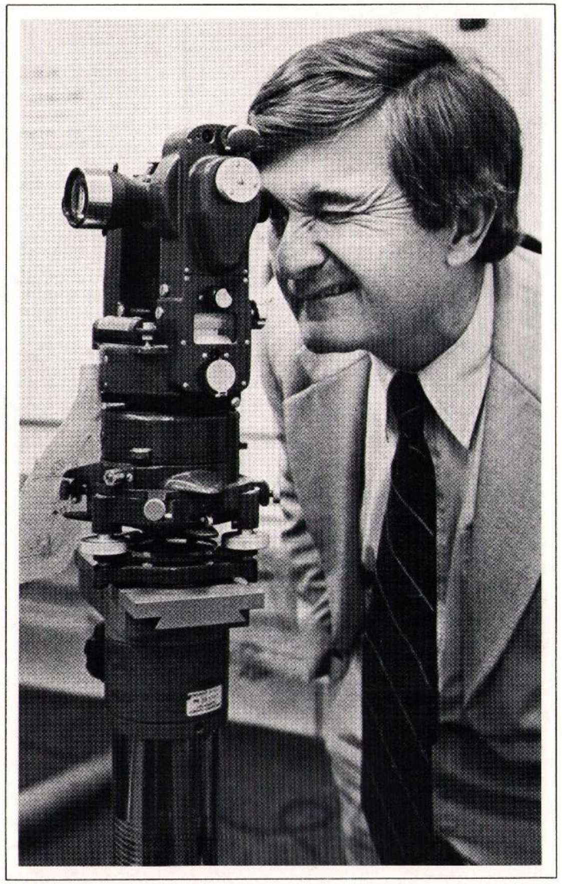

Cong. Charles Rose, (D) North Carolina, sighted through an optical device January 9 at the meson facility during part of a Laboratory tour. Rose is chairman of the Subcommittee on Evaluation, of the House Intelligence Committee.

Photo by LeRoy N. Sanchez

the Atom

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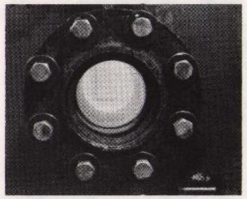
ON THE COVER:
Glove boxes surround much of the dual chamber incinerator at the Treatment Development Facility. The boxes allow access for ash removal; most of the residue is removed with a gravity drop-out system. Other residue is removed by a specially-constructed vacuum system. Other photos by Bill Jack Rodgers, and the story by John Ahearne, begin on page 10.

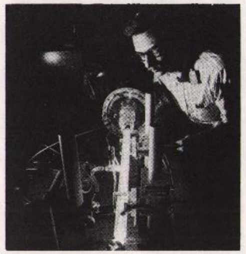
Preview:

Most people think of helium simply as the element which lifts Mickey Mouse and his friends to new highs at carnivals and circuses, or perhaps as preserver of the original Constitution. This inert gas, however, has many traditional industrial uses, and its value to the country's energy needs is expected to expand within the next generation. LASL is helping to reclaim once-used helium and to formulate a national helium policy.

Conventional trash is buried at the dump, but radioactive waste from "hot" areas must be differently handled. A unique, new furnace is part of the Treatment Development Facility at LASL. Controlled air incineration, the first process evaluated, is so stable that a box often retains its original shape after being burned. The final product exceeds federal air quality standards.

O.C. Nier, the man who first separated isotopes of uranium at the behest of Enrico Fermi, visited recently and discussed the 1940s' mass spectrometer process. Another story is about today's methods.





Gaseous helium is collected and stored in this 1,000-cubic-feet gas bag being inspected by CTR-9 member David Loya. When the Laboratory's liquid helium inventory is low, the helium is then purified and liquified. Gas entering the bag has been collected from researchers around LASL as part of the Laboratory's helium conservation and recovery program.

Photo by LeRoy N. Sanchez

Helium conservation: no Mickey Mouse program

By Vic Hogsett

To many persons the simple inert gas, helium, is little more than a delight to children at carnivals, circuses, and zoos where the lighter-than-air element lifts Mickey Mouse and his counterparts to new highs. Others recognize helium as the breathing medium that contributes to the squeaky voices of deep-sea divers.

It has many other traditional uses as a pressurization and purging gas, as an aid in gaseous leak detection, and as a tracer gas. Its special properties make it invaluable in welding, metallurgy, aerodynamic studies, and as a heat exchange medium. Our nation's Declaration of Independence is housed in a helium atmosphere.

Helium's inertness, lightness, and unique low-temperature properties make it exceptionally useful to science and industry.

"Helium possesses certain unique properties, which are being utilized in a number of advanced energy technologies now under development. Adequate supplies of helium are essential for their successful operation." So wrote Milton C. Krupka, systems analysis and assessment staff member at LASL, and Edward F. Hammel, assistant director for energy at LASL, in a paper presented to the Alternate Energy Sources International Symposium held in Miami Beach, Florida in December of 1977. Despite these two Los Alamos Scientific Laboratory researchers' concerns, and the concerns of other scientists across the country, billions of cubic feet of helium are being vented to the atmosphere each year; hundreds of thousands of cubic feet each day. This helium is extracted by a cryogenic process from natural gas, the cheapest and only practical source of helium yet discovered.

"Whereas projected eventual depletion of natural gas fields will contribute to the near-term energy crisis," Krupka and Hammel wrote, "few realize that depletion of helium gas, its only economical source being those same gas fields, can contribute to a potential energy crisis many years hence."

Some time in the early to mid-part of the next century, it is possible the United States will receive significant amounts of its electrical needs transmitted from fusion power plants by superconducting power transmission lines. Some of this power could be stored for peak-period usage in cryogenic magnetic-electrical-energy storage systems.

Scientists say the practical implementation of such fusion-energy systems could provide nearly unlimited supplies of electricity and give a rosy tinge to this country's future energy scenario.

These are the technologies of which Krupka and Hammel wrote. They are currently, and continually, reviewing the national helium program for the Department of Energy (DOE). In 1974, the Energy Research and Development Administration (ERDA, now the DOE) was required by Congress to draw up recommendations for the future management of the program. In 1975, Hammel became the director of this study. The recommendations developed were accepted by ERDA and transmitted for Congressional and Presidential consideration. Congressional action, however, failed to gel.

In the early 1960s the federal government began stockpiling helium to insure an ample source for future needs. In 1973 the Secretary of the Interior, federal administrator of the helium program, decided through the Bureau of Mines to stop stockpiling helium collected from the particularly helium-rich natural gas fields located in Kansas, Oklahoma and the Texas panhandle.

Helium, practically speaking, is a natural non-renewable resource....

Its special properties make it invaluable. Our Declaration of Independence is housed in a helium atmosphere.

Conservation Begins at Home

From his work space in the Controlled Thermonuclear Research Division at LASL, Ken Williamson is looking out upon the next century. What he hopes to see is an America blessed with ample supplies of energy. His work here is geared toward such a vision.

The Energy Storage Systems Group (CTR-9), of which he is a member, has as its main responsibility the development of the superconducting tokamak ohmic heating (TOH) systems required for the large tokamak fusion reactors. The cryogenic experiments and research the group performs rely upon relatively large quantities of liquid helium. In fact CTR-9, using about 30,000 liters of liquid helium per year, is, in Los Alamos, second only to the Clinton P. Anderson Los Alamos Meson Physics Facility (LAMPF) in the use of helium. LAMPF uses about 40,000 liters of liquid helium per year.

Williamson's knowledge of the uses of helium, coupled with both eventual cost increases and potential depletion of this natural resource, prompted him and others here at the Laboratory to implement a helium reclamation program.

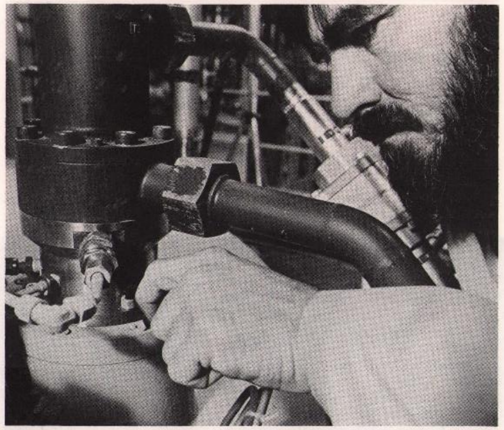
"Although an abundant element in the sun and stars," Williamson said, "helium is rare on the earth in the sense that the largest total amount of helium is dispersed throughout the atmosphere at a steady state concentration of about 1 part in 200,000."

Smaller amounts of helium exist in larger concentrations, as high as 9 parts per 100, in certain natural gas fields of the United States. On the average most natural gas fields contain much less than this maximum value. Helium extracted from the southwestern United States natural gas fields currently costs about $25 per thousand cubic feet when purchased commercially, and about $35 when purchased from the Bureau of Mines. Helium extracted from the atmosphere is estimated to increase in cost by a factor of at least 100. Williamson said the increased cost is a result of the dramatic difference in the concentration of helium between the atmosphere and the helium-rich (generally greater than 0.3% helium) natural gas sources. With reasonable extensions of present day gas-separation technologies, Williamson explained, considerably more energy is required to separate the helium from the atmosphere.

Ken Williamson, CTR-9, left, and Stretch Fretwell, Cryogenic Group member of LASL's Energy Division, inspect and make adjustments on the liquid nitrogen cooling system used in the helium liquefaction process. Liquid-nitrogen-cooled charcoal beds are used to remove impurities such as water vapor, nitrogen and oxygen from helium gas before it is liquified.

75 per cent Goal

What the group of helium savers hopes to accomplish is the recycling of about 75 per cent of the present amount of helium used at LASL. Williamson said this could amount to a savings of about 75,000 liters of liquid helium this year and a somewhat higher figure next year.



David Loya adjusts the bolts on one of two in-line gas-bearing turbines located on the top of the "cold box." Through the length of the turbine (four inches), the temperature of helium gas drops from room temperature to a few degrees above absolute zero — a change of about 300 degrees (Celsius). The centrifugal turbines remove about 2,700 watts from the flowing helium.

"We'll probably never be able to save 100 per cent of the helium we use here," he said. "About 30 per cent of the helium users here are small users with no recovery capability."

The helium conservation program here employs several recovery systems scattered at the sites of prime helium users. The collected gaseous helium is taken by way of tube trailers to a central repurification and reliquefaction facility located at CTR-9.

"In order to encourage conservation at the experimentalist level," Williamson wrote in a to-be-published LASL minireview, "two incentives were built into the program. First, funds for capital equipment, such as liquid helium Dewars, recovery compressors, and gas bags, were provided from Laboratory overhead instead of from the experimentalists' operating funds. Second, a two-tiered pricing system was established for the liquid helium."

The prices paid by helium consumers with no recovery system is $2.11 per liter, about the same price the Laboratory pays the U.S. Bureau of Mines for new helium. Those with recovery systems get by at a somewhat lower rate of $1.40 per liter.

Two systems

The group uses two types of recovery systems—two permanently installed systems, one at LAMPF and one at CTR-9, and portable stations for short term users. Williamson explained that the LAMPF station currently in use is mounted on a semi-truck trailer and is actually portable. In addition the primary difference between the two types of recovery systems is the size of gas bags used for initial storage.

A 3,000-cubic-foot gas bag will be installed at LAMPF and is a major component of the permanent LAMPF recovery system. According to Williamson, the bag should be sufficiently large to handle gas vaporized from a little over 100 liters of liquid helium. The LAMPF facility is capable of collecting the boiloff from 550 liters of helium per day under steady-state running conditions. Once collected, the helium is compressed to 2,000 psi pressure, fed into a tube trailer, and taken to the purification and liquefaction facility at CTR-9.

At the receiving facility, the gaseous helium is funneled through a purification system cooled to liquid nitrogen temperatures. Williamson explained that the liquid nitrogen beds remove impurities such as water vapor, nitrogen, and oxygen. The purified helium gas is drawn off and either stored for future liquefaction or liquefied immediately.

When the liquid helium inventory is low, the liquefaction system is brought into operation to fill a 1,000-gallon storage Dewar, which is essentially a large vacuum container insulated with aluminized Mylar.

The heart of the reliquefaction system is a large liquefier, a major

CTR-9 uses about 30,000 liters of liquid helium each year; the meson facility uses 40,000. Savers hope to recover three-fourths of the present amount used at Los Alamos.

component of which is affectionately dubbed the "cold box." The main purpose of the cold box is to remove energy from the gaseous helium thus cooling it to its liquefaction temperature, about 4 degrees above absolute zero.

The large jumble of pipes, grating, valves, heat exchangers, and other components making up and surrounding the cold box are used in conjunction with two small turbines, each a cylinder four inches long and about ½ inch in diameter.

Gaseous helium is forced through the system by a 500 hp compressor, which operates at 200 psi. The two centrifugal gas-bearing turbines expanders are used to produce refrigeration by extracting heat from the compressed helium. Purified gaseous dry helium enters the two-in-line series turbine combination at 200 psi and 32° Kelvin (K) and is discharged at 17 psi and 11 K. The turbines remove 2700 watts from the flowing helium.

The final expansion procedure includes a trip through a Joule-Thompson valve which further expands the gaseous helium causing a sizable fraction of it to liquefy, Williamson explained. Not all the gaseous helium is converted to the liquid state. What remains as gas is channeled back to the compressor through a series of heat exchangers for another trip through the entire procedure.

The cold box is capable of producing 250 liters of liquid helium per hour. From the cold box, liquid helium flows into a 1,000-gallon storage Dewar and then into 100- and 500-liter Dewars used for Laboratory-wide distribution. Williamson said the LASL Dewars have a boil-off loss of about 1.25-1.50 per cent per day and thus will hold liquid for about 75 days before it has all "boiled" away.

Nationwide

The importance of helium has not been overlooked on a national scale. The Los Alamos Scientific Laboratory's helium conservation efforts follow similar programs instituted by other national installations, for example the Fermi National Accelerator Laboratory in Illinois. The National Science Foundation has started a program to provide funding for small-scale helium users to reclaim, purify, liquefy, and reuse helium. The Foundation will release as much as $500,000 per year for the development and purchase of helium reclamation units. The Foundation as well as the American Chemical Society and the American Physical Society have released public policy statements encouraging the conservation of helium.

Recovered helium has been vaporized, compressed, and liquified. The heart of the system is the 'cold box.'

But the amount of helium saved through individual laboratory conservation is small compared to the amount of helium that is vented to the atmosphere each year.

From 1962 to 1971, helium was extracted from helium-rich natural gas fields. The helium was purchased by the government and stored underground in government-owned partially depleted natural gas field near Amarillo, Texas.

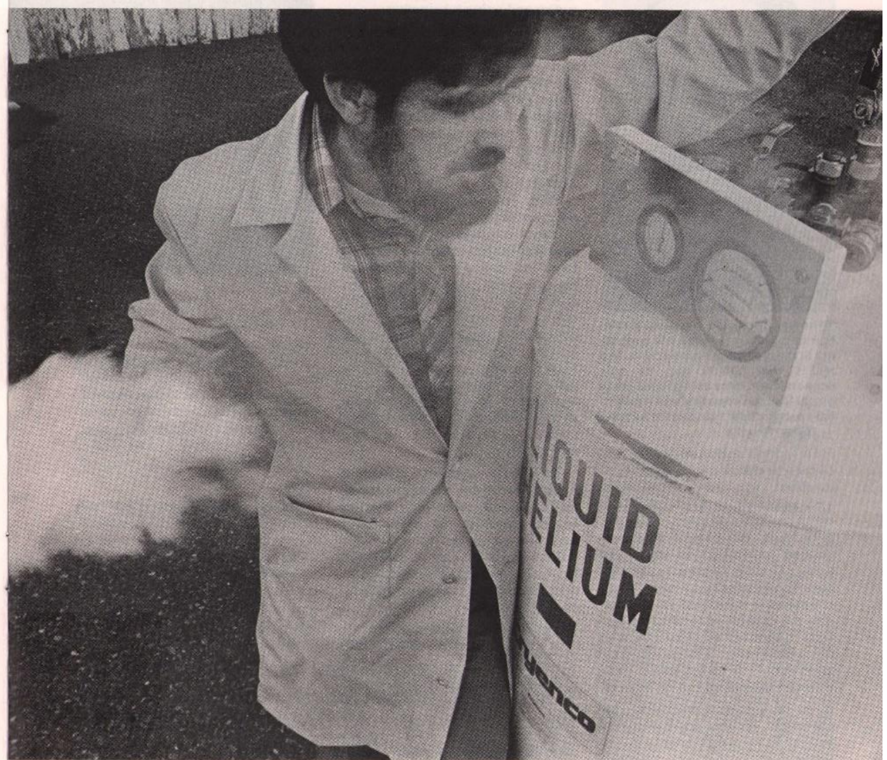
According to a publication from ERDA, since almost 30 billion cubic feet of helium had been stored by the government by 1970 and because the federal demand had fallen substantially below projections, the Secretary of the Interior terminated the helium conservation purchase contracts.

The publication, entitled "The Energy Related Applications of Helium" (ERDA-13), also states that considerable litigation ensued, much still pending, over the termination of the existing contracts. Since that time there has been no large-scale stockpiling of helium. Private production has stayed approximately even with commercial usage.

Projections and studies quoted in the report indicate that, as of 1975, about 280 billion cubic feet of helium existed as measured (proved) reserves. Updated information, provided by Krupka, indicates that as of 1978 this number has been reduced to less than 200 billion cubic feet. Of the latter amount it is estimated that by 1990 about 16 billion cubic feet will have been used beneficially, 120-125 billion cubic feet will have been wasted to the atmosphere, and only about 60-65 billion cubic feet including the stored helium will remain.

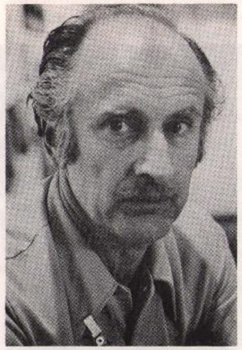
Large amounts needed

The 1975 ERDA report points out the probable need for large amounts of helium beginning after the turn of the century. The actual amount of helium required will depend upon the mix of the systems by which energy will be generated, i.e. how much electricity will be generated by fossil-fuel plants, fission and fusion reactors, and solar energy technology. Krupka points out that the DOE is expending considerable effort developing energy technologies, many of which utilize superconducting subsystems for which



The unique properties of liquid helium make it extremely useful in a number of advanced energy technologies now under development. Here David Loya uses the super-cold liquid to cool a transfer line before inserting it into a cryogenic system.

helium is presently required. If certain designs of fusion reactor systems prove themselves economically feasible, the national requirements for helium will be large. Coexistent with fusion systems will probably be superconducting electrical storage and transmission systems, similarly requiring significant amounts of helium.



"Whereas projected eventual depletion of natural gas fields will contribute to the near-term energy crisis, few realize that helium gas, its only economical source being those same gas fields, can contribute to a potential energy crisis many years hence."
— Milton Krupka

Helium is important to all three of these technologies because of its excellent heat transfer properties and extremely low boiling temperature (about 4.2 K), permitting the use of superconducting technology in key design areas. Certain materials become superconductors when their temperature is lowered. In this state they are capable of conducting very large quantities of electricity with no resistance. Excessive heat generation is eliminated and material quantities can be reduced.

It is, of course, conceivable that through either sophisticated molecular engineering, or serendipitous discovery, or both, improved superconducting materials, i.e., those having much higher transition temperatures that withstand very high magnetic fields and above all permit commercial fabrication, could become available in the future thus mitigating the need for large quantities of helium.

Prudence suggests, Krupka said, that present long-range planning must consider the use of helium to achieve the temperature range required for the operation of superconducting equipment.

The Helium Act Amendments of 1960 (Public Law 86-777) authorized the Department of the Interior through the Bureau of Mines to buy and store helium from helium producers. This action was taken in response to growing helium needs projected primarily for the United States' space program.

The storage conservation program was set up to pay for itself. Private companies erected five plants for the extraction of helium from natural gas. The Interior Department established an arbitrary price of $35 per thousand cubic feet and decreed that government agencies must buy helium only from the Bureau of Mines at the set price. Private producers eventually built their own extraction plants and were able to sell helium at a reduced price, thereby undercutting the government's price.

By 1970, the commercial price of helium had dropped to about $21 per thousand cubic feet. It soon became apparent that the helium stockpiling program was not economically viable when the Interior Department found itself in debt to the Treasury Department by over $450 million.

Though most agree we will need the helium now being wasted, few have been able to say who should pay for extracting and storing this helium.

"Perhaps pushing private storage with appropriate financial incentives would stimulate private companies to extract additional helium," Krupka said. "Furthermore, helium vented to the atmosphere can, for all practical purposes, be considered lost under present circumstances."

Both Krupka and Hammel are maintaining close contacts with the Department of Energy, private industry, and Congress. Whenever major changes in the helium conservation issue become apparent they make it their business to be aware of these changes and evaluate their impact upon long-range helium conservation.

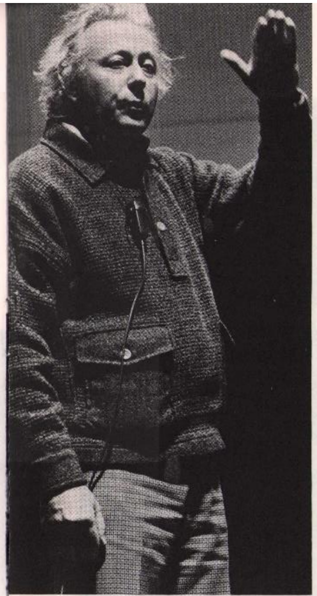
"Many issues are involved," Krupka intoned, "including those relating to domestic and foreign resource estimation, socio-economics, legal, legislative, as well as the technical. It is these issues that we will address when we make our new recommendations."

The basic problem is simple: We will probably need the large amounts of helium currently being wasted, but the economic base for large-scale recovery does not now exist and will not be apparent until helium is needed, and that probably won't be until around the early part of the 21st century.

Krupka also looks at it in a different light.

"Helium has proven to be immensely useful to the scientific community in particular and to society in general," he said, "and here we have billions of cubic feet of it being thrown away. I look at it in terms of prudent conservation—we have a valuable nonrenewable resource that must be protected."

By 1970, the government had stored almost 30 billion cubic feet of helium. Demand fell, and the Secretary of the Interior terminated the conservation purchase contracts.



Expatriate certain of contaminated Russian zone

Photo by LeRoy N. Sanchez

Zhores Medvedev spoke of buried nuclear waste in the Soviet Union accumulating heat, and a 'mud explosion' occurring.

Los Alamos people packed the Administration Building auditorium to hear a Russian biochemist recount his efforts to explain high radiation levels, which he believes existed in the Ural Mountain area of the central Soviet Union in 1958.

According to Zhores Medvedev, an expatriated Soviet citizen, an undetermined type of nuclear waste buried near the town of Kyshtym accumulated heat to a point where a mud "explosion" occurred, covering thousands of square miles with radioactive dust and waste.

Medvedev admitted he could only speculate as to the cause of the nuclear accident because he is not a trained nuclear physicist. He said the Soviet government has never offered a reason nor officially acknowledged whether such a disaster occurred. He also said he has no personal knowledge of anyone being injured or any property being damaged, since his theory is based on a search of literature relating to biological experiments.

More than 1,000 people may have been killed, thousands more relocated, and nearly a 1,000-square-mile tract of land rendered uninhabitable as a result of the accident, Medvedev told the pre-Thanksgiving holiday crowd. He said he reached his conclusion after an extensive search of Soviet scientific literature released since 1967. In a subsequent group discussion, however, he denied having any basis for believing there was an explosion or injuries. He was only certain a large contaminated area must have existed.

He said his findings have been corroborated by the CIA and by a fellow expatriated Soviet scientist, Lev Tummerman. Medvedev said Tummerman passed near the alleged contaminated site.

According to Tummerman, as related by Medvedev, buildings in villages near Kyshtym (located between two major industrial centers, Sverdlovsk and Chelyabinsk) were destroyed by Soviet officials to prevent residents from returning to the contaminated area.

Medvedev, who has studied biological effects of radiation, said he believed the released material was waste from the Soviet Union's primary efforts at producing nuclear weapons. The proximity of Kyshtym to major industrial centers, coupled with its otherwise isolated location, made it an ideal place for secret research.

Much of the suspected radioactive waste was buried at a time when the Soviet Union lagged far behind the United States in nuclear capability, he said, adding that no attention was paid to the problems buried waste would present in the future.

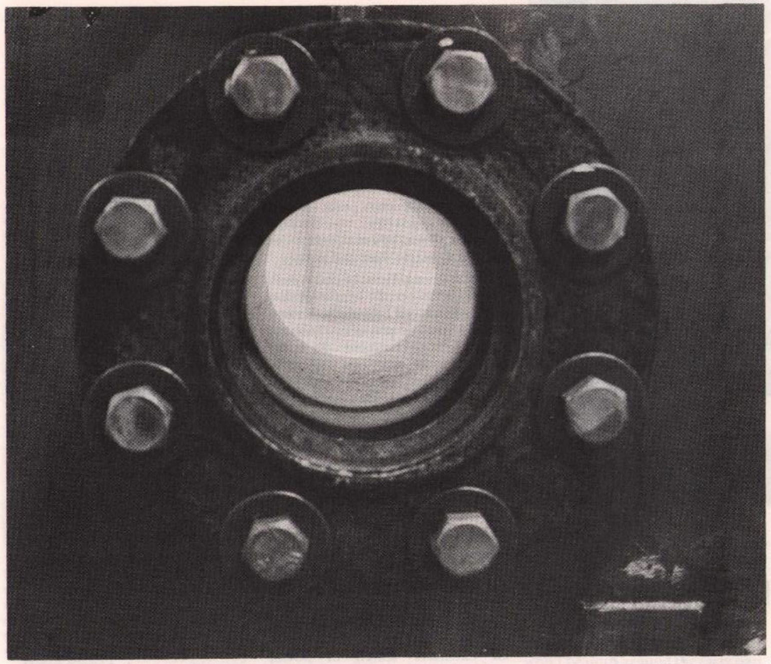
During his investigation, Medvedev said he studied numerous reports dealing with the effects of radiation, which were based on levels of radiation higher than necessary for laboratory experimentation. The experiments dealt with animal and plant studies and the effects of radiation on two lakes located in the Kyshtym vicinity.

"I found certain patterns of radiation in the studies," Medvedev said. "The level of contamination was the same.

"The lakes were 4.7 kilometers square," he added. "Nobody would contaminate such large lakes for scientific experimentation. It is quite difficult to believe that this was the case."

Medvedev said the levels of radiation in the experiments were consistently 100 times larger than permissible research levels. "They (radiation levels) were measured in microcuries, not picocuries," he said.

The Soviet exile is currently pursuing studies on aging. He works in a laboratory provided by the National Institute of Health, London, England. He has authored a book which he said will soon be released in English. He said the book details his studies to uncover the Ural incident.



A porthole near the main chamber provides visual access to the interior of this special incinerator. The window is made up of two plates of one-half inch temperature resistant quartz. Two separate plates are used for added insulation.

Photos by Bill Jack Rodgers

Unconventional furnace for special waste

By John Ahearne

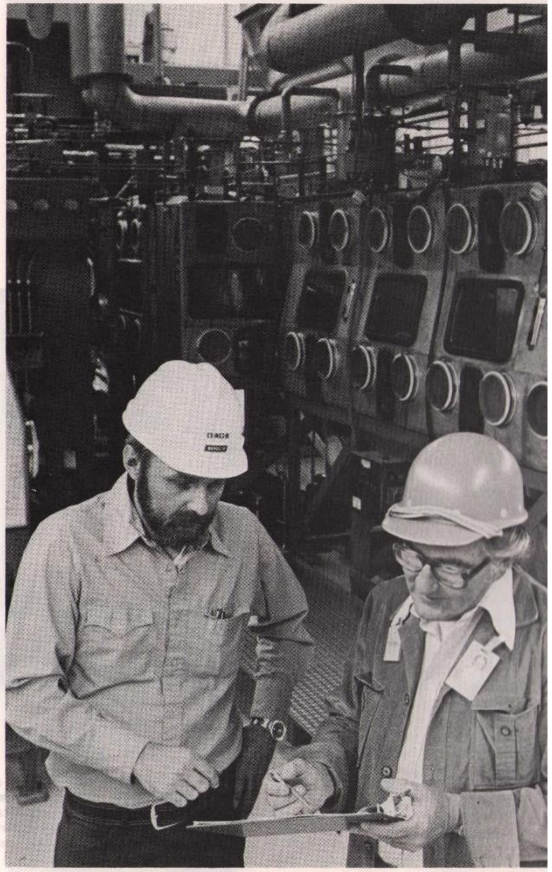
Anything used in a "hot" area—a laboratory where radioactive materials are handled—is considered radioactive waste. Kleenex, cartons, pliers, beakers, cans, paper, rags, lab coats, booties, pipettes, filters, even large machines and actual sections of buildings, must be discarded, whether they are really contaminated or not.

Even low-risk items like these are treated with the utmost care and caution, as are all materials used in laboratories dealing with transuranic elements. But unlike conventional trash, these items can't be hauled off to the municipal dump; they must be safely disposed of in some manner.

Isolation of waste varies from shielded bins or tanks for high-level contaminants to storage arrays of packaged transuranics with long half-lives to land burial of low-activity materials. Radionuclides range from the short-lived (a few days or weeks) to those with half-lives of thousands of years; all must be managed for the duration of their radioactive lives.

But the sheer bulk of the waste material poses a storage problem. While compaction can indeed reduce the *volume*, it does little to change the chemical and physical form of the waste. It was this problem of chemical change, along with volume reduction, that led to the construction of the Treatment Development Facility (TDF) to house demonstration projects

Unlike conventional trash, these items can't be hauled to the dump; they must be safely disposed of in some manner.



Waste Management (H-7) Group leader Tom Keenan, right, discusses the progress of the experiment with TDF research, development, and demonstration project leader Leon Borduin. The TDF research is only part of LASL's extensive program of waste management headed by Keenan. He is also responsible for the liquid treatment facility, burial/retrievable storage management, and a wide range of research activities.

The result of this pilot project is an assembly that ingests two-cubic-foot boxes of combustible waste. Air flow is so stable that a box will often retain its shape in the chamber after burning.

aimed at improved treatment processes for transuranic waste.

Equally important as volume is "waste form stabilization," the ultimate goal of the research facility. "Stabilization," says project manager Lee Borduin, "pertains to the chemical and physical make-up of the final product; that is, a form easy to handle and store.

"The purpose of the research is demonstration of engineering methods to stabilize transuranic waste. Our work demonstrates production-scale models and ultimately will provide a base for waste problems throughout the Department of Energy and in private industry."

(Borduin heads the research and development efforts for LASL's waste management group, H-7, under Tom Keenan. Working with Borduin in this part of the Health Research (H) Division are engineers Wiley Draper, Ralph Koenig, Al Neuls, Jack Newmyer, Larry Stretz, and Charles Warner.)

Controlled air incineration

The first process chosen for evaluation at TDF was controlled air incineration, selected after reviewing technologies available in 1973. This project aims to stabilize and reduce the volume of combustibles—paper, rags, plastics, and rubber—that contain transuranics. These items measure above 10 nanocuries per gram (a curie is the basic measurement of decay, the amount of a nuclide that undergoes 3.7×10^{10} disintegrations per second; a nanocurie is one billionth of a curie).

The result of this pilot project is an assembly that ingests two-cubic-foot boxes of combustible waste. After suitable inspection, burning, cooling, scrubbing, washing, and extensive off-gas filtering, an ash residue results that will be stabilized for terminal storage.

The massive equipment is sequestered within three levels of ever-lower negative atmospheric pressure. This prohibits any possible air flow from the incinerator toward the laboratory or other working areas.

All combustible materials received by the TDF are first assayed to keep track of all transuranics contained in the wastes. The H-7 programs partially support H-1's assay section, under John Umbarger. A sophisticated device known as a Multiple Energy Gamma Assay System (MEGAS) is capable of detecting radiation levels of transuranics in the low nanocurie range.

Incoming boxes are lifted mechanically from the protective metal shipping drums, assayed, marked, and passed before an x-ray scanner similar to those used at airport baggage inspection stations. This insures that noncombustibles (bottles, metal, or liquids) do not make their way into the incinerator; they are removed and separately processed. A final storage glove box allows the operators some flexibility in running the entire system, as items can be held "in transit" for periods.

Wylie Draper demonstrates the x-ray system used to insure that the packaged wastes contain only combustible materials. The system is similar to those used in airport security systems. The packages are automatically lifted and rotated so they can be observed from a variety of angles. This prevents the operator from missing, for example, a thin piece of metal that is being viewed toward its edge.

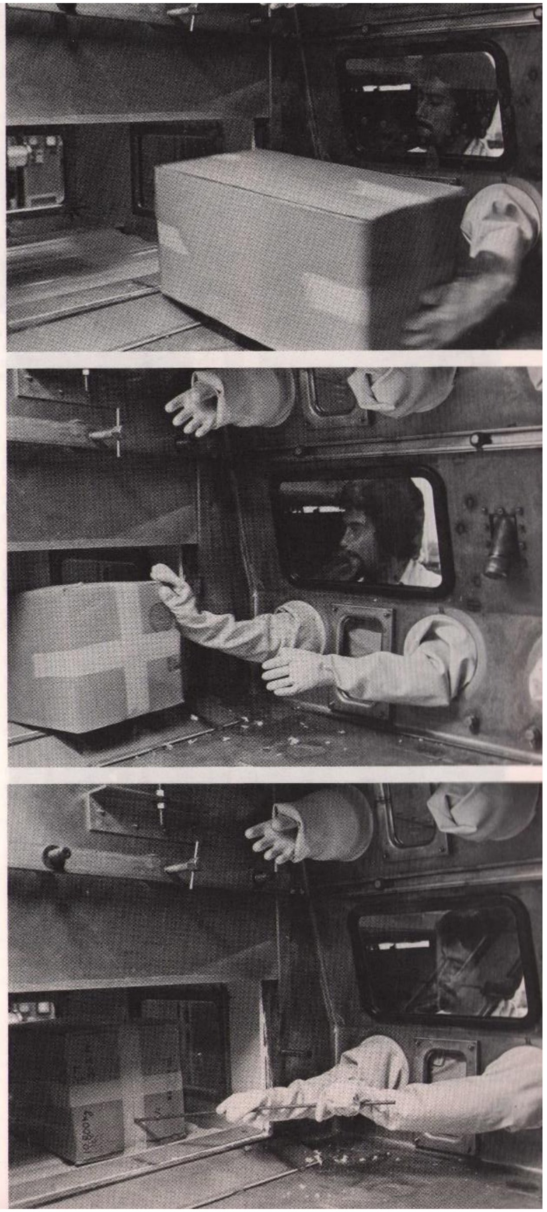
Commercially purchased

The incinerator is a commercially purchased conventional model that has proven successful in disposing municipal and industrial solid wastes. Because of the nature of radioactive waste, however, extensive alterations were required. The introductory glove boxes described above were installed, along with other containment for the incinerator itself. An elaborate scrubbing system was added to cleanse the gaseous combustion products.

The system uses a dual combustion chamber design. Wastes are moved into the lower chamber with a ram feeder; natural gas is mixed with just enough air to support burning. Incineration is at 1500° F.

This controlled air flow produces very little turbulence: A box, though reduced to ashes weighing a fraction of the original material, will often retain its shape in the chamber. It could be compared to a patio barbeque grill where the charcoal briquets frequently retain their shape after they have been burned. The primary advantage of the non-turbulent condition is the reduction of ash in the off-gas.

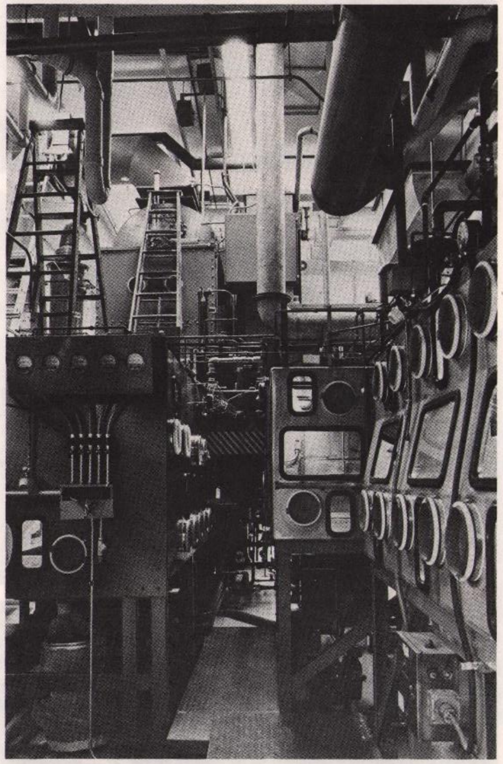
Additional air and increased temperature (2000 degrees F.) in the upper chamber assure the near-total combustion of the waste. The off-gas then moves to a "quench column," where a high-energy water spray cools it to about 180 degrees F. Sequential scrubbing



H-7 technician Perfector Martinez moves a waste package from the storage glove box to the elevator where the side ram feeder pushes the boxes to the main ram feeder for entry into the incinerator. When the system is being tested, the wastes are kept in this storage box until sufficient quantities to warrant operation accumulate.

steps then remove most particulate and soluble combustion products.

The cooled gases go through a venturi scrubber which removes more than 99 per cent of any remaining particulates.



The feed preparation glove boxes, right, allow the operators to assay, x ray, open, shred, and compact boxes of waste. The preparation phase insures that noncombustibles, such as bottles, metals, and liquids, do not make their way into the incinerator. Wastes are moved by an elevator and side ram feeder to the main ram feeder assembly, foreground left, which automatically inserts the wastes into the incinerator.

An adjustable throat valve in the venturi introduces turbulence in the off-gas and causes a pressure drop, so particulates can be more easily removed downstream. After the gas has traveled down the quench column and laterally through the venturi scrubber, it passes through a packed column to remove any mineral acids that combustion may have left.

Special plastic rings fill the packed column, offering a vast area over which gas contacts a scrub solution traveling down the column.

The gas is now ready for the multiple banks of final filters. A condenser, mist eliminator, and reheater are included to condition the gas before this step. The condenser lowers the gas temperature and removes the bulk of the water vapor. The gas must then be reheated to avoid corrosion of the filters, ducting, and blowers.

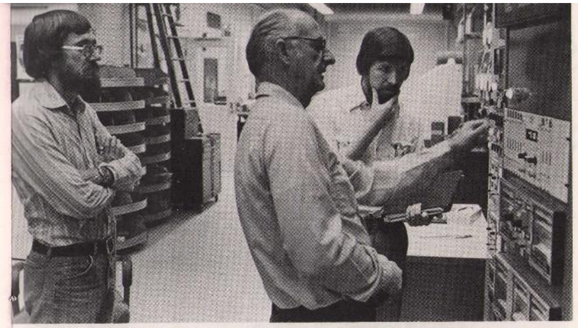
The gas finally moves through roughing filters and two banks of High Efficiency Particulate Air (HEPA) filters before exiting the stack. Filters and their assemblies are extensively tested by H Division before and after installation. Hatch-like "bagout" doors are fitted onto the filter housings to expedite safe removal and changing of the filters.

Product outstrips standards

The off-gas that leaves the stack is as clean as modern technology can make it. It is clean enough after the venturi scrubbing operation to far outstrip Environmental Protection Agency standards, and that is before the lengthy filtration process.

The cycle of volume reduction is now complete, but two byproducts must also be handled—the ash and the scrub solution used to clean the gas.

Ash is removed from the lower incinerator chamber by a specially constructed vacuum system, and experiments are underway at TDF to evaluate ash stabilization. Researchers mix the ash with a variety of hardening media—such as concrete, glass, and ceramic clays—in an effort to isolate it in a highly inert form.



TDF researchers make adjustments to the main control console in their continuing testing and checking of the system. At left is Jack Newmeyer, a chemical engineer; Wylie Draper, a nuclear engineer who specializes in instrumentation, and Ralph Koenig, a chemical engineer who specializes in combustion.

The scrub solution is recycled as much as possible, with make-up chemicals added to control acidity. When the solution is exhausted, it is sent to the LASL liquid radioactive waste treatment plant for processing.

Health and safety

Overriding concerns in the design of the experimental facility were the health and safety of the personnel who work there, and the protection of the environment. There are literally hundreds of modifications and enhancements to both the commercially purchased and the in-house manufactured equipment. Redundant and backup systems are built into every phase of the operation.

With the extras, the price tag on this experiment came to $1.65 million, including the incinerator and the building. Industrial versions will be considerably less expensive, because the required extra equipment will have been defined by LASL experiments. The facility has been successfully "cold-tested" using non-radioactive combustibles; it will be extensively tested with radioactive wastes early in 1979.

Experiments successful

"We are very satisfied with the way the incinerator operates," says Borduin. "The experiments have been extremely successful so far in regard to verifying the original engineering calculations."

The experiment has already accomplished most of the design goals, he adds, and the technology will be available to both nuclear and non-nuclear industries after the radioactive tests now starting.

"For a time, we will continue to improve the incineration process, such as modifications of the off-gas treatment to reflect technological advances made since we began this experiment," said Borduin.

"Further, we would like to investigate other waste management problems, such as techniques to exhume buried nuclear wastes which must be disinterred in the future. Chemical wastes—such as PCBs or carcinogenic chemicals—have become a national problem," he added. "They could be readily and permanently disposed of by incineration."

Finally, the engineering research approach that aimed at producing practical, near-term objectives seem to have paid quick dividends. In a relatively short period, the TDF personnel have been able to apply proven technology to the new and demanding area of radioactive waste incineration.

Al Nuels, H-7 chemical engineer, records data from the system's main control console. The console provides continuous monitoring of variables such as temperature, fuel gas/oxygen mix, and combustion gas composition.

The facility has been successfully 'cold-tested' and will handle radioactive waste extensively early this year.

Solstice watchers of Chaco Canyon

Photo by Bill Jack Rodgers

Fajada Butte in Chaco Canyon, 430 feet higher than its surroundings, protects three massive rock slabs and twin spiral petroglyphs.

Anna Sofaer discovered solstice marker in northwestern New Mexico.

Photo by Vic Hogsett

Did the ancient civilization of Chaco Canyon have a way to predict high noon on the day of summer solstice? A special LASL seminar speaker advanced that theory at a talk here in late December.

Anna Sofaer, a Washington, D.C. artist and discoverer of the solstice marker, said that three vertical slabs of stone and twin petroglyphs existing on the south face of Fajada Butte in Chaco Canyon accurately indicate midday of the year's longest day. She said the marker is probably a product dating back to the classic or Bonito phase of occupation of the canyon located in northwestern New Mexico.

"A horizontally moving light source (the sun) moving against the critically-curved surfaces of the construct (the slabs) produced a vertically moving, light form," Sofaer said. "On the summer solstice the light form passed through the center of the spiral (petroglyph)."

She added the light form bisected the petroglyph for a period of 18 minutes during midday on June 21. In order to show the uniqueness of the phenomena, she and others photographed the petroglyph at noon each day for about a month prior to the solstice.

"The light form passed through the spiral right of center each day," she said. "Our preliminary calculations indicated that on the solstice the dagger of light would pass through the center of the larger petroglyph; this is what happened."

The construct is located on the east side and near the top of the 430-foot butte, and consists of three massive slabs of rock weighing about two tons each, resting perpendicular to the rock face of the butte. The slabs are big, measuring between 6 and 9 feet in height, 6 feet wide, and about 1 foot thick. Cracks between the slabs allow for the dagger of light to be projected on the wall of the butte.

Scratched in the face of the butte, behind the rock slabs, are twin petroglyphs of nine-ring spirals. The larger spiral is 15 inches in diameter. Though it is the larger spiral that Sofaer has concerned her studies with, she says the smaller spiral has apparent significance too.

"That spiral appears to track the moon and record its phases also," said Sofaer. "This would coincide with the Indians' theme of duality, which runs throughout the Pueblo culture."

According to Sofaer, the light form also indicates spring and autumn equinoxes and has a unique position during the winter solstice. She gave her presentation in the Physics Division Auditorium the day following the winter solstice.

"We thought there was a possibility the dagger (light form) would enter the center of the spiral on the winter solstice also," she said. "This would have been truly remarkable; what did happen, however, is the two light forms framed the larger spiral; in a sense the spiral is 'held' by the light forms." During the equinox, the dagger passed between the fourth and fifth rings of the spiral.

It was her interest in ancient rock art and what has been described as her intense fascination with astro-archaeology that brought Sofaer to the precipitous butte on June 29, 1977. She had earlier heard of the seemingly meaningless spiral petroglyphs and braved a nearly 400-foot climb, including an ascent through a 30-foot natural chimney guarded by rattlesnakes, to bring herself a few minutes past noon, to the site of the rock pictures. As she knelt behind the rock slabs to examine the art work, she became aware of the light forms, gradually descending through the spiral.

"It was obvious to someone sensitive to such things that the light meant something," she said. "It was just an incredible coincidence that I was there just a few days past the summer solstice, at noon. If I would have come just a little earlier or later, I would have missed the whole thing.

"Just think about how many people, from Wetherill on, must have passed by and looked at these petroglyphs without the light being apparent," she added. "It was just incredible.

"The construct is incredibly precise," she said. "I've been told the curves of the surfaces of the slab are critical; they apparently need to be just right in order for the vertically moving light form to work.

"All of this raises some highly interesting questions," she continued. "Did the Anasazi find the light forms caused by a pre-existing condition and scratch the petroglyphs to give the desired effects, or did they place the slabs and work them for the critical geometric curve, which would allow the phenomena to occur?"

She said the slabs could have fallen from an overhang 12 feet over their current position; they could have fallen into their present position, or they could have been raised to their present position.

"That hypothesis is not entirely satisfactory," she said. "A geologist said the measurements of the rocks do not fit the overhang—no scar marks are apparent, and the slabs are composed of a different colored rock than that found composing the overhang."

She continued: there is a strong possibility the rocks may have been carried from another area, worked for the desired critical shape, and erected to their present position, after which the petroglyphs were scratched into the desired size and shape.

These are questions she feels further research will answer. She is currently seeking backing for continuation of her work regarding the Chaco Canyon find. However, she seems more concerned over the future preservation of the find. Fearing sightseers and curiosity seekers, she was initially reluctant to have her work reported in this publication and is working with the Park Service in an attempt to have the Fajada area placed off limits to casual tourists.

— Vic Hogsett

Photo by Bill Jack Rodgers

O.C. Nier: uranium-to-lead decay was most important contribution to science.

Separation by mass spectrometer

Very briefly, the method used by Nier to separate isotopes of uranium in 1940 was an electromagnetic one. It used a mass spectrometer, which analyzed streams of ionized particles by passing them through deflecting fields.

A uranium compound was vaporized, then bombarded with electrons to ionize uranium atoms or a uranium compound. Ions were accelerated with an electric field to get a tight beam.

The ions were directed to a magnetic field, with two circular paths for charged particles.

The heavier elements were induced to the slightly larger path, the lighter to the smaller radius. Focusing takes place at the end of a bending path.

The amount separated was small, millionths of a gram, but sufficient. Bombarded targets were sent under a neutron beam from the Columbia University cyclotron for analysis.

Isotope separation

Pioneer recalls the earlier days

O.C. Nier discovered potassium-40 and has designed probes for planetary atmospheres, but he visited the Laboratory recently to discuss his best-known success. The separation of uranium isotopes was a different prospect in 1940, he said: the Applied Photochemistry (AP Division) does it today with lasers, and heard Nier speak about his methods.

"In 1933, nuclear physics was a 'hot item,'" Nier said in an interview. "I'd built a mass spectrometer that had higher resolution than before." Two years later, potassium-40, which decays to argon-40 and is used to date minerals, was "very interesting to find," he added.

Nier met Enrico Fermi in the spring of 1939. "Fission had been discovered, but they didn't know what isotope was needed for it. And could we get separated isotopes of uranium?"

On Fermi's urging, Nier's laboratory created the first small sample of uranium-235 in February, 1940. The sample was large enough to show this isotope responsible for fission. In October, Fermi said the discovery was of considerable theoretical importance and perhaps of some practical importance.

"Fermi wasn't sure the odd-numbered isotopes would be responsible for the slow neutron fission of uranium," Nier said.

In the ensuing war years, Nier worked on the Manhattan Project. "Oppie (Director J. Robert Oppenheimer) tried to get me to come to Los Alamos," Nier said, but instead in 1943 he went to Oak Ridge's diffusion plant. Helping to develop instruments, Nier made the first helium leak detector, an item now in common use.

Nier returned to the University of Minnesota in 1945 and worked on a program to accurately measure atomic masses. At the university, Nier had earned his Ph.D. in 1936; he is now Regents Professor of Physics. Former students of his now at Los Alamos include Tom Scolman (J-DO), B.B. McInteer (CNC-4), and Wallace Leland (L-10).

The space age has expanded his scope further. He has been measuring the atmosphere at 200 kilometers over White Sands Missile Range, and he gave a colloquium here two years ago about the Viking project to Mars, where his instruments determined the composition of the atmosphere as a function of altitude.

Now, he's in Germany to share in analysis of data sent back from the surface of Venus. The Germans built the probe's mass spectrometer from Nier's design, with his consultation. "We joke they changed the English to metric dimensions from the Viking project to the Pioneer probes," he said.

The years have seen some changing.

"You couldn't produce uranium hexafluoride in 1937," Nier commented. "Now, it's produced by the ton."

He had also, in the late 1930s, studied the product of uranium decay: lead. Uranium-235 and -238 became lead-207 and -206. Work by others followed; the observation resulted in the dating of the earth at 4½ billion years, not the two billion as had been believed.

"That was probably the most important thing I ever did," Nier said.

Those who have benefited from his work may be hard-pressed for a choice.

— Jeff Pederson

Fermi wanted to know

October 28, 1939

Dr. Alfred O. Nier
Department of Physics
University of Minnesota
Minneapolis, Minnesota

Dear Nier:

Since our discussion last spring in Washington on the possibilities of using a mass spectrograph separation of the uranium isotopes for deciding whether the slow neutron fission is or is not due to 235 isotope, I have convinced myself that this is actually the best way to decide the question, which is of a considerable theoretical and possibly practical interest.

I understand that you have lately undertaken such a separation, and I should very much like to know whether and how this work is progressing.

Please give my best regards to Professor Tate.

Yours sincerely,
E. Fermi

Isotope separation

Modern promise: laser enrichment

Uranium isotopes are separated in a completely different manner today, compared with O.C. Nier's 1940 process.

"His important technology produced a few micrograms," said Reed Jensen, alternate leader of the Applied Photochemistry (AP) Division. "Our process looks only at the isotope of interest, and bypasses others."

The technology is based on uranium hexofluoride (UF_6) and uses modern lasers. The program has grown in recent years; a new building should be completed by 1980.

Laser isotope separation at AP-Division is being developed to enrich uranium so its fissionable isotope, U-235, can be increased more than fourfold to 3.2 per cent. Uranium could then be used as a light water reactor fuel.

With current enrichment methods, 35 per cent of the U-235 isotope cannot be economically separated from uranium and goes into tailing waste form. It mounts up. The stockpile tails expected to be generated each year a generation from now could provide the ore requirements for 160 light water reactors.

Tails have been stored for years as UF_6. LASL seeks to enrich them with lasers and photochemistry, with an eye toward small but efficient plants. The technology uses little power and could prove profitable; it also carries a low risk of proliferation.

The laser method uses photons to extract the U-235 left in enrichment plant tails. An infrared, or long-wavelength, photon is used to excite selectively only the $^{235}UF_6$ molecules.

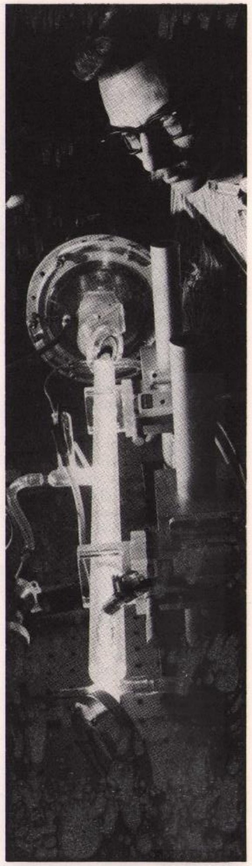
They are then separated from the $^{235}UF_5$ through the absorption of a second, or short-wavelength, photon. The new molecule is a powder that can be collected.

From enrichment plant waste, the removal rate of U-235 could approach 100 per cent. The final product is equivalent to natural uranium, and our reserves of that element could be increased through laser isotope separation.

The laser process involves photochemistry, where the bundles of energy from light (photons) are used to induce a chemical reaction. When a molecule absorbs light, is excited to a higher level of energy. The wavelength and intensity of the absorbed light determine not only the excitation level, but also the products of the reaction. Films such as Polaroid are an example of a light-controlled chemical reaction.

The process also involves the laser, which deposits enough energy with its coherent light to cause molecules to break into fragments, forming new products. Laser sources now available can be tuned to frequencies required by a variety of molecules. The narrow frequency band of the laser allows all of the energy to be absorbed, in contrast to other light sources that only inject perhaps a millionth of their energies into the selected molecule.

The selectivity of the process can be used to drive chemical changes in one isotope, but not others, to produce a permanent change in the basic substance. In this way, the $^{235}UF_6$ molecules in gaseous form can be converted to UF_5 powder. This is easily separated from the gas and collected by standard techniques.



LASL photo

Norman Barnes, AP-2, uses a low pressure carbon dioxide laser for frequency stabilization of a high pressure carbon dioxide laser. Isotope separation research, as carried out in AP-Division, is markedly changed from the 1940s method of O.C. Nier.

Short subjects

The Laboratory was closed entirely December 7 and for part of the working day December 6, as a winter storm delivered nearly two feet of snow to Los Alamos. The closing was apparently the longest, due to weather, in at least 25 years. The streets were slippery and parking lots were close to unpassable. News was distributed on LASL's "Hotline" telephone service, which was updated four times a day.

* * *

Secretary of Energy James R. Schlesinger announced this month that the DOE's Energy Research Advisory Board will examine the relationship between the University of California and two DOE laboratories it operates under contract — Los Alamos and Lawrence Livermore Laboratory. The Secretary said, "It is necessary at this time to review the relationship of the University and the two laboratories in the light of changing conditions to assure that the laboratories will continue effectively to carry out the missions assigned to them." The Advisory Board's recommendations will be submitted to Schlesinger by May 1; the present contracts expire in September, 1982. Within DOE, the laboratories are the responsibility of the Assistant Secretary for Defense Programs.

* * *

LASL's Critical Assembly Laboratory received a plaque in December acknowledging 30 years of experimental work without a disabling injury. Operations involve the critical assembly of plutonium and uranium; the award was given by Director Harold M. Agnew.

* * *

G.A. Keyworth has been named to succeed Henry T. Motz as leader of the Physics (P) Division. Keyworth, a fission and nuclear structure specialist, has been a group leader and was alternate leader of P-Division. He received a Ph.D. in nuclear physics from Duke University in 1968 and came to LASL that year. Motz is now a staff member in the office of the Associate Director for Research.

* * *

Donald N. Bryson has replaced Robert J. Van Gemert as head of the Supply and Property (SP) Department. Bryson is a 10-year Laboratory employee and is a material management and contract specialist; he has been alternate head of SP since 1975. Van Gemert is retiring after more than 25 years of service. Purchase orders, one of SP's specific duties, amount to millions of dollars per month.

* * *

The presidency of General Atomic Co., San Diego, California, will be the new job of LASL Director Harold M. Agnew as of March 1. Agnew announced his resignation early last November; he has been associated with Los Alamos for all but brief periods since 1943 when the Manhattan Project began. General Atomic Co. is an equal partnership company of Gulf Oil and Scallop Nuclear Inc. (a member of the Royal Dutch Shell group). General Atomic Co. engages in a wide variety of research and manufacturing programs, including nuclear fusion. The University of California's search committee has been accepting nominations for the Director's position and met in Los Alamos January 4-5.

* * *

A mistaken caption in the December issue labelled an item at the National Atomic Museum as a 280-millimeter atomic cannon. It actually was a pair of Terrier missiles (page 16).

A new test station for solar research

Bill Jack Rodgers Photo

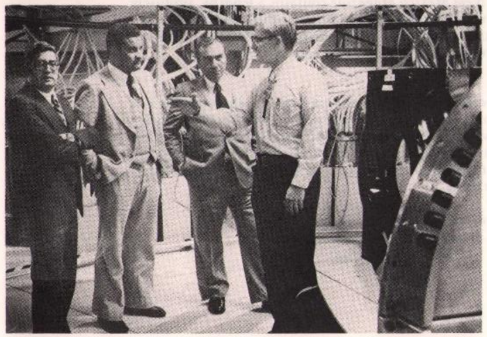
A Martin Marietta heliostat has been installed at the Solar Laboratory (TA-46) and is being converted to a two-axis tracking collector test station. To get as much solar energy as possible on a collector surface, the sun will be tracked in a near-normal mode, with the collector perpendicular to the sun from morning to evening. The first test setup, said Stan Moore of the Solar Energy (Q-11) Group of the Energy (Q) Division, will be for a high-temperature collection loop—scheduled for early 1979. Other tests will be of a low-temperature liquid, medium liquid, and of a low-temperature air loop.

Under contract with the Department of Energy, Martin Marietta worked on a five megawatt prototype heliostat for Sandia Laboratories' solar experiments in Albuquerque. This particular model was obtained through Denver by the Los Alamos Scientific Laboratory to use as a collector test station. Shown is the framework of the old heliostat, designed to accommodate an array of mirrors. The machine will be altered to mount the solar collectors.

Among our visitors

Members of Congress were briefed on eight major Laboratory programs during a visit January 4. Here, at a laser demonstration, are (from left): Robert Walker (R), Pennsylvania; Paul Robinson of LASL; Manual Lujan (R), New Mexico; Mike McCormack (D), Washington; Reed Jensen of LASL; and Eldon Rudd (R), Arizona. McCormack chairs the Subcommittee on Advanced Energy Technologies and Energy Conservation, Research, Development and Demonstration. This is part of the House Science and Technology Committee, responsible for reviewing many LASL programs.

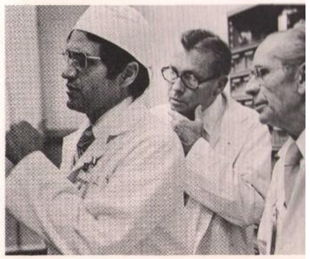
Applicants for the Director's job were considered by a University of California advisory committee, which met in Los Alamos January 4-5. University President David M. Saxon (hand on chin, at left) said about two dozen persons have been nominated for the position; he hopes a selection can be made by March 1, when Director Harold M. Agnew's resignation is effective.



The east Arabian emirate of Qatar was represented by three Egyptian officials when they were given energy-related briefings here in December. With George Sawyer (at right), CTR-Division alternate leader, are Taher A. El-Hadidi, Abdel-Kader A. Nada, and Hamed M. El-Ahmady, all of Qatar's Ministry of Finance and Petroleum. The visit was arranged with Scientific Software Corporation of Denver.

Photos by LeRoy N. Sanchez

U.S. Sen. Harrison H. "Jack" Schmitt visited LASL recently; stops included a tour at the Plutonium Facility. From left are Schmitt in lab whites; Bill Maraman, CMB-11 group leader; and Richard Baker, CMB-Division leader.



10 years ago

CLASSIFIED?

The highjacking of airliners to Cuba has had effects spreading as far as Los Alamos, according to last week's issue of the LASL Bulletin. The AEC has recently ruled that neither AEC nor contractor personnel can carry top secret or weapons materials of any sort on commercial airliners. "Also, effective immediately, other classified matters may not be handcarried on commercial airliners unless prior approval has been obtained from the area manager, Los Alamos Area Office," the statement concluded.

ECONOMY

The Los Alamos Scientific Laboratory this week froze hiring of new personnel, overtime and equipment procurement. The move grew out of an AEC-wide belt tightening and seemed likely to last until the end of the fiscal year. However, Director N.E. Bradbury assured his supervisors that no layoffs would be necessary.

The economy move also hit travel by LASL employees and new construction. In addition, Bradbury outlined cutbacks in the Rover program for the coming fiscal year that "may require the transfer to other jobs within the laboratory or terminations if suitable jobs cannot be found for some 20 people." The present lab population stands at 4,165.

LOS ALAMOS FEATURED

The February issue of the *New Mexico Magazine* contains a lengthy, profusely illustrated story on Los Alamos. Written by Walter Briggs, a different slant is taken on the Atomic City. The article emphasizes the town itself and its surroundings. Previous stories have concentrated primarily on the Laboratory.

PEEWEE TESTED

Peewee I, the first in a new series of reactors, designed and developed at the Los Alamos Scientific Laboratory, was successfully tested at the Nuclear Rocket Development Station in Nevada last month. The reactor is a unique test-bed for fuel elements and support hardware that can possibly be included in a flyable space vehicle. Peewee was never intended to fly, but is expected to make a significant contribution to reactors that will.

Culled from the January and February, 1969 files of *The Atom* and the *Los Alamos Monitor* by Robert Y. Porton

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