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Pacific Northwest Laboratory Annual Report for 1983 to the DOE Office of the Assistant Secretary for Environmental Protection, Safety and Emergency Preparedness

Part 5 Overview and Assessment February 1984

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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W. J. Bair and Staff Members
of Pacific Northwest Laboratory

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Pacific Northwest Laboratory
Richland, Washington 99352

PREFACE

This 1983 annual report from Pacific Northwest Laboratory (PNL) to the Department of Energy (DOE) describes research in environment, health, and safety conducted during fiscal year 1983. 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 Environmental Protection, Safety and Emergency Preparedness. 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 1983 Annual Report are:

Part 1: Biomedical Sciences Program Manager - J. F. Park	D. L. Felton, Report Coordinator and Editor
Part 2: Ecological Sciences Program Manager - B. E. Vaughan	B. E. Vaughan, Report Coordinator C. M. Novich, Editor
Part 3: Atmospheric Sciences Program Manager - C. E. Elderkin	N. S. Laulainen, Report Coordinator J. L. Downs-Berg, Editor
Part 4: Physical Sciences Program Manager - J. M. Nielsen	R. M. Garcia, Report Coordinator J. E. Danko, Editor
Part 5: Overview and Assessment Program Managers - S. Marks W. A. Glass	R. W. Baalman, Report Coordinator and 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.

Credit for this annual report goes to 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.

W. J. Bair, Manager
S. Marks, Associate Manager
Environment, Health and Safety Research Program

Previous reports in this series:

Annual Report for

1951	W-25021, HW-25709
1952	HW-27814, HW-28636
1953	HW-30437, HW-30464
1954	HW-30306, HW-33128, HW-35905, HW-35917
1955	HW-39558, HW-41315, HW-41500
1956	HW-47500
1957	HW-53500
1958	HW-59500
1959	HW-63824, HW-65500
1960	HW-69500, HW-70050
1961	HW-72500, HW-73337
1962	HW-76000, HW-77609
1963	HW-80500, HW-81746
1964	BNWL-122
1965	BNWL-280; BNWL-235, Vol. 1-4; BNWL-361
1966	BNWL-480, Vol. 1; BNWL-481, Vol. 2, Pt. 1-4
1967	BNWL-714, Vol. 1; BNWL-715, Vol. 2, Pt. 1-4
1968	BNWL-1050, Vol. 1, Pt. 1-2; BNWL-1051, Vol. 2, Pt. 1-3
1969	BNWL-1306, Vol. 1, Pt. 1-2; BNWL-1307, Vol. 2, Pt. 1-3
1970	BNWL-1550, Vol. 1, Pt. 1-2; BNWL-1551, Vol. 2, Pt. 1-2
1971	BNWL-1650, Vol. 1, Pt. 1-2; BNWL-1651, Vol. 2, Pt. 1-2
1972	BNWL-1750, Vol. 1, Pt. 1-2; BNWL-1751, Vol. 2, Pt. 1-2
1973	BNWL-1850, Pt. 1-4
1974	BNWL-1950, Pt. 1-4
1975	BNWL-2000, Pt. 1-4
1976	BNWL-2100, Pt. 1-5
1977	PNL-2500, Pt. 1-5
1978	PNL-2850, Pt. 1-5
1979	PNL-3300, Pt. 1-5
1980	PNL-3700, Pt. 1-5
1981	PNL-4100, Pt. 1-5
1982	PNL-4600, Pt. 1-5

FOREWORD

Part 5 of the 1983 Annual Report to the Department of Energy's Assistant Secretary for Environmental Protection, Safety and Emergency Preparedness presents Pacific Northwest Laboratory's progress on work performed for the Office of Nuclear Safety and the Office of Operational Safety. For each project, as identified by the Field Task Proposal/Agreement, articles describe progress made during FY 1983. Authors of these articles represent a broad spectrum of capabilities derived from various segments of the Laboratory, reflecting the interdisciplinary nature of the work.

For additional information on any of the projects reported in Part 5, contact the authors of the articles.

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Nuclear
Safety

NUCLEAR SAFETY

- **Health Physics Support and Assistance to the Department of Energy**
- **Technical Guidelines for Personnel Dosimetry Calibrations**
- **Personnel Neutron Dosimeter Evaluation and Upgrade Program**
- **Beta Measurement Evaluation and Upgrade**

To establish and maintain an effective nuclear safety program, DOE has assigned to the Office of Nuclear Safety responsibility for developing and promulgating nuclear safety policy, standards and guidance and for DOE-wide independent overview, support, and counsel. The objective of the Nuclear Safety Program is to assure that the activities of the Department of Energy (DOE) and its contractors are in full compliance with DOE and other applicable nuclear safety, health and emergency preparedness standards and regulations and to provide technical support to DOE Office of Nuclear Safety.

The major emphasis at Pacific Northwest Laboratory continues to be on developing criteria, instruments, and methods to assure 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 exposure measurement and recording programs and on improving reporting systems.

•Bullets denote Field Task Proposal/Agreement (FTPA) titles.

• Health Physics Support and Assistance to the Department of Energy

Pacific Northwest Laboratory functions as the lead laboratory providing health physics support and assistance to the Office of Nuclear Safety, Department of Energy (DOE), on special studies principally associated with the analysis of impact of standards, regulations, and engineering and administrative actions on occupational and environmental exposure. Support and assistance are also provided for other specific studies identified by DOE as priorities. The designation of lead laboratory in health physics, with an agreement and budget in place, provides the Division with the additional expertise necessary to respond to the many questions and situations that arise during the operation of their numerous nuclear energy research, development and demonstration facilities.

L. G. Faust, J. M. Selby

TECHNICAL EVALUATION OF THE CAPABILITY OF PRESENT INSTRUMENTATION TO MEET THE DRAFT ANSI STANDARD ON PERFORMANCE SPECIFICATIONS FOR RADIATION PROTECTION SURVEY INSTRUMENTATION*

J. L. Kenoyer, K. L. Swinth, R. L. Kathren

The objectives of this project are to evaluate the applicability and practicability of the proposed ANSI standard (ANSI N42.17), "Performance Specifications for Health Physics Instrumentation," to determine the degree of conformance to the proposed standard of selected currently available commercial instruments; to develop a formal test and evaluation protocol and specific procedures; and to lay the groundwork for establishing a permanent testing and certification laboratory.

During the past year, approximately 75 health physics instruments were procured for test and evaluation. Three methods of procurement have been used to date: (1) direct purchase of instruments from the manufacturer, (2) the loan of instruments by manufacturers, and (3) the loan of instruments by DOE laboratories. The types of instruments have been grouped into six categories: ionization chambers, GM detectors, alpha detectors, neutron monitors, air monitors, and others not covered by the preceding categories.

Instrument test and evaluation procedures were developed that followed existing, proposed, and draft standards and guides. All of the requirements stated in ANSI N42.17 are covered by these procedures. Procedures were written for the following tests: inspection, AC power, battery lifetime, alarm reset, stability, geotropism, response time, accuracy, precision, IER energy dependence, beta energy dependence, neutron energy dependence, radiation overloads, angular dependence, extracameral response, nonionizing electromagnetic radiation, electrostatic fields, magnetic fields, interfering ionizing radiations, temperature, humidity, ambient pressure, vibration, and shock.

Development of test and evaluation procedures to be used under extreme conditions was initiated during this fiscal year. Extreme-range testing procedures will include temperature (extremes and shock testing), humidity, ambient pressure, vibration, shock, and exposure rate.

New testing facilities that have been installed and characterized include an environmental chamber for controlled temperature and humidity tests, a pressure/vacuum exposure chamber, vibration tables, shock-testing equipment, and a radio-frequency field generation system. With the exception of a few highly specialized tests, PNL has the facilities for all the required testing. Arrangements have been investigated for specialized testing at other laboratories where required by the standard.

The testing phase of the program was initiated, and during the fiscal year more than 320 tests were performed on a thorough cross section of the instruments that have been procured. Tests are assumed to apply to all instruments of a particular class and will thus permit evaluation of the performance specifications in the draft ANSI standard. Initial testing results have identified some weaknesses in the draft standard; they have also identified unsatisfactory performance of instruments during specific tests. Selected results from the testing program are listed in Table 1; results from nine different tests using ion chambers and GM detectors are represented.

For the instruments tested to date, the GM detectors and ion chamber instruments fall into two distinct categories. Ion chamber instruments generally lack the sensitivity of the GM detectors but can meet the requirements of the standard. The GM detectors seldom meet the test of radiation response and electronic requirements of the standard, and their poor precision makes it difficult to make definitive statements concerning their performance on some tests.

*This task is jointly sponsored by the Nuclear Regulatory Commission.

TABLE 1. Selected Results from the Testing Program

Test	No. of Instruments Tested		No. of Instruments that Failed	
	Ion Chamber	GM	Ion Chamber	GM
Stability	10	30	0	9
Geotropism	8	14	3	1
Response Time	0	20	0	11
Accuracy	4	12	1	6
Energy Dependence	9	7	4	7
Temperature	15	19	9	0
Humidity	5	17	1	4
Ambient Pressure	5	5	0	0

Recommendations to the ANSI working group will include comments on: (1) derivation of statistically reliable data, (2) the precision requirement of the relative standard deviation of $\leq$ 2.5% on all ranges, (3) equilibration periods for the environmental tests, and (4) the need for quality assurance information in the standard.

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

D. R. Fisher, A. V. Robinson, R. T. Hadley

The purpose of this study is to evaluate the adequacy of draft ANSI Standard N13.30 by conducting a nationwide bioassay intercomparison test. The study involves the performance testing of in-vitro and in-vivo service laboratories against minimum criteria for accuracy and precision specified in the draft standard.

During the past year, the first of two rounds of intercomparison testing was conducted. Invitations were extended to four DOE whole-body counting laboratories, six utilities and one fuel fabrication facility to participate in the in-vivo testing. Similarly, forty in-vitro bioassay laboratories were invited to participate in the first round intercomparison. Of the latter, twenty-one laboratories accepted the invitation. All radioactive materials employed in the testing were provided by the National Bureau of Standards.

A torso phantom with three pairs of interchangeable lungs tagged with ^{235}U, ^{241}Am and ^{60}Co, respectively, was employed. The lungs were prepared using a foaming polyurethane polymer. A point source of enriched ^{40}K was imbedded into the heart cavity of the torso phantom to provide a natural ^{40}K background interference.

A whole-body bottle phantom was purchased and filled with a gelatinous matrix containing precisely known quantities of fission and activation products (^{137}Cs, ^{144}Ce and ^{60}Co) along with background interference radionuclides (^{90}Sr and ^{40}K).

The two phantoms were shipped to participating in-vivo counting facilities for measurements, one facility at a time. This phase is in progress, and results will not be presented at this time.

A total of 560 samples of artificial urine containing carefully controlled quantities of ^{3}H, ^{238}Pu, ^{241}Am, ^{90}Sr, U(nat) or ^{137}Cs were prepared and shipped to participating in-vitro laboratories. At the same time, a third-party cross-check laboratory verified that the intended activity levels were present in the test samples.

The measurement results from participating bioassay laboratories were received and analyzed according to the statistical methods of the draft Standard. Analytical criteria for passage or failure were defined by the following:

1. minimum detectable amount (MDA) $\leq$ the acceptable MDA
2. relative bias within the range -0.25 to +0.50
3. accuracy parameter $\leq$ 0.40.

Failure was defined as the inability to pass any one of the above three analytical performance criteria.

The intercomparison results are shown in Tables 1 and 2. Bioassay laboratories had difficulties meeting the draft Standard performance criteria in many categories. The causes of test failures varied markedly. Failures to measure ^{238}Pu and ^{241}Am were usually related to difficulties in precision, whereas failures to measure natural uranium most often involved difficulties meeting criteria for relative bias. Failures to adequately measure ^{137}Cs were largely attributable to unacceptable MDAs.

The test results indicate a need for laboratory accreditation to ensure quality bioassay results. The testing program provides an opportunity for laboratories to assess their performance in light of industry standards and to identify areas of weakness; it also reinforces the need for continual quality assurance.

*This task is jointly sponsored by the Nuclear Regulatory Commission.

TABLE 1. In-Vitro Measurements Failing One or More of the Three Draft ANSI Standard N13.30 Analytical Performance Criteria (Accuracy, Precision, or MDA)

Test Category	Percent Analytical Failures Among Laboratories That Reported Results	Total Failures,(a) Percent
Liquid Scintillation	11	22
Alpha Spectrometry	50	72
Beta Measurements	10	50
Fluorescence Measurements	43	56
Gamma Spectrometry	43	43

(a) Includes participating laboratories that failed to report results.

TABLE 2. Summary of Failures by Performance Criterion

Measure of Performance	Percent Failure
Minimum Detectable Amount	28
Relative Bias	12
Accuracy	4
Not Reporting Results	29
Any of the Above	55

EVALUATION AND UPGRADE OF DOE INTERNAL DOSIMETRY

B. L. Murphy, K. R. Heid, R. J. Traub, D. R. Fisher

The purpose of this task is to characterize current practices in internal dosimetry at DOE facilities and evaluate those practices with respect to consistency among DOE contractors. This task is multifaceted in that all aspects of an internal dosimetry program are addressed. Items considered include, but are not necessarily limited to, record systems and ease of information retrieval; ease of integrating internal dose and external dose; modeling systems employed, including ability to modify models depending on excretion data, and verification of computer codes utilized; bioassay procedures, including quality control; and ability to relate air concentration data to individual workers and bioassay data. This task will also identify collective and individual strengths and weaknesses in the assessment of internal dose by DOE contractors. Furthermore, it will serve as a basis by which these practices can be improved. Initial efforts in this task were directed toward development of a comprehensive program plan.

A comprehensive questionnaire was prepared and has been sent to the field offices through DOE Headquarters. The topics addressed by this questionnaire include documentation, bioassay, procedures, data analysis/interpretation, quality assurance, air monitoring/sampling program, and records. The questionnaire also contained a section in which several questions were posed to obtain objective comments on such topics as the current state of internal dosimetry practices and improvements that could be made.

The questionnaires were distributed in September 1983. They will be analyzed by the second quarter of FY 1984.

A survey of the available literature concerning internal dosimetry has been initiated. Particular emphasis has been placed on material related to the practical application of ICRP-26, metabolic models and available computer codes for assessment of internal exposure. A portion of this work supported the Standards Evaluation Task. This task also supported auxiliary studies to complement the ongoing performance testing of radiobioassay laboratories for the technical evaluation of draft ANSI Standard N13.30. These studies are directed toward determining the validity of artificial urine for intercomparison testing.

WORKPLACE AIR SAMPLING AND MONITORING UPGRADE

D. P. Higby, E. H. Carbaugh

The purpose of this task is to evaluate the current status of workplace air sampling and monitoring at DOE and DOE contractor facilities and to identify specific areas for upgrading. Workplace air sampling and monitoring are commonly used as indications of the effectiveness of engineered controls on dispersible radioactive materials. Less commonly, air sampling and monitoring results are used to evaluate personnel exposure to airborne radionuclides. Although the accuracy and precision of existing air sampling and monitoring techniques are typically not adequate for this purpose, proposed regulatory changes may place increased emphasis on the use of air sampling to assess internal dose.

The initial effort included the development of a comprehensive long-range program plan. The plan includes the establishment of an

aerosol testing laboratory, development of performance criteria for air sampling and monitoring equipment, and development of an improved workplace aerosol monitoring instrument.

A detailed air sampling and monitoring questionnaire was sent to DOE contractors through the respective field offices in the fourth quarter of FY 1983. This questionnaire covered eight aspects of workplace air sampling and monitoring:

- Documentation
- General Practices
- Continuous Sampling
- Personnel Air Sampling
- Sample Handling and Analysis
- Air Monitoring Practices
- Air Monitor Calibration
- Development Needs

Final tabulation and analysis of responses to the questionnaire will be completed once all responses are received.

This task supported a subcontract to Lawrence Livermore National Laboratory to develop an improved transuranic aerosol monitor. Progress was made this year on improving the filter transport system, energy resolution and background interference.

CHARACTERIZATION OF HEALTH PHYSICS TECHNICIAN MANPOWER SUPPLY AND TRAINING PROGRAMS

R. L. Kathren, J. C. Gillings, B. L. Murphy

This study has two purposes: (1) to determine the current status and recent trends in radiation safety manpower supply and demand among DOE contractors, and (2) to document the scope of radiation safety training activities within the DOE contractor system.

A questionnaire was developed in conjunction with Oak Ridge Associated Universities (ORAU) to gather data in these two areas. The questionnaire was sent to DOE field offices in the second quarter of FY 1983. Responses were received and tabulated in the third and fourth quarters of FY 1983 by ORAU.

In FY 1984, conclusions and recommendations regarding manpower supply and demand and training practices will be developed.

HEALTH PHYSICS TRAINING PROGRAM FOR DOE HEADQUARTERS PERSONNEL

J. C. Gillings

A two-week health physics training course was presented at PNL to Dr. George Rotariu and Dr. Greg D'Alessio November 29 through December 17. The course included a comprehensive review of health physics principles and practices and site visits and lectures by Hanford area contractors. The following groups participated in this training:

PNL - External Dosimetry Records, Instrument Calibration and Evaluation Lab, Environmental Monitoring, Transportation, Internal Dosimetry

RHO - Transportation, Radiation Engineering, Radiation Monitoring

UNC - N Reactor, Radiological Engineering

OCCUPATIONAL RADIATION EXPOSURE RECORDS SYSTEM EVALUATION AND UPGRADE

B. L. Murphy, D. W. Murphy, J. M. Selby

The objective of this report is to evaluate and provide recommendations for improvement to the DOE-wide Occupational Radiation Exposure Record System. During FY 1982, alternatives upgrading the system were developed from the information that was reported in the previous two reports, "Overview of DOE Radiation Exposure Information Reporting System, REIRS," and "Current Personnel Dosimetry Practices at DOE Facilities." An ad hoc committee on Occupation Exposure Registry Upgrade consisting of twelve members was assembled to provide guidance. Comments received from the field have been incorporated into the report, which will be published in the first quarter of FY 1984. Work has been initiated on the development of performance criteria for the new record system.

ANALYSIS OF QA REQUIREMENTS

P. L. Roberson, C. D. Hooker, J. M. Selby

The purpose of this study is to develop a program to evaluate the performance of DOE occupational exposure measurement systems. Initially the program will test dosimetry system performance. Development of a DOE standard for performance testing was begun; development of procedures to be used by the performance testing laboratory was initiated.

The DOE standard was based on the American National Standard, Criteria for Testing Personnel Dosimetry Performance, ANSI N13.11-1983 and the recommendations in Guidelines for the Calibration of Personnel Dosimeters PNL-4515 (Roberson and Holbrook 1983). The recommendations in PNL-4515 resulted from an analysis of ANSI N13.11 performed during the development of a data base on the performance of DOE dosimetry processors. Additional information is presented under "Technical Guidelines for Personnel Dosimetry Calibrations" in this document.

The procedures manual will cover dosimeter handling, exposure sequencing, quality assurance, radiation field standardization, dosimeter irradiation uncertainty analysis, and liaison with the National Bureau of Standards.

TECHNICAL EVALUATION OF NATIONAL AND INTERNATIONAL OCCUPATIONAL EXPOSURE RECOMMENDATIONS, STANDARDS, AND REGULATIONS

J. P. Corley, K. R. Heid, B. L. Murphy, J. M. Selby

The objective of this task is to provide a timely technical evaluation of national and international occupational exposure recommendations, standards, and regulations to determine in particular their technical accuracy, their impact on DOE operations, and compatibility with DOE operations and orders. As appropriate, technical expertise is drawn from other DOE contractor laboratories to assist in the evaluation. In FY 1983, evaluations were performed of ICRP Publication 26; proposed NRC revision to 10 CFR 20 and 10 CFR 140; proposed EPA revision to Federal Radiation Protection Guidance; Transuranium in the General Environment (EPA); Clean Air Act (EPA); and numerous ISO, IAEA, NEA, and ANSI standards. A Technical Advisory Committee consisting of representatives from several DOE contractor laboratories was formed to assist with evaluations that specifically affected occupational exposure regulations.

ALARA STUDY

L. H. Munson, R. L. Kathren, W. N. Herrington, D. P. Higby

In early 1980, a manual "Guide to Reducing Radiation Exposure to As Low As Reasonably Achievable (ALARA)," was published as DOE/EV 1830-T5. This document has since been specified as mandatory in the DOE Orders. Since its publication, existing standards have been revised and upgraded, and increasingly detailed interpretations of ICRP and NCRP recommendations have been promulgated. Thus, revision and upgrading of the guide are necessary to maintain DOE leadership in the application of ALARA in radiation protection.

This task was initiated in FY 1983, with the objective to review and upgrade DOE guidance on ALARA. The existing general guide is being revised to reflect changes in ALARA practices and concepts and to include the development of additional detailed guidance as necessary. A draft of the revised guide has been sent to the sponsor for comment prior to circulation for more general peer review.

Additional ALARA manuals providing in-depth guidance will be developed. These may be developed for specific types of facilities (e.g., reactors, fuel fabrication plants, accelerators, radiological laboratories, fuel processing facilities, waste repositories and enrichment facilities) or for specific topical areas (e.g., facility design, training, instrumentation).

CHARACTERIZATION OF DOE FACILITY EMERGENCY PREPAREDNESS

K. L. Swinth, J. C. Gillings, J. M. Pisarick, A. V. Robinson, B. L. Murphy, J. M. Selby

The purpose of the emergency preparedness task is to update and expand the emergency instrument performance criteria published in the 1970s and to provide guidance on the proper elements of emergency instrument programs. The work will entail development of a generic document on emergency preparedness instrumentation followed by documents on emergency instrument performance criteria and requirements for specific categories of facilities.

In 1980, following the Three Mile Island incident, DOE requested PNL to expand and update an earlier study on emergency instrumentation preparedness conducted in 1970. The 1970 survey study resulted in four reports on performance criteria for radiological emergency instrumentation. Three of these documents addressed criteria for emergency instrumentation at (1) reactors, (2) mixed oxide fuel fabrication plants, and (3) fuel reprocessing plants. The fourth document addressed evaluation testing and calibration methodology for these instruments.

These early studies examined source terms and potential accident scenarios to determine the required performance characteristics of instrumentation used to assess such releases. The instrumentation included meteorological instruments, radiological instruments for measurement of airborne and liquid releases, criticality monitors, survey instrumentation, and stack monitors.

The update of this earlier study has included a survey of 30 DOE contractors to assess current emergency preparedness capabilities. This survey showed that in approximately one-half of the criteria surveyed in both 1970 and 1980 there was no significant improvement. Approximately 30% of the criteria that were included in both surveys showed an improvement, and 20% indicated a decline in emergency response capabilities.

There has been little change in the area of medical treatment arrangements, gaseous effluent monitoring at the point of release, boundary and environs air monitoring, and meteorological measurements, with the

following exceptions: (1) the performance of sampling and analysis of gaseous effluents showed a marked increase between 1970 and 1980 with a corresponding increase in the sampling of gases as compared to particles, and (2) there was a marked decrease in the reported abilities of the contractors to perform ground deposition and dispersion calculations for airborne effluents.

Liquid effluent monitoring showed an overall improvement between 1970 and 1980; more sites seemed to provide continuous monitoring of liquid effluents, and the system was reported to function during a design basis accident. There was a greater emphasis on intermittent monitoring of environmental dose rates in 1980, but a lesser percentage of respondents reported that health physics approval was required for system deactivation. Finally, although emergency communications systems remained essentially the same (except for an increased use of the pageboy call system), provisions for emergency communication channels to the local police, local government, and the public news media showed a decline from 1970 to 1980.

The review has also shown that the earlier instrument performance criteria should be updated to reflect the current state-of-the-art. Refinements have been made in models for atmospheric transport, and new and improved instruments have become available including the current trend toward digital instruments. Several standards have been written or are in preparation covering instrument performance under a variety of conditions. Recommendations on emergency preparedness instrumentation will be updated to reflect changes in DOE facility types, instrument performance criteria as reflected in standards, and state-of-the-art instrumentation.

Updating of the reports has started with a document on generic requirements for emergency instrument preparedness at DOE facilities. This report covers the elements common to all emergency preparedness programs regardless of facility type. Following completion of this report, specific documents will be prepared for all facility types in the DOE family. This will include reports examining the specific requirements for fuel fabrication, reactors, reprocessing, research, enrichment, and weapons facilities.

NEUTRON DEPTH DOSE STUDY

R. I. Scherpelz

The determination of personnel doses due to exposure to a field of neutron radiation usually depends on the use of a set of flux-to-dose conversion factors. These factors are applied to an energy-dependent flux distribution at the body surface to derive the dose and dose equivalent values resulting from the neutron exposure. Some of the commonly used tabulations of these flux-to-dose conversion factors are based on calculations performed at widely spaced energy points, and different interpolating schemes can lead to widely varying conversion values for energy points not explicitly included in the tabulation. Tabulations are often based on calculations with little experimental verification of the modeling technique. This study is adding improvements to the tabulations of neutron flux-to-dose conversion factors by calculating neutron flux, dose and dose equivalent distributions in a tissue-equivalent phantom exposed to a beam of monoenergetic neutrons. These depth dose profiles will be used to derive flux-to-dose conversion factors. Some of these factors will be determined for comparison with previously published values, and some will be intended to fill in gaps. The model used in the calculation is also being designed to allow for a comparison with planned experimental measurements.

The computer code BMC-MG (Battelle Monte Carlo-Multigroup) is the code used to perform the depth dose calculations. It is a sophisticated neutron transport code using the Monte Carlo methodology, well-suited to these calculations. Two different cross-section sets are being used to develop the model: a 27-neutron-group set derived from ENDF/B-III data, and a newer coupled neutron-gamma set derived from ENDF/B-IV data. The calculational model has been developed to implement the advanced features of BMC-MG for efficient, cost-effective operation. Some of these features include Russian roulette, particle splitting, importance weighting by region, and thermal weighting. The model used for the calculations has thus been optimized and is being used for calculating depth dose profiles.

A typical example of a depth dose calculation is presented in the accompanying figure. This graph plots dose as a function of depth into the phantom for a parallel beam of neutrons having an energy of 1 MeV, and a total fluence of 1.0 n/cm^2. The dose points for this calculation were arranged in a line parallel to the

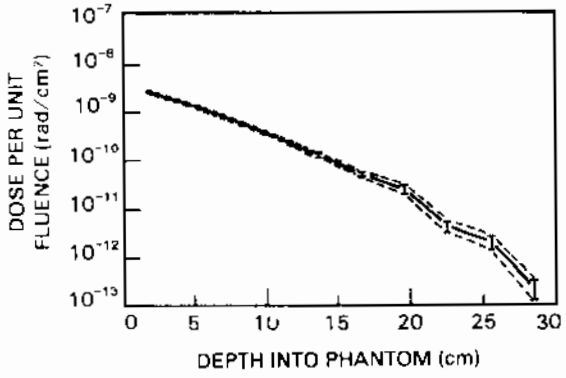

FIGURE 1. Dose vs Depth into Phantom - 1 MeV

neutron beam, passing through the center of the cylindrical phantom. These calculations were made with the 27-neutron group cross-section set, and the results compare well with previously published values.

NEUTRON INSTRUMENT DEVELOPMENT

L. W. Brackenbush, J. C. McDonald

There are two objectives to this task: (1) to investigate the use of tissue equivalent proportional counters (TEPC) as standard neutron instruments to help characterize neutron fields and (2) to investigate new types of neutron detectors that could potentially be useful dosimeters. There is renewed interest in tissue equivalent proportional counters with the release of the "NCRP Statement on Dose Limits for Neutrons," in which the National Council on Radiation Protection and Measurements discusses possible changes in the recommended absorbed dose limits for neutrons. References cited in the NCRP statement propose the redefinition of quality factor in terms of lineal energy, which is a quantity directly measured by the TEPC, rather than in terms of linear energy transfer (LET), which is presently used. Tissue equivalent proportional counters can also be used to directly measure absorbed dose and are absolute dosimeters, since they are self-calibrating. A program has been established for several years to develop the TEPC into a more practical health physics instrument to directly measure absorbed dose from any type of ionizing radiation. The Pacific Northwest Laboratory and several other laboratories have demonstrated that it is possible to simultaneously measure neutron and gamma dose with a single proportional counter and two amplifiers operated at different gains. This is possible using a propane-based tissue equivalent filling gas, which has a higher gain than the methane-based gas previously used.

Previous work utilized spherical counters, which are expensive and difficult to build. Current work emphasizes cylindrical tissue equivalent proportional counters, which may be manufactured commercially. Algorithms for determining LET distributions and quality factors have already been established for spherical counters. Efforts this year were directed at establishing similar algorithms for cylindrical proportional counters. These results and limitations in the various methods for determining quality factors were reported at the Tenth International Neutron Dosimetry Workshop sponsored by DOE and were published in PNL-SA-11686.

Neutron dosimeters in use today have improved on well established techniques. No really new, innovative practical neutron dosimeter has been developed in the past 20 years. All neutron dosimeters in use today are limited because of an energy dependence problem (i.e., the responses per unit of dose equivalent are not constant, but vary with neutron energy). Since the major contribution to neutron dose in tissue is neutron interactions with hydrogen, it appears that a dosimeter containing hydrogen or matching the cross section of hydrogen with energy could overcome some of the energy dependence problems with existing dosimeters. A limited amount of work with organic semiconductors and amorphous silicon (which contains 10 to 50 atom percent hydrogen) is presented in PNL-SA-11461. However, these devices have not proved sensitive enough for a practical dosimeter, and more work needs to be performed.

• Technicial Guidelines for Personnel Dosimetry Calibrations

This program continues to provide technical evaluations of personnel dosimetry calibration procedures at 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 intercomparison program for laboratory calibrations was initiated.

TECHNICAL GUIDELINES FOR PERSONNEL DOSIMETRY CALIBRATIONS

J. C. McDonald, R. A. Fox, C. D. Hooker, J. L. Pappin, P. L. Roberson, K. L. Swinth

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

This task was initiated by developing a performance data base on personnel dosimeters in use at DOE laboratories. The data were used to prepare guidelines for calibration of personnel dosimeters. The development of guidelines for the calibration of radiation protection instruments is being implemented by means of a survey of practices for DOE laboratories and an evaluation of current instrument standards.

An intercomparison program for laboratory calibrations was also initiated between major DOE calibration facilities. This program will help resolve any possible discrepancies and establish a firm basis for calibration standardization. It will also help during the implementation of calibration guidelines for both dosimeters and instruments.

GUIDELINES FOR DOSIMETER CALIBRATIONS

P. L. Roberson

A document, Guidelines for the Calibration of Personnel Dosimeters (Roberson et al. 1983a), was prepared. This guide describes minimum levels of acceptable performance for personnel dosimetry systems used at DOE facilities. The goal is to enhance the quality of radiological calibrations and the comparability of reported occupational doses between DOE facilities.

The guide defines a set of reference calibration techniques to encourage uniform dosimeter response. Also included are a standard by which personnel dosimetry systems can be evaluated and recommended design parameters for personnel dosimeters. Approximate limits for the energies of the radiation for which these guidelines are appropriate are 20 keV to 2 MeV for photons; 0.5 MeV to 4 MeV for beta particles; and 100 keV to 2 MeV for neutrons. The procedures specified by the guidelines differ from those of ANSI N13.11-1983 in that they are designed to standardize and evaluate rather than test a personnel dosimetry system. The geometries of the calibration techniques follow those given in ANSI N13.11 as closely as practical.

The analysis of ANSI N13.11 as a standard for DOE was based on performance evaluations of selected personnel dosimetry systems in use at DOE facilities. The results of the analysis are as follows:

- The number of test categories was incomplete. Required additions include a low-energy beta source, a second neutron source, and an x-ray/neutron mixture category.
- The performance algorithm was arbitrarily specified. It was modified to meet recommendations of the International Commission on Radiation Units and Measurements (Report 20) and the National Council on Radiation Protection and Measurements (Report No. 57).
- The beta-particle specifications were insufficient. Specification of the acceptable range of depth dose was required to improve standardization of calibrations.
- The exposure-to-dose conversion factors for photons (C_x factors) did not match the calibration geometry; therefore, appropriate C_x factors were used.

Recommendations for the design and use of personnel dosimetry systems are included; they were based on performance evaluations of selected DOE systems.

In addition, the dosimeter performance characteristics described in our last annual report were reported in Performance Comparison of Selected Personnel Dosimetry Systems in Use at the Department of Energy Facilities (Roberson et al. 1983b).

GUIDELINES FOR INSTRUMENT CALIBRATIONS

K. L. Swinth

A data base is being developed to characterize the calibration techniques, the performance, and the types of instruments currently used at DOE facilities. A survey of DOE facilities and a compilation of data available from Hanford experience and data from related projects are both under way. Site visits to several major DOE laboratories and use of related data from the laboratories are planned. Experience from the calibration of instruments used in radiation protection at Hanford is being compiled and will form the basis of integration of data from other DOE sites. Experience gained from the ongoing evaluation of ANSI N42.17D2 and additional evaluations deemed necessary will be used to determine instrument performance. Information has been tabulated on typical instrument performance, existing calibration capabilities, and calibration requirements (e.g., frequency of calibration, type of radiation, dose and energy ranges).

When new or more rigorous calibration requirements are established for instruments, tests will be performed to assure that they are practical. Uniform calibration requirements have not been established for many instruments. When they are established, the entire range of influencing parameters must be considered, such as energy response, temperature response, and environmental influences.

INTERCOMPARISON OF CALIBRATION STANDARDS

J. C. McDonald

At the request of the DOE Office of Nuclear Safety, Health Physics Group an intercomparison study of radiological calibration standards is being conducted by Pacific Northwest Laboratory (PNL). The intent of the program is to identify and eliminate sources of variation in calibration procedures and techniques. This study, similar to one conducted in Europe, is expected to encourage greater communication between laboratories regarding field-tested procedures to be used to solve calibration problems specific to DOE facilities. Further, the program will provide DOE laboratories an opportunity to obtain independent checks of calibration standards.

The intercomparison program involves cross-checks of both instrument and dosimeter calibrations. Laboratories will have the opportunity to participate in four categories of testing: high energy photon, low energy photon, beta, and fast neutron. Laboratories participating in the study will be shipped a set of instruments and dosimeters and will be requested to expose the devices to their calibration sources at specified doses. The laboratories will report the instrument response and return the dosimeters to PNL for readout.

The intercomparison instruments are being routed from one laboratory to the next in a predetermined sequence. The instruments will be returned to PNL periodically for post-intercomparison testing. The types of instruments used are listed below.

Category	
X ray	Capintec* PM-30 Ionization Chamber Wall Material: Shonka C-552 Air Equivalent Plastic Volume: 28 cc (nominal) Energy Range: 15-1250 keV
^{137}Cs	Capintec PM-30 Ionization Chamber with buildup cap
Beta	Far West Technology** EIC-1 Extrapolation Chamber Window Material: Conducting Polyethylene 6.9 mg/cm^2 thick Electrode Separation: 0.3 to 4.5 mm
Neutron	Far West Technology IC-80 Ionization Chamber Wall Material: Shonka A-150 Tissue Equivalent Plastic Volume: 80 cc (nominal)
	Far West Technology GM-2 Geiger Counter Energy Range: 10-2060 keV

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Roberson, P. L., et al. 1983a. Guidelines for the Calibration of Personnel Dosimeters. PNL-4515, Pacific Northwest Laboratory, Richland, Washington.

Roberson, P. L., et al. 1983b. Performance Comparison of Selected Personnel Dosimetry Systems in Use at Department of Energy Facilities. PNL-3983, Pacific Northwest Laboratory, Richland, Washington.

* Capintec Inc., Pittsburgh, PA

** Far West Technology Inc., Goleta, CA

• Personnel Neutron Dosimeter Evaluation and Upgrade Program

A program was initiated during FY 1981 with Pacific Northwest Laboratory as the lead laboratory: (1) to evaluate response characteristics of personnel neutron dosimeter systems in current use at several DOE laboratories, and (2) to develop improved neutron detection techniques for use as personnel neutron dosimeters and/or portable instruments, and (3) to provide improved calibration procedures and techniques. Evaluation of neutron dosimeters from twelve DOE laboratories was completed during FY 1982.

PERSONNEL NEUTRON DOSIMETER EVALUATION AND UPGRADE PROGRAM

L. G. Faust, D. E. Hadlock, L. W. Brackenbush, M. A. Parkhurst, J. C. McDonald, D. L. Haggard, G. W. R. Endres

The objective of this program is to provide a continuing effort to resolve problems of assessing personnel neutron dose at DOE facilities. Progress during FY 1981 and FY 1982 included: an assessment of the current status of personnel neutron dosimeter systems at DOE facilities; recommendations on methods of calibrating personnel neutron dosimeters; and continuing development of several concepts that show promise of upgrading the state-of-the-art in personnel neutron dosimetry. In addition, this program has continued to pursue improved personnel neutron dosimetry at DOE facilities and to provide DOE contractors with program accomplishments. This allows vendors the opportunity to manufacture developed prototypes in the form of commercially available dosimeters and/or instruments.

During FY 1983, PNL and other DOE laboratories as well as universities and private industry conducted research in nine principal areas: (1) technology transfer, (2) prototype evaluation, (3) field measurements, (4) dosimeter intercomparison, (5) track etch plastic (CR-39) technology, (6) dosimetry grade CR-39 (University of California), (7) combination dosimeter concepts (Lawrence Livermore National Laboratory), (8) remmeter dosimetry, and (9) semiconductor dosimetry. In addition, an International Workshop was conducted. Many of the results of these studies were presented at the Tenth International Neutron Dosimetry Workshop held in Mexico August 30-September 2, 1983 and are included in the proceedings.

Transfer of program developments to field operations is being continued through the use of contractor meetings and workshops. Prototype dosimeters and instruments are being evaluated to determine their potential for upgrading existing capability.

Field Measurements of neutron dose and spectra are being conducted in several DOE laboratories and commercial power reactors. This information, along with the measured responses of new devices, will allow determination of the accuracy of field neutron measurements and will be published at a later date.

Evaluation of neutron dosimeters from twelve DOE laboratories was conducted. The data and their analysis were published in an intercomparison report (McDonald 1983), which evaluates the dosimeters for accuracy, precision, lower dose detection, and energy response.

Field implementation of dosimetry grade CR-39 is being accomplished as its uniformity and long-term stability are established. Other selected concepts potentially capable of state-of-the-art improvements in personnel neutron dosimetry are also being developed.

REFERENCE

McDonald, J. C. et al. 1983. Response Characteristics of Selected Personnel Neutron Dosimeters. PNL-3982. Pacific Northwest Laboratory, Richland, Washington

• Beta Measurement Evaluation and Upgrade

This program focuses on resolving the problems associated with the field measurement of the beta dose component at DOE facilities. Little attention has been paid to improving beta measurements during the past 10 or 15 years. The change in DOE programs, including increased efforts in improved waste management and D&D facilities, coupled with beta measurement problems identified at TMI has heightened DOE's awareness for the need to improve beta measurements. In FY 1982, this program was begun to provide a continuing effort to identify problems associated with beta dose assessment at DOE facilities. Personnel beta dosimeters and instruments used at DOE facilities are being evaluated and characterized and includes (1) an assessment of measurement systems now in use, (2) development of improved calibration systems and procedures, (3) application of innovative beta dosimetry concepts, (4) investigation of new instruments or concepts for monitoring and spectroscopy, and (5) preparation of a "manual of good practice" to assure an adequate beta measurement program.

BETA MEASUREMENT EVALUATION AND UPGRADE

K. L. Swinth, L. A. Rathbun, P. L. Roberson, D. W. Murphy

The Beta Measurement Evaluation and Upgrade program was initiated to review the problems associated with beta dosimetry practices. The work performed in FY 1983 can be classified into three major areas: (1) current practices, (2) dosimeter development, and (3) instrument development.

A questionnaire was developed and distributed to assess the current beta dosimetry practices at DOE laboratories. The responses to the questionnaire are expected during the first quarter of FY 1984. Based on the questionnaire, a report will be produced covering the current practices at DOE sites in relationship to beta dosimeters, beta instrumentation, and beta calibration methods. The report will summarize the weaknesses, strengths, and problem areas identified at various facilities.

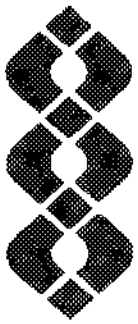
Field measurements were initiated at a DOE facility where significant beta exposures exist. Beta spectral analyses were performed and beta dose rates determined using the multielement dosimeter being developed in conjunction with the program. The response of the instruments and dosimeters currently in use at the facility were compared with the field measurement results. The data collected during the measurements are currently being analyzed.

Work continued on refining the multielement dosimeter for field applications. The number of elements in the dosimeter was increased, calibrations were performed, and new algorithms were developed for analysis of the response. This has improved the information available on beta fields.

Tests were performed at Pacific Northwest Laboratory on the graphite-backed thin TLD which is being developed by Kansas State University under subcontract to PNL. Tests showed that the thin TLD has an energy response that is relatively independent of beta energy. This type of chip has the potential for direct incorporation into present TLD badges.

A second dosimetry system is being developed under a subcontract to International Sensor Technology. This system uses an infrared laser system to heat the TLD chips and leads to selected area readout and an improved signal-to-noise ratio. Development of the prototype system is complete, and the unit will be delivered to PNL for further test and evaluation during the first quarter of FY 1984.

Tests were performed on five commonly used ion chambers and one GM-type instrument to characterize their energy response. Over the beta end-point energy range of 0.225 to 3.5 MeV, the ratio of maximum to minimum response varied from a factor of 2.5 to a factor of 16. This illustrates the severe dependence of instrument response on beta energy. Additional tests are planned including tests of the effect of source geometry on instrument response.



Operational Safety

OPERATIONAL SAFETY

- **Policy Studies—Radiation**
- **Former Nuclear Site Risk Estimation**
- **LGF Safety Studies**
- **Environmental Protection, Support and Assistance**

The responsibility of the Department of Energy (DOE) Office of Operational Safety is to assure that DOE-controlled activities are conducted in a manner that will minimize risks to the public and employees and will provide protection for property and the environment. The program supports the various energy technologies by identifying and resolving safety problems; developing and issuing safety policies, standards, and criteria; assuring compliance with DOE, federal, and state safety regulations; and establishing procedures for reporting and investigating accidents in DOE operations.

The Office of Operational Safety also has responsibility for overview of the remedial action program conducted by the DOE Office of Nuclear Energy. Relevant past activities have included the development of methods for estimating health risk due to radiological contamination at former MED/AEC facilities and properties where uranium mill tailings were used as landfill. In addition to risk assessment, the overview role has now been expanded to include program technical support and assistance; quality assurance reviews and appraisals; radiological criteria and standards as well as radiological monitoring and surveys; and evaluations and recommendations.

• Policy Studies—Radiation

The major effort on this project was to write a booklet for the Department of Energy to present to the people of the Marshall Islands concerning radiological surveys of several northern atolls and islands in 1978.

POLICY ANALYSIS--NORTHERN MARSHALL ISLANDS

W.J. Bair

The purpose of this project was to write a booklet to support a Department of Energy (DOE) presentation to representatives of the government of the Marshall Islands and of several atolls in the northern Marshalls. The document, The Meaning of Radiation for Those Atolls in the Northern Part of the Marshall Islands That Were Surveyed in 1978, authored by W.J. Bair, J.W. Healy, and B.W. Wachholz (1982), describes the radiological conditions of several northern atolls and islands as of 1978 resulting from the nuclear weapons tests conducted in the Marshalls in the 1940s and 1950s. The booklet summarizes Lawrence Livermore National Laboratory's dose assessments for people living on those islands and atolls and discusses the possible health risks people might face if they live there now or in the future.

This dual-language booklet was drafted in English and translated into Marshallese using a dynamic-equivalent translation method. The English text is a modified literal translation of the Marshallese by A. Buck, M. Jelke, and K. Sam from the Marshall Islands. M. C. Sheets created special graphics, and R. W. Baalman edited the booklet.

W.J. Bair participated with DOE representatives in a meeting with elected representatives of atolls in the northern Marshalls and officials of the government of the Republic of the Marshall Islands to explain the contents of the book and to answer questions.

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Bair, W.J., J. W. Healy, and B.W. Wachholz. 1982. Melelen Radiation Ilo Ailin ko Ituion Ilo Majol, ko Rar Etali Ilo 1978: The Meaning of Radiation for Those Atolls in the Northern Part of the Marshall Islands That Were Surveyed in 1978. DOE/NBM--1052. U.S. Department of Energy, Washington, D.C.

• Former Nuclear Site Risk Estimation

This project has involved the estimation of health effects at formerly utilized MED/AEC nuclear sites or inactive uranium mill tailing sites. This activity is a component of the overview role of the Office of Operational Safety (OOS), specifically addressing the issue of risk assessment. During FY 1983, work progressed on development of the methodology used in health effects estimation, and reports of the results of health effects calculations were prepared for vicinity properties, principally in the Salt Lake City area.

FORMER NUCLEAR SITE RISK ESTIMATION

S. Marks, F. T. Cross, D. H. Denham, W. E. Kennedy, Jr.

To date, this project has been directed principally to the development of procedures to be followed in calculating estimates of projected health effects at formerly utilized MED/AEC nuclear facilities or at properties in the vicinity of inactive uranium mill tailings sites. The principal activities have been primarily directed to vicinity properties in the Salt Lake City area. These are properties immediately adjacent to the deactivated Vitro uranium mill tailings pile or, more frequently, at a greater distance. In the latter case, tailings material had been transported to the properties at some past time for use as landfill. During FY 1983, reports were completed in final form for a number of properties and draft reports prepared on others.

Tasks under the project include characterization of the source term for each property, selection of an appropriate set of health risk coefficients, evaluation of risk from environmental pathways, calculation of estimated health effects, and suggestions for the revision of radiological survey procedures to improve the achievement of objectives under this project.

The radiological source term was described in a report for each property in which we summarized radiological survey data compiled by Oak Ridge National Laboratory (ORNL) and Mound Laboratory. The reports briefly identified the nature of activities conducted at each property, the physical characteristics of the site and structures upon it, and the presence of various types of land cover, either in or outside the structures, that may modify radiological exposure levels. Contour lines were mapped on diagrams of the properties to reflect the isopleths for gamma exposure rates when taken at 1 meter above ground. Building diagrams were incorporated in the property reports.

The source-term section described the bases for selection of gamma-ray and radon daughter exposure values that were used in the health effect calculations. The gamma-ray values were usually the arithmetic means of measurements in buildings or in areas of differing exposure within a building. Guidelines were developed for the selection of grab or continuous radon gas measurements or of grab radon daughter measurements for use in the health effect calculations. The basis for acceptance of a calculated equilibrium factor or use of a default factor of 30% was also discussed for each property.

In the vicinity properties considered to date, three types of exposure have entered into the calculation of projected health effects. These are gamma-ray exposure rates at 1 m, radon daughter concentrations, and internal emitter exposure through the food pathway for two residential properties. The latter assumed the existence of home gardens on these properties that would provide a portion of the diet to the residents. In calculating health effects resulting from gamma exposure, the end point was cancer, and the currently accepted lifetime risk coefficient of 100×10^{-6} cancer cases per rem of exposure was employed. In the case of radon daughter exposure, a risk coefficient developed by the Task Group for Radon and Daughters of NCRP Scientific Committee 57 was used. The risk coefficient is 5.6×10^{-3}/WLM/yr for lifetime risk and lifetime environmental exposure for populations having a mixture of ages similar to that of the U.S. population. This risk coefficient was further adjusted for various values of the equilibrium factor.

Three expressions for health risk were employed. One is a lifetime cancer risk per individual for gamma exposure and lifetime lung cancer risk for radon daughter exposure. The second measure is the percent increase in cancer or lung cancer relative to the individual's normal cancer or lung cancer risk. The latter is obtained by dividing the probability of death from cancer or lung cancer as a result of the radiation exposure incurred during occupancy of the property by the population lifetime risk of mortality for the corresponding disease category. Finally, the number of projected excess cancer deaths due to the radiation exposure was calculated for each property as the sum of risks due to

gamma-ray exposure, radon daughters and, for the single family residences, ingestion of food products for the total number of occupants. The number of projected cancer deaths can then be related to the cost of cleanup, thereby establishing a cost-benefit basis for assigning priorities for remedial action on various properties.

In calculating excess cancer deaths, occupancy data for many properties were obtained from the state of Utah Department of Health during FY 1983. These data were more reliable than those previously available to us and permitted a better estimate of projected cancer deaths for individual properties. If the pattern of occupancy is included in the development of estimates of projected cancer deaths, the estimates become more realistic in reflecting the variation of exposure levels that do in fact occur within many properties.

In accordance with a task assigned to the project by our OOS sponsor, recommendations for modification of radiological survey protocols were developed. These were directed to improvement of the data base for calculating estimated health effects. The suggestions included improvement in the quality of occupancy data, including the typical distribution of persons within buildings; the simultaneous grab measurement of radon gas and daughters so that equilibrium factors could be estimated; and the use of distributed track-etch devices for radon gas measurement so that the pattern of exposure levels within different areas of the building could be more accurately characterized.

The report of methods and procedures previously submitted to OOS was finalized. It included a summary description of procedures used in the project with detailed appendices relating to environmental pathway calculations, the scientific basis for the radon daughter exposure risk coefficients, and the procedure for selection of radon gas or daughter grab or integrated values in calculating health effects.

Finally, we participated in a Technical Measurements Center Workshop in Grand Junction, Colorado, to help develop the survey protocols employed by DOE radiological survey contractors for estimation of indoor radon and radon daughter concentrations.

• Liquefied Gaseous Fuels (LGF) Safety Studies

The LGF Safety Studies project, started in FY 1977 with work on liquefied natural gas (LNG), was completed at the end of FY 1982. Objectives of this project were (1) to conduct research on LGF release prevention and control in support of DOE's LGF Safety and Environmental Control Assessment Program, and (2) to provide assistance to DOE in the planning, implementation, and technical surveillance of it's Program.

LGF SPILL TEST FACILITY

J. G. DeSteese

Though the LGF Safety Studies Project was completed at the end of FY 1982, PNL responded to a request from Headquarters to help complete a report. In March 1983, the House Appropriations Subcommittee on Energy and Water Development asked the DOE Assistant Secretary for Environmental Protection, Safety and Emergency Preparedness to prepare a report on the proposed Spill Test Facility for hazardous chemicals and liquefied gaseous fuels. PNL staff provided the executive summary and introduction sections together with the comprehensive appendix of background detail and the bibliography in the report DOE submitted to Congress. This report was entitled Construction and Operation of a Liquefied Gaseous Fuels Spill Test Facility (DOE/EP-0094). PNL also participated in the activities of the report preparation committee and assisted in the review and editing of sections provided by other contributors.

• Environmental Protection Support and Assistance

The Pacific Northwest Laboratory continued to provide technical assistance to DOE's Office of Operational Safety (OOS) in the area of environmental protection. PNL's technical support included extensive assistance in planning and conducting the fourth DOE Environmental Protection Information Meeting and assisting in the review of proposed Clean Air Act emission standards for radionuclides. The *Guide for Effluent Radiological Measurements at DOE Installations* was completed and published, and work was started on the new environmental radiological surveillance guide. A report summarizing the radioactive effluents from DOE facilities was prepared.

ENVIRONMENTAL PROTECTION SUPPORT AND ASSISTANCE TO DOE/OOS

J. P. Corley, C. D. Corbit, P. A. Eddy, C. J. English, K. A. Hawley, R. E. Jaquish, I. C. Nelson, L. S. Prater, J. K. Soldat, J. R. Raymond, D. G. Watson, E. C. Watson

The Environmental Protection Support and Assistance program provides the Department of Energy's Office of Operational Safety with technical support to assist OOS in accomplishing its environmental protection objectives. Several tasks are funded concurrently, at the request of OOS, to provide flexibility in response to management priorities as they evolve. Task areas addressed during 1983 included:

- completion and publication of a guide for effluent measurements at DOE facilities
- evaluation of the DOE Quality Assessment Program through a workshop and review of results submitted by participants
- review of environmental dose modeling methods at DOE facilities
- summation of environmental report information from DOE nuclear facilities
- continued development of reporting systems for management of environmental program information
- assessment of need for tracking DOE commitments made in environmental impact statements
- initial development of guidelines and model program for ground-water monitoring at DOE facilities
- assistance to OOS in organizing and conducting the Fourth DOE Environmental Protection Information Meeting
- review of emission standards proposed for radionuclides under the Clean Air Act.

EFFLUENT AND ENVIRONMENTAL MONITORING GUIDES

J. P. Corley

The environmental monitoring guide, a companion document to the effluent guide, is in the process of being revised and updated. This guide was written to promote greater uniformity in DOE environmental radiological monitoring programs.

QUALITY ASSURANCE REVIEW AND RECOMMENDATIONS

R. E. Jaquish

PNL's support to the DOE Quality Assessment Program continued with a review of the activities and facilities of the Environmental Measurements Laboratory in New York. A Quality Assurance Workshop was organized and conducted; a summary of the workshop was prepared and distributed to participants. The results of interlaboratory participation in sample analysis were reviewed, and statistical analysis of the data was provided to the Steering Committee.

ENVIRONMENTAL DOSE MODELING REVIEW

J. P. Corley

This task reviews the computer codes and models DOE facilities use to predict radiation doses to the public. A panel on environmental dose modeling has been established, selecting experienced individuals from throughout DOE. Members are currently reviewing the methods of dose modeling in use and will provide comments and recommendations early in FY 1984.

SUMMARY OF ENVIRONMENTAL REPORTS

K. A. Hawley

Each year, PNL provides for DOE management a summary of the information contained in the annual environmental reports generated by the DOE nuclear facility contractors. The 1981 report was published this summer; the 1982

report (based on contractor documents received in May of 1983) was distributed to the sites for comment.

REPORTING SYSTEMS FOR ENVIRONMENTAL INFORMATION

R. E. Jaquish

A prototype system designed to manage information on environmental programs at DOE facilities has been developed for the Office of Operational Safety. The system, which has several components, will manage information on the scope of environmental programs and on the status of their compliance with various environmental regulations.

FOLLOW-UP TO ENVIRONMENTAL IMPACT STATEMENT COMMITMENTS

I. C. Nelson

A method was developed to select and track commitments made in DOE Environmental Impact Statements. A level of effort for this "EIS Follow-Up" was drafted for DOE management to consider, and a paper on the feasibility of such a program was presented at the DOE Environmental Protection Information Meeting. The task was closed in July.

GROUND-WATER MONITORING

P. A. Eddy, J. R. Raymond

A draft guideline of ground-water monitoring programs for DOE facilities was provided to DOE/OOS for review along with a model program. DOE Orders were reviewed for their ground-water program requirements, and FY-1984 activities were developed in consultation with DOE/OOS staff.

DOE ENVIRONMENTAL PROTECTION INFORMATION MEETING

J. P. Corley

Arrangements for the Fourth DOE Environmental Protection Information Meeting were made. PNL staff provided administrative support during and after the meeting. The proceedings, edited and organized by PNL, were published by DOE this summer.

SPECIAL ASSISTANCE

R. E. Jaquish

This special assistance task provides quick responses to issues that fall outside the scope of the other established support programs. Technical support is given on an ad hoc basis as requested. During 1983, the activities conducted under this task included providing support to OOS staff by reviewing emission standards proposed for radionuclides under the Clean Air Act, reviewing changes suggested for 10 CFR 20, and examining the reporting requirements specified in DOE Order 5484.1A.

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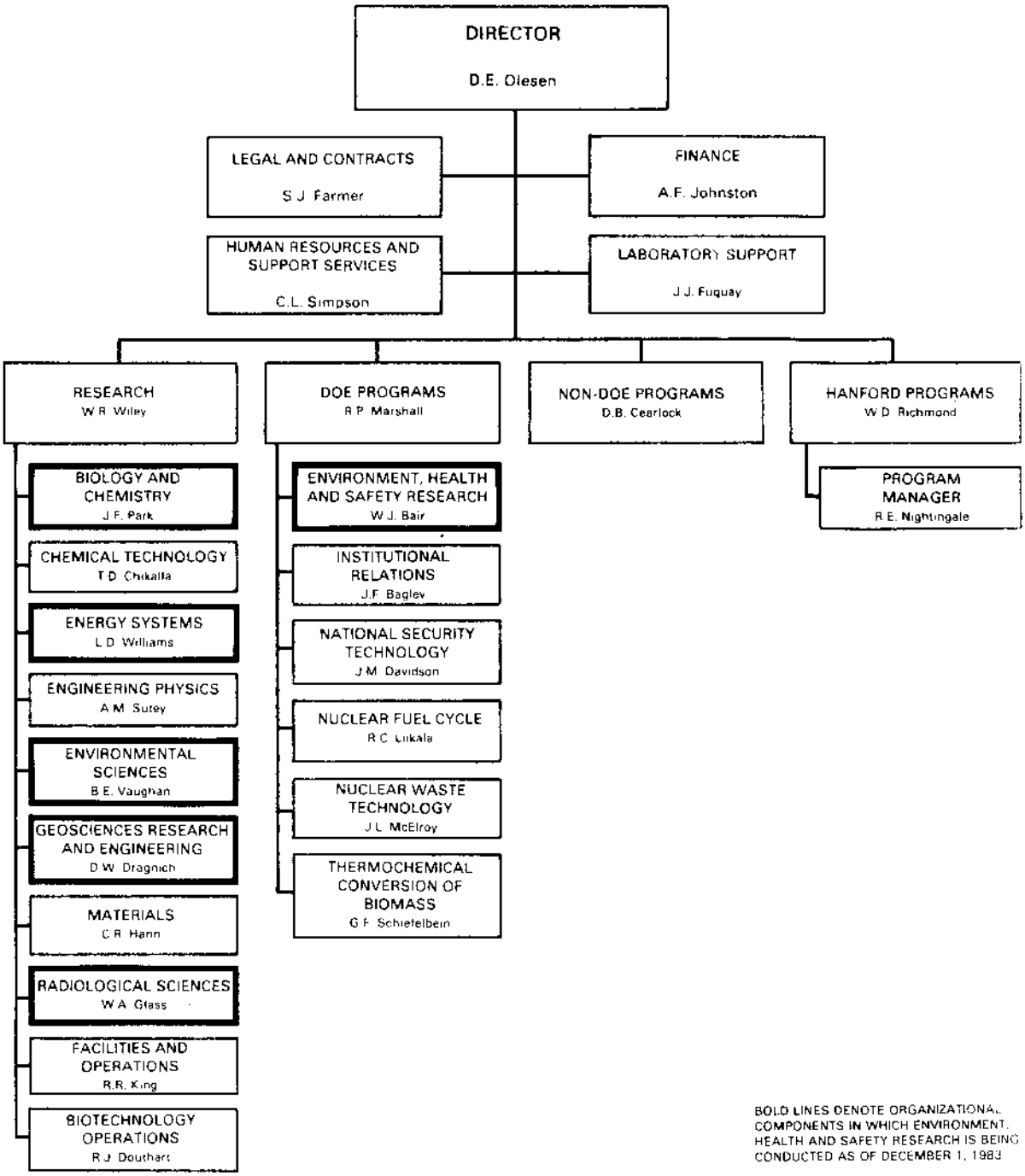

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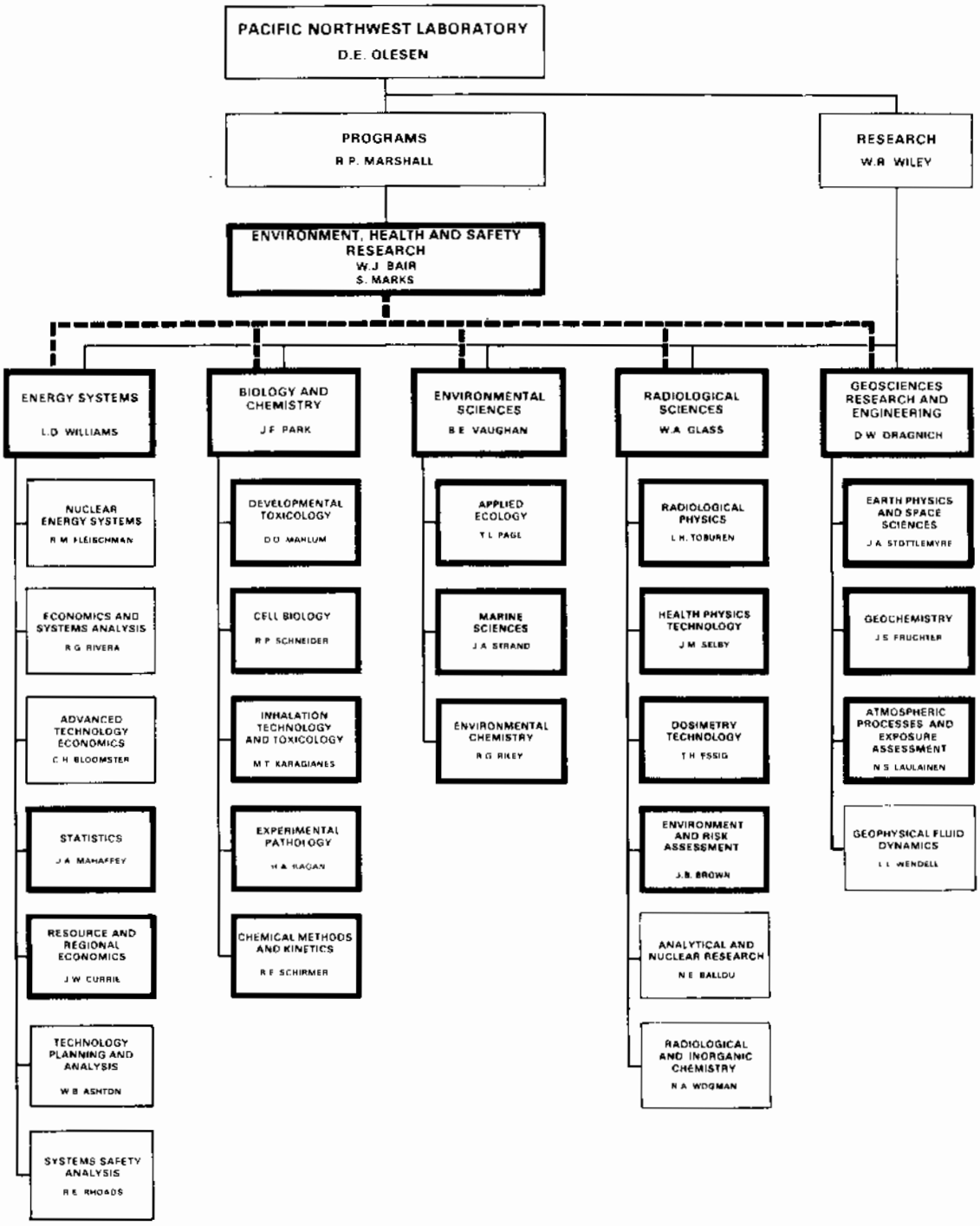

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