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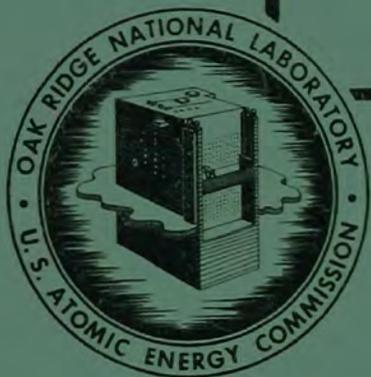


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THE OAK RIDGE SCHOOL
OF
REACTOR TECHNOLOGY

1951 - 1952



OAK RIDGE NATIONAL LABORATORY
OPERATED BY
CARBIDE AND CARBON CHEMICALS DIVISION
UNION CARBIDE AND CARBON CORPORATION



POST OFFICE BOX P
OAK RIDGE, TENNESSEE

THE OAK RIDGE SCHOOL OF REACTOR TECHNOLOGY

1951-1952

Established by

THE UNITED STATES ATOMIC ENERGY COMMISSION

at the

OAK RIDGE NATIONAL LABORATORY

operated by

CARBIDE AND CARBON CHEMICALS DIVISION
Union Carbide and Carbon Corporation
Post Office Box P
Oak Ridge, Tennessee

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THE OAK RIDGE SCHOOL OF REACTOR TECHNOLOGY

F. C. VonderLage, Director

FACULTY MEMBERS*

Elda E. Anderson
W. P. Berggren
E. C. Campbell
M. C. Edlund
G. E. Evans
C. C. Harris
Ernest D. Klema
Neal Lansing
Lewis Nelson
Herbert Pomerance
Richard J. Stephenson
T. A. Welton
P. Zmola

VISITING STAFF

T. R. Cuykendall
(Cornell University)

Reginald J. Stephenson
(Wooster College)

** The regular faculty members have been selected from ORNL Research Divisions and continue to devote approximately half of their time to research.*

PURPOSE AND HISTORY

The Oak Ridge School of Reactor Technology, authorized by the United States Atomic Energy Commission and conducted by the Oak Ridge National Laboratory, was established in March 1950 with a small pilot group of special students from industry and government agencies, who were selected primarily on the basis of urgent AEC needs. This School was instituted for the purpose of training engineers and scientists in the field of reactor theory and technology, looking toward their engaging directly in reactor research and development.

The School began regular operation in September 1950 with a group of students composed equally of recent graduates who have the status of student employees at the Oak Ridge National Laboratory (Category A) and representatives of industry and government agencies (Category B). The 1951-52 class, again to be composed of students in these two categories, will begin a full twelve months of sessions on September 10, 1951*.

* Applications for this session must be filed by March 1, 1951. For details see "Filing of Applications" (Page 9).

SELECTION OF STUDENTS*

Students are selected by a Committee on Admissions in accordance with the following basic considerations:

1. Needs of the AEC reactor program.
2. Training, experience, and personal qualifications of the applicant as set forth in the application (Form A or Form B) and in supporting statements by the applicant and by persons asked to complete the reference Form D in his behalf.
3. Academic record of the applicant as reflected in official transcripts of undergraduate and graduate records submitted with the application and summarized in the Academic and Research Summary (Form C).
4. Potential contribution which the applicant, in the opinion of the Committee on Admissions, can make to the reactor development program.

In making selections, the Committee will seek evidence of aptitude for competent research, development, or design activity in the field of reactor technology.

Students are selected from two categories, as follows:

Category A (Use application Form A)

Recent graduates (students who hold a bachelor's degree or a master's degree in chemistry, engineering, metallurgy or physics, including those students graduating before September 1951) who will join the Oak Ridge National Laboratory for the training period and will be paid a stipend of \$285.00 per month. After the training period, it is anticipated that these students will become available for regular employment by the AEC, its contractors, or other organizations interested in reactor development; however, appointment as a student in the School carries no commitment on future employment.

Category B (Use application Form B)

Employees of Atomic Energy Commission contractors, appropriate government agencies and their contractors, and industrial organizations having an active interest or potential active interest in the development of reactors and their components. All applications in this category must be submitted by the sponsoring agency on behalf of the prospective students. These students will remain on the payrolls of their sponsoring organizations for the training period and will return to these organizations upon completion of the course. This arrangement represents an effort to enable appropriate government agencies, their contractors, and especially private industrial organizations, to participate actively in this new and important field of industrial development and to stimulate more effective participation by those organizations already actively engaged in the field.

* Forms referred to in this section are described under "Filing of Applications" (Page 9).

ACADEMIC PREREQUISITES

Applicants must hold at least a bachelor's degree, preferably in one of the following fields:

Chemistry

Engineering (mechanical, metallurgical, chemical,
electrical or aeronautical)

Physics

Others with suitable academic background or experience will be considered.

It is expected that all applicants will have some background in ordinary differential equations, and in introductory nuclear physics.

GRADUATE CREDIT

The Oak Ridge School of Reactor Technology has no regular provisions for application of course credit toward advanced degrees; however, the School will continue its policy of cooperation with institutions interested in accrediting work done in Oak Ridge.

SCHEDULE

The training period will be a full twelve months.

Students should be prepared to devote from 50 to 70 hours per week to the School program, including outside study. Examinations are held at regular intervals, and the work of the School is carried on in conformity with standards of graduate collegiate instruction.

Lectures and laboratory work will be supplemented by assignment of certain students, depending upon qualifications and progress in the School, to Laboratory research and development groups for practical training for a portion of their time.

There will be no recess in the School program before March 1952; therefore students loaned from other organizations should plan to take any vacations due them before September 10, 1951.

CURRICULUM

The following course descriptions are indicative of the program planned for the 1951-52 sessions. In view of the anticipated variations in student preparation and background, it is likely that two curricula will be arranged.

The prominence of nuclear physics in the curriculum should not be construed to mean that students with a major background in physics are preferred over engineering graduates. On the contrary, the student trained originally in engineering who acquires a satisfactory acquaintance with nuclear physics through this curriculum will be very much in demand in the field of reactor development.

MATHEMATICS

Probability and Statistics: Discussion of basic concepts of the mathematical theory of probability; the Binomial, Poisson, and Normal distributions; mean-free-path, isotropic and non-isotropic scattering, and counting radioactive disintegrations. Calculus: Definitions of point function, derivative, directional derivative, gradient, divergence, and Laplacian. Discussion of orthogonal coordinate systems, in particular the rectangular, cylindrical, and spherical. Differential Equations: Boundary value problems solved by separation of variables, e.g., vibrating string, heat flow in simple geometries, etc. Emphasis is placed on the eigen-value problems which arise, orthogonal functions (including a brief discussion of the Bessel Functions), and Fourier series (generalized). Diffusion equation in simple geometries with simple sources, i.e., point source. Transforms: Discussion of Fourier and Laplace Transforms with reference to their application to the needs of the course in Reactor Theory. This course is calculated to equip the student with the mathematical tools he will use as a reactor engineer with emphasis on the needs of the course in Reactor Theory. Five hours per week for two months; additional as needed.

ATOMIC AND NUCLEAR PHYSICS

Selected topics in Atomic and Nuclear Physics, an understanding of which is essential for Reactor Theory and Technology. Topics will include atomic structure of matter, isotopes and nuclear structure, general laws of radioactive disintegration, nuclear radiations and their interactions with matter, nuclear reactions, general properties of nuclei, and essential information on radiation protection for personnel. This will be in the nature of a refresher course. Five hours per week for two months; two hours per week for four months.

REACTOR THEORY

Scattering and adsorption of neutrons, physics of the fission process, development of diffusion theory, solution of diffusion equation for various source geometries, diffusion kernels, slowing down of neutrons and slowing down kernels, solution of Fermi age equation, approach to critical, critical equation for unreflected homogeneous thermal reactors, neutron cycle, multi-group reactor equations, intermediate and fast reactors, heterogeneous reactors, reactor kinetics, perturbation theory and

statistical weights, effectiveness of control rods, temperature coefficients, fission product poisoning, transport equation and development of diffusion theory as first order approximation, and corrections to diffusion theory. 4½ hours of lectures plus two hours of recitation per week for sixteen weeks.

EXPERIMENTAL REACTOR PHYSICS

A laboratory course in which students will perform most of the now classical experiments of reactor physics. These include about twenty-five carefully selected experiments on the measurement of radiation, measurement of neutron cross sections, diffusion length, slowing-down distance, kinetics and neutron flux distribution in the uranium-graphite chain reactor. Emphasis is placed on those experiments giving a feeling for neutron physics, which characterizes the reactor engineer. Excellent facilities are available to advanced students for independent research in reactor physics; these include the large Oak Ridge Graphite Reactor, the School of Reactor Technology Exponential Pile, high-voltage accelerators, and complete machine and electronic instrument shops. Discussion sessions, two hours per week for six months; Laboratory, 3½ hours per week for six months.

REACTOR NUCLEAR PHYSICS

An advanced course on special topics applicable to reactors. Includes quantum mechanics of particle scattering, neutron-proton scattering, scattering of neutrons from crystalline substances and related matters, neutron scattering and reactions in heavier nuclei with emphasis on the derivation and use of the resonance formula, fission theory and charged particle reactions and scattering. Two hours per week for six months. (Registration in this course is limited to those students who come to the School with more advanced training.)

REACTOR CHEMISTRY

This course covers the chemical and chemical engineering aspects of reactor design. The following topics are discussed in some detail: the fundamental chemistry of the heavy elements, the nuclear species produced in reactors and their effects on reactor operation and chemical processing, the preparation of materials going into reactors, the processing of reactor products, radioactive waste disposal, and the effects of ionizing radiations on materials. The necessity of designing a reactor and its corresponding processing plant as a unit for maximum over-all efficiency is stressed. Two hours per week for three months.

REACTOR MATERIALS

A general survey of current and proposed reactor materials; the effects of pile radiation; applicable topics in solid-state physics and radiation chemistry; experimental techniques in radiation damage testing; criteria for the selection and evaluation of reactor materials. Three hours per week for five months.

REACTOR SCIENCE AND ENGINEERING

A survey of important reactor elements together with applications. A historical introduction, with a qualitative discussion of chain reacting systems, initiates the course. Metallurgy of the heavy elements and other metals of particular interest, followed by chemical technology with emphasis on separations processes. Other important topics treated include shielding, heat transfer, and control of transients in chain reactors. The second half of the course is devoted to descriptions of existing reactors, and a reactor design problem. Three hours per week for seven months.

REACTOR DESIGN ENGINEERING

Review of elementary concepts in fluid mechanics, including continuity equation and steady flow relations; boundary layer and turbulent flow theories; uni-dimensional compressible flow. Heat transfer by conduction, convection and radiation, including transient problems, thermal sources, thermal boundary layers, and entrance effects. Mechanics of deformable bodies including basic concepts in elasticity and properties in materials. Three hours per week for six months. (Students already possessing background in these subjects will not be required to register in this course.)

FILING OF APPLICATIONS

The complete set of forms necessary for application to the 1951-52 session of the Oak Ridge School of Reactor Technology consists of the following:

1. Form A - Application blank for Category A, OR
Form B - Application blank for Category B
2. Form C - Academic and Research Summary
3. Personnel Security Questionnaire (in duplicate)
(will be returned to applicants not accepted)
4. Security Acknowledgment (in duplicate)
5. Fingerprint card
6. Reference Form D - to be submitted directly to the School by three persons acquainted with the applicant's qualifications.

In addition to these forms, official transcripts of all completed college work must be submitted as a part of the application.

These forms may be obtained upon request from:

Oak Ridge School of Reactor Technology
Post Office Box P
Oak Ridge, Tennessee

The complete set of forms listed above must be filed with the Oak Ridge School of Reactor Technology by March 1, 1951. Appointments will be announced on or before April 1, 1951

GENERAL INFORMATION

In order to satisfy security regulations and to have access to classified information, all those enrolled in the School must have full AEC security clearance. Due to the nature of some of the courses in the School, all appointments are made contingent upon a satisfactory investigation prior to enrollment.

Tuition is free. Materials and equipment required in the School will be furnished by the Laboratory.

Adequate housing for students will be furnished in Oak Ridge government-owned facilities at a cost comparable to housing costs elsewhere. Housing assignments will be made by the Personnel Office in accordance with existing policies of the Laboratory and the Atomic Energy Commission.

Student-employees of the Laboratory will be reimbursed for certain of their expenses in reporting to the School, in accordance with existing policies of the Laboratory, and will be eligible for insurance and hospitalization benefits offered to regular employees.

OAK RIDGE NATIONAL LABORATORY

C. E. Larson,
Director

A. M. Weinberg,
Research Director

HISTORY OF THE LABORATORY

Oak Ridge National Laboratory, situated in East Tennessee about 12 miles from the city of Oak Ridge, represents the permanent outgrowth of a temporary wartime project - a project originally intended to last only two years. In the early part of 1943 the Laboratory was organized under what was known as the University of Chicago Metallurgical Project.

On December 31, 1947, the Atomic Energy Commission announced that the Carbide and Carbon Chemicals Division, Union Carbide and Carbon Corporation, would operate the Laboratory for the Commission beginning March 1, 1948. On February 1, 1948, the Atomic Energy Commission announced that the facility would be known as Oak Ridge National Laboratory.

In keeping with its designation as a permanent National Laboratory, the Laboratory is now being enlarged and modernized under a \$20,000,000 expansion program.

RESEARCH PROGRAM

The Laboratory has in the neighborhood of one hundred groups working on various research problems making up its program. The program can be divided into seven major categories, according to the broad objectives which have been developed under the guidance of the Atomic Energy Commission: reactor technology, chemical technology, basic research, education, radioisotope production, stable isotope production, and radiation protection.

The first objective and perhaps the most urgent at present, is that of carrying out a research and development program of direct relevance to the development of reactors. This includes the three major reactors now being developed here (namely, the Homogeneous Reactor, the Aircraft Reactor, and the Materials Testing Reactor), and other research of general interest to reactor development.

The Laboratory has recently formed an Aircraft Nuclear Propulsion (ANP) Division. The ANP Project is a joint effort of three laboratories, Oak Ridge National Laboratory, NEPA* Division of Fairchild Engine and Airplane Corporation, and the Lewis Laboratory of the National Advisory Committee for Aeronautics. The work of these three groups is guided in broad outline by the ANP policy committee in Washington whose members are representatives of the Atomic Energy Commission, the United States Air Force, the National Advisory Committee for Aeronautics, and the Bureau of Aeronautics, Navy Department. Under the ANP Program, the Oak Ridge National Laboratory has primary responsibility for reactor research. Within this general field, the Laboratory is responsible for over-all coordination throughout the project for the work on shielding theory and tests, nuclear measurements, critical experiments, radiation damage, and fuel reprocessing.

The Laboratory performs an educational function which has several aspects. It conducts a Professional Health Physics Training Program for AEC fellowship holders, which is designed to train persons who will be engaged in protecting others against radiation hazards. It operates the Oak Ridge School of Reactor Technology to supplement the training of engineers for working in the Commission's reactor development program. It performs a broad educational function, working in cooperation with the Oak Ridge Institute of Nuclear Studies, by providing training in specialized fields to university students and faculty members, inviting such persons to join the Laboratory for limited periods of time. It sponsors jointly with the Institute a traveling lecture program and conducts, in Oak Ridge, occasional symposia on specialized topics.

* See Page 12

THE OAK RIDGE AREA

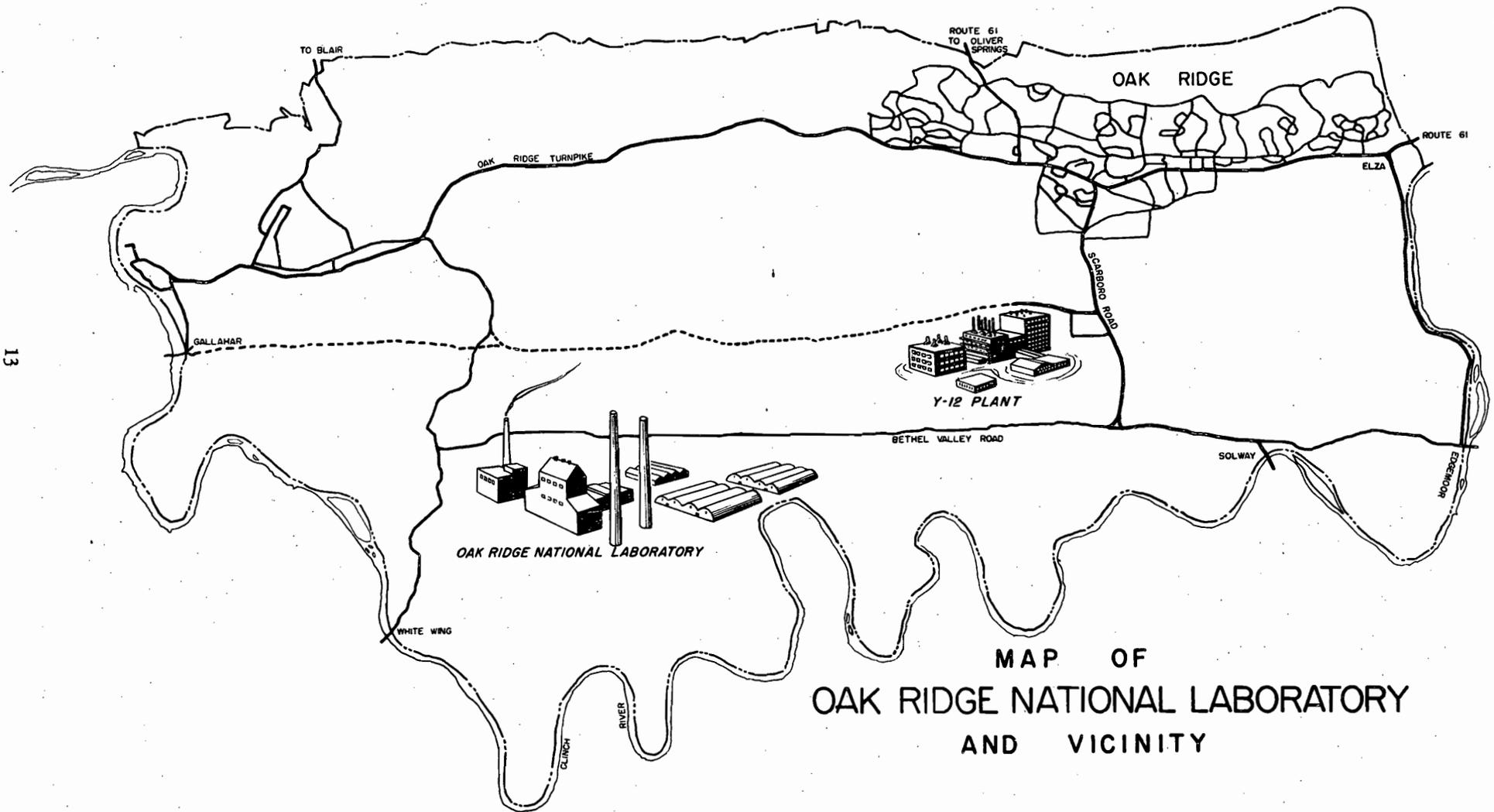
The Oak Ridge Area of the Atomic Energy Commission comprises 92 square miles in which are situated three main operating units concerned with atomic energy work (two plants for the production of and research on Uranium-235, and a third which serves as a nuclear research center) and the community of Oak Ridge, a city with a population of 30,000. The area is seven miles from the Anderson County seat, the town of Clinton, for which the area, formerly known as Clinton Engineer Works, was named. Oak Ridge is about 20 miles from the city of Knoxville and 18 miles from Norris Dam. When the site was selected in 1942 and the construction begun, nearly 1000 families were evacuated from the area.

The operating units are the gaseous diffusion plant for the production of U-235; the electromagnetic isotope separation plant for the limited production of U-235, the production of stable isotopes and research on process improvements; and the Oak Ridge National Laboratory, nuclear research center and production unit for radioactive isotopes, which served during the war as a pilot plant for construction of the huge Plutonium process buildings at Hanford Engineer Works in the State of Washington. These three main operating units at Oak Ridge are operated for the Atomic Energy Commission by the Carbide and Carbon Chemicals Division, Union Carbide and Carbon Corporation. Near the gaseous diffusion plant, there is also a high-temperature, high pressure, variable-frequency steam power plant, which has generating capacity of 238,000 kilowatts (twice the capacity of Norris Dam of TVA).

The Oak Ridge Institute of Nuclear Studies, Inc., is an organization of 26 member universities in the South and Southwest which has as its objective 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.

A hospital was opened in March, 1950 by the Oak Ridge Institute of Nuclear Studies for study and evaluation of radioactive isotopes in the treatment of cancer. A limited number of patients are now being admitted through the medical schools of the universities associated with the Institute.

The NEPA Division of Fairchild Engine and Airplane Corporation operates under an Air Force contract, the ultimate objective of which is to develop a nuclear powered tactical bombing plane. By its own direct scientific and engineering participation and by coordinating the efforts of some 9 affiliated organizations, NEPA discharges prime responsibility for the air frame design, engine development, and overall coordination of reactor, power plant and air frame into an integrated unit. A great amount of effort is expended in analytical work evaluating engine cycles, shielding configuration, and aerodynamic designs. Experimental work in materials and metallurgy, critical assemblies, instrumentation and controls, and physical chemistry is actively prosecuted at the NEPA laboratories. NEPA participates actively, by direct assignment of personnel, with the ANP program as it is being carried forward in Oak Ridge.



MAP OF
OAK RIDGE NATIONAL LABORATORY
AND VICINITY

