PROVISIONS FOR RESEARCH RELATED TO HEALTH SCIENCES

THE GEORGIA TECH RESEARCH REACTOR

12E

INTRODUCTION

The heavy-water-moderated, heterogeneous, enriched fuel reactor has been chosen as the type best suited for Georgia Tech's purposes. It offers the advantage of maximum safety and maximum neutron flux for a given power. The Georgia Tech reactor will be designed to permit operation up to a maximum power level of about 5 megawatts, with a thermal neutron flux of 10^{14} neutrons/ cm^2 - sec, or more.

The conceptual design of the reactor facility has been prepared under the direction of Dr. W. H. Zinn, who is one of the leading reactor designers in the world. Briefly, the facility consists of the reactor in a containment building which is 80 feet in diameter and 70 feet high, and an adjoining laboratory and office building with an area of about 23,000 square feet. There are no classrooms, but two rooms will be used as conference or lecture rooms. In support of the research activities at the reactor, laboratories are provided for research in electronics, metallurgy, physics, chemistry and biology. Also provided in the laboratory area are two "hot cells" and a pool for storage and use of spent fuel elements and other radioactive materials. Based on the conceptual design, Mr. E. A. Moulthrop, Robert and Company Associates, has supervised the preparation of the preliminary design of the buildings. Figures illustrating the present plans for the reactor facility are included at the end of this report.

The proposed facilities will make possible fields of research in health and related sciences which are new in the Southeast. A broad program of collaboration with other institutions is expected to give maximum use of numerous facilities incorporated in the Georgia Tech Research Reactor. These facilities include a shielded room in which biological specimens or human subjects may be exposed to massive quantities of either slow neutrons, fast neutrons or gamma rays. This room will be the site for such things as activation analysis of trace elements "in situ", and a research program in neutron capture therapy. This irradiation room will be the third such facility in the United States for medical research; the other two will be at Brookhaven National Laboratory, Upton, L. I., and Massachusetts Institute of Technology, Cambridge, Massachusetts.

In addition, there will be numerous ports, beam holes and a thermal column for irradiation of samples of varying sizes. Two ports will be equipped with pneumatic control for exposing small samples to brief irradiations in the reactor core.

Many short half-life radioisotopes will be made in the reactor for use in medical and other research. To use these radioisotopes, it is required that the research must be in the vicinity of the reactor. Thus, the reactor will open up new research possibilities with radioisotopes in this area.

The auxiliary laboratory and office building supplements the research at the reactor by providing space for preparation of biological or human subjects to be irradiated, and laboratories for related chemical or physical studies. There will also be a radiation counting laboratory and cells for handling kiloroentgen levels of radiation.

The research reactor facility encompasses numerous specialized research possibilities which are not reproduced or planned within a radius of several hundred miles. The versatility of the Argonne Research Reactor (CP-5) for biological, chemical, and physical research has already been demonstrated, and the Georgia Tech Research Reactor has incorporated the best features of CP-5 plus additional features provided specifically for medical research.

NEUTRON THERAPY

In order to amplify and emphasize the potential importance of the reactor in medical research, it is interesting to note the work of some of the present pioneers in neutron therapy. One of the unique contributions which is made in medical research by a reactor is noted by Farr, Robertson, and Stickley*:

> "The accepted applications of radiation therapy in wide use for the treatment of malignant disease rely chiefly on penetrating electromagnetic radiation; that is, X-rays and gamma rays. In addition, there are instances in which irradiation with light particles such as beta rays or electron beams is used. Except for recent developments which employ narrow beams of protons and deuterons of extreme energy, the application of heavier particles has been restricted to wholly superficial sites, since the penetration of alpha and other such particles is quite limited at energies hitherto generally available. Neutron capture therapy involves an important physical difference in the approach to radiation treatment of disease in that the malignancy is treated in depth and presumably in a uniform manner with heavy particle radiation. The kinetic energy of these particles is transferred to the tissues within a very short range from their point of

*L.E. Farr, J.S. Robertson, and E. Stickley, "Use of the Nuclear Reactor for Neutron Capture Therapy of Cancer", Peaceful Uses of Atomic Energy, Proceedings of the International Conference in Geneva, August 1955, Vol. 10, p. 182

origin. This range is of the order of 10 microns for the nuclear reaction used in our work. Such intensive transfer of energy along a short path in contrast to the lesser linear energy transfer along the path of an X-ray or gamma ray might be expected to produce qualitative as well as quantitative differences in the results observed."

Their early work in the field of neutron therapy defined the needs for a special facility for pursuit of this important study. Ultimately, as it is now widely known, these needs were satisfied by the Medical Research Reactor which is being built at Brookhaven National Laboratory. It is pertinent, however, that this decision to build a Medical Research Reactor was the result of a detailed study of the needs. This study is mentioned in another article by Robertson, Stickley, Bond, and Farr*:

> "Before the decision to request the medical research reactor was reached, a survey was made (under contract) for the Brookhaven National Laboratory by Nuclear Development Associates (NDA) of means for meeting the Medical Department's radiation-source requirements. Various accelerators and fixed sources were considered, but when all of the parameters of expected performance, versatility, safety, dependability, operational simplicity, security classification and cost were analyzed, the reactor emerged as being the most suitable instrument."

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*J.S. Robertson, E. Stickley, V.P. Bond, and L.E. Farr, "The Proposed Brookhaven Medical Research Reactor", Nucleonics, 13, 67 (1955)

MEDICAL ADVISORY COMMITTEE

For considering the medical research needs to be accommodated by the Georgia Tech Research Reactor, a committee was established by Dean A. P. Richardson, Emory University School of Medicine. This Medical Advisory Committee consists of the following members:

WALTER H. CARGILL, JR., M.D., Chairman; Assistant Professor of Physiology and Associate in Medicine, Emory University; former Chief of Radioisotope Service and Asst. Chief of Medical Service (Research), Veterans Administration Hospital, Atlanta; University Isotopes Committee; nine years experience in the use of isotopes in medicine.

JOHN T. GODWIN, M.D., Pathologist and Director of Laboratories, St. Joseph's Infirmary; Research Collaborator, Brookhaven National Laboratory, (BNL); former Head, Division of Pathology, BNL, (experience at BNL includes research in neutron therapy with other pioneers in this field*).

R. H. ROHRER, Ph.D., Associate Professor Physics and Assistant Professor Radiology (Physics); University Radiological Safety Officer; Member, University and Hospital Isotopes Committees. Twelve years experience at Oak Ridge National Laboratory, Duke University, and Emory in the use of radioisotopes, neutron sources, radiation physics, health physics, etc.

H. S. WEENS, M.D., Professor of Radiology; Chairman of the Department of Radiology; sixteen years experience in the use of X-rays and radium in Medicine.

*J.T. Godwin, L.E. Farr, W.H. Sweet, and J.S. Robertson, Cancer, 8, 601 (1955)

Following is an excerpt from a recent memorandum from the Medical Advisory Committee:

"Since the effects of neutron irradiation as opposed to the ionizing effects obtained from gamma, beta, and X-ray sources on living tissues remains an almost completely unexplored field, no attempt can be made to estimate the therapeutic results which might be obtained from the exposure of a malignant lesion to a beam of thermal (slow) neutrons. Selective localization of an element of low mass number within the tumor itself should yield alpha particles upon neutron bombardment and, theoretically, these particles should produce destruction of the neoplastic tissue without damage to surrounding normal cells. Preliminary experiments with the Brookhaven reactor have shown interesting changes in glioblastomata containing boron-10 following neutron capture. Many other neoplastic diseases are susceptible to similar investigations, but before any practical approach to the use of neutrons in the treatment of cancer can be designed, a great deal of basic research, particularly in the lower animals, must be done. Such experiments, although aimed ultimately at the treatment of human disease, should yield much valuable information as to the structure, function and response to radiation of living cells.

"The facilities which have been incorporated into the conceptual design of the reactor provide for extensive animal and human experimentation.

"The use of artificially produced radioactive isotopes in studies of metabolic abnormalities has been limited by the distance between the investigating laboratory and the facility for the production of the isotopes. This is particularly true of the isotopes of such biologically important elements as sodium, chlorine, potassium and magnesium, which decay so rapidly that the proper planning and the execution of experiments involving their use is feasible only in areas adjacent to a neutron source. The production, isolation and purification of the radioactive isotopes of these and other elements could be carried out in conjunction with the radiochemical laboratories planned as a part of the reactor, yielding an immediate source of radioactive isotopes for biochemical, physiological and medical research.

"The physiological functions of so-called "trace" elements such as zinc, manganese, molybdenum, etc., whose presence in animal tissue has been detected only by spectroscopy, possibly might be explained by utilizing activation analysis, a technique well known to inorganic chemists, but heretofore almost completely unexplored by biological scientists because of the lack of available neutron beams.

"The opinion of this Committee is that although no definite statement can be made as to the ultimate <u>absolute</u> value of the Georgia Tech Research Reactor to the advancement of medical science, the utilization of the reactor for medical and biological research would be of inestimable value to the investigative and teaching programs currently in progress in this community. It will lead to an expansion of the research and teaching potential of the entire area."

DESCRIPTION OF THE REACTOR FACILITY

Four figures are attached to this report. The first figure shows the designer's rendering of the facility. Note that the reactor is located in the cylindrical structure at the left of the figure, and the laboratory and office building is at the right.

The basement floor plan includes some very important provisions for medical research. The suite for medical research includes two patient rooms, a laboratory, a preparation room, and a large office. An ambulance entrance is provided at this level, so that patients may be easily transported to and from the hospitals in the region. An elevator is located near the medical suite so as to provide convenient access to the floor above for neutron activation or capture therapy. It is also pertinent that liquid helium and liquid nitrogen will be available in connection with other research related to health sciences, and space is provided at the basement level for the necessary equipment.

The first floor plan shows the principal working areas in the facility. In the reactor building, the shielded room can be seen attached to one side of the reactor. This room is called the "medical facility" in the figure, and it will be the site for neutron experiments, including neutron therapy and neutron activation in patients. In addition to the shielded room, the reactor will also incorporate a "thermal column", a large region permeated with thermal neutrons. The thermal column at the CP-5 reactor has been widely used in biological studies.

In the laboratory building, equipment will include fume hoods, glove boxes, and radiation counting devices, along with other kinds of laboratory apparatus to provide for a wide variety of research activities. The "hot cells" and the pool in this building will have special uses in studies of sterilization, and radiation effects on organisms. The laboratory will also be utilized in preparing samples for activation or irradiation in the reactor.

The second floor plan shows the high bay region above the "hot cells". The observation room and viewing gallery shown on this figure are provided for transient visitors.

Considering areas of the reactor facility which will be used exclusively for medical and biological studies, and other areas for joint use, it is estimated that about one-fourth of the facility is dedicated to research related to health sciences in the present plans.

THE CHALLENGE

Many frontiers are yet to be explored, and the Georgia Tech Research Reactor offers an exciting prospect for developments of great importance. In research related to health sciences, the present program at Georgia Tech is quite modest in comparison with research in other areas of science and engineering. For this reason, it is extremely important to develop strong liaison between Georgia Tech and regional agencies or institutions heavily committed to health sciences if the maximum benefit is to be derived from the Georgia Tech Research Reactor. Indeed Georgia Tech cannot justify efforts to make the special provisions for health sciences research in the Reactor Facility unless strong support is given by the health sciences research community in the Southeast. With these special provisions mentioned earlier in the report, researchers in certain aspects of health sciences related to the nuclear field will be equipped as well as any research group in the world. Without these provisions, it is clear that the maximum potential benefit from the Georgia Tech Research Reactor cannot be realized.

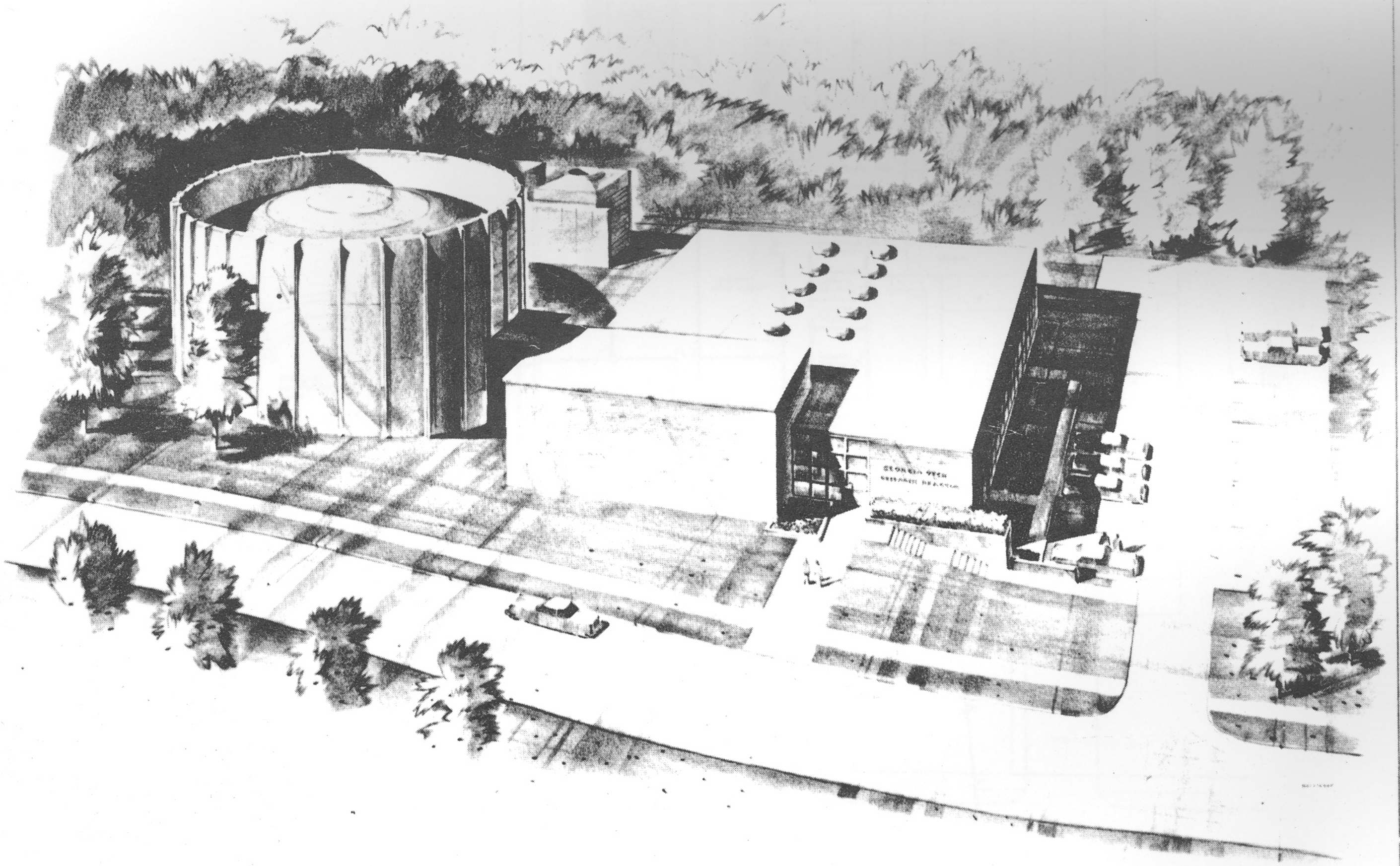
In the final analysis, whether or not special provisions will be made in the Georgia Tech Reactor Facility for research in health sciences will be determined by the agencies or institutions which have large programs in health sciences. There are immediate needs for such agencies or institutions to (1) show clear evidence of their interest, (2) show their intent to use the facility, and (3) participate in developing the mechanism by which they can use the facility most effectively.

As far as Georgia Tech is concerned, there exists a very strong incentive to retain the special provisions for health sciences research in the final plans of the Reactor Facility. If sufficient regional interest is shown in these facilities, it is the intent at Georgia Tech to seek financial support of these special provisions for health sciences from the National Institutes of Health and possibly from private foundations. To attain the maximum benefit from the Georgia Tech Research Reactor will require imagination and diligence, but the rewards will more than justify the effort.

W B Harrison

W. B. Harrison, Director
Reactor Project

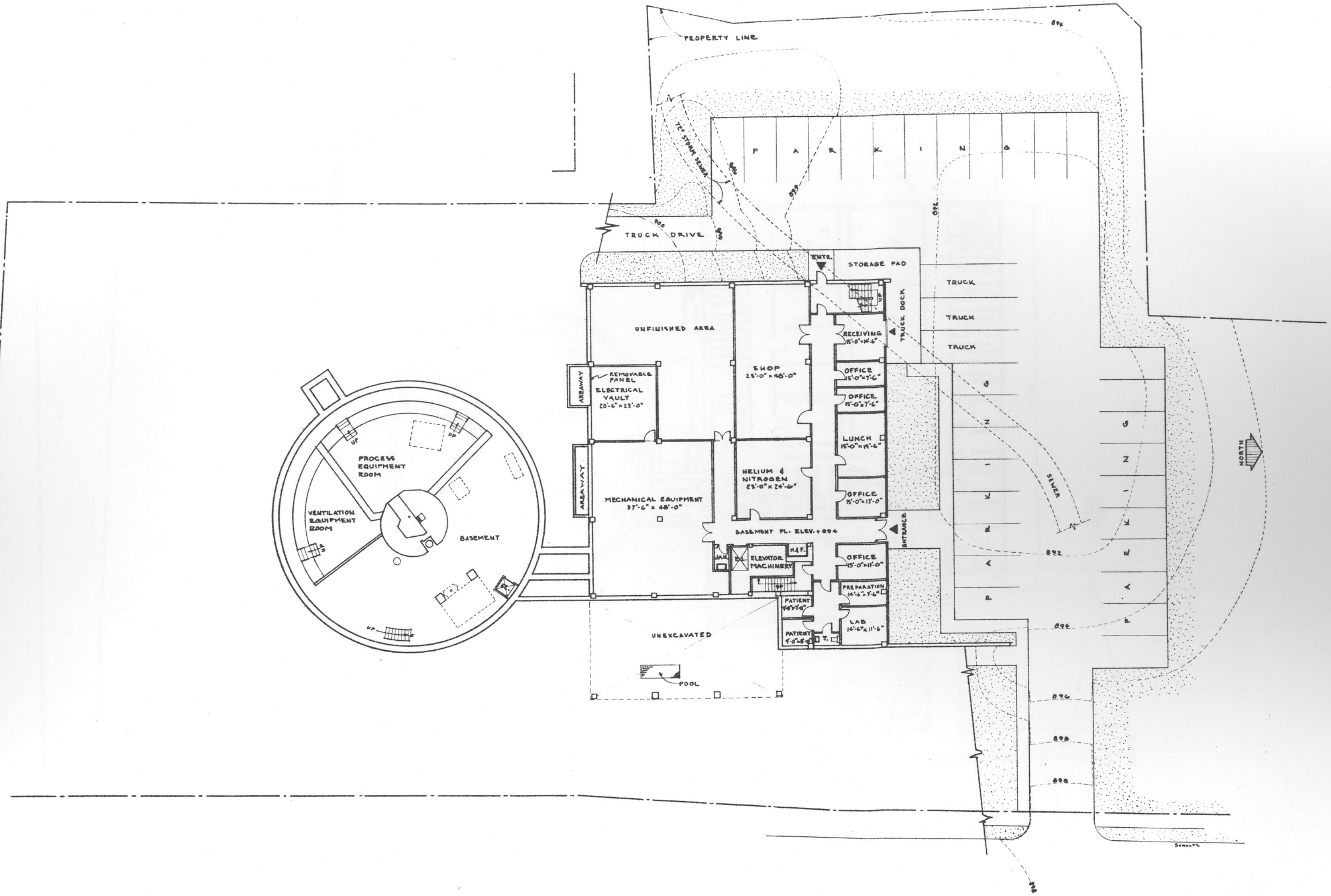
December 1958



PROPOSED REACTOR BUILDING FOR GEORGIA INSTITUTE OF TECHNOLOGY

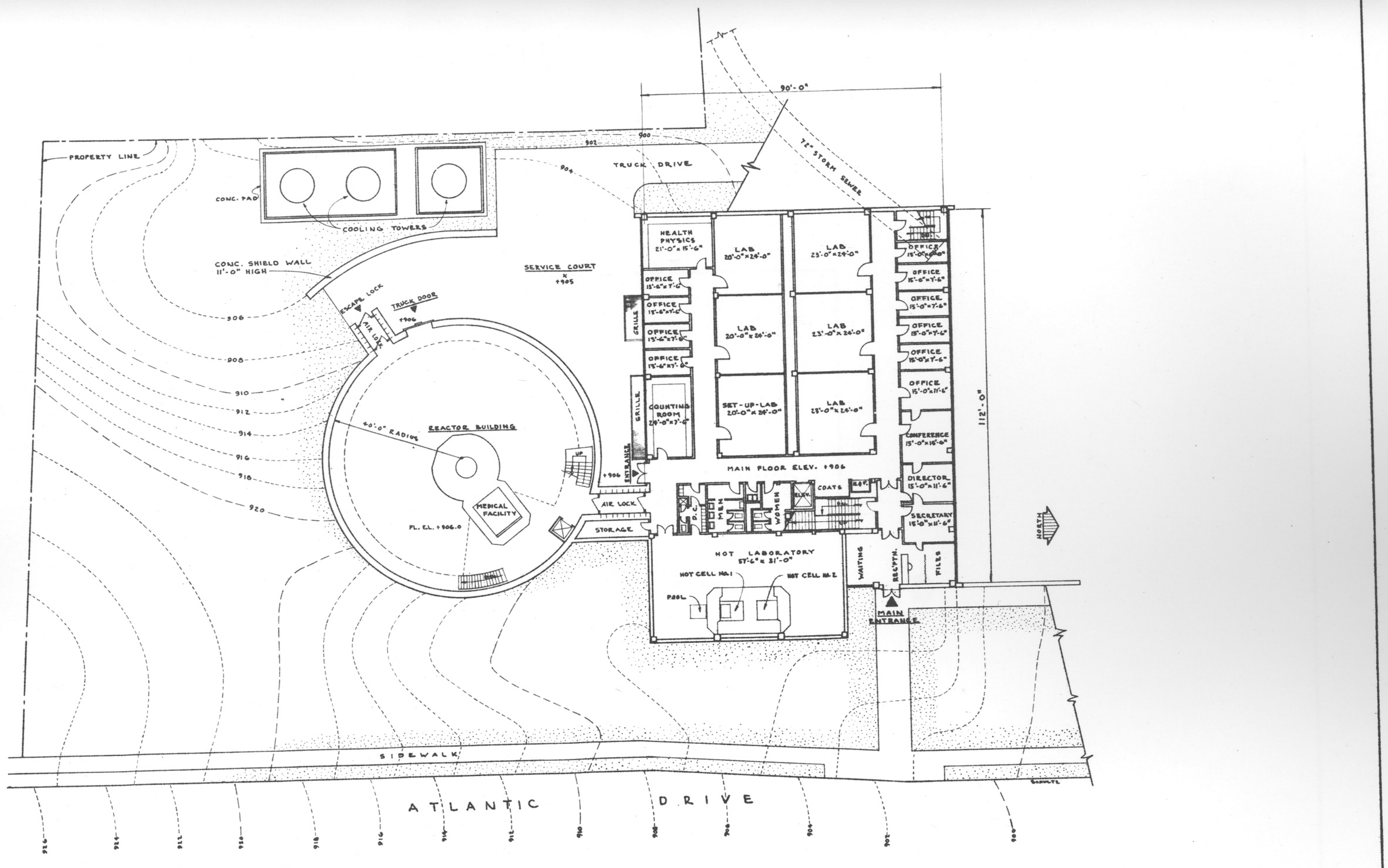
ROBERT AND COMPANY ASSOCIATES

JOB NO. 5816



BASEMENT FLOOR PLAN
SCALE 1/16" = 1'-0"

ROBERT AND COMPANY ASSOC. - ARCHTS & ENGRS



FIRST FLOOR PLAN

SCALE: 1/16" = 1'-0"

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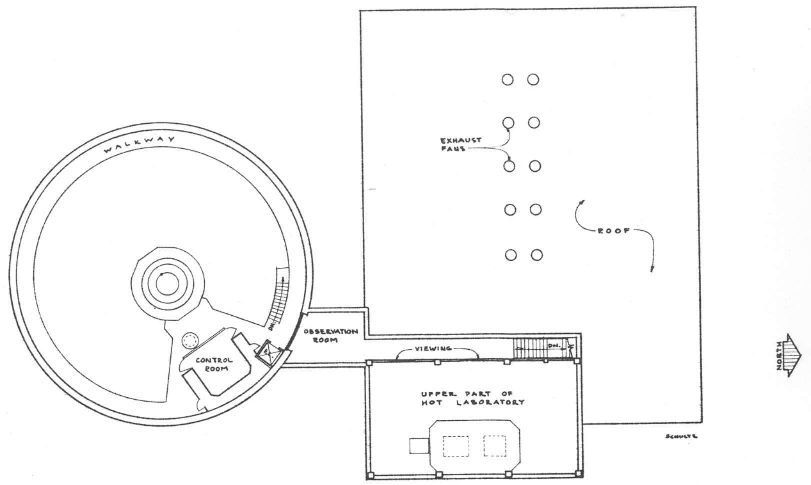
ROBERT AND COMPANY ASSOCIATES
ARCHITECTS & ENGINEERS
JOB NO. 5816
MAY 1958



SECOND FLOOR & ROOF PLAN
1/16" = 1'-0"

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