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**HEALTH AND SAFETY RESEARCH DIVISION
PROGRESS REPORT FOR THE PERIOD
October 1, 1988 - March 31, 1990**

Stephen V. Kaye
Director

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FOREWORD

Stephen V. Kaye

The Health and Safety Research Division (HASRD) of the Oak Ridge National Laboratory (ORNL) continues to maintain an outstanding program of basic and applied research displaying a high level of creativity and achievement as documented by awards, publications, professional service, and successful completion of a variety of projects. Our focus is on human health and the scientific basis for measurement and assessment of health-related impacts of energy technologies.

It is our custom to publish a division progress report every 18 months that summarizes our programmatic progress and other measures of achievement over the reporting period. Since it is not feasible to summarize in detail all of our work over the period covered by this report (October 1, 1988, to March 30, 1990), we intend this document to point the way to the extensive open literature that documents our findings.

Major changes were effected in the Division's management by appointment of three new Section Heads. Harvel A. Wright retired and was replaced by Robert N. Hamm as Head of the Biological and Radiation Physics Section. Tim Ensminger transferred to the Energy Division, and Po-Yung Lu was appointed as the new Section Head of the Biomedical and Environmental Information Analysis Section. John C. Miller was appointed Head of the Chemical Physics Section after W. Ray Garrett decided to return to full-time research. The Division is indebted to the former Section Heads for their dedicated service and their many contributions as managers.

The following individuals were appointed to group leader positions during the reporting period: C. H. (Winston) Chen, Group Leader of Photophysics, Mary W. Francis, Acting Group Leader of Environmental Regulations and Remediation, and Robert H. Ross, Group Leader of Chemical Hazard Evaluation and Communication.

Rufus H. Ritchie was named a Senior Corporate Research Fellow of Martin Marietta Energy Systems, Inc. His appointment elevated him to the highest level possible for a scientist at ORNL and is a deserved recognition for his outstanding career as a theorist in radiation physics and radiation dosimetry, surface physics, and plasmon interactions. His career has been characterized by a sustained level of creativity and productivity with major contributions to many fields.

Tuan Vo-Dinh, Leader of the Advanced Monitoring Development Group, was recipient of the *Medal of the Languedoc-Roussillon Region Award* (1989) for his scientific achievements and to commemorate the establishment of a research collaboration between ORNL and the Laboratory of Physical Chemistry, University of Perpignan, France.

In 1985, the Division established the *Excellence in Research Award* to be presented annually to a HASRD staff member for either applied research (even-numbered years) or basic research (odd-numbered years). The award is given for outstanding examples of creative and innovative contributions to science as judged by a special panel of senior ORNL staff. Tom Ferrell and Bruce Warmack were corecipients of the 1988 award for their invention of the Photon Scanning Tunneling Microscope. In 1989, the award was shared by Ray Garrett and Marvin Payne for their work in nonlinear optics.

A new HASRD award, the *Distinguished Achievement Award*, was instituted in 1989 for support staff. Ogene Jennings received the *Distinguished Achievement Award for Administrative Support* for 1989. Judy Wyrick received the *Distinguished Achievement Award for Technical Support* for 1989. The award will be given annually hereafter.

Three HASRD staff members were honored during Energy Systems Awards Night ceremonies for outstanding achievements in 1989. Gloria M. Caton received the *Operational Performance Award* for distinguished service in managing information for the formal critical review of the Department of Energy (DOE) Energy Conversion and Utilization Technologies Materials Program. T. L. Ferrell and R. J. Warmack shared the Inventor Award for their Photon Scanning Tunneling Microscope.

One index of creativity of which we are particularly proud relates to receiving patents. The HASRD staff were awarded a total of seven patents during the reporting period. Additionally, for their invention of the Photon Scanning Tunneling Microscope, Tom Ferrell and Bruce Warmack received both the *Fabry-Gramont Award* from the French Optical Society and, along with Robin Reddick, an *R&D-100 Award*. Plans are proceeding to commercialize this promising new instrument.

Russ Knapp, Leader of the Nuclear Medicine Group, was recipient of the prestigious *Senior U.S. Scientist Award* from the Alexander von Humboldt Foundation of West Germany, in recognition of his achievements in radiopharmaceutical research and the development of new agents for clinical applications in nuclear medicine.

During the reporting period the Division continued to maintain strong programs in its traditional areas of R&D, but also achieved noteworthy progress in other areas. Our

health risk analysis initiative is a vigorous program that involves most of the Division and has excellent prospects for long-term growth. Much of the Division's work on site characterization, development of new field instruments, compilation of data bases, and methodology development fits into this initiative. Other new work in tunneling microscopy in support of DOE's Human Genome Program and the comprehensive R&D work related to surface-enhanced Raman spectroscopy have attained new and exciting results. These examples of our progress and numerous other activities are highlighted in this report.

It is the HASRD staff who make all of these great things happen. Their contributions to ORNL, Energy Systems, DOE, and other sponsors are highly significant. We are confident that this high level of performance will carry on to the future as new programs and challenges arise.

1. HEALTH STUDIES SECTION

A. R. Hawthorne, Head

Staff

Research:

K. R. Ambrose¹
A. P. Callahan
M. Cristy
C. S. Dudney²
C. E. Easterly
K. F. Eckerman
G. D. Griffin
T. D. Jones
G. D. Kerr
F. F. Knapp, Jr.

D. C. Kocher³
R. W. Leggett
D. W. McPherson
S. Mirzadeh
P. C. Srivastava
R. L. Tyndall
M. Uziel
T. Vo-Dinh
A. P. Watson

Technical Support:

J. F. Allred
C. R. Lambert
G. H. Miller

B. A. Owen
D. E. Rice

Clerical Support:

L. K. Ailey
A. B. Brown^{1,2}
J. B. Cooper

S. L. Freels
L. E. Thurston
R. R. Weston

Consultants:

A. Bockisch
C. Brihaye
M. M. Goodman

M. K. Griffith
G. W. Kabalka
D. J. Laborde

Guest Scientists:

V. Ananthanarayanan
S. J. Boyarsky
R. E. Faw
A. M. Hoyt
A. M. Helmenstine
B. M. Hoffman
J. A. Holland
K. S. Houck
K. S. Ironside
R. A. Jernigan
E. L. Kleinpeter
J. Kropp

T.-W. Lee
M. Panjehpour
M. R. Pawel
R. D. Piccard
A. G. Montague
J. Muniz
R. J. Nichols
M. S. Ryan
A. K. Pal
T. Pal
R. D. Piccard
M. J. Sepaniak

M. G. Stabin
D. L. Stokes
E. Tan
G. Umbricht

A. A. Vass
P. Viallet
R. A. Zingaro

Students:

J. P. Alarie
K. K. Barnes
H. S. Busche
C. F. D'Cruz
F. G. Dolislager
S. K. Farrar
L. D. Ford
W. M. Hietpas
A. B. Holland
J. L. Holmes

D. S. F. Hyder
S. J. Lambert
M. Mouton
L. I. Pedraza-Martinez
K. Purcell
K. W. Stretch
B. J. Tromberg
W. E. Watts
R. J. Westfall
L. Zuckerman

Postdoctoral Fellows:

J. M. Bello
S. L. Blystone
H. F. Cheng
L. R. Glass

R. W. Johnson
A. Hasan
E. C. Lisic

Subcontractors:

T. E. Aldrich
L. T. Dillman
P. C. Gailey

C. B. Hamilton
L. R. Williams

Loanees from other divisions:

M. D. Morris⁴
J. C. Ryman⁵

A. J. Sjoreen⁵
R. C. Ward⁵

Research in the Health Studies Section is directed toward developing and applying new methods for the measurement and assessment of human health impacts from radiation and chemicals. This research is organized into four groups. The Advanced Monitoring Development Group develops novel or improved instruments and methods for assessing human exposures to low levels of toxic chemicals as well as for measuring potential bioindicators of health effects. The Health Effects and Epidemiology Group develops and improves human health effects assessment methodologies to assess the impact and relative risk of various technologies on human health. The focus of the Metabolism and Dosimetry Research Group is on understanding the radiation exposure-dose relationships through modeling the behavior of radionuclides within the body and

the deposition of ionizing energy within radiosensitive tissues from these radionuclides or from radiation externally incident upon the body. The Nuclear Medicine Group is involved in the design and development of new tissue-specific radiopharmaceuticals for disease diagnosis and therapy. Effective transfer of developed technology to the public (e.g., regulators and standard-setting bodies) and commercial sectors is emphasized by all of the groups. Highlights of accomplishments during this reporting period are given in the following sections.

¹Part-time employee.

²Dual capacity.

³Off-site assignment.

⁴Engineering Physics and Mathematics Division.

⁵Computing and Telecommunications Division.

ADVANCED MONITORING DEVELOPMENT

The research program of the Advanced Monitoring Development Group involves multidisciplinary research efforts targeted toward three major areas: (1) cost-effective chemical and biological screening techniques, (2) biological and chemical sensors, and (3) basic technical advances of emerging monitoring technologies.

We have initiated the development of the second-generation fluoroimmunosensors (FIS). The previous FIS devices were developed for "one-shot" measurements, whereas the second-generation FIS devices are designed to be regenerable. By combining FIS technology with a capillary reagent delivery system, we have constructed microscale sensors that are capable of performing a variety of heterogeneous FIS procedures repetitively, remotely, and in situ. These procedures include adding solid- or liquid-phase antibody, adding secondary reagents (e.g., the labeled "second" antibody when performing sandwich assays), and rinsing to remove unbound impurities. In addition to delivering reagents, the sensor has the capability of sampling analyte through a membrane via either diffusion or aspiration. The latter mode of sampling could be very beneficial in the eventual use of the sensor for the measurement of large molecules.

During this reporting period we have successfully demonstrated the effectiveness of fumed silica as a fluorescence enhancer on a paper support utilizing a biologically important compound [viz, benzo(a)pyrene-tetrol (BPT)] as a model system. Experimental factors such as the type and concentration of fumed silica and method of application were

evaluated in detail. The results indicate that fumed silica induces an efficient enhancement of the fluorescence emission signals from BPT on a filter-paper background and is therefore potentially useful for the luminescence screening of polynuclear aromatic (PNA)-DNA adducts.

We continue to develop and evaluate solid substrates that are designed to be practical, inexpensive, and effective for surface-enhanced Raman scattering (SERS) measurements. The SERS-active substrates based on microparticles (e.g., Teflon microsphere, titanium dioxide) have been further investigated and have demonstrated their effectiveness. During this reporting period we have measured several purines and pyrimidines and investigated their SERS spectral structures. Our substrates allow us to perform SERS measurements in solution.

We have produced a variety of DNA adducts by incubating calf thymus DNA with the appropriate polyaromatic epoxides in vitro. Four different PNA compounds [benz(a)anthracene, dibenz(a,c)anthracene, benzo(a)pyrene, and methylcholanthrene] were used to produce the adducts. Subsequently, the level of adduction for the various PNAs (i.e., PNA residue per unit of base pairs of DNA) was determined using fluorescence to quantify the PNA (hydrolyzed from the DNA by acid) and ultraviolet (UV) absorbance to quantify the DNA. Spectroscopic techniques were used to detect the PNA as actual DNA adducts (i.e., nonhydrolyzed, bound to DNA). The synchronous fluorescence technique developed in our group was found to provide excellent selectivity in identifying the PNAs bound to DNA. Limits of detection by this technique are currently in the range of 1 PNA adduct per 10^5 to 10^7 base pairs, and research is under way to extend the sensitivity to a lower level of adduct detection.

Novel DNA sequencing procedures using hybrid technologies are being developed. We are applying the techniques of fluorescence to detect the sequence ladder and capillary zone electrophoresis to develop the sequence. M13 Primer has been 5'-labeled with fluorescein and biotin. Subsequent electrophoresis on conventional slab gels has successfully demonstrated the performance of these modified primers in a standard sequencing reaction. Detection of the fluorescein is accomplished with the argon ion laser and a charge-coupled device as detector.

In addition, the development of an instrument for stepwise sequencing of DNA has led to a new selective chemical oxidant for alcohols that was shown to be quantitative within minutes in tests conducted at room temperature and at -80°C . The reagent has been demonstrated to react with both low-molecular-weight alcohols and oligodeoxynucleotides. Work is in progress to optimize conditions for use in the DNA stepwise

sequencer. Design of a low-cost, large-scale parallel processing unit is under way. This approach will provide additional sequence information that cannot be obtained by conventional sequencing methods.

HEALTH EFFECTS AND EPIDEMIOLOGY

To improve human health risk assessments, the Health Effects and Epidemiology Group synthesizes laboratory-based bioassay data, epidemiology results, and mathematical models based on first principles. Work is intentionally balanced between studies at a fundamental level and applications. Long-term objectives include the placement of hazards from varying insults (e.g., chemicals, nonionizing electromagnetic energy, physical agents, ionizing radiation) on a common scale and the development of methods to place the common scale of hazards in perspective with consequences of normal daily human life. This report summarizes three of many activities during the reporting period.

One of the group's activities is focused on the development of microbiological information needed to characterize the hazards of the human environment. Most studies detailing the impact on health of aerosolization of microorganisms from aqueous components of heating and cooling systems are concerned with industrial settings. Our recent study was undertaken with the Consumer Product Safety Commission to detail the microbiology of aerosolization reservoirs used in the home environment. Humidifiers tested included cool mist, ultrasonic, console, and steam vaporizers. When these humidifiers were initially filled with normal tap water, there was no obvious correlation of the ability to support microbial growth with type of humidifier. Conversely, the ability to aerosolize microbes was dependent on humidifier type. Cool-mist units aerosolized both bacteria and hydrophobic fungal spores while ultrasonic units aerosolized bacteria but not hydrophobic fungal spores. Console units and steam vaporizers aerosolized few microbes under test conditions used. Attempts to decontaminate humidifiers in laboratory studies were only temporarily effective.

In addition to laboratory studies, the microbial content of 88 humidifier reservoirs obtained from home environments was characterized. Several genera of bacteria (i.e., *Pseudomonas*, *Flavobacterium* and *Bacillus* sp.) and free-living amoebae were found in the majority of units. An encephalitic *Acanthamoebae* sp. was isolated from one of the units. Other potentially pathogenic or allergenic agents such as *Balantidium* and

Enterobius as well as fungi such as *Penicillium* and *Aspergillus* were found in over 30% of the home humidifiers.

Work for the Defense Nuclear Agency included evaluations and validations of the mathematical model of bone marrow cell-renewal kinetics that we have developed over the past few years. The cell-kinetic model can now be used to equate any protracted irradiation by photons to an equivalent prompt dose. The equivalent prompt dose can be used to estimate the magnitude of the depressed hematopoietic function and to predict the associated probability of death between about 5 and 60 days post-exposure.

The cell kinetic model is serving to elucidate biological mechanisms of mortality not understood previously. For example, recent work has demonstrated that the rate-limiting step for hematopoiesis may be structural integrity of the marrow stromal cells that provide the microenvironment upon which the hematopoietic stem cells (HSCs) seed and repopulate after injury from irradiation. A common opinion has been that only the surviving fraction of the HSCs controls recovery from bone-marrow depression and that the complete blood and marrow complex can be regenerated by very few of these cells—perhaps as few as 30 in mice. Because of complex biochemical interactions between the HSCs and the microenvironment, it has not been possible experimentally to explore the exact interaction of these cell populations quantitatively. However, with our cell kinetics model, we have been able to calculate the cell-survival curve for the rate-limiting step in HSC proliferation. The rate-limiting step seems to be the surviving fraction of stromal cells in the hematopoietic marrow. It is therefore expected that the exact number of surviving HSCs is not directly related to the fate of the animal. Rather, the surviving fraction of HSCs is likely to be a secondary index that is, under simple irradiation conditions, just another index of the equivalent prompt dose.

The finding that formaldehyde resins in plumbing fixtures in a large Naval housing complex could result in release of formaldehyde into residential drinking water prompted a concern that chronic ingestion may present a carcinogenic risk to Navy personnel. Based on a comprehensive analysis of formaldehyde metabolism and biological mechanisms, and comparison of drinking water exposure levels with formaldehyde levels commonly found in foods, it was concluded that low-level formaldehyde exposure (20 ppb) through the drinking water in base housing does not constitute a health hazard. By the same oral route of intake, humans typically ingest about 11 mg daily of formaldehyde in foods, a level of intake almost 300 times greater than that from ingestion of formaldehyde as a drinking water contaminant at 20 ppb. Metabolic studies indicate that the low levels of formaldehyde contaminating the drinking water are readily

detoxified by enzymatic processes already in place for the normal utilization of endogenous formaldehyde.

Investigation of the biological mechanisms of formaldehyde indicate that formaldehyde responses are distinctly nonlinear, resulting in an apparent threshold of effects from formaldehyde exposure. The primary determinant of formaldehyde toxicity is the concentration, not the cumulative dose. Thus, small doses that do not overwhelm metabolic detoxification do not result in cumulative toxicity. Furthermore, only cytotoxic levels of exposure appear to be capable of inducing a carcinogenic response, and the subcytotoxic levels, such as are found in the drinking water at the base housing and in normal foods, are not likely to potentiate carcinogenesis. Our work offered an approach to regulation based on available information suggesting that formaldehyde is a normal product of metabolism, possesses an apparent threshold of effects, is characterized by a nonlinear dose response, and is ingested daily in milligram amounts. Considering ingestion in foods as a surrogate chronic toxicity study, we estimated a permissible level of formaldehyde in drinking water to be about 0.5 ppm. This approach does not rely on linear extrapolation of the carcinogenic dose response from a chronic inhalation study to estimate low-dose risk from ingestion, a method that results in an overestimation of low-dose risk and may place an unnecessary, costly burden on regulated sources. The alternative approach offered by our analysis suggests that the regulation of formaldehyde should be based on a larger, comprehensive body of knowledge incorporating all levels of data instead of restricting the focus to formaldehyde's carcinogenic status.

METABOLISM AND DOSIMETRY RESEARCH

The main task of the Metabolism and Dosimetry Research (MDR) Group is the development of radiation exposure-dose relationships through modeling the biokinetics of radionuclides within the body and modeling the deposition of ionizing energy within radiosensitive tissues from these radionuclides and from radiation externally incident upon the body. Such exposure-dose relationships are the cornerstone of radiation protection and also serve an important role in the evaluation of medical diagnostic procedures involving use of radiopharmaceuticals and X-ray machines.

Biokinetic models developed in the past to describe the behavior of radioactive elements have been derived on an empirical basis—that is, by fitting simple mathematical expressions to available element-specific retention data for adult humans and laboratory animals. Such mathematical expressions provide some basis for calculating integrated

doses from radionuclides but, in general, have no discernible correspondence to the physiological processes actually controlling behavior of the radionuclides in the body. Development of models describing the biokinetics in persons other than a hypothetical young adult male has required a substantial departure from this approach because of the scarcity of element-specific data for special populations.

As far as is practical, the models currently being developed by the MDR group explicitly depict the tissues and physiological processes controlling the movement or retention of radionuclides in the body. The advantages of a physiologically realistic approach are that it allows (1) incorporation of basic physiological information into the model, (2) realistic treatment of decay products formed in the body, (3) meaningful extrapolation of data from laboratory animals to humans, (4) meaningful analogies between an element of interest and physiologically similar elements, and (5) linkage between excretion of a radioactive element and movement among body tissues and blood. Biokinetic models developed by the group as well as age-specific dosimetric models are featured in the first report of the International Commission on Radiological Protection (ICRP) to tabulate data on the organ dose per unit intake for individuals of various ages.

In a collaborative effort with Children's Hospital National Medical Center in Washington, D.C., routine diagnostic computerized axial tomography (CAT) scans are being used to develop a data base of three-dimensional images of the body. The data base is being used to define the volumes, masses, shapes, and spatial relationships of body organs in an age-dependent manner. CAT images have been used to construct a highly realistic anatomical representation used with Monte Carlo methods to evaluate radiation transport in the body.

Members of the group are involved in work of various committees and task groups of the National Council on Radiation Protection (NCRP), the Medical Internal Radiation Dose (MIRD) committee of the Society of Nuclear Medicine, and the ICRP. In addition, the group provides technical support to the work of the Radiation Effects Research Foundation (RERF) regarding the dosimetry of the A-bomb survivors and dosimetry expertise to the National Cancer Institute and various other working groups. Of particular relevance to our research interests is the work of Scientific Committee 57 on Internal Emitters of the NCRP and the task groups of ICRP Committee 2 (the task group on Revision of Reference Man, the task group on Age-Dependent Dose per Unit Intake, and the task group on Dose Calculations). The MDR group has also provided expert assistance to the local radiological health protection organization to help improve the

quality of radiological protection provided to contractor employees, guests, and the public.

NUCLEAR MEDICINE

Research conducted in the Nuclear Medicine Program focuses on the design and development of new tissue-specific radiopharmaceuticals for diagnosis and therapy. In addition to the synthesis and testing of new radiopharmaceuticals for in vivo nuclear imaging, other activities include biochemical studies to determine the mechanism of tissue specificity of the radiolabeled agents and preclinical testing of new radiolabeled agents in laboratory animals and various in vitro systems. In conjunction with the development of radiopharmaceuticals, production and processing techniques are developed for radionuclides of interest. New radiolabeling techniques are also developed to incorporate radionuclides into various tissue-specific agents for both diagnostic and therapeutic applications. New radiolabeled agents are distributed internationally to approximately 20 Medical Cooperative Programs at clinics, universities, and other research institutions for further collaborative preclinical testing and clinical evaluation. This balance between basic research and development and interaction with key programs at other institutions continues to form the basis of a strong Nuclear Medicine Program. Our collaborative programs bridge the gap between our development and initial distribution studies of agents in animals and more detailed preclinical testing in special animal models and clinical testing with collaborators.

Clinical testing in conjunction with several medical cooperative investigators is continuing. Iridium-191m from our activated carbon $^{191}\text{Os}/^{191m}\text{Ir}$ generator system has unique applications for the diagnosis of heart and vascular disease. The ultrashort half-life of ^{191m}Ir (4.9 s) allows rapid, repeat studies with low radiation exposure. Clinical trials are in progress through our Medical Cooperative Programs in Belgium and West Germany, and over 600 patient studies have been performed. Work on this generator at Oak Ridge National Laboratory (ORNL) is now supported by the National Institutes of Health (NIH) and is directed at optimizing generator fabrication and pursuing applications such as continuous elution. In addition, the ^{123}I -labeled (BMIPP) methyl-branched fatty acids developed in our program are also in clinical trials. This unique agent is an important tool in cardiology research and is used for the evaluation of differences in regional myocardial blood flow (perfusion) and fatty acid energy substrate uptake by single-photon computerized tomography (SPECT). One important collaborative program with Brookhaven National Laboratory (BNL) involves use of our BMIPP agent to

evaluate the effects of cocaine intoxication on myocardial metabolism. Cocaine-induced deaths usually result from heart failure.

New radiolabeled maleimide agents for labeling antibodies and other proteins for diagnostic and therapeutic applications are being further developed. The (piodophenyl) maleimide (IPM) has been licensed to E. I. Du Pont de Nemours & Company for research applications and is the first agent under license from this program. Monoclonal antitumor antibody labeling studies with radioiodinated IPM conducted in conjunction with medical cooperative investigators have demonstrated good labeling yield and very low loss of radioiodide in tumor-bearing animals. New maleimide analogues have also been prepared for easy introduction of radioactive iodine to further expand the scope of this important agent.

New methods are also being developed for synthesizing bifunctional chelates for attaching radioisotopes of copper (^{64}Cu - ^{67}Cu) and rhenium (^{186}Re and ^{188}Re) to antibodies for therapy and diagnosis. Our studies with ^{64}Cu -chelate antibody complexes are directed at developing an agent for tumor detection with positron emission tomography (PET). The development of ^{188}Re chelates parallels our development of the new $^{188}\text{W}/^{188}\text{Re}$ radionuclide generator system. We are also developing new radiolabeled agents that bind to specific receptors in the heart and brain for imaging applications.

The development and use of radionuclide generators continue to be an important focus of the program. Studies with the $^{188}\text{W}/^{188}\text{Re}$ radionuclide generator system developed in our program are continuing to assess approaches for attachment of ^{188}Re to antibodies and particles for a variety of therapeutic applications. There is widespread interest from both commercial manufacturers and cancer researchers in the use of ^{188}Re , which decays with the emission of high-energy electrons.

Another area of research includes the development of radiolabeled nucleoside analogues for the localization and therapy of tumors. Nucleosides are major constituents of nucleic acids and are attractive as carriers of radioactivity to tumors because of the increased cell division. Of particular interest are the radioiodinated acyclonucleosides which have the potential of localization in the hypoxic necrotic areas of tumors, offering diagnostic opportunities. The radioiodinated acyclonucleosides prepared under this project show tumor specificity.

Transfer of our new technologies to the commercial sector is progressing. Several U.S. patents have been granted, and discussions for additional licensing agreements are in progress. Beginning in FY 1989, a major new activity was initiated to support radioisotope production development technology for biomedical applications. This new

effort, closely related to our traditional radiopharmaceutical development efforts, involves development of production technology and radionuclide generator systems that have applications in nuclear medicine and related biomedical research. With the 1990 restart of the High Flux Isotope Reactor (HFIR), we also expect this resource to be available once again for production of radioisotopes for our research. New opportunities are under way in the area of PET in conjunction with the University of Tennessee Biomedical Imaging Center.

2. ENVIRONMENTAL MEASUREMENTS AND APPLICATIONS SECTION

B. A. Berven, Head

Staff

Research:

D. E. Bohrman
M. A. Buckner
R. F. Carrier
W. H. Casson
W. D. Cottrell
T. A. Cronk
K. S. Dickerson
C. S. Dudley
M. L. Espegren
D. E. Fields
R. D. Foley
R. B. Gammage
F. G. Gardner
L. G. Greeley
D. W. Greene¹
J. W. Haas III
D. K. Halford
S. C. Hall

D. C. Landguth
C. A. Little
J. E. Nyquist
J. E. Peterson
D. A. Pickering
J. L. Quillen
R. E. Rodriguez
C. S. Sims
D. R. Smuin
M. W. Smuin
R. E. Swaja
E. A. Wachter
S. J. Wallace
J. K. Williams
D. L. Wilson
D. A. Witt
E. A. Zeighami

Technical Support:

J. A. Atencio
A. C. Butler
R. L. Coleman
M. K. Jensen
R. R. Knott
R. P. Lenc
N. F. Lewis
R. A. Mathis
C. A. Muhr
V. P. Patania
R. C. Phillips

G. A. Pierce
E. M. Pilz
D. A. Roberts
D. A. Rose
T. R. Stewart
J. E. Thate
P. F. Tiner
G. H. Triplett
W. Winton
K. M. Woynowski

Clerical Support:

D. K. Barslund
T. L. Bradford
A. W. Brown²
D. E. Chavarria
L. E. Collins
A. DeLozier
D. F. Dickerson

T. J. Graves
S. E. Huckaba
O. V. Jennings²
G. Morrison
L. R. Pyles
C. D. Retolaza
L. H. White²

Guest Scientists:

L. L. Cole
A. Moreno
H. Murakami

S. C. Reddy
H. Sabuncu
P. K. TerKonda

Consultants:

M. M. Carrabba
J. A. Cherry
J. J. Daniels
S. L. Friess
J. S. Gaffney
P. M. Gschwend
D. E. Holloway
D. S. Kaback
J. A. McIntire

J. F. Pankow
D. L. Perry
J. W. Poston
M. L. Randolph
S. R. Sturm
J. M. Thomas
G. R. Walter
T. J. Whitaker
T. C. Yeh

Students:

G. S. Adkisson
B. C. Bauer
M. Brooks
B. P. Buckley
J. K. Buhl
R. L. Clemons
M. C. Dicke
S. A. Fink
D. D. Folse

D. D. Goff
G. L. Goolsby
S. Kilgore
E. Y. Lee
C. J. Liu
W. J. Oldendorf
B. E. Parish
S. M. Sipe
C. L. Thomas

Subcontractors:

M. Abdelrazek
V. E. Avery
S. F. Barnett
S. M. Berkoff
W. H. Burke
N. L. Conklin
J. R. Davidson
J. C. DePriest
P. V. Egidi
D. B. Ertel
S. M. Field
G. R. Foltz
D. S. Foster
W. L. Foutz
C. C. Francis
L. L. Friese
D. Gibson
R. C. Gosslee
C. Griffith

D. K. Hawkins
K. A. Hebbard
T. D. Herrera
R. F. Hughes
S. L. Jeffries
V. J. Johnson
A. K. Klitz
B. J. Krall
L. R. Lesperance
D. S. List
D. A. Locke
D. Marty
R. L. Meredith
M. Mumby
D. A. Over
A. T. Payne
R. G. Phillips
D. T. Redding
J. A. Rice

E. K. Roemer
 L. P. Routtan
 R. J. Saultz
 E. P. Schlauger
 R. M. Schlosser
 C. H. Searcy
 D. L. Sellers
 L. D. Sinclair
 R. B. Slaten

S. M. Smith
 T. J. Sowell
 G. K. Stone
 S. A. Tighe
 K. V. Warthan
 R. J. Watson
 L. West
 J. L. Zutman

Loanees from other divisions:

E. G. Bailiff³
 M. S. Blair⁴
 L. B. Holland³
 P. M. Kearn⁵

N. E. Korte⁵
 G. R. Patterson⁶

The major focus of the integrated groups in this section is the area of environmental assessments as they impact human health. Specifically, this section develops, calibrates, and uses instrumentation to measure radiological and chemical environmental contaminants and evaluates the transport of these contaminants through the environment to assess potential exposure to humans. Resources exist in this section to measure or sample virtually any radiological or chemical contaminant in the environment, determine its magnitude and extent, model its movement through the environment, and estimate potential human exposure to it. Capability and interest exist in the section in the areas of measurement and calibration of instrumentation and dosimeters in radiation detection, research and development of instrumentation to detect a variety of organic chemicals in the environment, and field investigations performed at federal facilities to develop new chemical and radiological survey methodologies and to test newly developed instrumentation. Education, training, and university interactions continue to be a major focus in the technology transfer process.

This section has several unique resources to enhance its research and development initiatives: (1) the Health Physics Research Reactor is an unshielded, unmoderated fast reactor suitable for mixed-field irradiation for research in health physics, radiobiology, biomedicine, component testing, and related fields; (2) the Radiation Calibration Laboratory is a facility with well-characterized radiation sources suitable to test radiation dosimeters to the requirements of national accreditation programs; (3) the Indoor Air Program is a nationally recognized effort to qualify and quantify a variety of indoor air contaminants, including radon, formaldehyde, asbestos, and volatile organics; (4) an integrated system of five high-purity germanium detectors is used for gamma spectroscopy of environmental

samples; (5) four large mobile laboratories are used for extended survey support at off-site locations; and (6) a facility with laboratories and technical staff is established in Grand Junction, Colorado, for more cost-effective response to environmental assessments at federal facilities in the western United States.

These collective resources enable this section to be a center of excellence in radiation measurement and calibration, development and application of chemical monitoring techniques, assessment of contaminants in the environment, and, collaboratively, determining the impacts to human health from these physical and chemical agents.

¹Leave of absence.

²Part-time employee.

³Research Reactors Division.

⁴Instrumentation and Controls Division.

⁵Environmental Sciences Division.

⁶Office of Environmental and Health Protection.

MEASUREMENT APPLICATIONS AND DEVELOPMENT

The primary activities of the Measurement Applications and Development (MAD) Group are aimed at measuring radiological and chemical pollutants in the environment and assessing the impacts of these pollutants on the health and safety of potentially exposed individuals. In support of these objectives, the MAD Group performs three major activities: (1) identifies potential locations of environmental pollutants; (2) characterizes radiological or chemical pollutants with regard to location, type, and concentration; and (3) conducts research and development of instrumentation and techniques to advance survey capabilities. Based on existing expertise and equipment, the MAD Group has the capability to detect and characterize almost any radiological or chemical environmental pollutant of concern to the general public.

Much of the radiological characterization work performed during the report period was in support of the Department of Energy (DOE) Formerly Utilized Sites Remedial Action Project (FUSRAP), which is funded through the Office of Environmental Restoration and Waste Management. This work involved surveying and identifying properties requiring remedial action in the vicinity of sites designated by DOE. Funding for this work, which had been almost constant for the past few years, decreased slightly for the report period. Comprehensive radiological characterizations were conducted at two sites in

Schenectady, New York. Preliminary scoping surveys were conducted at commercial properties in Painesville, Toledo, Warren, Columbus, Hamilton, and Luckey, Ohio; Madison and Granite City, Illinois; Springdale, Washington, and Pittsburgh, Pennsylvania; and Oak Ridge, Tennessee. In addition, a scoping survey was conducted at the Research Reactor Facility in Piqua, Ohio, to determine the existence of contamination and recommend actions to remove property from the site. Recent directives by DOE indicate that the scoping, characterization, and verification surveys will continue for several years at FUSRAP sites.

In addition to the DOE-funded FUSRAP work, the MAD Group conducted a major radiological contamination characterization program at the Oak Ridge National Laboratory (ORNL). This effort was funded by the Environmental Restoration Division and consisted of surveys at waste storage sites and suspected areas of contamination. Results of these surveys are being used to identify and prioritize areas requiring remedial action at ORNL.

Throughout the report period, the MAD Group conducted chemical and mixed-pollutant characterization efforts at the Y-12 and K-25 sites in support of corporate environmental restoration programs. This work involved field sampling to detect and measure all types of environmental pollutants, preparation of site-specific work procedures and health and safety plans, and evaluation of measured results. In addition to the detailed characterization efforts, staff members coordinated removal of underground storage tanks at K-25 and soil gas sampling for organic pollutants at Y-12.

With regard to research and development efforts, projects were conducted to evaluate the applicability of liquid scintillation techniques to analysis of soil samples, to develop data management systems and pattern recognition techniques for analyzing large sets of data for environmental sampling, and to determine methods for evaluating ^{238}U concentrations without neutron activation analysis. A comprehensive computerized sample tracking and data management system for recording the status of environmental samples and preparing data in report formats was implemented and expanded during the report period. This system is the most efficient and comprehensive of any existing at organizations doing environmental characterization work. The experience and capabilities acquired through the expanding environmental pollutant characterization work will be used to continue to advance methods and instruments used for environmental assessments and to support technology transfer through publications, presentations, training courses, and workshops.

POLLUTANT ASSESSMENTS

The Pollutant Assessments Group (PAG) has two primary missions. First, it conducts assessments of environmental pollutants in a variety of settings. Resources exist to measure or sample for any radiological or chemical contaminant in the environment, determine the magnitude and extent of that contaminant, model its transport, estimate potential human exposure, and suggest or design remedial measures as well as estimates of associated costs. Second, staff conduct research and development toward more efficient or accurate methods for making pollutant measurements in the field, modeling pollutant transport, or estimating risk to human or environmental receptors.

PAG has been involved in a variety of environmentally oriented projects. Involvement in the Uranium Mill Tailings Remedial Action Project (UMTRAP) has diminished because UMTRAP is drawing to a conclusion. The PAG's Inclusion Survey Contractor activities have produced approximately 12,000 property survey reports during the last six years. PAG will continue to support UMTRAP as the Independent Verification Contractor for Grand Junction remedial actions through FY 1992. Similar projects that are being conducted by PAG include verification of remedial actions both at the DOE Grand Junction Projects Office and at vicinity projects in Monticello, Utah, under the auspices of the Environmental Protection Agency (EPA) Superfund and the DOE Surplus Facilities Management Program.

The once primary emphasis on radiological assessments to support the group has largely been replaced by involvement in more detailed longer-term projects. During the last two years, PAG staff have conducted Remedial Investigation/Feasibility Studies (RI/FS) at five Department of Defense (DOD) facilities. RI studies have been conducted at nearly a dozen DOE and DOD sites from Tennessee to California. The RI studies may range from simple soil sampling to more complex air sampling to installation of monitoring wells and subsequent water sampling and operation of computer models.

PAG staff are also involved in research projects to improve field accuracy and precision of groundwater velocity measurements, to allow in situ measurement of diffusivity in boreholes, and to develop field data collection devices for various pollutants. PAG staff were instrumental in developing the UltraSonic Ranging and Data System (USRADS), which simultaneously transmits radioactivity, chemical, or geophysical data as well as the position of the measurement from field locations to a nearby microcomputer in real time. USRADS is currently being adapted for use with an X-ray fluorescence system to allow measurement of surface concentrations of heavy metals. PAG staff have also

recently devised a system to directly estimate groundwater velocity in situ using a borehole telescope to view colloids as they flow through the well. This groundwater velocity (GWV) meter will advance groundwater modeling capabilities by allowing numerous measurements of GWV in a well field at a relatively low cost. In a related development, PAG staff have designed a light, mobile drill rig that utilizes a hydraulic ram system to insert sampling tubes into soil to a depth of up to 15 m. The system allows rapid subsurface sampling of soil, water, or soil gas.

Sponsors have recently indicated a need to provide performance assessment capabilities to support new waste management facilities being developed and operated on DOE sites. The PAG is adding staff who are familiar with environmental transport models for a variety of environmental transport media. Consequently, performance assessment projects for a variety of DOE facilities are expected to be undertaken in the near future. These projects fit within the strategy of PAG to provide comprehensive environmental assessment capabilities to federal sponsors.

MEASUREMENT SYSTEMS RESEARCH

A major function of the Measurement Systems Research (MSR) Group is serving as a link between the Division's basic research groups and those engaged directly in environmental sampling and measurement at hazardous waste sites. Our objective is to ensure that the Division has state-of-the-art field monitoring capabilities. Since its inception three years ago, the MSR Group retains its original split of interests between developing monitoring devices for use at hazardous waste sites and investigations of indoor air quality.

The hazardous waste research is focused on developing and testing new in situ and remote sensing field devices essential to cost-effective hazardous waste characterization and management. Our work is supported by the Hazardous Waste Remedial Action Program (HAZWRAP) demonstration and testing programs, EPA, various DOE and DOD Operations Offices, and Laboratory Director's R&D discretionary funds. A fiberoptic sensor coupled to a portable, derivative ultraviolet spectrometer is near field testing. The probe has been reduced to about 1 cm diameter. This adaption permits monitoring of groundwater through narrow-bore wells for light-aromatic hydrocarbon constituents of solvents and fuels. Another fiberoptic sensor approach employs surface-enhanced Raman scattering (SERS) as the means for remotely sensing a wide variety of trace contaminants. Research groups in three of the Division's sections are engaged in a coordinated effort to develop workable SERS substrates of requisite sensitivity and ruggedness. A portable

SERS fiberscope accepting any one of a number of different types of probe is nearly complete. Three-year support by Laboratory Director's R&D funds is being followed by funding from the Chemical Weapons Reduction Verification Treaty. USRADS, used for automatic surveyor positioning, has been interfaced with an electromagnetic terrain conductivity meter. Successful demonstrations were made at landfills at the Idaho National Engineering Laboratory and the Muniz Air National Guard Base, Puerto Rico. Work is well advanced for interfacing USRADS with X-ray fluorescence probes for screening of surfaces contaminated with heavy metals such as mercury, copper, lead, and arsenic. Members of the MSR Group have served directly in instrumentation work groups developing DOE's RDDT&E five-year and mid-to-long-term basic research plans for environmental restoration, and the group is helping prepare the response of Martin Marietta Energy Systems, Inc., to these plans. Staff are also cochairing and organizing the Tenth ORNL Life Sciences Symposium on Hazardous Waste Site Investigations: Toward Better Decisions, to be held in May 1990.

The indoor air quality program derives support from two sources: the DOE-Office of Health and Environmental Research (OHER) and the U.S. Navy. A basic research program seeks understanding of radon availability and transport in hilly, karst terrains. A hitherto unrecognized temperature-related, subsurface transport process driven by aerostatic pressure differentials was hypothesized to explain anomalous radon soil-gas transport and entry into houses. A more applied radon program, centrally managed by AIRHAS/HAZWRAF, involves screening and assessment for the Navy at each of its 250 bases worldwide. The ongoing screening phase is using 25,000 alpha track detectors from a commercial vendor. The MSR Group is responsible for planning, protocols, quality assurance and quality control, data handling, and interpretation. If a screening measurement exceeds 70 pCi/L, the group is also responsible for immediate site evaluation, confirmatory measurements, and preliminary remediation diagnostics. The Navy Radon Assessment and Remediation Program (NAVRAMP) is about to enter the assessment phase. An estimated 400,000 alpha track detectors and 20,000 charcoal canisters will be deployed in occupied structures where screening has indicated radon at a level exceeding 4 pCi/L. An international symposium dealing with acute and subchronic health problems stemming from inadequate indoor air quality was organized for the American Industrial Hygiene Association in May 1989. There were about 1000 attendees, and invited papers were published in a hardcover book.

We will continue efforts to provide a reasonable balance of funding between basic research and applied activities derived from sources having more pragmatic interests.

Essential to success will be our continued interactions with the more basic research groups in HASRD as well as with those engaged in direct field work within the Environmental Measurements and Applications Section.

DOSIMETRY APPLICATIONS RESEARCH

Dosimetry Applications Research (DOSAR) Group activities are directed toward improving the quantification of the radiation dose received by individuals. These activities are consistent with the HASRD mission of assessment of impacts of energy-related technologies on human health. The primary research tool of the DOSAR Group is the Radiation Calibration Laboratory (RADCAL).

RADCAL dedication ceremonies were held on June 21, 1989, for RADCAL, which contains various gamma, beta, and neutron sources as well as an X-ray machine. It features computerized source control, data acquisition and logging, interlock assurance, and environmental monitoring. It also has closed-circuit television monitoring of experiments, rail systems for source/experiment positioning, and laser alignment. Although not yet fully functional, RADCAL has already been used to support DOSAR staff research in neutron dosimetry, in studies of nonperpendicular incidence of radiation on gamma dosimeters, in studies of backscatter effects of a variety of different phantoms, and in a unique study of the gamma spectrum associated with moderated and unmoderated ^{252}Cf . It has been used for work outside the group, including the performance of quality assurance testing of large batches of dosimeters, the development of a neutron survey meter, the calibration of sensitive ionization chambers, and the proof testing of dosimeter capabilities at extreme doses.

The Fourteenth Personnel Dosimetry Intercomparison Study (PDIS 14) was conducted using radioisotopic neutron sources at RADCAL. A total of 48 organizations (33 from the United States and 15 foreign) participated in the study. Government laboratories, nuclear power plants, dosimeter vendors, universities, and medical facilities were included in these organizations, which submitted over 1300 dosimeters for irradiation in the study. The results of PDIS 14 provided us with current knowledge of the international status of personnel neutron dosimetry.

The Second Conference on Radiation Protection and Dosimetry was organized and conducted by DOSAR staff. This conference, completely funded by participant registration fees, was attended by 196 persons (35 from outside the United States) representing a variety of organizations interested in dosimetry. A total of 79 technical presentations (69

formal papers and 10 works-in-progress reports) were made during the four-day meeting. In addition to the technical presentations, attendees saw and discussed the latest available dosimetry and radiation protection products with 16 vendors who had exhibit booths at the conference.

DOSAR staff members were involved in several other activities important to the field of personnel dosimetry. The most significant of these were: (1) a staff member served as chairman of the Health Physics Society committee charged with the responsibility of revising ANSI N13.11, the national personnel dosimeter performance standard; (2) a staff member served as an associate editor of the *Health Physics Journal*; (3) a staff member served as a dosimetry assessor for the DOE Laboratory Accreditation Program (DOELAP); (4) a combination bubble detector-thermoluminescence dosimetry albedo neutron dosimeter with spectrometer capabilities was developed; and (5) an Energy Systems-wide radiation source control system was developed and implemented in response to technical safety appraisal comments.

3. BIOLOGICAL AND RADIATION PHYSICS SECTION

R. N. Hamm, Head

Staff

Research:

D. P. Allison
E. T. Arakawa
J. C. Ashley
T. A. Callcott¹
J. G. Carter
L. G. Christophorou
O. H. Crawford
M. W. England
T. L. Ferrell
B. E. Hingerty

S. R. Hunter
D. R. James
S. P. McKenzie
R. H. Ritchie
I. Sauers
J. E. Turner
R. J. Warmack
H. A. Wright
H. Yoshida

Clerical Support:

J. E. Carrington
J. A. Cripps
N. J. Kwaak

B. L. Ramsey
S. S. Stockstill

Consultants:

V. E. Anderson
W. A. Garrison
W. Gibson

H. H. Hubbell, Jr.
S. R. Hunter
H. A. Wright

Guest Scientists:

A. Arnau Pino
P. M. Echenique
R. D. Edge
D. A. Engler
F. Flores
F. Fujimoto
J. P. Goudonnet
A. Gras-Marti
D. L. Hedden
A. Howie
B. Illman

T. Inagaki
B. N. Khare
E. Lesniewska-Choquet
J. R. Manson
R. K. Matsunami
D. L. McCorkle
Y. H. Ohtsuki
J. H. Park
J. M. Pitarke
C. C. Sung
Y. Yamazaki

Students:

D. L. Bailey
A. Bitouni
K. L. Burchett
C. Bruel

J. Y. Chang
D. Chilcott
P. G. Datskos
L. G. Dritt

H. J. Gill
 G. H. Harman
 C. M. Kachur
 J. Lawn
 I. Lee
 C. J. Lundy
 C. Meisse
 O. E. Messer
 C. G. Milne
 M. Namioka
 J. E. Parks, III

R. C. Reddick
 J. D. Richards
 J. M. Roesler
 J. P. Sawyer
 B. Seidemann
 S. H. Sharp
 P. P. Shelby
 J. R. Thompson
 D. P. Tsai
 P. S. Tuminello
 L. E. William

Postdoctoral Fellows:

P. Dawson
 P. G. Datskos
 H. Faidas
 J. G. Mantovani

L. A. Pinnaduwa
 P. A. Vanderhoff
 V. Zabel

Loanees from other divisions:

D. P. Allison²
 K. B. Jacobson²

S. McElhancy³

Activities within this section consist primarily of basic physics research studies directed toward providing new scientific knowledge about the fundamental properties of matter in all phases (gas, liquid, and solid) and, in particular, of processes and mechanisms important in the interaction of pollutants with biological materials. The section also maintains a strong surface physics program. Both theoretical and experimental studies are included in the section's research activities, which involve state-of-the-art technology in many areas such as scanning tunneling microscopy, surface-enhanced Raman scattering, soft X-ray emission spectroscopy, and microlithography. Some of the research highlights of the past 18 months in each of the four groups in the section are reported below.

The section continues to have significant interactions with many other research institutions, both in the United States and abroad. Thirteen visiting scientists from foreign institutions, 10 visiting scientists from U. S. institutions, and 30 students worked within the section at various times during this reporting period.

¹Part-time employee.

²Biology Division.

³Instrumentation and Controls Division.

ATOMIC, MOLECULAR, AND HIGH VOLTAGE PHYSICS

The research program of the Atomic, Molecular, and High Voltage Physics Group is devoted to the study of electron-molecule interactions and negative-ion processes, electron-excited molecule interactions, interphase physics, the electrical properties of the liquid state of matter, and the basic physics of gaseous dielectrics, pulsed power switches, and radiation detectors.

Extensive experiments with three different experimental arrangements helped us unravel the mechanisms of photoenhanced electron attachment to thiophenol molecules. A new technique has been developed for measuring photoenhanced electron attachment to very short-lived ($<10^{-8}$ s) electronically excited molecules. Using this technique, it was observed for the first time that electron attachment to superexcited states of molecules can occur with enormous ($>10^{-11}$ cm²) cross sections that (for triethylamine) are about 10^7 times larger than those for the ground state molecule. These incredibly large cross sections may involve high-lying Rydberg states.

The interphase study on the photoionization onset of a molecule (TMPD) in a dense gaseous and liquid (ethane) medium has been completed. The observed density and temperature dependencies of the photoionization onset have been explained from basic theory. The observed lowering of the ionization onset with increasing medium density is principally due to the effect of medium density on the photoionization electron's ground state energy V_0 and the corresponding positive ion's polarization energy P^+ .

A systematic study has been undertaken of the electron transport properties (especially electron drift and diffusion) of dielectric liquids, particularly at high applied electric fields. Apparatus for the study of the electrical properties of cryogenic and room temperature liquids has been designed and built. In particular, a new fast electron drift technique has been developed for the measurement of very fast drift times (and diffusion) for excess electrons in dielectric liquids. Using this technique, electron transport to very high applied electric field E ($\sim 1.4 \times 10^5$ V cm⁻¹) has been studied for a number of fast liquids (tetramethylsilane, neopentane, tetramethyltin, tetramethylgermanium, and 2,2,4,4-tetramethylpentane) and their mixtures.

The investigations on the electrical properties of the liquid state of matter and on the use of the obtained new knowledge on the electrical (and other) properties of liquids to develop novel (ultrafast and ultrasensitive) liquids for radiation/particle detectors progressed significantly. They provided the basic foundation for identifying and assessing fast room temperature dielectric liquids for Superconducting Super Collider calorimeters. They also led

to a totally new idea concerning the switching of the electrical properties of a fast dielectric liquid at submicrosecond times. The idea basically involves changing a good dielectric liquid into a conducting liquid by photoinjecting electrons into it externally. A concept for a dielectric-liquid pulse power switch employing flash lamps has thus been developed.

The study of slow electron—"hot" molecule interactions, especially electron attachment to energy-rich organic molecules and electron transport in hot gases, continued with emphasis on fluorocarbons, SO_2F_2 , and CH_3Cl . The weak dissociative electron attachment to CH_3Cl below ~ 1 eV increased by 3 to 4 orders of magnitude when the gas temperature was increased from 300 to 750 K. Experimental studies have been initiated and apparatus has been built to quantify the effect of internal energy of molecules on the rate of autodetachment and autodissociation of their parent anions.

Our comprehensive studies on electron motion and interactions in gases aided profoundly our new initiative to develop and characterize gaseous media for the SSC muon chambers.

The role of electron collisions in gas switches has been documented in an invited paper presented at the NATO Advanced Study Institute on Nonequilibrium Processes, and the basic physics of gaseous dielectrics has been discussed in a similar paper published in the *IEEE Transactions on Electrical Insulation* 25th year commemorative issue.

Plans to host the Sixth International Symposium on Gaseous Dielectrics in Knoxville proceeded well.

PHYSICS OF SOLIDS AND MACROMOLECULES

The Physics of Solids and Macromolecules Group concentrates on making basic measurements, by a variety of techniques, of the optical and electronic properties of solids, macromolecules, liquids, and thin films over a wide range of photon energies and temperatures. Other areas of research include resonance ionization spectroscopy, soft X-ray emission and absorption spectroscopy, photoacoustical measurements, gas decomposition and ion chemistry studies, and measurement and calculation of low-energy electron mean free paths in solids and macromolecules. Studies in this program should lead to a better understanding of biologically interesting materials and biological systems and to development of new low-level pollutant detectors.

A new method of photodesorption that uses an amplified electronic field strength in the surface region has been developed. The large field strength necessary for photodesorption is created by the excitation of surface plasmons in the attenuated total reflection (ATR)

geometry. In this geometry, a thin aluminum film deposited on the base of a glass prism is irradiated with frequency-doubled photons from a Nd-YAG laser incident through the prism. The desorbed aluminum atoms are ionized by a XeCl excimer laser and detected by time-of-flight mass spectroscopy. The number of aluminum atoms desorbed from the aluminum film as a function of incident angle shows excellent agreement with the theoretical angular dependence of surface-plasmon production. A linear relation between desorption yield and laser fluence was also observed. Rhodamine B molecules adsorbed on an aluminum film and desorbed through this method showed the same dependence with incident angle and laser fluence. The linear relation suggests a nonthermal desorption mechanism. This mechanism may provide a useful method to desorb many biologically important substances in solid form for analysis by mass spectroscopy without thermal degradation.

We have also studied the discontinuities in the polychlorinated biphenyls (PCB) concentration in the rings of some scales from striped bass taken from the Watts Bar Reservoir. A pulsed, tightly focused ultraviolet (UV) beam from an excimer laser was directed onto a known area of a fish scale placed within our apparatus. The UV beam ablates material from the sample and ionizes it. The mass and quantity of the ions are identified by a time-of-flight mass spectrometer. A knowledge of the relative PCB concentration in the seasonal rings of these scales could help determine the location of the contaminants within the reservoir.

We have continued our studies of soft X-ray emission excited by monochromatized soft X-ray photons from the National Synchrotron Light Source (NSLS). A new computer operating system with new data acquisition software and a new detector providing improved signal-to-noise ratio at very low photon count rates were put into operation. Papers were published on the high- T_c superconductors (HTSC), on bonding at the interfaces of Si-C multilayers, on the effects of excitation near threshold of Si $L_{2,3}$ spectra, and on the photon excitation of emission spectra. Studies continue on the HTSCs, layered compounds, rare gas solids, the effects of near threshold excitation, impurities in organic materials, and joint excitation by synchrotron light and a pulsed laser phase locked to the synchrotron light pulses.

We have reviewed the published data on the optical properties of beryllium for the spectral region from 0.03 to 300 eV. In the visible and infrared spectral regions, where published data from various authors show very large variations, we have performed experiments that identify the most probable sources of error and are using this information to select the best data from published sources. The effects of surface oxide overlayers have also been studied. A Kramers-Kronig analysis of the available reflectance and transmission data

has been carried out to determine the optical properties in this spectral range. These results were published as an Oak Ridge National Laboratory (ORNL) report and have been submitted for publication in a review volume of optical properties of solids.

Spectroscopic ellipsometry was used to measure the optical constants of liquid mercury, both in the free state and in contact with dielectric overlayers, in the visible spectral region. Reflectances of liquid mercury under vacuum and in contact with various overlayers were measured directly at large and small angles of photon incidence. These directly measured reflectances agreed well with those calculated from the optical constants determined by ellipsometry. In an independent experiment, measured reflectances of polarized light from a MgF_2 semicylinder/liquid mercury interface were used to determine the optical constants of liquid mercury. In all these experiments, the non-Drude optical response of liquid mercury was clearly demonstrated.

The production of S_2F_{10} as a by-product of SF_6 decomposition in spark and corona discharges has been studied. The importance of S_2F_{10} is its extremely high toxicity represented by a Threshold Limit Value (TLV) for human exposure of 10 ppb. The possible formation of this chemical has largely been dismissed by the utility industry because of the lower thermal stability of this compound relative to other SF_6 by-products and the lack of experimental data. Detection of S_2F_{10} in an SF_6 background is difficult unless some separation technique such as gas chromatography (GC) is employed. Using GC techniques, we have measured the spark and corona yields of S_2F_{10} and attempted to delineate the chemical reactions which lead to its formation. Basically, the combination of two SF_5 radicals leads to S_2F_{10} formation. However, reactions of impurities, such as water, with SF_5 or with other SF_6 fragments can alter the net production rate of S_2F_{10} . Our results have shown that S_2F_{10} is readily formed by electrical discharges in SF_6 . As a consequence of this finding, a collaborative project involving ORNL, National Institute of Standards and Technology (NIST), and Ontario-Hydro (a Canadian electric utility) has been initiated. The objective of this project is to determine whether S_2F_{10} is generated in power equipment used in the field.

We have also examined the thermal stability of S_2F_{10} . Although S_2F_{10} is known to be stable at temperatures below 200°C , we have observed a slow decomposition of S_2F_{10} due to surface catalyzed processes. The rate of decay increases as the surface-to-volume ratio of the storage cylinder increases. As a result, half-lives ranging from a few days to over a year have been measured. Increase of moisture was also found to increase the S_2F_{10} decomposition rate. Thus, improper sampling and storage of gas samples taken from SF_6 -gas-insulated high-voltage equipment in the field can lead to large errors in the measured concentrations of S_2F_{10} .

The positive- and negative-ion chemistry of SF_6 corona over an SF_6 pressure of 10 to 300 torr has been examined using mass spectrometry. For positive polarity point to grounded plane corona the major positive ions observed were SF_5^+ , SF_3^+ , and SF_2^+ . Addition of water vapor concentration in the range of 40 to 600 ppm results in the formation of clusters of water to these ions to form ions of the type $\text{SF}_x^+(\text{H}_2\text{O})_n$ and the clusters $\text{H}^+(\text{H}_2\text{O})_n$. In the case of negative polarity corona, the negative ions observed include SF_6^- , SF_5^- , and F^- . Addition of water vapor results in clusters of two types: $\text{F}^-(\text{HF})_n$ and $\text{OH}^-(\text{H}_2\text{O})_n$, where the HF is produced by reactions of fluorine with water in the corona. There is speculation that $\text{OH}^-(\text{H}_2\text{O})_n$ is responsible for the detaching electron which initiates breakdown in SF_6 . This is based on recent evidence that the threshold for electron detachment from SF_6 ions is too high to account for detached electrons.

LIQUID AND SUBMICRON PHYSICS

Research in the Liquid and Submicron Physics Group is devoted to the basic physics of liquids and of submicron structures with allied applications developed as they evolve. Important advances in microscopy, sequencing of the human genome, and detection of ultralow levels of chemical compounds have thereby been made. Electron scanning tunneling microscopy of isolated DNA molecules has been successfully carried out. This has produced the first images of DNA molecules that contain complete genes, the helical structure being readily apparent in the images. Sequencing of the human genome with simultaneous imaging may thus be practicable, and a major effort is being carried out with this objective.

The group has also invented a new type of microscope: the photon scanning tunneling microscope (PSTM). A patent is pending on the PSTM and commercial production will be realized within the next year by a combined French and U.S. industrial effort. The group is currently adding spectroscopic capabilities to the PSTM to develop a new chemical-mapping instrument for biological and environmental purposes. This instrument produces data at subwavelength resolution on insulators and yields a three-dimensional topographical map which can be directly processed by computer.

Surface-enhanced Raman scattering (SERS) has been studied, used, and improved by the group in collaboration with other groups. One goal of this work is to produce submicron structures of high signal enhancement capability in order to reduce the cost and size of the instrumentation. A highly useful, field-portable, chemical-screening instrument based on SERS would permit unambiguous detection of pollutants and toxic compounds at remote sites. The microstructures are vital to attaining this capability and have been improved using microlithographic methods.

ANALYTIC DOSIMETRY AND SURFACE PHYSICS

The Analytic Dosimetry and Surface Physics Group undertakes basic studies of the interactions of radiation with matter, both for understanding the fundamental physics involved and for application to dosimetry, instrumentation, and modeling of the chemical and biological effects of radiation. Particular emphasis is given to matter in the condensed phase and to surface physics phenomena. In addition, the group conducts strong collaborative studies with the Biology Division on the effects of chemical pollutants on biologically relevant molecules and on the mechanisms of radiation damage to biological systems.

A number of studies were completed or substantially advanced. A theory was developed for directional effects associated with a heavy ion penetrating an anisotropic solid. A model was developed to calculate positron or proton energy-loss rates and inelastic mean-free paths in condensed media from a knowledge of their optical properties. Multiple emission of electrons from thin carbon foils was explored. The theory of the spatial dependence of plasmon decay was developed to explain the good spatial resolution found experimentally in secondary-electron emission scanning electron microscopy. An explanation was found for the energy defect seen experimentally in the spectrum of photons emitted in radiative capture of electrons by swift ions channeled in solids. Additional work was performed on geminate recombination in liquid water. Other studies addressed the reported occurrence of nuclear fusion from accelerated $(D_2O)_n^+$ clusters on TiD. In a dosimetry application, our electron Monte Carlo transport code, OREC, was applied in calculations for assessing skin dose from beta emitters. Some work also continued on the optical charged-particle track detector for neutron dosimetry.

In collaborative studies with members of the Biology Division, measurements and calculations of the radiogenic products from glycylglycine irradiated by X rays in oxygen-free solutions were completed. Very good agreement was found between theory and experiment, supporting the proposed pathways of molecular damage. Work for the Human Genome Project continued. Computer models of DNA that agree with Nuclear Magnetic Resonance (NMR) Nuclear Overhauser Effect (NOE) data have been developed. Work progressed on determining protein structures, particular interest being focused on the human epidermal growth factor (hEGF) and a DNA repair enzyme. A study was initiated to examine the effects that different metal ions have on the hybridization of oligonucleotides. The results of this study could have practical use in achieving DNA sequencing by hybridization. In genetics studies on *Drosophila*, the allele associated with strontium-ion toxicity was found to be on the second chromosome.

4. CHEMICAL PHYSICS SECTION

J. C. Miller, Head

Staff

Research:

S. L. Allman
H. S. Carman, Jr.
C. H. Chen
R. N. Compton

W. R. Garrett
J. P. Judish
C. E. Klots
M. G. Payne

Technical Support:

S. L. Allman

R. C. Phillips

Clerical Support:

D. C. Crowell

N. S. Currence

Consultants:

D. Charalambidis
W. Christian
K. D. Cook
C. S. Figerle
G. S. Hurst
P. Lambropoulos

M. P. McCann
M. A. Moore
M. S. Pindozla
H. P. Saha
R. Williams
R. K. Wunderlick

Guest Scientists:

H. C. Baker
D. Charalambidis
W. M. Fairbanks, Jr.
C. Fotakis
H. B. Kinser
P. Lambropoulos
B. E. Lehmann

M. S. Pindzola
S. A. Taylor
L. J. Wang
R. K. Wunderlick
D. Zei

Students:

D. P. Armstrong
J. H. Arps
S. B. Bajic
L. E. Cuellar
I. Datskou
S. Evans

R. C. Hart
M. P. McCann
T. M. Murphy
M. J. Shea
J. E. Wray

Postdoctoral Fellows:

M. P. McCann

D. B. Smith

*Loanees from other divisions:*H. A. Barnette, Jr.¹

The research conducted in the Chemical Physics Section relies heavily on laser-based spectroscopic techniques in studies of fundamental atomic and molecular processes. These are relevant to energy-related problems in atmospheric physics and chemistry, radiation chemistry, advanced instrumentation technology, laser development, and advances in analytical methodology. In these efforts, laser-based resonance ionization spectroscopy (RIS) and RIS combined with mass spectrometry are used in developing ultrasensitive and/or highly selective techniques for chemical characterization and detection under a variety of circumstances. For problems requiring laser capabilities beyond those currently available, nonlinear optical processes are explored for their potential use in extending the ranges of tunable laser wavelengths. Picosecond laser techniques are being used to extend the range of accessible time scales for studies of fast photoinduced chemical and physical processes.

The following brief summaries of activities in the Molecular Physics and Photophysics groups provide general information on the accomplishments in the chemical physics program for the period October 1988 through March 1990. More detailed information on all of the research can be found in the open-literature references at the end of this report.

¹Instrumentation and Controls Division.

MOLECULAR PHYSICS

The Molecular Physics Group conducts basic and applied research in the area of Chemical Physics, that branch of science which interfaces physics and chemistry. Experimental studies involve the use of sonic nozzle expansions in order to produce ultracold molecules and molecular clusters. Gas phase molecules and clusters are then studied using laser, charged particle, and neutral beams. These studies involve the

formation and transformation of a variety of chemical species under interactions with other molecules or radiation fields. Very fast radiation-induced processes in molecular clusters, liquids, and surfaces are probed with picosecond laser techniques. A strong component of our program involves nonlinear optical studies (in order to generate vacuum ultraviolet and infrared radiation) as well as multiphoton ionization. A major part of the research is directed toward the development of advanced instrumentation for health and environmental applications.

The group has continued studies of Rydberg-atom reactions with rotationally and vibrationally cold molecules. The effect of the Rydberg "core" on charge transfer reactions to form negative ions has been examined for hydrogen iodide and carbon disulfide. In many cases, the presence of the "ion core" of the electron "donor" is necessary to stabilize a negative ion which is produced by low-energy electron attachment. An excellent example is the reaction $A^{**} + HI \rightarrow A^+ + HI^-$. In this interesting reaction, HI^- is formed only for alkali Rydberg atoms, A^{**} , at low principal quantum numbers, where the HI^- ion is "close" enough to the A^+ ion to allow for stabilization of HI^- . This is the first observation of a stable negative ion from a hydrogen halide. In another interesting example, an isotope-dependent rate constant for the formation of CS_2^- in $A^{**} + CS_2$ collisions has been studied. In these experiments, the formation of negative ions during collisions between cesium Rydberg atoms and CS_2 molecules has been studied for intermediate values of the effective principal quantum number ($n^* = 10 - 26$). The rate constants for CS_2^- formation are found to be different for the two isotopes $C^{32}S^{34}S$ and $C^{32}S^{32}S$ for a narrow range of n^* near $n^* = 17$, with the rate constant for $C^{32}S^{34}S^-$ production being up to 4.5 times larger than that for $C^{32}S^{32}S^-$.

The photoionization of an atom represents one of the most elementary collision processes. During the past year we have performed elementary studies of single and multiphoton ionization of many atoms and molecules. Noteworthy among these studies are the first measurements of the photoelectron angular distributions for ns levels in cesium. It has long been known that for photoionization from a pure s orbital ($l = 0$) without relativistic effects, the photoelectron angular distribution is a pure $\cos^2\theta$ distribution (i.e., the intensity of the photoelectron signal goes to zero when the electron ejection direction and the polarization direction are perpendicular). We have measured photoelectron angular distributions for cesium atoms via the $8s$, $9s$, $10s$, and $12s$ states and find values of the so-called asymmetry parameter which vary from +1.2 for the $8s$ state to -0.5 for the $12s$ state (a pure $\cos^2\theta$ distribution corresponds to $\beta \equiv 2$). Deviations

from a pure $\cos^2\theta$ distribution are due to relativistic spin-orbit interactions in the continuum.

A major new picosecond laser facility has recently become operational. The centerpiece of this new laboratory is a state-of-the-art Nd:YAG laser which pumps a novel short-cavity tunable dye laser. The high-peak power of such a system (10^{12} – 10^{14} W/cm²) will make possible the observation of high-order multiphoton processes in dense atomic and molecular gases. The short pulse time ($\sim 5 \times 10^{-12}$ s) will allow study of very fast chemical dynamics of liquids, solids, and clusters which is important in radiation chemistry and physics. In both cases, the ability to tune the wavelength of the laser will allow state-specific studies.

Currently two investigations are yielding promising new results. In the first, it has been found that nonresonant multiphoton processes are surprisingly efficient at producing ions of atomic and molecular clusters. Species such as Xe_n ($n = 1$ – 19), $(\text{NO})_n$ ($n = 1$ – 5), Ar_nNO ($n = 1$ – 10), and Ar_nI_2 ($n = 1$ – 12) have been observed. Detailed spectroscopic studies have been carried out on nitric oxide dimers, which are important parts of the NO_x pollution cycle in the upper atmosphere. Fast dissociative processes in $(\text{NO})_2$ can be studied only with picosecond timing.

The second study focuses on laser-matter interaction in metals and on surfaces. Short-pulse lasers are required to minimize thermal effects which mask the interesting physics. Recent laser ablation studies of solid surfaces have been carried out using the new picosecond laser system. Measurements of the mass-resolved kinetic energy distributions of laser-ablated ions are providing interesting new information on the fundamental physical processes involved as well as providing the basis for advanced detection instrumentation. Carbon cluster ions from graphite show "magic number" intensity distributions illustrating the switch from linear to cyclic C_n structure at $n \approx 10$. Enhanced ion signals are also seen in the region of the "soccer ball" structure of carbon atoms ($n \approx 60$).

Other studies include laser ablation of palladium electrolytically loaded with hydrogen. The most interesting results come from studies of picosecond laser interaction with roughened silver surfaces. Ag^+ ions are seen to peak at two energies, one at ~ 0.2 eV, which is attributed to a thermal emission process, and a second intense peak at 3.7 ± 0.2 eV. The second peak corresponds very well to the surface plasmon energy for silver. Mechanisms for possible ejection of silver ions at the plasmon energy are under consideration.

PHOTOPHYSICS

Major efforts in this reporting period fall into four broad categories and are detailed below:

(1) Studies of Nonlinear Optical Phenomena and Molecular Resonance Ionization Spectroscopy:

- (a) *Effects that can strongly suppress and/or shift resonant multiphoton excitation:* We have continued our detailed studies of fundamental processes that affect RIS, including nonlinear processes that can strongly affect resonant multiphoton excitations of atoms and molecular systems. We found that conditions can occur where photon fields generated within the sample greatly modify the atomic response to an incident laser field, resulting in reductions in expected resonant excitation and/or emission rate or in a strong shifting of resonant line positions at elevated pressures. Detailed experimental and theoretical studies have provided substantial understanding of a number of these cases.
- (b) *Effect of two-photon interference on parametric four-wave mixing:* We have shown theoretically and confirmed experimentally that two-photon interference effects involving parametric four-wave mixing (FWM), which can suppress two-photon excitation at elevated gas pressures, can also limit infrared (IR) and vacuum ultraviolet (VUV) emission from two-photon resonantly enhanced FWM processes. A detailed study of the interference effect on IR generation in sodium vapor was completed.

(2) Kinetics of Irradiated Materials:

- (a) *Desorbed ions and neutral molecules:* A mass spectrometer was constructed and used to measure spectra of ions and neutral components desorbed and/or ablated from superconductors, metals, and fish scales. The information generated is valuable not only for determining the components of the target samples, but also for understanding the mechanism of desorption processes.
- (b) *Studies of neutralization and sticking mechanism of radon and its progeny:* The mechanism of the neutralization of ^{218}Po in mixtures of $\text{N}_2 + \text{NO}_2$ has been modeled and experimentally studied. It was found that ion-ion recombination between NO_2^- and Po^+ is about $10^{-6} \text{ cm}^3/\text{s}$.

The fraction of ^{218}Po which thermalizes as an ion has been measured in N_2 and $\text{N}_2 + \text{NO}_2$ mixtures. In both cases, the result is 0.68 ± 0.05 .

(3) **Development of Advanced Instruments:**

In-situ monitor for thin films preparation: A facility equipped with a fluorescence spectrometer, mass spectrometer, and laser ablation capability was developed to monitor thin film preparation. It can be used to monitor all the desorbed species, such as excited atoms, ground state ions, and ground state atoms.

(4) **High- T_c Superconductors:**

- (a) We observed large amounts of O_2 trapped in high- T_c superconductors. This indicated that trapped oxygen may play a key role in high- T_c superconductivity. It also provided an explanation for the extra number of oxygen atoms found in high- T_c superconductors.
- (b) We studied the desorption mechanism of high- T_c superconductors and monitored all the desorbed species from laser ablation of these materials. This work led to the development of an in situ monitor of thin film preparation.
- (c) We discovered that the addition of alkali carbonate to $\text{YBa}_2\text{Cu}_3\text{O}_7$ can enhance the stability of high- T_c superconductors. This result can possibly provide more stable high- T_c superconductive materials in the future.

5. BIOMEDICAL AND ENVIRONMENTAL INFORMATION ANALYSIS SECTION

P. Y. Lu, Head

Staff

Research:

W. J. Allen
L. J. Allison
K. J. Brown
M. M. Brown¹
R. F. Carrier
G. M. Caton
S. S. Chang
G. S. Danford
M. W. Daugherty
K. A. Davidson
M. C. Davidson¹
A. R. Ehrenshaft
E. L. Etnier¹
R. A. Faust¹
J. M. Fielden
L. M. Floyd
A. A. Francis
M. W. Francis
R. M. Gove
R. T. Haas
C. L. Heckman
J. P. Hewins
F. M. Holland¹
L. M. Houlberg¹
P. S. Hovatter
S. M. Hubner
D. G. Kilgore
B. W. Kline
E. B. Lewis
B. K. Mansfield
F. M. Martin
K. H. Mavournin

I. C. Miller
K. C. Miller
D. D. Moore
H. B. Morgan¹
N. B. Munro¹
P. A. Noghrei-Nikbakht
C. J. Oen
P. S. Ogle
D. M. Opresko¹
P. T. Owen
E. T. Owens¹
B. C. Pal
H. A. Pfuderer
B. E. Ricci
L. M. Roseberry
R. H. Ross
M. G. Ryon
K. G. Slusher¹
J. G. Smith
R. S. Stafford
S. S. Talmage¹
R. K. Templeton
K. M. Thiessen¹
S. Y. Uppuluri¹
M. S. Uziel
E. S. Von Halle
J. S. Wassom
R. S. Weaver
B. L. Whitfield
J. K. Williams
R. A. Young

Technical Support:

J. W. Crutcher
S. C. Daniels
M. E. Gillespie
L. F. Goins
G. E. Groover

J. P. Hutson
N. P. Knox
M. E. Langston
J. O. Mynatt
J. H. Scott

C. C. Seaborn
D. M. Stokes
J. W. Taylor

K. A. Weaver
J. M. Wyrick¹

Clerical Support::

D. G. Arnwine
W. J. Barnard
G. E. Groover
B. S. Hayes
S. L. Roberts

S. G. Rogers
D. B. Stinnett
T. E. Watson
P. J. Wenzel

Consultants:

A. E. Adamson
C. B. Bast
C. R. Catlett
D. A. Douglas
N. P. Drago
S. M. Draime
J. L. Eads
T. G. Elledge
S. E. Estep
S. D. Ferguson
S. M. Ferrell
R. E. Gibson
P. S. Hammons
D. D. Hatmaker
J. C. Haufe
J. T. Hawkins
J. A. Holland

L. M. Houlberg
G. J. Johnson
S. E. Joy
S. E. Kilgore
C. S. Lever
S. A. Martin
M. D. Mayes
W. L. McNabb
A. C. Monroe
K. S. Rao
D. L. Shockey
P. L. Schumann
J. M. Stockstill
G. S. Thurmer
J. R. Webb
L. A. Wilson
L. N. Yust

Guest Scientists:

None

Students:

M. G. Billings
B. C. Cheek
T. L. Cox
M. K. Gustin
J. C. Haufe
J. W. Hodge
A. B. Holland
D. G. Jernigan
J. A. Longmire

J. M. McClure
A. H. Ordoubadian
M. A. Phillips
P. A. Quiggins
L. C. Robert
M. M. Romines
W. J. Samples
G. G. Santore
D. E. Wood

Postdoctoral Fellows:

None

Subcontractors:

G. Benke
A. Colb
K. Cooper
J. Dragun
G. Lambert
K. Menon
P. Mirkes

J. Perkins
R. Purdy
V. Rose
G. Stoner
G. Witz
C. P. Yu

The Biomedical and Environmental Information Analysis Section (BEIA) has been a part of the research and development environment of the Oak Ridge National Laboratory (ORNL) since its inception as the Environmental Information Systems Office in 1971 and has historically maintained its major scientific strength in the area of health and environmental effects of hazardous materials.

During the past year, the Section continued work which has been under way for many years in the development of computerized health effects data bases. Funded by the Environmental Protection Agency (EPA) and National Institute of Environmental Health Sciences (NIEHS)/National Toxicology Program (NTP), the Environmental Mutagen and Teratogen data bases now contain over 68,000 and 47,000 records, respectively, on approximately 21,000 total chemicals. The Environmental Mutagen Information Center (EMIC) has served as the focal point for the EPA Genetic Toxicology (Gene-Tox) Program. The purpose of the Gene-Tox Program is to conduct a systematic review and validation of genetic toxicology studies to establish a registry of test results for chemicals evaluated in selected short-term bioassays. The peer-reviewed Hazardous Substances Data Bank now contains over 4200 records on individual chemicals with comprehensive numeric and factual information. During the past year, the staff has prepared and updated 2000 of these records, which present a detailed profile of each substance. These resources, along with others, were used by the section staff for preparation of numerous health hazard assessments and review documents in related areas for EPA and the Army and publication in refereed journals.

A further application of these resources is the development of the computer-searchable Material Safety Data Sheets (MSDS) Data Base. With support from Martin Marietta Energy Systems, Inc. (Energy Systems), this data base has been developed to inform employees at the Energy Systems facilities of toxic/hazardous materials with which they may come in contact. This was a critical factor in bringing Energy Systems into compliance with hazard communication regulations for the community and the workplace. The overriding need for

high-quality health hazard data was the major factor in deciding to use the resources of the section, rather than the commercially available systems or chemical manufacturer's information. The work has now expanded to provide MSDS information to the Army, Navy, the Department of Energy (DOE) Toxic Materials Advisory Committee, the Pittsburgh Energy Technology Center, and Lawrence Livermore National Laboratory.

A data base has been developed for the EPA Office of Environmental Criteria and Assessment/Office of Health and Environmental Assessment (OHEA). The data base, which has been titled the Chemical Unit Record Estimates (CURE), will contain all risk-related values used by EPA and will become the central data resource for carrying out EPA risk assessments.

The Human Genome Management Information System (HGMIS) was initiated in 1989. It is to serve as a primary information source and communication media for DOE's Human Genome Program Tasks, which include publication of a newsletter and special reports and maintenance of an electronic bulletin board. As a result of its successful work for DOE, the National Institutes of Health has joined DOE in support of HGMIS.

In the energy and environmental areas, work has continued on development of computerized data bases in support of hazardous waste management, transportation, disposal, and remedial actions. Additionally, the staff has participated in radiological surveys of contaminated sites and has prepared numerous Remedial Action Survey Assessment reports. Collaboration with other Laboratory organizations includes acid deposition research and environmental regulation and compliance evaluation for DOE and Department of Defense (DOD) facilities with the Environmental Sciences Division; conservation and materials research with the Metals and Ceramics Division; and fossil energy with the Fossil Energy Technology Environmental Program. In conjunction with the latter effort, a flexible information management system has been developed using the INQUIRE data base management system. Features developed have proved to be transportable to other subject areas.

A relatively new initiative involves computer technology applications—desktop publishing and a personal computer (PC)-based expert system. There are a total of 14 major environmental laws/reference handbooks prepared by the section using desktop publication technology. The Section is also involved in PC-based expert system software evaluation, application, and training. Thus far, we have developed three applications in environmental review and compliance: (1) National Environmental Policy Act (NEPA) Environmental Review and Compliance; (2) Air Permit Regulations; and (3) Determination of Resources

Conservation and Recovery Act (RCRA)/Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) Compliance.

¹Part-time employee.

HUMAN GENOME AND TOXICOLOGY

HGMIS was inaugurated in March 1989 and has completed a very successful year. It was established to serve as a primary information resource for DOE's Human Genome Program. As part of its work, HGMIS has produced a quarterly newsletter, established an electronic bulletin board, and prepared two reports. One of these reports reviews the instrumentation currently used and that proposed for use in the DNA sequencing effort; the other publication is the DOE program report for 1989-90. The work of HGMIS has provided the DOE Office of Health and Environmental Research with one of its first opportunities to draw attention to its role in the overall effort within the United States to map and sequence the human genome. As a result of its successful work for DOE, the National Center for Human Genome Research (NCHGR) at the National Institutes of Health has joined DOE in support of HGMIS for the purpose of producing a joint DOE/NCHGR bimonthly newsletter. The first issue of this joint publication, *The Human Genome News*, is scheduled for April 1990.

EMIC continued updating its computer file that contains the structures and test results for over 6000 chemicals evaluated in one or more of 23 genotoxicity bioassays. This work is carried out under the auspices of the EPA's Gene-Tox Program. All structures in this EMIC file have also been assigned to three chemical classification schemes that allow for a quick means of segregating chemicals with common structural characteristics. This feature, coupled with the ability to visually examine the structures of chemicals within a specific class, has proved to be an immensely effective tool for studying the influence of chemical structure on genotoxic activity.

The CURE data base has been developed to provide OHEA access to EPA-generated risk assessment data and to serve as a research tool for agency scientists. This data base is currently in the Infodata's INQUIRE data base management system at ORNL and available to the EPA through Telenet dial-up. The accomplishments this year include migrating the file to

the Central INQUIRE, enabling work to be performed without interrupting the users. The design of the CURE data base includes specialized subfiles developed for efficient use of the data available in the EPA documents and special fields so that the data can be used for modeling and structural activity work. There are currently 1900 chemicals in the chemical file, all of which have been classified according to the structural categories developed in the EPA Gene-Tox program. This will now provide a basis for structural activity to span genetic toxicology, low-dose toxicology, and carcinogenicity. A PC version of selected information from the mainframe file has been developed and is currently being tested within the OHEA. This is to be provided to the regional offices for ease of access to the complete information on selected chemicals. Recently, a demonstration of the PC version of CURE was presented to the assistant administrator of the EPA Office of Research and Development and received a favorable review. Design and implementation of an environmental information subfile for the appropriate information in the EPA documents have begun, and a test file is under review. Plans are for CURE to be available within the agency in the next fiscal year.

CHEMICAL HAZARD EVALUATION AND COMMUNICATION

Under various environmental regulations, such as the Toxic Substances Control Act, the Clean Air Act, the Safe Drinking Water Act, and Superfund and its amendments, the Superfund Amendment Reauthorization Act (SARA), federal and state governments are charged by Congressional mandate with protecting public health and preserving environmental quality. The staff members of the Chemical Hazard Evaluation and Communication (CHEC) Group have assisted EPA, the Agency for Toxic Substances and Disease Registry (ATSDR), the Army, and the states of New York and Tennessee in developing scientific documents and technical reviews on chemicals potentially subject to these and other regulations. These reports facilitate the decision-making process of establishing permissible toxic levels for chemical regulation. Types of reports include: Toxicological Profiles; Chemical Hazard Information Profiles; Chemical Hazard Assessments; Tier-I Health Assessment Reports; Water Quality Criteria Documents; Health and Environmental Effects (chronic toxicity and carcinogenicity) Documents; Reference Dose Profiles (oral and inhalation); Reportable Quantity Profiles; Air and Water Quality Standards; Methodology Development for Occupational Health Criteria; and Problem Definition Studies.

In support of the DOD Installation Restoration Program (IRP), CHEC staff members are assisting the Army's Toxic and Hazardous Materials Agency and the U.S. Air Force's (USAF) toxicology program at Wright-Patterson Air Force Base. Assistance to the Army is

through guidance on scientific and regulatory issues and through defining cleanup criteria for hazardous waste sites. The Army has numerous waste sites that must be remediated in accordance with applicable EPA policies and guidelines. CHEC scientists are using their knowledge of EPA's regulations and risk assessment strategies to define the necessary criteria. For the USAF, an extensive update and revision of the original three-volume IRP toxicology guide was completed. The resulting four-volume IRP toxicology guide, covering 70 organic compounds, incorporated current (as of May 31, 1989) information on state and federal regulatory status, health hazard data, analytical techniques, environmental fate, and a wide range of toxicologic data including carcinogenicity, genotoxicity, teratogenicity, and short- and long-term exposure effects on humans and laboratory species. Additionally, all of the data were incorporated into an on-line, relational data base using the ORACLE data base management system. The present work involves compilation, analysis, and presentation of similar information on a series of metals, comprising over 80 individual compounds or salts, that are of concern to the USAF. This work, scheduled for completion in August 1990 and also to be included in the on-line data base, will constitute the fifth volume of the USAF IRP toxicology guide.

With the promulgation of the Hazard Communication Standard by OSHA and SARA, Title III, 14 million workers at more than 320,000 manufacturing facilities as well as private citizens were given the right to obtain chemical safety information about the hazardous chemicals in their surroundings. To assist Energy Systems in complying with the law, CHEC has developed an on-line, interactive retrieval system for MSDS. Data contents of MSDS come from peer-reviewed data bases (HSDB, GENE-TOX, CHEMLINE, RTECS, TOXLINE) and handbooks, as well as from manufacturers' and distributors' MSDS. The menu-driven system uses the INQUIRE data base management system, which resides on the IBM 3033. The system can be accessed through time-sharing option on-site and is available to all Energy Systems employees and Toxic Material Advisory Committee members/DOE. Currently, the data base contains information on 2600 pure chemicals and 4873 trade name products. This project has expanded to assist the Army and Navy in implementation of their hazard communication programs.

HAZARDOUS MATERIALS AND ENVIRONMENTAL INFORMATION

During the past two years, the Hazardous Materials and Environmental Information (HMEI) Group has increasingly become involved in remedial action activities at ORNL and, since the beginning of FY 1990, has been working with the Energy Systems Environmental

Restoration Division (ERD). The staff continues to prepare radiological characterization reports for radioactively contaminated sites on the Oak Ridge Reservation and has also assisted in on-site survey activities. As a part of the preparation of the reports, HMEI staff members have also been performing data synthesis, analysis, and evaluation to support proposed remediation alternatives and creating digitized maps that detail the extent of contamination at the sites being characterized.

The most significant area of growth in HMEI has been in providing information management support to the ORNL Remedial Action Program Office and the recently created Information Systems Management Group within ERD. The information management activities that have been conducted for the ORNL Remedial Action Program since 1985 to cover all Energy Systems facilities for ERD will be expanded. The HMEI staff will be on loan to ERD to design and develop central information resources and provide guidance for, and effective management of, those resources.

In support of the DOE Biomass Production Program, intense efforts were made to verify all on-line data for short-rotation woody crops and to expand the data base to include data from newly planted full-scale field trials and genetic research activities. Development of a similar data base management system for herbaceous energy crops was begun. These systems will provide important tools in assessing the energy potential, the cultural management techniques, genetic manipulation, and selective breeding programs for these energy crops that will lessen the U.S. dependence on imported fuels.

The information support provided to the DOE Office of Remedial Action and Waste Technology since 1979 will continue under the recently created Office of Environmental Restoration at DOE headquarters. This office now has the responsibility for managing the DOE Remedial Action Programs, the Formerly Utilized Sites Remedial Action Program (FUSRAP), the Surplus Facilities Management Program (SFMP), and the Uranium Mill Tailings Remedial Action Program (UMTRAP).

A program for the DOE Office of Environment, Safety, and Health (ES&H) for technical and management support of its hazardous materials Packaging and Transportation Safety (PATs) program has been developed and maintained. This includes the design of an on-line PATs data base. An information center, including a library and data base, is provided to the Energy Systems Waste Management R&D Program.

Several successful regulatory information projects continue to expand as the need for this vital information increases in DOE and DOD. The *Environmental Safety and Health News* (ESHNEWS), a current-awareness weekly publication on issues of environment and safety, received an achievement award in the Society for Technical Communications

Publications Competition in the newsletter category. The Environmental Regulatory Update Table is a monthly review of the status of pending and proposed environmental legislation published in conjunction with the Environmental Sciences Division for the DOE Office of Environmental Guidance and Compliance. Another cooperative effort with the Environmental Sciences Division is the periodic issuance of Environmental Guidance Program Reference Books on the 14 major federal environmental acts.

A NEPA compliance assessment team was assembled and put into action in response to Secretary of Energy James Watkins' introduction of a series of ten initiatives to strengthen environmental protection and waste management at DOE sites. The staff assisted in the development of the NEPA Compliance Audit Protocol, chiefly by designing and providing the documentation for a data base to be used to organize and maintain the information gathered during the review/audit process, including participation in "tiger team" audits at the Rocky Flats Plant, Feed Materials Production Center (Fernald), Pantex, Kansas City, Savannah River Site, and Lawrence Livermore National Laboratory.

The information management area has developed desktop publishing techniques for several applications, including the preparation of newsletters, composition of course manuals, development of a Drinking Water Regulations poster, preparation and updating of reference books on legislation, and composition of questionnaires. The *Ceramic Technology Newsletter* communicates developments in ceramic technology or advanced heat engines to over 1200 interested persons in the United States and abroad. The newsletter received a Society for Technical Communication Award in February 1989. In addition, a newsletter, *Radon Research Notes*, in support of the DOE Office of Health and Environmental Research, Radon Research Program, has been initiated.

A PC-based expert system, NEPA Environmental Review and Compliance (NERC), is under development for the Environmental Monitoring and Compliance Section of ORNL's Office of Environmental and Health Protection. This expert system is used in the preparation of documentation of compliance with NEPA requirements and other applicable federal, state, DOE, and ORNL environmental, safety, and health standards. Additional expert systems are: (1) Air Permit Regulations and (2) Determination of RCRA/CERCLA Compliance. Both were developed for the Environmental and Health Protection Division at the Y-12 Plant.

6. OFFICE OF RISK ANALYSIS

C. C. Travis, Coordinator

The Office of Risk Analysis (ORA) was organized to assist in the coordination of risk-related activities at Oak Ridge National Laboratory (ORNL). The office is involved in a variety of risk-related activities ranging from development of theoretical models to actual field work characterizing risk at hazardous waste sites.

For the Environmental Protection Agency (EPA), ORA is evaluating the use of pharmacokinetic models in risk assessment. ORA has developed pharmacokinetic models in mice, rats, and humans for tetrachloroethylene, methylene chloride, methyl chloroform, and benzene. The ability of physiologically based pharmacokinetic models to extrapolate between species provides a major tool for improving the estimation of human cancer risk based on animal cancer bioassays. ORA is also evaluating the use of pharmacodynamic models in the risk assessment process. These models relate fundamental cellular processes to the epidemiology of cancer in animal and human populations. They are based on the assumption that cancer is a two-stage process and incorporate data on genetic mutation frequencies and cell turnover dynamics. These models appear to have excellent possibilities of producing more realistic estimates of risk associated with hazardous substances. For the Department of Energy, ORA is evaluating rapid methods for prioritizing chemicals with respect to their potential threat to human health. Attributes of these methods are that they provide estimates of the potential human toxicity of organic chemicals for which little toxicological data exist, and they work equally well for carcinogens and noncarcinogens. ORA is also performing health evaluations at hazardous waste sites throughout the United States.

7. CONTRIBUTIONS TO NATIONAL AND LEAD LABORATORY PROGRAMS AND ASSIGNMENTS

ENVIRONMENTAL RESTORATION

B. A. Berven and C. E. Easterly

Environmental restoration is an extraordinarily complex and costly process. Basic research is urgently required to reduce costs, improve quality, and reduce exposure to the public and workers involved in the environmental restoration process. The Department of Energy (DOE) Office of Energy Research (OER) has undertaken an initiative to advance basic research in environmental restoration. The problem areas were identified in a planning document, *Evaluation of Mid-to-Long Term Basic Research for Environmental Restoration* (DOE/ER-0419). Basic research needs have been grouped into five major categories patterned after those identified in the planning document: (1) environmental transport and transformations; (2) advanced sampling, characterization, and monitoring methods; (3) new remediation technologies; (4) performance assessment; and (5) health and environmental effects of technology applications. Oak Ridge National Laboratory (ORNL) was asked to prepare a document extending, updating, and focusing the initial plan presented in DOE/ER-0419. Health and Safety Research Division (HASRD) representatives cochaired international working groups to assess basic research needs in advanced sampling, characterization, and monitoring methods and health and environmental effects of technology applications.

All DOE facilities have numerous waste sites requiring site characterization. These waste sites retain a vast array of chemical and radiological contaminants, both as individual contaminants and in complex mixtures. The extent and magnitude of site contaminants span many orders of magnitude. Site characterization is a costly, time-consuming process that balances the need to gather sufficient information about a site against the cost and time to gather that information. Research and development in advanced sampling, characterization, and monitoring will provide optimal solutions to cost versus benefit in site characterization.

Improved temporal and spatial information about subsurface contamination prior to, during, and after remedial efforts will enhance decision-making capabilities, resulting in greater cost savings and minimizing likelihood of failed remediation.

The extent and choice of environmental restoration strategy depends, in part, on estimates of human health and environmental risks. These include risks to the workers occupationally exposed during the restoration process, risks to the residents in the surrounding communities, risks to potential future inhabitants of the DOE sites, and risks to the environmental components both currently and in the future. Because the risks of DOE mixed wastes are poorly understood, HASRD is involved in both basic and applied research programs that will lead to a better understanding of human health risks from environmental contamination. The overall program goal of the proposed basic research program is to allow DOE to make significant fundamental scientific advance in the quantification of risks resulting from mixed (or simultaneous) exposure to radiation and chemicals that are associated with remediation and restoration of DOE waste sites. It is essential that policy makers understand the comparative health and environmental risks and costs of competing remediation technologies. The nature of DOE mixed wastes presents unique biological exposures, necessitating the development of new and sensitive approaches for predictions of exposure and biological response.

APPENDIXES

APPENDIX A. SOURCES OF FUNDING

	FY 1989 (\$K)	FY 1990* (\$K)
DEPARTMENT OF ENERGY		
Biological and Environmental Research	\$ 5,978	\$ 6,048
Remedial Action and Waste Technology	4,919	3,414
Environmental Research and Development	240	250
Electric Energy Systems	332	55
Defense Waste and Environmental Restoration	468	330
Multiprogram - Facilities Support	287	0
Fossil Energy - Coal	99	13
Solar Energy	110	111
Transportation	66	101
Multisector	79	0
Energy Technology Center	48	6
DEPARTMENT OF DEFENSE		
Air Force (including HAZWRAP)	2,657	1,356
Navy (including DSRD)	987	1,031
Army	519	1,152
National Security Agency	14	0
Defense Nuclear Agency	276	273
Strategic Defense Initiative Organization	100	0
OTHER FEDERAL AGENCIES		
Environmental Protection Agency	3,721	1,359
Department of Health and Human Services		
National Library of Medicine	1,788	934
Agency for Toxic Substances and Disease Registry	1,423	817
National Heart, Lung and Blood Institute	9	0
National Institute of General Medical Sciences	231	127
National Institute of Environmental Health Sciences	135	1
National Cancer Institute	157	82
National Science Foundation	288	282
Nuclear Regulatory Commission	199	84
Consumer Products Safety Commission	43	42
Bureau of Land Management	13	14
Office of the Inspector General	105	105
OTHER DOE		
Battelle Pacific Northwest Laboratory	35	32
Lawrence Livermore National Laboratory	25	0
Schenectady Naval Reactors Office	300	171
Los Alamos National Laboratory	482	610
Bendix	503	450

Nevada Operations Office	8	8
Sandia National Laboratories	0	5
Y-12	843	1,340
K-25	145	1,526
ORO/ORAU	45	0
EG&G Idaho	45	0
Multiplant	137	291
ORO/Energy Systems	10	96

PRIVATE, STATE AND LOCAL GOVERNMENT

Universities		
University of Tennessee	25	0
University of Southern California	48	0
New York University	17	17
Cornell University	5	15
University of New Jersey	5	0
Holmes and Narver	3	0
Federal Republic of Germany	17	6
American Petroleum Institute	66	99
Radiation Effects Research Foundation	0	50
Soap and Detergent Association	0	55

INTERNAL ORNL

Seed Money and Discretionary Funds	959	1,043
Laboratory Overhead Accounts	<u>123</u>	<u>187</u>
TOTAL Division	\$ 29,137	\$ 23,988

*Budget information through March 31, 1990.

APPENDIX B. PERSONNEL SUMMARY

	Professional	Technical Support	Administrative Support	Total
Permanent	111	26	29	166
Temporary	13	7	2	22
Part-time	14	1	3	18
Leave of absence	1	0	0	1
Off-site assignment	1	0	0	1
Division-supported loanees	18	3	0	21

Many types of employees are required to run the division effectively and efficiently. Several sources are used to staff the division to maintain the high standards. During this reporting period, we have had a total of 302 assignments to the division in the following categories: consultants, subcontractors, guests from universities, visiting scientists from other laboratories as well as private companies, postdoctoral fellows, and students who come to us under several different programs. Assignment terms vary in duration from a few months to a year or more. We view this as a very economical way to bring different and diversified talents to the division.

HEALTH AND SAFETY RESEARCH DIVISION



W L Foltz
W A Jernigan
A A Jiz
A B Jiz
R D Kott
D R Latt
D S Latt
C L Neebun
C A Nunez
M A Murry
G M Pierce
G M Piz
E D Reading
C D Reshele
J A Rice
E K Roemer
R M Schlosier
D L Sellers
W M Smith
K M Smuin
C K Stone
E Tate
G T Topping
K M Wagoner
J L Zeman

<p> CLERICAL C. C. Knecht R. W. Leggett V. C. Hyman A. C. Sorenson M. C. Sorenson A. C. Ward J. R. Williams </p>	<p> NUCLEAR MEDICINE F. F. Macg. Jr. L. K. Alley, Secretary K. R. Andreose A. H. Ballman S. J. Lambert D. W. McPherson S. Mizushima P. C. Nevisawa J. R. Lambert D. E. Rice </p>
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[illegible]

* Dual Capacity
 1 Student
 2 Postdoctoral Fellow
 3 Guest Assignment
 4 Post time
 5 Visiting Scientist
 6 Subcontract
 7 UT/DB Grant to the School of Biological Sciences

R B Gammage* D F Davidson	C S Dudley J C DePriest* J W Haas III E E Nyquist R J Sautz E A Wachner R J Watson D L Wilson	DOSIMETRY APPLIC RESEARCH C S Sims L R Sims, Secre E G Baslett W A Buchner W A Holland E B Holland E Muggidge G R Patterson
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PRINCIPAL MEDICAL COOPERATIVES

H. J. Bartsch	Department of Nuclear Medicine Bonn, West Germany
C. Bihary	Research Center University of Leuven, Belgium
A. B. Bitt	Department of Nuclear Medicine University of Massachusetts
D. Bonte	Department of Radiology University of Michigan
P. Franken	Middelheim Hospital Antwerp, Belgium
J. Huisman	VTT Reactor Laboratory, Finland
K. Hubner	Department of Nuclear Medicine University of Tennessee
G. Murray	Houma Heart Institute, Louisiana
R. Patterson	Longwood Long Hospital, Atlanta

<p>D M Gledits* J M Gledits* R A Gledits* G J Johnson*</p>	<p>HARMFUL MATERIALS AND ENVIRONMENTAL INFORMATION</p> <p>P T Owen* S L Roberts Secretary</p>	<p>ENVIRONMENTAL REGULATIONS</p> <p>L M Roachsen* K J Brown R M Goss M J Goss N B Muro* A E Nigam Nabahit R S Weaver S M Hoenberg S M Hoenberg H Orinobadan* C B Staymaker* J M F. 1025*</p>
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8 Leaves of absence	
9 Off site Assignment	
B	Biology
CT	Computing and Telecommunications
EHP	Environmental and Health Protection
EPM	Engineering Physics and Mathematics
ES	Environmental Sciences
FM	Finance and Materials
IC	Instrumentation and Controls
RR	Research Reactors

RWTH Aachen	
Aachen, West Germany	
R. K. Hobbs	
Physics and Research Inst	
Costa Mesa, CA	
P. Som	
Medical Department, BNL	
Upton	
Visiting Professor	
Erasmus Hospital	
Amsterdam, The Netherlands	
C. Weinburn	
ORAU	

P T Owen*	G M Cotton
J M Priden	A R Eason
H A Phibber	A R Everhult
M S Uziel	D G Migore*
J W Crutcher	T L Cas*
J E Ferguson	R E Gibson*
L F Goss	M E Jorgensen
N P Knaa	M J Lueken
M A Phillips	D M Stoves
J R Webb	J M Wynick**

SUPPORT FUNCTIONS	COMPUTING APPLICATIONS	CT
	R T Haas*	
	D G Kilgore*	
	K C Miller*	
	L M Roseberry*	
	VAX OPERATIONS	
	J G Craven	
	S C Daniels*	

APPROVED Stephens Kaye 3/14/90
Division Director

APPROVED Stephen W Kaye 3/14/90
Division Director

APPENDIX D. SEMINAR PROGRAM

P. C. Srivastava

The coordinator of the Health and Safety Research Division's seminar program works with staff members to identify distinguished seminar speakers from various disciplines of research interest to the Division.

During the period October 1, 1988, through March 31, 1990, the Division hosted ten seminar speakers representing industry, research institutions, and universities. A list of the seminar speakers and topics follows:

Hartmut Walter

Institute for Radiation Health, Neuherberg, West Germany, "Atmospheric Transport of Radionuclides after the Chernobyl Event: Problems and Possible Solutions," December 1, 1988.

Mary Jean Sawey

Harvard School of Public Health, Boston, Massachusetts, "Activation of Oncogenesis in Radiation-Induced Carcinogenesis," December 5, 1988.

Stephen W. Coates

J. T. Baker, Inc., Marietta, Georgia, "Protein Purification," February 23, 1989.

Elaina M. Kenyon

Department of Toxicology, University of Massachusetts at Amherst, Amherst, Massachusetts, "Extent and Implications of Interspecies Differences in the Intestinal Hydrolysis of Glucuronide Conjugates," April 7, 1989.

Jae-Ho Yang

School of Public Health, University of Massachusetts at Amherst, Amherst, Massachusetts, "Evaluation of Peroxisome Proliferation in Rainbow Trout," May 25, 1989.

Becky Van Beneden

Duke University Marine Laboratory, Beaufort, North Carolina, "The Role of Oncogenes in Carcinogenesis of Lower Vertebrates," August 15, 1989.

Philippe Garrigues

University of Bordeaux, Talence, France, "Shpolskii Luminescence Spectroscopy: The Ultimate Tool for Selective Organic Analysis," September 25, 1989.

Sandford A. Asher

University of Pittsburgh, Pittsburgh, Pennsylvania, "UV Raman Spectroscopy: A New Technique for Physical, Biophysical, and Analytical Chemical Studies," January 22, 1990.

Jennifer V. Hines

Medicinal Chemistry, University of Michigan, Ann Arbor, Michigan, "General Synthetic Methodologies for the Construction of Medicinally Important Compounds and Their Analogues: Application to the Anti-Cancer Agent Bestatin and the Glucosidase Inhibitor Australine," January 26, 1990.

Howard C. Kunreuther

The Wharton School, University of Pennsylvania, Philadelphia, Pennsylvania, "Are Risk-Benefit Tradeoffs Possible in Siting Hazardous Facilities?" February 2, 1990.

APPENDIX E. LIST OF HONORS AND AWARDS FOR STAFF MEMBERS

SPECIAL HONORS

T. L. Ferrell and R. J. Warmack

Recipients of the French Optical Society Fabry-Gramont Award for 1989

F. F. Knapp, Jr.

Recipient of the Senior U.S. Scientist Award from the Alexander von Humboldt Foundation of West Germany, in recognition of his achievements in radiopharmaceutical research and the development of new agents for clinical applications in nuclear medicine

C. S. Sims

Chosen to serve as an assessor for the Department of Energy Laboratory Accreditation Program (DOELAP) for personnel dosimetry

C. C. Travis

Appointed as a Senior Research Fellow with the Energy, Environment, and Resources Center at the University of Tennessee, beginning January 1, 1990

Chosen to serve on the Scientific Peer Review of the Environmental Protection Agency (EPA), Part 503, Comprehensive Sewage Sludge Regulations: *Federal Register*, February 6, 1989

T. Vo-Dinh

Recipient of the Medal of the Languedoc-Roussillon Region Award (1989) for his scientific achievements and to commemorate the establishment of a research collaboration between the Oak Ridge National Laboratory and the Laboratory of Physical Chemistry, University of Perpignan, France

R&D-100 AWARD

T. L. Ferrell, R. C. Reddick, and R. J. Warmack

"Photon Scanning Tunneling Microscope"

SPECIAL AWARDS

S. L. Allman

Sigma Xi Support of Research Award, 1989

Gloria M. Caton

Martin Marietta Energy Systems, Inc. 1988 Operational Performance Award for distinguished service in managing information for the formal critical review of the DOE Energy Conversion and Utilization Technologies Materials Program

T. L. Ferrell and R. J. Warmack

Martin Marietta Energy Systems, Inc. 1988 Inventor Award for invention of a photon scanning tunneling microscope that could revolutionize optical microscopy by ultimately allowing objects to be seen that are ten times smaller than can be imaged by conventional means

Health and Safety Research Division Excellence in Research Award for 1988

W. R. Garrett and M. G. Payne

Health and Safety Research Division Excellence in Research Award for 1989

O. V. Jennings

Health and Safety Research Division Distinguished Achievement Award for Administrative Support for 1989

R. H. Ritchie

Senior Corporate Fellow, 1990

J. M. Wyrick

Health and Safety Research Division Distinguished Achievement Award for Technical Support for 1989

Recipient of the Distinguished Service Award, East Tennessee Chapter of the American Society for Information Science (ASIS)

PUBLICATION AWARDS

Gloria M. Caton, Judy M. Wyrick, and the Ceramic Technology Staff

Society for Technical Communication Achievement Award for *Ceramic Technology Newsletter*

Richard W. Leggett and L. R. Williams

Martin Marietta Energy Systems, Inc., 1988 Publication Award for "A Biokinetic Model for Rb in Humans"

M. Uziel, N. B. Munro, D. S. Katz, T. Vo-Dinh, and E. A. Zeighami

Recipients of a Society for Technical Communication Technical Reports Achievement Award for "DNA Adduct Formation by Twelve Chemicals with Populations Potentially Suitable for Molecular Epidemiological Studies"

COMMITTEE APPOINTMENTS

- E. T. Arakawa
Member, International Advisory Board, Vacuum Ultraviolet Radiation Physics Group, 1989 - 1992
- B. A. Berven
Chairman, Environmental Section of the Health Physics Society Standards Committee, 1985 - present
- J. E. Carrington
Member, ORNL/Martin Marietta Energy Systems, Inc., Values Committee, 1988 - present
- L. G. Christophorou
Member, ORNL/Publications Selection Committee, 1990
- R. N. Compton
Member, Panel of Public Affairs (POPA), American Physical Society, 1989 - present
- M. Cristy
Member, Task Group on Dose Calculations, Committee 2 on Secondary Limits, International Commission on Radiological Protection, 1985 - present

Vice-chairman, Task Group on Revision of Reference Man, Committee 2 on Secondary Limits, International Commission on Radiological Protection, 1985 - present

Corresponding member, Task Group on Age-Dependent Dosimetry, Committee 2 on Secondary Limits, International Commission on Radiological Protection, 1988 - present
- C. E. Easterly
Member, Electromagnetics Subpanel of the Free-Electron Hazards Advisory Panel, U.S. Army Environmental Hygiene Agency, 1988 - present

Member, Subcommittee on Dose Assessment, DOE Emergency Management Coordinating Committee, 1989 - present

Member, ASTM Subcommittee E34.70, Single Crystal Whiskers, of Committee E-34 on Occupational Health and Safety, 1988 - present

Member, Monitoring and Modeling Subcommittee of the Oak Ridge Full-Scale Exercise Advisory Committee, 1988 - present
- K. F. Eckerman
Member, Task Group on Modeling and Scaling to Humans, DOE, 1985 - present

Member, National Council on Radiation Protection and Measurements, 1990

Member, Committee 2 on Secondary Limits, International Commission on Radiological Protection, 1982 - present

Chairman, Task Group on Dose Calculations, Committee 2 on Secondary Limits, International Commission on Radiological Protection, 1982 - present

Member, Task Group on Age-Dependent Dosimetry, Committee 2 on Secondary Limits, International Commission on Radiological Protection, 1988 - present

Member, Scientific Committee 57, Internal Emitter Standards, National Council on Radiation Protection and Measurements, 1979 - present

Member, Scientific Committee 64, Task Group 5, Public Exposure from Nuclear Power, National Council on Radiation Protection and Measurements, 1979 - present

Member, Scientific Committee 64, Task Group 6, Screening Models, National Council on Radiation Protection and Measurements, 1979 - present

Member, Advisory Group, Health Effects Model Revision, Nuclear Regulatory Commission, 1980 - present

R. B. Gammage

Member, Indoor Air Quality Committee, American Industrial Hygiene Association, 1987 - present

Member, DOE Research Development Demonstration Testing and Evaluation Working Group for Instrumentation, 1989 - present

T. D. Jones

Member, DOE Environmental Standards Steering Committee, 1990

G. D. Kerr

Member, Task Group on Revision of Reference Man, Committee 2 on Secondary Limits, International Commission on Radiological Protection, 1985 - present

Member, DOE Working Group on Reassessment of A-Bomb Radiation Dosimetry in Hiroshima and Nagasaki, 1982 - present

Member, American National Standards Institute/American Nuclear Society Standards Committee on Neutron and Gamma-Ray Fluence-to-Dose Factors, 1985 - present

Member, Nuclear Regulatory Commission Health Physics Research Overview Committee, 1988 - present

Member, Review Committee on BEIR V, DOE, 1990

D. C. Kocher

Member, Standards Committee, Health Physics Society, 1987 - present

R. W. Leggett

Member, Task Group on Dose Calculations, Committee 2 on Secondary Limits, International Commission on Radiological Protection, 1985 - present

Corresponding member, Task Group on Age-Dependent Dosimetry, Committee 2 on Secondary Limits, International Commission on Radiological Protection, 1988 - present

C. A. Little

Chairman, Public Information Committee, Environmental Radiation Section, Health Physics Society, 1988 - present

Member, Nominating Committee, Health Physics Society, 1990

Member, DOE Division of Remedial Action Programs Ad Hoc Committee on Hazardous and Mixed Wastes, 1987 - present

P. Y. Lu

Member, National Safety Council, Executive Committee Chemical Section, 1985 - present

R. H. Ritchie

Member, Executive Council, Southeastern Section, American Physical Society, 1986 - present

I. Sauers

Subcommittee Chairman, IEEE Gaseous Dielectrics Committee S-32-11, 1986 - present

C. S. Sims

Chairman, Technical Committee on Procedures and Data for the Intercomparison of Personnel Dosimeters, International Atomic Energy Agency, 1984 - present

Chairman, Technical Committee on Assessment of Occupational Exposure to External Radiation for Monitoring Purposes, International Atomic Energy Agency, 1985 - present

Chairman, ANSI N13.11 Review Working Group, Health Physics Society, 1987 - present

P. C. Srivastava

Member, National Institutes of Health Advisory Committee, Development Therapeutics Contracts Program, 1987 - present

R. E. Swaja

Member, ANSI N319 Committee on Personnel Neutron Dosimetry, Health Physics Society, 1986 - present

Chairman, ASTM E10.04 Committee on Criticality Accident Dosimetry, 1986 - present

C. C. Travis

Chairman, Scientific Bases for Risk Assessment Assumptions, Office of Science and Technology Policy, 1986 - present

Member, Science Advisory Board, Food and Drug Administration, 1987 - present

Member, Delivered Dose Work Group, American Industrial Health Council, 1987 - present

Member, State of New Jersey Governor's Science Advisory Board on Health and Environmental Issues, 1988 - present

Member, New Jersey State Department of Health Advisory Panel on Superfund Sites, 1988 - present

Member, State of Maryland Advisory Panel on the Maryland Power Plant Research Program, 1988 - present

Member, Technical Advisory Committee (TAC) to the New York City Sludge Management Plan, 1989 - 1992

Member, National Academy of Sciences Board on Radioactive Waste Management to Review the Idaho National Engineering Laboratory activities, 1989 - present

Member, National Academy of Sciences Board on Radioactive Waste Management Committee to Review Hanford Single Shell Tanks, 1989 - present

Member, National Academy of Sciences Committee on Biomarkers for Immunotoxicology, 1989 - present

Member, The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) Scientific Advisory Panel for the Environmental Protection Agency, 1990 - 1994

J. E. Turner

Member, Comprehensive Certification Panel of Examiners, American Board of Health Physics, 1987 - present

Member, RERF Advisory Dosimetry Subcommittee, National Research Council, 1988 - present

Consociate Member, National Council on Radiation Protection and Measurements, 1983 - present

T. Vo-Dinh

Co-chairman, International Committee on Polycyclic Aromatic Compounds, 1985 - present

Secretary, Technical Committee TT-6 on Energy-Environmental Interactions, Air Pollution Control Association, 1984 - 1989

Member, Technical Committee on Indoor Air Quality, American Industrial Hygiene Society, 1984 - 1989

Chairman, Program Committee, Air Pollution Control Association, East Tennessee Chapter, 1986 - 1988

Member, International Union of Pure and Applied Chemistry (IUPAC), 1989 - present

Chairman, Subcommittee on Fiberoptics, ASTM Committee E.13, 1989 - present

E. S. Von Halle

Chairman, Membership Committee, Environmental Mutagen Society, 1986 - present

J. S. Wassom

Chairman, Communication and Archives Committee, Environmental Mutagen Society, 1982 - present

Councilor, Environmental Mutagen Society, 1987 - present

A. P. Watson

Member, Reentry/Restoration Subcommittee of the Chemical Stockpile Disposal Program Steering Committee, Department of the Army and the Federal Emergency Management Agency (FEMA), 1989 - present

JOURNAL ACKNOWLEDGMENTS

R. N. Hamm

Associate Editor, *Radiation Research*, 1985 - 1989

F. F. Knapp, Jr.

Member, Editorial Board, *NucCompact-European/American Communications in Nuclear Medicine*, 1989 - present

K. H. Mavournin

Member, Editorial Board, *Environmental and Molecular Mutagenesis*, 1985 - present

C. S. Sims

Associate Editor, *Health Physics*, 1990

C. C. Travis

Editor-in-Chief, *Risk Analysis*, 1983 - present

Member, Editorial Advisory Board, *Toxicological and Environmental Chemistry*, 1989 - present

Member, Editorial Board, *Health and Environmental Toxicology*, 1989 - present

T. Vo-Dinh

Member, Editorial Board, *Applied Spectroscopy*, 1988 - present

Spectroscopy Editor, *Polycyclic Aromatic Compounds*, 1989 - present

E. S. Von Halle

Member, Editorial Board, *Environmental and Molecular Mutagenesis*, 1980 - present

Member, Editorial Board, *Mutation Research*, 1985 - present

Member, Editorial Board, *Registry of the Toxic Effects of Chemical Substances*, 1984 - present

J. S. Wassom

Member, Board of Managing Editors, *Mutation Research*, 1975 - present

A. P. Watson

Book Review Editor, *Environmental Management*, 1985 - 1989

Member, Editorial Board, *Environmental Management*, 1985 - 1989

UNIVERSITY APPOINTMENTS

E. T. Arakawa

Adjunct Professor of Physics, University of Tennessee, 1982 - present

L. G. Christophorou

Professor of Physics, University of Tennessee, 1969 - present

R. N. Compton

Adjunct Professor of Physics, Vanderbilt University, 1983 - present

Professor of Chemistry, University of Tennessee, 1985 - present

T. L. Ferrell

Professor of Physics, University of Tennessee, 1979 - present

W. R. Garrett

Adjunct Professor of Physics, University of Tennessee, 1990

C. A. Little

Adjunct Professor of Radiology and Radiation Biology, Colorado State University, 1987 - present

M. G. Payne

Adjunct Professor of Physics, University of Tennessee, 1990

R. H. Ritchie

Professor of Physics, University of Tennessee, 1965 - present

C. S. Sims

Adjunct Assistant Professor, Texas A&M University, 1990

J. E. Turner
 Professor of Physics (part-time), University of Tennessee, 1981 - present
 Professor of Nuclear Engineering (part-time), University of Tennessee, 1990

M. Uziel
 Professor of Biomedical Sciences (part-time), University of Tennessee, 1968 - present

T. Vo-Dinh
 Professor of Biomedical Sciences (part-time), University of Tennessee, 1987 - present

R. J. Warmack
 Professor of Physics, University of Tennessee, 1983 - present

OTHER

B. A. Berven
 Secretary, Oak Ridge Chapter of Sigma Xi, 1988

R. N. Compton and J.A.D. Stockdale
 Recipients, NATO International Collaboration Grant, 1988-90

K. F. Eckerman
 Consultant, Sloan-Kettering Memorial Medical Center, 1981 - present

A. R. Hawthorne
 Chairman, Awards Committee, Oak Ridge Chapter of Sigma Xi, 1990

S. V. Kaye
 Consultant, U.S. Department of Veteran Affairs, 1989 - present

G. D. Kerr
 Consultant, Radiation Effects Research Foundation, Japan, 1975 - present

D. C. Kocher
 Visiting Professor, Department of Radiology and Radiation Biology, Colorado State University, 1989 - 1990

J. C. Miller
 Chairman, FY 1989 DOE/University Research Instrumentation (URI) Panel
 Recipient, North Atomic Treaty Organization International Collaboration Grant, 1987 - 1990

R. H. Ritchie
 Recipient, North Atomic Treaty Organization Research Grant, 1987 - 1989

Recipient, Research Grant, U.S.-Spain Joint Committee for Scientific and Technological Cooperation, 1988 - 1989

Recipient, Grant from National Science Foundation for U.S.-Japan Collaborative Research, 1988 - 1990

Member, Board of Directors, Pellissippi International, Inc., 1987 - present

C. S. Sims

U.S. Dosimetry Contact for the Joint Standing Committee for Civil Nuclear Cooperation with Taiwan, Republic of China, 1985 - present

T. Vo-Dinh

Secretary, American Institute of Chemists (Tennessee Section), 1989 - present

A. P. Watson

Chair, Admissions Committee, Oak Ridge Chapter of Sigma Xi, 1989 - present

APPENDIX F. PATENTS GRANTED TO STAFF MEMBERS

PATENTS ISSUED

- L. G. Christophorou and S. R. Hunter
 "Gas Mixtures for Spark Gap Closing Switches," U.S. Patent No. 4,792,724,
 December 20, 1988
- M. M. Goodman and F. F. Knapp, Jr.,
 "Radioiodinated Glucose Analogues for Use as Imaging Agents," U.S. Patent No.
 4,789,542, December 6, 1988
- Mark M. Goodman and F. F. Knapp, Jr.
 "Radioiodinated Branched Carbohydrates," U.S. Patent No. 4,826,966, May 2,
 1989
- M. M. Goodman and F. F. Knapp, Jr.
 "Radiohalogenated Thienylamphetamine Derivative for Evaluation of Local Cerebral
 Blood Flow," U.S. Patent No. 4,900,539, February 13, 1990
- S. R. Hunter and L. G. Christophorou
 "Binary and Ternary Gas Mixtures for Use in Glow Discharge Closing Switches,"
 U.S. Patent No. 4,896,076, January 23, 1990
- Michael P. McCann, Chung H. Chen, and Steven D. Kramer, "Ultraviolet Laser Beam
 Monitor Using Radiation Responsive Crystals," U.S. Patent No. 4,792,690,
 January 1989
- Prem C. Srivastava
 "Mercuric Acetate Phenyl Maleimide Useful for Preparing Radiohalogenated
 Maleimides," U.S. Patent No. 4,812,577, March 14, 1989

PATENT APPLICATIONS

- Loucas G. Christophorou and Homer Faidas
 "Dielectric Liquid Pulsed-Power Switch," April 1989 (ESID 601-X)
- S. D. Kramer and M. P. McCann
 "Ultraviolet Laser Beam Monitor Using Alkali Halide Crystals," March 1990 (ESID
 63-X)
- Tuan Vo-Dinh
 "Surface-Enhanced Raman Optical Data Storage (SERODS) System," October 1989
 (ESID 448-X, S-67,190)

INVENTION DISCLOSURES

Allan I. Bennett, Lyon Mandelcorn, Robert L. Miller, and Karl F. Schoch (employees of Westinghouse), "Conducting-Polymer Coatings on Capacitor Dielectric Films to Eliminate Partial Discharges in Voids Between Films," August 1989 (ESID 643-X) (D. R. James)

Howard S. Carman, Jr., Cornelius E. Klots, and Robert N. Compton, "Process for Preparing Sulfur-234 Enriched Carbon Disulfide," September 1989 (ESID 665-X)

Chung-Hsuan Chen and Steve L. Allman, "Low Electron Energy Scanning Mass Spectrometer," August 1989 (ESID-649)

Loucas G. Christophorou and Homer Faidas, "Dielectric Liquid Pulsed-Power Switch," April 1989 (ESID 601-X)

R. N. Compton, "Metal Vapor Heat Pipe Dosimeter," August 1989 (ESID 648)

Thomas L. Ferrell, Mark J. Bloemer, and Robert J. Warmack, "Method for Preparing Improved STM Probe Tip," February 1989 (ESID 388-X)

John W. Haas III and Eric A. Wachter, "Undercoated SERS Substrates," June 1989 (ESID 621-X)

John W. Haas III and R. B. Gammage, "Fiberoptic Probe for Optical Spectrometry," March 1990 (ESID 757-X, S-70,488)

Furn F. Knapp, Jr., Daniel W. McPherson, and Gilbert Kirsch, "Bifunctional Chelates for Labeling Antibodies with Radioisotopes of Copper and Rhenium," February 1989 (ESID 571-X)

Ronald C. Phillips and Chung-Hsuan Chen, "Superconductor Thin Film Monitor," March 1989 (ESID 526-X)

Isidor Sauers, "SF₆ Hygrometer," October 1989 (ESID 681-X)

Michael J. Sepaniak (UT) and Tuan Vo-Dinh, "Fiber Optic-Based Regenerable Diosensor," July 1989 (ESID-638)

Prem C. Srivastava and Ahmad Hasan, "Acyclonucleosides of 2-Nitroimidazole and Uses as Diagnostic and Therapeutic Agents," March 1990 (ESID 738-X, S-70,482)

Richard L. Tyndall, "Amoeba/Bacteria Consortia and Related Process for Degrading TCE and Other Wastes and Contaminants," November 1989 (ESID 702-X, S-70,431)

Mayo Uziel, "Device and Method for Continuous, Two-Dimensional Sequential Column Chromatography and Electrophoresis, Especially for DNA Sequencing," August 1989 (ESID 636-X)

Tuan Vo-Dinh, "Raman-Based System for DNA Sequencing and Other Separations," November 1989 (ESID 699-X, S-70,429)

Tuan Vo-Dinh, "Phosphorescence-Based System for DNA Sequencing and Other Separations," November 1989 (ESID 700-X, S-70,430)

Tuan Vo-Dinh, "Chemical Coating Based SERS Substrates," March 1990 (ESID 760-X, S-70,490)

Roy Edward Voshall (employee of Westinghouse), "Conducting Polymer Coating on Vacuum Interrupter Insulating Envelope," August 1989 (ESID 642) (D. R. James)

Eric A. Wachter and John W. Haas III, "Overcoated SERS Substrates," June 1989 (ESID 622-X)

Eric A. Wachter and John W. Haas III, "Improved Needle Substrates for SERS and ESERS Analysis," February 1990 (ESID 735-X)

APPENDIX G. MEETINGS AND CONFERENCES

Second Conference on Radiation Protection and Dosimetry, Orlando, Florida, October 31 - November 3, 1988. Chairpersons: C. S. Sims and R. E. Swaja, Oak Ridge National Laboratory. Sponsor: Health and Safety Research Division.

APPENDIX H. ADVISORY COMMITTEE

RETIRING MEMBERS:

William A. Mills, Ph.D.
Senior Technical Advisor
ORAU/CIRRPC
1019 19th Street NW E700
Washington, DC 20036

John M. Palms, Ph.D.
President
Georgia State University
33 Gilmer SE
Atlanta, Georgia 30303

CURRENT MEMBERS:

1987-1990

Dr. J. Norman Bardsley
Lawrence Livermore National Laboratory
P.O. Box 808, MS L-296
Livermore, California 94550

Atomic Physics and
Quantum Chemistry

Dr. A. Welford Castleman
Pennsylvania State University
College of Science
152 Davey Laboratory
University Park, Pennsylvania 16802

Chemical Physics

1990-1993

Dr. Genevieve Roessler
Department of Nuclear Engineering Sciences
University of Florida
Gainesville, Florida 32611

Health Physics
Radiation Dosimetry
Nuclear Medicine

Dr. Robert Snyder
Professor and Director
Department of Pharmacology and Toxicology
College of Pharmacy, Busch Campus
Rutgers University
Piscataway, New Jersey 08854

Toxicology
Risk Analysis
Information Management

Dr. F. Ward Whicker
Professor, Department of Radiology
and Radiation Biology
Colorado State University
Ft. Collins, Colorado 80523

Environmental Transport
Site Characterization

APPENDIX I. PRESENTATIONS

- Adams, S.M., Shepard, K.L., Greeley, M.S., Jr., Jimenez, B.D., Ryon, M.G., Shugart, L.R., McCarthy, J.F., and Hinton, D.E., "The Use of Bioindicators for Assessing the Effects of Pollutant Stress of Fish," presented at the 50th Int. Symp. on Responses of Marine Organisms to Pollutants, Plymouth, Great Britain, Apr.12-14, 1989
- Allison, D.P., Thompson, J.R., Jacobson, K.B., Warmack, R.J., and Ferrell, T.L., "Scanning Tunneling Microscopy of Macromolecules," presented at the DOE Contractor-Grantee Workshop, Sante Fe, NM, Nov.3-4, 1989
- Ambrose, K.R., "Metabolism of Modified Fatty Acids," presented at the Meet. Nuclear Medicine Group, DOE Program Review, Oak Ridge, TN, Mar.28, 1989
- Ambrose, K.R., Kropp, J., Knapp, F.F., Jr., Biersack, H.-J., and Rogers, C.J., "Myocardial Washout of 15-(*p*-Iodophenyl)-3-R,S-methylpentadecanoic Acid (BMIPP) Represents Both Back Diffusion and Loss of Metabolites," presented at the 62nd Scientific Session of the American Heart Assoc., New Orleans, Nov.13-16, 1989
- Arakawa, E.T., "A Transmission Grating Soft X-Ray Monochromator for a VUV Beamline at NSLS," presented at the 10th Int. Conf. on Applications of Accelerators in Research and Industry, Denton, TX, Nov.7-9, 1988
- Arakawa, E.T. and Kamada, M., "Electron-Excited Optical Emission from H₂O Adsorbed on Potassium Halides at 78 Degrees K," presented at the 15th DOE Surface Studies Conf., Clearwater Beach, FL, Nov.1-3, 1988
- Arakawa, E.T. and Kamada, M., "Electron-Excited Optical Emission from H₂O Adsorbed on Potassium Halides at 78 Degrees K," presented at the Meet. Am. Phys. Soc., St. Louis, Mar.20-24, 1989
- Arakawa, E.T., Lee, I., Parks, J.E., and Callcott, T.A., "Photodesorption of Large Organic Molecules Induced by Surface Plasmons," presented at the 9th Int. Conf. on Vacuum Ultraviolet Radiation Physics, Honolulu, July 17-21, 1989
- Arakawa, E.T., Meisse, C., Khare, B.N., Thompson, W.R., Sagan, C., Gilmour, I., and Anders, E., "Optical Constants of Kerogen from 0.15 to 40 Mu-M," presented at the Meet. of Am. Astron. Soc., Div. Planet. Sci., Providence, RI, Oct.31-Nov.3, 1989
- Arakawa, E.T., Callcott, T.A., and Chang, Y.-C., "The Optical Properties of Beryllium," presented at the Optics-MODIL Industrial Briefing, New Bedford, MA, Nov.9-10, 1989
- Ashley, J.C. and Ritchie, R.H., "Energy Loss of Electrons and Positrons in Solids," presented at the 12th Werner Brandt Workshop on Penetration of Charged Particles in Matter, San Sebastian, Spain, Sept.4-7, 1989

- Ashley, J.C., "Inelastic Interactions of Electrons and Positrons with Solids," presented at the U.S.-Japan Workshop on Atomic Collisions in Solids, Honolulu, Feb.2-9, 1990
- Busbas, G. and Ritchie, R.H., "Physical Aspects of charged Particle Track Structure," presented at the 12th Werner Brandt Workshop on Penetration of Charged Particles in Matter, San Sebastian, Spain, Sept.4-7, 1989
- Belcher, G.D. and Travis, C.C., "The Food Chain as a Source of Human Exposure from Municipal Waste Combustion," presented at the Int. Conf. on Municipal Waste Combustion, Hollywood, FL, Apr.10-14, 1989
- Berven, B.A., Gammage, R.B., Little, C.A., and Nyquist, J.E., "Development of New Monitoring Techniques and Instrumentation for Field Measurement of Hazardous Waste," presented at the Weld. Test. Technol. Conf. '89, Knoxville, TN, Feb.14-17, 1989
- Berven, B.A. and Swaja, R.E., "ORNL Annual Review for FY 1988 - Formerly Utilized Sites Remedial Action Project," presented at the Annu. Formerly Utilized Sites Remedial Action Project Review Meet., Washington, DC, Nov.2-3, 1988
- Berven, B.A., Smuin, M.J., and Little, C.A., "ORNL Annual Review for FY 1988 - Surplus Facilities Management Project," presented at the Surplus Facilities Management Project Annu. Review Meet., Washington, DC, Nov.2-3, 1988
- Berven, B.A., Gammage, R.B., Dudney, C.S., and Wilson, D.L., "Underground Transport of Radon Through Limestone Solution Pipes," presented at the Am. Nucl. Soc. Int. Conf., Washington, DC, Oct.30-Nov.4, 1988
- Berven, B.A., Nyquist, J.E., Blair, M.S., Little, C.A., and Gammage, R.B., "Automation of Geophysical Surveys Used in Assessment of Hazardous Waste," presented at the 28th Hanford Life Sciences Symp., Richland, WA, Oct.16-19, 1989
- Berven, B.A., "Recognition of the Individual in a Large R&D Organization," presented at the Meet. of Industrial Research Inst. Advanced Study Group, Chicago, May 3-5, 1989
- Berven, B.A., Dudney, C.S., Gammage, R.B., and Wilson, D.L., "Limestone Cavities: A Source of Radon Transport," presented at the Annu. Meet. Am. Nucl. Soc., Atlanta, June 4-8, 1989
- Berven, B.A., Gammage, R.B., Little, C.A., and Nyquist, J.E., "New Monitoring Techniques and Instrumentation for Field Measurement of Hazardous Waste," presented at the Meet. of American Industrial Hygiene Assoc. on The Expanding Role of Industrial Hygiene, Oak Ridge, TN, Sept.28-29, 1989
- Bolch, W.E., Turner, J.E., Yoshida, H., Jacobson, K.B., Hamm, R.N., and Wright, H.A., "Monte Carlo Simulation of Free Radical Attack to Biomolecules Irradiated in Aqueous Solution," presented at the 10th Symp. on Microdosimetry, Rome, May 21-26, 1989

- Brown, K.J., "Managing Environmental Information for Government Agencies," presented at the 52nd Annu. Meet. Am. Soc. Inf. Sci., Washington, DC, Oct.30, 1989
- Brown, M.M., Phelps, T.J., Adler, H.I., and Boston, H.L., "Anaerobic Biodegradation of PCBs in Aquatic Sediments," presented at the DOE Model Conf., Oak Ridge, TN, Oct.3-7, 1988
- Callcott, T.A., "Soft X-Ray Emission Experiments on Exotic Materials," presented at the Health and Safety Research Div. Information Meet., ORNL, Oak Ridge, TN, Apr.18-19, 1989
- Carman, H.S., Jr., Compton, R.N., and Klots, C.E., "Charge Exchange Between High-Rydberg Atoms and Molecules or Clusters," presented at the 16th Int. Conf. on Physics of Electronic and Atomic Collisions, New York, July 26-Aug.1, 1989
- Carman, H.S., Jr., "Electron Transfer Between Rydberg Atoms and Molecules: Novel Sources of Negative Ions," presented at the Health and Safety Research Div. Information Meet., ORNL, Oak Ridge, TN, Apr.18-19, 1989
- Carman, H.S., Jr., "Charge Transfer Between Rydberg Atoms and Molecules and Clusters," presented at the Univ. of Kentucky, Lexington, Oct.30, 1989
- Carman, H.S., Jr., "Charge Transfer Between Rydberg Atoms and Molecules and Clusters," presented at the Semin. on Physical Chemistry, Dep. of Chemistry, Univ. of Tennessee, Knoxville, Jan.11, 1990
- Casson, W.H. and Sims, C.S., "A New Dosimeter Calibration Laboratory at ORNL," presented at the 2nd Conf. on Radiation Protection and Dosimetry, Orlando, FL, Oct.31-Nov.3, 1988
- Casson, W.H. and Sims, C.S., "The Measurement of Dosimeter Angular Dependence," presented at the Meet. Health Phys. Soc., Albuquerque, NM, June 25-29, 1989
- Chen, C.H. and McCann, M.P., "Two-Photon Induced Chemical Reactions in Liquids," presented at the 4th Int. Laser Science Conf. (ILS-IV), Atlanta, Oct.2-6, 1988
- Chen, C.H., "Resonance Ionization Mass Spectrometer to Count Isotopically Selective Atoms and Simple Molecules," presented at the 16th Fed. Anal. Chem. Spectrosc. Soc. Symp. on Lasers and Mass Spectrometry, Chicago, Oct.1-6, 1989
- Chen, C.H., Payne, M.G., Garrett, W.R., McCann, M.P., and Ailman, S.L., "Studies of Multiphoton Process in Condensed Medium," presented at the DOE Workshop on Advanced Laser Techniques for Chemical Measurements, ANL, Argonne, IL, May 9-11, 1989
- Chen, C.H., "Development of a Real Time Monitor for Superconductive Thin Film Preparation," presented at the Soc. Photo-Opt. Instrum. Eng. Symp./Conf. on Surface and Interface Analysis of Microelectronic Processing and Growth, Santa Clara, CA, Oct.8-13, 1989

- Chen, C.H., McCann, M.P., and Phillips, R.C., "Laser Surface Interactions of High- T_c Superconductors," presented at the 5th Interdisciplinary Laser Science Conf. (ILS-V), Stanford, CA, Aug.27-31, 1989
- Chen, C.H., "Multiphoton Processes and Their Applications on High- T_c Superconductors and Ultra-Low Level Detections," presented at Vanderbilt Univ., Nashville, TN, Nov.9, 1989
- Chen, C.H., "Nonlinear Processes and Their Applications on High- T_c Superconductors and Ultra-Low Level Detections," presented at a Seminar, Univ. of Tennessee, Knoxville, Jan.25, 1990
- Christophorou, L.G., "Differences in Electron Affinity, Electron Attachment Properties and Photoionization Energetics of Gases, High Pressure Gases and Liquids and Their Implications in Understanding Mechanisms of Action," presented at the 22nd Radiological and Chemical Physics Contractor's Meet., New Orleans, Feb.21-23, 1989
- Christophorou, L.G., "Electron Collisions in Gas Switches," presented at the NATO ASI on Non-Equilibrium Processes in Partially Ionized Gases Meet., Maratea, Italy, June 4-17, 1989
- Christophorou, L.G. and Faidas, H., and McCorkle, D.L., "Materials (Liquids and Gases) for SSC Detectors," presented at the Workshop on Major Superconducting Super Collider Detectors, Tucson, AZ, Feb.18-23, 1990
- Compton, R.N., Carman, H.S., Klots, C.E., and Feigerle, C.S., "DC-Electric Field Effects on Multiphoton Ionization (MPI) of Alkali Atoms," presented at the 4th Int. Laser Science Conf. (ILS-IV), Atlanta, Oct.2-6, 1988
- Compton, R.N., "Careers in Physics and Chemistry," presented at Career Day, Oak Ridge High School, Oak Ridge, TN, Mar.14, 1989
- Compton, R.N., Carman, H.S., Jr., Klots, C.E., and Miller, J.C., "Development and Applications of Nonlinear Laser Spectroscopy in the Gaseous and Condensed Phases," presented at the DOE Workshop on Advanced Laser Technology, ANL, Argonne, IL, May 9-11, 1989
- Compton, R.N., "The Cold Fusion Controversy - Panacea Or?" presented at the Steam Automobile Club of America and Mobile Steam Soc. Joint Meet., Oak Ridge, TN, May 5, 1989
- Compton, R.N., "Multiply Charged Negative Ions: A Critical Review," presented at the 37th Am. Soc. Mass Spectrom. Conf. on Mass Spectrometry and Allied Topics, Miami Beach, FL, May 22-26, 1989
- Compton, R.N., "Laser Studies in Atomic and Molecular Physics," presented to the Dep. of Chemistry, Louisiana State Univ., Baton Rouge, Jan.27, 1989
- Compton, R.N., "Multiphoton Ionization," presented to the Dep. of Physics, Clemson Univ., Clemson, SC, Oct.13, 1988

- Compton, R.N., "Multiphoton Ionization of Atoms," presented to Battelle, Pacific Northwest Labs., Pasco, Washington, Aug.22, 1989
- Crawford, O.H., "Radiation from Oscillators Embedded in an Adsorbed Film, and Implications for Surface Spectroscopy," presented at the Meet. Southeastern Section Am. Phys. Soc., Raleigh, NC, Nov.10-12, 1988
- Crawford, O.H., "Stopping Power of Crystals," presented at the Symp. on Dynamic Particle-Condensed Matter Interactions, Hakone, Kanagawa, Japan, Dec.4-5, 1988
- Crawford, O.H., "Second Thoughts on the Surface Selection Rule in the Spectroscopy of Adsorbed Species," presented at the ORNL Chemical Physics Semin. Series, ORNL, Oak Ridge, TN, Jan.12, 1989
- Crawford, O.H., "Direction-Dependent Stopping Power and Beam Deflection in Anisotropic Solids," presented at the 12th Werner Brandt Workshop on Penetration of Charged Particles in Matter, San Sebastian, Spain, Sept.4-7, 1989
- Crawford, O.H., "Directional Effects in the Interaction of Swift Ions with Anisotropic Crystals," presented at the 56th Meet. Am. Phys. Soc., Southeastern Section, Tuscaloosa, AL, Nov.9-11, 1989
- Crawford, O.H., "Independent-Particle Theory of Fusion in Cluster Impact," presented at the 12th Werner Brandt Int. Conf. on Penetration of Charged Particles in Matter, San Sebastian, Spain, Sept.4-7, 1989
- Crawford, O.H., "A Model for Cluster-Impact Fusion," presented at the U.S.-Japan Workshop on Atomic Collisions in Solids, Honolulu, Feb.2-9, 1990
- Crawford, O.H., "Bending of Swift Ion Beams by Graphite Foils," presented at the U.S.-Japan Workshop on Atomic Collisions in Solids, Honolulu, Feb.2-9, 1990
- Crawford, O.H., "Line Shapes in Resonant Coherent Excitation: Theory," presented at the U.S.-Japan Workshop on Atomic Collisions in Solids Honolulu, Feb.2-9, 1990
- Crawford, O.H., "Thoughts on Cold Fusion," presented at the U.S.-Japan Workshop on Atomic Collisions in Solids, Honolulu, Feb.2-9, 1990
- Crawford, O.H., "A Theoretician's View of Cold Fusion," presented at the Sigma Xi Scientific Research Soc., Oak Ridge Chapter, Oak Ridge, TN, Jan.30, 1990
- Cronk, T.A., Kearl, P.M., and Korte, N.E., "The Borehole Microscope - A Method of Measuring Groundwater Flow Velocity," presented at the Annu. Meet. of Colorado-Wyoming Academy of Science, Mesa State College, Grand Junction, CO, Apr.14-15, 1989
- Cronk, T.A. and Kearl, P.M., "The Relationship of Advective Transport in a Borehole to That in the Surrounding Aquifer - Theoretical and Experimental Results," presented at the Am. Geophysical Union Front Range Meet., Boulder, CO, Feb.5-6, 1990

- Davidson, K.A., Hovatter, P.S., and Ross, R.H., "Water Quality Criteria for Colored Smokes," presented at the Meet. Soc. Toxicol., Atlanta, Feb.27-Mar.3, 1989
- Dickerson, K.S., Pickering, D.A., Blair, M.S., Espegren, M.L., and Nyquist, J.E., "Field Testing and Applications of the Ultrasonic Ranging and Data (USRAD) System," presented at the 11th Annu. DOE Low-Level Waste Conf., Pittsburgh, Aug.22-24, 1989
- Dickerson, K.S., "Overview of the Uranium Mill Tailings Remedial Action Project," presented at the Environmental Geology, Mesa State College, Grand Junction, CO, May 3, 1989
- Dudney, C.S. and Hawthorne, A.R., "Seasonal and Annual Average Radon Levels in 70 Houses," presented at the Symp. on Radon and Radon Reduction Technology, Denver, Oct.18-21, 1988
- Dudney, C.S., Matthews, T.G., and Gammage, R.B., "Factors Affecting Success of Radon Mitigation in Houses," presented at the Southeastern Regional Meet. Am. Chem. Soc., Atlanta, Nov.9-11, 1988
- Dudney, C.S., "Radon in East Tennessee Homes," presented at the Trinity United Methodist Church, Oak Ridge, TN, Oct.12, 1988
- Dudney, C.S., Wilson, D.L., and Gammage, R.B., "Does Radon in Soil Pores Come from Solution Cavities?" presented at the Annu. Meet. Health Phys. Soc., Albuquerque, NM, June 25-28, 1989
- Dudney, C.S., "Radon in Homes and Schools," presented to the Chemical Engineering Dep., Univ. of Tennessee, Knoxville, Sept.5, 1989
- Easterly, C.E., "Relative Potency Can Be Used to Evaluate ELF Health Risks," presented at the Am. Stat. Assoc. Conf. on Radiation and Health, Copper Mountain, CO, July 9-19, 1989
- Easterly, C.E., "Use of Relative Potency in Health Effects Studies," presented at the Semin., College of Medicine, Univ. of Kentucky, Lexington, Sept.8, 1989
- Easterly, C.E., "Health Concerns for SiC Whiskers (ASTM Subcommittee E34.70 Plans)," presented at the U.S. Advanced Ceramics Assoc., Washington, DC, Oct.4, 1989
- Easterly, C.E., "Short-Term Bioassays May be Useful in Evaluating Fiber/Whisker Hazards," presented at the Am. Soc. Test. Mater. Subcommittee Meet., Orlando, FL, Nov.28-29, 1989
- Echenique, P.M., Ritchie, R.H., and Manson, J.R., "Cluster-Impact Fusion," presented at the U.S.-Japan Workshop on Atomic Collisions in Solids, Honolulu, Feb.2-9, 1990

- Eckerman, K.F., Ryman, J.C., Watson, E.E., and Stabin, M.G., "Use of Patient-Specific Kinetics and S-Values in Radioimmunotherapy Dosimetry," presented at the 29th Annu. Meet. Southeastern Chapter of Soc. Nucl. Med., Charleston, SC, Nov.4-6, 1988
- Eckerman, K.F. and Dolislager, F.G., "Lung Volumes Estimated from Diagnostic CT Images in Children," presented at the Annu. Meet. Health Phys. Soc., Albuquerque, NM, June 25-29, 1989
- Eckerman, K.F., "Current Dose Conversion Factors for Use in Dose Assessments," presented at the Health Phys. Soc. Summer School, Santa Fe, NM, June 19-23, 1989
- Eckerman, K.F. and Cristy, M., "Extension of the MIRD Dosimetric Approach to Children," presented at the Dosimetry of Administered Radionuclides, Washington, DC, Sept.21-22, 1989
- Eckerman, K.F., Ryman, J.C., Watson, E.E., and Stabin, M.G., "Use of Patient-Specific Kinetics and S-Values in Radioimmunotherapy Dosimetry," presented at the Meet. Soc. Nucl. Med., Southeastern Chapter, Charleston, SC, Nov.1-4, 1988
- Ehrenschaft, A. and Wright, L., "The Short Rotation Woody Crops Program Technical Data Base," presented at the Southern Biomass Conf., Blacksburg, VA, Sept.11-14, 1989
- England, M.W., Turner, J.E., and Jacobson, K.B., "Extrapolation of Indicators of Toxicity Across Species to Man," presented at the Int. Chemical Congress of Pacific Basin Societies, Honolulu, Dec.17-22, 1989
- Ensminger, J.T., Lu, P.-Y., and Wassom, J.S., "Maximizing Resources Through Data Validation," presented at the Finding the Future Conf., Natl. Governors' Assoc., Washington, DC, Dec.12-14, 1988
- Feigerle, C.S. and Miller, J.C., "Multiphoton Ionization(MPI) of Vibrationally Excited NO ($v'' = 0-9$) in a Pulsed Molecular Beam," presented at the 4th Int. Laser Science Conf. (ILS-IV), Atlanta, Oct.2-6, 1988
- Ferrell, T.L., Arakawa, E.T., Gammage, R.B., James, D.R., Goudonnet, J.P., Reddick, R.C., and Wachter, E.A., "Fiber-Optic Surface-Enhanced Raman System for Field Screening of Hazardous Compounds," presented at the Int. Symp. on Field Screening Methods for Hazardous Waste Site Investigations, Las Vegas, Oct.11-13, 1988
- Ferrell, T.L., "New Ideas in Scanning-Tunneling Microscopy," presented at the Southeastern Section Meet. Am. Phys. Soc., Raleigh, NC, Nov.10-12, 1988
- Ferrell, T.L., Reddick, R.C., Sharp, S.L.H., and Warmack, R.J., "Photon Scanning-Tunneling Microscopy," presented at the Conf. on Lasers and Electro-Optics, Baltimore, MD, Apr.24-28, 1989

- Ferrell, T.L., "Fiber Optic Substrate for Surface-Enhanced Raman Scattering," presented at the Licensing of Waste Management Technologies Forum, Oak Ridge, TN, Mar.23, 1989
- Ferrell, T.L., "Photon Scanning-Tunneling Microscopy," presented at the Health and Safety Research Div. Information Meet., ORNL, Oak Ridge, TN, Apr.18-19, 1989
- Ferrell, T.L., Warmack, R.J., and Allison, D.P., "Imaging DNA by STM," presented at a Press Conf., ORNL, Oak Ridge, TN, Dec.11, 1989
- Fields, D.E. and Cottrell, W.D., "Doses to Railroad Workers from Shipments of Radioactive Materials," presented at the Annu. Meet. Am. Nucl. Soc., Washington, DC, Oct.30-Nov.3, 1988
- Fields, D.E., "Investigations of Nuclear Winter Aerosols," presented at the Semin., Nuclear Engineering Dep., Univ. of Michigan, Ann Arbor, Feb.27, 1989
- Flynn, C.R., Williford, J.M., Little, C.A., and Nyquist, J.E., "Real-Time Environmental Surveys of Surface Soil Contaminants with USRADS," presented at the Oak Ridge Analytical Chemistry Conf., Gatlinburg, TN, Oct.10-12, 1989
- Francis, M.W., Miller, I.C., Stafford, R., Mynatt, J., and Lu, P.-Y., "Development of Chemical Unit Risk Estimates Data Base for Chemical Evaluation," presented at the Health and Safety Research Division Information Meet., ORNL, Oak Ridge, TN, Apr.18-19, 1989
- Francis, M.W., Reisman, D.J., Miller, I.C., Stafford, R.S., and Lu, P.Y., "Current Status of the Chemical Unit Record Estimates (CURE) Database," presented to staff of Health Effects Research Lab., Research Triangle Park, NC, Dec.18, 1989
- Gammage, R.B. and Vo-Dinh, T., "Luminescence Techniques for Screening Aromatic Contaminants in Environmental Samples," presented at the Int. Symp. on Field Screening Methods for Hazardous Waste Site Investigations, Las Vegas, Oct.11-13, 1988
- Gammage, R.B., Dudney, C.S., Landguth, D.C., Matthews, T.G., Wilson, D.L., and Saultz, R.J., "Solution Pipes in Limestone: Importance in Transporting Radon Beneath Houses," presented at the Southeastern Regional Meet. Am. Chem. Soc., Atlanta, Nov.9-11, 1988
- Gammage, R.B., Dudney, C.S., and Wilson, D.L., "Solution Pipes in Limestone: Importance in Transporting Radon Beneath Houses," presented at the American Industrial Hygiene Conf., St. Louis, May 21-26, 1989
- Gammage, R.B. and Vo-Dinh, T., "Cost Effective Monitoring and Screening of Chemical Hazardous Waste," presented at the Biomedical Director's Meet., Oak Ridge, TN, Nov.14-15, 1988
- Gammage, R.B., Haas, J.W., III, Miller, G.H., and Vo-Dinh, T., "Improved Luminescence Technique for Screening Aromatic Contaminants in Environmental Samples," presented at the 1st Int. Symp. on Field Screening Methods for Hazardous Waste Site Investigations, Las Vegas, Oct.11-13, 1988

- Gammage, R.B., "Human Exposure to Formaldehyde," presented at the Risk Assessment Workshop on Indoor Air Quality, Harvard Univ., Cambridge, MA, Dec.6-8, 1988
- Gammage, R.B., "Advances in Field Detection of Chemical Hazardous Waste," presented at the Health and Safety Research Div. Information Meet., ORNL, Oak Ridge, TN, Apr.18-19, 1989
- Garrett, W.R., Moore, M.A., Payne, M.G., and Wunderlich, R.K., "Suppression of Two-Photon Resonantly Enhanced Nonlinear Processes in Extended Media," presented at the 4th Int. Laser Science Conf. (ILS-IV), Atlanta, Oct.2-6, 1988
- Garrett, W.R., "Interference Effects in Stimulated Hyper-Raman Emission and Parametric Four-Wave Mixing," presented at the Semin., Drexel Univ., Philadelphia, Nov.11, 1988
- Garrett, W.R., "Suppression Effects in Two-Photon Resonantly Enhanced Processes," presented at the Naval Air Development Center, Warminster, PA, Nov.10, 1988
- Garrett, W.R., "Interferences and Other Suppression Effects in Stimulated Hyper-Raman Emission and Parametric Four-Wave Mixing," presented at the Chemical Physics Semin., ORNL, Oak Ridge, TN, Nov.7, 1988
- Garrett, W.R., Wunderlich, R.K., Hart, R.C., Moore, M.A., and Payne, M.G., "Influence on Parametric Four-Wave Mixing of a Two-Photon Interference Effect," presented at the Quantum Electronics and Laser Science Conf. (QELS '89), Baltimore, Apr.24-28, 1989
- Garrett, W.R., "New Effects Associated with Stimulated Hyper Raman Emission," presented to the Dep. of Chemistry, Northeastern Univ., Boston, Jan.9, 1989
- Garrett, W.R., "Nonlinear Optical Phenomena in Resonant Media," presented at the Harvard Univ. Observatory, Cambridge, MA, Jan.13, 1989
- Garrett, W.R., "Detecting Small Numbers of Atoms with Light - and Small Amounts of Light with Atoms," presented at the Semin., Physics Dep., Davidson College, Davidson, NC, Apr.6, 1989
- Garrett, W.R., Payne, M.G., Chen, C.H., and McCann, M.P., "Resonant Nonlinear Excitation Processes in Gaseous Media: Effects and Applications," presented at the DOE Workshop on Advanced Laser Technology for Chemical Measurements, ANL, Argonne, IL, May 9-11, 1989
- Garrett, W.R., Hart, R.C., Moore, M.A., and Payne, M.G., "Saturation Behavior of Parametric Four-Wave Mixing Due to Two-Photon Interference Effect," presented at the 6th Rochester Conf. on Coherence and Quantum Optics, Univ. of Rochester, Rochester, NY, June 26-28, 1989
- Gras-Marti, A., Ashley, J.C., and Ritchie, R.H., "The Theory of Track Formation in Insulators Due to Densely Ionizing Particles," presented at the 12th Werner Brandt Workshop on Penetration of Charged Particles in Matter, San Sebastian, Spain, Sept.4-7, 1989

- Griest, W.H., Ho, C.-H., Stewart, A.J., Tyndall, R.L., Tan, E., and Guerin, M.R., "Characterization of Explosives Processing Waste Decomposition Due to Composting," presented at the Workshop on Composting Development, New Orleans, Sept.6-8, 1989
- Griest, W.H., Ho, C.-H., Stewart, A.J., Tyndall, R.L., Tan, E., and Guerin, M.R., "Toxicological and Chemical Characterization of Composted Explosives Processing Waste," presented at the 14th Annu. Army Environmental R&D Symp., Williamsburg, VA, Nov.14-16, 1989
- Griffin, G.D., Nolan, M.G., Easterly, C.E., and Sauers, I., "Biological Effects of Spark-Decomposed SF₆," presented at the 174th Meet. Electrochem. Soc., Chicago, Oct.9-14, 1988
- Haas, J.W., III, Gammage, R.B., and Hawthorne, A.R., "A Derivative UV Absorption Fiberscope for Remote Monitoring of Aromatic-Containing Wastes," presented at the Int. Symp. on Field Screening Methods for Hazardous Waste Site Investigations, Las Vegas, Oct.11-13, 1988
- Haas, J.W., III, Lee, E.Y., Thomas, C.L., and Gammage, R.B., "Second-Derivative Ultraviolet Absorption Monitoring of Aromatic Contaminants in Groundwaters," presented at the 1st Int. Symp. on Field Screening Methods for Hazardous Waste Site Investigations, Las Vegas, Oct.11-13, 1988
- Haas, J.W., III, Folse, D.D., and Gammage, R.B., "Chemical Characterization of Hazardous Waste Sites Using In Situ Fiberoptic Derivative Ultraviolet Absorption Spectrometry," presented at the DOE Model Conf., Oak Ridge, TN, Oct. 2-6, 1989
- Haas, R.T., "The Gene-Tox Structure File in CHEMBASE," presented at the Eastern Regional Molecular Design Ltd. Users' Group Meet., Newark, NJ, June 7, 1989
- Haas, R., Kilgore, D., Roseberry, L., and Braunstein, H., "Using a PC-Based Expert System Shell to Generate a NEPA Environmental Review and Compliance Report," presented at the MMES Artificial Intelligence Community Information Meet., American Museum of Science and Energy, Oak Ridge, TN, Feb.27, 1990
- Hamm, R.N., Turner, J.E., Wright, H.A., Hunter, S.R., Hurst, G.S., and Gibson, W.A., "An Optical, Ionizing-Radiation-Track Detector," presented at the 10th Symp. on Microdosimetry, Rome, May 21-26, 1989
- Hamm, R.N., Turner, J.E., Wright, H.A., Hunter, S.R., Hurst, G.S., and Gibson, W.A., "Analysis of Data from an Optical, Ionizing-Radiation-Track Detector," presented at the 37th Annu. Meet. Radiat. Res. Soc., Seattle, Mar.18-2 1989
- Hamm, R.N., Wright, H.A., Turner, J.E., Howell, R.W., Rao, D.V., and Sastry, K.S.R., "Calculations of Physical and Chemical Reactions with DNA Aqueous Solution from Auger Cascades," presented at the 12th Werner Brandt Workshop on Penetration of Charged Particles in Matter, San Sebastian, Spain, Sept.4-7, 1989
- Hattemer-Frey, H.A., "Misconceptions Concerning Dioxin Emissions from Municipal Solid Waste Incinerators," presented at the Conf. Soc. Risk Anal., Washington, DC, Oct.30-Nov.2, 1988

- Hattemer-Frey, H.A., "Comparison of Human Exposure to Dioxin from Background Environmental Contamination and Municipal Solid Waste Incinerator Emissions," presented at the Inst. of Environmental Science Graduate Semin., Miami Univ., Oxford, OH, Jan.13, 1989
- Hattemer-Frey, H.A. and Travis, C.C., "A Perspective on Human Exposure to PCDDs and PCDFs Emitted from Municipal Waste Combustors," presented at the Int. Conf. on Municipal Waste Combustion, Hollywood, FL, Apr.10-14, 1989
- Hattemer-Frey, H.A., "Human Exposure to Organic Chemicals Through the Food Chain," presented at the Washington Risk Assessment Conf., Arlington, VA, Sept.27, 1989
- Hattemer-Frey, H.A. and Travis, C.C., "The Food Chain as a Source of Human Exposure to Organic Chemicals," presented at the Washington Risk Assessment Conf., Arlington, VA, Sept.27, 1989
- Hattemer-Frey, H.A., "Carcinogen Risk Assessment," presented as a Traveling Lecture, Dep. of Environmental Health Sciences, Univ. of Alabama, Birmingham, Dec.1, 1989
- Hattemer-Frey, H.A. and Travis, C.C., "An Overview of Food Chain Impacts from Municipal Waste Combustion," presented at the US EPA/ORNL Workshop on Municipal Waste Combustion, Cincinnati, June 8-9, 1989
- Hawthorne, A.R., "ORNL Nuclear Medicine Program: Performance Overview," presented at the Nuclear Medicine Committee Review Meet., ORNL, Oak Ridge, TN, Mar.28-29, 1989
- Hawthorne, A.R., "Laboratory Research in Support of Health Risk Analysis," presented at the Meet. with Beverly Berger, Health and Safety Research Div., ORNL, Oak Ridge, TN, Sept.14, 1989
- Hetrick, D.M., Travis, C.C., and Kinerson, R.S., "Comparison of an Unsaturated Soil Zone Model (SESOL) Predictions with a Laboratory Leaching Experiment," presented at the Winter Simulation Conf., San Diego, Dec.12-14, 1988
- Hingerty, B.E., "Structure of DNA Modified by the Carcinogens 2-Acetylaminofluorene (AAF), 2-Aminofluorene (AF), and + Anti-Benzo[a]pyrene Diol Epoxide," presented at the Indiana University Medical Center, Indianapolis, Nov.10, 1988
- Hingerty, B.E. and Broyde, S., "Hoogsteen Base Pairs in BPDE Modified DNA," presented at the Annu. Meet. of American Crystallographic Assoc., Seattle, July 23-29, 1989
- Hingerty, B.E. and Broyde, S., "Prediction of DNA Structure from Sequence: A Build-Up Technique," presented at the 6th Conversation in Biomolecular Stereodynamics, Albany, NY, June 6-10, 1989

Hingerty, B.E., "Structure of DNA Modified by the Carcinogens 2-Acetylaminofluorene (AAF), 2-Aminofluorene (AF), and + Anti-Benz[a]pyrene Diol Epoxide," presented on the ORAU Traveling Lecture Program, Texas A&I Univ., Kingsville, Sept.26, 1989

Hingerty, B.E., "Conformations of DNA Adducts with Polycyclic Aromatic Carcinogens," presented at the Medresearch Club, Univ. of Tennessee, Knoxville, Nov.2, 1989

Hovatter, P.S. and Rosencrance, A.B., "Environmental Assessment of the Military Use of Hexachloroethane," presented at the 9th Annu. Meet. Soc. Environ. Toxicol. Chem., Arlington, VA, Nov.13-17, 1988

Hovatter, P.S. and Newell, E., "Evaluation of U.S. Army Hazardous Waste Sites: Selection of Indicator Chemicals and Fate and Transport of Contaminants," presented at the 10th Annu. Meet. Soc. Environ. Toxicol. Chem., Toronto, Oct.28-Nov.2, 1989

Judish, J.P., Allman, S.L., Garrett, W.R., and Payne, M.G., "Experimental Studies of Self-Suppression of Vacuum Ultraviolet Generation in Xe," presented at the 4th Int. Laser Science Conf. (ILS-IV), Atlanta, Oct.2-6, 1988

Kaye, S.V., "Overview for Research and Training Opportunities Conference," presented at the Research and Training Opportunities Conf., Oak Ridge, TN, Nov.29, 1988

Kaye, S.V., "Executive Briefing," presented at the Health and Safety Research Div. Information Meet., ORNL, Oak Ridge, TN, Apr.18, 1989

Kaye, S.V., "Welcome," presented at the Health and Safety Research Div. Information Meet., ORNL, Oak Ridge, TN, Apr.18, 1989

Kaye, S.V., "Welcome Address - Radiation Calibration Laboratory (RADCAL) - Dedication Ceremony," presented at the RADCAL Dedication, ORNL, Oak Ridge, TN, June 21, 1989

Kaye, S.V., "Health Risk Analysis Initiative," presented to Beverly Berger, ORNL, Oak Ridge, TN, Sept.14, 1989

Kaye, S.V., "A Summary of the Mission and Programs of ORNL's Health and Safety Research Division," presented at the Lawrence Livermore National Laboratory, San Diego, CA, Nov.2, 1989

Kaye, S.V., "Health and Safety Research Division -- Oak Ridge National Laboratory," Presentation, Rutgers Univ., New Brunswick, NJ, Dec.4, 1989

Kaye, S.V., "The Health and Safety Research Division and the Health Risk Analysis Initiative," presented to personnel of Medical Univ. of South Carolina, HAZWRAP, ORNL, Oak Ridge, TN, Jan.30, 1990

- Kilgore, D.G. and Haas, R.T., "Implementation of a Material Safety Data Sheets System Using Oracle," presented at the International User Week, Int. Oracle User's Group, Dallas, Oct.1-6, 1989
- Klots, C.E., Carman, H.S., and Compton, R.N., "Electron Transfer from Highly Excited ns, np, nd ($n=15-40$) Alkali Atoms," presented at the 4th Int. Laser Science Conf. (ILS-IV), Atlanta, Oct.2-6, 1988
- Klots, C.E., "Thermal Kinetics in Small Systems," presented at the Meet. Am. Phys. Soc., St. Louis, Mar.20-24, 1989
- Klots, C.E., "The Arrhenius Equation Revisited," presented to the Chemistry Division, ORNL, Oak Ridge, TN, Mar.8, 1989
- Klots, C.E., Carman, H.S., Jr., and Compton, R.N., "Unorthodox Aspects of Charge-Exchange Between Alkali Atoms in Rydberg States and Molecules," presented at the 12th Int. Symp. on Molecular Beams, Perugia, Italy, May 29-June 2, 1989
- Klots, C.E., Hamm, R.N., Wright, H.A., and Turner, J.E., "Nonhomogeneous Kinetics in Irradiated Matter: An Appraisal of Computational Strategies," presented at the 10th Symp. on Microdosimetry, Rome, May 21-26, 1989
- Klots, C.E., "The Arrhenius Equation: A Centennial Revisit," presented to the Chemistry Dep., Brandeis Univ., Waltham, MA, Oct.16, 1989
- Klots, C.E., "The Arrhenius Equation: A Centennial Revisit," presented to the Chemistry Dep., Harvard Univ., Cambridge, MA, Oct.18, 1989
- Klots, C.E., "Kinetics-With Applications to Magic Numbers in Clusters," presented at the Seminar, Argonne National Lab., Argonne, IL, Mar.3, 1990
- Knapp, F.F., Jr. "The Metabolism of Methyl-Branched Fatty Acids Developed at ORNL," presented to the Cardiology Department, Free Univ. Hospital, Amsterdam, The Netherlands, Oct.4, 1988
- Knapp, F.F., Jr., "Generator Research for Diagnosis and Therapy," presented at the Meet. Nuclear Medicine Group, DOE Program Review, Oak Ridge, TN, Mar.28, 1989
- Knapp, F.F., Jr., "Reactor-Produced Radioisotopes for Nuclear Medicine Applications," presented at the Am. Chem. Soc. Int. Chemical Congress of Pacific Basin Societies, Honolulu, Dec.17-22, 1989
- Knapp, F.F., Jr., Kropp, J., Ambrose, K.R., and Blystone, S.L., "15-(*p*-Iodophenyl)-3-R,S-methylpentadecanoic Acid (BMIPP) Is Metabolized to an Unexpected Polar Metabolite by Rat Hearts," presented at the 62nd Scientific Session of American Heart Assoc., New Orleans, Nov.13-16, 1989
- Knapp, F.F., Jr., "Development and Initial Clinical Use of the Carbon-Based Osmium-191/Iridium-191m Generator System," presented at the 30th Commemorative Meet. Finnish Soc. Nucl. Med., Helsinki, Mar.3, 1990

- Knapp, F.F., Jr., "Evaluation of Myocardial Viability with Iodine-123-Labeled Methyl-Branched Fatty Acids with SPECT," Presentation, Dep. of Nuclear Medicine, Turku Univ., Turku, Finland, Mar.5, 1990
- Knapp, F.F., Jr., "New Agents for the Evaluation of Heart Disease by Single-Photon Imaging Techniques," Presentation, Dep. of Nuclear Medicine, Kupio Univ., Kupio, Finland, Mar.1, 1990
- Kocher, D.C., "Risks Associated with Radiation Protection and Environmental Radiation Standards for Members of the Public," presented at the 22nd Conf. on Radiation Protection and Dosimetry, Orlando, FL, Oct.31-Nov.4, 1988
- Kocher, D.C., "Regulatory and Institutional Issues for Development of Remedial Action Strategies at ORNL," presented at the Waste Management '89, Tucson, AZ, Feb.26-Mar.2, 1989
- Kocher, D.C., "Validation of a Model for Long-Term Retention of Globally Circulating Iodine-129 in Surface Soils," presented at the Annu. Meet. Health Phys. Soc., Albuquerque, NM, June 25-29, 1989
- Kocher, D.C. and Lee, D.W., "A Preliminary Performance Assessment for Near-Surface Land Disposal of Low-Level Radioactive Wastes," presented at the Annu. DOE Low-Level Waste Conf., Pittsburgh, Aug.22-24, 1989
- Kocher, D.C., "Development of Closure Criteria for Inactive Radioactive Waste Disposal Sites at Oak Ridge National Laboratory," presented at the Environmental Monitoring, Restoration and Assessment, Richland, WA, Oct.16-19, 1989
- Kocher, D.C., "An Update on Standards for Radiation in the Environment and Associated Estimates of Risk," presented at the Health Phys. Soc. Summer School, Santa Fe, NM, June 19-23, 1989
- Kocher, D.C., "Waste Classification - History, Standards, and Requirements for Disposal," presented at the Health Phys. Soc. Annu. Meet., Albuquerque, NM, June 26-29, 1989
- Komaki, K., Yamazaki, Y., Iwata, Y., Ritchie, R.H., Crawford, O.H., and Ashley, J.C., "MUSE Experiments and Monte Carlo Simulation," presented at the U.S.-Japan Workshop on Atomic Collisions in Solids, Honolulu, Feb.2-9, 1990
- Lisic, E.C., McPherson, D.W., Srivastava, P.C., and Knapp, F.F., Jr., "Radioiodinated *N*-(Omega-Iodoalkenyl)spiroperidol Analogs for Potential Dopamine Receptor Imaging by SPECT," presented at the 36th Annu. Meet. Soc. Nucl. Med., St. Louis, June 13-16, 1989
- Little, C.A., "Progress of the Chemical Assessment Program in Grand Junction," presented at the Health and Safety Research Div. Information Meet., ORNL, Oak Ridge, TN, Apr.18-19, 1989
- Little, C.A., Knott, R.R., and Espegren, M.L., "Qualitative and Quantitative QA Aspects of the Inclusion Survey Process," presented at the Annu. Meet. Health Phys. Soc., Albuquerque, NM, June 25-29, 1989

- Little, C.A., "Can We Compare Chemical and Radiation Risks?" presented at the Health Phys. Soc. Midyear Top. Symp. on Risk, Atlantic City, NJ, Feb.4-8, 1990
- Liu, J.C., Poston, J.W., and Sims, C.S., "The Development and Characterization of a New Combination Type Personnel Neutron Dosimeter," presented at the Meet. Health Phys. Soc., Albuquerque, NM, June 25-29, 1989
- Liu, Z.M., Wetsel, G.C., Weng, T.L., Gosney, M.W., and Warmack, R.J., "Effect of Environmental Gases on Tunneling Spectroscopy of Various Surfaces," presented at the Meet. Am. Phys. Soc., St. Louis, Mar.20-24, 1989
- Lu, P.-Y., Francis, M.W., Reisman, D.J., and DeRosa, C., "Toxicological Information for Hazard Evaluation: The Chemical Unit Risk Estimation Database," presented at the Symp. on Health Risk Assessment on Environmental, Occupational and Life Style Hazards, Taipei, Taiwan, Republic of China, Dec.20-22, 1988
- Lu, P.-Y., "Evaluated Data Bases for Health Risk Analysis," presented at the Beverly Berger Presentation, ORNL, Oak Ridge, TN, Sept.14, 1989
- Lu, P.Y., Wassom, J.S., Ross, R.H., and Francis, M.W., "Toxicology Information Used to Support Regulatory Decisions," presented at the Symp. on Health Risk Assessment on Environmental, Occupational and Life Style Hazards, Taipei, Taiwan, Republic of China, Dec.20-22, 1988
- Lu, P.Y. and Young, R.A., "Toxicology and Quantitative Risk Assessment of Inhalation Exposure to Nickel and Nickel Compounds," presented at the Meet. Soc. Toxicol., Atlanta, Feb.27-Mar.3, 1989
- Lu, P.-Y. and Hubner, S.M., "A Hazard Communication Tool - Material Safety Data Sheets," presented at the DOE and DOE Contractors Worker Safety and Health Conf., Germantown, MD, Feb.26-28, 1990
- Mansfield, B.K., Wyrick, J.M., Wassom, J.S., Lu, P.-Y., Gillespie, M.A., and McNeill, S., "Human Genome Management Information System," presented at the Human Genome Workshop, Santa Fe, NM, Nov.2-4, 1989
- Manson, J.R. and Ritchie, R.H., "Multiphonon Energy Exchange in the Collision of an Atom with a Surface," presented at the 12th Werner Brandt Int. Conf., San Sebastian, Spain, Sept.4-7, 1989
- Manson, J.R. and Ritchie, R.H., "Multiphonon Energy Exchange in Atom-Surface Collisions," presented at the U.S.-Japan Workshop on Atomic Collisions in Solids, Honolulu, Feb.2-9, 1990
- Mantovani, J.G., Allison, D.P., Manos, R., Warmack, R.J., Ferrell, T.L., Jacobson, K.B., Ford, J., and Reddick, B.B., "Imaging of Tobacco Mosaic Virus by Scanning-Tunneling Microscopy," presented at the Meet. Southeastern Section Am. Phys. Soc., Raleigh, NC, Nov.10-12, 1988
- Martin, F.M., "Reference Man Revisited," presented at the Meet. Soc. Toxicol., Atlanta, Feb.27-Mar.3, 1989

- Matthews, T.G., Haas, J.W., and Wilson, D.L., "Radon Diagnostics: Subslab Communication and Permeability Measures," presented at the EPA Symp. on Radon and Radon Reduction Technology, Denver, Oct.17-21, 1988
- McBride, S.E., Wetsel, G.C., Warmack, R.J., and van de Sande, B., "Displacement Calibration for STM Transducers," presented at the Meet. Am. Phys. Soc., St. Louis, Mar.20-24, 1989
- McGinnis, L.D., Cannon, W.F., Dickas, A.B., Ervin, C.P., Green, A., Hinze, W.J., Morey, G.B., Mudrey, M.G., Nyquist, J., Sexton, J.L., and Wang, H.F., "Geophysical and Tectonic Study of Sedimentary Basins and the Upper Crust Beneath Lake Superior," presented at the Spring Meet. American Geophysical Union, Baltimore, May 7-12, 1989
- McPherson, D.W., Umbricht, G., Knapp, F.F., Jr., and Callahan, A.P., "Copper-64 Labeled *p*-Carboxyalkylphenyldithiosemicarbazones (TSC) for Antibody Labeling," presented at the 36th Annu. Meet. Soc. Nucl. Med., St. Louis, June 13-16, 1989
- McPherson, D.W., "Approaches for Radiolabeling Antibodies with Radioisotopes of Copper and Rhenium," presented at the Meet. Nuclear Medicine Group, DOE Program Review, Oak Ridge, TN, Mar.28, 1989
- McPherson, D.W., "Development of Radioiodinated Agents for Evaluation of Brain Receptor Populations," presented at the Meet. Nuclear Medicine Group, DOE Program Review, Oak Ridge, TN, Mar.28, 1989
- McPherson, D.W., "New Approaches for Radiolabeling Antibodies with Radioisotopes of Copper and Rhenium," presented at the Health and Safety Research Div. Information Meet., ORNL, Oak Ridge, TN, Apr.18-19, 1989
- McPherson, D.W., "Copper-64 Labeled *p*-Carboxyalkylphenyldithiosemicarbazones (TSC) for Antibody Labeling," presented at the Univ. of Tennessee Research Semin., Knoxville, July 27, 1989
- McPherson, D.W., "Specialized Aspects of Radiolabeling - Protein Labeling with Radioisotopes of Copper," presented at the Radiolabeling Monoclonal Antibodies - A Practical Mini-Course, ORAU, Oak Ridge, TN, Dec.7, 1989
- McPherson, D.W., "Specialized Aspects of Radiolabeling - Protein Labeling with Radioisotopes of Copper," presented at the Radiolabeling Monoclonal Antibodies - A Practical Mini-Course, ORAU, Oak Ridge, TN, Mar.22, 1990
- Miller, J.C., "Two-Photon Resonant, Stimulated Processes in Krypton and Xenon," presented at the 4th Int. Laser Science Conf. (ILS-IV), Atlanta, Oct.2-6, 1988
- Miller, J.C., "Nanosecond and Picosecond Multiphoton Ionization of Weakly Bound Molecules," presented at the National Bureau of Standards, Washington, DC, Mar.17, 1989
- Miller, J.C., "Picosecond Laser Studies of the Gaseous and Condensed Phase," presented at the Health and Safety Research Div. Information Meet., ORNL, Oak Ridge, TN, Apr.18-19, 1989

- Miller, J.C., "Picosecond Multiphoton Ionization of Molecular Clusters," presented at the Annu. Meet. Am. Phys. Soc., Div. At. Mol. Opt. Processes, Phys. Soc., Windsor, Ontario, Canada, May 17-19, 1989
- Miller, J.C., "Applications of Lasers in Radiological and Atmospheric Sciences," presented at the DOE/OHER Meet., Washington, DC, Oct. 24, 1989
- Miller, J.C., "Multiphoton Spectroscopy of Weakly Bound Molecules," presented to the Chemistry Dep., Emory Univ., Atlanta, Sept. 26, 1989
- Miller, J.C., "Multiphoton Ionization Spectroscopy in Supersonic Molecular Jets," presented at the Univ. of Tennessee Space Inst., Tullahoma, TN, Nov. 15, 1989
- Miller, J.C., "Multiphoton Ionization Spectroscopy in Supersonic Molecular Jets," presented as an ORAU Traveling Lecture, Howard Univ., Washington, DC, Nov. 3, 1989
- Miller, J.C., "Nanosecond and Picosecond Multiphoton Ionization of Weakly Bound Molecules," Presentation at Centre d'Etudes Nucleaire de Saclay, France, Dec. 7, 1989
- Miller, J.C., "Nanosecond and Picosecond Multiphoton Ionization of Weakly Bound Molecules," Presentation at Univ. of Bristol, Bristol, Great Britain, Dec. 11, 1989
- Miller, J.C., "Picosecond Multiphoton Ionization of Atomic and Molecular Clusters," Presentation at Univ. of Paris, Orsay, France, Dec. 8, 1989
- Miller, J.C., "Lasers in Physics and Chemistry," presented at the Oak Ridge Science and Engineering Research Semester Series, Oak Ridge, TN, Feb. 14, 1990
- Miller, J.C., "VUV Spectroscopy Using Visible Lasers," presented at the Engineering Foundation Conf. on Future Prospects and Applications for UV and VUV Lasers, Santa Barbara, CA, Feb. 25-Mar. 2, 1990
- Miller, K.C., "Progress on MMES PC-Based Expert Systems Education and Applications Development Effort," presented at the Martin Marietta Energy Systems, Inc., Artificial Intelligence Community Information Meet., American Museum of Science and Energy, Oak Ridge, TN, Feb. 27, 1990
- Mirzadeh, S., McMurry, T., Gansow, O.A., Chu, Y.Y., and Todor, M., "Production of Gallium-66, A Positron Emitting Nuclide for Radioimmunotherapy," presented at the Pacificchem '89, Honolulu, Dec. 17-22, 1989
- Mo, G., Sung, C.C., and Ritchie, R.H., "Bound States of an Electron in the Vicinity of a Water Cluster," presented at the Southeastern Section Meet. Am. Phys. Soc., Raleigh, NC, Nov. 10-12, 1988
- Moore, M.A., Garrett, W.R., Payne, M.G., Wunderlich, R.K., and Judish, J.P., "Influence of Population Transfer on Parametric Four-Wave Mixing in Sodium Vapor," presented at the Quantum Electronics and Laser Science Conf. (QELS '89), Baltimore, Apr. 24-28, 1989

- Moore, M.A., Hart, R.C., Garrett, W.R., and Payne, M.G., "Saturation Behavior of Parametric Four-Wave Mixing Due to Two-Photon Interference Effect," presented at the 6th Rochester Conf. on Coherence and Quantum Optics, Univ. of Rochester, Rochester, NY, June 26-28, 1989
- Mudrey, M.G., Jr., McGinnis, L.D., Ervin, C.P., Nyquist, J., Dickas, A.B., Morey, G.B., Green, A.G., and Sexton, J.L., "Structure of the Midcontinent Rift System in Western Lake Superior: Results from 8-sec Reflection Seismic Data and Gravity and Magnetic Anomalies," presented at the Meet. American Geophysical Union, Baltimore, May 7-12, 1989
- Nyquist, J.E. and Blair, M.S., "A Positioning and Data Logging System for Surface Geophysical Surveys," presented at the Int. Symp. on Field Screening Methods for Hazardous Waste Site Investigations, Las Vegas, Oct. 11-13, 1988
- Nyquist, J.E. and Wang, H.F., "Flexural Modeling of the Midcontinent Rift and the Goodman Swell," presented at the American Geophysical Union Spring Meet., Baltimore, May 7-14, 1989
- Oen, C.J., "Mentoring--Past, Present, and Perhaps in Your Future," presented at the Professional Awareness Conf. for Students, Knoxville, TN, Feb. 15, 1989
- Owen, P.T., "An Overview of Technical Information Support Provided to U.S. Department of Energy's Remedial Action Programs," presented at the DOE Model Conf., Oak Ridge, TN, Oct. 2-6, 1989
- Paretzke, H.G., Turner, J.E., Hamm, R.N., and Wright, H.A., "Spatial Distributions of Inelastic Events Produced by Electrons in Gaseous and Liquid Water," presented at the 37th Annu. Meet. Radiat. Res. Soc., Seattle, Mar. 18-23, 1989
- Payne, M.G., Garrett, W.R., Judish, J.P., and McCann, M.P., "A New Coherent Cancellation Effect Involving Four-Photon Resonant Excitation," presented at the 4th Int. Laser Science Conf. (ILS-IV), Atlanta, Oct. 2-6, 1988
- Payne, M.G., "Effect of Two-Photon Cancellation on Two-Photon Resonantly Enhanced Four-Wave Mixing Processes," presented at the Univ. of Tennessee Atomic Physics Semin., Joint Inst. of Physics, ORNL, Oak Ridge, TN, Nov. 21, 1988
- Payne, M.G., "The Role of Coherent Interferences in the Resonant Excitation of Atoms by Laser Light," presented at the Chemistry Division Semin., Clemson Univ., Clemson, SC, Nov. 17, 1988
- Pfuderer, H.A., "PC-Based Expert Systems Prototypes Are Great for Marketing," presented at the MMES Artificial Intelligence Community Information Meet., Y-12, Oak Ridge, TN, Feb. 27, 1990
- Pitarke, J.M. and Ritchie, R.H., "Radiative Electron Capture by Channeled Ions," presented at the 12th Werner Brandt Workshop on Penetration of Charged Particles in Matter, San Sebastian, Spain, Sept. 4-7, 1989

- Pitarke, J., Echenique, P.M., and Ritchie, R.H., "Density Fluctuation Detection," presented at the U.S.-Japan Workshop on Atomic Collisions in Solids, Honolulu, Feb.2-9, 1990
- Reddick, R.C., Warmack, R.J., and Ferrell, T.L., "Theoretical Considerations on Photon Scanning-Tunneling Microscopy," presented at the Meet. Am. Phys. Soc., St. Louis, Mar.20-24, 1989
- Richter Pack, S.A. and Travis, C.C., "The Use of Short-Term Toxicological Data to Predict Carcinogenic Potency," presented at the Annu. Meet. Soc. Risk Anal., Washington, DC, Oct.30-Nov.2, 1988
- Ritchie, R.H., Ferrell, T.L., and Ashley, J.C., "Plasmons in Electron Spectra," presented at the 8th Pfefferkorn Conf. on Fundamental Beam Interactions with Solids, Park City, UT, May 7-12, 1989
- Ritchie, R.H., "Plasmon Decay," presented at the U.S.-Japan Workshop on Atomic Collisions in Solids, Honolulu, Feb.2-9, 1990
- Roseberry, L.M. and Shults, W.D., "An Informal Survey of Mentoring Activities at Martin Marietta Energy Systems," presented at the American Women in Science Meet., Knoxville, TN, Feb.13, 1989
- Roseberry, L.M. and Kilgore, D.G., "An EXPERT System to Facilitate Selecting a Database Management System," presented at the DOE Technical Information Meet., OSTI, Oak Ridge, TN, June 6, 1989
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- Ryon, M.G., Loar, J.M., and Harris, W.M., "Use of a Modified Index of Biotic Integrity (IBI) to Assess Effects of Pollution Abatement Projects for Complex Industrial Effluents," presented at the Meet. Am. Fish. Soc., Anchorage, AK, Sept.4-8, 1989
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APPENDIX J. PUBLICATIONS

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