Nuclear Engineering at Caltech

by Harold Lurie

A subcritical nuclear reactor, to be used in nuclear studies, has just been assembled at Caltech. The compact $10,000 reactor is the first of its type to be installed in an American college or university under a grant of the Atomic Energy Commission's education program.

The reactor was designed and manufactured by the Nuclear-Chicago Corporation for student instruction. With this reactor most of the characteristics of an operating power-producing reactor can be demonstrated and studied. It consists of a stainless steel tank four feet in diameter and five feet high, in which is inserted a grid of vertical aluminum tubes arranged in a symmetrical pattern. There are 260 vertical tubes standing in this tank, each containing five slugs of natural uranium metal. There are 1,299 slugs in the whole assembly, the total weight of uranium being about 2¾ tons. The uranium, valued at $100,000, is on loan to the Institute from the AEC.

Harold Lurie, associate professor of applied mechanics, assembles a pattern of uranium-filled tubes in Caltech's new subcritical nuclear reactor.

The volume between the tubes is filled with about 435 gallons of purified water, which not only serves as a shield but also slows the neutrons so they can more effectively bombard and split the uranium atoms. The center tube contains a neutron source made of a mixture of five curies of plutonium and beryllium. The neutrons from this source are slowed down by the water and then absorbed by the uranium to cause fission. The fission process in the assembly results in a multiplication of the neutrons by a factor of approximately seven.

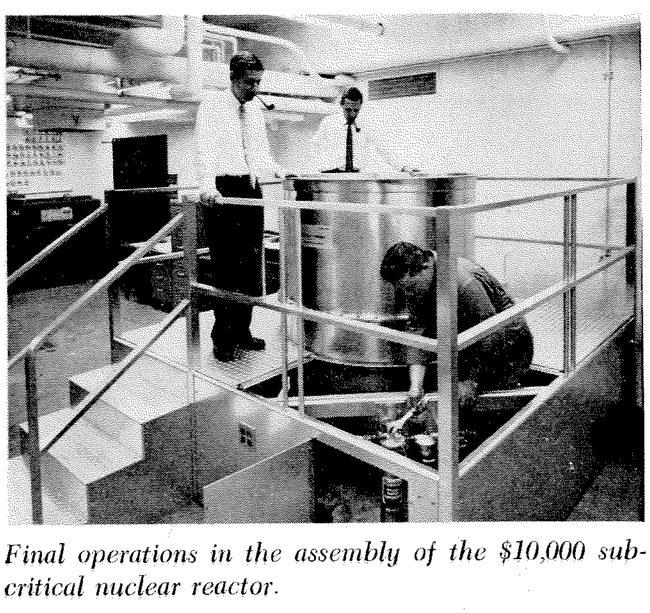
The chain reaction cannot be maintained in the absence of a neutron source, and in this respect the assembly differs from a power-producing reactor. This characteristic of being unable to achieve criticality (i.e., a self-sustaining chain reaction) makes the assembly inherently safe for student use, as a nuclear accident is impossible. However, the subcritical reactor is quite adequate for studying many of the steady-state characteristics of a full-scale power reactor. The student may therefore become intimately acquainted with the applications of reactor theory and design. For example, by changing the geometric configuration of the uranium lattice, he can check for himself what effect this would have on the characteristics of a critical reactor.

The influence of atomic energy on engineering has become increasingly evident ever since the discovery of nuclear fission. But it is only within the past decade that reactor technology has advanced to the point where its future is assured. Submarine nuclear power plants demonstrated very dramatically that a new branch of engineering had been weaned. Stationary nuclear power plants are presently being installed, with many more in the planning stage, and applications of nuclear systems to such other fields as aircraft and rocket propulsion are being seriously studied. Radioactivity and isotopes, too, are playing an increasingly important role in industrial applications.

At Caltech the possibility of incorporating education in the atomic energy field was recognized several years ago – but how to delineate an appropriate area of study was not at all obvious. In view of the "glamor" of nuclear energy, there was a danger of over-emphasizing its importance with respect to the established branches of engineering. There was also some doubt whether, from an engineering point of view, additional specialization was called for. It seemed apparent that at least some of the applications to reactor technology could be incorporated in the existing engineering curriculum.

In point of fact, reactor technology encompasses an unusually wide field of the engineering sciences, and includes many of the conventional subjects as well as those peculiar to the new industry. There are major contributions to be made in reactor development by engineers of every specialization. But such mechanical, electrical or chemical engineers, for example, must have some familiarity with the *application* of modern (as well as classical) physics if they are to apply their specialties to reactor technology. The program at Caltech was formulated with this in mind. In addition, the curriculum was designed to provide suitable courses for those students who wanted to specialize in reactor theory in its application to engineering.

The additional courses which have been introduced include the study of applied nuclear physics, reactor theory, shielding and radiochemistry. These special courses were thought to be taught most appropriately in the graduate school. No changes in the undergraduate curriculum were envisaged, except that examples from the nuclear field have been included in the undergraduate subjects wherever appropriate. The additional courses have been included in a new fifth year nuclear energy option in mechanical engineering – a parallel option to the previously existing ones of jet propulsion and physical metallurgy. Accordingly, a student interested in nuclear engineering will take a regular engineering course in his undergraduate work, and continue in the fifth year in the nuclear energy option of mechanical engineering. Graduate students in other engineering options can take, as electives, selected subjects in the new option to enable them to apply their specialties to reactor development.



Final operations in the assembly of the $10,000 subcritical nuclear reactor.

Five slugs of uranium are loaded into each of the 260 tubes that go into the atomic reactor. The uranium, valued at $100,000, is an AEC loan.

The graduate program developed in this way has been approved by the Atomic Energy Commission as fulfilling the requirements for students receiving an AEC Special Fellowship in Nuclear Science and Engineering. These fellowships are similar to those offered by the National Science Foundation, and allow a student up to three years of graduate study at a school whose nuclear engineering program has been approved by the AEC. This year there are seven graduate students enrolled in the nuclear energy option, of whom four hold AEC fellowships.

An essential part of the nuclear course is training in the laboratory. As a result of an AEC grant, a new laboratory has been equipped to teach engineering students the techniques of nuclear measurements. The laboratory contains a representative group of radiation-measurement instruments which can be used by the students to provide familiarity with those phenomena which are encountered in the reactor business. With the subcritical reactor installed in this laboratory, it is felt that Caltech is now in a position to offer a balanced and appropriate program to students interested in this phase of engineering.