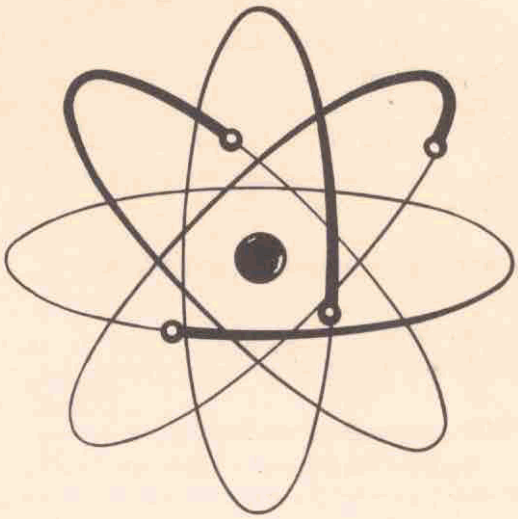
AEC HANDBOOK ON OAK RIDGE



prepared by

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ATOMIC ENERGY COMMISSION
OAK RIDGE, TENNESSEE

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I. OAK RIDGE OPERATIONS

During World War II, one of the most remarkable communities and industrial areas in the world came into being on a site where only oak and pine trees dotting small farms had been before. It was named Oak Ridge.

In three years Oak Ridge grew from nothing to the fifth largest city in Tennessee and became one of the historic cities of America—a town that will ever remain associated with the greatest secret project of World War II.

Oak Ridge was the heart of the United States' military atomic energy project. Under the code name of Manhattan Engineer District a program was directed from headquarters in Oak Ridge which succeeded in harnessing atomic energy into the most devastating weapon in history, and in so doing, built a great national industrial complex.

The nation's atomic energy program continued to be directed from Oak Ridge until headquarters of the new Atomic Energy Commission was established in Washington in 1947.

Oak Ridge then assumed the position of a major field installation of the AEC. The Oak Ridge Operations Office at Oak Ridge is staffed by some 950 persons, the only AEC employees in the city. The various facilities of the Commission are operated by contractors.

Established September 15, 1947, the operations office has five primary functions:

1. To direct the operation and maintenance of plants and facilities for the production of fissionable and related materials.

2. To direct design and construct plants and facilities as may be required.

3. To administer research and development contracts including that of the Oak Ridge Institute of Nuclear Studies.

4. To administer the AEC program for production and distribution of radioactive and stable isotopes.

5. To direct the construction, maintenance and administration of housing and community facilities for the town of Oak Ridge until government ownership is terminated.

Five important area offices of the AEC in addition to Oak Ridge come under the direction of the Manager of Oak Ridge Operations. These are the Paducah Area Office, site of a huge uranium-235 separation plant near Paducah, Kentucky; the Portsmouth Area Office, site of another mammoth U-235 separation plant near Portsmouth, Ohio; and the feed materials facilities of the St. Louis Area Office, Fernald (Ohio) Area Office, and the New Brunswick, N. J., Area Office.

Paducah Area Office

The Paducah Area Office was established January 15, 1951, to direct the construction and operation of a new gaseous diffusion plant for the separation of uranium-235, to be built 16 miles west of Paducah.

Plant units, upon completion, were turned over to the Carbide and Carbon Chemicals Company, (now Union Carbide Nuclear Company) a division of Union Carbide and Carbon Corporation, for operation. The facility is similar to the gaseous diffusion plant at Oak Ridge, also operated by Carbide for AEC. (See Section III, "The Gaseous Diffusion Plant", for an explanation of the mechanics of the gaseous diffusion process.)

The general contractor for construction of the plant was F. H. McGraw and Company of Hartford, Connecticut. McGraw also was awarded the principal contract for construction of additional plant units, estimated to cost $459,000,000, announced in 1952, and Carbide was selected as the operating contractor for these units.

Four architect-engineer firms were retained for the original project: Giffels and Vallet, Inc., Detroit; Sargent and Lundy, Chicago; Singmaster and Breyer, New York; and Smith, Hinchman and Grylls, Inc., Detroit. Giffels and Vallet and Sargent and Lundy were given additional tasks connected with the expansion.

Electric power for the plant is being supplied jointly by the Tennessee Valley Authority and Electric Energy, Inc. The latter is a syndicate of five private utility firms: Central Illinois Public Service Company, Illinois Power Company, Kentucky Utilities Company, Middle South Utilities Company and Union Electric Company. Each agency built a power plant to supply half of the million kilowatts needed for the originally planned facilities. Additional project power requirements will be met 75 per cent by TVA and 25 per cent by EEI.

Portsmouth Area Office

In July 1952, a major new office was established in Oak Ridge to direct construction and operation of a gaseous diffusion plant estimated to cost $1,219,000,000 in the Ohio River Valley.

Consideration of several sites already was under way, and the AEC announced the following month that the plant would be located in Pike County, Ohio, about 20 miles northeast of Portsmouth. The Oak Ridge organization was moved to the area, designated the Portsmouth Area Office, and acquisition of the required 3,700 acres was begun by the Army Corps of Engineers for the AEC.

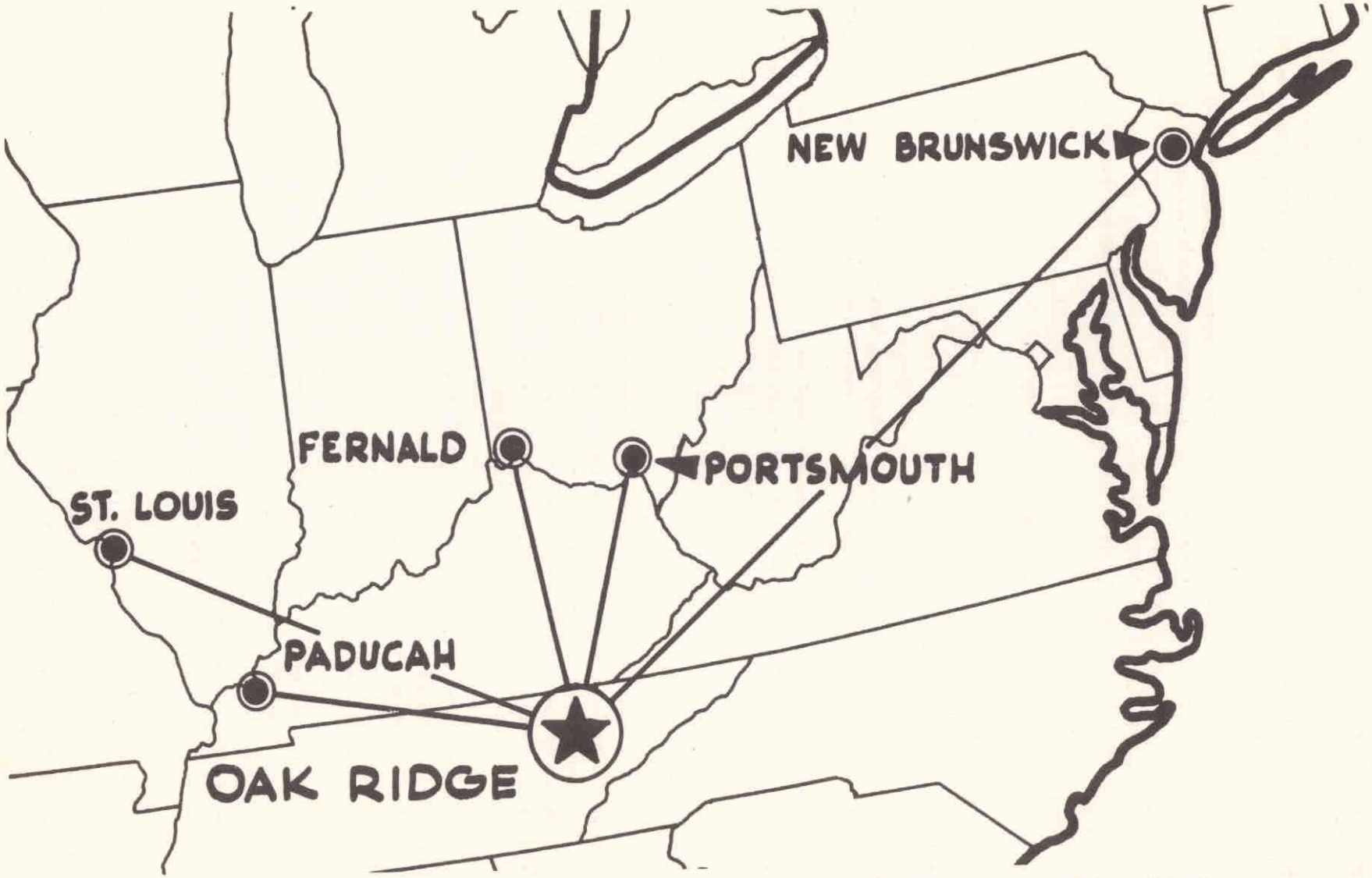
Important factors in the selection of the site were the ability to obtain immense amounts of interim and permanent power, a large and dependable source of water, adequate potential labor supplies and suitable transportation facilities.

Electric power is supplied by a group of 15 private power companies known as the Ohio Valley Electric Corporation, which will furnish the required 1,800,000 kilowatts for the completed Portsmouth plant. A 25-year agreement was made between the corporation and AEC, with provision for a two-year notice of cancellation if the AEC's power demand should diminish or cease. The annual cost of power for the plant is estimated at $60,000,000. The 15 companies in the OVEC are: Appalachian Electric Power Co., Cincinnati Gas and Electric Co., Columbus and Southern Ohio Electric Co., Dayton Power and Light Co., Indiana and Michigan Electric Co., Kentucky Utilities Co., Louisville Gas and Electric Co., Monongahela Power Co., Ohio Power Co., Pennsylvania Power Co., Potomac Edison Co., Southern Indiana Gas and Electric Co., Toledo Edison Co., and West Penn Power Co.

The principal construction contract was awarded to Peter Kiewit Sons' Co. of Omaha, Nebraska. Goodyear Atomic Corporation, a subsidiary of the Goodyear Tire and Rubber Company, was selected as the operating contractor. Named to handle various phases of design and architectural work were: Union Carbide and Carbon Corporation of New York; Giffels and Vallet, Inc., Detroit; Sargent and Lundy, Chicago; Singmaster and Breyer, New York; Smith, Hinchman and Grylls, Detroit; A. M. Kinney, Inc., of Cincinnati; Burns and McDonnel, Kansas City, Mo.; Alvord, Burdick & Howson of Chicago, and Holabird and Root and Burgee, Chicago.

A peak force of 22,500 workers on the project was reached in the summer of 1954, but the average construction employment was not expected to exceed 17,000. A permanent force of approximately 3,000 is needed for plant operations.

The size and complexity of the new plant is indicated by the quantities of construction materials required for the mammoth job. If all the building materials needed were loaded on a single freight train,



OAK RIDGE OPERATIONS INSTALLATIONS

100,000 freight cars would be required, making a procession 814 miles long—approximately the distance between Cincinnati, Ohio, and Wichita, Kansas.

The floor area of the permanent buildings totals about 9,000,000 square feet—or approximately 210 acres. An additional 1,200,000 square feet of floor space is included in temporary buildings.

When the plant is completed it will require a permanent water supply of 40,000,000 gallons per day. The necessary water supply comes from the Scioto River and from three wells with a capacity of 2,500 gallons per minute.

It will take 120,000,000 man-hours to complete the project—enough to keep one man on a 40-hour week busy for 57,692 years.

Fernald Area Office

The Fernald Area Office was established in 1951, shortly after the announcement of a new Feed Materials Production Center to be located near Cincinnati, Ohio. The facilities are situated near the town of Fernald, Ohio, which is 14 miles northwest of Cincinnati.

The property, consisting of 1,050 acres of slightly rolling land, was acquired by the U. S. Corps of Engineers in 1951. The industrial or plant area covers approximately 136 acres in the center of the site.

Engineering and design were performed by Catalytic Construction Company of Philadelphia, Pa. Construction was started in May 1951 by the George A. Fuller Company of New York and completed in June 1954. The plant is operated for the AEC by the National Lead Company of Ohio. Peak construction employment was 3,200 persons and the operating employment as of July, 1955, was approximately 2,700, including fewer than 30 AEC employees. The total cost of construction, design and engineering was approximately $85,000,000.

The Feed Materials Production Center is a complete integrated series of plants, whose function is to convert high grade raw uranium ore and concentrates into highly purified uranium compounds or metal. Uranium concentrates from mines located throughout the world are received at the site, sampled, processed through several refining and fabrication plants and the product used as feed for reactors or diffusion plants. The process is so designed as to reclaim essentially all of the uranium contained in the concentrates, and also a substantial portion of the chemicals used in the various process steps.

The plant consists of nine major process plants, twelve service type buildings, and twelve miscellaneous facilities associated with utilities, maintenance and process storage, and safety and security facilities. The total area under roof is 11.8 acres.

An expansion program estimated to cost $20,100,000 was announced in October 1954. Construction work is in progress on modification of existing buildings and equipment and auxiliary facilities to expand productive capacity. Singmaster and Breyer, New York, N. Y., is performing design work for the expansion; and Maxon Construction Company, Dayton, Ohio, is the prime construction contractor.

Electric power and natural gas are supplied by Cincinnati Gas and Electric Company. The plant has its own water supply, consisting of three deep wells of 700 gallons per minute capacity, and auxiliary facilities.

St. Louis Area Office

The St. Louis Area Office, established in 1942, occupies approximately 10.5 acres adjacent to the main plant of the Mallinckrodt Chemical Works, the operating contractor. The function of the area is the refining of ores and concentrates into high purity uranium metal and intermediate compounds.

Early in 1942, the Army Corps of Engineers contracted for production of very pure uranium oxide by refining uranium ores. In November the contract was revised to include production of green salt (uranium tetrafluoride) and uranium metal. Initial production operations were performed in Mallinckrodt Plant facilities and a nearby building on Broadway leased by the Corps of Engineers. The uranium used in the first atomic reactor at Chicago in 1942 was fabricated at Mallinckrodt.

As requirements for uranium products increased it became necessary to construct a new refinery. The refinery was completed early in 1946 on a tract of land leased from Mallinckrodt and production facilities were removed from the Mallinckrodt main plant. New metal production facilities were placed in operation in July, 1950, and a green salt plant in March of 1951. In addition, a boilerhouse, warehouses, maintenance shops, laboratories, personnel service and office facilities have been constructed.

The building leased on Broadway is now used as a process development pilot plant. In addition, a 22-acre tract in St. Louis County was purchased in 1945 to serve as a storage area for refinery residues. The government investment in St. Louis Area facilities totaled more than $17,000,000 at the end of June 1955.

In October 1954, the AEC announced that the existing plant operated by Mallinckrodt was to be expanded and that a new plant was to be built on a portion of the government-owned Weldon Spring Ordnance Works, 27 miles west of St. Louis. Construction work is under way on both facilities under the expansion program estimated to cost $39,800,000.

The Weldon Spring plant will occupy about 200 acres of the manufacturing area of the Ordnance Works, and will consist of a purification unit, uranium chemical unit, uranium foundry and auxiliary facilities. Mallinckrodt will operate the new facilities also. A permanent operating force of some 1,000 will be required.

Mallinckrodt currently employs about 830 persons in the St. Louis Area operations. AEC personnel totals 34.

New Brunswick Area Office

The New Brunswick Laboratory at New Brunswick, N. J., was established in 1949 to provide facilities for quality control of uranium and related materials used or processed by other AEC plants.

The Laboratory, a 32,000 square foot brick building formerly a manufacturing plant, was purchased by the AEC in 1948. It was reconverted and began operations in the spring of 1949. Representing an investment of over $1,600,000, it is one of the best equipped analytical control laboratories in the country. The Laboratory is an AEC facility completely owned and operated by the government. Employment at New Brunswick Laboratory is approximately 65. The nucleus of the staff is a group formerly employed by the National Bureau of Standards on Atomic Energy Commission analytical activities.

In addition to the analytical work comprising assay, service analysis, and development work on new methods of analysis, the laboratory is engaged in investigation of plant production processes and assists contractors on technical problems.

II. THE OAK RIDGE AREA

The Oak Ridge Area of the Atomic Energy Commission is a 60,000-acre Government-owned tract—approximately 94 square miles—in Anderson and Roane Counties. In little more than 12 years, Oak Ridge has changed from quiet East Tennessee countryside to an internationally famous and significant center of scientific and industrial activity. In 1942, the United States Army launched a project here in an area containing three little communities and a few farms. What took form was a community unique in history. American men and women, with skill, ingenuity, energy and teamwork—and dogged determination—labored

mightily in a war-born boomtown with a single secret goal.

By mid-1945, this raw, thriving project behind a security fence housed 75,000 persons and employed 82,000. The result: A significant contribution toward ending the war. In Oak Ridge was produced the fissionable material used in the weapon that wiped out Hiroshima and brought into sight the end of hostilities.

Situated in Oak Ridge today are three main operating facilities concerned with atomic energy work—two plants for production and related research, and a third which serves as a nuclear research center. Also there is the community of Oak Ridge, with a population of approximately 32,000.

The operating facilities are the gaseous diffusion plant for the production of U-235; the Y-12 area for programs of special interest to the AEC, the production of stable isotopes, and research on process improvements; and Oak Ridge National Laboratory, nuclear research center and source of most of the nation's radioactive isotopes. This unit served during World War II as a pilot plant for the huge plutonium process buildings constructed at Hanford Engineer Works in the state of Washington, now known as the AEC's Hanford Operations Office, Richland, Washington.

The three principal facilities at Oak Ridge are operated for the AEC by Union Carbide Nuclear Company, formerly Carbide and Carbon Chemicals Company, a Division of Union Carbide and Carbon Corporation.

Near the gaseous diffusion plant is a high-temperature, high-pressure, variable-frequency steam power plant with a generating capacity of 238,000 kilowatts—twice the capacity of Norris Dam.

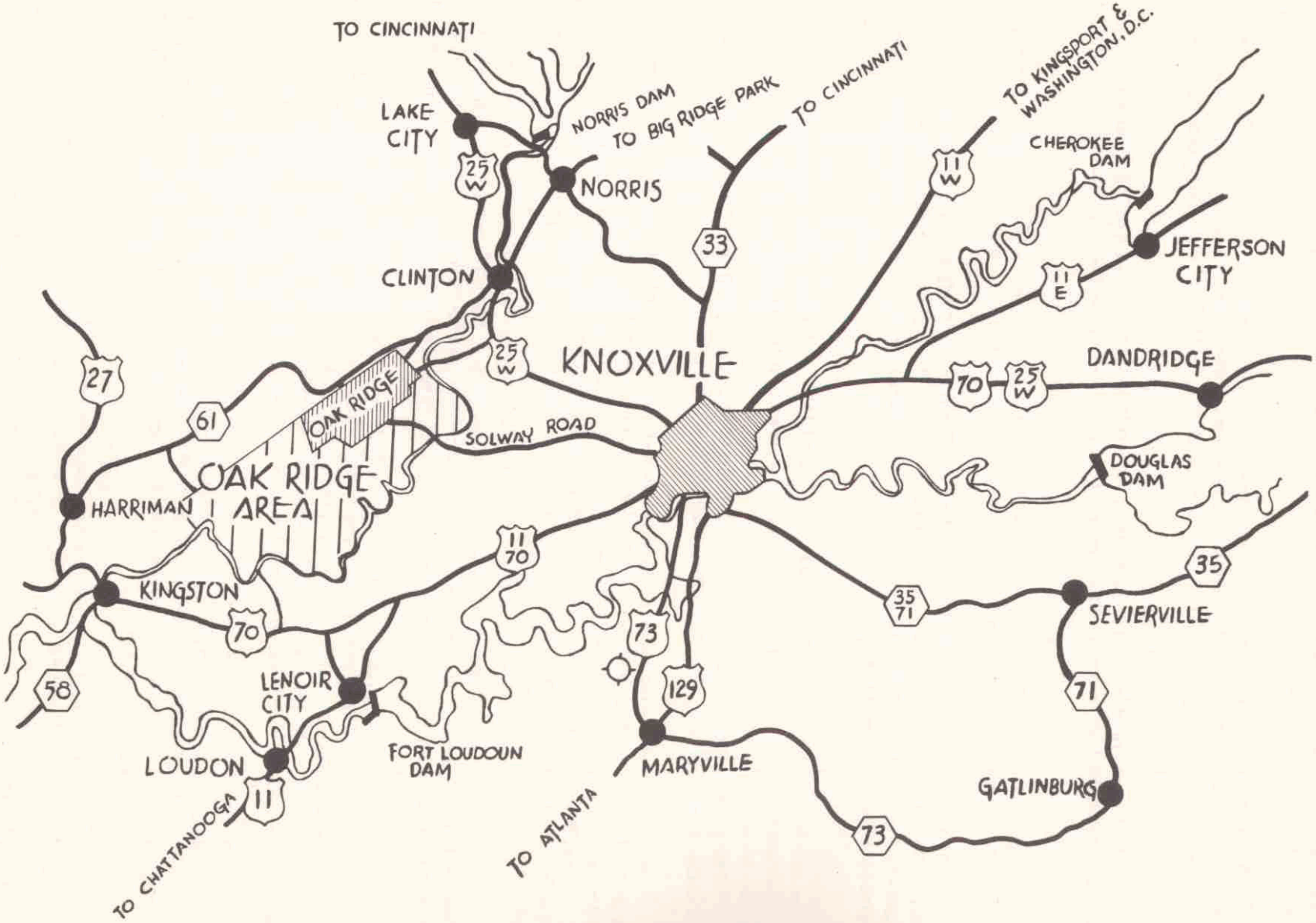
The Oak Ridge Area also is headquarters for the Oak Ridge Institute of Nuclear Studies, Inc., an organization of 32 member universities in the South and Southwest. The objective of the ORINS is a program of assistance to universities in developing strong graduate and research programs in nuclear energy. The Institute also is available in an advisory capacity to the Commission on programs for fundamental research in atomic energy.

The site for the Oak Ridge Area (formerly known as Clinton Engineer Works) was selected on September 19, 1942, by representatives of the Army Corps of Engineers' Manhattan District, which had been established August 13, 1942, and the Stone and Webster Engineering Corporation of Boston, which had the contract for the construction of the town of Oak Ridge and the electromagnetic plant. The site was selected because it had to be: (1) isolated from large centers of population, (2) large enough to accommodate several huge plants in flat areas separated by natural barriers, (3) near dependable electrical power in large quantities, (4) near a large supply of water, and (5) easily accessible by rail and motor transport.

The 58,800 acres originally comprising the Oak Ridge Area were acquired at a cost of $2,600,000 under the cloak name of "Kingston Demolition Range". While additional acreage has been purchased since 1942, other land has been sold or relinquished. Of the 60,000 acres now in the site, 32,000 are in Anderson County and 28,000 in Roane.

The investment in the existing operating units and the town of Oak Ridge totals more than 1.25 billion dollars. Preliminary site preparation started on November 2, 1942; the first building (now the AEC Administration Building) was started November 25, 1942; the first plant buildings were started February 1, 1943; the first carload of materials was received November 3, 1942, and the first production of U-235 on a mass basis (at the electromagnetic plant) was started on January 27, 1944.

The Oak Ridge Area has these over-all dimensions: greatest length, about 17 miles, greatest width, about nine miles. The area is approximately seven miles from the Anderson County seat—Clinton, the town for which the area first was named. Oak Ridge is about 20 miles northwest of Knoxville and about 18 miles southwest of Norris Dam. Running generally northeast and southwest, the Oak Ridge Area is bounded on


TO CINCINNATI
LAKE CITY
NORRIS DAM
TO BIG RIDGE PARK
TO CINCINNATI
TO KINGSPORT & WASHINGTON, D.C.
CHEROKEE DAM
NORRIS
CLINTON
KNOXVILLE
JEFFERSON CITY
DANDRIDGE
DOUGLAS DAM
OAK RIDGE
OAK RIDGE AREA
SOLWAY ROAD
HARRIMAN
KINGSTON
LENOIR CITY
LOUDON
FORT LOUDOUN DAM
TO CHATTANOOGA
TO ATLANTA
MARYVILLE
SEVIERVILLE
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the east, southeast and southwest by the Clinch River which meanders some 35 miles while serving as a boundary.

When the site was selected in 1942 and site preparation started, approximately 3,000 persons were moved out of about 1,000 homes along the ridges and in the valleys of the area. Originally, within the area were three small farming communities, Scarboro, Robertsville, and Wheat. Most of the farm homes have now been vacated and razed.

Fifty-five miles of railroad and more than 300 miles of roads were built and improved during the construction period. In 1949, a portion of the railroad trackage was removed to make way for a new business site.

Highest point above sea level in the Oak Ridge Area is 1,204 feet on Outer Drive on the ridge along which the town was built; lowest point above sea level is 775 along the Clinch River.

The Atomic Energy Commission, established under an Act of Congress signed into law August 1, 1946, by President Harry S. Truman, took over jurisdiction of the Oak Ridge Area from the Army Corps of Engineers' Manhattan District on January 1, 1947. The Manhattan District was abolished in a Corps of Engineers order of August 15, 1947.

III. THE OPERATING UNITS

The Gaseous Diffusion Plant

The gaseous diffusion plant for the concentration of uranium-235 lies in Roane County in the southwest corner of the area near the Clinch River, approximately 13 miles from the town of Oak Ridge.

Design work on original units of this plant was started early in 1943 by the Kellex Corporation, a unit of the M. W. Kellog Corporation of New York City, which also handled the supervision of construction and procurement of equipment. Chief construction contractor was the J. A. Jones Construction Company of Charlotte, North Carolina. Ford, Bacon and Davis, Inc., of New York designed, constructed, and for a time operated an auxiliary 400 x 1,000-foot plant to condition equipment before placement in the process plant.

Carbide and Carbon Chemicals Company, now Union Carbide Nuclear Company, on January 20, 1943, accepted a letter of intent for operation of the gaseous diffusion plant and later signed a long-term operating contract. Carbide also made important contributions to the research and planning connected with the facility.

The main gaseous diffusion process building, K-25, is a huge U-shaped structure. Each side of the building is 2,450 feet long and averages 400 feet in width and 60 feet in height. The total area of the main building is 44 acres. Nearby are three additional diffusion process buildings, K-27, K-29, K-31, and K-33, completed since the original K-25 plant went into operation. The plant area of 600 acres contains more than 70 additional buildings. Present plant units cost about $650,000,000, exclusive of construction now under way.

Construction of the main process plant started September 10, 1943, and the first units for the production of U-235 began operating February 20, 1945. The construction forces on this early plant reached 25,000 in May 1945. The peak war-time operating force for this process was about 12,000. Employment as of July 1, 1955, was about 5,500.

Plans to erect the K-33 addition were announced in July 1952, and work immediately got under way. The Maxon Construction Company of Dayton, Ohio, which had built K-29 and K-31 in 1949-1951, was selected as construction contractor for the additional big unit. Selected for architect-engineer services for the K-33 job were the firms of Giffels and Vallet, Sargent and Lundy, and Smith, Hinchman and Grylls.

The tremendous electric power demand involved in the gaseous diffusion plant facilities here are being met by TVA, which constructed additional generating facilities to meet Oak Ridge needs.

Approximately 16 billion kilowatt hours of electric energy per year is consumed at Oak Ridge. This can be compared with the 11 billion KWH used in 1952 in the entire state of Tennessee, exclusive of Oak Ridge, or the 5.7 billion KWH used in the highly industralized city of Detroit.

The first gaseous diffusion plant-structure and equipment-has been described as a monument to the ingenuity and vision of America's top scientists and development engineers, headed by Dr. Harold C. Urey and Dr. John R. Dunning, both of Columbia University, by P. C. Keith of the Kellex Corporation and Dr. George T. Felbeck of Carbide. The immensity of the first gaseous diffusion plant is shown by some of the quantities of materials required: concret, 350,000 cubic yards; structural steel, 40,000 tons; sheet steel, 15,000 tons; and bricks, 5,000,000.

The purpose of the AEC's gaseous diffusion plants is large-scale separation of the uranium isotope 235 from a chemical compound of uranium by the process of gaseous diffusion through porous barriers. These barriers must contain billions of holes smaller than two-millionths of an inch, withstand a pressure head of 15 pounds per square inch, can not become enlarged or plugged up as a result of corrosion or dust coming from elsewhere in the system, and must be amenable to manufacture in large quantities (measured in acres) and in uniform quality.

The separation process involves several thousand stages in each of which a portion of the gas—uranium hexafluoride (UF_6)—diffuses through the porous barriers and is enriched in U-235. The enriched product is then sent on to the next higher stage for further concentration. The improverished portion is re-pressured and recycled through the next lowest stage. The total volume of gas recycled is enormous—over 1,000,000 times the volume of the enriched gas. In passing through several thousand stages, the U-235 is gradually separated and concentrated.

No similar plant had ever before been contemplated. Essential tolerances and complexities were such that many advisors considered the plant impossible to build, and many more felt that even if built it would not work. Problems were encountered that called for excursions into the unknown far beyond any accepted method of design and construction. Development of some of the materials and equipment used in the plant was not successfully completed until after construction was well under way. The equipment required the installation of many miles of piping and electrical conductors. So important was the problem of producing welded joints to meet tightness and cleanliness specifications that it was necessary to develop 14 new special welding techniques. Installations of piping for the main process building exceeded anything of this type ever before constructed. Millions of feet of copper tubing were installed in the instrument system. The successful operation of such a plant is dependent largely upon the reliability of the instruments.

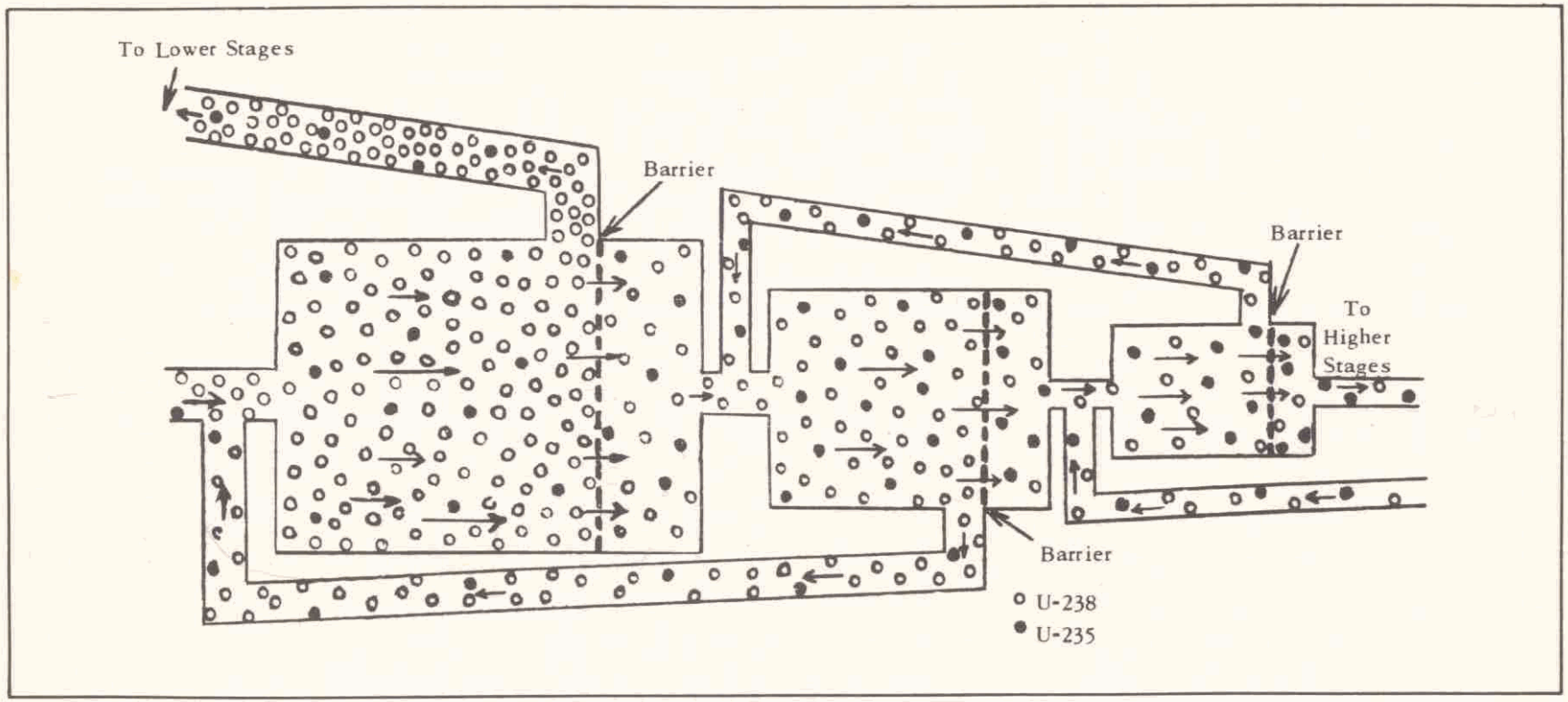
In connection with new techniques needed for the operation of the plant, pumps were developed to operate at velocities greater than the speed of sound. It has been estimated that the time spent in research, development and the design of the pumps alone totals 250,000 hours or the equivalent of one engineer working 100 years.

Other technical advancements made in the development work on the plant include a new improved type of mass spectroscope and an electronic device called the "leak detector," which is remarkably sensitive and plays an important part in insuring that all parts of the gaseous diffusion plant are vacuum tight. Industry eventually may reap rich rewards from technical advancements made in these and other fields.

The Steam Power Plant

A high-temperature, high-pressure, variable-frequency steam power plant lies near the gaseous diffusion process area and is an important adjunct to the production plant. The power station was designed and developed by the Kellex Corporation and Sargent and Lundy of Chicago and constructed by the

PROCESS GAS FLOW
IN K-25-GASEOUS DIFFUSION PROCESS



SCHEMATIC DIAGRAM

The uranium hexafluoride gas that passes through the barriers becomes enriched in its scarce U-235 atoms (black dots) as it moves through successively higher stages. Gas not passing through barriers, containing mainly the unwanted U-238 atoms (white dots) is returned to lower stages. K-25 plant uses hundreds of acres of barriers, thousands of miles of pipe.

J. A. Jones Construction Company at a cost of $34,000,000. At the time it was the largest steam plant ever constructed in one operation. The paradox of this gigantic steam plant in the heart of the TVA region is explained by plant requirements for variable frequency current and the necessity for minimizing possibilities of interruption of power. The use of the steam plant is in addition to such power as is available from the TVA, the general source of supply for all of the Oak Ridge area.

The power house contains three boilers, each designed to produce 750,000 pounds per hour of superheated steam at a pressure of 350 p.s.i. and a temperature of 950 degrees. The plant's 14 turbo-generators range in size from 1,500 to 35,000 kilowatts. Adjacent to the power plant are a main switch house, an auxiliary switch house, a pump house, a 154-KV switchyard, a service building and facilities for storage and handling of coal and fuel oil. Natural gas is now being used as fuel for the plant, with coal as a supplementary fuel.

Construction of the power plant started June 1, 1943, and initial operation was begun April 13, 1944. It reached its full generating capacity in July 1945. The plant is operated by Union Carbide Nuclear Company.

The Y-12 Plant

Covering some 500 acres, the Y-12 plant is located in Anderson County near the center of the Oak Ridge Area, approximately three miles from the city of Oak Ridge. Its programs include production of stable isotopes, research on process improvements, biological research, and other activities of special interest to the AEC.

The Y-12 area was the site of the electromagnetic plant which was built on a "crash" basis during World War II for the concentration of U-235. The plant was placed in standby following World War II, and in 1953 a program of modification and alteration of certain existing plant buildings was started, with Rust Engineering Company, Pittsburgh, Pa., as the prime construction contractor.

The Y-12 plant includes some 170 buildings with a floor area of more than 4,500,000 square feet. The plant is operated by Union Carbide Nuclear Company. Operating employment in July 1955 was approximately 5,500.

The construction and successful operation of the unique electromagnetic plant was a historical achievement. Ground was broken on February 1, 1943 for the first plant building. The first production building was put into use on January 27, 1944, by the operating contractor, Tennessee Eastman Corporation, a subsidiary of Eastman Kodak Company. Tennessee Eastman Corporation indicated a desire to withdraw as operator, and Carbide assumed operations on May 5, 1947.

The peak of plant construction employment totaled 13,200 workers. The peak of operational personnel was 22,000 in 1945.

The Stone and Webster Engineering Corporation of Boston, Massachusetts, designed and constructed the plant in cooperation with technical experts from the University of California. The cost was approximately $427,000,000.

The building of the electromagnetic plant involved unprecedented problems of design and construction. It became the first and only plant of its kind in the world, and there was no time to construct even a small pilot plant to perfect the method of separating the uranium atoms (U-235 from U-238) by the electromagnetic process as developed by Dr. E. O. Lawrence of the University of California. He receives much of the credit for the scientific development which made possible the transformation of the process from laboratory to industrial scale.

The electromagnetic process used an enormous amount of electric power, and this was a compelling reason for its location in the Tennessee Valley.

The size of the construction job at the electromagnetic plant is indicated by these figures from job records: excavation, 1,000,000 cubic yards; concrete, 275,000 cubic yards (the buildings themselves are not concret); and lumber, 37,562,000 board feet.

Basically, the theoretical operation of the electromagnetic separation plant depends on the principle of the mass spectrograph. It involves ionizing chemically treated uranium particles, accelerating a continuous stream of these particles to a speed approaching that of light, and then bending this stream into semi-circular paths by means of a powerful magnetic field applied in an almost absolute vacuum. The various ionized particles follow arcs with radii proportional to their masses; the U-235 particles of lower mass traverse an arc having a shorter radious than the path followed by the U-238 particles. Thus, the two uranium isotopes can be caught in different containers at the end of a 180-degree arc.

The electromagnetic plant was flexible—one reason for its selection. Units were build in groups, although most of the controls were separate from each unit. Thus, it was possible to build the plant in steps and to start operating the first unit before the second was begun. Design of subsequent units was improved as construction proceeded and obsolescent units were replaced, insuring smoother plant operation and increased output.

Magnets were designed and built containing thousands of tons of steel each, nearly 100 times as large as any previous magnets ever built. They were 250 feet long, and so powerful that their pull on the nails in workers' shoe heels made walking difficult. Since the magnets threated to snatch wrenches from workmen's hand, complete kits of non-magnetic tools were designed and manufactured. Because the flying ionized particles could have sliced through ordinary metals, elaborate shield-protectors of specially machined carbon were designed and fabricated.

During construction, copper was scarce and time was more valuable than gold, so approximately 14,000 tons of silver worth $300,000,000 was borrowed from the U.S. Treasury for use in conductors. The Commission which succeeded the Corps of Engineers as custodian of this silver, is returning it to the Treasury Department.

The U-235 produced in the electromagnetic plant during the war was so precious that Stone and Webster designed a chemical salvage plant 100 times as large as any test plants that could be used as guides. Every possible trace of U-235 was reclaimed—from work clothes, from water and steel, and even from the air in the plants. The production units were designed with amazing automatic controls which could be operated by personnel of average intelligence (many of the employees were high school girls). Without the faintest idea what their jobs actually were, these employees read dials and manipulated controls to produce a material having the greatest concentration of power ever known to man.

Some 6,200,000 linear feet of piping were required for the plant buildings. This included water lines, oil lines for cooling purposes, chemical lines and vacuum piping. Altogether, nearly one quarter of a million valves were installed. Cleanliness was essential for successful operation of the process and this necessitated construction of a special pickling and washing plant for cleaning pipes and valves. Each section of pipe and each valve was carefully sealed after treatment. A seal could not be broken until just before assembling the line.

IV. OAK RIDGE NATIONAL LABORATORY

Oak Ridge National Laboratory, designated "X-10" during World War II, is situated in Roane County near the Clinch River in the southeastern part of the area, about 12 miles from the city of Oak Ridge. The plant was designed and built by E. I. duPont de Nemours and Company. It was originally a small pilot plant on which the design of the huge plutonium plant at Hanford Engineer Works in the state of Washington was based. Construction began February 1, 1943, and operation of the first uranium chain reactor in the world with a production potential began at 5 a.m., November 4, 1943. First significant amounts of plutonium for research leading to the building of the Hanford Plant were produced here. The original plant cost approxi-

mately $13,000,000 and the peak construction force reached 3,247 employees. Peak operating employment in wartime was 1,513. Employment in July 1955 was approximately 3,400.

Until July 1, 1945, the plant was supervised by the University of Chicago. It was then taken over by the Monsanto Chemical Company of St. Louis, Missouri, for operation as a nuclear research center, called Clinton Laboratories. On December 31, 1947, the Atomic Energy Commission announced that Carbide and Carbon Chemicals Company, now Union Carbide Nuclear Company, would operate the laboratory beginning March 1, 1948. On February 1, 1948, the Atomic Energy Commission announced that the new name for the facility would be Oak Ridge National Laboratory.

War-time facilities, constructed on a temporary basis, were inadequate for the expanding program undertaken by ORNL, and in keeping with its designation as a permanent national laboratory, a $20,000,000 program of construction and improvement was begun in 1949. Among the first new facilities to be completed was a radioisotope processing area consisting of ten buildings especially designed for the chemical processing, storage, packing, and shipping of radioisotopes, and an additional pilot plant facility for chemical process development. A new research building and a high voltage building were completed in 1952. The latter structure houses a two-million electron volt Van de Graaff particle accelerator completed in October 1952, a five Mev Van de Graaff machine moved from the Y-12 area, a Crockroft-Walton linear accelerator, and associated equipment.

Today the laboratory is actively engaged in solution of problems related to the Commission's primary production and military applications programs, and the laboratory is working also on other problems with direct and indirect peacetime applications. ORNL has had a role in virtually every major scientific operation and activity in the far-flung facilities of the atomic energy program. The Laboratory has approximately 100 research groups at work in six major fields, some of these utilizing facilities at the Y-12 Plant. These fields are:

(1) Reactor technology

Reactor development work and design of reactors such as the aircraft reactor and the homogeneous reactor, which may be extremely helpful in the ultimate economic production of electric power with atomic energy

(2) Chemical Technology

The development of chemical separation processes for application to the Commission's production program

(3) Basic research in the fields of biology, chemistry, physics, metallurgy and health physics related to the atomic energy program

(4) Education and specialized training

(5) Radiation protection and applied biology

(6) Research and development in the production and utilization of stable and radioactive isotopes

Major reactors being developed in connection with the general reactor research and development program at the Laboratory include the Homogeneous Reactor and the Aircraft Reactor. ORNL did much of the development work on the Materials Testing Reactor, which is in operation at the National Reactor Testing Station in Idaho. Also developed—and being operated at ORNL—are the Low Intensity Test Reactor and the so-called "Swimming Pool" Reactor which is a part of the bulk shield testing facility.

A reactor of the swimming pool type was designed, built and successfully test-operated in the record time of three months by the Laboratory for the International Conference on the Peaceful Uses of Atomic Energy. After testing, the 100-kilowatt, completely automatic reactor was airlifted to Geneva, Switzerland as a major United States exhibit feature for the conference. The occasion marked the first time that a reactor had

been transported by air. The reactor was sold to Switzerland for use as a research tool after the August 1955 conference.

Production of useful amounts of electric power by nuclear energy was achieved from the operation of the Homogeneous Reactor at ORNL on February 24, 1953, when scientists brought the pilot model of the reactor up to full design power of 1,000 kilowatts of heat output. The reactor steam then was switched to a turbine-generator and about 150 kilowatts of electricity was produced. This was enough electricity to meet the estimated needs of 50 average five-room dwellings.

The reactor, though capable of producing both fissionable material and electric power, was not designed to produce economic electric power. Its design is simple—a pot, a pipe and a pump. It is a homogeneous reactor in that its fuel, coolant and moderator are all in a solution. Project scientists emphasized that many problems remained tc be solved, but declared that the ORNL demonstration of the feasibility of homogeneous liquid-fuel reactor systems was an important milestone toward economical production of electricity by means of nuclear reactors.

The reactor was dismantled in the spring of 1954 to make way for the construction—in the same building—of Homogeneous Reactor Experiment No. 2, which should be completed and put in operation in 1956.

A new high flux reactor for fundamental research and engineering studies is under construction and will be completed during 1956. The reactor, which will cost an estimated $3,600,000, will provide ORNL and the AEC with much-needed irradiation test facilities for research and development on reactor fuels, materials and components under actual conditions of modern reactors.

Construction of a tower shielding facility as part of the Aircraft Reactor program was completed at the Laboratory early in 1954. The facility includes four 324-foot steel towers. Protective shielding for the crew and a test reactor with its own shielding can be suspended from these towers well above the ground, simulating shielding conditions of an airplane in flight. Experiments began in May, 1954.

Presently under construction at the Laboratory is the Multi-Curie Fission Products Pilot Plant which will provide for separation and purification of kilocurie quantities of long-lived fission products and for fabrication of those products into large radiation sources.

Also under construction is a new laboratory building for the study of the effect of radiation on solids. The two-story building will expand the present Physics of Solids Building. Much of the research to be carried out in the new laboratory will be associated with the new research reactor which is under construction nearby.

Oak Ridge National Laboratory has become a principal center in research with radioactive isotopes, a wartime by-product often called the greatest scientific development since the invention of the microscope. Radioactive isotopes are variations of common elements with the same chemical properties as the stable form but having a different atomic weight and exhibiting the property of radioactivity. The graphite reactor at the Laboratory is the nation's principal source of radioactive isotopes. Currently more than 1,000 shipments a month are made to 2,500 institutions throughout the United States and in about 50 foreign countries. This is a million-dollar a year business operated on a cost-recovery basis. Radioisotopes comprise a peacetime promise of atomic energy which has been fulfilled, with these tools proving of increasing value in medicine, agriculture, biology and industry.

The Laboratory also performs fundamental and applied research on stable isotopes and is the only AEC installation in which stable isotopes are separated. More than 5,000 stable isotope shipments have been made.

The Laboratory pursues a vigorous program of radiation protection and monitoring, developing new methods of shielding and radiation detection. A major program in biological research is concentrated on the

cytogenetic effects, biochemical changes, and pathological-physiological changes produced by radiation, and the use of radioisotopes in these problems. A long-range project in mammalian genetics is being conducted as a part of the Laboratory's program in biological research, and is directed toward a comparative determination of the effects of ionizing radiations in causing mutations. Explorations are also being made in the field of chemical protection and recovery from biological damage due to radiation exposure.

Atomic energy education and training has been an integral part of the activities of the Laboratory ever since 1943, when one of the primary objectives of the installation was the training of personnel to operate the Hanford Plant. Since that time, scientists, health-physicists, pilot plant operators, engineers, and administrators who have staffed other vital projects for the Atomic Energy Commission have received on-the-job training at ORNL.

A part of the Laboratory's educational program is conducted jointly with the Oak Ridge Institute of Nuclear Studies. Under this cooperative effort, the Research Participation Program provides an opportunity for faculty members on leave from their universities to engage in advanced research at ORNL, and the Graduate Training Program enables graduate students to complete thesis research toward master's or doctoral degrees at the Laboratory through AEC fellowships.

The Clinton Laboratories Training School, established in 1946 as a nuclear technology school for scientists interested in entering the field of atomic energy, operated one year. It numbers among its alumni several widely known figures in the American atomic energy effort. The successful experience in this first training school was a factor contributing to the decision of the AEC to establish the Oak Ridge School of Reactor Technology at ORNL. ORSORT was organized in March 1950 with 18 students. Three hundred seventy-three students have graduated in five classes, and about 80 students are enrolled for the 1955-56 class. Many are now engaged in reactor design and development in industry and government agencies.

To assist in research at ORNL, a modern high-speed electronic computing machine, called the "ORACLE" (Oak Ridge Automatic Calculator Logical Engine), was constructed at Argonne National Laboratory and moved to ORNL in September 1953 and is now in use by the Mathematics Panel.

The ORACLE contains about 3,500 electronic tubes and about 20,000 resistors. It is based on the general design of one at the Institute for Advanced Study at Princeton, N.J., and is similar to another machine at Argonne. The machine can multiply together two twelve-digit numbers such as 976,345,012,983 and 276,507,433,209 in less than 1/2000 second. In about 20 to 30 minutes, it can solve complicated problems that would require the time of two mathematicians working for 5 to 6 years using ordinary desk-type electric calculators. Despite the speed of the computer, some studies require its continuous operation for days or weeks.

The ORACLE is distinguished by an improved memory device in which instructions and intermediate results are held in a memory unit. Pairs of cathode tubes are used so that the second tube will remember what the first one is unable to, because of small defects in the first tube. Either one or the other tube gives the right answer. Using this system, the machine has been found to be extremely reliable.

V. UNIVERSITY OF TENNESSEE-AEC AGRICULTURAL RESEARCH PROGRAM

A program of radiobiological research with domestic animals is being operated for the AEC in Oak Ridge by the University of Tennessee College of Agriculture under contract. The program includes some plant work bearing on the animal program.

The facilities for research include a large acreage of improved farm land, a research laboratory, greenhouse, nutrition barn, and a unique type of gamma irradiation field and associated structures for studying the effects of whole body external radiation on large animals such as burros.

Extensive experimentation has been carried out with both laboratory and domestic animals in connection with important studies of the metabolism and biological effects of fission-product radioactive elements and their access to animals through foodstuffs and drinking water. Such studies are of importance in long-range agriculture.

Another objective of the research program is to use the external radiation field for plant and animal studies. Research also is being accomplished, under partial or whole support of the University, in the nutrition and physiology of farm animals as they bear on radiobiology, pathology, and reproduction. In addition, some training facilities and activities are provided for graduate students and the military.

VI. THE OAK RIDGE INSTITUTE OF NUCLEAR STUDIES

The Oak Ridge Institute of Nuclear Studies, Inc., one of the contractors of the AEC at Oak Ridge, is an organization composed of 32 member universities in the South and Southwest. The Institute received its charter of incorporation from the State of Tennessee on October 15, 1946. Its general purposes are: (1) to stimulate cooperation between the Government and participating universities in undertaking fundamental research in the field of atomic energy, (2) to foster increased opportunities and improve programs of graduate study and education in nuclear energy in educational institutions in the South, (3) to aid in the acquisition and training of scientific personnel, and (4) to utilize the unique facilities in the Oak Ridge Area of graduate research and instruction.

Member universities of the Institute are Alabama Polytechnic Institute, University of Arkansas, Catholic University of America, Clemson Agricultural College, Duke University, Florida State University, University of Florida, Emory University, Georgia Institute of Technology, University of Georgia, Louisiana State University, University of Maryland, Mississippi State College, North Carolina State College, University of Puerto Rico, Rice Institute, Tulane University, Texas A & M, University of Alabama, University of Kentucky, University of Louisville, University of Mississippi, University of North Carolina, University of Oklahoma, Southern Methodist University, University of South Carolina, University of Tennessee, University of Texas, Tuskegee Institute, University of Virginia, Vanderbilt University, and Virginia Polytechnic Institute.

The Institute conducts a number of programs in support of its basic aims. One of the most interesting of these is a series of basic and advanced courses in the safe and efficient handling of radioisotopes. More than 2,100 scientists have come from every state and from a number of foreign countries to take these courses.

The Institute also is conducting a long-range study of the treatment of malignant diseases with special emphasis on the effects of radiation and radioactive materials on these diseases. This program is not open to the general public for purposes of treatment.

In the field of university-government cooperation in atomic energy research and training, the Institute sponsors several programs cooperatively with the Oak Ridge National Laboratory. These programs include participation of university faculty members and graduate students in Oak Ridge research, a series of regional and topical symposia in various fields of interest to the scientific community, a traveling lecture program through which Oak Ridge scientists go out to universities to lecture and conduct seminars, and allied activities of this nature.

In the field of training new scientists, the Institute administers the AEC-sponsored fellowship programs in radiological physics and industrial hygiene. Up to 83 fellowships may be given each year to train specialists in these fields.

American Museum of Atomic Energy

The American Museum of Atomic Energy is operated for the Atomic Energy Commission by the

Oak Ridge Institute of Nuclear Studies, Inc., in order to give the visiting public a comprehensive story of the development of atomic energy. The museum is located on Jefferson Circle in Oak Ridge. It is the world's first permanent museum devoted exclusively to telling the story of the atom.

By the use of scale models, pictures, maps and diagrams, the museum shows, among other things, the massive plants for the separation of uranium-235, the model of a uranium chain-reacting pile (atomic "furnace"), the production of radioactive isotopes, the possibilities for production of power from nuclear energy, a 250,000-volt generator used in atomic energy work, a model of a pitchblende mine, and the first small-scale model for the production of U-235 by the gaseous diffusion method. These and many other processes and principles of atomic energy are explained in exhibits occupying 18,000 square feet of floor space.

The museum is open to the public from 9:30 a.m. to 5 p.m. on week days and from 12:30 to 6:30 on Sundays. Admission charge is 50 cents for adults, tax included. Children under 12 are admitted free. Organized elementary and high school groups will be admitted on payment of twenty-five cents for each person.

VII. THE COMMUNITY OF OAK RIDGE

The city of Oak Ridge was constructed by the United States Government to provide living accommodations for personnel employed in the Oak Ridge Area. In general, the city is laid out on the long sloping side of a ridge—once known as Black Oak Ridge—which runs northeast to southwest. The city occupies approximately 20 square miles and lies in the northeast corner of the area. The original site is a hilly, wooded section about 2 miles wide by 7 miles long and is bounded on the north by the ridge and on the south by the Oak Ridge Turnpike, the main artery through the area. The Turnpike, which was part of State Highway 61 before the project started, has since been made a four-lane highway and hard surfaced.

Under a Master Plan for the city's future physical development, new neighborhoods were developed in 1948-49 south of the Turnpike. Twenty-nine garden-type apartments with 453 units have been completed and hundreds of new houses to replace old temporary units too costly to maintain have been built. Three hundred-fifty new apartment units and 100 row-type houses also have been erected south of the Turnpike and west of Lafayette Drive, in the new Woodland neighborhood.

In 1954, 500 permanent, modern, three-bedroom houses for rental to project personnel were completed and occupied. Located in East Village, at the eastern end of the community where hundreds of temporary flat-top houses have been removed, these units are being built with private capital under Title VIII of the National Housing Act. Another 400 units for sale or rent were constructed in West Village under Title IX of the Act. Another 150 Title IX houses for project personnel were constructed outside but in the vicinity of Oak Ridge.

Oak Ridge was named in June of 1943 when the District Engineer of the Manhattan District asked for suggestions from employees for a name of the community. Many suggestions were made, including the names of prominent persons throughout the country. "Oak Ridge" was finally selected because: (1) the site on which the town was being constructed was known as Black Oak Ridge, and (2) its rural connotation held outside curiosity to a minimum.

Construction of the city was begun early in 1943. Built entirely in two and one-half years, it became the fifth largest city in the state, having a peak population in 1945of 75,000 persons, and exceeded only by Memphis, Nashville, Knoxville, and Chattanooga. Population decreased more than 50 per cent after World War II, but Oak Ridge still holds the position of fifth city in the state. Construction costs to date total approximately $100,000,000. Oak Ridge was planned by Skidmore, Owings and Merrill, architect-engineer firm of Chicago. First housing designs were developed by the John B. Pierce Foundation of Raritan, New Jersey. The town was built by contractors under the general direction of Stone and Webster Engineering Corporation. The construction of the town proceeded to a considerable extent simultaneously with the construction of the plants and extended also into the period of operation.

At the peak of war-time operations, 5,000 trailers, 16,000 hutment and barrack spaces, 9,600 houses (semi-permanent type and prefabricated flat-tops) and 90 dormitories had been built and were occupied. More than 800 buses were being operated on and off the area, making this transportation operation the ninth largest in the country. Now, 70 buses operated by American Industrial Transport, Inc., under contract with the AEC, serve the area. The community itself has more than 180 miles of streets and roads.

Since the end of World War II, all of the hutments and trailers have been removed from the area. Use of flat tops also has been gradually reduced, as permanent housing was built to replace them. Hundreds of semi-permanent frame-type units, as well as 375 flat-tops, have been rehabilitated for longer life and better appearance. The population on July 1, 1955, was about 32,000.

The community has thirteen shopping centers, the principal ones being Jackson Square and the new "Downtown" center on the Turnpike. The community has one high school, two junior high schools, and nine elementary schools, complete and up-to-date fire and police departments and a large hospital. It has approximately 170 businesses which cater to the needs of Oak Ridge residents, including department, grocery and drug stores, banks, restaurants, laundries, and most other businesses found in any community of comparable size. It also has four theaters and a wide variety of recreational facilities.

Most business concerns operate under long-term leases with Management Services, Inc., which is the management contractor for the city of Oak Ridge under the supervision of the Community Affairs Division of the AEC Oak Ridge Operations. Director of the Community Affairs Division is F. W. Ford. At present, there are no elected city officials, but a seven-member Town Council elected by the residents acts in an advisory capacity to the city officials.

The Roane-Anderson Company (the name was derived from the names of the two counties in which the Oak Ridge Area is situated), a subsidiary of Turner Construction Company, New York, was management contractor for the community from September 23, 1943 until December 1, 1951. Its functions were taken over by Management Services, Inc., a no-fee contractor. A new corporation, it was chartered by seven Oak Ridgers. Directors of MSI are Lyle D. Worrel, Walter H. Leedom, R. W. Hamer, and C. C. Martin, and Edward A. Bagley, T. D. Clines, and Dr. Christopher P. Keim. The latter three serve without pay.

The AEC's Community Affairs Division, through its City Management and Commercial Services Branches, determines general policies for municipal and real estate operations within the community. Management Services, Inc., following these policies, performs functions normally carried out by the municipal authorities in a typical city, manages and maintains about 8,000 housing units in Oak Ridge, and handles water and electrical distribution in the town.

Roane-Anderson originally operated directly practically all of the town services and facilities, but some of the facilities have gradually been subcontracted to other firms or leased for private operation. The Management Services, Inc. Commercial Realty Department handles leases and concessions for commercial enterprises. The company's Housing Division manages residential real estate. Both groups follow policies determined by the AEC's Commercial Services Branch. All leases and concession contracts must be approved by the government. All recognized business concerns on the area are provided with operating licenses by the Management Services, Inc.

Revenues from real estate are audited by the government and applied to reduce the cost to the government of all services performed under the MSI contract.

The Oak Ridge Area was entirely enclosed until March 19, 1949, when the community was opened to the general public. At the same time, the security of the plant area was improved by erection of a fence enclosing the plants in a Controlled Area. The open section, including the community of Oak Ridge, comprises 24,000 acres. In July 1953, the main roadways through the 34,762-acre Controlled Area were opened to the general public. With the opening of these roadways, it is now possible for visitors to Oak Ridge to drive by and view the huge production and research plants at a distance. The plants are still under protect-

ive security control and admission is limited to those on official business.

For a number of years officials in charge of community operations, in cooperation with the residents, had under study several plans directed toward making Oak Ridge a normal city comparable to the average American community of the same size. These studies included home ownership and self-government through incorporation of the city. A policy of long-term leases for business establishments, which generally had operated on a year-to-year basis, was approved in 1949 and many such leases have been signed. Early in 1953, a program was approved under which suitable vacant land in residential areas could be leased for construction of houses by individuals or construction of housing projects by developers. Such houses built on leased land can be either for rent or sale. A number of individuals have built homes under this program.

In 1951, the recommendations of the Panel on Community Operations ("Scurry Panel"), which the AEC had retained to study the feasibility of home ownership and self-government here, were submitted to the Commission and were made public. In 1952, the residents and the non-resident employees of the project were polled by the U. S. Bureau of the Census for their opinions on the Scurry Panel recommendations, and were found to favor government disposal of the community.

Congress in the summer of 1955 passed the "Atomic Energy Act of 1955" which provides for termination of government ownership and management of the community of Oak Ridge. Under the provisions of the act, local self-government would be facilitated, property sales would be made to private purchasers, and municipal functions, municipal installations and utilities would be transferred to local entities. Work toward implementation of the act is in progress.

Meanwhile, land has been sold to more than thirty church groups to build their own buildings and twenty-seven have started or completed permanent structures. Title to a 20-acre site for a National Guard Armory has been transferred to the State of Tennessee.

VIII. OAK RIDGE OPERATIONS OFFICIALS

Atomic Energy Commission

S. R. Sapirie, Manager, Oak Ridge Operations
E. A. Wende, Deputy Manager, Oak Ridge Operations
C. Vanden Bulck, Assistant Manager for Administration
Dr. N. H. Woodruff, Assistant Manager for Operations
R. J. Brown, Assistant Manager for Construction and Engineering
F. W. Ford, Director, Community Affairs Division
Kenneth A. Dunbar, Area Manager, Portsmouth Area Office
K. C. Brooks, Area Manager, Paducah Area Office
C. L. Karl, Area Manager, Fernald Area Office
Fred H. Belcher, Area Manager, St. Louis Area Office
C. J. Rodden, Area Manager, New Brunswick Area Office

Union Carbide Nuclear Company

Clark E. Center, Vice President
L. B. Emlet, Manager of Production
A. M. Weinberg, Director, Oak Ridge National Laboratory
A. P. Huber, Plant Superintendent, K-25 Plant
J. P. Murray, Plant Superintendent, Y-12 Plant
R. G. Jordan, Plant Superintendent, Paducah Plant

Goodyear Atomic Corporation (Portsmouth Area)

A. J. Gracia, General Manager

National Lead Company of Ohio (Fernald Area)

George Wunder, Plant Manager

Mallinckrodt Chemical Works (St. Louis Area)

Dr. C. D. Harrington, Project Manager

Oak Ridge Institute of Nuclear Studies

Dr. W. G. Pollard, Executive Director
Dr. W. W. Grigorieff, Chairman, University Relations Division
Dr. Ralph T. Overman, Chairman, Special Training Division
Dr. Marshall Brucer, Chairman, Medical Division
Charles G. Wilder, Chairman, Exhibits Division

University of Tennessee - AEC Agricultural Research Program

John A. Ewing, Project Leader

Management Services, Inc.

L. D. Worrel, President and General Manager

American Industrial Transport, Inc.

A. H. Gossard, President