Project M
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REPORT OF INSPECTION TRIP TO PARTICLE ACCELERATORS AT CERN (GENEVA, SWITZERLAND) AND ORSAY (FRANCE)

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This report presents a summary of observations made during an inspection trip to CERN, Geneva, Switzerland, and Orsay, France. The inspection team was composed of J. E. Armstrong, Director, Engineering Division, SAN Office, Atomic Energy Commission, K. W. Copenhagen, Manager, Plant Engineering, Project M, Stanford University, and R. L. Sharpe, Technical Director, Aetron-Blume-Atkinson, A-E-M for Project M.

The laboratory at CERN was visited from August 21 through August 23, 1961, and at Orsay on August 25, 1961.

Purpose of Trip

The purpose of the trip was to study some of the architectural and engineering design problems that have been encountered in the design of large high-energy physics laboratory facilities. Our interest was in the site layout, utility distribution and building design areas, not in the design of accelerators; however, our attention was focused on the effect that the design and function of the accelerator and its auxiliary equipment had on the design of the buildings and the distribution of utilities and the location of buildings on the site. The knowledge gained on this visit will be applied to the design of the Project M facilities.

Through the extensive courtesy of the people visited at each laboratory, we were able to accomplish our purpose.

C E R N

During our stay at CERN, the facility and its program were outlined and we were conducted through the facility by various people, including:

Dr. M. G. Hine, Research Director
Mr. S. A. Dakin, Business Director
Mr. F. A. R. Webb, Assistant Director, Plant Engineering
Dr. H. Coblans, Head, Scientific Information Service
Mr. K. H. Reich, Assistant to Dr. Hine for Facilities
Mr. A. Burger, Assistant to Director, Tracking Division
Mr. R. Zurcher, Mechanical Engineering

The CERN proton synchrotron has been in operation for about two years. The machine has produced proton beams at energies in excess of 30 Bev. The accelerator is housed in a concrete structure with earth shielding at the sides and top.

Experimental Areas

Because of the demand of new physics experiments and new experimental techniques, the experimental areas are being enlarged. A building for housing bubble chambers is under construction. Much of the new experimental area will not be enclosed initially; however, provisions are being made to enclose the area in the future. Even in this new area, the density of equipment on the floor is high, with a maximum in the target area where the beam is brought tangentially from the accelerator. Standardized designs of beam handling equipment has allowed the set up of the maximum number of experiments.

The experimental areas are served with 40-ton bridge cranes, although many pieces of gear now exceed 40 tons. Loads exceeding crane capacities are moved by one of two rather ingenious methods. One method involves the use of an "air cushion" to minimize friction between the load and the floor. Drawings of the device and a report on its use are on file at Stanford. The other method involves the use of an electric motor-driven unit that is attached at each corner of the load. The device uses a caterpillar roller track. Drawings and a report on the device are on file at Stanford.

Separate small buildings have been constructed in which bubble chambers are built and tested. The buildings have concrete walls on three sides with one frangible wall on the side facing away from adjacent buildings. Light fixtures and outlets are not explosion-proof design but are instead standard items that are semi-sealed and pressurized with air to exclude hydrogen accumulation and possible explosion. CERN rules for handling gaseous or liquid H_2 are adapted from those of large companies that work with hydrogen. Cranes in H_2 areas have compressed air motors. Large walk-through utility trenches are used for distribution of utilities and as input air ducts. The positive air pressure in these ducts keeps any H_2 gas from the utilities which, therefore, need not be explosion-proof. A high speed (3,000 rpm) motor-generator set was used as the source of DC power. The motor-generator set was an excellent design and was performing very well.

Utility distribution in the experimental areas, always a problem, has been attempted both in floor trenches and in overhead, wall mounted trays. Both systems present unsolvable problems. Equipment is often placed on top of the trenches. On the other hand, it is difficult to extend utilities from the walls to experiments in the center of buildings. Large DC power cables seem to dominate the utility distribution system.

Handling of Shielding

Another point of interest was the method used for lifting the concrete shielding blocks. Steel castings are anchored in the concrete block into which a large steel key-shaped lifting lug is inserted. Drawings of this device are being sent to Stanford from CERN. The high density shielding blocks have protective steel angles on all edges to eliminate chipped and broken edges. No interlocking blocks were observed, but the inset lifting lug allows neat stacking of blocks.

Main Building

One building of particular interest contains the information and travel center, two auditoriums, a library, a cafeteria, coffee bar and offices on the floors above. The large 400-seat auditorium, used for international meetings, has provisions for simultaneous translation of lectures and was acoustically and architecturally well designed.

The library was also outstanding. It is self-service and is open 24 hours a day. Several small soundproof alcoves with a black board, table and chairs are provided for meetings of up to six people. The library area including work room totaled about 4100 square feet. A comment was made that the area should be slightly larger for better operations. An equal amount of space was required for the reproduction and compiling of documents.

Pertinent Statistics

Following are certain statistics about CERN:

1. The total work force at CERN is about 1,200 people, including about 180 engineers and physicists with university degrees.

2. Construction funds average from 3.5 to 4.0 million dollars per year, with slightly more than half for buildings and structures, and the remainder for mechanical and electrical systems.

3. The land area of the site is 93 acres. Additional land adjacent to the site, but located in France, will have to be acquired to provide space for major structures that are planned for the future.

4. Power consumption in 1960 was about 40 million kilowatt hours. Maximum power demand is 11.0 megawatts with between 40 and 50 Mw connected load. The bulk of the distributed AC power was at 380 volts. New primary power lines will have to be brought to the project if it is to expand.

5. The cooling water system is mostly "once through" with water obtained from wells some distance from the site.

6. The safety, hazard protection and fire protection standards vary greatly from United States standards, so that no useful comparison can be drawn.

General Impressions

In spite of many very complex monetary, language and diplomatic problems, CERN has been successful in creating an environment conducive to physics research.

Economic, cultural and geographic differences make a comparison with United States construction techniques and costs meaningless.

When the CERN site was first planned it was, no doubt, considered large enough, but there are now signs that indicate that the research functions that are being performed or will be performed in the near future will be compromised by site considerations. Recognizing that infinite flexibility is not possible in building design, CERN's present problems of expanding the experimental areas around the machine emphasize the need for careful, flexible, imaginative or ingenious design in the area where the beam is transported from the machine into the experimental areas.

At CERN, as in all physics research laboratories, the problems of utility distribution to research apparatus on the floor of the experimental areas begs a safe, flexible and inexpensive solution.

O R S A Y

On Friday, August 25, 1961, we visited the linear electron accelerator facility, Laboratorie des Hautes Energies, Universite de Paris, Orsay (Seine-et-Oise), France, about 30 kilometers south of Paris. The facility and its program were outlined and we were conducted through the laboratory by various people, including:

Dr. Bishop, Director, Accelerator Group

Dr. Boris Milman, Director of Research

Dr. Burnod, Director of Accelerator Operations

Dr. Verion, Director of Facilities Engineering

Each of these gentlemen was extremely hospitable and helpful.

The constant gradient accelerator, or parts of it, has been in operation since 1958. A 40 Mev beam was produced in 1958, 200 Mev in 1959, 730 Mev in 1960, and 1.3 Bev is planned for late 1961.

Purpose of the Trip

Although the linear electron accelerator at Orsay is of similar specifications to the Mark III accelerator at Stanford, it represents an advancement in accelerator engineering design. Like the Project M accelerator will be, the Orsay accelerator was designed as a production machine and not as an experimental machine solely to advance the art of accelerator design. We had the opportunity to see some of the complex relationships that exist between the machine that produces particle beams and the experimental areas that use the beams.

Experimental Areas

The Orsay accelerator is built with bending magnets at 25 meters (250 Mev), 50 meters (500 Mev), 75 meters (750 Mev), and at the end (100 meters). Small experimental areas are located at one side of the accelerator trench at each of these points. Access to these areas for equipment can be gained by removing concrete shielding blocks. Personnel can walk through a narrow labyrinth into the area. Lateral shielding is equivalent to 6 feet of concrete and 25 feet of earth. Most portable shielding blocks were quite small, ranging from 8" x 8" x 12" up to 3' x 3' x 3'. Only the blocks used for overhead shielding were larger.

The experimental area at the end of the machine is now being completed and a larger (100' diameter) end station is being planned for the 1.3 Bev beam. This round end station is to be covered by a concrete dome structure and 5 feet of earth shielding. Radiant heating coils were installed in the roof of the accelerator building for heating. The method has had limited success.

Accelerator

The accelerator structure (pipe) is located in a trench in the floor of a long high-bay industrial-type building. The trench is covered with about 10 feet of concrete shielding blocks. The trench with all of the cooling piping, control cables, etc., installed is very cramped. Maintenance work is therefore costly. Additional shielding is provided over the bending magnet areas by a movable steel tank containing water one meter deep.

The accelerator is powered by klystrons located above the trench on the main floor of the building. The power-supply modulators for energizing the klystrons are combined in one large walk-in cubicle. The arrangement of the modulators, klystrons, and vacuum pumps appeared to be well engineered and was neatly arranged. There was ample work space.

Orsay has had about one year's experience with sealed-off klystron tubes. Operating life has varied from 1500 to 2000 hours. Failures have occurred in the cathodes, not in the windows.

General Impressions

There appears to be some possibility that the design of the production portion of the accelerator and design of the experimental physics areas were not in good balance. From the rather limited space originally given to experiments, one gathers that the design of the accelerator and its environment was better understood than was the design of the experimental areas. Much of the new construction going on presently is to improve and extend the experimental physics areas. The lack of flexibility in the original design has added many problems to both building and equipment design.

In many areas, such as health, safety, fire hazards, construction methods and construction costs, standards varied so widely from those in the United States that no meaningful comparison could be drawn.

CONCLUSION - CERN AND ORSAY

Along with a substantial broadening of our general knowledge of the design considerations for a major physics research facility, we have gained the following specific information:

1. Confirmation of the Stanford Linear Accelerator Laboratory's plan to obtain a site that will, in general, allow each building to be expanded by a factor of four. The experimental areas' ability to expand must be considered as a primary criterion of its design. The entire site layout of the Stanford project is being reanalyzed to make certain that site considerations will not compromise research functions.

2. Flexibility is the key word in design of an experimental area. The design of these areas must be done as late as possible and only then when some proposed type of experiment is being planned. Fortunately, the construction of the experimental areas and the accelerator at Stanford can be decoupled; thus allowing for design and construction of the experimental areas late in the project's design schedule.

As part of the design of a flexible facility, we must allow for the use of standardized movable components that will constitute much of the End Station experimental equipment.

3. As a direct result of the experience at CERN, we are now studying the grouping of the planned Cafeteria and Auditorium Building into a "Meeting Center" where all the physical facilities that are required for a national scientific meeting (say 300 persons) will be available. This will allow for efficient handling of large groups of visitors with a minimum of interaction with the operation of the project.