NORTH CAMPUS "CAVES"

by JURIS SLESERS, '58 EE

On the ground floor of the new Phoenix Memorial Laboratory, presently under construction on the University's North Campus, are located two bulky steel and concrete cubes with massive steel doors, and several holes of various shapes and sizes in their walls. These are the high level radiation "caves", one of the most important features of the new laboratory. When they are completed, these "caves" will make possible many experiments with strongly radioactive materials which are either impossible or exceedingly difficult to perform with the more primitive facilities available in many radiation laboratories today. Experiments in the chemistry and mechanics of materials containing 8,000 or 10,000 curies of radioactivity will be performed with relative ease and accuracy by men using mechanical arms, hands and fingers to manipulate the deadly matter while standing safely behind three feet of heavy shielding.

Each of the finished caves will enclose a floor area of about ten feet by five and one half feet with three foot walls of barytes concrete and steel. The ceiling will be four feet thick. Each cave will be equipped with manipulators, for remote handling of materials and equipment, three windows of lead glass, a door opening covered by two 14 inch thick steel slabs, and transfer holes and ducts to facilitate the introduction and removal of radioactive materials.

Steel Shell. The first step in the construction of the caves was the installation of a shell of ⅜ in. steel sheets forming the inside and outside surfaces of the walls, as well as the surfaces of the openings that were to be left for windows, the door, manipulators and material transfer ducts. This steel shell was made by Whitehead and Kales in Detroit, from where it was shipped in sections to Ann Arbor. These sections were then lowered through a hole in the floor above the site where the caves were to be constructed. Once in place, the separate sections were assembled and welded together to form a mold for high density concrete—the main constituent of the walls. A steel beamwork was finally laid across the top.

Concrete. The mineral barytes, instead of the conventional gravel and sand aggregates, was used in the concrete. Since barytes concrete weighs about 216 pounds per cubic foot as compared with the 120 to 140 pounds for conventional concrete, the gross cost, because of higher initial cost, added transportation costs, and added handling cost, was four to five times the cost of ordinary concrete. However, although a wall of identical shielding capacity made with ordinary concrete would undoubtedly be less expensive, after considering the value of the space saved (the shielding capacity of a material is a function of its density) and other factors, it was decided that the barytes concrete is the best material in this instance.

Other than its greater density, the physical properties of the concrete are about the same as those of ordinary sand and gravel concrete, and, consequently, it was mixed and forced into its mold—the steel shell—in the usual manner. Special attention, however, had to be paid to the shaking operation, since it is essential that as little void as possible remain in the concrete and that every part of the shell be completely filled, if the wall is to be an effective shield. The four feet thick ceiling was cast with the same material.

Windows. As was stated earlier, each cave will be equipped with three windows—the same thickness as the walls. The dimensions of the windows on the inside of the cave will be 2 ft. 6⅝ in. by 2 ft. 11⅝ in. and on the outside—1 ft. 9¾ in. by 2 ft. 4⅛ in., each window consisting of six plates of glass six inches in thickness. The cracks between the individual plates will be filled with a mineral oil exhibiting similar optical properties as the glass. The film of oil will eliminate all surface reflections.

The windows will consist of three layers of different dimensions containing two plates of glass each. These layers will be so arranged that the windows will become larger by steps toward the inside of the cave (see layout). Such an arrangement has a double advantage in that a wider possible range of vision will be obtained, and also a radiation barrier will be produced blocking any radiation that might otherwise leak through the crack between the glass and the window frame.

Cerium stabilized lead glass is used in the windows. This type of glass consists partly of lead oxide, and its greatest advantage over other shielding glasses lies in its extremely high density. Small amounts of cerium oxide are incorporated in the glass because of its ability to retard darkening of the glass upon exposure to high energy radiation. The thick slabs of glass were cast in the Herrodsburg plant of the Corning Glass Works, and the assembled windows will be installed this spring.

Manipulators. Probably the most complicated feature of the caves are the manipulators. Each cave will be equipped with a pulley type device for heavy lifting and two "master-slave" manipulators for the more intricate and delicate operations required in most scientific work. While the pulley type manipulator is essentially a movable lifting crane, the manual master-slave manipulators are delicate and sensitive instruments, and are the result of years of study and research. The manipulators that will be installed in the Phoenix Laboratory's caves are of the model 8 type manufactured by the Central Research Laboratories in Red Wing, Minnesota, from a design originated at the Argonne National Laboratory. Essentially each manipulator is a rather intricate system of aluminum tubing, stainless steel cables, gears, levers, etc., designed so that when a motion is carried out with a handle at one end of the mechanism, a tong at the other end goes through a nearly identical motion. With the friction and the weight of parts kept at a minimum, every force exerted upon the handle produces an equal force upon the tong, and, conversely, every opposing force exerted upon the tong is reflected back to the master handle, thus giving the operator the ability to "feel"—by remote control. This is extremely important when handling fragile objects or sensitive equipment. These features plus the fact that several types of tongs and respective master handles can be easily substituted will enable an operator to perform almost every operation ordinarily done directly by hand, without giving special thought to every motion made.

Special holes through which the connecting shafts of the master-slave manipulators and also the lifting crane enter the cave were left in the wall above the double window. Intricate lead follow blocks have been designed to allow the manipulators to move the width of the ve. The manipulators will be installed is spring.

Ventilation. In handling highly radio-tive materials ventilation becomes an aportant problem. In the "caves" there ill be two intake ducts on the bottom ad one at the top in the front of the ive. Two exhaust ducts at the bottom ad one at the top are in the back of the ive. This particular arrangement cuts ie top to bottom wind currents to a inimum keeping disturbance of any ork being done in front of the window a minimum. Each cave is kept below mospheric pressure so that all leakage ill be into the cave. The air going rough the exhaust ducts is first filtered rough a rough filter and then a fine fil-r which will remove more than 99% f the radioactive particulate material. he exhaust air then goes to a stack the p of which is ten feet higher than any uilding in the vicinity and let out.

Lighting and Finishing. There will be ne fluorescent light fixture at the top of the cave and six sodium vapour lamps around each window. The reason for using sodium lights around the windows is that it has a single wavelength and thus on going through the thick window a simple diffraction takes place, whereas, if ordinary lights with multiple wave emission lengths is used a complex diffraction pattern occurs which would make the reading of things like scales inside the cave very difficult.

Amercoat 33, a special paint which resists dilute acid solutions will be used to finish the inside, thus allowing it to be thoroughly hosed down. The "hot" water and acid drains to a tank below the building where it will eventually be decontaminated.

The outsides of the caves have been made as streamlined as possible by recessing many fixtures.

Special Applications. Aside from being a general purpose radiation cave where experiments will be conducted with materials brought in from the outside for that purpose, each cave will also be adapted to fulfill certain more specialized duties. The southernmost of the two caves will be connected by a "hot" passageway directly to a well in the so called "high gamma" area which lies adjacent to this cave. The high gamma area is a heavily shielded room with a deep well in its center filled with water. A high level gamma source, probably 5000 curies of cobalt-60, will be stored at the bottom of this well when it is not in actual use. Other radioactive materials will also probably be temporarily stored here. A small open shaft from the cave to the well will make possible safe and efficient transfer of materials from the cave to the well and vice versa, without requiring the use of a lead container.

The second cave will be operated in close accord with the new nuclear reactor which the University is planning to construct this year. Since this cave lies adjacent to the north wall of the building,

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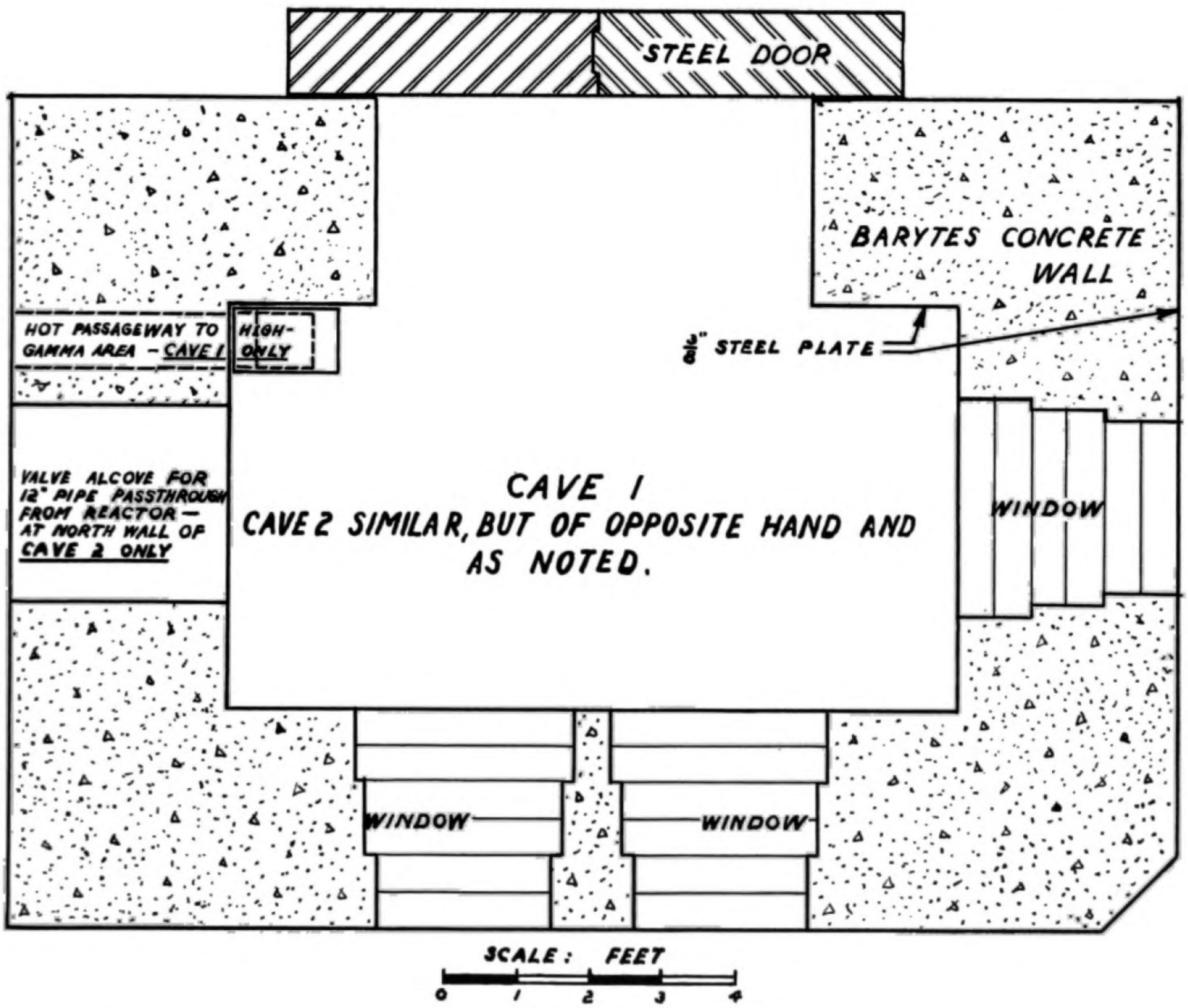

TRANSITION FLOW IN AIRFOIL DESIGN

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this stall characteristic may be improved by allowing the boundary layer to change from laminar to turbulent at high angles of attack. This improves the stall because the turbulent boundary layer is able to resist separation better than the laminar boundary layer.

Use of the conventional airfoil is more common than the laminar boundary layer airfoil. The big disadvantage of the turbulent boundary layer airfoil is the high drag coefficient. Even so, this type of airfoil is the most used in aircraft. The turbulent boundary layer airfoil has been used since the invention of the airplane. Not until the late 1930s did the laminar boundary layer airfoil come into use.

The big advantages of the turbulent boundary layer airfoil are its high lift coefficient and excellent stall characteristics. Over a wide range of angles of attack the lift coefficient is higher than that of a laminar boundary layer airfoil. Consequently this type of airfoil is used in aircraft where heavy loads are to be carried and violent maneuvers are performed. The excellent stall characteristic is due to the ability of the turbulent boundary layer to resist separation of air flow over the airfoil. The stall doesn't take place abruptly, but gradually with wing vibration to give warning that lift is about to be lost over the wing.

Designing the turbulent boundary layer airfoil is somewhat simpler than designing a laminar one. Less attention is paid in attempting to hold a favorable pressure gradient over the entire length of the airfoil. In this type of airfoil low drag coefficient is sacrificed for a higher lift coefficient. From the preceding it can be seen that before designing an airfoil, all requirements must be carefully weighed and often times sacrifices must be made. Much research in boundary layers is being carried on at present.

STOCKINGS IN THE SOUP

Noting the failure of a recent attempt to sell a soup mix by means of a hosiery premium, Food Engineering, suggests that perhaps association of the two products gave rise to a mental picture of "the overalls in Mrs. Murphy's chowder."

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where the reactor will be located, a valve alcove has been provided for an eventual pipe pass-through leading into the "pool" of the reactor. By providing a convenient place for experimentation with reactor products and facilitating the introduction and removal of materials into and out of the reactor pool, this cave will become an important asset to the reactor as well as to the radiation laboratory.

Cost of Caves

6 windows	$ 70,000
Manipulators, Model 8	31,000
Const., design, planning	159,000
Total (2 caves)	$260,000

Note: Above costs are not final and do not include special features of the building which were added to accommodate the caves.

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The Author

THEATER PICKLE

Dill pickles, with napkins, are sold in three Ponca City, Okla., theaters. One movie house moves 100 gallons of pickles a month.

* * *

An Indian ordered a sandwich at the Union lunch counter. When it arrived, he picked it up and peered between the two slices of bread.

"You slice um ham," he asked the waiter.

"Yes," ordered the surprised waiter.

"Ugh," grunted the Indian, "you pretty near miss him."

* * *

Doctor: "Is your cold any better?"

Patient: "Naw."

Doctor: "Did you drink the orange juice after a hot bath?"

Patient: "Naw, after drinking the hot bath I couldn't get the juice down."

* * *

Sugar Daddy: A form of crystallized sap.