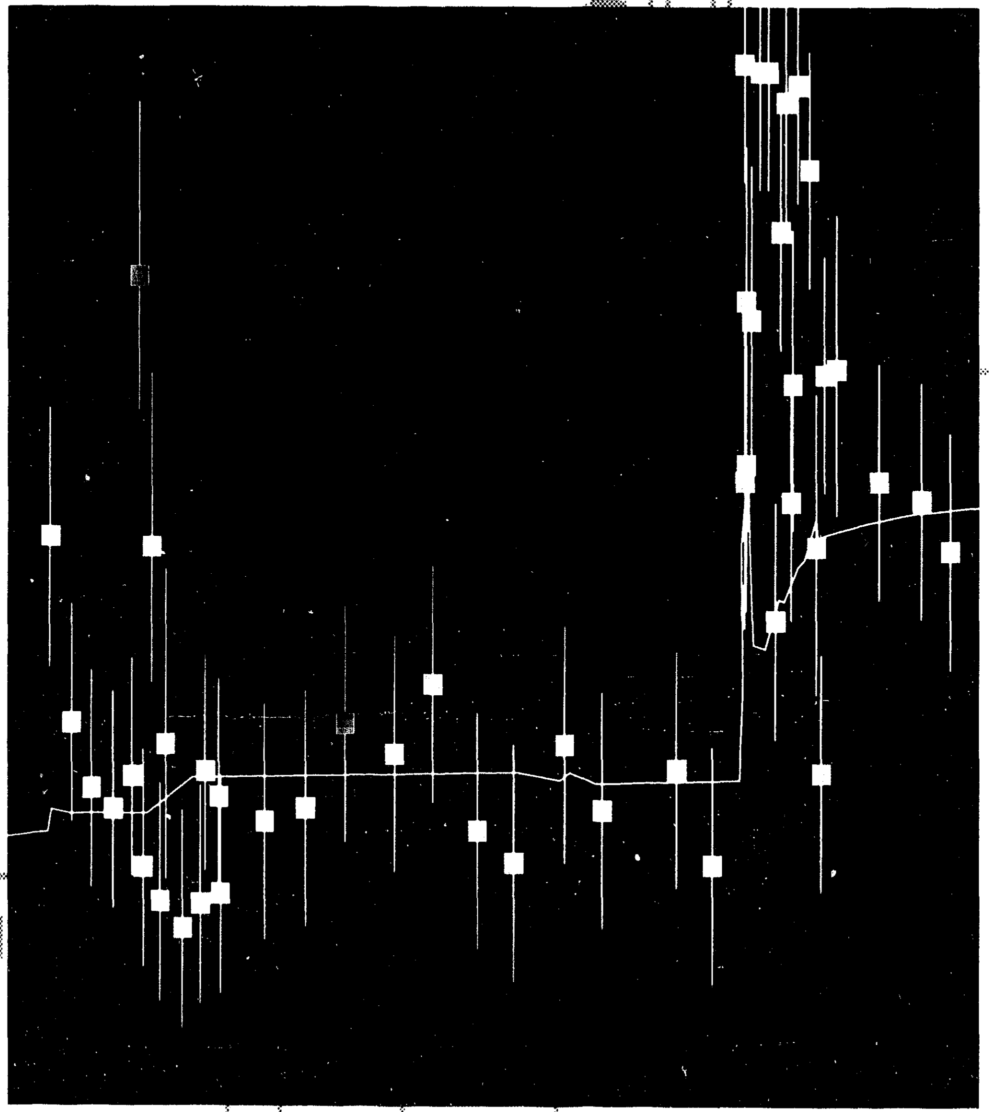
LA-12739-PR

Health Physics

1992 Progress Report



Los Alamos
NATIONAL LABORATORY

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LA-12739-PR
Progress Report

UC-907
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Health Physics

1992 Progress Report

Los Alamos
NATIONAL LABORATORY

Los Alamos, New Mexico 87545

Contents

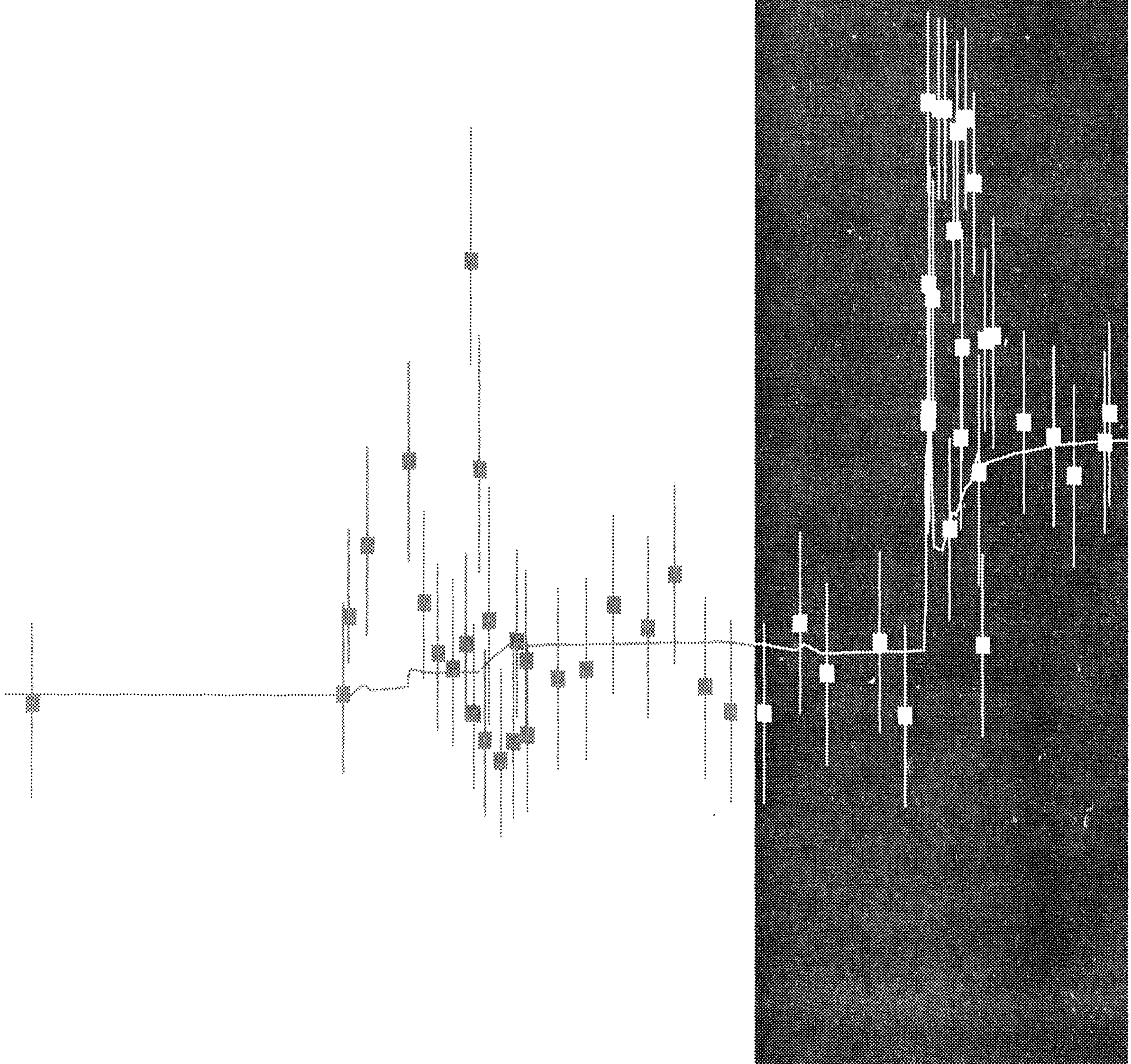
Abstract

At Los Alamos National Laboratory, radiation protection services are provided by ESH-1, -4, and -12, and technical support is provided by ESH-6 to Laboratory groups that work with significant quantities of fissile material. The mission of all these groups is to protect Laboratory workers, the public, and the environment from radiation associated with Laboratory operations.

In this report, 1992 radiation protection performance trends are presented. These data show that, in general, the collective external dose equivalent quantities from penetrating (gamma, x-ray, and neutron) radiation and from nonpenetrating (beta and low-energy photon) radiation showed a slight downward trend during 1992. The number of confirmed contaminations of skin and personal clothing decreased in 1992 when compared to the previous year. Finally, there was one reportable DOE 5000.3A internal contamination event in 1992.

The 1992 radiation protection activities of the Laboratory, conducted at both the Nevada Test Site and at Los Alamos, are presented and discussed. These activities include external dosimetry, internal dosimetry, radiation-monitoring instrumentation, sample analysis, workplace radiological monitoring, nuclear criticality safety, hazardous materials response, radiological training, and radiological records. This report details routine activities, including any significant changes and improvements in 1992; additional activities, including special investigations, studies, and reviews; publications and presentations; and professional activities, including professional memberships, training received, and conferences attended.

Overview



OVERVIEW

Introduction

At Los Alamos National Laboratory, radiation protection services are provided by three groups within the Environment, Safety, and Health (ESH) Division: Health Physics Operations (ESH-1), Health Physics Measurements (ESH-4), and Policy and Program Analysis (ESH-12). Technical support is also provided by Nuclear Criticality Safety (ESH-6) to Laboratory groups that work with significant quantities of fissile material. The mission of all these groups is to protect Laboratory workers, the public, and the environment from radiation associated with Laboratory operations.

This report provides an overview of the Laboratory's radiation protection performance in 1992. It summarizes the radiation protection activities of the Laboratory, conducted at both Los Alamos and the Nevada Test Site, for 1992. At Los Alamos, these activities were conducted in the following areas.

- external dosimetry
- internal dosimetry
- radiation-monitoring instrumentation
- sample analysis
- workplace radiological monitoring
- nuclear criticality safety
- radiological training
- radiological records

Each area is presented in a separate section of this report. Each section details the routine activities of the program, including any significant changes and improvements in 1992; additional activities conducted in support of the routine program, including special investigations, studies, and reviews; publications produced and presentations given in support of the program; and professional activities related to the program, including professional memberships, training received, and conferences attended.

Also included is a list of acronyms used throughout the report.

Performance Indicators

The Laboratory Assessment Office (LAO) collects and publishes a quarterly report of performance indicators, which are parameters that indicate how well the Laboratory has performed in general representative areas. These performance indicators are used to identify trends, evaluate performance, allocate resources, change and enhance programs, assess conduct of operations, communicate lessons learned, and facilitate continuous improvement.

Among the performance indicators reported by LAO are those reflecting health physics activities. For each quarter of 1992, penetrating radiation doses, nonpenetrating radiation doses, skin and clothing contaminations, and internal contaminations were analyzed as performance indicators for various facilities. The data were provided by the health physics groups (ESH-1, -4, and -12) and Laboratory operating groups and were coordinated by ESH-12.

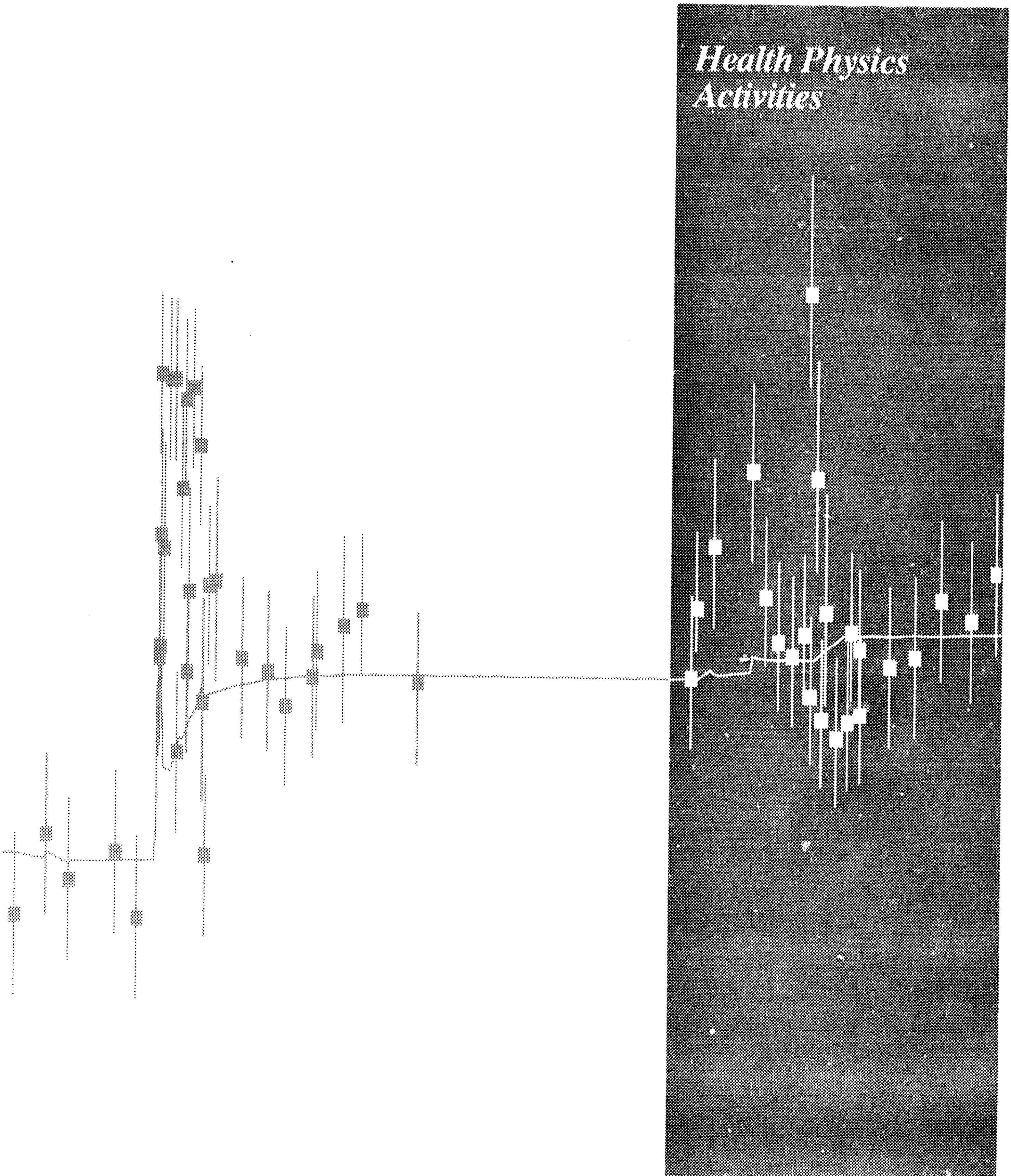
Trends

In general, the Laboratory's collective external dose equivalent quantities from penetrating (gamma, x-ray, and neutron) radiation showed a slight downward trend over calendar year 1992. This downward trend was largely attributable to the shutdown of LAMPF for maintenance in the fourth quarter. The quarterly 1992 collective external dose equivalents for the first through the fourth quarters were 34.12 rem, 34.62 rem, 38.17 rem, and 21.84 rem, respectively. The total collective external dose equivalent for the year was 128.75 rem.

No specific trend was discerned for the cumulative shallow radiation dose at the Laboratory over calendar year 1992. The quarterly 1992 collective shallow radiation doses for the first through the fourth quarters were 13.45 rem, 16.11 rem, 16.29 rem, and 13.31 rem, respectively. The total collective shallow dose equivalent for the year was 59.16 rem.

There were 36 DOE 5000.3A skin and personal clothing contaminations at the Laboratory in 1992, compared to 46 such contaminations in 1991, a decrease of 22%. There was one reportable DOE 5000.3A internal contamination event in 1992. This event occurred at TA-55 in the second quarter.

Health Physics Activities



External Dosimetry

Introduction

The Laboratory's External Dosimetry Program resides in ESH-4 and provides whole-body, extremity, and criticality accident dosimetry to the Laboratory. ESH-4 is also responsible for quality assurance programs for these dosimetry systems and technical excellence in dosimetry methods.

In addition to routine production dosimetry, major efforts in 1992 included purchasing and operating the new Harshaw 8800 card reader. The 8800 has thermoluminescent dosimeter (TLD) heating by hot gas rather than by ohmic heating.

Routine Activities

Whole-Body Dosimetry

In 1992, ESH Division issued TLD badges to over 11,000 individuals to monitor their exposure to gamma and neutron radiation fields. These individuals included employees of the University of California (UC), Johnson Controls World Services (JCI), Protection Technology Los Alamos (PTLA), the DOE Los Alamos Area Office, EG&G, other contractors, and Laboratory visitors. The 1992 Laboratory TLD badge distribution by employment type is shown in Table I.

The dosimetry results for 1992 are summarized in Table II.

Table III shows the external dosimetry and tritium results for all Laboratory workers, including UC, JCI, PTLA, DOE, and other contractors for 1982 to 1992.

Table IV summarizes the average external dosimetry results for all Laboratory visitors and workers, including JCI, PTLA, DOE, and other contractors for 1988 to 1992.

As shown in Tables III and IV, external doses incurred by individuals working at the Laboratory decreased significantly.

In 1992, 5429 UC employees were monitored for external exposure to gamma radiation fields. These employees received a total of 39 person-rem in 1992. In 1992, 108 employees received annual effective dose equivalents exceeding 100 mrem, and 469 individuals exceeded 0 mrem. The highest 1992 individual annual effective dose equivalent for exposure to gamma fields was 565 mrem. External gamma dosimetry results for UC employees since 1988 are summarized in Table V.

***Table I.* Laboratory TLD Badge Distribution by Employment Type[a]**

Employment Type	Number of Assigned TLD Badges
LANL	5478
External - JCI	1706
External - PTLA	464
External - DOE	359
External - EG&G	21
Contractors	619
Visitors	2837
Total	11,484

[a]Compiled from EDBS and Laboratory Personnel System

***Table II.* Total Effective Dose Equivalent to All Laboratory Workers from External Radiation and Tritium**

	Number of Workers in Each Range												
Employer	0 mrem	>0-10 mrem	>10-25 mrem	>25-50 mrem	>50-75 mrem	>75-100 mrem	>100-250 mrem	>250-500 mrem	>500-750 mrem	>750-1000 mrem	>1000-2000 mrem	>2000 mrem	Number Monitored
LANL	7746	73	390	165	85	47	141	100	36	11	8	0	8802
JCI	1548	6	57	3	13	8	32	7	0	0	0	0	1706
DOE	353	1	4	0	0	1	0	0	0	0	0	0	359
PTLA	458	2	1	3	0	0	0	0	0	0	0	0	464
EG&G	20	0	1	0	0	0	0	0	0	0	0	0	21
Other[a]	325	2	5	1	1	0	0	0	0	0	0	0	334

[a]Other includes anyone who doesn't work for one of the above employers; for example, employees of subcontractors such as Butler, Kirk-Mayer, and Salem.

***Table III.* Radiation Dosimetry for Laboratory Workers**

Year	Number Monitored	Number with Zero Dose	Collective Dose[a] (person-rem)
1982	4697	2677	613
1983	4713	2532	614
1984	5098	1713	707
1985	5351	3690	649
1986	5660	4516	493
1987	5526	4515	371
1988	5405	4382	366
1989	5903	4823	288
1990	5936	5071	206
1991	6916	6052	163
1992	8802	7746	121

[a]Includes deep gamma, neutron, and tritium annual effective dose equivalent.

***Table IV.* Radiation Dosimetry for Laboratory Workers and Visitors**

Year	Number Monitored	Collective Dose Deep Gamma (person-rem)	Collective Dose Neutron (person-rem)	Collective Dose Shallow (person-rem)
1988	9468	135	257	154
1989	10608	121	206	139
1990	10795	90	139	113
1991	11275	64	99	99
1992	11540	39	93	63

***Table V.* External Dosimetry for Gamma[a]**

Year	1988	1989	1990	1991	1992
Number Monitored	5122	5522	5597	5649	5429
Collective Dose {> 100 mrem} (person-rem)	116	94	73	46	22
Collective Dose {> 0 mrem} (person-rem)	135	121	90	64	39
Highest Annual Dose (rem)	1.710	1.470	2.280	1.862	0.565
Highest Monthly Dose (rem)	—	0.680	2.130	1.820	0.255
Number > 100 mrem	253	228	202	162	108
Number > 0 mrem	609	660	556	629	469

[a]1988 detailed monthly external dosimetry data have been electronically archived and are not readily available for database searches.

In 1992, 5428 UC employees were monitored for exposure to external neutron fields. These employees received a total of 93 person-rem. In 1992, 198 UC employees exceeded 100 mrem, and 561 UC employees exceeded 0 mrem as a result of exposure to external neutron fields. The highest 1992 individual annual effective dose equivalent for exposure to an external neutron field was 994 mrem. Table VI summarizes external neutron dosimetry results for UC employees since 1988.

As shown in Tables V and VI, the external doses received by UC employees at the Laboratory since 1988 decreased significantly. The number of employees receiving doses exceeding 100 mrem also dropped over that period of time.

Note that Table II shows results from external gamma and neutron results and internal tritium results. The contribution to effective dose equivalent from internal tritium is not significant.

Extremity Dosimetry

Approximately 400 TLD finger rings were issued each month during 1992. At the TA-55 Plutonium Facility, where most extremity doses are incurred, the highest recorded annual total extremity dose was 6.8 rem (the dose limit is 50 rem). A total of 267 employees were monitored at TA-55 for extremity doses, and the collective extremity dose was 177 person-rem—an average of 0.66 rem per person.

Personal Nuclear Accident Dosimetry

Approximately 1000 personal nuclear accident dosimeters (PNADs) are permanently issued to Laboratory and subcontractor personnel who have access to criticality-alarmed facilities. There were no criticality accidents or events during 1992; thus, no routine activities were performed with these dosimeters.

Table VI. Neutron Dosimetry Results Since 1988[a]

Year	1988	1989	1990	1991	1992
Number Monitored	4899	5093	5299	5504	5428
Collective Dose {> 100 mrem} (person-rem)	232	177	115	80	70
Collective Dose {> 0 mrem} (person-rem)	257	206	139	99	93
Highest Annual Dose (rem)	2.450	1.410	1.690	1.530	0.994
Highest Monthly Dose (rem)	—	0.430	0.390	0.280	0.342
Number > 100 mrem	326	299	264	187	198
Number > 0 mrem	721	684	574	494	561

[a]1988 detailed monthly external dosimetry data have been electronically archived and are not readily available for database searches.

Quality Assurance

Procedures in all dosimetry programs were reviewed and updated as necessary to accommodate the move of dosimetry operations to a new location and the reorganization that created ESH-4. In addition, the DOE Laboratory Accreditation Program (DOE LAP) site visit was completed on December 14, 1990, and the whole-body dosimetry program was reaccredited for the next two years effective September 1, 1991. This accreditation is based on performance testing in multiple radiation categories; on-site assessment of the quality assurance program; adequacy of personnel, facilities, equipment; and dosimetry records. ESH-4 is preparing for the next audit, which will occur in late 1993 or early 1994.

Additional Activities

Whole-Body Dosimetry

New dosimeter readers based on gas-jet heating (rather than "hot-finger" heating) were acquired in 1992, and an effort began to completely redesign the Laboratory's dosimeter. This project will require significant monetary resources, which were detailed in an action plan written in response to the DOE Tiger Team investigation.

Because neutrons account for about 60% of the external collective dose incurred at the Laboratory, significant resources were spent in 1992 to improve the accuracy of neutron dose measurements. In 1992, the energy-dependent nature of the Laboratory's current neutron dosimetry methods were the focus of a two-part upgrade program to

- understand the neutron spectra encountered at the Laboratory and the resulting dosimeter response, and
- implement the best available neutron dosimetry technology for Laboratory workers with the highest potential for exposure to neutron radiation fields.

Preliminary field spectral studies were completed in 1992 at TA-55 in preparation for detailed spectroscopy studies scheduled for 1993-94.

The neutron spectra at over 20 glove box locations were measured and analyzed with assistance from the DOE Environmental Measurements Laboratory. Several papers were presented on these measurements. The data indicate that the present neutron correction factors used for correcting TLD information cause a factor of 2 overestimation of the neutron dose at newly shielded glove boxes. An effort is under way to integrate this new infomation into the dosimetry program.

Track etch dosimetry and bubble dosimetry have been used on an experimental basis at NMT-9 as an additional check on the need to upgrade the TLD neutron correction factors.

ESH-4 has aided NIS-6 in neutron dose measurements at several critical reactors and DX-13 at the plasma neutron source.

Extremity Dosimetry

In 1992, complete replacement of the Laboratory's extremity dosimetry system was begun. The ESH-4 self-assessment, the DOE Tiger Team investigation, and preliminary testing through DOELAP indicated that the existing system was inadequate. The rest of the extremity dosimetry system equipment was purchased in 1992. The change-over will begin in 1993.

Personal Nuclear Accident Dosimetry

In 1992, radiation dosimetry procedures for screening nuclear accident victims in the field and for evaluating both personal and fixed (area) dosimetry packets were reviewed. Significant documentation and performance testing, needed to upgrade this program, began in 1992.

Extensive calculations were performed in support of the extremity program. A survey was performed initially that encompassed those sites that had yielded extremity doses in the past. The result of the survey was an extensive list of beta-particle, positron, and low-energy x-ray emitters. Transport calculations were performed to estimate the amount of dose deposited in the sensitive skin layer for several of the emitters. Additional calculations are under way.

Miscellaneous Activities

A direct-funded joint ESH-4 and P-17 program to assist DOE Energy Research in assessing the state of high-energy neutron dosimetry was carried out in 1992, and an LA report was written. DOE asked the ESH-4 and P-17 team to submit a proposal for a multiyear program aimed at improving high-energy neutron dosimetry at all DOE-funded high-energy accelerator facilities. The proposal was submitted in early 1993.

Publications and Presentations

Harvey, W. F., J. M. Hoffman, J. L. Bliss, R. J. Brake, "Personnel Neutron Dosimetry Improvements at Los Alamos National Laboratory," LA-UR-92-2243, presented at the 10th International Conference on Solid State Dosimetry, Georgetown University, Washington, D.C., July 1992.

Hoffman, J. M., W. F. Harvey, and E. M. Foltyn, "Bubble Dosimetry Experience at Los Alamos National Laboratory," LA-UR-92-3700, presented at the TLD User Symposium, Dosimetry: Uses, Results, and Trends, San Antonio, Texas, November 10-13, 1992.

Hsu, H. H., "Monte Carlo Calculations on EXT-RAD Extremity Dosimetry System," presented at the 1992 STI/ Harshaw TLD User Symposium, November 9-13, San Antonio, Texas.

Hsu, H. H., "A Neutron Dose Detector with REM Response to 1 GeV," presented at the ANS/ENS International Meeting, November 15-20, 1992, Chicago, Illinois.

Hsu, H. H., "Beam Heating and Cooling of Thick Targets for On-Line Production of Exotic Nuclei," presented at the American Physical Society, Division of Nuclear Physics, East Lansing, Michigan, October 23-26, 1992. Published in *Nucl. Instr. & Methods in Phys. Res.* **B70** 175-181 1992.

Related Professional Activities

In 1992, health physics personnel participated in the following professional activities related to the External Dosimetry Program.

- Flight Performance of DMSP Package B Instruments, EUV, X-Ray and Gamma-Ray Instrumentation for Astronomy, San Diego, CA, July 1992.
- Radiations Produced in Proton Irradiations of Thick Targets for On-Line Production of Exotic Nuclei, APS Joint April Meeting, April 1992.
- Served on organizing committee for TLD User Symposium, November 1992.
- Served on organizing committee for Extremity Conference, Paris, 1992.
- Served as DOE LAP auditors.
- Implemented Routine Bubble Dosimetry Program for NMT-9 and expanded special neutron monitoring for other groups.
- 5000.3 Incident Investigation Committee.
- TA-18 Neutron Dosimetry Support
- Autoscan 60 Automatic Track Etch Evaluation
- Advanced neutron TLD research and development.

INTERNAL DOSIMETRY

Introduction

The Internal Dosimetry Program at the Laboratory is administered and coordinated by ESH-12. Measurements used to estimate internal doses are carried out by ESH-4 and CST-9. ESH-12 dose assessment staff interpret bioassay results and estimate and assign internal doses. Measurement results and assigned doses are maintained by ESH-12 Data Management Section.

Personnel assigned to work in areas where there is a significant potential for intake of radioactive materials are required to participate in the bioassay monitoring program. Intakes may take place by inhalation, ingestion, or skin absorption. Bioassay monitoring includes both routine and special urinalysis, chest counts, whole-body counts, and nasal swipes. Wound counts are performed when a cut or abrasion is potentially contaminated with radioactive material. Personnel who have suspected or confirmed intakes may be required to participate in a diagnostic or prompt-action bioassay program. In these cases, several bioassay measurements of each type are taken to more accurately determine the quantity of intake and the corresponding committed effective dose equivalent.

Routine Activities

In 1992, radionuclides routinely measured by urinalysis, wound counts, nose swipes, and whole-body/chest counts included plutonium, americium, uranium, tritium, and various gamma-emitting radionuclides. In addition, a number of dosimetry and work restriction requirements were evaluated in 1991: 2379 Health Physics Checklists were reviewed, 20 pregnancy evaluations were performed, and 140 terminations were processed.

Plutonium/Americium Analyses

In 1992, approximately 1700 Laboratory employees were monitored by urinalysis either once or twice during the year. The highest individual annual internal dose equivalent for 1992 was 4.2 rem (this was from an intake in the early 1970s). There was one confirmed intake of plutonium/americium in 1992, resulting in approximately 400 mrem committed effective dose equivalent from Pu-239 and approximately 1.4 rem committed effective dose equivalent from Am-241.

Table I summarizes plutonium urinalyses based on internal dosimetry results for 1991 and 1992.

In 1992, 1893 Laboratory employees and visitors were monitored by chest counts for intakes of Am-241. Of these, 18 employees had positive results and an annual collective effective dose equivalent of 4.1 person-rem. The highest estimated annual dose equivalent of those monitored was 910 mrem. All but one of the positive results were due to Am-241 intakes in previous years. Table II summarizes americium internal dosimetry results according to chest count measurements for 1991 and 1992.

Uranium Analyses

In 1992, ESH-12 initiated a study of background levels of uranium in drinking water supplies in the Los Alamos, Española, and Santa Fe areas. Historically, background levels of uranium in drinking water have affected the interpretation of uranium bioassay results. This study provided a reasonable area-specific background and improved the quality of the uranium dosimetry estimates.

In 1992, approximately 70 Laboratory employees were monitored by urinalysis for uranium intakes once every two weeks. Of these, 3 individuals exceeded 10 mrem and 37 exceeded 0 mrem committed effective dose equivalent. Table III summarizs 1991 and 1992 uranium internal dosimetry results.

***Table I.* Plutonium**[a]

Year	1991	1992
Number Monitored	~1700	~1700
Highest Annual Dose (rem)	6.4	4.2
Number > 100 mrem	150	157

[a]Eighteen wound counts and 29,863 nasal swipes were performed.

***Table II.* Americium**

Year	1991	1992
Collective Dose (person-rem)	3.5	4.1
Highest Annual Dose (rem)	0.920	0.910
Number >100 mrem	14	18

***Table III.* Uranium**

Year	1991	1992
Number Monitored	~70	~70
Collective Dose (person-rem)	0.160	0.141
Highest Annual Dose	0.078	0.050
Number > 10 mrem	8	3

Tritium Analyses

In 1992, 129 Laboratory UC employees were monitored by urinalysis for tritium intakes. The routine tritium monitoring program requires submission of a urine sample once every two weeks. Of the 129 monitored individuals, 39 exceeded 0 mrem and 2 exceeded 100 mrem committed effective dose equivalent. The collective dose for this group was 596 mrem. The highest internal dose from tritium intake in 1992 was 172 mrem. Table IV summarizes tritium dosimetry results for UC employees at the Laboratory for the period 1988 to 1992.

Gamma-Emitter Analyses

Estimates of internal doses from gamma-emitting radionuclides (including americium) were based on whole-body/chest counts. Whole-body/chest counts of radionuclides were performed on 1843 Laboratory employees and visitors in 1992. Of these, 52 employees had positive results, 29 of which were due to Am-241 and 23 to other radionuclides. ESH-12 dose assessment staff also evaluated results from 98 whole-body/chest counts.

Table IV. Tritium

Year	1988	1989	1990	1991	1992
Number Monitored	151	155	148	168	129
Collective Dose {> 100 mrem} (person-rem)	2.220	1.094	1.581	0.000	0.275
Collective Dose {> 0 mrem} (person-rem)	2.820	1.696	2.091	0.305	0.596
Highest Annual Dose (rem)	0.750	0.468	1.346	0.030	0.172
Number > 100 mrem	5	4	3	0	2
Number > 0 mrem	28	51	43	24	39

Publications

Miller, G., W. C. Inkret, and H. F. Martz, "Bayesian Detection Analysis for Radiation Exposure," *Radiation Protection Dosimetry*, **48**, 251-256 (1993).

Related Professional Activities

In 1992, health physics personnel participated in the following professional activities related to the Internal Dosimetry Program.

- Chaired the ANSI N13.14 Tritium Internal Dosimetry Standard Committee. Final draft of document completed and submitted to American National Standards Review Committee. All comments will be addressed and the new version will be published in 1994.
- Reviewed 13 scientific papers submitted to the *Health Physics Journal, International Journal of Radiation Biology*, and *Radiation Research.*
- Member of 1993 Los Alamos National Laboratory-Directed Research and Development (LDRD) Biosciences Review Committee.
- Invited to speak at DOE Internal Dosimetry Workshop at 38th Annual Conference on Bioassay, Analytical and Environmental Radiochemistry, Santa Fe, NM, November, 1992.
- Presented workshop on Statistical Methods in Bioassay Interpretation, 38th Annual Conference on Bioassay, Analytical and Environmental Radiochemistry, Santa Fe, NM, November 1992.
- Member of Los Alamos National Laboratory Library Periodicals Review Team.
- Chaired workshop presentations at 38th Annual Conference on Bioassay, Analytical, and Environmental Radiochemistry, Santa Fe, NM, November 1992.
- Chaired technical presentations and programs at 38th Annual Conference on Bioassay, Analytical and Environmental Radiochemistry, Santa Fe, NM, November 1992.
- Invited to participate in Internal Dosimetry Workshop, Committee on Interagency Radiation Research and Policy Coordination, Atlanta, GA, April 1992.
- Attended Pathway Analysis and Risk Assessment Course, Kiawah Island, SC, March 1992.

Radiation Instrumentation

Introduction

The ESH-4 staff administers the Radiation Instrumentation Program, providing radiation instrumentation and measurement services to ensure that high-quality devices are used to measure ionizing radiation and radioactive material levels for health physics purposes. The group

- maintains a Laboratory-wide radiation-monitoring instrument pool;
- maintains, repairs, and calibrates instruments; and
- develops and implements new and improved radiation-monitoring instruments.

The Radiation Instrumentation Program strives to meet the requirements of ANSI N323 and the *LANL Radiological Control Manual.*

Routine Activities

In 1992, more than 433 new radiation-monitoring instruments were registered with the ESH-4 health physics instrument pool. Users of these instruments included ESH, NIS, CST, NMT, OS, ESA, and P Divisions. In some cases, ESH-4 purchased these instruments for users; in other cases, the instruments were purchased by other ESH groups or by operating groups.

Procedure Approvals

In 1992, six procedures were reapproved for use by the Instrumentation and Calibration Section of ESH-4. Eight new procedures were included in the review process.

Instrument Maintenance

During 1992, the following maintenance activities were performed on radiation-monitoring instruments.

- 6229 instruments were processed through the ESH-4 health physics instrument pool.
- 44 instruments were serviced in the field.
- Of the 6973 instruments processed through the pool and serviced in the field, 5026 were worked on and returned to service.
- 1603 instruments required repair and maintenance other than battery changes.
- 1460 alpha probes and 23 floor monitor probes were sent to United Nuclear Corporation for refurbishment. When the probes were returned, they were checked for proper operation.
- 583 in-leakage tests were performed on continuous air monitors.

Calibrations

In 1992, 2852 alpha and 604 beta contamination instruments were calibrated with National Institute of Standards and Technology (NIST)-traceable sources. In addition, a wide variety of tritium-, beta-gamma-, and neutron-measuring instruments were calibrated in 1992. Table III summarizes these calibrations.

***Table III.* Calibrations of Instruments for Monitoring Tritium, Beta/Gamma Radiation, and Neutron Radiation**

Period	Number Certified	Number Rejected	Total
Tritium-Measuring Instruments			
January–March	75	7	82
April–June	57	2	59
July–September	101	9	110
October–December	49	5	54
1992 Total	282	23	305
Beta-Gamma-Measuring Instruments			
January–March	527	23	550
April–June	481	17	498
July–September	601	42	643
October–December	399	13	412
1992 Total	2008	95	2103
Neutron-Measuring Instruments			
January–March	231	28	259
April–June	151	33	184
July–September	118	6	124
October–December	84	8	92
1992 Total	584	75	659

During 1992, the following calibrations were performed on various types of dosimeters used at the Laboratory.

- 670 pocket chamber dosimeters were calibrated at SM-130.
- 105 boxes of TLD quality assurance cards were exposed to 200 mR of radiation, also in support of the ESH-12 External Dosimetry Section.
- Several exposures were performed for ESH-8 dosimeters and for experimental dosimeters.

The ESH-4 staff calibrated six neutron sources in the standard graphite pile at TA-3 during 1992. These sources included

- ^{241}AmBe,
- ^{252}Cf, and
- ^{239}PuBe.

Additional Activities

The Monte Carlo Neutron Photon code is used by ESH Division for a broad spectrum of radiation shielding calculations. One such application involves the determination of skyshine dose for a variety of photon sources. To verify its accuracy, the code was benchmarked with the Kansas State University (KSU) photon skyshine experiment of 1977. The KSU experiment was simulated in great detail to include all scatter pathways.

The main focus of a course offered to ESH Division technical staff, titled "Practical MCNP," was the use of the Los Alamos MCNP Monte Carlo code for solving a variety of radiation protection and dosimetry problems.

The neutron scatter experiment in the Graphite Pile Room, TA-3, SM-40, was investigated to determine scatter corrections for the Albatross Instrument Range, which is located in this room. The gamma skyshine field in the environs of the Gamma Range, SM-40, was investigated in detail. Calculations and measurements were performed to assess the degree of hazard in occupied areas. As a result of this study, operation of the high-range well was administratively restricted to limit skyshine exposure.

The Los Alamos performance-testing program was expanded in scope to include alpha contamination monitors, neutron rem meters, and tritium air monitors. Three new performance testers were developed to allow instrument testing under reproducible conditions as required by DOE guidelines.

The Instrumentation and Calibration Section continued to participate in the DOE program for the intercomparison of radiological calibrations. As a result of this intercomparison, the Radcal MDH 1515 monitors used as secondary exposure rate standards were modified at the factory to disable automatic pressure and temperature compensation and were then recalibrated at Batelle, Pacific Northwest Laboratories (PNL).

Publications and Presentations

The photon energy response of a new environmental dosimeter design that uses aluminum oxide TLDs was calculated using Monte Carlo radiation transport techniques. The work was performed at the request of ESH-8. The results were presented at the IEEE 1992 Nuclear Science Symposium, October 1992, Orlando, Florida.

Related Professional Activities

In 1992, ESH-4 personnel participated in the following professional activities related to the Radiation Instrumentation Program.

- Attended meetings held by OS-2 on self-inventory requirements and on procedures for conducting self-inventories of Category IV accounts.
- Submitted a doctoral thesis proposal on "Performance Testing to Include Photon Energy, Photon Angular, and Environmental Dependence of Portable Direct Reading Radiation Detection Instrumentation at the Los Alamos National Laboratory in New Mexico," to the University of Massachusetts at Lowell.
- Attended Laboratory-sponsored courses in industrial x-ray safety, hazard communication, hazardous materials, hazardous waste generator, electrical safety, and radiation worker; and the Harshaw 8000C, 8800, and 6600 readers. Attended a user-group meeting on the Eberline PCM-1B.
- Attended a class in electrical troubleshooting at UNM and a class in the HpI model 2080 (Albatross) in California.
- Attended a five-day short course on "Calibration of Nuclear Instruments" in New Orleans, LA, sponsored by TMS, Inc.
- Provided training in radiological protection, including radiation and radioactivity, external and internal radiation hazards, basic principles of radiological protection, procedures for handling potentially contaminated instruments, and emergency response procedures.

Sample Analysis

Introduction

In 1992, four health physics analysis laboratories analyzed various types of samples for radiation. The laboratories are located at TA-3, TA-50, TA-35, and TA-55, and in 1992 their activities were carried out under the direction of ESH-4. They provided support to health physics operations as well as to operating groups throughout the Laboratory. Fourteen satellite laboratories also support health physics operations.

Routine Activities

In 1992, routine activities of the health physics analysis laboratories supported every aspect of the radiological protection program by analyzing nearly 633,626 samples of various types. The total number of analyses increased from the previous year (from 553,000 analyses) because of Laboratory-wide preparations for the DOE Tiger Team visit. The total number of analyses performed from 1982 through 1992 is shown in Figure 8.

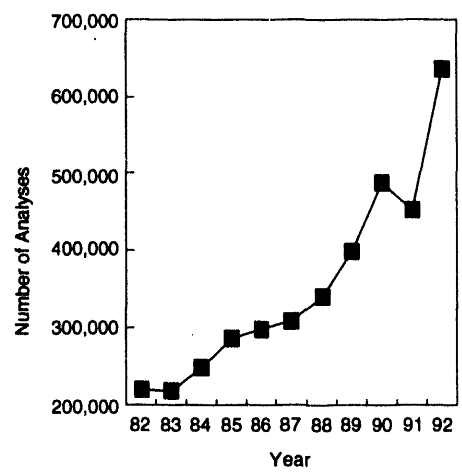


***Figure 8.* Total analyses performed by health physics analysis laboratories. Satellite laboratories became operational and workload increased for compliance issues.**

In support of internal dosimetry, 19 wound counts were performed by the health physics analysis laboratories in 1992. These analyses used a photon detector to measure low-energy x-rays (such as those emitted by plutonium) in employees' wounds. The number of wound counts performed from 1982 through 1992 is displayed in Figure 9.

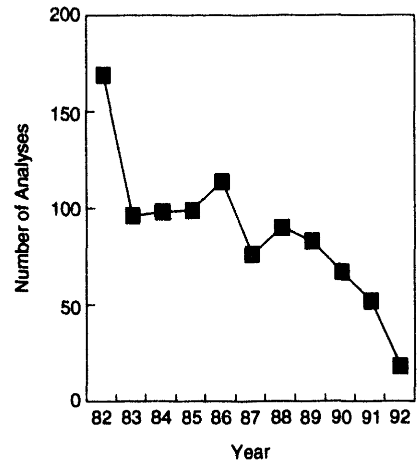


***Figure 9.* Wound counts performed by health physics analysis laboratories.**

The health physics analysis laboratories also supported internal dosimetry efforts by analyzing more than 41,000 nose swipes by liquid scintillation in 1992. These samples were taken to determine whether workers' nasal passages were contaminated by alpha or beta radiation. The number of nose swipes analyzed from 1982 through 1992 is displayed in Figure 10.

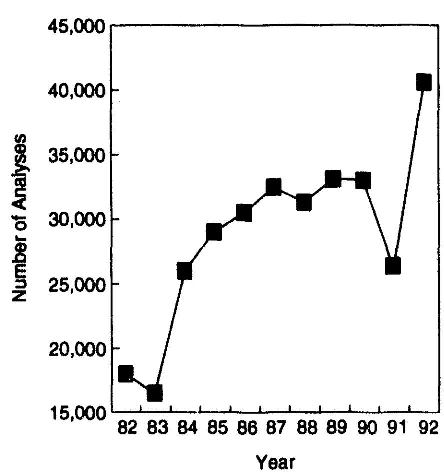


***Figure 10.* Nose swipes analyzed by health physics analysis laboratories.**

In support of external dosimetry activities, the health physics analysis laboratories analyzed about 9100 TLDs in 1992. These devices were used to measure dose equivalents to workers' extremities (hands and feet) to external gamma radiation and x-rays. They were also used to survey work areas for these types of radiation.

The number of TLDs processed from 1982 to 1992 is displayed in Figure 11. In 1984, there was a marked increase in the number of TLDs processed, which reflects tests run on 6000 new TLDs by the health physics analysis laboratories. In 1992, fourth quarter, the TLD program was transferred to the Personnel Dosimetry Operations Section.

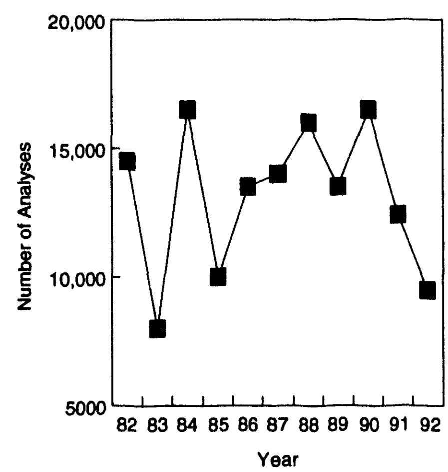


***Figure 11.* Thermoluminescent dosimeters processed by Personnel Dosimetry Operations Section.**

In 1992, the health physics analysis laboratories supported workplace monitoring by performing more than 368,000 routine analyses for contamination by alpha and beta radiation in samples such as surface swipes, filters from continuous air monitors, and other materials from special air tests. They also analyzed more than 11,000 swipes taken of shipping containers for these types of radiation. The number of shipment samples decreased as a result of the TA-55 mixed-waste shutdown. In support of both workplace monitoring and ESH-15 (Radioactive Air Emissions Management Group), the health physics analysis laboratories analyzed nearly 142,656 workplace air- and stack-monitoring filters in 1992 for alpha contamination. Here, again, the samples decreased as a result of the Tiger Team audit and people looking for guidance.

The number of routine analyses of shipping containers and air and stack filters performed from 1982 through 1992 is displayed in Figures 12, 13, and 14, respectively. Note that beginning in 1988, the number of routine analyses increased as the Laboratory began to comply with new DOE orders and the decontamination of the CMR Building progressed. Also, in 1984, shipping container analyses increased because of increased requirements for monitoring local shipments of radioactive materials. However, because of the TA-55 mixed-waste shutdown, samples decreased in 1992.

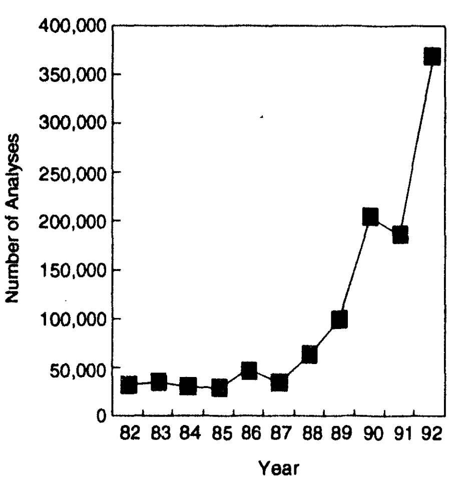


Figure 12. **Routine analyses for alpha and beta contamination performed by health physics analysis laboratories.**

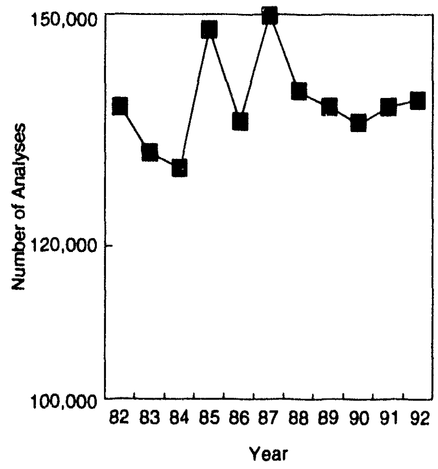


Figure 14. **Analyses of air- and stack-monitoring filters by health physics analysis laboratories.**

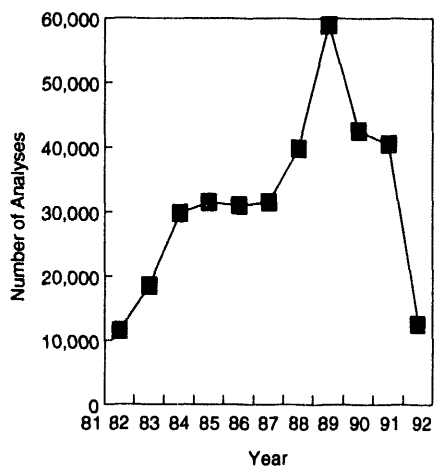


Figure 13. **Shipping container analyses by health physics analysis laboratories.**

Various other Laboratory activities were supported in 1992 by analyses done by the health physics analysis laboratories. For example, the liquid scintillation technique was used to determine alpha and beta contamination in approximately 38,000 samples, which included swipes (taken specifically to identify tritium contamination), oil samples, and water samples. As illustrated in Figure 15, this number decreased in 1992. The decrease was due to shutdown of TA-33, where tritium swipes were taken for routine surveys of main work areas, the hood room, offices, floors, and equipment; for shipments of material, both in and out; and for analysis of soil core samples at varying depths and locations.

In addition, spectroscopy was used to identify all types of radiation in various types of samples; in 1992, more than 13,399 spectroscopy samples were analyzed. The numbers of these analyses for 1982 through 1992 are displayed in Figure 16.

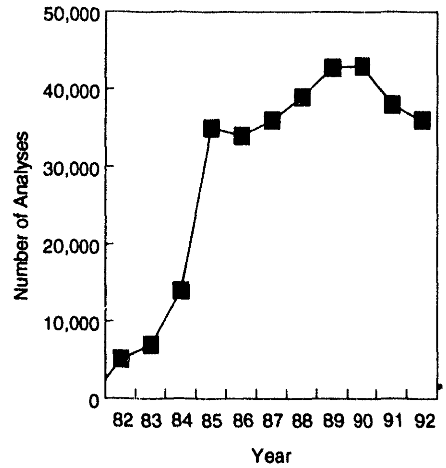


Figure 15. **Liquid scintillation analyses by health physics analysis laboratories.**

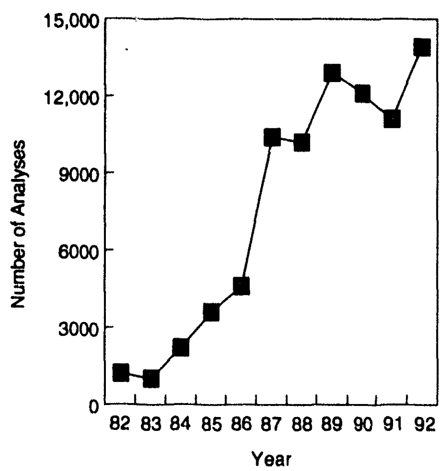


Figure 16. **Spectroscopy analyses by health physics analysis laboratories.**

WORKPLACE RADIOLOGICAL MONITORING

Introduction

At the Laboratory, general radiological monitoring is provided in direct support of individual jobs; for example, when external radiation fields are present, workplace surveillance is used to minimize exposure of personnel to radiation fields as well as to control the spread of contamination. In addition, workplace air is monitored at various Laboratory locations that have a potential for radiological contamination, and surface radiological contamination is monitored throughout the Laboratory wherever radioactive materials are handled or activation is possible. Other activities to monitor and control workplace contamination and radiation fields include registration of x-ray-producing devices and radioactive sources.

The Workplace Monitoring Program provides general radiological monitoring, surface monitoring (through smears and instrument surveys), and air monitoring; evaluation of survey results; and assistance in establishing contamination controls and implementing Laboratory contamination control procedures. This program is being consolidated to provide consistent workplace air monitoring throughout the Laboratory. It also provides registration, monitoring, and annual surveys of x-ray devices and registration and control of radioactive sources.

Before July 1991, this program was the responsibility of the three health physics groups (ESH-1, -10, and -11). In July 1991, ESH-1, -10, and -11 were reorganized (and in August 1991, ESH Division was reorganized) to form ESH-1, -4, and -12; and the Radiological Monitoring Program was centralized in ESH-1. Source and x-ray device control are the responsibility of ESH-12. The program is being improved to meet the requirements of DOE Order 5480.11 and the *DOE Radiological Control Manual.*

Routine Activities

General Radiological Monitoring

In 1992, ESH-1 provided general radiological monitoring in all facilities working with radiation-generating devices and radioactive material. Notably, these areas include CMR, TA-18, TA-21, TA-35, TA-46, TA-50, TA-53, TA-54, and TA-55. Table V summarizes ESH-1 support for these activities.

Workplace Air Monitoring

In 1992, workplace air samples were taken at various locations throughout the Laboratory and analyses were performed at three health physics analysis laboratories at TA-3, TA-50, and TA-55. A graph comparing these tests for 1990 through 1992 is shown in Figure 17.

***Table V.* Responses to requests for radiological surveillance.**

	January–March	April–June	July–September	October–December	1992 Total
Total responses	9340	11,280	13,380	4830	39,000
Responses/ day	150	135	150	90	135

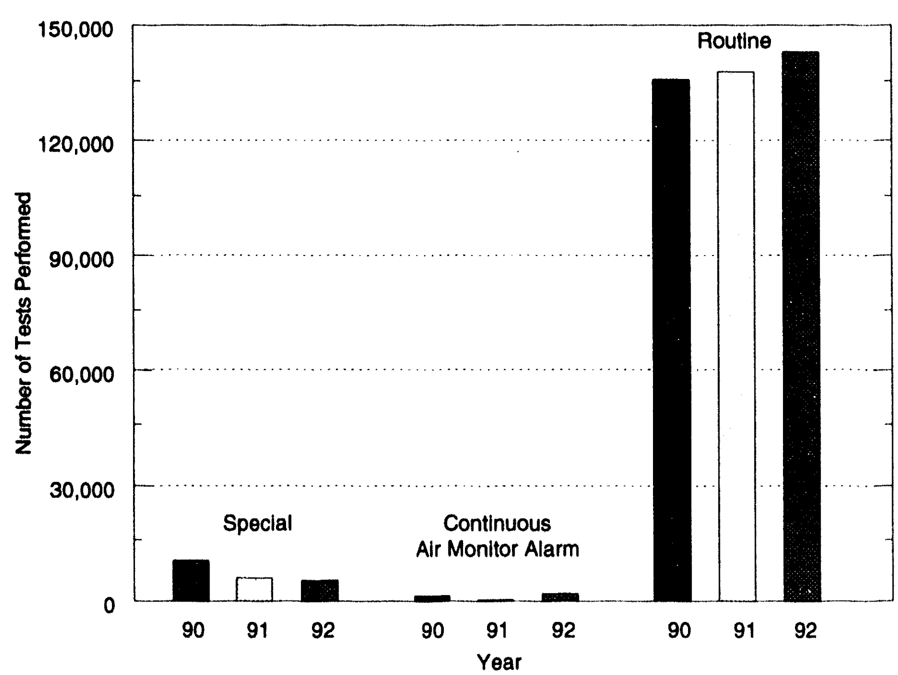


***Figure 17.* Workplace air radiological tests performed.**

Surface Contamination Monitoring

In 1992, samples to determine contamination were taken throughout the laboratory and analyzed at three health physics analysis laboratories at TA-3, TA-50, and TA-55. Figures 18 and 19 compare the number of samples analyzed from 1990 through 1992 to determine contamination.

By evaluating the results of smear and instrument surveys, ESH-1 personnel were able to suggest improvements in surface contamination control at several specific areas throughout the Laboratory, including TA-18, -21, -35, -46, -48, -50, -54, -55, CMR Building, and Sigma Building. These improvements included installation of the smear counters discussed above, changes in area designations as controlled or contaminated, and increased survey requirements.

X-Ray and Source Control

X-ray-producing devices are located in most technical areas of the Laboratory. In 1992, there were almost 250 registered x-ray devices at the Laboratory controlled by approximately 125 registered x-ray device custodians and operated by numerous trained operators. Both custodians and operators receive training every two years in x-ray safety; details are provided in this report in the "Radiological Training" section. In 1992, each x-ray device was visited at least annually to document that it was being operated in accordance with applicable standards and operating procedures.

In 1992, the ESH-12 registrar received copies of all purchase requests for radioactive material. About 300 radioactive sources used at the Laboratory were registered with the ESH-12 registrar in 1992, and the ESH-12 records for these registrable sources included source control numbers, inventory lists, and files on sources that had been disposed of. In 1992, sixteen of our registered sources were deleted because of decay or disposal. In 1992, the ESH-12 source registrar also maintained files on all nonregistrable sources that had been disposed of. Ensuring that sources are leak-tested twice a year and radiographed every three to five years (depending on the activity of the source) is the responsibility of the source custodian.

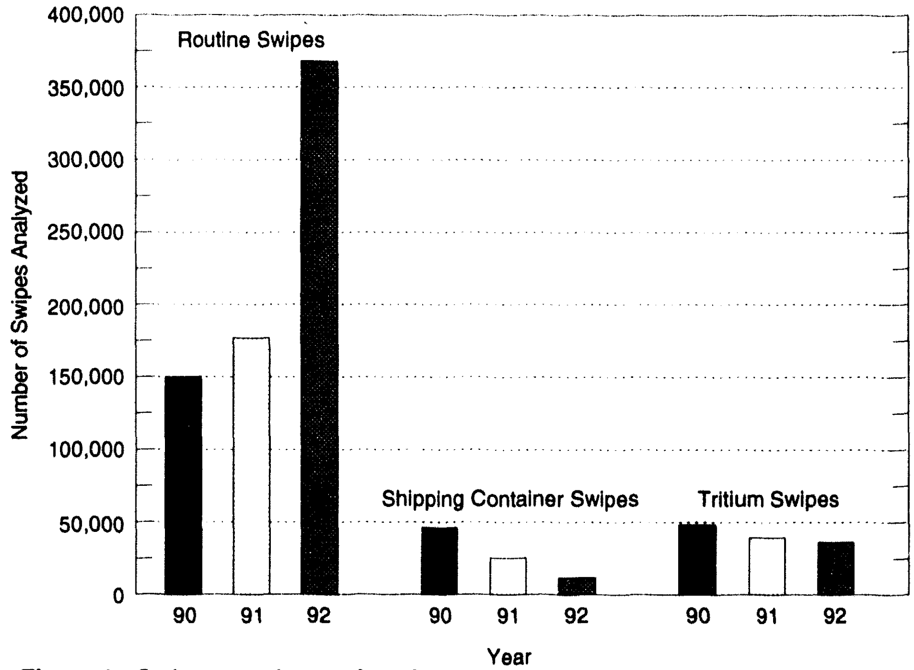


Figure 18. **Swipe samples analyzed.**

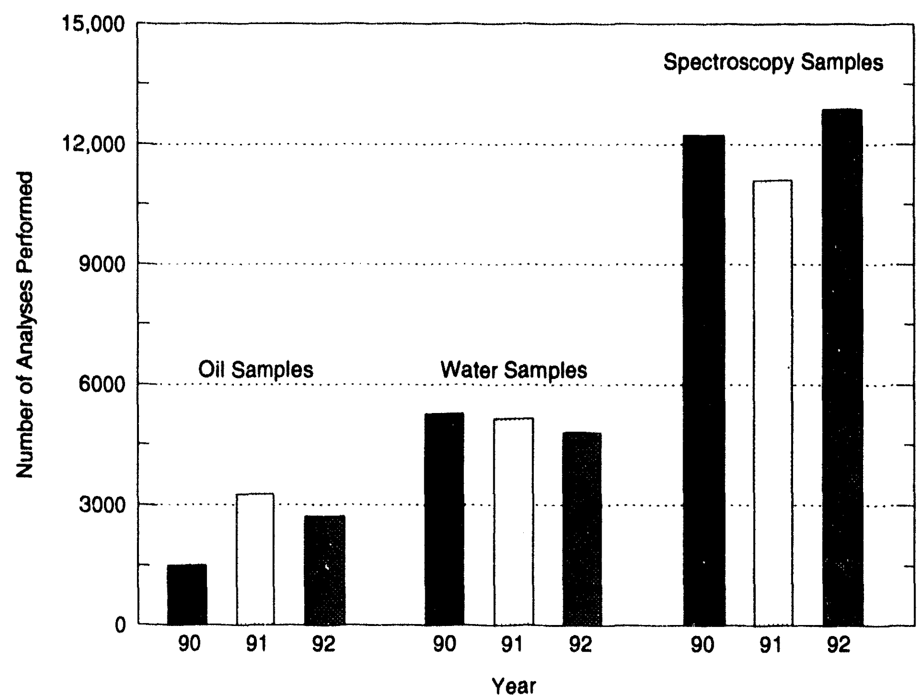


Figure 19. **Oil, water, and spectroscopy samples analyzed.**

Additional Activities

Radiological Control Manual Compliance Evaluations

In an effort to standardize radiological control practices across the Laboratory and in response to Tiger Team concerns and regulatory requirements, ESH-1 began a comprehensive effort to help bring Laboratory facilities into compliance with the *LANL Radiological Control Manual* (RadCon). This effort incorporates a phased approach for all Laboratory facilities with significant radiological hazards, including a preliminary review in phase 1 and, where applicable, a detailed follow-up radiological characterization in phase 2. Phase 1 evaluations include comprehensive reviews of RadCon compliance status for facility radiological programs, including ALARA, access control, workplace air monitoring, contamination and exposure control, area designation and posting, radiological training requirements, instrumentation, internal and external dosimetry, and procedures used by facility radiological control technicians (RCTs). This effort is being performed facility-by-facility according to a priority listing established by ESH-1, which takes into consideration "nuclear facilities," political pressure for RadCon compliance, and the estimated level of effort for these evaluations. These evaluations include interviews, walk-throughs, reviews of historical, present, and planned activities, reviews of radiological data, and preliminary radiological surveys. The product of each evaluation is an analysis of current RadCon compliance status and recommendations for bringing the facility more into compliance. These recommendations are reviewed and approved by radiological control management to ensure Laboratory-wide consistency. Each evaluation lasts several days to two weeks, with Laboratory-wide completion expected in September 1994.

Phase 2 entails, as necessary, detailed radiological characterizations performed by resident and supplemental ESH-1 RCTs under the direction of ESH-1 managers and the Facility Evaluation Team. These characterizations help to ensure that no radiological hazards remain in uncontrolled areas as a result of past Laboratory activities. Phase 2 activities, Laboratory-wide and labor-intensive, are expected to require many years for completion. One large-scale phase 2 effort has been in progress since 1990 at TA-3, SM-29 (CMR Building). The results of these characterizations are fed back to facility and radiological control managers, as well as to the Facility Evaluation Team, so that indicated changes can be made in radiological control programs and RadCon compliance status can be updated.

Also in 1991, ESH-1 provided general radiological monitoring support during the LAMPF beam line D shielding modifications. This support included analyzing samples of the concrete inside the beam channel to assess the level of induced activity that could be expected in the soil beneath the beam. The results indicated that there would be essentially no activation in the soil and thus no radioactive waste. In addition, an extensive series of measurements was made to evaluate the effectiveness of the added shielding, neutron and gamma radiation levels above the shield were measured, and neutron spectra were determined at various locations.

Workplace Air Monitoring

The new Canberra continuous air monitors (CAMs) are being installed, along with other types of CAMs, fixed air samplers, and glove box hand monitors at TA-3, SM-29 (CMR Building), as part of the CMR phase 1 upgrades. CAM and fixed air samplers were placed according to the results of earlier studies of airflow patterns and source terms, but placement has been systematically updated under a change control program to reflect changes in facility and operating group programs and needs. Canberra CAMs are also being used in CMR stack monitoring, along with in-line filters. All of the CMR CAMs will be networked using customized software so they can be monitored and queried in the CMR Operations Center and the Operational Health Physics Section Office.

The CAM computer-based system will allow the radiological control technician who is on call to query the status of the alarming CAM before leaving home. The RCT can then obtain additional support, if necessary, and analyze the situation. This system allows the network to monitor the status of personnel contamination monitors, hand and foot monitors, and any other health physics instrumentation that supports a standard communication protocol.

Surface Contamination Monitoring

Analysis capabilities for contamination survey samples have been expanded in the ESH-1 CMR count room. Recent upgrades allow the operation of two automated alpha/beta/gamma smear and air sample counters, a ten-detector alpha/beta smear counter, a liquid scintillation counter, and alpha and gamma spectroscopy systems. Operational and quality assurance procedures have been developed and ESH-1 personnel trained to operate this equipment, which will be used to support major projects, routine needs, and special analysis requests in support of section activities.

The large-area-swipe technique, originally adapted from the nuclear power industry by ESH-1 personnel at the CMR Building, is being implemented by ESH-1 personnel Laboratory-wide. In this technique, oil-impregnated cloth is attached to a mop that is used to wipe a large area. Surveys and decontamination can now be performed in a fraction of the time required for methods used previously. The technique is particularly effective in controlling hot particles and performing decontrolling surveys, which are part of phase 2 characterizations and RadCon implementation.

ESH-1 conducted a study at CMR to determine the effectiveness and the self-absorption property of the oil-impregnated cloth. The preliminary data indicate that the oil-impregnated cloth is more effective and has less self-absorption properties than the cloth smears currently being used. This study will be published at a later date.

X-Ray and Source Control

In 1992, ESH-12 conducted TLD surveys for group DX-13 personnel at the new TA-15 Radiographic Support Laboratory/Integrated Test Stand (RSL/ ITS) facility. In consultation with ESH-12, lights, fences, temporary shielding, and a standard operating procedure (SOP) were put in place. At TA-3-316, the Anaconda (a pulsed x-ray unit) was reviewed by ESH-12, safety features were discussed, and an SOP was prepared before the unit was brought back into operation by P-1.

NUCLEAR CRITICALITY SAFETY

Introduction

The Nuclear Criticality Safety Program provides technical support to Laboratory groups that work with significant quantities of fissile material. The program is administered by ESH-6 following Laboratory requirements (Administrative Requirement 4-1), DOE orders (particularly DOE Order 5480.5), and, by reference, the guidance of the American National Standards Institute (ANSI) covering nuclear criticality safety.

Routine Activities

Evaluation of Fissile Material Operations

Through site visits, discussions with operations personnel, and formal analyses ESH-6 personnel provided design guidance and evaluated existing operations to ensure that safety is built into every operation that involves significant quantities of fissile materials. For example, in 1992, a major analysis was performed and documented concerning the use of slab tanks for fissile solution processing at TA-55. Also, at TA-55, a series of glove box operations were assessed to determine appropriate criticality limits and controls.

Monitoring Operations

To maintain familiarity with operations that involve fissile materials, ESH-6 personnel reviewed written procedures and observed their performance. In this way ESH-6 was able to ensure that DOE regulations and ANSI guidance were incorporated into operations and that any changes in operations met such guidance. ESH-6 also supported the Laboratory's Nuclear Criticality Safety Committee by assisting with criticality safety reviews of various Laboratory operations.

Training

By request, ESH-6 personnel provided training in criticality to workers at the Laboratory and at the Nevada Test Site. In 1992, ESH-6 provided annual refresher training in criticality safety to Laboratory workers, mainly from CST, ESA, NIS, and OS Divisions and the TPO. NMT Division presents criticality safety training and testing itself, with guidance from ESH-6.

Facility Design

ESH-6 provided input on criticality aspects of the safety analysis report (SAR) for the CMR Building.

Review of Criticality Orders, Guides, and Standards

In 1992, ESH-6 personnel were heavily involved in reviewing drafts of DOE Order 5480.24, "Nuclear Criticality Safety." Also, they were significantly involved in providing input into implementation guidance documents for this order and criticality aspects of Order 5480.22, "Technical Safety Requirements." Several ESH-6 staff were active in the generation and review of criticality safety standards for the American Nuclear Society. ESH-6 chairs the committee on draft standard ANS-8.23, "Emergency Plans and Procedures in Nuclear Criticality Safety." Another staff member chairs committee ANS-8, which is responsible for the development, review, and oversight of all criticality-related American National Standards. In accordance with a contract between the Laboratory, the DOE, and the US Nuclear Regulatory Commission (NRC), ESH-6 continued in its efforts to update the 1978 version of "The Nuclear Safety Guide" (TID-7016, Rev. 2).

Additional Activities

In 1992, an ESH-6 staff member participated in the DOE/HQ-led operational readiness review of Building 707 at the Rocky Flats Plant. This several-week effort culminated in restart approval from DOE for specific operations in Building 707. At the request of DOE/HQ, ESH-6 personnel reviewed operations at other contractor sites and provided guidance to the DOE.

DOE sponsored criticality safety training classes, which had been in abeyance for two years and were resumed in 1992. These unique classes were conducted in 2-, 3-, and 5-day versions to over 100 DOE, contractor, NRC, Licensee, and Department of Defense (DoD) personnel from sites nationwide.

ESH-6 staff also were active as participants in several Laboratory committees, both standing and ad hoc: Safeguards, Policy, SNM Consolidation, Nuclear Material Holdup, and Emergency Response.

A Russian delegation visited the Laboratory for discussions on and assistance with designs for transportation containers and storage facilities for fissile material. ESH-6 participated heavily in these meetings and supplied several documents to their Russian counterparts.

ESH-6 personnel provided criticality guidance to Nevada Test Site personnel on weapons tests and to DoD personnel on one-of-a-kind weapons systems. They also provided consultation services to DOE contractors other than the Laboratory. One ESH-6 person has been assigned full time to EG&G Rocky Flats, and several others assist as needed to provide independent review of that facility's criticality accident alarm system and various process operations. Assistance with criticality concerns was also provided in 1992 to Oak Ridge National Laboratory, Lawrence Livermore National Laboratory, Sandia National Laboratory, Mason & Hanger-Silas Mason Pantex Plant, and EG&G Mound Applied Technologies. In addition, support was provided to accident response groups and nuclear emergency search teams throughout the DOE complex.

Publications and Presentations

- Nuclear Criticality Safety: 2-Day Training Course, LA-12386-M, November 1992, compiled and edited by J. A. Schlesser.
- Nuclear Criticality Safety: 3-Day Training Course, LA-12387-M, November 1992, compiled and edited by J. A. Schlesser.
- Nuclear Criticality Safety: 5-Day Training Course, LA-12388-M, November 1992, compiled and edited by J. A. Schlesser.
- McLaughlin, T. P., "Process Criticality Accident Likelihoods, Consequences and Emergency Planning, " *Journal of Nucl. Energy*, 1992, **31**, No. 2, Apr., 143-147.

Related Professional Activities

In 1992, ESH-6 personnel participated in the following professional activities related to the Nuclear Criticality Safety Program:

- Served on the Laboratory's Nuclear Criticality Safety Committee.
- Served on the executive committee of the Criticality Safety Division of the American Nuclear Society.
- Served on the DOE/AL Weapons Criticality Committee.
- Served as chair and secretary of ANSI/ANS-8 Standards Writing Committee and as members of various writing groups.
- Chaired Trinity Section, ANS
- Served on the Laboratory's Reactor Safety Committee
- Served on UNM's Reactor Safety Advisory Committee

Hazardous Materials Response

Introduction

The Hazardous Materials Response Group, ESH-10, was formed from the HS-12 Radiological Emergency Assistance Section and the HS-5 Hazardous Materials Response Team. ESH-10 is responsible for emergency preparedness for on-site and off-site DOE programs that involve radiological hazards. Programs supported by ESH-10 include the Accident Response Group (ARG), Nuclear Emergency Search Team (NEST), and the Radiological Assistance Program (RAP).

In January 1992, ESH-10 assumed health physics responsibilities from ESH-1 for maintaining the operational readiness of the decontamination room at the Los Alamos Medical Center.

Routine Activities

On-site activities in 1992 included developing emergency response procedures, developing and maintaining capability resources, and planning and participating in exercises.

In September 1992, ESH-10 began providing two radiological control technicians to accompany two ESH-5 HAZMAT specialists during assessments of Laboratory incidents. The assessment team has rotating team leaders who are contacted directly by the Emergency Management Office (EMO) when a call for team assistance is received. The team provides assessment and mitigation for hazardous materials incidents and/or calls for additional ESH Division support as required.

Quality Assurance Program

The ESH-10 Quality Assurance Program comprises a Quality Assurance Program Plan (QAPP), administrative procedures, and technical procedures for responding to radiological emergencies. Operational procedures are being written for periodic testing and calibration of radiation detection instruments, rapid response kits, the Radiological/Hazardous Materials Contamination Control Station (CCS), and the field instrument for the detection of low-energy radiation (FIDLER).

ARG Participation

In October 1992, ESH-10 personnel participated in a US Navy Explosive Ordnance Disposal exercise at Kirtland Air Force Base. The exercise focused primarily on weapons recovery, with a small health and safety group supporting the Joint Hazards Evaluation Center (JHEC).

A DOE/DoD training drill was conducted in November 1992 at the Nevada Test Site, Area 11. The training provided an opportunity for the ARG field teams to get hands-on practice in a plutonium-contaminated environment. A drill format was used rather than an exercise format so that all participating organizations could have the opportunity to interface with each other and informally review procedures. Full dress-out, health and safety, field monitoring, sampling, contamination control station operations, and the mobile laboratories were practiced. A forward JHEC was established to direct and coordinate operations.

RAP Participation

In 1992, ESH-10 RAP personnel completed four WIPP Transportation Exercises (WIPPTREX) accident scenarios for the Western Governor's Association and submitted one additional scenario to DOE/AL for final approval. Planning in support of WIPP, as requested by DOE/AL, included a meeting in Raton, NM, for Incident Command System (ICS) Training.

Transuranic Packaging Transporter (TRUPACT) II training for initial corridor RAP teams was completed, and 96 RAP team members received TRUPACT-II training certificates, including teams from Los Alamos, Sandia National Laboratory, Battelle-Pantex, WIPP, Rocky Flats, and INEL.

1992 Transportation Accident Exercises (TRANSAX) included a radiation assessment drill and dress rehearsal at Ft. Hall, ID, and two planning meetings at Pocatello, ID, from May through September.

Additional Activities

With the assistance of the US Army, ESH-10 is developing methodology for dose reconstruction for nuclear weapons maintenance personnel that will involve all nuclear weapons in the stockpile.

During 1992, ESH-10 section personnel worked closely with the Laboratory's Emergency Management Office (EMO) to evaluate and recommend a digital personal dosimeter for Los Alamos Fire Department responders. A dosimeter was chosen and a report will be finalized in early 1993, recommending the purchase of Aloka dosimeters for estimating accumulated doses in "real time" for Los Alamos Fire Department personnel responding to Laboratory incidents/accidents that have a potential for external radiation dose.

ESH-10 personnel provided support for ARG capability development projects, including Violinist III kits, Global Positioning System (GPS) technology, and the Joint Hazards Evaluation Center (JHEC) Data Center.

Other ESH-10 personnel traveled to Germany and England in May 1992 to provide health physics technical assistance to DOE personnel performing technical work in these countries and to Sandia National Laboratory in April 1992 to provide health physics support for "real time" and "static" radiography demonstrations, using the LANL WX-3 6-Mev Schonberg Minac. In April 1992, ESH-10 personnel demonstrated ARG/RAP Emergency Response Equipment to Admiral Ellis and other DP-23 dignitaries.

Related Professional Activities

In 1992, ESH-10 personnel participated in the following professional activities related to the Radiological Emergency Assistance Program.

- ARG Activities
  - 24-Hour Emergency Responder Training Program for compliance with OSHA standards.
  - 3-day JHEC course in February at Sandia National Laboratory for senior DoD and DOE managers in the ARG JHEC.
  - Full-Face Respirator and Self-Contained Breathing Apparatus (SCBA) Training
  - 40-hour logistical support course on the loading of equipment in DoD aircraft.
- NEST Activities
  - ATX-92 NEST Searcher Training drill in San Diego, March 23-27, 1992.
  - NEST Search Team Leader Training in Las Vegas, March 11, 1993.

Radiological Training

Introduction

During 1992, the goal of the ES&H Training Group (ESH-13, then a section in the Facility Risk Management Group) was to continue delivering radiological training for all occupational workers and radiation workers to meet the requirements of DOE Orders 5480.11 and 5480.20.

In the spring of 1992, ESH-13 assumed responsibility for the Radiological Control Technician (RCT) Training program from ESH-12. ESH-1 and ESH-12 continued to provide health physics subject matter expertise in reviewing training materials.

In July 1992, ESH-13 moved from TA-59 into the new ES&H Training Center in White Rock.

Occupational Workers

During 1992, Radiation Protection for the Occupational Worker was delivered as part of ESH-13's weekly General Employee Training (GET) to about 2000 workers at the Laboratory. In September 1992, a self-study booklet for this training course was developed and distributed to all workers at the Laboratory. Approximately 10,500 workers signed a statement affirming that they had read the booklet.

Radiation Workers

During 1992, about 1800 workers received Basic Radiation Worker Training, which consisted of a 4-hour videotaped presentation.

Radiological Control Technician Training

In 1991, the RCT training program consisted of a commercially developed computer-based training program. In 1992, ESH-13 training specialists, together with ESH-12 personnel, determined that significant errors in the computer-based training program needed to be corrected and that the RCTs currently in the program were experiencing difficulties with some of the modules and needed additional assistance.

Because of the imminent implementation of the *DOE Radiological Control Manual* (which included RCT training requirements) and the difficulties experienced in attempting to acquire source codes from the vendor of the computer-based training (CBT) program, the RCT training program was put on hold until the new DOE RCT training program could be implemented. Responsibility for performance-based training on RCT procedures stayed with ESH-1.

X-Ray Safety

During 1992, ESH-13 training specialists continued to assist ESH-12 with the delivery of classes in X-Ray Safety. One hundred and twenty workers were trained in Analytical X-Ray Safety and 130 workers were trained in Industrial X-Ray Safety. Eight sessions of Industrial X-Ray Safety and twelve sessions of Analytical X-Ray Safety were conducted. In late 1992, discussions were held with ESH-12 that resulted in the combining of the two courses and revision of the course materials.

Tritium Safety

During the first half of 1992, an ESH-13 training specialist continued to provide approximately half-time support to Tritium Systems Test Assembly (TSTA). Working with TSTA personnel, the training specialist designed and developed a tritium safety training course that was piloted in June of 1992. About 20 individuals attended the course.

Health Physics Checklist Indoctrination

During the last quarter of 1992, ESH-13, working with ESH-12, facilitated the entry of training data into the Employee Development System (EDS). Two training sessions were conducted at the ES&H Training Center, as well as other locations, and about 300 training records were entered into EDS.

Criticality Safety

During 1992, ESH-13 facilitated the delivery of Criticality Safety Training at the ES&H Training Center. The courses were delivered by ESH-6 personnel. About 35 workers attended the 2-day program, 80 attended the 3-day program, and about 150 attended the Ad Hoc Refresher.

Additional Activities

In the first half of 1992, ESH-13 participated in the DOE review process for the *DOE Radiological Control Manual* and the standardized core training materials for General Employee Radiological Training (GERT), Radiological Worker I and II, and Radiological Control Technician training. In June 1992, DOE issued the *DOE Radiological Control Manual*. ESH-13 assisted with the development of Chapter 6, Training, as part of the *LANL Radiological Control Manual*, which was distributed in December 1992.

In July 1992, several ESH-13 personnel, together with ESH-1 and ESH-12 subject matter experts, attended segments of the pilot programs for standardized core training conducted at Hanford. In August 1992, ESH-13, -1, -12, and PS-1 Testing personnel attended the Lessons Learned meeting at Hanford to discuss and review the pilot programs.

From September through December, ESH-13, working with subject matter experts,

- reviewed the GERT materials and concluded that the subject matter was already included in and delivered as the radiation module in General Employee Training,
- developed Laboratory-specific information to be added to Radiological Worker I and II training, and
- developed practical exercises and associated lessons for Radiological Worker I and II training.

A cost-effective solution to instructor and space resource constraints for the training programs was developed for Radiological Worker I and II. The two courses were combined and all students would be trained in the classroom content of Radiological II; however, separate written tests and practical exercises for Radiological I and II would be administered. The finalized core materials were received from the DOE in late November. Implementation was scheduled to begin in January of 1993 when Basic Radiation Worker training would cease.

ESH-13 worked with ESH-1 and HRD-3 to implement a Basic Skills program to prepare RCTs for entry into the RCT training program. All RCTs were given an assessment, and Basic Skills training began in September 1992.

Because the DOE test bank was not finalized and available for use, ESH-13 developed challenge tests for the first 13 lessons in the classroom-training phase of this program. These were ready for administration to eligible RCTs in January of 1993.

ESH-13 began to revise, correct, and enhance the RCT training materials, student guides, and lesson plans in preparation for classroom training.

ESH-13 personnel participated in discussions with the TA-55 training group and ESH-1 to address the performance-based training requirements for accreditation (DOE Order 5480.18A) with respect to the RCT training program.

Related Professional Activities

In 1992, health physics personnel participated in the following professional activities related to the Radiological Training Program.

- In November 1992, training personnel attended the annual TRADE conference in Seattle, which included a meeting of the Radiation Protection Special Interest Group. At these meetings, Laboratory personnel elected to serve as members of various training committees. These committees were asked to develop training requirements and guidelines for DOE for categories of workers specified in the *DOE Radiological Control Manual.*
- Also in November of 1992, training personnel attended a Continuing Education For Radiation Protection Instructors course conducted by Oak Ridge Institute of Science Education.

Radiological Records

Introduction

The Radiological Records Program was established in response to audits and investigations that found that the Laboratory's radiological records were not kept in a single location. Although all elements of the program were in place, they were not centralized. Thus, the goal of the program is to design, develop, implement, and maintain a centralized radiological protection record system, which includes records of internal and external dosimetry and of routine workplace monitoring.

ESH-12 is responsible for administering the Radiological Records Program as part of its data management effort. The program follows the requirements of DOE Orders N5480.6 and 5484.1 and the guidance of ANSI N13.6.

Routine Activities

Among the routine activities of the program are the maintenance of dosimetry records, the production of dosimetry reports, the collection and maintenance of exposure results received by Laboratory employees during previous employment, and the review of standard operating procedures (SOPs) for activities that involve radiation and special work permits for radiation work (SWP/RWs).

In 1992, radiological incidents and accidents were reported at TA-55 with the aid of a computerized reporting system; elsewhere, such events were reported with the Radiological Occurrence Reporting (ROR) System.

Records Maintenance

Before 1991, dosimetry records for individual employees were maintained in various locations throughout the Laboratory. In fall 1991, the effort began to centralize these records. Toward this end, dosimetry records from 1980 through 1989 were reviewed and prepared for entry into a centralized database. Currently the external dosimetry database contains detailed data for 1989-1992 and summary data or 1988-1992. Such a database will allow studies (such as studies of effects of background radiation on thermoluminescent dosimetry and trend analyses) that support the Laboratory's Radiological Protection Program.

In addition, plans are being developed to centralize records of

- the external dosimetry badge system,
- in vivo measurements laboratories,
- the urinalysis scheduling and tracking system,
- the health physics checklist,
- routine area surveys,
- relationships between workplace and personnel dosimetry results, and
- radiological occurrence reports.

Reports

Table XI summarizes the reports prepared in 1992.

***Table XI*. 1992 Radiological Protection Reports**

Title	Frequency	Recipient	Information Provided
External Exposure Report	Monthly	Group leaders	External skin dose equivalent penetrating effective dose equivalent from gamma and neutron radiation, and effective dose equivalent from tritium intakes
Report to the Radiation Exposure Information Reporting System (REIRS)	Annually	DOE Idaho Office	External and internal dosimetry results for all types of radiation as measured by TLDs, bioassay, and in vivo testing
Radiation Report Card	Annually	Employees	External and internal dosimetry results for all types of radiation as measured by TLDs, bioassay, and in vivo monitoring
Exposure History	Upon request	Current and former Laboratory personnel and current employers of former Laboratory personnel	Summary of external and internal dosimetry results for all types of radiation monitored while working at the Laboratory
Performance Indicators Program Report	Quarterly	DOE Headquarters, DOE Albuquerque Office, and LAO	Penetrating and nonpenetrating radiation dosimetry results listed by Laboratory facility

Standard Operating Procedures and Special Work Permits for Radiation Work

In 1992, the health physics groups (ESH-1, -4, and -12) reviewed 292 SOPs for radiation protection concerns. In addition, ESH-1 issued SWP/RWs in 1992 as follows.

- Operational health physics locations: 1092 permits
- TA-53: 694 permits
- TA-55: 712 permits
- CMR Building: 349 permits
- TA-50: 186 permits
- Machine shops: 90 permits
- Sigma Building: 79 permits
- TA-54: 40 permits

Additional Activities

In preparing to implement the Radiological Records Program, ESH-12 data management staff took on several projects in 1992. The External Dosimetry Badge System (EDBS) continues to perform well. It is being modified to meet customer requests, enhance reporting capabilities, improve spurious TLD card handling, and permit new peripheral implementation. The EDBS was developed to support the radiological protection program, which is responsible for monitoring exposure to external radiation for approximately 8000 Laboratory employees, visitors, and contractors each month. External radiation fields are monitored using TLDs. The EDBS controls the assembly, distribution, return, disassembly, and analysis of TLDs each month to determine individual effective dose equivalents. The system reports results and stores them in a database designed to maintain detailed individual dosimetry data and complete histories of annual external dosimetry data. The database allows ESH-12 to respond to various requests for dosimetry information and to identify trends in the data. This system is expected to serve as a model for automating radiological protection records throughout ESH Division.

The Urinalysis Tracking and Scheduling (UTS) system is being enhanced to meet user requirements. Enhancements include cleaning up log-in results data, automating data validation for results received from EM-9, and implementing bioassay kit bar-coding. This system allows ESH-12 to schedule and track urinalysis kits for workers participating in the bioassay program, which monitors internal radiation from intake of tritium, uranium, americium, and plutonium. The UTS system assigns individual kits and tracks them from issuance through sample analysis, thus ensuring a documented chain of custody. The system maintains results in a data base and provides records of individual bioassay results, which are used for internal dose assessments.

In an effort to centralize radiological protection records, ESH-12 in 1992 continued to maintain and report dosimetry results. This responsibilitiy includes reporting external and internal dosimetry results to Laboratory and non-Laboratory personnel both inside and outside the Laboratory, preparing and reporting dosimetry histories for former Laboratory workers at the request of their current employers, and requesting dosimetry histories for current Laboratory workers from their former employers and maintaining those histories. To expand radiation occurrence reporting to include the entire Laboratory, design and development work began in 1992 for a new ROR system. At this time, radiation occurrence reporting includes TA-55, TA-48, and CMR.

Radioactive Air Emissions Management

The Laboratory's 1992 radioactive air emissions have been summarized, by radionuclide or product and by emitting facility, in a separate progress report written by the Radioactive Air Emissions Management Group (ESH-15). In 1992, the total activity of radionuclides emitted into the air from Laboratory stacks was approximately 73,500 Ci. This was an increase over the activity of the total 1991 radioactive air emissions, which was approximately 62,400 Ci. Compared to 1991 radioactive air emissions,

- total tritium activity was decreased,
- total plutonium activity was decreased,
- total uranium activity was decreased,
- total mixed fission product activity was increased,
- total ^{41}Ar activity was decreased,
- total gaseous/mixed activation product (except ^{41}Ar) activity was increased,
- total particulate/vapor activation product activity was increased, and
- total ^{32}P activity was decreased.

Contact ESH-15 for a copy of the Radioactive Air Emissions 1992 Summary.

Nevada Test Site

Introduction

The Nevada Test Site/Off-Site Operations Section of ESH-12 provides health physics support for all operations at the Nevada Test Site that involve Laboratory personnel. As the only Laboratory ES&H professionals permanently stationed at the Nevada Test Site, ESH-12 health physics personnel serve as liaisons to the Nevada Test Site Test Group Director. They are responsible to the Test Group Director for interpreting and providing compliance direction and guidance on applicable Laboratory, DOE, DOE Nevada Office, and other policies, rules, and regulations. ESH-12 also interacts with other agencies, assisting them in areas where facilities and/or equipment limitations delay them.

Routine Activities

In 1992, health physics personnel at the Nevada Test Site participated in several routine activities. Support was provided for shipment of radioactive materials, which included calculations and consultations for departing shipments and monitoring for arriving shipments.

Support during assembly of test devices included monitoring assembly operations (using air samples and surface swipes) and packaging and on-site transportation of completed assemblies.

ESH-12 provided test support, which included analyzing radioactive tracers installed when test devices were inserted into racks, analyzing drilling fluids when emplacement holes were drilled, installing radiation detectors when racks were lowered into emplacement holes, maintaining and operating a radiation telemetry system for 24 hours after each test to confirm containment, and providing radiation information for data recovery teams that entered test areas when tests were completed. Solar-rechargeable detectors were developed for the telemetry system and field studies were completed. Also, development of a more refined Data Acquisition System (DAS-16 replaced DAS-6) enables ESH-12 health physicists to instantaneously provide more state-of-the-art graphics of downhole backfill packages.

After each test was completed, core samples were taken, and sampling support was provided during these operations. This support included monitoring for radiation, explosive mixtures, and noxious gases during drilling; monitoring equipment and tools used to drill; monitoring near drilling operations for airborne radioactivity and then scheduling bioassays (based on monitoring results) to assess internal doses; and monitoring the radioactivity of core samples and supervising the packaging, loading, and documentation of samples being sent back to Los Alamos for analysis. Also, airborne radiation monitoring data were processed, analyzed, and distributed. To support drillbacks, a new flow system was developed and incorporated to monitor and record air flow in the containment and cellar exhaust systems located on the drilling rig; a new data acquisition system was developed and tested to assist in monitoring radionuclides in airborne samples; and a new drillback core monitor was developed.

Support provided when a test area was cleaned up included monitoring for radiation and explosive mixtures while drillback holes were being plugged; sampling to ensure that plugs were effective; and certifying that test areas were at or below radiation limits and ready for release. Radiation protection training was provided for Laboratory radiation workers and to those who processed an ESH-12 Health Physics Checklist. Special dosimetry support was provided for nonroutine projects, to follow up on unexplained dosimetry results, and to assist the Reynolds Electrical and Engineering Company (REECo) dosimetry section. Also, overdue Nevada Test Site dosimeters were tracked and returned to the REECo system, thus providing timely exposure data.

The ESH-12 Health Physics Analysis Laboratory at the Nevada Test Site performed various analyses in 1992 in support of routine activities. These analyses are summarized in Tables XII and XIII.

***Table XII.* Samples Analyzed at the Nevada Test Site**

	Type of Sample				
Period	**Air**	**Swipes**	**Drilling Fluid**	**Other**	**Total**
January–March	11	378	64	336	789
April–June	265	205	106	24	600
July–September	146	359	45	291	841
October–December	267	68	129	40	504
1992 Total	**689**	**1010**	**344**	**691**	**2734**

***Table XIII.* Analyses Performed at the Nevada Test Site**

	Type of Radiation Analyzed					
Period	**Alpha**	**Beta**	**Gamma**	**Tritium**	**Gamma Spectroscopy**	**Total**
January–March	444	480	212	169	149	1454
April–June	580	587	672	258	313	2410
July–September	723	723	374	100	213	2133
October–December	630	630	1049	88	303	2700
1992 Total	**2377**	**2420**	**2307**	**615**	**978**	**8697**

Additional Activities

The Nevada Test Site counting system was automated, using a VAX-based gamma spectroscopy component in the ESH-12 health physics analysis laboratory to process samples on a network.

The analysis of cuttings from emplacement holes continued, and no holes were found to be contaminated with either tritium or fission products.

The practice of allowing drinking water in a controlled areas was implemented in 1992, allowing workers in protective clothing to be monitored as they move from the controlled area to the break area without requiring them to pass through a portal monitor.

The JTO (Joint Test Operations) was established in the fourth quarter of 1992. JTO is an attempt at merging Los Alamos National Laboratory and Lawrence Livermore National Laboratory.

The design and development of a gas monitoring system to support low-yield nuclear explosive research (LYNER) was initiated.

The annual Radiation-Laboratory Trailer systems calibration (with ^{133}Xe) was performed, and appropriate documentation was submitted.

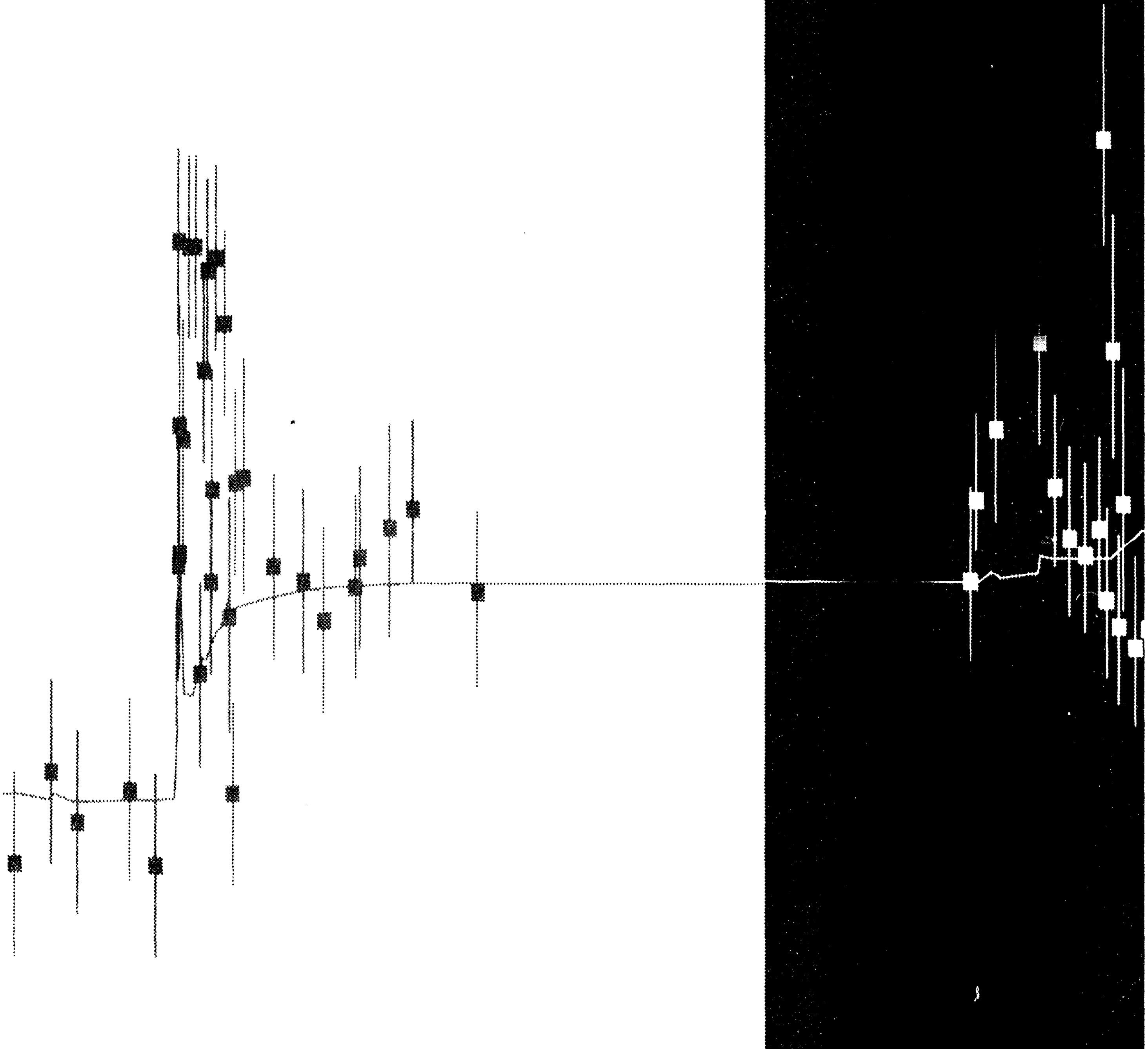
Special Reports and Other Documents

- Annual report on effluent information and on-site discharge information for EG&G Idaho
- Annual report on ionizing radiation-producing equipment surveillance for REECo
- Two semiannual reports on radioactive source location and leak tests for REECo
- Five completion reports certifying that testing areas were ready to be returned to DOE Control
- Procedures were developed in the following areas:
  - Chemical Hygiene Plan
  - Various quality control/assurance plans
  - Various routine and special operating plans (detailed procedures)

Related Professional Activities

- Served on the Site-Wide ALARA Committee
- Served on the RadCon Committee (to include helping to create the RadCon Manual for DOE/Nevada Test Site)
- Served on the Effluent and Environmental Monitoring Group
- Served on the Device Assembly Facility SAR Working Group
- Participated in the Test Operations Review Team and co-chaired the Test Operations Rad-Safe Team

Acronyms and Abbreviations



ANS	American Nuclear Society
ANSI	American National Standards Institute
ARG	Accident Response Group
CCS	Contamination Control Station
CAM	Continuous Air Monitor
CBT	Computer-Based Training
CMR	Chemistry Metallurgy Research
CST	Chemistry, Science , and Technology Division
CST-9	Environmental Chemistry Group
DAS	Data Acquisition System
DoD	Department of Defense
DOE	Department of Energy
DOE/AL	Department of Energy Albuquerque Office
DOE/HQ	Department of Energy Headquarters
DOE LAP	Department of Energy Laboratory Accreditation Program
DP	Defense Programs
DX	Dynamic Experimentation
DX-13	Hydrodynamics Group
EDS	Employee Development System
EG&G	Contractor to the Department of Energy
EDBS	External Dosimetry Badge System
ESA	Engineering Sciences and Applications
ESH-8	Environmental Protection Group
EMO	Emergency Management Office
ESA	Engineering Sciences and Applications
ES&H	Environment, Safety, and Health
ESH-DO	Environment, Safety, and Health Division Office
ESH-1	Health Physics Operations Group
ESH-2	Occupational Medicine Group
ESH-3	Risk Management Support Group
ESH-4	Health Physics Measurements Group
ESH-5	Industrial Safety and Hygiene
ESH-6	Nuclear Criticality Safety
ESH-12	Health Physics Policy and Programs Analysis
ESH-15	Radioactive Air Emissions
FIDLER	Field Instrument for the Detection of Low-Energy Radiation
GET	General Employee Training
GERT	General Employee Radiological Training
HAZMAT	Hazardous Materials Team
HPAL	Health Physics Analysis Laboratory
ICS	Incident Command System
IEEE	Institute of Electrical and Electronics Engineers
JCI	Johnson Controls World Services, Inc.
JHEC	Joint Hazards Evaluation Center
JTO	Joint Test Operations
KSU	Kansas State University
LAMPF	Los Alamos Meson Physics Facility
LANL	Los Alamos National Laboratory
LAO	Laboratory Assessment Office
LDRD	Laboratory-Directed Research and Development
LYNER	Low-Yield Nuclear Explosive Research
MST	Materials Science and Technology Division
NEST	Nuclear Emergency Search Team
NIS	Nonproliferation and International Security
NIS-6	Advanced Nuclear Technolgy Group
NIST	National Institute of Standards and Technology
NMT	Nuclear Materials Technology Division
NMT-9	Heat Source Technology
NRC	Nuclear Regulatory Commission
OS	Operational Safeguards and Security Division
P	Physics Division
P-17	Neutron and Nuclear Science
PNAD	Personal Nuclear Accident Dosimeter
PNL	Pacific Northwest Laboratories
PTLA	Protection Technology Los Alamos
QA	Quality Assurance
QAPP	Quality Assurance Program Plan
RAP	Radiological Assistance Program
REECo	Reynolds Electrical and Engineering Company, a contractor to the Department of Energy
REIRS	Radiation Exposure Information Reporting System
ROR	Radiological Occurrence Reporting
RSL/ITS	Radiographic Support Laboratory/Integrated Test Stand
SAR	Safety Analysis Report
SCBA	Self-Contained Breathing Apparatus
SM-40	South Mesa (Technical Area 3), Building 40
SM-43	South Mesa (Technical Area 3), Building 43 (the Administration Building)
SM-130	South Mesa (Technical Area 3), Building 130
SM-2006-2010	South Mesa (Technical Area 3), Buildings 2006 through 2010
SNML	Special Nuclear Materials Laboratory
SOP	Standard Operating Procedure
SST	Safe Secure Transport
	Space Science and Technology Division

SST-8	Space Plasma Physics Group
SST-11	Space Engineering Group
SWP/RW	Special Work Permit for Radiation Work
TA-3	Technical Area 3
TA-15	Technical Area 15
TA-18	Technical Area 18
TA-21	Technical Area 21
TA-35	Technical Area 35
TA-46	Technical Area 46
TA-48	Technical Area 48
TA-50	Technical Area 50
TA-53	Technical Area 53
TA-54	Technical Area 54
TA-55	Technical Area 55 (the Plutonium Facility)
TLD	Thermoluminescent Dosimeter
TPO	Test Program Office
TRADE	Training Resources and Data Exchange
TRANSAX	Transportation Accident Exercises
TRUPACT-II	Packaging for Radioactive Materials
TSTA	Tritium System Test Assembly
UC	University of California
UK	United Kingdom
US	United States
UTS	Urinalysis Tracking and Scheduling System
WIPP	Waste Isolation Pilot Plant
WIPPTREX	WIPP Transportation Exercises

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