DESIGN CRITERIA REPORT
FOR
END STATION "B"

REPORT TO STANFORD LINEAR ACCELERATOR CENTER - NO. ABA-84
STANFORD UNIVERSITY - ABA SUBCONTRACT S-136
UNDER STANFORD - AEC CONTRACT AT(04-3)-400

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I. INTRODUCTION

This report presents the design criteria for performing the Title I design of End Station "B" and associated facilities and equipment. Included are criteria for the following items of work:

A. The End Station "B" structure including the beam port funnel, the target room and the target room access tunnel.

B. Mechanical and electrical house utilities within a line 5 feet from the building.

C. Bridge cranes for End Station "B" and the target room.

D. Earth shielding retaining walls.

Mechanical, electrical and space requirements were defined by a SLAC outline "Proposed Criteria for End Station 'B' Building" dated October 29, 1963 and SLAC Drawing GP 863-304, R5, dated December 2, 1963. Additional criteria and modifications were established by SLAC Target Area Criteria dated October 2, 1963 and in supplemental memoranda and minutes of meetings. The sequence and extent of "Target Area Facilities" construction were described in an ABA memorandum dated October 24, 1963 and in a "Time Grid" dated December 2, 1963.

Design criteria and Title I reports have previously been issued on the following related projects:

A. Design Criteria Report for End Station "A", ABA-83, dated December 6, 1963.

B. Title I Report for the Beam Switchyard, ABA-85, dated December, 1963.

A future ABA report will describe the "Target Area Utilities and Site Improvements" including among other things, the supply of general purpose compressed air and domestic water to the building utility tunnels and the supply

and distribution of low conductivity cooling water and magnet power within the End Stations. Design criteria for portable shielding blocks will also be described in a subsequent report.

II. DESIGN CRITERIA

A. GENERAL

End Station "B" will be a large single story reinforced concrete structure located at the east end of the Beam Switchyard Area. This facility will house various research experiments and will be designed to provide maximum flexibility for target configurations within budgetary limitations. Figure 1 indicates the site location for End Station "B" and its relationship to other Target Area facilities.

All design work will conform to U. S. Atomic Energy Commission Manual, Chapter 6000 and the codes and standards listed therein. In addition, standards developed for this project by SLAC will be used wherever appropriate.

No personnel will be assigned to this building on a permanent occupancy basis.

B. ARCHITECTURAL - STRUCTURAL

1. Architecture. The architectural design of this building is a departure from the vocabulary established for the Campus and Shops areas of the SLAC site. This departure results from the functional and structural requirements of the building. However, the Target Area is far enough away from these areas (approximately one-quarter mile) so that differences in architectural treatment will not be seen simultaneously.

2. Description. End Station "B" will have clear inside floor space dimensions of 75 feet by 150 feet, as shown in Figure 2. The interior building height (approximately 45 feet) will be determined either by a minimum clearance to

crane girder or a hook height of 35 feet above the floor, whichever is lower. The west end of the building, above an elevation of 25 feet, will be extended westward 34 feet to provide crane coverage of the beam port shielding. Building dimensions are as follows:

Length (inside at floor)	150 ft.
Length (inside at roof)	184 ft.
Width (inside)	75 ft.
Height (clear inside)(approx.)	45 ft.
Total Floor Area	11,250 sq. ft.

3. Structure. The structure will be entirely of reinforced concrete and will be made up of precast, prestressed and poured-in-place elements. The use of concrete was predicated on the requirement that all roof and wall areas must provide a minimum shielding mass of 300 pounds per square foot. (Corresponding to two-foot thick concrete walls and roof.)

a. Walls. The building will be windowless because of shielding requirements. The column spacing will be 25 feet, 50 feet and 75 feet on the north and south walls. The east wall will have columns at the corners only. The lower portion of the building walls will be clear openings to provide the maximum possible space for experimental set-ups which extend outside of the building. These openings (20 feet high for the central bay of the north and south walls, 12 feet for all other walls) will be sealed with weatherproof siding and then shielded with portable blocks. The cost of the shielding will be detailed in a separate report. Provisions will be made for attachment of shielding blocks to the building structure for lateral support from seismic forces. Two 4-foot by 8-foot man doors will be located in these shielding blocks for air exhaust and emergency personnel exit requirements. A 20-foot by 20-foot by 2-foot thick mechanically operated concrete door will be located in the south wall to permit

passage of large research assemblies into the building. Ports with removable concrete plugs (5 on each side wall and 3 on the east end wall) will be located in the building walls to accommodate portable hydrogen exhaust systems.

b. Roof. In an effort to reduce the weight of the roof system as much as possible and to achieve a column free floor, prestressed concrete roof beams will be used to span the width of the building. These beams can be cast on the ground and lifted into position, thereby minimizing the requirement for high forming. The top flange of these beams will serve as a form for the poured-in-place roof slab and will be tied to the slab so that the beams and slab will act as a structural unit.

A roof live load of 30 psf will be used in order to accommodate possible future random placement of mechanical equipment. A 10% roof slope upward to a center ridge will be used to facilitate the flow of hydrogen gas towards exhaust openings through the roof slab between each beam. Roof openings will be fully shielded.

c. Floor. The floor will be designed for maximum concrete shielding loads of 5,600 psf distributed to the floor from 10-foot thick parallel walls spaced 15 feet apart. The 15 feet of floor space between these shielding walls will be subjected to concentrated magnet loads of a maximum of 20 tons each on 8-inch diameter bases spaced 3 feet on centers. The thickness of concrete floors will be kept to a minimum. The floor will be founded on undisturbed soil wherever possible and will be kept structurally separate from the building walls. Underfloor ducts will be limited to those specified by SLAC.

4. Utility Tunnels. Three utility tunnels, approximately 8 feet by 8 feet inside dimension, will be located under the End Station floor for bringing utilities and ventilation air into the building. Approximately five 3-foot by 6-foot manholes will be provided for access into each utility tunnel. Removable manhole covers will be of two types: one will be solid and capable of supporting the

maximum floor loads when an experiment is set up in that area, and the other will be an open grating capable of carrying only moderate floor loads. The three tunnels, which run in a north-south direction, will extend beyond the building on the south side to permit installation of long lengths of pipe into the tunnels. The tunnels will be connected to a common header tunnel on the north side of the building. The header tunnel will be described in the Target Area Utilities and Site Improvements report and the cost is not included herein.

5. Beam Port Funnel. A concrete port will be constructed at the west end of the building. This tapered port will accommodate magnets placed close to the secondary beam targets. In plan the taper will be 26.5^{o} each side of the beam centerline, starting from a point 39 feet from the inside face of the west wall of End Station "B". This angle will permit the shielding blocks in the funnel to be designed in simple 3-foot modules with the length twice the width. Vertically, the funnel extends to a height of 25 feet, at which point it flattens out to form a platform that joins the side and upstream walls of the end station. Shielding blocks will be fitted around variable beam configurations as determined for each experiment and will be recessed into the west end of the funnel with some permanent steel shielding located directly above them. These shielding blocks will be the subject of another report and their cost is not included here. The floor of the funnel will be designed to withstand loading to a height of 25 feet with material of average specific gravity of 4.0 (6250 pounds per square foot of the floor). These concrete blocks will be handled by means of the end station bridge crane. The areas to the north and south of the beam port funnel will be earth retained-by-concrete to a height of 25 feet. The earth will be compacted and capped with a concrete slab. A 3-foot thick layer of beam port funnel concrete shielding blocks may be stored on top of this cap with the load being distributed to the retained earth.

6. Target Room and Access Tunnel. To the west of the beam port will be located a rectangular target room with interior dimensions of 20 feet along the beam axis, 25 feet wide and 26 feet 6 inches high. The target room ceiling will be approximately 32 feet below the outside grade. Two 24-inch diameter vertical shafts will be installed through the shielding fill and roof of the target room for SLAC instrumentation. A stainless steel lined sump will be located along the beam axis below the floor level of the target room to contain spilled cooling water from the target assembly. A penetration which slopes upward to a concrete pad at the level of the experimental yard area on the north side of the end station, near the retaining wall will provide means of emptying the sump and supplying low conductivity cooling water to the target assembly.

A 10-foot wide by 12-foot high (inside dimension) tunnel will provide a means of personnel and vehicle access to the target room. A concrete shield block will be used to close off the tunnel during operation for radiation safety. An emergency shielded opening will be provided at the tunnel entrance for personnel egress. Portable shielding within the target room will be described in a separate report.

7. Exterior Facilities. Space allowance will be made around the building for possible future addition of more shielding. A concrete pad will be constructed on the north, east and south sides of the end station for extending experiments to the outside of the building. This exterior area will be described in the Target Area Utilities and Site Improvements report and the cost is not included herein.

Retaining walls for earth shielding fill will be constructed to the north and south of the end station. The cost of shielding fill over the target area and access tunnel is included herein, as well as the cost of the south side retaining wall and a portion of the north wall.

C. MECHANICAL

1. Ventilation. Ventilation for End Station "B" will be by means of a roof-ridge exhaust fan-plenum extending the length of the building. The fan-plenum will receive air from the highest point of the building through shielded openings in the 2-foot thick roof slab. Fans spaced along the length of the plenum will exhaust the air through automatic dampers. The fan motors will be explosion proof.

In order to meet hydrogen safety requirements, the ventilation design will be based upon a two-minute air change of the upper 20 feet of the building. The exhaust fans will be manually controlled. An override control will provide for full capacity operation when called for by the hydrogen detection system.

Normal ventilation requirements will be met by air supplied from the utility tunnels up through the grating-covered floor openings. The two 4-foot by 8-foot man doors located in the shielding blocks, or an equivalent area, will be opened automatically when more than 50% of the fans are on to meet the added high summer ventilation or hydrogen purge air intake requirements. A suitable barrier will be provided across the openings to control personnel access for radiation safety.

Ventilation will be provided for the target room and the access tunnel by means of a separate system which will operate only when required for personnel entry.

2. Services. Piping will be provided in the utility tunnels and target room for 110 psig general purpose compressed air and domestic water. The utility tunnel piping will terminate just below the floor in each of the manholes. Drains will be tied into a collection system header, located in the utility tunnel, which can be monitored for radiation. The extension of these utilities beyond the 5-foot building line will be described in the Target Area Utilities and Site Improvements report. Low conductivity cooling water lines will also be installed in the utility tunnels, target room and experimental areas outside and will be described in the

Target Area Utilities and Site Improvements report.

There will be no natural gas, hot water, drinking water or toilet facilities provided within the building. Toilet and change room facilities will be provided outside of the building as described in the Target Area Utilities and Site Improvements report.

D. ELECTRICAL

1. House Power. Electrical house power will be supplied from the Research Area Substation at 480 volts, 3 phase, 60 cycles. The substation will be described in the Target Area Utilities and Site Improvements report. Power will be transformed down to 110/208 volts at various locations as required.

a. Receptacles. A 100-amp, 480-volt, 3-phase power receptacle and a two-gang duplex 20-amp, 120-volt, single-phase convenience receptacle assembly will be provided at building columns about 4 feet above the floor, on each side of the beam port funnel recessed into the west wall, at each utility manhole, in the target room and in the access tunnel. Additional power of approximately 200 KVA will be provided in breaker panels located on the outside of the building for use in the experimental areas surrounding the building. Exterior power will be described in the Target Area Utilities and Site Improvements report.

b. Lighting. Pressurized mercury-vapor fixtures with about 10% pressurized incandescent fixtures will provide a minimum illumination of 10 foot-candles at the floor level of End Station "B". The fixtures are to be pendant mounted from the ceiling to just above crane level. Incandescent fixtures will be provided for the target room and access tunnel.

Explosion-proof emergency lighting will be provided from a separate battery powered system.

A minimum amount of exterior security lighting will be provided at door and wall locations. Mounting heights will be less than a 35-foot maximum, and lighting will be just enough to permit viewing of the entire building perimeter.

c. Power Distribution. Power at 480 volts, 3 phase will be provided for service to roof-mounted ventilation fans, motorized doors, and other building services.

d. Heating. About 100 kw of heating will be provided from infra-red lamps or quartz fixtures mounted on the walls and suspended from the ceiling of the building. Heat will be required only during periods of occupancy.

e. Emergency Power. Approximately 50 KVA of emergency power will be automatically switched to designated receptacles, emergency lighting and exhaust fans during periods of conventional power outage. The source of this emergency power from outside the building will be described in the Target Area Utilities and Site Improvements report.

2. Magnet Power. Additional power will be provided for magnets at each of the utility tunnel manholes and in the experimental areas outside. This power will be described in the Target Area Utilities and Site Improvements report and the cost is not included herein.

3. Equipment Grounding System. The Klystron Gallery copper grounding bus system will be extended to End Station "B" as described in the Target Area Utilities and Site Improvements report. This bus system will be available at each of the utility tunnel manholes for equipment grounding. The craneways will be connected to this bus system. The grounding of the neutral bus of the electrical power system will be kept separate from the equipment grounding system.

E. HYDROGEN DETECTION SYSTEM

1. Detectors. Individual head type detectors will be installed under the roof to detect hydrogen before a hazardous concentration can be accumulated. A separate alarm system will be provided to indicate when hydrogen has been detected.

2. Power Interlocks. Power for the cranes, heating, general lighting, and other hazardous circuitry will be interlocked with the hydrogen detection system so as to be disconnected when hydrogen has been detected. Emergency lighting and exhaust fans will remain operative at all times.

F. FIRE ALARM SYSTEM AND RADIATION SAFETY

The project fire alarm system will be extended into the building and the access tunnel, and auxiliary boxes and alarm horns will be provided as required. The master fire alarm box will be provided at an exterior location.

Chemical and CO_2 fire extinguishers will be installed by SLAC. Water protective devices will not be used in the building.

Personnel access will be controlled at all entrances by means of door interlocks and radiation monitoring devices which will be installed by SLAC.

G. COMMUNICATIONS

Provision will be made for telephone and intercom system lines. Cable and communication equipment criteria and cost are not included in this report.

H. CRANES

A cab-operated electric overhead crane with 50-ton bridge capacity will span the width of the building. Mounted on the bridge will be two trolleys, each with a 25-ton main hoist. One trolley will be equipped with a high speed 5-ton

auxiliary hoist. The minimum clear hook height above the floor of End Station "B" will be 35 feet.

A pendant-operated electric underslung crane with a 15-ton capacity will span the target room. This crane will handle the target, equipment and shielding within the target room, at the beam port and at the access tunnel entrance. Consideration will be given to the use of the beam switchyard crane in the target room during construction.

III. DESIGN AND CONSTRUCTION SCHEDULE

The following schedule for design and construction of End Station "B" is based on the "Target Area, Time Grid" dated December 2, 1963.

Criteria	Draft to SLAC	December 6, 1963*
Criteria	Comments from SLAC	December 17, 1963*
Criteria	Final Submittal	December 20, 1963*
Criteria	Approval by SLAC	January 16, 1964
Title I	Draft to SLAC	March 20, 1964
Title I	Comments from SLAC	April 17, 1964
Title I	Final Submittal	May 1, 1964
Title I	Approval by SLAC	May 22, 1964
Title II	50% Submittal	July 28, 1964
Title II	90% Submittal	September 24, 1964
Title II	Revise and Issue for Bid	November 5, 1964
	Bid Opening	December 8, 1964
	Notice to Proceed	January 7, 1965
	Complete Construction	December 9, 1965

* Actual date

IV. PRELIMINARY COST ESTIMATE

END STATION "B"

ACCOUNT NUMBER	ITEM	QUANTITY	AVERAGE UNIT COST	ITEM COST
5-620	STRUCTURE			
	Excavation & Backfill including Target Room	25,000 CY	$ 4.25	$ 105,000
	Foundation & Floor Slab	1,640 CY	65.00	106,000
	Walls & Columns including exterior treatment	3,290 CY	98.00	323,000
	Roof including Beams, Fascia, Baffles	1,750 CY	95.00	166,000
	Utility Tunnels, Manholes & Shafts	285 LF	330.00	94,000
	Target Port Funnel	555 CY	85.00	47,000
	Target Room including service shafts	410 CY	90.00	40,000
	Mechanical Concrete Door	1 Each	-	35,000
	Weatherproof Siding including seals	4,300 SF	2.50	11,000
	Roofing & Downdrains	-	-	11,000
	Miscellaneous Metal including shield block attachments, crane rails and supports, mandoors, sight screens	-	-	23,000
	Access Tunnel	-	-	44,000
	TOTAL STRUCTURE COST			$1,005,000
5-620	MECHANICAL			
	Piping & Ventilation including hydrogen exhaust & Target Room ventilation & sump system	-	-	40,000
5-620	ELECTRICAL			
	House Electrical including grounding, infra-red heating, hydrogen detection, fire alarm & communications	-	-	65,000
5-620	RETAINING WALLS	-	-	60,000*
	TOTAL COST			$1,170,000
7-935	CRANES			
	50-Ton Crane & 15-Ton Crane			$ 160,000

* Budgeted allowance pending a detailed review of alternate configurations.

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V. DRAWINGS

FIGURE		
1.	SITE PLAN	SKA-12203-A
2.	PLAN, SECTION & ELEVATIONS	SKA-12203-B