

Electrical Distribution

The electrical distribution system is indicated on the following drawings:

- Electrical One Line Diagram . . . . . ESH-11
- End Station Plan-Mechanical and Electrical . . ESH-12
- Center Station Plan-Mechanical and Electrical . ESH-13
- Housing Sections, Mechanical and Electrical . . ESH-14

The electrical distribution system has been revised to incorporate the latest changes in loads and layout of equipment. These drawings were prepared to better scope and define the power system. The system is described as follows:

1. Main power supply is from a single 110 KV line from the P.G. & E. system. A second 110 KV line and breakers will be added as the future load is added.
2. The main substation includes a 110 KV oil circuit breaker ahead of the transformers, three 15/20/25 MVA, 110 KV/12 KV transformers, and 12 KV feeder switchgear with tie breakers between busses.
3. All substations are fed with double feeders, each capable of supplying 100 percent of the load.
4. The End Station and Administration Area substations consist of two 1000 KVA, 12 KV/480-277V transformers, main tie breaker and feeder breakers for general utility loads.
5. The End Station magnet supplies are supplied from two 7500 KVA, 12 KV2.4 KV substations connected similarly to item 4.

6. The klystron power supplies are supplied from substation B at 12 KV. See Drawings ESH-13 and WSH-7.
7. Substation A supplies the center station cooling tower and the 300 KVA, 12KV/208-120V load centers located in each sector of the klystron housing.
8. A 2400 volt emergency substation consisting of 1500 KVA, 12 KV/2.4 KV transformer and 2-750 KVA, 2.4 KV diesel-driver generators with tie breakers is provided. Emergency loads are fed with double feeders similar to the normal distribution system.
9. Future klystron power supplies and additional power requirements at the end station will be supplied by the second 110 KV feeder and additional 110 KV/12KV transformers at the main switchyard.

TABLE XXI-4

ELECTRICAL POWER REQUIREMENTS

<u>Item</u>	<u>Stage I Max. Operating Load(KVA)</u>	<u>Stage II Max. Operating Load(KVA)</u>
Modulator Power Supplies	22, 000	88, 000
Klystron Housing Aux. Power	4, 600	6, 000
Beam Switchyard	1, 300	2, 600
Cooling Towers	800	1, 400
End Station		
Magnet Supplies	10, 000	20, 000
Auxiliaries	2, 200	7, 200
End Station Laboratory	4, 000	4, 000
Administration, Shops, Klystron Lab., etc.	<u>4, 000</u>	<u>4, 000</u>
	48, 900	133, 200

The possible effect of the electrical characteristics of the direct current high voltage power supplies on the Pacific Gas and Electric Company system in the area was reviewed in considerable detail. Electrical model tests and mathematical analyses were conducted by Stanford and reviewed by a leading authority in this field (See Appendix S). After careful evaluation of the factors involved, it appears that the contingency of \$400,000 included in the electrical estimates presented in Volume III-Blume Report is sufficient.

This amount of \$400,000 has been transferred from Item C 3(c) in the estimate to Item C 5, Accelerator, as the present studies indicate that electrical filters and electrical phase shifting devices are required in the high voltage DC power supplies to reduce the effect on the power system. In addition, two spare DC power supplies are required instead of the one spare previously provided because of the different arrangements of wiring required for the phase-shifting devices. These provisions are estimated to cost about \$400,000.

### Mechanical Systems

The mechanical systems were designed on the following basis:

1. Water Supply

- a. 900 gpm of raw water is supplied from the nearest main to provide the domestic, demineralized, and cooling tower water make-up requirements. Make-up water is not treated. Piping is cast iron underground, and copper in the klystron housing and end station area buildings. Water meters are in a fenced enclosure, on a concrete slab.

b. End Station area buildings are sprinklered as required. A cast-iron distribution loop includes fire hydrants outside of buildings. A 750,000 gallon storage tank is constructed on a hill adjacent to the buildings. A booster pumping system consisting of two dual-drive fire pumps, each with electric motor, gasoline engine, accessories and controls, is provided. A fire protection system for the klystron cubicles is provided, consisting of one fog spray nozzle for each cubicle. Each nozzle is controlled by a solenoid valve operated by a thermostatic sensing device or by a manual push button.

2. Cooling Water

a. Cooling water for the klystron cubicles and the accelerator tube is demineralized water. The water temperature and rates of circulation for the cubicles and tube are based upon the following requirements.

1) Klystron Cubicle (per cubicle)

12 gpm 50 psi drop (including 2 gpm for ignitron)

100 psi maximum pressure

158°F. maximum outlet water temperature

67 KW maximum heat load

2) Accelerator Pipe (per each 10-foot section)

(32 active per 330-foot sector)

200 psi maximum pressure

Supply temperature regulated at  $\pm 1^\circ\text{F}$ .

Stage I - 7 gpm at 1 psi drop

5.0 KW heat load with beam off

Stage II - 27 gpm at 20 psi drop

20.1 KW heat load with beam off

(with beam on, heat load is reduced by  
beam power which appears at beam stop)

- b. For cooling the accelerator tube, a separate pumping circuit for each sector of  $333\frac{1}{3}$  feet of tube circulates cooling water through the tube sections, which are connected in parallel. The water enters at  $140^{\circ}\text{F.} \pm 1^{\circ}$  and leaves the tube at  $3.6^{\circ}\text{F.}$  higher temperature. Temperature leaving the R-F load is  $5^{\circ}\text{F.}$  higher than that entering the tube. An electric heater mounted in the piping system is provided to maintain the  $140^{\circ}\text{F.}$  operating temperature against heat losses when the R-F power is off. A capacity of 15 KW per sector will make up for pipe temperature loss at winter conditions.
- c. For cooling the klystron cubicles a separate pumping circuit for each sector circulates cooling water through the cubicles. The cubicles are connected in parallel by means of quick-attaching hose connections to the sector circulating mains. The water enters at  $90^{\circ}\text{F.}$  and leaves at a temperature of  $134^{\circ}\text{F.}$  For Stage I operation the output of klystron circulating pump is partially by-passed so as to maintain the design rate of flow through each cubicle. The lengths of waveguides in the pipes embedded in the shielding fill are coiled with  $\frac{1}{2}$  inch water lines attached to each waveguide.

- d. The circulating pumps for the accelerator cooling circuit and the klystron cooling circuit operate on a common cooling water system. One heat exchanger per sector is installed for Stage I, delivering water at a temperature of 90°F. Cooling is provided by 80°F. cooling tower water. For Stage II, provision is made to install an additional heat exchanger.
- e. Demineralized cooling water systems are provided for the following end station area locations:
1. Klystron Laboratory  
Accelerator test section, 24 sections.  
6 klystron cubicles plus 10 test stands. Stage I, 960 KW load.  
24 klystron cubicles, plus 10 test stands. Stage II, 2040 KW load.
  2. Target Buildings  
Stage I - 2 buildings, each 500 KW load.  
Total simultaneous load, both buildings, 10,000 KW.  
Stage II - each building - 10,000 KW load.  
Total simultaneous load, 20,000 KW.
  3. Beam Stop and Dumping Magnet
    1. At each Target Building, 6400 KW load, Stage II.  
Stage I load, 1600 KW.
  4. Beam Switchyard  
Magnets, each 300 KW load.  
Each system consists of an installation of pumps and heat exchangers, similar to the klystron and accelerator cooling systems described above. 80°F. cooling tower water is circulated to each of the above systems.

- f. Cooling water heat exchangers are single-pass shell and tube heat exchangers, all Everdur construction.
- g. Demineralized water piping smaller than 2" is plastic pipe and fittings; piping 2" and larger is plastic-lined steel pipe, with flanged joints and fittings. Pipe is insulated with 1" thick Fiberglas.
- h. Demineralized water make-up is furnished by a demineralizer station located in the end station utility building. Capacity is 300 gpm, with a specific resistance of 500,000 ohms. A supply main distributes make-up water to each of the sectors in the klystron housing, and to each of the end station systems.  
  
A demineralized water recirculation system, consisting of return mains and circulating pump, is installed to make possible continuous deionization of the water.
- i. Two cooling towers are provided: Tower No. 1, providing cooling water for the cooling water heat exchangers in the klystron housing, is a one-cell tower with provision for three additional cells. Stage 1 operation requires 5700 gpm from 105°F. to 80°F. Tower No. 2 providing cooling tower water for the cooling water heat exchangers in the end station area is a one-cell tower with provision for additional cells. Stage I operation requires cooling 5800 gpm from 105°F. to 80°F. Design wet bulb temperature is 70°F.
- j. Cooling tower water is circulated through supply and return mains in the klystron housing and the end station

area. Piping above ground is black steel with welded fittings. Mechanical joint cast-iron pipe is used below ground.

3. Sewers and Drains

- a. Sanitary waste system for the klystron housing consists of a gravity main outside of the housing with a pumping lift station every 333-1/3 feet. Each lift station consists of a duplex sewage ejector in a sump tank.

The main terminates in a manhole and from thence into the gravity sewer for the site. Main is vitrified clay soil pipe and fittings. A toilet facility, consisting of one flush tank water closet is located in every other equipment alcove. A service sink is provided for every alcove.

- b. Drainage system for the accelerator housing consists of a duplex ejector installed in a sump located every 333-1/3 feet. These pumps discharge the drainage water outside the housing. Drain piping outside the accelerator conducts underground water into the sumps.

- c. Sanitary soil lines at the end station area collect the soil lines from the buildings, 5 feet outside the building, and connect to the sanitary district sewer main on Alpine Road. Sewer piping underground is vitrified clay pipe. Manholes are sectional precast concrete.

4. Heating and Ventilating

- a. The klystron housing is ventilated with outside air at a rate to maintain the inside temperature at not more than



8°F. above outside air temperature, with a minimum of 40°F. under Stage I operating loads. Under Stage II loads the inside temperature will be 15°F. above outside temperature. Heat gains are based on these loads:

Klystrons and accessories - 1248 KW (Stage I)  
1994 KW (Stage II)

Lights - 3 watts per square foot. 25 percent usage.

Solar gains - 85°F. outside  
100°F. inside

- b. 600,000 cfm of ventilating air is supplied to the klystron housing by means of 60 propeller fans, each provided with an outside air filter. Two fans at each equipment alcove supply 10,000 cfm each to the building. The air is relieved to the outside by automatic louvers. When access to the accelerator housing is necessary, air enters the accelerator enclosure through the access passageways and is exhausted by means of 15 vertical vane axial fans located on the surface. Exhaust air is drawn through concrete pipe ducts to the fans.
- c. The klystron housing is not heated in winter. When the machine is operating, part of the building heat losses will be compensated for by the cubicle and piping heat losses. For local spot heating requirements portable electric heaters may be used.
- d. The end station area buildings are not air conditioned, except for three small areas. Each of these areas has a self-contained packaged air conditioning unit.

Loft spaces are provided with unit heaters. All other spaces are provided with heating and ventilating systems.

- e. The central heating system for the end station area buildings consist of two water heaters, each with a capacity of 300 boiler horsepower, located in the end station utility building. Burners are combination-type natural gas and No 2 fuel oil. One 10,000 gallon storage tank is provided. A total of 400 gpm of 250°F. hot water is circulated to the end station area buildings by mains in trenches.

All piping is steel with 1" thick Fiberglas insulation.

#### 5. Natural Gas System

14,000 cfh of natural gas is supplied to the end station utility building for burners. Piping is black steel with protective wrapping. Meter and regulator are in the same fenced enclosure as the water meters, on a concrete slab.

### Safety Provisions

Special provisions for radiation safety are incorporated into the accelerator design. A vertical offset in the cross-passageways interrupts straight-line radiation from the accelerator. Key-interlocked doors in the passageways prevent accidental access into the accelerator while the beam is in operation. Refer to discussion in this section of provisions for shielding.

A large allocation of the equipment funds is designated for radiological safety equipment and for the implementation of standard

monitoring techniques. Standard industrial safety code requirements have been observed in building design and site layout. For fire protection, transformer oil dump pits are provided under the klystron cubicles with fog nozzles above. Fire stops are provided at each sector in the klystron housing together with a fire resistive ceiling.

### Landscaping

The cut-and-cover method of construction can leave scars on the landscape with high fill slopes or cut banks. Unless these slopes are planted and otherwise stabilized considerable erosion from wind and rain will occur. For the installation detailed herein landscaping consisting of ground cover, shrubs, and trees is provided to maintain the slopes and to erase the unsightly slashes resulting from construction operations. The type of landscaping envisaged will be hardy, largely native, and require minimum maintenance. In addition, buildings are placed, where practical, to preserve existing oak trees on the site. Provision in the cost estimate is made to transplant, where possible, specimen trees that have to be removed during construction operations.



FIG. 12 SAND HILL SITE

## VOLUME IV

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### SECTION XXII

#### EAST SAND HILL SITE

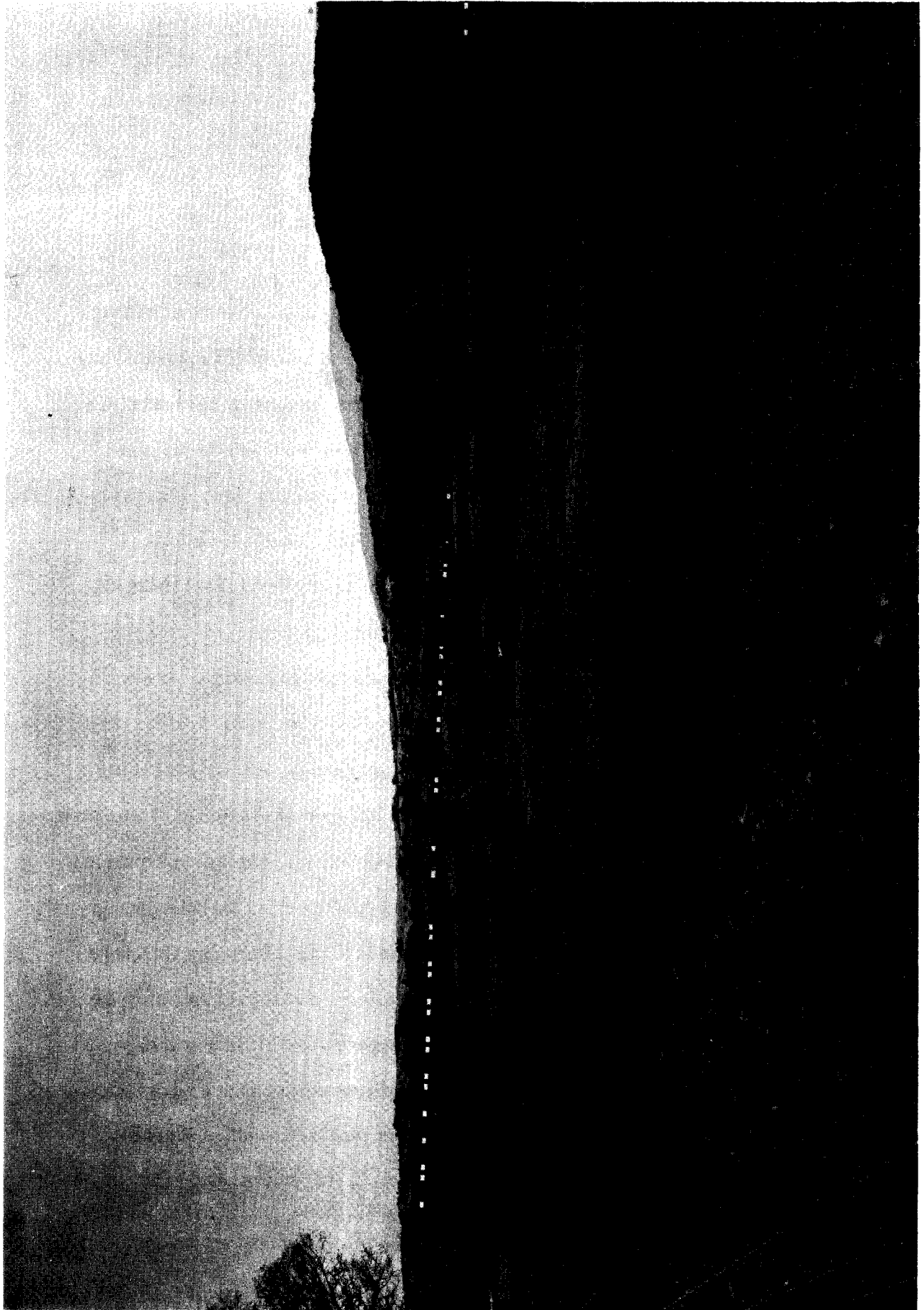
##### Project Implementation

General project requirements are described in the preceding section. In the proposed Sand Hill location a preferred alignment has been determined for the beam housing, with two possible end station area locations. These are at the east and at the west ends of the chosen alignment. Each possesses inherent advantages and disadvantages, and the merits of both locations have been considered at length. This section of the report covers the East Sand Hill Site. The following section considers the West Sand Hill Site.

In both cases the accelerator and cross-passageways are constructed on a foundation prepared by cut and fill methods. After the accelerator housing and passageways are completed, earth shielding material is backfilled over the completed accelerator housing structure.

Beam switchyard housings are constructed in the same manner as the accelerator housing and terminate at the target buildings. Beam housing for proposed future extensions of the beam switchyard are constructed to points from which subsequent construction can be initiated without interfering with existing accelerator operations.

Auxiliary and support buildings are situated in the end station area, except for a small utility building group located at a center station. Drawings ESH-1 through ESH-6 show site plans and end station and center station layouts.



SAND HILL SITE LOOKING SOUTH-EAST

FIG. 13

### Site Characteristics

The East Sand Hill cut and cover alignment is located in the foothills just west of the Stanford campus. This is an area of subdued relief, with low, rolling hills and wide, shallow valleys. The land has been grazed intensively, and remaining vegetation consists mainly of scattered oak trees and short grass.

The area is elongated in an east-west direction and is bounded on the north by Sand Hill Road, on the east by Alpine Road, and on the south by San Francisquito Creek. Sand Hill Road and the creek converge to an intersection at the extreme western end of the area. The land involved is owned by Stanford University.

### Site Adaptation

The length of the accelerator and the topography of the site require that the accelerator be aligned roughly parallel to the long direction of the Sand Hills area and generally along the northern drainage slope of the creek. The alignment of the 10,000-foot accelerator length has not changed significantly from the previous location used for the Sand Hill site in Volume III of the Blume Report.

The proposed beam elevation for the East Sand Hill Site is selected to obtain the maximum practical length of rock foundation for the accelerator, and to balance cut and fill quantities. Cut heights of as much as 100 feet are required. Fill under the accelerator housing is restricted to a maximum of 25 feet above the existing ground elevation. Along three portions of the accelerator, compressible upper soil layers are stripped and replaced with select fill material. With the shielding embankment height added, total fill

heights will reach a maximum of about 75 feet.

Slopes used are those recommended as maximum stable slopes for the various materials encountered. Additional space is kept available at the tops of cut slopes in the event occasional slope flattening in weak zones is found to be necessary during construction.

Material balances between cut and fill have been achieved by carefully determining the optimum beam elevation. The excess of cut material, generated by the requirement that the accelerator be founded on rock to the maximum practical extent, is taken up by the shielding fill embankment over the housing and around the end station yards. Drainage culverts are provided for several small tributary valleys which are cut off by the accelerator embankment.

A minor amount of ground water seepage is anticipated at the east end. Adequate capacity for these small flows is provided by the drainage measures described in Section XXI. In the western portion of the area a significant amount of ground water seepage is expected, and a cost estimate allowance is made for supplementary drainage measures, such as horizontal bored-in drains.

The End Station target buildings are located in cut areas and are consequently founded on rock. The rock at the east end is a flat-lying series of sandstones and cemented gravels. Settlement under all expected loads will be small and should be uniform over the loaded area.

Water is brought to the site from an existing valve in the San Francisco Water Department's Aqueduct No. 3, which crosses the northeast corner of the Sand Hills area. The main supply line terminates in a meter station in the end station area, with secondary distribution from that point.

Sanitary sewage collection lines are provided for the end station area. Another collection line runs the length of the Klystron Housing. The two lines intersect near the east end of the accelerator and are routed to a Menlo Park Sanitary District main on Alpine Road.



A natural gas regulator station is available at Sand Hill Road near the east end station location. From this location gas is brought to a central meter location in the end station area, with secondary distribution from that point throughout the end station.

Access roads for the east end station connect with Sand Hill Road north of the end station, and Alpine Road to the south and east.

### Architectural Studies

As part of the work included in this investigation, limited studies of various architectural treatments of the End Station Buildings were made. In Volume III the functions of the two buildings were housed in one large building 400 feet by 500 feet in plan by 98 feet high. The buildings as now contemplated are 120 feet by 300 feet and 120 feet by 100 feet in plan. The building heights are now reduced to about 75 feet, which greatly reduces the architectural problems.

After the required building dimensions were determined various possibilities were considered for the exterior treatment of the building. Drawings ESH-9 and ESH-10 present two of the tentative treatments considered. The types of exterior wall panels studied varied from metal siding and cement asbestos siding to pre-cast concrete panels and various combinations of same. Cost estimates for these treatments ranged as much as two dollars per square foot of building from the lowest to the more costly designs. This range indicates the cost spread that could be encountered. For purposes of the cost estimate of this report, the exterior walls were considered as treated corrugated metal similar to the arrangement shown on Drawing ESH-9.

It is recognized, of course, that these studies are only tentative and that other design studies will be necessary to effect the optimum design for the nature of the project, local conditions, and economy of initial cost and operations.

## Project Cost Estimate

Cost estimates are based on construction for Stage I operation, with sufficient additional space and capacity provided to facilitate future transition to Stage II operation. Operation at the Stage II level is outlined in the table of machine parameters contained in Section XXI. The cost estimate format of previous volumes of the Blume Report is retained. Costs are based on the prevailing wage rates and unit prices in the Palo Alto area, projected to July 1961 by adding an assumed escalation factor of  $2\frac{1}{2}$  percent.

Table XXII-1, Project Cost Estimate, is a detailed breakdown of the cost estimate for the East Sand Hill Site. The following discussion is concerned with major differences between this cost estimate and the January, 1960, cost estimate for the Sand Hill Site, presented in Section XV, Volume III, of the Blume Report.

Item A, Engineering, is increased, reflecting the increases in site and accelerator construction costs. For Item B, Land and Land Costs, no land costs are involved because the land required is entirely owned by Stanford University and will be made available at no cost to the project.

Item C1, Improvements to Land, shows an increase. Part of this increase is due to escalation. The remaining increase is attributable to design changes, primarily increased end station area, resulting in increases in costs of all sub-items, with the exception of a slight decrease in site preparation costs.

Item C2, Buildings, is decreased, primarily because the large End Station Building has been replaced with two smaller target buildings and one large concrete target chamber. Part of the decrease is offset by the added cost of the greater number of shielding blocks required for operation of two separated target buildings. Escalation costs also tend to offset the decrease due to the design change. (The remainder of the decrease is subsequently taken up by providing increased magnet power

for research magnets under item C5(a)).

Item C3, Utilities, shows an increase, attributable to both escalation and design changes. Item (a), Pacific Gas and Electric Company powerline, has almost doubled in cost due to rapidly increasing right-of-way costs. A design change, reducing the number of sections, results in a decrease in item (c). Power to Klystrons (Auxiliary feeders and power panels). The decrease in number of sectors causes some increase in item (e), Cooling Water. The major increase in item (e) is due to greater cooling requirements for klystron cubicles and in the end station areas. Revised sewer and drain designs have decreased item (f). Heating and ventilating design changes result in lower costs for item (g). Other items show small increases, primarily due to escalation.

Item C4, Accelerator and Klystron Housing, is increased, partly due to design changes and partly due to escalation. Design changes include revised slope stability requirements and increased space and fireproofing requirements in the klystron housing. A small decrease in the beam switchyard cost is due to changes in the target area layout. Slope protection measures for the reservoir are included with an estimated added construction cost of \$152,000. Small increases in other items are primarily escalation costs.

Item C5, Accelerator, shows an increase which is partly due to design changes and partly to escalation during the past year. Item (b) is increased because of the use of ignitron tubes in place of spark gaps, which increase is partially offset by the elimination of the compressed air system. \$400,000 of the increase in this item results from shifting this amount from C3(c). (See Electrical Distribution, Section XXI) The inclusion of metal-seated vacuum valves for the wave guides and a

coaxial line in item (c) result in cost increases, slightly offset by reduced vacuum costs. An increase in item (e) is due to magnet changes and beam dump cooling requirements. Addition of temperature monitors increases the cost of item (f). Other increases are due to escalation costs.

Item C6, Equipment, is increased, primarily because of design changes. Item (a) is increased because of the increased power for the target areas. Item (d) is decreased largely because of the elimination of two 100-ton capacity cranes of the four previously provided. Other items show small increases due to escalation. The increase due to design changes is offset by the decrease in item C2.

Item D, Escalation, is reduced by revised scheduling, with as much construction being accomplished in the early stages of the project as possible.

Item E, Contingency, is increased reflecting the increased construction costs.

Table XXII-2, Suggested Fiscal Year 1962 Obligations, sets forth a suggested program of fiscal obligations for the first year, based on the proposed construction schedule. In general, the increase over the suggested first-year obligations listed in the January, 1960, Volume III of the Blume Report is due to: (1) the work and research performed during the intervening period, which will enable Stanford and the project to move ahead rapidly in Fiscal Year 1962; and (2), escalation during the one-year delay.

Table XXII-2, Obligation and Cost Schedule, presents an outlined program of costs and obligations for the proposed construction schedule. It should be noted that this cost estimate is based on the assumption that the accelerator project is authorized by July, 1961, and work initiated soon thereafter. If the program is delayed, costs should be increased at the rate of 5 percent per year of delay, assuming that the current rate of wage and price escalation continues.

Table XXII-4, Stage II Conversion Cost Estimate Breakdown, presents a breakdown of estimated Stage II conversion costs.