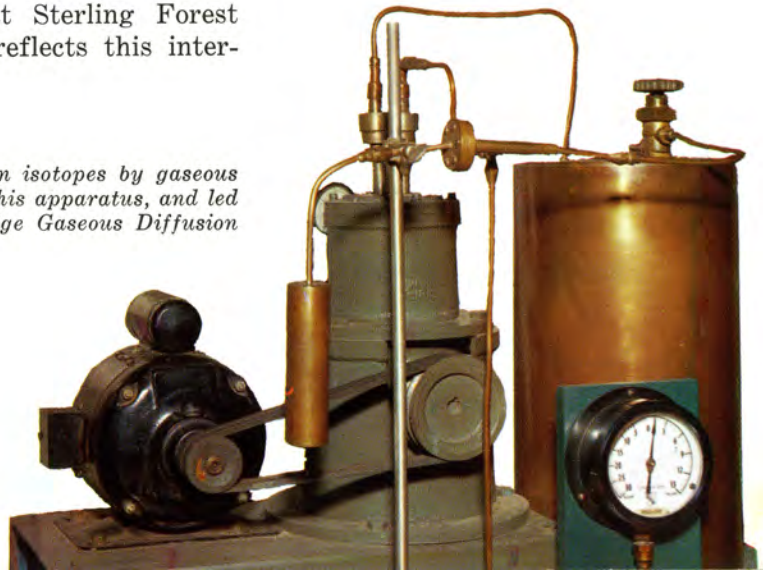
UNION CARBIDE'S 20 YEARS IN NUCLEAR ENERGY

THE NUCLEAR AGE BORN OF NECESSITY

In January of 1942, soon after the beginning of World War II, Columbia University scientists made the first small-scale separation of uranium isotopes by the gaseous diffusion process with the apparatus below. The analyses, showing that separation had been accomplished, were performed at the University of Minnesota. This long-distance collaboration proved that uranium isotopes could be separated by diffusion.

Within a year, under the stimulus of an all-out war, scientists at Columbia and other universities had enough information on gaseous diffusion to show that production of large quantities of separated uranium-235 might be possible. At that time, Carbide and Carbon Chemicals Company was called in. On January 18, 1943, a contract to operate a gaseous diffusion plant and to provide engineering and research help was signed by James A. Rafferty for Carbide and Lt. Col. K. D. Nichols for the Manhattan Engineering District. The scope of this contract has been expanded many times by the U. S. Atomic Energy Commission and Union Carbide. Carbide now operates, for the Commission, gaseous diffusion plants at Oak Ridge and Paducah, the Y-12 Plant, and the Oak Ridge National Laboratory. The productive relationship between Carbide and the Commission has always been one of mutual respect and full cooperation.

Union Carbide was brought into the atomic energy program because of the wide diversity of its interest in chemical and metallurgical fields, and because of the Corporation's important contributions to the atomic energy program prior to the Government contract. Since then, the Corporation has maintained an active interest in nuclear energy applications. The construction of a reactor and nuclear energy research center at Sterling Forest near Tuxedo, New York, reflects this interest.



The first separation of uranium isotopes by gaseous diffusion was accomplished in this apparatus, and led to construction of the Oak Ridge Gaseous Diffusion Plant (left) as seen in 1948.

The Oak Ridge Gaseous Diffusion Plant "was a first in every sense, and its design, involving many acres of barrier, was based on a small piece less than two square inches in area. Even this practical foundation soon disappeared when it became known that the material used in the first filter could never be employed in the main plant. One of the great contributions made by Union Carbide during the design and construction period was in connection with the development of a satisfactory barrier, and with the cooperation of a large number of firms mass production was achieved in ten months after manufacture was started."
(Lt. Gen. L. R. Groves in Now It Can Be Told, *p. 113)*

ORGDP, as it looks today at the left, contributed significantly to ending of World War II.

The Central Data Processing Facility.

PROCESS IMPROVEMENTS

The process development program supporting fissionable materials production is one of the most rewarding activities carried on by the Commission. Major reductions in cost of fissionable materials have resulted from these efforts. The program is conducted by contractors operating the major fissionable materials production facilities, and is analogous to the development and improvement programs pursued by progressive private industries.

All components of the gaseous diffusion process, such as barriers, gas compressors, gas coolers, and coolant, have been under study since the K-25 plant at Oak Ridge was put into operation in 1945. As a result of these studies, intensified when the expansion program started, improvements have been made in every part of this process. Net results of the improvements over the years are that the capital costs for diffusion plants built since 1946 have been several billion dollars less than if the plants had been built utilizing the same types of equipment as in the original K-25 plant. In addition to the savings in capital investment, these improvements also have resulted in annual operating costs which are several hundred million dollars less than plants of the K-25 type.

(AEC Semi-Annual Report to Congress, January-July 1954).

A LARGE-SCALE OPERATION

The gaseous diffusion process is huge. Through these (below) and similar towers at Paducah, Ky., more than 400 million gallons of water are circulated every 24 hours. This is enough to serve a city of two million people. Other statistics are equally staggering. The AEC capital investment in Oak Ridge and Paducah diffusions plants is $1,644,000,000. This is equivalent to more than $300,000 capital investment per employee, and about 10 times the average per worker in the chemical industry. The diffusion process buildings at Oak Ridge and Paducah cover about 420 acres. Electrical power consumption for these two plants is about twice that of New York City. In February, 1962, the plants completed shipments of more than one million pounds of uranium hexafluoride for AEC's Civilian Applications Program. This uranium will be used in power reactors all over the world.

Shown above is a portion of the largest fluorine plant in the free world located at Paducah. Fluorine is used to manufacture uranium hexafluoride feed for the cascade. From the time Carbide agreed to operate the diffusion plant, its personnel have had an active interest in the manufacture of diffusion barrier and uranium hexafluoride feed. Carbide carried out successful development programs to improve the manufacture of both vital materials. This success resulted in construction of feed plants in Oak Ridge and Paducah.

The U. S. Atomic Energy Commission selected Carbide not only to operate the Paducah plant (left), but also to develop the basic process designs because Carbide was the only firm in the country at that time which had operation experience with the gaseous diffusion process, as well as the necessary research, design and engineering background. The Paducah plant has grown, in 11 years, to become one of the Commission's most important production installations. It represents an investment of almost $800 million or more than 10 percent of the total investment in plant and equipment of all AEC facilities.

MILESTONES IN GASEOUS DIFFUSION

1939—U. S. Vanadium developed a process for preparing uranium concentrate as a by-product from their vanadium operations. Union Carbide's Linde Research Laboratory developed a process for preparation of pure sodium diuranate from the concentrate.

1940—Scientists at Columbia University became interested in the large-scale separation of uranium isotopes. This work was sponsored by Naval Research Laboratory, and later by the Office of Scientific Research and Development (OSRD).

July 1, 1941—An OSRD contract was signed with Columbia University which specifically called for diffusion research. The contract was followed by others wth OSRD, and later with the Manhattan District, and led to the organization of the SAM (Substitute Alloy Materials) Laboratories at Columbia. This organization had the primary responsibility for gaseous diffusion research and development.

Oct. 31, 1941—Dr. Leo Szilard requested 8 lb. of uranium oxide from Union Carbide for analysis by the National Bureau of Standards.

Aug. 1, 1942—Union Carbide received an order for 2,000 lb. of uranium oxide for experimental purposes. It was shipped from stock the next day.

Oct. 20, 1942—The U. S. Engineers Office ordered 80,000 lb. of uranium oxide, the first order under Contract W-7401 eng-15.

Dec. 14, 1942—The Manhattan District signed a contract with the Kellex Corporation, a subsidiary of M. W. Kellogg Co., to serve as architect-engineers for construction of a gaseous diffusion plant.

Jan. 18, 1943—J. A. Rafferty, president of Carbide & Carbon Chemicals Co., accepted a letter contract to operate a gaseous diffusion plant, and to perform certain research and development and consulting services on the project. Lt. Col. K. D. Nichols signed for Manhattan Engineering District.

May 18, 1943—J. A. Jones Construction Company signed contracts to build the K-25 powerhouse, cascade buildings, and administration area at Clinton Engineer Works.

June 1943—Ground was broken for the powerhouse at the gaseous diffusion plant.

July 9, 1943—A contract was signed by Ford, Bacon and Davis, Inc. for construction of the conditioning area.

Sept. 1943—Ground was broken for the K-25 building.

April 1944—Carbide assumed overall management of the gaseous diffusion barrier development and production program. Dr. George T. Felbeck had primary responsibility for this program.

Jan. 1945—The first cascade equipment was operated with uranium hexafluoride.

Feb. 1, 1945—Carbide took over responsibility for management of SAM Laboratories from Columbia.

Mar. 19, 1945—The first enriched uranium was shipped from K-25 to Y-12.

Aug. 15, 1945—The K-25 cascade was in full operation.

Dec. 1945—The K-27 building was in full operation.

Dec. 1946—The electromagnetic separation facility at Y-12 was shut down.

Dec. 1947—Barrier plant and uranium hexafluoride feed plant started operation in Oak Ridge.

Aug. 1949-Jan. 1951—Construction of K-29 plant at Oak Ridge.

Nov. 1949-Dec. 1951—Construction of K-31 plant at Oak Ridge.

Dec. 1950—Construction started on Paducah Gaseous Diffusion Plant.

Apr. 1, 1951—The first Carbide payroll at the Paducah site was established.

July 10, 1952—Plans were announced for expansion of Oak Ridge and Paducah plants, and for construction of a new gaseous diffusion plant at Portsmouth, Ohio.

Sept. 18, 1952—Goodyear Atomic Corporation, a subsidiary of Goodyear Tire and Rubber Co., was announced as operating contractor for Portsmouth Gaseous Diffusion Plant. Many key personnel for this plant were trained at Oak Ridge and Paducah.

Nov. 7, 1952—Interplant operations were started between Oak Ridge and Paducah diffusion plants.

Feb. 1953—The C-31 plant at Paducah was on stream.

July 1951-Oct. 1953—Construction of C-33 plant at Paducah.

Aug. 1952-Nov. 1954—Construction of K-33 plant at Oak Ridge.

Aug. 1952—Apr. 1954—Construction of C-35 plant at Paducah.

Sept. 1952-Dec. 1954—Construction of C-37 plant at Paducah.

July 1953—UF_6 feed plant at Paducah in operation.

Aug. 1955—An improvement program started in Oak Ridge and Paducah plants.

Aug. 1956—Feed plant expansion at Paducah in operation.

Sept. 17, 1956—First shipment of enriched uranium hexafluoride made under AEC's Civilian Applications Program.

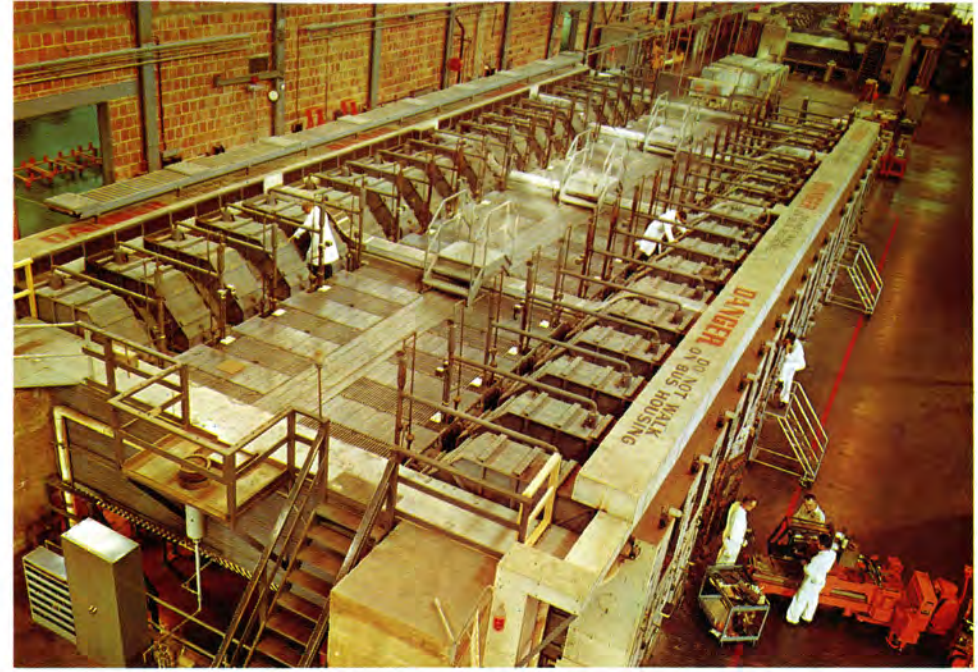
Dec. 1956—Initial operation of the uranium metals plant at Paducah.

Nov. 1960—Electronic Data Processing building, housing the IBM 7090 computer, was completed. Construction started in Oct. 1959.

Dec. 1961—The new Development Laboratory for Chemistry and Physics departments of Technical Division was completed. Construction started Nov. 1960.

Feb. 1962—Gaseous diffusion plants ship their millionth pound of uranium hexafluoride for use in the Civilian Applications Program.

Y-12 ELECTROMAGNETIC APPROACH TO URANIUM SEPARATION



The Y-12 plant today (left) includes about 170 buildings with a floor area approximately equal to 78 football fields or 4,500,000 square feet. The plant investment today is $442,000,000. When the electromagnetic process was discontinued, most of the uranium isotope separation equipment (similar to that shown above) was stripped from Y-12 and the plant assumed a new role with many widely diversified programs. Today's activities include the reduction of uranium hexafluoride—enriched in U-235—to metal, followed by casting, rolling, machining, and fabricating the enriched metal into various forms, including nuclear weapon components.

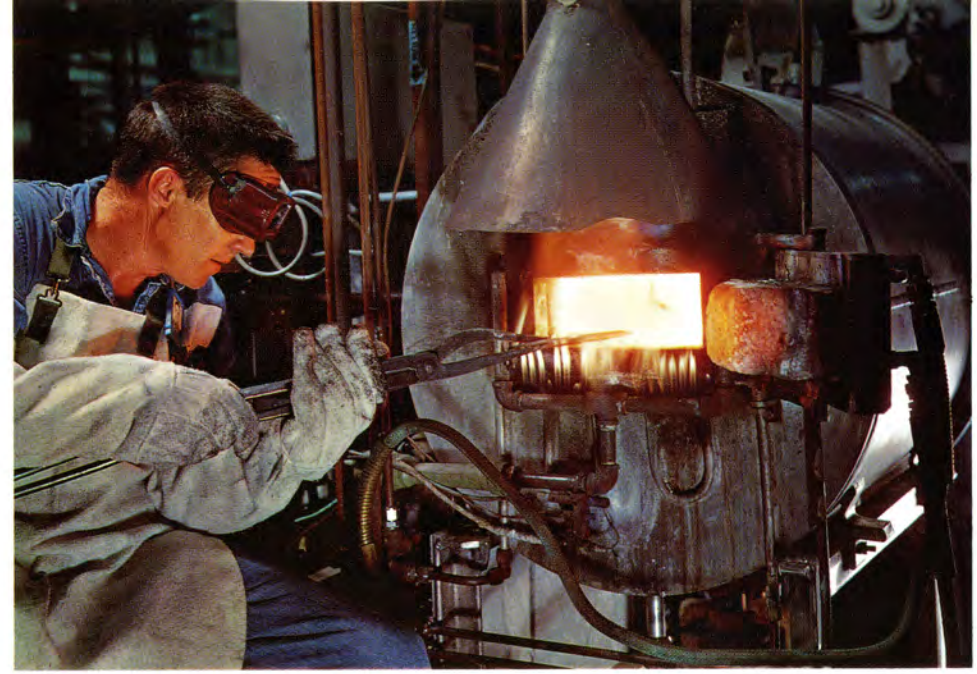
The Y-12 Plant was built on a "crash" basis during World War II to produce enriched uranium by the electromagnetic process. The first production building went into operation January 27, 1944. By 1945, Y-12 employed 22,000 operating personnel. It was the first plant to produce large quantities of enriched U-235.

The electromagnetic process involved ionizing uranium tetrachloride, accelerating a continuous stream of uranium ions to a very high speed, then bending the stream into semi-circular paths in a powerful magnetic field. The lighter U-235 traveled an arc of shorter radius than that of the heavier U-238, and the two isotopes were caught in separate containers at the end of a 180-degree arc.

After the war, the electromagnetic process for U-235 separation was discontinued and only gaseous diffusion was used on a production basis. A few of the electromagnetic units are still used at Y-12 for separation of stable isotopes of other elements.

Carbide has been the operating contractor since May 4, 1947, when Tennessee Eastman Corporation withdrew from the operation.

A MAJOR PRODUCTION AND RESEARCH FACILITY



Because of Y-12's vast reservoir of industrial skills, many problems in areas such as metallurgy, special fabrications, chemistry, chemical engineering and health physics are brought for solution to its development engineers.

Y-12 has assisted in developing reactor fuels, particularly those employing uranium oxide. The plant perfected a procedure for producing hafnium-free zirconium, a material used extensively in Naval reactors. The first large-scale precision machining of beryllium, which is used in some reactors as a neutron reflector, was performed at Y-12. In addition, development activities in the pressing and machining of tungsten have made valuable contributions to the missile program. Y-12 also has developed, and operates, a plant for large-scale separation of lithium isotopes.

About 5,500 are employed at the plant which is engaged in many exacting and complex processing activities. Its personnel have made Y-12 one of the nation's safest plants. In late 1960, more than 10 million man-hours were worked without a lost-time accident, setting a new record for Carbide's nuclear energy plants and the Corporation.

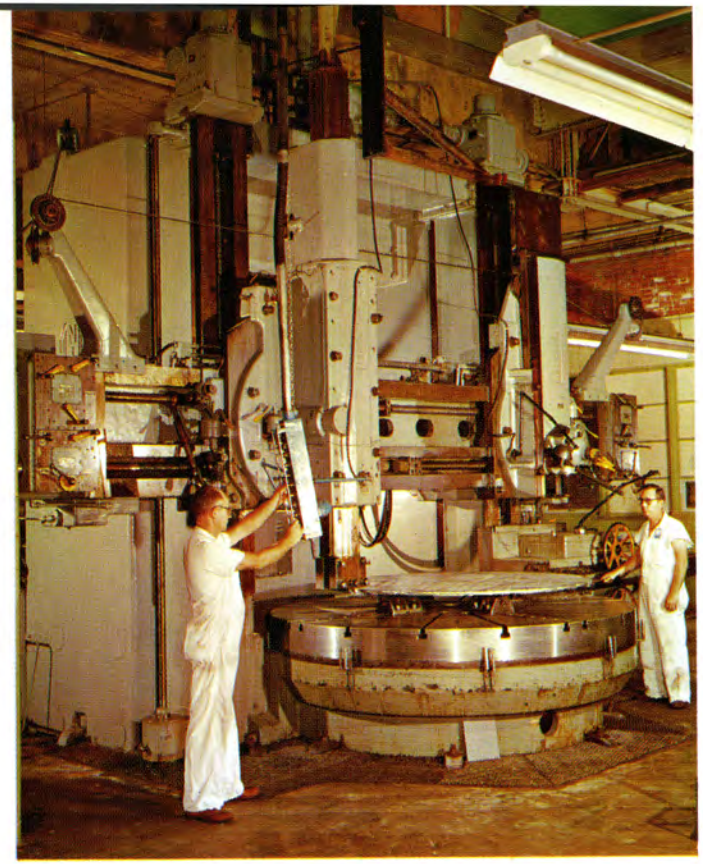
In addition to developing and operating complex chemical processes (left), Y-12 makes significant contributions in the field of advanced metallurgy and special fabrication. A high-temperature furnace with hydrogen atmosphere used in developing tungsten rolling techniques is shown above.

EQUIPPED TO HANDLE ANY PROJECT

Y-12 is engaged in continued development and pre-production work on fuel elements for the nuclear rocket program, and on shields for nuclear power sources used in space satellites. Considerable development work for the weapons program is also undertaken at Y-12 at the request of weapons design laboratories. Components for nuclear devices being developed for the Commission's Plowshare program, directed towards demonstrating the peaceful uses of nuclear explosives, are fabricated at Y-12.

In conjunction with its various engineering, development, fabrication and production activities, Y-12 has developed ultra-precision analytical and inspection capabilities.

AEC has said, about the Y-12 plant: "The capability and versatility of Y-12 are now proven assets to the United States nuclear energy effort. As the highly-skilled personnel of Y-12 continue to perform difficult production and engineering development jobs, frequently on lightning schedules, they add immeasurably to the nation's defense posture while at the same time advancing the peaceful application of the atom."



A 100-inch turning, facing and boring mill (above) used for fabricating large parts, such as are used on reactors. At left is a tape-controlled, three-axis grinding, turning and milling machine used for specialized short-run items.

Y-12 PLANT MILESTONES

1941-1942—Scientists at University of California Radiation Laboratory, Berkeley, began development of a magnetic separator which would function on the principle of the mass spectrograph, and would separate U-235 from natural uranium in appreciable quantities.
By autumn 1942, the rate at which U-235 was separated at UCRL justified authorization of construction of the Electromagnetic Separation Plant at Y-12.

1943-1946—Ground was broken for the first building in the Y-12 area on Feb. 1, 1943. Chemical operations for magnetic separator charge preparation began October 1943, and the first magnetic separator was started up in November 1943.
The first production building went into operation Jan. 27, 1944, and conversion of highly-enriched uranium-235 to UF_4 began in November. Ultimately, Y-12 employed 22,000 operating personnel and was the first plant to produce large quantities of enriched U-235. Uranium recovery began in January 1945. On September 22, 1945, all electromagnetic separators used to produce low-level enriched U-235 were shut down, since the K-25 gaseous diffusion plant was supplying a sufficient amount of partially-enriched feed for the product-level electromagnetic separators.

1946—All magnetic separators were discontinued December 23 as production units.

1947—Carbide replaced Tennessee Eastman Corporation as operating contractor of Y-12 on May 4, 1947.
Enriched uranium-235 produced by the gaseous diffusion process was reduced to metal and fabricated at Y-12 in accordance with AEC requirements.

1948—Machining of enriched uranium on a small scale was started early in the year.

1950—Hafnium-free zirconium production was started in January for use in the Naval Reactor program. The casting and machining of uranium-aluminum alloy and the first large-scale precision machining of beryllium began.

1953—Additional uranium casting facilities and another uranium machining shop were installed and completed by fall. A hydraulic pressing facility was installed in October.

1954—An expansion of the enhanced uranium salvage facility was completed early in the year. Installation of equipment for a new method of UF_6 reduction was completed during the second quarter.

1955—Installation of additional uranium casting facilities was completed early in the year.

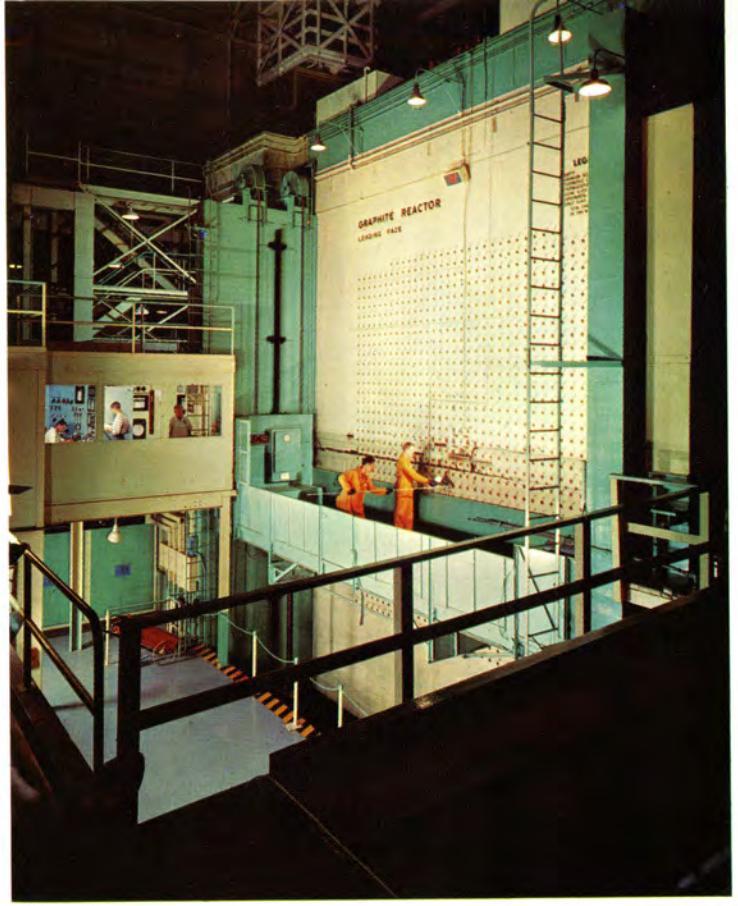
1956—An accelerated program of providing technical information and assistance to industry interested in uranium salvage and recovery operations began.

1957—Installation of a Primary Rolling Mill and further pressing facilities for fabricating uranium were completed during the third quarter.

1958—Installation of a heavy machine shop for uranium fabrication was completed in the first quarter. A second rolling mill for uranium processing was installed late in the year.

1959—Development and special fabrication service in pressing and machining of tungsten was provided for the benefit of the missile program. Commission announced public sale of highly-enriched lithium-7.

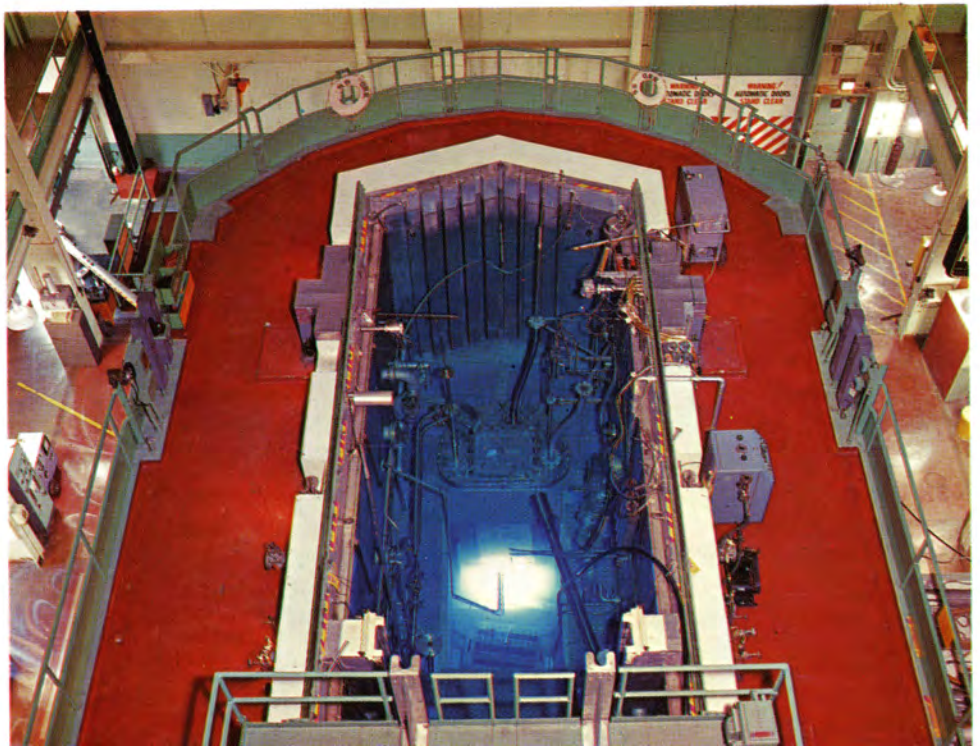
1960-1962—Specialized development and preproduction fuel element fabrication for the nuclear-powered rocket (Rover) program was started in August 1960. AEC authorized Y-12 to provide specialized fabrication service for a missle nose cone in February 1962. During this period, there was continued operation of a plant developed at Y-12 for large-scale separation of lithium isotopes.

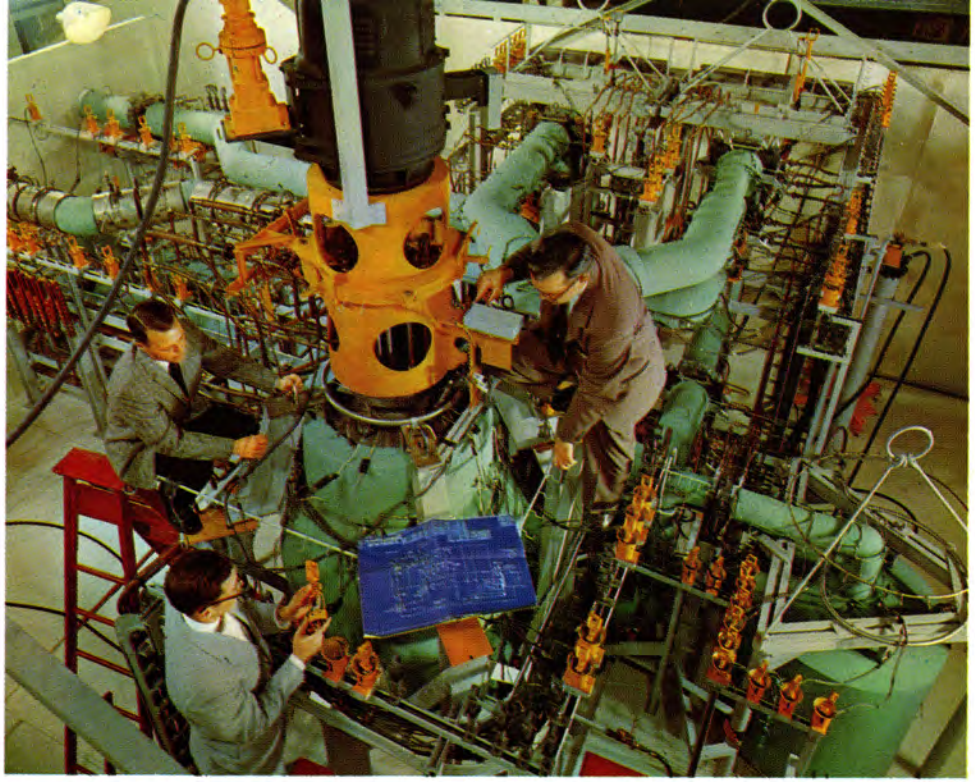


WORK WITH THE PEACEFUL ATOM

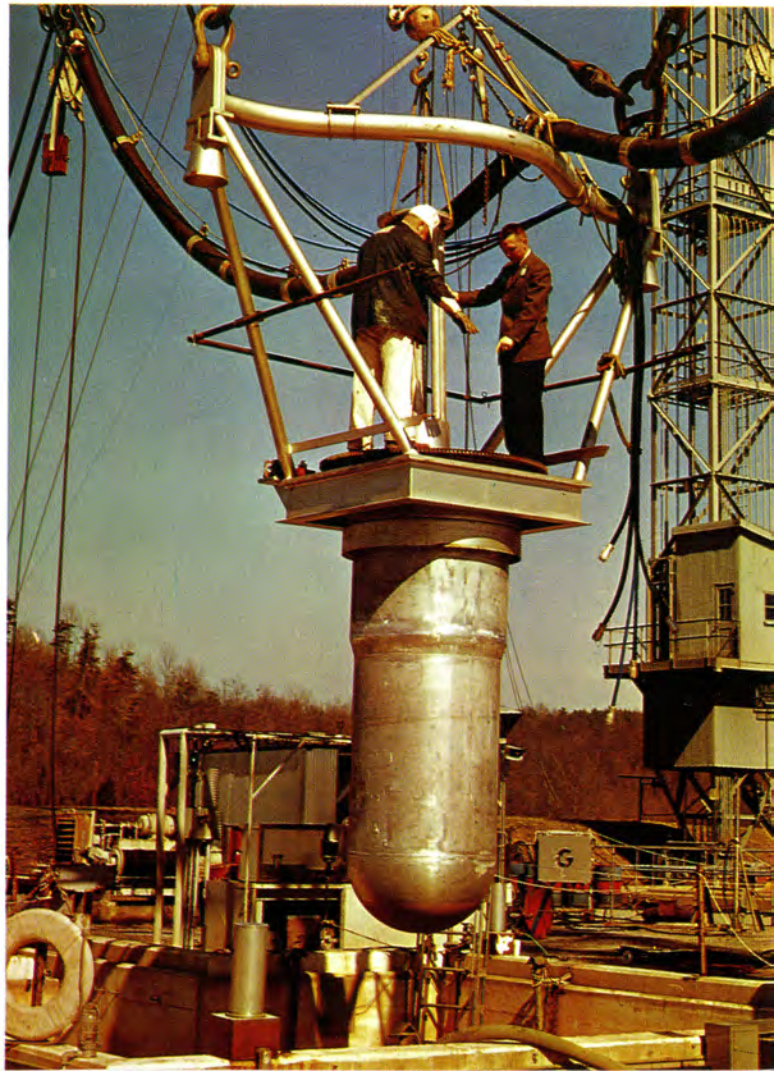
Emphasis on peaceful applications of nuclear energy increased under the Atomic Energy Commission, which was organized in 1946. The Clinton Laboratories, which had been a pilot plant for research and development on plutonium production, became, in 1948, the Oak Ridge National Laboratory; a vigorous program of fundamental research, radioisotopes production, and nuclear power development was undertaken at the enlarged laboratory. Union Carbide became the operating contractor in March, 1948.

WORLD'S OLDEST—The Graphite Reactor (above) is the second reactor built and the first with a sizeable power output. It has been in continuous operation at Oak Ridge National Laboratory (left) since November 4, 1943, mostly for research and radioisotope production. It has achieved a performance three times greater than its original design rating. ONE OF THE NEWEST—The Oak Ridge Research Reactor (right) uses pure water for shielding from radiation and thus offers a clear view of the fuel region where the nuclear reaction occurs. The water shield also offers easy access to the core, thereby facilitating experimentation in the reactor.



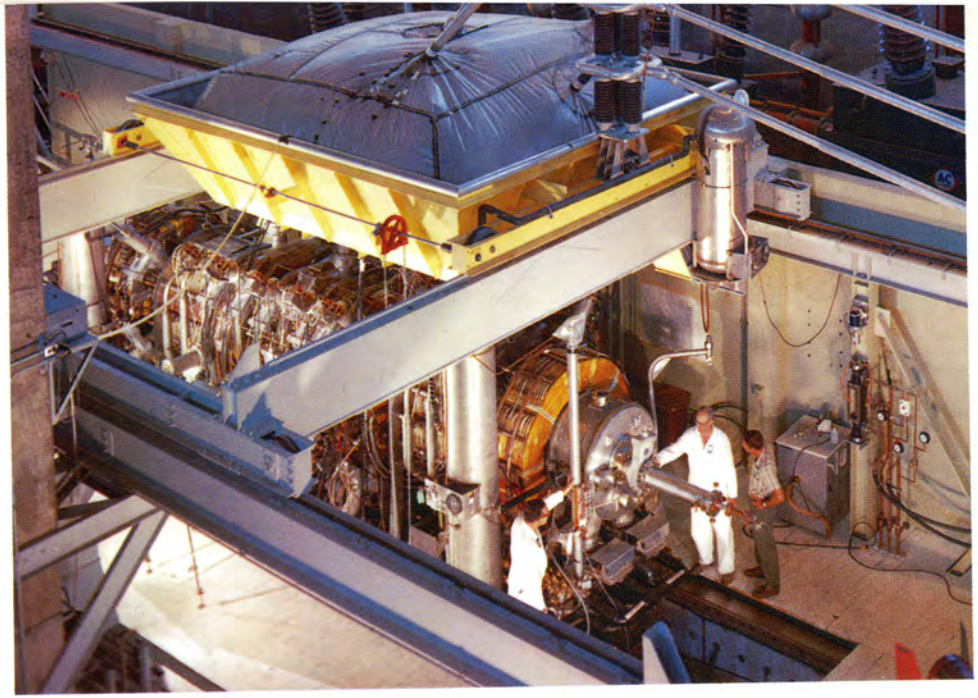


FLUID FUEL SYSTEM—In a full-scale model of the Molten Salt Reactor (left), salts containing uranium fuel were pumped through the system. An actual reactor, to demonstrate advantages of the system for producing electricity, is now under construction.
AIRBORNE—The Tower Shielding Reactor (below) can be raised 200 feet by cables suspended from four 325-foot towers. These towers can be seen from Melton Hill dam.

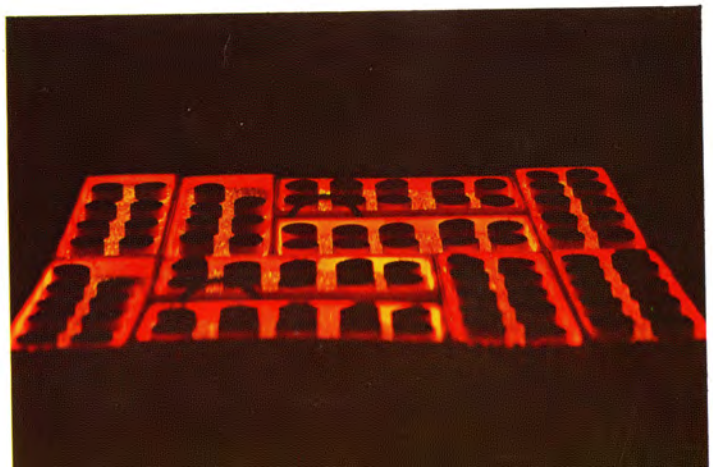


REACTOR PROVING GROUND

ORNL developed the Materials Testing Reactor, the first postwar nuclear reactor designed for research on high-performance materials to be used in reactors producing power. Work on this reactor led to the development of submarine propulsion reactors, the "package" reactors for power at remote locations, and swimming pool research reactors. Advanced power-producing reactors now being developed at ORNL include those using fluid fuels and others with solid fuels and gaseous coolants.



FUSION—The Direct Current Experiment-2 (above) is a device for investigating the problems of achieving power from the fusing of light atoms under conditions of extremely high vacuum and within a strong magnetic field.
SATELLITE SOURCES—Intensely radioactive pellets (below) glow from the energy of their radioactivity. Such fission product sources will provide electricity to operate instruments for satellites. NUCLEAR SHIP—The NS Savannah (right above) has a propulsion system based on a pressurized water reactor designed with technical advice and assistance from ORNL.



NEW SOURCES OF ENERGY

Electricity from nuclear energy is generated by ORNL's radioisotopes in power sources used to operate automatic, unattended arctic weather stations and deep-sea oceanographic research data instruments.

Power from nuclear energy is also the goal of fusion research at ORNL. The energy of atoms fusing at the temperature of the sun can provide power with a fuel from sea water—an almost limitless supply.

PACKAGING AND SHIPPING—Because of the radiation they emit, radioisotopes are shipped in shielded containers, such as those on the assembly line (left). Nearly 100 radioisotopes and more than 250 stable isotopes are now routinely available from the Laboratory. RADIOISOTOPES—From August 2, 1946 through 1962, ORNL has shipped more than 1,500,000 curies of radioisotopes and 5,000 grams of enriched stable isotopes throughout the world for use in industry, agriculture, training and medicine (below).

RADIOISOTOPES FOR PEACEFUL USES

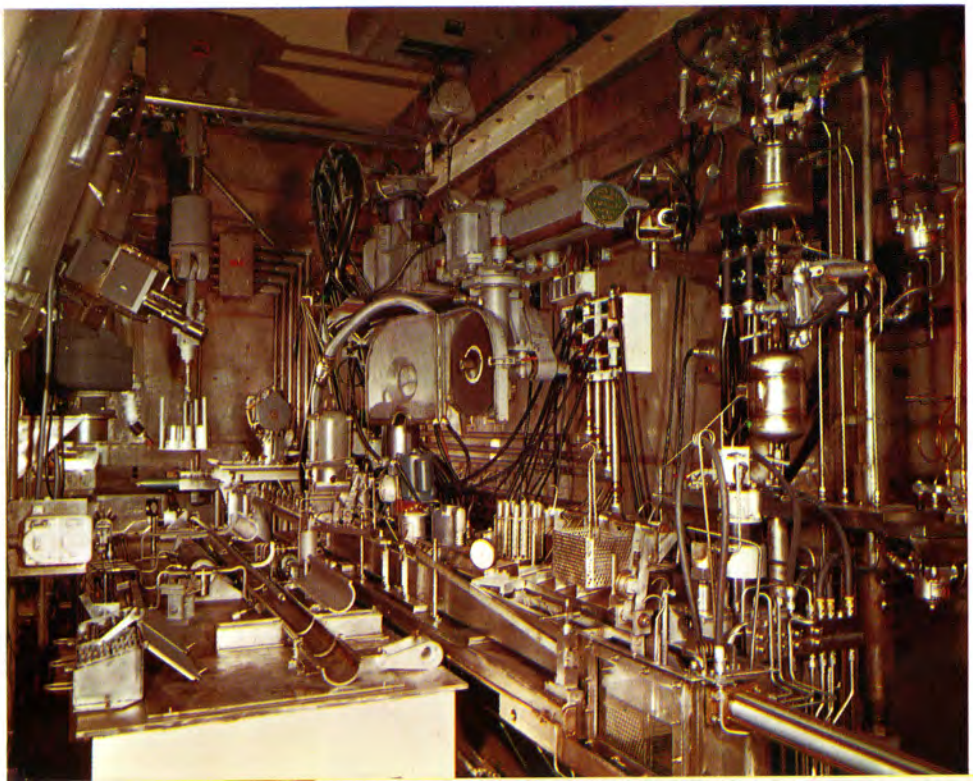
The first large-scale peaceful uses of nuclear energy came from radioisotopes produced at ORNL and made generally available beginning in 1946. Called "the most valuable new research tool since the invention of the microscope," radioisotopes have saved many lives through medical uses. They have also resulted in yearly savings of millions of dollars for the nation's industries and consumers. Radioisotopes produced in Oak Ridge are now in use from pole to pole and to the ocean's depths.

FUNDAMENTAL RESEARCH

Fundamental research is performed at the Laboratory on materials made radioactive by neutron bombardment in nuclear reactors and by irradiation in cyclotrons. Research covers the effects of radiation on both living and non-living matter. Much of the work done at the Oak Ridge National Laboratory involves the detection and measurement of potentially hazardous radiations which human senses cannot detect. An over-riding consideration in all work is to assure safe working conditions and protection for employees.

REPROCESSING SPENT NUCLEAR FUEL

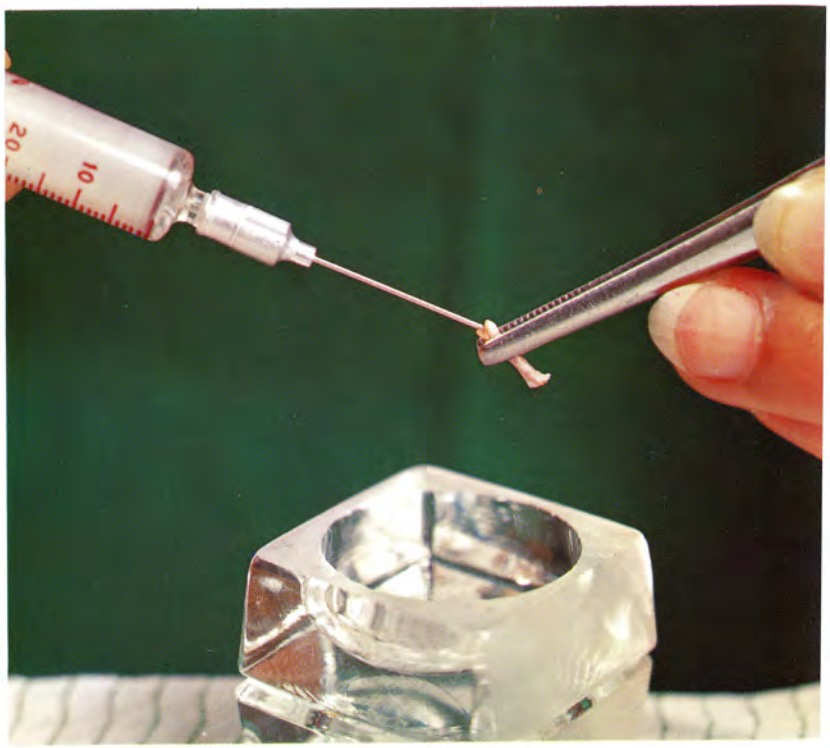
Fuel from nuclear reactors is processed at the Laboratory to recover valuable radioisotopes, and to prepare the unconsumed uranium for re-use as reactor fuel. Processing research is concerned not only with providing better and cheaper products, but also with the safe and economical disposal of radioactive wastes. The transmutation of plutonium into even heavier elements—like californium and berkelium—will be accomplished in the High Flux Isotope Reactor now under construction.



REMOTE CONTROL—Highly-radioactive fuel elements from reactors cannot be handled directly because of radiation hazards. This complex equipment (right) was designed to dejacket fuel elements prior to chemical processing for removal of fission products and the recovery of unused uranium. Such equipment is located behind shielded walls. FUNDAMENTAL RESEARCH —The new and highly versatile Oak Ridge Isochronous Cyclotron (above) provides opportunities for research in medium-energy nuclear physics and transuranium elements. The ORIC uses a 220-ton magnet sheltered behind thick walls and the world's heaviest (65 tons) doors.

RESEARCH ON RADIATION

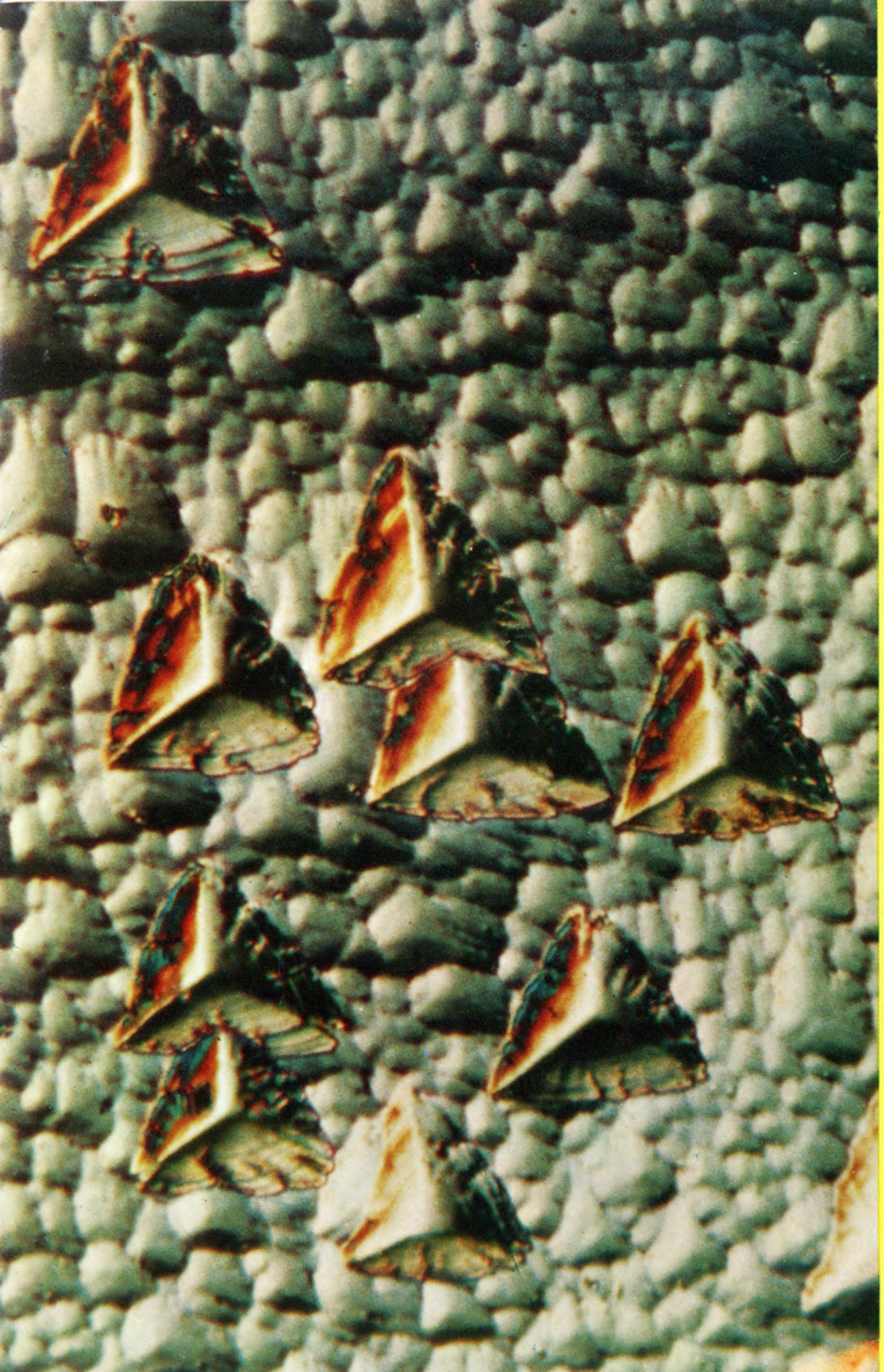
Research and development activities at ORNL are concerned generally with radiation and radioactive materials — the essential ingredients of nuclear energy. The Laboratory performs research in broad fields of science, including physics, metallurgy, chemistry and engineering, to advance knowledge of nuclear energy in all its aspects. The new tools are extremely helpful in biological research, and it is anticipated that the secrets of life processes may ultimately yield to the application of these tools and techniques.



BONE MARROW CELLS from the thigh bone of a mouse are flushed with a salt solution (above). The needle, placed in the marrow cavity, flushes out the marrow. RADIATION EFFECTS—Fundamental research on the effects of radiation on solids includes the study of crystals (right) of pure materials exposed to radiation. Such research leads to development of improved materials for nuclear applications and to better methods of machining, welding and fabrication of materials.

THE PROMISE OF THE NUCLEAR AGE

In an address before the Society of Nuclear Medicine on June 28, 1962, Dr. Glenn T. Seaborg, chairman of the U. S. Atomic Energy Commission, said, "Nuclear research today is varied and rewarding. Its future is so exciting that we cannot but envy the future scientists who will reach maturity two decades from now. But I trust that we may have the satisfaction of knowing that we have in a real sense paved the way for their achievements."



OAK RIDGE NATIONAL LABORATORY MILESTONES

Feb. 1, 1943—Construction of a plutonium production pilot plant started near Knoxville under the code name of Clinton Laboratories; to be operated by the University of Chicago as part of the Metallurgical Project.

Nov. 4, 1943—Graphite Reactor operated successfully. This was the world's first reactor to produce plutonium.

Dec. 1943—Chemical processing operations started to separate plutonium from uranium.

Dec. 30, 1943—First milligram quantities of purified plutonium shipped from Clinton Laboratories to University of Chicago for research.

Aug. 1944—Pilot plant demonstration of plutonium production processes completed and final process design report for Hanford issued.

Jan. 1945—Emphasis of work at Clinton Laboratories shifted from pilot plant operation to research on other problems connected with development of nuclear energy.

June 1945—All original objectives of Clinton Laboratories successfully accomplished.

July 1, 1945—Monsanto Chemical Company became operating contractor for Clinton Laboratories.

Aug. 2, 1946—First radioisotope shipment made.

Jan. 1, 1947—AEC took over operations from Manhattan District.

Mar. 1948—Carbide accepted operating contract, and name was changed to Oak Ridge National Laboratory.

1948—Construction started on permanent research facilities. $2 million radioisotope production facilities completed.

1949—Homogeneous reactor development reactivated. Aircraft reactor development work initiated. A new pool-type research reactor was developed, constructed and placed in operation as the second reactor on the site. This was the first of the "swimming pool" type of research reactors now in wide use.

1950—Research divisions and some physical facilities of Y-12 became part of ORNL. Oak Ridge School of Reactor Technology opened. Metal Recovery Plant built for processing irradiated reactor fuel.

1951—Full-scale model of the Materials Testing Reactor (MTR) converted to a third operating reactor, the Low Intensity Testing Reactor (LITR).

1952—MTR, largely designed by ORNL, placed in operation at Arco, Idaho.

1953—Homogeneous Reactor Experiment (HRE) became the second reactor to produce electricity. High Voltage Laboratory constructed for physics research with Van de Graaff accelerators.

1954—Aircraft Reactor Experiment operated successfully with all components at bright red heat. HRE dismantled and construction of HRE-2 started. Tower Shielding Reactor built for aircraft shielding research.

1955—An operating swimming pool reactor and building were designed and constructed in five months, and exhibited at the Atoms for Peace Conference in Geneva, Switzerland.

1956—Thermonuclear fusion research expanded to develop a promising new approach to achieving a controlled reaction by injection of high energy ions into a plasma—the Direct Current Experiment, referred to as DCX.

1957—From an ORNL concept, an Army Package Power Reactor was designed and constructed at Ft. Belvoir, Va.

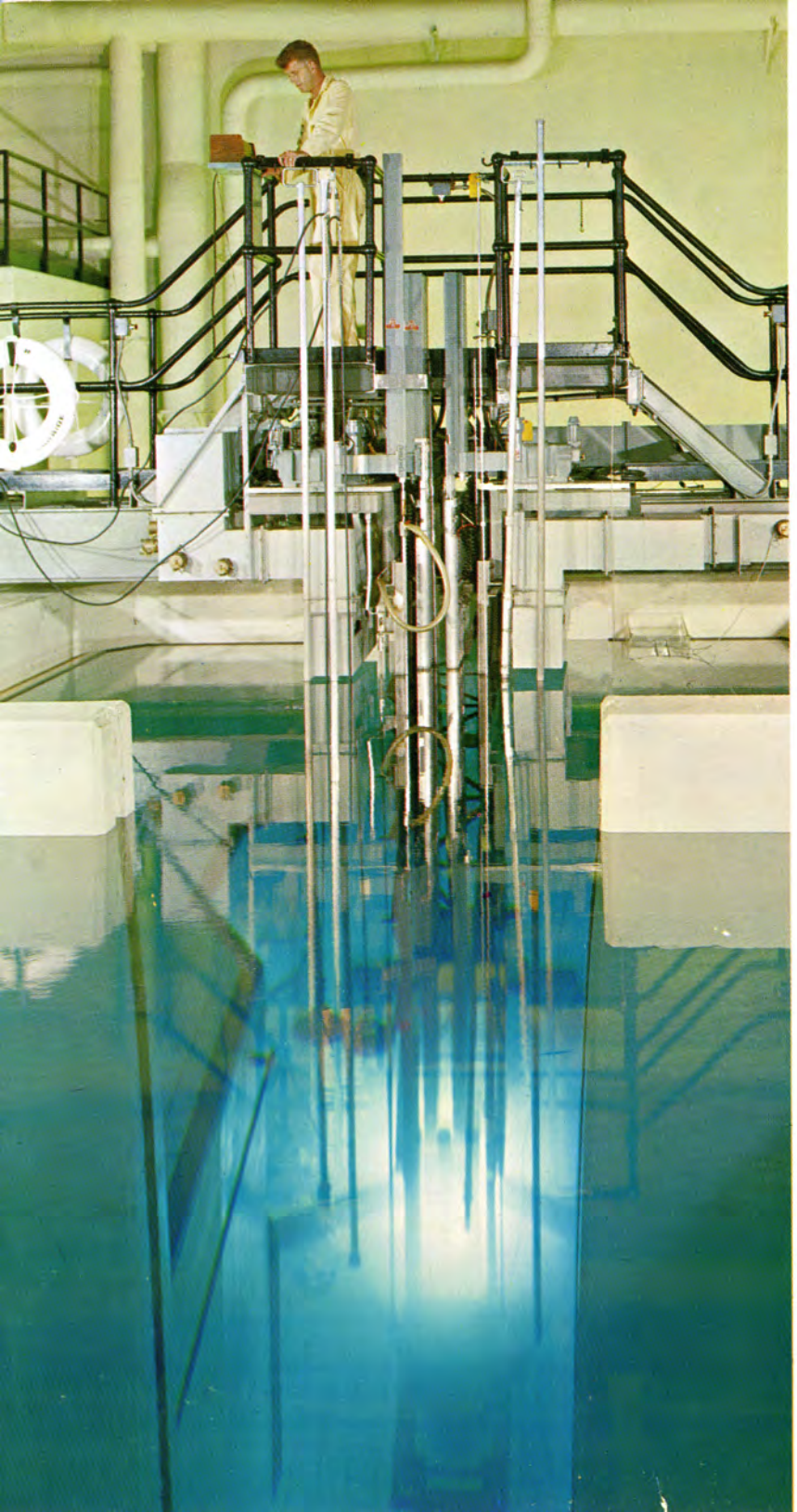
1958—A new 30 megawatt research reactor (ORR) was completed. The Fission Products Development Laboratory was constructed. ORNL coordinated the fusion exhibit at the Second Conference on Peaceful Uses of Atomic Energy, and the Laboratory exhibited a working model of the DCX.

1959—Major construction program initiated to provide new research facilities, including the Central Research Laboratory additions, the Metals and Ceramics Laboratory, the High Radiation Level Examination Laboratory, and major renovations to facilities used by ORNL in Y-12.

1960—Construction begun on a new cyclotron of advanced design, the Oak Ridge Relativistic Isochronous Cyclotron (ORIC) and on a 10-Mev Van de Graaff charged particle accelerator for physics research.

1961—ORNL established as AEC center for production of transuranium elements not existing in nature. Construction of a High Flux Isotope Reactor and transuranium elements processing laboratory planned. Construction also begun on a special unshielded reactor for bio-physics research on radiation effects, and on a Molten Salt Reactor Experiment to test non-aqueous fluid fuel systems for producing electricity.

1962—Additions completed to the Central Research Laboratory, and a new Metals and Ceramics Laboratory constructed. AEC established ORNL as the Isotopes Development Center. The Bare Reactor Experiment, Nevada (BREN) was conducted by ORNL, using the unshielded health physics reactor mounted atop a 1500-foot tower to simulate nuclear weapons explosions in the air.



UNION CARBIDE IN NUCLEAR ENERGY

Like many other companies, Union Carbide is putting the atom to work in its own business, both in production operations and in research.

Radioisotopes are used as tracers in checking reactions in making chemicals and plastics. They permit accurate determinations that were impossible previously.

Agricultural researchers working for Union Carbide are using radioisotopes to study fertilizers used in plant nutrition and in studying fungicides and herbicides developed to help farmers obtain more abundant food crops. Radioactive thickness gauges and similar instruments have simplified and improved the control of many mechanical processing operations, particularly in plastics manufacture.

STERLING FOREST—Union Carbide Nuclear Company's research center consists of the reactor (left) and the radioactive materials laboratory, which is being used for studying the effects of radiation on various compounds.
RESEARCH CENTER — The facility (right) is the focal point for nuclear and ore research within the Corporation. Included in this project are the main research building, a power and utilities building, and an ores and minerals development laboratory.

FROM PRODUCTION TO RESEARCH—Uranium salts such as these (right) find their way into various research, production and development programs (above and below) for the peaceful uses of nuclear energy.

UNION CARBIDE'S mill (left) at Uravan, Colorado, is one of the largest on the Colorado Plateau. The Corporation is a major supplier of uranium for the nation's nuclear energy program.

UNION CARBIDE

THE OAK RIDGE, TENNESSEE
AND PADUCAH, KENTUCKY
NUCLEAR FACILITIES
ARE OPERATED BY
UNION CARBIDE CORPORATION
FOR THE
U. S. ATOMIC ENERGY
COMMISSION