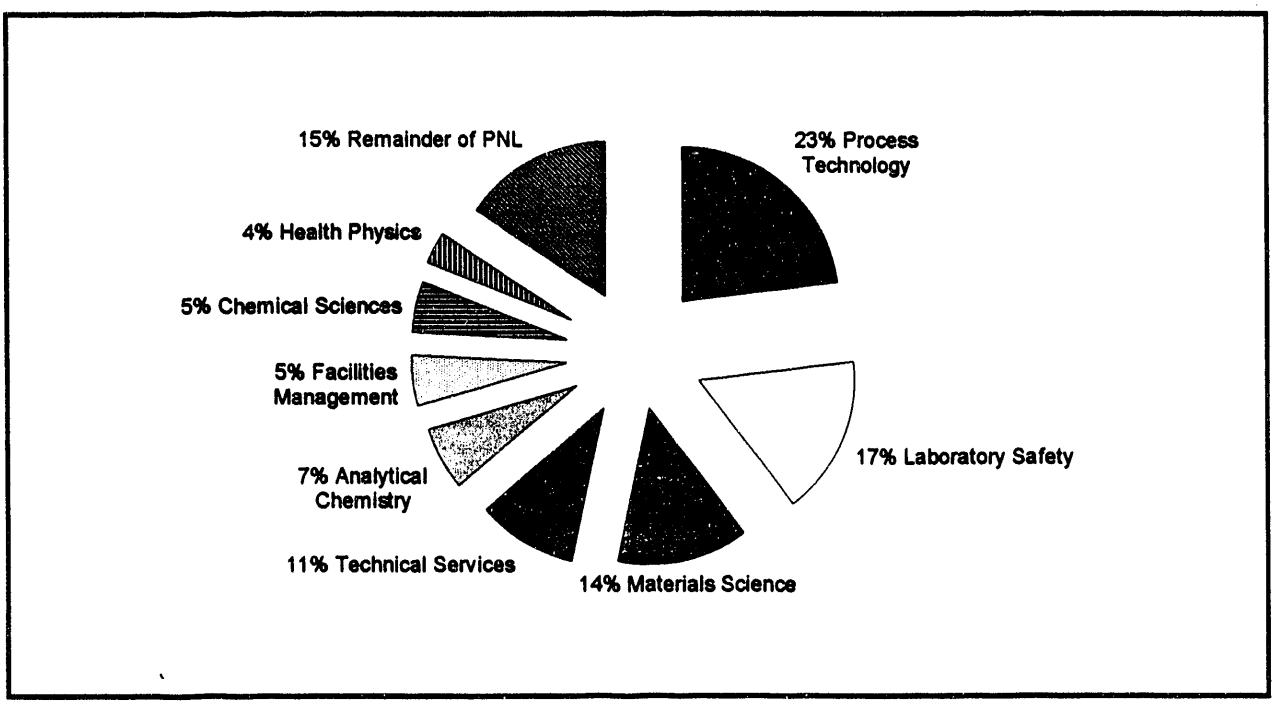

FIGURE 4. Distribution of Dose Among High-Dose Departments, 1991

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. The number of projects involving radiation work and the relative amount of this type of work load has been historically variable, making it somewhat difficult to adjust or weight the collective doses for comparison of different years. Line management may reassign personnel and

organizational groups to other jobs or organizational groups continuously throughout the year, making it relatively difficult to accurately assign doses to specific projects and work. One good example of this is the transfer of the 327 hot cell facilities and personnel from the Reactor Technology Center to the Waste Technology Center. Considering these obstacles involved in accurate trend analysis, a qualitative analysis of the 1991 overall collective dose totals for PNL have shown typical or expected values when compared with the recent years' totals (after 1986).

Quarterly Exposure Evaluations

Procedures for identification, tracking and evaluation of job tasks of staff members receiving potentially excessive whole-body and/or extremity doses remained in place in 1991. Supervisors of staff members with doses that indicate potential to exceed annual or quarterly limits receive an exposure evaluation request (and form) for each staff member with a high dose. The supervisor evaluates the tasks being performed by the individual(s), and records pertinent information on the exposure evaluation form so that line management can implement further ALARA practices wherever possible, and, if necessary, increase the administrative limit. Radiological Engineering reviews the supervisor's evaluation and initiates follow-up actions as appropriate. The whole-body and extremity quarterly doses used as criteria for evaluation are those values that extrapolate to year-end doses of 0.02 sievert (2 rem) for the whole-body and 0.30 sievert (30 rem) for the extremities. As shown in Table 1, three PNL staff members exceeded the criteria for evaluation during 1990. In 1991, one individuals exceeded the limit in first quarter due to an off-site exposure; however, no one exceeded the limit for the year. This decrease in the number of projected high dose individuals shows the attention to detail of the staff and their management, as well as the effectiveness of the ALARA program.

TABLE 1. Number of Staff Members Whose Extrapolated Year-End Dose Exceeded 0.02 Sievert

Quarter	CY 89	CY 90	CY 91
1st	6	3	1
2nd	1	0	0
3rd	1	0	0
4th	0	0	0

Skin Contamination

In CY 1991, PNL staff had a total of 13 cases of skin contamination compared to an expected number of 30 (see Appendix D). The number of skin contaminations in 1991 is a significant reduction from previous years. Figure 5 shows the historical trend of yearly skin contaminations for the period 1986-1991. This is mostly due to a heightened awareness on the part of the staff, attention to detail while removing protective clothing, and a decrease of the use of personal clothing in contaminated and potentially contaminated areas. Another cause of the reduction of skin contaminations is the survey for contamination of protective clothing received from the laundry before use.

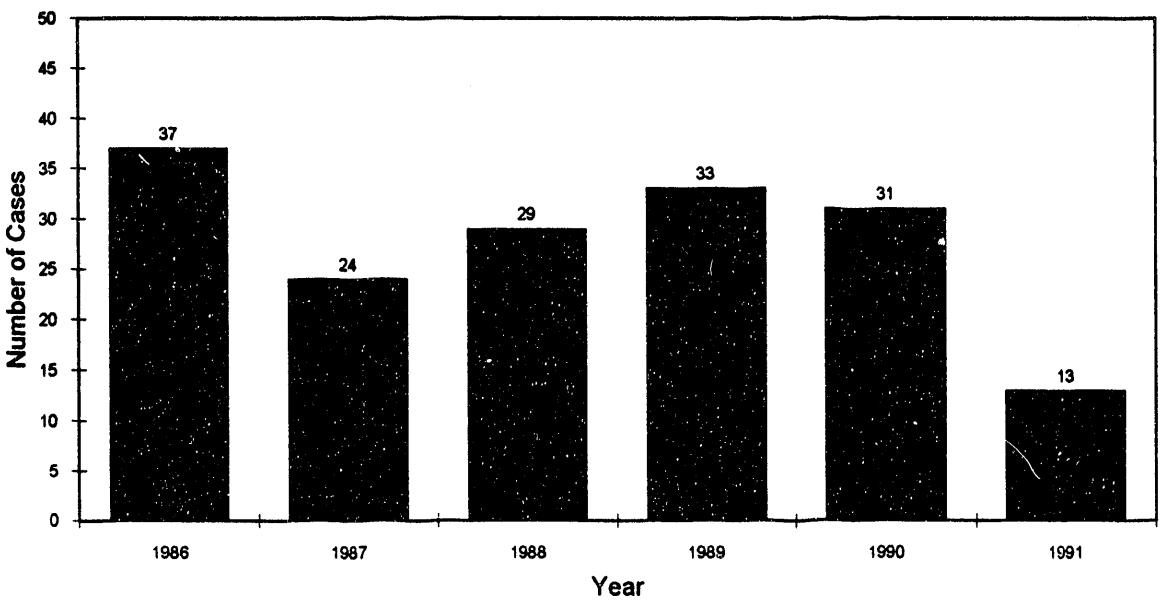

FIGURE 5. Annual Incidence of Skin Contaminations from 1986 through 1991

An analysis of the available data shows that the rate of the skin contaminations, as well as the number of the skin contaminations dropped in 1991. In 1990, the rate of skin contaminations per entry into a Radiologically Controlled Area (RCA) was approximately 3-4 x 10^{-5} contaminations per entry, while in 1991 the rate was only 1-2 x 10^{-5} per entry into a RCA. The number of entries into RCAs in both years was approximately 500,000.

Figure 6 provides a breakdown of skin contamination cases by facility since 1986. Many of the 1991 cases (5) occurred in the 324 Building. At the beginning of the year, the ALARA coordinator projected 30 cases based on planned activities. The

decrease in the number of contaminations in the 325 Building from 1990 to 1991 is partly due to work on the single-shell tank waste characterization project being placed in standby. The decrease in the number of contaminations in the 324 Building is despite the Shielded Materials Facility hot cell clean-out, the B-Cell clean-out, and continued work with materials that have historically caused many contaminations, such as cesium chloride and tritium.

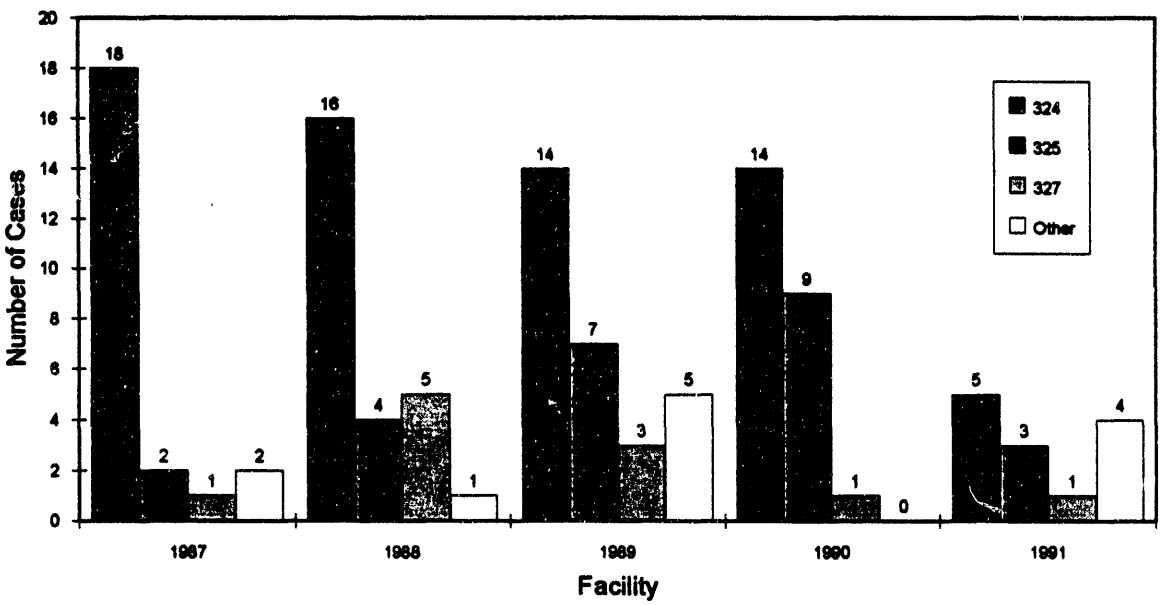

FIGURE 6. Annual Totals of Skin Contamination Cases by Year and Facility

III. NONRADIOLOGICAL ALARA

During CY 1991, the Laboratory had an average of 3229 full-time staff members who worked 6.5 million hours on private and PNL-related programs. This section discusses the nonradiological safety performance of PNL for CY 1991.

Accident Investigation

Laboratory Safety investigates all accidents, injuries, illnesses, motor vehicle accidents, fires and property damage with serious consequences and documents them in detail. PNL policy requires line management involvement in the response and investigation of accidents and in the establishment and implementation of corrective action. These activities ensure that line management takes appropriate actions to prevent recurrence of the accident, and they demonstrate PNL's commitment to providing a safe and healthy workplace.

First Aid Cases

The Laboratory Safety Department investigated 127 first aid cases during CY 1991, a decrease from 132 cases in 1990. Laboratory Safety investigated each reported occupational injury or illness and recommended corrective actions to line management, as appropriate, to prevent recurrence.

Recordable Injuries and Illnesses

Current criteria consider occupational injuries recordable if they are severe enough to require medical attention beyond first aid (e.g., prescription medication, sutures, treatment of broken bones, lost workday cases, etc.). Before 1990, PNL used criteria defined by the U.S. Department of Energy (DOE) or the State of Washington to classify the injury or illness and to determine required documentation. In 1991, PNL fully implemented Bureau of Labor Statistics (BLS) criteria. Laboratory Safety classified all injuries during 1991 using the BLS criteria, which results in higher numbers of recordable injuries. Laboratory Safety examined the records from 1990 with partial use of the BLS criteria. These new criteria resulted in a higher number of recordable injuries than those in 1989. Laboratory Safety considers all occupational illnesses recordable.

The Laboratory Safety Department and line management jointly investigate recordable injuries and illnesses. During CY 1991, staff members incurred 91

recordable injuries. This number resulted in a recordable injury incidence rate of 2.82 recordable injuries or illnesses per 200,000 work hours. Figure 7 compares this rate to past PNL rates and to DOE-RL. The ALARA coordinator expects that the numbers of recordable injuries DOE wide will rise when full implementation of the BLS criteria occurs.

Lost Workday Injuries

Laboratory Safety considers an injury or illness a lost workday case if the staff member misses an entire, regularly scheduled, work shift due to an occupational accident. These injuries are more serious than most other recordable injuries since the consequences include significant lost time. Staff members sustained 42 lost workday cases during 1991, which resulted in a lost workday case incidence rate of 1.3 lost workday cases per 200,000 work hours. Figure 8 compares this rate to past PNL rates and to DOE-RL averages. While the number of first aid cases dropped, the severity of the cases increased, which resulted in larger numbers of recordable injuries and lost workdays. Implementation of the BLS criteria also had some effect on the number of lost workday cases.

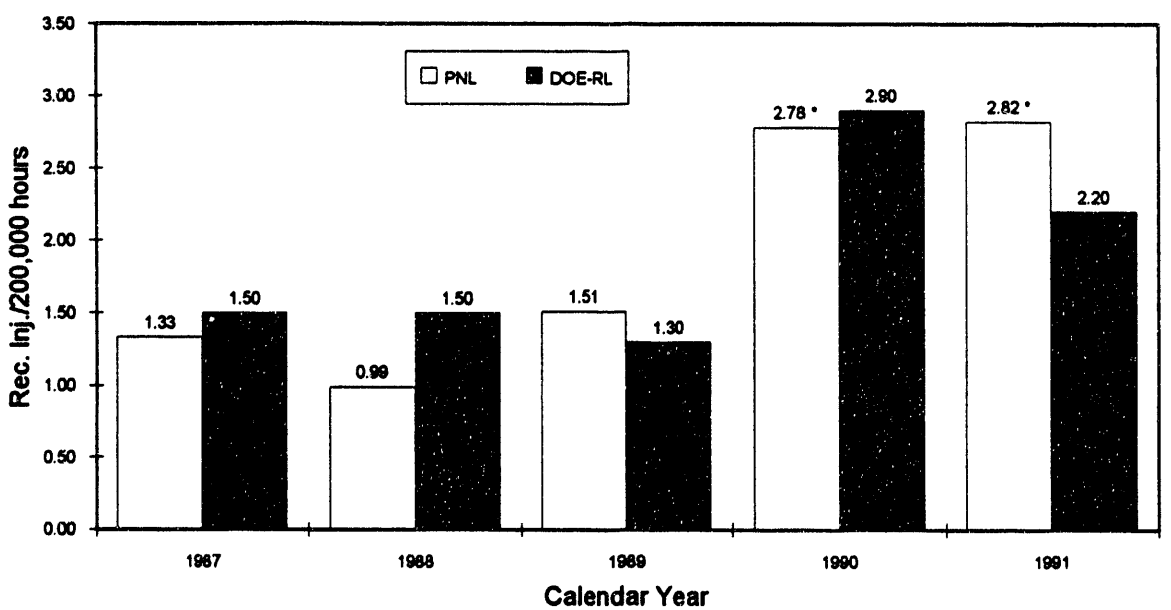

FIGURE 7. PNL Recordable Injury Incidence Rate

* These higher numbers are the result of the implementation of the BLS criteria mentioned above.

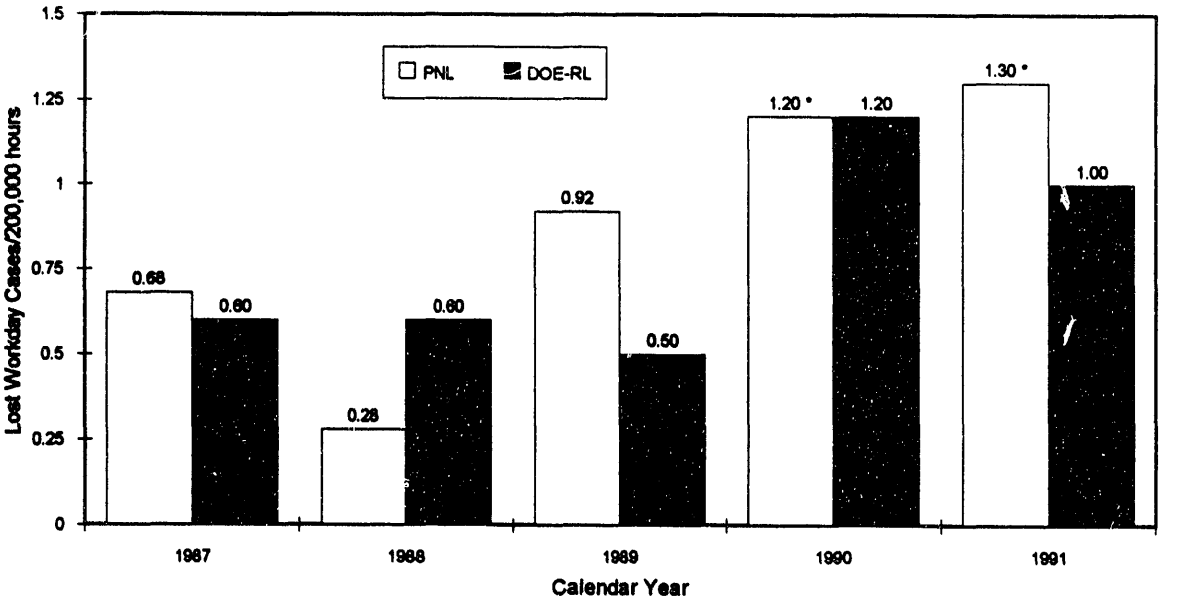

FIGURE 8. PNL Lost Workday Case Incidence Rate

* See previous footnote

The 42 lost workday cases resulted in 343 lost workdays and 481 days of work restriction. These lost and restricted workdays resulted in a lost workday incidence rate of 25.52 lost workdays per 200,000 work hours. Figure 9 compares this rate to past PNL rates and to DOE-RL averages.

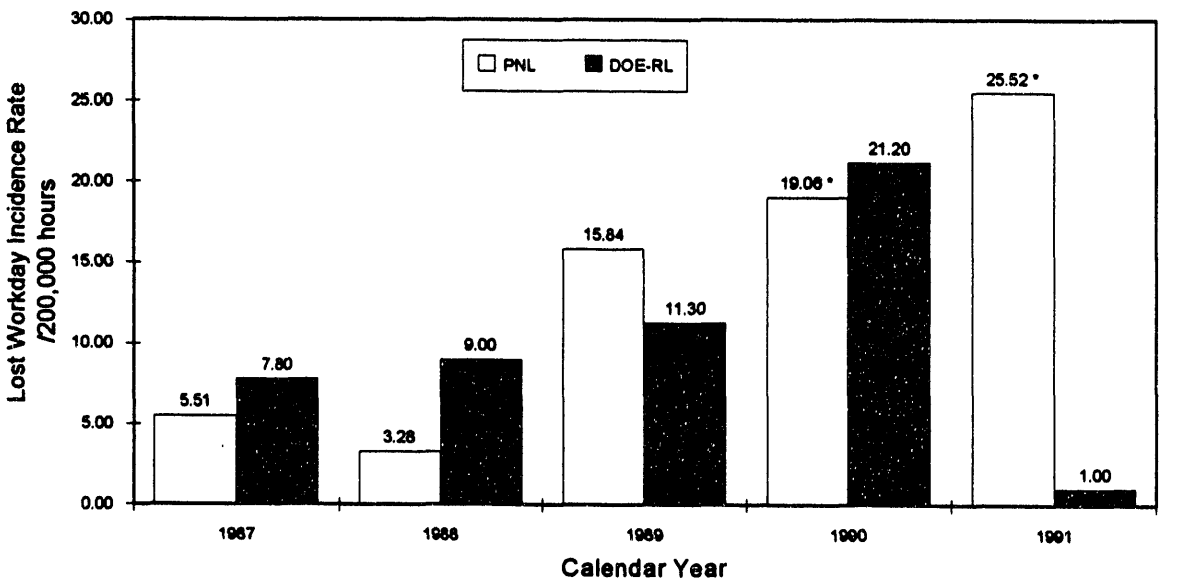

FIGURE 9. PNL Lost Workday Incidence Rate

* See previous footnote

Motor Vehicle Accidents

Staff members drove government vehicles approximately 0.75 million miles with two reportable accidents during 1991. PNL's motor vehicle accident rate for 1991 was 2.67 accidents per million miles, as compared to 6.67 accidents per million miles in 1989, and 0 (none) in 1990. Figure 10 compares these rates to past PNL rates and to DOE-RL averages.

The motor vehicle loss rate for 1991 of $2.47 per thousand miles compares to $6.67 per thousand miles in 1989, and 0 (none) in 1990. Figure 11 compares this rate is to past PNL and DOE-RL rates. Due to the relatively few miles that the PNL staff drive each year, a single accident can significantly vary the PNL statistics.

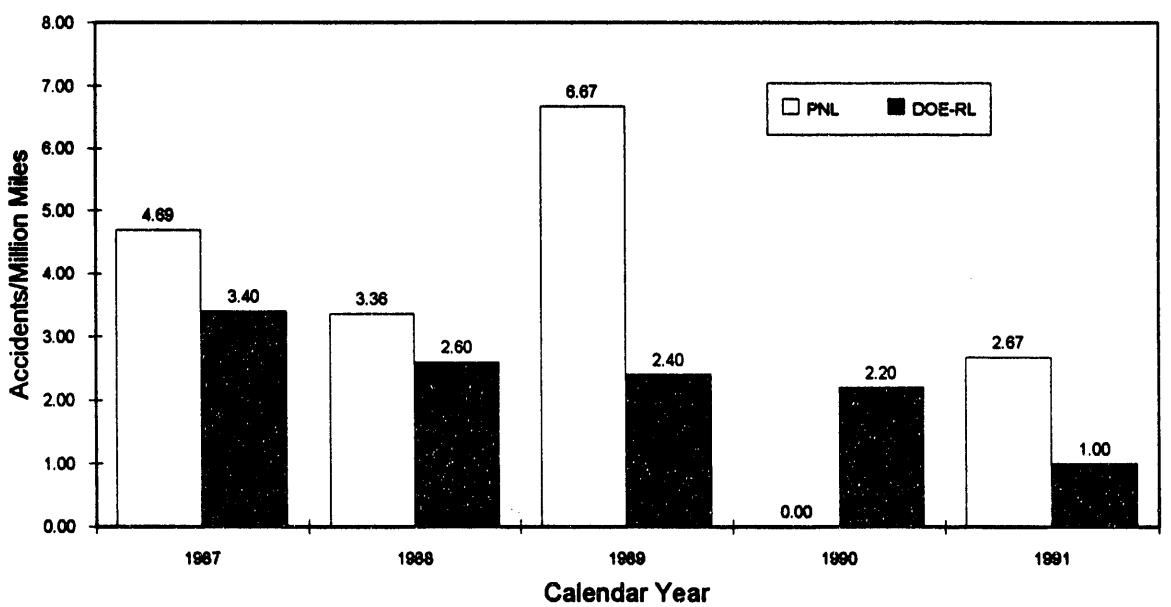

FIGURE 10. PNL Motor Vehicle Accidents Per Million Miles

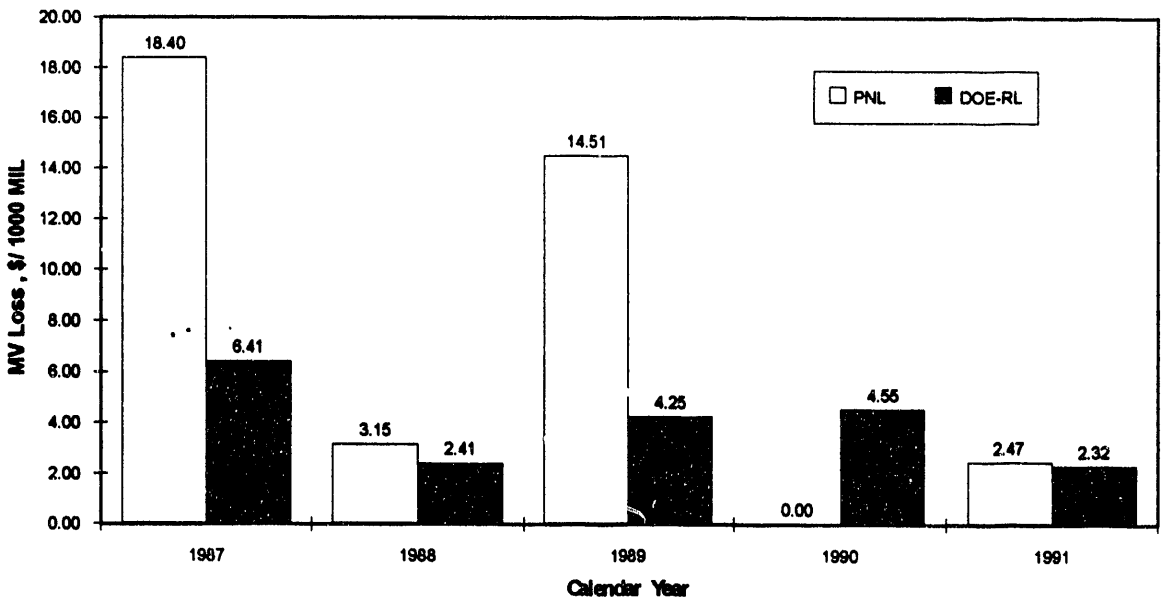

FIGURE 11. PNL Motor Vehicle Loss Rate

Property Damage and Fires

During CY 1991, PNL work resulted in three non-fire property loss accidents and $116,766 in losses. Primary among these losses ($95,000) was molten glass damage associated with the In-Situ Vitrification Experiment. This resulted in a property damage rate of 3.09 for CY 1991. Figure 12 compares this rate to other PNL property loss rates and to DOE-RL averages.

One fire damaged PNL property in 1991, resulting in a $5000 loss. The fire was due to a twenty-five year old transformer overheating and spontaneously combusting. This is a fire loss rate of 0.13. Figure 13 compares this rate to other PNL fire loss rates and to DOE averages.

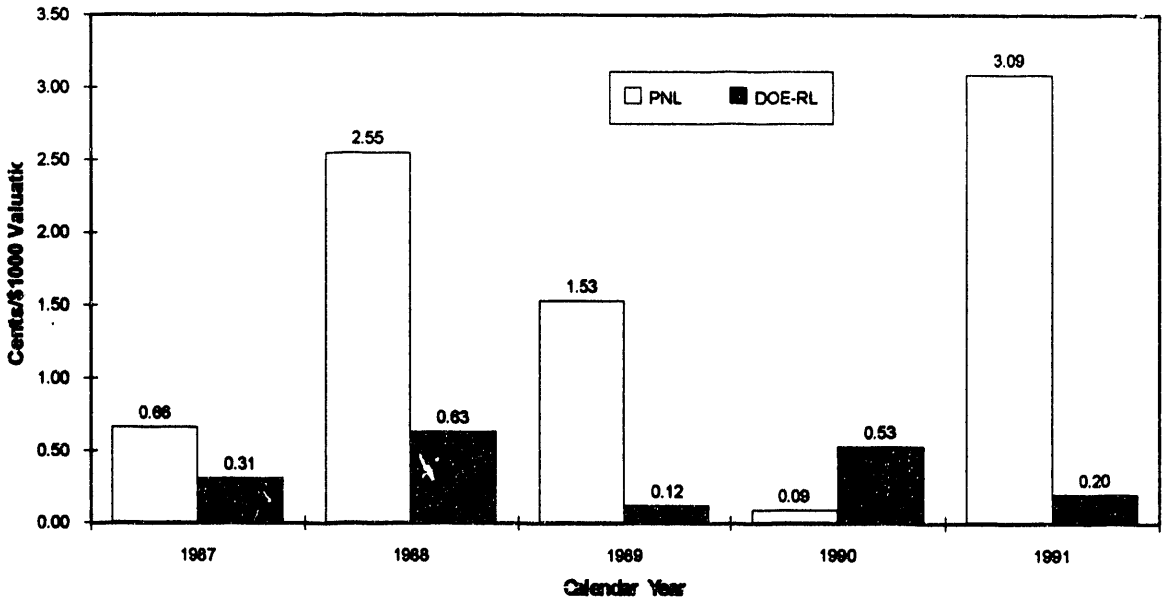

FIGURE 12. PNL Property Damage Loss Rate

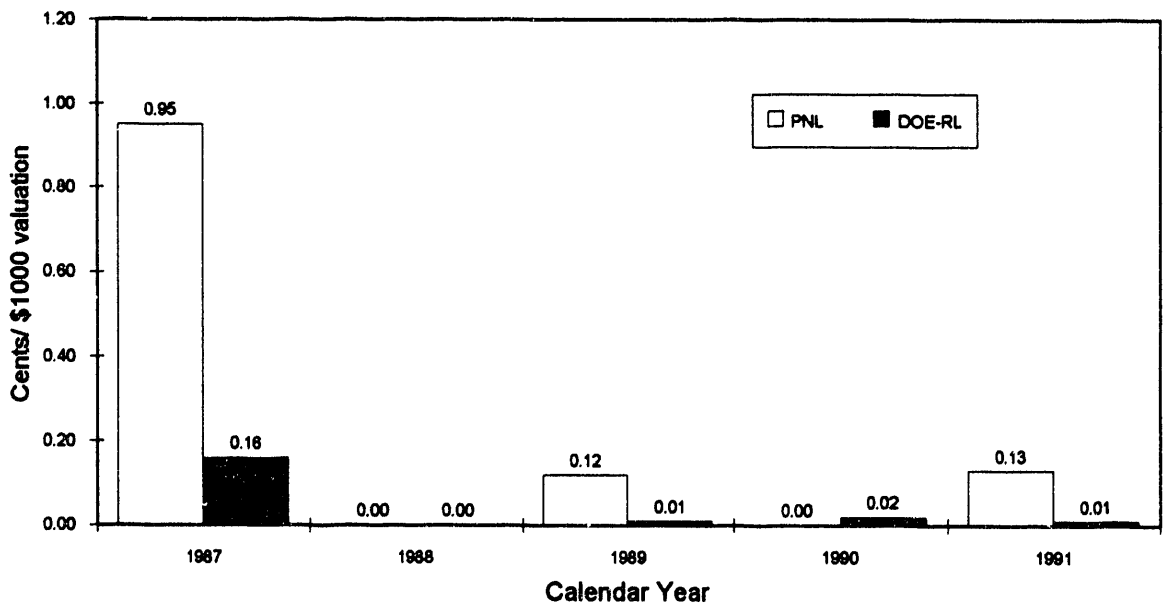

FIGURE 13. PNL Fire Loss Rate

APPENDIX A

STATUS OF CY 1991 ALARA GOALS

The majority of the CY 1991 ALARA goals were completed. Two goals were not completed due to circumstances beyond the control of the organization working on the goal; these goals were "rolled over" into CY 1992 goals. One goal was not met due to an unexpected increase in workload. The other thirteen goals were completed successfully.

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

The following organizations had ALARA goals for CY 1991: Waste Technology Center (WT), Reactor Technology Center (RT), Materials and Chemical Sciences Center (MC) and the Laboratory Safety Department (LS).

WT-324-1 Reduce dose to hot-cell operations technicians by 20% from CY 1990. This will be accomplished by reviewing dose reduction techniques, such as time, distance, and shielding at pre-job ALARA meetings.

This goal was not accomplished due to additional work requiring more staffed entries into high radiation areas than planned. A slight decrease in dose per task was accomplished.

WT-324-2 Reduce quantity of secondary waste products generated by programmatic activities by 50% from CY 1990.

This goal was met and exceeded, with a total reduction on quantity of waste of 70%. The line management of the 324 Building showed commendable ALARA enthusiasm in meeting this goal, as evidenced by the extent to which they exceeded the target quantity.

WT-324-3

Reduce the number of skin contamination events of Waste Technology Center staff by 25% from CY 1990. This will be accomplished by reviewing, during the pre-job ALARA meetings, proper donning/doffing techniques.

This goal was met and exceeded; the Waste Technology staff reduced the number of skin contaminations from 14 in 1990 to 6 in 1991. The staff and management accomplished this 67% reduction by careful attention to detail and particular care in doffing of protective clothing, as well as management support of safer programs.

LS-324-1

Improve pencil dosimeter program for RPTs assigned to the 324 Building. This program will allow the Radiation Protection Section to more closely track RPT exposure as a function of work performed.

This goal was met; the gamma pencil dosimeter program is actively being used in the 324 Building, and to a lesser extent in other facilities with significant dose rates.

MC-306W-1

Continue to pursue the relocation or disposal of the ThO_2 located in Room 141 to reduce dose rate in Laboratory 151. A Material Request was submitted to Safeguards on 5/7/90, but this CY 1990 goal was not completed since no disposition instructions were received.

This goal was "rolled over" into a CY 1992 ALARA goal, because offsite problems stalled completion of the goal.

MC-306W-2

Locate material storage and waste barrels for depleted uranium metal turnings in a central location within the specialty machine shop in Room 132. This location is to be, at a minimum, ten feet away from any equipment/machinists' work station in order to reduce background exposure to all program personnel. Previous storage areas were more convenient to both program machinists and the project's technical staff, but their random placements throughout the shop placed larger-than-necessary quantities of radioactive material next to the work stations.

This goal was completed, reducing dose to the staff of the 306W, as well as providing a safer working environment.

MC-306W-3

Modify to increase the physical size of the radiation area in Room 132 to allow for the transport of radioactive material from the heat treatment area in Room 152 to the specialty shop (Room 132). This would allow the large roll-up door between the two bays to be opened to more easily transport material to and from the material processing areas without the use of roller carts. Material will be loaded onto one cart, then moved directly to its next processing/machining station while remaining within a radiation area.

This goal was completed, not only reducing possibility of spread of contamination to uncontrolled areas, but also providing a more ergonomically correct and efficient work procedure.

MC-325-1

Reduce the dose rate at the front face of the 325A hot cells by providing adequate shielding in the front face and ducts under the floor, and changing the filters on the ducts.

This goal was completed, with a dose rate reduction at the front of the hot cells of approximately 50%.

MC-325-2

Reduce radiological exposure to personnel during radiochemical analysis of waste tank samples by implementing a recently developed analytical procedure for the analysis of transuranic elements in single shell tank and double shell tank samples. This procedure replaces four previously used procedures, thereby reducing considerably the total quantity of radioactive sample required. In addition, the period of time that staff members will be in contact with the sample during the analytical process has also been reduced. As funding permits, additional procedure development activities to reduce staff exposure will be undertaken.

This goal was completed; new analytical equipment and procedures were developed for the processes.

RT-324-1*

Return cesium chloride capsules not needed for performance evaluation of cesium chloride encapsulation programs to the Waste Encapsulation and Storage Facility. Removal of the capsules will facilitate operation in both SMF South and East cells and reduce exposure risks to personnel.

The cesium chloride capsules not needed were removed to the 327 Building storage pool, reducing dose rates to WTC staff to a minimum.

RT-324-2*

Shield manipulator through tubes to reduce exposure to building occupants. Shielding will effectively decrease exposure to acceptable levels.

This goal was completed ahead of schedule and accomplished a dose reduction to the occupants of the building, particularly by reducing non-productive radiation dose potential.

RT-327-1* Convert Model G and Model E manipulator Z-motion tape to cable. The number of repairs/replacements will be reduced, as will fewer change-outs, which will result in lower personnel exposure.

All manipulators which suffered mechanical failure were converted; the goal is complete. Several model G and E model manipulators remain, which will be replaced as they fail, as good ALARA practice dictates.

RT-327-2* Clean the interior of D and F-Cells' ventilation ducts. Successful cleaning in the ducts will reduce radiation levels in the basement area by 50 to 75%.

This goal could not be completed during CY 1991 due to manpower and funding issues, and was "rolled over" into a CY 1992 ALARA goal.

RT-327-3* Review 327 Post-Irradiation Testing Laboratory safe operating and technical procedures and revise, as necessary, to include requirements for preplanning meeting, ALARA meeting outline, and chemical/radiological ALARA information where applicable.

New safe operating procedures (SOPs) were developed for the 327 Building while under control of the Reactor Technology Center. When the operation of the building was transferred to the Waste Technology Center, the SOPs were rewritten. This goal is complete.

---

* Indicates a Reactor Technology ALARA goal which was transferred to the Waste Technology Center upon transfer of the 324 SMF facility and 327 Building operations.

APPENDIX B

RADIOLOGICAL ALARA GOALS FOR CY 1992

The following organizations had ALARA goals for CY 1991: Waste Technology Center (WT), Reactor Technology Center (RT), Materials and Chemical Sciences Center (MC) and the Laboratory Safety Department (LS).

Goal Number	Goal
WT-324-1	Decontaminate room 147 to reduce exposure to operating staff and to reduce potential for skin contaminations.
WT-324-2	Reduce personnel exposure by reducing the number of personnel entries into the Shielded Materials Facility (SMF) hot cell Airlock in order to introduce materials into or retrieve materials from south cell. One to three shielded transfer mechanisms will be designed, fabricated, and installed into existing 4-inch diameter cell access ports.
WT-324-3	Reduce personnel exposure in the SMF airlock by developing a remotely operable system for removing radioactive wastes, created as a result of the Cesium Encapsulation Program (CEP), from south cell for disposal in the HN-200 liner.
WT-327-1	Remove radioactive contamination from the interior of the "D" and "F" cells' ventilation ducts in order to significantly reduce radiation dose rates in the 327 Building basement. It is estimated that the successful removal of this contamination will lower dose rates in the vicinity of these ducts by 75% or more.
WT-327-2	Further reduce personnel exposure to hazardous chemicals by identifying and obtaining alternate, non hazardous materials for use in decontamination work and other operations which require the use of various reagents. Decreasing the potential for exposure to hazardous chemicals will enhance prevention of radiological mishaps. Minimizing the potential generation of radioactive mixed waste will be enhanced.
MC-306W-1	Relocate or dispose of ThO_2 located in Room 141 to reduce dose rate in Laboratory 151.
MC-306W-2	Reduce handling and transportation required for movements of depleted uranium bar stock within 306W Facility by the addition of supplemental in-process inspection equipment.

MC-306W-3	Declassify depleted uranium cores that are being stored in Room 123, allowing inventory and potential exposure reduction.
MC-325-1	Reduce exposure to potentially radioactive soil samples during analysis of cyanide through the acquisition and implementation of semi-automated instrumental analysis equipment.
MC-325-2	Install pressure and moisture sensors in the 325 Building Hot Cells which will provide notifications of over-pressure and over-flow conditions in the cells for early response to these abnormal events.
MC-325-3	Review and modify, as appropriate, the building routine radiological survey schedule and frequency to more accurately reflect current building operations and requirements.
MC-325-4	Pursue the elimination of all Westinghouse Hanford Company (WHC) nuclear materials from the basement cage storage area, and relocate/consolidate building TRU waste drum storage in this cage area.
RT-306W-1	Reduce inventories of enriched UO_2 materials within the 306W Facility.
LS-324-1	Evaluate the benefit of the closed loop SWP laundry recycling system in use at the 324 Building, in preventing skin and personal effects contaminations.

APPENDIX C

PROJECTIONS FOR CALENDAR YEAR 1992

The projections for CY 92 are based on several sources. The primary source is the individual organization's estimate of collective dose to their organization 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. This estimate is usually relatively accurate, due to exposure rates for certain tasks being relatively well known, and the extensive planning that occurs before a new task is undertaken.

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 unexpected sources of contamination. Some of the unexpected sources found in CY 1991 were historical, undocumented contamination and contaminated "clean" laundry (see CY 1992 ALARA goal LS-324-1).

Very few new or unexpected intakes of radioactive materials have occurred at PNL in recent years, and as such, none are usually projected. The uptakes in past years have been either chronic uranium uptakes in the millirem range, or offsite uptakes of tritium. However, new projects involving significant quantities of tritium will be activated in CY 1992; the group involved and the Laboratory Safety Department expect some chronic uptake of tritiated water to occur. The amount expected is very small and involves relatively few people.

The Projections for CY 1992 are as follows:

0.55 person-Sievert (55 person-rem) collective whole-body dose

25 skin contaminations

1 milliSievert (100 mrem) of new internal dose from Tritium

APPENDIX D

Skin Contamination Cases in Calendar Year 1991

There were 13 cases of skin contamination of PNL staff at the Hanford site in 1991, 43% of the projected 30. Of these 13 cases, five were in the 324 Building, three in the 325 building, one in 327, one in the 306W Facility, one in the LSL II building, one in the 329 Building and one in the 326 Building. The table below lists the skin contaminations in chronological order, including the building where the contamination occurred, a brief description of the details and a cause. An occurrence classifier determines the severity of the event and the cause of the event according to the guidance given by DOE Order 5003.A. The occurrence classifiers determined that all skin contaminations in CY 1991 fit the category of "Off-Normal Occurrence." The Off-Normal Occurrence reports describe all skin contaminations in more detail and can be found using the occurrence number listed (note: all occurrence numbers have the prefix RL-PNL).

Date	Occurrence number	Building	Details	Cause/ Problem
1/09/91	PNLBOPER-1991-0005	306W	Hand contamination was due to shoe contamination brought to Hanford from Chalk River, Canada.	Procedure problem
1/15/91	324-1991-0009	324	Contamination was found on a finger of an R&D technician after work inside SMF hot cell.	Personnel error
1/17/91	325-1991-0010	325	An electrician found contamination on his thumb after entering a controlled area.	Equipment/ material failure
1/18/91	324-1991-0012	324	A PNL craftsman was contaminated on the knee by contaminated laundry.	Procedure problem
2/28/91	PNLBOPER-1991-0039	LSL II	A leak from a radon generator resulted in personnel contamination.	Design problem
5/17/91	PNLBOPEM-1991-1002	327	A technician contaminated a finger while decontaminating a fume hood.	Personnel error
6-05/91	PNLBOPER-1991-1012	329	An R&D staff member was found to have contamination on his hand after working in a contaminated fume hood.	Personnel error
6/25/91	324-1991-1006	324	A craftsman found contamination on his hand after working in a contaminated area.	Equipment/ material failure

8/01/91	325-1991-1015	325	An R&D scientist had hand contamination after re-using gloves that were apparently contaminated.	Procedure problem
9/05/91 9/06/91	PNLBOPER-1991-1042	326	A technician became contaminated on the hand after electro-polishing small samples. Identical incident occurred the next morning.	Design problem
9/09/91	324-1991-1016	324	Contamination was found on the left palm after exiting the SMF gallery.	Personnel error
9/16/91	324-1991-1017	324	A skin contamination in the 324 Building.	Procedure problem
12/20/91	325-1991-1035	325	A skin contamination occurred in room 511.	Equipment/ material problem

Appendix E

Raw Data Used in CY-1991 ALARA Report

This is the raw form of the information used to generate the calendar year 1991 ALARA report. Brief explanations of the data will be given after the exhibits. The format of the information is a summary sentence or paragraph describing the information.

Exhibit 1

Organization Name	Dose in millirem	% dose
Facilities and Operations	17460	34
Life Sciences	3250	6
Applied Physics	480	1
Earth and Environmental Sciences	1190	2
Materials and Chemical Sciences	14346	28
Reactor Technology	1027	2
Waste Technology	14418	28
Other	650	1

This lists the CY 1991 distribution of the collective dose among the centers and Directorates of PNL. Only those with 1% or more are shown; all organizations below 1% are considered "other." The percentages are to the nearest percent, which leads to more than 100% total collective whole-body dose.

Exhibit 2

Center/directorate	1988	1989	1990	1991
Facilities and Operations	0.21	0.23	0.19	0.17
Material and Chemical Sciences	0.16	0.22	0.12	0.14
Reactor Technology	0.11	0.17	0.07	0.01
Waste Technology	0.10	0.17	0.11	0.14
Life Sciences	0.04	0.05	0.03	0.03
Earth and Environmental Sciences	*	*	0.01	0.01

This illustrates the collective whole-body dose of the "high dose" centers and directorates for the last 4 years. All doses are in collective person-Sievert. The Earth and Environmental Sciences dose was not tracked in 1988 and 1989 due to low dose.

Exhibit 3

Section	mrem	% PNL
Radiation Protection Section	8073	16%
Technical Services Department	4534	9%
Analytical Chemistry Department	3407	7%
Waste Process Technology Department	4990	10%
Post-Irradiation Testing Laboratory	3254	6%

These are the "high dose" departments and sections in CY-1991. The percents are of PNL's total collective whole-body dose.

Exhibit 4

Year	#
1986	37
1987	24
1988	29
1989	33
1990	31
1991	15

This is the total number of skin contaminations at PNL over the last 6 years.

Exhibit 5

Building	1987	1988	1989	1990	1991
324	18	16	14	14	5
325	2	4	7	9	3
327	1	5	3	1	1
Other	2	1	5	0	4

This demonstrates the breakdown of the skin contamination events by building. Only the 324, 325 and 327 Buildings have skin contamination events with any regularity. All other buildings are considered "other."

Exhibit 6

Dose Range	# of staff in the range
0	878
0.01-0.99	425
1.00-2.50	57
2.50-5.00	31
5.00-7.50	13
7.50-10.0	9
10.0-20.0	2
20.0+	0

This separates the distribution of dose for PNL staff in CY 1991. All doses are in milliSievert.

Exhibit 7

Year	Dose
1980	0.62
1981	0.69
1982	1.09
1983	1.49
1984	1.13
1985	1.26
1986	2.30
1987	0.85
1988	0.55
1989	0.90
1990	0.68
1991	0.52

This shows the collective dose to PNL staff yearly from 1980 to 1991. The doses are in person-Sievert.

END

DATE FILMED

1/13/93