AC POWER SYSTEMS COST STUDY

REPORT TO PROJECT M - NO. ABA-24

STANFORD UNIVERSITY SUBCONTRACT S-128

UNDER AEC CONTRACT AT(04-3)-363

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This report is issued as a fulfillment of the request made in AC Power System Memorandum No. 26 for a cost study on the project power system. The request asks that two different configurations of primary power be compared from a cost standpoint and their relative merits described. These two are called schemes A and B.

Two drawings, SK-E30 and SK-E31, describe the basic features of schemes A and B respectively. Scheme A is basically a secondary selective system with an ability to transfer loads and maintain a high degree of reliability. Scheme B is modified version of a ring-bus system with a strictly radial type of distribution. Table I gives a cost comparison between these two schemes, a revised cost comparison for the system proposed in the June 1961 ABA estimate, and the corresponding portions of the Blume IV costs. Following the tabulation is a discussion of the relative merits of schemes A and B.

TABLE I

	Scheme A	Scheme B	ABA June (Rev)	Blume IV
Primary Services	Parallel 220 kv Single 60 kv	Parallel 220 kv Single 60 kv	Parallel 110 kv Single 60 kv	Single 110 kv
System interruptable load capability mva	341 or more	341 or more	216 maximum	100 maximum
System firm load capability mva	150	150	100	0
Type of power distribution				
Primary	Selective	Looped	Selective	Radial
Secondary	Selective	Radial	Selective	Modified Radial
Cost Comparison				
1. Primary Services HV	$ 969,000*	$ 969,000*	$1,275,000*	$$ 995,000
60 kv	55,000	55,000	55,000	-
2. Main Substations	2,094,000	2,179,000	1,033,000	1,079,000
3. 12 kv Power Distribution	941,000	770,000	1,355,000	1,808,000
4. Unit Substations	1,248,000	1,248,000	1,248,000	1,801,000
5. Grounding & Testing	963,000	963,000	963,000	(Prorated)
Total Distribution System Cost	$6,270,000	$6,184,000	$5,929,000	$5,683,000
Connected Load mva	142	142	119	65
Cost per kva of connected load	$44.15	$43.55	$49.82	$87.43

*Estimated by Stanford

Comparative Costs: An examination of Table I discloses several interesting facts. It shows the cost breakdown for the power distribution systems as represented by Blume IV, the June ABA estimate, and the two schemes being presently compared. It should be pointed out that Schemes A and B consider conditions two years after beam turn-on. The other cost figures represent conditions at beam turn-on. The cost differences between the two time periods represent over $700,000 for Scheme A. The bottom line of figures are particularly representative of the refinements in the design as better understanding of the project needs developed. The costs have increased very little while the connected loads have more than doubled. The reliability and capability of the electrical system has kept pace with the operational demands.

Scheme A: Scheme A is comparable with the system presented in the June ABA estimate. There are two main differences. The major power source voltage was doubled in order that the growth capabilities of the project would not be jeopardized. And secondly, the distribution system costs were decreased by splitting the Master Substation into two parts. The second part serves the large bulk loads in the experimental areas at the primary voltage rather than at the lesser distribution voltage. Scheme A represents a power system which has reliability commensurate with the needs of the loads it serves. Those portions of the system which may reasonably be expected to fail first are backed-up by alternate means of supplying power. Those portions in which supply interruptions can be tolerated do not have this back-up.

Scheme B: Scheme B represents an approach which is not wholly compatible with desired operational concepts of the machine. An outage in most parts of the system may cause a shut-down of the experimental work until repairs can be made.

The savings are not worth the risk.

Recommendations: ABA recommends that a system as depicted by Scheme A should be used. It appears that due to the inability of the 110 kv to supply the future needs of the project, that the 220 kv power system should be used.

The following tabulation describes the various substations referred to on drawing SK-E31.

1. Project Master Substation (see arrangement below).
2. Project Auxiliary Substation (see arrangement below).
3. Klystron Gallery Substation, 2 - 750 KVA, 12 KV to 480 volt, Secondary Selective.
4. Injection Stations DC Power Supply, 600 KVA, 12 KV to 23 KV DC.
5. Central Cooling Tower Substations, 1500 KVA, 12 KV to 2.4 KV and 500 KVA, 12 KV to 480 V.
6. Modulator DC Power Supplies, 3100 KVA, 12 KV to 23 KV DC each.
7. Shops Substation, 750 KVA, 12 KV to 480 V.
8. Control Building Substation, 750 KVA, 12 KV to 480 V.
9. Test Laboratory Substations, 4 - 2000 KVA, 12 KV to 480 V, Secondary Selective.
10. Central Laboratory Substation, 2 - 2000 KVA, 12 KV to 480 V, Secondary Selective.
11. Beam Switchyard "A" DC Power Supply, 3000 KVA.
12. Beam Switchyard "A" Auxiliary Substation, 500 KVA, 12 KV to 480 V.
13. Beam Switchyard "A" DC Power Supply, 1000 KVA.
14. End Cooling Tower Substations, 1500 KVA, 12 KV to 2.4 KV and 1000 KVA, 12 KV to 480 V.

15. End Station "A" Substation, 2000 KVA, 12 KV to 480 V.

16. Beam Switchyard "B" DC Power Supply, 2500 KVA.

17. Beam Switchyard "B" Auxiliary Substation, 500 KVA, 12 KV to 480 V.

18. Beam Switchyard "B" DC Power Supply, 1000 KVA.

19. End Station "B" Substation, 750 KVA, 12 KV to 480 V.

20. Beam Switchyard "C" DC Power Supply, 1500 KVA.

21. Beam Switchyard "C" Auxiliary Substation, 500 KVA, 12 KV to 480 V.

22. Beam Switchyard "C" DC Power Supply, 1000 KVA.

23. End Station "C" Substation, 1500 KVA, 12 KV to 480 V.

24. End Station "A" Research Equipment, 26,000 KVA.

25. End Station "B" Research Equipment, 26,000 KVA.

26. End Station "C" Research Equipment, 20,000 KVA.

27. Master Substation and DC Power Supply Auxiliary Substation, 500 KVA, 12 KV to 480 V.