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MOUND LABORATORY
ANNUAL
REPORT

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Annual Highlights **Report** for 1975

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MOUND LABORATORY

operated by

MONSANTO RESEARCH CORPORATION

for

**UNITED STATES ENERGY RESEARCH
AND DEVELOPMENT ADMINISTRATION**

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Overview

Mound's work through the year centered on development, production, and surveillance of weapon components; development and assembly of plutonium-238 heat sources; production and sales of stable isotopes; separation of special radioisotopes; development of Safeguards procedures for nuclear materials control; and development of improved techniques for effluent control and waste management.

Reductions in funding for certain programs led to reductions in the work force during the last half of the year. Yearend employment was 1542, down 157 from January 1. Application of the Zero-Base Budgeting concept, particularly in the overhead areas, enabled the Laboratory to manage the funding reductions with minimal impact on vital services.

To continue a trend toward a broadened base of nonweapons programs, intensive efforts were made to apprise all divisions of the Energy Research and Development Administration, the Nuclear Regulatory Commission, the Environmental Protection Agency, and other government agencies of Mound's diverse capabilities and resources which are applicable to many of today's technological problems. Favorable responses to these efforts in 1975 are expected to result in funding ranging from about \$800,000 to \$1 million for new nonweapons projects in FY-1976 and FY-1977. At yearend there

were over 40 active proposals on file with various government agencies.

Though production requirements for weapons components were reduced, some major new-build weapons systems were supported, and major efforts were directed toward pilot and qualification activities. Qualification production of detonators incorporated new methods and techniques of assembly, and new materials for detonator heads, cylinders, and explosives were evaluated and recommended for production.

A major process development activity was investigation of processes, materials, and components for the in-house production of pyrotechnic devices. Activities centered around developing an alumina ceramic technology and bringing a ceramic processing facility on stream. A new ingredient for pyrotechnic material was found to meet design specifications for three weapons systems.

Extensive activity related to fabrication of Milliwatt Generator

(MWG) heat source capsules continued throughout 1975. Production facilities were completed, and Mound was established as the MWG supplier for two weapons systems.

Multihundred Watt (MHW) programs were another major heat source activity. The last two flight heat sources for the MHW/Lincoln Experimental Satellite (LES) Program were completed, and fabrication of flight sources for the MHW/Mariner-Jupiter-Saturn Program was started.

Four of the seven heat sources fabricated at Mound for the Viking program were aboard the two Viking satellites launched toward Mars on August 20 and September 9.

Eight demonstration heat sources were shipped to the U. S. Department of the Navy in February. Work on fabrication of fifty additional heat sources for the Navy was initiated in the middle of the year.

Several disciplines were joined to develop an Automated Plutonium Assay System which was proposed as a prototype of the controlled systems which will be required to safeguard nuclear materials and vital equipment in commercial production of power reactor fuels.

A number of technological advances were made in the separation of various stable isotopes by thermal diffusion. A 25% increase in helium-3 production was realized by development of new operating parameters. The first enrichment of krypton-78 above 99% ever to be achieved at Mound occurred in October, and the annual production rate of krypton-83 was the highest achieved to date. About 20 g of sulfur-34 at an average concentration of 92% was produced in a

12-column liquid thermal diffusion cascade system, in what is believed to be the first successful application of liquid thermal diffusion to the separation of a rare isotope at high concentration.

Mound employees continued in 1975 to set new safety records. A world record for chemical plants was established on October 7 as the 35,000,000 safe hours mark was reached. The yearend total was 35,622,872 safe hours, a figure representing over nine years of operation without a disabling injury.

Robert L. Wainwright (left), Manager of the Dayton Area Office of the Atomic Energy Commission, presented the AEC's Award of Honor for Mound's safety record to Richard K. Flitcraft, Director of Mound Laboratory, on January 18, the last day of the AEC's existence.

In its first year of operation under the Energy Research and Development Administration, Mound Laboratory's management made several organizational changes to ensure effective response to changing conditions and opportunities. Monsanto-Mound interchange of personnel was an especially important element in these changes. John R. McClain was named Associate Direc-

tor, reporting to Richard K. Flitcraft, Vice President-Operations, Monsanto Research Corporation, and Director of Mound Laboratory. Three new department directors were transferred from Corporate Monsanto to fill vacancies resulting from transfers, and 29 Mound employees were moved into growth positions at other Monsanto locations.

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Program development

Mound interfaces with eight ERDA divisions and also performs work for the Nuclear Regulatory Commission.

Responding to needs of the new ERDA organization and to program changes resulting from reduced requirements for weapons components, Mound management and technical staff were busy throughout the year with program briefings and project proposals.

In line with Mound's prime role as a production site for components in the nuclear weapons complex, potential involvements in future weapons programs were defined and several specific projects were proposed. But in view of the nation's energy needs and the broad ERDA charter in energy matters, proposals for nonweapons work were more numerous and covered a wide spectrum of subjects reflecting the diverse technical capabilities and resources of the Laboratory. Many contacts were made with the various ERDA divisions and several other Federal agencies.

Sixty-four formal nonweapons proposals for new business were submitted to seven divisions of ERDA and to the Nuclear Regulatory Commission, the Environmental Protection Agency, and the U. S. Army during 1975. Of these, seven were funded or budgeted for in FY-1976 and 39 were still pending at the end of the year. Three other proposals submitted in 1974 were also still pending.

The seven proposals favorably received resulted in the funding of \$614,000 for FY-1976 and expected funding of \$823,000 for FY-1977. Sponsors were two ERDA divisions and the Nuclear Regulatory Commission. An additional \$200,000 to \$300,000 is anticipated from the Nuclear Regulatory Commission for each of these two fiscal years.

Dr. Richard W. Roberts (center), Assistant Administrator for Nuclear Energy, ERDA, conducted a press conference in Dayton on October 20 to discuss energy programs. In prominent display was a slide presentation produced at Mound to highlight programs of Monsanto Research Corporation applicable to energy-related problems. Prior to the press conference, Dr. Roberts was greeted by Robert L. Wainwright (left), Manager of ERDA's Dayton Area Office and Richard K. Flitcraft (right), Director of Mound Laboratory, and toured main Mound facilities.

Component production, development, and surveillance

Throughout its history, the prime mission of Mound Laboratory has been to manufacture explosive and nuclear components for nuclear weapons which are assembled elsewhere. In association with ERDA weapons design laboratories, process development programs are conducted to develop materials and techniques and to fabricate models and other items for experimental purposes. Certain explosive detonators and other components which are removed from stockpiled nuclear weapons at another site are returned to Mound for surveillance testing.

Mound Laboratory continued throughout the year to meet its production, process development, and supporting research commitments as a major prime contractor for the U. S. Energy Research and Development Administration. As in past years, weapons-related activities were directly associated with programs at the design laboratories--Los Alamos Scientific Laboratory, Lawrence Livermore Laboratory and the Sandia Laboratories at Albuquerque and Livermore. Reductions in funding at the beginning of FY-1976 in July led to reduced activity in certain production and process development areas.

Some major new-build weapons systems were supported during the year and major efforts were directed toward pilot and qualification activities. Full lead delivery status was recovered on one program through accelerated production following a shutdown to resolve a material failure detected in quality assurance testing; a new material specification resulted from investigation of this problem. Qualification production of detonators incorporated new methods and techniques of assembly, and new materials for detonator heads,

Lieutenant General W. D. Johnson (left), United States Air Force, Director of the Defense Nuclear Agency, was briefed on surveillance testing of stockpile components during a March 2 visit.

cylinders, and explosives were evaluated and recommended for production.

Shipment of a group of components in July completed current commitments for a nuclear production program.

A capability for automatically compacting "green" ceramic shapes was established in support of new programs at Lawrence Livermore Laboratory and Sandia Laboratories, Albuquerque. High-quality electronic ceramic parts and assemblies were manufactured in a variety of complex shapes and sizes. The bulk of these assemblies were of 94% alumina; however, many other ceramic materials were molded, including 99.5+% alumina. The molded parts typically shrink 16% linearly from the as-molded condition to a fully sintered ceramic approaching theoretical density. Tolerances were held to ± 0.0015 in. on the final as-sintered assemblies, thus eliminating much of the high cost of machining these very hard and brittle materials into useful shapes.

Improved plastic materials developed for detonators and timers reduced requirements for asbestos in a diallylphthalate molding pow-

der matrix and thereby measurably decreased processing problems associated with the handling of asbestos.

A major process development activity was investigation of processes, materials, and components for the in-house production of pyrotechnic devices. Activities centered around developing an alumina ceramic technology and bringing a ceramic processing facility on stream. A major effort was also devoted to pyrotechnic materials characterization, formulation, and component performance. Extensive parametric studies were conducted to evaluate and optimize materials and component designs associated with pyrotechnic devices. These studies resulted in a new ingredient for pyrotechnic material which met the design specifications for three weapons systems.

In phase with materials development, a Pyrotechnic Facility was completed for the blending and molding of pyrotechnic powders. Processes developed for the safe and efficient handling of pyrotechnic materials incorporated a specialized automatic pneumatic pelletizer with an automatic ejection system.

In other development areas, operation of a new synthesis facility vital for work in the Beret Program was started in July. Materials development and system testing for the Araz Program continued throughout the year.

To support performance testing of weapons components containing radioactive materials, a new environmental chamber was installed in the testing area in September. Components can be tested at temperatures from -70°F to 200°F and at atmospheric pressure or under vacuum.

H. E. Roser (left), new Manager of the ERDA Albuquerque Operations Office, inspected Mound facilities on November 14.

Personnel from Lawrence Livermore Laboratory, the Mason & Hanger Pantex site, and the two Sandia Laboratories were at Mound in September to assist in the buildup of two exposure test assemblies

and witness testing of systems from stockpile samples. The test assembly was the first of its type made at Mound, and all evaluations performed with it were successfully completed.

High speed camera used in quality assurance testing

Plutonium-238

heat sources

Following Mound's pioneer work in the 1950's on the utilization of polonium-210 in thermoelectric generators, the development of plutonium-238 radioisotopic heat sources was started at the Laboratory in 1961. Since that time, a large number of plutonium-238 heat sources have been developed and fabricated for lunar experiments, weather satellites, navigational satellites, and spacecraft.

During the past year, plutonium-238 heat sources were being fabricated for five programs: the Multihundred Watt/Lincoln Experimental Satellite, the Multihundred Watt/Mariner-Jupiter-Saturn, the Viking, the Navy, and the Milliwatt Generator.

Two flight heat sources for the Lincoln Experimental Satellite (LES) were fabricated to complete the LES fabrication portion of the Multihundred Watt Program. All five units for this program are being temporarily stored, and gas buildup and electrical characteristics are being measured periodically.

One qualification source and one flight source for the Mariner-Jupiter-Saturn Program were fabricated. Six more flight sources will be required.

Over 40 fueled sources and about 70 sources containing fuel simulant were fabricated for testing of the Milliwatt Generator (MWG) heat source capsules. These tests included pressure-burst, impact, aging, and related studies. The heat source design was changed from a 16-yr life to a 25-yr life;

this will result in a slightly larger capsule containing ~4 W of fuel rather than 3.5 W.

Production facilities for the MWG Program were completed. Mound was assigned the responsibility of MWG heat source production through FY-1984.

New clad members were installed on two Viking heat sources, one of which required complete re-encapsulation. Four of the seven Viking heat sources fabricated at Mound were aboard as auxiliary power sources on the two Viking satellites successfully launched toward the planet Mars on August 20 and September 9.

Eight demonstration heat sources (0.5 W electrical), fabricated in December 1974 with plutonium-238 fuel, were shipped to the U. S. Department of the Navy in February. An additional 50 heat sources for the Navy will be fabricated by mid-1977.

Installation of a facility for impact testing of fueled heat sources was nearly completed. The impact gun to be used is unusual in that

it fires vertically upward; it also has a unique trigger mechanism to fire the inert gas propellant. The gun has been fired successfully at the vendor's plant.

Plutonium-238 recovery operations associated with heat source development were terminated at the end of June. Scrap materials containing plutonium-238 are now processed and packaged for shipment offsite.

Thermoelectric generator with a MHW heat source being removed from shipping container

Tritium technology

Surveillance of weapon components containing tritium, initiated in 1958, was the first of many Mound activities in tritium technology. Today Mound has an extensive capability for handling and studying tritium and tritium compounds, including a facility for the recovery and purification of tritium from all types of wastes generated at ERDA sites.

Development of methods to recover tritium from effluent streams dominated Mound's 1975 work in tritium technology. Characterization of tritiated materials and evaluation of their use in classified systems continued to be an important part of process development activities. As a leader in tritium management, Mound participated in several reviews of tritium-related technology associated with nuclear reactor programs.

Parts of a distillation system designed to recover tritium from aqueous wastes were completed and tested.

Work in Mound's Tritium Effluent Control Project moved forward, with emphasis shifting from development of atmospheric effluent treatment systems to the development of detritiation and recovery processes that can be applied to tritiated liquid wastes. Started in 1972, this project is concerned with the advanced technology which will be needed for control of tritium waste streams throughout the nuclear industry in the years ahead. Investigations this year centered around application of molecular excitation, catalytic exchange, and electrolysis techniques as methods to remove tritium from liquids. A new Tritium Effluent Control Laboratory was equipped for this project in preparation for operation with tritium in 1976.

The HT/H₂O catalytic exchange process, which has a high isotopic separation factor, was selected to be one of the most likely processes for development and demonstration of waste water detritiation. Fabrication and installation of an experimental system to test this process was completed, and analytical instruments were integrated into the apparatus. Startup operations without tritium were completed, and a computer program was made operational for calculating concentrations of various molecular species at thermodynamic equilibrium.

In a new assignment, Mound was authorized by ERDA's Division of Controlled Thermonuclear Research to make a study of tritium requirements and availability for the Controlled Thermonuclear Research Program through the year 1990 to ensure an adequate supply of tritium and to obtain accurate unit costs. In addition to costs, this study will include factors such as forecasted tritium requirements, sources of tritium production and generation, ERDA production capabilities, and tritium sources.

In a related area, critical reviews were performed of tritium-handling procedures and facilities for three proposed large controlled thermonuclear research experiments: the Tokamak Fusion Test Reactor (TFTR), to be constructed by Princeton Plasma Physics Laboratory; the Intense Neutron Source

(INS), to be constructed at Los Alamos Scientific Laboratory; and the mirror Fusion Engineering Research Facility (FERF), proposed by Lawrence Livermore Laboratory.

At the request of Westinghouse Electric Corporation, budgetary information was supplied in September for a tritium storage and supply system which will be used at the Tokamak Fusion Test Reactor. An engineering estimate was prepared, including several Mound recommendations for possible improvements in the system.

Mound's experience in catalytic air detritiation systems was the subject of several consultations throughout the year with representatives from Lawrence Livermore Laboratory, Los Alamos Scientific Laboratory, Westinghouse Corporation, and KMS Fusion, Inc.

Nuclear materials management

Nuclear materials management is concerned with the accountability and safeguarding of source and special nuclear materials such as uranium and plutonium. It requires an integrated system of analysis, process control, and inventory management.

Accountability of nuclear materials, always a prime concern in production and development programs, continued to receive major attention. Increased emphasis on safeguarding of nuclear materials from unauthorized use highlighted the importance of the sampling, inventory, analytical, and management procedures which are integrated to control the use and movement of nuclear materials at Mound. Operating procedures were updated to strengthen control, and

a new technical manual Nuclear Materials Safeguards and Accountability was issued as an additional reference guide for personnel who are responsible for source and special nuclear materials.

Developing from concepts generated during the last three years, an Automated Plutonium Assay System (APAS) was assembled as a prototype of systems which can be used for accurate in-line control and assay of mixed oxide fuels for nuclear

Lieutenant General A. D. Starbird (left), U. S. Army (Retired) and Assistant Administrator for National Security, ERDA, was briefed on the Automated Plutonium Assay System during a November 18 visit.

power reactors. The mechanics of the system are based on an automated transport and positioning system, developed by Mound's Automation Development Group. The assay system uses calorimetry for precise thermal power measurements and high resolution gamma-ray spectroscopy for determination of plutonium isotopes and associated americium-241. Work on APAS was supported this year by the Nuclear Regulatory Commission.

Mound continued to coordinate and participate with four other ERDA sites in a sample exchange program designed to refine the accuracy of plutonium-239 analyses, an important factor in the verification of plutonium-239 inventories.

Calorimetry, the basis for non-destructive analysis of nuclear materials, particularly plutonium-238 and tritium, continued to be an important area of development. Three calorimeters were built for other ERDA sites.

Separation and sales of stable isotopes

Mound research on thermal diffusion columns in the 1950's led to a continuing program to separate the stable isotopes of the noble gases. Today, Mound Laboratory is a leader in thermal diffusion research, and other separation processes—chromatographic, cryogenic, and chemical exchange— have been developed to provide nearly 30 nonradioactive isotopes for distribution throughout the world.

In 1975 sales of stable isotopes from Mound Laboratory were made to 159 domestic and 69 foreign customers. The total value was \$1,053,533, compared with \$1,038,040 in 1974.

Customers used these isotopes in nuclear physics research, biological tracing, metabolic studies,

cryogenic applications, nuclear fuel element gas tagging, geochemistry, gas laser studies, neutron radiography, agronomic research, heart scanning, and cancer research. The five major contributors to 1975 income were, in decreasing level of sales, helium-3, carbon-13, nitrogen-15, xenon-124, and xenon-136.

The availability of new enrichments of krypton-78, krypton-80, carbon-13, nitrogen-15, oxygen-17, oxygen-18, and sulfur-34 was announced in March. Over 1,500 updated stable isotope catalogs were mailed to domestic and foreign users in April.

As a result of system modifications during the year, 20 g of sulfur-34 at an average isotopic concentration of 92% was produced in a 12-column liquid thermal diffusion cascade system. The sulfur-34 effort is believed to be the first successful application of liquid thermal diffusion to the separation of a rare isotope at high concentration. It was made possible, in part, by the development of thermal diffusion columns three or four times more efficient than those constructed in earlier research and development efforts.

The operating pressure of the four-column helium thermal diffusion system was raised from 2,750 to 3,235 torr, to effect an approximate 25% increase in production rate with no decrease in product concentration. This modification enabled production of budgeted product in less time, thereby allowing for more attention to enrichment of very low helium-3 concentrations to intermediate concentrations.

The first enrichment of krypton-78 (natural abundance, 0.4%) above 99% to be achieved occurred at

Mound Laboratory during the latter part of October.

Production of approximately 0.9 STP liter of 70% krypton-83 was sufficient for orders on hand. The 70% isotopic concentration is the highest produced at Mound and is believed to be the highest achieved anywhere by thermal diffusion.

The 13-column thermal diffusion system, generally used for production of argon-38 at intermediate enrichment, was adapted to produce argon-36 at a concentration >99.5%.

Separation of radioactive isotopes

Mound Laboratory has processed radioisotopes for more than 25 years and has separated and purified several heavy-element isotopes for research, development, and production purposes. Today, four radioisotopes—protactinium-231, thorium-229, thorium-230, and uranium-234—are purified in gram quantities from residues and are supplied to the Heavy Elements Pool at Oak Ridge National Laboratory and other ERDA sites. In new technology, chemical exchange processes are being investigated for the separation of rare metal isotopes.

Two shipments of thorium-229, totalling 9 mg, were made to Brookhaven National Laboratory in 1975. This radioisotope, a decay product of uranium-233, was separated and purified by solvent extraction.

Two samples of thorium-229, extracted late in the year in a second "milking" of uranium-233, were analyzed to be 59% and 74% isotopically pure. These purities were the highest for thorium-229 ever attained at Mound and presumably were due to elimination of substantial thorium-232 during the first "milking."

One shipment of thorium-230 product, amounting to 40.58 g of the radioisotope, was made to the

Heavy Elements Pool at Oak Ridge National Laboratory. This material was obtained by processing uranium concentrate supplied by the Cotter Corporation. An additional 18.4 g of uranium-234 which had been separated and purified from aged plutonium-238 was also shipped to Oak Ridge.

The feasibility of a new chemical exchange process for the separation of uranium isotopes was examined and some basic criteria for a useful chemical exchange system were investigated. Liquid-liquid extraction was found to be a promising enrichment process. Installation of bench-scale equipment was started to provide more information for economic analysis.

Physical research

Mound conducts several research programs in the physical sciences to support and develop technologies for ERDA programs. Current programs are concerned primarily with isotope separations, low temperature research, and metal hydride research.

Because of potential applications of hydrogen in advanced energy systems, Mound's research on metal hydrides assumed additional importance this year. Work in this area is designed to elucidate mechanisms responsible for macroscopic characteristics of various metal-hydrogen systems. Recent work has been directed towards understanding and evaluating specific atomistic properties and physical processes that can be applied in solid-state hydrogen storage systems.

To determine the relationships between structure and diffusion mechanisms in metal hydrides, initial measurements of structure and proton diffusion were made for VH_x and $FeTiH_x$ using pulsed NMR techniques.

Computer programs were developed to calculate electronic properties of transition metals and their hydrides. These programs permit prediction of properties such as crystalline stability, electronic resistivity, Fermi surfaces, bulk moduli (or compressibilities), and hydrogen coordination of the metal atoms. Detailed calculations were performed for lithium and lithium hydride, and initial calculations were made for palladium hydride and nickel hydride.

To characterize molecular motion, diffusion, and distribution of iso-

topic species in metal hydrides the formation of helium-3, molecular tritium gas bubbles, and lithium metal were determined as a function of time in lithium tritide samples.

Low-temperature research included investigations to determine whether cubic boron, a unique form of boron which Mound has produced at high temperatures, will exhibit superconductivity, as has been predicted. Cubic boron and a boron compound, YB_{70} , were tested in a

A unique form of cubic boron, produced in a plasma torch at Mound, was investigated as a possible superconductor.

special press at the Naval Research Laboratory. First measurements to 100 kbars pressure at temperatures as low as 0.03° absolute did not reveal transitions to the superconducting state; however, additional tests were planned.

To continue development of fundamental information necessary for isotope separation processes, additional physical properties of several noble gases and their mixtures were determined. Thermal diffusion factors for the Ne/Ar, Ne/Kr, and Ar/Kr systems were measured as a function of composition and temperature. Total scattering cross sections of the Ar/Kr system were measured as a function of relative kinetic energy. Equipment development included the construction of a quadrupole mass filter system for use as a sensitive particle detector in differential cross section experiments.

A total reflux operation was achieved in a prototype chemical exchange system for enrichment of calcium isotopes with a Karr re-

ciprocating-plate countercurrent extraction column. The polyether dicyclohexyl 18-crown-6 was used for the exchange reaction.

In work associated with separations chemistry, new methods to dissolve the noble metals platinum and iridium were developed. The platinum procedure involves fusion with potassium nitrate at 1100°C and is superior to the traditional aqua regia method because it is faster and can be used in steel equipment. Iridium is dissolved by nitric acid treatment of a fused mixture of iridium in KOH/KNO₃.

A better understanding of previously measured properties of liquid metals and fused salts was obtained by the application of a recently developed liquid model concept. Experimental studies of liquid metals were continued with the fabrication and testing of equipment to determine the x-ray structural features of liquid cerium and the electrotransport behavior of liquid lithium.

Analytical support

A highly diversified analytical facility is maintained at Mound Laboratory to support all technical activities. Equipment includes many of the most sophisticated instruments currently available, as well as equipment designed for Mound's special needs. Techniques range from chemical characterization in the parts-per-million range to advanced physical and nondestructive testing.

A number of new analytical tools and techniques were acquired and developed in 1975.

Installation of a new neutron generator for neutron activation analysis was completed in May. It is anticipated that this unit will increase the reliability of the neutron activation system, and, because it is completely sealed, the need for target changing will be eliminated.

A neutron activation analysis for silicon in steel was developed to replace the former method using wet chemistry. By means of the new technique three samples can be analyzed in 3-1/2 hr; the former method required four hours per sample. The new technique is non-destructive, and the only sample preparation involved is fitting the sample into a transfer container.

A new Leco WR-12 dual-range carbon analyzer increases the accuracy, precision, and range of carbon analysis compared with former capabilities. It is now applicable for analysis of samples containing 0.005-5.0% carbon.

A semiquantitative procedure to determine metallic impurities in

inorganic samples of unknown composition or in samples for which appropriate standards are not available was developed by the General Analytical Group. The method uses emission spectroscopy and requires a master reference plate, standard addition samples, and a total burn technique. Except for rare earth metals, it provides rapid estimation of metallic impurities in the concentration range of 30 to 1000 ppm with a reliability within one-half to two times actual concentrations.

A system was developed to measure the velocity of sound in a material to an accuracy of at least one part in 10,000. The method was applied to the determination of differences in material properties, such as grain size and second-phase impurities, from one lot of material to another. Specific applications have been made to steel used in detonator casings, tantalum-based alloys used in heat sources, and molded ceramics.

A new technique permits rapid, accurate ultrasonic thickness gauging of thin-walled cylinders. It was successfully demonstrated on two strength member bodies for Navy heat source capsules. Measurement of sidewall thickness required only 3 minutes per part

compared to approximately 30 minutes with mechanical gauging. Adoption of this technique to existing or new programs entails only fabrication of appropriate standards. It will be adapted for simultaneous measurement of inside and outside diameters, roundness, and eccentricity.

Improvements were made in the procedure to determine plutonium-238 and uranium-233 in effluent water from the Waste Disposal Building. A fourfold increase in sample size provides better counting statistics and increased sensitivity for detecting other alpha emitters. Electrodeposition time was decreased from 120 to 90 minutes with no sacrifice in electrodeposition efficiency.

An 18-month program for the development of a prototype one-kilogram vacuum balance for weighing thermally hot objects was culminated in February with the successful weighing of 700 mg of tritium to an accuracy of ± 0.65 mg. This balance circumvents the inherent

A new scanning electron microscope was installed in SW-Building early in 1975. This instrument, which features a digital magnification unit, provides identification and magnification information on the photomicrograph as it is recorded.

weighing problems caused by large base weight of containers and container buoyancy effects caused by heat (self-heating of tritium in this case).

Waste management

Management of radioactive wastes has always been an integral part of Mound's operation. Activities include removal of radioactive nuclides from plant waste streams, processing and recovery of wastes from production and development operations, and packaging of wastes for storage and/or dispersal at other locations. Non-radioactive wastes are also stringently controlled, and wherever possible reclamation rather than disposal is pursued.

In a program funded by ERDA's Division of Waste Management and Transportation, Mound conducted extensive pilot plant tests of an incineration process for volume reduction of combustible low-specific-activity (LSA) radioactive wastes. Such a method is needed to reduce the costs of transporting and disposing of such wastes and could have widespread application. Operating parameters for the incineration process were established and studies were made with variable feedstocks (combinations of paper, cardboard, rubber, plastics), with and without radioactive contamination.

Another major activity potentially applicable throughout the ERDA laboratory and contractor network was the design and testing of shipping containers. A reusable primary container, developed and designed at Mound Laboratory for intersite shipment of high-level tritiated water waste, was fabricated offsite and delivered to Mound during the year. This container is intended to be enclosed and shipped in a specially constructed 55-gal steel drum, which is a form of containment approved by ERDA and the Department of

Transportation for the shipment of plutonium-239 and uranium-235. The new primary container can be accommodated in a calorimeter for tritium accountability. Up to 1.7 kg of water contaminated with tritium, contained in a suitable absorbent to preclude the presence of free liquid, can be transported. Further, the container may be used indefinitely because the water may be removed for tritium recovery, and the absorbent can be regenerated by heating under vacuum.

Over 1200 tons of thorium ore concentrates were removed from the site by sale to commercial interests, a waste management project worth \$340,000 in terms of revenue gained and removal costs avoided.

Typical of ongoing efforts to recover valuable nonradioactive wastes, an improved electrolytic recovery unit was procured to recover silver from process solutions, mercury-contaminated wastes were shipped offsite for reclamation, and a surplus supply of nickel carbonyl was sold to a chemical firm.

Environmental control

Mound Laboratory has an integrated set of environmental control capabilities which are used to protect the Laboratory area and ensure the integrity of the surrounding environment. A health physics organization ensures safe working conditions for Mound employees who process radioactive materials. A comprehensive environmental monitoring program is conducted to detect and assess effects of Laboratory operations on the surrounding environment.

Mound Laboratory significantly reduced its radioactive effluents over the past year, in some areas almost to negligible levels. The reduction of personnel radiation exposures continued downward; there were no significant exposures to radiation workers and exposures to all workers were well below the radiation standard.

A new health physics program, "Incident Prevention," was started during the year to evaluate job activities in and around radiation areas. The program incorporates an Incident Prevention Evaluation card to aid in identification of potential problem areas.

Two videotapes were produced at Mound for health physics training. These tapes—"Breaching a Tritium Contaminated System" and "Stepping into Trouble" illustrate special techniques to control radiation exposures in a tritium facility.

As a result of concerted action to reduce radioisotopic releases in liquid effluents from the waste disposal building, the actual release of plutonium-238 in 1975 was reduced to approximately 60% of the working goal, a level far below maximum guidelines set by ERDA regulations.

The efficiency of the Effluent Removal System (ERS) in the tritium processing building was significantly increased by installation of palladium afterburners operating at approximately 585°C. This new feature eliminates release of organic materials originating from breakdown of pump oils.

A program was developed to enable the Environmental Control section to check the quality of the analyses performed for trace elements

A Wright State University student (right) completed a 10-week internship in environmental health protection at Mound in a program designed to demonstrate principles and daily routines involved in environmental health.

found in air and water effluents from Mound Laboratory. Prepared samples containing metals and trace quantities of radioactive material are furnished to Mound by the Analytical Quality Control services of the International Atomic Energy Agency, Vienna, Austria. These samples contain trace levels of tritium, plutonium, lead, mercury, calcium, cadmium, iron, nickel, zinc, cobalt, copper, selenium and barium. Additionally, air and biological samples traced with radioactive substances will be received for analyses.

Mound Laboratory has some of the most sensitive instrumentation in the United States for counting alpha-emitting particulates inhaled into the lungs. Efforts were started this year to provide lung counting services to other installations and to adapt the system for

liver counting. By counting quantities of radioactivity in the human liver, evaluation of radioactive uptake by individuals is enhanced.

A survey instrument was developed jointly by Mound Laboratory and Wright Patterson Air Force Base which will detect low-energy X- and gamma radiation in soil and silt. The instrument can be submerged under water for radiation surveys in silt, is field repairable, and is easily portable for field use.

A five-year plan was developed to improve the control of natural drainage onsite. Several projects were initiated to control natural drainage to prevent the movement of potentially contaminated silt offsite.

Automation development

Mound maintains a versatile facility for the development of automated systems to perform some of the intricate operations required for production and supporting activities, many of which have exacting requirements for uniformity, reliability, and reproducibility.

A number of automated systems were developed during the year to improve control of production and development operations, particularly those involving explosive or pyrotechnic materials. But a highlight was the application of automated techniques in the development of an Automated Plutonium Assay System (APAS) which was proposed to the Nuclear Regulatory Commission as a prototype of the controlled systems which will be required to safeguard nuclear materials and vital equipment in commercial production of nuclear reactor fuels.

The basis of the APAS system was the development of a three-axis positioning and pickup system, completely computer controlled, which was designed for moving plutonium samples to and from operational stations inside an enclosed line. The positioning device runs the length of the process line (up to 30 ft) on overhead rails and is accurate to within ± 0.005 in. in the X axis, and ± 0.002 in. in both the Y and Z axes. Actual travel is automatically measured and corrected if necessary by computer. With this system, the handling of containers of plutonium can be accomplished completely automatically, thereby improving both operator safety and material security.

A mechanized and automated system for pressing powder into pellets was built for production processes.

Controlled and operated pneumatically, this system was designed for operations with hazardous materials such as pyrotechnics. In initial use to produce pyrotechnic pellets, productivity was increased four-fold with less labor.

In support of other production, a semi-automated wire cutoff machine was developed to precisely cut electrode wires at given heights above the molded plastic of detonator heads, and a mechanized deburring device was developed to remove the burr generated during precision cutting of mild detonating fuse.

An automated pressure/volume calibration system became operational during the year and now is used by Mound's Standards Laboratory for volume calibrations with an accuracy of approximately $\pm 0.3\%$. This automated system, under mini-computer control, has increased by three times the number of calibrations that can be performed in a given time with a large reduction in direct labor costs.

An automatic depth gauging system was one of the systems completed for development programs. It will gauge the depth of a number of holes in a component part, calculate minimum, maximum, and mean depths, and record results.

Engineering

In addition to its responsibilities for the maintenance of facilities and utilities, Mound's Engineering Department supports production and development operations in the design and construction of new facilities. It is also responsible for the Laboratory's Energy Conservation Program. Engineering shops are geared to produce the precision parts and assemblies required in much of Mound's work.

In a year of reduced funding and personnel cuts, the Engineering staff maintained vital support for the Laboratory's programs and, as evidenced in other sections of this report, were active in many different areas.

Four major engineering projects costing \$1,767,028 were completed during the year:

- The Milliwatt Generator Heat Source Facility
- A new sewage disposal plant
- Installation of fire walls and doors in various manufacturing buildings
- The Pyrotechnic Facility

At the end of the year, there were \$6,590,000 worth of major projects in construction, and projects in the design stage totalled \$1,215,000.

Construction began this year on the "Additional Upgrading of R Building." The ventilation systems serving R Building are being extensively modified and upgraded at a cost of \$3 million. The project is scheduled for completion in December 1976.

A new fire testing facility was completed for testing shipping containers for radioactive materials. The facility was designed to produce a controlled, open gasoline fire for testing, without generating objectionable smoke. This facility is a unique capability within ERDA.

In September an improved preventive maintenance program was established for approximately 6500 pieces of equipment throughout the Laboratory. The improvements

Conversion to metric operations accelerated during 1975 with addition of metric systems in Mound's machine shops.

provide for positive feedback to assure that maintenance action has been taken.

The Machine Shop is being converted to metric operation as program needs arise and funds permit. Four metric conversion kits were purchased that can be used with 16 of our lathes to cut metric threads. Two mills and one lathe are equipped with combination metric/English dials and readouts. Gages and cutting tools have also been obtained for metric work.

The ongoing energy conservation program at Mound Laboratory resulted in a 5.5% reduction in energy requirements from 1974 usage, to exceed the Monsanto goal of 2.5% and the ERDA goal of "no increase." The conservation pro-

gram reduced total energy usage even while new facilities, such as the sewage disposal plant, were placed into operation. These savings were made in the following resources:

Electricity	2,834,066 kilo-watt-hours
Natural Gas & Fuel Oil	12,110,500 cubic feet
Gasoline	6,647 gallons

The major effort in energy conservation was to shut down unneeded equipment and lighting. Approximately 30,000 watts of lighting were removed from various buildings. Wherever possible, electricity for heating, ventilating, and lighting were shut off over weekends and at night.

Senator Robert A. Taft of Ohio (left) greeted Machine Shop personnel during his visit to Mound on October 27.

Utilities in twelve buildings were shut down over the weekends in September and October for a savings of \$10,000.

A laboratory-wide shutdown during Christmas week resulted in the conservation of 53,500 kilowatt-hours of electricity and 2,100,000 cubic feet of natural gas.

Another energy-saving project was the upgrading of a cooling tower loop in the powerhouse. A secondary pump was installed in the cooling system so that the larger primary pump could be shut down during the winter. This change will conserve electrical energy during periods of low demand on the cooling system.

Computer programming and data processing

In addition to a mini-computer network, used mainly for analytical and process control, Mound Laboratory has two Model 50 IBM 360 Computer systems for onsite operational support. The system serves a number of accounting and physical inventory functions as well as numerous other scientific and management reporting purposes.

Generating the vast amount of data necessary for management of the Laboratory's business and developing additional programs for new information systems, data processing operations continued at a steady pace, with emphasis on extension of computer capabilities by linkage of facilities.

Two steps toward a hierarchical computer structure and interface among computers at Mound Laboratory were completed. The first was the successful test of a translation program converting ASCII code on a Texas Instruments 960 into IBM 360 compatible EBCDIC code. The second was the successful linking of a PDP/8 and the IBM 360/50. The mini-computer is operated as a remote job terminal through a software package which combines the 360 job control language with the user-generated data and communicates to the IBM 360 system.

As a step toward meeting needs for large volume technical computations, an interface was established between Mound Laboratory and a CDC-6600 computer at Wright Patterson Air Force Base. This interface is on a "time-available" no-charge basis up to a maximum of 50 computer CPU (central processing unit)

hours. This time, equivalent to 1000 hr of processing on Mound Laboratory's equipment, will be used to support research activities.

The operating efficiency of computing systems was improved by the acquisition of a software monitor, SUPERMON. This software package monitors both the software and hardware components of computing systems and provides a "picture" of a system at any given time.

The configuration control system (Product Index) by which weapons components are manufactured has been the object of a three-year upgrading and improvement program. With the completion and implementation of a new computer program in September 1975, the resulting system now gives wide flexibility for documentation of product manufacture.

To assist the technical staff in the development of programs for their special needs, a nine-week course in FORTRAN IV programming was conducted for over 40 members of the Engineering, Explosives Operations, and Nuclear Operations Departments.

Technical information

Technical information is a major product line, second only to the hardware and materials which comprise main production commitments. Mound maintains an active effort to report and disseminate technical information. The Library and Document Control Center ensure that information required by the technical staff is readily available and that classified documents are controlled according to security regulations.

This year, the technical library obtained 22 comprehensive literature bibliographies for the development of program proposals and the start-up of new programs. Unclassified research and development reports received from ERDA and other agencies increased library holdings by 34,965 to a total holding of over 220,000 titles, 215,000 of which are on microfiche. New receipts were 70% higher than in 1974. Fifty-eight holdings of journal titles were converted from original copy to microfilm, to release over 100 linear feet of limited shelf space for current storage of new issues.

As in past years, Mound authors maintained a steady output of technical publications, and staff members gave many oral presentations on a wide variety of subjects. Technical information products for the year included

- 16 journal articles
- 3 patents
- 40 topical reports
- 33 progress reports
- 2 translations
- 1 bibliography
- 2 brochures
- 7 conference publications
- 94 oral presentations

Preparation of technical manuals for production and development processes was another major publication activity: new or revised issues of 573 technical manuals were completed.

Renewed emphasis was given to the importance of audiovisual techniques in technical communication, especially for project reviews and management briefings. A new Visual Communications function was established to design and coordinate audiovisual programs in the most effective medium. In addition to the conventional 35-mm slides, 8 x 10-in. transparencies, and flip charts, Visual Communications makes available more advanced media, such as synchronized sound/super slides, 16-mm color sound film, and color videotapes.

Several programs were prepared for offsite use, including videotapes on

"Diallylphthalate Processing at Mound Laboratory,"

"Automation and Mechanization at Mound Laboratory,"

and

"Automated Plutonium Assay System - A Visual Status Report."

Seven slide presentations described Mound's work in tritium technology, nuclear materials management, and energy conservation.

Another prime application of video-recording was the preparation of tapes for onsite training in health physics, high-pressure systems, security, and management techniques.

Over 5,500 secret documents were declassified during a special review at Mound in April.

Safety

Safety is the foremost requisite of all Mound operations. Safety programs stress individual responsibility and include an incentive program to mark milestones in the safety record.

Mound employees continued their consistent attention to safety matters in 1975, with record results. Operation without a disabling injury brought the safety record at the end of the year to 35,622,872 safe hours without a disabling injury, a total representing over nine years of operation. When the 35 million mark was reached on October 7, a new record for chemical plants was set, which added extra weight to the safety clock slogan: "Every hour a new Monsanto record." Each employee received a commemorative gift for this event.

Recognition of Mound's safety performance came from several sources. On January 18 - on the last day of its existence - the Atomic Energy Commission presented to Monsanto Research Corporation its "Award of Honor" in safety performance. Monsanto's Fourteenth and Fifteenth Board of Directors' Awards were received on March 31 and October 9. A commemorative plaque from the Dayton/Miami Valley Safety Council's Occupational Safety and Health Committee was presented to the Laboratory on November 11 for the 35 million record.

To support new areas of technical activity, a new program to ensure safety of high-pressure systems was implemented during the year. All pressure systems were reviewed, and a series of videotapes was

used to inform designers and users of high-pressure safety practices. A Pressure Advisory Committee formulates guidelines for high-pressure safety of systems throughout the Laboratory.

Emphasis on emergency preparedness was continued with relocation of the Emergency Control Center to a location with improved communication facilities. In late summer, the Laboratory participated in an area-wide disaster drill and assisted in controlling a simulated radioactive spill. In December, the newly organized Montgomery County Environmental Health District Emergency Response Team visited the Laboratory and was briefed on Mound resources, particularly radiological monitoring assistance, that could be made available to the team under emergency conditions.

Security

Security is an integral part of Mound's work. The security organization is responsible for the physical protection of facilities, classified materials, and classified information. It also administers a personnel security program and maintains a security training program.

In concert with some of the technical programs, the security program directed much attention to the safeguarding of nuclear materials. A revised Safeguards Upgrading Program was developed and submitted to the Safeguards Task Force headed by ERDA. The task force visited Mound in September.

Capabilities to respond to terrorist attack were effectively demonstrated during an annual audit of Security operations by ERDA's Albuquerque Operations Office in November.

An internal security audit of all departments emphasized reduction of classified holdings. Several thousand documents were returned to Document Control for disposal.

The three-year security orientation required for all employees was completed in April.

Four security infractions were recorded during the year, three less than in 1974.

U. S. Congressman Thomas N. Kindness, Ohio Eighth District, which includes the Miamisburg area, checked through a security station for a July 3 tour of Mound facilities.

Staff development

Monsanto Research Corporation stresses staff development as the key to effective management of multiprogram assignments.

1975 brought a number of organizational changes, some reflecting response to changing program directions and conditions, others reflecting Monsanto's emphasis on individual growth.

In February, John R. McClain, formerly Director of Engineering, assumed the new position of Associate Director, reporting to

Richard K. Flitcraft, Vice President of Monsanto Research Corporation and Director of Mound Laboratory. Also in February, Donald R. Storey, Director of Administration, was named Director of Personnel and Administration for MRC. He was succeeded in June by Robert T. Braun, who was named Director of the revamped and renamed Administrative Services Department. Mr. Braun came to Mound from Monsanto

John R. McClain (third from left), Associate Director, congratulated Mound's Managerial Specialists upon their certification to teach MA Retrofit and MA Refresher seminars.

Commercial Products Company. Another June appointment was that of Hilliard L. Williams, formerly with Monsanto Industrial Chemicals Company, to be Director of Engineering.

At midyear Mr. Flitcraft was named to the new position of Vice President-Operations for Monsanto Research Corporation. Retaining his duties as Mound Laboratory Director, he also assumed responsibility for MRC's Dayton Laboratory. Later in the year Donald E. Crook, Director of Finance, transferred to Olympia Industries, Inc., a Monsanto subsidiary. He was succeeded in November by James E. Caldwell, who came from Monsanto's Corporate Controllers Department.

Twenty-nine Mound employees transferred to other Monsanto locations in moves which presented personal growth opportunities and also alleviated effects of a force reduction which occurred during the latter half of the year.

The force reduction, a consequence of reduced funding for certain programs, was phased to minimize personal hardships and promote placement with other employers. Mound employment at the end of the year was 1542, 157 less than on January 1.

The year's changes brought new import to Mound's longtime emphasis on training and development.

In April, a Managerial Analytics Applications Team was established to provide Mound personnel with initial MA training and continual coaching and consulting service.

Reflecting the need for a higher proportion of engineering skills among Mound's scientific staff, a Scientific Retraining Program began in May in cooperation with the University of Dayton. Several Mound professionals are pursuing a 24 credit hour program of undergraduate math and engineering courses. Instruction is held on-site after working hours by the university staff.

THE UNDER MOUND

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MONSANTO NEWS BRIEFS

European Polystyrene Capacity Expansion - Monsanto Polymers & Petrochemicals will build a new manufacturing facility with a capacity of 50,000

The \$1 million project is designed to provide 100 per cent efficiency on removal of particles above 3 microns in size and 99.3 per cent on particles below 3 microns.

Brin...

physical sciences and systems development, Dr. Binning had done pioneering work in Monsanto Company on separations processes and had developed the first commercially feasible process for direct conversion of propylene to propylene oxide, an important chemical intermediate.

In response to increased requirements for technical briefings and program proposals, a Technical Presentation and Proposal Design Seminar was added to the list of Mound courses which are available for staff development.

Near the end of the year, the Monsanto Management Style was detailed to all exempt employees in a series of seminars describing "management by results" principles.

A new weekly in-plant paper UnderMound was added to the other media which are established to promote communications to and among Mound employees--Mound-Vue, a quarterly magazine mailed to the home and "Newsline," a daily recorded telephone message. Coupled with UnderMound is *Response*, an employee feedback system which directs questions or comments to the Management staff and ensures that answers are transmitted to the originators either directly or in UnderMound's *Response* column.

Community interactions

Maintaining concern for national and community interests, Mound management encourages its employees to participate in community affairs and supports an active program to communicate information about the Laboratory and its missions to the public.

Ten radio/television appearances were made by Mound personnel in 1975 to mark special events, such as the Viking spacecraft launches, or to further describe Mound programs. One of these was a one-hour prime-time Dayton television program on energy research and development.

Mr. Jack Jones, Science and Aviation Editor of the Dayton Daily News, visited Mound in November to pursue a story on Mound's Automated Plutonium Assay System (APAS) and nuclear materials safeguards. His article, "Mound Works on Automatic Plutonium Hound" was featured in the Sunday edition of the Daily News on November 30.

E. E. Hardy (third from right), Director of Monsanto Research Corporation's Dayton Laboratory, and R. K. Flitcraft (second from right), Director of Mound Laboratory, received U.S. Treasury Department Minute-man flags symbolizing the high rate of participation of MRC employees in the Annual U. S. Savings Bond drive.

As a follow-up to press briefings held last year to describe Mound's investigations and corrective actions following discovery of trace amounts of plutonium-238 in some adjacent offsite waterways, results of the final report, Mound Plutonium Study, were disseminated to local news media and various government officials and agencies.

In less visible but very tangible actions, Mound employees reacted to community responsibilities and needs by pledging a record amount to the United Appeal and participating to a record degree in the annual U. S. Savings Bond drive. They also sponsored a Junior Achievement Company at Dayton's Dunbar High School and supported the Miamisburg Helping Hand organization at Christmas.

Support of minority business enterprises was continued, with substantial results. One hundred and seventy-eight purchase orders, worth over \$176,000, were awarded to minority businesses; surveys resulted in the establishment of two new minority vendors; management assistance was provided to two local minority firms; and a minority business directory was furnished to other ERDA contractors.

In a cooperative effort with the City of Miamisburg Mound assisted as an unpaid technical advisor in the submission of a proposal to ERDA's Division of Solar Energy for the development of a solar heating demonstration project.