

**Pacific Northwest Laboratory
Annual Report for 1986 to
the Assistant Secretary for
Environment, Safety and Health**

**Part 5 Nuclear and Operational Safety
February 1987**



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

Pacific Northwest Laboratory
Operated for the U.S. Department of Energy
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L.G. Faust, W.E. Kennedy, B.L. Steelman,
J.M. Selby, and Staff

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Pacific Northwest Laboratory
Richland, Washington 99352



PREFACE

This 1986 annual report from Pacific Northwest Laboratory (PNL) to the Department of Energy (DOE) describes research in environment, health, and safety conducted during fiscal year 1986. The report again consists of five parts, each in a separate volume.

The five parts of the report are oriented to particular segments of our program. Parts 1 to 4 report on research performed for the DOE Office of Health and Environmental Research in the Office of Energy Research. Part 5 reports progress on all research performed for the Assistant Secretary for Environment, Safety and Health. In some instances, the volumes report on research funded by other DOE components or by other governmental entities under interagency agreements. Each part consists of project reports authored by scientists from several PNL research departments, reflecting the multidisciplinary nature of the research effort.

The parts of the 1986 Annual Report are:

Part 1: Biomedical Sciences

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Part 2: Environmental Sciences

Program Manager - R. E. Wildung

R. E. Wildung, Report Coordinator
K. A. Borgeson and
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P. L. Gurwell, Editor

Part 5: Nuclear and Operational Safety

Program Managers - L. G. Faust
W. E. Kennedy, Jr.
J. M. Selby
B. L. Steelman

L. G. Faust, Report Coordinator
S. K. Ennor, Editor

Activities of the scientists whose work is described in this annual report are broader in scope than the articles indicate. PNL staff have responded to numerous requests from DOE during the year for planning, for service on various task groups, and for special assistance.

A major effort was in response to OHER's request for assistance in collecting information on the release of radioactivity from the nuclear power plant accident at Chernobyl. Environmental and chemical scientists participated in collecting and analyzing atmospheric and environmental samples in Sweden, over the Pacific Ocean, along the northwest coast of North America and along the path of the radioactive plume as it passed across the United States.

Credit for this annual report goes to the many scientists who performed the research and wrote the individual project reports, to the program managers who directed the research and coordinated the technical progress reports, to the editors who edited the individual project reports and assembled the five parts, and to Ray Baalman, editor in chief, who directed the total effort.

Members of the Scientific Advisory Committee established last year are:

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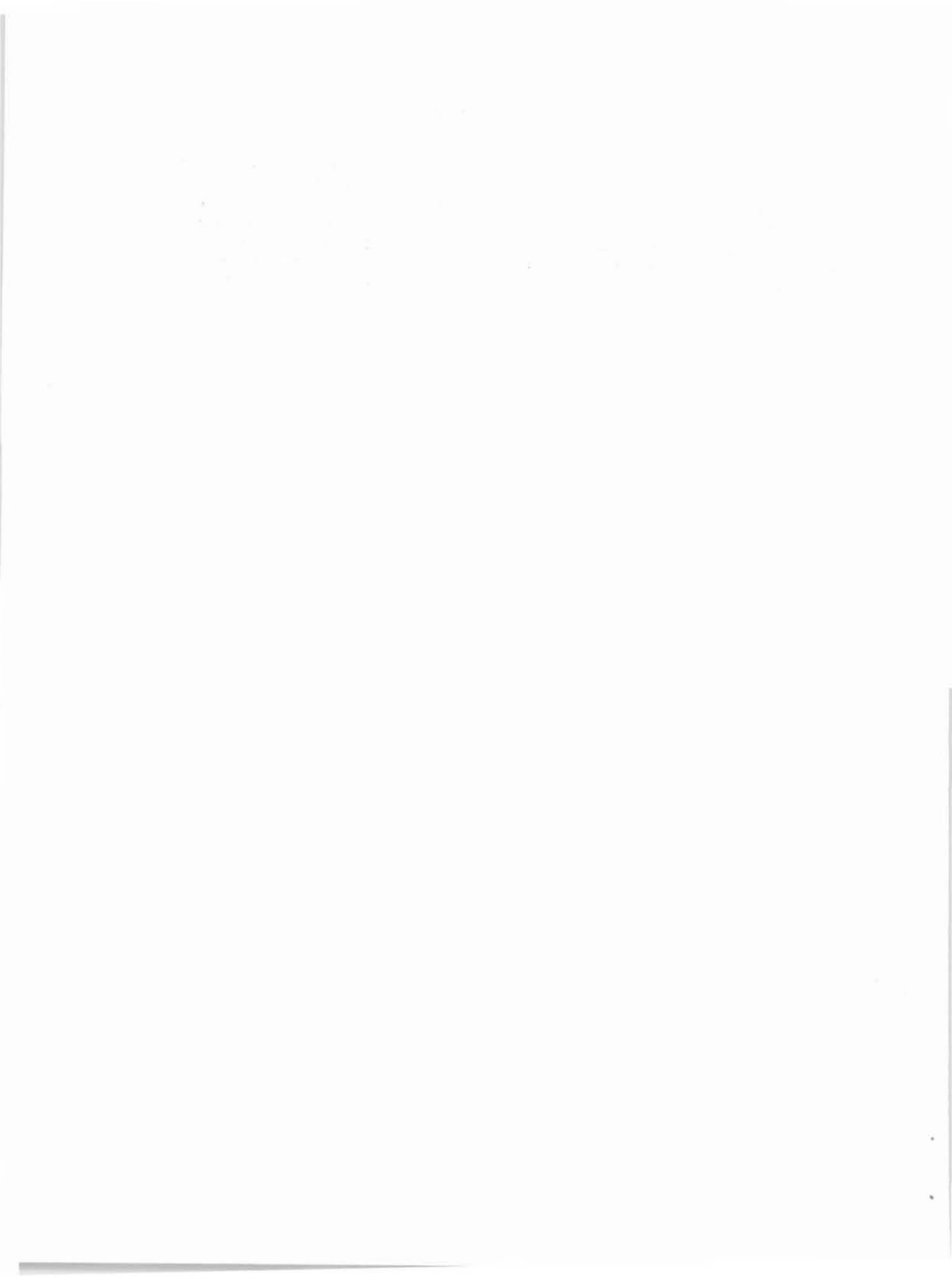
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FOREWORD

Part 5 of the 1986 Annual Report to the Department of Energy's Assistant Secretary for Environment, Safety and Health presents Pacific Northwest Laboratory's progress on work performed for the Office of Nuclear Safety, the Office of Operational Safety, and for the Office of Environmental Analysis. For each project, as identified by the Field Task Proposal/Agreement, articles describe progress made during fiscal year 1986. Authors of these articles represent a broad spectrum of capabilities derived from three of the seven research departments of the Laboratory, reflecting the interdisciplinary nature of the work.



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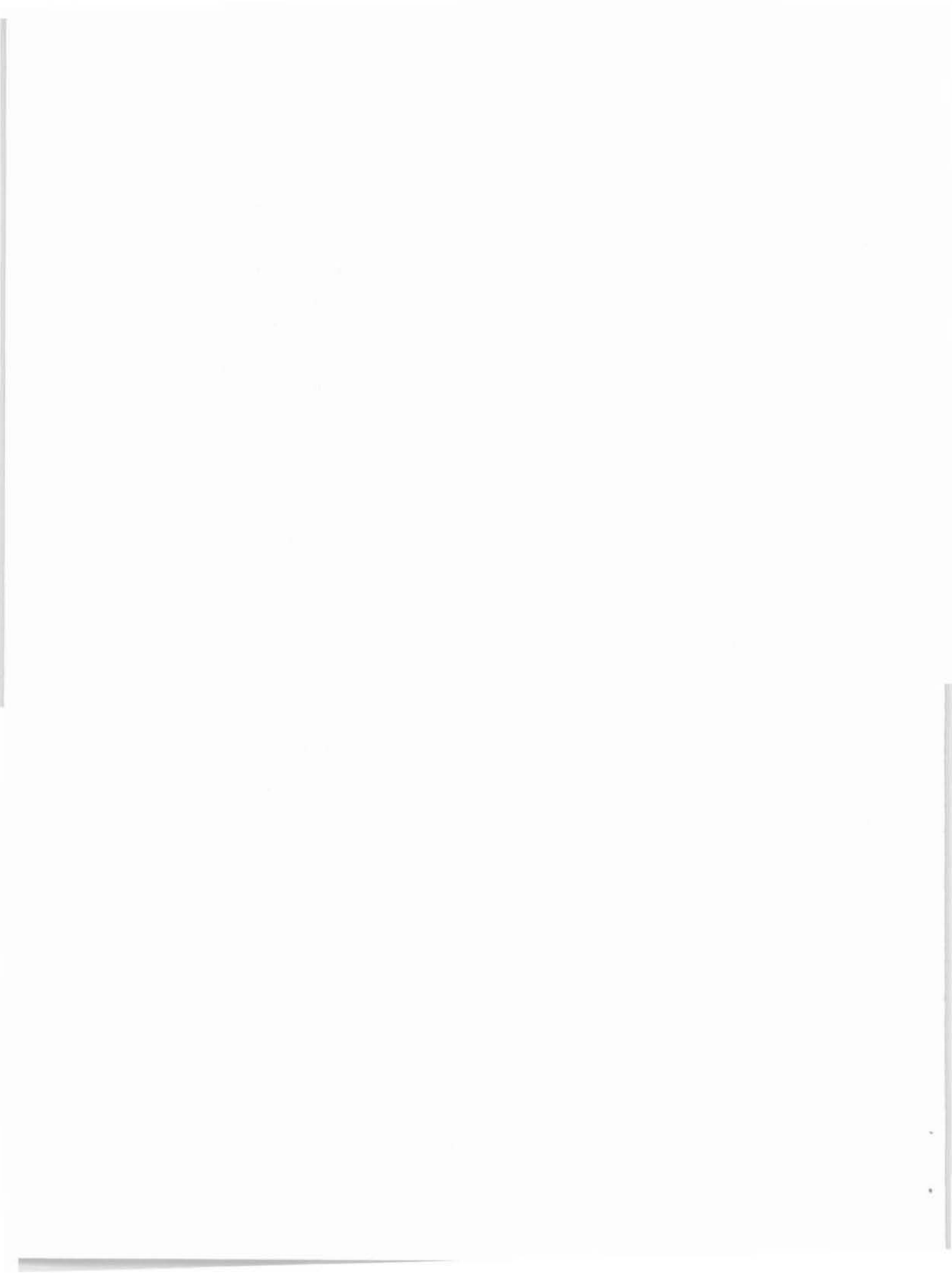
Nuclear
Safety

NUCLEAR SAFETY

To establish and maintain an effective nuclear safety program, the Department of Energy (DOE) has assigned to the Office of Nuclear Safety (ONS) responsibility for developing and promulgating nuclear safety policy, standards, and guidance and for DOE-wide independent overview, support, and counsel in nuclear safety. The objective of the Nuclear Safety Program is to ensure that the activities of the DOE and its contractors are in full compliance with applicable nuclear safety, health, and emergency preparedness standards and regulations, and to provide technical support to the DOE Assistant Secretary for Environment, Safety and Health. To accomplish this, ONS has established Pacific Northwest Laboratory (PNL) as a lead lab in health physics and established the following five projects to assist the ONS in its mission.

- **Personnel Neutron Dosimeter Evaluation and Upgrade**
- **Beta Measurement Evaluation and Upgrade**
- **Health Physics Support and Assistance to the Department of Energy**
- **Technical Guidelines for Radiological Calibrations**
- **Department of Energy Laboratory Accreditation Program for Occupational Radiation Exposure Measurements**

The major emphasis at PNL continues to be the development of criteria, instruments, and methods to ensure that radiation exposure to occupational personnel and to people in the environs of nuclear facilities is maintained as low as reasonably achievable. Particular emphasis has been placed on improving basic personnel radiation exposure measurement and recording programs. Collectively, the above five projects make up the Health Physics Outlay Program.



• Personnel Neutron Dosimeter Evaluation and Upgrade Program

A program was initiated during fiscal year (FY) 1981 with Pacific Northwest Laboratory (PNL) as the lead laboratory to: 1) evaluate response characteristics of personnel neutron dosimeter systems in current use at Department of Energy (DOE) laboratories; 2) develop improved neutron detection techniques for use as personnel neutron dosimeters and/or portable instruments; 3) provide technical coordination of work being conducted by various laboratories, universities, and private companies; 4) maintain program quality and timeliness; and 5) provide leadership in the overall neutron dosimetry field.

PERSONNEL NEUTRON DOSIMETER EVALUATION AND UPGRADE PROGRAM

L. G. Faust, D. E. Hadlock, L. W. Brackenbush, M. A. Parkhurst, R. I. Scherpelz, F. M. Cummings, G. W. R. Endres, W. D. Reece, P. L. Roberson, T. J. Whitaker, J. C. McDonald, J. E. Tanner, and S. D. Miller

This program is a continuing effort to resolve problems of assessing personnel neutron dose at DOE facilities. It is intended that the program focus on the significant problems affecting the field determination of personnel neutron dose and compliance with applicable DOE Orders and regulations. Problem areas in personnel neutron dosimetry are to be identified and, where appropriate, improved dosimetry techniques are to be recommended for implementation.

Progress to date includes an assessment of the current status of personnel neutron dosimeter systems at DOE facilities, recommended methods for calibrating personnel neutron dosimeters, and continued development of concepts that provide the "leading edge" for improving personnel neutron dosimetry.

Studies are being conducted at PNL and several supporting DOE laboratories, some universities, and private companies to focus the capabilities of the most appropriate organizations on the neutron dosimetry problems being encountered. A continuing implementation phase has been identified for FY 1986 through FY 1989 to pursue the tasks of this program, which will enhance personnel neutron dosimetry at DOE facilities and provide the opportunity for transfer of program accomplishments to DOE facilities, as well as to manufacturers of commercially available dosimeters and/or instruments. Program

accomplishments are publicized and commercial vendors are encouraged to participate through technology transfers that could lead to commercialization of dosimeters and/or instruments.

Neutron dosimetry studies being conducted for DOE have been coordinated through this program by designating PNL as the lead laboratory. Pacific Northwest Laboratory is responsible for providing: 1) research and development capabilities; 2) technical coordination of work being conducted by laboratories, universities, and private companies; 3) financial administration of the program, including subcontracting; 4) establishment of task objectives and milestones; and 5) maintenance of program quality and timeliness.

During FY 1986, PNL and its subcontractors conducted neutron dosimetry research and development or other activities in nine principal areas: 1) prototype evaluation; 2) field measurements; 3) combination thermoluminescent dosimeter/track etch dosimeter (TLD/TED) development and implementation; 4) development of a device for total dose (photon and neutron) measurement; 5) neutron depth dose characterization; 6) development of a manual of radiation protection practices at accelerators; 7) development of a systematic method for the assay of induced radioactivity at accelerators; 8) technology transfer; and 9) proof of feasibility studies. This last area consisted of research into 1) laser-induced fluorescence readout, 2) optical luminescence readout, 3) $1/\nu$ detectors, and 4) semiconductor detectors.

Prototype dosimeters and instruments are being developed from proof-of-principle concepts and are being evaluated to determine their potential for improving the existing capability.

Field measurements of neutron dose and spectra are being conducted in DOE laboratories, Department of Defense (DOD) facilities, and commercial power reactors. This information, along with the measured responses of new devices, will allow for the determination of the accuracy of field neutron measurements, and the information will be published as it becomes available.

Technology transfer of an improved neutron dosimeter (which uses TLDs in combination with TEDs) was completed this year. The

dosimeter system provides DOE with an improved minimum dose sensitivity and an expanded useful energy range that did not exist with previous dosimeter systems. This combination TLD/TED system is shown in Figure 1. The track etch material developed by the program and used in the system is "dosimetry grade" CR-39 (Columbia Resin-39).

The combination TLD/TED task was accomplished by the University of California at Berkeley, the University of Connecticut at Storrs, Lawrence Livermore National Laboratory, Los

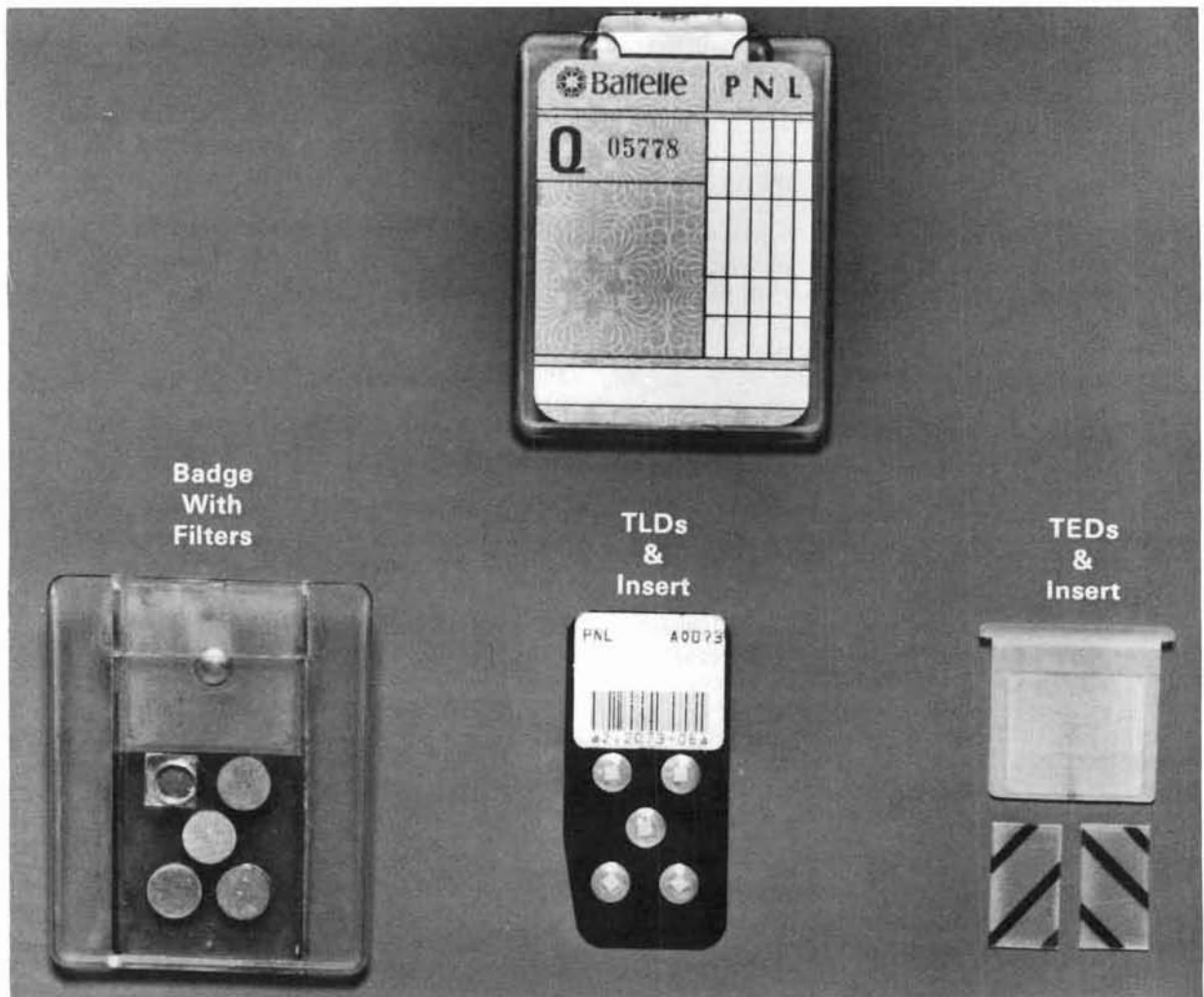


FIGURE 1. Combination TLD/TED.

Alamos National Laboratory, and PNL working together to: 1) produce a chemical processing system that can handle large numbers of TEDs during any one processing period; 2) improve the manufacturing process to make "dosimetry grade" CR-39; 3) evaluate the long-term properties (e.g., fading, change in sensitivity, etc.) of the dosimetry grade CR-39; 4) develop improved CR-39 monomers, CR-39 copolymers, and self-developing track etch polymers; and 5) develop new, improved processing and readout technologies for track etch polymers.

Technology transfer of a pocket-sized total dose meter (which uses a tissue-equivalent proportional counter [TEPC]) was completed this year. This device provides DOE with a small "active" dosimeter that did not previously exist. The system is capable of making simultaneous neutron- and gamma-dose measurements with a single cylindrical TEPC. Using algorithms programmed into an internal microprocessor, quality factors and dose equivalent for the radiation environment encountered are determined. The total dose meter is a product of improvements made by PNL in state-of-the-art electronic circuits and EG&G/Santa Barbara to develop more sensitive TEPC detectors. The device is shown in Figure 2.

Neutron depth-dose profiles inside tissue-equivalent phantoms have been measured by PNL for both monoenergetic and continuous neutron energy spectra. These measurements have been conducted using TLDs, TEDs, and small TEPCs implanted at various locations within the phantoms. Improved flux-to-dose conversion factors have resulted by using the measured profiles of neutron flux, dose, and dose equivalent. With this revised data base, DOE will be able to provide an improved neutron measurement system for use in its personnel protection program.

The DOE Neutron Program supported Argonne National Laboratory staff in developing a systematic methodology for the assay of induced radioactivity in various materials and equipment used in and around accelerators and designated for disposal or reuse. In addition, Stanford Linear Accelerator staff developed a manual of good practices to upgrade and standardize the level of performance of health physics programs at DOE accelerator facilities.



FIGURE 2. Total Dose Meter.

Other selected concepts potentially capable of state-of-the-art improvements in personnel neutron dosimetry were also investigated during the year as proof of feasibility studies.

- Staff from PNL completed a series of preliminary studies for a dosimeter readout system. The system is designed to measure the number of atoms released from a solid matrix material by neutron collision events that correlate with neutron dose. The xenon atoms released, during the period of exposure to neutrons, would be counted using a laser-induced fluorescent technique.
- Some solid-state dosimetry systems, such as TLDs, currently require readout techniques that may be destructive to the dosimeter detecting element. A PNL approach

to this problem has been to use a reader that optically interrogates the dosimeters with monochromatic light sources using an optical luminescence technique. This reader technology is nondestructive and has the potential of providing additional dose information to DOE that currently is not available.

- A prototype survey instrument is being developed from proof of principles by PNL staff. It is designed using $1/v$ detectors and absorbers and is compact in size. The components of the detector are shown in Figure 3. Initial studies indicate that it has an improved energy response for intermediate energy neutrons over that of currently available instrumentation.
- The Tri-Cities University Center staff conducted studies to prove the feasibility of using the change in electrical and magnetic properties of a semi-conductor when irradiated by neutrons to produce both

active and passive dosimeters. A prototype has been produced that can compete with more conventional types of semi-conductor detectors but is much less expensive.

Major accomplishments to date by PNL through this program have been: 1) recommendations for personnel neutron dosimeter calibration procedures; 2) measurement of response characteristics of current personnel neutron dosimeters; 3) development of a combination TLD/TED; and 4) development of a total dose meter using TEPC technology.

Future accomplishments are expected to include: 1) evaluation of new neutron dosimeter prototypes, implementation of new dosimetry systems and programs; 2) field measurements of dose equivalent and spectra at DOE facilities; 3) evaluation of impacts on neutron exposure from new technologies; and 4) technology transfer to commercial vendors.

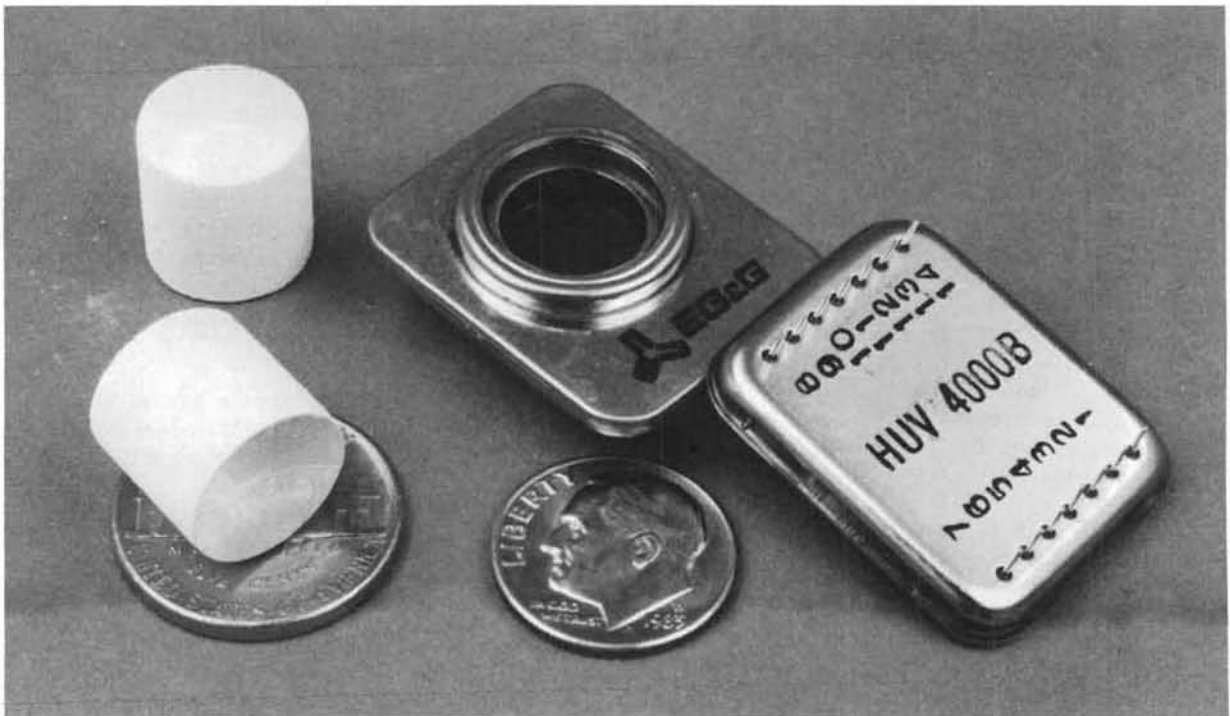


FIGURE 3. $1/v$ Detector.

• Beta Measurement Evaluation and Upgrade Program

This program focuses on the resolution of problems associated with the field measurement of the beta dose component at Department of Energy (DOE) facilities. The change in DOE programs, including increased efforts in improved waste management and decontamination and decommissioning (D&D) of facilities, coupled with beta measurement problems identified at Three Mile Island have increased the need to improve beta measurements. In fiscal year (FY) 1982, work was initiated to provide a continuing effort to identify problems associated with beta dose assessment at DOE facilities. The problems identified resulted in the development of this program. The investigation includes: 1) an assessment of measurement systems now in use; 2) field measurements at DOE facilities; 3) the development of improved calibration and evaluation procedures; 4) the application of innovative beta dosimetry concepts; 5) the investigation of new instruments or concepts for monitoring and spectroscopy; and 6) the preparation of a "manual of good practices" to ensure an adequate and uniform beta measurement program at DOE facilities.

BETA MEASUREMENT EVALUATION AND UPGRADE PROGRAM

K. L. Swinth, L. A. Rathbun, P. L. Roberson,
D. R. Sisk, S. E. Merwin, and
L. W. Brackenbush

The Beta Measurement Evaluation and Upgrade Program is designed to provide a continuing identification and resolution of significant problems that affect field measurement of beta dose and to ensure that DOE facilities can comply with applicable standards. The objective of this program is to investigate and upgrade beta radiation measurements through development of improved personnel beta dosimeters and instruments for use in DOE facilities.

The work performed in FY 1986 can be classified into eight major areas: 1) current practices, 2) field measurements, 3) dosimeter development, 4) instrument development, 5) beta calibrations, 6) manual of good practices, 7) theoretical considerations, and 8) beta workshop and technology transfer. Milestones have been met on all of the sub-tasks in the above areas, which include efforts by subcontractors (universities, private companies, and DOE laboratories) in addition to efforts by PNL staff. Except for delays caused by late deliveries from suppliers, most tasks are on or ahead of schedule.

Current Practices

The purpose of this task is to evaluate the current status of beta detection and beta

dosimetry programs at DOE-contractor facilities and to identify specific areas where these programs might be upgraded. The report on beta measurement practices was reorganized, reviewed internally, and additional information was added prior to its submittal to the sponsor for approval. The report has received approval and is ready for publication.

Field Measurements

The purpose of this task is to characterize typical beta radiation fields at various DOE facilities. This will provide essential firsthand knowledge of the beta fields and measurement techniques presently employed. The draft report on the field measurements has been reviewed and comments are being incorporated.

A subcontract with Kansas State University (KSU) led to development of a proportional counter-scintillation counter-coincidence system that provides excellent discrimination against photons in a mixed beta-gamma field. A paper describing the system and results was presented at the Annual Meeting of the Health Physics Society (HPS) in Pittsburgh.

A summary of the results from the first two tasks was published in Radiation Protection Dosimetry (Swinth, Rathbun, and Brackenbush 1986).

Beta Dosimeter Development

The objective of this task is to identify and develop new and innovative beta dosimeters for the assessment of beta dose and for the

estimation of beta spectra. Laboratory evaluation of the KSU thin, graphite-backed thermoluminescent dosimeter (TLD) is complete; the data has been analyzed, and a report is in draft form. Twenty-three of the chips have been incorporated into a commercial holder for field evaluation. Initially, the vendor improperly placed chips in the commercial holders, which had to be remounted prior to chip sensitivity studies and testing. This delayed this phase of the TLD evaluation and only beta and x-ray (energy) studies were completed in FY 1986.

The new laser TLD reader was received and the computer interface was developed for the prototype system. Since the system was delivered late, the milestone "New Laser TLD System Operating, June 1986" was delayed to mid-August. The system is now operating and it permits the positioning of up to 12 chips for readout under computer control. Software on the computer also permits the display of the glow curve and integration of the area under the curve.

A monopoint Geiger counting system for the registration of thermally or optically stimulated exoelectrons (TSEE and OSEE) was received and assembled. Two prototype BeO thin-film dosimeters were obtained from Europe and were used to evaluate the capabilities of the counting system. A computer-controlled linear heating system was also developed and basic radiation response characteristics of the prototypes were investigated using the TSEE mode. Results indicated that the dosimeters exhibited a linear response over the range of 0.3 to 200 mrad. The upper bound existed due to the high resolving time of the counting system selected for the preliminary evaluations.

Fifty dosimeters were received from Battelle-Frankfurt in July and were extensively analyzed using the OSEE mode. The dosimeters were much less sensitive in the OSEE mode relative to the TSEE readout mode with a ratio of $OSEE/TSEE = 0.01$. The lower level of detection was about 10 mrad and the response was linear to 10 rad. Since initial optical stimulation does not significantly affect subsequent TSEE measurement, the effective range using this counting system is approximately 0.3 mrad to 10 rad. Simple improvements to the counting system could appreciably expand this range.

The dosimeters were irradiated using gamma and beta sources of various energies. The results indicated that the dosimeters have excellent energy response characteristics. The response variation over a wide range of beta and gamma energies is less than 30%, a result that demonstrates the superior energy response of exoelectron dosimeters.

Fading studies indicated that the dosimeters do not fade in a high-humidity environment, but do fade when exposed to high temperatures (50% fading at 150°F for 72 hours) and fluorescent light (100% fading after short, direct exposure to a fluorescent bulb). These fading results are similar to results with TLDs and agree with studies by other investigators. Our studies indicate that the dosimeters exhibit 20% fading after two weeks in an office environment even though they were shielded from light. Further studies are planned to determine if the dosimeters fade further and if the problem can be overcome by post-annealing or some other means.

Studies performed over the past year indicate that the dosimeters' precision is acceptable (~3% TSEE, ~7% OSEE) and that the two independent modes of stimulation can be used cooperatively. However, since electrons are emitted, rather than photons as from TLD chips, problems with linearity at high dose rate must be overcome before exoelectron dosimeters can be used routinely as personnel dosimeters. Government-sponsored development of these dosimeters in several foreign countries is indicative of the advantages of thin-film dosimeters over conventional TLDs.

Tests were also performed on optically stimulated readout of TLDs. Both optical annealing and readout were demonstrated to have advantages over a thermal readout method that requires heating of the material. This could be important since several promising beta dosimetry concepts have used powders in a binder or plastic, which will not withstand repeated reheating and annealing at high temperatures. The work to date is described in the paper, "Optical Readout Method for Solid-State Dosimeters," presented at the Eighth International Conference on Solid State Dosimetry in Oxford, England (McDonald, Eichner, and Stahl 1986). Due to general interest in this technique the neutron dosimetry program has begun to share in sponsoring the research.

Beta Instrument Development

This task encourages the development of instrumentation for beta measurements based on new and innovative ideas. The instruments must provide a correct determination of the penetrating and nonpenetrating field.

An experimental scheme to determine the response of beta measurement instruments to an array of point sources has been developed. The system collects data from 3721 points over a 30-cm x 30-cm matrix from which the response to various source geometries can be reconstructed. Data have been collected with Co-57, Cs-137, Sr-90/Y-90, and Tl-204 sources and analyzed for line, disk, and square geometries. Significant differences were observed between the beta and gamma sources, which are probably due to differences in backscatter. Comparison with large-area sources calibrated with an extrapolation chamber showed reasonable agreement. The data were presented in a paper at the Annual Meeting of the HPS in Pittsburgh. Studies are continuing that are aimed at developing a better understanding of the response of survey instruments when used close to a source.

A report on the geometry dependence study including recommendations is in preparation. Correction factors ranging from 12.1 to 33.7 have been obtained at 0.5 cm from a 0.5-cm-dia beta source. The size of the correction factor varies with the source energy and with the type of detector used in the measurements. The correction factors are larger for high energies (Sr-90/Y-90) and for deep ionization chambers. Extrapolation of the data to zero distance (contact) indicates correction factors as high as 150 to 500 may be required to correctly interpret the dose rate from readings on an ionization chamber.

Investigations of a phoswich system for discrimination against photons in a mixed beta-gamma field and for the development of a thin, tissue-equivalent survey meter for beta measurement are ongoing. Difficulties in obtaining the required scintillators from the manufacturer have been identified and appropriate corrective actions have been initiated.

Beta Calibrations

The purpose of this task is to develop and maintain calibration capabilities unique to the beta measurement project. This was one of the areas of deficiency identified at the Beta Workshop in January.

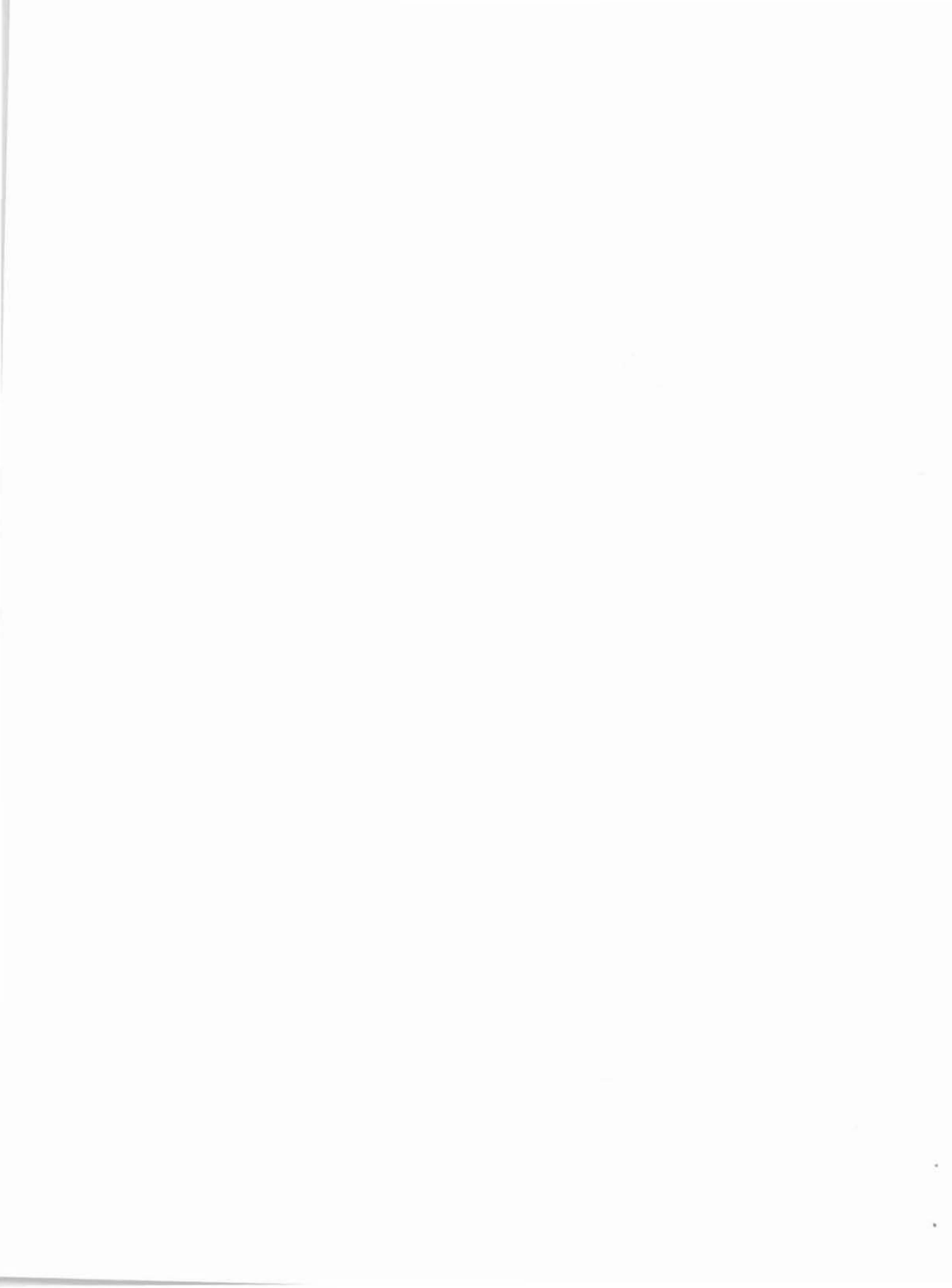
The monoenergetic electron Van de Graaff source is operational. Preliminary tests indicated contamination of the beam by what was thought to be stray electrons. Tests indicated that the contamination was caused by bremsstrahlung, which was initially thought to be due to interaction of the electrons with the exit window. Replacement of the metal window with plastic did not significantly lower the contamination. It is believed that the radiation arises from the large number of electrons discarded during focusing of the beam. Selected shielding of specific areas will be attempted early in FY 1987.

Manual of Good Practices

An incomplete draft of a manual of good health physics practices for a facility handling or processing beta emitting materials has been prepared. The purpose of this manual is to provide written guidance defining "good practices" for radiation protection at facilities where significant beta exposures may occur. When complete, the document will provide information on the design and operation of such facilities.

REFERENCES

- McDonald, J. C., F. N. Eichner, and K. A. Stahl. 1986. "Optical Readout Method for Solid State Dosimeters." Paper presented at the Eighth International Conference on Solid State Dosimetry, August 26, 1986, Oxford, UK.
- Swinth, K. L., L. A. Rathbun, and L. W. Brackenbush. 1986. "Beta Fields and Measurement Practices at DOE Facilities." Radiation Protection Dosimetry 14(2):105-108.



• Health Physics Support and Assistance to the Department of Energy

Pacific Northwest Laboratory (PNL) functions as the lead laboratory providing health physics support and assistance to the Health Physics Branch of the Office of Nuclear Safety. Support and assistance are provided for specific tasks or special studies identified by the Department of Energy (DOE) as high priorities. The designation of lead laboratory in health physics, with an agreement and budget in place, provides the Branch with the additional expertise necessary to respond to the many questions and situations that arise during the operation of its numerous nuclear energy research, development, and demonstration facilities.

HEALTH PHYSICS SUPPORT AND ASSISTANCE

J. M. Selby and J. B. Martin

The Health Physics Support and Assistance project provides the DOE ONS with technical support to assist ONS in accomplishing its occupational safety and health objectives. Several ongoing tasks, as well as quick-response, ad hoc tasks, are funded within this project to provide a flexible response to DOE management priorities as they evolve. Tasks addressed during fiscal year (FY) 1986 are discussed in the following subsections.

INTERNAL DOSIMETRY EVALUATION AND UPGRADE

D. R. Fisher, K. R. Heid, and R. J. Traub

Internal dosimetry is the assessment of radiation doses to organs and tissues from internally deposited radioactive materials. It involves evaluating the intake of radioactive materials, their redistribution in body fluids, tissues, and organs, and their rate of excretion. It also involves measurement of radionuclides in the body by external counting. Internal dosimetry is a difficult and complicated science.

The purpose of this research program is to improve the performance of internal dosimetry at DOE and DOE-contractor facilities. Its objectives are 1) to evaluate current problems and deficiencies in dose-assessment practices, 2) to develop better analytical techniques for radiation measurements and calculational procedures, and 3) to recommend improved methods for calculating internal doses for protection of workers and for determining compliance with radiation protection standards. The program is a multilaboratory research effort.

An ad hoc Internal Dosimetry Advisory Group, consisting of internationally recognized experts, was appointed to prioritize the tasks needed to perform this work, and to provide guidance to DOE with regard to compliance with revised DOE Orders 5480.1A (DOE-RL 1981) and 5484.1 (DOE 1981). Pacific Northwest Laboratory solicited research proposals from national laboratories, universities, and private industry. More than 30 proposals were received and evaluated. Subcontracts were awarded to the highest-rated proposals, including:

- development of resonantly enhanced collisional ionization (RECI) measurement techniques (PNL)
- improvement of low-energy in vivo counting statistics (PNL)
- in vivo phantom development using a human skeleton containing Am-241 (PNL and New York University [NYU])
- updating of Reference Man biological and metabolic data (Oak Ridge National Laboratory [ORNL])
- review the chemical and radiotoxicity of uranium (ORNL)
- improvement of the detection of strontium and neptunium in man (Oak Ridge Associated Universities [ORAU])
- improvement of capabilities for detection of plutonium in the lung (Lawrence Livermore National Laboratory [LLNL])
- reevaluation of the Langham data for plutonium excretion (Los Alamos National Laboratory [LANL]).

Among the more significant accomplishments of the program during FY 1986 was a demonstration of the laser-based RECI analytical technique for ultra low-level element detection. Further work is in progress to apply the technique to measurement of radionuclides of importance to DOE operations. A successful Workshop on Internal Dosimetry and Bioassay was also held in Albuquerque, New Mexico, January 20-22, 1986.

REFERENCES

U.S. Department of Energy-Richland Operations (DOE-RL). 1981. Environmental Protection, Safety, and Health Program for DOE Operations. RL-5480.1A, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

U.S. Department of Energy (DOE). 1981. Environmental Protection, Safety, and Health Protection Information Reporting Requirements. DOE-5484.1, U.S. Department of Energy, Washington, D.C.

TECHNICAL EVALUATION OF DRAFT ANSI STANDARD N13.30, PERFORMANCE CRITERIA FOR RADIOBIOASSAY

J. A. MacLellan and R. J. Traub

The purpose of this task was to evaluate the adequacy of draft ANSI Standard N13.30, "Performance Criteria for Radiobioassay," by conducting a nationwide bioassay intercomparison test. The study involved two rounds of performance testing of laboratories involved in both in vitro (excreta analysis) and/or in vivo (external counting) measurements. The performance of bioassay laboratories was judged against criteria specified in the draft standard for bias, precision, and minimum detectable activity.

The results of these tests were reported at three conferences during FY 1986; the bioassay testing program at the 31st Annual Conference on Bioassay, Analytical and Environmental Chemistry held at Chalk River, Ontario; the Bioassay and Internal Dosimetry Workshop held in Albuquerque; and the Annual Meeting of the Health Physics Society (HPS) held in Pittsburgh.

AIR SAMPLING AND MONITORING UPGRADE

J. L. Kenoyer, K. L. Swinth, J. Mishima, T. P. Lynch, K. M. Poad, and E. E. Hickey

This task is designed to identify and resolve problems associated with work environment air sampling and monitoring as performed as part of routine surveillance programs for airborne radioactivity in work locations.

Work is continuing on the proceedings from the First Annual DOE Workshop on Workplace Aerosol Monitoring. Comments were received from the sponsor and incorporated into the proceedings. Final review by the sponsor, PNL peer review, and publication should occur during the first quarter of FY 1987.

A number of subtasks were initiated and performed under the evaluation of the prototype units task during the third quarter. These included establishment of the proper operation and evaluation procedures for the aerosol exposure chamber, the vibrating orifice aerosol generator, and the aerodynamic particle size analyzer. These tasks are scheduled to be completed in the first quarter of FY 1987.

During the fourth quarter of 1986, a draft document providing guidance on the placement of workplace air samplers was completed and sent to the sponsor for review. This document will be finalized in FY 1987. Some of the major aspects of the general guidance are 1) before selecting the location of sampling points, a well-documented characterization of the ventilation patterns and characteristics of the anticipated airborne particulates should be performed; 2) for existing facilities, part of the preplacement characterization should be development of a data base of the sources, conditions, and behavior of the known airborne releases of materials within the workplace; 3) samples should be extracted between the source and the personnel affected when possible (alternate placement is possible providing the placement provides better overall coverage); 4) samples should be extracted and transported to the detector in keeping with established practices; and 5) increase the current alpha instrument sensitivity of 8 MPC-h to a sensitivity of 1 MPC-h exposure of personnel if

possible and achievable by increasing the volumetric sampling rate.

The second prototype of the WOTAMS (Workplace Transuranic Aerosol Measurement System) air monitor has been constructed by LLNL personnel and is undergoing final testing. The unit will be sent to PNL for evaluation during the second quarter of FY 1987.

EXTREMITY DOSE MEASUREMENTS EVALUATION AND UPGRADE

W. D. Reece, R. Harty, and P. L. Roberson

The objective of this task is to provide guidance on the needs and problems associated with extremity dosimetry. The results to date are contained in the report titled Determination of Photo Conversion Factors Relating Exposure and Dose for Several Extremity Phantoms Designs (PNL-5660) by P. L. Roberson, F. N. Eichner, and W. D. Reece (Roberson, Eichner, and Reece 1986). A presentation with the same title was given at the Annual Meeting of the HPS in Pittsburgh. The report titled Extremity Dosimetry at U.S. Department of Energy Facilities (PNL-5831) by R. Harty, W. D. Reece, and J. A. MacLellan was also published (Harty, Reece, and MacLellan 1986).

REFERENCES

Harty, R., W. D. Reece, and J. A. MacLellan. 1986. Extremity Dosimetry at U.S. Department of Energy Facilities. PNL-5831, Pacific Northwest Laboratory, Richland, Washington.

Roberson, P. L., F. N. Eichner, and W. D. Reece. 1986. Determination of Photo Conversion Factors Relating Exposure and Dose for Several Extremity Phantoms Designs. PNL-5660, Pacific Northwest Laboratory, Richland, Washington.

TECHNICAL EVALUATION OF THE CAPABILITY OF PRESENT INSTRUMENTATION TO MEET THE DRAFT STANDARD (N42.17) ON PERFORMANCE SPECIFICATIONS FOR RADIATION PROTECTION SURVEY INSTRUMENTATION

J. L. Kenoyer, K. L. Swinth, G. A. Stoetzel, P. L. Roberson, M. R. Tinker, and E. E. Hickey

During FY 1986, work was performed on the evaluation of commercially available instruments against requirements in draft ANSI Standards N42.17A, B, and C, "Performance Specifications for Health Physics Instrumentation." The evaluation of draft ANSI N42.17A is essentially complete and loaned instruments have been sent back to the vendors.

The draft of ANSI N42.17A was revised to address objections and concerns of the ANSI N42.1 Committee and was reissued. Draft ANSI N42.17B is being updated to incorporate comments from the ANSI working group meeting held in February. Draft testing procedures for both draft ANSI N42.17B and C are being rewritten based on the requirements and methods discussed in the revised standards.

Extreme range testing of ANSI N42.17C continues to be revised. Testing to date has been performed in accordance with the draft standard in effect at the time of testing with discrepancies between the tests performed and the current draft standard noted. In some cases, the testing used procedures expanded from normal range testing if the draft standard provided no guidance.

The results from instrument testing have been presented at three meetings and formed the basis for an invited presentation at a short course. Presentations were made at an internal seminar and a joint meeting of the Cascade and Columbia Chapters of the HPS in collaboration with Ian Thompson from the

Central Electricity Generation Board in England. Two papers based on the testing were presented at the Annual Meeting of the HPS and a short course on instrument performance was presented at Harvard University. Experience developed on instrument testing was used to assist LANL in the testing of alpha survey meters.

SPECIAL STUDIES

Quality Factor

L. G. Faust

The final report of the DOE Ad Hoc Committee - Neutron Quality Factor was submitted to Mary Walker on June 5. It is being reviewed by a special committee of the Committee on Interagency Radiation Research and Policy Coordination (CIRRPC) and, partially dependent on that committee's review, the recommendations contained in the report may be accepted and put into place by DOE.

A CIRRPC-sponsored meeting on the neutron quality factor (Q) was held October 16, 1986, which provided members of two science sub-panels of CIRRPC the benefit of discussions by scientists knowledgeable of the scientific basis for establishing the "Q" value for neutrons. The meeting is expected to assist CIRRPC in developing a consensus federal position on this issue.

Nonequilibrium Dose Effects from Gamma Skin Contamination

W. D. Reece

Computer calculations to determine the dose to skin from contamination with Co-60 have been completed and a report of the results has been prepared. Our calculations showed that doses to the basal layer from gamma rays are overestimated by as much as a factor of 30 for point sources of Co-60 and about a factor of 3 for small disk sources of Co-60, if normal dose calculations assuming electronic equilibrium are used. Practical methods for the calculation of dose arising from nonequilibrium gamma rays were identified. This information will be important for future actions to be taken in extremity dosimetry programs.

Impact of ICRU Report 39 Concepts on DOE Operations

W. D. Reece

A draft report titled "Impact of ICRU Report 39 Concepts on DOE Operations" was completed. Little was found in the International Commission on Radiological Units and Measurements (ICRU) report that would advance the theory of dosimetry or would help radiation worker protection. Specifically, relating effective dose equivalent (as recommended by the International Commission on Radiological Protection [ICRP] in Publication 26) (ICRP 1977) to doses in an ICRU tissue-equivalent sphere seems to be a definite step backwards. The use of a spherical phantom is no better than the use of a slab phantom, and the use of the sphere presents many practical problems. While it is encouraging to have routine dosimetry practices officially sanctioned, the adherence to the ICRU sphere as an appropriate phantom and the continued use of dose index quantities negate most of the constructive parts of the report.

2nd International Workshop on Lung Dosimetry

D. R. Fisher

The 2nd International Workshop on Lung Dosimetry was held September 2-6, 1985, in Cambridge, England, in conjunction with the 6th International Symposium on Inhaled Particles. The Workshop, which was co-sponsored by DOE, Office of Nuclear Safety (ONS), focused on the assessment of lung dose from inhaled radioactive materials. The workshop proceedings were edited by M. R. Bailey and D. R. Fisher and will be published as the second volume of a two-volume hard-cover supplement to the Annals of Occupational Hygiene (Pergamon Press) titled Inhaled Particles VI.

DOE Annual Radiation Exposure Report

S. E. Merwin and J. B. Martin

The 17th DOE Annual Radiation Exposure Report of 1984 personnel exposures was prepared and submitted to DOE Headquarters (HQ) for review and publication as report DOE/EH-0011.

Lifetime Dose Study

R. J. Traub

The lifetime dose study was initiated to assist the DOE in determining the impact of changes in health physics standards upon DOE operations. The first phase of the study was to analyze the occupational exposure records at Hanford. Dose records were merged with work location records so that comparisons could be made between exposure environments and radiation doses. This was a considerable task since there were about 355,000 external exposure records.

We have found in one group of workers that individuals who have received a single large radiation exposure seem to have a history of generally elevated radiation exposures. We intend to determine whether this is the case at all Hanford facilities. We also noted that the average radiation dose received by radiation workers has decreased over the time interval 1969 to 1984.

Fetal Exposure Study

D. R. Fisher, M. R. Sikov, and J. M. Selby

Contributions were made to a report of the Committee on Radiation Protection and Public Health (CRPPH) of the Nuclear Energy Agency (NEA) titled Consultant Group Report on the Assessment and Control of Dose to the Fetus. A copy of the report outline and the draft were sent to David Sowby at Headquarters, who is coordinating the report production. Substantive editorial changes and additions were made to the first draft of the report. A second draft was completed in July, and further comments on the second draft were sent to Dr. Sowby in September.

Radiation Worker Safety Course

J. A. MacLellan and J. B. Martin

A technical program review of the "Stand-Alone Microcomputer-Based DOE Contractor Generic Radiation Worker Safety Course" being developed by Westinghouse Hanford Company was conducted. A letter report concluded that the course appeared to fulfill the requirements of the proposal in the areas completed, and the balance of the work should be finished on schedule. The course developers

made good use of information gathered on the training needs of DOE contractors and have incorporated the task mastery learning concept into the course software.

Technical Safety Appraisals

J. M. Selby, T. H. Essig, J. B. Martin, L. H. Munson, K. R. Heid, J. J. Fix, and L. G. Faust

Assistance was provided on five technical safety appraisals conducted during FY 1986. In each case contributions were made to draft appraisal reports prepared by the team for DOE-HQ. Recommendations for improvement were made in the areas of radiation protection, emergency preparedness, personnel dosimetry, and safety/security interfaces.

REFERENCE

International Commission on Radiological Protection (ICRP). 1977. Recommendations of the International Commission on Radiological Protection. ICRP Publication 26, Pergamon Press, New York.

STANDARDS EVALUATION

J. M. Selby, J. B. Martin, J. P. Corley, K. R. Heid, K. L. Swinth, J. L. Kenoyer, L. G. Faust, and L. W. Brackenbush

The objective of this task is to provide a timely technical evaluation of national and international occupational radiation exposure recommendations, standards, and regulations to determine their technical accuracy, impact on DOE operations, and compatibility with DOE Orders. As appropriate, technical expertise is drawn from other DOE contractor laboratories to assist in the evaluations.

The national standards efforts have been associated primarily with the development of a new draft of the three instrumentation standards, American National Standards Institute (ANSI) Standards N42.17A, B, and C. A meeting of the ANSI working group members and consultants was held in Richland on February 10-12. ANSI Standards N42.17A, B, and C were reviewed and changes were incorporated. ANSI Standard N42.17A has gone

back to the committee members for final comments before the draft standard is sent to the ANSI N42.1 committee for a vote.

Members of Working Group 2.5 of the Health Physics Society Standards Committee (HPSSC) preparing draft ANSI N13.30, "Performance Criteria for Radiobioassay," met in Los Angeles on June 3-5 to review the draft standard. A draft of the completed standard, including appendices, was submitted to the HPSSC for approval at the annual HPS meeting in Pittsburgh.

Comments were provided on two National Council on Radiation Protection and Measurements reports, one Nuclear Regulatory Commission proposed standard, and 24 others from various organizations, including the International Organization of Standardization, International Electrotechnical Commission, American Society for Testing and Materials, and American Nuclear Society.

MANUALS OF GOOD PRACTICE

J. B. Martin, L. G. Faust, L. H. Munson, K. L. Soldat, and L. W. Brackenbush

Training Manual

The revision and update of the Radiation Safety Technician Training Course (ANL-7291) (ANL 1972) is progressing. A detailed outline was prepared and approved.

Progress in FY 1986 is summarized as follows: about 390 pages of the draft have been completed, representing about 80% of the total effort; sections that need to be completed from the existing text are Section 7 on radiation protection standards, Section 9 on internal dose, Section 12 on health physics instruments, and Section 17 on particle accelerators. In addition, sections on x-ray machines and sealed gamma-ray sources are planned, but the proposed section on environmental surveillance is being dropped. The remaining five sections will be completed by December 1. This schedule allows for typing, corrections, and adding questions and problems.

Plutonium Manual

Efforts on this task during FY 1986 were directed to a much-needed revision of the manual, A Guide to Good Practices at Plutonium Facilities, BNWL-2086, originally published in 1977 (Faust et al. 1977). This manual provides principles and guidelines for use in setting up a sound radiation protection program for work with plutonium, and it was based on the experiences of government contractors and those portions of private industry concerned with the operation of plutonium facilities. The six sections and appendix to the manual were titled, "Properties of Plutonium," "Siting of Plutonium Facilities," "Facility Design," "Radiation Protection," "Emergency Preparedness," "Decontamination, Decommissioning and Dismantling," and "Diagnostic Evaluation of Internal Deposition." Since its publication, existing standards have been revised and upgraded, nine years of additional experience have been accumulated in handling plutonium, and much additional research has been conducted. The revision and upgrading of the guide is necessary to maintain DOE leadership in the application of the as low as reasonably achievable (ALARA) concept in the radiation protection programs of plutonium handling and processing facilities.

The first draft of the revised plutonium manual was completed in September and sent to the DOE/ONS technical review committee for comment. Comments are expected by mid-January 1987. The manual is scheduled for completion in mid-1987.

Tritium Manual

The first draft of a "Manual of Good Practices at DOE Tritium Facilities" was completed in September. The draft is currently being reviewed by the DOE/ONS technical review committee.

The purpose of this document is to provide written guidance that defines the generally accepted "good practices" in use at DOE tritium facilities. In essence, this document presents a compendium of information on the

design and operation of modern tritium facilities. In so doing, it recognizes that radiation safety and environmental control are dependent on facility design, operating procedures, and personnel training. Health physics organizations must be involved in all three of these areas, in addition to their normal role of the independent monitor of radiation exposures and environmental releases.

Uranium Manual

The committee writing the "Manual of Good Practices at DOE Uranium Facilities" met on April 15-16 in Idaho Falls and on June 29 in Pittsburgh to compile the draft manual. The first draft of the manual is about 50% complete with the various chapters ranging from 10 to 75% complete. The draft production is on schedule with a final draft scheduled to be issued April 1, 1987.

The objective of the manual is to provide general guidance and program elements but not be totally comprehensive--particularly in areas such as emergency response and ALARA program design.

REFERENCES

Argonne National Laboratory (ANL). 1972. Radiation Safety Technician Training Course. ANL-7291 Rev. 1, Argonne National Laboratory, Argonne, Illinois.

Faust, L. G., L. W. Brackenbush, L. A. Carter, G. W. R. Endres, and R. D. Glenn. 1977. A Guide to Good Practices at Plutonium Facilities. BNWL-2086, Pacific Northwest Laboratory, Richland, Washington.

• Technical Guidelines for Radiological Calibrations

This program provides technical guidelines for radiological calibration procedures at Department of Energy (DOE) laboratories. This information and guidance will help to optimize equipment and procedures for radiological calibrations. The current tasks include developing a performance data base for radiation protection instruments and preparing guidelines for their calibration. In addition, an inter-comparison program for laboratory calibrations is under way.

TECHNICAL GUIDELINES FOR RADIOLOGICAL CALIBRATIONS

J. C. McDonald, P. L. Roberson, and K. L. Swinth

The objective of this program is to establish guidelines for the calibration of personnel dosimeters and radiation protection instruments. This guidance will help DOE laboratories institute optimum techniques for radiological calibrations in a cost-effective and prompt manner. It will also establish a more uniform approach to dosimetry by helping to reduce site-dependent differences in reported personnel doses that may arise from calibration differences. The accomplishments of the program are:

- The pilot study intercomparison of calibration sources was completed and a report describing the results was prepared. The results demonstrated that photon calibrations were consistent, but neutron calibrations continued to remain difficult to perform. The intercomparison has now been

incorporated as a task of the DOE Laboratory Accreditation Program (DOELAP).

- Measurements of the exposure-to-dose equivalent factors necessary for low-energy x rays were carried out. A report was written documenting the data presently available for these factors. This report points out that there is considerable confusion regarding the specification of beam geometry, phantom shape, and composition. It will be necessary to carry out a self-consistent set of calculations and measurements to verify the factors presently in use for DOELAP irradiations.

Starting in fiscal year 1987, the Technical Guidelines for Radiological Calibrations Program will merge with the DOELAP Research Program. This will make for greater efficiency, since the purpose of the work performed on these programs is parallel. They will continue to provide solutions to the problems that arise in personnel dosimetry calibrations.



• Department of Energy Laboratory Accreditation Program for Occupational Exposure Measurements

This program provides research support for the Department of Energy Laboratory Accreditation Program (DOELAP) for personnel dosimetry services. The research effort encompasses the development of improved accreditation methods and the operation of intercomparison and measurement assurance programs for DOE laboratories. Major accomplishments for fiscal year (FY) 1986 included: 1) and 2) the development of data bases on the performance of thermal neutron dosimeters and the angular responses of representative personnel dosimeters; 3) the operation of a calibration intercomparison program for DOE laboratories; and 4) participation in working committees that are reviewing performance testing data and finalizing the documents required for the implementation of the accreditation process.

DEPARTMENT OF ENERGY LABORATORY ACCREDITATION PROGRAM FOR OCCUPATIONAL EXPOSURE MEASUREMENT

P. L. Roberson, F. M. Cummings, R. A. Fox, and K. L. Jones

A national approach to the quality assurance and accreditation of personnel dosimetry services for DOE laboratories is being implemented through the DOELAP. The DOELAP operated a performance testing laboratory located at the Radiological and Environmental Sciences Laboratory (RESL) in Idaho Falls and a research program located at Pacific Northwest Laboratory (PNL). The research effort encompassed: 1) research into improved accreditation methods; 2) intercomparison of DOE radiological calibration standards using round-robin shipment of transport standards (instruments and sources); and 3) research support for the performance testing laboratory.

The FY 1986 effort included: 1) the development of a performance data base for thermal neutron dosimeters; 2) the development of a data base for angular response of personnel dosimeters; 3) operation of the DOE intercomparison program; 4) participation in the working committees that are reviewing results of the pilot-testing session; and 5) coordination of the editing to finalize the DOELAP documents (the DOELAP Handbook for program participants, the DOE Standard for Performance Testing of Personnel Dosimetry Systems, and the Quality Assurance Manual for the operation of the performance testing laboratory).

Five DOE laboratories participated in the development of the data base for the performance of thermal neutron dosimeters. Irradiations were performed for two thermal neutron source types. Mixture irradiations with fast neutrons and photons were also performed. The data base will be used to develop recommendations for a thermal neutron test category.

The angular response measurements were performed according to the procedures in the DOE Standard. Five DOE laboratory dosimeter designs were used to develop a data base. The study will result in final recommendations for performance criteria and possibly for improvements in the measurement procedures.

The routine operation of the DOE intercomparison program was initiated in January 1986. The objectives of the program are to provide: 1) standard measurement techniques to allow the opportunity to assess and improve the accuracy of radiological calibrations; 2) a data base for recommending potential improvements in calibration techniques; and 3) improved radiological calibrations. An instrument set was sent to requesting laboratories on approximately a monthly cycle and a beta standard source set was sent on a two- to three-month cycle. Five DOE laboratories participated in the instrument portion of the program, with one laboratory using a set twice during the year. Three laboratories participated in the beta-source set part of the program. Results were in good agreement for gamma sources with 70%

of the measurements agreeing within 10%. The average of all measurements was 1.21 with a standard deviation of 0.49. Measurements with the beta-source set were within 15% for the Sr-90/Y-90 sources. However, the results for the one laboratory measuring the low-energy sources were 11% high (Tl-204) and 38% low (Pm-147). Both the accuracy and precision of the measurements with low-energy beta sources are more difficult to attain. Problems encountered in the program were user unfamiliarity with the equipment and equipment malfunction. To address the first problem, the documentation of the procedures was improved, including graphic schematics. Training workshops were also proposed. To address the second problem, additional cabling, adapters, and equipment were included

in the sets to help overcome malfunctions due to rough handling during shipment and due to use by inexperienced personnel at some laboratories.

Research personnel attended committee meetings held to review the results of the pilot-testing session performed at RESL in FY 1985. Modifications made to the DOELAP documents were incorporated, and copies were sent to DOE Headquarters and RESL for editing and publication. Research personnel also presented material at the participants' information meeting in December 1985. Personnel from DOE laboratories were presented with the program performance requirements and the historical evolution of the program. Participant comments were helpful for the implementation of the routine testing program.



**Operational
Safety**

OPERATIONAL SAFETY

The responsibility of the Department of Energy (DOE) Office of Operational Safety (OOS) is to ensure that activities and installations of the DOE and its contractors are in full compliance with DOE environmental protection, safety, and health protection policies and applicable federal, state, and local environmental, safety, and health (ES&H) standards and regulations. The OOS provides technical support to DOE ES&H programs and assurance systems. The OOS also ensures that all DOE-controlled activities are conducted in a manner that will maintain risks to the safety and health of the public and employees at acceptably low levels, and that will provide for adequate protection of property and the environment. Pacific Northwest Laboratory has established the following two projects to assist the OOS in its mission:

- **Environmental Protection, Support, and Assistance**
- **Hazardous Waste Risk Assessment**



• Environmental Protection, Support, and Assistance

The Pacific Northwest Laboratory (PNL) continued to provide technical assistance to the Department of Energy's (DOE's) Office of Environment, Safety and Health (ES&H) through a project with the Office of Environmental Guidance (OEG). Pacific Northwest Laboratory's assistance included: 1) the development of draft technical requirements to support the revised DOE Orders concerning environmental protection; 2) calculation of Derived Concentration Guides (DCGs) for exposure of the public to contaminated air or drinking water; 3) development of tables of dose conversion factors for estimating public radiation exposures; 4) development of a draft document concerning monitoring for compliance with the revised Clean Air Act; 5) application of a previously developed, priority ranking system for identified ES&H upgrade projects; and 6) additional ad hoc efforts concerning technical reviews and comments on draft public radiation exposure standards. Pacific Northwest Laboratory also supported OEG by providing a draft recommended strategy to address updating the DOE public and environmental radiation protection programs.

ENVIRONMENTAL PROTECTION SUPPORT AND ASSISTANCE

W. E. Kennedy, Jr., J. P. Corley, R. D. Stenner, K. A. Hawley, R. A. Peloquin, J. Mishima, D. H. Denham, J. K. Soldat, M. F. Mullen, V. K. Hopkins, C. F. Schauls, and N. C. Van Houten

The Environmental Protection Support and Assistance project provides the DOE's OEG with technical support to assist OEG in accomplishing its public and environmental radiation protection and assurance objectives. Several ongoing tasks, as well as quick-turnaround, ad hoc tasks, are funded concurrently within this project to provide flexibility in response to DOE management priorities as they evolve. Task areas addressed during fiscal year (FY) 1986 are discussed in the following subsections.

Radiological Effluent Monitoring and Environmental Surveillance Manual

R. D. Stenner, J. P. Corley, J. Mishima, W. E. Kennedy, Jr., D. H. Denham, J. K. Soldat, V. K. Hopkins, and C. F. Schauls

Both comment draft and field review draft versions of a manual titled "Requirements for Radiological Effluent Monitoring and Environmental Surveillance" were completed. When finalized, this manual will contain the mandatory requirements for effluent monitoring and environmental surveillance in support of revised DOE Orders on "Radiation Protection of the Public and the Environment." The

manual contains mandatory requirements that: 1) are identified in the current (or draft) DOE Orders on environmental protection, 2) are identified in other established or pending Federal Regulations, and 3) represent sound technical practice. Fifteen PNL technical contributors, in selected areas of expertise, provided the draft material that was used in the preparation of these draft versions of the manual. Additional peer reviews of the comment draft included nine technical reviewers from across the country within the DOE and contractor community. The field review copy was distributed to the DOE Operations and Program Offices and their contractors for further review and comment. Final revisions to the manual are anticipated during FY 1987 before the manual will be published as a DOE document.

Internal Dose Conversion Tables

J. P. Corley, W. E. Kennedy, Jr., and R. A. Peloquin

Revised text and tables for a document titled "Committed Dose Equivalent Tables for U.S. Department of Energy Population Dose Calculations" were completed and sent to the OEG. The tables are intended to support the revised DOE Orders on public radiation protection and were distributed to the DOE Operations and Program Offices for review. The tables are based on the revised recommendations of the International Commission on Radiological Protection (ICRP) as found in its Publications 26 and 30 (ICRP 1977, 1979). The camera-ready version of this

document was completed and it will be published as a DOE report.

Derived Concentration Guides

W. E. Kennedy, Jr., R. A. Peloquin, C. F. Schauls, and N. C. Van Houten

Tables of DCGs, in units of $\mu\text{Ci/mL}$ and Bq/mL , were developed for public exposure to contaminated air or drinking water. These tables were based on the effective dose equivalent factors developed by the ICRP in their Publication 30. The resulting tables were included as an attachment to the revised DOE Orders on radiation protection of the public and the environment. The tables will replace the Concentration Guides (CGs) found in previous DOE Orders.

Criteria for Measuring Airborne Radionuclides

J. P. Corley and J. Mishima

A draft document was prepared titled "Criteria for Systems Used in DOE Facilities to Sample and Measure Airborne Radionuclide Emissions to Comply with 40 CFR 61, Subpart H." The criteria included reflect current technology that is acceptable for monitoring airborne emissions. This draft was distributed to the DOE Operation and Programs Offices for review and comment. Based on the comments provided, a revised version was prepared. After discussions with OEG staff, this version was included as Chapter 4.0 of the DOE manual on effluent monitoring and environmental surveillance requirements, and it was reissued for review and comment.

Priority Ranking System for Environment, Safety and Health Upgrade Projects

M. F. Mullen

A priority ranking system for evaluating identified ES&H deficiencies was developed and modified during past years as part of this project. During FY 1986, this method was applied to the identified facility upgrade projects to be considered in the FY 1988 budget. Additional efforts included the development of an improved software package and the preparation of updated supporting documentation.

Special Assistance

W. E. Kennedy, Jr., J. P. Corley, and R. D. Stenner

Through a special assistance task, PNL further supports the OEG by providing quick-turnaround technical responses or reviews to priority requests from the OEG. These requests typically are in areas that fall outside the scope of the identified tasks but have an urgency to DOE and its operations. During FY 1986, these special assistance activities included: 1) development of comments on the Computerized Radiological Risk Investigation System (CRISS); 2) technical reviews of proposed Environmental Protection Agency (EPA) regulations on low-level radioactive waste disposal and decommissioning criteria; 3) technical reviews and comments on additional draft reports and standards, including the task group report on "Public Radiation Exposure from Nuclear Power Generation in the United States" by Scientific Committee 64 of the National Council on Radiation Protection and Measurements; 4) presentation of papers at the DOE Uranium Health Protection Seminar and Workshop held in Rockville, Maryland; 5) development of an interim criteria for onsite liquid discharges of radioactive materials; 6) development of a draft document concerning radiation tolerance limits for aquatic biota; 7) review of and comment on an EPA statement on reportable quantities for accidental releases of radioactive materials; and 8) consulting support to the International Atomic Energy Agency concerning exempt quantities for recycle of slightly contaminated materials recovered during decommissioning.

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• Hazardous Waste Risk Assessment

Pacific Northwest Laboratory (PNL) continued to provide technical assistance to the Department of Energy (DOE), Office of Environment, Safety and Health (ES&H) in the area of environmental risk assessment for hazardous and radioactive mixed waste management. The overall objective of this work is to provide technical assistance to ES&H in developing risk assessment tools and strategies to assist DOE in developing guidance and assuring compliance with applicable environmental regulations or standards. Major efforts during fiscal year (FY) 1986 included: 1) completion of the initial development efforts for the Remedial Action Priority System (RAPS) for ranking inactive waste sites for further action; 2) initiation of efforts to modify RAPS for use in ranking issues identified by the DOE Environmental Survey for further action; 3) development of user-friendly personal computer software for implementing the Hazard Ranking System/modified Hazard Ranking System; and 4) provision of technical support in commenting on the proposed Environmental Protection Agency (EPA) regulations on Land Disposal Restrictions and the Toxic Characteristic Leaching Procedures.

REMEDIAL ACTION PRIORITY SYSTEM DEVELOPMENT AND TESTING

G. Whelan, D. L. Strenge, J. G. Droppo, and B. L. Steelman

Pacific Northwest Laboratory has completed the initial development of the RAPS, which is an objective, physics-based management tool to assist DOE in ranking its inactive hazardous and radioactive mixed waste sites for further action. Using limited site data (i.e., results of the DOE Comprehensive Environmental Response, Compensation, and Liability Act of 1980 [CERCLA] Phase I effort), RAPS employs empirically, analytically, and semianalytically based mathematical algorithms to predict the potential contaminant migration from inactive waste sites to receptors of concern using pathways analyses. Based upon the results of these pathways analyses, simplified exposure assessments are performed for important receptors, and the risks associated with the sites are calculated relative to other sites for each pathway and for all pathways combined. Toward the end of FY 1986, testing of the RAPS code was initiated using data from actual DOE facilities. Upon completion of the testing, the code will be finalized, an external peer review will be conducted, and documentation of the development efforts will be completed.

DOE ENVIRONMENTAL SURVEY: RANKING IDENTIFIED ISSUES REQUIRING FURTHER ACTION

G. Whelan, K. A. Hawley, D. L. Strenge, J. G. Droppo, E. A. Jacobson, and B. L. Steelman

The DOE Environmental Survey will identify and then prioritize, on a DOE-wide basis, environmental issues requiring further action. Scientifically defensible ranking of the identified issues is an essential part of the Environmental Survey process; therefore, identification/development of an objective and defensible method to assist in the prioritization process is important. An ES&H study of available ranking methods concluded that the RAPS technology, with modifications to allow the system to assess active environmental discharges, is the most objective and scientifically defensible technology available for prioritizing the environmental issues of the Environmental Survey. Late in FY 1986, efforts were initiated to modify the RAPS technology for use by the Environmental Survey. An interim version of the modified RAPS technology, called the Multimedia Environmental Pollutant Assessment Systems (MEPAS), will be completed during FY 1987.

HAZARD RANKING SYSTEM/MODIFIED HAZARD RANKING
SYSTEM COMPUTER CODE

R. D. Stenner, R. A. Peloquin, and
K. A. Hawley

The Hazard Ranking System/modified Hazard Ranking System (HRS/mHRS) is used to identify the inactive waste sites that require further action under the CERCLA. The mHRS is a modification of the original HRS designed for the EPA; it was developed by PNL at the request of DOE for use at its radioactive and mixed-radioactive and hazardous waste facilities. Both systems are computerized to facilitate their application at DOE sites. The computer code, developed during FY 1986, is designed to run on a personal computer. The code, which was finalized, tested, and documented during FY 1986 will allow for consistent, auditable scoring of waste sites within DOE.

TECHNICAL SUPPORT IN COMMENTING ON PROPOSED
REGULATIONS

B. L. Steelman, G. Whelan, J. E. Hansen,
J. S. Fruchter, and D. L. Streng

Pacific Northwest Laboratory provided technical support to ES&H in reviewing and commenting on new environmental regulations being proposed by the EPA. While technical support was provided on a wide range of issues, the major focus during FY 1986 was on proposed regulations related to the 1984 amendments to the Resource Conservation and Recovery Act (RCRA). Specifically, PNL provided ES&H with detailed technical comments on two major proposed RCRA regulations: 1) the Land Disposal Restrictions and 2) the Toxic Characteristic Leaching Procedure.



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and
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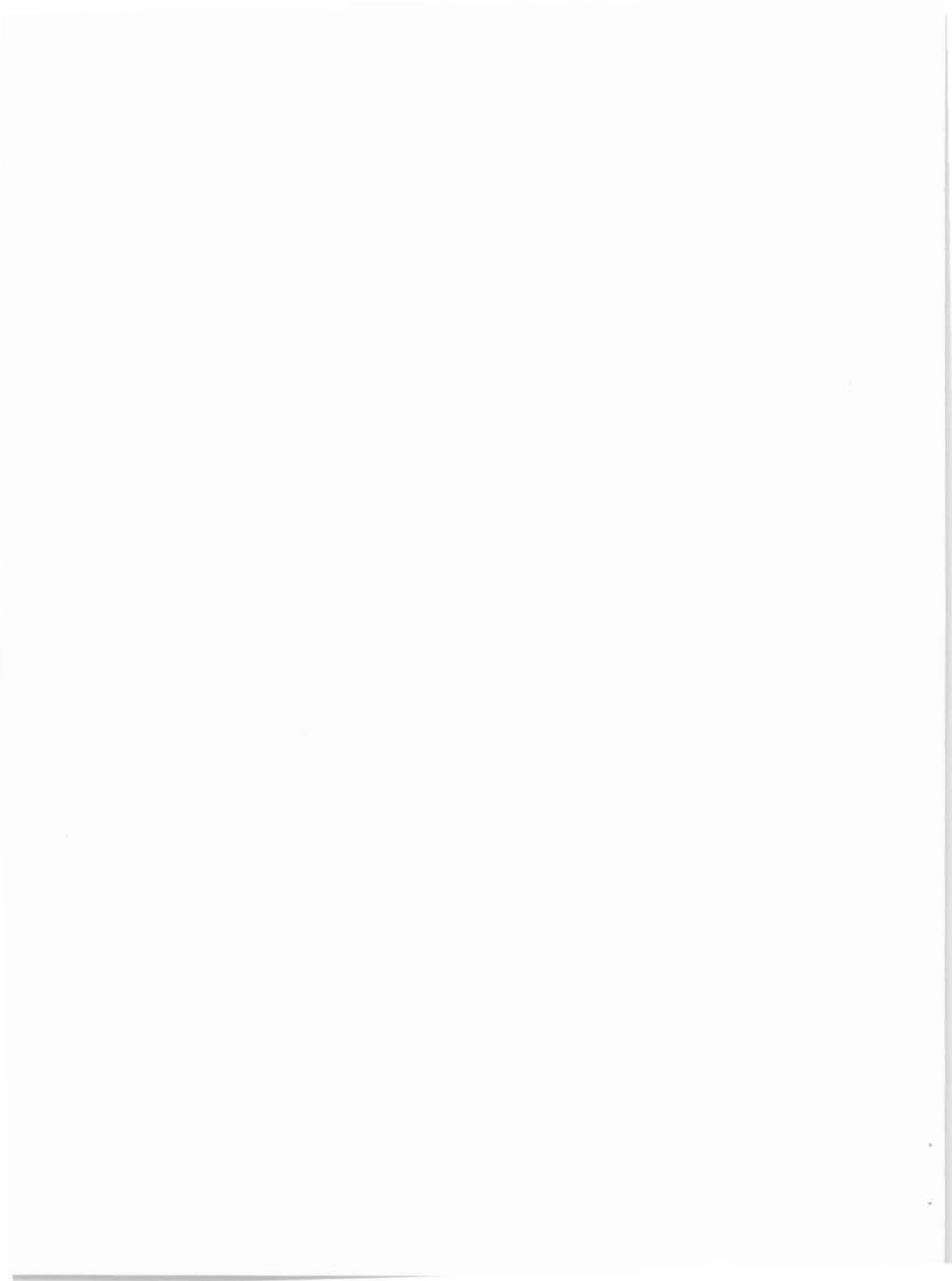
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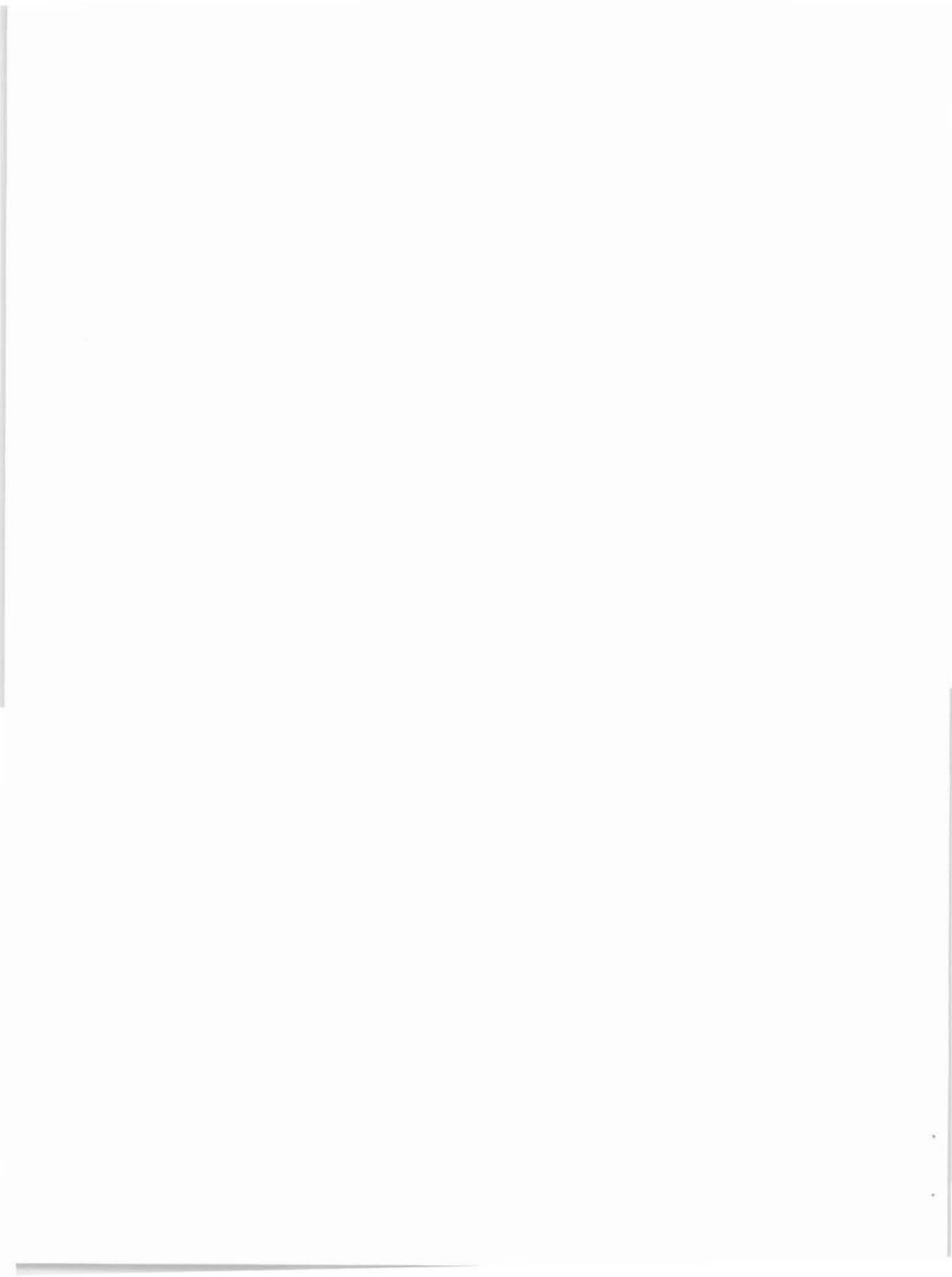




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