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BUILDING, SITE, UTILITIES, AND SERVICES FOR THE BERKELEY 88-INCH CYCLOTRON

Torleif H. Myhrer and William P. Carpenter

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ABSTRACT

The process of fitting the building project within the budget limitation is discussed. Included are such matters as the allocation and organization of interior space on the basis of accelerator application, provision for possible future changes, and the influence of the selected site and its topography on the building design. The factors that determined the choice of steel frame and steel siding are listed. The selection and development of utilities for present and planned future needs, especially the high-purity water systems, are summarized. An overall review is made of the building project, with an evaluation of basic design, adequacy of utilities and equipment, project scheduling, and coordination.

It was evident that the time element for the building construction (including design) had become a critical factor. A delay here could indeed delay the whole project. Emphasis was therefore put on all measures that would reduce time. Since a site had not yet been chosen all planning was directed towards an ideal solution, particularly with respect to functional (or area) relationships.

2. Building Site

The increase in building project size also complicated the problem of using the site eventually proposed. Special provisions for future expansions had to be incorporated in the present design because of many site limitations. Nevertheless, the importance of the site location (near the University of California campus and Laboratory Chemistry building) outweighed other considerations. Of the limitations the two most important ones were restrictions in size with respect to future horizontal expansion and proximity to a residential neighborhood. After this important decision had been made the work could begin on fitting the building project within the limits set by cost, time, and natural environment. The size and relationships of the various areas worked out during the preliminary studies proved to be very useful. In the adaptation of this 'presite' plan, advantage was taken of the steep hillside by creating shelves for the principal building parts. The elevations of these shelves were calculated to achieve balance between excavated and compacted earth. This resulted in a 2-acre site, allowing some space for future expansion.

To save time the site was prepared during the summer prior to the completion of the building construction documents. Delays normally caused by inclement weather were thus avoided.

At the preplanning stage it had been agreed that the cyclotron should be surrounded on all sides with portable shielding blocks. This was a requirement based on experience with the other accelerators at our Laboratory, which had

demonstrated the need for the greatest amount of flexibility. The shielding walls should be of adequate thickness to permit unlimited time occupancy on all sides, except on the side where the "beam" was extracted. Calculations established that a 10-ft-thick wall of 150-lb/ft^3 concrete would meet the safety standard. These requirements, together with estimated need for experimental area and so-called staging area, determined the size of the 80 by 150 by 45 ft high bay. Cost estimates of various crane sizes (e.g., capacity and span) and high-bay spans helped pin down the 80-ft width as an economical optimum width. The size of the largest shielding block, existing experimental magnets and other Laboratory cranes determined the need for a 30-ton hoist and an auxiliary 5-ton hoist for lighter work. Since the space under this crane would be the most expensive, all other areas not requiring crane coverage were placed under a low-bay structure. Because of the weight of the cyclotron, the shielding, etc., the high-bay space was located on the cut portion of the site, where loads up to 10 000 lb/ft^2 could be carried. The rest of the areas were located on the downhill and south end (fig. 2). The position of the high bay on the site permitted approximately 150 ft along the direction of the external beam to be used for experimental setups and also would provide space for future expansion of the high and low bay. The proximity to the residential neighborhood dictated that all noisy equipment be placed indoors. A basement was therefore created to accommodate this equipment, as well as electric equipment, and the building heating and ventilating plant. The hillside gave us the advantage of truck access for the whole basement. All utilities could now be carried to the pit under the cyclotron through a tunnel. The placement of the cooling tower, heat exchangers, and associated pumps on the uphill side of the building gave us a better distribution of the utility lines in the tunnel (fig. 3). It also created an isolated area for heat exchangers containing potentially "hot" cooling water.

The tunnel could be used as a second access, and as an emergency exit from the cyclotron cave and pit. The uphill part of the tunnel would also be used for a large exhaust duct from the cyclotron pit. Areas for experimental counting equipment, cyclotron control, shops and offices were placed above the basement on the downhill side. Areas for internal target extraction, radiochemistry caves were placed on the opposite or uphill side, and radiochemistry laboratories at the south end. All of these areas, in accordance with the preplanning philosophy, were kept behind or south of a line drawn through the beam exit or north cyclotron shielding wall.

The foundation under the building consists of continuous and spread footings. All structural material below the main floor level is reinforced concrete. The floor-load capacity is 3000 lb/ft^2 in the high bay and 125 for the low bay. Except over the basement, all slabs are on grade. Bell caissons carry the weight of the cyclotron shielding roof through the north and south walls of the shielding enclosure. The monolithic 3-ft-thick cyclotron foundation is structurally separated from the rest of the slab in the pit. This was done to minimize transfer of vibration from other parts of the building. Also, the low-bay steel structure is structurally separated from that of the high bay. This prevents most of the vibrations set up by the crane from reaching the electronic equipment.

The floor surrounding the control-counting room has been depressed to provide space for all electric wires to the electronic racks constituting the walls of the inner room. Slots in the depressed floor lead directly to the electrical equipment in the basement below.

Originally it had been our intention to construct the building of reinforced concrete, but due to the critical time schedule it was decided to use industrial steel-frame construction with insulated steel panels (figs 4 and 5). In the end this choice proved to be the time saver that prevented a number of unpredicted delays from pushing the completion date far behind schedule.

3. Radioactivity

All problems concerning radioactivity in its various forms were dealt with extensively. Local wind patterns were studied to find the best locations for exhaust from rooms, hoods, glove boxes, etc. where radioactive materials would be handled and accidental spills might occur. Since the operation of the cyclotron would increase the level of radioactivity in air inside the shielded enclosure, it was decided to draw filtered air from the high bay through the enclosure to prevent radioactivity from building up. This air was ducted through the uphill tunnel and exhausted in to the updraft airstream from the cooling tower. About 1500 cfm was needed to take care of this problem. However, in order not to increase the load on the cooling tower it was decided to air cool all electronic equipment in the pit. A four-step ventilation system was therefore installed, with a maximum capacity of 12 000 cfm. The first step, or 4 000 cfm, was connected to the emergency circuit. Under normal conditions an average temperature of about 80°F will be maintained.

The exhaust ducts from the hoods and glove boxes in the radiochemistry laboratories were taken out through the uphill wall and directed up outside the edge of the roof on a separate screened platform. This arrangement will permit us to add a future second story to the low bay without interrupting the research work. Future exhausts of various designs may be added without a disturbing effect on the present appearance of the building.

4. Utilities: General

The municipal-type utilities provided were generally already available from the immediate environment.

Electric power, city water, gas, sewer, telephone, fire alarm, and public address were all extensions of the existing Laboratory systems, and entail no extraordinary concepts. In the San Francisco Bay Area, private utility companies provide gas, electric energy, and telephone. Municipalities and special districts provide water, sewers, and drainage—all at nominal costs. Special services such as fire alarm, public address, roads, fences, walks and dry compressed air, of course, are furnished by the Laboratory.

A particle accelerator, such as the 88-inch cyclotron and its associated laboratories, does require several fairly exotic internal "utilities," namely, high-purity cooling water, tower water, acetylene, aged methane, oxygen, special active-sewer and monitoring tanks, emergency power, demineralized or distilled water, and chilled water for air conditioning. Although not strictly a utility, the high-vacuum system should also be mentioned here—and its associated cascaded refrigeration system for supercooling baffles and traps. These exotic systems account for a considerable amount of the thought and investment required to make this machine operative.

5. Emergency Power

Exhaust fans, emergency lights, radioactivity monitoring devices, fire alarm, etc., require an unfailing source of electrical energy. The electrical system must be so designed that a casual power shutdown will not cause the spread of radioactivity over the entire building. To meet this requirement, a 30-kVA diesel-driven automatic-starting generator is currently being installed. An underground oil-storage tank of 550-gal capacity will provide 140 hr of emergency power.

6. Electric Power

The basic power requirement for the initial machine was met by a 2-MVA unit substation which transforms the primary 12-KV 3-phase power to the distributed secondary 480-V 3-phase-with stepdown transformers for 120/208 V, and 220 V for auxiliary power and building utilities.

The transformer pad is designed to allow the easy installation of another 2 MVA unit substation and additional magnet power supplies.

7. Cooling System - General

We have found that, in general, the overall cooling capacity should match the incoming electric power. The losses to atmosphere are more than made up for by the air conditioning loads imposed on this sytem.

Consequently, a 2-MW-capacity cooling tower removed heat from the three-plus separate cooling water systems. A space is provided for an additional 2-MW cooling tower.

In Berkeley, a 65° F design wet-bulb temperature is used, and tower water at 75° F maximum supply temperature is generally expected. The primary cooling water design supply temperatures are 85° F maximum, with typical rises through the cooled equipment of 18° F.

The tower is an induced-draft redwood-filled open-deck type set on a concrete basin. Its cement-asbestos exterior was chosen to blend aesthetically with the building exterior.

8. Tower-Water System

Most of the tower water is used to cool the primary systems through shell-and-tube heat exchangers. Some is circulated in the building for conventional cooling chores, such as air conditioner and other refrigeration condensing water, mechanical-vacuum-pump jacket cooling, etc. The tower water piping is predominantly steel. A careful program of tower-water treatment has been instituted to control corrosion.

9. The Low Conductivity (LCW) and Active Low Conductivity (ALCW) Systems

High-voltage equipment, water-cooled vacuum tubes, cyclotron dee, rf cavities, magnets, etc. require a clean cooling water, low in dissolved solids. It has been found both desirable and necessary to provide an extensive sophisticated primary water system using demineralized water of 5 micromho, or less, conductivity at a pressure of about 100 psig. Copper, brass, and stainless steel piping and pumps have been found the most suitable for handling the extremely corrosive demineralized water and keeping it clean. The shell-and-tube heat exchangers used at our cyclotron are of all-monel construction, with the LCW (and ALCW) in the shell. Vinyl-lined surge and storage tanks are provided, and the pumps for these systems are all-bronze, trimmed with stainless steel.

The LCW system is the general-purpose high-voltage cooling system. It is distributed throughout the building to the power supplies, laboratories, the bombardment areas, and experimental areas.

The ALCW system is specially separated system which cools the machine itself, particularly those parts where activity may be induced directly in the cooling water. The ALCW pumps, heat exchangers, and surge tank are located, as previously indicated, on an isolation pad on the east side of the high bay of the building in such a location that the contact with the operators will be at a minimum.

Demineralized water is provided to both systems by means of a small mixed-bed demineralizer which reduces the 60- to 150-micromho city water to 0.5 to 5 micromho conductivity suitable for use in these systems. A 1- to 5-gpm slip stream is recycled from the LCW system through the demineralizer to keep the solids in this system from accumulating. The ALCW system has its own disposable-type demineralizer cartridges and filters for recycling.

10. Bottled Gases

The shops and laboratories require, of course, oxygen and acetylene for their operations. These are provided from conventional manifolds at the building exterior.

A special "aged methane" system provides methane that is at least two weeks old, through interior piping to the counting equipment.

11. Waste-Monitoring System

Active wastes are to be disposed of in special containers provided in the laboratories and hot target areas. These containers will be carefully stoppered, then removed to a disposal yard-when required in accordance with good current practice for disposing of active materials.

However, as a second line of defense, the floor drains and sinks in the laboratories and target areas, and the drainage from the ALCW area are fed into a special active sewer which drains into two phenolic-coated 1 000-gal retention tanks arranged in parallel.

These tanks are intended primarily for holdup or retention, one being sampled and dumped while the other is filling. Should there be an intolerable amount of radioactivity in a given batch of retained sewage, it can be precipitated and pumped into a tank truck and hauled away. A recording device permanently records the amount of sewerage handled.

The exterior color of the building was selected in accordance with prevailing views about blending as much as possible with the natural surroundings. Some exceptions were made to accent the structural simplicity. In spite of the use of commonplace materials and subdued colors, a certain elegance has been achieved.

The same simplicity and restraint regarding colors has been applied on the inside. With the exception of the structural members, which are beige, the principal color throughout the building is eggshell white with contrast

(or accent) color provided by equipment, furniture, etc. This gives a pleasant light atmosphere and encourages cleanliness and good housekeeping. As a consequence safety hazards are reduced. The light-colored resilient tiles in the low bay add both to the pleasant feeling and to the custodian's daily exercise.

All rooms have fluorescent light except the high bay, where a combination of mercury and incandescent light was chosen as the most practical. With respect to daylight in the high bay only diffused glare-free light would be acceptable. Sun rays or excessively bright light would interfere with the reading of dials, scopes, etc. The problem was solved very successfully by using milky-white plastic panels projecting into the rooms along the top of the 45-ft-high side walls. The rest of the building-- with the exception of basement, control-counting area, and the radiochemistry laboratories--has clear windows, which afford the occupants a sweeping view of much of San Francisco Bay and the surrounding communities.

In conclusion it should be noted that everyone involved on the 88-inch-cyclotron project directly or indirectly contributed to the overall planning and design. An intimate working relationship was established from the beginning between the accelerator and building project people. Decisions were in general made by consensus, which in our opinion helped substantially to integrate the accelerator and the associated equipment and utilities with the building and site. This also resulted in reduction of conflicting problems and simplification in the overall design.

FIGURE CAPTIONS

Fig. 1. Grouping and functional relationships of areas.

Fig. 2. Building and site plan.

Fig. 3. Isometric section through building and site.

Fig. 4. Aerial view of building.

Fig. 5. South and entrance view of building.

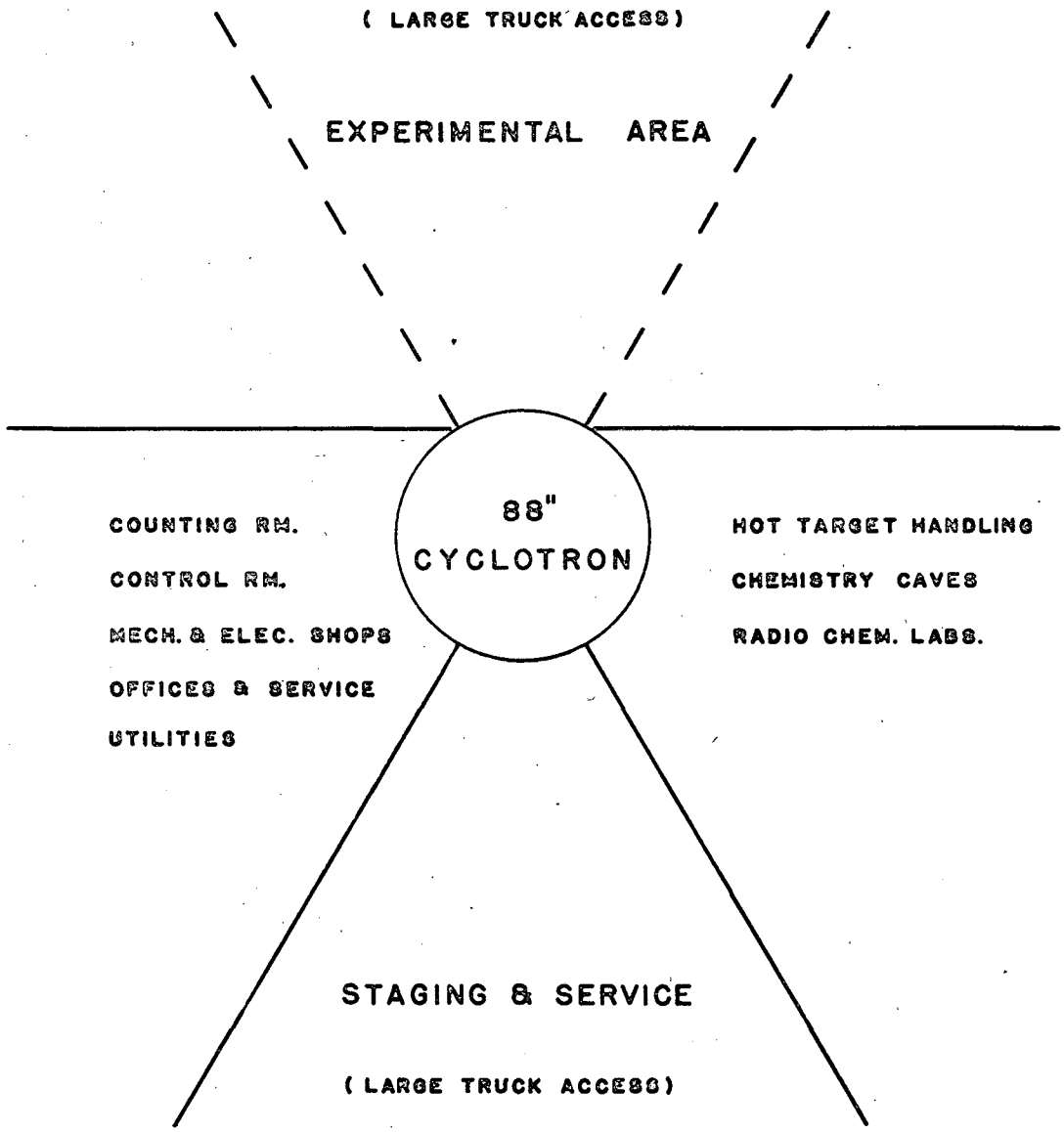

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Fig. 1

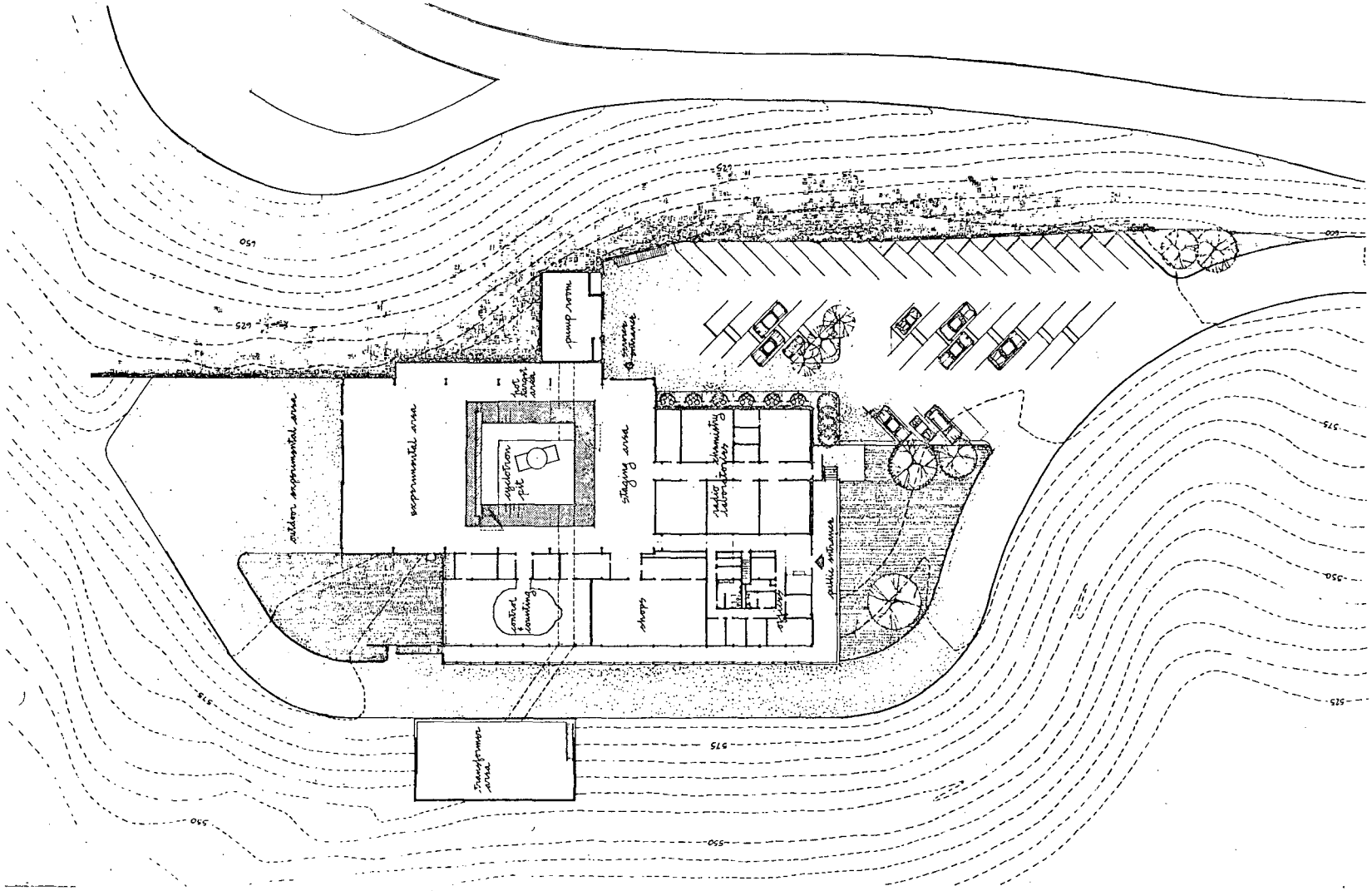

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Fig. 2

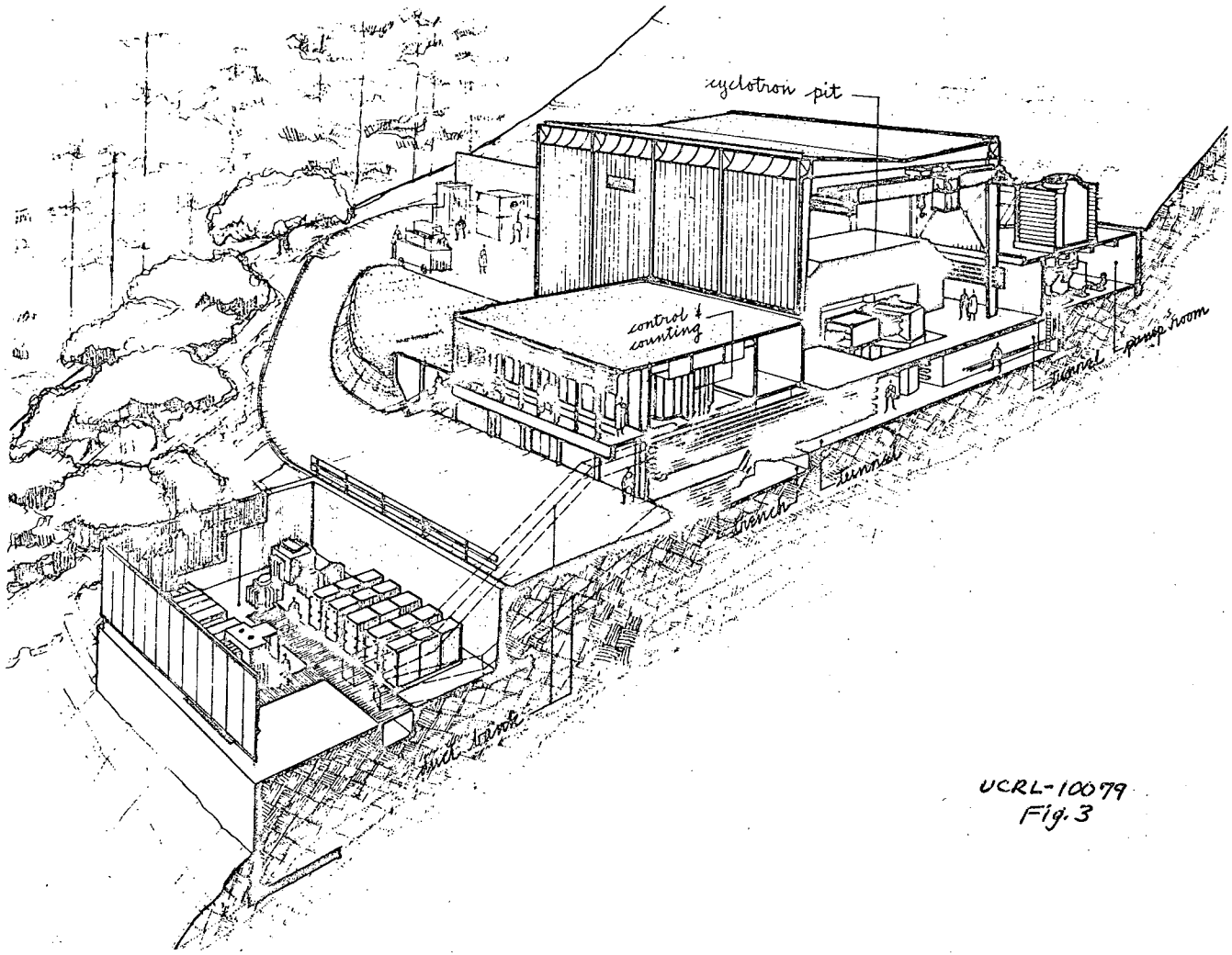

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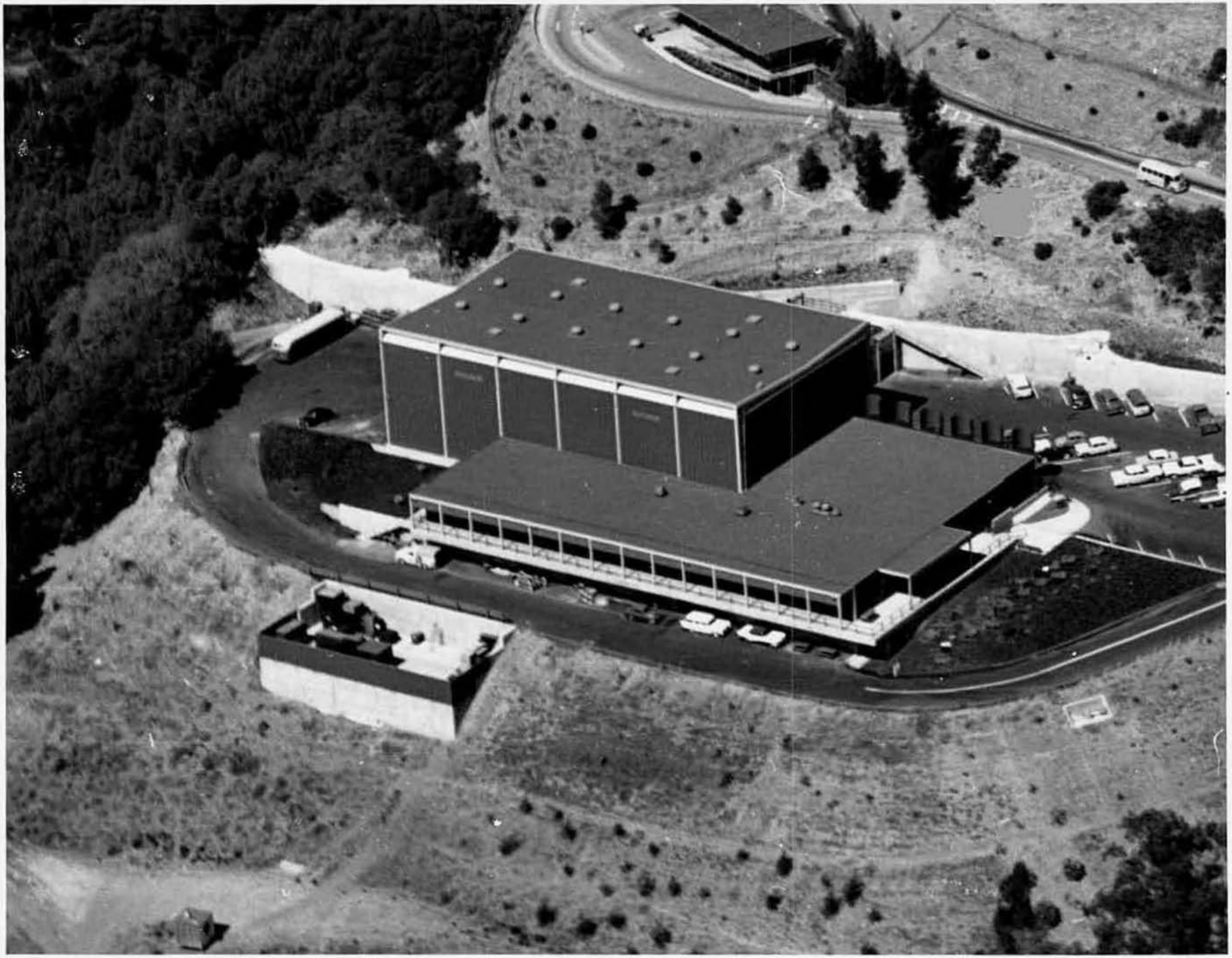
Fig. 3



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