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MOUND LABORATORY
operated by
MONSANTO RESEARCH CORPORATION
a subsidiary of Monsanto Company
for the
U. S. ATOMIC ENERGY COMMISSION

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Summary of Activities

EXPLOSIVE COMPONENT PRODUCTION

Schedule Commitments Met

At the end of the quarter, all scheduled commitments for interplant shipment within the Albuquerque Operations Production Complex had been met; 65% of the shipments were ahead of schedule.

Record Transducer Production Yield

Improvements in production fixturing aided assembly of the PXD-B transducer and resulted in an excellent product yield of 98.8%. This figure exceeded the expected acceptance yield of 82% of the transducers through the x-ray inspection stage.

Mound Expands Capability to Include Systems Tests

As a result of a continued effort toward greater depth of technological capability, Mound broadened its scope of testing with the successful completion of 3 systems tests. The systems tests evaluated Mound explosive components in conjunction with associated units manufactured by other plants in the Weapons Complex. Previously, Mound had only tested those components produced in-house. Representatives of the cognizant design agencies observed the progress of the tests.

The tests carry 3 points of special significance to Mound. First, they are a demonstration of Mound's ability to perform component system tests with presently available equipment

Second, Mound seized an opportunity to provide a testing service when another contractor was unable to perform satisfactorily.

Third, it was possible to institute a unique test because of the immediate availability of supporting technology at the Laboratory.

Audit Results Reflect Favorably on Mound

A QAP-N-10.0 quality audit was performed by the AEC on the manufacturing and quality procedures related to the detonator-cable assemblies for the Mark-62 and Mark-68 weapon programs. A "satisfactory" rating, the highest given, was awarded as a result of the audit. A Tool-Made Sample survey was made by Sandia Corporation on the 227706/227720 Joint Test Assembly transducer. The result, again, was a satisfactory rating.

An AEC QAP 5.3 quality audit of the MC-2369 transducer (SLA) process was conducted; a satisfactory rating was awarded.

Mound Represented on AEC Planning Committee

A High-Explosive Facilities Planning Committee was created by the Albuquerque Operations Office of the AEC to prepare a long-range (through 1980) facilities master plan for optimum support of AEC/ALO explosive production requirements. The committee met for the first time on Oct. 20; Mr. A. F. Vollmer represented MRC. As a part of this activity a detailed report was submitted to ALO describing Mound Laboratory's current capabilities and capacities which support the system's explosive technological and production needs. The next meeting is planned for Jan. 1971.

PRODUCTION SUPPORT

Vapor Plating Capability Reactivated

Mound is reactivating a capability to vapor plate MC-2389 ceramics with gold. With this capability, Mound can act as a backup supplier to ensure that production commitments are met on schedule. Problems experienced with an outside supplier in meeting schedule commitments dictated the preventive effort. These ceramics had been plated at Mound for 2 years during the development of the MC-2389 transducer.

Improved Cleaning Process Increases Potting Compound Adhesion

An additional cleaning step was added to the MC-1651 transducer fabrication process prior to encapsulation in potting compound. The adhesion of the potting compound with transducers cleaned a second time was 900 psi, as compared with the 450 psi without the additional cleaning. Quantitative techniques used to evaluate the degree of adhesion were also developed. The improvements in yield are being evaluated.

Semiautomatic Density Gaging System Enables 100% Inspection

A semiautomatic DXT gaging system designed at Mound was fabricated for use in the 1E30 and 1E31 detonator programs for LASL. This system will permit 100% nondestructive inspection of loaded detonators as opposed to the current destructive testing sampling plan. In addition to the added quality assurance achieved by the 100% inspection, the cost of the inspection has also been reduced.

Computerized Reporting Forms Used Successfully

Sandia and the AEC/DAO commended Mound for successful development and implementation of a series of 3 automated report forms required for AEC acceptance of the MC-2369 transducer. MC-2369 transducer Lot 012 was the first lot submitted to, and accepted by, the AEC with the computerized Serial Number and Lot Summary Form. Lots 010 and 011 were accepted during November with computerized Ceramic Charge Data and Record of Assembly Forms. Previously, all 3 forms were compiled manually. The automation eliminates manual transcribing errors, reduces clerical work, and aids quality control evaluation. One of the forms, the Serial Number and Lot Summary, has general application and will be used in other programs to similar advantage.

New Capability Established for Fabricating Detonator Heads

A complete set of fixturing was designed and fabricated to provide Mound with the capability for producing heads for the MC-2320 detonator (SLA). Although the heads were formerly purchased from a vendor, it has become necessary to produce the heads in-house in order to achieve the required level of quality. Included in the fixturing is a positioning device that will hold one electrode for pulse-arc welding to the housing. Other fixtures will be used for crimping the ground lead to the detonator housing and for shaping the electrode wires.

Audit Results Confirm Mound Standards

The ALO Primary Laboratory submitted a set of mass standards to Mound for an audit of the Mass Laboratory. The results of the audit showed that the agreement between the results from the 2 laboratories was within 1 part in 50 million, an indication that our system of mass standards is in excellent control.

NUCLEAR COMPONENT DEVELOPMENT

Surveillance Facility Equipment Installation Completed

Installation of test equipment in the recently constructed surveillance facility was completed on schedule during November. Testing is under way in the new facility. Systems testing is now part of Mound's surveillance program, as contrasted to previous testing which was limited to individual components.

RADIOISOTOPIC POWER SOURCE PROGRAMS

Transit Program

The first fueled capsule of the current series for the Transit program is being fabricated. The Transit capsule is fueled with a minimum of 827 thermal watts of plutonium-238 in the form of plutonia-molybdenum cermet disks. Requirements for FY 1971 call for the completion of 3 flight capsules. These sources will be used to generate electrical power for navigational satellites.

Pioneer Program

The 4 prototype capsules required for the Pioneer program were completed and shipped on schedule to Isotope Nuclear Systems Division, the prime contractor. Each of the capsules contains approximately 645 thermal watts of plutonium-238 in the form of plutonia-molybdenum cermet disks, the same type of fuel used in Transit.

Program requirements for Pioneer call for 4 flight capsules and 1 backup capsule to be completed during the first half of CY 1971.

Pioneer Radioisotopic Heater Unit

Five PRHU heat sources fueled with solid solution cermet were completed for ground test application. Although solid solution fuel was used in these test capsules, the flight capsules will be fueled with 1.000 ± 0.025 thermal watt of plutonia-molybdenum cermet fuel.

Eleven flight capsules plus backup capsules will be fabricated by June 1971.

Have Sinew Program

A Pioneer heat source capsule was loaded with simulated fuel for the "Have Sinew" program. Have Sinew is a reentry flight test program associated with Transit and Pioneer. The test capsule was completed on schedule in November and will be shipped to Sandia Corporation in January 1971.

SNAP-27 Program

Two SNAP-27 capsules were shipped on schedule to Cape Kennedy for the Apollo XIV launch scheduled for Jan. 31.

One SNAP-27 capsule, a test capsule, was opened for recovery and reuse of the fuel. The plutonium-238 dioxide microspheres are being processed for reloading into another set of capsule hardware. The processing includes removal of fines and vacuum baking to remove as much entrapped helium as possible.

Mound Honored for Contribution to Apollo XII

Mr. D. L. Prosser and Dr. D. P. Kelly were honored for their contributions to the SNAP-27 program and the Apollo XII mission in a ceremony held at AEC Headquarters, Washington, on Nov. 18. The men, who were 2 of the key figures in the Mound team effort in fabricating the heat sources, received citations signed by the members of the Atomic Energy Commission and by Astronaut Bean.

Cardiac Pacemaker Program

Twelve Cardiac Pacemaker heat sources have been fueled. The liners have been closed, radiographed, and found acceptable. These capsules represent the first group of a total scheduled requirement of 30-36 fueled capsules during FY 1971.

Milliwatt Generator Proposal

Mound Laboratory will develop and supply the plutonium-238 heat sources for use in a series of milliwatt generators to be developed by Sandia Corporation. Work on the heat source development will probably begin early in CY 1971.

Universal Source Containers Approved by DOT

Three Universal Source Containers, designed at Mound for transporting various designs of heat sources, were completed on schedule for use in shipping Transit and Pioneer heat sources. Two additional containers are being fabricated. The design was approved by the U. S. Department of Transportation for radioactive shipments as DOT SP #6321. This container concept

will save over $100,000 in the cost of designing and manufacturing individual shipping containers for various heat source programs.

Hydroforming Capability for Heat Source Capsules

A capability is being developed at Mound Laboratory for hydroforming metal capsule parts for use in heat source and possibly other programs. In preliminary work with the hydroforming press, tantalum, platinum-rhodium alloy, and tantalum-10 wt % tungsten alloy have been formed. The techniques are being developed further.

ISOTOPE PROGRAMS

Carbon-13 Sales Up Sharply

Increased production rates, the availability of carbon-13 from another AEC contractor, and a decrease in manpower required to operate the enrichment system made possible a sharp reduction of the former price of $685/gram to the present level of $80/gram as barium carbonate and $60/gram as carbon dioxide. Chemical exchange is used in conjunction with low-temperature distillation for the enrichment. As a consequence of the price reduction, record quantities of the isotope are being manufactured and shipped. The enrichment system is presently producing carbon enriched to 90% in carbon-13 at a rate of approximately 4 grams per day.

Stable Isotope Sales

The table on the following pages shows the sales of stable isotopes by Mound Laboratory during CY-1970.

AEC Audit Shows Mound Control of Nuclear Materials Satisfactory

The ALO Source and Special Materials Survey was performed at Mound. The auditors reviewed the controls maintained over supplies of fissionable isotopes, and awarded a satisfactory rating with no recommendations, the highest rating given.

Polonium Source to Be Used in Analysis of Moon Rocks

A small source of polonium-208/209 (approximately 0.01 microcurie total alpha count) was prepared and shipped to Argonne National Laboratory for use as a tracer for polonium-210 in the analysis of lunar rocks.

1970 STABLE ISOTOPE SALES

Isotope ≥99.5% (Unless noted otherwise)	No. of Shipments	Quantity (STP liters)	Value (Dollars)
Helium-3	400	4200.0	$577,000
Neon-20	30	60.0	6,000
Neon-22	10	26.0	6,400
Argon-36	26	5.0	15,000
Argon-38 (25-95%)	10	0.5	4,000
Argon-40	2	2.0	200
Krypton-78 (8-15%)	9	0.4	3,000
Krypton-86	7	0.1	1,200
Xenon-124 (1-20%)	13	2.2	43,000
Xenon-124, Raffinate	1	50.0	600
Xenon-136 (90-99%)	5	0.1	1,000
Carbon-13 (90-99%)[a]	42	306.6 grams	35,000
Mixtures	11	60	13,000
Totals	566		$705,400

[a] Forms of carbon-13:

CO_2	4	85.0	$ 7,200
CH_4	9	16.1	4,700
C	7	4.9	2,000
CO	8	32.6	7,800
$BaCO_3$	13	168.1	13,300
	41	306.7	$ 35,000

Plutonium-238 Wastes Being Shipped to South Carolina

Backlogged plutonium-238 wastes are being shipped to the AEC's Savannah River Plant at Aiken, S. Car. The packaged wastes are shipped in ATMX railcars modified by Mound for radioactive shipments. To date, 5 shipments of low-level waste, containing approximately 4500 grams of plutonium-238, have been made. Additional shipments as necessary will be made during 1971, including backlogged high-level wastes containing 4.1 kilograms of plutonium-238.

ENGINEERING SUPPORT

Facilities Upgrading Program

Engineering activity continues to be concentrated on the Facilities Upgrading Program, a 3-year effort directed toward enhancing the safety of all existing facilities and operations. Six projects are currently in the design stage: a waste solidification facility, an emergency power system, 2 modifications of exhaust systems, a fire detection system for gloveboxes, and an automatic sprinkler system for buildings housing radioactive operations. A platform to facilitate loading of radioactive shipments onto ATMX railcars was recently completed.

Shipping Cask Test Facility to Broaden Mound Capabilities

A project that began in October will provide Mound with a facility to test shipping containers designed for hazardous material. The facility will contain equipment for destructive physical tests, including fire, puncture, and drop tests.

Optimum Level Maintained for Utilization of Skilled Workers

Skilled trades manpower is routinely being maintained at the planned allocation of 30% for maintenance and 60-70% for Engineering Work Orders (EWO). This allocation permits adequate maintenance of the plant with the maximum remaining effort on work controlled by program related priorities. Time lost to nonwork activities, such as vacations, illness and grievance meetings, is drawn from the 70% allocated to EWO's. The goal of a minimum of 60% of total time devoted to EWO work was achieved as a result of improved communications, use of the resource allocation program to level workloads, and improved consistency in responses to grievances. These efforts have improved productivity 10% and have reduced nonwork time to 10% or less of the total available effort.

ENVIRONMENTAL CONTROL

Mound Environmental Control Program Recognized

In opening remarks to the ALO Industrial Relations Conference held at Monsanto World Headquarters, the Assistant General Manager for Operations, AEC, Washington, commented favorably on Mound Laboratory's environmental control program. He stated in the meeting that Mound's current control of effluents showed the results that could be achieved when positive steps were taken to improve an environmental control program.

Mound Environmental Program Reviewed by Vice President Eck

Mr. John R. Eck, Vice President, Operations, and member of the Board of Directors, visited Mound Laboratory on Nov. 3 to tour the facilities and to review the Environmental Control Program.

Water Sampling Stations Erected

Two continuous water sampling stations for more representative effluent water analysis were constructed. One station is presently in operation; the second will go into operation in Jan. 1971.

Air Sampling Station Installed

A continuous, high volume air sampling station was installed at Mound Laboratory in November to monitor environmental air quality and to serve as the prototype for a number of continuous monitoring stations to be set up in the countryside surrounding the Laboratory.

Environmental Control Interface with Monsanto

An active program has been initiated to share information on environmental control programs, procedures, and equipment with Dayton Laboratory and with Monsanto Co. This cooperative effort has been undertaken to help achieve the objective of establishing Mound Laboratory as a center of excellence in environmental technology.

DATA PROCESSING

Data Handling Automated

Several computer programs have improved efficiency by replacing a manual method of collecting and processing surveillance data.

Calculations and data analysis have been mechanized, and the design agencies are furnished with exception notations only. The automated system achieved a manpower savings and eliminated transcribing errors.

SYSTEMS DEVELOPMENT

Consolidated Property Management System Implemented

On Dec. 1 a consolidated Property Management System was implemented on schedule at Mound Laboratory. The Dec. 1 date was committed to the AEC in response to an audit of our property management program. The system provides for good management control over all capital equipment during its life at Mound Laboratory. The far-reaching scope of this system, which involves all departments at the Laboratory, and the timeliness with which it has been implemented will enhance our credibility with the AEC with regard to our capability to make timely corrective actions and meet our commitments.

Mound Computerized Financial System Recognized as Model

The AEC has pointed out one of Mound's computerized financial systems as an excellent model to guide another integrated contractor in their efforts to meet AEC Headquarters reporting requirements. The Mound system automatically maintains the general ledger and generates reports to meet standard AEC requirements. Thus far, Mound is 1 of only 2 AEC contractors who have been able to develop and make such a system operational.

Mound Responsibility Increased for Material List

Testing of the IMOG Material List is near completion. The computerized system is scheduled for operation in Jan. 1971. The Material List is a computerized index of specifications for Sandia weapon components. An efficient system of input permits daily updating of changes to products. Duplicate systems at Mound and the design agency aid rapid communication of product modifications from engineering to the production line. Mound will begin initiating changes to the List in January.

INFORMATION MANAGEMENT

Two Mound Technical Papers Accepted for Presentation in Vienna

The International Atomic Energy Agency has accepted 2 Mound Laboratory technical papers for presentation at their meeting in Vienna in Feb. 1971. The papers are "Design and Performance Evaluation of a Large Fissile Source Container" by E. P. McDonald, and "The Effect of Hypothetical Transport Accident

Conditions on the Quantity of Fissile Material Allowed Per Package" by R. A. Wolfe. Mr. Wolfe will represent Mound Laboratory at the meeting.

AEC Appraises Classification Program

Mound Laboratory classification activities were appraised by a representative of the ALO Classification and Technical Information Division. A satisfactory rating was given as the result of the appraisal.

Patent Activity Accelerated

As part of the management effort to improve Mound's overall patent program, Mr. L. B. Stevens and Mr. F. D. Shearin of the MRC Patent Department were invited to Mound to present seminars to all technical personnel on the proper handling of technical information relative to patent matters. Mound Laboratory will be making greater use of the MRC patent department in intensifying the effort to gain patent protection for the AEC and Monsanto for potentially valuable technical discoveries. Mr. Shearin will spend the equivalent of 2 days per week at Mound to support the patent work, with additional assistance from Mr. Stevens.

EMPLOYE RELATIONS

Employes Meet Goal in Group Blood Donor Program

The Executive Safety Committee approved a Group Blood Assurance Program for Mound employes with the Community Blood Center of Dayton. The program was initiated in May 1970 with employes donating 102 pints of blood. A second group donation during November of 90 pints, met and exceeded the annual quota of 180 pints required for total plant eligibility.

Contract Settlement with UPGWA

A new 3-year contract between MRC and the International Union, United Plant Guard Workers of America, Local Number 146, was ratified on Nov. 15, 1970. The agreement included wage increases amounting to 81¢ over the 3-year term, and other fringe benefits similar to an earlier settlement with the OCAW union. The Company achieved a commitment from the Union to support the equal opportunity programs.

Grievance Activity Declines Sharply During 1970

Action taken by management resulted in significant reductions in the number of grievances. Plantwide grievance activity in 1970 declined 43% from grievance activity in 1969.

Union Withdraws Petition

Mound was notified during December by the NLRB that the IUE was withdrawing a petition filed during October in which they claimed to represent "all technical employes" at the Laboratory.

EDUCATION

Management Education

During the quarter, 89 supervisors attended at least one of several management development courses made available as part of the continuing education program. The total enrollment for these courses during 1970 was 373. Personnel training and development will continue to be emphasized during CY 1971.

COMMUNITY RELATIONS

Equal Opportunity

Several employes are participating in the Black and White Realities program at Miamisburg High School. The program is a series of discussions of the problems of prejudice and racial discrimination in society.

Minority Business Program Introduced

A Minority Business Program was introduced that is designed to involve Mound Laboratory with minority businesses capable of providing goods and services to meet Laboratory requirements. A formal procedure was established to ascertain the potential capability of minority firms and to establish and maintain communication and cooperation with them.

PERSONNEL INFORMATION

The level of personnel at Mound Laboratory for Oct., Nov., and Dec. 1970 is shown in the table on the following page.

SAFETY AND SECURITY

Outstanding Safety Record Continues

During the fourth quarter, Mound Laboratory employes worked approximately 990,000 safe manhours. This brings the total for the year to approximately 4,010,000 safe manhours and 17, 492,440 safe manhours since the last disabling injury of Aug. 24, 1966. Mound ranks first among all Monsanto plants in total safe manhours. Mound Laboratory also received its fifth Board of Directors' Safety Award during the quarter. The Serious Injury frequency for the year was 2.8, as compared with 5.2 for 1969.

1970 PERSONNEL SUMMARY

DEPARTMENT	End of October			End of November			End of December		
	Since Last Month		Total Employment	Since Last Month		Total Employment	Since Last Month		Total Employment
	Gains	Losses		Gains	Losses		Gains	Losses	
Administration	3	2	340	2	3	339	2	2	339
Engineering	3	3	504	4	3	505	3	1	507
Explosives Operations	2	18	527	1	5	523	1	2	522
Finance	2	2	48	0	0	48	2	0	50
Mgt. Info. & Sys.	0	1	112	1	2	111	0	1	110
Nuclear Operations	1	3	324	1	1	324	0	1	323
Office of Laboratory Director	0	0	2	0	0	2	0	0	2
Total	11	29	1857[a]	9	14	1852[b]	8	7	1853[c]

[a]Includes 5 co-op students and 2 part-time employes; does not include 2 temporary employes.
[b]Includes 5 co-op students and 2 part-time employes; does not include 2 temporary employes.
[c]Includes 5 co-op students and 2 part-time employes.

Safety Recognition Program

A new safety and housekeeping program called the Safety Recognition Program was put into effect during the quarter. It involves inspection of all plant areas by the Director of the Laboratory, a Department Director, an area representative and a member of the Safety staff. Outstanding areas are identified and recognized on a competitive basis.

Medical Program Upgraded

A vital capacity measurement to detect pulmonary emphysema has been added to the employe health program. The cardiac work-up for executives has also been upgraded in order to more accurately evaluate "coronary risks."

COST REDUCTION

Mound Cost Reductions Published by AEC

Eight Mound cost reduction actions were selected by the AEC for publication in the fall 1970 issue of the Cost Reduction Abstract. Since only 39 items were listed in this issue for all AEC offices and contractors--17 items from ALO--Mound Laboratory received unusually good recognition. Mound was also commended for its cost reduction activities by the Director of the Budget Division, ALO.

TECHNICAL HIGHLIGHTS
FOR 1970

POLYMERS

Three-Component Adhesive System for Use with Explosives

A 3-component adhesive system was developed for use with explosive components. The system is Epon 828 epoxy resin cured with 2 partial phosphate esters. The ratios of the 2 curing agents, as well as the total concentration, can be adjusted to control the tensile strength and the flexibility of the cured adhesive. The adhesive system is chemically non-reactive with explosive powder, cures at room temperature, is easy to apply, and has good strength.

ENERGY CONVERSION

Pioneer and Transit Programs

Four prototype capsules were completed and shipped to the system contractor for the Pioneer spacecraft, which will be used in the Jupiter Flyby Mission. The first Transit source is being fabricated; Transit is a navigational satellite. Mound Laboratory successfully developed the plutonium-238 dioxide-molybdenum cermet fuel compacts, when problems of cracking and low power density arose with the intended solid solution (plutonium dioxide-thorium dioxide)-molybdenum cermet fuel. Tungsten-inert-gas welding parameters were developed for the tantalum-10 wt % tungsten alloy liners, the T-111 alloy strength members, and the platinum-20 wt % rhodium alloy cladding. A technique was also developed for plasma-spraying an emissive coating of platinized alumina onto the cladding and Inconel container. The Transit heat source contains at least 827 thermal watts of plutonium-238 in cermet form; the Pioneer contains 645 thermal watts of the same fuel.

Pioneer Radioisotopic Heater Unit Sources Developed

Small heat sources fueled with 1 thermal watt of plutonium-238 dioxide were developed as heaters for the Pioneer spacecraft propulsion system to prevent the hydrazine propellant from freezing. The heat source fuel is encapsulated in a tantalum-10 wt % tungsten alloy liner, a T-111 alloy strength member, and platinum-20 wt % rhodium alloy cladding. The development program is complete, and fabrication of flight sources for this program will begin in CY 1971.

SNAP-27 Heat Sources for Apollo XIII and Apollo XIV

Two SNAP-27 heat source capsules were shipped to Cape Kennedy for the April 11 flight of Apollo XIII. One capsule was a backup unit and the other accompanied the Apollo XIII astronauts. After the flight aborted, the SNAP-27 heat source capsule splashed down in the ocean near the Fiji Islands at a depth between 12,000 and 20,000 feet. Air and water samples taken in the area revealed no release of activity, indicating that the capsule remained intact.

A second flight capsule and the backup capsule were shipped to Cape Kennedy for the Jan. 31, 1971, launching of Apollo XIV.

One of the previously fabricated capsules, used for tests, has been opened, and the fuel is being processed for loading into a new capsule for flight use.

Water Recovery Unit Program

An extended test of the Water Recovery Unit was performed in the Space Station Simulator at McDonnell-Douglas. The 3-month test was completed in September. Both the system and the heat sources were highly successful in operation. The system, which was designed by the Air Force Aerospace Medical Research Laboratory, used 5 heat sources to recover potable water from waste liquids. The sources were designed and fabricated at Mound. Four of the sources were fueled with 73 thermal watts of plutonium-238 dioxide and one with 48 watts.

Chemical Radioisotope Battery Developed

A new type of radioisotope battery was developed which depends on chemical changes. The battery requires virtually no isotopes at one electrode and only a few milligrams at the other. The radioisotope is in a refractory form; the battery is compact; and the energy accumulates when the battery is not in operation.

NUCLEAR MATERIALS AND TECHNOLOGY

High-Temperature Compatibility of Copper with Tantalum-Based Alloys

A study was made to determine if copper left by chill block fixtures has any deleterious effects on heat source capsule components at operating temperatures, which range near 1100°C. It was found that copper wets the grain boundaries and forms eutectics with tantalum-10 wt % tungsten alloy and T-111 (tantalum-8 wt % tungsten-2 wt % hafnium) at 1100°C under vacuum and in an inert atmosphere. After several hours the copper evaporates and leaves a crack in the alloys. Further study showed that a chromium plating on the copper fixtures prevents contamination and has no detrimental effects itself on the alloys.

PHYSICAL AND INORGANIC CHEMISTRY

Helium Release from Plutonium-238 Alpha Decay

A theoretical mechanism was proposed for the release of helium from plutonium-238 dioxide microspheres. With this mechanism it was possible to predict within 2% the amount of helium that would be released from a sample of the microspheres. This information is needed in the design of heat sources with plutonium-238 fuel.

Improved Method for Dissolution of Plutonium-238 Dioxide

An improved method was developed for dissolving refractory plutonium-238 dioxide as the first step in the recovery of the plutonium-238. The oxide is first reduced in a vacuum furnace; then it can be dissolved in nitric acid without the use of auxiliary chemicals as presently required. The technique is faster than previously existing methods.

High-Temperature Study of Plutonium-238 Dioxide Microspheres

An x-ray study was performed on plasma-spheroidized plutonium-238 dioxide to obtain accurate coefficients of thermal expansion for this heat source fuel at high temperatures. The lattice parameters, obtained at 22 different temperatures from 14° to 1505°C, exhibit linearity up to 675°C, then expand in a normal fashion up to 1137°C. At 1137°C the expansion curve exhibits anomalous behavior, which is attributed to helium release and removal of configurational defects through annealing. Fourth degree polynomial expressions were obtained as functions of temperature of the lattice parameter and coefficient of thermal expansion.

Plutonium-238 Dioxide Compatibility Testing

A broad program of evaluating the compatibility of plutonium-238 dioxide with potential heat source capsule materials continued during CY 1970. The potential capsule materials are being evaluated at anticipated operating temperatures for heat sources. Testing has been under way for almost 2 years at 800°C on the following metals and alloys: titanium, TZM alloy, molybdenum-50 wt % rhenium, and tantalum-10 wt % tungsten. Testing at 1900°C has continued for 500 hours on the following metals and alloys: tantalum, tantalum-10 wt % tungsten, T-111 alloy, niobium, molybdenum, TZM alloy, molybdenum-50 wt % rhenium, tungsten, tungsten-25 wt % rhenium, hafnium, and rhenium. In general, the best compatibility--i.e., least chemical reactivity--is obtained with the molybdenum and molybdenum-based alloys.

Radioisotope Production

During 1970 Mound Laboratory isolated small quantities of the following isotopes for distribution for research work: polonium-210, thorium-229, lead-206 (stable), actinium-227, and uranium-234.

Calorimeters for Safeguarding Reactor Fuels

Calorimeters are being applied to the assay of plutonium-239 reactor fuels under the sponsorship of the AEC Office of Safeguards and Materials Management. A calorimeter system was loaned to General Electric for an in-plant test of calorimetry for fissionable material control. Similar applications have been discussed with Westinghouse and Atlantic Richfield. Comparative analyses of plutonium-239 reactor fuel have achieved agreement within 0.2-1.0%.

Residue Adsorption

The technique of residue adsorption is being investigated for radiochemical analysis and potential process development applications. Lead-210 was separated from its decay products, bismuth-210 and polonium-210, by desorption from platinum with ammonium acetate.

New Uranium Compound

A new tetramethylurea adduct of uranium tetrachloride ($UCl_4.2TMU$) was prepared and characterized. Similar compounds of thorium and plutonium were prepared but not characterized.

Liquid Actinide Metals Research

The thermal conductivity of high purity plutonium was determined from 250° to 800°C and is the only published data reported above 150°C. The liquid phase is a better conductor than any solid phase, which is unusual for a liquid metal. The Lorenz number (ratio of thermal to electrical conductivity divided by the temperature) of epsilon phase plutonium is the lowest reported for a metal, suggesting a difference in electronic behavior between these two modes of energy transport.

The constant heating rate method was used to measure the thermal diffusivity of plutonium-239 from 250° to 800°C. The diffusivity was constant through the gamma and delta phases (250-260°C) at 0.055 square centimeters/second. It decreased markedly in the epsilon phase between 500°C and the melting point 640°C, to an average value of 0.034 square centimeters/second, then increased in the liquid phase to 0.056 square centimeters/second. Plutonium-239 is unusual among metals in that the liquid is a better conductor than the solid.

Stable Isotopes Enrichment

A 13.8-liter batch of 99.994% argon-36 was produced from enriched feed material in a 5-stage, hot-wire thermal diffusion system. This is the highest enrichment of argon-36 ever achieved at Mound Laboratory. The natural abundance of argon-36 is only 0.34%.

A batch of xenon was enriched in xenon-131 to greater than 60%, the highest concentration ever attained at Mound.

Molecular Beam Chamber

The first single beam was produced in a molecular beam chamber designed for research in low energy physics. Preliminary calculations indicated that a beam intensity of about 3×10^{13} molecules/second/steradian was achieved using argon at a nozzle source pressure of 10 torr. This intensity closely matched theoretical predictions. This preliminary test was made while the chamber was at a pressure of 10^{-5} torr and still being evacuated. Since then, the molecular beam chamber has attained the design vacuum region of 10^{-9} torr. Initial single beam experiments have shown that the vacuum system can sustain a useable beam intensity without a significant rise in background pressure in the scattering section; therefore, maximum detector sensitivity can be attained.

Diffusion Coefficients for the Helium-Hydrogen System

Direct measurements of the diffusion coefficients for the helium-hydrogen system were made over the temperature range 70-800°K. These measurements agreed closely, within 1.6%, with a smooth curve drawn through literature data for the range 90-523°K, the current limits of published data.

Enrichment of Carbon-13

A combination of techniques is used to enrich carbon-13 to greater than 90% for sale. A carbon monoxide distillation column enriches the carbon-13 to 15-20%. This material is used as feed for a carbon dioxide-carbamate chemical exchange system, which enriches the isotope to greater than 90%. Improvements in the carbon monoxide distillation system have made possible a total production rate of 4 grams of 90% carbon-13 per day. Increased production rate, the availability of carbon-13 from another AEC contractor, and a decrease in the manpower required to operate the system, made possible a sharp price reduction to $60 per gram from the former price of $685 per gram.

Conversion of Carbon Dioxide to Barium Carbonate

A new enlarged system for the conversion of carbon dioxide to barium carbonate (enriched in carbon-13) has increased the batch size to 20 grams of contained carbon. The old system handled batches of approximately 1.5 grams of contained carbon. The system operated by the absorption of carbon dioxide into ammonium hydroxide to produce ammonium carbonate, which is reacted with barium chloride to form insoluble barium carbonate.

ANALYTICAL

Neutron Accelerator

The technical capability of the Laboratory was extended with the final assembly and successful testing of a Crockroft-Walton accelerator. A beam estimated at 2×10^{10} neutrons/second was obtained. The accelerator will be applied to investigation of the fission characteristics of plutonium-238, and will be used to further evaluate neutron radiography for nondestructive testing.

Dry Tritium Standards for Low-Level Radiocounting

Standard tritiated water was reduced to prepare dry gas standards to check the efficiency of systems for radiocounting low levels (as low as 10^{-12} mole %) of tritiated gas. The tritiated water was reduced completely by excess amalgamated magnesium and mercury at 400°C in an enclosed Pyrex tube. Amalgamation is achieved in an inert drybox by adding mercury to magnesium ribbon with a clean, unoxidized surface. In a test of the reduction method, reproducible volumes of gas were obtained from deionized, non-tritiated water samples. Subsequently, the method was used successfully to prepare a tritium gas sample from standard tritiated water.

Eddy Current Technique for Evaluating Uniformity of Cermet Fuel

In support of the production of cermet fuel, an eddy current technique was evaluated for determining the uniformity of the matrix. The fuel is plutonium dioxide or solid solution thorium dioxide/plutonium dioxide in a molybdenum matrix. The good correlation between molybdenum content and electrical conductivity in a test composite of thorium dioxide in molybdenum indicates that the eddy current technique can be used with confidence to evaluate molybdenum content over a wide range of compositions.

Eddy Current Techniques for Thickness of Emissive Coatings

An eddy current technique was developed to measure the thickness of platinized alumina emissive coatings on platinum-20 wt % rhodium cladding and on Inconel cans for Transit and Pioneer heat sources. The precision of the measurements has been established by destructive metallography to be within 0.0002 inch.

Pulse Height Analyzer Interfaced with Particle Size Analyzer

An interface unit was designed and constructed to adapt a Coulter counter particle size detector for operation with a multichannel pulse height analyzer. With the combination system particle size information gathered as raw data by the Coulter counter can be processed immediately then printed out or stored by the pulse height analyzer.

Fourier Synthesis Computer Program

A Fourier Synthesis computer program was recently made operational. The program will synthesize unstructured crystallographic data to permit an analyst to abstract a meaningful pattern from an apparently random mass of information. The program requires 25 minutes of computer run time; a similar manual operation would require several years.

PROCESS ENGINEERING

Chemical Destruction of Explosive Components

A chemical method was developed for destroying explosive components, including plastic and metal parts and explosive powder. This method was developed in order to avoid contributing pollutants to the atmosphere by open burning of parts rejected from production processes. The metallic parts and explosive are dissolved in nitric acid; then the plastic is ground up for disposal by burial.

Boron Recovery

An economical process was developed for recovery of boron powder from elastomer without significantly altering the chemical purity of the boron. The elastomer is dissolved from the boron powder by heating the material in a caustic solution in a Hastelloy reactor. Then the powder is washed. The process recovers greater than 95% of the boron. Approximately 110 kilograms of boron powder have been recovered to date at a fraction of the cost that would be required to produce new material.

X-ray Density Inspection

A semiautomatic system was built utilizing commerical x-ray equipment for 100% inspection of production components. The parts are metal cups loaded with pressed explosive powder. Batches of 50 of the loaded cups are x-rayed in a carrier. With this system, 100% of the production parts can be inspected for density verification, compared with only a sample by the former destructive gaging technique.

Plutonium-238 Dixoide-Molybdenum Cermet Fuel Production

A process was developed for the production of cermet fuel disks for the Transit and Pioneer programs. The disks are formed by hot-pressing particles of plutonium-238 dioxide that have been coated with molybdenum.

Plutonium-238 nitrate was precipitated with ammonium hydroxide, then calcined to produce a high purity plutonium dioxide. The product was exchanged with oxygen-16 gas to reduce the total neutron emission due to alpha-neutron reactions with the oxygen-17 and -18.

The exchanged oxide was coated with molybdenum by a 2-step process. The particles were coated first by hydrogen reduction of molybdenum pentachloride; then a heavier coating was deposited by the hydrogen reduction of molybdenum hexafluoride. The preliminary chloride step minimized neutrons produced as a result of alpha-neutron reactions with residual fluorine.

The particles were pressed into 2.2-inch disks at 1625°C and 13,500 pounds per square inch. The disks did not crack and had satisfactory thermal power densities averaging 3.4 thermal watts per cubic centimeter. A stack technique was also developed for pressing 2 disks at a time to double the throughput of the pressing operation.

Modification of Railroad Cars for Radioactive Shipment

Two types of ATMX-500 series railroad cars were modified by Mound for use in shipping radioactive materials. One type of car is used to transport radioactive wastes for burial or storage. The other type of car can be used both to store and transport the complete series of heat sources to be fabricated for the Isotope Brayton program, a total of up to 25 kilowatts (thermal output) of plutonium-238. The engineering modifications to the existing railroad cars provided substantial savings in cost over the conventional methods of handling radioactive components and wastes. At the AEC's recommendation, this concept, which originated at Mound, has been adapted for use at other sites where radioactive material is handled.

Universal Shipping Container for Heat Sources

A universal shipping container for heat sources was developed according to a concept proposed by Mound and accepted by the AEC Division of Space Nuclear Systems. The container includes an outer case as the universal portion; only the insert is tailored to the shape and size of the specific source. The container, which has a maximum containment capacity of 1275 thermal watts, meets all AEC and Department of Transportation shipping regulations. This concept in shipping containers saved over $100,000 in the cost of designing and manufacturing shipping containers for the individual heat source programs. Three of the containers are complete; two more are being fabricated.

Vibratory Platform for Powder Loading

A vibratory platform was designed to improve the transfer of powder from a loading tool to a cylindrical receptacle. The vibrations are directed so that they are parallel to the axis of the bore of the loading tool to use action-reaction momentum to free the powder from the tool.

Ultrasonic Assembly of Plastic Parts

Ultrasonic methods are being tested for joining thermoplastic parts. Welding, crimping, insertion, and reactivation of adhesives all produced satisfactory joints. Thermoplastic materials with low elastic moduli, such as acrylics and polycarbonates, bonded best. Ultrasonic crimping was used successfully to join parts of an experimental detonator.

Mechanized Assembly of Detonators

Mechanization is being used to increase quality, reliability, and efficiency in detonator production processes. A system was designed and fabricated for electrochemically etching serial numbers on 0.005-inch thick aluminum cups. An air-powdered tool was designed and fabricated for simultaneous crimping of 2 eyelets on a detonator firing board. A mechanically operated wire-cutoff fixture was designed and is being fabricated to trim detonator electrodes more quickly and precisely than the former manual technique.

Fluidic Powder Pressing Barricade

A fluidic (fluid-logic) controlled system for pressing explosive powders was assembled and tested. The system lowers a protective door, presses the powder, then raises the door. The fluidic system offers several advantages over conventional powder pressing systems, which are electrically controlled. This system has a lower initial cost, complete portability and a faster cycle time. Because the system requires only one air line for power, the explosion hazards of an electrical system are eliminated.

Color-Coded PETN for Detonators

A process was developed for color-coding as a means of identifying types of PETN. Test-firing results showed that the coloring had no effect on the firing performance of the PETN in detonators; nor did it have any effect on the compatibility of the PETN with the components of the detonators.

Redesign of PXD-B Pressure Transducer

An improved, cost-cutting design for the PXD-B transducer (SLA) was proposed to, and accepted by, Sandia. This device is used to qualify the MC-1984 (SLA) and the MC-2361 (SLA) timers. Formerly, the sensing element of the transducer was mounted on an individual head that was potted inside an aluminum container. In the new design, the sensing element is simply potted in one step, thereby eliminating the need for the head and the aluminum container. The design reduces fabrication labor by 60% and material costs by 25% without changing the basic function of the transducer. Fabrication of transducers according to the new design will begin in Jan. 1971.

Timer/Detonator Interface Study

A development study was made to establish a process for installing detonators in explosive timers using a glue bond, thus eliminating production difficulties associated with the present press-fit process. The maximum clearance tolerable between the two parts was determined, and parts assembled by the 2 methods were compared. The results indicated that the press fit could be eliminated and that the tolerances could be relaxed. This change was approved by the design agency on the basis of the study and was incorporated into 2 production processes. In addition to greater ease of manufacture, this modified assembly process eliminates the need for a new pressing machine.

Hydroforming Technology

As part of a heat source capsule forming technology effort, a hydroforming machine was installed, and operating techniques are being developed. Hydroforming offers the possibility of improved precision at a lower cost than is possible with die pressing. In preliminary studies, tantalum, platinum-rhodium alloy, and tantalum-10 wt % tungsten alloy were formed. The techniques are being developed further.

Remote Measuring System

A system was developed which uses a jig transit for remote dimensional measurements of fueled heat source capsules from distances as great as 30 feet. The system was refined to an accuracy of 0.0003 inch under laboratory conditions, 0.0005 inch in production use.

Automated Product Index System

An automated system was developed to maintain complete records on products at every stage of the production cycle. The records define each product by materials, process operations, and inspections. Changes in the production cycle are entered into the system daily, and printouts of changes are provided to production management. Thirty-three products are now being controlled with the product index system.

SPOOLING Computer Program

A SPOOLING program has been written and is operational. SPOOLING is an acronym for "Simultaneous Peripheral Operation On-Line." The program allows for the simultaneous operation by the computer of low-speed input/output devices independently of batch or high-speed execution. As a result, comparatively low-speed card readers, printers, and plotters are operated essentially off-line, while batches of data are process at high speed with input from, and output to, magnetic tape. SPOOLING is expected to increase the volume capacity of the computer 25-30%.

INSTRUMENTATION

Electrical Resistance Standards

As part of Mound's continuing program to ensure the integrity of length, time, mass and electrical standards, an electrical resistance decade box with a range from 1 to 150,000 ohms was sent to the Primary Standards Laboratory at Sandia for a comparative evaluation. The average of 30 values resulted in a 0.0037% difference from primary laboratory values; the maximum deviation for a single measurement was 0.02%.

Large-Volume Calorimeter

A large-volume calorimeter was fabricated for measuring samples with low thermal outputs. The sample chamber, which is 12 inches in diameter by 16 inches high, has an internal fan to circulate the air and equalize the temperature inside the chamber. The instrument accuracy is 3.2% at 0.4 watt and 8.3% at 0.1 watt, with a 95% confidence level.

Determination of Plutonium-238 in Soil Samples

As part of an environmental monitoring program, a technique is being refined to analyze for plutonium-238 in a sample of soil down to a level of one picocurie (10^{-12} curie, i.e., one trillionth of a curie). The technique involves an acid leach or a fusion of the soil sample, followed by a solvent extraction, and in the case of the acid leach procedure, an ion exchange separation of the plutonium from other actinides. Finally, the plutonium-238 is electroplated out of solution and measured by alpha pulse-height spectroscopy. In the case of the fusion procedure, the plutonium recovery is about 80%. Improvements in the leach procedure are still in progress to improve erratic recoveries.

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