MASTER SUBSTATION DESIGN STUDY

REPORT TO STANFORD LINEAR ACCELERATOR CENTER NO. ABA-37
STANFORD UNIVERSITY SUBCONTRACT S-128
UNDER AEC CONTRACT AT(04-3)-363

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I. SCOPE

The purpose of this design study was to investigate the general features and cost of the two master substations as an aid in the selection of the final design. Several meetings were held between SLAC and ABA personnel to define required features. Several designs were proposed and the final selection was narrowed down to two basic types. This report is concerned with these two designs only.

II. DESIGN CONSIDERATIONS

It is axiomatic that the final design must optimize the requirements of function, maintenance, appearance, and cost. The basic needs of one of these requirements is too often opposed to one or more of the remaining three. As noted in the several meeting notes, a few basic ground rules have been established. The ratings and sizes of the basic equipment has been established. The major clearances have been standardized. It has been established that the system will be operated with both power lines normally paralleled; in other words, with the tie-breaker normally closed.

The two basic designs which this report will consider are called normal and low profiles. The normal profile design extends higher above ground but uses less area. The low profile does not extend as high nor does it have the same mass extending to this lesser height. It is spread out over a larger area. Two sketches, marked Ic and IIIc are attached. Sketch Ic is the normal profile and IIIc is the low profile. These sketches show only the West Master Substation as this is the extent to which the 220 kv power will be extended at the time of beam turn-on.

One of the major differences between the two designs is the construction of the bus-work. The normal profile design has a tension type of bus which is constructed of cable strung between two insulators which are connected to the steel structure. It is simple and requires little maintenance. The low profile design uses a tubular type bus supported from station post insulators located on about 20 to 30 foot centers. There are many more supports and they are more costly. The design of this type of bus structure to resist seismic and short-circuit stresses is more expensive.

The major advantage of the low-profile design is that less mass is sky-lined for possible view from the surrounding areas. Operationally it will accomplish the same end results as the normal profile design. Another important factor to be considered is that it is not usual practice to operate a power circuit-breaker without means of by-passing the breaker for routine inspection and maintenance. With the low profile design this is not readily possible without increasing the area of the station by a substantial amount. Such inspection work must be done at a time when part of the system may be de-energized or the whole system operated at a reduced level by feeding it from a single transformer with the 12 kv tie-bus.

The next point upon which to ponder is the value of providing primary protection for the transformers. At the time of beam turn-on for physics, T_0, this is really no problem. The system is simple and adequate protection can be provided by the two line and one tie circuit-breakers. As the system grows and more transformers are added plus the extension of the 220 kv to the East Master Substation, the problem of primary protection becomes more imperative. It is considered good design and economic practice to adequately protect a costly investment such as these main power transformers. It is recommended that no transformer primary breakers be provided at this time, but that provisions be made in the original design for the future addition of these units as the system grows.

III. COSTS

From a cost standpoint a true comparison between these two types of designs cannot be made without extracting the cost of the breaker by-pass switches in the normal profile design. As was noted above, it is normal practice to use these switches. They can be left out if reduced power operations can be tolerated when and if the breakers they by-pass require maintenance or inspection. On the basis of omitting the breaker by-pass switches the following cost comparison is presented:

	Normal Profile	Low Profile	Difference
Without Primary Protection	$1,456,000	$1,530,000	+ $74,000
With Primary Protection	1,671,000	1,724,000	+ 53,000
Cost of Primary Protection	215,000	194,000	- 21,000
Cost of By-Pass Switches			
Without Primary Protection	67,000		
With Primary Protection	95,000		

IV. OTHER CONSIDERATIONS

It should be noted that this report considers only the electrical aspects of the problem. There are two other facets of importance which should be mentioned. They are the cost of earthwork and the architectural viewpoint. It is obvious that the larger area in hilly topography will have greater earthmoving costs. Although the normal profile design is higher, it should be easier to treat aesthetically as the smaller area required will make less of a scar and impact on the landscape. Size of area is often more difficult to treat than height, especially in the ranges under consideration.

V. RECOMMENDATION

In light of the foregoing discussion, it is recommended that the Master Substation designs be of the normal profile design, and that no transformer primary protection be provided at this time. The design should incorporate the requisite provisions for the future addition of primary protection.