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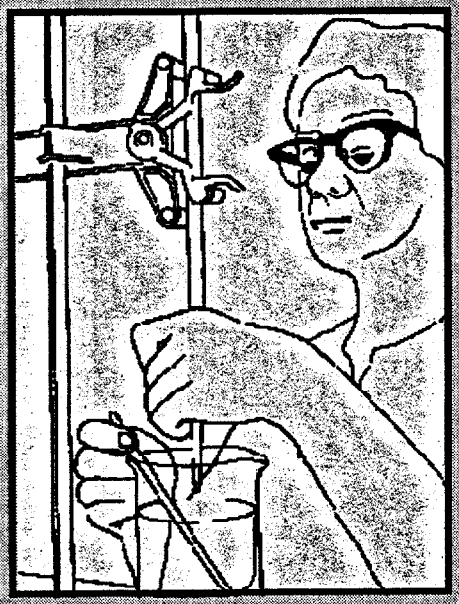
A Brief History of the Analytical Chemistry Division of Oak Ridge National Laboratory

1950



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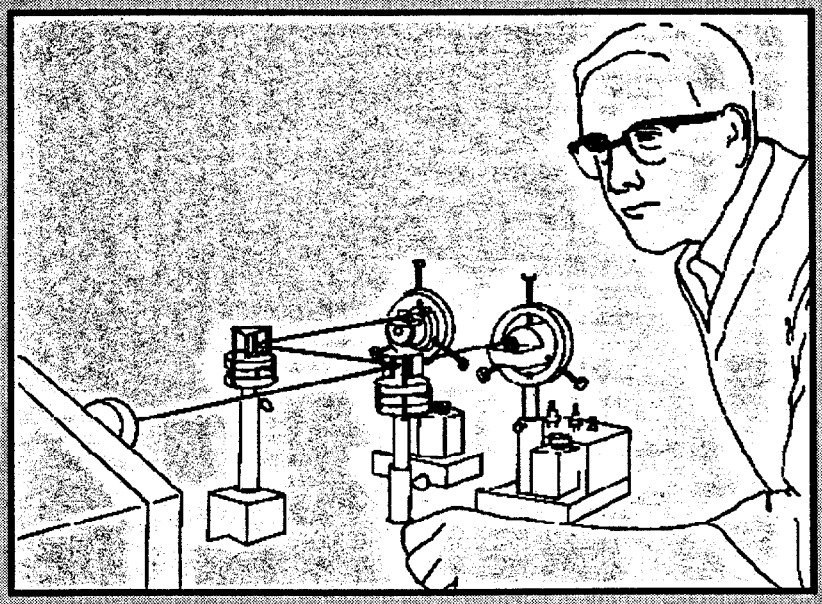

A BRIEF HISTORY

THE ANALYTICAL CHEMISTRY DIVISION

OF

OAK RIDGE NATIONAL LABORATORY

1950 - 1990

BY

W. S. LYON

WITH

W. D. SHULTS

AND

CAROLYN COLEMAN, EDITOR

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OAK RIDGE NATIONAL LABORATORY

May 22, 1950

To: All Members of the Chemistry Division

R-on: J. A. Swartout

In ra: Transfer of Personnel to Analytical Chemistry Division

The following are transferred from ths Chemistry Division to tha newly constituted Analytical Chemistry Division under Dr. M. T. Kelley, effective immediately;

C. L. Burros and Group

L. T. Corbin and Group

J. H. Edgerton and Group

C. Feldman and Group

E. J. Frederick and Group

D. E. LaValle and Group

S. A. Reynolds and Group

P. F. Thomason and Group

T. E. Willmarth and Group

E. I. Wyatt and Group

H. L. Hemphill, K. A. Odom, W. L. Bruce,

E. U. Bonine, M. Owsley and E. L. Viles

G. W. Tyler, J. W. Loy and their groups will provide administration and service assistance to the Analytical Chemistry Division as well as to the Chemistry Division.

J. A. Swartout

JAS/ca

cc: C. E. Larson
A. M. Weinberg

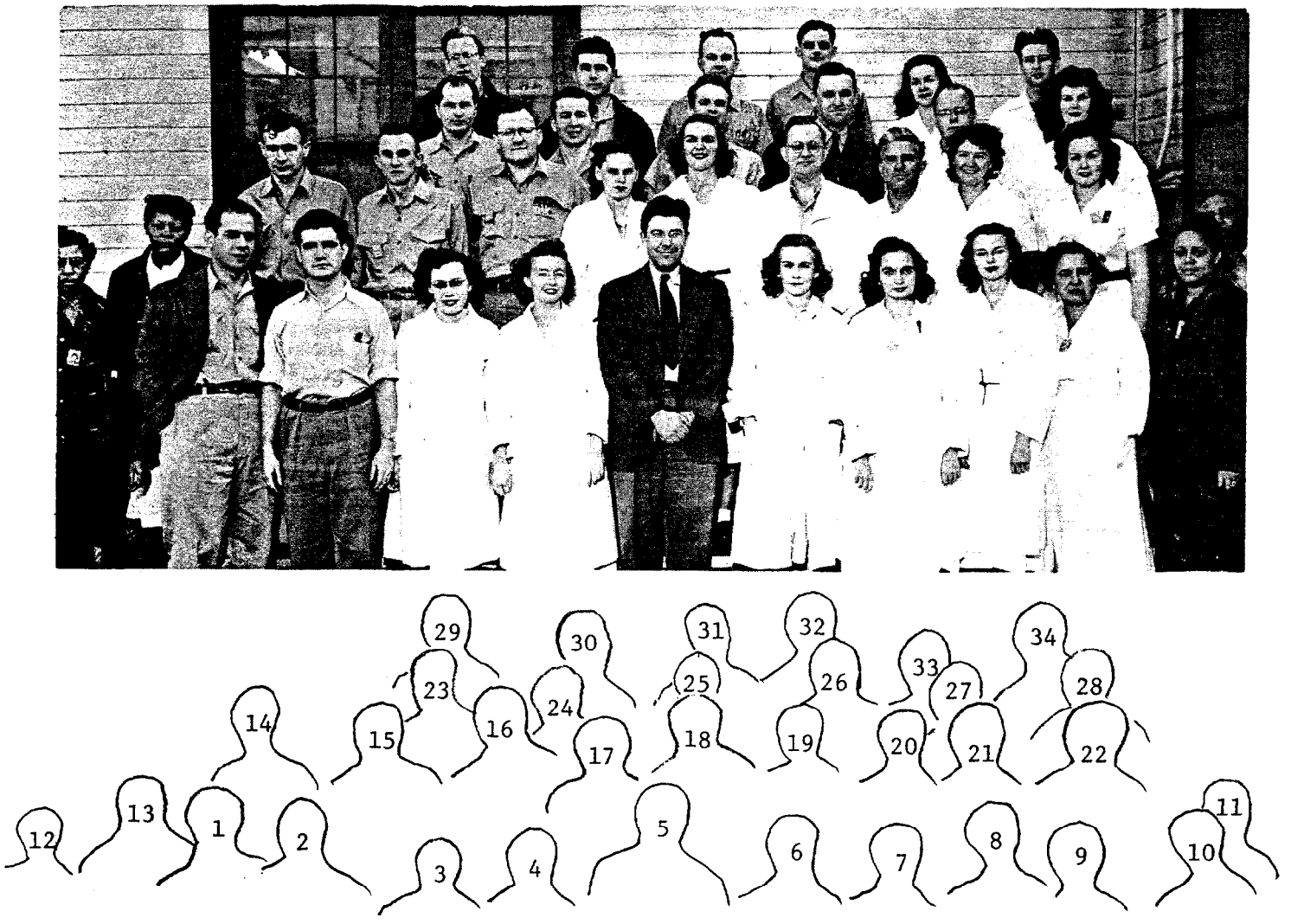
The First Forty Years
A Brief History of the Analytical Chemistry Division

INTRODUCTION

On May 22, 1950, Dr. John A. Swartout, Director of the Chemistry Division at the Oak Ridge National Laboratory (ORNL), sent a memo to his staff announcing the transfer of several groups to a newly formed Analytical Chemistry Division (ACD). That memo, a copy of which appears as the cover page, is the official birth certificate of ACD. It designates Dr. Myron T. Kelley, who had been Assistant Director of the Chemistry Division, as the first Director of the new division. Ten groups were transferred. This means that approximately 100 chemists and technicians and administrative people became the charter members of the Analytical Chemistry Division, at least on paper. In reality, most of them remained in the same laboratories, did the same work, and reported to the same supervisor. But it was a start.

Several groups of analytical people associated with the Y-12 plant and still located in that area, but whose work had expanded beyond that of uranium-235 enrichment, were added to the newly formed Analytical Chemistry Division. Those groups, though officially a part of ACD, continued to operate as an essentially autonomous unit under Charles D. Susano, who became the Associate Director of the division. Thus, ACD was an Eve created from the two Adam's ribs: the Chemistry Division at ORNL and the Analytical Group at Y-12.

This Brief History of the Analytical Chemistry Division begins with a look at the Garden of Eden from whence ORNL came.



1. F. J. Miller
2. C. Feldman
3. Helen Ghann
4. E. T. Runge
5. M. T. Kelley
6. Mary Mason Winsbro
7. Anna Bell McBride
8. Donna Coombs Michelson
9. P. Z. Westerdahl
10. Lillian Henry
11. Clarence Gaston
12. C. L. Stowers
13. Ethel Jackson
14. D. E. LaValle
15. J. H. Oliver
16. W. J. Wolkowitz
17. W. L. (Bruce) Townes
18. Neva Harrison
19. P. F. Thomason
20. H. L. Hemphill
21. Ester Wrinkle
22. E. L. Viles
23. C. L. Ghann
24. D. I. Gilbert
25. G. W. Robinson
26. J. H. Edgerton
27. S. A. Reynolds
28. K. A. Odom
29. Bill Davenport
30. G. W. Ledicotte
31. R. H. Powell
32. F. L. Moore
33. Betty Steele Frederick
34. W. A. Brooksbank

Figure 1. This is a photograph of the analytical component of the Chemistry Division in 1949. Most of these people became charter members of the Analytical Chemistry Division when it was established in May 1950. Dr. Myron Kelley (front row, center) was the first Division Director.

Chapter One

IN THE BEGINNING

The birth date of Oak Ridge is considered to be September 19, 1942, the date on which General Leslie Groves first visited the Tennessee site. Shortly afterward in 1943, E. I. du Pont de Nemours and Company, Inc. was given "The specific responsibilities...to engineer, design, and construct a small-scale semi-works at the Clinton Engineer Works in Tennessee and to engineer, design, construct, and operate a large-scale plutonium production plant of large capacity at the Hanford Engineer Works in the State of Washington."* Thus, ORNL was born during World War II as Clinton Laboratories, a part of the Clinton Engineer Works which in turn was a part of the Manhattan Project. "Because of its close connection with fundamental research, the Clinton semi-works was to be operated under the direction of the University of Chicago. A large number of key technical people from du Pont were to be used on a loan basis at Chicago and Clinton to provide the University with much needed personnel, particularly men with industrial experience, and to train certain of such personnel for future service at Hanford."* Clinton Laboratory was built, a graphite "pile" constructed, and a semi-works for processing irradiated fuel elements built. Personnel were a mixture of graduate students from Chicago and other universities, some faculty members, transfers from du Pont plants around the country, and native Tennesseans. There were also a number of privates and non-commissioned officers from a unit of the Army known as the Special Engineer Detachment. Most of the du Pont people were at Oak Ridge strictly for training, and their part of the operation was known as the Hanford Engineer Works (HEW) Training School. Much of the chemistry was highly applied in that it was directed toward understanding the chemical processing for plutonium, but it was also research-oriented because most of the chemistry of the fission products and the heavy

*Smyth, H. D., *Atomic Energy for Military Purposes*, Princeton University Press, Princeton, N. J. (1945), p. 1 11.

elements produced in the irradiated fuel was unknown. Obviously much of this work was analytical in nature, but in the loose organization of war-time Clinton Lab, analytical work was performed in various groups by variously employed people. At the end of the war Clinton Lab faced an uncertain future, but the success of the atomic bomb and the beginning of the cold war kept Oak Ridge alive. After a number of organizational management changes and Laboratory name changes (Monsanto operated Clinton National Laboratory for a while), Carbide and Carbon Chemicals Division of Union Carbide Corporation took over management of the now Oak Ridge National Laboratory. C&CCD had operated K-25 and had replaced Tennessee Eastman at Y-12 after the war ended. Thus by 1950 ORNL had begun to branch out into more peaceful activities. Several new buildings had been built, including an isotope production area across from the chemistry building (706A, later numbered 3550), and a new research complex was nearing completion (known as 4500). New buildings were needed because the Laboratory was expanding and all the old buildings were of temporary construction. How temporary they were can be judged today by a walk from the East to the West Portal where portions of them are still in use!

ADVENTURES AT THE GRAPHITE REACTOR

In the 1950s the activation analysis group spent considerable time investigating the radioactive products produced when pure elements were irradiated at the reactor. Samples were inserted in 6" composition tubes (rabbits), removed from the reactor after irradiation, and after removal from the rabbit were counted. The counting room in the reactor building was several floors below the rabbit station, so when the induced activity was known to be short lived, time was of the essence.

Harvey Mahlman and John Manning were working with a very short-lived product. Harvey decided he would toss the irradiated rabbit down from the reactor face to John, who would catch it in a bucket and race to the counting room. They practiced this procedure with a dummy rabbit until they had it perfectly worked out. Then the real rabbit was irradiated, brought from the reactor, and Mahlman ran to toss the rabbit over to John. Unfortunately, just at this moment the Operations Director entered the building with a group of visitors. The sudden appearance of these people so shook up the experimenters that Harvey either tossed the rabbit incorrectly or John missed it with his bucket. Anyway, the hot rabbit fell among the visitors causing some consternation when the Operations personnel realized what it was, consternation that was exacerbated by Manning darting among them trying to pick up the rolling rabbit with a pair of tongs.

The incident was just laughed off as another example of "crazy scientists" and the visitors tour continued on its way.

Chapter Two

THE FORMATIVE FIFTIES

Analytical chemistry at ORNL has always closely followed the major programs of the Laboratory. In a sense it has mirrored the Lab's activities. Chemistry and chemical technology programs at ORNL and in the Analytical Chemistry Division were in 1950 still directed toward the separation and processing of plutonium. Most reports were classified as SECRET, and the small chemistry library in 706A contained mainly reports and a few bound chemical and physics journals. Work within the ACD comprised primarily analytical services. Laboratories were located in 3550, 3560 (the "hot" laboratories), and 3019. Government-issued khaki clothes were worn by everybody, and change rooms with showers were provided. The service work consisted primarily of determinations of uranium and plutonium, fission products, a few transition elements such as cadmium, and a number of anions such as fluoride, nitrate, and chloride.

Most of the people working at ORNL were in their twenties and early thirties. Indeed, the new Analytical Chemistry Division Director was just 32 years old and possessed the only doctorate in the entire division. There were several chemists with master's degrees; the remaining monthly salaried personnel were mainly B. S. chemists. Many of the latter were enrolled in The University of Tennessee Graduate School program that was conducted at the Oak Ridge Institute of Nuclear Studies (later ORAU) in Oak Ridge. Some of these chemists had come onto the project during the war and stayed on afterward. Some were hired after discharge from the armed forces or after termination from other Oak Ridge installations. A few were recent college graduates. Laboratory technicians came almost exclusively from armed forces veterans. None of the staff had ever worked with radioactivity, and for many of the chemists and almost all of the technicians this was their first laboratory experience. Seminars and courses were given on the Lab site frequently.

When one went to the library to look up a procedure or other information, one carried a notebook and copied the data into it; there were no copying machines or reproduction equipment. Graphs and tables were constructed by hand and then sent to a draftsman for final copying. Obviously one made his own calculations, that's what slide rules or the electric calculators that occupied a third of one's desk space were for. All work was classified until proved otherwise. Open literature and open conference talks were just beginning to be permitted by management. And speaking of management, the term was hardly known at the time. Most technical people went about their jobs unconcerned about (or rather unknowing of) the many dictates that now govern life at ORNL. The Atomic Energy Commission (AEC), which seemed a million miles away to most people, allowed ORNL to set its own policies and programs rather independently. When something big happened (e.g., the hydrogen bomb) ORNL and all AEC labs were quick to respond as AEC directed. Paperwork was infinitesimal by today's standards.

Colorimetry was the main technique for "trace" analysis, i.e., parts per thousand to parts per million, in the Fifties. Fluorimetry was an early "ultra-trace" technique since uranium could be determined at the sub-ppm level by solid matrix fluorescence. Comparisons with standards were made by personal observation. An optical spectrograph provided very semi-quantitative estimates of selected elements, while optical and electron spectroscopy provided specialized information. Balances were "chainomatic" and titrations were made by hand with visual end-point detection. Precise (0.5%) uranium analyses could be made gravimetrically. There was only one micro balance in the entire division. Prior to completion of the 4500 complex, ACD people were housed in WW-II buildings that were sparsely furnished and not air conditioned. Wooden hoods that had been used for perchloric acid procedures were beginning to fall apart, and on several occasions material fell to the bottom of the hood and exploded. The radiochemical groups had a real advantage over the ionic groups in that the counting rooms were air conditioned (for the instruments, not the people). Radioactive samples were "counted" by technicians known as counting girls.

Radioactivity was measured primarily by Geiger-Mueller counters, ionization chambers, and gas flow alpha counters. The first single-channel NaI(Tl) gamma ray spectrometer was built and installed in the counting room in the early Fifties. This made possible reasonably accurate measurements of gamma ray energies. Prior to that time gamma ray energies were determined by lead absorption curves, or by measuring conversion electron spectra in a huge magnetic lens beta ray spectrometer in the Chemistry Division. A number of experimental irradiations had been made in the ORNL Graphite Reactor which resulted in new radioactive nuclides that were characterized as to decay scheme (beta and gamma energies, half lives, etc.). Additionally, a new analytical technique, neutron activation analysis, was being vigorously studied as the first multi-element, ultra-trace analytical technique. Requests for special analyses and analytical assistance were already being received from outside the Laboratory.

ORNL had chosen a new type of reactor -- a "homogeneous" reactor in which the fuel was a solution of uranyl sulfate -- for research and for later construction. This research program and its successors were to provide both samples and R&D projects for ACD for many years. Emphasis in methods development was on rare or unusual materials like zirconium, a metal that was attractive because of its low neutron cross section. Emphasis in development was on instrumentation that had the potential of being used remotely for analysis of radioactive samples. A special densitometer was developed for remote colorimetric analysis. An ORNL-designed automatic microtitrator was placed in operation. (Microtechniques were popular because less sample meant less radioactivity to contend with.) Electrochemical methodology began to attract attention, especially polarography, because it offered the possibility of remote trace analysis with good accuracy and sensitivity. The emphasis in research was on inorganic separations that could be used to purify and concentrate the so-called heavy metals: uranium and its neighbors in the periodic table. Much pioneering separations research was done in both solid and liquid ion exchange and other solvent extraction techniques.

The Fifties were truly formative years for the Analytical Chemistry Division. This is reflected most clearly by the fact that ACD inaugurated an annual meeting to enhance communication and collaboration between analytical chemists from the atomic energy community, both domestic and foreign. These meetings became known as the Gatlinburg Conferences because they were held in the small mountain community of Gatlinburg, Tennessee. They provided the forum for presentation of new developments in analytical chemistry as it related especially to atomic energy and nuclear technology, and for the scientists to get to know each other and each other's work.

This was an era in which ORNL either initiated or was involved in several large reactor programs. The Analytical Chemistry Division played an important role in these programs. Much ACD work was presented and disseminated through the Gatlinburg Conferences, which emphasized the fact that ACD was becoming a leading research-oriented analytical chemistry organization. This was reflected also by the fact that many foreign scientists began to come to ACD for training and research experience following the first "Atoms for Peace" Conference in Geneva in 1955. Often these foreign guests were sponsored by the newly created International Atomic Energy Agency. Another indication of the formative nature of the Fifties is that ACD initiated preparation of a Master Analytical Manual during this period of time, to collect and formalize standard methods and calibration procedures used in the division. It was a massive undertaking. All in all this was a time of tremendous progress and excitement in ORNL and ACD.

Figure 2 Division dances were annual social events in the Analytical Chemistry Division in the early days. This one took place at the Oak Ridge Country Club.

Figure 3

The Analytical Chemistry Division began to sponsor the annual Gatlinburg Conference on Analytical Chemistry in 1957. It soon became a prime means of communication among analytical chemists in the nuclear field, both domestic and foreign. Leo Brady and Elizabeth Young (Division Secretary) were key figures in running many Gatlinburg Conferences.

Figure 4. The Analytical Chemistry Division pioneered development of an extensive compendium of procedures in the 1950s and early 1960s. As Division editor, Helen Raaen (left) was the key figure in that work. She is shown here with Myron Kelley and Marion Ferguson. The compendium was entitled the ORNL Master Analytical Manual.

SCENES FROM Y-12

Discipline and life were much harder at Y-12 during the Fifties - largely because of the production background at this plant. ORNL was often referred to as the "country club". C. D. Susano, the Associate Director of ACD stationed at Y-12, was a stern taskmaster. He was always seeking ways to raise the number of analyses per person. Dissatisfied with the slowness of some technicians, he called Kay Webb, one of his best and fastest analysts, into his office and ordered her to spend half a day at the Blue Circle and Krystal hamburger joints in Knoxville. Object: to see how efficient the cooks were there and to bring back ideas for use in the Y-12 labs. Unfortunately, hamburgers were not the product of the Y-12 plant, so there was not much technology transfer.

Having failed at the hamburger scheme, Susie decided maybe the problem was that his technicians were spending too much time sitting down. He ordered all chairs and stools removed from the lab. One technician, however, consulted an authority on Tennessee law, and found that state law required that chairs be provided wherever female employees were working. When this technician threatened to sue both Carbide and Susano, the chairs were promptly returned.

Chapter Three

THE EXPANSIVE YEARS

During the Sixties research and development became a primary activity within the Analytical Chemistry Division. The completion of Building 4500S enabled the division to move into much larger facilities. J. C. White slowly took over the management of the division's nonservice work and new areas of interest were added. These included organic preparations, gas chromatography, and the design and use of instruments employing solid state devices. The Laboratory had acquired an IBM 7090 computer, and some of the staff were using it for various purposes. The twelve service groups were consolidated into five, and much of the semiroutine work formerly handled by the R&D groups was turned over to them. Considerable funding was obtained from the AEC for various research projects, including applications of radioisotopes and nuclear measurement techniques. The solid state Ge(Li) detector came onto the market, and better NaI crystals were also being made. The ACD initiated one of the first efforts to use computer techniques to deconvolute gamma ray spectra. Valence states of radioisotope products were studied, and several tracer techniques were developed for chemical analysis.

An Activation Analysis Group had been formed within ACD in the Fifties. It was located in irradiation facilities in the basement of the newly constructed Oak Ridge Research Reactor, the ORR. Analytical Chemistry Division was one of the few places where neutron activation analysis could be done, hence many outsiders came to the Lab to learn or to do work. A little known fact is that after the assassination of President Kennedy in 1963, the FBI sent bullets, fragments of lead, paraffin casts, and other evidence with their top scientific investigator to ORNL. Here he worked with ACD activation analysts in complete secrecy for a number of months. Twenty years later the data from these studies were reviewed elsewhere and some additional studies made using modern equipment, and very little difference was found between the early and the new data.

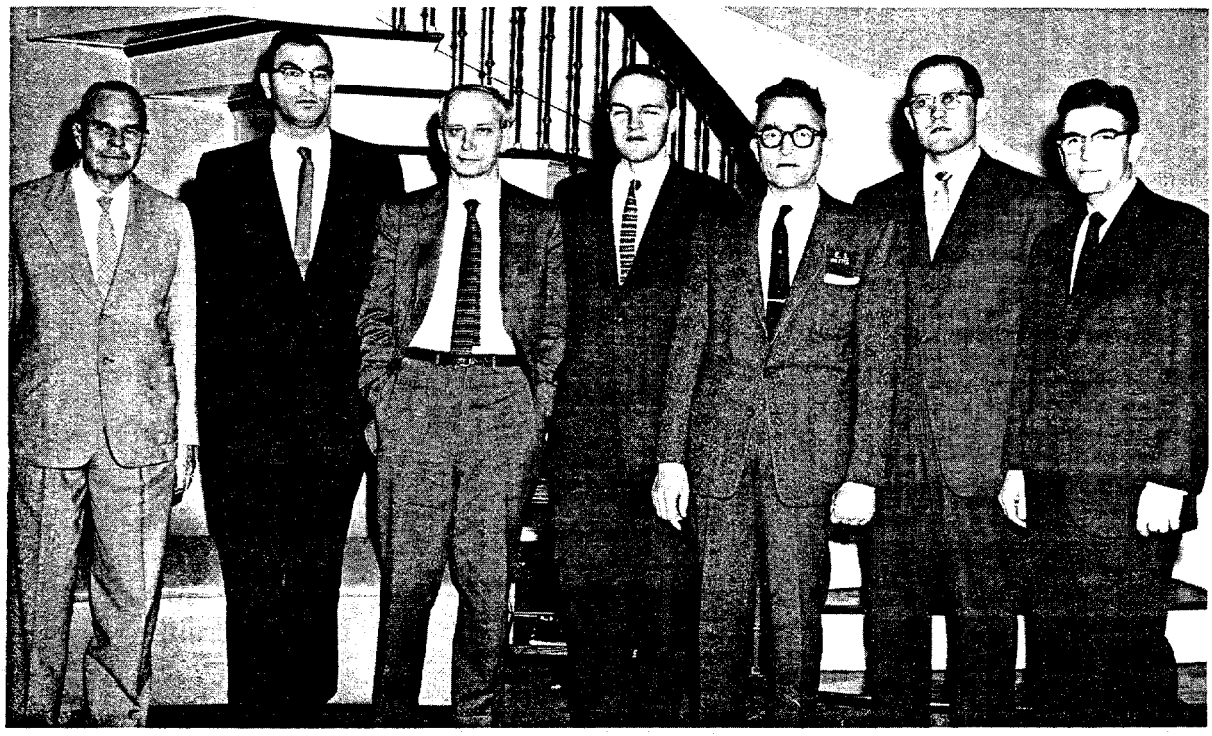


Figure 5. Many prominent analytical chemists have served on the Advisory Committee for the Analytical Chemistry Division. Shown here are several from the late 1950s. From the left: Professor Hobart Willard (Michigan), Professor Lynn Merritt (Indiana), Professor David Hume (MIT), Professor Wayne Meinke (Michigan), Ed Bettis, Jim White, and Myron Kelley.

Figure 6. Researchers in the Analytical Chemistry Division made many contributions to the field of nuclear radioanalytical chemistry. Bill Lyon (left) and Harley Ross (right) wrote the biennial reviews of the field for Analytical Chemistry for many years. Enzo Ricci was a coauthor in the 1960s and early 1970s.

The first U.S.-authored book on neutron activation analysis was produced by ACD people in 1964, with W. S. Lyon as the editor. A year later an effort began that was to span three decades, namely, preparation of the biennial review series "Nucleonics" for the journal Analytical Chemistry.

ORNL was asked to take the lead in designing and staffing a Lunar Receiving Laboratory for handling samples returned from the moon during the Apollo II moon shot. Several members of ACD were involved in setting up a prototype laboratory at ORNL and later in the actual receipt and study of the "moon rocks." Because of this involvement, ORNL people were among the first anywhere to view material from the moon.

This was the "golden era" of nuclear and radiochemistry in ACD. Several new facilities were built including a photon activation analysis facility and two 14-MeV neutron generators. Research was carried out on the use of ^{3}He activation, and the use of ^{252}Cf and Sb-Be sources. From all of this work was to come a number of awards for the researchers, including three Radiation Industry Awards, a Hevesy Medal, Apollo Awards from NASA, and the first IR-100 Award to be won by ORNL.

Similar accomplishments were being made in the "ionic analysis" component of ACD. Much effort was put into high temperature molten salt chemistry and the specialty instrumentation needed for such research. This was driven by the Molten Salt Reactor Experiment, later Program. Specialty methodology and instrumentation were developed for the transuranic elements that were to be produced in the new High Flux Isotope Reactor, separated at the Transuranium Processing Plant, and investigated at the Transuranium Research Laboratory. The relatively new High Radiation Level Analytical Facility, Building 2026, was expanded and an electron microscope for examining radioactive materials was installed in Building 3019. At the other extreme of the radiation scale, a Low-Level Radiochemical Laboratory was established in a once-secret building in the woods several miles from ORNL. (This location was dubbed Katie's Kitchen after Katherine Odom, the first divisional

secretary. She is #28 in Photo No. 1.) The effects of radiation on common analytical methods were investigated. The mass spectrometry group installed special instrumentation for studying transuranium and transplutonium elements to augment their state-of-the-art isotopic mass spectrometry capabilities. First steps were made into the new field of organic mass spectrometry. Even more adventuresome was the creation of a bioanalytical group to support the Body Fluids and Molecular Anatomy Programs at ORNL. This work also led to a number of awards for ACD people, including two prestigious Chemical Instrumentation Awards from the American Chemical Society.

The 1960s was a decade of expansion, in facilities and capabilities and accomplishment. Nevertheless, toward the end of the decade there were signals that some of ORNL's "traditional" activities were about to change. No new reactor programs were on the horizon. The radioisotope and activation analysis work was being given to private concerns. Ecological investigations were increasing as were concerns over air and water quality. Funding was not as easy as it once was. ACD, like many other divisions at ORNL, began to work for other Federal agencies on projects that offered mutual benefit. One such program was the Tobacco Smoke Program, funded by the National Cancer Institute. At the time, this program was viewed with some jaundice by many staff members in ACD, but it proved to be extremely important because it provided ACD with early expertise in organic analysis, far ahead of other laboratories. In many ways, the emergence of the Tobacco Smoke Program was a signal of things to come.

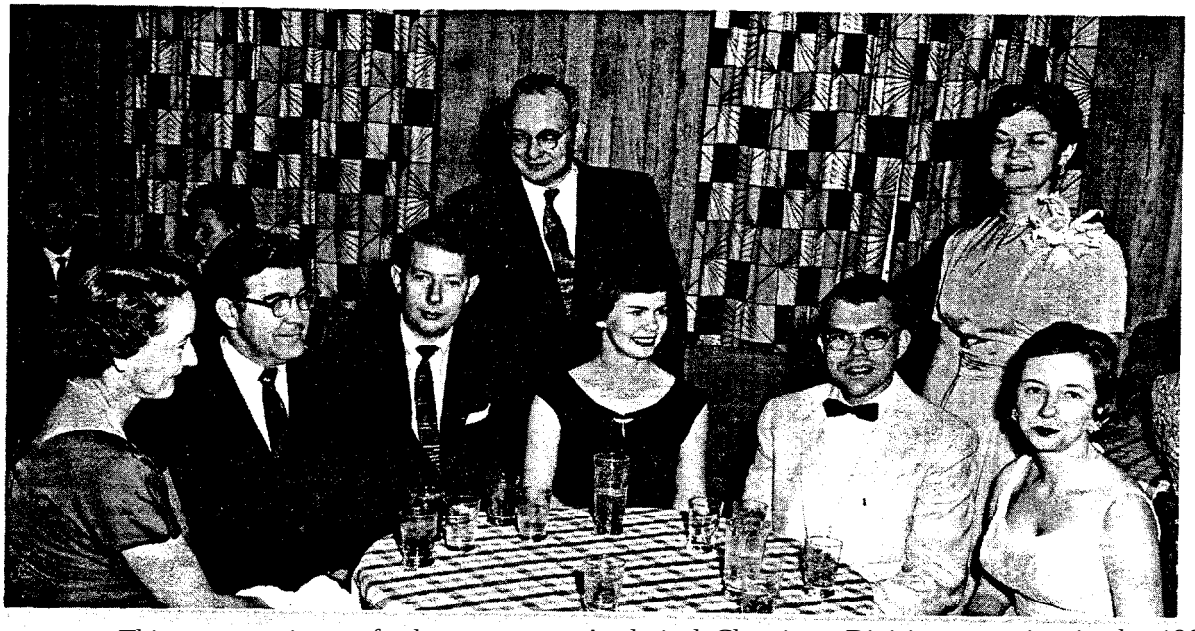


Figure 7. This group enjoys refreshments at an Analytical Chemistry Division reception in the 1960s. Paul and Veta Thomason are standing. He was Group Leader of Methods Development. Myron and Mary Elizabeth Kelley are seated on the left. Myron was Division Director. Bill and Jean Laing are in the center. Bill was Group Leader of Inorganic Analysis. Dale and Ruth Fisher are on the right. Dale was Group Leader of Analytical Instrumentation,

Figure 8

C. D. Susano (left) was Associate Division Director, Myron Kelley was Division Director, and Alvin Weinberg was Laboratory Director when this photograph was made. ca. 1965.

Figure 9. The Analytical Chemistry Division was the first analytical organization within the Atomic Energy Commission to develop a strong program in organic analysis. Mike Guerin on the right and Art Horton, second from the left, were prime movers in organic analysis in the late 1960s and early 1970s. Others in this picture are Dub Shults (left), Jim White (center), and Larry Corbin (second from right).

THE APHRODISIACAL PERFUME

Maynard Pro of the Internal Revenue Service had brought samples of imported perfumes that **they** *suspected to be counterfeit to ORNL for the Neutron Activation Group to test. Harley Ross worked out a scheme with Doris Willson, the ACD secretary, and Tom Tuck, a member of the Health Division, whereby a Ph.D. graduate student we'll call Joe would be asked to help in preparing aliquots of the perfume. Ross told Joe that one of the perfumes was believed to be a powerful aphrodisiac but one that only affected women. While Joe was preparing the samples, Doris* **came** *in, asked what he was doing, grabbed one of the bottles and applied some of the perfume to her face. Ross appeared horrified and told Joe to watch Doris closely while he searched the literature for an antidote. Doris immediately began making overtures to Joe, caressing him and trying to get him to return the compliment, which Joe, being a rather straitlaced fellow, refused to do. Ross then returned and told Joe they had better take Doris to Medical. This they did, and all the way over Doris continued to drape herself around Joe. When they arrived at the dispensary Tom Tuck met them at the door, told Joe that this was a very serious matter and that he had better leave at once. Which he was very happy to do.*

The next day Joe was told it was all a joke, but he refused to believe it. Even today he has his doubts.

Chapter Four

THE SEARCHING SEVENTIES

The decade of the Seventies was both exciting and difficult for the Laboratory and for the Analytical Chemistry Division. Traditional, well-focussed missions gave way to others that were described as "multidisciplinary" and the Laboratory began to describe itself as "multipurpose". The Oak Ridge National Laboratory had always been a multidisciplinary sort of organization, of course, and was therefore well positioned to attack a diversity of technical problems that were important nationally. The challenge was to search out and find the right mix of disciplines.

As the Molten Salt Reactor Program drew to completion, interest in environmental problems began to grow. During the summer of 1970, ORNL carried out a "Summer Study" for the National Science Foundation called an "Environmental and Technological Assessment". This landmark activity ultimately led to a major program at ORNL funded by the NSF Research Applied to National Needs organization, the "Ecology and Analysis of Trace Contaminants Program". This program resulted in new directions for the Laboratory that extended over many years. It also led to the formation of close contact and collaboration between ORNL and most funding agencies responsible for environmental work. ACD was a key component in the EATC Program.

ACD's work in this program can be described as applied chemistry. Advanced methodology for determining mercury and methylated mercury was developed and adopted nationally. Cadmium was studied. An electrochemical monitor was developed for chlorine in the air. Extensive studies of fly ash were made, including the movement of trace elements into the environment from ponded fly ash. A massive study of trace elements in and around a coal-fired steam plant -- the Allen Steam Plant in Memphis -- was carried out and involved virtually every group in the division.

Figure 10. Four members of the Radiochemistry group take a break: Fletcher Moore (who held more patents than anyone in ACD), Doris Willson (the heroine in the perfume anecdote), Jim Stokely (who later became Section Head), and Sam Reynolds (a pioneer in radioanalytical chemistry).

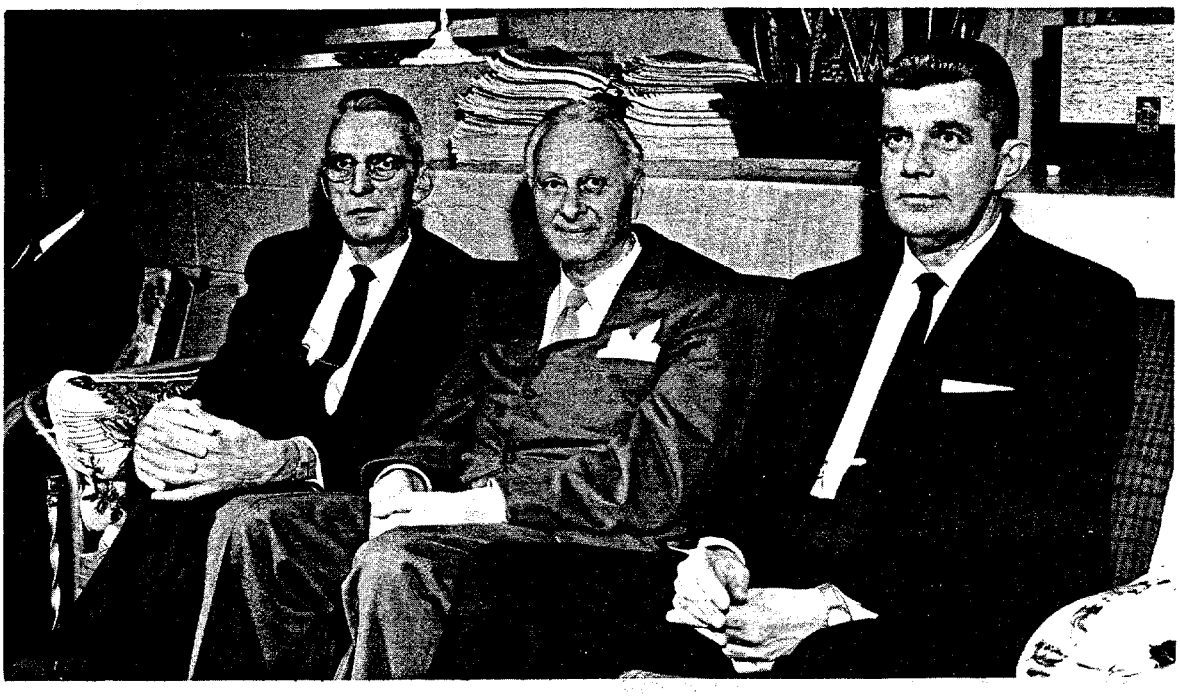


Figure 11. Shown here at an Analytical Chemistry Division social function are: Gus Cameron (left), Larry Hallet (center), and 0. G. Stone (right). GUS was Assistant Division Director and a pioneer in analytical mass spectrometry; Larry was editor of the journal Analytical Chemistry; 0. G. was Division Administrative Assistant.

Meanwhile, the mass spectroscopists were quietly improving in both equipment and capability and gaining an international reputation. Cooperative efforts in geochronology were carried out with several universities throughout the country. A close relationship developed with the IAEA such that ACD designed and built a two-stage spectrometer for safeguards work and installed it in the Agency's Seibersdorf Laboratory in Austria. Several ACD staff members worked in the Seibersdorf Laboratory during this period on special assignments. Development of the resin bead sampling technique for isotopic analysis of uranium and plutonium at ultratrace levels was initiated. This technique was destined to be adopted internationally for safeguards applications, replacing macro-scale sampling that was prohibitively more difficult and expensive. Work in organic mass spectrometry continued to expand, capped off by acquisition of a state-of-the-art, high sensitivity spectrometer designed specifically for organic work, the MS-50.

In 1972, after 22 years as Division Director, Myron Kelley stepped out of the directorship and became the senior scientific advisor within ACD. James C. White was named Division Director and W. D. (Dub) Shults was advanced to Assistant Division Director in parallel with Larry Corbin. Shults became Associate Division Director in 1975. This was the same year that the Atomic Energy Commission was dissolved and replaced with the Energy Research and Development Administration (ERDA). ERDA was destined to become the Department of Energy.

Two types of equipment appeared during the Seventies that were to have a big impact on the field of analytical chemistry: small computers and big lasers. In earlier years the development of analytical instrumentation had involved design and construction of circuitry and hardware. With the appearance of so-called mini-computers, emphasis shifted toward interfacing hardware with systems that provided control and computation. The first machines were in reality programmable calculators, but rather small affordable computers appeared shortly thereafter. The promise of the mini-computer was increased capability as well as increased speed, hence much effort was spent learning to program and use these machines. Efficiency in programming was important at the time because memory was very expensive. The

promise of the laser clearly lay in new capabilities: enhanced selectivity and sensitivity. The prime example of the time was resonance ionization spectroscopy, a laser-based technique tabbed as "one atom detection". ACD researchers were prominent in the team that developed and demonstrated this technique. Spectroscopies of various types were invented, improved, or evaluated during the Seventies.

Because of the national energy crisis of the early Seventies, there was much emphasis within ERDA laboratories on energy technology of all types. Coal conversion was a popular term, and ACD developed collaborations with several of the Energy Technology Centers. Various coal-derived liquids and synthetic fuels were characterized for chemical make-up and potential health hazard. ACD's experience in organic analysis gained through the Tobacco Smoke Program was especially valuable in this work. ACD's capabilities in neutron activation analysis were valuable in a totally different but major program of the Seventies: the National Uranium Resource Evaluation (NURE) Program. This was a massive sampling and analysis effort that covered the entire country and attempted to measure its inventory of uranium. ACD was a key laboratory in the NURE Program.

All in all, the Seventies was a decade of searching for the Laboratory and for ACD. Significant changes occurred in missions, in funding, in technology, in collaborators, and in management. These changes were accompanied by an increase in oversight of one type or another. Information Meetings were a long tradition in ACD, but were now augmented with site reviews by program sponsors. Quality control was enhanced with quality assurance. Attention to many administrative functions grew: affirmative action, safety, environmental protection, technology utilization, financial management, radiation control, etc. The challenge was to search out and find the proper balance in a high-flux decade.

Figure 12

These three were division managers in the Seventies. Jim White (left) was Division Director, Dub Shults (center) was his Associate, and Larry Corbin (right) was his Assistant. Shults became Division Director in 1976. Shults and White carried their managerial expertise to the ACS where both served as Chairman of the Analytical Chemistry Division. Corbin was a leading figure in the ASTM where he chaired a subcommittee and won several awards.

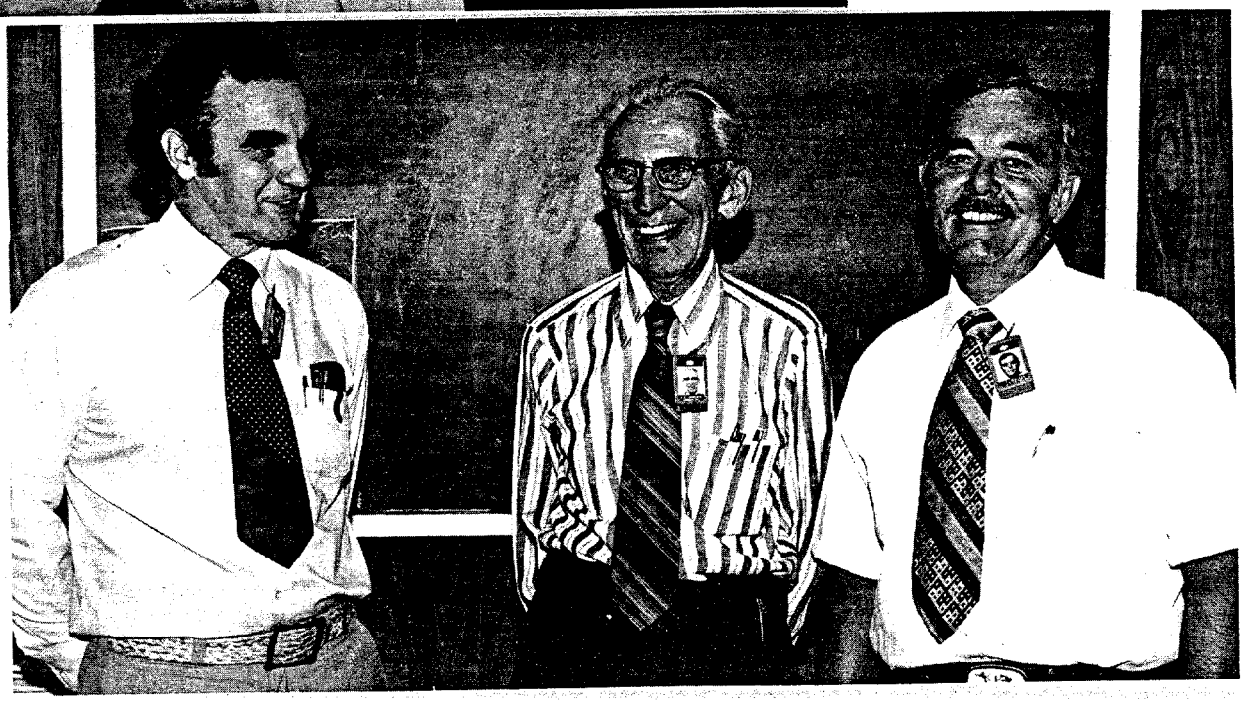


Figure 13. These three men were key figures in analytical mass spectrometry at ORNL. Gus Cameron (center) was the pioneer and served as Assistant Division Director. Joel Carter (left) expanded and diversified the organization and served as Section Head for Analytical Spectroscopy. Ray Walker (right) was Assistant Section Head to Joel and Group Leader for Actinides and Inorganic Mass Spectrometry.

THE SAYINGS OF ARNOLD HARROD

- That's enough to make a bulldog break its chain -- and a big one at that.

- I believe his cone is red.

- We need a treat instead of a treatment.

- A man's got to have enough to hold onto.

- She'd stop an eight-day train two days out.

- He must sit at the low end of the table and get all the gravy.

- Top drawer.

- Table grade.

- If it was any better, I couldn't stand it.

Chapter Five

THE EXCITING EIGHTIES

Suddenly one morning in 1982, the loudspeakers in and around ORNL announced that Union Carbide Corporation would not seek renewal of its contract to operate facilities for the Department of Energy. This short announcement would prove to have major impact on the Laboratory and on ACD. It led ultimately to the selection of Martin Marietta Energy Systems, Inc., a newly created subsidiary of Martin Marietta Corporation, as the operating contractor for ORNL and other facilities in Oak Ridge, Tennessee and Paducah, Kentucky. The change in contractors occurred on April 1, 1984.

The change of contractor held an unexpected but direct benefit for ACD. It revealed the need to relocate the mass spectrometry section from the Y-12 site to the X-10 site. That section was located in World War II vintage laboratories that were not readily accessible to visiting scientists, yet it had developed into a very diverse and capable analytical mass spectrometry operation. (The ACD Advisory Committee described it as a "national resource".) Accordingly, plans were made and a campaign was run to construct new facilities for mass spectrometry at X-10. The first building -- the plan called for three -- was occupied in 1989, by the Organic Mass Spectrometry group. Other buildings will be occupied in the early 1990s. It is notable that the first group to relocate was Organic Mass Spectrometry. That group developed in scope and technical excellence during the Eighties and was attracting an increasing number of students, post-docs, and outside collaborators. It needed to be located in user friendly facilities.

Fundamental research within ACD in the Eighties, which was supported primarily by DOE's Office of Chemical Sciences and Office of Health and Environmental Research, was both diverse and successful. The division acquired the first Fourier Transform Mass Spectrometer within the DOE community of laboratories and initiated fundamental and applied research work with it. Work was pursued with gas

Figure 14. As Administrative Assistant, Arnold Harrod was a fixture around the Analytical Chemistry Division for almost forty years. Here he is congratulated for another successful United Way campaign by Dub Shults, Division Director.

phase ion chemistry, with instrumental configurations of many types, with the MS/MS technique, with various ionization sources and schemes, with positive and negative ions, and with trapped ion techniques. A major success came with the development of an atmospheric sampling glow discharge ionization source which made possible the detection of ultra-trace levels of organics in the air and/or in other matrices by sparging. The coupling of the ASGDI source with ion trap mass spectrometry operated in the MS/MS mode was studied for detection and monitoring purposes. Other fundamental research centered around the use of lasers in analytical chemistry, microwave spectroscopy, positron spectroscopy, secondary ion mass spectrometry, inorganic mass spectrometry, resonance ionization mass spectrometry, liquid chromatography, the identification of DNA adducts, and heavy-ion stimulated x-ray emission. Several ACD projects were initiated through the ORNL Exploratory Research (Seed Money) program.

There was a wide variety of applied research activities in ACD in the Eighties, funded by numerous Federal and non-Federal agencies. The Tobacco Smoke Program moved toward the measurement of lesser and lesser amounts of smoke and its markers, ultimately searching for and studying "environmental tobacco smoke". This program led to the development of expertise in generating and studying aerosols of various types, and this expertise was applied to several studies for the Department of Defense. A method for measuring the volumes of large tanks used in nuclear fuel processing was developed via mass spectrometry with lutetium as a spike material. This technique was tested in collaboration with the Savannah River Laboratory. Chemometrics was applied to the detection of counterfeit currency. Numerous monitors and specialty instrumental systems were developed and deployed. Methodology for characterizing mixtures of radioelements and chemicals (mixed wastes) was developed and used to define the contents of unused waste tanks around the Laboratory. During the Eighties ACD's applied projects increasingly were driven by environmental and remedial action concerns.

Two unrelated events had tremendous impact on ACD's radiochemical activities during the Eighties. The Three-Mile Island incident invoked immediate and long-

term assistance from the division, particularly with regard to radioactivity measurements. Several ACD staff members were recognized for their work on behalf of TMI. Later in the decade, in November of 1986, the High Flux Isotope Reactor was shut down because of safety concerns. This led to cessation of neutron activation analysis for several years, at the very time when a new state-of-the-art NAA facility was nearing completion. Not until the end of the decade was this type of analytical work done again at ORNL. However, planning for the next generation of research reactor, the Advanced Neutron Source, was begun at ORNL and ACD led the conceptualization and planning of NAA facilities for it. Because of increasing concerns with environmental monitoring at the Laboratory, much emphasis was placed on radioelement analysis at extremely low levels.

The most dramatic change for ACD's service components during the Eighties came as the result of a huge DOE program, the Environmental Survey. This program involved a sampling and analysis effort at each major DOE site around the country. ACD was one of five participating organizations. The program required extensive rigor in methods, procedures, data handling, and quality assurance so as to have "comparability" of data. Accordingly, ACD was forced to move away from its traditional position of striving for the best data, toward the practical position of striving for rigorously specified data. The experience gained in the Survey was invaluable to ACD in that it prepared the division for the types of analytical work needed to support environmental and remedial action programs in the future. State-of-the-art methodology will continue to be needed to support the experimental research programs at the Laboratory and elsewhere.

All in all, the decade of the Eighties was a time of technical advances, achievement, new facilities and instrumentation, and challenges (opportunities) of all sorts. This description is really not much different from that of previous decades: the menu is similar but the items have changed. And the intensity level increased significantly.

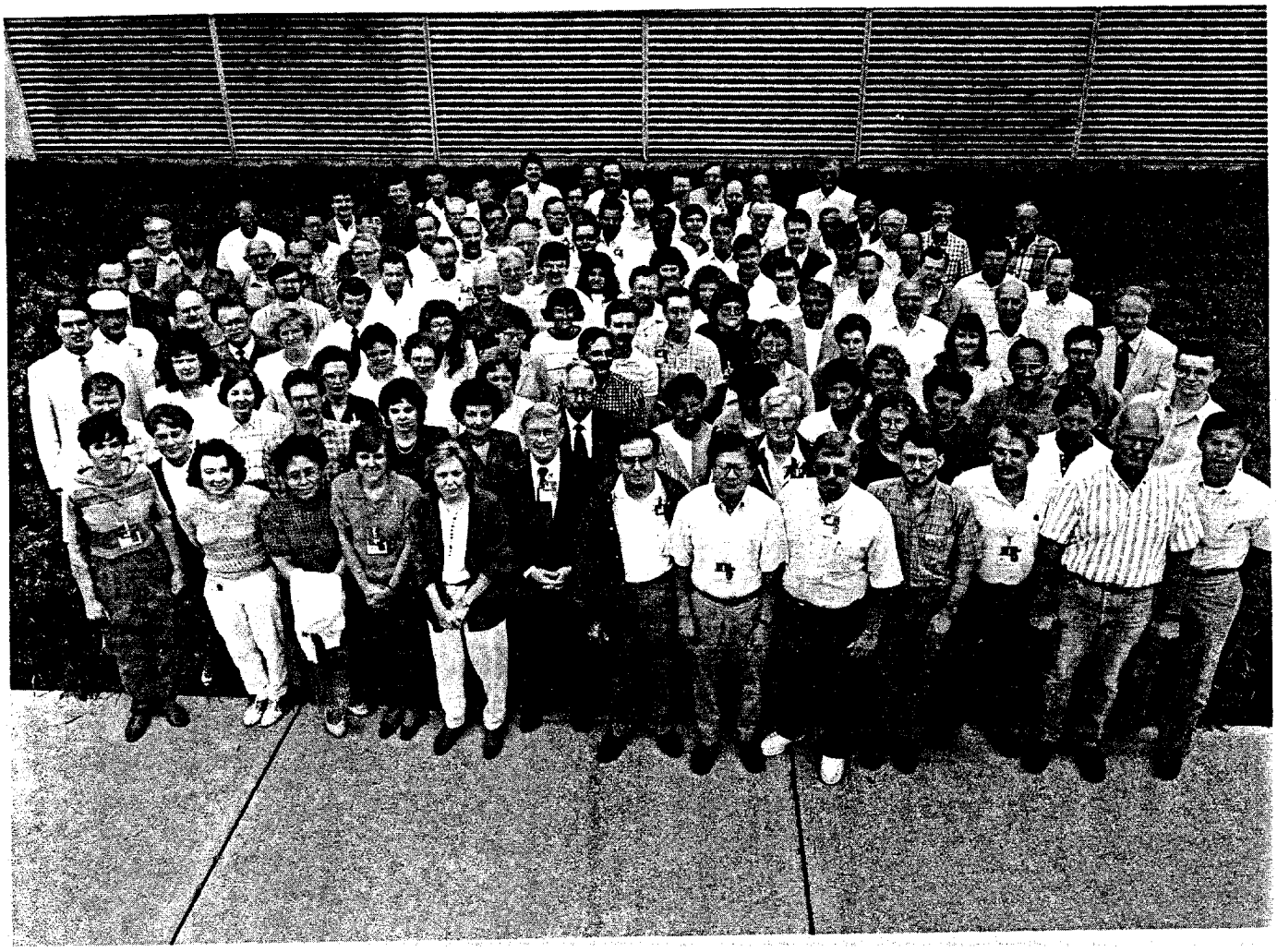


Figure 15. Analytical Chemistry Division at 40 years of age, May 22, **1990.**

L'ENVOI

In tracing the fortunes of analytical chemistry and the Analytical Chemistry Division at ORNL we have seen how the discipline and the division have evolved through four decades. Analytical Chemistry has changed from a reagent-added personally observed and measured physical change enterprise to its present state of highly complex instrumentation and computer controlled chemistry. Analytical Chemistry Division has changed from a small group of young B. S. chemists and high school graduate technicians to a new predominately middle-aged staff encompassing Ph.D. level chemists and technicians with at least several years of college or technical institute training. The problems the present staff are being asked to solve are at least partially an inheritance from earlier ORNL activities.

To older members of the division such retrospective reminders as this short history may evoke fond memories and perhaps a longing for the "good old days". To younger staff members the activities and enthusiasms of the prior decades may seem naive, primitive and environmentally careless. Regardless of perspective, one sees in Analytical Chemistry Division a living tradition of service and discovery that continues into the present and will persist into the future. As history shows, there have been many changes at ORNL, but with ACD's tradition of accomplishment we may confidently exclaim, "Plus ca change, plus c'est la même chose".

MAJOR ACCOMPLISHMENTS OF THE ANALYTICAL CHEMISTRY DIVISION

Some accomplishments of the division are listed in the following sections on Awards and Honors and Patents. These are a tribute to all members of ACD because the division's success derives from an underlying spirit of dedication, teamwork, and professionalism in the work.

Awards and Honors

Members of the Analytical Chemistry Division have won many awards and honors over the years. We list here those that have been cited in various reports, and we apologize to those who are inadvertently omitted. Memberships in various societies and organizations, of which there are many, are not listed here because of space constraints.

American Association for the Advancement of Science

C. A. Horton	1964	Fellow
J. C. White	1964	Fellow
J. P. Young	1982	Fellow

American Chemical Society

Michelle V. Buchanan	1981	Treasurer, East Tennessee Section
J. A. Carter	1971	Chairman, Analytical Group, East Tennessee Section
J. A. Carter	1981	Advisory Board
D. A. Costanzo	1971	Secretary-Treasurer, Analytical Group, East Tennessee Section
J. M. Dale	1968	Secretary-Treasurer, Analytical Group, East Tennessee Section
Marion Ferguson	1973	Secretary-Treasurer, Analytical Group, East Tennessee Section
D. J. Fisher	1969	Chemical Instrumentation Award
D. J. Fisher	1970	East Tennessee Analytical Group Plaque
R. L. Hettich	1989	Treasurer, East Tennessee Section
M. T. Kelley	1974	Chemical Instrumentation Award
L. N. Klatt	1978	Chairman, Analytical Group, East Tennessee Section
L. N. Klatt	1978	Program Advisory Committee, Division of Analytical Chemistry
L. N. Klatt	1984	Secretary, Division of Analytical Chemistry
T. R. Mueller	1972	Chairman, Analytical Group, East Tennessee Section
J. M. Ramsey	1989	Chairman, Program Advisory Committee, Division of Analytical Chemistry
H. H. Ross	1983	Fellowship Committee, Division of Analytical Chemistry
W. D. Shults	1970	Chairman, Analytical Group, East Tennessee Section
W. D. Shults	1975	Secretary, Fellowship Committee, Analytical Chemistry Division
W. D. Shults	1980	Chairman, Division of Analytical Chemistry
W. D. Shults	1982	Canvassing Committee for ACS Award for Creative Advances in Environment and Technology
W. D. Shults	1986	Advisory Board, ACS Publications

W. D. Shults	1989	Chairman, Education Committee, Division of Analytical Chemistry
W. D. Shults	1989	Chairman-Elect, East Tennessee Section
E. J. Spitzer	1967	Chairman, Analytical Group, East Tennessee Section
J. C. White	1967	Secretary-Treasurer, Division of Analytical Chemistry
J. C. White	1967	Representative to Project N11, Basic Materials and Materials Testing for Nuclear Applications, Nuclear Standards Board,
J. C. White	1970	Chairman, Division of Analytical Chemistry
J. S. Wike	1978	Secretary-Treasurer, Analytical Group, East Tennessee Section
J. P. Young	1973	Chairman, Analytical Group, East Tennessee Section

American Institute of Chemists

Gerald Goldstein	1969	Fellow
Gerald Goldstein	1973	President, Tennessee Chapter
C. E. Higgins	1971	Fellow
A. D. Horton	1970	Fellow
C. A. Horton	1956	Fellow
C. A Horton	1969	Treasurer, Tennessee Chapter
L. D. Hulett	1968	Fellow
L. D. Hulett	1970	Treasurer, Tennessee Chapter
M. T. Kelley	1968	Fellow
D. L. Manning	1970	Fellow
Helen P. Raaen	1964	Fellow
S. A. Reynolds	1969	Fellow
J. E. Strain	1969	Secretary-Treasurer, Tennessee Chapter
C. D. Susano	1968	Fellow
J. C. White	1968	Fellow

American Nuclear Society

Richard Hahn	1977	Radiation Industry Award
C. E. Lamb	1966	Chairman, National Membership Committee
C. E. Lamb	1966	Chairman, Membership Committee, Remote Systems Technology Division
C. E. Lamb	1967	Executive Committee, Remote Systems Technology Division
G. W. Leddicotte	1964	Special Award
W. S. Lyon	1976	Program Chairman, Executive 'Committee, Isotopes and Radiation Division
W. S. Lyon	1980	Radiation Industry Award
W. S. Lyon	1981	Chairman, Isotopes and Radiation Division
W. S. Lyon	1982	Vice Chairman, Isotopes and Radiation Division
W. S. Lyon	1983	Fellow
W. S. Lyon	1983	Chairman, Isotopes and Radiation Division

S. A. Reynolds	1972	Chairman, Standards Subcommittee, Isotopes and Radiation Division
Enzo Ricci	1968	Executive Committee, Isotopes and Radiation Division
Enzo Ricci	1970	Chairman, Subcommittee on Activation Analysis
Enzo Ricci	1973	Chairman, Committee on Analytical Applications of Radiation and Isotopes
Enzo Ricci	1976	Chairman, Planning Committee, Isotopes and Radiation Division
Enzo Ricci	1977	Radiation Industry Award
Enzo Ricci	1977	Secretary, Isotopes and Radiation Division
Enzo Ricci	1982	Fellow

American Public Health Association

W. S. Lyon	1967	Chairman, Referee Committee F, Industrial Wastes, Subcommittee on Radiological Methods for Biological and Environmental Samples

American Society for Mass Spectrometry

Michelle V. Buchanan	1986	Chairman, Environmental Applications Group
Michelle V. Buchanan	1988	Treasurer
G. L. Glish	1984	Chairman, History Committee
G. L. Glish	1986	Chairman, Ion Physics and Instrumentation Committee
G. L. Glish	1988	Vice President
S. A. McLuckey	1989	Chairman, Ion Physics and Instrumentation Committee
D. H. Smith	1984	Chairman, Isotopes Ratio Committee

American Society for Testing. and Materials

R. F. Apple	1981	Chairman, Task Group on Methods for Coatings Analysis
J. E. Attrill	1983	Advisory Committee, Subcommittee E-38:01 on Energy
R. D. Brooksbank	1983	Chairman, Task Group on Methods for Coatings Analysis
J. A. Carter	1975	Secretary, Subcommittee C-5:05, Analytical Task Group
W. H. Christie	1977	Secretary, Subcommittee E-42.06, SIMS
L. T. Corbin	1973	Chairman, Subcommittee C-26:05, Test Methods
L. T. Corbin	1973	Vice-Chairman, Committee C-26, Fuel, Control, and Moderator Materials for Nuclear Reactor Applications
L. T. Corbin	1974	Fellow
L. T. Corbin	1974	Award of Merit
L. T. Corbin	1976	Chairman, Committee C-26, Fuel, Control, and Moderator Materials for Nuclear Reactor Applications
L. T. Corbin	1981	Harlan J. Anderson Award
L. T. Corbin	1952	Charles B. Dudley Medal

Cyrus Feldman	1968	Chairman, Task Group on Photographic Photometry
Cyrus Feldman	1972	Award of Merit
Cyrus Feldman	1972	Fellow
G. Goldberg	1977	Secretary, Subcommittee D-01.43
W. R. Laing	1969	Secretary, Subcommittee C-26:05, Test Methods, Nuclear Fuel Cycle
W. R. Laing	1973	Chairman, Subcommittee C-26:01, Nomenclature
W. R. Laing	1975	Secretary, Committee C-26, Fuel, Control, and Moderator Materials for Nuclear Reactor Applications
W. R. Laing	1976	Chairman, Subcommittee C-26:05, Test Methods, Nuclear Fuel Cycle
W. R. Laing	197s	Achievement Award
W. R. Laing	1982	Award of Merit
W. R. Laing	1982	Vice Chairman, Committee C-26, Nuclear Fuel Cycle
W. R. Laing	1984	Award for Editorial Excellence
W. R. Laing	1984	Chairman, Long Range Planning Committee
W. R. Laing	1988	Chairman, Committee C-26, Nuclear Fuel Cycle
W. R. Laing	1989	Fellow
W. S. Lyon	1983	E-10 Honorary Member Award
S. A. Reynolds	1968	Vice Chairman, D-19 Subcommittee 4, Methods of Radiochemical Analysis
S. A. Reynolds	1975	Secretary, D-19 Subcommittee 4, Methods of Radiochemical Analysis
J. H. Stewart, Jr.	*1981*	Harlan J. Anderson Award
J. H. Stewart, Jr.	1984	Chairman, Task Group on X-rays

American Vacuum Society

T. M. Rosseel	1985	Chairman, Scholarship Committee, Tennessee Valley Chapter
T. M. Rosseel	1985	Chairman, Awards Committee, Tennessee Valley Chapter
T. M. Rosseel	1987	Treasurer, Tennessee Valley Chapter
T. M. Rosseel	1989	Vice President, Tennessee Valley Chapter

Analyst

M. T. Kelley	1969	Advisory Board
W. S. Lyon	1981	Advisory Board

Analytica Chimica Acta

M. T. Kelley	1967	Editorial Board
W. D. Shults	1979	Editorial Board

Analytical Chemistry

A. E. Cameron	1967	Advisory Board
J. A. Carter	1982	Advisory Board
G. A. Guiochon	1989	Associate Editor
W. D. Shults	1976	Editorial Board
W. D. Shults	1979	Advisory Committee, "Analytical Approach"
W. D. Shults	1989	Journal Review Committee

Analytical Chemistry Division

Arnold Harrod	1988	Distinguished Service Award
C. E. Higgins	1988	Distinguished Service Award
L. N. Klatt	1988	Distinguished Service Award
H. S. McKown	1987	Distinguished Service Award
J. H. Moneyhun	1987	Distinguished Service Award

Analytical Letters

J. C. White	1967	Editorial Board

Association of Indiana University Chemists

D. J. Fisher	1971	President
D. J. Fisher	1972	Chairman, Advisory Committee

Association of Women in Science

Michelle V. Buchanan	1988	Distinguished Scientific Achievement Award

Biomedical and Environmental Mass Spectrometry

Michelle V. Buchanan	1986	Editorial Board

Chemical, Biomedical, and Environmental Instrumentation

L. N. Klatt	1980	Associate Editor

Chemical Instrumentation

D. J. Fisher	*1967*	Editorial Board
L. N. Klatt	*1977*	Associate Editor
W. S. Lyon	1967	Editorial Board

Chromatographia

G. A. Guiochon	1989	Advisory Board

Department of Energy

Debra A. Bostick	1985	Weapons Complex Award of Excellence for the In-Line Photometric Uranium Concentration Monitor
A. E. Cameron	1971	Certificate of Appreciation
J. A. Carter	1973	Viking Mission Pin
J. A. Carter	1982	DOE/ISA Laboratory Advisory Group for Effluent Research (LAGER)
M. R. Guerin	1980	Chairman, DOE/OHER Workshop on Preparation of Complex Mixtures for Bioassay
W. T. Rainey, Jr.	1973	Viking Mission Pin
R. L. Walker	1982	DOE/ISA Laboratory Advisory Group for Effluent Research (LAGER)

Denartment of State

Joel A. Carter	1979	ORNL Coordinator, International Safeguards Program Office

Electron Microscopy Society of America

Frances L. Ball	1976	Secretary

Environmental Protection Agency

M. P. Maskarinec	1987	EPA/DOE National Task Force for QA/QC.

Federation of Analytical Chemistry and Spectroscopy Societies

J. C. White	1974	Chairman
J. C. White	1975	Governing Board

Fulbright-Hays

A. E. Cameron	1955	Fellowship

Health Physics Society

J. S. Eldridge	1986	President, Environmental Radiation Section
J. S. Eldridge	1987	Board Member, Environmental Radiation Section
J. S. Eldridge	1989	Chairman, Membership Committee, Environmental Radiation Section
K. J. Northcut	1986	President, Environmental Radiation Section

Industrial Research

Michelle V. Buchanan	1986	JR-100 Award for Development of the Multimode Ionization Detector
R. S. Ramsey	1985	IR-100 Award for a Helium-Ionization Detector for GC ("PHIDELS")
H. H. Ross	1967	IR-100 Award for a Radioisotopic Light Source Photometer
J. H. Stewart, Jr.	1982	IR-100 Award for the ORNL-Inductively Coupled Plasma (ICP) Spectrometer (Model JY-85CP)
M. B. Wise	1986	IR-100 Award for development of the Multimode Ionization Detector
J. P. Young	1977	IR-100 Award for Resonance Ionization Spectroscopy

Instrument Society of America

H. S. McKown	1971	Treasurer, Oak Ridge Section
H. S. McKown	1975	Secretary, Oak Ridge Section

International Atomic Energy Agency

J. A. Carter	1987	Analytical Services Observer, Advisory Group Meeting on Quality of Safeguards
H. H. Ross	1986	Technical Chairman, Advisory Group on Comparison of Nuclear Analytical Methods with Competitive Methods

International Union of Pure and Applied Chemistry

A. E. Cameron	1968	International Committee on Atomic Weights
Gerald Goldstein	1975	Chairman, IUB-IUPAC Subcommittee on Nucleotides and Related Compounds
J. C. White	1969	Associate Member, Commission V.7, Analytical Radiochemistry and Nuclear Physics

J. C. White	1973	Titular Member and Secretary, Commission V.7, Analytical Radiochemistry and Nuclear Materials
J. C. White	1975	Secretary, Division of Analytical Chemistry

Journal of the American Society for Mass Spectrometry

G. L. Glish	1989	Associate Editor

Journal of Chromatographic Science

G. A. Guiochon	1989	Advisory Board

Journal of Chromatography

G. A. Guiochon	1989	Advisory Board

Journal of Electron Spectroscopy

L. D. Hulett	1972	Editorial Board

Journal of Liquid Chromatography

G. A. Guiochon	1989	Advisory Board

Journal of Radioanalytical Chemistry

W. S. Lyon	1973	Regional Editor
W. S. Lyon	1981	George Hevesy Medal
H. H. Ross	1977	Editorial Advisory Board

Journal of Radioanalytical and Nuclear Chemistry

H. H. Ross	1983	Editorial Advisory Board

Journal of Radioanalytical and Nuclear Chemistry, Letters

H. H. Ross	1989	Editorial Board

Los Alamos National Laboratory

W. D. Shults	1989	Advisory Committee, Chemistry and Laser Science Division

Martin Marietta Energy Systems

Debra A. Bostick	1987	Inventors Award for a Method for Measurement of Refrigerant/Absorbent Concentration in Heat Absorption Machines
G. L. Glish	1987	Inventors Award for an Advanced Atmospheric-pressure Ionization Source for Mass Spectrometry
L. N. Klatt	1987	Inventors Award for a Method for Measurement of Refrigerant/Absorbent Concentration in Heat Absorption Machines
S. A. McLuckey	1987	Inventors Award for an Advanced Atmospheric-pressure Ionization Source for Mass Spectrometry
J. E. Strain	1987	Inventors Award for a Method for Measurement of Refrigerant/Absorbent Concentration in Heat Absorption Machines
Debbie Blazier	1989	President's Award for Performance Improvement for the Standardization of Secretarial Computers in ACD
Pat Trentham	1989	President's Award for Performance Improvement for the Standardization of Secretarial Computers in ACD
Gail Vineyard	1989	President's Award for Performance Improvement for the Standardization of Secretarial Computers in ACD
W. D. Shults	1990	President's Award for Performance Improvement in the Job Opportunity System
Michelle V. Buchanan	1985	Publications Award for "Differentiation of Polycyclic Aromatic Hydrocarbons Using Electron Capture Negative Chemical Ionization"
G. Olerich	1985	Publications Award for "Differentiation of Polycyclic Aromatic Hydrocarbons Using Electron Capture Negative Chemical Ionization"
J. M. Ramsey	1985	Publications Award for "Self-Scanning of a Dye Laser Due to Feedback from a $BaTiO_3$ Phase-Conjugate Reflector"
W. B. Whitten	1985	Publications Award for "Self-Scanning of a Dye Laser Due to Feedback from a $BaTiO_3$ Phase-Conjugate Reflector"
Michelle V. Buchanan	1989	Technical Achievement Award for exceptional achievements in modern organic analytical chemistry
J. A. Carter	1987	Technical Achievement Award for exemplary technical leadership and many significant achievements in analytical mass spectrometry

M. R. Guerin	1988	Technical Achievement Award for pioneering the development and application of modern organic analytical chemistry within the health and environmental programs of DOE and many agencies .
W. D. Shults	1988	Chairman, United Way Campaign

Massachusetts Institute of Technology

M. T. Kelley	1967	Program Review Committee, Chemistry Section, Laboratory of Nuclear Science

Microchemical Journal

M. T. Kelley	1967	Advisory Committee

National Academy of Sciences

J. S. Eldridge	1967	Secretary, Subcommittee on the Use of Radioactivity Standards, Committee on Nuclear Sciences
Gerald Goldstein	1969	Committee on Specifications and Criteria for Biochemical Compounds
Gerald Goldstein	1970	Chairman, Subcommittee on Nucleotides and Related Compounds
Gerald Goldstein	1970	Committee on Specifications for Adenine for Use in Anticoagulant Solutions
M. R. Guerin	1986	Committee on Multimedia Approaches to Pollution Control
M. T. Kelley	1966	Committee on Analytical Chemistry
W. D. Shults	1972	NAS/NRC Panel on Chlorine and Hydrochloric Acid
W. D. Shults	1973	Panel on Environmental Quality Indicators
J. C. White	1967	Committee on Analytical Chemistry
J. C. White	1967	Chairman, Subcommittee on Reference Materials, Committee on Analytical Chemistry

National Aeronautics and Space Administration

J. S. Eldridge	1970	Apollo Achievement Award
J. S. Eldridge	1975	Apollo-Soyuz Group Achievement Award
K. J. Northcut	1970	Apollo Achievement Award

National Autonomous University of Mexico

Michelle V. Buchanan	1981	Invited Lecturer
L. D. Hulett	1979	Invited Lecturer

National Cancer Institute

M. R. Guerin	1973	Chairman, Chemistry Subgroup, Smoking and Health Program
M. R. Guerin	1986	Chairman, Program Project Review Committee on Experimental Tobacco Carcinogenesis

National Council on Radiation Protection and Measurement

W. S. Lyon	1967	Scientific Committee 25 on Radiation Protection in the Use of Small Neutron Generators

National Science Foundation

Michelle V. Buchanan	1987	Biological Centers Program Advisory Board
W. D. Shults	1973	Coordinator, ORNL-NSF Ecology and Analysis of Trace Contaminants Program

Oak Ridge National Laboratory

W. D. Shults	1983	Chairman, Division/Program Directors Caucus
B. R. Clark	1981	Environmental Protection Outstanding Achievement Award
H. G. Davis	1981	Environmental Protection Outstanding Achievement Award
H. W. Dunn	1981	Environmental Protection Outstanding Achievement Award
J. S. Eldridge	1981	Environmental Protection Outstanding Achievement Award
R. R. Rickard	1981	Environmental Protection Outstanding Achievement Award
W. F. Rogers	1981	Environmental Protection Outstanding Achievement Award
T. G. Scott	1981	Environmental Protection Outstanding Achievement Award
R. L. Sherman	1981	Environmental Protection Outstanding Achievement Award
W. D. Shults	1981	Environmental Protection Outstanding Achievement Award
J. H. Stewart, Jr.	1981	Environmental Protection Outstanding Achievement Award
J. R. Stokely	1981	Environmental Protection Outstanding Achievement Award
J. E. Attrill	1982	Environmental Protection Outstanding Achievement Award
M. V. Buchanan	1982	Environmental Protection Outstanding Achievement Award
H. G. Davis	1982	Environmental Protection Outstanding Achievement Award
N. M. Ferguson	1982	Environmental Protection Outstanding Achievement Award
S. H. Harmon	1982	Environmental Protection Outstanding Achievement Award
R. W. Harvey	1982	Environmental Protection Outstanding Achievement Award
D. R. Heine	1982	Environmental Protection Outstanding Achievement Award

M. P. Maskarinec	1982	Environmental Protection Outstanding Achievement Award
G. Olerich	1982	Environmental Protection Outstanding Achievement Award
W. F. Rogers	1982	Environmental Protection Outstanding Achievement Award
J. H. Stewart, Jr.	1982	Environmental Protection Outstanding Achievement Award
B. A. Tomkins	1982	Environmental Protection Outstanding Achievement Award
K. I. Webb	1982	Environmental Protection Outstanding Achievement Award
J. H. Stewart, Jr.	1984	Environmental Protection Award
W. R. Laing	1988	Quality Recognition Award
D. L. Donohue	1988	Significant Event Award for a high-intensity source of low-energy positrons
G. L. Glish	1987	Significant Event Award for inventing a unique ion source for analytical mass spectrometry
G. L. Glish	1988	Significant Event Award for development of an explosive vapor detector
L. D. Hulett	1988	Significant Event Award for a high-intensity source of low-energy positrons
S. A. McLuckey	1987	Significant Event Award for inventing a unique ion source for analytical mass spectrometry
S. A. McLuckey	1988	Significant Event Award for development of an explosive vapor detector
J. M. Ramsey	1987	Significant Event Award for research in degenerate four-wave mixing
W. B. Whitten	1987	Significant Event Award for research in degenerate four-wave mixing
W. D. Shults	1982	Chairman, United Way Campaign
S. A. McLuckey	1985	Wigner Fellowship
J. M. Ramsey	1979	Wigner Fellowship

Optics and Spectroscopy

Cyrus Feldman	1968	Scientific Editor

Organic Mass Spectrometry

Michelle V. Buchanan	1989	Editorial Board

Professional Secretaries International

Elizabeth B. Young	1962	Member of the Year, Oak Ridge Chapter

Progress in Analytical Spectroscopy

J. M. Ramsey	1986	Editorial Advisory Board

Radiochemical and Radioanalytical Letters

W. S. Lyon	1969	Associate Editor

Science Digest

G. L. Glish	1985	Top 100 Innovator Award

Sigma Xi - RESA

L. D. Hulett	1973	Treasurer, Oak Ridge Chapter
W. T. Rainey	1974	Treasurer, Oak Ridge Chapter
W. D. Shults	1982	Vice President, Oak Ridge Chapter
W. D. Shults	1983	President, Oak Ridge Chapter

Society for Applied Spectroscopy

S. A. MacIntyre	1961	Outstanding Published Paper Award
J. C. White	1975	SAS Representative to the American Chemical Society
Anna M. Yoakum	1967	Secretary-Treasurer, Southeast Section

Society for Technical Communications

W. S. Lyon	1980	East Tennessee Chapter 2nd Place Prize for Periodic Progress Reports

Union Carbide Corporation

Carolyn C. Granger	1982	Community Service Award
W. R. Laing	1980	Chairman, Analytical Committee
W. D. Shults	1980	Chairman, Analytical Specialist Group

Universidad de Los Andes, Venezuela

J. M. Ramsey	1987	Guest Instructor on Laser Spectroscopy

University of Kentucky

M. R. Guerin	1987	Tobacco and Health Research Institute Advisory Board

University of Minnesota

A. E. Cameron	1955	Minnesota University Distinguished Alumni Award

University of Tennessee

G. A. Guiochon	1987	Distinguished Scientist
H. H. Ross	1985	Adjunct Professor, Science Alliance, Department of Chemistry
W. D. Shults	1986	Board of Visitors, Chemistry Department
W. D. Shults	1987	Faculty Awards Committee, Science Alliance

University of Wisconsin

Michelle V. Buchanan	1987	Samuel M. McElvain Seminar Series Speaker

William Jewell College

P. F. Thomason	1968	Citation for Achievement

Patents

Year	Number	Patentee	Subject
1961	3,009,062	W. A. Brooksbank, Jr. G. W. Leddicotte J. E. Strain H. H. Hendon, Jr.	Absorption Analyzer
1963	3,110,555	D. R. Cuneo M. J. Kelly J. H. Shaffer J. E. Strain	Separation of Protactinium from Molten Salt Reactor Fuel Compositions
1965	3,178,256	F. L. Moore	Method for Separating Transplutonium Elements from Rare Earth Fission Products
1966	3,276,849	F. L. Moore	Method for Separating Members of Actinide and Lanthanide Groups
1966	3,294,494	F. L. Moore	Method for Removing Lanthanides and Trivalent Actinides from Aqueous Nitrate Solutions
1968	3,402,027	F. L. Moore	Method of Separating Berkelium from Cerium
1968	3,404,270	H. H. Ross	Radioactive Isotope-Activated Light Source for Color Photometer
1968	3,409,414	F. L. Moore	Extraction of Berkelium Values in the Tetravalent State Using 2-Thenoyltrifluoroacetone
1968	3,409,415	F. L. Moore	Method of Extracting Soluble Metal Complexes Using Amine Solvents
1968	1,105,929 (British)	H. H. Ross H. L. Holsopple	Liquid Scintillator
1969	3,431,414	L. C. Bate F. F. Dyer L. H. Thacker	Radiation Detector and Recorder
1969	810,596 (Canadian)	H. H. Ross H. L. Holsopple	Liquid Scintillator

Year	Number	Patentee	Subject
1970	3,535,205	L. C. Bate F. F. Dyer	Method for Effecting Uniform Radiation of Samples
1970	3,549,492	T. H. Handley E. Ricci M. G. Willey	Fluid Supported Capsule Holder for Homogeneously Irradiating Samples
1970	3,513,704	D. W. Hatcher	Photometric Thermometer and Method of Operation
1971	3,615,268	F. L. Moore	Isolation, and Purification of Americium from Other 5f and 4f Elements by Extraction Chromatography
1972	3687,641	F. L. Moore	Separation and Recovery of Americium from Curium and Other Elements
1972	3,691,084	H. E. Zittle L. C. Bate S. B. Lupica	Base-Borate Reactor Safety Spray Solution for Radiolytic Hydrogen Suppression
1973	3,711,600	B. J. Sturm R. B. Quincy, Jr. C. T. Butler	Process for Preparing Calcined Oxides
1973	3,713,994	W. D. Shults, II J. R. Kuempel	Electrochemical Air Pollution Monitoring Device and Method of Use Thereof
1973	3,733,130	J. P. Young	Slotted Probe for Spectroscopic Measurements
1973	3,744,974	W. L. Maddox R. L. Coleman W. D. Shults, II	Loading Disk for Photometric Analyzer of Rotary Cuvette Type
1974	3,785,803	F. L. Moore	Extraction of Mercury from Alkaline Brines
1974	3,835,008	D. J. Fisher T. R. Mueller	Automatic Controlled-Current Coulometric Environmental Monitor
1976	3,958,178	H. H. Ross T. R. Mueller	Automatic Ranging Circuit for a Digital Panel Meter
1976	3,969,209	T. R. Mueller	Automatic Electrochemical Ambient Air Monitor for Chloride and Chlorine

Year	Number	Patentee	Subject
1976	3,988,919	C. B. Pollack Y. Talmi	Use of Graphitized Carbon Beads for Gas Liquid Chromatography
1977	4,026,790	F. L. Moore	Removal of Zn or Cd and Cyanide from Cyanide Electroplating Wastes
1980	4,227,081	A. J. Caputo D. A. Costanzo W. J. Lackey, Jr. F. L. Layton D. P. Stinton	Method of Evaluating the Integrity of the Outer Carbon Layer of Trisco-Coated Reactor Fuel Particles
1981	4,272,247	H. H. Ross J. E. Strain	Continuous-Flow Free Acid Monitoring Method and System
1983	4,422,044	T. R. Mueller	High Precision Triangular Waveform Generator
1984	4,459,481	H. S. McKown D. H. Smith P. J. Todd	Ion Source for High-Precision Mass Spectrometry
1987	4,705,947	R. S. Ramsey R. A Todd	Closed-Loop Pulsed Helium Ionization Detector
1987	4,705,948	R. S. Ramsey R. A. Todd	Pulsed Helium Ionization Detector
1988	4,721,858	M. V. Buchanan M. B. Wise	Variable Pressure Ionization Detector for Gas Chromatography
1989	4,879,472	M. V. Buchanan M. B. Wise	Multiplexed Electronically Programmable Multimode Ionization Detector for Chromatography

Figure 1	No number
Figure 2	ORNL News Photo 22126
Figure 3	ORNL Photo 2976-71
Figure 4	ORNL News 12061
Figure 5	ORNL News 8016
Figure 6	ORNL Photo 0322-78
Figure 7	ORNL News 3306
Figure 8	ORNL News 4058
Figure 9	ORNL Photo 0755-73
Figure 10	No number
Figure 11	ORNL News 9408
Figure 12	ORNL Photo 6150-76
Figure 13	ORNL Photo 6711-77
Figure 14	ORNL Photo 4858-82
Figure 15	ORNL Photo 3923-90

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