SURFACE WATER: Scant attention was given to the problem of surface waters, except to note that two natural drainage channels pass through the west end station area, whereas no surface drainage problems exist in the east end station area.

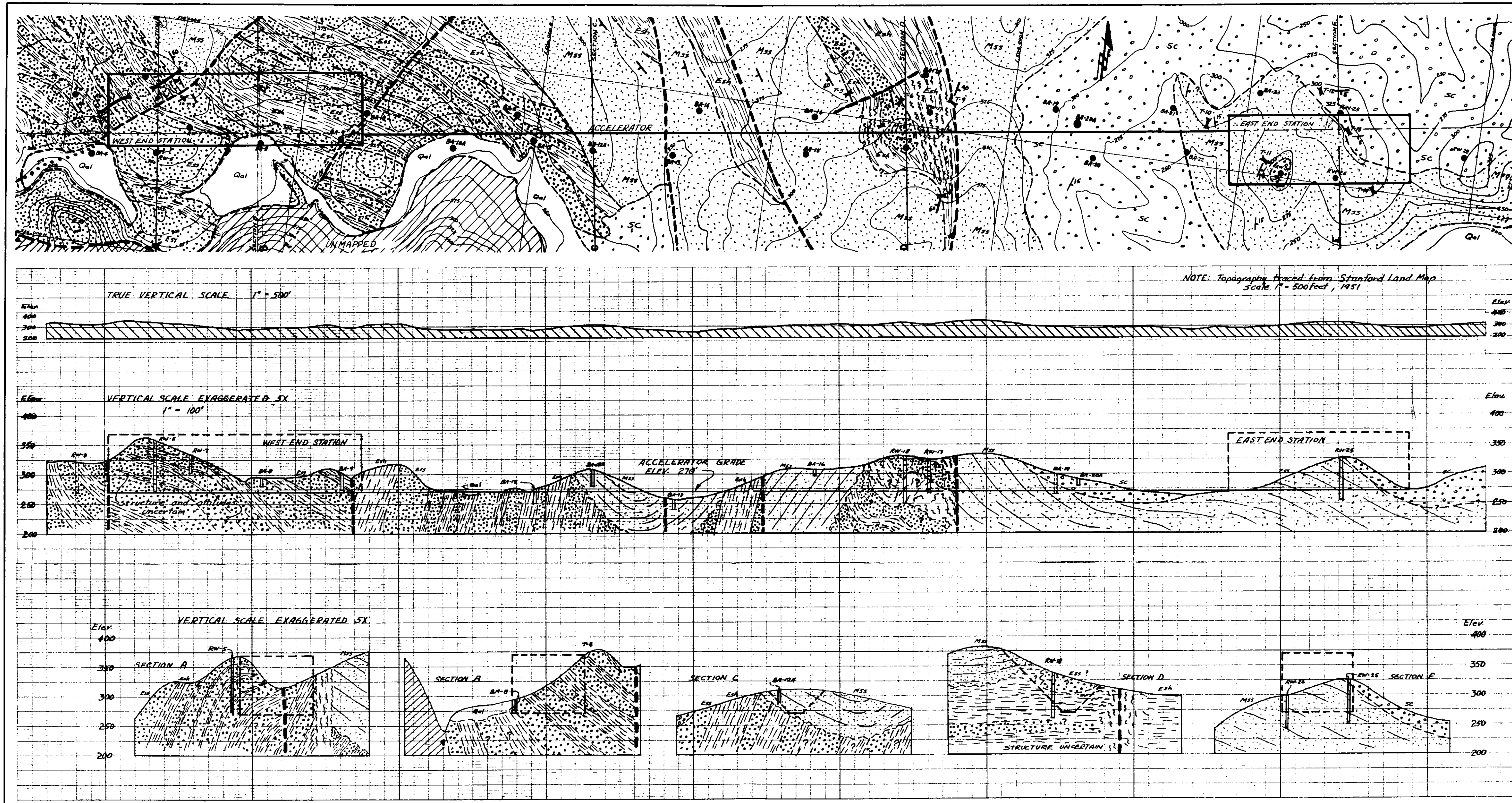
## SUMMARY AND CONCLUSIONS

The present report presents a brief description of the general geology of the Sand Hill accelerator alignment, together with appraisal of site conditions bearing on foundation design and construction. Comparative discussion of the alternate east and west end station areas is included. Reviewing the report discussion and considering the scope and results of the explorations, I conclude the following:

1. The investigation has revealed no geological conditions which would be prohibitive to the ultimate total development of the proposed Sand Hill accelerator site.

2. The trenching and drilling explorations have provided sufficient information on general foundation conditions to undertake project planning and construction design, with provision for additional borings and testing in local areas of uncertainty and at specific points of heavy loading prior to final foundation design.

3. In review of the described excavation difficulty, material quality, settlement problems, slope stability, ground water problems, and surface drainage, I conclude that the east end station area offers substantially superior conditions for assured foundation design.




| | |
|---|---|
| Qal | ALLUVIUM, Unconsolidated sand gravel and clay |
| SC | SANTA CLARA FORMATION, Sandstone with gravel lenses. |
| Mss | MIOCENE SANDSTONE, Fine grained, friable sandstone. |
| Ess | EOCENE SANDSTONE, Medium grained, poorly sorted, hard and soft sandstone. |
| Esh | EOCENE SHALE, Thin bedded, blocky, silty shale and sheared clay shale. |
| | UNMAPPED AREA |
| | STRIKE and DIP of Beds |
| | ROCK CONTACT, Approximate |
| | FAULT TRACE, Approximate |
| | SHEAR ZONE |
| BA | Bucket Auger Drill Hole |
| RW | Rotary Wash Drill Hole |
| T | EXPLORATION TRENCH |

# GEOLOGY OF THE SAND HILL LINEAR ACCELERATOR SITE

## STANFORD UNIVERSITY

FRANK ATCHLEY SEPTEMBER 1960

CONTOUR INTERVAL 25 feet

0 500 1000 1500 2000 2500 Feet

# APPENDIX Q

## LETTER REPORTS ON SAND HILL LINEAR ACCELERATOR SITE

Dated January 25, 1960
and October 4, 1960

By

Perry Byerly

and

Garniss H. Curtis

Perry Byerly
6037 Contra Costa Road
Oakland 18, California

January 25, 1960

Mr. Roland L. Sharpe
John A. Blume and Associates
612 Howard Street
San Francisco, California

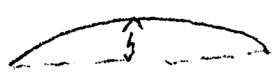
Dear Mr. Sharpe:

Regarding the northern location of the last two proposed sites for a linear accelerator on the Stanford Campus, the western end is about 0.2 km. from the fault.

Accepting the formula for accumulated strain

$$v = 194 \cot^{-1} 0.325 \times 10^{-5} x$$

Where v is displacement in centimeters per hundred years and x is distance from the fault in centimeters, we compute that the 3 km. tube, which is perpendicular to the fault, might possibly accumulate a radius of curvature of 5800 kilometers in 100 years. This would mean that its departure from linearity as measured by h would be



h = 20 cm.

So we might expect 2 cm. in 10 years.

Yours sincerely,

Perry Byerly

Perry Byerly

PB:lm

Perry Byerly
6037 Contra Costa Road
Oakland 18, California

October 4, 1960

John A. Blume and Associates
612 Howard Street
San Francisco, California

Gentlemen:

Concerning our opinion on which end of the Sand Hill Linear Accelerator Site is most suitable seismically and geologically for locating the target installations, we believe that the eastern end--the end most remote from the San Andreas fault--is best.

Geologically, there appears to be little choice between the eastern and western ends in so far as the stability of bedrock is concerned. The possible advantage of the more firmly compacted Eocene shales and sandstones of the western end is matched by the adequately compacted and better drained Miocene, Pliocene and Pleistocene sands and gravels of the eastern end. Seismically, we believe that, other factors being equal, safety lies in placing the target installation the greatest possible distance from the San Andreas fault.

In that the Sand Hill Site lies approximately normal to the trend of the San Andreas fault, we are somewhat concerned over the possibility of shearing strains distorting the accelerator. This appears somewhat less of a hazard in the Felt Lake Alignment which parallels the San Andreas fault. If, as appears to be the case, slow distortion of the tube is not as serious a consideration as disruption of the target installation itself, the eastern end of the Sand Hill Site is again the superior site for the target installation.

Yours truly,

Perry Byerly

Perry Byerly

Garniss H. Curtis

Garniss H. Curtis

PB:lm

# APPENDIX R

LETTER FROM U. S. ARMY ENGINEER DISTRICT,
SAN FRANCISCO, CORPS OF ENGINEERS,
REGARDING SAN FRANCISQUITO CREEK
FLOOD CONTROL PROJECT

U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS
180 NEW MONTGOMERY STREET
SAN FRANCISCO, CALIFORNIA

Address reply to
DISTRICT ENGINEER
U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS
BOX 3050, RINCON ANNEX
SAN FRANCISCO 19, CALIFORNIA

Refer to file SPNGP

20 October 1960

Mr. Roland L. Sharpe
Vice President
John A. Blume and Associates, Engineers
612 Howard Street
San Francisco, California

Dear Mr. Sharpe:

This acknowledges your letter of 6 October 1960 and substantiates the discussions of 14 October between yourself, Messrs. Rodger Skjea, Charles L. Nichols of Dames and Moore, Consultants, and Gerald T. Trail relative to the relationship and compatibility of the linear accelerator with the proposed San Francisquito Creek Flood Control project.

Review of your preliminary plan dated 9-27-60 indicates that the accelerator and reservoir projects can be made compatible with each other.

To assist you in your engineering designs and further understanding the flood control water surface stage relationships in the reservoir, a stage hydrograph for the standard project flood was presented. As discussed, the standard project flood is a flood of a magnitude greater than the adopted design flood and smaller than the spillway design. The design flood is estimated to have a recurrence of about once in one hundred years. In addition, Stage-Duration-Frequency curves were presented for storms of one hundred-year recurrence and less.

Based on the oral question of acceptable hydraulic opening for your proposed culvert connecting the severed portion of the reservoir, it was found that a minimum hydraulic opening equal to an opening of seven-foot diameter would be acceptable for reservoir operation. It is suggested that trash racks be installed at both ends of the culvert.

Based on your present designs it is understood that the proposed accelerator project will result in a balance of cut and fill, and will not require borrow from the adjacent areas. This is of paramount importance to the cost of the proposed reservoir project inasmuch as the construction of the embankment for the dam is predicated on the availability of local borrow material within the reservoir area.

I trust that the foregoing will serve your purpose. If you desire additional information, please contact Mr. G. T. Trail, telephone YUkon 6-3500, extension 3591.

Sincerely yours,

V. K. Sanders

V. K. SANDERS
Lt. Colonel, Corps of Engineers
Acting District Engineer

# APPENDIX S

## LETTER REPORT ON EFFECTS OF ACCELERATOR ON POWER COMPANY SYSTEM

By

M. D. Horton

GENERAL ELECTRIC
COMPANY
ONE RIVER ROAD, SCHENECTADY 5, NEW YORK . . . TELEPHONE FRanklin 4-2211

INDUSTRIAL
SALES
OPERATION

December 2, 1960

Mr. R. L. Sharpe
John A. Blume and Associates
612 Howard Street
San Francisco 5, California

Dear Sir:

Subject: Stanford Project M

This letter is written in response to your request for my written opinion on whether or not the large d-c rectifier and d-c resonant charging system, proposed for the Project M accelerator, can be successfully applied to the Pacific Gas and Electric Co. 115 KV system.

It is my opinion that this load can be successfully applied to the P G and E 115 KV system if proper precautions are taken to limit the rectifier harmonic currents and the d-c load pulsations.

The techniques for accomplishing these objectives are well known in the electrical industry and have been the subject of my previous discussions and correspondence with you and with the men at Stanford University.

In general these precautionary measures include:

1. Providing the necessary a-c voltage phase-shift in the several rectifiers so that the harmonic frequencies impressed upon the P G and E system do not constitute a serious problem to the utility company or to its other customers.

2. Providing adequate d-c filtering of the rectifier outputs so that the effects of the pulsing loads are within acceptable limits.

My preliminary estimates for the incremental cost of providing the necessary rectifier a-c voltage phase-shift and the additional d-c filtering (over and above that required for successful modulator performance) indicate that the $400,000 which you have allocated for these items is a good estimate.

Sincerely yours,

GENERAL ELECTRIC COMPANY

M. D. Horton

M. D. Horton
Testing Equipment Engineering
Industrial Engineering Operation

# APPENDIX T

## REVISION OF ESTIMATE OF STANFORD TWO MILE LINEAR ACCELERATOR STAGE I ACCELERATOR CONSTRUCTION COST

By

William M. Brobeck & Associates

REVISION OF ESTIMATE

OF

STANFORD TWO MILE LINEAR ACCELERATOR

STAGE I

ACCELERATOR CONSTRUCTION COST

REPORT NO.
200-58-R1

OCTOBER 1960

This report has been prepared for inclusion in Volume IV of the report now in preparation of John A. Blume & Associates on the Stanford Linear Accelerator.

November 4, 1960

CHANGES IN THE ACCELERATOR PLANS SINCE PREPARATION OF VOLUME I OF THE BLUME REPORT AND THE EFFECT OF THESE CHANGES ON THE ESTIMATED COST.

Appendix A of Volume I of the report of John A. Blume & Associates, "The Proposed Stanford Two-Mile Linear Electron Accelerator at Alternate Sites" consisted of an estimate made by William M. Brobeck & Associates of the construction cost of the Accelerator. This estimate applied to the accelerator design as of December, 1959. Since that time certain changes have been proposed, most of which are minor, but some of which affect the estimated construction cost. Most of the changes are the result of more detailed study of components and sub-systems than had been made at the time of the previous estimate.

Some changes discussed are not mentioned here because they either (1) affect the design only in a degree of detail not considered in the estimate, or (2) are too tentative to be considered actual design changes. Those changes that are considered sufficiently firm and basic enough to possibly affect costs are discussed below.

1. Changes in Sector Length and Number:

The number of "sectors" making up the linear accelerator has been changed from 40 to 30 with the length of the sectors changed from 250 to 333-1/3 feet as required to maintain the overall length at 10,000 feet. Certain items of auxiliary equipment such as vacuum pumps, microwave booster amplifiers, and local control stations are required in the quantity of one for each sector. The number of these items is therefore reduced in the ratio of 32 to 40 while in general their capacity is increased in the inverse ratio. In most cases the cost of the increased capacity would be expected to be less than the saving in the number of units. However, as the difference is not large, and its detailed estimate is beyond the scope of the present review, no change in the estimated cost is made as a result of the change in sector length.

2. Temperature Monitors on Accelerating Pipe:

This is a new item consisting of a temperature sensor (thermocouple or resistance thermometer) at the water outlet of each ten foot accelerating pipe section and at two points on the water supply manifold for each sector. This temperature information will be presented on multipoint recorders at each sector. The reading at any point may be displayed in the central control room in digital form by manual selection of the desired recorder. A maximum delay of about one minute would occur in obtaining a reading due to the scanning time of the local recorder. This system is an addition to the instrumentation previously estimated. Its estimated cost is $200,000.

3. Use of Coax Instead of Waveguide for Sector Sub-Drive Lines:

A total of 10,000 feet of line is required to distribute power from the sector boosters to the klystron modulators. There is an estimated increase in cost of about four dollars per foot for the coaxial line over the waveguide resulting in an increase in cost of $42,000.

4. Use of Metal-Seat Valves in High Vacuum System:

DELETED

5. Beam Switchyard and Target Area Vacuum System:

The end station arrangement has been considerably revised since the previous estimate. As a result, the length of vacuum tube beyond the accelerator has been reduced from 2,800 to approximately 2,100 feet. This results in a saving in the vacuum tube and vacuum pumping system amounting to $76,000.

6. Beam Switchyard Magnets and Power Supplies:

The arrangement of the beam paths in the beam switchyard in the previous estimate was based on the use of three magnets each capable of deflecting the beam horizontally through an angle of 15 degrees. In the present design, four bending magnets are used providing a total deflection of 56 degrees. The cost of the bending magnets and their power requirements are, in general, proportional to the deflection angle. Part of the first deflection after the beam leaves the accelerating pipe can be made by magnets in which the current can be reversed. The ability to deflect in either direction effectively doubles the available deflection angle of these magnets at negligible increase in cost. This reduces the total deflection required for cost estimating purposes to about 52 degrees.

The accuracy requirement of the downward deflecting magnet is less than that of the horizontally deflecting magnets.

Considering the fact that about $7^{\circ}$ more deflection is required in a magnet and power supply of somewhat lower required accuracy, the additional cost is estimated at $52,000.

7. Change From Spark Gaps to Ignitron Switching Tubes in Klystron Modulators:

Tests made during the last year have established the desirability of using ignitron tubes to replace the spark gaps in the klystron modulators. An ignitron tube of special design is to be used. The ignitron requires more complicated and expensive firing circuits than the spark gap. However, there is a considerable saving in the removal of the requirement for compressed air. This permits deletion of the spark gap compressed air system and reduces the load of air coolers on the cooling system. These savings appear in the section of the estimate covering the facilities. The effect of this change is to increase the klystron modulator cost by $1,057,000.

8. Addition of Waveguide Valves:

Two valves per klystron are added to the waveguide system to permit isolating the waveguide windows from the accelerating pipe vacuum system. These valves are estimated as metal-seat valves. Their development costs are not included in the accelerator construction item. The estimated cost of this addition, not including development is $1,008,000.

# ACCELERATOR COST ESTIMATE COMPARISON

(Costs in thousands of dollars)

| | Volume III | Volume IV | 1960-61 Price Increase | Additional Increase | Total Increase |
|---|---|---|---|---|---|
| Accelerator Test Section | | | | | |
| Test Section | 2,672 | 2,779 | 107 | | 107 |
| Utilities | 328 | 341 | 13 | | 13 |
| | 3,000 | 3,120 | 120 | | 120 |
| Accelerator Power Components | | | | | |
| Modulators & DC Supplies | 7,342 | 9,150 | 351 | 1,457 * | 1,808 |
| Special Wiring | 21 | 22 | 1 | | 1 |
| Compressed Air for Spark Gaps | 767 | | | (-767) | (-767) |
| | 8,130 | 9,172 | 352 | 690 | 1,042 |
| Accelerator | | | | | |
| Accelerator Pipe Sections | 2,415 | 2,512 | 97 | | 97 |
| RF Couplers & Installation | 178 | 185 | 7 | | 7 |
| Waveguides & Valves | 2,646 | 3,760 | 106 | 1,008 ** | 1,114 |
| Windows | 58 | 60 | 2 | | 2 |
| Vacuum Pumping System | 3,274 | 3,329 | 131 | (-76) | 55 |
| Accelerator Support | 376 | 391 | 15 | | 15 |
| Coax Line | | 42 | | 42 | 42 |
| | 8,947 | 10,279 | 358 | 974 | 1,332 |
| Klystrons | | | | | |
| 300 Klystrons | 1,350 | 1,405 | 55 | | 55 |
| Shields & Magnets | 519 | 540 | 21 | | 21 |
| | 1,869 | 1,945 | 76 | | 76 |

| | | | | | |
|---|---|---|---|---|---|
| Beam Switchyard & End Station | | | | | |
| Deflection System | 238 | 299 | 9 | 52 | 61 |
| Vacuum System | 186 | 193 | 7 | | 7 |
| Steel Plug Shield (Now beam dump cooling) | 120 | 140 | | 20 | 20 |
| | 544 | 632 | 16 | 72 | 88 |
| Controls & Instruments | | | | | |
| Controls & Wiring | 1,307 | 1,559 | 52 | 200 *** | 252 |
| RF System | 995 | 1,035 | 40 | | 40 |
| Trigger System | 264 | 275 | 11 | | 11 |
| Injector-Deflector System | 654 | 680 | 26 | | 26 |
| Auxiliary Systems | 247 | 257 | 10 | | 10 |
| Vacuum Gages | 702 | 730 | 28 | | 28 |
| Communications & Signals | 68 | 71 | 3 | | 3 |
| Other Controls & Instruments | 908 | 945 | 37 | | 37 |
| | 5,145 | 5,552 | 207 | 200 | 407 |
| TOTAL | 27,635 | 30,700 | 1,129 | 1,936 | 3,065 |

* Includes $1,057,000 for ignitron tubes and $400,000 from Item C 3(c).
** Metal seated vacuum valves
*** Temperature monitors

# APPENDIX U

LETTER FROM STATE OF CALIFORNIA,
DIVISION OF HIGHWAYS, DISTRICT IV
REGARDING PROPOSED HIGHWAY ROUTE 239

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS
DISTRICT IV
150 OAK STREET
SAN FRANCISCO 2, CALIFORNIA
UNDERHILL 3-0222

ADDRESS ALL COMMUNICATIONS TO
P. O. BOX 3366, RINCON ANNEX
SAN FRANCISCO 19

November 15, 1960

PLEASE REFER
TO FILE NO.

4T-10H-1403.9
IV-SM-239-A

John A. Blume & Associates, Engineers
612 Howard Street
San Francisco 5, California

Attention: Mr. Roland L. Sharpe

Gentlemen:

This will acknowledge and thank you for the two additional prints of the Stanford accelerator site plan and cross-section furnished us with your letter of November 9, 1960.

In accordance with your recent request, returned herewith is one print of your 500' scale feasibility study plan on which we have shown approximate alignment of proposed Route 239 freeway in the vicinity of proposed accelerator tunnel. We have also indicated the approximate area required for proposed interchanges on Route 107 at Sharon Heights Road and Whiskey Hill Road as well as proposed interchange at the intersection of Routes 107 and 239.

Data furnished herewith is preliminary in nature and will be subject to minor modification during precise design. It is our belief that through a combination of highway alignment adjustment and longitudinal adjustment of planned location of proposed accelerator tunnel, if possible, we will be able to position proposed freeway crossing between alcoves of the accelerator facility.

Preparation of precise freeway plans at this location is contingent upon receipt of firm plans for proposed accelerator facility. We will appreciate accurate information showing the proposed location of the accelerator facility as soon as possible.

Very truly yours,

J. P. Sinclair
Asst. State Highway Engineer

By: J C Black
J. C. Black
Asst. District Engineer

# APPENDIX V

## SUMMARY OF TOPOGRAPHIC DATA COMPILED BUT NOT BOUND IN VOLUME IV

SUMMARY OF TOPOGRAPHIC DATA COMPILED BUT NOT BOUND IN VOLUME IV

1. Aerial photography suitable for photogrammetric mapping of approximately 1100 acres at a scale of 1" = 50', contour interval 2'.
2. Aerial photography suitable for a photo-contour map covering an area 10,000 feet by 16,000 feet at a scale of 1" = 500', contour interval of 20'.
3. A first order horizontal control net by triangulation and/or tellurometer, including a precision base measurement located near the accelerator alignment. Monuments are set in concrete.
4. A second order vertical control system with monuments set in concrete.
5. Control diagrams and summary sheets of all field survey data.

THE FOLLOWING DATA IS ON FILE AT THE SAN FRANCISCO OPERATIONS OFFICE, U. S. ATOMIC ENERGY COMMISSION.

1. Sheets 1 through 18, original cronaflex manuscript of topographic map, scale 1" = 50', contour interval 2' showing all trees, wooded areas, roads, fences, structures and rock outcrops.
2. One set, double weight semi-matte contact prints, Flight 538 1-15 and Flight 539 1-14.
3. One sheet, original cronaflex manuscript photo-contour map, scale 1" = 500', contour interval 20'.
4. One sheet, original transparency of control diagram, and four sets (sheets 1 through 5) of computation summary sheets.