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ABA-76

DESIGN CRITERIA REPORT

FOR THE

BEAM SWITCHYARD

REPORT TO STANFORD LINEAR ACCELERATOR CENTER - ABA No. 76

STANFORD UNIVERSITY SUBCONTRACT S-136

UNDER AEC CONTRACT AT(04-3)-400

Submitted by George Liik
G. Liik

Approved by Roland L. Sharpe
Roland L. Sharpe

AETRON-BLUME-ATKINSON
A Joint Venture
Architect-Engineer-Manager
Palo Alto, California

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INTRODUCTION

This Report presents the design criteria for performing the Title I design of the Beam Switchyard and associated facilities and equipment.

Included are criteria for the following items of work:

Beam Switchyard Structure including Access Penetrations, Special Shielding.

Excavation and Fill.

Site work including Sub-surface Drainage, Erosion Control.

House Electrical and Mechanical.

The following items are described insofar as they relate to the Beam Switchyard:

Utilities.

Material Handling System.

DESIGN CRITERIA

Beam Switchyard Structure

Support of Shielding Fill:

The required shielding thickness for the Beam Switchyard has been determined by SLAC as 32 feet of concrete and earth from the top of the interior of the structures to finish grade.

The design of the transverse reinforcement and thickness of concrete is based on conventional reinforced concrete design theory.

Vertical loading of the shielding fill is assumed at 1.0 times the nominal weight of the soil above the structure. This loading factor, which is considerably less than that used for the Accelerator

Housing design, can be attained if certain procedures are followed during construction. The lowering of the load factor is possible because there is no critical settlement tolerance for fill over the Beam Switchyard structures and no important structures requiring more than nominal aseismic resistance will be located on top of the fill.

Horizontal pressure on the sides of the housing is assumed at 0.5 times the vertical pressure. This conforms to the coefficient used for the Accelerator Housing as recommended by Dames and Moore, Soils Engineers. However, due to the retangular configuration of the Two-story design, further study is recommended for this detailed case. If it is possible to reduce this coefficient because of the granular type material, a saving may be possible in the cost of the concrete housing.

Support of the Accelerator Tube, Magnets & Accessories:

The Beam Switchyard floor will support the beam tube supports, the bending magnets, collimators, and other appurtenant equipment.

Special provision is made in the concrete structure for the support of a shielding floor and ledge rails just above shielding floor and for support of the material handling equipment. The rail cost is estimated @ $10/foot.

Beam Dump:

An allowance is made in the estimate for a beam dump on Line "A", Right which includes space for dump tank and special shielding, but does not include space for pumping equipment.

Type of Construction Material:

Various materials were considered for construction of the underground structure such as wood, steel and concrete. Wood was discarded

for several reasons: (1) difficulty in spanning large areas, (2) high maintenance, (3) water and dirt problems, and (4) general unsuitability for a facility of this type.

Steel was considered for two types of construction; (1) steel frames with liner plates, whether rectangular or horseshoe shaped, were estimated to cost roughly twice as much as concrete. Corrugated metal pipe might present a solution in certain areas, however, in the larger areas where the switching magnets are located, the framing required becomes quite costly. Also, there are problems of corrosion on the outside of the structure and possible radioactivity in the interior.

Reinforced concrete sections have been explored in considerable detail (Ref: Report ABA-74, Draft).

Prestressed or post-stressed reinforced concrete was also considered, but based on present structure configuration there is no economy in this type of construction.

Because of the required alignment tolerances for equipment in the switchyard structure, it is contemplated that concrete similar to that specified for the Accelerator Housing will be used, i.e,, low shrinkage and low thermal coefficient of expansion. The finish requirements, however, will be basically to remove fins and patch holes after forms are removed.

For sections wider than the typical 12 foot interior dimension, it is proposed that an inverted "T" Beam design be utilized to support the roof system. This will not interfere with head room in the housing or encroach into needed shielding fill. Columns are utilized where space is available. Beam spacing may be varied at will due to the demands of the final design. See Drawing SK-S-06063 for details.

Special Shielding:

Steel plate 2 feet in thickness will be placed on the housing roof over certain designated spots of intense radiation. Allowance is made in the estimate for five 5 shielded areas, each 2' thick, 12' wide and 30' long. If these are eliminated and an additional 5 feet of shielding fill is added over the entire area, the cost is approximately the same.

A special shielding door at structure entrance is also provided.

Penetrations:

a. Personnel Accessways

Allowance is made for one personnel accessway.

(Concrete construction).

b. Alignment Penetrations

Allowance is made for five alignment penetrations

(3/16" wall steel pipe).

c. Service Shafts

Allowance is made for seven service shafts.

(3/16" wall steel pipe).

Earthquake Resistance:

The dynamic response of the structure to seismic forces has been reviewed on a very preliminary basis. Final conclusions and recommendations will be made after the structure design and configuration have been established.

Watertightness:

ABA Report #68, dated February 1963, covers various methods of waterproofing and recommends a polyvinyl chloride sheet envelope all around the Accelerator Housing. This system can be used also for the Beam Switchyard underground structures.

Cost of this material in place is estimated at $0.35/s.f.

Excavation and Fill

Excavation:

The larger part of the common excavation required for construction of the Beam Switchyard housings will be accomplished under the Accelerator Housing Contract as borrow excavation for use as shielding fill over the Accelerator Housing. The small amount of common excavation remaining will be that required to bring the borrow area to final grade and alignment for construction of the Switchyard Housing.

Some structural excavation will be required to accommodate the increased bottom slab thickness and possibly use of a concrete sub-slab as used in the Accelerator Housing construction.

Shielding Fill:

The material for the required 32 feet of shielding fill in the Switchyard area will be obtained from excavation for the future End Station areas. It is estimated that approximately 300,000 cubic yards of fill material will be required for the Switchyard shielding.

The shielding fill in general will be placed at 90% to 95% of maximum density. Special zoning and compaction densities of the shielding fill will be utilized in areas adjacent to and directly over the Switchyard housings.

The special zoning and compaction will be designed with the aim of obtaining a minimum load factor to be used in design of the Switchyard housing. All fill slopes will be constructed on a slope of 1-1/2

horizontal to 1 vertical. All fills exceeding 30 feet in height will have a 15 foot wide bench at the 30 foot level. The fill will be of sufficient width to maintain the 32 foot shielding requirement and will terminate short of the future End Station Buildings.

Site Work

Subdrains:

The Beam Switchyard housings will have a subdrain system similar to the Accelerator Housing. The subdrains will be constructed of a six inch perforated asbestos cement pipe placed in a layer of filter material. The subdrains will be located along each side of each housing at approximately floor level. The subdrainage will be collected into a single outfall and drained to the south of the Switchyard. The outfall will be located so as to provide for monitoring and the possible construction of a holding tank for the subdrainage.

Roads:

Preliminary grading will be done for all required roads in the Switchyard area. Roads will be provided for access from Klystron Gallery level at Station 100+00 to the top of the Switchyard shielding fill and for access to the future End Station areas from the Klystron Gallery or top of the Switchyard fill.

Temporary earth dikes and corrugated metal pipe down drains will be used to control surface drainage. All roads will be designed with a maximum gradient of 6%. All fillets and curves will be as large as practically feasible to accommodate movement of heavily loaded vehicles.

Erosion Control

Erosion control will be provided on all permanent 1-1/2:1 slopes constructed in the Switchyard area. Erosion control will consist of eight inches of topsoil with a straw mulch spiked into the surface.

Protection against erosion due to concentrated flows of surface water will be provided for by earth dikes and corrugated metal pipe drains. The 42 inch storm drain to be installed under the Accelerator Housing and Earthwork contract will pass under the Switchyard at Station 103+35± and will be available for disposal of surface storm water.

House Electrical and Mechanical

Electrical:

Power for lighting, convenience receptacles, and power outlets will be supplied from unit-substations and lighting transformers located at grade. The lighting installation for each of the two levels of the Beam Switchyard will be comparable to the design for the Accelerator Housing. Lighting fixtures will be porcelain sockets with bare 100 watt incandescent lamps mounted on about ten foot centers. Circuit design loads will be 1200 watts allowing lamp replacement to larger wattage bulbs in specific working areas.

Convenience receptacle assemblies will be installed at about 40-foot centers along each level. Each receptacle assembly will consist of a two-gang duplex 120 volt, single phase receptacle. Each duplex receptacle of the assembly will be supplied by a separate circuit. A maximum of six duplex receptacles will be connected to a 20 ampere circuit.

480-volt power receptacles will be provided for the upper level only. They will be located near the floor and will be spaced at about 100 foot intervals.

Wiring materials for the upper level will be polyethylene insulated conductors, rigid-steel conduit, and cast conduit fittings. Type MI copper-clad cable with cast junction boxes will be used in the lower level because of the anticipated radioactivity level. All wiring in the structure will be run exposed.

Fire and Communication Systems:

The fire-protection facilities will be similar to that of the Accelerator Housing. Manual fire boxes will be provided at each manway access. No fire detection or automatic fire protection systems are included. No telephone or communication systems or facilities are included. Portable fire fighting equipment is provided by SLAC.

Mechanical:

The ventilation system proposed is similar to the system being provided for the Accelerator Housing. The ventilation system will be of the exhaust type that will not be operated during beam-on time. The fans will be single speed, sized and located to provide uniform purging of the entire structure at the rate of six air changes per hour. Intake air will be filtered. An air-tight barrier will be provided between the Accelerator Housing and the Beam Switchyard to prevent infiltration of air from one area to the other. Accessway hatch covers as used for the Accelerator Housing will be provided. Fan control, and control of ventilation hatch covers will be local with provisions for future remote control and interlock. No air heating or humidity control will be provided.

Utilities - Electrical and Mechanical

Electrical:

The Beam Switchyard will be supplied by 12.47 kv, 3 phase power from the Master Substation via an underground duct, manhole and cable system. Unit substations will be provided, as required to transform the 12.47 kv service to the 480 volt three phase utilization voltage. The unit substations will be located at grade above the Beam Switchyard to serve lighting and convenience receptacles to the Switchyard and any utility buildings, in addition to providing power for exhause fans, pumps and the like.

A separate 12.47 kv cable system will provide power for the Switchyard magnet loads. The unit-substations for magnet power, the dc rectifiers and control equipment, and the dc distribution system to the magnets are not in the scope of this report.

Mechanical:

A common cooling tower is proposed to serve the loads of the Beam Switchyard and End Stations A and B. A single water demineralizer or distillation unit is proposed to provide LCW water for the Beam Switchyard magnets and equipment. Heat exchangers will be arranged in banks and will be located with respect to the heat loads and the utility shafts to the Switchyard. The number of LCW closed loops, heat exchangers and holding tanks will be defined by SLAC on the basis of need for isolation and temperature control. Buried transite pipe will be used for the cooling tower water supply and return systems. Aluminum pipe will be used for LCW systems. The above items are not within the scope of this report.

Material Handling System

A material handling system is required for placement, removal and transport of magnets, collimators, floor shielding blocks, etc., throughout the length of the Beam Switchyard. Heaviest lifts are on the order of 15 to 20 tons.

In considering the over-all requirements of the Beam Switchyard Material Handling System, it is apparent that the equipment reliability must be a prime concern; this, being due to residual radiation of all equipment in the area after the accelerator is in operation. Other key features of the system should be flexibility and ease of operation, economic adaptability to unknown future requirements, completeness of

area coverage, system simplicity, ease of maintenance, and minimum head room requirements. Other considerations include equipment utilization as remote operated television camera vehicles.

The system is illustrated in Drawing SK-S-06063. As shown, four standard underhung bridge cranes are utilized. By the use of interlocks, only two hoists with trolleys are used to provide coverage of the Switchyard. A hoist and trolley will transfer the loads to and from the magnet yard.

Bridge cranes of the underhung system will be able to negotiate the long radius curves of the Switchyard due to the short spans of the bridges and the flexible supports of the rails.

The crane coverage provided is of standard construction and usage, is simple in its mechanization, and has proven reliable and economical.

The system requires maintenance of all equipment under hazard of radiation. Television scanning cameras could be mounted on the trolleys of each bridge crane with the trolley and bridges remotely controlled. Bridge cranes will only be able to provide approximately 5' transverse hook coverage over beam in a 12 foot wide tunnel.

Cost of the material handling system is not within the scope of this report.

COST ESTIMATE

Acct. No.			
505	**Earthwork**		
	Excavation 300,000 c.y. @ .35	$105,000	
	Compaction 300,000 c.y. @ .20	60,000	
	Overhaul, 1,500,000 sta. yds. @ .004	6,000	
			$171,000
505	**Underground Structures**		
	Structure Excavation 6000 c.y. @ $4.00	24,000	
	Foundation Drainage 1400 1.f. @ $5.00	7,000	
	Concrete Structures including damp proofing		
	Main Structure	1,267,000	
	Extension & Beam Dump	202,000	
	Service Shafts	6,000	
	Alignment Shafts	4,000	
	Access Shaft	15,000	
	Horizontal Access	56,000	
	Shielding Door	17,000	
	Steel Shielding 1,800,000 lbs. @0.02	36,000	
	Removable Steel Beam & Post System 25 T @ $400.	10,000	
			$1,644,000
505	**Other**		
	Ventilation	40,000	
	AC Power and Lighting	40,000	
	Miscellaneous Shielding Structures	30,000	
	Surface Structures	75,000	
	Concrete Structure STA 100+00 to 100+88	30,000	
			$215,000
			$2,030,000

BEAM SWITCHYARD CRANE COST SUMMARY

System, including crane rails and electrification	$200,000

DESIGN AND CONSTRUCTION SCHEDULE

Criteria	19 July 1963
Criteria Approval & Sub-directive	27 Aug. 1963
Title I Preliminary Draft	8 Nov. 1963
Title I Review and Comments	19 Dec. 1963
Title I Revisions & Report Submittal	30 Dec. 1963
Title I Approval	21 Jan. 1964
Title II 50%	15 Apr. 1964
Title II 90%	25 June 1964
Review and Comments	15 July 1964
Revised and Reproduced	5 Aug. 1964
Bid Documents Issued	7 Aug. 1964
Bid Opening	10 Sept. 1964
Notice to Proceed	8 Oct. 1964
Construction Complete	20 Aug. 1965

DRAWING LIST

Beam Switchyard-Plan and Sections	SK-S-06063, Rev. 1