3-7 Antenna Facilities

3-7-1 Current Status and Condition of Maintenance

(1) As can be seen from the site map in Fig.3-7-1 showing how various facilities are installed on the premises, the antenna facilities are dispersed throughout the premises. The elements and other specifications of the transmission antennas are given in the following tables and figures:

1) Elements of transmission antennas in Table 3-7-1
2) Specifications of the towers in Table 3-7-2
3) The routes of the antenna feeders for the External Service in Fig. 3-7-2
4) The routes of the antenna feeders for the Domestic Service in Fig. 3-7-3
5) Operating schedule of antennas for the External Service in Table 3-7-3
6) Operating schedule of antennas for the Domestic Service in Table 3-7-4

(2) The antenna facilities for the External Service were constructed in 1946 by Marconi. They are now more than 40 years old and, as can be seen in Table 3-7-1, antennas Nos. 1 to 3 and Nos. 12 to 14 are currently in an unusable condition as a result of such damage as the breakage of supporting pipes and insulators and warping of wires. In all of the towers, a number of portions damaged by rust are seen. In some of the towers, the rust has progressed to a considerable extent, especially at some parts of the horizontal members.

The SLBC officials say that the removal of rust and repainting of the towers are done, in principle, once every five years. However, the speed of the corrosion has apparently increased due to such additional factors as the geographical location of the station which is only 6km from the seashore and is constantly exposed to sea breezes.

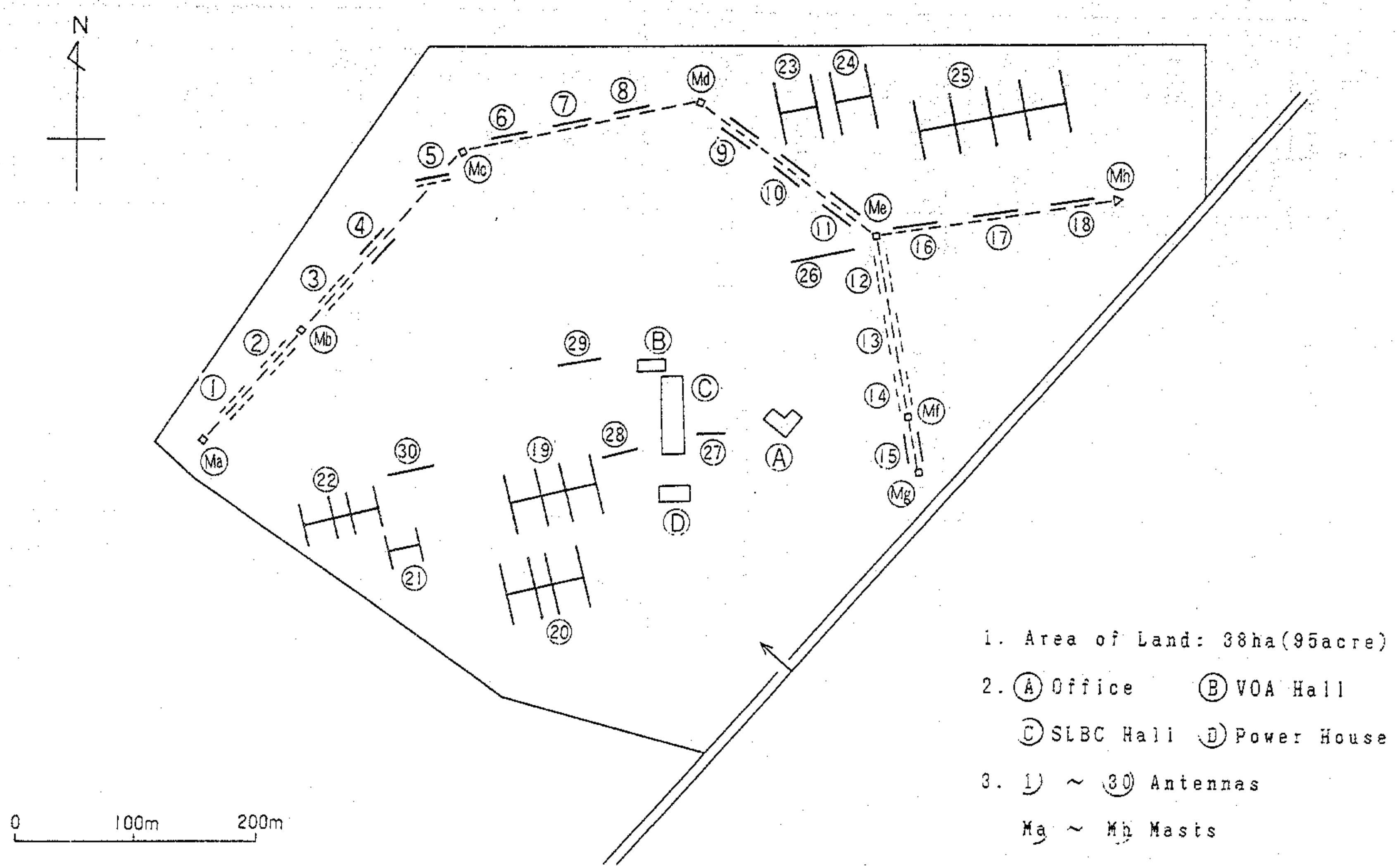


Fig.3-7-1 Existing Antennas at Ekala Station

Table 3-7-1 Transmitting Antenna Specification

No.	Type			Azimuth angle	Remarks
1	HRRS	4/4/1.0	13mb	◦ 312° (U. K.)	External (nonoperational)
2	HRRS	4/4/1.0	16mb	◦ 132° (Australia)	〃 (〃)
3	HRRS	2/4/1.0	19mb		〃 (〃)
4	HRRS	2/4/1.0	25mb		〃
5	HR	2/2/0.5	31mb	◦ 350° (India)	External
6	HR	2/2/0.25	41mb		〃
7	HR	2/2/0.5	19mb		〃
8	HR	2/2/0.5	25mb		〃
9	HRR	2/3/1.0	25mb	◦ 36° (Far East)	External
10	HRR	2/3/1.0	19mb	◦ 210° (South Africa)	〃
11	HRR	2/3/1.0	31mb		〃
12	HRR	2/3/1.0	31mb	◦ 80° (Southeast Asia)	External (nonoperational)
13	HRR	2/3/1.0	19mb	◦ 260° (East Africa)	〃 (〃)
14	HRR	2/3/1.0	25mb		〃 (〃)
15	HRR	2/3/1.0	16mb		〃
16	HR	2/2/0.25	41mb	◦ 350° (India)	VOA
17	HR	2/2/0.5	19mb		〃
18	HR	2/2/0.5	25mb		〃
19	SB1	2/4/0.25	61mb		Internal
20	SB2	2/4/0.25	61mb		〃
21	SB3	2/2/0.25	49mb		〃
22	SB4	2/4/0.25	49mb		〃
23	SB5	2/2/0.25	41mb		〃
24	SB6	2/2/0.25	61mb		〃
25	SB7	2/5/0.25	61mb		〃
26	FD7		49mb		〃
27	FD8		61mb		〃
28	FD1		49mb		〃
29	FD4		61mb		〃
30	FDR		31mb		〃

Table 3-7-2 Tower Specification

NO	Type	Height	Remarks
Ma	Guy	150 ft (45 m)	
Mb	〃	260 ft (78 m)	
Mc	〃	325 ft (97.5 m)	
Md	〃	260 ft (78 m)	
Me	〃	325 ft (97.5 m)	
Mf	〃	260 ft (78 m)	
Mg	〃	102 ft (31.5 m)	
Mh	〃	325 ft (97.5 m)	V O A

Distance between Towers

Ma — Mb	400 ft	(120 m)
Mb — Mc	650 ft	(195 m)
Mc — Md	650 ft	(195 m)
Md — Me	600 ft	(180 m)
Me — Mf	500 ft	(150 m)
Mf — Mg	147 ft	(44.1 m)
Me — Mh	650 ft	(195 m)

FEEDER ROUTES (300Ω)

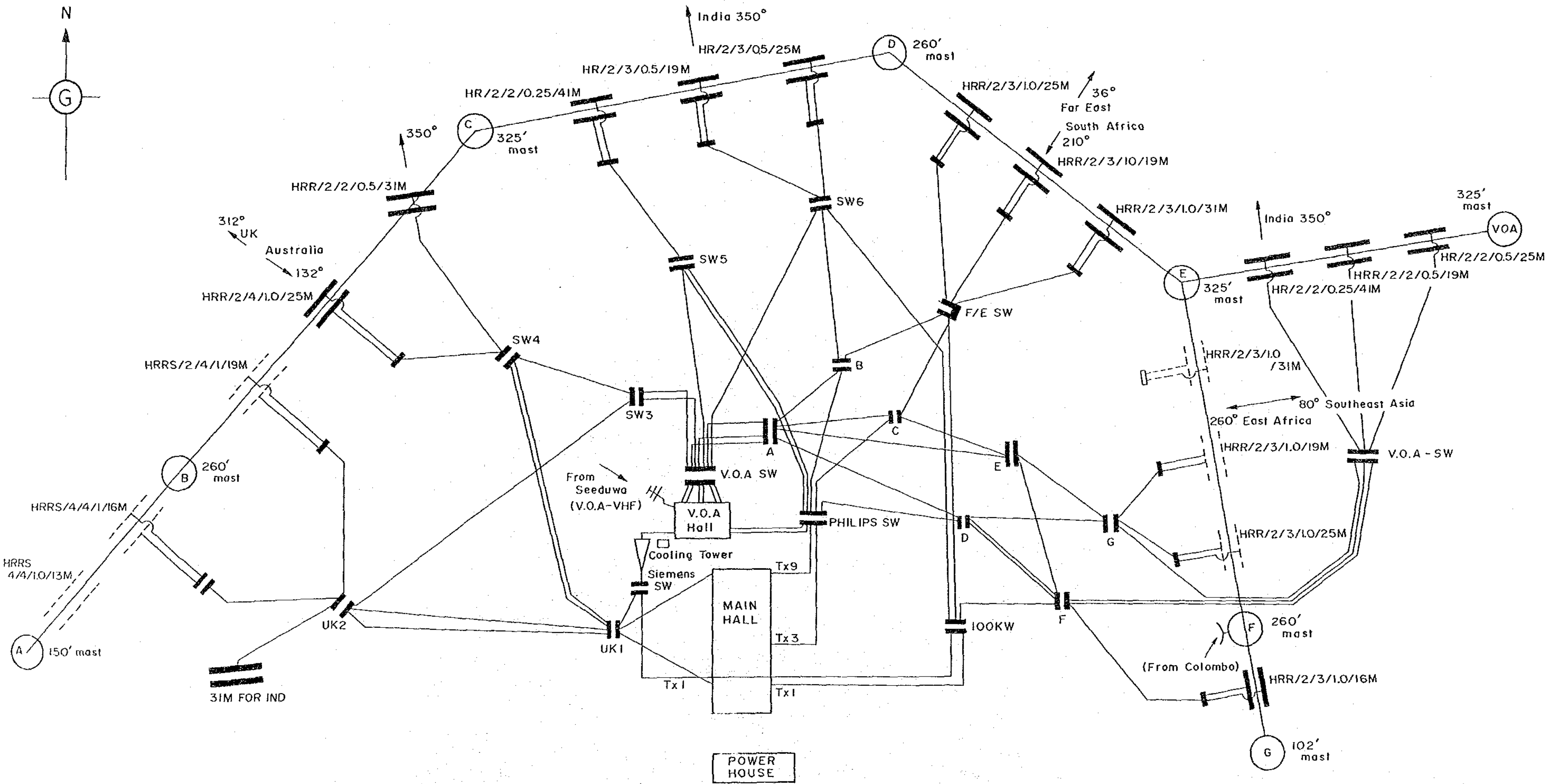


Fig. 3-7-2 Aerial Field Diagram for the External Service

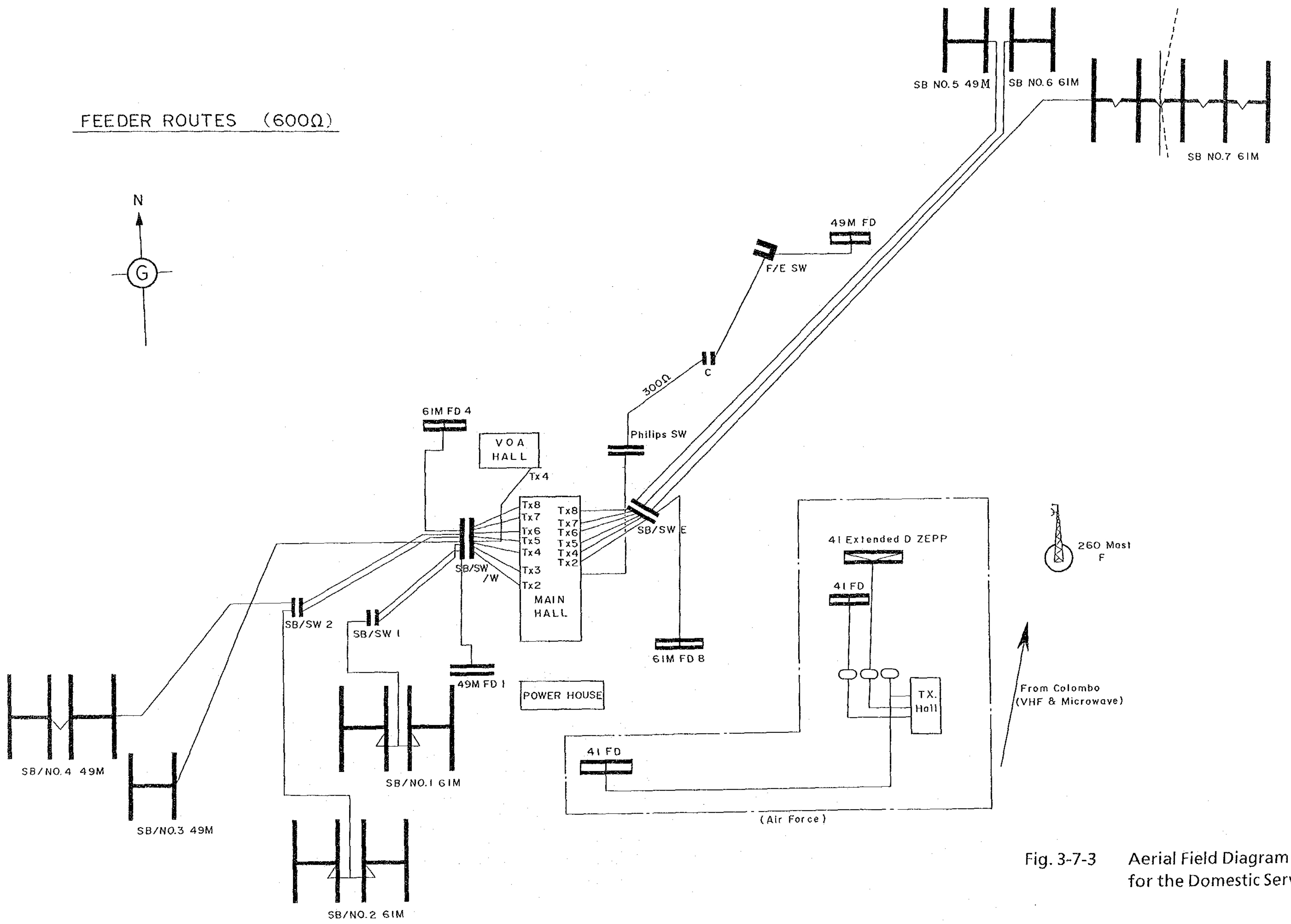


Fig. 3-7-3 Aerial Field Diagram for the Domestic Service

Table 3-7-3 Operating Schedule of Antennas for the External Service May 1988

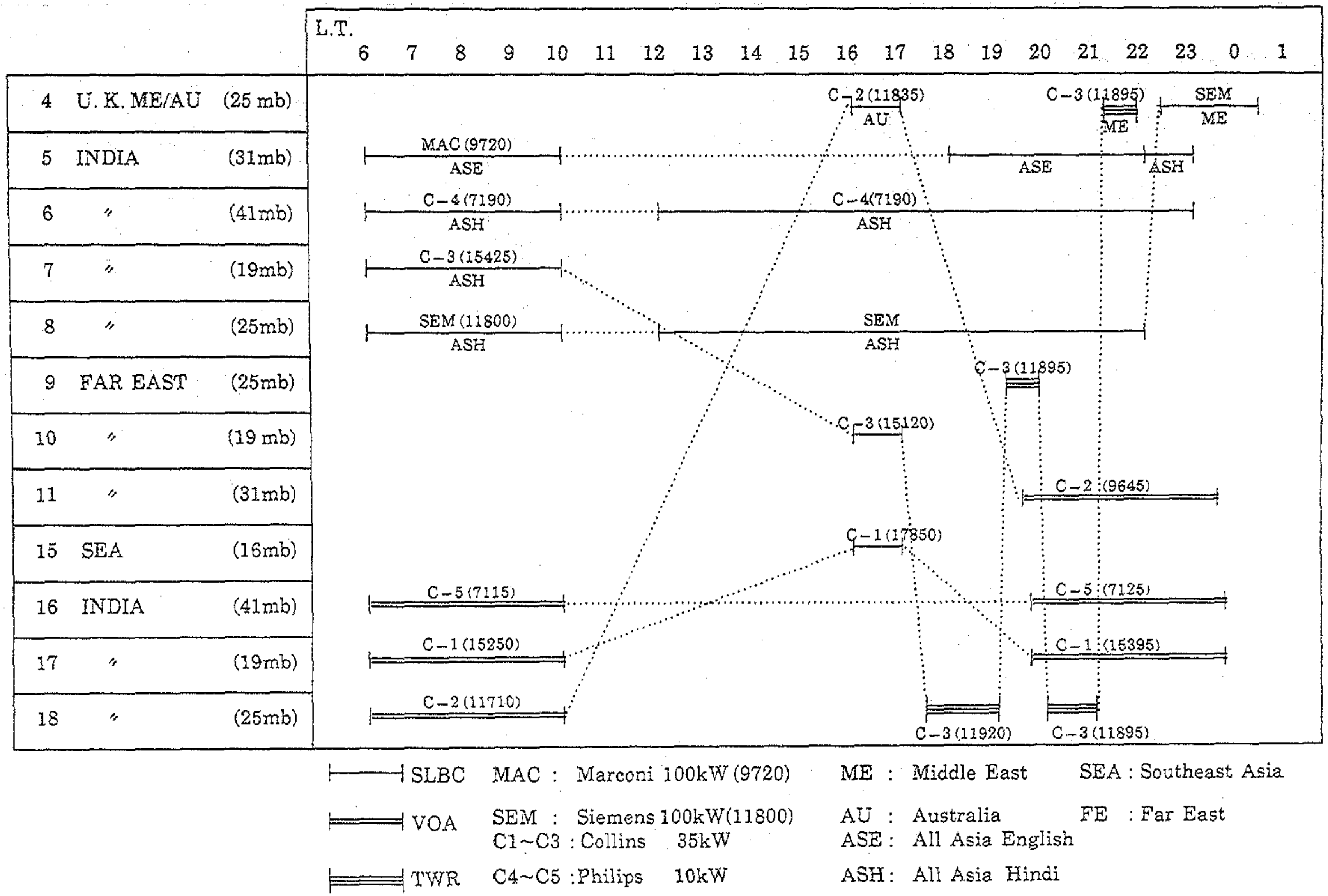
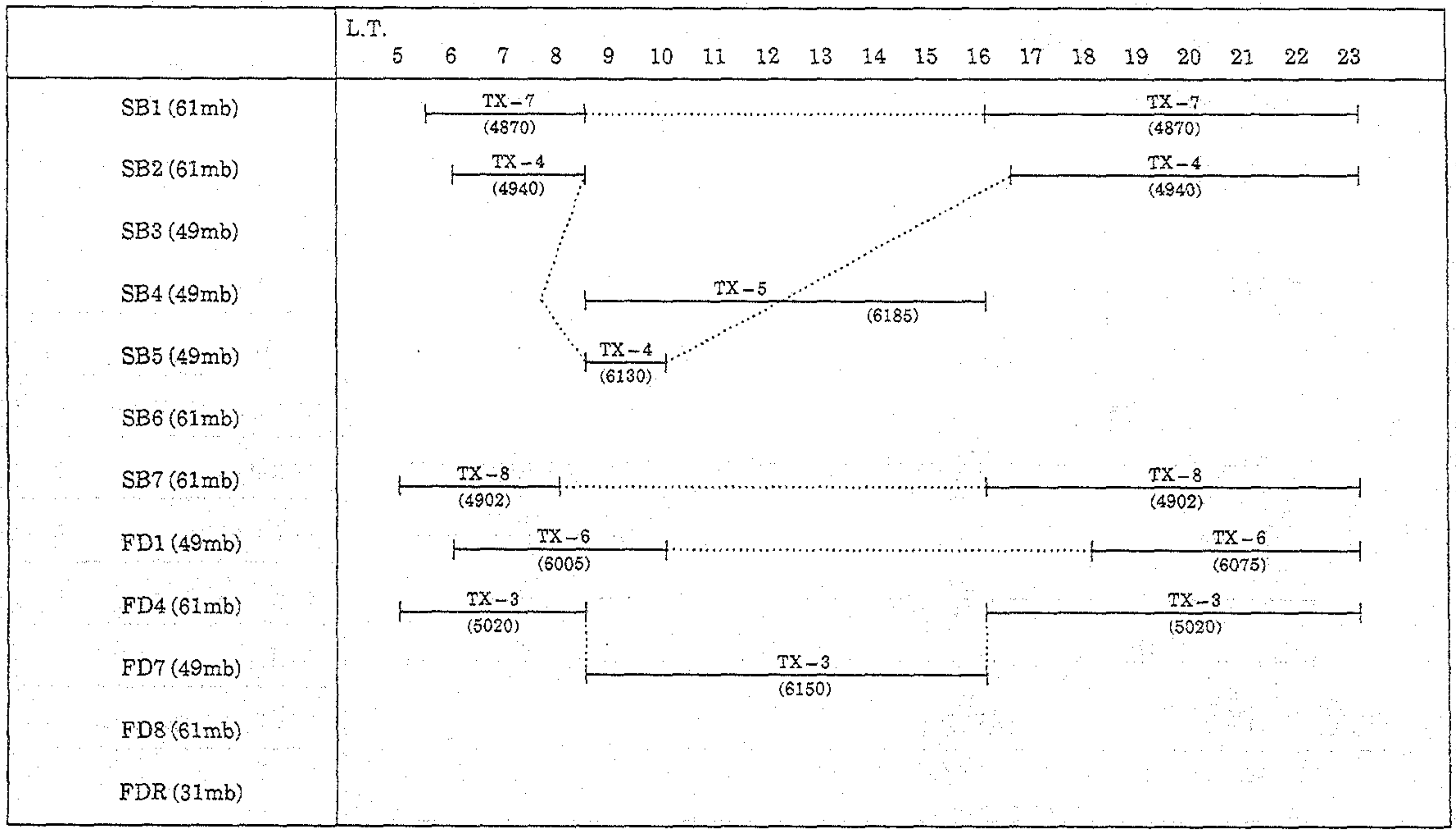


Table 3-7-4 Operating Schedule of Antennas for the Domestic Service May 1988



In Sri Lanka, there are no producers of antennas, and the SLBC is obliged to depend entirely on imports for the supply of antenna parts. Moreover, given the tight financial condition of the SLBC, the actual condition of antenna facilities indicates that great efforts have evidently been made by the SLBC in the maintenance of the facilities and equipment over many years.

(3) As for the antenna facilities for the Domestic Service, some of them have also been in use for over 40 years but, because of their being of a simple type, their replacement, removal from one location to another, and repairs have been done over the years by the SLBC itself. The maintenance and management of these facilities can similarly be done by the SLBC itself hereafter as in the past.

(4) At the Ekala Transmitting Station, there are also shortwave facilities for the Sri Lankan Air Force, including several dipole antennas.

3-7-2 Need for the Renewal of Antennas

(1) Since the existing antennas and feeders at the Ekala Transmitting Station are for a 100kW-class transmitter, they will have to be completely replaced so as to make them adaptable to a transmitter with an output of 300kW.

(2) Regarding the antenna supporting towers, it is considered advantageous to replace them from the viewpoint of finance and operation, as explained in the following:

1) The antennas for transmitters with an output of 300kW would be larger and heavier than those for the present 100kW-class transmitter. In this regard the existing towers are not capable of supporting the 300kW antennas.

2) If the existing towers are used, reinforcement of the towers' bases and so on, would be necessary. However, because of the superannuation of the towers and their present rust state, the cost for such improvement is estimated to be almost the same as for their replacement, or more.

3) Suspension of broadcasting for at least about two months would be necessary if the complicated work of reinforcement of the existing towers were to be conducted.

3-7-3 STL Antenna Tower

Having visually checked the tower, which is scheduled to have an antenna installed for the reception of programmes through STL, it was found that, even though it had been repainted, some parts of the structural steel frame were considerably damaged by rust. Some safety measures, including partial reinforcement, may have to be taken.

3-8 Studio to Transmitter Link (STL)

The STL currently in use by the SLBC links its Colombo studio and the Ekala Transmitting Station with a microwave circuit at 2.142GHz with an output of 4W over a distance of about 22km. Ten audio channels are put together into a multiplexed signal and the carrier is modulated in FM. This multiplex equipment was manufactured in 1976 by an affiliated company of Motorola. However, spare parts are no longer available because of the bankruptcy of the company.

Both the transmitting and the receiving sides use a parabolic antenna of 1.9m in diameter. In order to clear the low hills lying on the propagation path, both antennas have a height of about 70m above the ground. As a result, a long feeder is needed, so the equipment is installed in a hut just beside the bases of the towers.

3-9 Power Source Facilities

3-9-1 Present Status

As shown in Fig. 3-9-1, electric power comes from the Gampaha substation of the Ceylon Electricity Board (CEB) on 33kV and along power lines of about 4.5km. The receiving power system consists of two transformers, one stepping down to 6kV with 1MVA capacity, and the other down to 400V, and 600kVA.

Emergency engine generators consisting of two 350kVA and three 300kVA generators are provided. The output voltage is 400V and all the generators can be operated in parallel. However, due to superannuation, the actual output appears to be about 50% of the normal output capacity.

The Gampaha C.E.B. substation receives power from the Colombo thermoelectric power plant and also from the power plant in the northern area with high voltage 220kV in a dual receiving system. The capacity is 240MVA, while the actual load power is about 60MVA. Thus it has quite enough power capacity and is extremely spacious. The existing power lines to the Ekala station are connected to about 27 factories near the Ekala site, and the voltage regulation is about ± 10%. This is caused by the operations of the factories getting power from the same lines and results in abrupt changes from time to time for about 5-10 minutes at all seasons.

Frequency of power supply is very stable and its change is almost zero. Regarding power failures, it is said that instantaneous ones occur once for 2-3 days. During last year's drought season there were repeated power failures, but this year, as of June 1988, there have been no long duration failures.

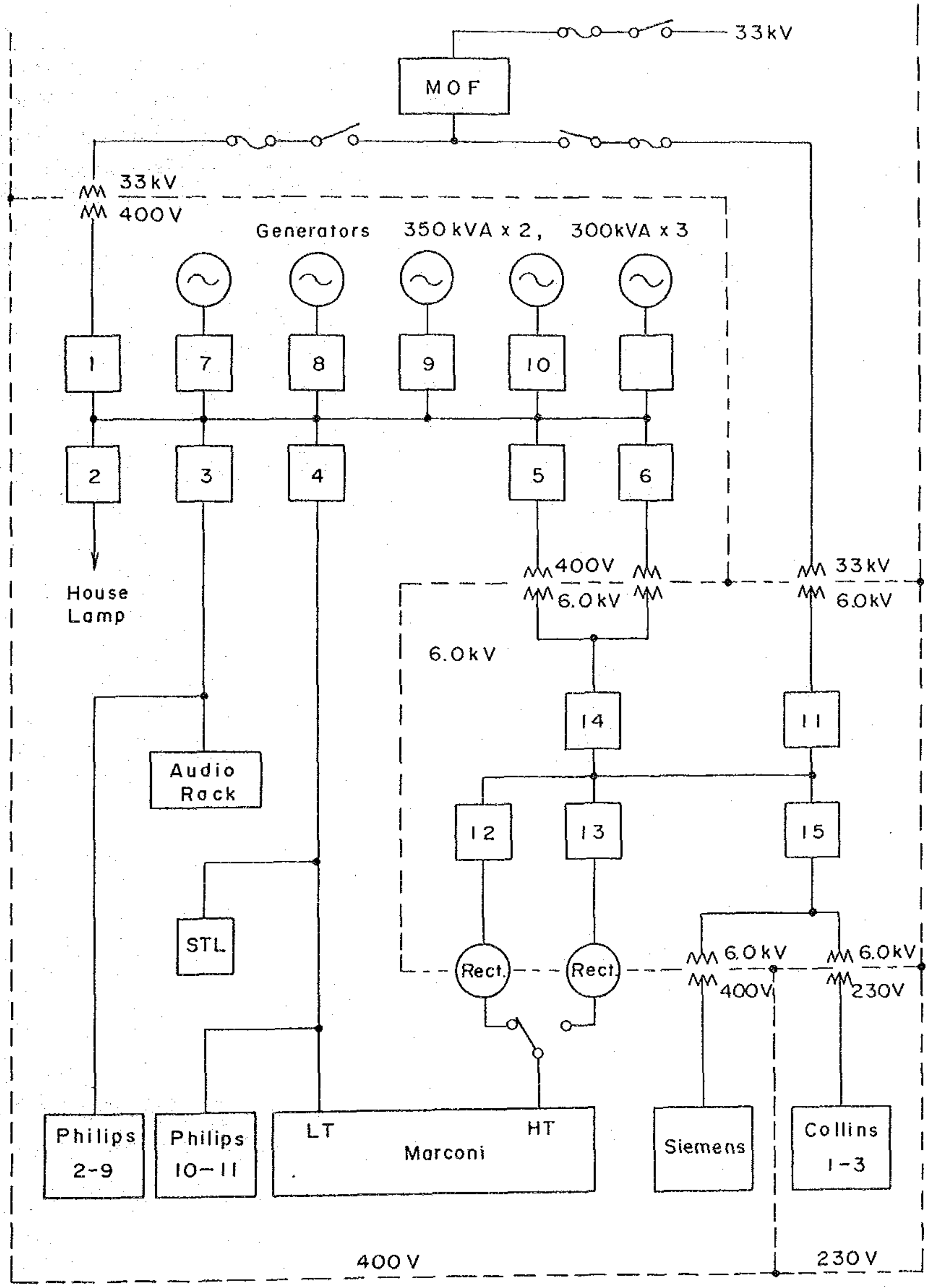


Fig.3-9-1 Schematic Diagram of Existing Power Supply

Suspension of power supply for maintenance purposes is quite rare so that conditions regarding the Ekala station which requires 24 hour operation, are very satisfactory because the CEB places high priority on feeding power to the lines according to the user's importance.

3-9-2 Power Demand of Existing Equipment

Existing load capacity of each equipment is as follows:

Table 3-9-1 Power Demand

Equipment	Max. power demand per unit	Max. power demand total
Marconi 100kW TX	300KVA	300KVA
Siemens 100kW TX	300KVA	300KVA
Collins 35kW TX(3 sets)	105KVA	315KVA
Philips 10kW TX(10 sets)	30KVA	300KVA
Lighting	3KVA	3KVA
Ventilation	10KVA	10KVA
Miscellaneous	10KVA	10KVA
STL	1KVA	1KVA
Air conditioner (STL hut)	2KVA	2KVA
Total		1241KVA

Efficiency of the transmitters is assumed to 50% and power consumption of the programme input equipment is included in the transmitter.

CHAPTER 4

CONTENTS OF THE PROJECT

CHAPTER 4 CONTENTS OF THE PROJECT

4-1 Objectives and Summary of the Project

4-1-1 Objectives

As mentioned in detail in Chapter 3, the transmitter facilities at the Ekala station, which have been in operation for 35 to 40 years since its initial construction, are still working as the indispensable main facilities.
However, due to aging and lack of spare parts, they are barely maintaining daily operation at only 50~80% of normal output power.
If the present situation continues without rectification, the whole operation of the Ekala station might be seriously jeopardized.
In order to improve the situation, reinforcement of the present functions together with the replacement of some existing facilities is to be realized by installing new equipment.

4-1-2 Summary

(1) Outline of the equipment

The equipment to be newly installed is divided into three categories as follows;

1) For external broadcasting
Construction of a new transmitter hall building for two 300kW* shortwave transmitters with power source equipment, and renewal of four wideband antenna systems.
2) For domestic broadcasting
Replacement of the four existing 10kW shortwave transmitters with new ones including associated input and output equipment.

* Paragraph 4-2-1 explains the reasons for deciding on transmitter power from the "above 250kw" of the initial plan to 300kW.

3) Measures to lengthen the lives of the existing two 100kW transmitters by supplying urgently needed spare vacuum tubes and parts.

Based on the foregoing policy, the project plans are drawn up as shown in Table 4-1-1. The expected service area to be covered by the new facilities is shown in Fig. 4-1-1.

(2) Programming policy for overseas broadcasting

1) Programming for external broadcasting will not be changed for a while, reflecting the lack of sufficient finances.

2) Programming will be reasonably modified in the first phase after the completion of the Project in 1991. An increase in broadcasting hours to the Middle East and the Indian subcontinent is planned, aimed at increasing revenue to improve the financial condition by selling air time and renting out the transmitter equipment.

3) In 1993, it is planned to complete the construction of VOA transmitter station at Puttalam. One of the seven 500 kW shortwave transmitters will be available for use of the SLBC by the mutual agreement reached between the SLBC and the VOA. At that time it will become possible to rearrange the programming extensively. This is called the "second phase".

In order to realize the above plan, it is necessary to maintain and to operate the two existing antiquated 100kW transmitters until 1991. After that, one of them has to be used for the continuation of service.
Accordingly, it is indispensable to extend the lives of the two old 100kW transmitters by any means, such as supplying spare vacuum tubes, etc.

Table 4-1-1 Outline of the Project

	Present	After Completion	Remarks
B' cast hrs./day	hrs./day		
Domestic S.	66.5hrs	ditto	
Exernal S.	55.5hrs	ditto	
Commercial S.	25 hrs	increase approx. 10hrs.	Increase of commercial prog. hours.
Target area	No. of antennas	Exist. Remove Renew Total	Increase of antennas for more variety of service and improvement of receiving condition by the high gain antennas.
Middle East	1	1 − 1 + 2 = 2	
India	4	4 − 1 + 2 = 5	
Australia	1	1 − 1 + 2 = 5	
Facilities			
300kW TX	—	2 new*	* Power increase for the External Service.
100kW TX	2	ditto**	** Modification is made by SLBC.
35kW TX	3	ditto	
10kW TX	10	10 (4, renewed*)	
STL	1 system	2 systems	
Power line	Common line (4.5km)	Exclusive line* (2.0km)	*Constructed by SLBC Completed in Nov. 1889.
Employees	132 pers.	(132+10) pers.	
Construction Period		About 2 years	
Construction cost		* 2.5 mil. Rs, ** Grant aid	* To be borne by SLBC ** From Japan
Service area		See Fig. 4-1-1	

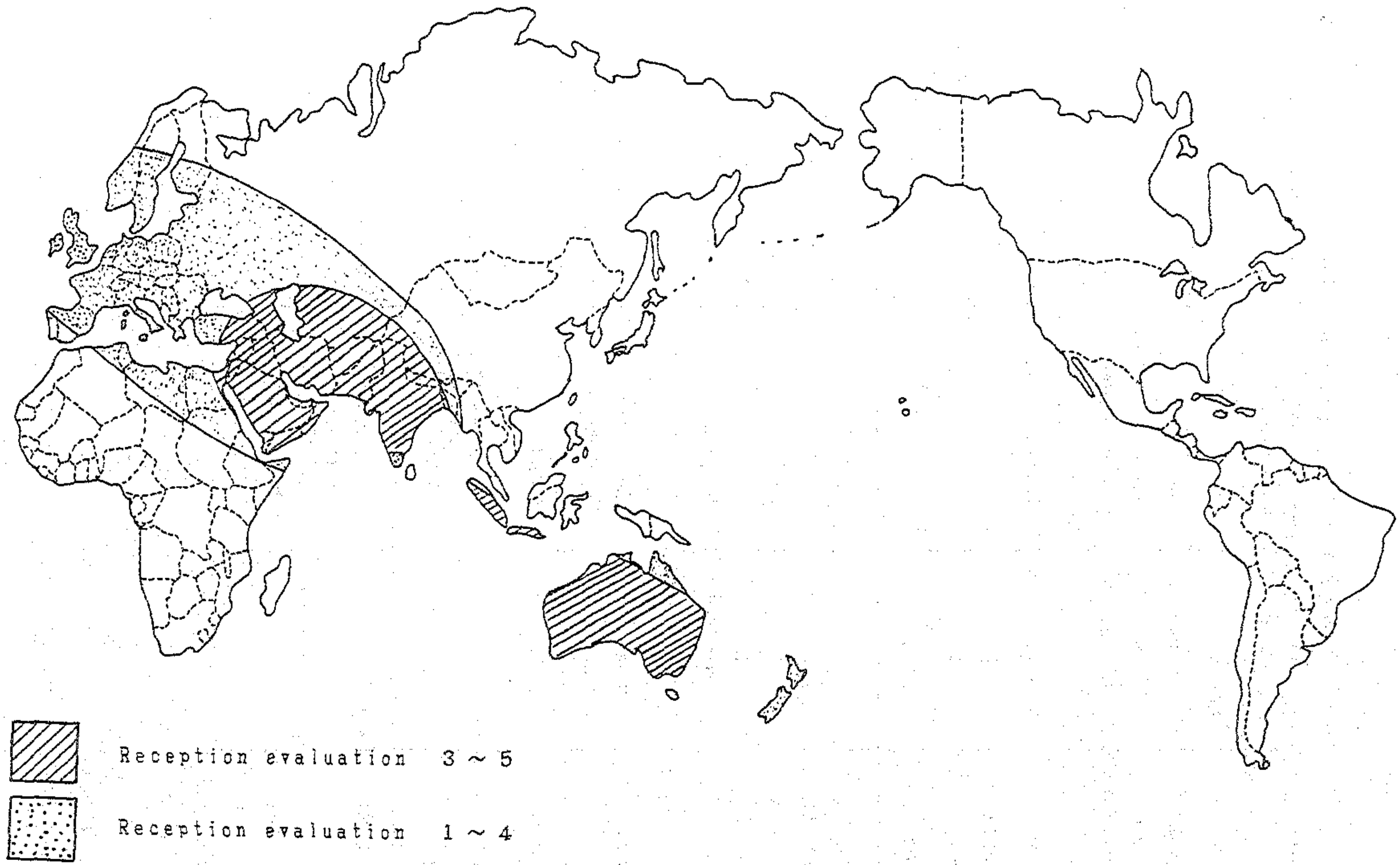


Fig.4-1-1 Expected Service Area

4-1-3 Programme Plan

(1) In relation to the Project, the policy of the SLBC for the programming of shortwave broadcasting has mainly focussed on the following:

1) to serve as a supplementary medium for domestic radio broadcasting, which is now being partly and insufficiently carried out on medium wave and FM in some places.

2) to serve as external broadcasting to inform people overseas of current topics and the Sri Lankan situation, including the country's philosophy and culture, in order to obtain deeper international understanding.

3) to serve as an information and entertainment medium for Sri Lankan people living overseas.

However, in order to achieve the above objectives steadily and successfully, it is also necessary to solve the financial problems which the SLBC now faces. Therefore, the first means is to increase the SLBC's revenue by offering use of the facilities to foreign broadcasters, thereby taking advantage of Sri Lanka's geographical position which is ideal from the viewpoint of shortwave radio propagation, and the second means is to conduct commercial broadcasts. These are prerequisite conditions when considering programme compilation.

The tentative plan formulated by the study team for the transmission of programmes after completion of the Project is shown in Table 4-1-2.

(2) As for domestic broadcasting, five different kinds of programme services will be transmitted, using a total of six transmitters consisting of the four new 10kW transmitters and the two existing ones (Nos. 7 and 8), so that the operation will become flexible.

(3) Some consideration for rationalizing the operation of external broadcasting are explained in the following.

1) The three Collins transmitters are used for transmissions to the Middle East and Australia (these are in the exact opposite directions), which are conducted as follows at present:

16:00~17:00 to Australia using C-2

21:15~21:45 to the Middle East using C-3

These transmissions will be done by the newly installed No.4 antenna directed at the Middle East / Australia.

Therefore, by changing the use of transmitter from C-2 to C-3 for Australian transmissions during 16:00~17:00, and for the transmissions to the Far East during the same hour, changing C-3 to C-2, the No.4 antenna can be fed power by the same C-3 transmitter so that the feeder connection circuit and the daily operation will be simplified.

2) In order to conduct broadcasting to the Middle East during the nighttime from 22:15~00:15 in the 25 meter band with the 100kW Siemens transmitter, the All Asia Hindi Service broadcast by the same Siemens transmitter has to be changed to Marconi 100kW transmissions in the 31 meter band half way, and at the same time the All Asia Hindi Service broadcast also has to be cut off half way.

This means that listeners receiving the All Asia Hindi Service in the 25 meter band have to retune to the 31 meter band at 22:00 for another hour of Hindi broadcasting.

This is caused by the insufficient number of transmitters. However, with the installation of the new 300kW transmitters, the above inconvenience can be avoided.

3) As for the transmission service for foreign broadcasters, the tentative schedule decided by the SLBC (to India, 5.5 hours and to the Middle East, 4.5 hours a day) would apply to the new No.1 300kW transmitter.

Table 4-1-2 Tentative Broadcast Schedule

HOURS OF RADIATION 1991

LT: 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 0 1 2

UTC: 21 22 23 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

TRANS-MITTER	DAYS	UTC (meter band)	HOURS OF RADIATION	FREQ kHz	ANT NO.	TARGET AREA	SERVICE
K-1 10kW	WDs	49	EDUCATIONAL	6075	SB4		DOMESTIC SERVICE
		61	SINHALA-N; SINHALA-N SERVICE	4902	SB7		
	WEs HOLIDAYS	49	SINHALA-N SERVICE; for Poyaday				
		61	All-night for Poyaday; SINHALA-N; SINHALA-N SERVICE; All-night for Poyaday				
K-2 10kW	DAILY	49	SINHALA-C SERVICE	6185	SB3		
		61	SINHALA-C; SINHALA-C SERVICE	4870	SB2		
K-3 10kW	DAILY	49	TAMIL SERVICE	6150	FD7		
		61	TAMIL; TAMIL SERVICE	5020	FD4		
K-4 10kW	WDs	49	ENGLISH; ENGLISH	6130	SB5		
		61	ENGLISH; ENGLISH SERVICE	4940	SB1		
	WEs HOLIDAYS	49	ENGLISH SERVICE	"	"		
		61	ENGLISH; ENGLISH SERVICE				
PH-6 10kW	DAILY	49	6005 ALL ASIA ENGLISH; 6075 ALL ASIA ENGLISH	60··	SB6	IND	INTERNATIONAL SERVICE
PH-9 10kW	DAILY	31	ALL ASIA ENGLISH; ALL ASIA ENGLISH	9720	STBY		
C-1 35kW	DAILY	16	SEA	17850	15	SEA	
		19	15250 VOA; 15395 VOA	15···	17	IND	
C-2 35kW	DAILY	25	VOA	11710	18	IND	
		19	FE	15120	10	FE	
		31	VOA	9645	11	FE	
C-3 35kW	DAILY	19	ALL ASIA ENGLISH	15425	7	IND	
		25	AU	11855	4SE	AU	
		25	TWR 11895	11···	9	FE	
			11920 TWR; TWR 11895		18	IND	
			TWR 11895		4NW	ME	
PH-10 10kW	WDs SUNDAY	41	ALL ASIA HINDI; ALL ASIA HINDI SERVICE	7190	6	IND	
PH-11 10kW	DAILY	41	7115 VOA; 7125 VOA	71··	16	IND	
MARCONI 100kW	DAILY	31	ALL ASIA ENGLISH; ALL ASIA ENGLISH	9720	1	IND	
SIEMENS 100kW	WDs SUNDAY	25	ALL ASIA HINDI; ALL ASIA HINDI SERVICE	11800	8	IND	
J-1 300kW	DAILY	L	IND; IND		2	IND	
		H	ME; ME		3	ME	
J-2 300kW	DAILY	L					
		H	ME		4NW	ME	

METER BAND; WDs : WEEKDAYS, WEs : WEEKENDS, IND : INDIA, FE : FAR EAST, AU : AUSTRALIA, SEA : SOUTH-EAST ASIA, ME : MIDDLE EAST

As for the new No.2 300kW transmitter, there are many ways to replace the service conducted at present on 100kW transmitters and to offer new programmes and so on. However, the part of the time schedule shaded with oblique lines partially in Table 4-1-2 shows that the transmitter cannot be available for low-band frequency transmission because the new antennas for the low band are fully used by other service, but for high band transmission it can be used.

4) In short, after the completion of the present project, it will become possible for the SLBC to make effective use of the 300kW transmitters, in place of the aged Marconi and Siemens transmitters. If the measures succeed in prolonging the lives of the Marconi and Siemens 100kW transmitters, then either transmitter can be used for the commercial services of other foreign broadcasters.
Therefore, maintenance measures for the aged transmitters, as mentioned above, are most essential for carrying on commercial transmission services. Since this would lead to an increase in the SLBC's revenue, maintenance measures for the aged transmitters should be carried out by all means.

5) As regards the service for Australia, which is currently conducted for one hour at 16:00-17:00 with a 35kW transmitter, the completion of this project will enable 300kW transmissions using either one of the new transmitters. In view of the good propagation time for Australian regions, an increase in the transmission hours is possible as well.
In Table 4-1-3, a sample of a tentative plan for the future use of the transmitters is shown.

Table 4-1-3 A Tentative Plan for the Use of the Shortwave Transmitters

Service	1988	1991	1993
Overseas Broadcasting			
All Asia English Service	Marconi 100kW	(J-2)	(J-2 or VOA500kW)
	Collins 35kW No.3	Collins 35kW No.3	Collins 35kW No.1
	Philips 10kW No.6	Philips 10kW No.6	Philips 10kW No.11
All Asia Hindi Service	Siemens 100kW	(J-2)	(J-2 or VOA500kW)
	Philips 10kW No.10	Philips 10kW No.10	Collins 35kW No.2
Standby	Philips 10kW No.9	Philips 10kW No.9	Philips 10kW No.10
Domestic Broadcasting			J1 , J2
Sinhala National Service	Philips 10kW No.8	K-1	K-1
Sinhala Commercial Service	Philips 10kW No.5	K-2	K-2
Tamil Service	Philips 10kW No.7	—	—
English Service	Philips 10kW No.3	K-3	K-3
Educational Broadcasting	Philips 10kW No.4	K-4	K-4
Standby	Philips 10kW No.8	Philips 10kW No.7	Philips 10kW No.7
		Philips 10kW No.8	No.6, 8, 9
Other Service			
VOA	Collins 35kW No.1	Collins 35kW No.1	—
	Collins 35kW No.2	Collins 35kW No.2	—
	Philips 10kW No.11	Philips 10kW No.11	—
TWR	Collins 35kW No.3	Collins 35kW No.3	Collins 35kW No.3
New Service		J-1	J-1

Code within the parentheses shows the possibility of replacements.

(Note): J1,J2,K_1~K_4 are tentative codes.

The symbols (K. PH. C. J) used in Tables 4-1-2 and 4-1-3 denote particular transmitters as follows:

K: New 10kW transmitter, PH: Philips 10kW transmitter
C: Collins 35kW transmitter, J: New 300kW transmitter
(K and J are tentative codes)

4-1-4 Facilities Plan

At the SLBC's Ekala Shortwave Transmitting Station, two 300kW transmitters will be newly installed, and at the same time, some of the 10kW transmitters currently used for the Domestic Service will be replaced with four new ones. Also, in order to improve services to such regions as the Middle East, the Indian subcontinent and Australia, a plan to improve facilities has been drawn up.

Fig. 4-1-2 shows the eventual systems to be established at the Colombo Studio and the Ekala Transmitting Station on completion of this project. The following are the main facilities and equipment to be eventually installed:

(1) Transmitter facilities

1) Shortwave transmitters (incl. dummy load, etc.)	300kW	2
2) Shortwave transmitters (incl. dummy load, etc.)	10kW	4
3) Programme distribution/input equipment*		1 set
4) Monitoring/controlling equipment*		1 set
5) Power supply*		1 set

* Newly installed as associated necessary equipment.

(2) Antennas

1) Renewal of antenna for transmission use (wideband antennas) 4
   (Two for India and two for the Middle East/Australia, incl. feeder, matrix switch & impedance converter, etc.)

2) Construction of self-supporting towers for antennas 4

(3) Building

1) Construction of a building to install the new transmitters mentioned in (1)-1) Approx.800 m^2

(The building layout plan is shown in Fig. 4-1-3.)

(4) Others

1) STL	1 set
2) Measuring equipment	1 set
3) Microbus	1

Since this Project includes replacement of existing facilities and equipment, the Project will be carried out in close cooperation with the SLBC. Besides the above-mentioned plans for the installation and replacement of equipment, the following items are included in the course of the Project's implementation.

(1) Removal of existing antennas Nos. 1 to 5 and the towers supporting those antennas.

(2) Removal to another location of some of the existing feeders.

(3) Construction of exclusively used electric power lines.

(4) Removal of four existing 10kW transmitters.

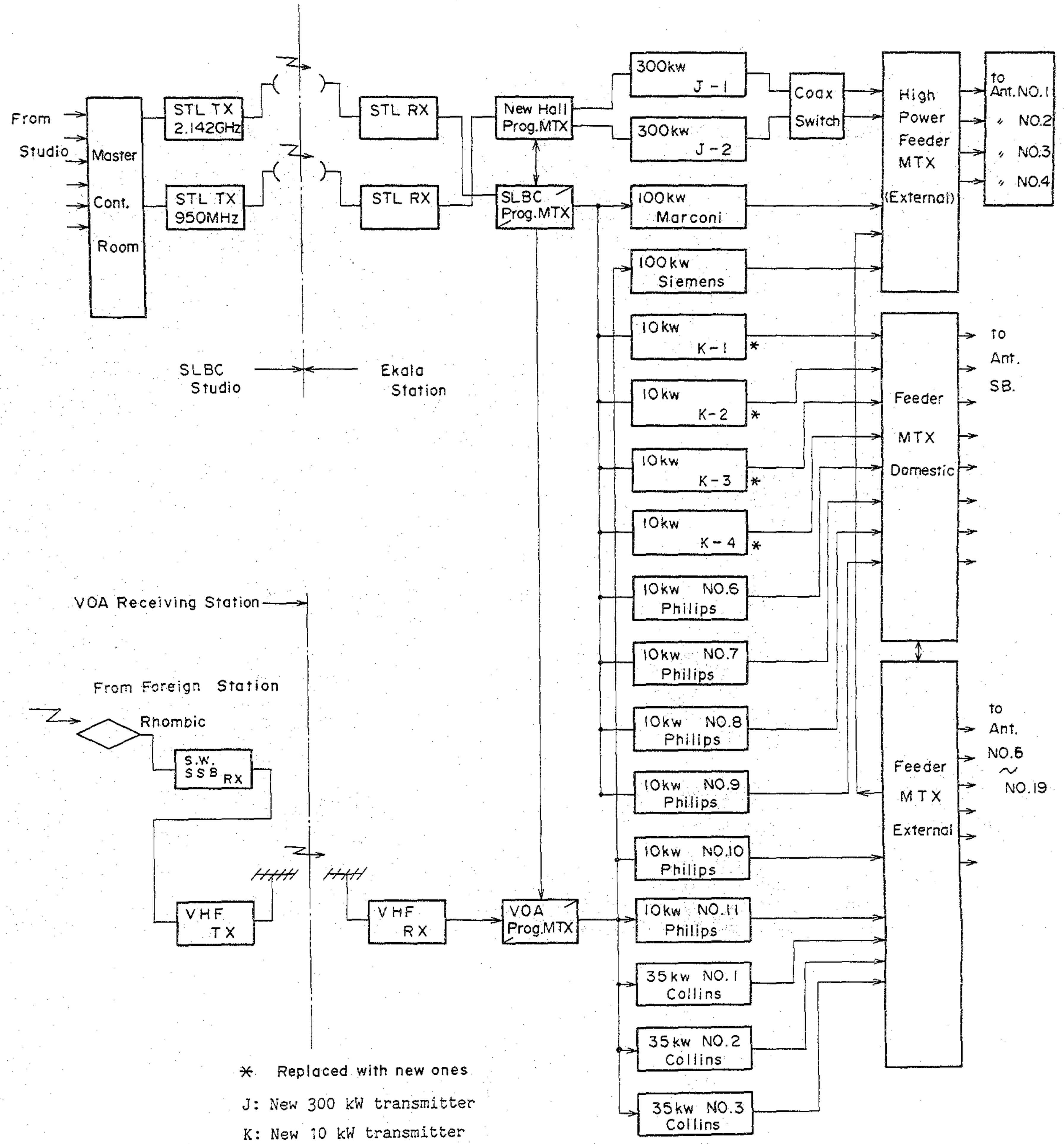


Fig. 4-1-2 Schematic Diagram of the Ekala Shortwave Transmitter Station (Expected)

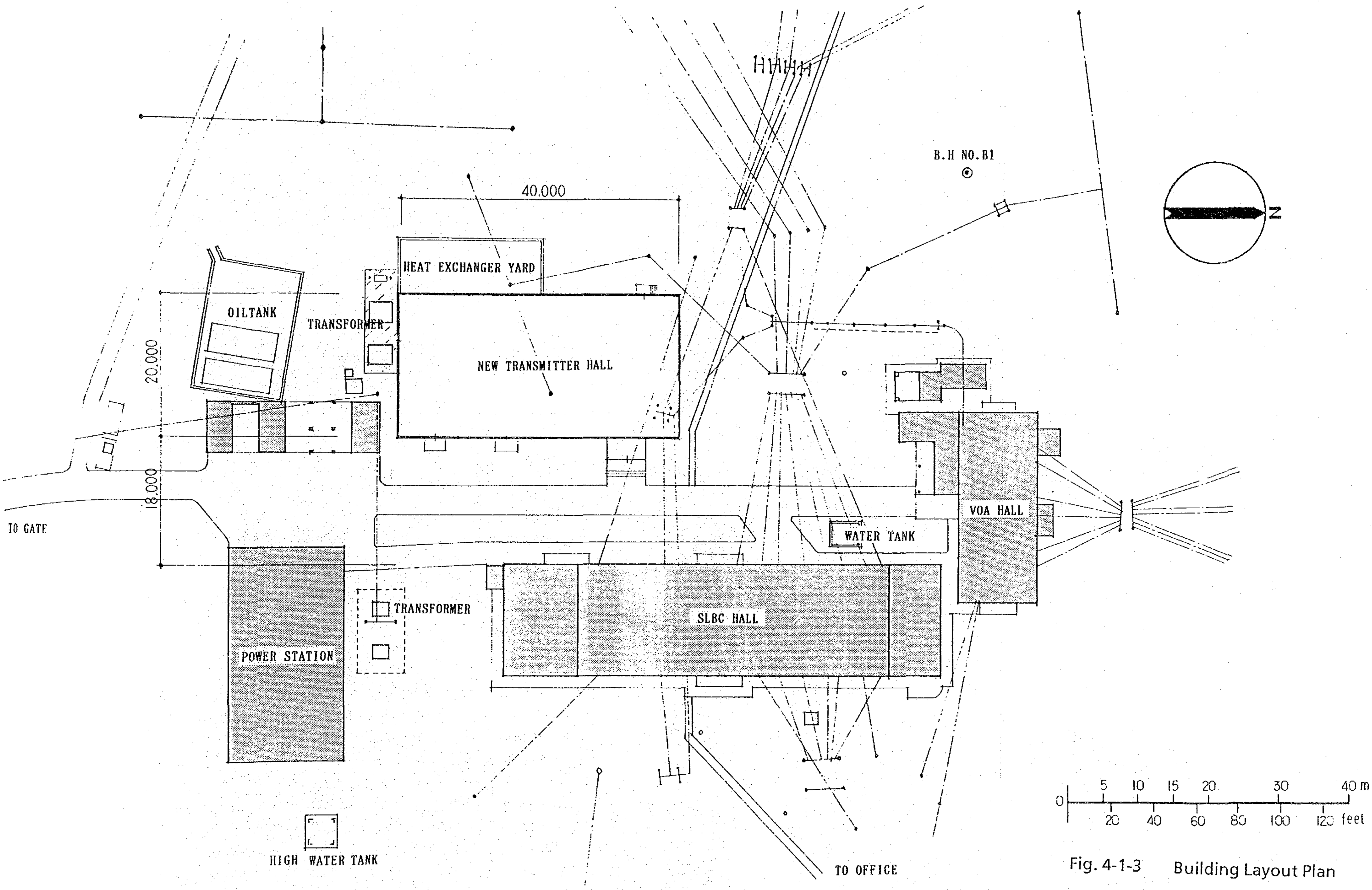


Fig. 4-1-3 Building Layout Plan

4-2 Transmitter Facilities for External Broadcasting

4-2-1 300kW Transmitters

The rated output power of the two high-power transmitters which was expressed as "above 250kW" during the the preliminary study, was fixed at 300kW after consultation with SLBC counterparts.

(1) Output power and field strength

Table. 4-2-1 Comparison of High-power Transmitter

Output	600kW	500kW	300kW	250kW	200kW	100kW
F.intensity (dB)	8dB*	7dB*	5dB*	4dB*	3dB*	0dB*
Constitution of output power. tube	PA: TH 558 ×2, MO: TH 573 ×2		PA: TH 558, MO: TH 573 ×2			PA: TH 555, MO: TH 573 ×2

* Relative field strength with reference to 100kW (approx.)
PA: Modulated Power Amplifier MO: Modulator

In the table, an example of the classification of transmitter output power by the constitution of vacuum tubes for the final amplifier is shown. As can be seen from the table, the tube constitution for 300KW and 250kW transmitters is the same. The difference in the output power for the same vacuum tube constitution is merely a difference in the impressed voltages and almost no difference is seen in other parts. An increase of output power from 250kW to 300kW is realized by boosting the plate voltage applied to the power tube by about 10%. Since the cost of the power supply is less than 10% of the cost of the total transmitter facility, the increment of plate voltage by about 10% will result in an increase in the total cost of less than 1%, which is negligible.

(2) Superiority of 300kW over 250kW as output power

The rated outputs of high-power shortwave transmitters used at present in the world are mainly 100kW, 250kW and 500kW. A few are using other output ratings. In the East Asian countries east of Pakistan, including Soviet oriented countries, only 12.6% of the total stations exceeding 100kW have a rating in excess of 300 kW as can be seen below.

100-250kW	235	..............87.4%
300-500kW	34	....12.6%

In European countries (excl.USSR), the ratio is as follows:

100-250kW	193	.... 80 %
300-500kW	47	.............20 %

and in Africa

100-250kW	77	.............90 %
300-500kW	8	.............10 %

In order to maintain superiority in the shortwave service to the important target area of the Middle East, which is surrounded by the Asian, European and African continents where almost all transmitters have an output power of less than 250kW, it is considered effective to increase the output power to exceed them even though by a small margin.

On the other hand, there is fierce international competition to increase the output power of shortwave transmitters to the present maximum of 500kW. However, this increases not only the cost of power supply equipment, antennas and transmitters but also consumption of electric power, and it would be inappropriate from the viewpoint of cost performance for SLBC/Sri Lanka, where power charges represent about 20% of the total operational cost.

In other words, the initial investment cost will be greatly increased, by about 20~30%, if 500kW transmitters are installed, due to the difference in the tube constitution, which means not only the added cost of vacuum tubes, but also their associated circuits including coils, condensers, output feeders, antennas, etc., which have to be increased in capacity to cope with the high voltage and large current. Moreover, the power demand is about 1.7 times that of a 300kW transmitter, which means extra costs for power equipment in addition to the power consumption charge, which will push up the daily operational cost of the station. Therefore, the installation of 500kW transmitters is not preferable for the SLBC.

Above are the main reasons stressed by the SLBC and the study team concluded that 300kW is the best for the service.

A schematic diagram of the new 300kW transmitters is shown in Fig.4-2-1.

4-2-2 Control and Supervisory Functions

(1) Control functions

In order to rationalize the operation of transmitters, remote control and supervisory functions will be provided to operate the transmitters from a monitoring room.

The functions are:

1) Transmitter on and off
2) Switchover of antenna matrices
3) Switchover of input lines (programme)
4) Frequency change
5) Remote/manual, mode change and other important functions

(2) Monitoring functions

Supervisory/monitoring functions are as follows:

1) Completion of frequency change
2) Completion of antenna matrix connection
3) Completion of pre-heating (standby)
4) Completion of impress of high voltage
5) Completion of switch off of high voltage
6) Ceasing of operation
7) Indication of abnormal operation of transmitter
8) Forward power
9) Reflected power
10) Completion of tuning
11) Modulation level
12) Indication of remote/manual modes, etc.

Other liaison functions such as interphone, and UHF wireless equipment are also to be provided.

4-2-3 Arrangement of Equipment in the New Hall

The New Hall is to be composed of transmitter, power supply, and monitoring rooms, etc.

Two 300kW transmitters will be installed in the central room of the building to rationalize the take-out of feeders and cooling devices, considering the location of new antennas and feeders, as shown in Fig. 4-1-3.

An air inlet will be provided to prevent the intrusion of rain and dust from strong rainfall and wind. Heat exchangers will be installed just behind the New Hall to cool the secondary water which is used for cooling vacuum tubes and dummy load, etc. Distilled water is to be used and a purifying (organic resin) system including a reserve tank is to be installed at the south-west corner of the transmitter room.

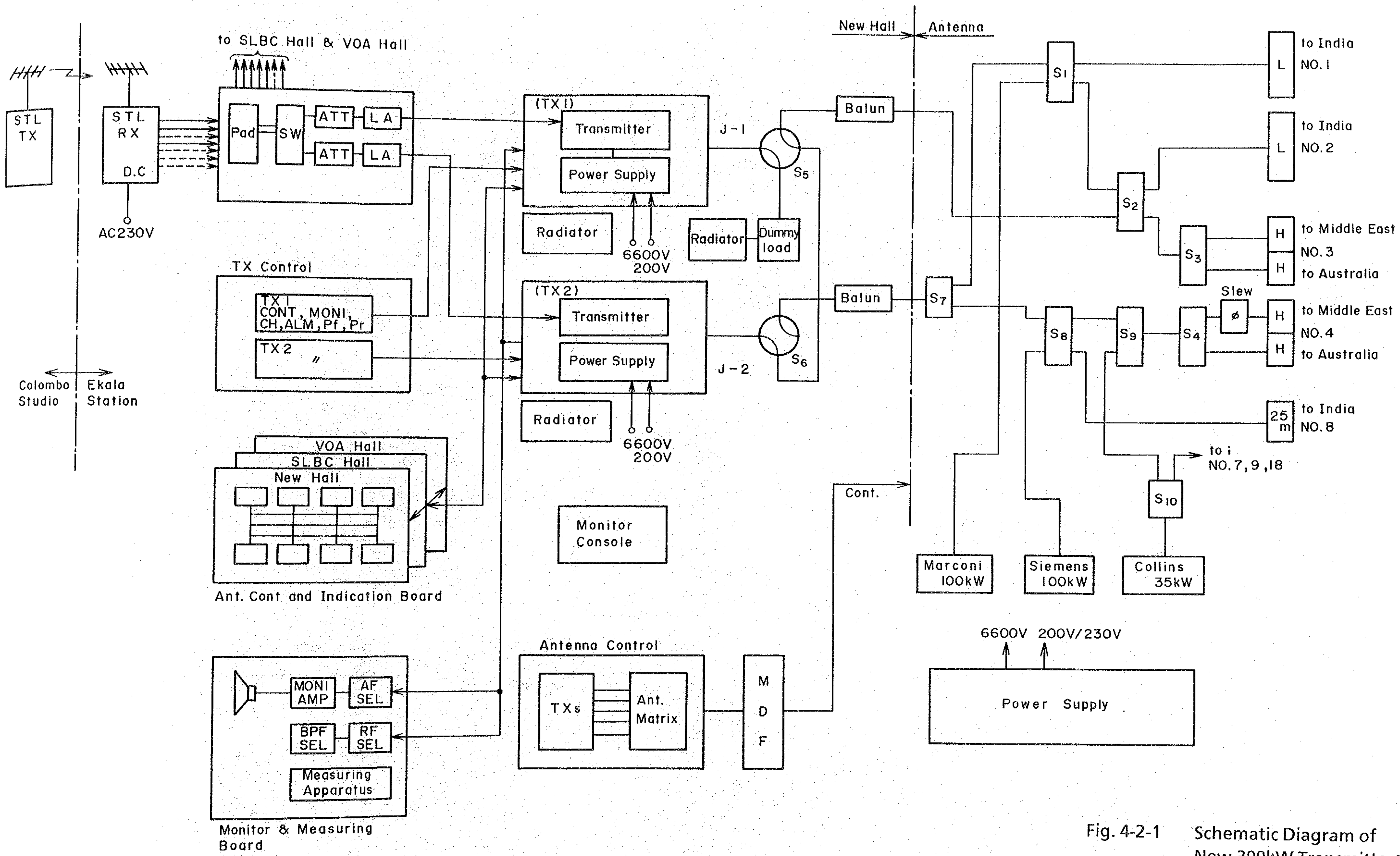


Fig. 4-2-1 Schematic Diagram of New 300kW Transmitters

Other related equipment outside of the transmitter cubicles is to be arranged all together within the protective fence, just in front of the cubicles so that the middle portion can be used as a passage way.

Carry-in doors with shutters are to be located in the transmitter and power supply rooms.

A power supplying transformer for the New Hall is to be positioned at the outer corner of the southwest part of the New Hall.

Electro-magnetic shielding is to be installed in the monitoring and workshop rooms to enable the measurement of equipment during transmission. Air conditioners will also be provided for office, monitoring and workshop rooms. Furthermore, a small kitchen, spare parts storage, etc., are also to be provided.

4-2-4 Programme Input Circuit

Ten channel programmes (incl. standby channels) are sent from the studio at Colombo to the Ekala station through the new STL and the received signals are sent to the New Hall directly through underground cable and relayed to the SLBC and VOA Halls via the terminal board provided in the rack of the New Hall.

Output signals of the existing STL are sent from the SLBC Hall to the VOA Hall at present, and the programme circuits for external service are provided to extend from the SLBC Hall to the terminal board in the New Hall as standby.

Accordingly, programme transmission within the premises becomes as shown in Fig. 4-2-2.

4-2-5 STL Equipment

(1) Circuit constitution

1) Span: From SLBC Colombo Studio to Ekala

Transmitting Station

2) Channel capacity : Audio 10 circuits

3) Carrier frequency: Two carrier frequencies within the band between 915 and 935 MHz

4) Modulation: 5 channel-multiplexing in FM

(2) Propagation Path

1) Points and Direction: as shown in Fig.4-2-3

2) Profile of the Propagation Path: as shown in Fig.4-2-4

(3) Equipment layout: as shown in the following figures

	Colombo STL-Tx.	Ekala STL-Rx.
Block Diagram	Fig. 4-2-5	Fig. 4-2-5
Arrangement in the site	Fig. 4-2-6	Fig. 4-2-7
Tower and Antenna	Fig. 4-2-8	Fig. 4-2-9
Arrangement in the room	Fig. 4-2-10	Fig. 4-2-10

(4) Usage of audio circuits

For Domestic Service (5 programmes)
- Sinhala National Service (**)
- Sinhala Commercial Service
- Tamil Service
- English Service
- Educational Service (*)

For External Service (5 programmes)
- All Asia English Service
- All Asia Hindi Service
- Far East/Southeast Asia/Australia Service (**)
- TWR Service (*)
- Middle East Service (*)

Total: 10 programmes

1) At the transmitting station, it is the custom not to switch programme lines in principle. However, at such times as when the Southeast Asia/Australia service is conducted using the Collins transmitters and while they are not being used by the VOA, staff at the transmitting station may switch input signals.

2) Since the services marked with an asterisk (*) are short and their transmission hours are mutually staggered, it is possible for them to use the same STL channel as the one used for the services marked with two asterisks (**).

3) If some switching operations were to be allowed at the transmitting station, it would mean that there is currently room to accommodate three more channels.

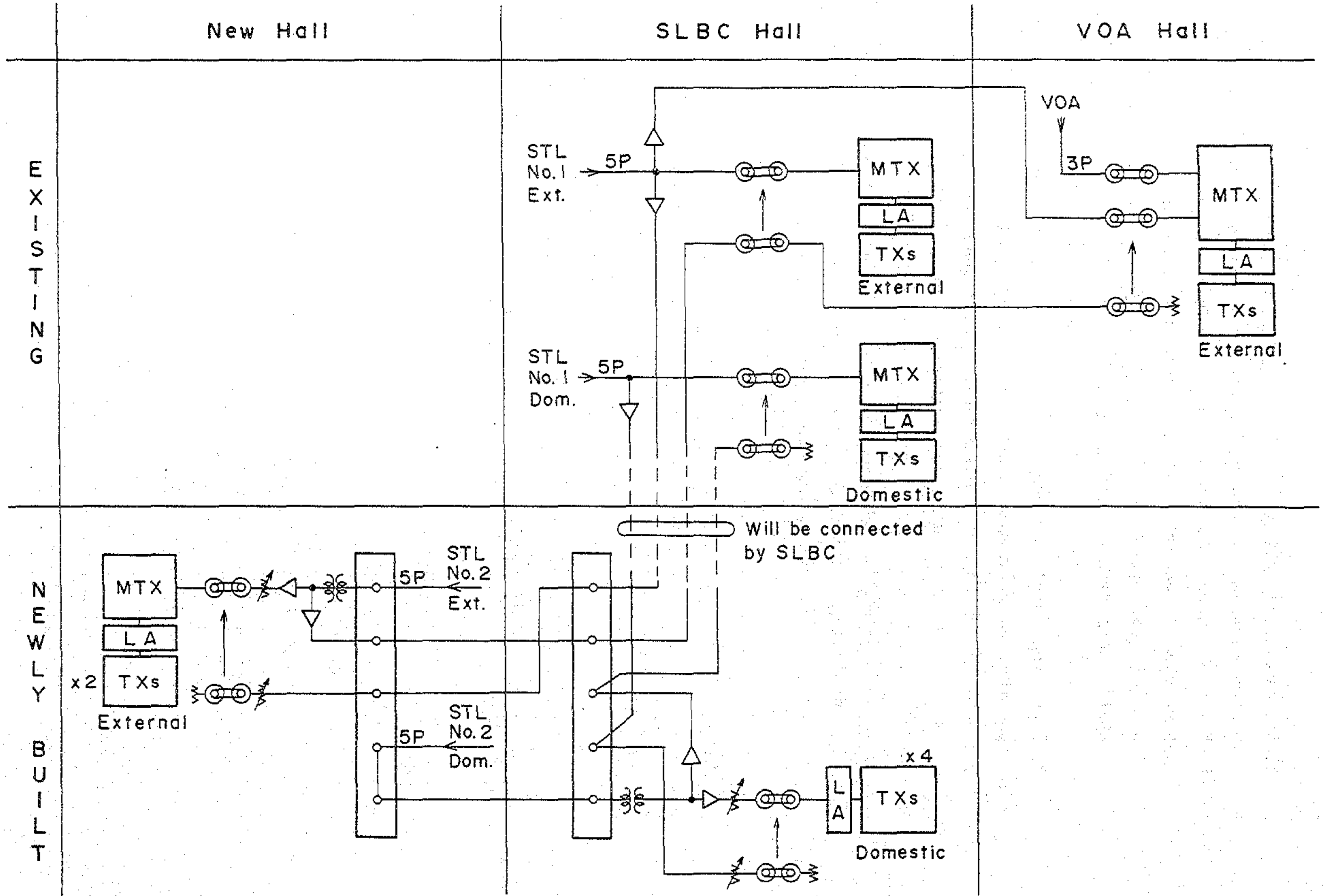


Fig.4-2-2 Connection of Input Circuit

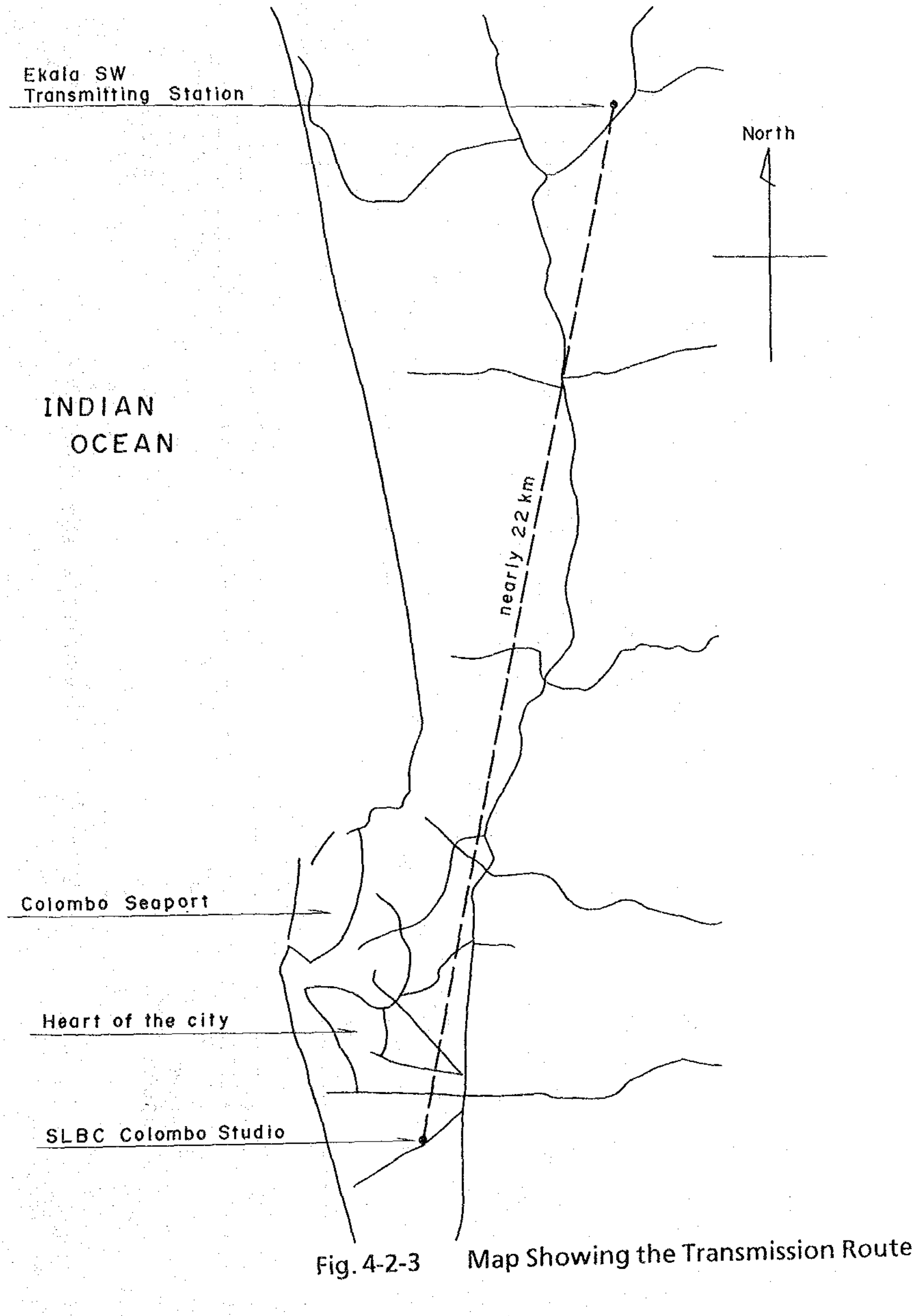


Fig. 4-2-3 Map Showing the Transmission Route

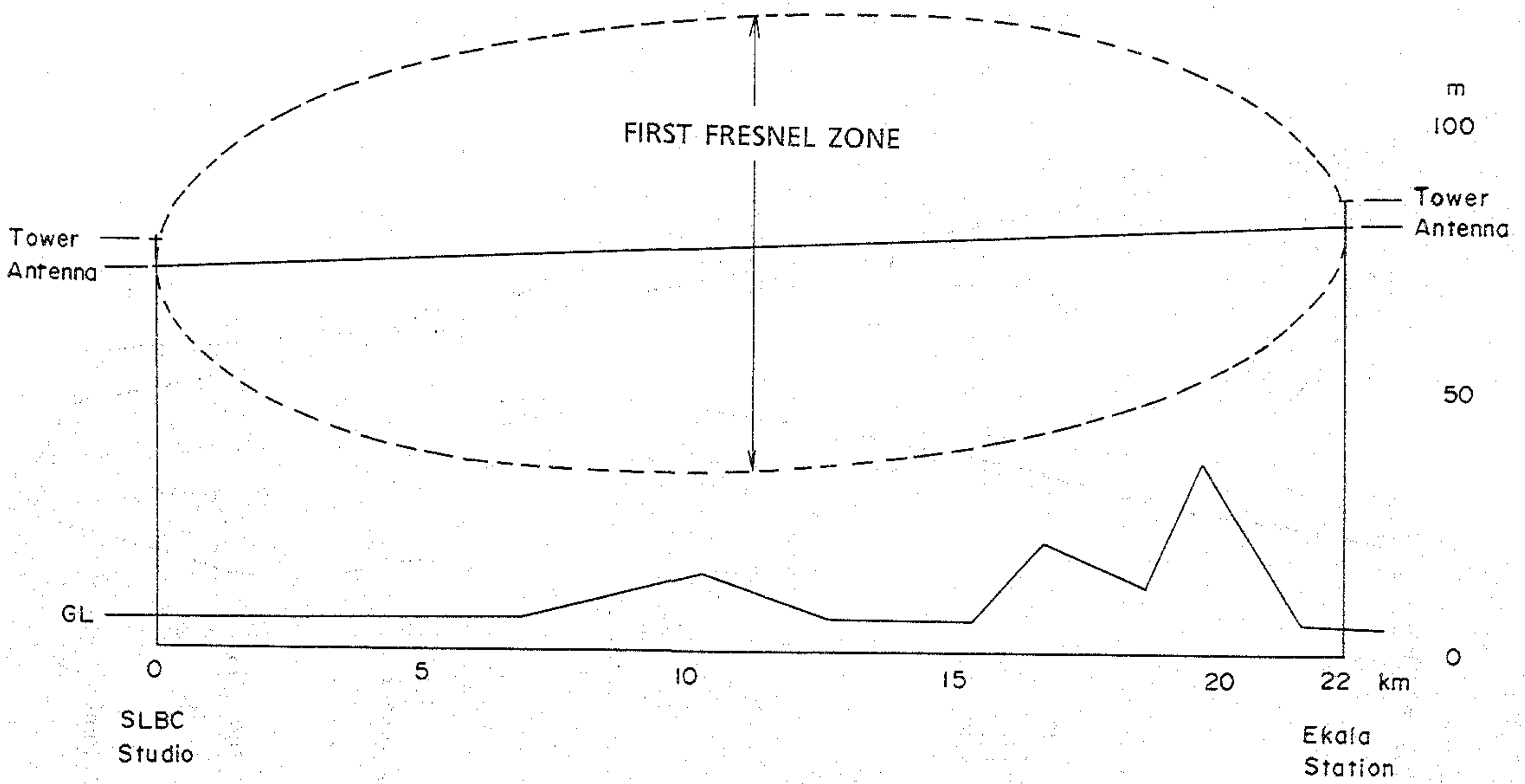


Fig. 4-2-4 Profile of Propagation Path

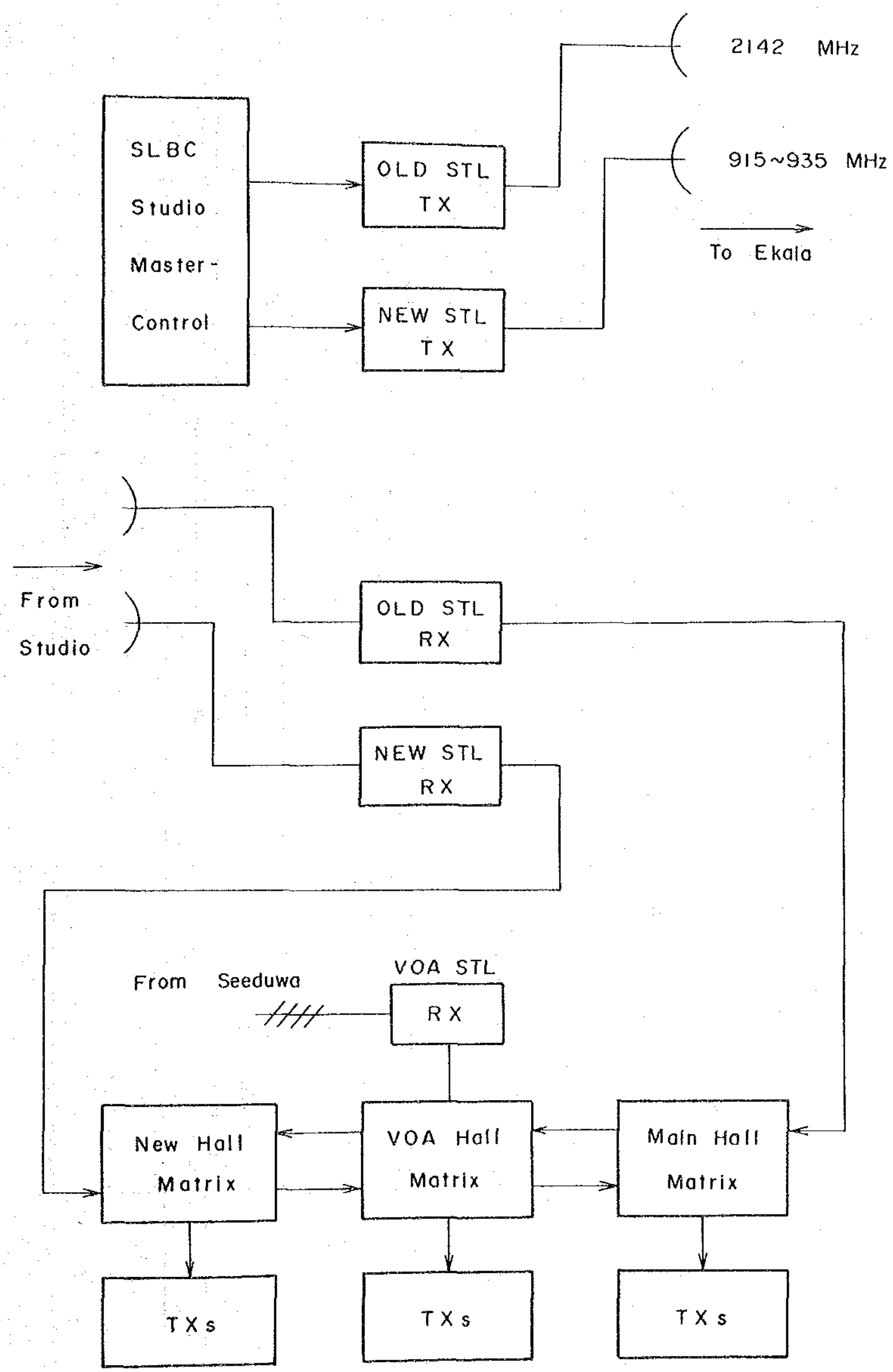


Fig. 4-2-5 Schematic Diagram of STL

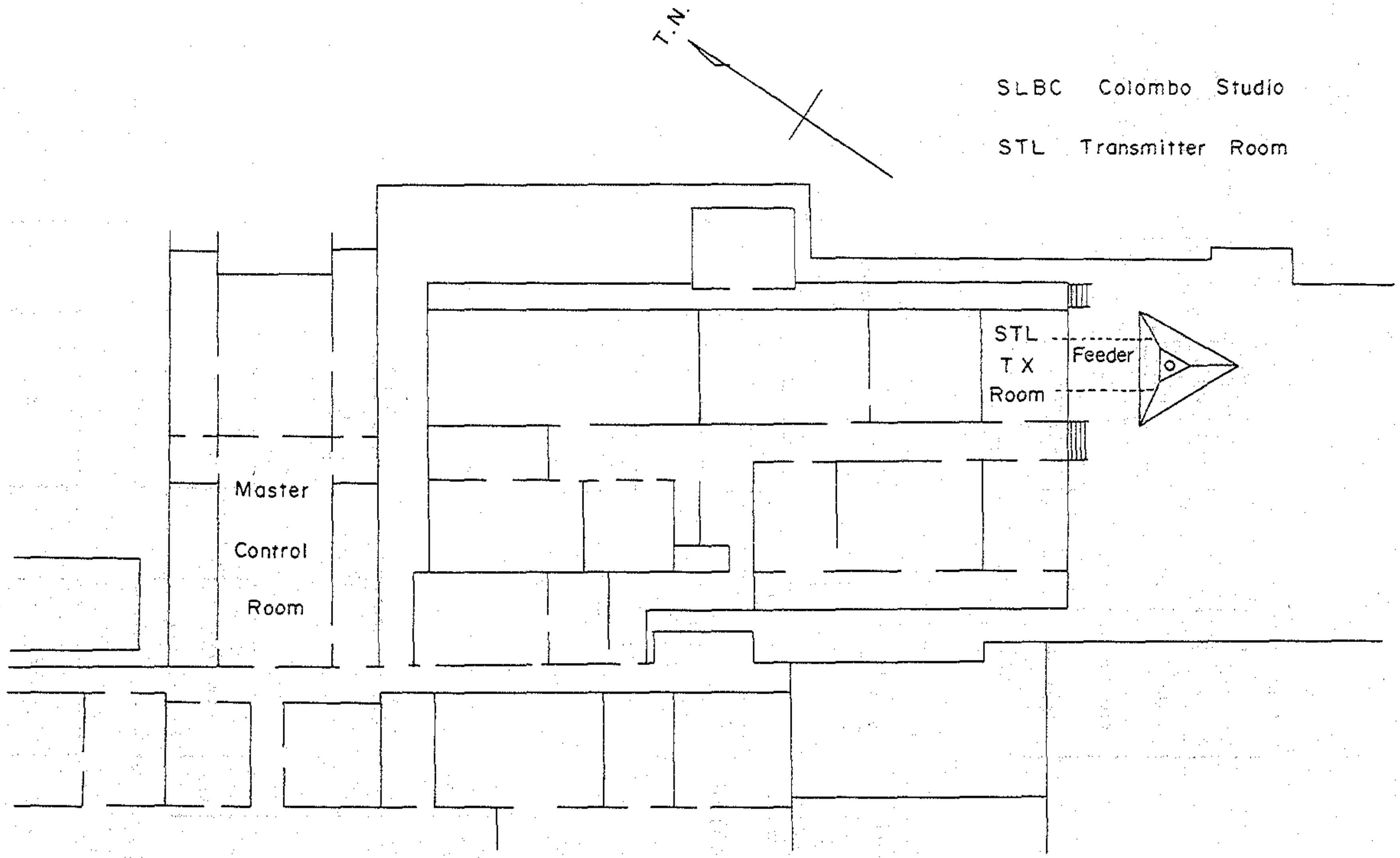


Fig. 4-2-6 Location of STL in the SLBC Studio

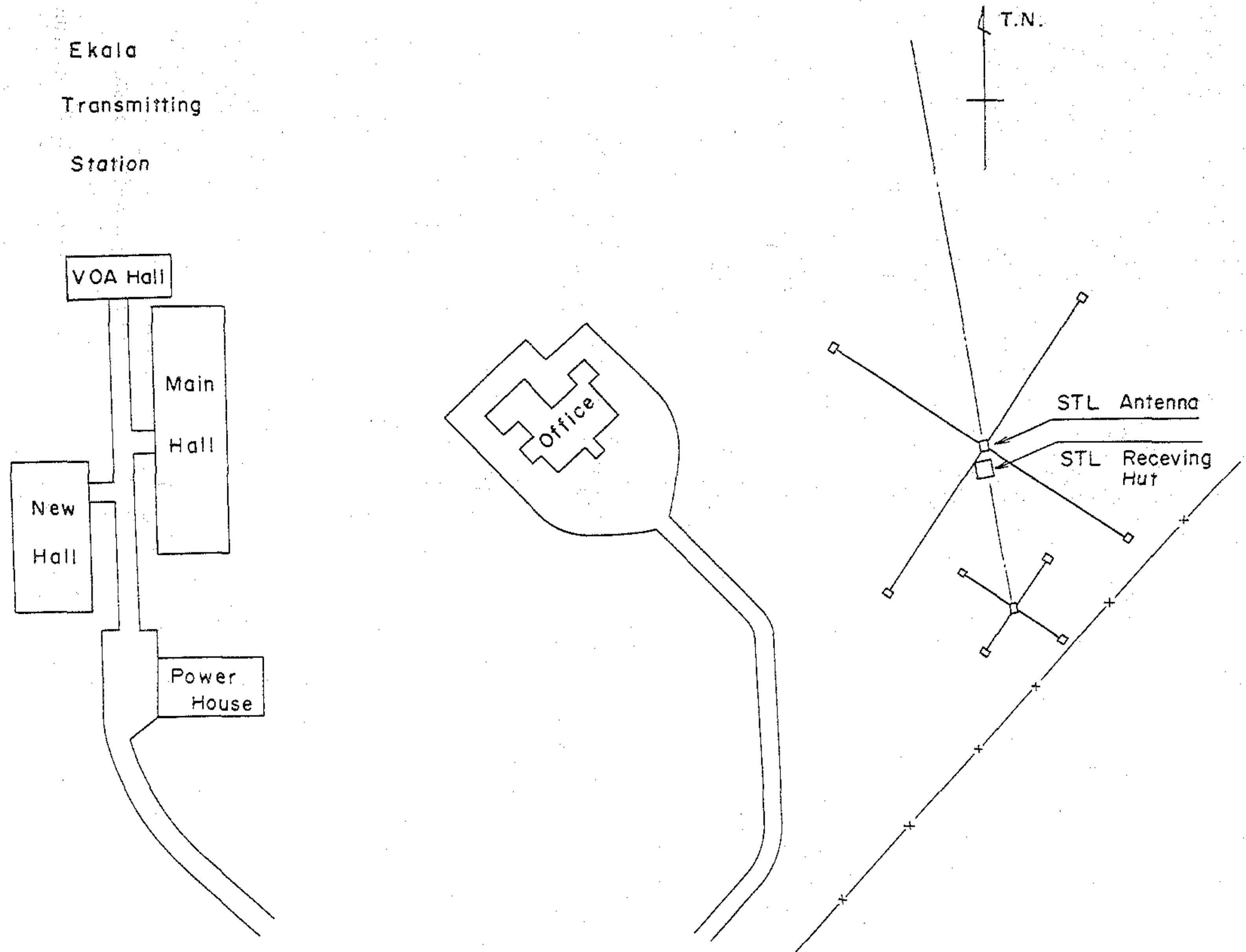


Fig. 4-2-7 Arrangement of Facilities at the Ekala Station

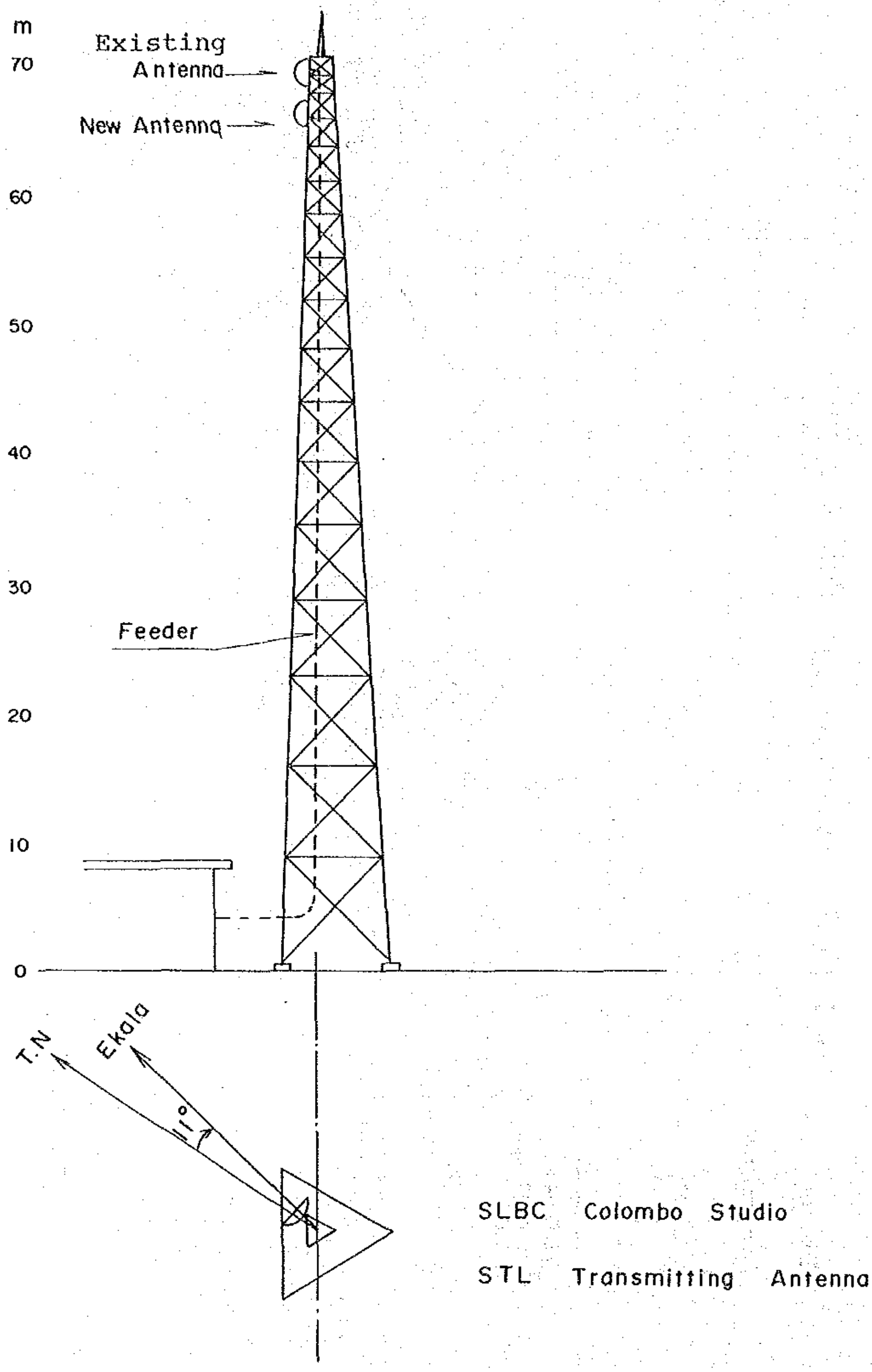
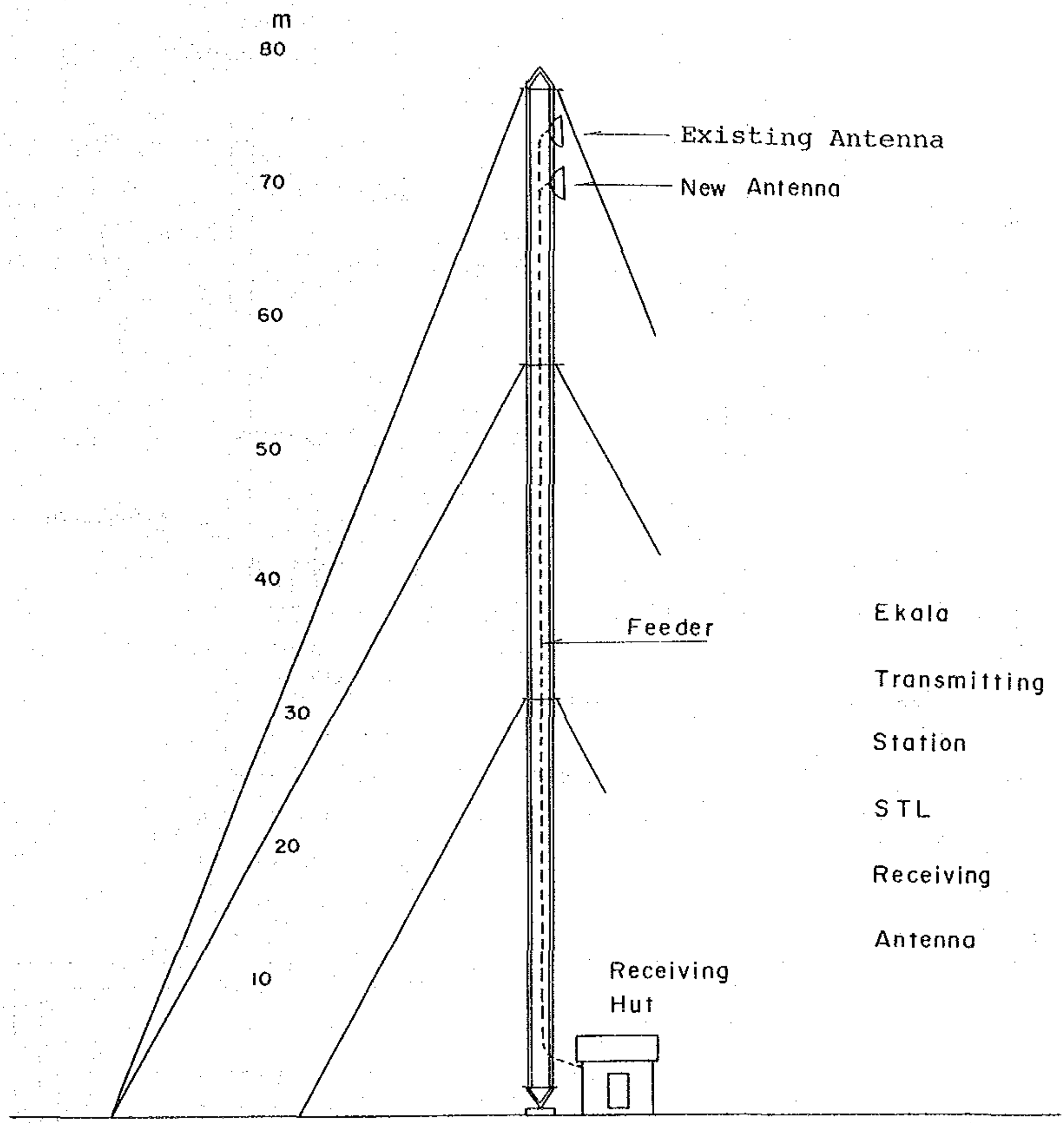


Fig. 4-2-8 Side View of Antenna Tower



Ekala Transmitting Station STL Receiving Antenna

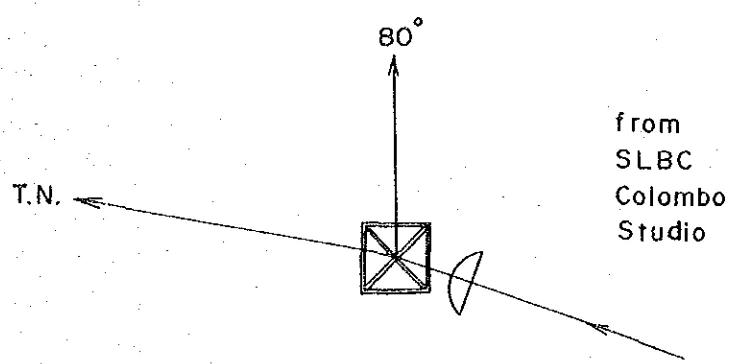
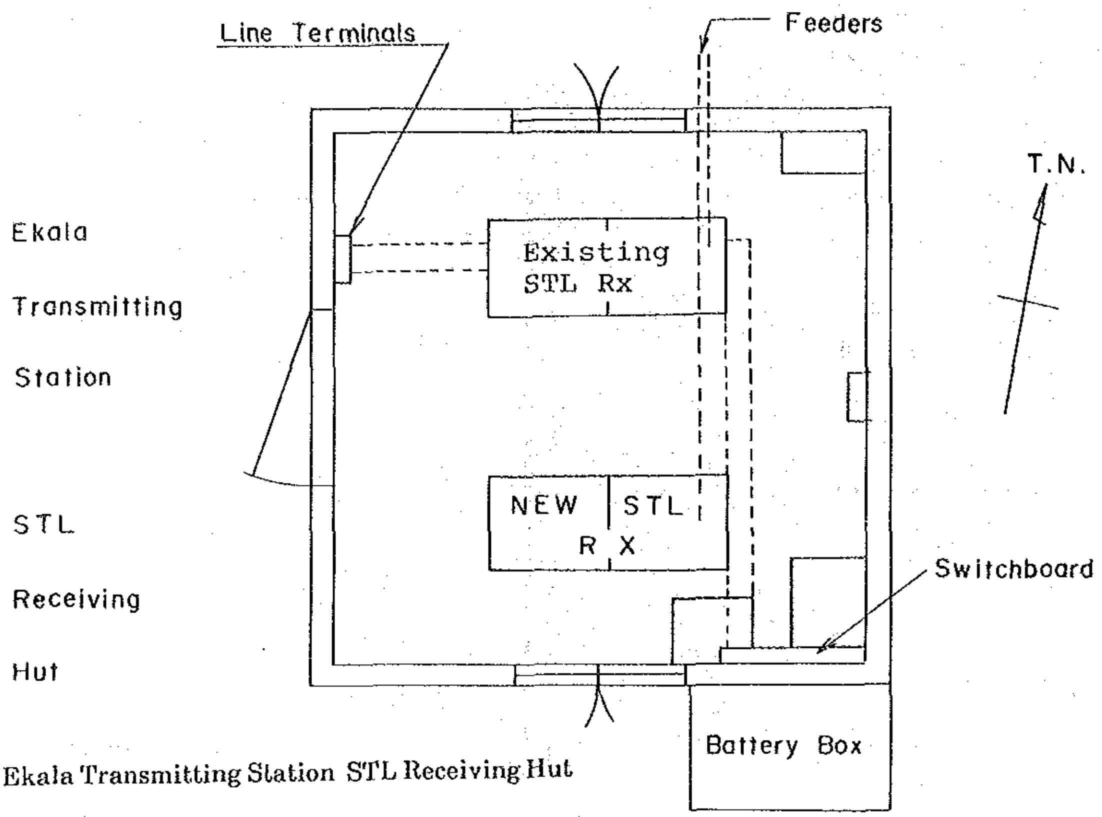


Fig. 4-2-9 Side View of Guyed Tower



Ekala Transmitting Station STL Receiving Hut

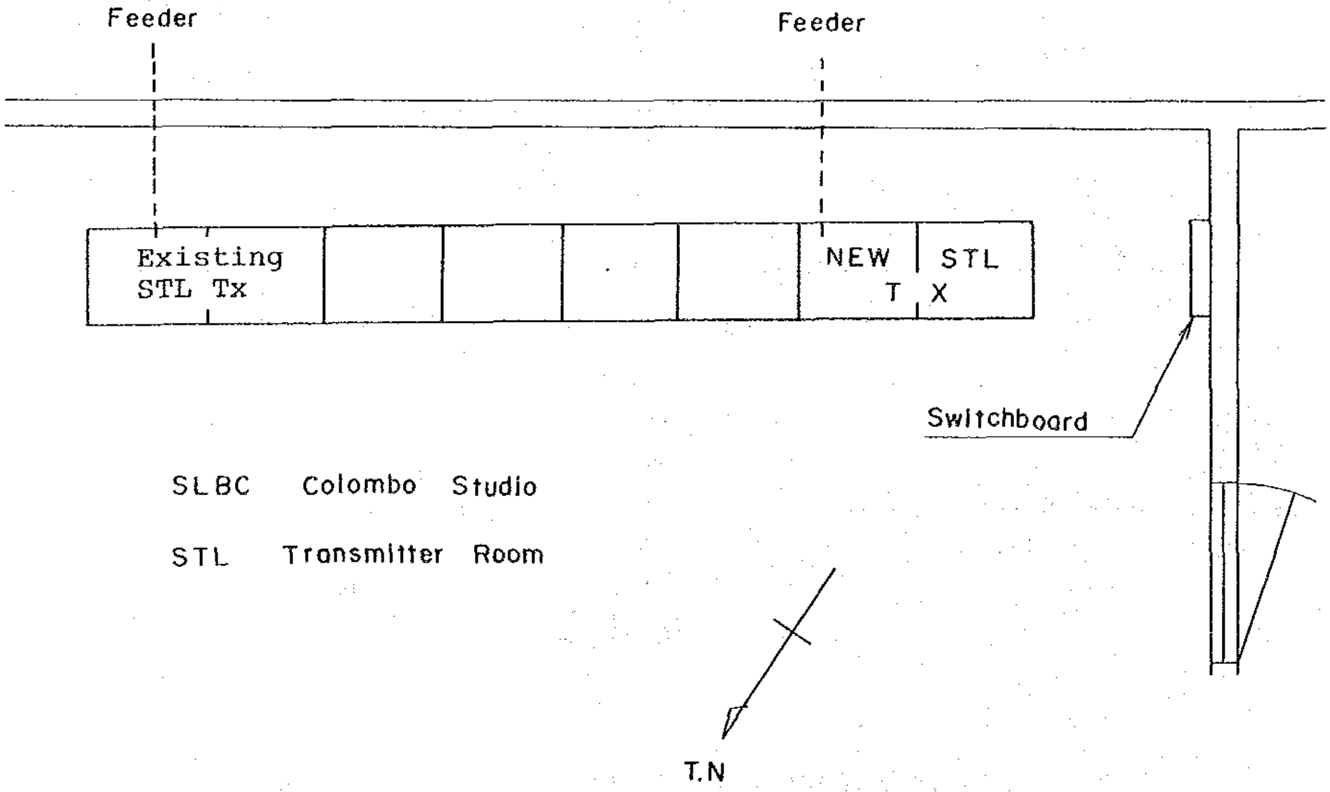


Fig. 4-2-10 Arrangement of Equipment in the Receiving Hut and in the STL Room in the SLBC Studio

4-3 New Antenna System

4-3-1 Location of the Antennas

Fig. 4-3-1 shows the proposed site for the new antennas. In order to minimize the mutual effects, such as interference, on the existing antennas, a site as close as possible to the border of the western premises has been chosen.

4-3-2 Antenna and Supporting Tower

(1) Antenna Types

The antenna types have been chosen considering the basic concepts of the SLBC's improvement plan and technical conditions, such as present utilization of frequencies and future plans, propagation characteristics of shortwave (high band frequencies for long distance services and low band frequencies for short distances are more advantageous), and also taking into account economies in construction and operational costs.

Specification/parameters for the antennas studied and the great circles centered on Colombo are shown in Table 4-3-1 and Fig.4-3-2 respectively.

Table 4-3-1 Specification of Wideband Curtain Antennas

Type	Gain (dB)	Vertical Beamwidth (°)	Take-Off Angle (°)	Vertical Beamwidth (°)
HR 4/4/1	19~20	35°	8°	10°
HR 4/4/0.5	19~20	35°	10°	12°
HR 4/2/1	17~18	35°	12°	15°
HR 4/2/0.5	17~18	35°	18°	20°
HR 2/2/1	14~15	70°	12°	15°
HR 2/2/0.5	14~15	70°	18°	20°

Note: Data are numerical values at the central frequency.

Note : Abbreviations for indicating the type of curtain antenna are as follows:

```
H R R S m/n/h
│ │ │ │ │ │ └── Height of lower antenna element in wavelength
│ │ │ │ │ └─── Number of antenna elements arrayed vertically
│ │ │ │ └──── Number of antenna elements arrayed horizontally
│ │ │ └───── With slew function, beam slew is possible
│ │ └────── Reversible function of direction of radiation
│ └─────── With reflective curtain element
└──────── Horizontal polarization
```

1) For the Middle East/Australia

(a) When seen from Sri Lanka, the Middle East region is located within the range of 35° and 40° in terms of horizontal angle, and 3,000km - 6,500km in terms of distance.

So, if it is planned to use a single-hop service to the region with such a location as outlined above, the vertical emission angle has to be 5°, with the result that the vertical beam width would be as narrow as 7°. Consequently, in more than a half of the Middle East region, the propagation of the signals would become unstable. Thus the most appropriate kind of service would be one with a propagation mode of two-hop propagation, the first step taking place at a distance of about 3,000km from the originating station. In order to conduct this service, the HR 4/2/1 would be the most suitable type of antenna.

The reason for this is that referring to Table 4-3-1, the horizontal beam width of HR 4/2/1 is 35° which approximately coincides with the above mentioned requirement as to the horizontal angle covering the Middle East area; 35°~40°.

Also, with regard to the takeoff angle, the HR 4/2/1 has 12°, which is the optimum angle to obtain 3000km as the first step point by reflecting the radiated signal at the ionospheric layer about 300km above the earth.

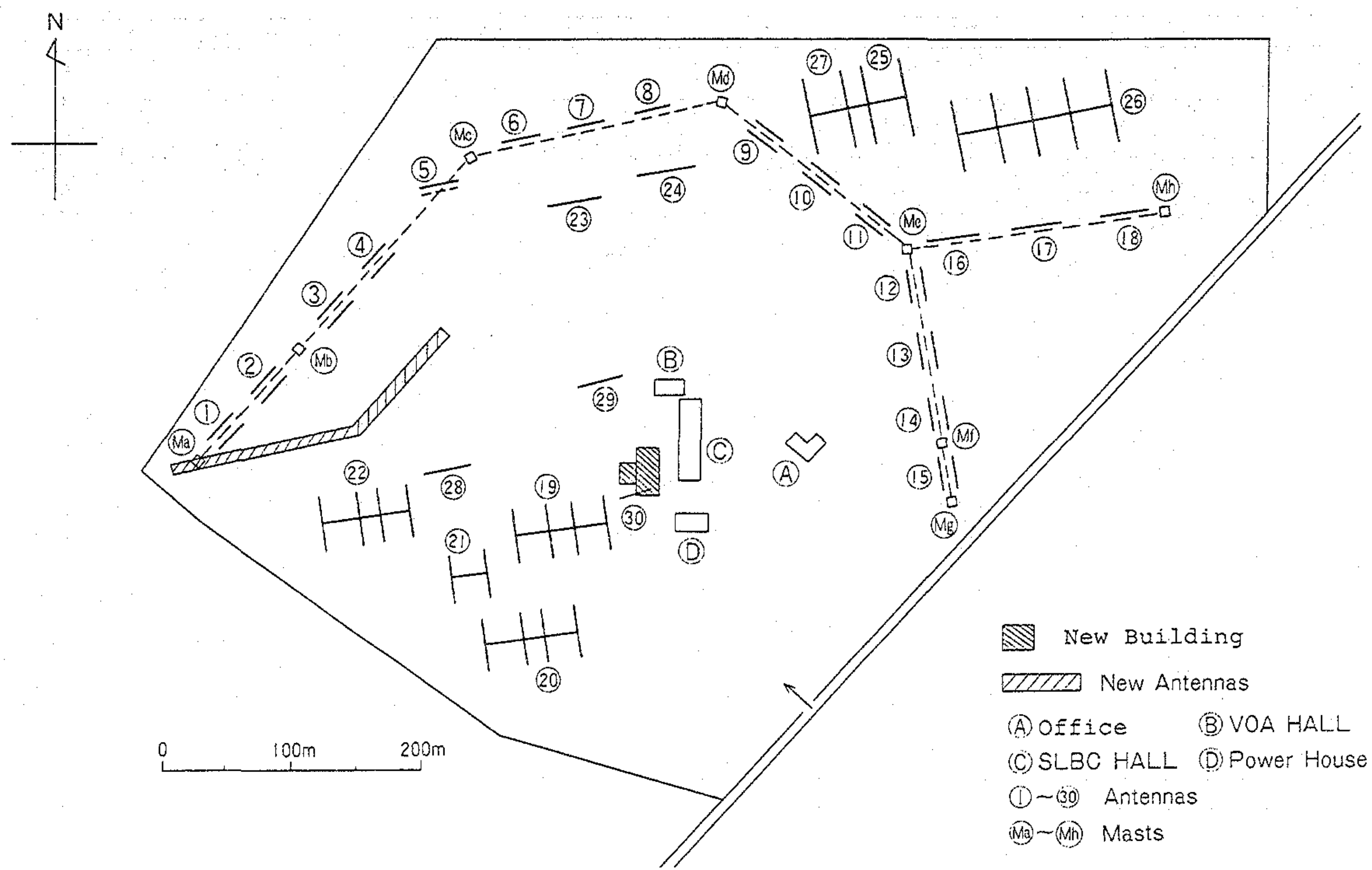


Fig. 4-3-1 Arrangement of Antennas at the Ekala Station

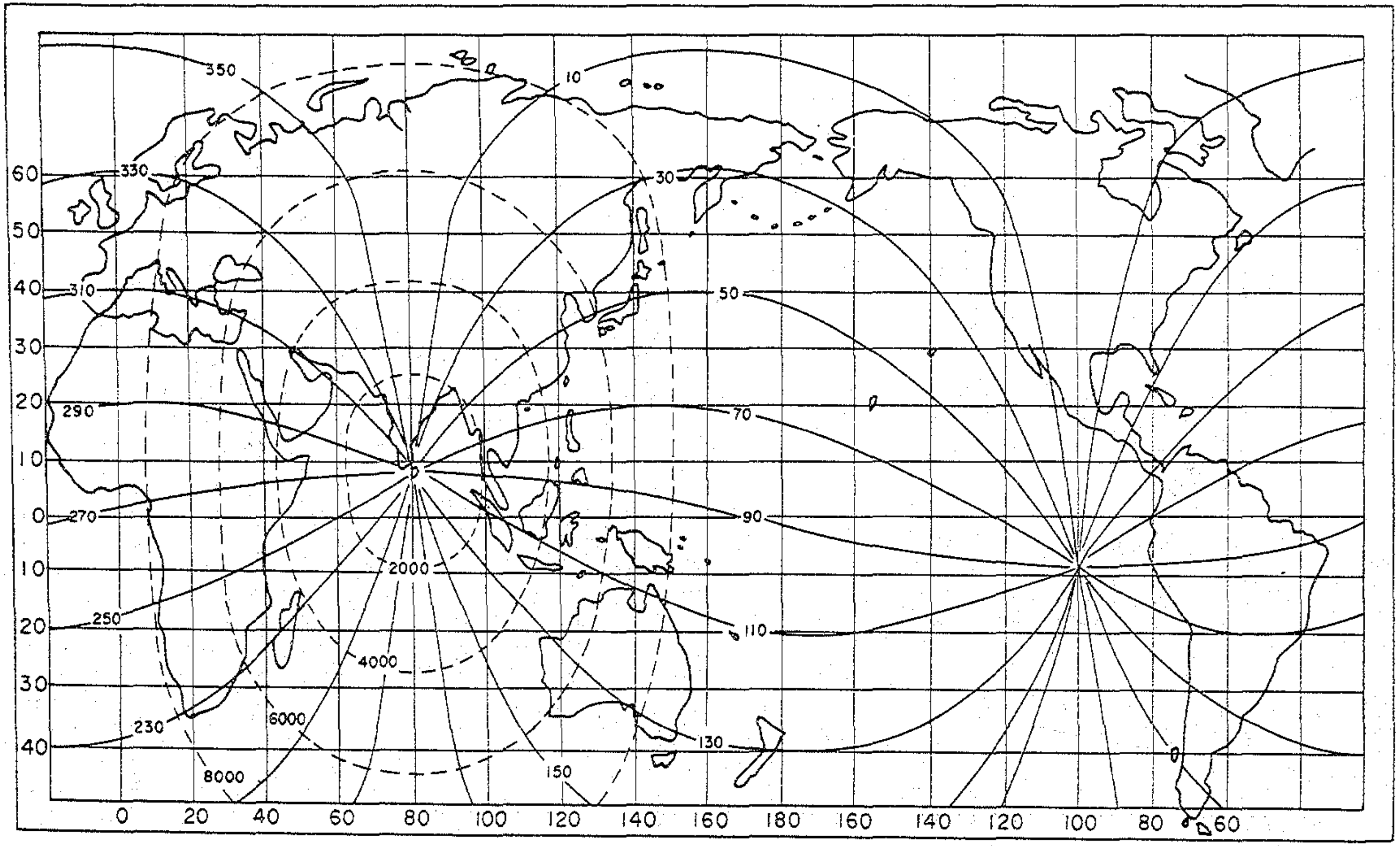


Fig. 4-3-2 Map Showing the Great Circle Centered on Colombo

(b) For broadcast to Australia, the reflection curtain used is also that used for broadcast to the Middle East, since Australia is located in exactly the opposite direction from the Middle East and therefore has similar conditions.

(c) As for the frequency bandwidth to be covered by the antenna , it is specified at 11 MHz - 21 MHz so that the frequencies in current use for the Middle East/Australia may continue to be used.

(d) Further, in order to secure services for northwest India, Pakistan and Afghanistan, the antenna is designed to give the slew in the direction of the north by shifting the phase of the r.f feeding signal to each antenna element horizontally.

The antenna type for the Middle East/Australia that takes into account of the above-mentioned conditions is the HRRS 4/2/1 which has an S suffixed to the HRR 4/2/1. S means slew. Slew function is given to the No.4 antenna.

(e) As for the directions, 310° was selected for the Middle East and 130° for Australia, almost the same as at present.

2) For India

In order to serve the Indian subcontinent as uniformly and efficiently as possible, it would be necessary to ensure that the horizontal beam width is about 70°, the take-off angle is 15°-25° and the vertical beam width, more than 15°. Taking these conditions into account, and referring to Table 4-3-1, the HR 2/2/0.5 would be the most appropriate type to be used.

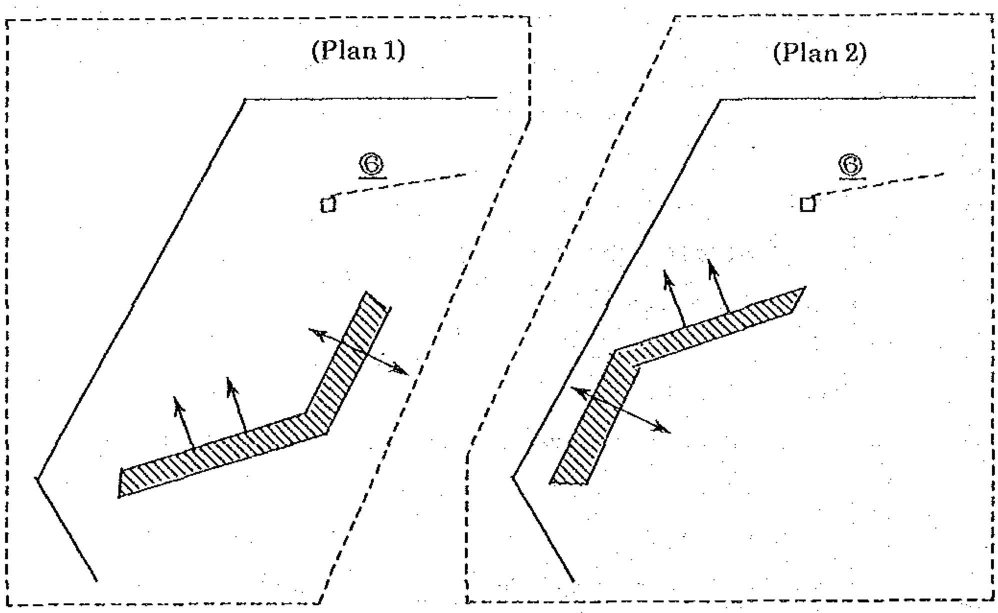
HR 2/2/0.5 has a 70° horizontal beamwidth, 18° takeoff angle and 20° vertical beamwidth which satisfy the above requirements.

As for the antenna frequency bandwidth to be covered, the frequency band from 6 MHz - 11 MHz was chosen. As for direction, 350°, the same as currently in use, could be taken.

(2) Arrangement

There are several possible combinations of antenna arrays. However, in view of the technical condition, economy and site conditions, the following two layout plans shown in Fig. 4-3-3 will be feasible. The first plan requires less coupling to the existing antenna No.6, so Plan 1 is chosen. As for the supporting towers, in consideration of economy and maintainability, two towers of 57 meters and 45 meters respectively are to be built. Arrangement and construction of antenna arrays are shown in Fig. 4-3-4.

Fig. 4-3-3 Arrangement Plan of the New Antenna



(3) Estimation of the improvement of field strength in the service area

The gains of the new and existing antennas for the Middle East/Australia are estimated at about 17dB and 10-12dB respectively. So, the degree of improvement achieved by the new antenna in the above-mentioned direction is estimated at about 5-7dB.

On the other hand, the gains of the new and existing antennas for the direction of India are estimated at about 14dB and 9-11dB. Consequently, the degree of improvement in reception in the region is estimated at about 3-5dB.

(4) Relations with existing antenna facilities

1) Of the existing antenna facilities, the No.1 - No.5 antennas, feeders and Ma-Mb towers are to be removed. (As to the numbers, refer to Tables 3-7-1 and 3-7-2)
2) The antenna facilities Nos. 28 and 29 are to be moved elsewhere. (Refer to Fig. 4-3-1)
3) As for the Siemens 100kW transmitter, it is designed to connect with the No.8 antenna through a matrix switch as it is.

(5) Installation of feeders

The feeder routes for the new antennas are shown in Fig.4-3-5.

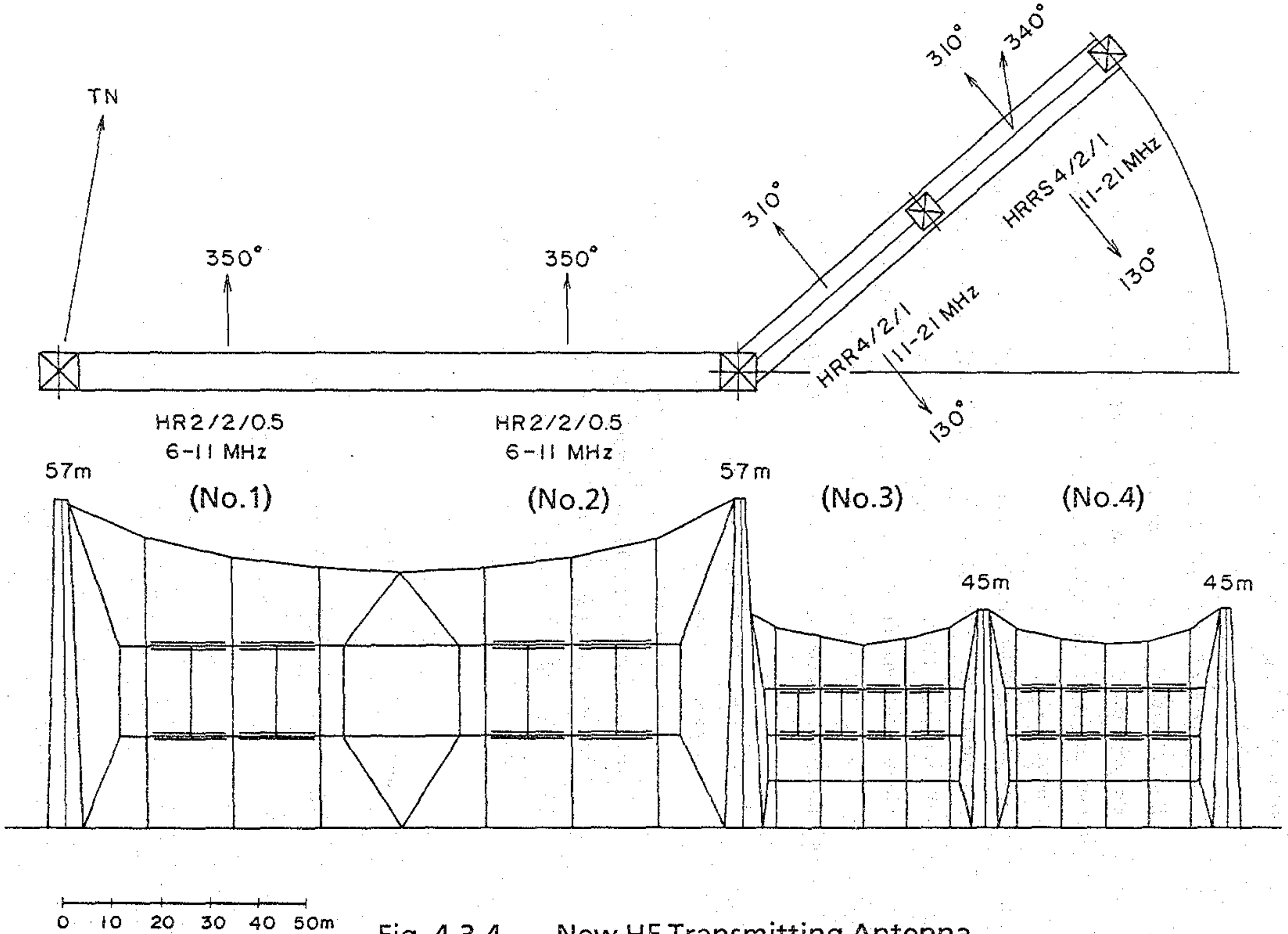


Fig. 4-3-4 New HF Transmitting Antenna

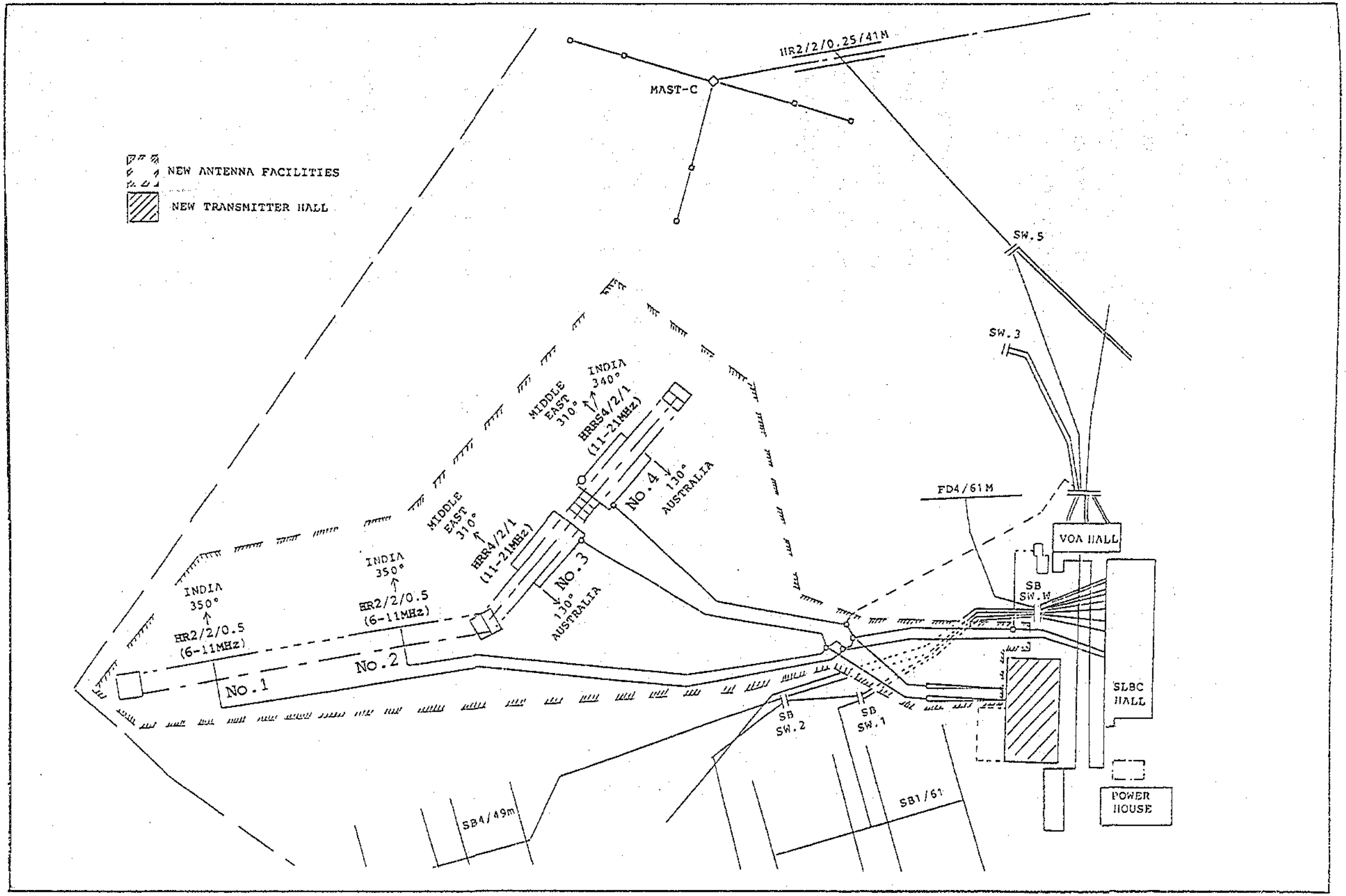


Fig. 4-3-5 Feeder Routes

4-3-3 Connection of Transmitters and Antennas

Connection of transmitters and antennas are made by feeder matrix switch. The matrices are composed of a group of switches. It is necessary to minimize the number of switches and to ensure flexibility in daily operation. The function must be closely related to the present programme schedule and also have increased capability for future requirements.

The whole system has to be designed and arranged primarily to fulfill the existing transmission schedule without any difficulty, as well as to accomodate new services to the Middle East and the Indian subcontinent with one 300kW transmitter and two new antennas (low band to India, high band to the Middle East). Extra matrix switches will ensure these services.

The other 300kW transmitter could be used to serve as a backup for the Marconi and Siemens transmitters and its companion 300 kW transmitter. From the considerations mentioned above, it is proposed to implement the schematic connection diagram shown in Fig. 4-3-6.

The switching will be controlled remotely from the New Hall with interlocked protection, to avoid any danger from handling the high-power equipment of more than 100kW.

The current manual matrix operation and switching for the 100kW transmitters is to be replaced with a new remote control matrix.

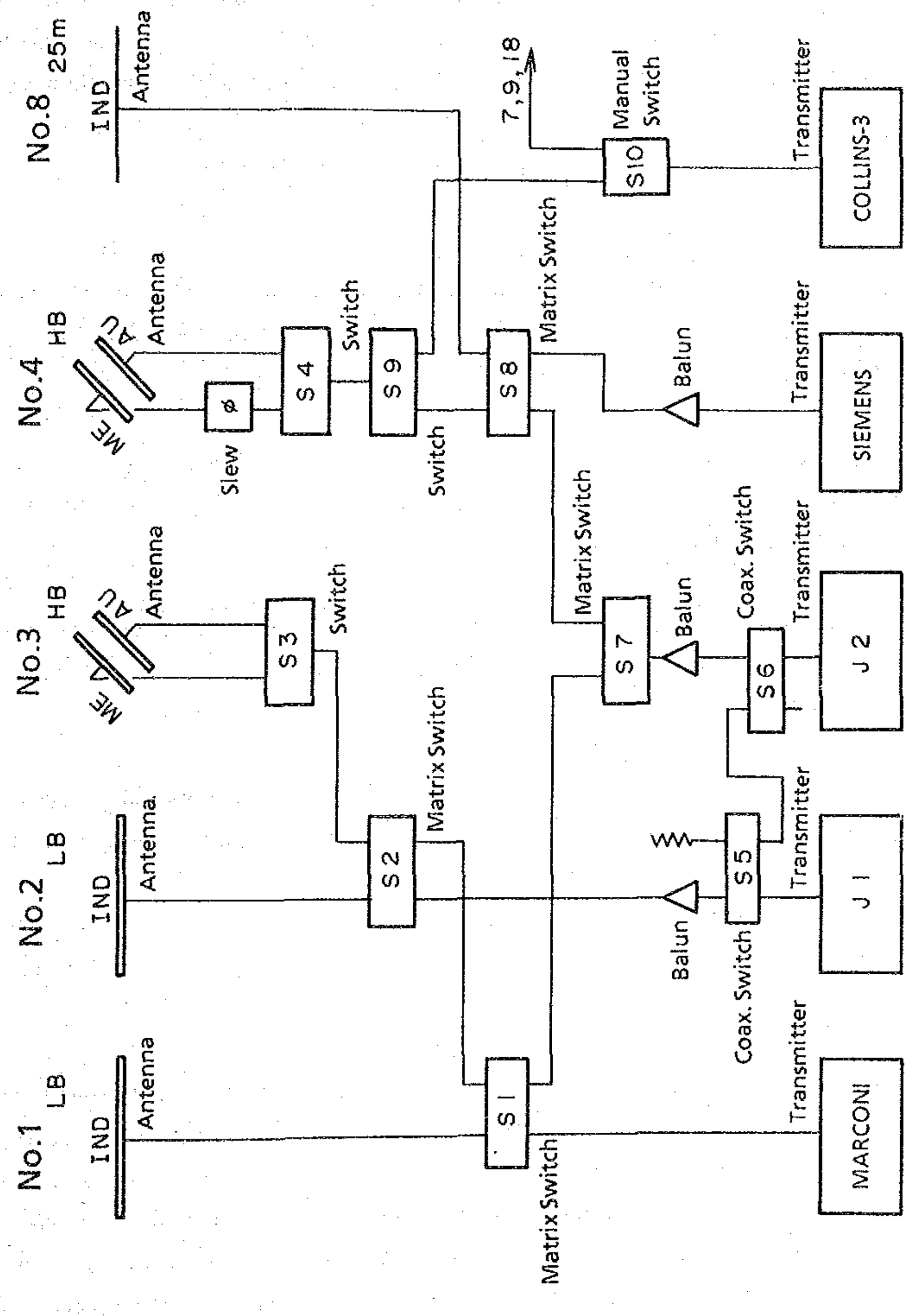


Fig. 4-3-6 Connection of Transmitters and Antennas

4-4 Shortwave Transmitters for Domestic Service

4-4-1 Replacement of 10kW Transmitters

Four of the existing 10kW transmitters (Nos.2-5) are to be replaced with new ones. The new transmitters could be driven with crystal oscillators (max: 6 frequencies) and a synthesizer. The output impedance of the transmitters is specified at 600 ohms so as to match existing domestic-use feeders.

The four new transmitters would use the dummy load in common, and each transmitter will be able to be switched to either of two feeders going out to the east and west sides of the building, as shown in Fig. 4-4-1.

The transmitters are to be controlled and operated from a control panel, and programme monitoring is to be conducted with equipment in the monitoring racks.

Fig. 4-4-2 shows the schematic diagram of the 10kW transmitters and Fig. 4-4-3, the arrangement of the four 10kW transmitters in the SLBC Hall.

Removal of existing equipment is to be conducted by the SLBC and the installation of new equipment is to be carried out with the cooperation of the SLBC and the contractor.

The installation work will be done according to the following steps.

The existing No.2 and No.3 transmitters are to be removed and replaced with new transmitters. The No.4 and No.5 transmitters will then be replaced with new ones so as not to interfere with the broadcasting. Exhaust air from the transmitters is to be blown out in the room, but an exhaust fan will be installed in a window just by the upper portion of the No.2 transmitter to lower the temperature in the room.

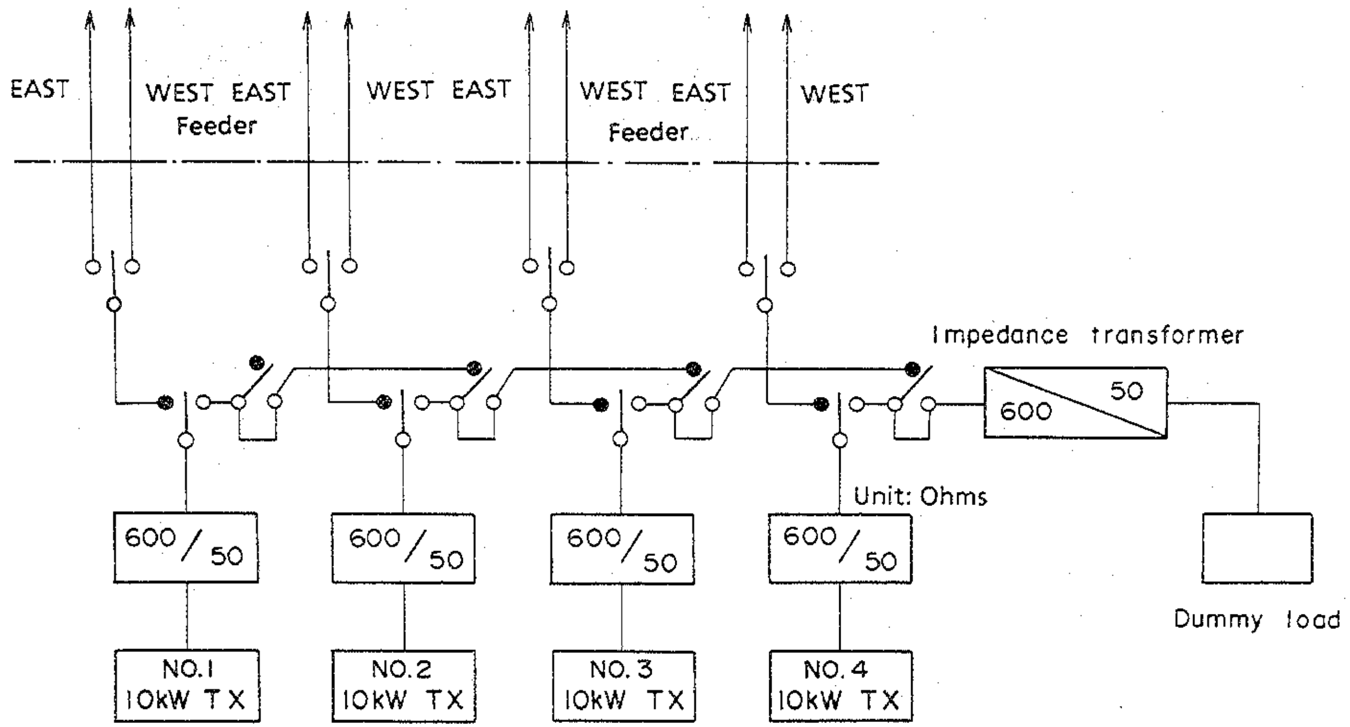


Fig. 4-4-1 Output Circuits of 10kW Transmitters

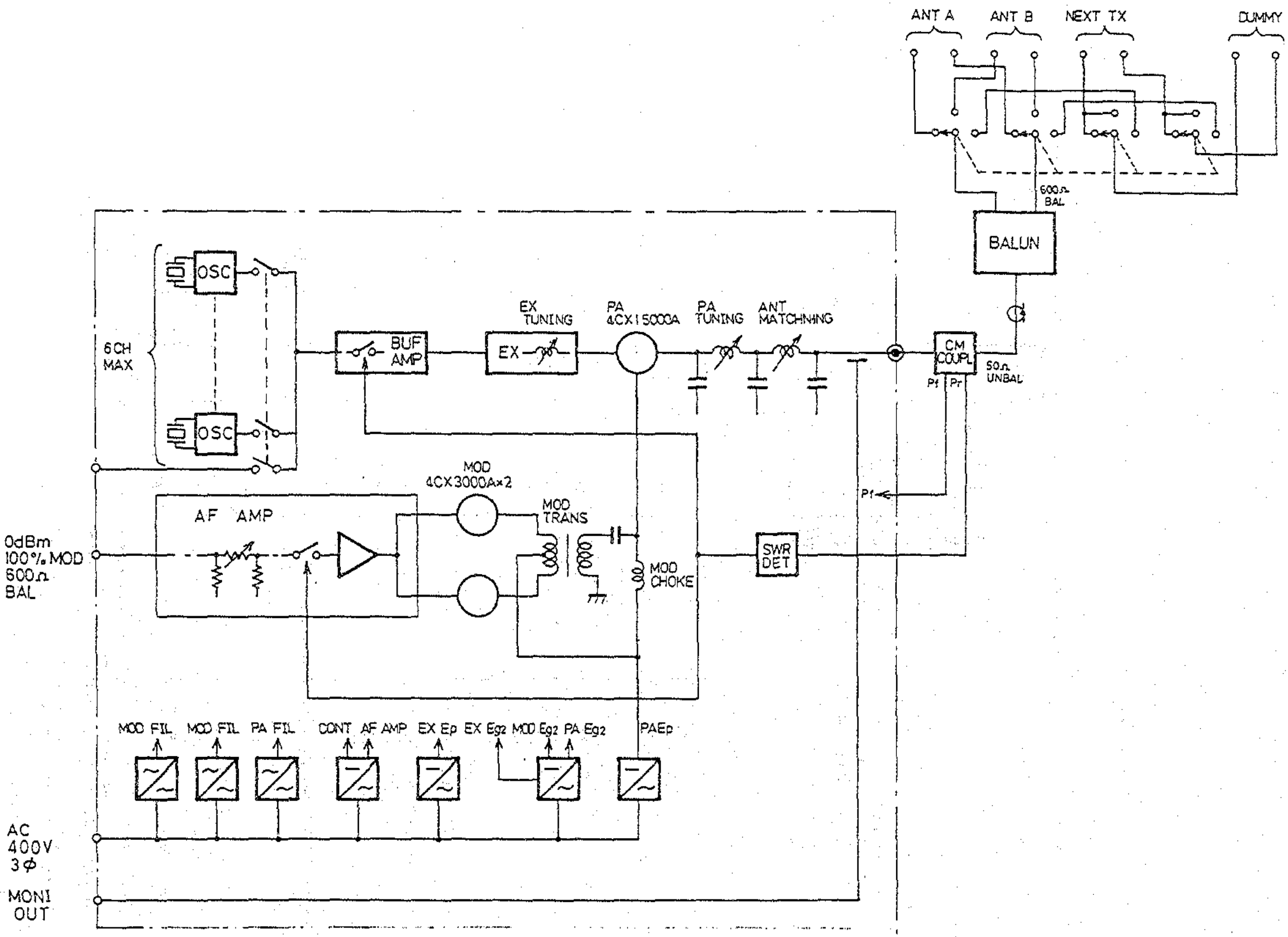


Fig. 4-4-2 Schematic Diagram of 10kW Transmitter

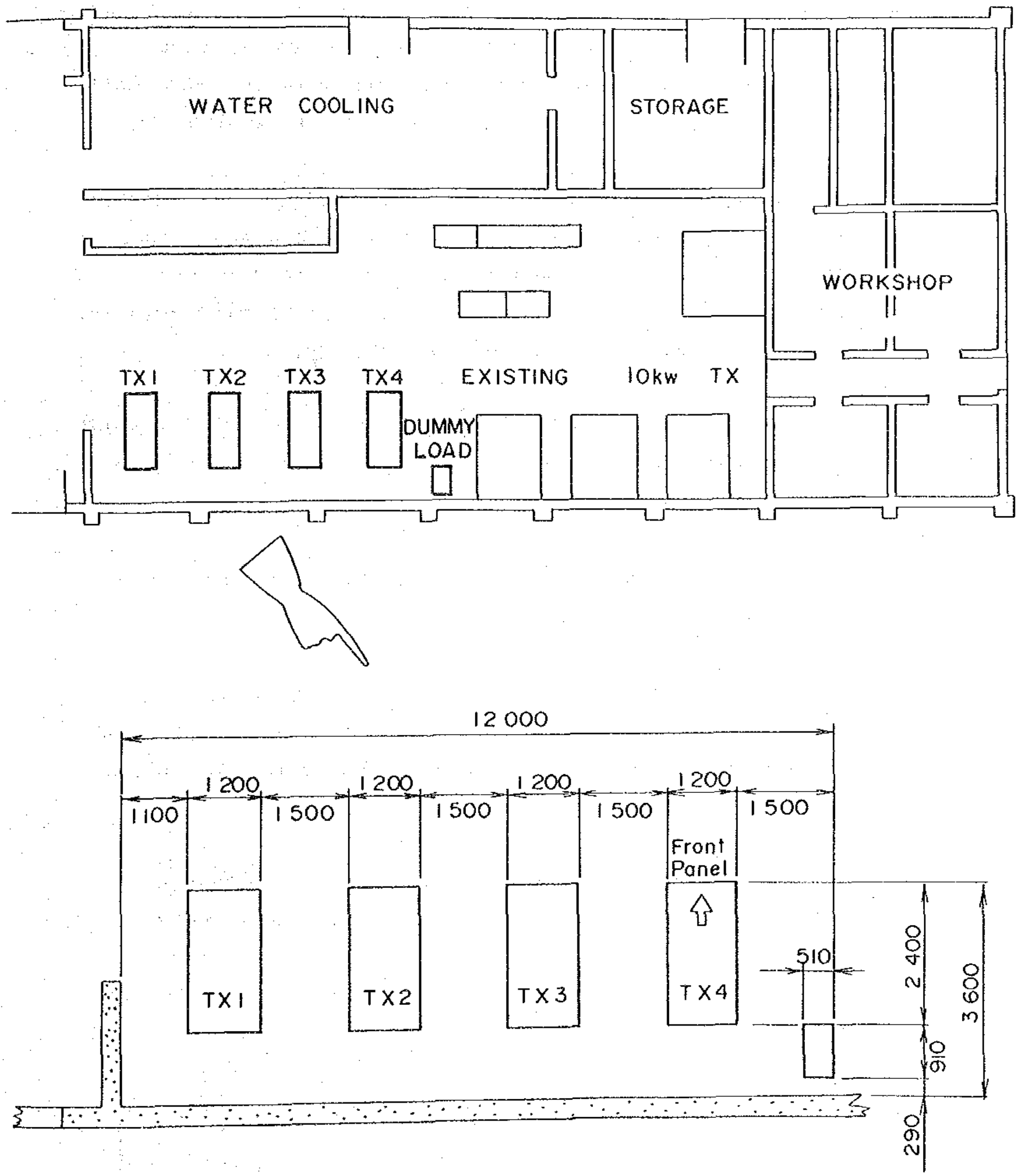


Fig. 4-4-3 Arrangement of 10kW Transmitters in the SLBC Hall

4-4-2 Control and Supervisory Equipment

(1) Programme Input (See Fig. 4-4-4)

Programmes for the Domestic Service are to be sent first from the New Hall to the matrix circuit in the SLBC Hall, and then sent to the transmitters via limiter amplifiers.

Monitoring of programmes is to be carried out by switching the selecting buttons connected to the input and output of the limiter amplifier and transmitters, and the modulation and input levels are also to be monitored with parallel level indicators and VU meters respectively.

An oscilloscope mounted in the monitoring rack will display the modulated waveform by selecting one of the four r.f. modulated signals.

Measuring equipment will also be provided for common use in the SLBC and New Halls.

A clock driven warning buzzer, interphone and all-band receiver will also be installed in the rack to verify the operation of equipment and the monitoring of off-air programmes.

In Fig. 4-4-4, a schematic diagram of the input and monitoring circuits of a shortwave transmitter is shown.

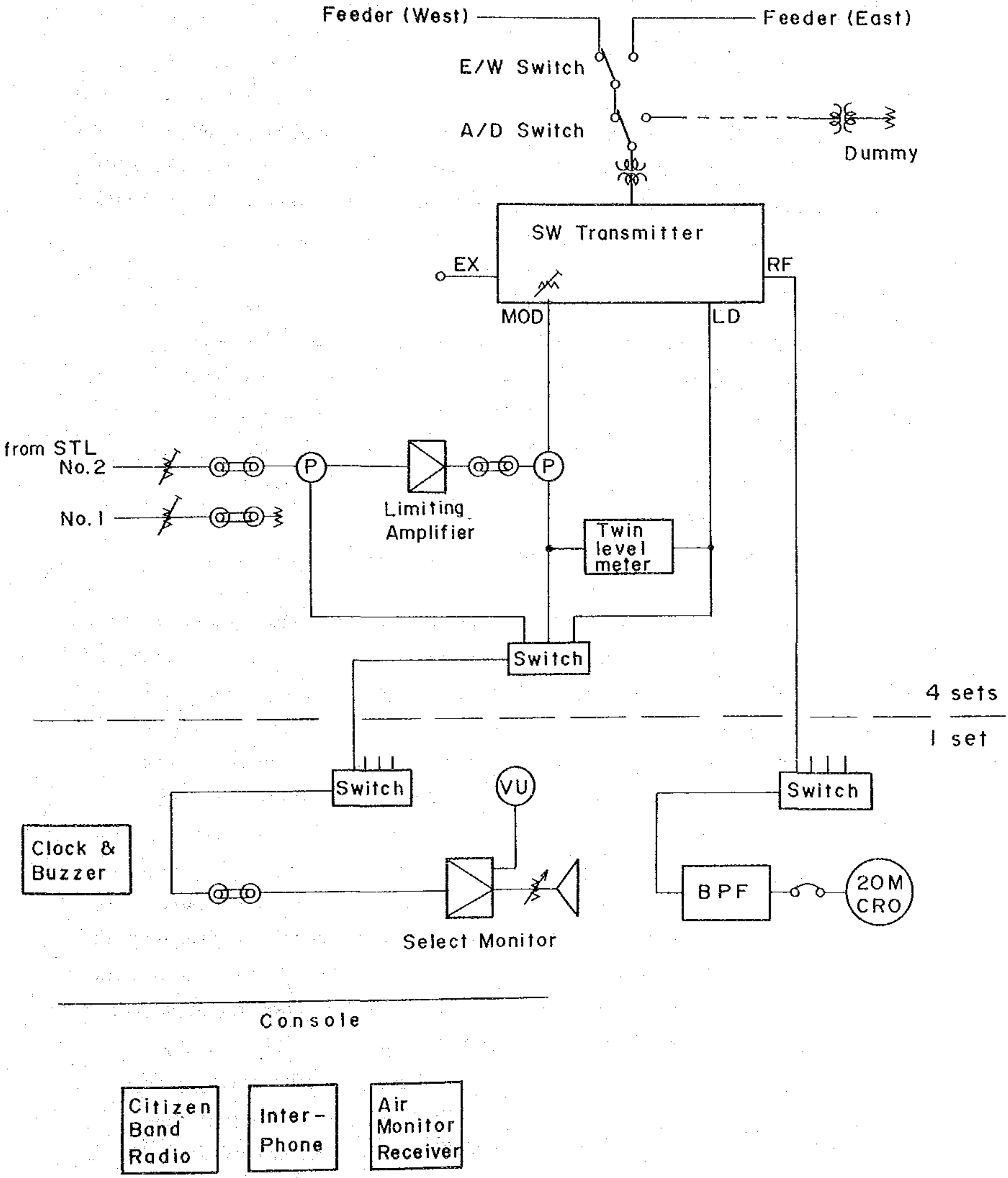


Fig. 4-4-4 Input & Monitoring Circuits of SW Transmitters

4-5 Power Supply

4-5-1 Increase of Load Capacity

(1) The load capacity of the station will be increased by approximately 1940 kVA, as shown in the following list, from the present load of approximately 1240 kVA, so the total demand capacity would become 3180 kVA.

Increase of load capacity

300 kW transmitter (×2)	1900kVA	(at 100% modulation)
Ventilation	15kVA	
Illumination	5kVA	
STL	1kVA	
Matrix switch	2kVA	
Miscellaneous	10kVA	
Total	1,943kVA	

(2) Power consumption of shortwave transmitters is not always constant. Maximum power consumption appears at the time of 100% modulation and minimum consumption at 0% modulation (no modulation).
Accordingly, the power consumption of transmitters is calculated assuming an average modulation degree of 40%.

The practical increase of power consumption of a transmitter equivalent to 40% modulation is about 8% compared with no modulation, and the overall efficiency of the transmitter is assumed to be 52%. Therefore from the relation shown below, average power consumption of a 300kW transmitter P_c can be calculated as follows:

$$\text{Overall efficiency of TX} = \frac{\text{R.F output power of TX (kW)}}{\text{Power consumption of TX (kW)}}$$

TX : transmitter

Power consumption of a 300 kW transmitter (Pc) per set will be as follows on the assumption that the average degree of modulation is 40%:

P_c = 300kW x 1.08 x 1/0.52 = 623 kW

(3) Power consumption by hour each day changes greatly reflecting the discontinuation of programme transmission by each transmitter.

In Fig.4-5-1, the estimated change of power consumption of existing transmitters is shown by the white bar portion, based on the present programme schedule. The expected increase in the power consumption of a 300 kW transmitter is shown by the dotted bar for operation from 6:30 to 10:30 and from 18:30 to 24:30. In practical terms, an equivalent increase in power consumption will be added by another 300kW transmitter.

4-5-2 Exclusively Used Electric Power Lines

At present, the CEB plans to construct a new 20MVA substation at point "B" in Fig. 4-5-2. The tender contract has already been concluded on the installation of a 165kV power transmission line from the Gumpaha substation (A) to the new substation (B), and on the new substation facilities, and the construction work is expected to be completed by the end of 1989. From the substation at point (B) to the Ekala Transmitting Station, the distance in a straight line is less than 2km. If the SLBC wishes, the CEB will draft a plan, estimate the construction expenses and notify the SLBC of the plan and estimated cost, so that the construction work may be started promptly upon receipt of payment from the SLBC.

Before actually starting the construction, the CEB will have to negotiate with the landowners for permission to erect poles

Note : Dotted areas indicate the increase of power consumption when a 300 kW transmitter operates 10 hours from 5:30 to 10:30 and 18:30 to 24:30 and does not include another 300kW transmitter

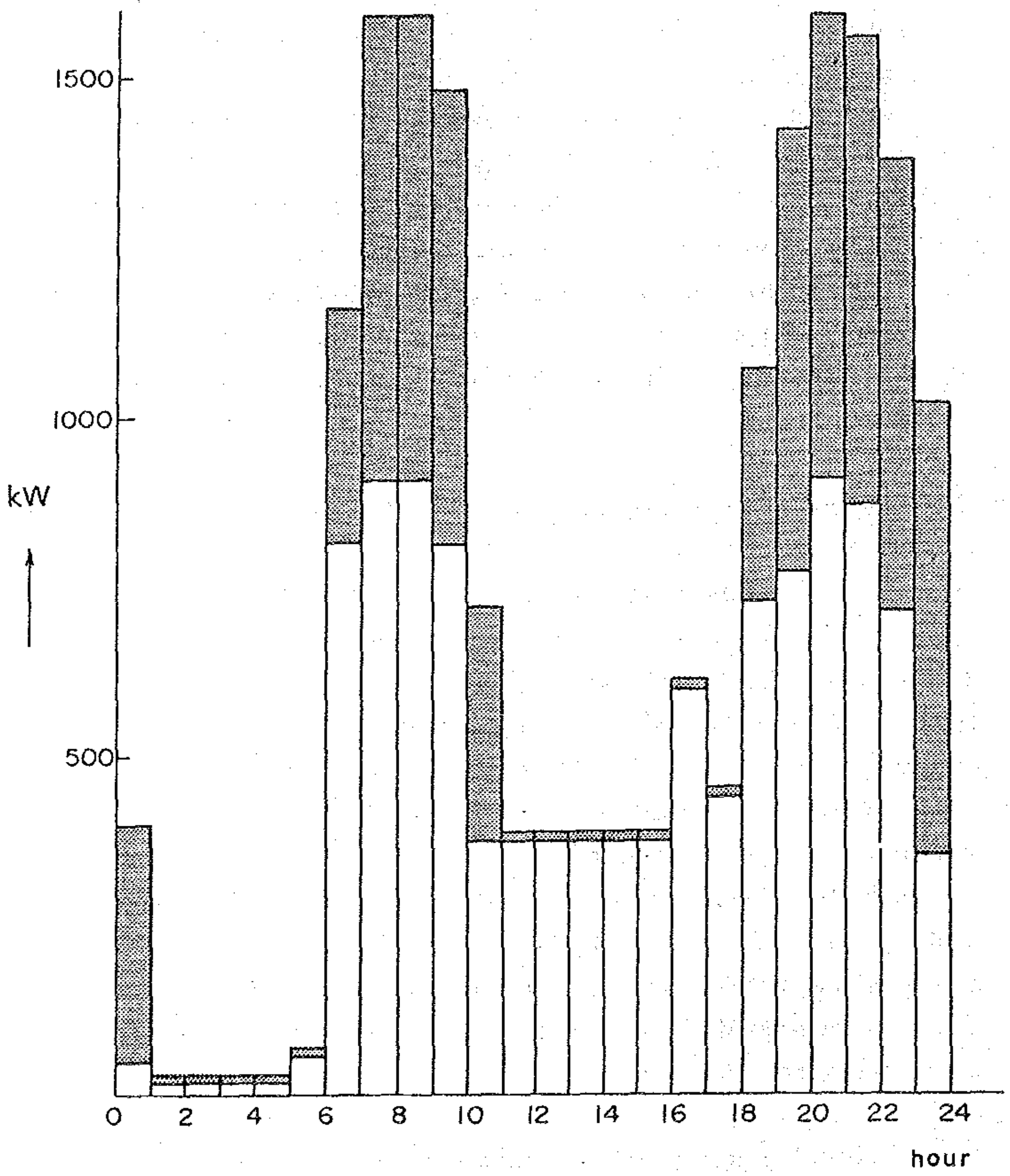


Fig.4-5-1 Estimated Change of Power Consumption by Hour

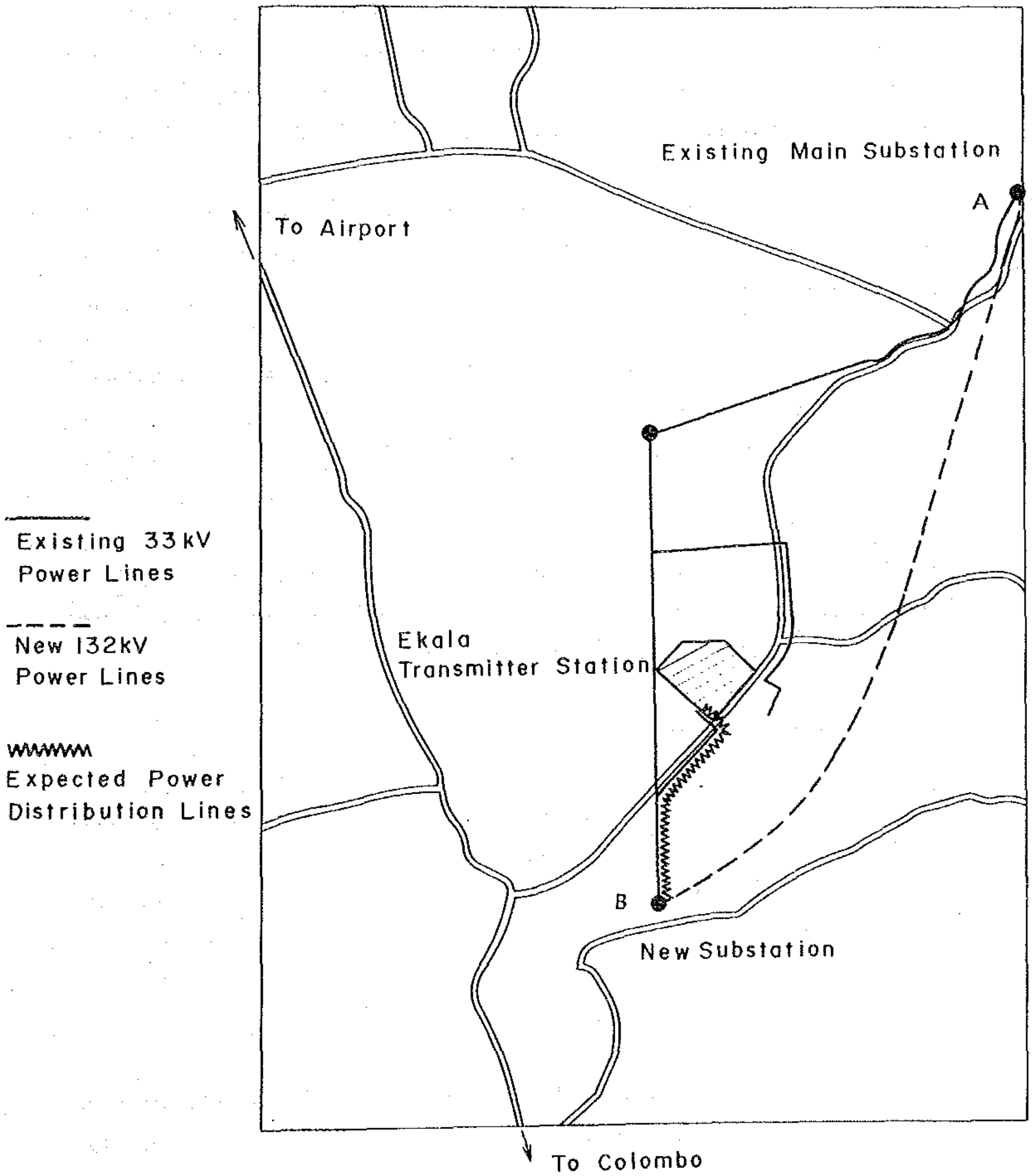


Fig. 4-5-2 Map Showing the Route of Electric Power Lines

and to cut down trees. Such negotiations would take a minimum of six months.

A shortwave transmitting station is required to pay power charges at the same rate as a general type of factory. This means that the station is required to pay three kinds of charges; a demand charge (Rs/kVA), a unit charge (Rs/kWH) and a fixed charge (Rs).
Meanwhile, the SLBC's share for the construction of the new electric power lines is estimated as follows: (Amounts shown in parentheses are tentative estimates)

(1) The share of the increment of the load capacity. (380,000Rs)
(2) The cost of the substation. (900,000Rs)
(3) The cost of the distribution lines.(2 km) (679,000Rs)
(Total=1,960,000Rs)

In the case of the Ekala Transmitting Station, the estimated amount payable in connection with the construction of the new power lines and substation is about 1,960,000Rs.

4-5-3 High Voltage Receiving Equipment

Existing and new power receiving equipment are to be connected to the new electric power lines. An outdoor type transformer is to be installed along the south side wall of the new building. (See Fig. 4-5-3)

4-5-4 Power Supply in the New Building

Power supply to the New Hall is shown in the schematic diagram of Fig. 4-5-4 and the arrangement of equipment is shown in Fig. 4-5-3. Electricity received at 33kV is stepped down to 6.6kV and 200V to supply each of the new transmitters and to serve miscellaneous equipment. An independent transformer (6.6kV/230V)

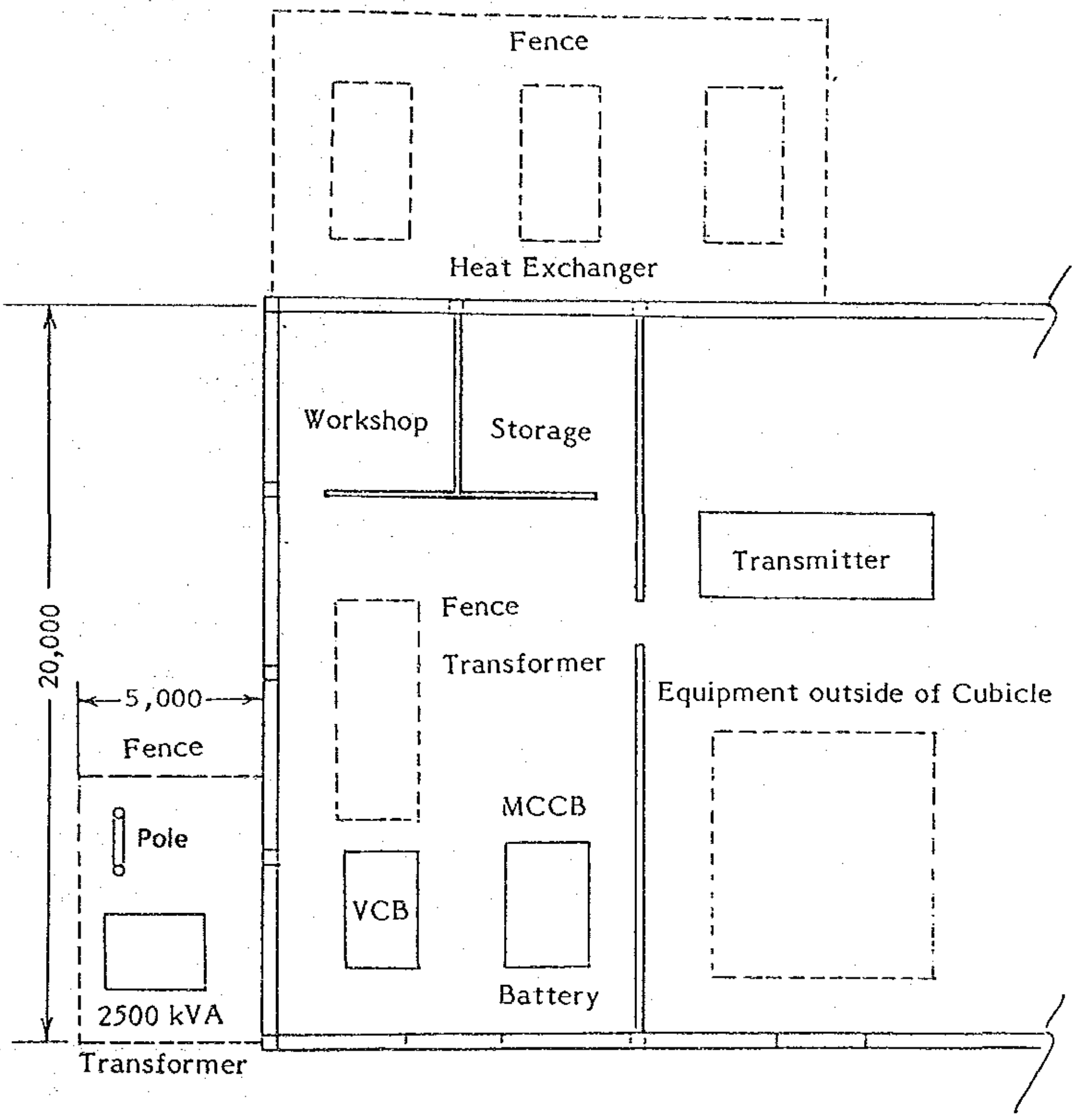


Fig. 4-5-3 Location of Power Receiving Equipment

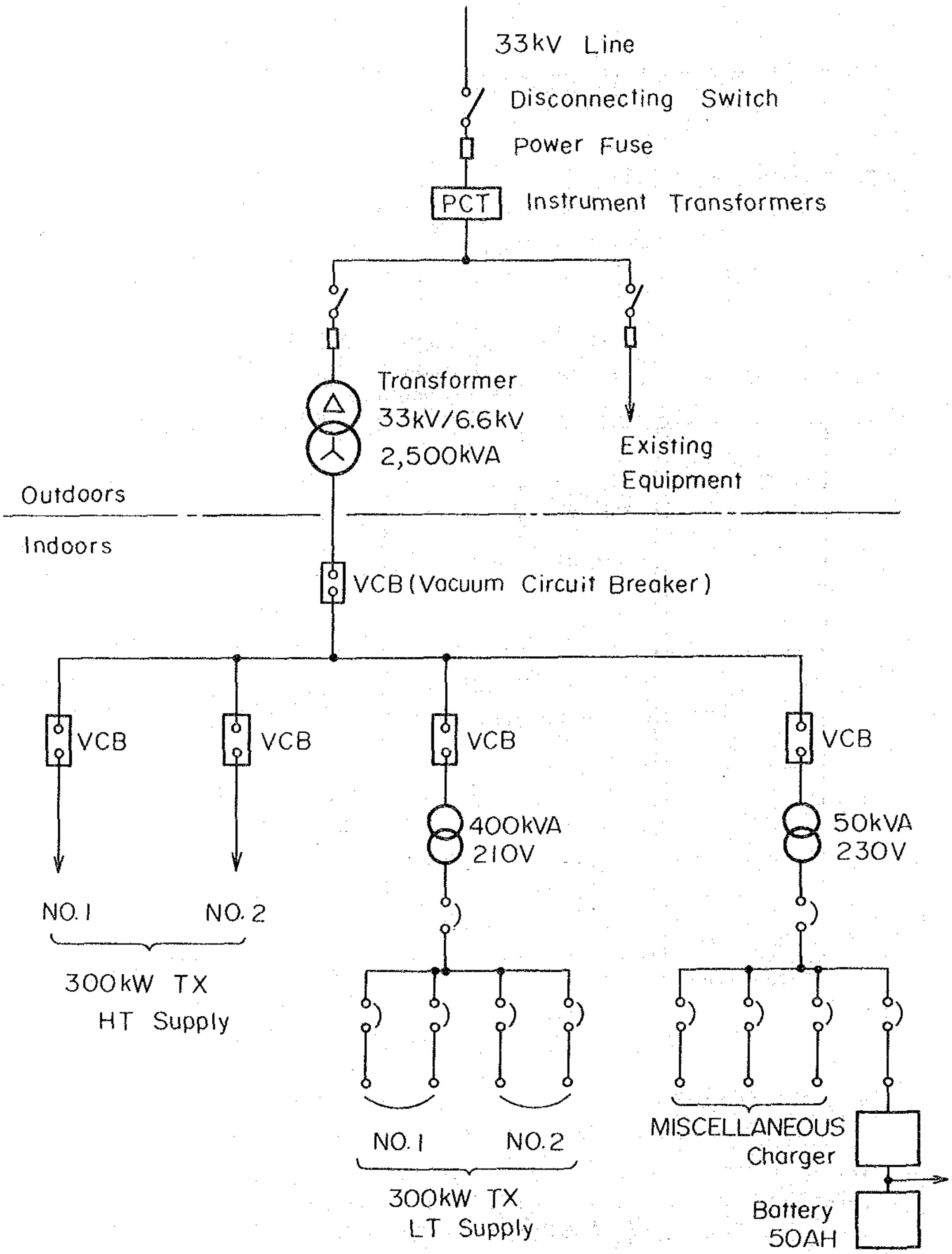


Fig 4-5-4 Schematic Diagram of New Power Supply

is to be provided together with batteries and a charger for circuit breaker use and so on.

As mentioned previously, the new power lines are to be of a very short length and near the new substation which provides sufficient capacity, and the lines will be for exclusive use, providing almost ideal conditions for a stable power supply. Accordingly, provision of an automatic voltage regulator (AVR) is not planned.

4-6 Measuring Equipment and Spare Parts

4-6-1 Measuring Equipment

The transmitter system intended for the Project is to be provided with sufficient features necessary for its operation and maintenance. However, the following equipment and measuring devices for maintenance and adjustment, as shown in Table 4-6-1, are for common use.

Table 4-6-1 List of Measuring Equipment

Instrument	Q'ty	Remarks
Oscilloscope	2	40MHz, Dual with H.T. Probe
Spectrum Analyzer	1	With Plotter, 0 to 3.5GHz
Audio Test Set	1	0 to 20kHz
Power Meter	2	Absorption and forward type
Signal Generator	1	50kHz to 30MHz
R. F. Volt Meter	1	10kHz to 100MHz/300μV to 3V
Frequency Counter	1	1000MHz
LCR Meter	1	1mH to 1μH, 0.1μF to 1pF.
Megger	1	500/1000V
Clamp Ammeter	1	
Reducer	1	205D to N type connector
DC High Voltage Meter	1	30kV
DC Volt & Current Meter	1	3,000 V, 50 Amperes max.
Button Attenuator	1	60dB
Field Intensity Meter	1	500kHz to 30MHz
AM Linear Detector	1	500 kHz to 30MHz
Decade Type Attenuator	1	60 dB
Measuring Rack	2	
Cart	2	
Circuit Tester	2	

4-6-2 Spare Parts and Procurement

The standards for storage of spare parts differ for each unit and amount used. Consideration also has to be taken of the life of each part. Procurement plans are made according to such factors as the importance of each part and the ease or difficulty of procurement of equivalent parts.

Generally speaking, in the case of transmitter tubes, which are considered as having the shortest life span of the various parts, it is preferable to store at least as many spares as those presently being used. Needless to say, where procurement is difficult, it is desirable to purchase spares in excess of what seems to be the right amount, but, in practice, one cannot ignore the financial aspect of the question.

Shortwave transmitters are generally not used continuously for long hours, but are used intermittently with some intervals in between. So, assuming that a transmitter is used 5,000 hours a year and that the average life of vacuum tubes is 5,000-10,000 hours, then the transmitter could be used for about one to two years. Since the availability of spare vacuum tubes would ensure the operation of the station for another one to two years, this means that the purchase of new transmitter tubes can be done during those two years.

In view of the difficulty of procuring special items, it is recommended that at least one replacement set should be held in stock at all times. However, in the case of items that are especially costly, such as power-source transformers and chokes, it would be better not to have any replacement in stock, in view of the fact that there is no problem with respect to stability.

However, an item like organic resin (ion exchange resin) for a water purifier, which is expendable, requires that a sufficient reserve to be kept in storage for about three years use (six times).

As for measuring instruments, it is not necessary in principle to consider replacement, except for such items as fuses.
Many of the transmitter tubes in the 100 kW transmitters currently in operation are outdated models, and there are considerable differences in their life expectancy. Table 4-6-2 shows the types of transmitter tubes currently being used in the 100 kW transmitters, the number of spares in stock (as of June 1, 1988), and the number needed to be carried as spares until completion of the Project. This calculation has been based on actual performance at the Ekala Station up to now.

Table 4-6-2 Stock of Spare Vacuum Tubes

(1) Siemens 100kW transmitter

Tube	Use	Number in use	Number in Stock	Q'ty to be supplied
C 3M	R.F amp	4	0	4
Rs 1003	R.F amp	2	0	3
Rs 1012V	R.F amp	1	4	1
Rs 1001V	R.F amp	1	2	2
Rs 1002A	Sub Mod	10	0	10
Rs 1031V	Mod	2	3	2
Rs 2001K	P.A	1	0	3

(2) Marconi 100kW transmitter

Px 25	Audio	2	0	4
TB 4/1250	Audio	2	9	-
3CX 2500A	Audio	2	2	2
807	R.F & Audio	10	0	15
PT-6	R.F & Audio	4	0	6
BEL-1000	R.F & Audio	2	3	1
BTW-6-3	R.F amp	2	3	1
BTW-25-3	P.A. & Mod	4	1	6

4-7 New Transmitter Building

4-7-1 Location on the Site

The present Ekala Transmitting Station has a centripetal layout in which the station buildings and their attached facilities are located roughly at the centre of the site and are surrounded by groups of antennas, with feeders stretching in all directions from the transmitting station buildings. From the gate a paved access path extends inward along which are built the SLBC Hall and the VOA Hall at the end. This access path ends with what looks like a plaza surrounded by a group of station buildings. In selecting the site for construction of a new building, too, the study team believes that consideration should be given so that the plan will be in conformity with the basic format of the entire layout of the present station as it is. (Fig. 4-7-1 Layout of the Ekala Transmitting Station)

The study team focused its studies on the western side adjoining the VOA Hall, the site considered at the time of the preliminary survey, and made comparisons with other locations. As a result, for the reasons given below, it was determined, after consultation with SLBC executives, to construct the new building to the west of the SLBC Hall, with the plaza at the end of the access path lying in between. (See Fig. 4-7-2).

(1) Construction of the new station building and installation of machines in the building will make it necessary to move a number of feeders as well as antennas and matrices from one place to another . Yet such construction and related work can be minimized.

(2) Locating the new building facing the SLBC and VOA halls across the plaza and close to the office building will rationalize the access between the buildings.

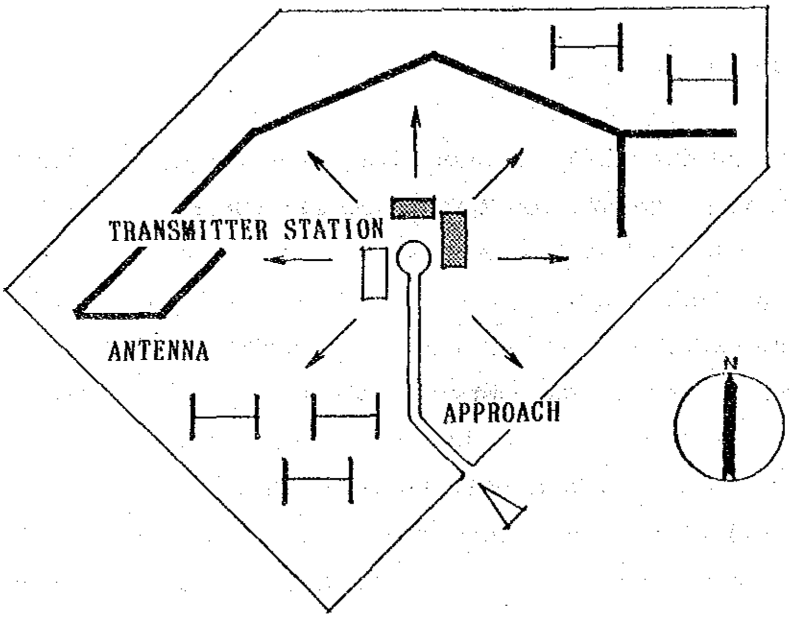


Fig. 4-7-1 Layout of the EKALA Transmitter Station

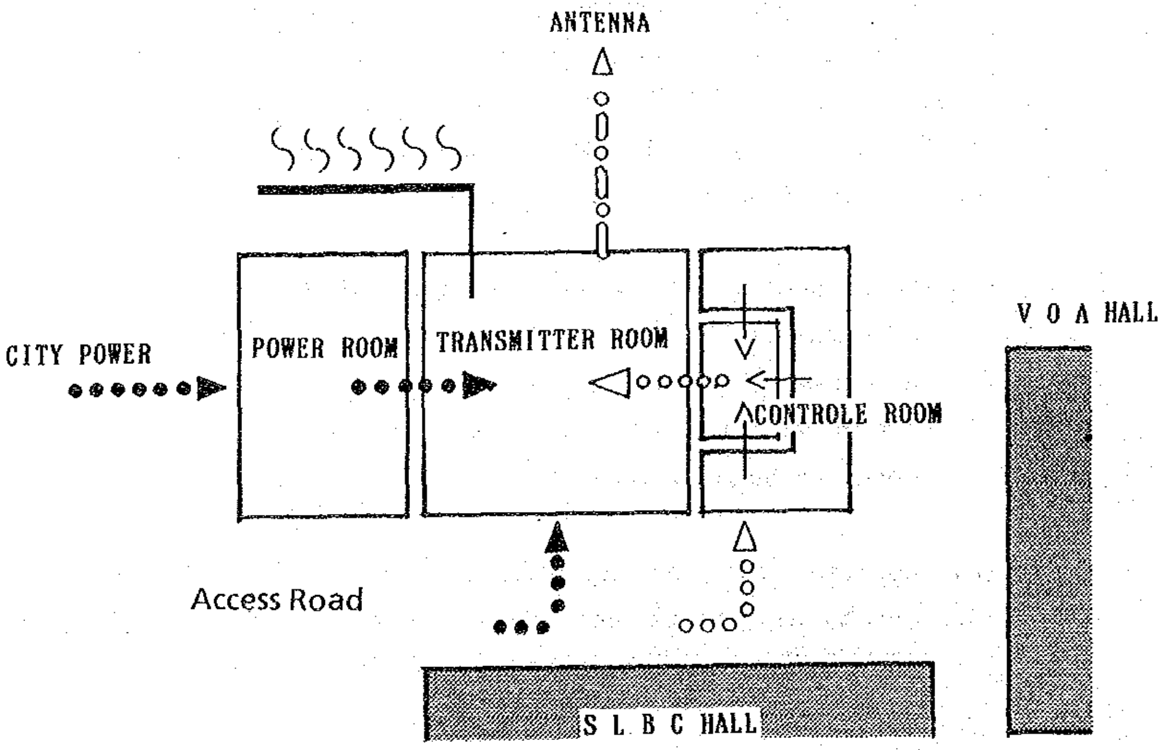


Fig. 4-7-2 Conceptional Arrangement of Transmitter Buildings

(3) The proposed layout will be the most reasonable one in relation to the feeders for the new 300kW transmitters. The new building will also be very close to the new antennas.

(4) The power source inlet will be extremely simple and it will be easy to match it with the existing equipment, too.

(5) The new building will be close to the well for cooling water.

(6) There already is a path from the gate to the site of the new building. As a result, there will be no need to construct a new road for such purposes as bringing in equipment at the time of construction.

Thus, the proposed plan of constructing an oblong-shaped building in parallel with, and about 18m to the west of the SLBC Hall will definitely be the best plan which also conforms to the layout of the existing buildings. The main entrance and gate through which equipment will be brought in will face the plaza, while the power-source room will be located on the south side where the new power lines will come in. The exit of the feeders will be at the western side of the building that is closest to the new antennas. The radiators for cooling the transmitters are designed to be installed at a corner on the western side of the building so that they will not obstruct the feeder exit.

4-7-2 Floor Layout Plan for Equipment

The new station building may be defined as the minimum facility and space required to ensure that the new 300kW shortwave transmitters will continue to function normally as planned and as long as possible. The functions and objectives, the layout for the various items of equipment to be installed in the building and that for the various rooms in the building should give maximum consideration to ensuring that the new building will function properly at any time and under any conditions. The points to be particularly taken into account are:

(1) It should be a facility that is neither excessive nor lacking; it should perform all functions in line with the project objectives.

(2) Maintenance and management should be done economically and easily.

(3) The building should have on the whole a well-balanced durability.

(4) It should ensure maximum safety against all kinds of anticipated disasters.

In order to achieve the most effective ideals in the design of this building and meet all the above-mentioned requirements, it is necessary to design a simple form of building that properly performs the expected functions, as well as a reasonable and simple layout for the various items of equipment to be installed in the building. So, in designing this building, every care will have to be taken to ensure that the design ideals mentioned above will be achieved by means of accurate planning, including plane planning that faithfully follows the proposed layout for equipment; cross-section planning that is both simple and reasonable; and appearance planning that is functional and simple.

In planning the layout for various functions within the building, careful consideration should be given to the relative positioning of the various items of equipment, the movements of people and materials (bringing equipment into the building), access to the power source and the paths of various lines. By doing so, the design should result in all the functions within the building being located in mutually harmonious positions. (Fig. 4-7-2)

The front side of the new transmitter building faces to the east, opposite SLBC Hall.

Power supply and control rooms are arranged on both sides of the transmitter room to put it in between and carry-in doors and an entrance for employees are provided in front of the building. At the rear portion, a radiator yard and the exit of the coaxial feeder which extends to the antenna are provided.

The span length is determined by the transmitter room which will be the core of the building, i.e. the cubicle of a transmitter has a width of about 5~6 meters and if it is required to provide enough space on both sides, a frontage of about 10m will be necessary.

On the other hand, in the right angle direction of the transmitter, facilities outside of the cubicle are put in line, accordingly a depth of about 20 meters is necessary.

And a space of 10m × 20m in which there are no pillars is required.

This is regarded as one unit, and one unit each for the power supply room and the monitor/office room is given, constituting the whole building with four units.

One unit will be formed with the connection of four spans, frontage 10m × depth 5m in tandem.

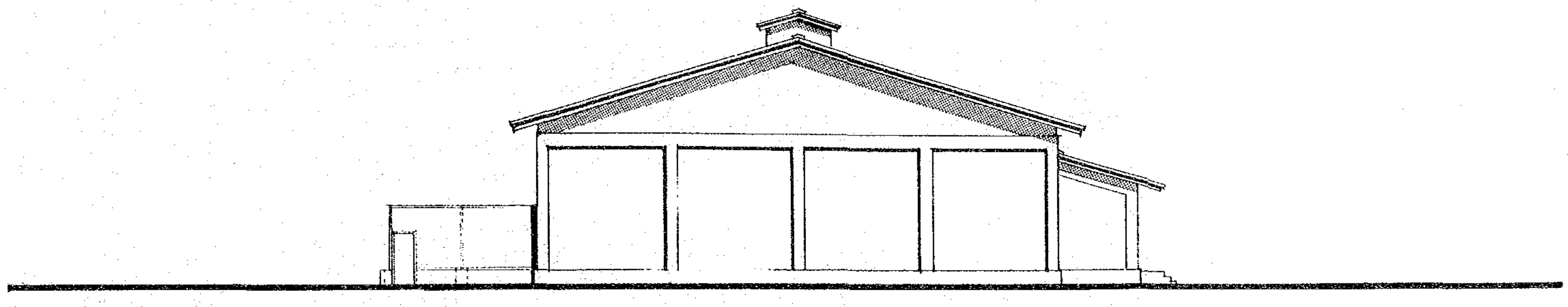
A powerful ventilation device will be needed in each of the rooms with equipment emitting a great volume of heat, such as a transmitter and a dummy-load. In such rooms, air inlets should be installed in a lower position on the outer wall, with a ventilation fan installed at the centre of the roof of the building to expel the air. These rooms will be so designed as to be as open and airy as possible so that the air may come in and go out freely.

On the other hand, the control room and the workshop will need electro-magnetic shielding in order to protect such delicate items as precision measuring equipment from the effects of strong electric fields.

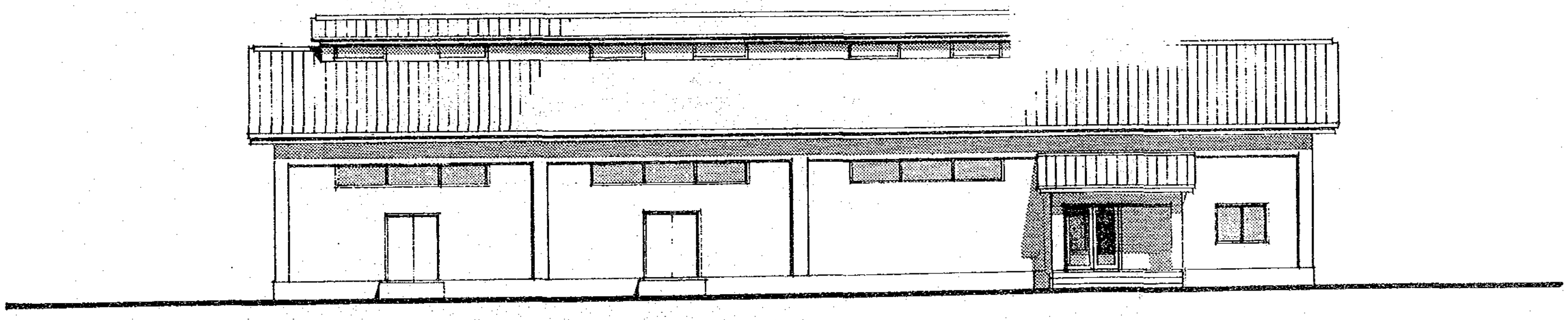
In Colombo, the maximum average temperature exceeds 30°C four months during each year. There are even days when the maximum temperature rises higher than 37°C. The humidity is very high throughout the year. Such high temperatures and humidity in Colombo mean that air-conditioning devices are essential to the control room and office where work goes on continuously.
In Figs. 4-7-3 and 4-7-4, front and side views of the new building are shown, and Fig. 4-7-5 shows the layout plan of facilities.

4-7-3 Structure Plan and Conditions for Construction

Because the station building to be newly constructed is to be a single-storey structure, the first type that comes to mind is a purely steel-frame structure. However, given the present construction conditions in Sri Lanka, it seems to be difficult for the study team to expect the required volume of shaped steel of a certain level to be ready and processed and assembled in time for a designated date of delivery. As a result, it becomes necessary to import construction materials in the form of finished framework members. On the other hand, in Sri Lanka, the construction of buildings with a ferro-concrete structure is common and therefore there is no particular difficulty in using this method in constructing a building of the scale of the proposed station building. In this case, it would be advisable to secure at an early date the necessary amounts of cement and steel rods, which are both import items, depending on the level of their stock in Sri Lanka.



SOUTH SIDE ELEVATION



EAST SIDE ELEVATON

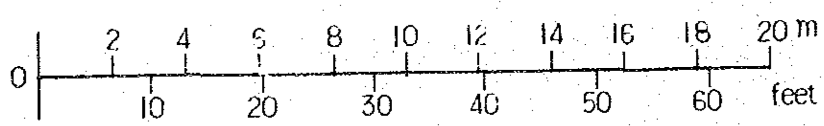


Fig. 4-7-3 Front and Side Views
of the New Building

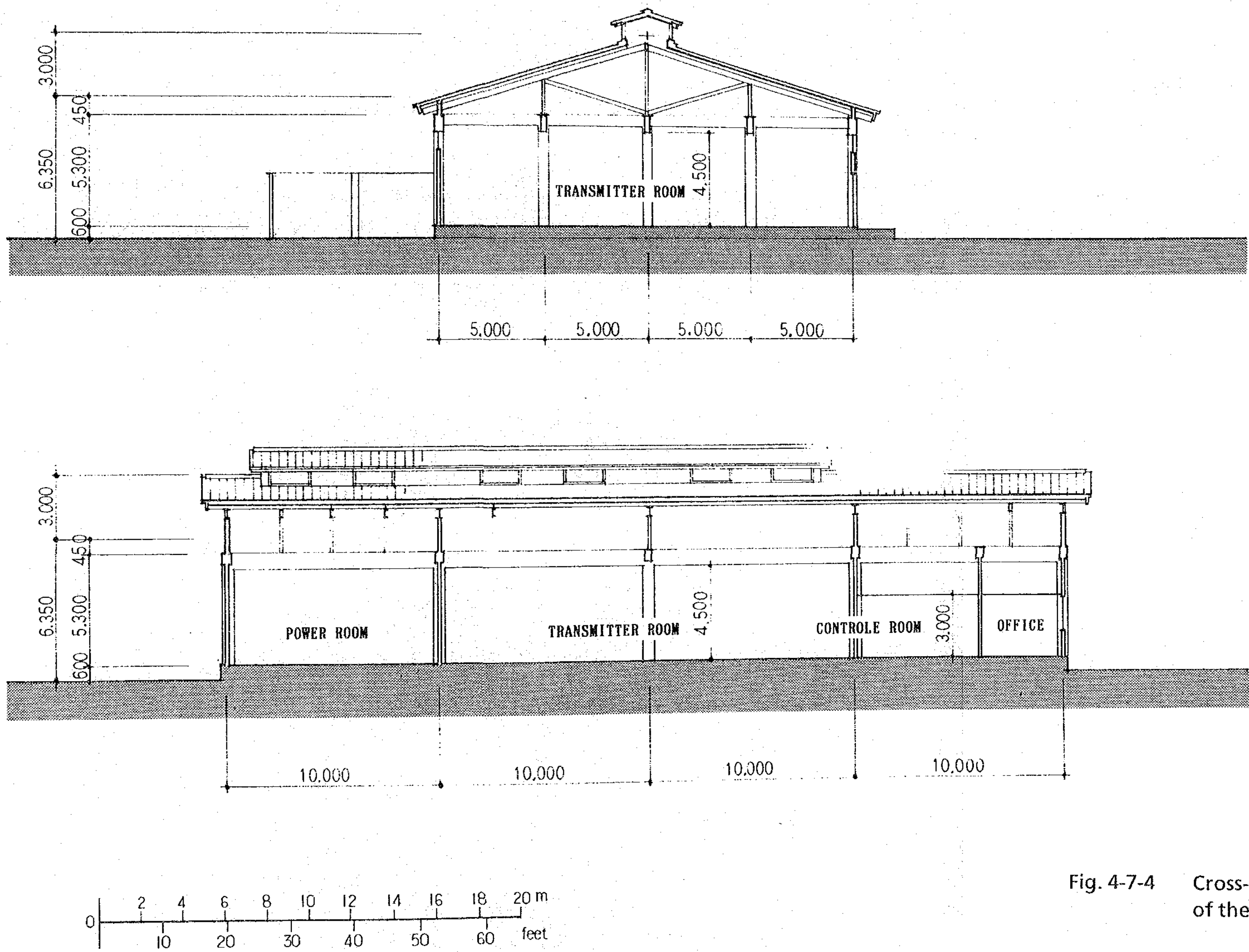


Fig. 4-7-4 Cross-sectional View of the New Building

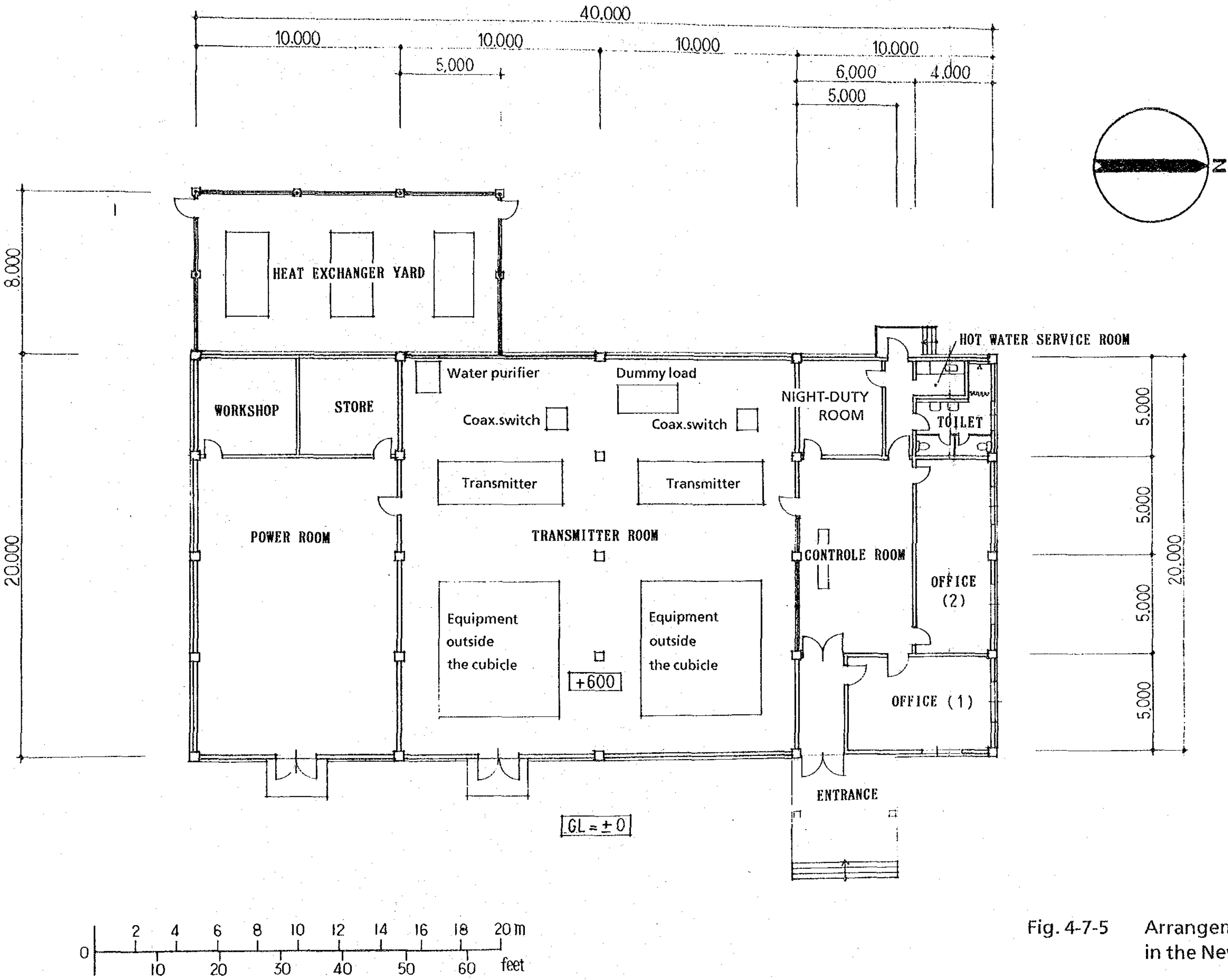


Fig. 4-7-5 Arrangement of Facilities in the New Building

The concrete, however, can be obtained locally in the form of ready-mixed concrete. So, under the circumstances described above, it is desirable to adopt the ferro-concrete structure for the proposed new station building.

Thus, what the study team would like to propose is that the principal structure of the building should be ferro-concrete, the outer walls and partition walls be built of bricks, and the roof have a steel frame to make it lightweight. Even if the need to import steel frames arises, the proposed method of construction would be quite feasible, since the amount of steel frames to be imported for the roof would be small and, besides, there would be some time-lag for the construction of the roof portion of the building.

As for the height of the floor, the study team proposes more than 600 mm above the ground level, taking into account anti-rainwater measures and the convenience of bringing in or carrying out equipment and facilities. As for the space under the beam, the team would like to secure 4,500 mm in order to have ample space left between the beam and the various kinds of cables running over the equipment. No ceilings will be constructed except in the office rooms, control room, toilets, etc., which are to be air conditioned.

The roof will be of the simplest gable type. For the roof, the team proposes to use locally-manufactured tiles which are the most popular and which excel in heat-insulation.

As a result of an on-site boring test, the sand bed one meter or more below the ground surface can be expected to have a long-term durability of about $10t/m^2$. So, it is expected to construct the building on a direct foundation of footings without using piles.

4-7-4 Items to be considered for Construction

In Sri Lanka, there is a construction slump owing to the stagnant economic conditions and other unfavourable factors, such as the decrease in the number of foreign tourists following social unrest in some parts of the country. As a result, it seems that Sri Lanka's self-supply ability has somewhat fallen with regard to construction materials.

One of the points that need to be taken note of when considering the question of construction in Sri Lanka is that it continues to depend on imports for supplies of such basic construction materials as cement. None of the basic construction materials can be expected to be kept in stock in any substantial amount. Hence, it seems that steps should be taken as early as possible for the importation of at least the steel rods for use in the foundation work for the station building and the tower, the construction of which should be started first.

The steel-frame processing for such work as the putting up of a truss for the gabled roof can be handled locally without turning to outside assistance. However, sufficient attention needs to be paid to anti-rust processing, in view of the location of the station which is only about 6 km away from the seacoast and so faces the constant danger of damage from the briny air.

As for construction materials, it would be desirable to import from Japan all the fittings and finishing materials excepting those that can be obtained locally, such as cement, ready-mixed concrete, bricks, roof-tiles, lumber, glass, paints for general use and veneer. Hence, there is every need of giving careful thought to the import conditions, such as the period required for manufacture and transport, so that the imported items may be ready for use according to the construction schedule.

Furthermore, there is the need to apply to the Sri Lankan authorities concerned for confirmation of construction under the

U.D.A Planning and Building Regulations. Since this would take about one month, it is necessary to take into account this period preceding the start of construction work.

4-8 Execution Plan

4-8-1 Execution Policy

The basic guidelines for executing the project are as follows:

(1) Sufficient care should be paid for the whole construction works so as not to give any interruption on the continuation of broadcasting services.

(2) The construction works shall be completed within the specified period, and the measures for safety should be sufficiently considered.

(3) Liaison between Sri Lankan side and contractor should be closely kept to carry out the construction works smoothly.

(4) Regulations and acts related to power supply, architecture, wireless communications and labour, shall be taken into consideration.

(5) Construction materials and equipment should be kept and controlled under the best setup.

4-8-2 Items to be considered for construction works

(1) Procurement of construction materials shuold be made as early as possible.

(2) Coordination for the evacuation and installation of the exiting and new equipment shall be made with the cooperation of both sides.

(3) Construction of new electric power lines shall be completed as early as possible.

(4) Evacuation of existing antennas and towers should be carried out with the cooperation of a consultant.

(5) Administration of labourers should be made under the control and supervision of the SLBC.

4-8-3 Allotment of works

The scope of work which should be undertaken with grant aid assistance from Japan, and the range which the Sri Lankan Government should carry out at its own expense will be as follows:

(1) The scope of works covered by the Government of Japan are as follows:

1) Construction and installation of two 300 kW transmitters including indication boards for operational use in the SLBC and VOA halls, wirings, etc.
2) Construction and installation of four 10kW transmitters including wirings, etc.
3) Construction and installation of STL equipment and wiring.
4) Construction of antenna facilities, foundation work of towers, erection of towers and antennas and necessary wirings.
5) Construction and installation of power receiving and distribution boards etc., for the new 300 kW transmitters.
6) Construction of a new transmitter building (New Hall) including the followings:
   a) Water supply
   b) Drainage
   c) Electrric equipment
   d) Auxiliary terminal box and conduit pipes for telephone (excl. telephone), etc.
7) Transportation of equipment and material from Japan.

(2) The scope of works covered by Sri Lanka side are as follows:

1) Evacuation of four existing 10 kW transmitters.
2) Dismantling of existing antennas from Nos. 1 to 5, supporting towers and feeders.
3) Removal of existing antennas No.28 and No.30, and related facilities.

4) Removal of the feeders of Marconi and Siemens tranmitters partially and their connection to the new feeder lines.

5) Connection of programme transmission lines from the new terminal board in the SLBC Hall to the existing transmitters.

6) Construction of new electric power lines.

7) Drainage, earth-laying and ground-levelling work around the site on which the new antenna facilities are to be installed.

8) Provision of furnitures and fixtures, including telephone.

9) Countermeasures for preventing electro-magnetic interference to neighbouring area.

10) Steps, Commission, etc.

   a) Bank commissions on the bank agreement.

   b) The expenses on the exemption of tax and tariffs.

   c) Undertakings on the customs clearance and inland transportation.

   d) Exemption of tax and tariffs on the Japanese nationals who work for the purpose of executing the Project under the agreement/contract approved by the Government of Japan.

   e) Undertakings to the above mentioned Japanese nationals for getting permission for their entry, departure and stay for the purpose of their work on the Project.

   f) Maintenance and operation to operate and maintain the equipment and facilities properly and effectively which have been supplied and installed through Japan's grant aid.

4-8-4 Construction and Management

The transmitters, antennas and power-source facilities to be used in the present plan are all of high-power and high-capacity; and the frequencies to be used are shortwave and of wide bandwidth. Furthermore, a matrix switching system interlinked for each set of "programme input system, transmitter and antenna", including the existing transmitters as well, needs to be considered within the entire system. So, the construction work will not be straightforward.

On the other hand, with regard to the construction work to be carried out by the Sri Lankan side as their responsibility, they are required to execute the dismantling of the existing tower safely and efficiently in keeping with the progress of the construction work.

As a result, in order to carry out this project smoothly and efficiently within a restricted period, it is extremely important to adopt a work system that takes account of the following points in particular with even greater care than hitherto:

(1) Grasp the entire structure of the system and the construction process so that the construction work may be carried out according to a carefully planned schedule.

(2) Adopt a strong system of cooperation and, at the same time, make sure that any problem that may arise can be solved quickly through joint efforts.

From such a point of view, it is most essential to select subcontractors and consultants with rich experience in this type of construction work. Similarly indispensable are management and supervision by consultants who have abundant experience in the field of broadcasting.

The consulting firm will not only undertake the compilation of a precise construction schedule, but also assign suitable personnel to take charge of the construction management. The consultants will keep in close touch with both the Japanese and the Sri Lankan organizations concerned, so as to ensure smooth running of the construction work. Furthermore, in order to prevent problems or difficulties from arising, and also to solve problems once they arise, the consultants will always make sure that appropriate and speedy guidance and advice will be given to assist either in the prevention or solution of problem obstructing the progress of the construction work.

4-8-5 Measures for Preventing Electro-magnetic Interference in the Neighbouring Area

(1) The study team surveyed potential interference with the neighbouring homes and factories, especially those near the north and west borders of the Ekala premises, caused by the shortwave radiations of the new transmitter antenna. It was found that there has been no claim or complaint so far about TV interference caused by the radiation of the existing 100kW, 35kW and 10kW transmitters. (The TV receiving antennas of the homes are directed south towards Colombo City)

Although it cannot be said decisively what interference will occur with the installation of new 300kW transmitters together with high gain antennas, the number of households possessing television sets are about 20 or so. Also around the site, there are sparsely located factories manufacturing vinyl and carbide products etc., from which there has been no claim so far concerning electro-magnetic interference. Therefore, the study team agreed with their SLBC counterparts that it would be most economical to take individual measures to cope with whatever interference may arise after the commencement of actual transmission by the newly augmented facilities at the preliminary test stage.

(2) Study of the effects on the Aviation Control System of Colombo International Airport.

A survey has been done on the possible effects on electronic communication devices used in Colombo International Airport.

With regard to the above potential interference, the study team confirmed with the Director of Civil Aviation Control at the airport, that the control and communication devices now being used are operating at the VHF frequency range of 150MHz and are having no trouble with the present shortwave radiation. Therefore, providing the Ekala station is properly operated, there would be no problem even once the power is increased to 300kW. The airport is located about 7.5km north of the Ekala station.

4-9 Execution Schedule

The necessary procedures to be taken for the implementation of the project are:

-After the conclusion of the Exchange of Notes between the Government of the Democratic Socialist Republic of Sri Lanka and the Government of Japan, a Japanese consultant firm is appointed by the Government of the Democratic Socialist Republic of Sri Lanka, and the contract for the consulting service on the design and administration of the project is made,

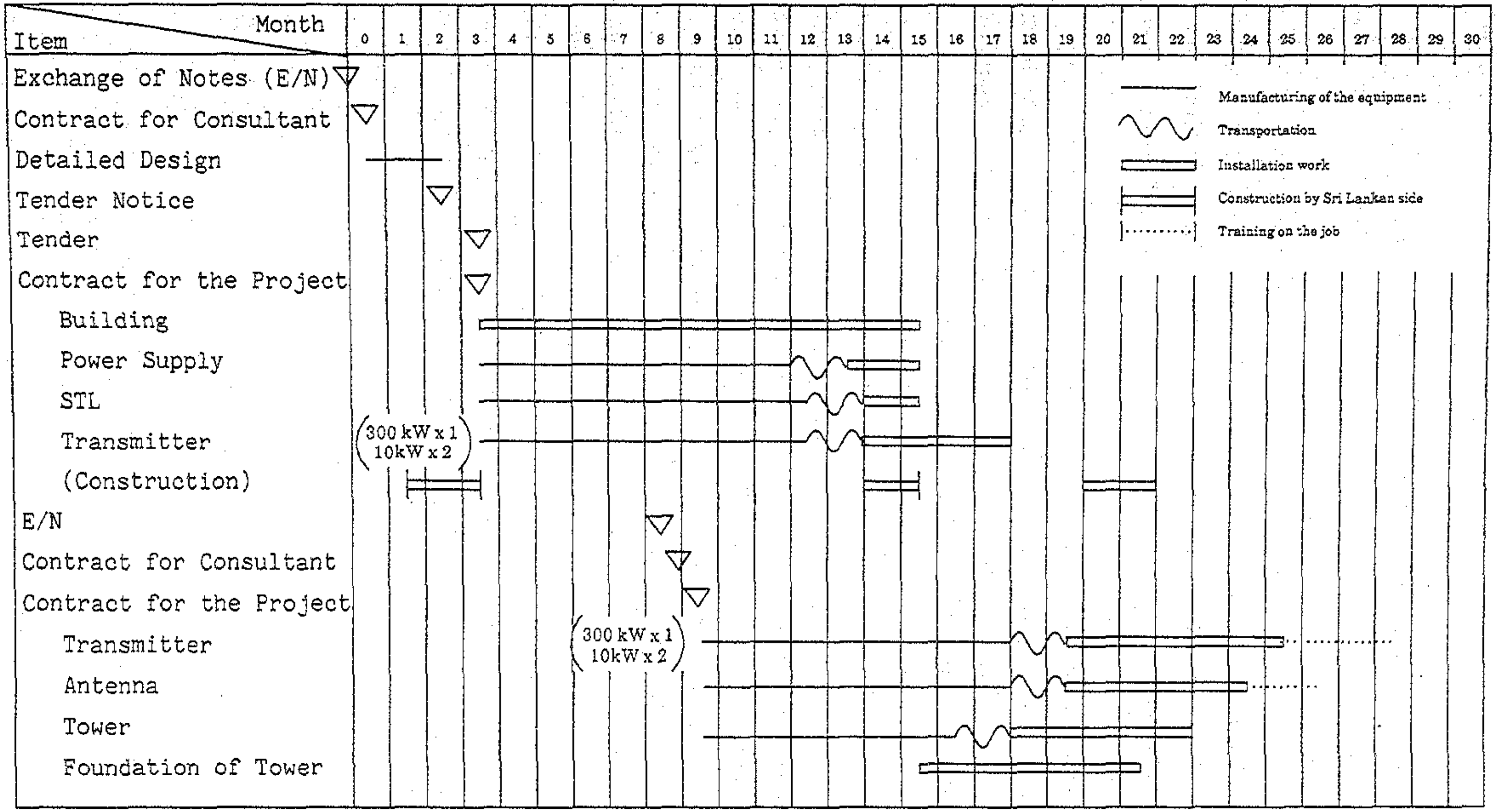
-after that, detailed design, preparation of Tender Documents are carried out by the consultant and the Tender is taken place,

-after the evaluation of the Tender proposal, contract for the execution of the project will be made between the Government of the Democratic Socialist Republic of Sri Lanka and the Japanese contractor and the construction work will be started.

The term of the execution of the Project will be divided into two phases. During the first phase, construction of a transmitter building, installation of power supply facilities, STL and some of the transmitters will be carried out, and in the second phase, construction and installation of antennas, towers and feeders, and the remaining transmitters will be carried out.

Total term including the first and second phases will be totally about 21 months. The summary of the execution schedule is shown in Table 4-9-1 on the next page.

Table 4-9-1 Tentative Schedule of the Project



4-10 Administration and Management Plans

4-10-1 Executing Organization and Staff

The execution of the Project and the operation and maintenance of the facilities after the completion of the Project are to be undertaken by the Sri Lanka Broadcasting Corporation (SLBC).

The organizational chart of the SLBC is as shown in Fig. 1-6-1. Since the completion of the Project will not result in any new type of work, there will be no need for any organizational changes after completion of the Project.

The total number of SLBC staff members at present is 2,100, of which 800 are engineering personnel, 500 are programme production personnel and 800 are administration personnel. Of these, about 150 staff members are engaged in the work (on shifts) at the Ekala Transmitting Station; among them, about 35~40 employees are working on three shifts. When the Project is completed, there will be the need to assign a total of about 10 operational staff members (incl. 2 staff x 3 shifts), but since the completion of the Project will result in considerable improvements in the operation and maintenance of this station, there probably will be no substantial increase in the volume of work at the station as a whole.

4-10-2 Operational Cost (after the completion of the Project)

The annual operational expenses of the Ekala Transmitting Station at present are as follows.

Electric power costs	Approx.	6,000,000 Rs
Personnel expenses	Approx.	3,000,000 Rs
Other expenses (maintenance, vehicles, spare parts, etc.)	Approx.	6,000,000 Rs
Total	Approx.	15,000,000 Rs

If an estimate is made of the annual operational expenses of the Ekala Transmitting Station in fiscal 1991 with the following assumptions, the estimated total cost would be about 34,000,000 rupees which will be an increase of about 19,000,000 rupees over the present amount.

(Assumptions)

(1) The power charge rate will be increased by 30% from fiscal 1989.

(2) Other expenses will increase by 10% every year (referring to the past trends).

4-11 Approximate Estimate of the Project Cost

(1) Approximate project cost to be covered by the Sri Lankan side is estimated as follows:

1) Construction of new electric power lines for exclusive use 2,000,000 Rs

2) Removal or relocation of the existing antennas and feeders on the site
(incl. four 10kW transmitters) 500,000 Rs

total 2,500,000 Rs