ORCA-7

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A HISTORY OF CLASSIFIED ACTIVITIES AT OAK RIDGE NATIONAL LABORATORY

Arvin S. Quist

Oak Ridge Classification
Associates, LLC
104 Neville Lane
Oak Ridge, TN 37830
(423) 482-6722

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CONTENTS

Chapter 1
INTRODUCTION

The facilities that became Oak Ridge National Laboratory (ORNL) were created in 1943 during the United States' super-secret World War II project to construct an atomic bomb (the Manhattan Project). During World War II and for several years thereafter, essentially all ORNL activities were classified. Now, in 2000, essentially all ORNL activities are unclassified.

The major purpose of this report is to provide a brief history of ORNL's major classified activities from 1943 until the present (September 2000). This report is expected to be useful to the ORNL Classification Officer and to ORNL's Authorized Derivative Classifiers and Authorized Derivative Declassifiers in their classification review of ORNL documents, especially those documents that date from the 1940s and 1950s.

The general area where the main facilities of ORNL are now located was known as Bethel Valley, Kingston, Tennessee, prior to its acquisition in late 1942 by the Army Corps of Engineers. When the Army first acquired the land for ORNL and the other Oak Ridge facilities, the site was called the Kingston Demolition Range. In January 1943, that site was designated as the Clinton Engineer Works. Later in 1943, the name "Oak Ridge" was chosen for the name of the major town constucted on this site, after the name "Black Oak Ridge" on which the major portion of the town's residential area was built. When the city of Oak Ridge was incorporated in 1959, its boundaries included all of the area originally encompassed within the Clinton Engineer Works.

ORNL was initially known as the Clinton Laboratories.* In early 1947, those facilities were named the Clinton National Laboratory, which became the Oak Ridge National Laboratory on February 1, 1948. In late 1974, Congress unexpectedly changed ORNL's name to the Holifield National Laboratory, in honor of a retiring California congressman who had been prominent in atomic energy matters. The name Oak Ridge National Laboratory was restored by congressional action in late 1975. Throughout this report, ORNL and its predecessor organizations will usually be referred to as ORNL.

* Manhattan Project security reasons required that the operator of these laboratories, the University of Chicago Metallurgical Laboratory, not be linked to these laboratories. Thus, a separate organization, the Clinton Laboratories, was created to obfuscate that link. That name was chosen because the U.S. Army Corps of Engineers site on which the laboratories were located was the Clinton Engineer Works, whose name came from the nearby town of Clinton, Tennessee.

The main ORNL site is frequently known as "X-10." That name had its origins in late 1942 as a code name for the initial product (plutonium) of the Graphite Reactor and chemical processing plant at Oak Ridge.

ORNL (including its predecessors) has been "owned," successively, by the U.S. Army Corps of Engineers (Manhattan Engineer District, Clinton Engineer Works; 1943-1946), the U.S. Atomic Energy Commission (1947-1975), the U.S. Energy Research and Development Administration (1975-1977), and the U.S. Department of Energy (1977-present).

ORNL (including its predecessors) has been operated, successively, by the University of Chicago's Metallurgical Laboratory (March 17, 1943-June 30, 1945), the Monsanto Chemical Company (July 1, 1945-February 29, 1948), divisions or subsidiaries of Union Carbide and Carbon Corporation and Union Carbide Corporation (March 1, 1948-March 31, 1984), subsidiaries of Martin Marietta Company and Lockheed Martin Company (April 1, 1984- March 31, 2000), and UT-Battelle, LLC, a partnership between the University of Tennessee and Battelle (April 1, 2000-present).

Prior to describing ORNL's classified activities during the 1943-2000 time period, this report will provide several chapters describing some historical U.S. atomic energy information that may be of interest in establishing a context for ORNL and its classified activities. Because ORNL was established during the Manhattan Project, a brief summary of the origins of that project will be given in Chapter 2. ORNL was created as a pilot plant for producing plutonium for use in nuclear weapons; therefore, information concerning the selection of plutonium as a fissionable material for nuclear weapons is given in Chapter 3. Selection of Oak Ridge as the site for the plutonium-production pilot plant is described in Chapter 4.

Chapters 5 through 9 summarize operations at ORNL from 1943 through 2000 and describe the classified activities at ORNL during that time. The time covered by a chapter corresponds to the tenure of each of the five contractors that has operated ORNL.

Chapter 2

THE ORIGINS OF THE MANHATTAN PROJECT

INTRODUCTION

ORNL was created as a facility of the Manhattan Project, a World War II project of the Manhattan Engineer District of the U.S. Army Corps of Engineers. Thus, it is of interest to review the events leading to the formation of the Manhattan Project.

In summary, the Manhattan Project was formed upon a recommendation by the Office of Scientific Research and Development, which was created to supersede the National Defense Research Committee, an organization created in June 1940 to provide civilian scientific and technical expertise and assistance to the military. The National Defense Research Committee had, upon its creation, absorbed the Advisory Committee on Uranium as part of its responsibilities. The Advisory Committee on Uranium was created by President Roosevelt in October 1939 after receipt of a letter from Albert Einstein. Einstein had written this letter in August 1939 at the urging of Leo Szilard and Eugene Wigner. Some details follow.

MANHATTAN PROJECT ORIGINS

The Manhattan Project had its roots in the Advisory Committee on Uranium (the "Uranium Committee"), which was appointed by President Roosevelt on October 12, 1939. This committee was established to investigate the military uses of neutron-induced nuclear fission of uranium (e.g., naval nuclear propulsion and "atomic" bombs). The possibility of such uses arose from the discovery, by Otto Hahn and Fritz Strassman in Berlin in December 1938, of the fission of the uranium nucleus by neutrons. Subsequent discoveries about the energy released in this nuclear fission, and number of neutrons released per nuclear fission, indicated the possibility of a chain uranium-nuclear-fission reaction that would release large amounts of energy from a relatively small mass of uranium.

The Advisory Committee on Uranium was created by President Roosevelt after he received a letter, conveyed personally by Alexander Sachs* on October 11-12, 1939, from Albert Einstein. Einstein's letter described the weapons potential of uranium-nuclear-fission energy and warned of German interest in that subject. The letter from Einstein was written in early August 1939, at the urging of Leo Szilard and Eugene Wigner. Szilard and Wigner were very concerned about the weapons potential of uranium nuclear fission and the awful consequences that would ensue if Nazi Germany became the first nation to create and use such a weapon.

* Alexander Sachs was a some-time advisor to President Roosevelt and an acquaintance of Leo Szilard.

The Uranium Committee became part of the National Defense Research Committee (NDRC) when the NDRC came into existence on June 27, 1940. The Uranium Committee officially reported to NDRC Chairman Vannevar Bush, although in practice that reporting was through James B. Conant, President of Harvard University and member of the NDRC.

The NDRC became part of the Office of Scientific Research and Development (OSRD) on June 28, 1941, when President Roosevelt issued an Executive Order establishing that Office. Bush headed the OSRD, and Conant became chairman of the NDRC. The Uranium Committee became the OSRD Section on Uranium, later known as the S-1 Section.

On October 9, 1941, after a briefing by Bush, President Roosevelt decided to expedite uranium research and development. In late November-early December 1941, Bush created a Planning Board, staffed mostly by chemical engineers, to make engineering studies relative to atomic-energy matters (e.g., to start planning for large-scale facilities). On December 6, 1941, the U.S. atomic-energy program (the OSRD S-1 Section) was removed from the NDRC and reported directly to Bush.

On March 9, 1942, Bush recommended to President Roosevelt that the atomic bomb project be turned over to the Army. Progress on atomic-energy matters had been such that it seemed likely that an atomic bomb could be constructed. An atomic-bomb project was expected to be a very large project and would require management by a governmental entity accustomed to managing large projects. President Roosevelt agreed, and on June 17, 1942, the atomic-bomb project was officially assigned to the Army Corps of Engineers.

The Corps of Engineers first designated this project as the Laboratory for the Development of Substitute Materials (DSM) (June 26, 1942) and later (August 13, 1942) as the Manhattan Engineer District (MED). On September 23, 1942, Brigadier General Leslie R. Groves was officially placed in charge of the atomic-bomb project, which later became known as the Manhattan Project.* General Groves had previously been in charge of construction of the Pentagon and other major Corps of Engineers projects.

The Manhattan Project ended on December 31, 1946. Operation of Manhattan Project facilities became the responsibility of the newly created U.S. Atomic Energy Commission (AEC) on January 1, 1947.

* General Groves was appointed to this post on September 17 but the appointment was not made official until September 23, the day on which Groves was promoted from colonel to brigadier general. Groves was promoted to major general on March 4, 1944, and to lieutenant general on January 24, 1948.

Chapter 3
SELECTION OF PLUTONIUM AS A FISSIONABLE MATERIAL FOR A NUCLEAR WEAPON

INTRODUCTION

The original major purpose of the facilities that became ORNL was to provide the Manhattan Project with its pilot plutonium-production plant. Those ORNL pilot facilities included a graphite-moderated, air-cooled, natural-uranium, nuclear-fission reactor to produce plutonium and pilot-plant chemical-processing facilities for separating and purifying that plutonium. Subsequently, the large plutonium-production reactors and chemical facilities that were built at Hanford, Washington, provided the plutonium for the atomic device tested at Alamagordo, New Mexico, in July 1945 and the atomic bomb dropped on Nagasaki, Japan, in August 1945.

The oldest ORNL facilities are the Graphite Reactor (the pilot plutonium-production reactor) and the chemical-processing facilities (the pilot facilities for separating the plutonium produced in the Graphite Reactor's uranium fuel). Personnel who initially operated the Hanford plant were trained at those Oak Ridge facilities.

It is of interest to summarize the events that led to the selection of plutonium as a fissionable material for a nuclear weapon, which subsequently led to the location of the plutonium-production pilot facilities in Oak Ridge. The following subsections describe how the U.S. governmental program investigating neutron-induced uranium nuclear fission led to selecting plutonium as an alternate fissionable material for a nuclear weapon.

INITIAL GRAPHITE-REACTOR RESEARCH IN THE UNITED STATES

The Uranium Committee's (see preceding section) principal initial support to atomic-energy development was a $6000 grant to Columbia University, in February 1940, for the purchase of high-purity graphite for studies on the neutron-absorption cross-section of graphite. Graphite slows ("moderates") the "fast" neutrons produced when a uranium nucleus fissions. Slower neutrons have a larger probability of capture by other uranium nuclei, leading to fission of such other nuclei and propagation of a chain nuclear-fission process. The main interest was in the possibility of establishing a controlled, self-sustaining, uranium-nuclear-fission chain reaction (a nuclear reactor) with natural uranium as fuel and graphite as a neutron moderator (a graphite-uranium "pile"). Power production (e.g., steam generation for naval nuclear propulsion or for electricity-generating plants) was a forseeable use for such a reactor. Subsequent studies at Columbia showed, in mid-1940, that the neutron-capture cross-section of graphite was very low and that high-purity graphite would probably be a good moderator for a nuclear-fission reactor. Enrico Fermi was a principal investigator in reactor matters at Columbia; Leo Szilard also played a major role.

The first NDRC contract for atomic research was awarded to Columbia University in early November 1940 to continue with nuclear-reactor research with graphite as the neutron moderator.

PLUTONIUM AND ITS NEUTRON-FISSION PROPERTIES

Early U.S. atomic energy research was concerned with uranium's nuclear-fission properties. In early February 1939, Danish physicist Neils Bohr (then at Princeton University) suggested that the uranium-235 isotope, present to the extent of only 0.7% in natural uranium, was the fissionable isotope of uranium. On September 1, 1939, Bohr and John A. Wheeler (of Princeton) published a paper in *Physical Review* which thoroughly described the nuclear-fission process for U-235. That article also suggested that the element with atomic number 94 would be fissionable with slow neutrons. (Element 94 was yet to be discovered and when discovered was named plutonium.) The practical way to produce element 94 would be in a nuclear-fission reactor, where excess neutrons produced by uranium-235 fission could be captured by uranium-238 to produce element 93 whose nucleus could then undergo beta-particle decay to produce element 94. (Element 93 was also yet to be discovered and when discovered was named neptunium.)

In June 1940, Edwin M. McMillan and Philip H. Abelson at the University of California, Berkeley, published the discovery of the first transuranic element, 93-239 (neptunium-239) by irradiating uranium-238 with neutrons in a Berkeley cyclotron. They suggested that its daughter product, element 94-239 (plutonium-239), had a long half-life. An artificially produced element with a long half-life could be made in "large" quantities.

In December 1940, Fermi, E. O. Lawrence (University of California, Berkeley), and Emilo Segre (also at Berkeley) decided to institute a major effort to produce element 94 in the Berkeley cyclotron and to examine its neutron-fission properties. Glenn Seaborg was a principal investigator in this effort. Subsequently, in February 1941, Seaborg, Joseph W. Kennedy, and Arthur C. Wahl chemically established the existence of element 94. On May 18, 1941, Seaborg, Kennedy, Segre, and Wahl determined that the slow-neutron-fission cross-section of 94-239 was 1.7 times that of uranium-235 (the modern value is 1.24). This, together with its long half-life, indicated that 94-239 would be a good fissionable material for an atomic bomb. Lawrence, Arthur H. Compton (University of Chicago) and Bush were immediately informed of those results. The NDRC provided $2000 to Seaborg in June 1941 to continue work on elements 93 and 94.

EARLY BRITISH CALCULATIONS ON FAST-NEUTRON-FISSION OF PURE U-235

In February 1940, Otto Frisch and Rudolph Peierls at Birmingham University, England, concluded that a uranium bomb made from nearly pure uranium-235* and fissioned by fast neutrons† would have a critical mass of about one kilogram. Such a bomb made with 5 kg of uranium-235 was calculated to have an explosive power equivalent to several thousand tons of dynamite. This was in contrast to earlier calculations based on natural uranium (0.7% uranium-235) fissioned by thermal (slow) neutrons, which indicated that a bomb mass of tens of tons of uranium was required to achieve criticality. As a consequence of the Frisch-Peierls memorandum describing this conclusion, the British formed the Ministry of Air Production Uranium Development (MAUD) Committee to investigate atomic-weapon matters.

The Frisch-Peierls prediction received a major validation in March 1941, when the results of measurements of the fast-neutron cross-section of uranium-235 by Merle A. Tuve's group at the Carnegie Institution of Washington were provided to Peierls in England. Peierls then calculated a critical mass of uranium of 9 kg and a "tamped" optimally efficient critical mass of 10 kg. Assuming 2% efficiency, such a bomb would have an explosive power of about 1800 tons of TNT. Peierls therefore concluded that an atomic bomb was feasible if uranium-235 could be produced in high enrichments. By June 1941, the MAUD Committee had produced a draft report recommending an all-out effort to produce an atomic weapon that used nearly pure uranium-235. That report also stated that element 94 produced in a (heavy-water) nuclear reactor would be expected to have nuclear-fission properties similar to uranium-235 and thus be useful to make an atomic bomb.

THE EFFECT OF BRITISH ATOMIC BOMB CALCULATIONS ON THE U.S. NUCLEAR-FISSION PROGRAM

The news of the 1940 Frisch-Peierls calculations apparently only slowly (or not at all timely) reached the appropriate scientists in the U.S. (the chairman of the Uranium Committee was quite secretive about uranium-fission matters, even with members of the Uranium Committee). Although the September-October 1940 Tizard Mission from England to the United States provided U.S. scientists with information about British work in atomic energy, and the fission potential of element 94 was discussed, it appears that this British visit did not greatly stimulate U.S. interest in nuclear weapons. Perhaps the Frisch-Peierls calculations were not even discussed during this visit because the implications of fast-neutron fission of uranium did not seem to be discussed in the United States until much later (about July 1942).

In April 1941, Bush was informed of the extent of British interest in an atomic bomb by an NDRC representative in London who had attended a MAUD Committee meeting at which (it was likely) Peierls' new calculations on fast-neutron-fission of pure U-235 were discussed.

* Earlier it was mentioned that Bohr had postulated that U-235 was the fissionable isotope of uranium. In early March 1940, John R. Dunning and colleagues at Columbia University, using a small sample of uranium enriched in the U-235 isotope by Alfred O. Nier (using a mass spectrograph) at the University of Minnesota, experimentally determined that U-235 was indeed the fissionable isotope of uranium.

† Frisch and Peierls expected, from theoretical considerations, that nearly every collision between a fast neutron and a U-235 nucleus would fission that nucleus.

Information about the possible use of element 94 in atomic bombs may also have been discussed at that MAUD Committee meeting. This information probably greatly stimulated Bush's interest in atomic weapons possibilities. Also, the draft MAUD Committee report was provided to Bush in early July 1941.

Subsequently, a November 1941 National Academy of Sciences (NAS) Committee (chaired by Arthur H. Compton of the University of Chicago) reviewing the U.S. uranium program (at the request of Bush) recommended an expanded atomic-bomb program that used uranium-235 as the fissionable material. [It took the committee three tries (three reports), with new committee members added (at the suggestion of Bush) after each of the first two reports, to give Bush the recommendation he wanted. Information from the MAUD Committee probably significantly influenced Bush in his "suggestions" to the NAS Committee.]

In late September 1941, the British decided to proceed with an atomic-bomb project. A final copy of the MAUD Committee report was provided to Conant on October 3, 1941. The report's contents had earlier been discussed with the NAS Committee and with the NDRC S-1 Section. The British decision to proceed with an atomic bomb undoubtedly had a major effect on U.S. nuclear-fission activities (i.e., on the U.S. decision to proceed with an atomic bomb program).

INCREASED U.S. INTEREST IN PLUTONIUM AS A FISSIONABLE MATERIAL FOR AN ATOMIC BOMB

By October 1941, there was greatly increased U.S. interest in producing plutonium in nuclear reactors for use in an atomic bomb. Eugene Wigner, at Princeton University, was confident that such plutonium production was feasible. Although nothing was said about use of plutonium in an atomic bomb in the November NAS report, Compton recommended to Bush and Conant, on December 6, 1941, that more attention be given to the use of plutonium for an atomic bomb.

On December 13, 1941, Bush assigned responsibilities for nuclear-weapons work (bomb design) and plutonium-239 production to Compton. On January 24, 1942, Compton decided to combine the nuclear-reactor groups at Columbia and Princeton and move them to the University of Chicago. The overall plutonium project was called the "Metallurgical Project," and the combined group was called the "Metallurgical Laboratory." Work on nuclear reactors continued at Chicago. The first controlled,* self-sustaining, uranium-nuclear-fission reactor (designed by Fermi) was operated (went "critical") on December 2, 1942, at the University of Chicago. That reactor's natural-uranium fuel was distributed throughout a graphite "pile."

* An uncontrolled water-moderated uranium-nuclear-fission reactor went critical at the current site of the Oklo uranium mine in Gabon, West Africa, two or three billion years ago when the concentration of U-235 in natural uranium was about 3%.

PLUTONIUM-PRODUCTION REACTORS AND PLUTONIUM-SEPARATION FACILITIES

With the successful operation of the first nuclear reactor, there was little doubt that significant quantities of plutonium-239 could be produced in a graphite-uranium reactor. Chemical separation of the plutonium from the uranium and the fission products also seemed feasible. (Seaborg and colleagues from the Berkeley had joined the Metallurgical Laboratory in April 1942 to continue their investigations on plutonium chemistry.) Thus, there was now another route to a nuclear weapon (i.e., other than nearly pure uranium-235).

On December 10, 1942, the Manhattan Project's Military Policy Committee* recommended proceeding rapidly with constructing and operating plutonium-production and plutonium-separation facilities.

* Vannevar Bush was chairman of this committee, with James B. Conant as alternate chairman. Military members were General Wilhelm D. Steyer and Rear Admiral William R. Purnell. General Groves was the committee's executive officer.

Chapter 4
SELECTION OF OAK RIDGE AS THE SITE OF A PILOT PLANT FOR PLUTONIUM PRODUCTION

PILOT PLANTS FOR PLUTONIUM PRODUCTION AND SEPARATION

There were so many uncertainties associated with the design, construction, and operation of large facilities to produce tens of kilograms of plutonium that construction and operation of pilot plutonium production reactors and chemical separation plants were necessities. The E. I. du Pont de Nemours Company agreed, on October 3, 1942, to design the plutonium-production pilot plant (reactor and separation facilities) and later agreed to construct that plant. However, du Pont wanted the University of Chicago's Metallurgical Laboratory to operate that pilot plant because of the Metallurgical Laboratory's research and development experience with nuclear reactors and the plutonium-separation processes. In early 1943, the University of Chicago rather reluctantly agreed to operate the plutonium-production pilot facilities.

SELECTION OF THE OAK RIDGE SITE BY THE MANHATTAN PROJECT

During the spring of 1942, after it had been determined that an atomic bomb project was likely to be successful and that the Army would manage this project, selection of a site for that project's major production facilities began. At that time, four methods were under consideration for production of fissile materials for nuclear weapons: plutonium production by nuclear reactors and enriched-uranium production by the electromagnetic, gaseous diffusion, and centrifuge methods. Initially, all of those production facilities were to be located at one site.

The site that became Oak Ridge was first examined on April 24, 1942, by a three-person group that included representatives from OSRD and the Corps of Engineers. That group was seeking a large but sparsely populated inland location that had access to large amounts of electrical power (for a diffusion plant and an electromagnetic plant), to sufficient cooling water (for the plutonium-production reactor), and to transportation facilities. To limit the effects of possible air bombardment or a catastrophic explosion at a plant site, they also sought a site that had smaller areas reasonably remote from each other and that were suitable for electromagnetic, diffusion, centrifuge, and nuclear reactor facilities. That group recommended (April 29, 1942) the Elza (Oak Ridge) site as almost ideal for the location of the planned facilities.

General Groves visited the Elza, Tennessee, site on September 24, 1942 (the day after he officially assumed command of the Manhattan Engineer District). He quickly decided that it was suitable and directed that it be acquired. Formal authorization for its acquisition was made on September 29 by Under Secretary of War Robert Patterson. On October 26, 1942, offices of the Clinton Engineer Works were opened in Knoxville, Tennessee, to begin the land-acquisition process.

After selection and acquisition of the Oak Ridge site, Manhattan Project officials decided, on December 10, 1942, that a more remote area was desirable for the major plutonium-production reactors and associated chemical-processing facilities. However, the Oak Ridge site was deemed suitable for locating pilot facilities for plutonium production. Although Metallurgical Laboratory management wanted those facilities to be located in the Argonne Forest, at the outskirts of Chicago, General Groves decided that a safer location for the pilot plutonium production reactor and associated separation facilities would be at the Oak Ridge site.

Sic crevit Querceum Dorcum Genticum Laboratorium.*

* "Thus came into existence Oak Ridge National Laboratory." Latin courtesy of Fred M. O'Hara, Jr.

Chapter 5
CLASSIFIED ACTIVITIES AT ORNL, 1943-1945

ORIGINAL PURPOSES OF ORNL

The four major original purposes of ORNL were (1) to operate a small, graphite-moderated, air-cooled, natural-uranium-fueled, nuclear-fission reactor to produce small amounts of plutonium; (2) to operate a chemical pilot plant to separate plutonium from uranium and its fission products using the bismuth phosphate carrier process; (3) to operate a training school for technical personnel who would form the nucleus for operating Hanford's production plants; and (4) to perform research and development related to nuclear fission, nuclear reactors, and plutonium-separation processes. The first two items, the engineering scale-up of laboratory processes, were the most important original purposes of ORNL, followed by (3) and then (4). A fifth purpose may have been to evaluate the health hazards from fission and fission-product radioactivity.

[It is of interest to note that the air-cooled Graphite Reactor at Oak Ridge was not exactly a pilot plant for the water-cooled graphite reactors ultimately constructed at Hanford, Washington (they were initially planned to be helium-cooled).]

CONSTRUCTION OF ORNL, 1943-1945

On December 18, 1942, du Pont agreed to design, construct, and operate the Manhattan Project's nuclear reactors and reactor-fuel-processing facilities to produce plutonium for atomic bombs. On January 4, 1943, du Pont also agreed to design and construct the plutonium-production pilot plant (reactor and chemical-processing facilities). On January 11, 1943, Oak Ridge was selected as the site for those pilot facilities. (Hanford was chosen as the site for the major production facilities on January 23, 1943.) The initial du Pont personnel arrived in Oak Ridge on January 18, 1943. Du Pont began construction at the Oak Ridge X-10 Site on February 2, 1943, the first plant construction at the Clinton Engineer Works.

Most of the World War II construction at ORNL occurred from February 1943 until mid-summer 1944. Peak construction employment was about 3000.

One of the first major buildings to be constructed at ORNL, after construction of the initially planned pilot-plant facilities, was a "hot laboratory" to process greater-than-laboratory quantities of highly radioactive isotopes other than those needed for plutonium-separation-process investigations. This facility became operational in March 1944. Later, an addition to this laboratory enabled production of kilo-curie quantities of barium-140 as required by Los Alamos for the production of lanthanum-140 (see below).

OPERATION OF ORNL, 1943-1945

On February 17, 1943, the University of Chicago agreed in principle to operate the plutonium production pilot facilities in Oak Ridge. Formal agreement was reached in March 1943. Martin D. Whitaker of the Metallurgical Laboratory was the first director of the Clinton Laboratories. Because of the University's lack of experience in operating "industrial" facilities, the University subcontracted with du Pont to have du Pont supply several hundred experienced personnel to help with initial operations of the Oak Ridge facilities. Most of those persons formed the nucleus for subsequent staffing of Hanford plant operations. Peak operating employment at ORNL during World War II was 1513.

On November 4, 1943, the Graphite Reactor at Oak Ridge (known then as the "Clinton Pile" or the "X-10 Pile") went critical. A principal designer of this reactor, from a nuclear-physics standpoint, was Alvin M. Weinberg, a member of Wigner's group at the Metallurgical Laboratory. These data set the basic reactor-design parameters for the du Pont engineers who designed the complete reactor. The Graphite Reactor's design power was 1000 kW (upgraded to 1800 kW in early 1944 and to 4000 kW by about July 1944).

Processing operations in the plutonium-separation pilot plant (now Building 3019; then Building 205) started in December 1943, with uranium irradiated to produce plutonium-239 in the Washington University (St. Louis) cyclotron. This allowed initial plutonium-separation operations to be carried out with smaller amounts of radioactivity as compared to the much greater radioactivity of uranium irradiated in the Graphite Reactor. The first few milligrams of plutonium shipped to the Metallurgical Laboratory were from those early operations. Later shipments were of plutonium obtained from low-power and full-power Graphite Reactor operations.

The first product from the Oak Ridge pilot facilities, 1.5 mg of plutonium, was shipped from Oak Ridge to the Chicago Metallurgical Laboratory on December 30, 1943. This was followed by shipments of ever-increasing amounts of plutonium to the Metallurgical Laboratory and to Los Alamos. Gram quantities were shipped by mid-March, 1944.

The Clinton Laboratories' plutonium-production mission was accomplished by about the end of 1944. In December 1944, operation of the Graphite Reactor for plutonium production ended. The pilot plant for the chemical separation of plutonium was placed in standby in January 1945. The total plutonium production during 1943-1945 was about 326 grams.

After the Graphite Reactor's plutonium-production mission was completed, it was operated to produce radioisotopes for use in research and development (R&D) programs at ORNL and elsewhere within the Manhattan Project.

In January 1944, irradiation of bismuth "slugs" in the Clinton Pile was started. The objective was to produce an isotope of polonium (polonium-210) for use in atomic-bomb initiators. Separation of polonium from the bismuth was performed at laboratories in Dayton, Ohio, operated by Monsanto Chemical Company.

In early 1944, Los Alamos requested that ORNL produce hundred-curie quantities of radioactive barium-140 for use in weapons development. Barium-140 decayed to produce radioactive lanthanum-140 ("RaLa"), which was used for implosion diagnostics. Such quantities were produced in ORNL's "hot laboratory" (see above, "Construction of ORNL, 1943-1954") by about mid-1944. [RaLa activities continued at Oak Ridge for several years, subsequently using fuel elements from reactors at other sites (e.g., Hanford) as the source of barium-140.]

With the completion, in mid-to-late 1944, of most of the Metallurgical Laboratory's (and Clinton Laboratories') major responsibilities with respect to the Manhattan Project, some of the scientists at those laboratories began to think about, and plan for, future R&D efforts directed towards peaceful (but still classified) uses of atomic energy. Such activities included greater-than-laboratory-scale production of radioisotopes, efforts towards design of a high-neutron-flux nuclear reactor for R&D purposes, and fundamental research related to nuclear fission.

The University of Chicago's responsibility for operating ORNL ended on June 30, 1945, after the initial purposes of ORNL had been accomplished.

CLASSIFIED ACTIVITIES AT ORNL, 1943-JUNE 30, 1945

Essentially all scientific and technical activities carried out at ORNL from its inception in early 1943 until June 30, 1945, were classified. During that period, ORNL was part of the Manhattan Project. When the University of Chicago ceased operating ORNL on June 30, 1945, there had been no declassification of atomic energy scientific or technical information by Manhattan Project officials.

The classified activities at ORNL encompassed construction and operation of all of its technical facilities. Those facilities included the Graphite Reactor; the chemical-processing facilites using the bismuth phosphate carrier process to separate plutonium from uranium and its fission products; the facilities for producing radioisotopes (including RaLa) in relatively large quantities; and the other chemistry, physics, engineering, health physics, biology, and medical R&D facilities.

The scope of ORNL's activities from 1943 through June 30, 1945, can perhaps best be presented by briefly describing the activities of ORNL's five principal divisions during those early years. [Author's note: the following information is probably not 100% accurate; it was taken from secondary sources that gave conflicting information as to organization names and responsibilities.] Those divisions were as follows:

Chemistry Division. The Chemistry Division provided research and development support to the operation of the chemical-processing pilot plant for separating plutonium from graphite-reactor-irradiated uranium and its fission products. The initial five sections of this division were: chemistry of plutonium and uranium, fission-product chemistry, separations processes, preparation of radioisotopes, and analytical chemistry. After the Chemistry Divison's support of the pilot process ended, its research program was broadened to include preparation and use of other radioisotope tracers (e.g., tritium, radiophosporous, and radioantimony) that could be produced in the Graphite Reactor. (This work was carried out in collaboration with other divisions.) Analytical methods were developed for the chemical identification of fission products and for other purposes.

Separations Development Division (initially the Chemical Engineering Section). The Separations Development Division consisted mostly of chemical engineers and was responsible for operating the plutonium-separation and -processing pilot plant. Many of that division's technical personnel were transferred to Hanford when the chemical-processing-pilot plant demonstration work had been completed. The ORNL pilot plant was then used for R&D on other separations processes. A "hot laboratory" was put into operation in March 1944 to produce radioisotopes other than those used in developing the bismuth phosphate plutonium-separation process, many of which were shipped to other Manhattan Project facilities. In October 1944, Separations Development Division became the Chemical Technology Department of the Technical Division.

Physics Division. Initial activities of the Physics Division supported start-up and operation of the Graphite Reactor, including determining the operating characteristics of that reactor. This division also carried out research concerning operation of the water-cooled Hanford reactors and radiation-shielding measurements on materials used in constructing those reactors. Some Los Alamos-related work was also performed, using the Graphite Reactor. Studies on neutron absorption by fission products were also carried out. Later reactor-physics work was concerned with R&D on new research reactors. Such reactors included a graphite-moderated reactor using stainless-steel-clad uranium carbide fuel and an aqueous homogeneous reactor using enriched uranium fuel (and also possibly being useful as a breeder reactor).

Engineering Development Division. Initially, the Engineering Development Division was primarily concerned with ORNL pilot-plant operations (including radioactive-waste storage) and with Hanford reactor problems (e.g., corrosion studies). The staff was largely made up of chemical engineers. Later, this division became involved in recovery of uranium from the highly radioactive liquid wastes resulting from plutonium processing and in reactor development. In October 1944, the Engineering Development Division became part of the Technical Division.

Health Division. The Health Division consisted of three groups: medical, biology, and physics. The division had responsibilities for the normal medical activities of a large industrial organization, clinical studies involving radiation exposures of employees (radiation protection and monitoring), studies on the biological effects of external radiation (using animals as research subjects), metabolism of short-lived fission-products, health-physics activities (controlling radiation and contamination hazards and developing radiation-measuring equipment, including dosimeters), and other activities. [In September 1946, this division was split into the Health Division, the Health Physics Division, and the Biology Division.]

SUBSEQUENT DECLASSIFICATION OF ORNL'S 1943-1945 ACTIVITIES

General

Although all of ORNL's 1943-June 30, 1945, activities were still classified when operation of ORNL by the University of Chicago ended, most, if not all, of the information about those activities was subsequently declassified. Thus, most of the documents produced by ORNL during that 1943-1945 period are now unclassified. The current classification of the 1943-1945 ORNL activities is summarized in the following sections (Declassified Information and Currently Classified Information), the first of which is organized according to major ORNL activities.

Declassified Information

Health, Safety, and Environmental Matters. All information concerning biological, physical and chemical effects of radiation, including all information on human radiation experiments has been declassified. All information on radiation safety, methods, and procedures; radiation-producing equipment; personnel dosimetry matters; and handling, storing, and monitoring radioactive materials has been declassified.

Chemistry and Chemical Engineering. All information concerning the basic chemistry of elements and all information concerning the recovery of plutonium and uranium from nuclear fuels, including the reduction of uranium and plutonium compounds to metals, has been declassified.

Nuclear Reactors. All information concerning the design and operation of commercial or research reactors, including basic reactor chemistry and chemical technology for spent fuel reprocessing has been declassified. This category includes all information about the Graphite Reactor, the pilot plant for chemical recovery of plutonium from that reactor's fuel elements, and design information about future commercial or research reactors that was developed during 1943-1945.

Physics. All information on experimental and theoretical physics, except that related to nuclear-weapons matters, of which there should have been none produced at ORNL during 1943-1945, has been declassified. An exception to this might be data from some neutron-physics experiments concerning uranium that were carried out for Los Alamos in the Graphite Reactor during this period.

Hanford Reactor Information. ORNL conducted some R&D in support of Hanford plutonium-production-reactor operations. All information about the design, construction, and operation of Hanford plutonium-production reactors is now (September 2000) unclassified. This body of knowledge includes all information about the following: Hanford fuel, targets, and cladding; Hanford reactor operating parameters; and process technology for the recovery of plutonium, uranium, and fission products. A caveat to the preceding sentences is that such information must not reveal actual quantities of plutonium used in nuclear-weapon production. Those quantities are still classified.

Currently Classified Documents Generated by ORNL in 1943-1945

As noted above, it is possible that some ORNL documents from the 1943-June 30, 1945, period could contain classified information related to nuclear-weapon design that was obtained in neutron-physics experiments on uranium in the Graphite Reactor during that period. It is also possible that some ORNL documents might contain classified information on actual quantities of plutonium provided by the Hanford reactors for nuclear-weapon production.

Also, some ORNL documents might contain classified information (e.g., about nuclear weapons) obtained at other sites (e.g., reports on trips to Los Alamos), but this is not likely because of the extensive compartmentalization of information during the Manhattan Project.

Chapter 6

CLASSIFIED ACTIVITIES AT ORNL, 1945-1948

INTRODUCTION

The Monsanto Chemical Company began operating ORNL on July 1, 1945, and continued to operate this facility through February 29, 1948. The Corps of Engineers continued to oversee ORNL operations until the AEC assumed that responsibility on January 1, 1947.

During 1945-1948, ORNL activities transitioned from a focus on plutonium-production-related operations to a wider scope of basic and applied R&D activities. Some of those new activities had been started in late 1944. Additional activities were initiated after the AEC assumed responsibility for the Manhattan Project facilities and programs. In recognition of Clinton Laboratories' broad scope of nationally important activities, its name was changed to Clinton National Laboratory in early 1947.

Because of a moratorium on new building construction in 1946-1947, the expanding ORNL (2141 employees in 1947) began to occupy empty buildings at the Oak Ridge Y-12 Plant, which was transitioning from a uranium-enrichment plant (by the electromagnetic or "calutron" process) to a weapons-components-manufacturing plant. The Biology Division moved into some of those Y-12 Plant buildings in 1947.

In May 1947, Monsanto decided not to seek renewal of its contract to operate ORNL. That contract expired on June 30, 1947. However, Monsanto agreed to operate ORNL on an interim basis until a successor was selected. That contractor was selected in December 1947, and Monsanto's operation of ORNL ended on February 28, 1948.

CLASSIFIED ACTIVITIES, 1945-1948

By July 1, 1945, the Graphite Reactor's mission to produce small quantities of plutonium had ended, and the plutonium-processing chemical pilot plant had been shut down. Activities at ORNL during July 1, 1945-February 29, 1948, included some that were started in late 1944 [e.g., radioisotope production and radioisotope chemistry, high-neutron-flux nuclear-reactor design (including an aqueous-homogeneous "breeder" reactor to produce uranium-233, with thorium as the fertile material), plutonium chemistry, and recovery of uranium from waste solutions containing uranium and fission products]. New activities started after mid-1945 (some may have started earlier) included separation of uranium-233 from irradiated thorium, solvent extraction processes, ion-exchange processes, measurements of neutron-absorption cross-sections on elements and isotopes, physical metallurgy, power-reactor development, and biological and health-physics studies. Most of ORNL's R&D activities during this time period were in the Chemistry, Physics, and Technical divisions.

Eugene Wigner came from Princeton University to ORNL in mid-1946 to serve for one year as ORNL's research and development director (Martin Whittaker had continued as ORNL director until that time).* Wigner placed special emphasis on nuclear- reactor development and nuclear-science training. The Clinton Training School was established in August 1946 with Frederick Seitz as its director. Navy Captain Hyman Rickover was one of the first attendees of that school. After Wigner returned to Princeton in mid-1947, Edgar Murphy served as interim research director until a new contractor was selected to operate ORNL.

Early reactor development included studies on an aqueous homogeneous reactor (those studies started in 1944). Problems related to corrosion, solution stability, and bubble formation led to ending this project in late 1945. Efforts then focussed on a heavy-water-moderated, light-water-cooled heterogeneous reactor (heavy-water cooling was also investigated and abandoned). Later, heavy-water moderation was also abandoned in favor of a light-water-moderated, light-water-cooled reactor that had enriched uranium as the fuel. This reactor was to have a beryllium neutron reflector, and its fuel was to be in the form of flat, closely-spaced aluminum-clad plates of a uranium-aluminum alloy. This design became the basis of the Materials Test Reactor (MTR) that was subsequently built in Idaho.

A Power Pile Division was formed in July 1946 from personnel from the Technical Division but largely populated by engineers from industry. Work on a gas-cooled power reactor had started in late 1945 and continued as the initial principal focus of the Power Pile Division. This reactor had been designed in 1944 by Farrington Daniels at the Metallurgical Laboratory and featured a bed of enriched uranium pebbles moderated by beryllium and cooled by helium gas. [This particular reactor concept was abandoned in about 1948 although gas-cooled reactors of other designs have operated in England, the United States, and elsewhere.]

In September 1946, the Medical Division was split into three divisions: the Health Division, the Health Physics Division, and the Biology Division. Also in September 1946, the Metallurgy Division was established from part of the Technical Division.

An Isotopes Section was established in the Operations Division in 1947 to handle production and distribution of radioisotopes. Earlier, in August 1946, radioisotopes were made available to organizations outside the Manhattan Project. The Technical Division handled those matters until isotope production and distribution was transferred to the Operations Division.

* James Lum was appointed administrative director of ORNL in mid-1946.

SUBSEQUENT DECLASSIFICATION OF ORNL'S 1945-1948 ACTIVITIES

General

Broad information about ORNL's classified Manhattan Project activities were declassified in August 1945, when the Smyth Report was issued. Subsequent declassification of ORNL-generated reports was on a case-by-case basis. A Manhattan Project declassification guide was issued effective March 31, 1946. Although the Atomic Energy Act of 1946 was approved on August 1, 1946, there was little impact on the classification of ORNL's activities until long after the AEC assumed responsibility for ORNL's operations, which was on January 1, 1947.

As was true for the 1943-June 30, 1945, period, essentially all ORNL scientific and technical activities during the July 1, 1945-February 29, 1948, period were classified. However, some information concerning the chemistry of nonclassified substances not directly involved in the production or utilization of special nuclear materials was declassified during 1945-1948, as were methods of chemical analysis of nonclassified substances and basic studies of the chemical effects of radiation. Some "elementary" information concerning neutron diffusion and general "pile" theory was also declassified. Instrumentation useful in laboratory practices (for unclassified applications) was declassified, as well as some information on metallurgy and ceramics.

Declassified Information

Most, if not all, of the information about ORNL's activities during July 1, 1945-February 29, 1948, was subsequently declassified. Since ORNL's 1945-1948 activities were essentially the same in general scope as the 1943-1945 activities, refer to the "Declassified Activities" section for that time period for information on the subsequent declassification of ORNL's 1945-1948 activities.

Currently Classified Documents Generated by ORNL in 1945-1948

It is possible that some ORNL documents might contain classified information on actual quantities of plutonium provided by the Hanford reactors for nuclear-weapon production. Also, some ORNL documents might contain classified information (e.g., about nuclear weapons) obtained at other sites (e.g., reports on trips to Los Alamos) but this is not likely because of the continued relatively extensive compartmentalization of information during the AEC's early years.

Chapter 7
CLASSIFIED ACTIVITIES AT ORNL, 1948-1984

INTRODUCTION

The AEC initially requested the University of Chicago to succeed Monsanto as operator of ORNL. However, during negotiations with that University, the AEC became concerned that the ORNL research program might become too academic under such an operator. An emphasis on "the industrial phases in chemistry and chemical engineering work" was sought. Shortly before Christmas 1947, the AEC decided that Carbide and Carbon Chemicals Company (CCCC, later renamed Union Carbide Corporation, Nuclear Division), a division of Union Carbide and Carbon Corporation (UCCC, later renamed Union Carbide Corporation), would operate ORNL. That company was also operating the other two major AEC facilities in Oak Ridge, the gaseous-diffusion uranium-enrichment plant at the K-25 Site and the Y-12 Plant (which had been initially operated by Tennessee Eastman Company).*

CCCC assumed responsibility for the operation of ORNL on March 1, 1948. The name of the laboratory had been changed from Clinton National Laboratory to Oak Ridge National Laboratory on February 1, 1948. Nelson Rucker served as CCCC's first ORNL director until Clarence E. Larson, Manhattan Project chemist and superintendent (1948-1950) of the Y-12 Plant, was appointed ORNL director in 1950. At that time, Alvin Weinberg, then head of ORNL's Physics Divison, became ORNL's research director. Weinberg subsequently served as ORNL director from 1955 until his retirement in 1972. Floyd Culler, a chemical engineer who had worked during the Manhattan Project in the Y-12 Plant and had transferred to ORNL in 1947, served as interim ORNL director until 1974. He was succeeded by Herman Postma, then director of ORNL's Fusion Energy Division, who was ORNL's director until 1988.

As the Y-12 Plant transitioned from a uranium-enrichment plant (using the electromagnetic method, or calutrons) to a weapon-component-manufacturing plant, its research divisions were transferred to ORNL (which increased ORNL staff by about 50%). In 1949, the Y-12 Plant Criticality Experiments Laboratory was expanded and transferred to ORNL to help guide new reactor designs. A new facility, the Critical Experiments Facility (CEF), became operational on August 1, 1950. This facility was shut down in March 1987.

The Y-12 Plant Electromagnetic Research Division became the ORNL Electronuclear Division in 1950. At that time, the Y-12 Plant's Isotope Research and Production Division, which used calutrons to produce stable isotopes, became part of ORNL's Isotopes Division.

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* Another explanation for the choice of CCCC as ORNL's operating contractor is that CCCC was concerned about potential labor relations complexities at the K-25 Site and the Y-12 Plant if an academic institution operated the third (ORNL) three major Oak Ridge AEC facility.

Also in 1950, Y-12 Plant Chemical Research Division personnel were incorporated into several existing ORNL divisions.

In 1950, ORNL's Technical Division was split into the Chemical Technology Division (February) and the Reactor Technology Division (July 1, 1950). The Reactor Technology Division was responsible for reactor development, and the Chemical Technology Division was principally involved in separation processes relative to nuclear-fuel reprocessing and other nuclear-fuel matters. During 1951, the Reactor Technology Division was split into the Aircraft Nuclear Propulsion Division (later the Aircraft Reactor Engineering Division and still later the Reactor Projects Division) and the Reactor Experimental Engineering Division. Those divisions moved to facilities at the Y-12 Plant. Those two divisions were recombined in late 1960 to form the Reactor Division, which became the Engineering Technology Division in 1977.

The Oak Ridge School of Reactor Technology (ORSORT) was established in 1950 (an earlier reactor training school was operated in 1946-1947). Most nuclear-fission reactor technology was still classified in 1950 and could not be taught in universities.

ORNL's Solid State Division was formed in 1952 by a combination of sections from the Physics Division and the Metallurgy Division. Its principal initial purpose was to study radiation damage of materials. A ceramics research group was added to the Metallurgy Division (later renamed the Metals and Ceramics Division) in 1952.

ORNL's ecology program started in 1954 as part of the Health Physics Division. That program became the Ecological Sciences Division in 1970 and in 1972 was renamed the Environmental Sciences Division.

Nonnuclear work for other federal agencies (Work for Others) started in the 1960s. Such work was encouraged by a 1967 Congressional amendment to the Atomic Energy Act.

CLASSIFIED ACTIVITIES

Concurrently with the decision to have CCCC operate ORNL, the AEC decided that all nuclear-reactor development would be located at the Argonne National Laboratory (ANL). Following that decision, ORNL programs concerned with the construction and operation of a high-neutron-flux reactor and a reactor for the production of useful power were transferred to ANL. Thus, in 1948, ORNL's Power Pile Division and personnel from the Chemistry, Metallurgy, and Physics divisions were transferred to Argonne.

The contract between the AEC and CCCC to operate ORNL included the following as areas of work for the laboratory:

1. Fundamental research in biology, chemistry, physics, and related sciences associated with the utilization of the present or future facilities of the Laboratory;
2. Research, development, and engineering of chemical and other processes;

3. Research, development, production, and distribution of isotopes;
4. Supporting and allied research;
5. Inauguration and advancement of broad participation by academic institutions and industry in research, engineering, development, and training; and
6. Continuation of research, development, and operation of the high-flux-pile program and associated facilities, pending transfer of such facilities to the Argonne National Laboratory.

A June 17, 1948, letter from the AEC's Oak Ridge Operations office indicated that the AEC wanted ORNL to develop into a strong center of basic research in chemistry, physics, biology and medicine, applied research and developmental engineering [especially chemical engineering], and isotope production and research.

Although the AEC transferred all reactor-development work to Argonne in 1948, Argonne's capability was not adequate to handle all such responsibilities. Thus, ORNL continued to design the Materials Test Reactor (MTR), which was to be located at the Idaho National Engineering Laboratory. ORNL personnel, many of whom transferred to Argonne, also participated in the initial planning and design of a pressurized-water nuclear reactor for naval ship propulsion.

In February 1950, ORNL first operated a mock-up of the MTR. This mock-up later became the 3-MW Low Intensity Test Reactor (LITR), which was shut down on October 10, 1968.

In September 1949, ORNL began participation in the Aircraft Nuclear Propulsion (ANP) Project, with Alvin Weinberg as the project director. That project had been initiated by the Air Force in 1946, with Fairchild Engineering and Aircraft Corporation as the major contractor. Fairchild used the vacant thermal-diffusion-plant facilities (S-50 Plant) at the K-25 site for its work for the Air Force. General Electric took over this project in about 1950 and transferred the site of the work to Ohio. About 180 Fairchild employees joined ORNL's aircraft project in May 1951 and the S-50 facilities were closed. Much of ORNL's initial ANP Project work was on radiation-shielding problems.

In support of radiation shielding work for the ANP Project, ORNL constructed a "swimming pool" reactor that became known as the Bulk Shielding Reactor (BSR). This reactor became operational in December 1950 at an initial power level of 10 kW. Improvements to this reactor (e.g., use of stainless-steel-clad uranium dioxide fuel elements) allowed its power level to be raised to 1 MW and later to 2 MW. Later, a 10-kW Pool Critical Assembly (PCA) was constructed and operated in one corner of the pool of the Bulk Shielding Reactor. The BSR and the PCA were shut down in March 1987.

The Tower Shielding Facility (TSF), completed in 1953, was also built to support the ANP project. In this facility, which conducted radiation-shielding tests, an unshielded reactor could be hoisted about 200 feet in the air. The first reactor at the TSF was a 500-kW reactor, Tower Shielding Reactor-I (TSR-I). In 1958, the Aircraft Shield Test Reactor (ASTR) was used at the TSF. This was replaced by TSR-II in 1960. TSR-II eventually was operated at 1 MW. During 1967-1973, the TSF-SNAP (Systems for Auxiliary Nuclear Power) reactor was also used at the TSF, along with TSF-II. The TSF was shut down in March 1987, but restarted in December 1989, for breeder-reactor-shielding studies.

An Aircraft Reactor Experiment (ARE) was operated in October 1954. It was a 1-MW reactor that used molten uranium salts as a fuel. A 60-MW Aircraft Reactor Test (ART) reactor was subsequently designed. The ANP project was greatly reduced in scope in 1957 and was cancelled on June 30, 1961.

ORNL designed a 10-MW (thermal) reactor for the Army. Later called the Army Package Power Reactor (APPR), it was completed at Fort Belvoir, Virginia, in 1957. This was a pressurized water reactor using highly enriched uranium in flat, plate-type fuel elements clad with stainless steel.

In 1949, ORNL began studies (again) on an aqueous homogeneous reactor to be operated at high temperatures and pressures with enriched uranium sulfate as fuel. A Homogeneous Reactor Experiment (HRE) was operated at 1 MW in February 1953 and continued operating until the early part of 1954. Subsequently, the 5-MW Homogeneous Test Reactor (HRT) was designed and built; it operated at full power in February 1956. This program, a major objective of which was to develop a thorium-232/uranium-233 breeder reactor, was terminated in mid-1961.

The 20-MW thermal (later increased to 30-MW) Oak Ridge Research Reactor (ORR) was completed late in 1957, went critical in March 1958, and operated until March 1987.

ORNL work in support of a gas-cooled reactor began again in 1958. An experimental gas-cooled reactor (EGCR) was built on the Oak Ridge site and was to be operated by the Tennessee Valley Authority for electrical power production. However, the EGCR was cancelled in 1966 without ever starting operation (going critical).

The Health Physics Research Reactor (HPRR), also known as the Fast-Burst Reactor, was installed in the new Dose Applications Research Facility in 1962; first operated on May 31, 1963; and continued operation (intermittently, as was its purpose) until March 1987. The power of the HPRR could be varied from 0.1 W to 10 kW.

The Graphite Reactor was shut down in November 1963 after 20 years of operation.

The 100-MW High-Flux Isotope Reactor (HFIR) was completed in 1965 and continues to operate (although now at about 80% of its original power level). An associated Transuranium Processing Plant produced targets for neutron-irratiation in this reactor and processed the irradiated targets for extraction of transuranic elements. Those transuranic elements were studied in a new Transuranium Research Laboratory at ORNL.

ORNL's Molten Salt Reactor Experiment (MSRE) went critical in June 1965 and operated, with uranium-235 and then with uranium-233, until December 1969. The MSRE project continued until 1976.

The Chemical Technology Division carried out many major projects, as would be expected because applied chemical engineering R&D activities was one of the major areas assigned to ORNL by the AEC in 1948. That division's chemical-separation activities encompassed (1) a pilot plant for the REDOX process (a solvent-extraction process developed at Argonne) for recovering plutonium and uranium by solvent extraction; (2) design of a plant to use the "25 Process" to recover uranium from the MTR fuel plates; (3) development of the tributylphosphate (TBP) process to recover uranium from fuel-reprocessing waste solutions; (4) development of the plutonium and uranium extraction (PUREX) process to separate plutonium and uranium from fission products and from each other (this process was used at the Savannah River Plant, at Hanford, and in commercial-nuclear-power plant fuel reprocessing in the United States and other nations; (5) development of the THOREX process to separate thorium, protoactinium, and uranium-233 from fission products and from each other; (6) the Interim-23 process to isolate uranium-233 from irradiated thorium and fission products; (7) the Slurrex process, which used TBP for the recovery and purification of uranium from ores; (8) the Excer process for converting uranyl nitrate to uranium hexafluoride; and other processes. As part of Chemical Technology Division activities, the Metal Recovery Facility was constructed, which used the TBP process to separate plutonium and uranium from fuel elements from a Canadian reactor at Chalk River.

In 1958, ORNL began space-related activities, including nuclear-propulsion systems and power sources for use in space, and radiation-shielding studies. Research on Systems for Nuclear Auxiliary Power (SNAP) for space exploration started. ORNL's Medium-Power Reactor Experiment (MPRE, terminated in 1966) was part of those activities. Most of the space-nuclear-power activities ended in 1973, but were restarted in 1983 with the Strategic Defense Initiative's (SDI) interest in the SP-100 project (a 100-kW electric power source). In about 1967, work on the Isotope Space Power Program started. Some of this work has continued until the present (September 2000).

ORNL began classified work on controlled thermonuclear fusion in 1953 as part of the AEC's Project Sherwood.

Eugene Wigner returned to ORNL in 1964 to initiate civil-defense (related to nuclear weapons) research. Classified nuclear-weapons data was used for some of this research. ORNL's civil-defense program ended in 1974.

Other R&D for the Department of Defense in support of President Reagan's SDI ("Star Wars") program began at ORNL in 1983. Some of that work was classified.

During 1948-1984, some of ORNL's expertise was used for a number of relatively small (generally) tasks in support of classified programs sponsored by the AEC and its successors and also in support of classified activities by other federal agencies. Describing those many small classified activities is outside the scope of this report (also, it is very difficult to characterize those activities in an unclassified document).

SUBSEQUENT DECLASSIFICATION OF ORNL'S 1948-1984 ACTIVITIES

General

During CCCC's (and its UCCC-related successors) tenure as operator of ORNL, the activities of the laboratory changed from a situation where most activities were classified to one in which most were unclassified. Early in this time period, the Atomic Energy Act of 1946 was replaced by the Atomic Energy Act of 1954. The 1946 Act declared that all atomic-energy information ("Restricted Data") was "born classified" and established a rigid standard for its declassification. Relatively little atomic-energy information was declassified between 1946 and 1954. The 1954 Act retained the "born classified" concept, but established a less rigid standard for declassification of Restricted Data. This was consistent with congressional and presidential objectives to commercialize atomic energy (e.g., use nuclear reactors for the commercial production of electricity) and to use atomic energy as a tool in U.S. "cold war" competition with the USSR (e.g., President Eisenhower's Atoms for Peace Program).

As a consequence of declassifications under the Atomic Energy Act of 1954 and ORNL's continuing mission to focus on unclassified areas of research of national importance (as contrasted to work on nuclear weapons), by March 31, 1984, essentially all of ORNL's scientific and technical work was unclassified. Further, as a consequence of the above-mentioned declassifications, most of ORNL's classified work done between March 1, 1948, and March 31, 1984, (e.g., work on nuclear reactors and nuclear-fuel reprocessing) has been declassified.

Declassified Information

The years 1948-1984 encompassed ORNL's "reactor-building" era. As noted earlier, ORNL was involved in the design, construction, and operation of many nuclear reactors during 1948-1984. During the early part of this period, most nuclear-reactor technology was classified. However, all information concerning the design and operation of commercial or research reactors has been declassified, including basic reactor chemistry and chemical technology for spent fuel reprocessing. Also, all such information about the Army Package Power Reactor and the reactors related to the Aircraft Nuclear Propulsion Project was declassified.

All information on fuel reprocessing has been declassified except certain information on naval-nuclear-fuel-element reprocessing.

All information on controlled thermonuclear fusion has been declassified. (Note that some work on inertial confinement fusion is classified.)

Refer to the Chapter 5 section on "Subsequent Declassification of ORNL's 1943-1945 Activities" for information on declassification of health, safety, environmental, and other matters. That information is also pertinent to the 1948-1984 period.

Currently Classified Documents Generated by ORNL in 1948-1984.

The only nuclear-reactor information that is currently classified, other than certain aspects of the production reactors at the Savannah River Plant, is that related to naval nuclear propulsion; very little technical information on that subject has been declassified. As noted earlier, ORNL was involved with the naval nuclear propulsion reactor program (including fuel element matters) from the earliest days of that program. Thus, many ORNL-generated documents containing information about naval nuclear propulsion are likely to still be classified. Many, if not most, of the documents generated at ORNL during 1948-1984 and containing such information were produced by the Chemical Technology Division.

ORNL participated to some extent with respect to reactors, fuel-element matters, etc. for the production reactors at the Savannah River Plant. For example, the PUREX process used to separate plutonium and uranium from fission products and from each other was developed by the Chemical Technology Division. Some of this information related to the Savannah River Plant is still classified and ORNL documents concerning that participation (especially those produced by the Chemical Technology Division) may still be classified.

As noted earlier, during 1948-1984 some ORNL personnel participated in a number of relatively small tasks that supported classified programs located at other AEC facilities. Documents produced under those tasks may still be classified. Some of those activities used code words; finding a code word in a document may be an indicator of such classified activities.

Documents concerning safeguards and security activities, including nuclear material control and accountability matters, may still be classified. Also to be noted is that documents concerned with costs (prices, inventory values, etc.) of certain materials (e.g., plutonium, tritium, etc.) may still be classified.

Work for Others began during 1948-1984 and had become a significant ORNL activity by 1984. Some of that work was classified and documents prepared for those projects were classified when produced. Generally, most of those currently classified documents will have to be referred to the agency that sponsored the work for declassification or downgrading decisions.

Chapter 8
CLASSIFIED ACTIVITIES AT ORNL, 1984-2000

INTRODUCTION

Martin Marietta Energy Systems, Inc. (MMES), a subsidiary of Martin Marietta Corporation, assumed responsibility for the operation of ORNL on April 1, 1984. Later, after Martin Marietta Corporation merged with Lockeed Martin Corporation, a new entity, Lockeed Martin Energy Systems, Inc. (LMES) became ORNL's operating contractor. LMES initially operated, as did UCCC and its successors, all three major DOE facilities in Oak Ridge. To provide particular management attention to ORNL's R&D operations, which were distinctly different from the nuclear-weapon-component production operations at the Y-12 Plant and the decontaminating, decommissioning, and environmental restoration activities at the K-25 Site (formerly the Oak Ridge Gaseous Diffusion Plant), Lockheed Martin Corporation created Lockheed Martin Energy Research Corporation (LMER) in 1996 to operate ORNL. LMER's operation of ORNL ended on March 31, 2000.

In 1988, Herman Postma, Laboratory Director since 1974, became an LMES vice-president and Alex Zucker became acting Laboratory Director. Alvin Trivelpiece became Laboratory Director in 1989, serving in that position until March 31, 2000.

CLASSIFIED ACTIVITIES, 1984-2000

As noted earlier in the chapter on 1948-1984 ORNL activities, by 1984 most of ORNL's activities were unclassified. This was the situation during 1984-2000. The number of classified documents produced by ORNL and given a document number during 1984-2000 was only about 1% of the unclassified numbered reports issued by ORNL during that period. Most of those classified ORNL documents concerned safeguards and security matters, including nuclear-material control and accountability activities. Costs of certain nuclear-energy-related materials are classified and some ORNL accounting documents contain such information. Very few classified ORNL documents produced during this period concerned scientific or technical information. Of those classified scientific or technical documents, many concerned non-DOE activities (i.e., were in the category of National Security Information as contrasted to Restricted Data). Historically, ORNL produced very few documents that contained Formerly Restricted Data.

Work for Others projects within ORNL grew significantly in the mid-1980s, some of which were classified. Computer-related work for the Department of Defense was a major growth area within ORNL's Energy Division. In the late 1980s, that activity was split from the Energy Division to become the Data System Research and Development (DSRD) organization, a separate MMES entity not associated with ORNL. Similarly, there was an increase in environmental-related work for the Department of Defense within the Environmental Sciences Division. In the late 1980s that activity, the Hazardous Waste Remedial Action Program (HAZWRAP), was split from the Environmental Sciences Division to form a separate MMES entity not associated with ORNL.

In 1985, ORNL began participation in the Strategic Defense Initiative's (SDI) Multimegawatt Space Power Program. Other SDI activities were subsequently conducted as part of ORNL's Space and Defense Technology Program, including optics programs such as the Optical Characterization Laboratory (OCL) and Manufacturing Operations Development and Integration Laboratory (MODIL).

Work for Others projects, other than DSRD and HAZWRAP activities, included some classified work for the Air Force, Army, Navy, and other federal agencies. A major activity in the late 1980s was work on the Navy's Seawolf submarine program. Most of the Seawolf-related work was transferred to the Y-12 Plant by the early 1990s.

Since 1985, several ORNL divisions have participated in the Department of Defense's Chemical Stockpile Disposal Program, some aspects of which were classified.

In 1989, ORNL's Chemical Technology Division received plasma-separation-process (PSP) uranium-isotope-enrichment equipment from DOE-supported activities at TRW, Inc. Some of that equipment, currently (2000) being transferred by DOE from ORNL cognizance to a private company for use in stable- isotope production, is classified.

Technical personnel with expertise in classified gas-centrifuge technology transferred from the K-25 Site to ORNL's Engineering Technology Division in about 1992. Some ORNL technology-transfer work is closely related to that classified expertise.

During 1984-2000 some ORNL personnel participated in Work for Others through the National Security Program's Office (NSPO), initially a K-25 Site organization, later a Y-12 Plant organization, and currently organizationally affiliated (in part) with ORNL. That ORNL work is a relatively small effort, but most of it is classified.

In recognition of that fact that nearly all ORNL work is unclassified, and in order to simplify classification, security, and information-release matters related to unclassified work, ORNL established Designated Unclassified Subject Areas (DUSAs) and non-DUSAs in early 1993. (The idea for this categorization came from a similar categorization established by the Lawrence Livermore National Laboratory Classification Office.) In 1993, all ORNL classified work was identified and specifically designated as a non-DUSA. Lists of non-DUSA activities from 1993 to 2000 are contained in the files of the ORNL Classification Office.

SUBSEQUENT DECLASSIFICATION OF ORNL'S 1984-2000 ACTIVITIES

General

As noted earlier, most of ORNL's 1984-2000 activities were unclassified. Atomic-energy related declassifications during 1948-1984 had resulted in most or ORNL's Department of Energy-sponsored activities being unclassified much earlier than 1984.

Declassified Information

There were no Department of Energy declassifications during 1984-2000 that affected major ORNL programs or activities.

Currently Classified Documents Generated by ORNL in 1984-2000

The only nuclear-reactor information that is currently classified is that related to naval nuclear propulsion; very little technical information on that subject has been declassified. Thus, any ORNL-generated documents containing information about naval nuclear propulsion are likely to still be classified. Few such documents were generated during 1984-2000 and any such documents would probably have been generated under Work-for-Others activities by either the Chemical Technology Division or the Metals and Ceramics Division.

During 1984-2000, ORNL personnel participated in some relatively small tasks that supported classified programs located at other AEC facilities. Documents produced under those tasks may still be classified.

Documents concerning safeguards and security activities, including nuclear material control and accountability matters, may still be classified. Also to be noted is that documents concerned with costs (prices, inventory values, etc.) of certain materials (e.g., plutonium, tritium, etc.) may still be classified.

Work for Others was a significant ORNL activity during 1984-2000, particularly during the early years of this period. The list of non-DUSAs for the period starting with early 1993 (when such non-DUSA's were first identified) should be consulted to identify ORNL's classified Work for Others. Generally, most of the classified documents prepared under classified Work for Others activities will have to be referred to the agency that sponsored the work for declassification or downgrading decisions.

Chapter 9

OPERATION OF ORNL, 2000-PRESENT

UT-Battelle, LLC, a joint organization of The University of Tennessee, Knoxville, and Battelle (Columbus, Ohio), became the operator of ORNL on April 1, 2000. Bill Madia became Laboratory Director on that date.

Because this document is concerned with "historical" classified activities at ORNL, classified activities from April 1, 2000 to the present (September 2000) will not be discussed except to say that there has been little change in ORNL's classified activities since April 1, 2000.