社会開発協力部報告書

MALAYSIA

FEASIBILITY STUDY REPORT ON VHF/FM BROADCAST COVERAGE FOR PENINSULAR MALAYSIA

MARCH 1981

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

In response to the request of the Government of Malaysia, the Government of Japan decided to conduct a feasibility study on VHF/FM broadcast coverage for Peninsular Malaysia and entrusted the survey to the Japan International Cooperation Agency.

JICA sent to Malaysia a survey team headed by Mr. Tadashi Makino, Deputy Director of Engineering Division, Broadcasting Department, Radio Regulatory Bureau, Ministry of Posts and Telecommunications from June 15th to July 30th, 1980.

The team had a series of discussions with the officials concerned of the Government of Malaysia and conducted a field survey in Peninsular Malaysia. After the team returned to Japan, further studies were made and the present report has been prepared.

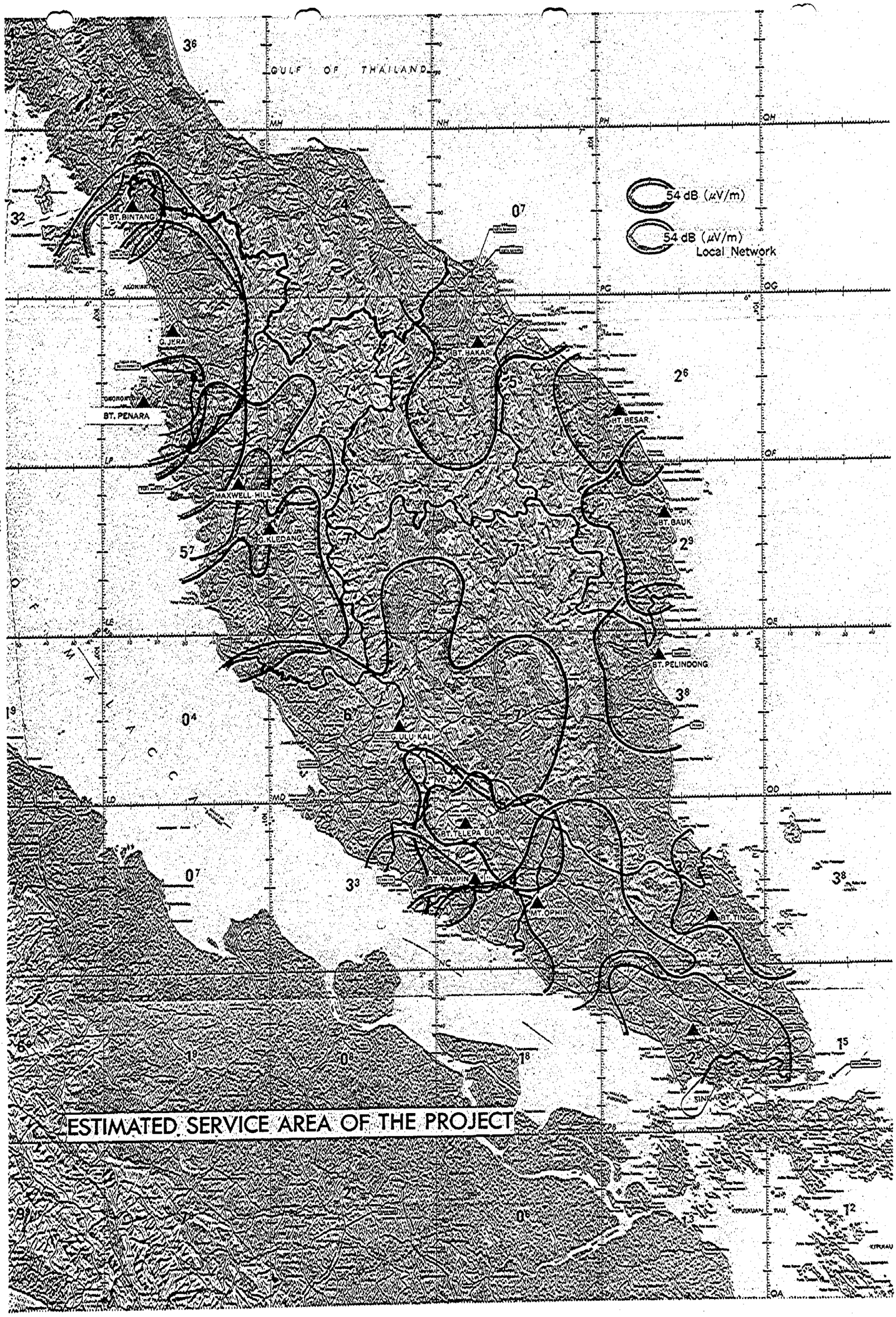
I hope that this report will serve for the development of broadcasting in Malaysia and contribute to the promotion of friendly relations between our two countries.

I wish to express my deep appreciation to the officials concerned of the Government of Malaysia for their close cooperation extended to the team.

March, 1981

Keisuke Arita

Keisuke Arita
President
Japan International Cooperation Agency



ESTIMATED SERVICE AREA OF THE PROJECT

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Abbreviated Words Used in the Report

ERP	Effective Radiated Power
STL	Studio to Transmitter Link
FM	Frequency Modulation
AM	Amplitude Modulation
LF	Low Frequency
MF	Medium Frequency
VHF	Very High Frequency
CIN	Constant Impedance Notch Diplexer
AVR	Automatic Voltage Regulator
S/N	Signal to Noise Ratio
D/U	Desired to Undesired Signal Ratio
SCA	Subsidiary Communications Authorization
CCIR	International Radio Consultative Committee
PSP	Bahagian Perkhidmatan Sebaran Pendidikan (Educational Media Service)
RTM	Radio Television Malaysia
NHK	Nippon Hoso Kyokai (Japan Broadcasting Corporation)
EPU	Economic Planning Unit
M$	Malaysian Ringgit
G	Genung (Mountain)
Bt	Bukit (Hill)
CCITT	International Telegraph and Telephone Consultative Committee
OB	Outside Broadcasting
ODM	Other Departments Maintenance
LLN	Lembaga Letrik Negara Tanah Melayu (National Electricity Board of the States of Malaya)

I. SUMMARY

1. Introduction

The Government of Malaysia is attempting to improve the reception in pocket areas which are not covered by present medium wave transmitter network, however, there is a difficulty in obtaining consent of foreign countries in order to realize this attempt by medium frequencies. Although the Government also wishes to improve Regional Broadcast Services and Educational Broadcast Services, this is also difficult due to the same reason. Introduction of VHF/FM is more preferable for these improvement than the use of conventional MF broadcasting. Besides these improvement, listeners can enjoy high quality broadcasting service also in stereophonic. Under these circumstances the Government of Malaysia requested the Government of Japan to conduct the Feasibility Study on VHF/FM Broadcast Coverage for Peninsular Malaysia. Japan International Cooperation Agency carried out the Survey in 1980. The following descriptions are the Summary of the Study Report.

2. Technical Standards

The frequencies for this project will be 87.8 MHz - 108 MHz, and the recommendable technical standards are as followings.

1) Technical standards for stereophonic broadcasting

The CCIR Recommendation 412-2 and 450 are recommended.
The pre-emphasis of 50 μs and pilot-tone system are recommended.

2) SCA system

The introduction of SCA system is inappropriate.

3) Estimation of field strength

On the basis of the measured results of the survey team, an amount of 1.7 dB was substracted from the values derived from the CCIR Recommendation 370-3 propagation curve, and these values were adopted estimating the field strength at distance within the horizon. For estimating of the field strength at distance beyond the horizon, an equation was used, and gradient of modified refraction index of 60 was substituted in the case of Malaysia.

4) Technical standards for transmission

The CCIR Report 293-4 is recommended.

5) Technical standards for buildings

In designing the buildings and towers, the Architectural Standards Laws and structural design standards of Japan and the British Technical Standards were employed as reference.

3. Site and ERP of the Project

Main points for this subject are that (1) three networks of National, Regional and Local are required, (2) population distribution should be considered, and (3) common use of TV sites is preferable due to economical reason.

The field strength required in CCIR Recommendation 412-2 was adopted for calculation. As a result, 13 sites of the existing TV stations, one site of the existing microwave stations and one additional new site, namely, a total of 15 sites were selected for projected sites. By installing FM transmitting stations at these sites, a population coverage of 98% and an area coverage of 67% will be achieved. By classifying the 15 transmitting sites into transmitting power, there will be six stations of 1 kW, four stations of 500W, three stations of 100W and two stations of 50W.

For regional and local service of the two stations of the six 1 kW stations, a power of 500W and 100W would be sufficient. At 11 sites of the 15 sites, all network services will be located on the same sites. At two of the 15 sites, separate regional and local services will be transmitted to two directions. At two sites of the 15 station sites, only local services will be transmitted.

4. Frequency Assignment

The frequency spacing for each channel was determined as 200 kHz, in considering the radio interference protection ratio.

The frequency spacing between any two transmitting stations were estimated from the results of calculation.

The frequency spacing required for transmitters located on a site was determined as 800 kHz.

With regard to measures for radio interference arriving from foreign countries, which were confirmed by field measurements, the necessary protection ratio could be ensured.

With regard to the influence upon existing TV off-air relay and existing radio stations other than the broadcasting services, it was confirmed that it will be possible to eliminate any interference by ordinary way.

In considering the foregoing items, a frequency for each site was assigned, and frequencies for 79 transmitters were determined. As a result, six channel services will be available.

5. Transmitting Facilities

The transmitters were planned to be the full solid-state type. As for the reserve transmitter, a shared reserve system was adopted.

The STL transmitters and receivers were also planned to be the full solid-state type. As for the reserve STL equipment, a full reserve system will be advantageous than the shared reserve system because the operating frequencies are high. The STL antenna will be used for three frequencies in common.

The polarization of transmitting wave would be horizontal, in considering the polarization of existing TV stations and economical aspects.

The FM transmitting antenna will be used in common for all of the FM broadcasting services. It will not be used in common with TV antenna.

For multiplex feeding circuits, a CIN diplexer will be used between high power transmitters, and a combination of CIN diplexer and circulator will be used between low power transmitters.

For transmitting antennas, a 2-dipole type antenna was adopted as a standard, and a 4-dipole type was added when it was necessary to get higher ERP.

The electric power facilities will be difficult to be used in common with those of TV transmitter facilities, therefore, an independent facility will be provided.

The supervision and monitoring of FM transmitting station will be performed at the attended TV or microwave transmitting station on the co-site. The operation will be set under joint structure with existing facilities. The supervision, monitoring and operation for un-attended TV site and the new site will be done by Telecom branch staff.

6. Station Building and Tower

For TV/microwave station buildings can be used in common for the FM transmitter facilities, meanwhile an engine generator building will be newly built. At the remaining 11 sites, FM station buildings will be newly built. One proposed FM transmitting site is a new site and an access road is to be built.

For the FM transmitting station buildings which will be built on existing station sites, the tower is to be erected at a position where mutual interference with existing TV antenna can be avoided, and the station building is to be built near it.

The FM transmitting station buildings which will be newly built are structures of 2-3 stories and are classified into four classes, and the engine generator buildings are of one-story structure classified into two classes.

The structure of the new FM transmitting station buildings will be reinforced concrete. Materials which can be purchased easily in Malaysia will be used. The finishing of the building and the building facilities are the same as those of existing TV/microwave buildings.

For the FM transmitting stations which will use the TV/microwave station building in common, the FM transmitter room and combiner room will be accommodated in this building.

With regard to the FM transmitting towers, the TV towers will be used in common for the height of over 100m.

The number of sites which the towers will be used in common is four. At the other 11 sites, FM transmitting towers will be newly built.

The new towers will be classified into four classes of 40m, 50m, 65m, and 80m. The structure of steel towers is to be the square cross-section self-supporting type. All material composing the steel tower are to be galvanized and finished with coating on surface.

7. Program Planning

According to technical examinations, the possible number of program service is six. The six services would be as follows.

FM 1 RTM National Program (1)
FM 2 RTM National Program (2)
FM 3 RTM National Program (3)
FM 4 RTM Regional Program
FM 5 RTM Local Program
FM 6 PSP Educational Program

The principal points of expectation of the Government of Malaysia to FM broadcasting are (1) complete coverage of whole country which could not be realized by the medium wave broadcasting, (2) high fidelity broadcasting service by means of FM stereophonic, (3) an independent educational broadcasting service. In order to realize these expectations by six frequencies, some considerations are to be provided. It would be impossible to utilize the features of FM broadcasting successfully, by transmitting the AM programs through three FM channels. It is more recommendable to produce own FM programs, to utilize the feature of FM broadcasting successfully. For a certain period, the AM programs could be transmitted temporarily through FM channels, but, the program production compilation would be reorganized at an early date as possible. In this report, recommendable period is three years after commencement of the new FM service. With regard to the regional local services, production of programs suitable for utilizing the features of FM broadcasting would be possible from the beginning. In this case, program compilation for the change-over period will be necessary in considering the construction schedule.

The existance of the present metropolitan broadcasting service will have no fundamental influence on the frequency planning of this project. Accordingly, examination on program planning is only to be considered. The metropolitan service would continue present service due to importance of capital city.

By exclusive occupancy of one FM channel, the educational broadcast service will be capable to provide a substantial service than the present ones, in means of broadcasting hours. However, as the school education in Malaysia is two shift and the school hours are limited to very short daytime hours, it would be difficult to provide educational programs by using only one channel. It would be necessary to lease one channel from RTM National Service to transmit school education programs.

8. Program Transmission Line

For program transmission, the off-air relay will be employed from the view point of economy. However, the Telecom transmission lines would be leased to the following two routes.

(1) For the section between stations where off-air relay is technically impossible.

(2) As all national programs for regional/local transmitting stations are to be sent through regional studios, in accordance with the intention of RTM, the Telecom lines will be leased for program transmission between the Headquarters and regional stations.

From studio to transmitter, a STL will be constructed for distance over 10 km and Telecom lines will be leased for the shorter distance.

The technical quality of Telecom transmission lines for stereophonic transmission is to ensure the values defined in CCITT Recommendation J-21. The S/N of STL and off-air relay is to be better than 60 dB and the reliability is to be higher than 99% in time.

9. Staff Planning

Staff planning is closely related with operational organization. In this report, the number of staff was estimated under the condition that general programs will be produced and operated by RTM, and transmitted by Telecom, and the educational programs produced and operated by PSP of Education Ministry and transmitted by Telecom. The number of staff to be increased for this project will be as following.

Telecom		60	
RTM	Continuity operation	48	
	Program production	552	727
	Studio operation	127	
PSP	Continuity operation	6	
	Program production	48	66
	Studio operation	12	

By adding the number of indirect staff, the total number of staff to be increased will be as follows.

Telecom	90	
RTM	1063	1277
PSP	124	

10. Construction Schedule

In accordance with the intention of RTM, the construction work will be implemented in two phases. The first phase will be for Headquarters and regional stations, and the second phase will be for local stations. The interval between the first and the second phase is to be preferably short. But, (1) to avoid duplication in construction, (2) for efficient operation of transmission lines, (3) considering the term for staff training, three years will be required.

As three years will be required for preparatory work and construction work, the first phase stations will be in operation after three years and second phase stations will be after six years, from the start of this project.

11. Construction Cost

Transmitter and related facility	M$ 25,847,000
Installation of above	M$ 3,329,000
Station building and tower	M$ 16,428,000
STL facility	M$ 5,113,000
Installation of above	M$ 514,000
Sub total	M$ 51,231,000

10% contingency shall be added to above figure. Furthermore, the following expense will be necessary.

Inland transportation	M$ 239,000
Access Road Construction	M$ 3,391,000

An amount of approximately 24,000,000 M$ (plus 10% contingency) will be necessary for construction of studio facilities and related offices.

Construction cost grand total	M$ 86,384,000

12. Operation Cost

Operational cost increase by this project will be as following:

ODM	M$ 1,800,000
Transmission Line Rentals	M$ 4,387,000
Program Production	M$ 4,199,000
Personnel	M$ 8,986,000
Total	M$ 19,372,000 (per annum)

13. Financial Assessment and Economic Appraisal

We have made studies, from financial and economic points of view, of the expense = investment-effects relationship mainly with respect to the RTM's revenue and expenditure on the assumption that development investments are made towards the FM project. As the method of financial analysis, we have designated 15 years as the project assessment period and, on the basis of the growth in the numbers of radio and TV licences, we estimated the revenue and expenditure of the RTM during the 15 years. By such process, we have made an estimation of the scope of revenue that would be required if we are to implement the FM project and, at the same time, achieve a balance in the budget. For that purpose, we have made an analysis of internal rate of returns and of present values during the project period and, as a result of the analysis, it has been recognized that, from a financial point of view, this project will be quite feasible. In our economic apprisal, we have made an analysis from a more or less 'economic' point of view, although such economic analysis has been made on the basis of the 'financial' analysis of the project. As a result, we have reached a conclusion that the social benefits of broadcasts will thus be further enhanced and so, the establishment of the FM networks would be benefitial to the society as a whole.

14. General Assessment

(1) In Peninsular Malaysia, the present medium wave broadcasting service does not cover entire country. Construction of more medium wave transmitting stations or power increase of the existing stations, to overcome this situation are very difficult in considering the international frequency allocation.

(2) Successful district services which are intended by the Government of Malaysia will not be realized by medium wave due to its nature.

(3) Radio receiver sets, tape recorders and disc record players, as home appliances, were distributed widely in the country. And their quality has been very much improved. Along with this, audience expect better technical quality of broadcasting.

(4) Utilization of educational broadcasting are being activated in the world.

In above circumstances, VHF/FM broadcasting plays important role.

As the result of this study, it was proved that six VHF/FM programs will be possible. These six channels avail high technical quality broadcasting service, improvement of pocket areas of present medium wave services, better district services and better educational service.

Construction cost and operation cost of this project is not small amount, but, Financial Assessment in the Report suggested successful finance and Economic Appraisal stressed the social benefit by this project.

Advanced electronics technology will help efficient realization of the project.

Since a scale of the project is rather big in broadcasting field, this Report recommends construction period of six years. For earlier realization, earlier start will be required.

II. INTRODUCTION

1. The Background of the Project

Malaysia is a multiracial country, comprising the Malay, the Chinese, the Indian, etc. She is trying hard to develop her economy and to improve civilization. Then full use of information media became important in the country. Present RTM National Network of sound broadcasting services cover most part of the country, but there are still areas where the reception is poor according to radio interference from foreign countries. The other networks do not cover whole country. In order to overcome this situation by adding new medium wave stations or power increase of existing stations, there is difficulty in obtaining consent of foreign countries in accordance with the agreement of the "Regional Administrative LF/MF Broadcasting Conference" of 1975, and there is no hope of realization. The VHF/FM broadcasting is suitable to overcome this situation. The VHF/FM broadcasting is also suitable for regional services which is expected by the Government. Then, this project was introduced.

2. The Outline of the Preliminary Plan of the Malaysian Government

VHF/FM broadcasting project was introduced to eliminate the pocket areas of present medium wave services, to expand the regional services and to broadcast in higher technical fidelity.

2-1 Compsition of Network

The network consists of the following.

(1) National network to cover whole Peninsular Malaysia . . . . . 4 channels

(2) Peninsular Malaysia is divided into four regions. A regional network to cover each region . . . . . 4 channels

(3) Local networks to cover State . . . . . 4 channels

The listeners in Peninsular Malaysia will be able to receive a total of 12 program services. Each regional and local network will compose independent programs.

If technically possible, three educational channels will be added to the national network.

Networks of this project are independent from the existing FM broadcasting (two transmitting stations). Particulars of each network are shown in Table II-1 and Table II-2.

Table II-1 Composition of Network

Classification	Number of Areas	Number of Channel
National Network	1	4
Regional Network	4	4
Local Network	11	4

Table II-2 Service Area of Each Network

National Network	Regional Network	Local Network
Troughout Peninsular Malaysia	1 NORTHERN REGION (1) State of Perlis (2) State of Kedah (3) State of Pinang (4) State of Perak 2 CENTRAL REGION (1) State of Selangor (2) State of Negeri Sembilan 3 SOUTHERN REGION (1) State of Johor (2) State of Melaka 4 EASTERN REGION (1) State of Kelantan (2) State of Trengganu (3) State of Pahang	1 State of Perlis 2 State of Pinang 3 State of Trengganu 4 State of Selangor 5 State of Negeri Sembilan 6 State of Melaka 7 State of Kedah 8 State of Kelantan 9 State of Perak 10 State of Johor 11 State of Pahang

2-2 Priority

The priority of each network is in the following order, but, the priority of first and second is almost the same and both are top priority.

(1) First

National Network ..... 1 channel
Regional Network ..... 1 channel
Local Network ..... 1 channel

(2) Second

National Network ..... 3 channels

(3) Third

Regional Network ..... 3 channels

(4) Fourth

Local Network ..... 3 channels

2-3 Program Plan

A "Program Planning Committee" was established and now studies are proceeding. The Committee will draw some conclusions within the year of 1980, but, so far, the plans are progressing as follows.

(1) National Network

For the time being, the programs of the three channels out of the four channels, are to be the same as that of the present medium wave broadcasting, and one is independent program. In the future, programs for several categories of audience, such as farmers, fishermen, factory workers and travelers will be intended.

(2) Regional Network

Programs for regions will be produced at regional studios of major cities in Peninsular Malaysia, and for the time being, broadcasting hour will be 2 – 3 hours daily.

(3) Local Network

For the time being, programs will be produced at existing studios, but in the future, new local studios will be constructed.

For the time being, programs of all networks will be in monophonic, and convertion to stereophonic will be determined upon results of this feasibility study. Therefore, for the time being, programs will be produced at existing studios Kuala Lumpur and local cities, and no stereophonic studios will be newly built.

3. Particulars of Survey Team

The Government of Malaysia asked the Government of Japan to carry out a feasibility survey on VHF/FM broadcasting network plan, and the Japan International Cooperation Agency sent a preliminary survey team to Malaysia from Feburary 25 to March 9, 1980. The preliminary survey team confirmed the contents of the "Terms of Reference" and determined the scope and the principle of Feasibility Survey. Also the team discussed the Scope of Work. The "Scope of Work" was signed on the 25th of June, 1980.

The feasibility survey team was dispatched to Malaysia from the 15th of June to the 30th of July in 1980, by the Japan International Cooperation Agency. The objectives and the range of survey are described in Section 2 and Item 2) of Section 3 of the "Scope of Work".

SCOPE OF WORK
FOR
FEASIBILITY STUDY
ON
VHF/FM BROADCAST COVERAGE FOR PENINSULAR MALAYSIA

This Scope of Work is agreed by the following two authorities: –
Economic Planning Unit, Prime Minister's Department, the Government of Malaysia

Japan International Cooperation Agency, the official agency responsible for the implementation of technical cooperation programmes of the Government of Japan

To confirm the aforementioned, the Scope of Work is herewith attached and signed by the representative of the said authorities.

For the Japan International Cooperation Agency;	For the Economic Planning Unit, Prime Minister's Department;
(signed)	(signed)
(TADASHI MAKINO) Leader of the Japanese Survey Team.	(TAN SRI ISHAK B. PATEH AKHIR) Director General, Economic Planning Unit, Prime Minister's Department.
Date 24th June, 1980	24th June, 1980
Issued at KUALA LUMPUR	KUALA LUMPUR

I. Introduction

In response to the request of the Government of Malaysia, the Government of Japan has agreed to conduct a Feasibility Study on VHF/FM Broadcast Coverage for Peninsular Malaysia in accordance with Laws and regulations in force in Japan, and the Japan International Cooperation Agency (JICA), the official agency responsible for implementation of the technical cooperation programmes of the Government of Japan, will carry out the Study in close cooperation with the Government of Malaysia and the authorities, in particular the Ministry of Information and the Telecommunications Department of Malaysia.

The present document sets forth the Scope of Work for the Study.

II. Objective of the Study

The objective of the Study is to prepare the basic frequency plan, among other matters, for the successful implementation of VHF/FM Stereophonic Broadcast with the optimum number of networks for the entire Peninsular Malaysia including pocket areas which are not

covered by Present Medium Wave Transmitter Network and to examine and assess technical and economic feasibility of the Project.

III. Scope of the Study

1) Study area

Entire Peninsular Malaysia

2) Contents of the Study

2)-1 Study of existing broadcasting facilities and service.
2)-2 Study of existing facilities of domestic telecommunications network.
2)-3 Interview with relevant Government Department and Agencies.
2)-4 Data collection and analysis.
2)-5 Study of broadcasting service revenue and expenditure.
2)-6 Study of National Development Plan with reference to broadcasting.
2)-7 Study of laws and regulations concerned.
2)-8 Study of technical standards on the Project.
2)-9 Study of materials and labour force.
2)-10 Survey of topographical condition and their surroundings at expected sites.
2)-11 Selection of sites;
a) Using existing Telecoms Stations.
b) Other alternative sites.
2)-12 Selection of optimum system.
2)-13 Radio propagation test.
2)-14 Determination of transmitter power & ERP and estimate coverage area for each expected transmitting station.
2)-15 Preparation of frequency allocation plan for the optimum number of networks.
2)-16 Determination of Programme relay system; various alternatives to be explored.
2)-17 Study of additional message channels, viz. SCA etc.
2)-18 Study of programme plan.
2)-19 Study of Personnel Plan.
2)-20 Preparation of preliminary engineering designs.
2)-21 Estimation of construction, operation and maintenance costs.
2)-22 Economic and financial analysis.
2)-23 Preparation of implementation programme.
2)-24 Recommendation of institutional organization and management.

IV Reports

The JICA will prepare and submit the following reports in English to the Government of Malaysia.

1) Draft Final Report

o 20 copies

- o Within 6 months after completion of the field survey.
- o The Government of Malaysia will provide the JICA with its comments within two months after the receipt of the Draft Final Report.

2) Final Report

- o 50 copies
- o Within 2 months after receipt of the comments on Draft Final Report.

3) All reports when finalised and submitted to the Government of Malaysia would remain the property of the Government of Malaysia.

V. Contribution of the Government of Japan;

1) To send the Japanese experts team to Malaysia for excution of the Study.

2) To provide necessary measuring equipment and materials for the field survey.

3) To transfer the knowledge and technology of the project to the Malaysian counterpart personnel during the Study period.

VI. Contribution of the Government of Malaysia;

1) To provide the Study Team with relevant data, information and materials necessary for implementation of the Study.

2) To exempt the Study Team from taxes and duties normally accorded under the provision of General Circular No. 1 of 1979 for materials, equipment and personal effects brought into Malaysia, for the purpose of the Project.

3) To provide the Study Team with suitable office space with necessary equipment and service for the Study.

4) To arrange adequate means of transportation (expenses for transportation will be born by the Team).

5) To assign official counterparts during the Study period in Malaysia and to arrange necessary number of labourers (expenses for employment of labourers will be born by the Team).

6) To prepare necessary permit for implementation of the out door works (e.g. to operate transmitter equipment for radio propagation test, to enter restricted areas to take necessary photograph, etc.).

7) To make the Study Team secure during their stay in Malaysia.

8) To make arrangement for the Study Team to take the necessary data, maps and materials concerning the Study back to Japan in order to prepare the Reports subject to the approval by the Government of Malaysia.

4. Members of The Survey Team

The survey team comprised 12 people as requested by the Japan International Cooperation Agency.

Tadashi Makino (Leader of Team),	Deputy Director Engineering Division, Broadcasting Department Radio Regulatory Bureau Ministry of Posts & Telecommunications
Fusao Saito,	Senior Engineer Techincal Investigation Division Radio Regulatory Bureau Ministry of Posts & Telecommunications
Akira Yoshimoto,	Senior Engineer Engineering Division Monitoring Department Radio Regulatory Bureau Ministry of Posts & Telecommunications
Yukio Yamamoto,	Engineer Engineering Division Broadcasting Department Radio Regulatory Bureau Ministry of Posts & Telecommunications
Eiichi Yaguchi,	Senior Engineer Headquarters of Technical Administration & Construction Japan Broadcasting Corporation
Shinichiro Uda,	Coordinator International Cooperation Management Planning Bureau Japan Broadcasting Corporation
Tetsuo Kawamoto,	Engineer Headquarters of Technical Administration & Construction Japan Broadcasting Corporation
Toshiaki Arai,	Engineer Headquarters of Technical Administration & Construction Japan Broadcasting Corporation
Shooji Nishizawa,	Architect Headquarters of Technical Administration & Construction Japan Broadcasting Corporation

Hogara Chiba,	Chief Engineer Architectural Division All Japan Television Service Co., Ltd.
Kazuhiro Takahashi,	Engineer Consulting Service Division All Japan Television Service Co., Ltd.
Eiji Sakihara (Coordinator),	Special Assistant to Head 2nd Development Survey Division Social Development Cooperation Dept. Japan International Cooperation Agency

5. Survey Schedule

Day		Activities in KL	Field Survey
16 June	Meeting	Japanese Embassy	
	Meeting	JICA	
17	Meeting	EPU, RTM & Telecom	
18	Meeting	Telecom & RTM	
19	Unpack & set up measurement equipment		
20	Map study		
21	Map study		
22	Map study		
23	Meeting	RTM	
24	Meeting	EPU Signed on Scope or work	
25			KL north, KL south, KL west
26			Sungai Besi Tx
27	Meeting	RTM	KL north, KL city, Fraser Hill Tx
28			Bt. Tampin Tx, G. Ulu Kali Tx
29			P. Langkawi
30			P. Langkawi, G. Telepa Burok Tx
1 July			Kangar, Bt. Kayu Ara Tx, Kuantan city & RTM studio
2			Alor Setar city & RTM studio Kuantan south
3			Alor Setar south, Mt. Ophir Tx Kuantan west-north

4 July			G. Jerai Tx, Melaka north, Kuantan north
5			Melaka east, Bt. Pelindong Tx Pinang city & RTM studio
6			
7			P. Pinang, Melaka south, Bt. Bauk Tx
8			Bt. Penara Tx Melaka city & RTM studio, Bt. Besar Tx
9			Taiping, Bt. Banang Tx, K. Trengganu south
10			Maxwell Hill Tx, Johor Bahru west K. Trengganu city & RTM studio
11	Meeting	EPU	Ipoh north, Johor Bahru south
	Meeting	JICA	and north,
	Meeting	Jetro	K. Trengganu north
12	Meeting	Telecom	Ipoh city & RTM studio, Johor Bahru city &
	Meeting	RTM	RTM studio, Kota Bharu Tx,
13			Bt. Banang Tx
14	Meeting	AIBD	Lumput, G. Pulai Tx, Kota Bharu east
15	Meeting	RTM	G. Kledang Tx, Menkibol Tx,
	Meeting	Ministry of Information	Kota Bharu south
16	Meeting	RTM	Cameron High Land Tx,
	Inquiry	Ministry of Education	Bt. Tinggi Tx, Bt. Bakar Tx
17	Meeting	EPU	Bt. Brinchang Tx
	Meeting	Telecom	Johor Bharu east
	Meeting	RTM	Kota Bharu city & RTM studio
18	Meeting	RTM	G. Kledang Tx
	Meeting	Ministry of Information	

19 July	Meeting	EPU	Maxwell Hill Tx
	Meeting	RTM	
20			K. Lipis, G. Jerai Tx
21	Meeting	RTM	
	Meeting	Telecom	
	Inquiry	University of Malaysia	
22	Inquiry	Pinang University	
23	Inquiry	Ministry of Education	
	Meeting	RTM	
24	Meeting	RTM & Telecom	
	Inquiry	Ministry of Education	
25	Inquiry	LLN	
	Meeting	Jetro	
	Meeting	Telecom	
	Meeting	Ministry of Information	
	Inquiry	Advertisement Agency	
26	Meeting	RTM	
	Inquiry	University of Malaysia	
27			
28	Meeting	EPU	
	Meeting	Telecom	
	Inquiry	Ministry of Education	
	Inquiry	Bank Negara	
	Inquiry	Newspaper office	
29	Reporting	Japanese Embassy	

6. The Contents of The Discussion With The Malaysian Government

A series of joint meeting between the Malaysian Government authorities and the Japanese Survey Team were held during the period of the survey, mainly for the purpose of coordination and collection of data and information relating to the project.

The main joint meetings, matters confirmed and agreed are as follows–

1) 17th June 1980 Meeting between EPU, TELECOM, RTM and Japanese Survey Team, Embassy of Japan at EPU.

Japanese Survey Team

(1) Proposed survey schedule as well as draft Scope of Work for the Feasibility Study.

(2) Also handed over the questionaire related to the study.

2) 18th June 1980 Meeting between TELECOM, RTM and Japanese Survey Team at TELECOM.

(1) The Japanese Survey Team explained the detail of the questionaire, which was handed over on the 18th June and the consultation between the two parties was taken place.

(2) The Japanese Survey Team also requested the reference materials relating to the Feasibility Study.

(3) The Japanese Survey Team notified that the requested 12 channels allocation is very difficult to realize. Only about 6 to 7 channels are quite possible. A brief explanation on the type of coverage and priority were given by RTM.
The Survey Team enquired when stereophonic services will be commenced. RTM explained that it will be determined upon results of this feasibility study.

3) 24th June 1980 Meeting between EPU, TELECOM, RTM and the Japanese Survey Team at EPU.

In relation with the proposed draft of Scope of Work which was submitted by the Japanese Survey Team, discussion was held and the two parties agreed to the draft and signed.

4) 24th July 1980 Meeting between TELECOM, RTM and the Japanese Survey Team at TELECOM.

(1) Types of Coverages

A) RTM expressed wishes to set up 12 networks containing various types of coverages. Among these 12 networks RTM explained the priority in relation with combination of networks in case the number of networks should be reduced, which is shown below.

CASE	6 channels	7 channels	8 channels
National	3	4	4
Regional	1	1	1
Local	1	1	1
Educational	1	1	2

B) The Japanese Survey Team confirmed:
"National" meant nationwide broadcast service; "Regional" meant regional broadcast service consisting to 4 regions namely North, Central, South, and East; and "Local" meant local area broadcast in each state and accordingly there were 11 local services since the number of states are 11.

(2) Implementation Plan

RTM explained it wished to implement FM broadcast expansion plan in 2 phases as follows:

PHASE 1 – Central Region, Pinang (Kedah Peak), Kota Bharu, Johor Bahru, Kuantan or Kuala Trengganu

PHASE 2 – other districts

(3) Technical Standard

The Japanese Survey Team inquired whether the technical standard to be used for the feasibility study is based upon the recommendations of CCIR and CCITT. TELECOM confirmed to use the technical standard recommended by CCIR and CCITT.

(4) Utilizing of existing transmitting station

A) Tower
TELECOM agreed to the utilization of the existing towers for FM service, if technically admissable and the heights of tower is more than 100 meters.

B) Building
TELECOM explained that in the case of TV transmitter station building if there was sufficient space, it would agree that the station would be used for FM transmission as well.
Whereas in the case building used not only for TV but also for other transmissions, it would agree the station to be utilized for FM broadcast only when there is sufficient space in TV transmitter floor.

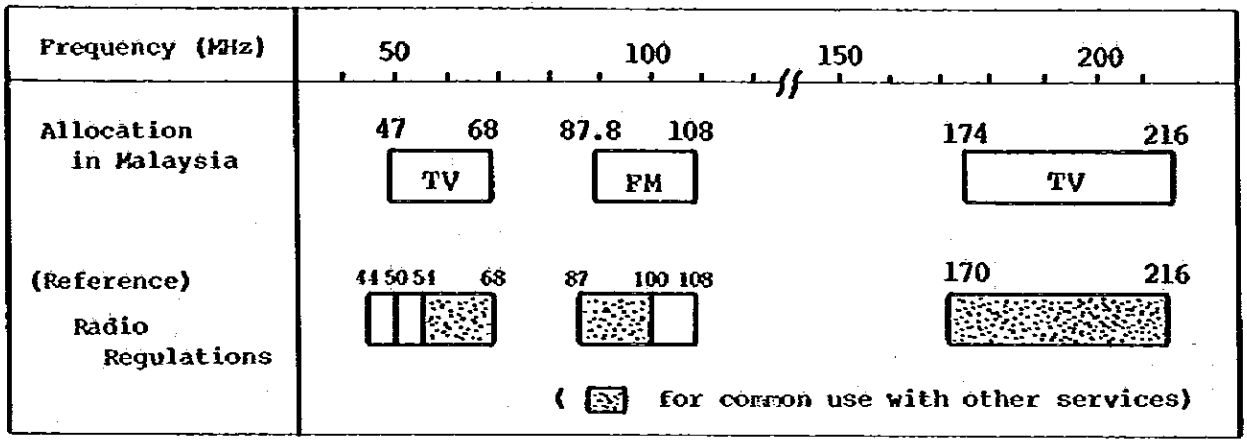
III. MAIN SUBJECT

1. Technical Standards

1-1 Frequency Allocation for FM Broadcasting

In accordance with the frequency allocation policy of the Government of Malaysia, the 87.8 MHz – 108 MHz will be used for the FM broadcast in this project.

Table 1-1-1 Allocation of VHF Broadcast Frequency in Malaysia



1-2 Standards System for FM Broadcasting

1-2-1 Standard System for Stereophonic Broadcasting

According to the desire of the Government of Malaysia and the results of the survey, it would be appropriate to comply with the CCIR Recommendation 412-2 (Standards for VHF/FM Broadcast) and Recommendation 450 (Systems for VHF/FM Stereophonic Broadcast).

(1) Pre-emphasis is defined as 50 μs or 75 μs, in Recommendation 412-2, according to the following reasons, 50 μs is appropriate.

1) The fact that existing stations are adopting 50 μs and receivers for this standard are being diffused.

2) In considering the modulation index and bandwidth, 50 μs is safer than 75 μs.

3) In considering the fact that in the United States of America, 75 μs is adopted, but in Europe, many countries adopt 50 μs.

4) In case the amount of emphasis is large, the line-up-level of transmitter will be decreased in order to avoid over-modulation at high modulating frequencies. Thus the S/N-improvement coefficient will be decreased.

5) That there is no difference recognized in listening of audio receiver output.

6) That the degree of reduction in noise, according to calculation is respectively 4 dB at 50 μs and 4.9 dB at 75 μs, thus the difference is small.

(2) In the CCIR Recommendation 450 for FM systems, it is stated to consider the polar modulation system or the pilot tone system, and the FM-FM system combined with a compressor/expander. As the existing station is the pilot tone system and receivers for this system are being diffused, and this system is adopted in the United States of America and countries in Europe, the pilot tone system will be appropriate.

1-2-2 SCA (Subsidiary Communications Authorization)

The frequency arrangement for SCA is shown in Fig. 1-2-1.

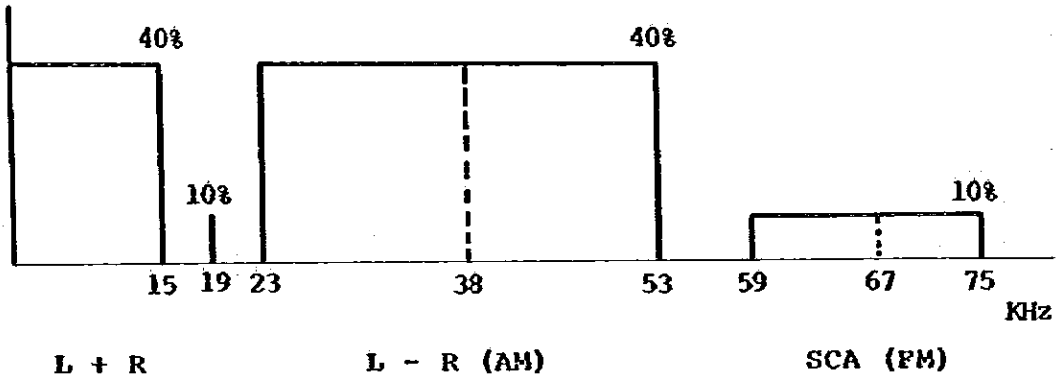


Fig. 1-2-1 Frequency Arrangement for SCA

In the case of stereophonic broadcasting, there exists interference from SCA channel to stereophonic reception and crosstalk interference from stereophonic channel to SCA channel, and thus high quality reception cannot be ensured. In order to ensure an excellent condition of reception, a method of adding a SCA channel trap and audio low-pass filter to the receiver is available, but, as this is not a general method, the adoption of SCA is inappropriate.

1-3 Estimation of Field Strength

For the estimation of field strength (1) in the coverage area, (2) of interfering signal and, (3) for off-air relay, the propagation curve defined in CCIR Recommendation 370-3 was used by compensating it with the amount of propagation loss estimated from the topographical elements of a map (scale, 1/60,000) and the results of the TV field strength measurements carried out by the survey team, according to the following method.

1-3-1 Estimation of Field Strength at Distance within the Horizon

The propagation curve (Fig. 1-3-1) defined in CCIR Recommendation 370-3 is based mainly on the radio wave propagation data in Europe and North America, and would be difficult to apply it for Malaysia in the from as it is, because the meteorological condition and topographical condition are different.

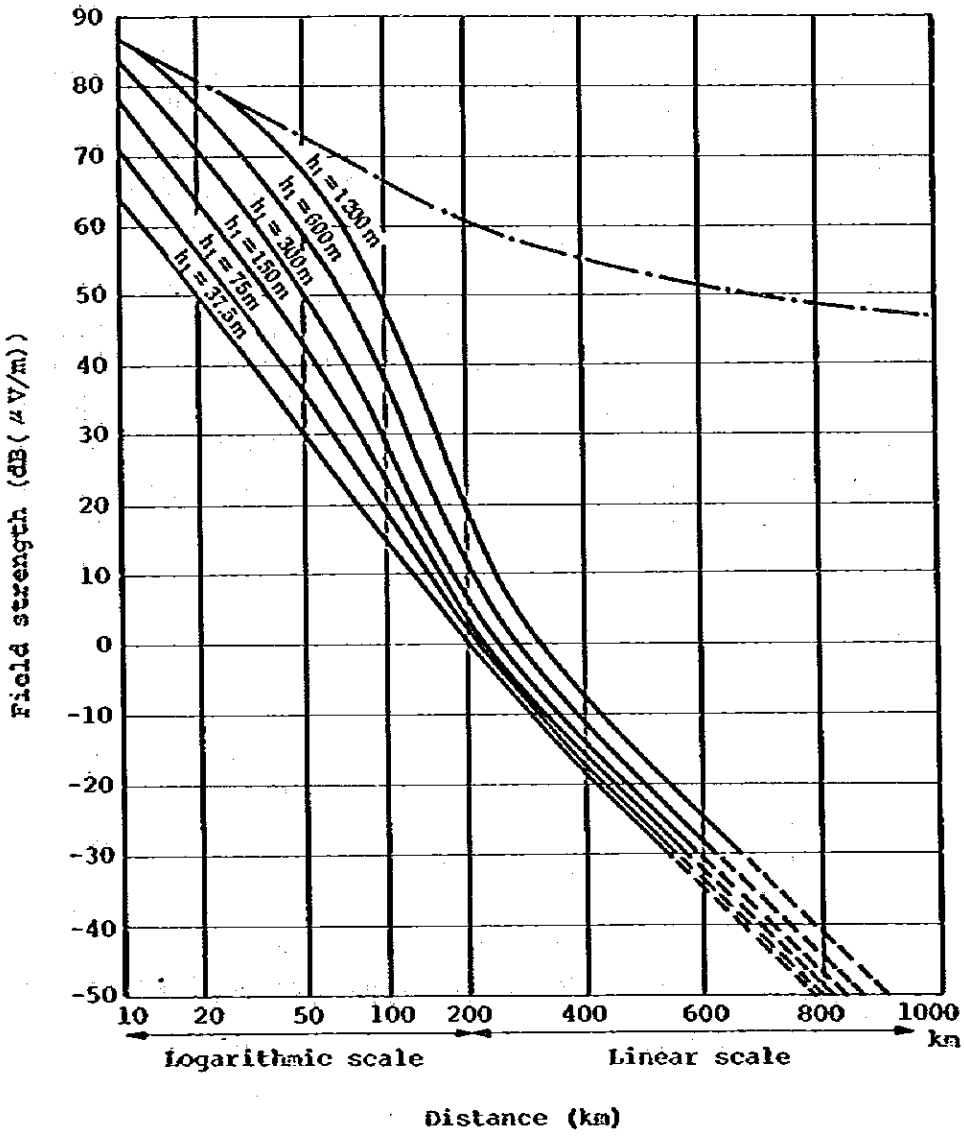


Fig. 1-3-1 Field Strength (dB (μv/m)) for 1 kW ERP

Frequency: 30 to 250 MHz (Bands, I, II and III); Land, North Sea and Mediterranean region; 50% of the time; 50% of the locations; h_2 = 10 m

——·——·—— Free space

CCIR REC 370-3

For this reason, in this report, the propagation loss was estimated from the TV field strength survey carried out by the survey team, and an amount of −1.7 dB compensation was added to the above CCIR propagation curve and used as a standard for estimation of field strength.

In Malaysia, as there is no great change in the condition of meteorology and the condition of growth of trees in forests, during the year, which are the causes of propagation loss, the above mentioned compensation provided by the measured results of the survey team is considered to be effective throughout the year.

The compensation according to topographical conditions was performed individually by making a profile map from a 1/60,000 scale map.

(1) Compensation of propagation loss by the measured TV field strength

Of the measured TV field strength values, 25 sampled from the main radiation direction where disorder of transmitting antenna pattern was small and within line of sight from the transmitting site and reflection points were smooth. The distribution of deviation in field strength compared with results of the field strength equation (Equation 1-3-1) for spherical ground surface are as shown in Fig. 1-3-2 and Fig. 1-3-3.

It was a normal distribution of mean value −7.6 dB and of standard deviation 5.2 dB.

$$E = \frac{14\sqrt{W}}{d} \left| \sin \frac{2\pi h_1 h_2}{\lambda d} J \right| \quad \text{..... (Equation 1-3-1)}$$

where;

W : Effective radiated power.
d : Distance between transmitting and receiving point.
λ : Wave length.
h_1 : Height of Transmitting antenna.
h_2 : Height of receiving antenna.
J : Compensating coefficient for phase difference.
Note : The reflection coefficient for ground was assumed as −1, and the diffusion coefficient as 1.

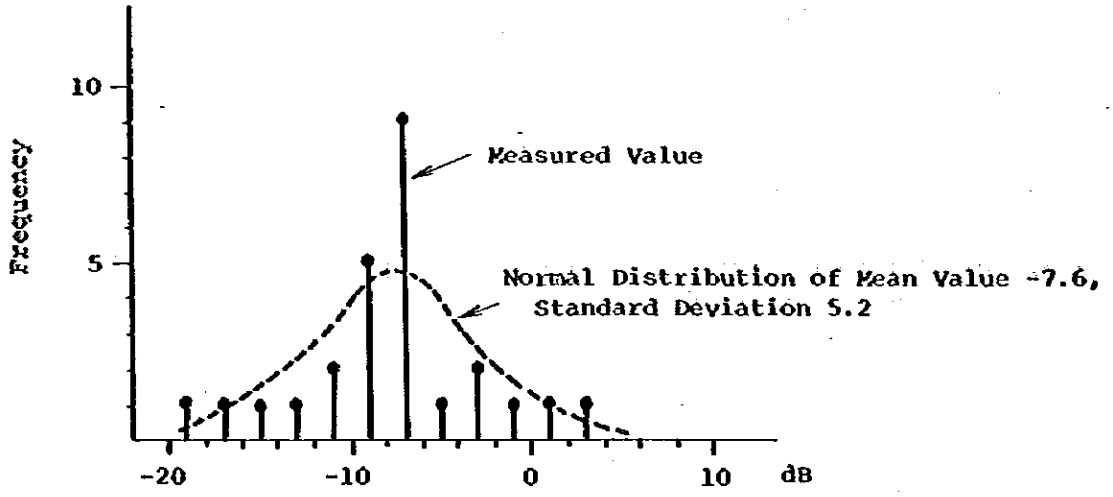


Fig. 1-3-2 Deviation in Measured Value and Calculated Value

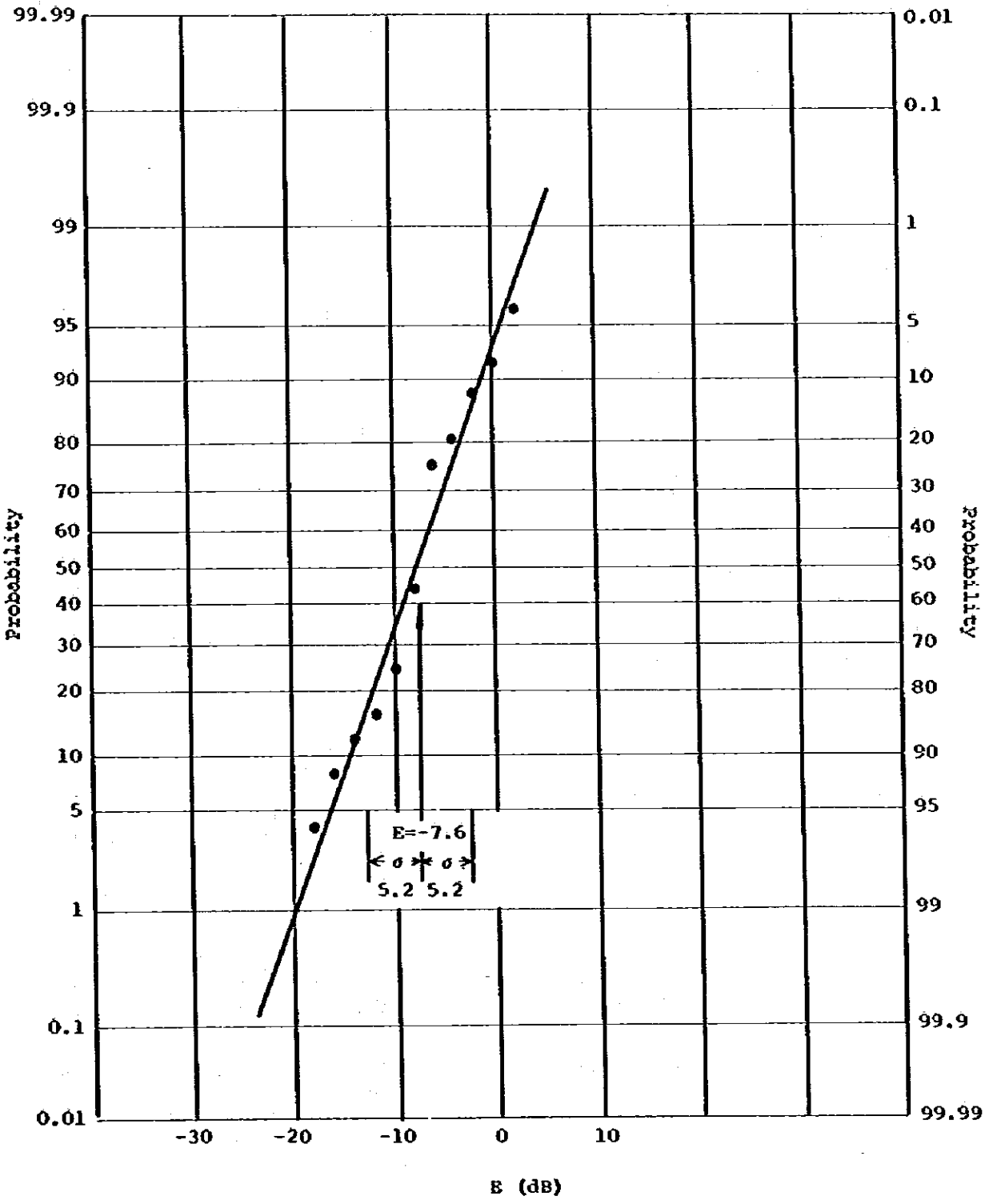


Fig. 1-3-3 Distribution of Measured Field Strength

(2) Deviation of CCIR propagation curve and calculated value

On the other hand, the deviation of CCIR propagation curve (Fig. 1-3-1) and field strength calculation equation (Equation 1-3-1) is a normal distribution of mean value of −5.9 dB, and standard deviation of 1.2 dB. Accordingly, the deviation of the measured TV field strength is as −1.7 dB, and the standard deviation will become as 5.3 dB.

According to the above, a compensation of −1.7 dB was added to the CCIR propagation curve, and this was used as a standard for field strength estimation within the horizon.

1-3-2 Estimation of Field Strength Beyond The Horizon

It is experimentally known that field strength E at a point beyond the horizon can be expressed by the following equation.

$$E = -\frac{56 \times 2^{1/4} (Ka)^{5/4} \sqrt{W}}{\sqrt{\lambda} d^4 (1 + 3/4\, S)}$$

(Equation 1-3-2)

$$S = \frac{d}{3.57 \sqrt{k} (\sqrt{h_1} + \sqrt{h_2})}$$

where;

K : Equivalent radius factor.
a : Radius of earth.
W : Effective radiated power.
d : Distance between transmitting and receiving point.
h_1 : Height of transmitting point.
h_2 : Height of receiving point.
λ : Wave length.

Here, the equivalent radius factor K is determined by the refractive index of atmosphere. As the gradient of modified refractive index according to CCIR Report 563-1 for Malaysia is 60 throughout the year, from this, the equivalent radius factor is assumed as K and 1.62 is conducted, and the field strength beyond the horizon was estimated from the equation 1-3-2.

1-4 Technical Standard for Transmitting Facilities

With regard to the transmission characteristic of stereophonic signal, the CCIR Report (Rep. 293-4) proposes a technical standard as shown in Table 1-4 on the transmission characteristics of the cascaded connection of transmission line-stereo encoder-transmitter.

In respect to the characteristics of transmitter output in chapter 4, this CCIR technical standard is recommended.

Table 1-4 Technical Standard for Transmitting Facilities

Characteristics and signals[1]	Frequencies (kHz)	Broadcast signal[2]
Bandwidth *A*, *B*, *M* and *S*		0.04 to 15 kHz
Amplitude/frequency response profile *A* and *B* (dB)	0.04 to 0.125 0.125 to 0.630 0.630 to 1.25 1.25 to 10 10 to 14 14 to 15	+0.7 to −2.5 +0.7 to −0.7 +0.5 to −0.5 +0.7 to −0.7 +1 to −2.5 +1 to −3
Gain difference[3] *A* and *B* (dB)	1 0.04 to 0.125 0.125 to 10 10 to 14 14 to 15	1 2 1 2 3
Phase difference[3] *A* and *B* (degrees)	0.04 0.04 to 0.2 0.2 to 4 4 to 15 15	40° oblique segment 20° oblique segment 45°
Linear crosstalk[3] *A* and *B* (dB)	0.04 to 0.3 0.3 to 4 4 to 15	−36 −36 oblique segment 6 dB per octave
Weighted signal-to-noise ratio *A*, *B* and *M* (dB)		54[4]
Non-linearity distortion *A*, *B* and *M* (dB) Total harmonic distortion Non-harmonic products	0.04 to 0.125 0.125 to 7.5 7.5 to 15	−37 −43 −40

(1) *A* is the signal on the left and *B* the signal on the right. $M = 1/2\,(A + B)$ and $S = 1/2\,(A - B)$.

(2) The broadcast signal tolerances apply to the chain circuit + encoder + transmitter. The circuit taken is the reference circuit defined in Recommendation 502.

(3) This concerns only differences of gain, differences of phase or linear crosstalk, which are introduced unintentionally between the *A* and *B* channels owing to imperfections in the transmission chain.

(4) The indicated values result from r.m.s. noise measurements when a weighting network is used in accordance with Recommendation 468-2.

1-5 Technical Standards for Buildings and Towers

1-5-1 Technical Standards for Buildings

The structural analysis and design, of buildings are carried out in this report as referring to the Building Standards Laws and related Regulations of Japan, the structural design standards set out by the Architectural Institute of Japan and the British Technical Standards (BTS).

Also, with regard to the loading weight, the Building Standards Laws of Japan and loading weight standards set out by the Architectural Institute of Japan and the British Technical Standards are referred to.

1-5-2 Technical Standards for Towers

The structural analysis and design of towers are carried out in this report by referring to the Building Standards Laws and the related Regulations of Japan, the structural design standards set out by the Architectural Institute of Japan and the British Technical Standards (BTS).

2. Site and E.R.P. of The Project

2-1 Fundamental Concept of Planning

In selecting the transmitting sites and determining the transmitting condition, the following items were taken into consideration.

(1) That the constitution of this project is three networks; National, Regional and Local, and that each network is aimed at plural number of channels.

(2) That a television network covering almost all of Peninsular Malaysia is already completed.

These two points were considered, and in addition to the general items which were necessary for station site planning, the following points were especially considered.

(1) To obtain the necessary service area with the minimum number of stations, and to utilize existing television sites for minimizing construction expenses.

(2) To suppress the unnecessary radiation to ensure adequate number of channels for each transmitting site.

2-2 Network Constitution and Service Area

The constitution of network is classified into the following three.

(1) A national network covering all regions in Peninsular Malaysia as its service area.

(2) Peninsular Malaysia will be divided into four regions; Eastern, Northern, Southern and Central as shown in Table 2-2-1 and Fig. 2-2-1, and each region will have a regional network as service area.

(3) Local networks cover each of the 11 states which constitute Peninsular Malaysia.

Table 2-2-1 Network Constitution and Service Area

	National Network	Regional Network	Local Network
Service Area	Whole Peninsular Malaysia	1. EASTERN REGION State of Kelantan State of Trengganu State of Pahang 2. NORTHERN REGION State of Perlis State of Kedah State of Pinang State of Perak 3. SOUTHERN REGION State of Johor State of Melaka 4. CENTRAL REGION State of Selangor State of Negeri Sembilan	States

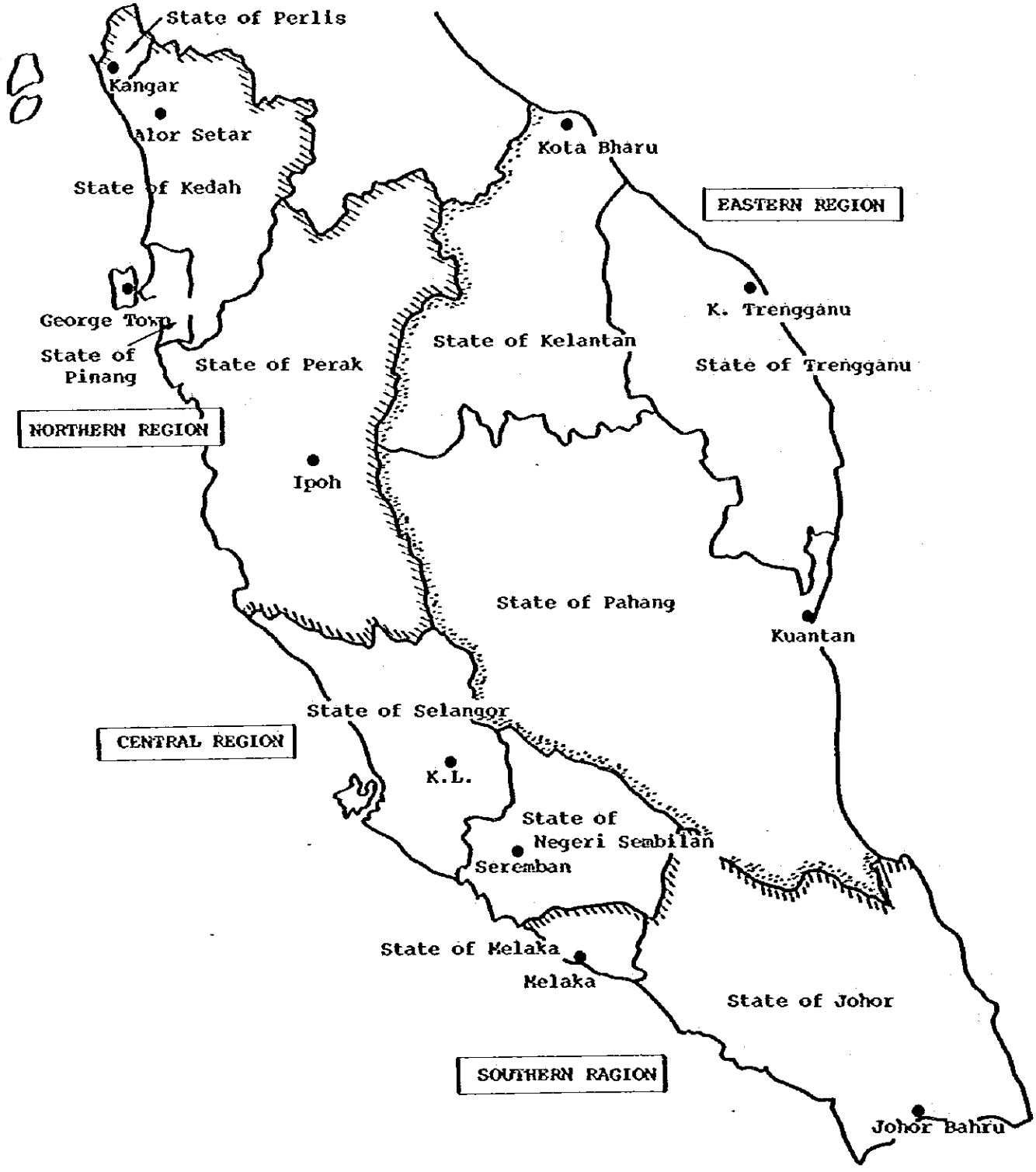


Fig. 2-2-1 Service Area

2-3 Population Distribution

The population of Peninsular Malaysia is about 10.4 million (1976), and the majority is distributed in the principal cities of Northern, Central and Southern regions, and the Eastern mountainous region is the sparsely populated zone.

As it is of great importance to grasp the condition of this population distribution for selecting the transmitting sites and determining the transmitting condition, in this report, the Population Distribution Map (MALAYSIA BARAT 1970) of the Statistical Department of Government of Malaysia was used as reference.

2-4 Topography

In Peninsular Malaysia, a mountain range of 2,000 m class is located at the central part of the peninsular from north to south, and from this mountain range many large rivers are flowing toward the east and west directions, thus forming a complicated topography.

These topographical conditions, which dominate the propagation of wave greatly, were checked by a profile map and results of the field survey carried out by the survey team throughout Peninsular Malaysia.

2-5 TV Transmitting Stations in Operation

When the existing television transmitting sites are used for the FM transmitting sites of this project, sufficient care is to be paid to mutual interference because many radio stations for general services are also equipped in the sites, thus frequency planning of the station will become complicated. But on the contrary.

(1) Access road is completed at each transmitting station and city electric power is supplied at most of the stations.

(2) Most of the stations are being manually operated and the staff will be available to perform the necessary operation and maintenance work for the FM transmitting station.

Thus, it has a great merit in minimizing the construction cost and operation cost.

For this reason, the survey team has selected 20 stations out of the existing TV transmitting stations (Table 2-5-1) which were considered to be most suitable for FM transmitting sites. Survey was carried out at these sites.

Table 2-5-1 List of Existing TV Transmitting Stations

Existing TV Sites	Altitude	Longitude	Latitude
1. Bt. Sg. Besi	998(ft)	101°44'00"	3°04'20"
2. G. Kledang	2650	101°00'46"	4°35'27"
3. Bt. Tampin	568	102°12'33"	2°29'34"
4. G. Jerai	3990	100°26'12"	5°47'25"
5. G. Pulai	2147	103°32'47"	1°36'12"
6. Bt. Banang	1400	102°56'35"	1°48'56"
7. Bt. Mengkibol	400	101°23'00"	2°01'00"
8. G. Ulu Kali	5814	101°47'27"	3°25'40"
9. Maxwell Hill	4558	100°48'30"	4°51'27"
10. Bt. Besar	513	103°08'15"	5°18'24"
11. Bt. Pelindong	880	103°21'50"	3°49'55"
12. Bt. Bauk	1550	103°24'50"	4°41'48"
13. Kota Bharu	100	102°14'50"	6°06'35"
14. G. Brinchang	6664	101°23'02"	4°31'04"
15. Bt. Bakar	2019	102°17'03"	5°42'25"
16. Kayu Ara	998	102°15'00"	2°44'10"
17. Bt. Fraser	4341	101°45'12"	3°43'05"
18. Changkat Rembian	670	101°15'23"	4°10'47"
19. Bt. Penara	1750	100°15'30"	5°22'10"
20. Mt. Ophir	4187	102°36'34"	2°22'24"
21. Bt. Tinggi	1141	103°40'26"	2°17'12"
22. Bt. Istana	656	102°21'06"	3°56'20"

2-6 Minimum Field Strength Required

2-6-1 Noise

The minimum field strength required is determined by the required S/N ratio of receiver output, the improvement coefficient of receiver and the external noise level.

Accordingly, it is necessary to know the noise level in Malaysia, but, it is difficult to get data in a short period. In this report, the CCIR Report 258-3 (Fig. 2-6-1); data of the United States of America and of Japan (Table 2-6-1) were respectively referred.

Table 2-6-1 Noise Level (Mean Value at 4m height)

Number of house holds	Noise level
30,000	23 dB
10,000 30,000	17
6,000 10,000	16.5
less than 10,000	15.5

(an example of Japan)

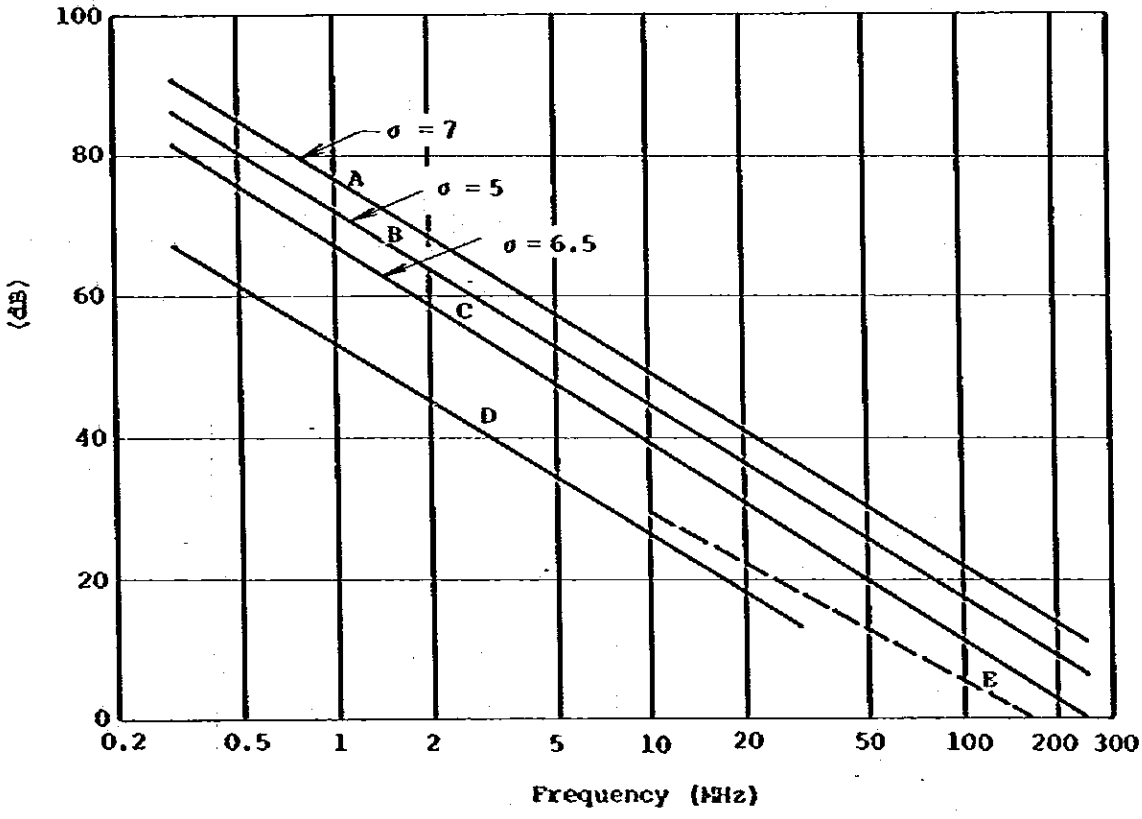


Fig. 2-6-1 Mean values of man-made noise power for a short vertical lossless grounded monopole antenna

A : Business
B : Residential
C : Rural
D : Quiet rural
E : Galactic

(CCIR. Rep. 258-3)

The majority of external noise affecting the FM broadcast band will be artificial noise generating from automobiles, electric appliance etc. Of these noise, the ones generating from automobils are dominant and have close relation with the distribution of population.

2-6-2 Minimum Field Strength Required

The minimum field strengths required were based on CCIR Recommendation 412-2. The standard values at a height 10m above ground level are as following.

(1) Monophonic Broadcast

1)	Large cities	3mV/m	70 dB (μV/m)
2)	Urban areas	1 mV/m	60 dB (μV/m)
3)	Rural areas	0,25 mV/m	48 dB (μV/m)

(2) Stereophonic Broadcast

1)	Large cities	5 mV/m	74 dB (μV/m)
2)	Urban areas	2 mV/m	66 dB (μV/m)
3)	Rural areas	0.5 mV/m	54 dB (μV/m)

Here, from the materials of item 2-6-1 related to noise distribution, the following classifications were referred to determine the transmitting condition.

Large cities : Number of households, over 30,000.
Urban areas : Number of households, 5,000 – 30,000.
Rural areas : Villages with number of households, less than 5,000.

2-6-3 Input S/N of Receiver and Evaluation of Reception

The relation between evaluation of receiver input S/N of monophonic broadcasting and the evaluation of reception by the five point scale method (Table 2-6-2) is as Fig. 2-6-2 (Investigated by NHK).

Table 2-6-2 Grading Scales

Five-point scale	
Quality	Impairment
5 Excellent	5 Imperceptible
4 Good	4 Perceptibel but not annoying
3 Fair	3 Slightly annoying
2 Poor	2 Annoying
1 Bad	1 Very annoying

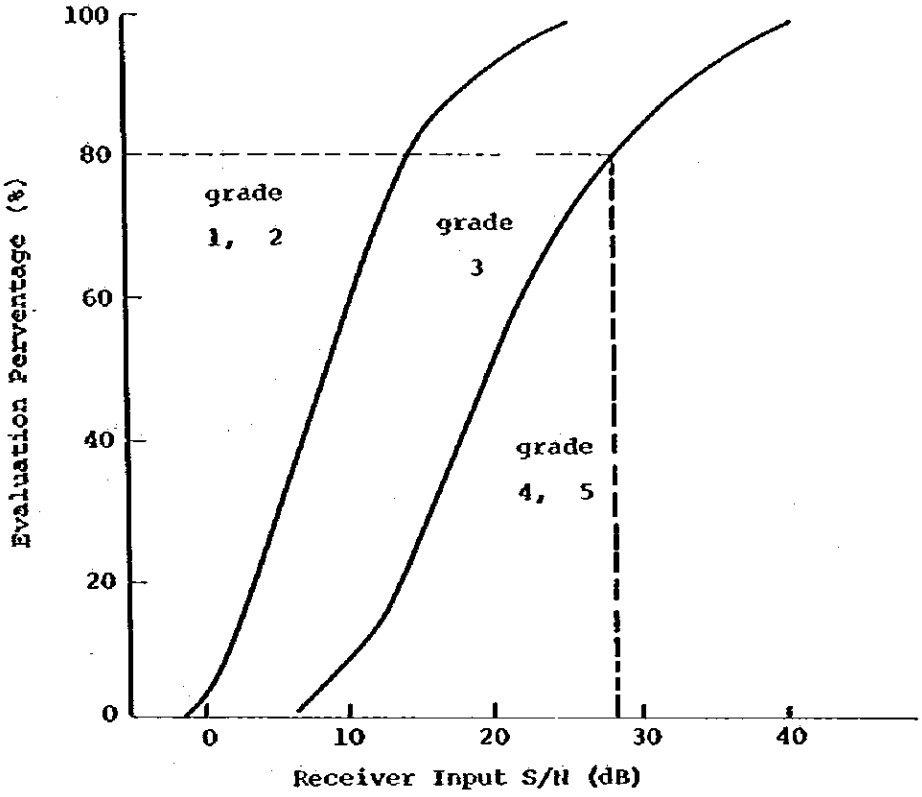


Fig. 2-6-2 Receiver Input S/N and Evaluation of Reception

In this table, the receiver input S/N evaluated higher than rank 4 by more than 80% of the audience is 28 dB.

In general, the distribution of field strength is a normal distribution of 7 dB standard deviation, according to CCIR Recommendation 370-3. Accordingly, the probability to obtain a receiver input S/N of 28 dB in case of serving large cities, urban areas and rural areas with the field strength defined in item 2-6-2, is over 98% for all cases, as shown in Table 2-6-3.

Table 2-6-3 Field Strength and Probability to Obtain the Required Receiver Input S/N

	Service Field Strength ( ): Standard Deviation (dB)	Noise Level ( ): Standard Deviation (dB)	Receiver Input S/N ( ): Standard Deviation (dB)	Receiver Input S/N Probability to obtain 28 dB (%)
Large cities	70 (δ = 7)	22 (δ = 7)	48 (δ = 10)	98
Urban areas	60 (δ = 7)	17 (δ = 5)	43 (δ = 7)	98
Rural areas	48 (δ = 7)	less than 10	over 38	over 98

In stereophonic broadcasting, the necessary input to obtain equivalent reception quality as that of monophonic broadcasting is 6 dB higher than that required for monophonic broadcasting (Investigated by NHK).

Accordingly, the standards defined in item 2-6-2 for the required minimum field strength is adequate for stereophonic broadcasting and is appropriate values.

2-7 Transmitting Site

As from the results of consideration of the most efficient transmitting sites, 13 existing TV transmitting stations, one existing microwave relaying station and one new site, a total of 15 sites were selected.

The highest power of transmitters of the project could be made as 1 kW which solid state transmitter is available, in order to minimize the projected space in the building and to facilitate maintenance. By adopting high gain antenna, the required highest ERP of the project can be achieved combining with 1 kW transmitter.

By taking above consideration into account, transmitting condition of all projected station was determined. The results are shown in Table 2-7-1 and on attached map (estimated field strength, 54 dB (μV/m)).

It is to be noted that for Perlis local service, it will be advantageous to use the existing transmitting station (G. Jerai) from the view point of economy, but to avoid duplication of service area and to make effective use of frequencies, a new transmitting station at Bt. Bintang is recommended.

In addition, the percentage of coverage of this project is presumed as 67% by area percentage and 98% by population percentage.

Considerations on areas which will not be covered with the above 15 stations, and measures for filling the pocket areas in the service area, are to be dealt with after the transmitting stations are in operation. It would be desirable to consider an effective plan after grasping the actual reception condition. Appendix C attached to the Report shows outline of the Plan which supplements 15 basic station planning for reference.

Table 2-7-1 List of Transmitting Stations

Transmitting Condition / Transmitting Station	Location (Longitude E) (Latitude N)	Altitude (ft)	Network	Transmit. Output Power	Antenna				E R P
					Array x Stage	Direction	Power Distribution	Gain (dB)	
1. BT. BAKAR	102° 17' 03" 5° 42' 25"	2019	N. R. L	1 kW	3 x 2	0°, 90°,210°	4 : 1 : 1	7.1	5.1 kW
2. BT. BESAR	103° 08 15" 5° 18' 24"	513	N. R. L	1 kW	2 x 2	170°, 290°	1 : 1	6.4	4.4 kW
3. BT. BAUK	103° 24' 50" 4° 41' 48"	1550	N. R. L	500 W	2 x 2	210°, 330°	4 : 1	7.6	2.9 kW
4. BT. PELINDONG	103° 21' 50" 3° 49' 55"	880	N. R. L	1 kW	3 x 2	200°,290°, 20°	4 : 1 : 1	7.1	5.1 kW
5. BT. TINGGI	103° 40' 26" 2° 17' 12"	1141	N. R. L	1 kW	4 x 2	355°, 85° 175°, 265°	2 : 2 : 2 : 1	5.0	3.2 kW
6. G. PULAI	103° 32' 47" 1° 36' 12"	2147	N. R. L	500 W	4 x 2	310°, 40° 130°, 220°	4 : 1 : 4 : 1	6.9	2.5 kW
7. MT. OPHIR	102° 36' 34" 2° 22' 24"	4187	N. R. L	500 W	3 x 2	130°,250°, 40°	4 : 1 : 1	7.1	2.6 kW
8. BT. TAMPIN	102° 12' 33" 2° 29' 34"	1862	N. R. L (to Sembilan)	100 W	1 x 2	300°	-	9.4	870 W
			L (to Melaka)	100 W	1 x 2	150°	-	9.4	870 W
9. BT. TELEPA Buyok	102° 04' 10" 2° 50' 30"	3915	N. R. L	100 W	2 x 2	30°, 120°	1 : 1	5.6	360 W
			N	1 kW	3 x 2	190°,280°, 50°	4 : 1 : 4	5.4	3.5 kW
10. G. ULU KALI	101° 47' 27" 3° 25' 40"	5814	R, L (to Selangor)	500 W	2 x 2	190°, 280°	1 : 1	6.4	2.2 kW
			R, L (to Pahang)	500 W	1 x 2	50°	-	8.0	3.2 kW
11. G. KLEDANG	101° 00' 46" 4° 35' 27"	2650	N. R. L	500 W	3 x 2	190°,320°,100°	4 : 1 : 1	7.1	2.6 kW
12. MAXWELL HILL	100° 48' 30" 4° 51' 27"	4558	N. R. L	100 W	4 x 2	210°, 300° 30°, 120°	1 : 1 : 4 : 1	6.5	450 W
13. G. JERAI	100° 26' 12" 5° 47' 25"	3990	N, R	1 kW	3 x 2	350°,170°, 80°	4 : 4 : 1	5.4	3.5 kW
			L (to Kedah)	100 W					350 W
14. BT. PENARA	100° 15' 30" 5° 22' 10"	1750	L (to Pinang)	50 W	3 x 2	50°,140°,270°	4 : 4 : 1	5.4	170 W
15. BT. BINTANG	100° 11' 40" 6° 32' 15"	1060	L (to Perlis)	50 W	3 x 2	230°,140°, 50°	4 : 1 : 1	7.1	260 W

3. Frequency Assignment

In assigning frequencies to each transmitting station, the basis of consideration is to assign maximum number of frequencies to each transmitting station, in accordance with the objective of this project. As a result, the number of frequencies which could be assigned to each transmitting station have become six at the maximum. Meanwhile by including the frequencies of existing FM station and for two independent regional/local services, a total of 9 frequencies are assigned to G. Ulu Kali and 7 frequencies to Bt. Tampin.

The details will be described in the following section.

3-1 Channel Number and Frequency

In order to assign a maximum number of frequencies from the available frequency bandwidth of 20.2 MHz (87.8 – 108 MHz), it is necessary to make the channel spacing as narrow as possible.

Here, as the occupancy of bandwidth for FM broadcast frequency is 200 kHz, the maximum frequency spacing between channels will be 200 kHz. Meanwhile, there is a method to arrange the frequency spacing of channels narrower than 200 kHz by using the off-set effect, however,

(1) The radio interference protection ratio of CCIR Recommendation 412-2 (Table 3-1-1, Fig. 3-1-1) is very stringent near frequency of 50 kHz.

(2) Accordingly, if the frequency spacing between channels were even to be narrower than 200 kHz, an increase in number of available assignment frequencies for each transmitting station cannot be expected.

(3) As a number of frequencies will be transmitted from each transmitting station, in this project, interfering waves caused by mutual modulation will fall into the FM channel bandwidth.

Table 3-1-1 Radio Interference Protection Ratio (CCIR Rec. 412-2)

Frequency spacing, (kHz)	Radio-frequency protection ratio (dB)			
	Monophonic		Stereophonic	
	Steady interference	Tropospheric interference	Steady interference	Tropospheric interference
0	36	28	45	37
25	31	27	51	43
50	24	22	51	43
75	16	16	45	37
100	12	12	33	25
150	8	8	18	14
200	6	6	7	7
250	2	2	2	2
300	–7	–7	–7	–7
350	–15	–15	–15	–15
400	–20	–20	–20	–20

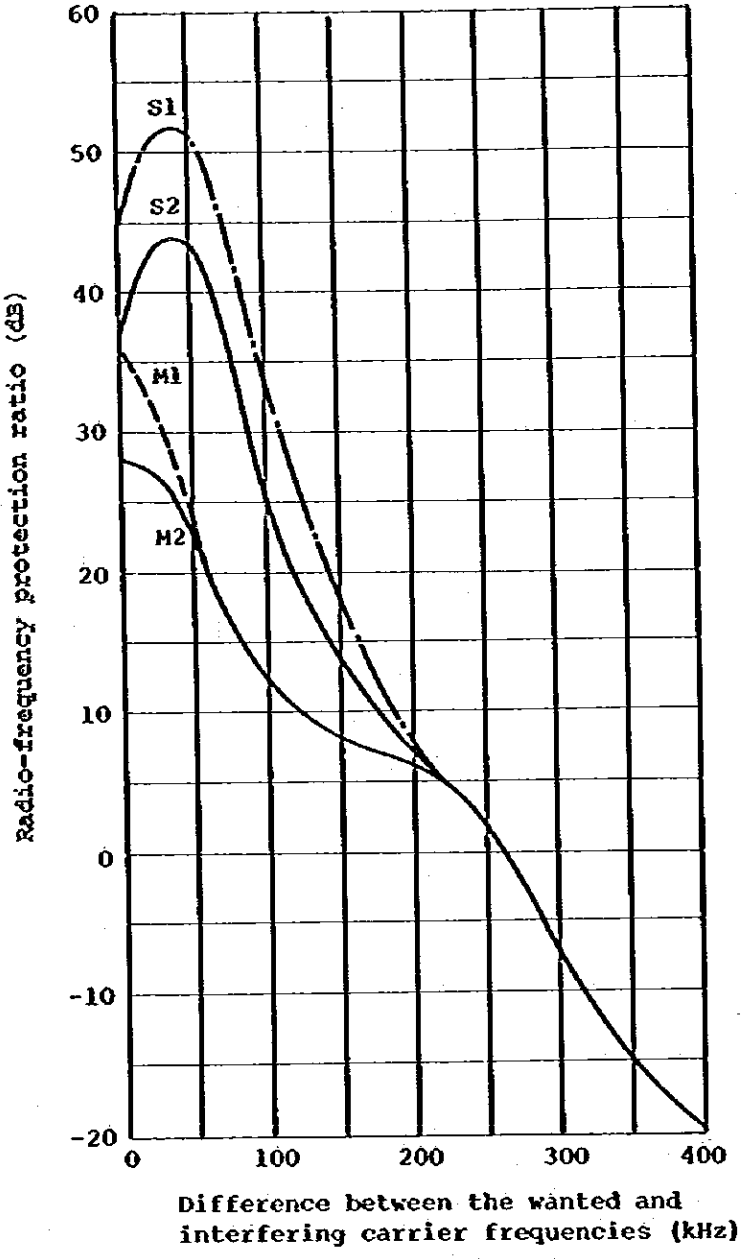


Fig. 3-1-1 **Radio-frequency protection ratio required by broadcasting services in bands 8 (VHF) at frequencies between 87.5 MHz and 108 MHz using a maximum frequency deviation of ± 75 kHz**

Curve M1 : monophonic broadcasting; steady interference

Curve M2 : monophonic broadcasting; tropospheric interference (protection for 99% of the time)

Curve S1 : stereophonic broadcasting; steady interference

Curve S2 : stereophonic broadcasting; tropospheric interference (protection for 99% of the time)

(CCIR Rec. 412-2)

Thus, in principle the frequency assignment is performed by 200 kHz spacing, and frequency off-set of 100 kHz will be added especially only when it is effective.

In Table 3-1-2, the channel number and its respective frequencies are shown.

Table 3-1-2 List of Channel Number and Frequency

ch	$f_{(MHz)}$	ch	$f_{(MHz)}$	ch	$f_{(MHz)}$	ch	$f_{(MHz)}$
1	87.9	31	93.9	61	99.9	91	105.9
2	88.1	32	94.1	62	100.1	92	106.1
3	88.3	33	94.3	63	100.3	93	106.3
4	88.5	34	94.5	64	100.5	94	106.5
5	88.7	35	94.7	65	100.7	95	106.7
6	88.9	36	94.9	66	100.9	96	106.9
7	89.1	37	95.1	67	101.1	97	107.1
8	89.3	38	95.3	68	101.3	98	107.3
9	89.5	39	95.5	69	101.5	99	107.5
10	89.7	40	95.7	70	101.7	100	107.7
11	89.9	41	95.9	71	101.9	101	107.9
12	90.1	42	96.1	72	102.1		
13	90.3	43	96.3	73	102.3		
14	90.5	44	96.5	74	102.5		
15	90.7	45	96.7	75	102.7		
16	90.9	46	96.9	76	102.9		
17	91.1	47	97.1	77	103.1		
18	91.3	48	97.3	78	103.3		
19	91.5	49	97.5	79	103.5		
20	91.7	50	97.7	80	103.7		
21	91.9	51	97.9	81	103.9		
22	92.1	52	98.1	82	104.1		
23	92.3	53	98.3	83	104.3		
24	92.5	54	98.5	84	104.5		
25	92.7	55	98.7	85	104.7		
26	92.9	56	98.9	86	104.9		
27	93.1	57	99.1	87	105.1		
28	93.3	58	99.3	88	105.3		
29	93.5	59	99.5	89	105.5		
30	93.7	60	99.7	90	105.7		

(Note) When off-set is used, the above frequencies are shifted by ± 100 kHz.

3-2 Frequency Spacing Required Between Transmitters at Different Sites

The field strength of one transmitting station at another service areas can be presumed from the transmitting conditions. By calculating the minimum D/U ratio for each service area from these data, and by assuming that the results will satisfy the interference protection ratio (Table 3-1-1), the minimum frequency spacing between any two transmitting stations can be determined. The minimum frequency spacing between any two transmitting stations which were obtained are shown in Table 3-1-3.

This list is only for first check, further inspection is carried out, after the concrete frequency assignment, in 3-6.

Table 3-1-3 Minimum Frequency Spacing Required between Any Two Transmitting Stations

	BT. BAKAR	BT. BESAR	BT. BAUK	G. PELINDONG	BT. TINGGI	G. PULAI	MT. OPHIR	BT. TAMPIN	BT. TELEPA BUROK	G. ULU KALI	G. KLEDANG	MAXWELL HILL.	G. JERAI	BT. PENARA	BT. BINTANG
BT. BAKAR	4	2	1	1	0	0	0	0	1	1	1	2	1	1	1
BT. BESAR		4	3	1	0	0	1	0	0	1	1	1	1	0	0
BT. BAUK			4	3	1	0	0	1	1	1	1	0	0	0	0
PT. PELINDONG				4	1	1	2	0	1	2	1	0	0	0	0
BT. TINGGI					4	1	2	1	2	1	0	0	0	0	0
G. PULAI						4	3	2	1	1	0	0	0	0	0
MT. OPHIR							4	3	3	1	1	0	0	0	0
BT. TAMPIN								4	2	3	1	0	1	0	0
BT. TELEPA BUROK									4	3	1	1	1	0	0
G. ULU KALI										4	3	2	1	1	0
G. KLEDANG											4	3	2	4	1
MAXWELL HILL.												4	3	2	1
G. JERAI													4	4	3
BT. PENARA														4	4
BT. BINTANG															4

Frequency Spacing

4 ;	800 kHz
3 ;	600
2 ;	400
1 ;	200
0 ;	0

3-3 Frequency Spacing Required between Transmitters at One Site

In case a plural number of transmitters is installed on a same transmitting site, the desired wave and un-desired wave arrive in a receiver of the service area with an equivalent level. Therefore, it is necessary to determine the frequency spacing by paying special attention to radio interference and mutual modulation interference occuring in the receiver.

(1) Radio Interference

With regard to radio interference under a strong field strength higher than 90 dB, it is experimentally known that if the frequency spacing is over 800 kHz, there will be no disturbance. Therefore, in assigning frequencies for a transmitter on one site, the minimum frequency spacing is 800 kHz.

(2) Intermodulation Interference

With regard to intermodulation interference caused by nonlinear characteristics of the receiver mixer stage, it is difficult to make a quantative prediction on interference as it is largely affected by the characteristic of individual receivers.

However, in considering the ordinary portable receiver whose selectivity of radio frequency stage is not necessarily adequate, the frequency assignment was devised so that intermodulation will not occur.

Intermodulation up to the third dimensional distortion was taken into consideration.

Cross modulation interference may not be necessary to pay special considerations in case of FM system.

3-4 Protection Against Interference Arriving from Foreign Countries

The survey team has measured the field strength of FM broadcast band throughout Peninsular Malaysia, and has confirmed that a total of 8 frequencies are arriving from Thailand and Singapore, as shown in Table 3-4-1.

Table 3-4-1 FM Broadcast Signals Arriving from Foreign Countries in FM Broadcast Band

Frequency	Name of Country
93.25 MHz	Thailand
95.25	"
97.0	"
103.5	"
92.4	Singapore
94.2	"
95.8	"
96.8	"

The radio interference protection ratios in Table 3-1-1 was ensured against these arriving signals.

The measured field strength data is attached to the annexed papers.

3-5 Considerations on Interference to Existing TV Off-Air Relay

When an FM transmitting station is installed at existing TV transmitting stations, the interference to existing TV off-air relay must be taken into consideration.

Mutual modulation interference and image interference can be eliminated by the band-pass filter in the receiver of TV off-air relay equipment. As the interference, only the harmonic spurious waves were considered.

3-6 Frequency Assignment for Each Transmitting Station

The results of frequency assignment which satisfies all conditions explained in item 3-2 and the successive items, and assigns as many frequencies as possible, are shown in Table 3-6-1.

As a result, the maximum number of channels which can be assigned is six.

The frequencies of two existing FM transmitting stations will have to be changed as follows.

BT. SUNGAI BESI : 97.2 MHz → 94.5 MHz
G. ULU KALI : 95.0 MHz → 95.3 MHz

Table 3-6-1 Frequency Assignment Plan

	f 1 (N)	f 2 (N)	f 3 (N)	f 4 (N)	f 5 (R)	f 6 (L)	
	MHz ch	MHz ch	MHz ch	MHz ch	MHz ch	MHz ch	
1. BT.BAKAR	95.5 (39)	96.5 (44)	97.3 (48)	98.5 (54)	99.3 (58)	100.3 (63)	
2. BT.BESAR	89.7 (10)	90.5 (14)	91.7 (20)	92.5 (24)	88.7 (5)	87.9 (1)	
3. BT.BAUK	95.9 (41)	96.9 (46)	97.7 (50)	98.9 (56)	99.7 (60)	100.7 (65)	
4. BT.PELINDONG	103.3 (78)	104.1 (82)	105.3 (88)	106.1 (92)	107.1 (97)	107.9 (101)	
5. BT.TINGGI	90.1 (12)	90.9 (16)	92.1 (22)	92.9 (26)	89.1 (7)	88.3 (3)	
6. G.PULAI	102.9 (76)	103.7 (80)	104.9 (86)	105.7 (90)	106.7 (95)	107.5 (99)	
7. MT.OPHIR	93.6 (30)	94.8 (36)	95.6 (40)	96.6 (45)	97.4 (49)	100.4 (64)	
8. BT.TAMPIN	103.3 (78)	104.1 (82)	105.3 (88)	106.1 (92)	107.1 (97)	107.9 (101) 102.3 (73) [to MELAKA]	
9. BT.TELEPA BUROK	89.7 (10)	90.5 (14)	91.7 (20)	92.5 (24)	88.7 (5)	87.9 (1)	
10. G.ULU KALI	96.3 (43)	97.1 (47)	98.3 (53)	99.1 (57)	100.1 (62) [to SELANGOR] 106.7 (95) [to PAHANG]	100.9 (66) [to SELANGOR] 107.5 (99) [to PAHANG]	95.3 (38) [existing] 94.5 (34) [S.BESI]
11. G.KLEDANG	90.1 (12)	90.9 (16)	92.1 (22)	92.9 (26)	89.1 (7)	88.3 (3)	
12. MAXWELL HILL	103.3 (78)	104.1 (82)	105.3 (88)	106.1 (92)	107.1 (97)	107.9 (101)	
13. G.JERAI	96.7 (45)	97.5 (49)	98.7 (55)	99.5 (59)	100.5 (64)	101.3 (66)	
14. BT.PENARA						95.7 (40)	
15. BT.BINTANG						94.9 (36)	

3-7 Interference to Existing Radio Stations other than Broadcast Service

In the existing TV transmitting site, radio stations for general purposes are also in operation. The interference from the FM transmission proposed in this project to these radio services were also examined.

In general, as the possibility and extent of interference depends greatly upon the characteristics of the radio station and upon relation between each location, it is difficult to predict by calculation. However, it is possible to predict harmonic spurious interference and mutual modulation interference.

By considering the frequency list of existing radio stations which were offered to the survey team, it was found that there would be no interference to these existing stations from the harmonic spurious radiation from any of the FM transmitting stations. In addition, the transmitting stations which are likely to provide intermodulation interference are the three stations of BT. BAKAR, G. ULU KALI, BT. TINNGGI, and the list of interfering waves is given in Table 3-7-1.

Even when the interference really occurs, the frequency spacing between these stations and FM broadcast is over 2 MHz, therefore, the counter measures can be effective by filters.

Table 3-7-1 (1) Interference to Existing Radio Stations BT. BAKAR

Frequency of Existing Radio Station (Rx)	Interfering wave
62.5000 MHz	
71.7500	
71.9500	
72.1500	
72.7000	
80.9500	80.9
136.4000	
136.6250	
136.7000	
137.0000	
140.3000	
142.9000	
143.1000	
143.2000	
144.1000	
144.4000	
157.6000	
158.5000	
162.0000	
162.3500	
167.4000	

Table 3-7-1 (2) G. ULU KALI

Frequency of Existing Radio Station (Rx)	Interfering wave												
71.5250 MHz	71.1	71.3	71.5	71.7	71.9	72.1							
71.7500	71.3	71.5	71.7	71.9	72.1	72.3							
71.8500	71.3	71.5	71.7	71.9	72.1	72.3							
72.0000	71.5	71.7	71.9	72.1	72.3	72.5							
72.1000	71.5	71.7	71.9	72.1	72.3	72.5	72.7						
72.2500	71.7	71.9	72.1	72.3	72.5	72.7							
72.7000	72.1	72.3	72.5	72.7	72.9	73.1	73.3						
121.5000	120.9	121.1	121.3	121.5	121.7	121.9	122.1						
132.8000	132.3	132.5	132.7	132.9	133.1	133.3							
136.4250	135.9	136.1	136.3	136.5	136.7	136.9							
136.6000	136.1	136.3	136.5	136.7	136.9	137.1							
147.3000	146.7	146.8	146.9	147.0	147.1	147.2	147.3	147.4	147.5	147.6	147.7	147.8	147.9
150.2500	149.7	149.8	149.9	150.0	150.1	150.2	150.3	150.4	150.5	150.6	150.7	150.8	
152.5250	152.0	152.1	152.2	152.4	152.5	152.6	152.7	152.8	152.9	153.0	153.1		
152.5500	152.0	152.1	152.2	152.4	152.5	152.6	152.7	152.8	152.9	153.0	153.1		
152.5750	152.0	152.1	152.2	152.4	152.5	152.6	152.7	152.8	152.9	153.0	153.1		
152.9000	152.4	152.5	152.6	152.7	152.8	152.9	153.0	153.1	153.2	153.4	153.5		
152.9250	152.4	152.5	152.6	152.7	152.8	152.9	153.0	153.1	153.2	153.4	153.5		
152.9500	152.4	152.5	152.6	152.7	152.8	152.9	153.0	153.1	153.2	153.4	153.5		
157.7000	157.2	157.4	157.6	157.8	158.0	158.2							
157.7500	157.2	157.4	157.6	157.8	158.0	158.2							
157.8000	157.2	157.4	157.6	157.8	158.0	158.2	158.4						
157.9500	157.4	157.6	157.8	158.0	158.2	158.4							
158.0500	157.6	157.8	158.0	158.2	158.4	158.6							
160.0500	159.6	159.8	160.0	160.2	160.4	160.6							

Table 3-7-1 (3) BT. TINGGI

Frequency of Existing Radio Station (Rx)	Interfering wave					
75.7500 MHz	75.3	75.7	75.9	76.1		
80.4500	79.9	80.1	80.3	80.5	80.7	80.9
453.5000						

Table 3-7-1 (4) Frequencies for other Services at the Transmitting Site, to which any interference does not affect

	BT. BAUK	BT. BESAR	BT. PELINDONG	G. PULAI		BT. TAMPIN
Frequency (Rx) MHz	72.6500	71.5500	71.7000	60.7500	152.3500	71.7000
	136.1000	72.1250	72.0500	71.7500	152.6500	72.4000
	136.1500	72.3500	72.1000	72.2000	153.1500	136.0500
	136.4000	136.1500	75.8750	72.3750	153.2500	136.1500
	136.7750	136.1750	76.4750	72.4000	153.3000	141.5000
	155.2000	136.4750	136.2750	72.6500	153.9250	141.6500
	157.8500	136.8500	136.5750	72.7250	155.5000	154.5000
	165.9000	160.0182	136.8750	76.5750	155.8750	155.3000
	166.5000	162.8000	141.1000	81.1500	158.0500	155.5500
			141.9000	81.6750	158.6750	155.6500
			148.0000	98.7250	158.7250	165.5000
			154.4000	123.9000	159.0750	166.5000
			157.5000	132.2000	159.2250	
			160.0500	136.1000	160.2000	
				136.1500	167.6000	
				136.1750	215.7500	
				136.3250		
				136.3500		
				136.4000		
				136.4250		
				136.5000		
				136.7000		

Table 3-7-1 (5) Frequencies for other Services at the Transmitting Site, to which any interference does not affect

	BT. TELEPA BUROK	G. KLEDANG	MAXWELL HILL		G. JERAI	
Frequency (Rx) MHz	71.5500	71.8250	71.8250	150.0000	71.5500	152.9000
	72.4500	136.0250	72.0500	154.3000	71.7000	153.1000
	72.6500	136.2500	72.1250	154.9000	72.2000	153.3000
	136.1250	136.3250	72.6500	155.4000	72.3000	154.0000
	136.3000	136.7000	75.5000	155.9000	123.9000	154.3000
	136.6000	155.9000	75.6250	156.9000	132.8000	154.9000
	136.9000	156.9000	76.2500	157.9000	136.0250	155.1000
	141.4750	157.9000	76.5000	157.9500	136.0500	155.1250
	141.9250	160.2000	77.2500	160.2000	136.1000	155.2000
	152.7000	432.000	77.8500	160.4000	136.2500	155.3500
	152.7500	437.000	81.8000	162.5500	136.3250	155.9000
	152.7750	455.000	82.8000	166.5000	136.3500	156.8000
	152.8500		82.9400	170.000	136.5500	157.2000
	157.8500		136.0250		136.6250	157.3000
	158.2500		136.2500		136.6750	157.3500
	160.2250		136.3250		136.8000	158.0500
			136.4000		136.8500	160.0500
			136.7000		146.8000	167.4000
			136.7250		147.0000	
			141.4000			
			141.7250			

4. Transmitting Facilities

4-1 Transmitters

A solid state transmitter are recommended for the FM transmitter in this project. Because it promises high stability, high reliability, compactness and low power consumption. At the same time, in designing a multi-wave transmitter system, the wide-band characteristic which is a feature of a solid state transmitter is utilized.

4-1-1 Reserve System in the Multi-Wave Transmitter

In designing a transmitter system for six waves the reserve system is an important element in respect to such points as reliability, maintenance and economy. With regard to the reserve system, the following two systems were compared in this study.

(1) Full Reserve System

This is a system which each transmitter has its own reserve. It has a high reliability reserve system for each of the transmitters for six waves to operate independently against troubles in any of the transmitters. It is also excellent in maintenance as it enables simultaneous maintenance of all transmitters.

However, this system demands about 1.5 times as much in the cost as the shared reserve system which will be stated later, because it requires 12 transmitters for the six waves. And the space for installation of the transmitters are large, hence leading to an increase in the cost of station construction.

(2) Shared Reserve System

This is a system which has a single shared reserve transmitter for the six wave transmitters. This system utilizes wide-band characteristic of the solid state transmitter.

The system reliability is same with the aforementioned full reserve system under the condition that no transmitters in plural number start trouble at the same time. Therefore, the reliability of each transmitter accounts for the reliability of the whole system. Since solid state FM transmitters are highly reliable now, there is very little chance of two transmitters starting trouble at the same time. Therefore, with regard to the reliability of the system as a whole, there exists almost no problem about operation and maintenance. However, the switching control system is complicated and demands high reliability.

In the meantime, as mentioned earlier, this system excels economically. As to maintenance, although there is a handicap in that two transmitters can not be maintained simultaneously, there is no serious problem as to stability in considering the broadcasting hours which is proposed in Chapter 6 and the composition of the maintenance system which is mentioned in Chapter 8.

The shared reserve system is not very inferior to the full reserve system in reliability and maintenance, but has economical merits. Therefore, shared reserve system for the transmitter system is recommended for this project.

4-1-2 Composition of Transmitters

In accordance with the station planning in Chapter 2 and the program transmission plan in Chapter 7, the transmission facilities of each station shall be designed as shown in Table 4-1-1, Fig. 4-1-2 to Fig. 4-1-16.

The composition of the transmitters at each station is divided into three basic types as shown in Fig. 4-1-1 on the basis of the difference in program transmission systems.

(1) Modulation System Transmitter – Type A

This is a modulation system transmitter which input signal comes from Telecom line.

A shared reserve system is recommended to this system (refer to the composition of the transmitters of Mt. Ophir Station in Fig. 4-1-10).

This system could be employed because the FM modulator directly modulates the transmission frequency, therefore, reserve transmitter can meet multi-channel requirement.

(2) STL Linked Transmitter – Type B

This is a heterodyne transmitter which is connected to a STL receiver for transmission of programs from RTM studio. Recommended system is to use the output of the STL receiver without demodulation but as the high frequency signal itself.

A shared reserve system (refer to the composition of the transmitters of G. Pulai transmitting station in Fig. 4-1-11) is recommended for power amplifier. The reason why a partial shared reserve system is employed is that multi-channels of reserve transmitter requires a switching mechanism for a BPF for spurious elimination of the receiver local and the transmitter local as well as of the multiplier stages, which tends to complicate the control circuits and to deteriorate reliability.

(3) Off-air Relay Transmitter – Type C

This is a heterodyne transmitter. A shared reserve system (refer to the composition of the transmitters of Bt. Pelindong Station in Fig. 4-1-13) at the power amplifier stage is employed. The reason is the same as already mentioned regarding the STL linked transmitters.

These are the basic types of the transmitters which have been employed in this project. However, it should be noted that the network composition at each transmitting station is not same for all six channels. There are many stations which have different compositions as the case of G. Kledang transmitting station (Fig. 4-1-6). Therefore, the composition of the transmitters actually becomes mixtures of the above mentioned basic types. The actual composition of the transmitters for each station is shown in Fig. 4-1-2 to Fig. 4-1-16.

Standard floor layout of the FM transmitter room is shown in Fig. 4-1-17 and 4-1-18.

Table 4-1-1 (1) The Composition of Transmission Facilities

Station / Composition	BT. BINTANG	G. JERAI		BT. PENARA	MAXWELL HILL	
Network	L (1)	N, R	L	L	N, R	L
Transmitter (2)						
Composition	50w x 1 (1)	1kw x 5 (1)	100w x 1(1)	50w x 1 (1)	100w x 6 (1)	
Type	B (3)	B	B	B	C	
Antenna						
Receiving Antenna	1.8mΦp	3mΦp x 2	2.4mΦp	1.8mΦp	5Y x 2	5Y x 2
Transmitting Main Feeder	20D, 85m x 2	39D, 140m x 2		20D, 115m x 2	20D, 60m x 2	
Transmitting Antenna	2.2D x 3	2.2D x 3		2.2D x 3	2.2D x 4	
Power Source						
Automatic Voltage Regulator	2kVA	35kVA		2kVA	10kVA	
Engine Generator	5kVA x 2	45kVA x 2		5kVA x 2	20kVA x 2	
Schematic Diagram	Fig. 4-1-2	Fig. 4-1-3		Fig. 4-1-1	Fig. 4-1-5	

Table 4-1-1 (2)

Station / Composition	G. KLEDANG		G. ULU KALI		
Network	N, R	L	N	R, L (to Selanger)	R, L (to Pahang)
Transmitter					
Composition	500w x 6 (1)		1kw x 4(1)	500w x 2(1)	500w x 2(1)
Type	C	B	B		A
Antenna					
Receiving Antenna	5Y x 2	2.4mφp	2.4mφp x 2		(line)
Transmitting Main Feeder	39D 45m x 2		39D 50m x 2	39D 50m x 2	39D 50m x 2
Transmitting Antenna	2.2D x 3		2.2D x 3	2.2D x 2	2.2D x 1
Power Source					
Automatic Voltage Regulator	30kVA		40kVA		
Engine Generator	40kVA		50kVA x 2		
Schematic Diagram	Fig. 4-1-6		Fig. 4-1-7		

Table 4-1-1 (3)

Station / Composition	BT. TELEPA BUROK		BT. TAMPIN			MT.OPHIR
Network	N, R	L	N	R, L (to Sembilan)	L (to Melaka)	N, R, L
Transmitter Composition	100w x 6 (1)		100w x 6 (1)		100w x 1(1)	500w x 6(1)
Type	C	B	A	B	B	A
Antenna Receiving Antenna	5Y x 2	2.4mφp	5Y x 2	2.4mφp	2.4mφp	(line)
Transmitting Main Feeder	20D, 85m x 2		20D 80m x 2		20D 80m x 2	39D 95m x 2
Transmitter Antenna	2.2D x 3		2.2D x 1		2.2D x 1	2.2D x 3
Power Source Automatic Voltage Regulator	10kVA		15kVA			30kVA
Engine Generator	20kVA x 2		25kVA			40kVA x 2
Schematic Diagram	Fig. 4-1-8		Fig. 4-1-9			Fig. 4-1-10

Table 4-1-1 (4)

Station / Composition	G. PULAI	BT. TINGGI	BT. PELINDONG		BT. BAUK	BT. BESAR
Network	N, R, L	N, R, L	N, R	L	N, R, L	N, R, L
Transmitter						
Composition	500w x 6 (1)	1kw x 6 (1)	1kw x 6 (1)		500w x 6 (1)	1kw x 6 (1)
Type	B	A	C	A	C	A
Antenna						
Receiving Antenna	2.4mφ x 2	(line)	5Y x 2	(line)	5Y x 2	(line)
Transmitting Main Feeder	39D 50m x2	39D 95m x 2	39D 75m x 2		39D 45m x 2	39D 50m x 2
Transmitting Antenna	2.4D x 2 2.2D x 2	2.4D x 3 2.2D x 1	2.2D x 3		2.2D x 2	2.2D x 2
Power Source						
Automatic Voltage Regulator	30kVA	35kVA	35kVA		30kVA	35kVA
Engine Generator	40kVA	45kVA x 2	45kVA		40kVA x 2	45kVA
Schematic Diagram	Fig. 4-1-11	Fig. 4-1-12	Fig. 4-1-13		Fig. 4-1-14	Fig. 4-1-15

Table 4-1-1 (5)

Composition \ Station	BT. BAKER
Network	N, R, L
Transmitter	
Composition	1kw x 6 (1)
Type	B
Antenna	
Receiving Antenna	3mφ x2
Transmitting Main Feeder	39D 90m x 2
Transmitting Antenna	2.2D x 3
Power Source	
Automatic Voltage Regulator	35kVA
Engine Generator	45kVA x 2
Schematic Diagram	Fig. 4-1-16

Note: (1) N – National, Educational
R – Regional
L – Local

(2) Transmitter composition is indicated as follows:
50W* x 1** (1)***
* Transmitter Power
** Number of operating transmitter
*** Number of reserve transmitter

(3) Type of transmitter is shown in Fig. 4-1-1

(4) Composition of transmitting antenna is indicated as follows:
2* . 2D** x 2***
* Number of stages
** Kind of Dipole antenna
*** Number of faces

4-2 STL Facilities

The STL transmission facilities to be set up in the RTM studio in accordance with the program transmission plan in Chapter 7 shall be prepared as shown in Table 4-2-1, Fig. 4-2-1.

4-2-1 The Composition of STL Transmitter

As for STL transmitter, solid-state transmitter which assures high stability, high reliability and compactness is recommendable.

The transmitter system is shown in Fig. 4-2-1, which has a built-in stereo modulator with the audio signal from the studio as input.

For the reserve system for multi-wave transmission, a full reserve system stated in Clause 4-1-1 is to be employed. The reason why a shared reserve system is not employed is as follow; the direct modulation is technically difficult for such high transmission frequency as 960 MHz band. Namely, the local oscillator for each transmitter and a BPF eliminating spurious which is generated in the oscillators must be equipped and this mechanism is very complicated at high frequency and lowers reliability of STL transmitter system.

4-2-2 STL Transmitting Antenna

For the transmission antenna, a parabolic antenna of 1.8 mφ, 2.4 mφ, 3 mφ, is to be used on the basis of the program transmission plan in Clause 7-2.

With regard to the multiplex circuit, a three-wave synthesis is a standard because leakage between channels and insertion loss. Therefore, for a six-wave transmission, the antenna system is composed of two transmission antennas.

Table 4-2-1 Composition of STL Transmission Facilities

Composition / RTM Studio (→ FM Station)	Network	Transmitter	Transmitting Antenna	
			Main Feeder	Antenna
KANGAR (→ BT. BINTANG)	L(1)	1W x 1 (1)(2)	20D	1.8 mφ
PINANG (→ G. JERAI)	N, R	10W x 5 (5)	20D	3 mφ x 2
PINANG (→ BT. PENARA)	L	0.5W x 1 (1)	20D	1.8 mφ
ALOR SETAR (→ G. JERAI)	L	10W x 1 (1)	20D	2.4 mφ
IPOH (→ G. KLEDANG)	L	0.5W x 1 (1)	20D	2.4 mφ
K. L. (→ G. ULU KALI)	N, R, L	10W x 6 (6)	20D	2.4 mφ x 2
SEREMBAN (→ BT. TELEPABUROK)	L	1W x 1 (1)	20D	2.4 mφ
SEREMBAN (→ BT. TAMPIN)	R, L	10W x 2 (2)	20D	2.4 mφ
MELAKA (→ BT. TAMPIN)	L	10W x 1 (1)	20D	2.4 mφ
JOHOR BAHRU (→ G. PULAI)	N, R, L	5W x 6 (6)	20D	2.4 mφ x 2
KOTA BHARU (→ BT. BAKAR)	N, R, L	10W x 6 (6)	20D	3 mφ x 2
FM Station (→ RTM Studio)				
BT. TELEPABUROK (→ SEREMBAN)	L	1W x 1 (1)	20D	2.4 mφ

Note: (1) N – National, Educational R – Regional L – Local

(2) STL Transmitter composition is indicated as follows:
1W (STL Transmitter Power) x (Number of operating transmitter) (1) (Number of reserve transmitter)
Schematic diagram is shown in Fig. 4-2-1.
The composition of STL transmission facilities consist of Transmitter, Monitoring Equipment, Measuring Equipment and Remote Control Equipment.

4-3 Antennas

4-3-1 Polarization for Transmission

Polarization for FM Transmission on this project should be determined in considering the transmission condition of the projected station, the topographical condition in Malaysia, the receiving condition of receivers and polarization of the existing TV.

With regard to these conditions, following problems are reffered.

(1) The CCIR Report 464-2 proposes polarization for the comparison horizontal polarization with vertical polarization;

(a) In most cases where the grazzing angle is not more than a degree or so, the effect is substantially independent of polarization.
Distortion of vertical polarization becomes important where the path difference between direct and reflected signals exceeds about 3 km (10 μs).
Where the reflecting object is a tree, particularly of the coniferous type, vertically-polarized signals will be reflected more strongly.

(b) Transmission of a vertical component can result in an increased signal strength where receiving antenna are essentially vertically polarized and used at low hieghts, but in rugged mountainous country, the increase in received signal strength is small, whereas multipath distortion may be increase, especially when reflections are from mountains with coniferous trees.

(c) The main source of man-made interference is from vehicle-ignition systems. Interference radiated from vehicles has a semi-random polarization but with a preponderant vertical component.

(d) Where existing service are horizontal or vertical polarization, the new service should use either the same or mixed polarization.

In this Report of CCIR, Table 4-3-1 is attached. According to this Table 4-3-1, for existing service of horizontal polarization;

(a) Horizontal polarization is preferable for intending service, for high quality reception probably with stereo regardless of terrain.

(b) For the purpose to reach the largest audience, especially those using portable or car sets, mixed polarization is desirable for flat or rolling terrains, and horizontal polarization is desirable for rugged terrains.

(2) As a result of studies on horizontal polarization and circular polarization, in Japan, following information was obtained.

(a) Receiver input signal with using rod antenna is increased by 2 – 3 dB in city areas with many tall buildings and 4 – 6 dB in open suburban areas, when circular polarization is introduced instead of horizontal polarization in the same transmitter power. But, similar effects are possible by horizontal polarization depending on the type of receiving antennas or the position of their installation.

(b) In order to raise the reception grade for a running car radio by one rank (of five rank evaluation), the received signal strength has to be raised as much as 15 – 18 dB.

(3) The difference in the transmitting condition between horizontal polarization and circular polarization.

(a) The difference in the received signal strength between horizontal polarization and circular polarization in the same transmitting power is 3 dB theoretically, which means circular polarization needs a transmission power higher as much as 3 dB in order to require the same received signal strength.

(b) In comparison of the gains of dipole antennas between horizontal polarization and circular polarization, the latter requires 4 stacks of dipole antennas in order to gain as much as 8 dB of one stack of the dipole antenna in horizontal polarization, which affects tremendous influence in designing the transmitting antennas as well as the transmitting power.

In the foregoing studies, the horizontal polarization, vertical polarization and circular polarization in respect to various conditions were compared. On the basis of such studies;

(a) Vertical polarization has no advantage in considering of the existing TV service of horizontal polarization and of the topographycal condition of Malaysia.

(b) While circular polarization is advantageous for expansion of the receivers by means of car and portable radios, it has no exact merits to overcome the economical merits of horizontal polarization in respect to the transmitting condition.

From these reasons, horizontal polarization is recommended with regard to the polarization for FM broadcast of this project.

Table 4-3-1 Choice of Polarization Appropriate for New Services

Type of service intended	Polarization of existing services	Type of terrain	Preferred polarization for new services
Primarily for high-quality receiving installations, probably with stereo, with no improvement to reception conditions for portable or car sets envisaged	nil	any	horizontal
	horizontal	any	horizontal
	vertical	flat or rolling	vertical
	vertical(1)	rugged	mixed(2)
Primarily to reach the largest audience, especially those using portable or car sets. Account to be taken of those installations already equipped to receive any existing transmissions	nil or horizontal	flat or rolling	mixed
		rugged	horizontal
	vertical	flat or rolling	vertical
	vertical(3)	rugged	mixed

(1) It would be preferable to change any existing services to horizontal polarization.
(2) Horizontal, if existing services can be changed to horizontal polarization.
(3) It would be preferable to change any existing services to mixed polarization. (CCIR. Report 464-2)

4-3-2 Multiplex Feeding System

There are two kinds of antenna feeding system for six FM waves.

(1) To install six antenna elements for six FM waves independently.

(2) To feed six FM waves to the existing TV antenna or a new FM antenna in multiplex.

The (1) is for the case when it is difficult to commonly use one antenna for a plural number of FM waves. It is not recommended both technically and economically. Of the multiplex feeding method of (2), use of the existing TV antenna is technically difficult because of the TV band of 44 – 68 MHz and 170 – 216 MHz, and the band width of TV dipole antennas.

Therefore, multiplex feeding of six FM waves to one FM antenna is recommended for this project.

The multiplexing circuit can be composed of combination of diplexing circuits such as 3 dB directional coupler, circulator synthesis, bridge diplexer and CIN type diplexer. Selection among these diplexing circuits demands careful assessment as to the number of FM channels to be fed, feeding power, channel separation and specifications for the required FM stereophonic service.

Hence, the following points have to be thoroughly considered in selecting multiplexing circuit.

(1) Spurious radiation due to cross modulation which occurs by the leakage between the transmitters.

(2) Deterioration of the distortion factor due to the narrow band characteristics of tuning elements, and deterioration of the left-right separation in stereophonic characteristics because of the channel separation of 800 kHz – 1 MHz.

(3) Insertion loss.

(4) The difference of the antenna power between channels.

Table 4-3-2 Performance Specifications of 6-channel Combiners

Item \ Type	1 kW. 500W	100W
Frequency Range	87 to 108 MHz	87 to 108 MHz
Rated Power (Output)	10 kW	1 kW
Input VSWR	Less than 1.1	Less than 1.1
Insertion Loss	Less than 1.5 dB	Less than 2.0 dB
Decoupling between Transmitters	Less than 50 dB	Less than 50 dB
Carrier Separation	More than 800 kHz	More than 800 kHz

Taking these points into account, a CIN diplexer-type multiplexing circuit shown in Fig. 4-3-1 for the 1 kW and 500W transmitter, and a multiplexing circuit of the combination of a CIN diplexer and circulator shown in Fig. 4-3-2 for the 100W transmitter are recommended. Regarding the 100W class, economical merits and compactness were considered.

4-3-3 Antenna Composition

The antenna composition for each transmitting station is given in Table 4-1-1. The standard antenna composition is given in Fig. 4-3-3. The basic concept is as follows.

(1) For the off-air receiving antenna, a stack of five-element Yagi antenna or diversity connection is the standard composition.

(2) For the STL receiving antenna, a parabolic antenna of 1.8 mφ, 2.4 mφ, 3 mφ as described in Clause 4-2-2 is employed.

(3) For the transmitting antenna, the antenna types have been unified into the combination of either 2-dipole or 4-dipole antennas from the fact that the existing TV transmission antennas are dipole antennas. Proposed FM antennas will be composed of two stages which the upper and lower stages are to be fed separately by two main feeder. This has been designed to facilitate a separate use of either of the antennas independently in case of trouble.

(4) The transmission main feeders are 20D coaxial cable for 100W six waves and 39D coaxial cable for 500W or 1 kW six waves.

4-4 Power Source Facilities

As a result of the feasibility survey, it was found that the power source capacity of the existing TV transmitting station is not sufficient to cover the requirement for six-wave FM broadcasting facilities. Therefore, the power source for the FM broadcasting facilities has to be provided separately, independent from the existing power source for TV transmission. The power source facilities for each FM transmitting station is shown in Table 4-1-1.

The basic concept is as follows.

4-4-1 AVR Facilities

FM transmitter which is suggested for this project is a solid-state transmitter in all cases, which is equipped with a stable power source. Therefore, there is no particular need of an AVR in the actual operation of the transmitters. However, when the power source condition in Malaysia is taken into account, it is considered that it would be safer to equip the transmitter with an AVR. Incidentally, an AVR is effective for protection from lightning. Reserve AVR is not needed. The standard of the AVR capacities for the respective power of the transmitters on the presumption of the six-wave transmitter composition is given in the following table.

Table 4-4-1 Required AVR Capacity

Transmitter power	AVR Capacity
1 kW (6 waves)	35 kVA
500W (")	30 kVA
100W (")	10 kVA

4-4-2 Main Power Line Equipments

(1) At the FM stations which will be co-sited with the existing TV stations except BT. PENARA, it is not advisable to employ automatic switching systems for switching between commercial and engine power or for switching between the main and reserve engine generator, because of attended sites. Therefore manual switching devices are proposed.

(2) At BT. PENARA station and BT. BINTANG station, automatic operation of the power source equipment is proposed. Therefore, automatic switching performance between the main engine generator and reserve one, as well as remote control system is recommended.

4-4-3 Engine Generator

(1) For the FM station with commercial power supply, a unit of engine generator is to be installed for the emergency power source.

(2) As to those FM stations without commercial power supply, two units of engine generator which consist of main and reserve, are to be installed. The power capacity of engine generator for six transmitter is given in the following table.

Table 4-4-2 . Required Capacity of Engine Generator

Transmitter Power	Engine Generator Capacity
1 kW (6 waves)	45 kVA
500W (")	35 kVA
100W (")	20 kVA

4-5 Supervisory System

Operation organization at transmitting station which is important element to design supervisory system is stated in Chapter 8, Staff Planning.

The kinds of circuits, location and items of the supervisory system of the each FM transmitting station should be as shown in Table 4-5-1. The basic concept is as follows:

(1) With regard to the FM station to be set up in the attended TV station, both FM and TV transmissions are supervised in the TV transmitter control room.

(2) In respect of the BT. TELEPA BUROK transmitting station to be set up in the attended microwave station, FM transmission facilities are to be included in the microwave transmission set up so as to be supervised in the FM transmission room.

(3) BT. PENARA station and BT. BINTANG station are supervised by the Telecom office nearby because those stations transmit only one Local Program and their transmitter power is both low power of 50W.

The controlling and monitoring items of the FM transmitting facilities are shown in Fig. 4-5-2. And the following matters have to be noted related to the difference in the composition of the transmitters described in Clause 4-1-2.

(1) For the A-type transmitter, control items: 1 – 14, 21, 22, monitoring items: 1 – 18, 31 – 36 should be the standards.

(2) For the B, C-type transmitters, control items: 1 – 22, monitoring items: 1 – 36 should be the standards.

At BT. PENARA station and BT. BINTANG station, control and monitoring items shall be as shown in Table 4-5-3.

Additionally, the supervision of STL transmission facilities to be installed in the RTM studio are operated in the RTM master control room, and their control and monitoring items are same with those in Table 4-5-2.

Table 4-5-1 Composition of Control & Monitoring Systems

FM Station	Kind of Control & Monitoring Circuit	Place of Control & Monitoring	Control & Monitoring Items
G. JERAI MAXWELL HILL G. KLEDANG G. ULU KALI BT. TAMPIN MT. OPHIR G. PULAI BT. TINGGI BT. PELINDONG BT. BAUK BT. BESAR BT. BAKAR	Line	Control Room in TV Transmitter building	Table 4-5-2 Table 4-5-3
BT. TELEPA BUROK	Line	FM Transmitter Room	
BT. PENARA	VHF radio link	PINANG Telecom	Table 4-5-4
BT. BINTANG	VHF radio link	KANGAR Telecom	

Table 4-5-2 Control and Monitoring Item

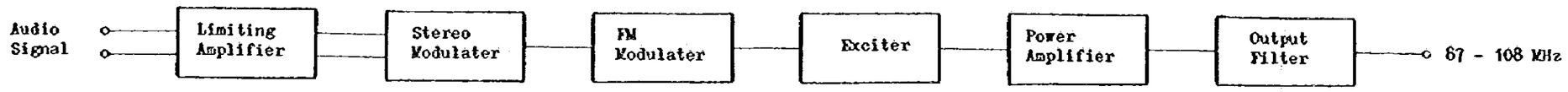
Control Item	Monitoring Item
1 Control Automatic/Remote	1 Fire
2 N_1 Transmitter(Tx), ON/OFF	2 Door
3 N_2 " , ON/OFF	3 Control, Manual
4 N_3 " , ON/OFF	4 Control, Automatic
5 E " , ON/OFF	5 Control, Remote
6 R " , ON/OFF	6 N_1 Transmitter, Operating
7 L " , ON/OFF	7 N_2 " , "
8 Reserve Tx , ON/OFF	8 N_3 " , "
9 Switchover of N_1 Tx/Reserve Tx	9 E " , "
10 Switchover of N_2 Tx/Reserve Tx	10 R " , "
11 Switchover of N_3 Tx/Reserve Tx	11 L " , "
12 Switchover of E Tx/Reserve Tx	12 Reserve " , "
13 Switchover of R Tx/Reserve Tx	13 N_1 Transmitter, Abnormal
14 Switchover of L Tx/Reserve Tx	14 N_2 " , "
15 N_1 Receiver, No1/No2 Operating	15 N_3 " , "
16 N_2 " , No1/No2 Operating	16 E " , "
17 N_3 " , No1/No2 Operating	17 R " , "
18 E " , No1/No2 Operating	18 L " , "
19 R " , No1/No2 Operating	19 N_1 Receiver, No1/No2 Operating
20 L " , No1/No2 Operating	20 N_2 " , " "
21 Remote Control, Test	21 N_3 " , " "
22 Retransmittion	22 E " , " "
	23 R " , " "
	24 L " , " "
	25 N_1 Receiver, No1/No2 Abnormal
	26 N_2 " , " "
	27 N_3 " , " "
	28 E " , " "
	29 R " , " "
	30 L " , " "
	31 Remote Control, Test
	32 Remote Control, Operating
	33 Control, Operating
	34 Remote Control, Abnormal
	35 Control Lines, Abnormal
	36 Indicator Lines, Abnormal

Note: N_1 - National 1 E - Educational
N_2 - National 2 R - Regional
N_3 - National 3 L - Local

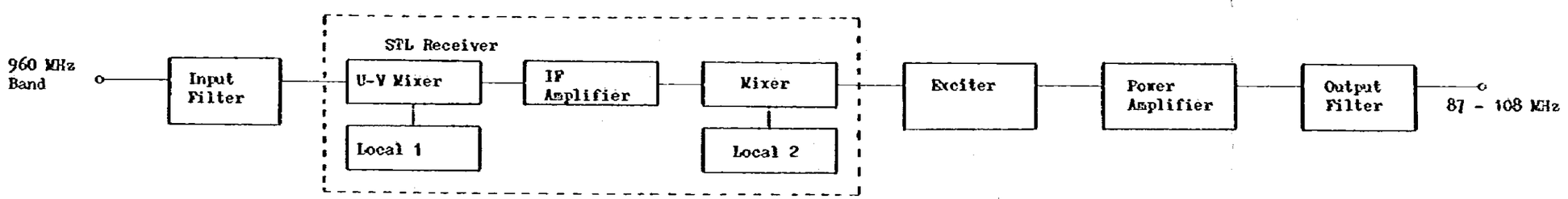
Table 4-5-3 BT. PENARA
BT. BINTANG Transmitting Station Control and Monitoring Item

Control Item	Monitoring Item
1 Control Automatic/Remote	1 Fire
2 No 1 Transmitter, ON/OFF	2 Door
3 No 3 Transmitter, ON/OFF	3 Control, manual
4 No 1 Engine Generator, Start/Stop	4 Control, Automatic
5 No 2 Engine Generator, Start/Stop	5 Control, Remote
6 No 1 Engine Generator, Operating	6 No 1 Transmitter, Operating
7 No 2 Engine Generator, Operating	7 No 2 Transmitter, Operating
8 Remote Control, Test	8 No 1 Transmitter, Abnormal
9 Retransmittion	9 No 2 Transmitter, Abnormal
	10 No 1 Engine Generator, Normal
	11 No 2 Engine Generator, Abnormal
	12 No 2 Engine Generator, Normal
	13 No 2 Engine Generator, Abnormal
	14 No 1 Engine Generator,Operating
	15 No 2 Engine Generator,Operating
	16 Remote Control, Test
	17 Remote Control, Operating
	18 Control, Operating
	19 Remote Control, Abnormal
	20 Control Lines, Abnormal
	21 Indicator Lines, Abnormal

A TYPE : FM TRANSMITTER



B TYPE : STL INPUT FM TRANSPOSER



C TYPE : OFF-AIR INPUT FM TRANSPOSER

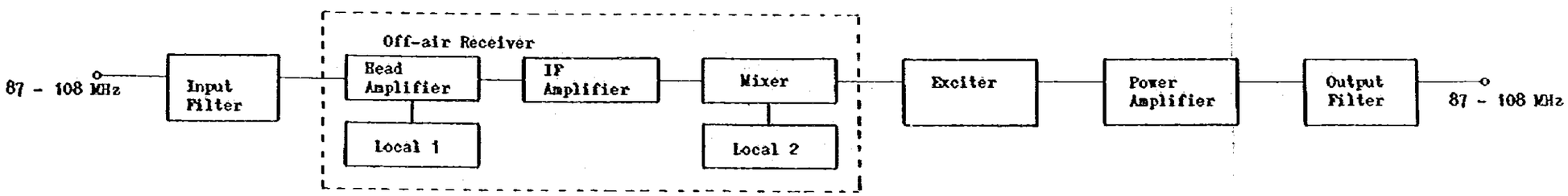


Fig. 4-1-1 Types of Transmitting Facility

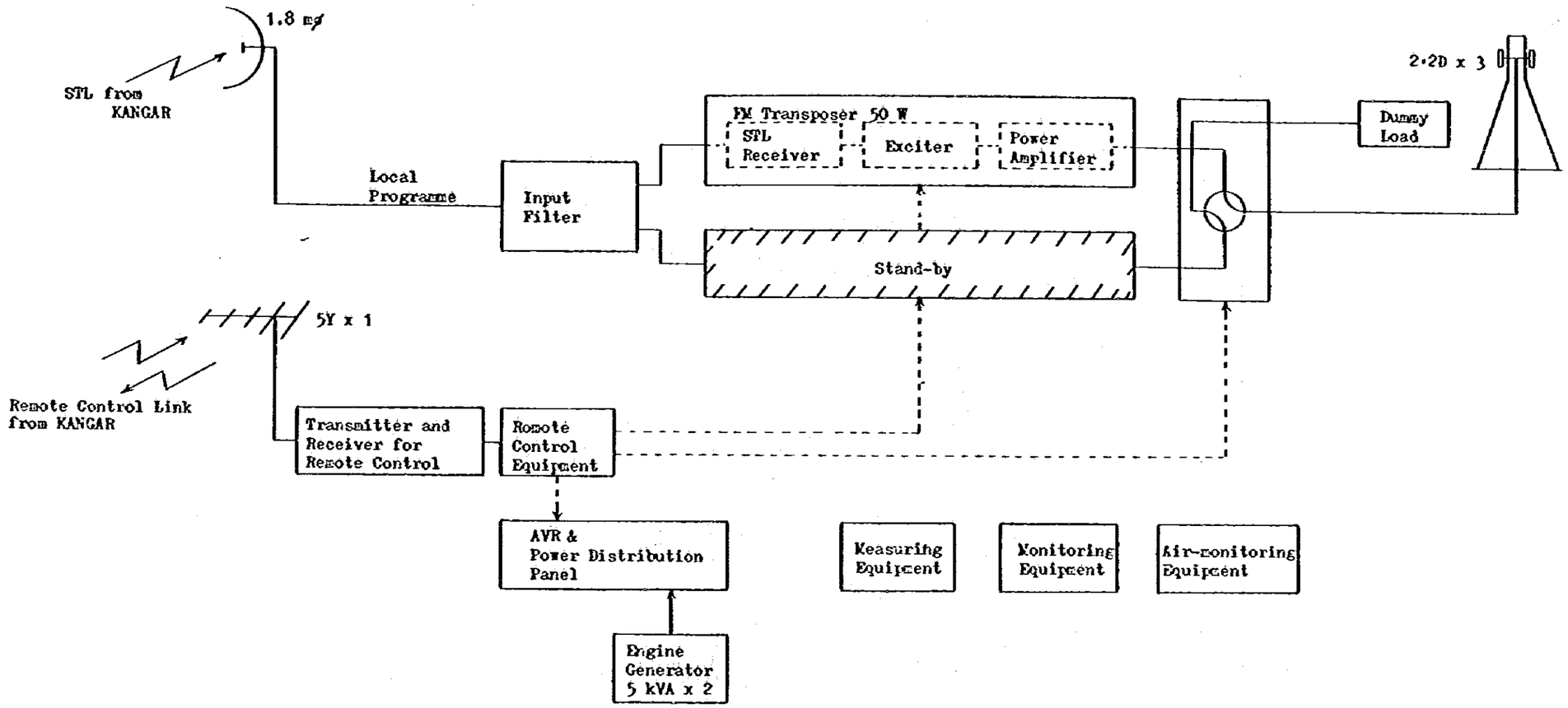


Fig. 4-1-2 Schematic Diagram of BT. BINTANG Station

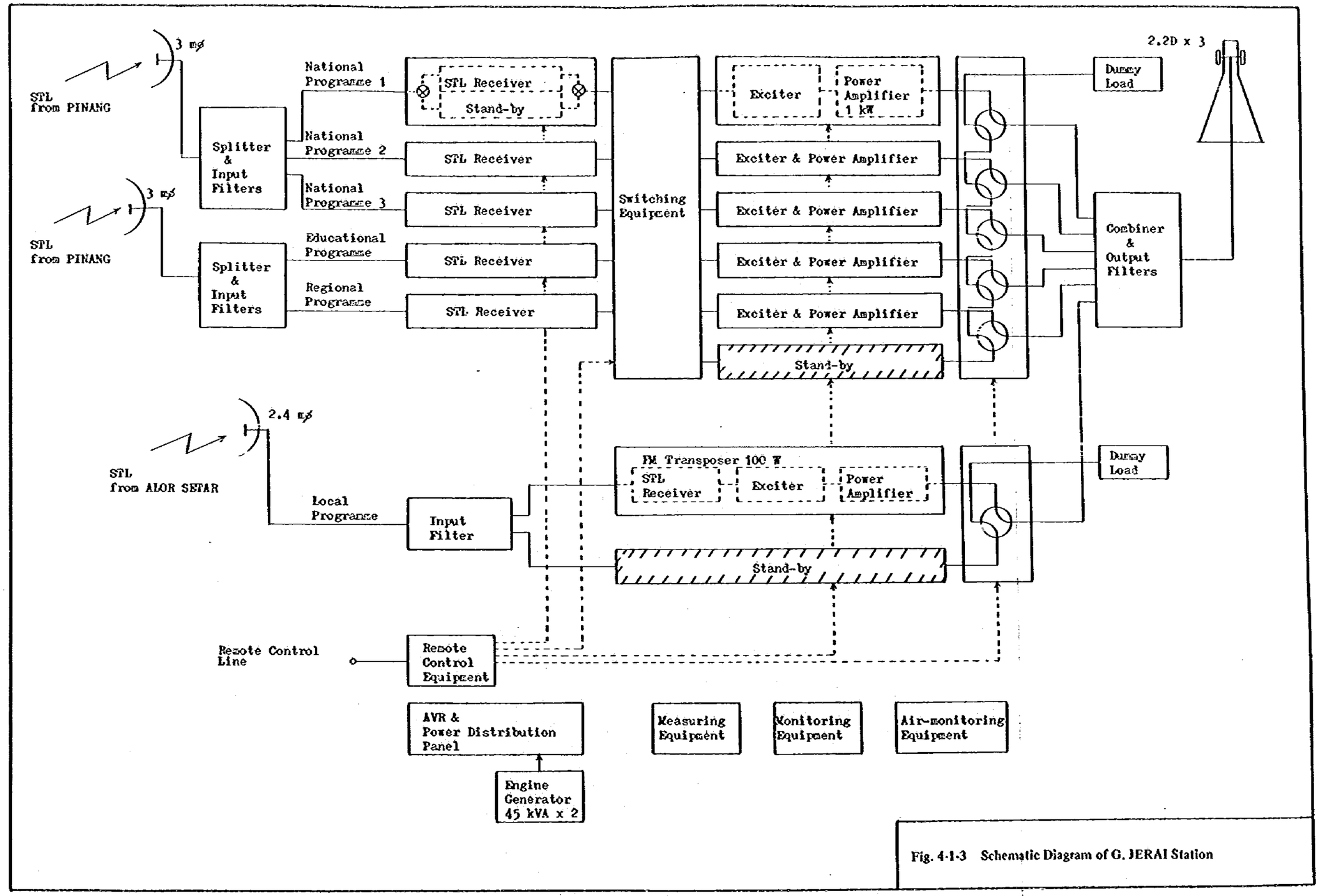


Fig. 4-1-3 Schematic Diagram of G. JERAI Station

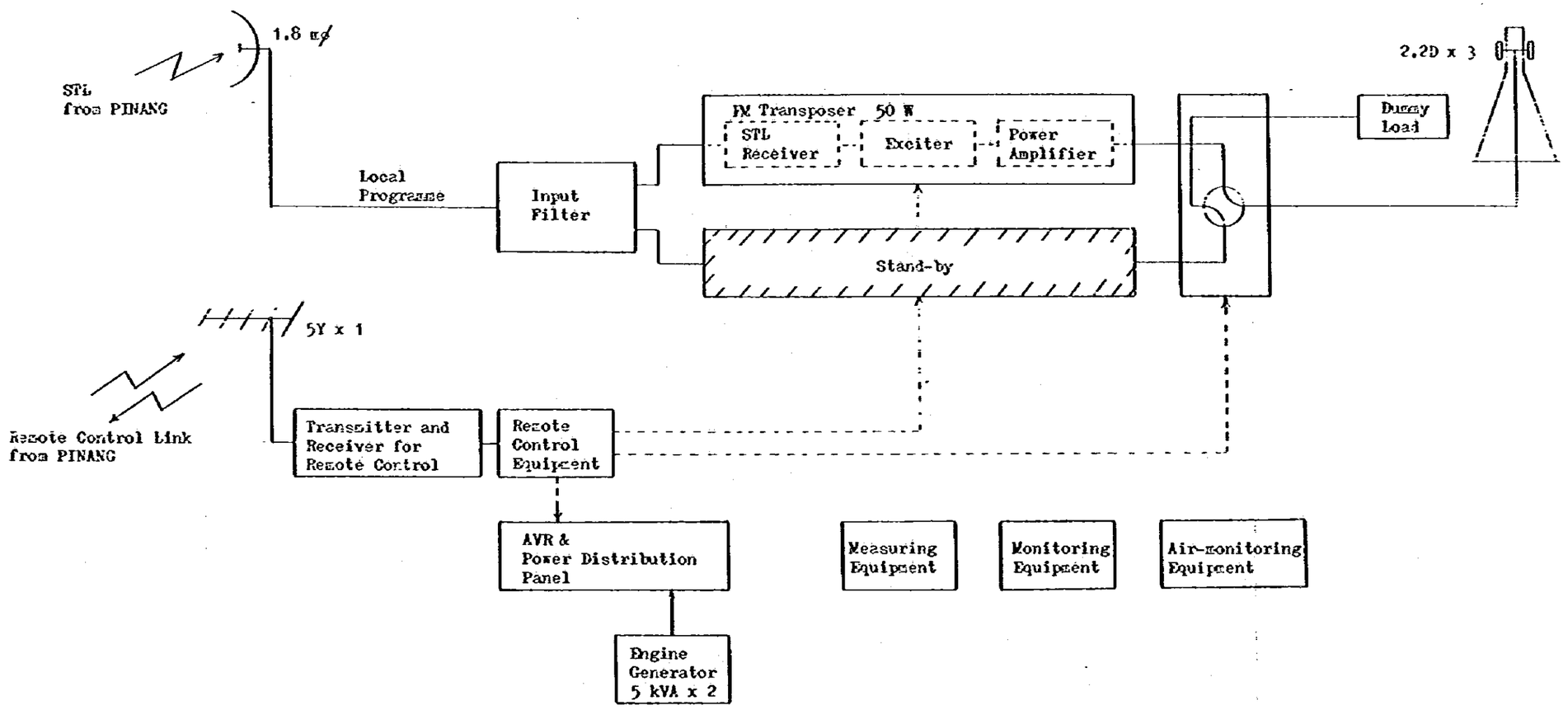


Fig. 4-1-4 Schematic Diagram of BT. PENARA Station

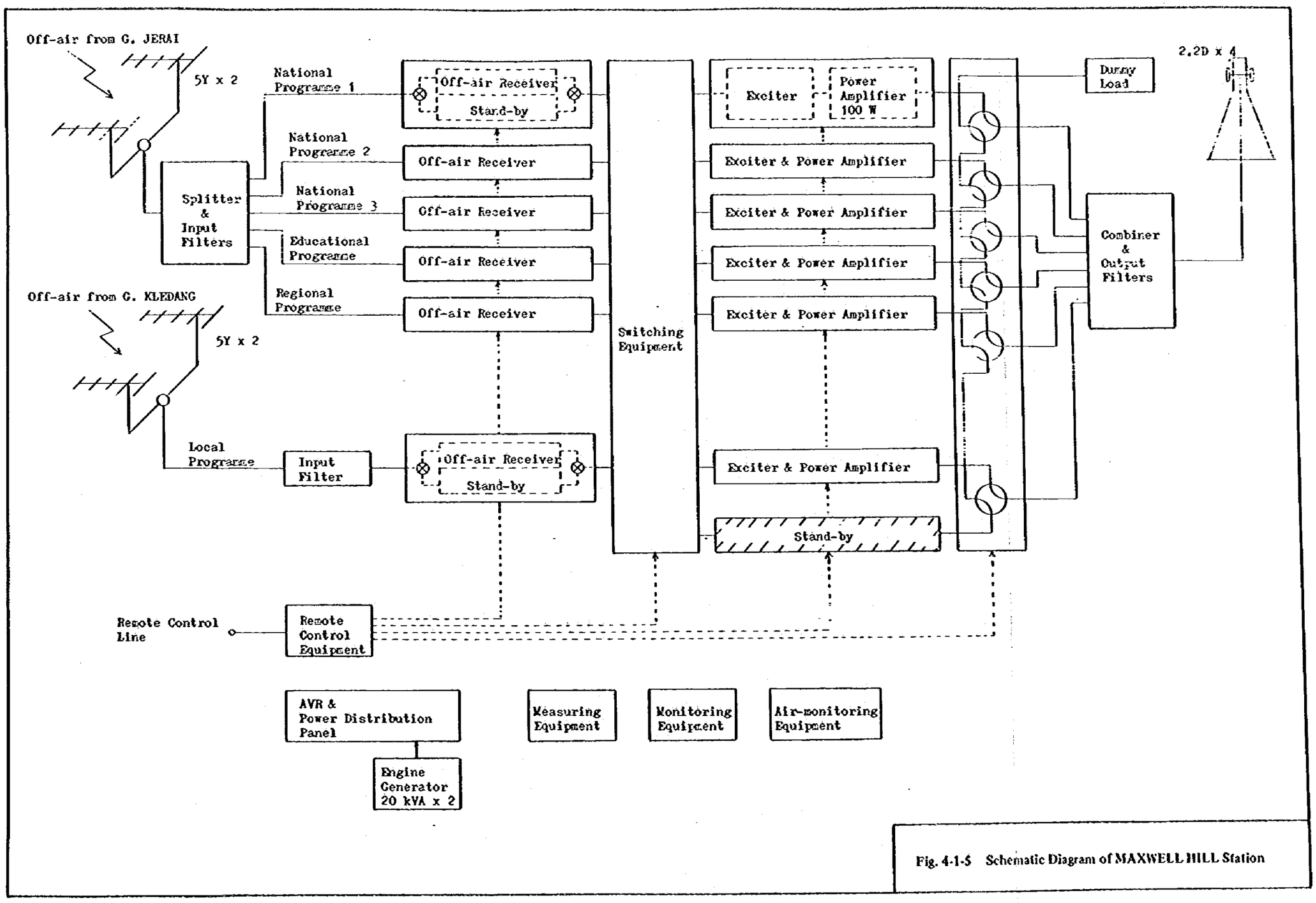


Fig. 4-1-5 Schematic Diagram of MAXWELL HILL Station

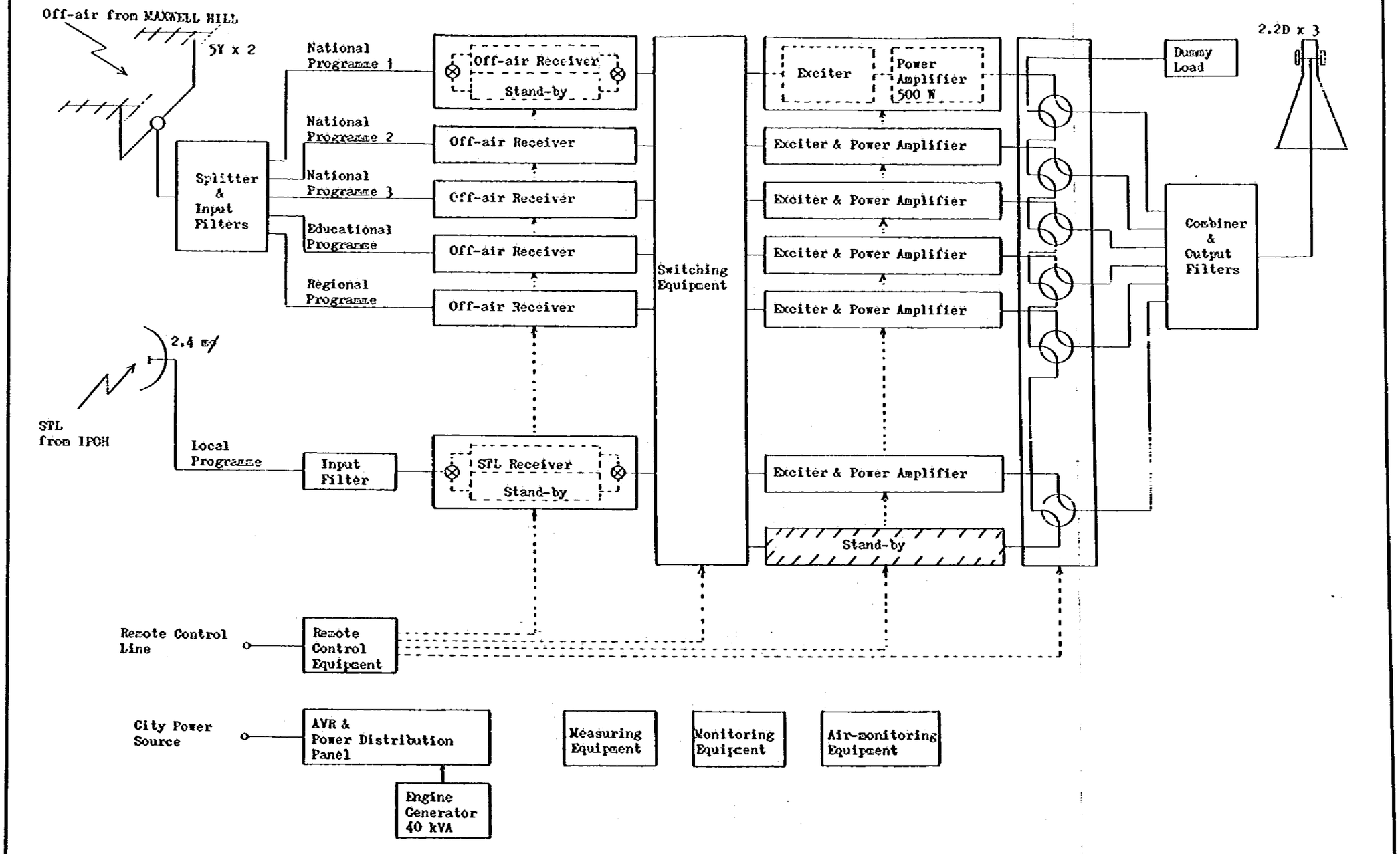


Fig. 4-1-6 Schematic Diagram of G. KLEDANG Station

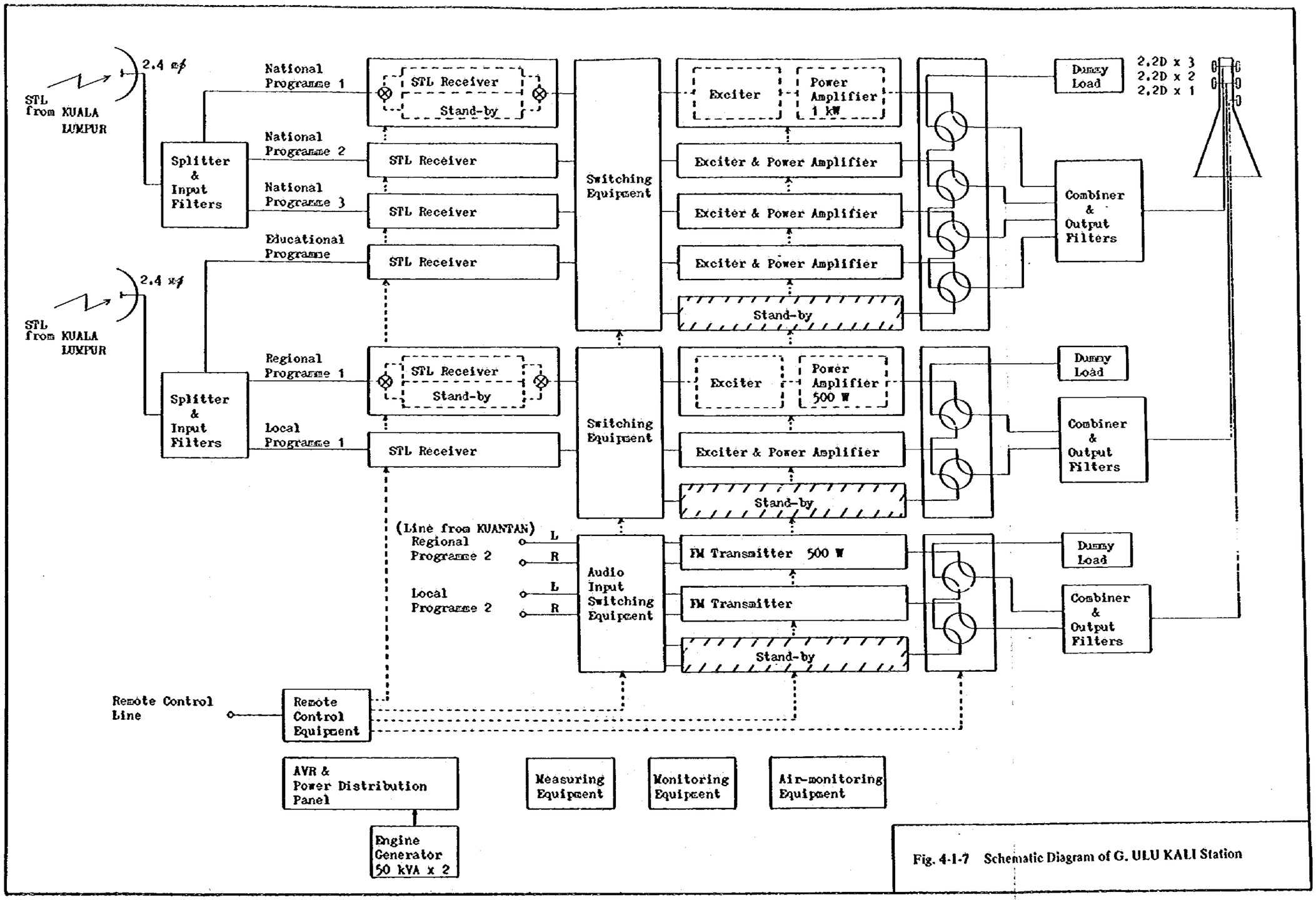


Fig. 4-1-7 Schematic Diagram of G. ULU KALI Station

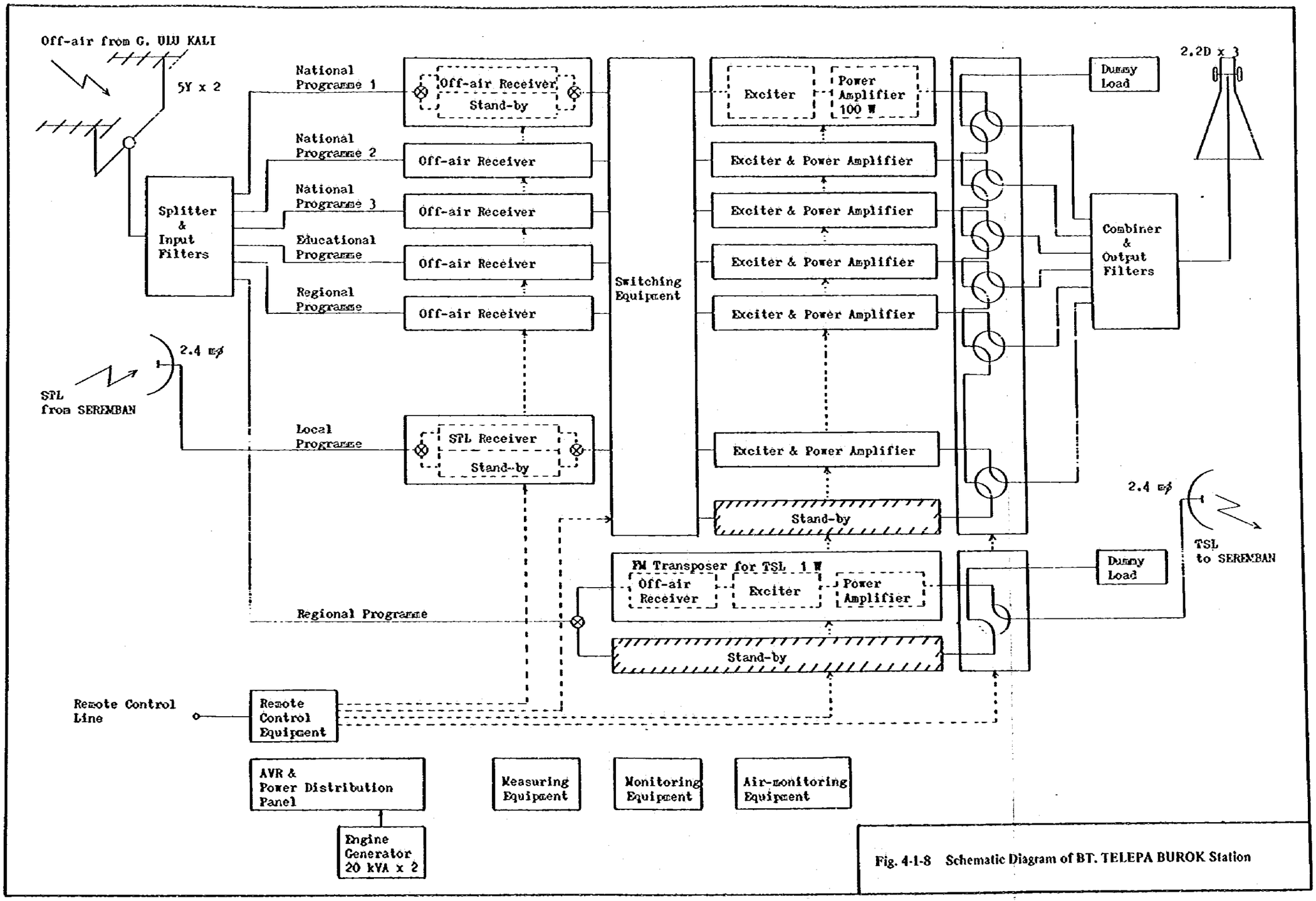


Fig. 4-1-8 Schematic Diagram of BT. TELEPA BUROK Station

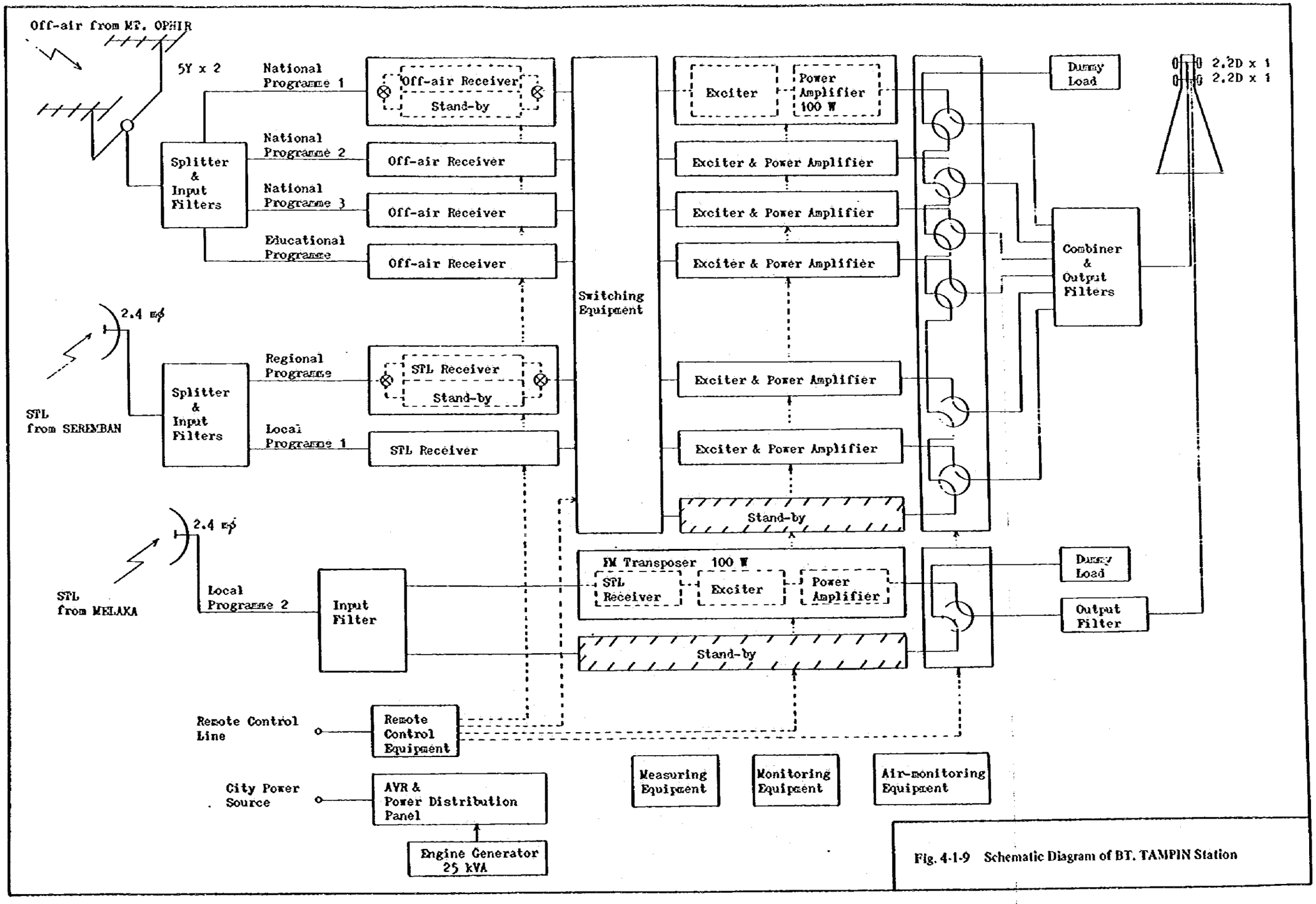


Fig. 4-1-9 Schematic Diagram of BT. TAMPIN Station

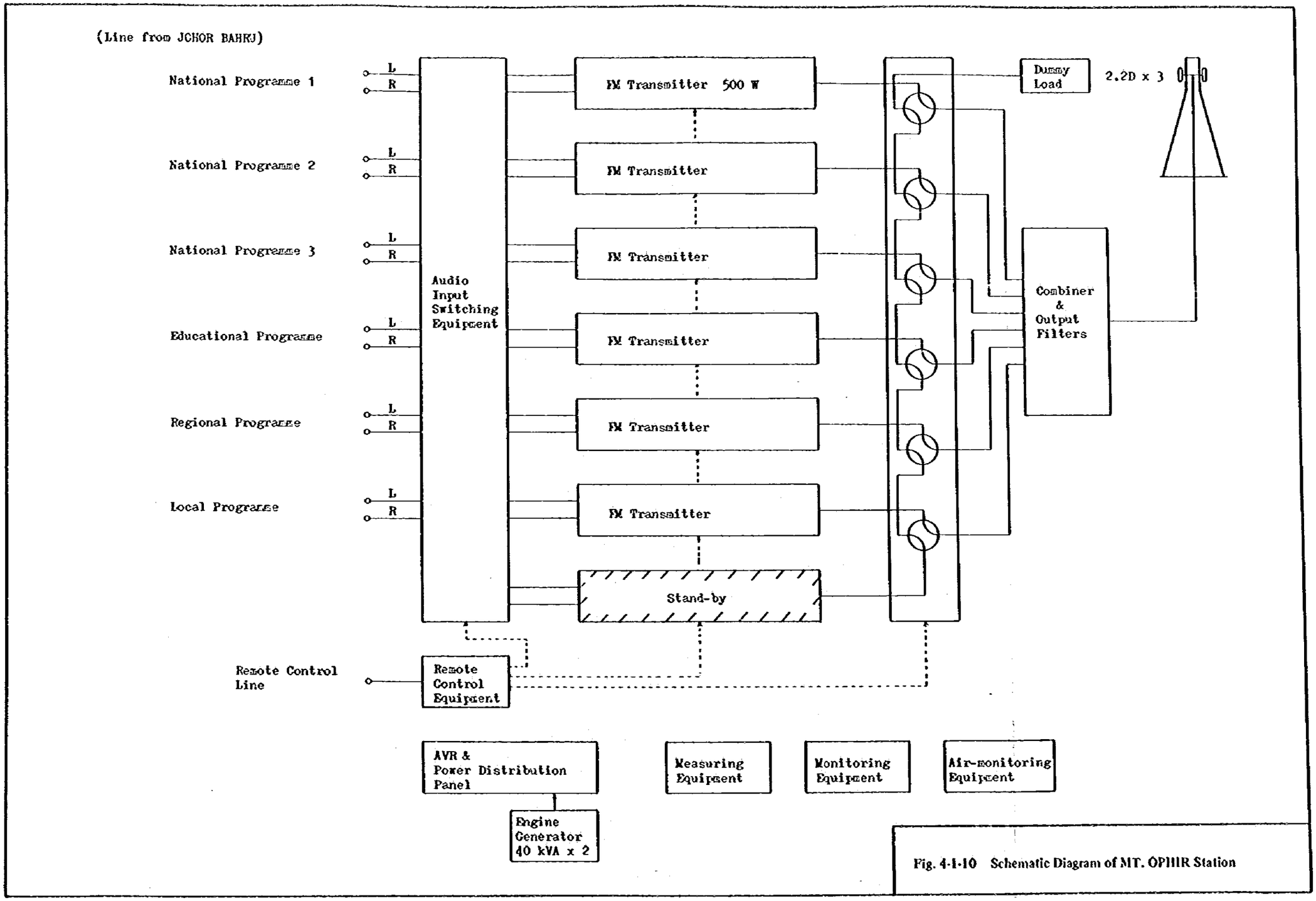


Fig. 4-1-10 Schematic Diagram of MT. OPHIR Station

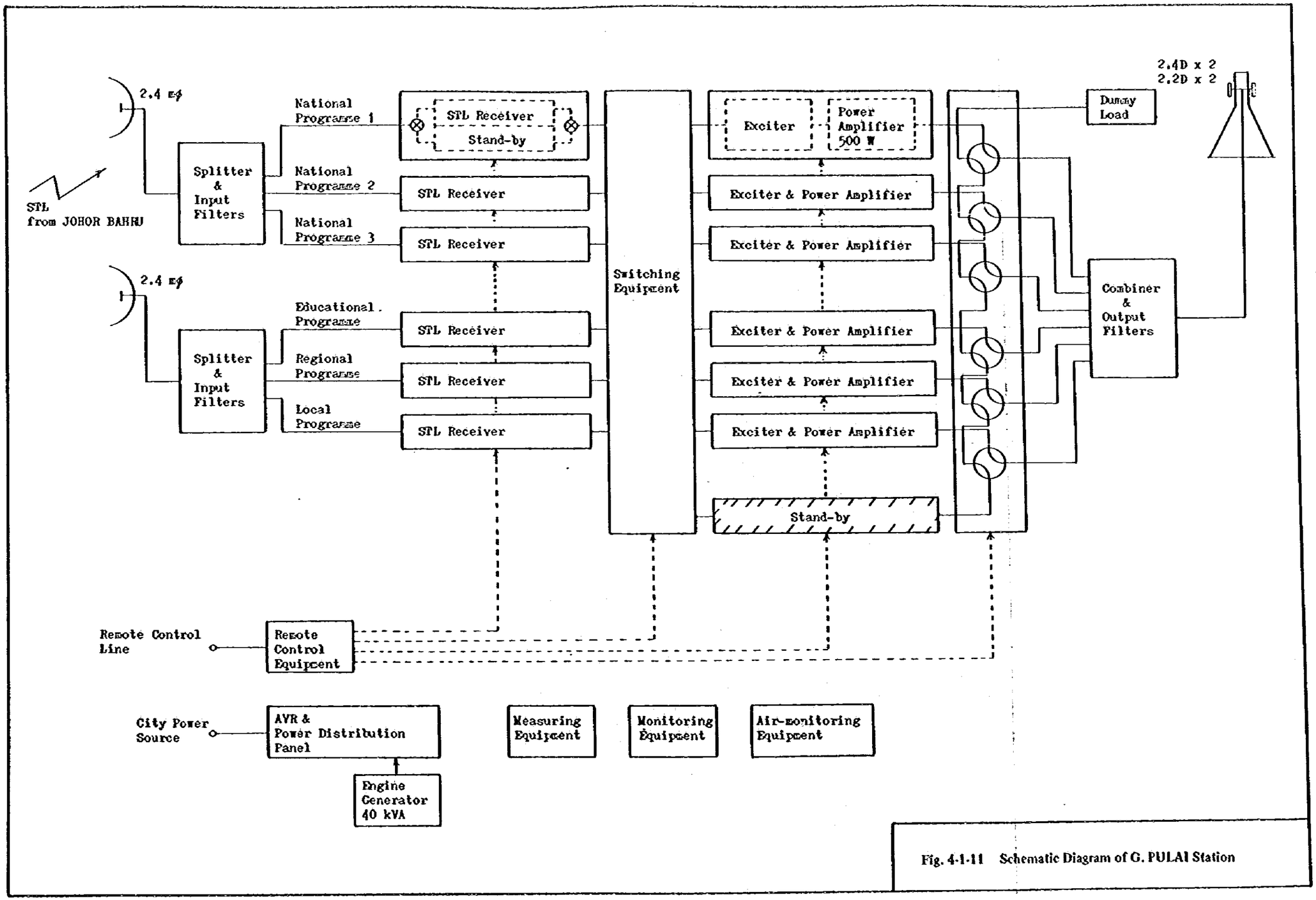


Fig. 4-1-11 Schematic Diagram of G. PULAI Station

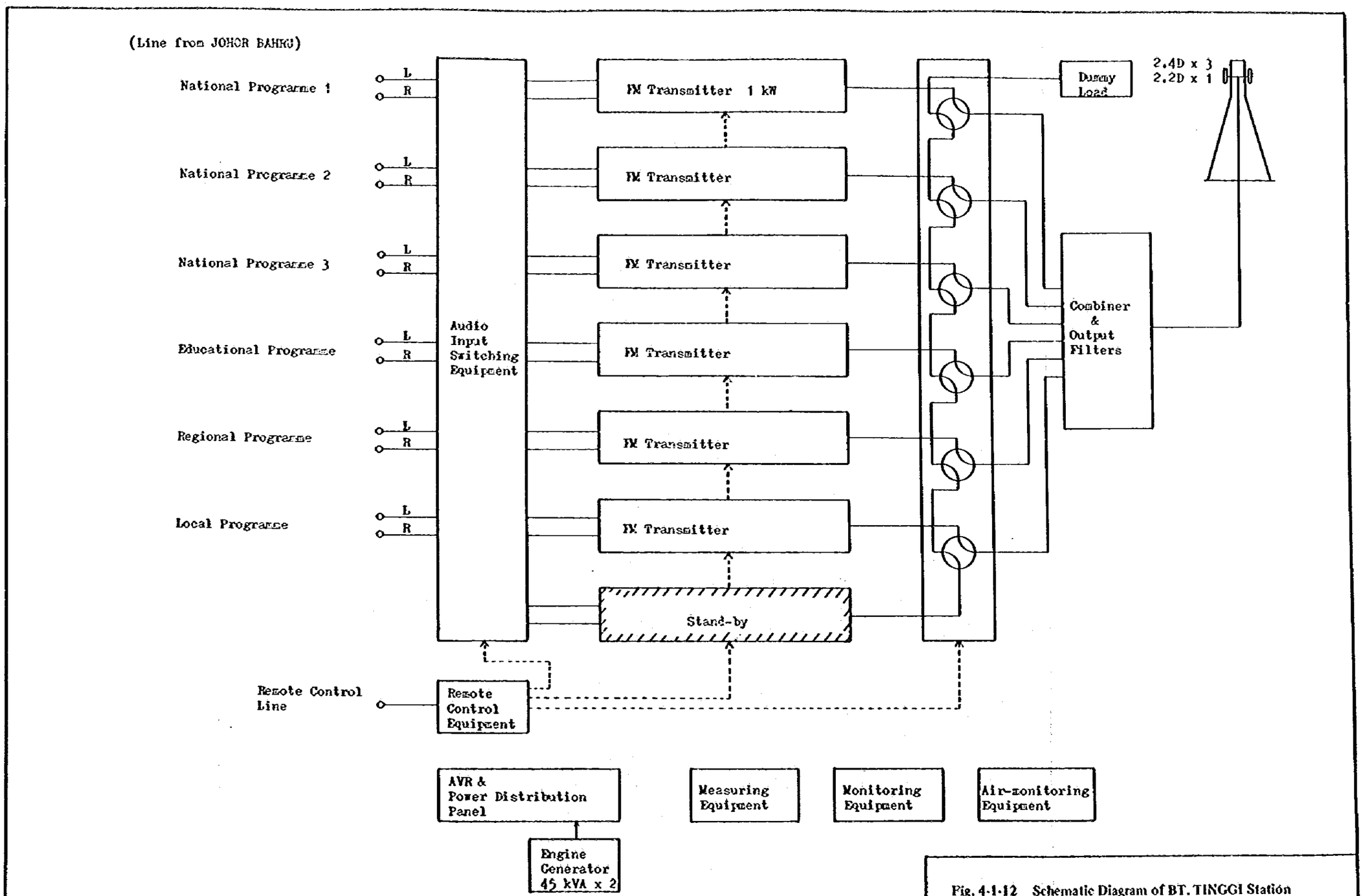


Fig. 4-1-12 Schematic Diagram of BT. TINGGI Station

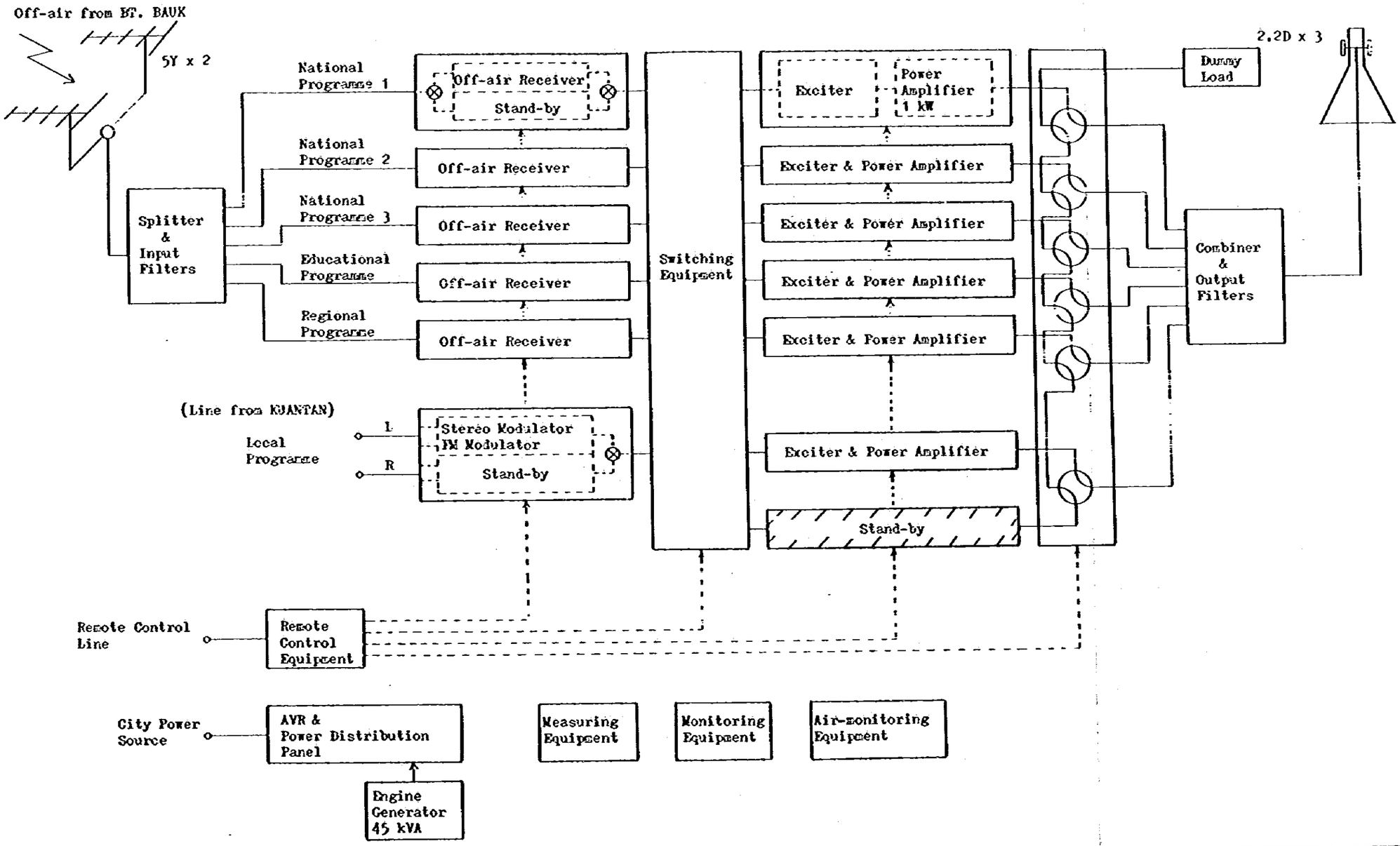


Fig. 4-1-13 Schematic Diagram of BT. PELINDONG Station

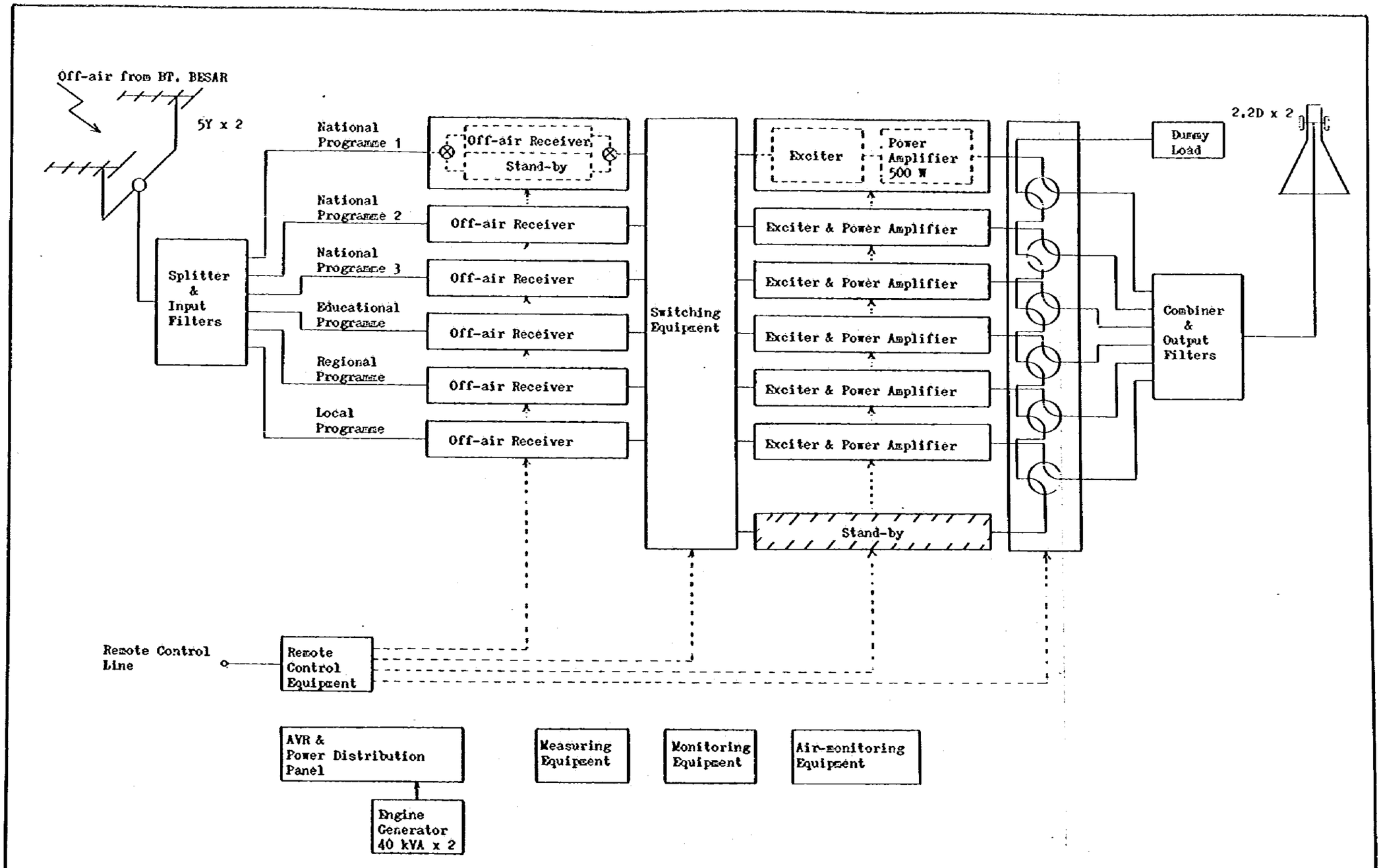


Fig. 4-1-14 Schematic Diagram of BT. BAUK Station

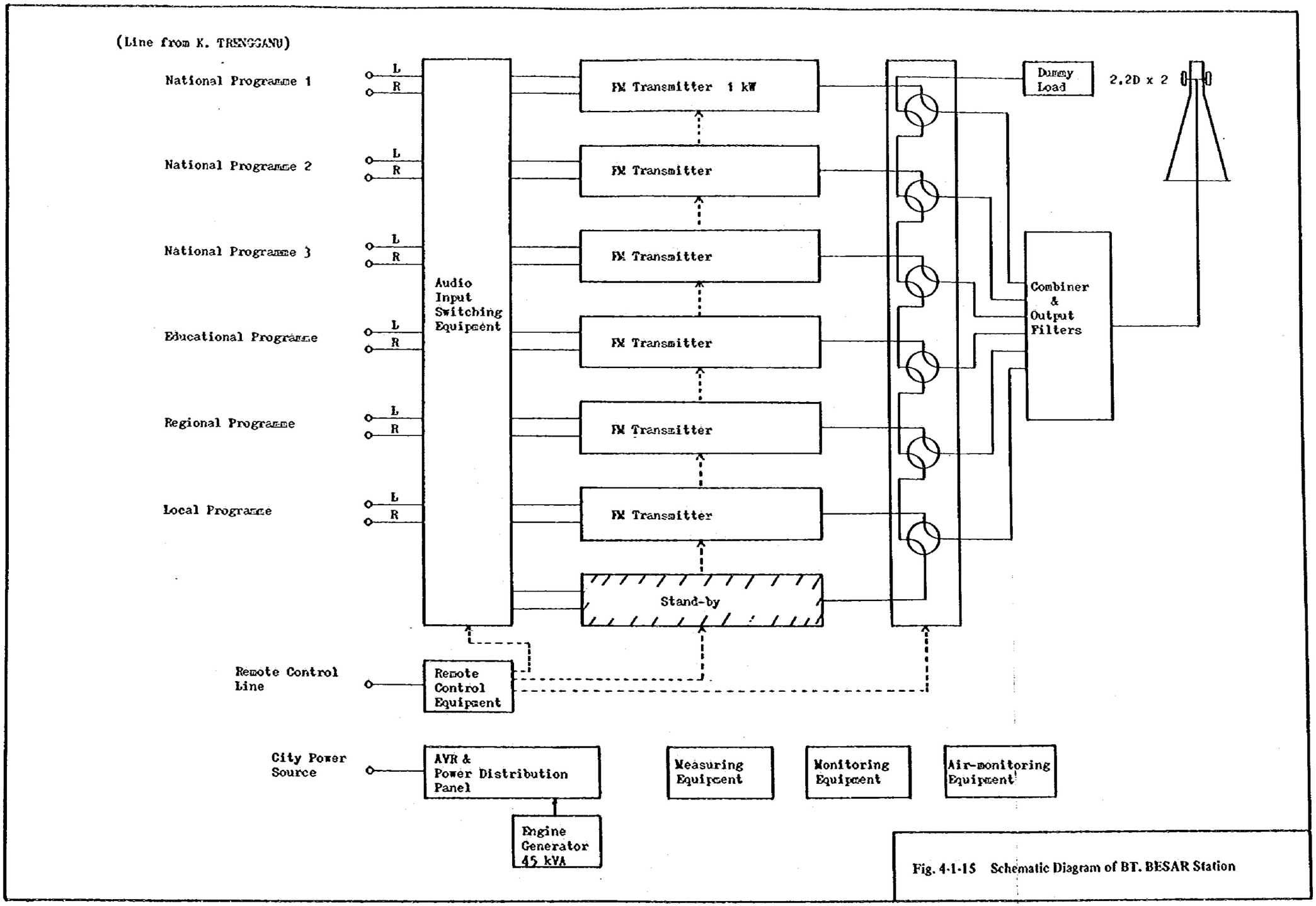


Fig. 4-1-15 Schematic Diagram of BT. BESAR Station

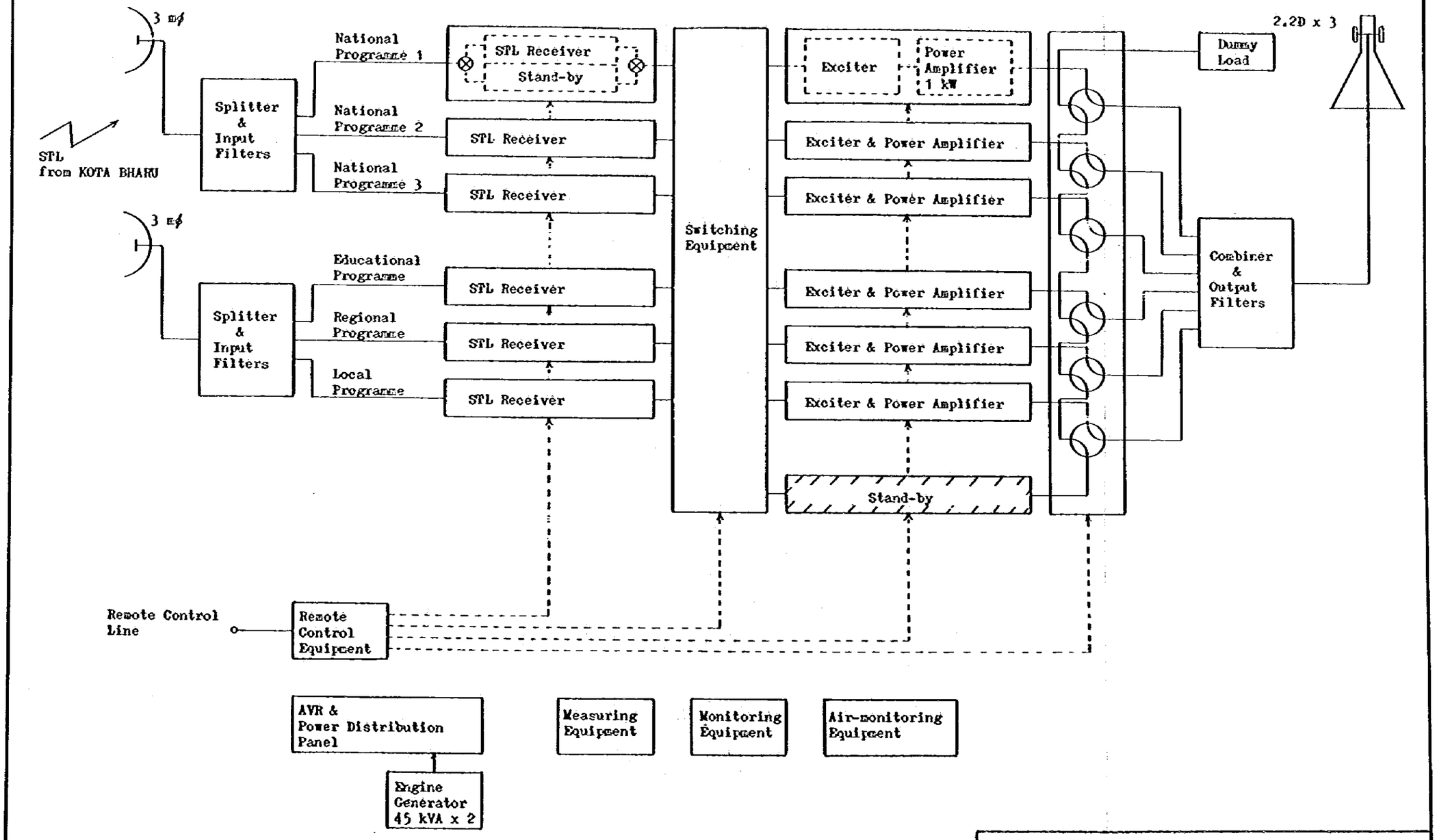


Fig. 4-1-16 Schematic Diagram of BT. BAKAR Station

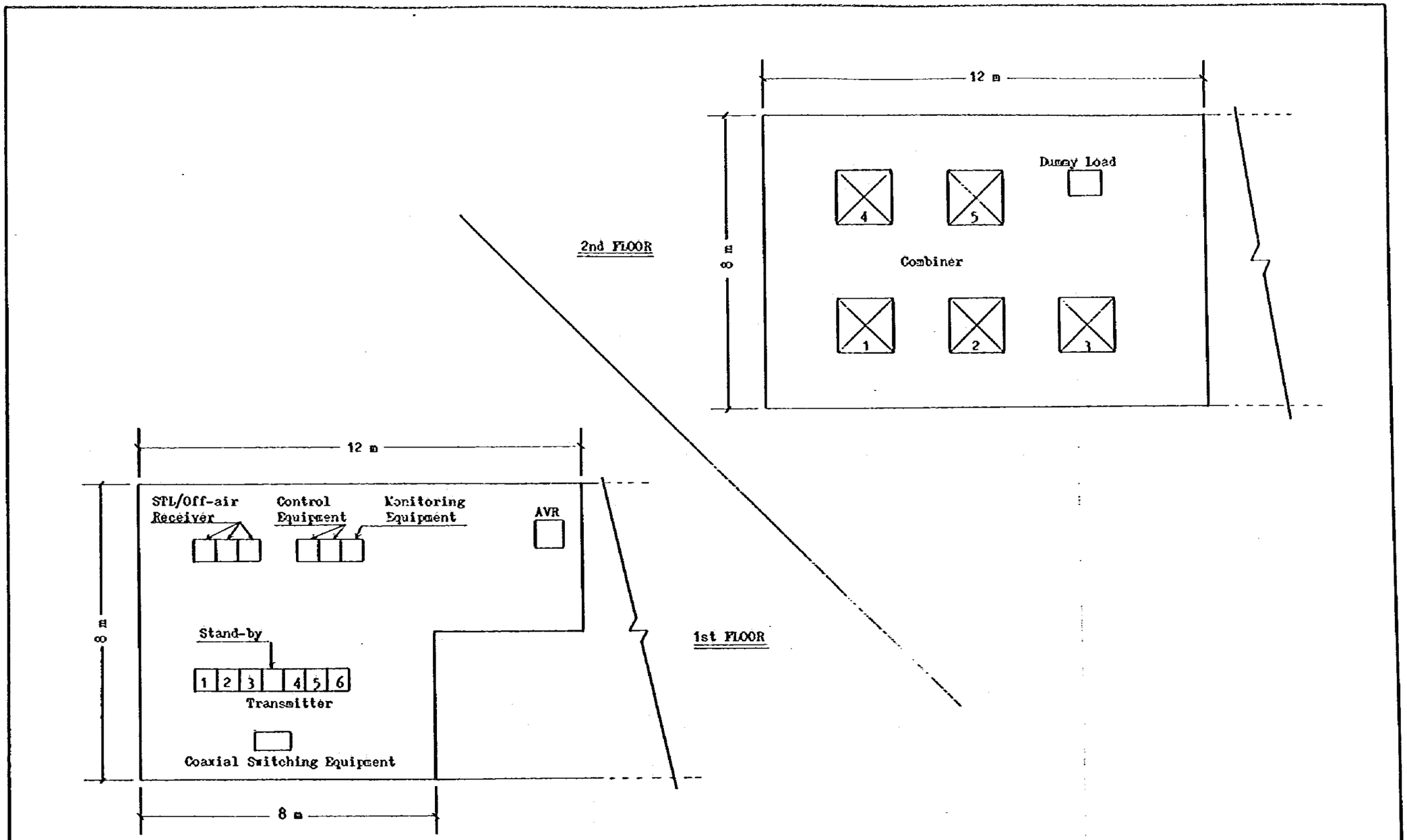
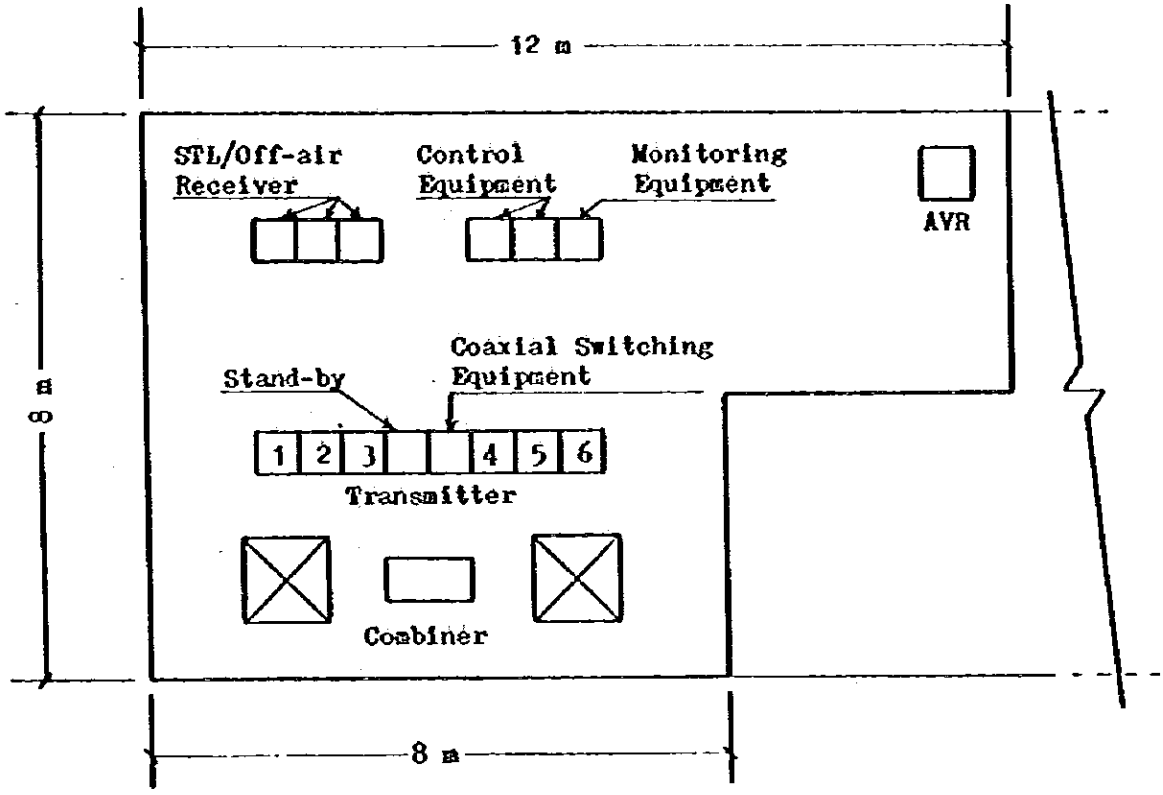


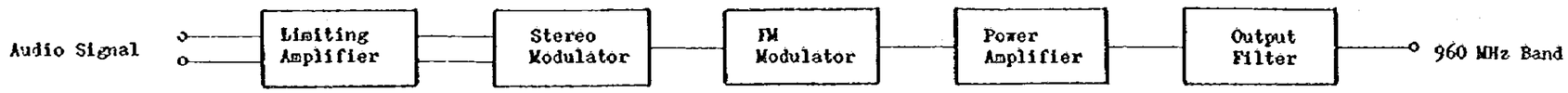
Fig. 4-1-17 Standard Floor Layout of Transmitting Room for 1 kW / 500W Station



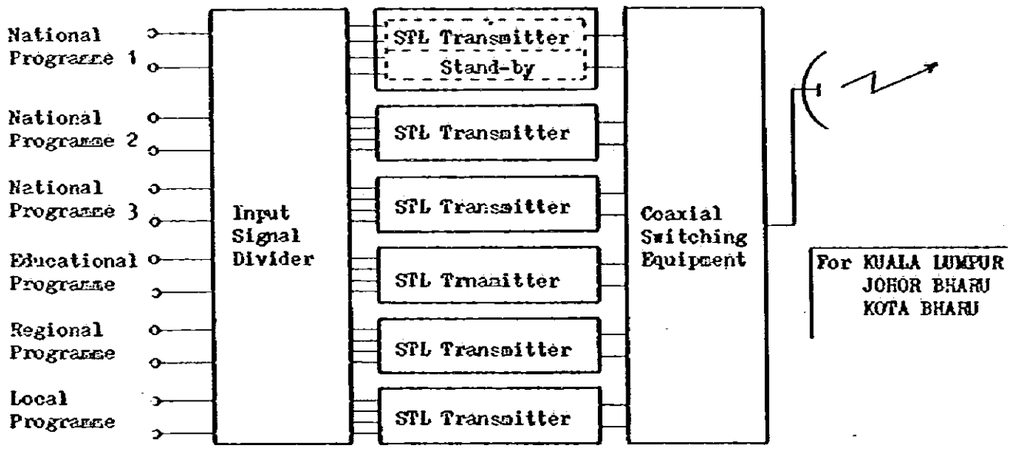
1st FLOOR

Fig. 4-1-18 Standard Floor Layout of Transmitting Room for 100W Station

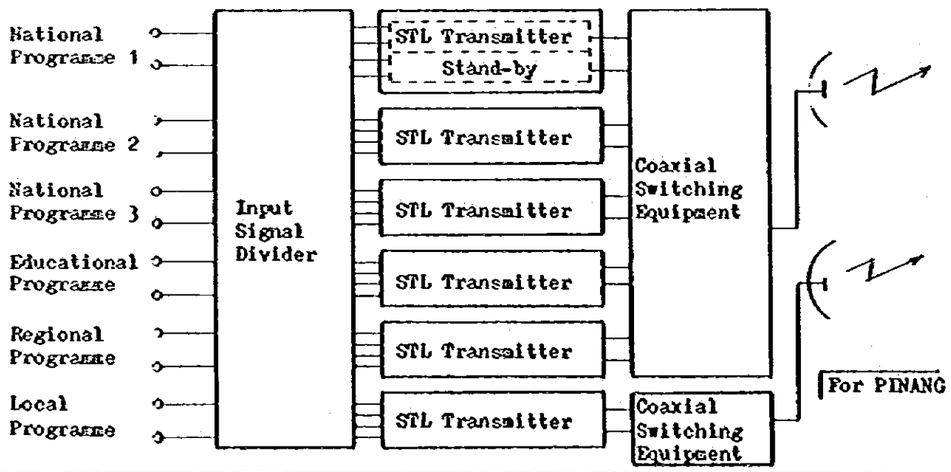
BLOCK DIAGRAM OF FM STL TRANSMITTER



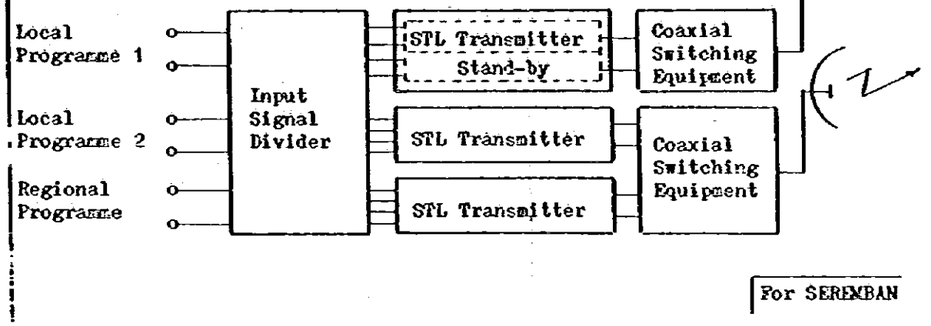
A TYPE SYSTEM



B TYPE SYSTEM



C TYPE SYSTEM



D TYPE SYSTEM

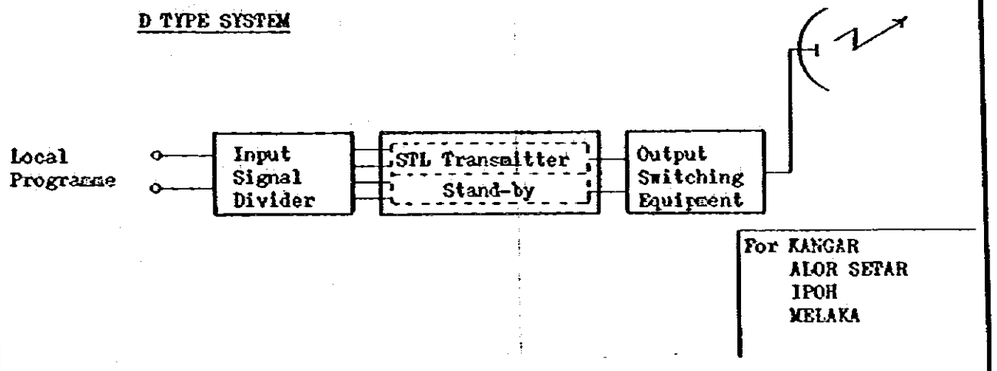


Fig. 4-2-1 Types of FM Transmitting System

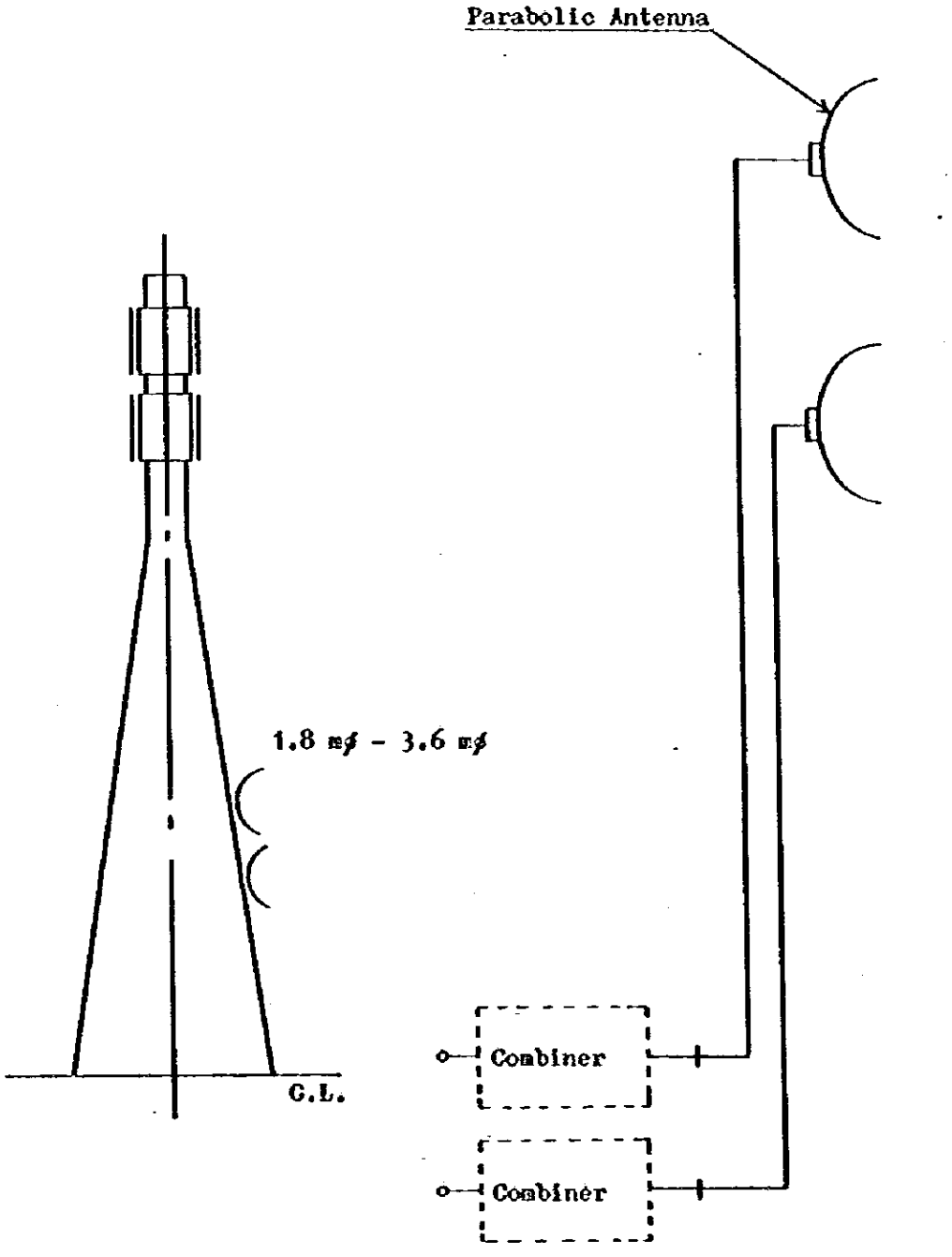


Fig. 4-2-2 General View of STL Transmitting Antenna System

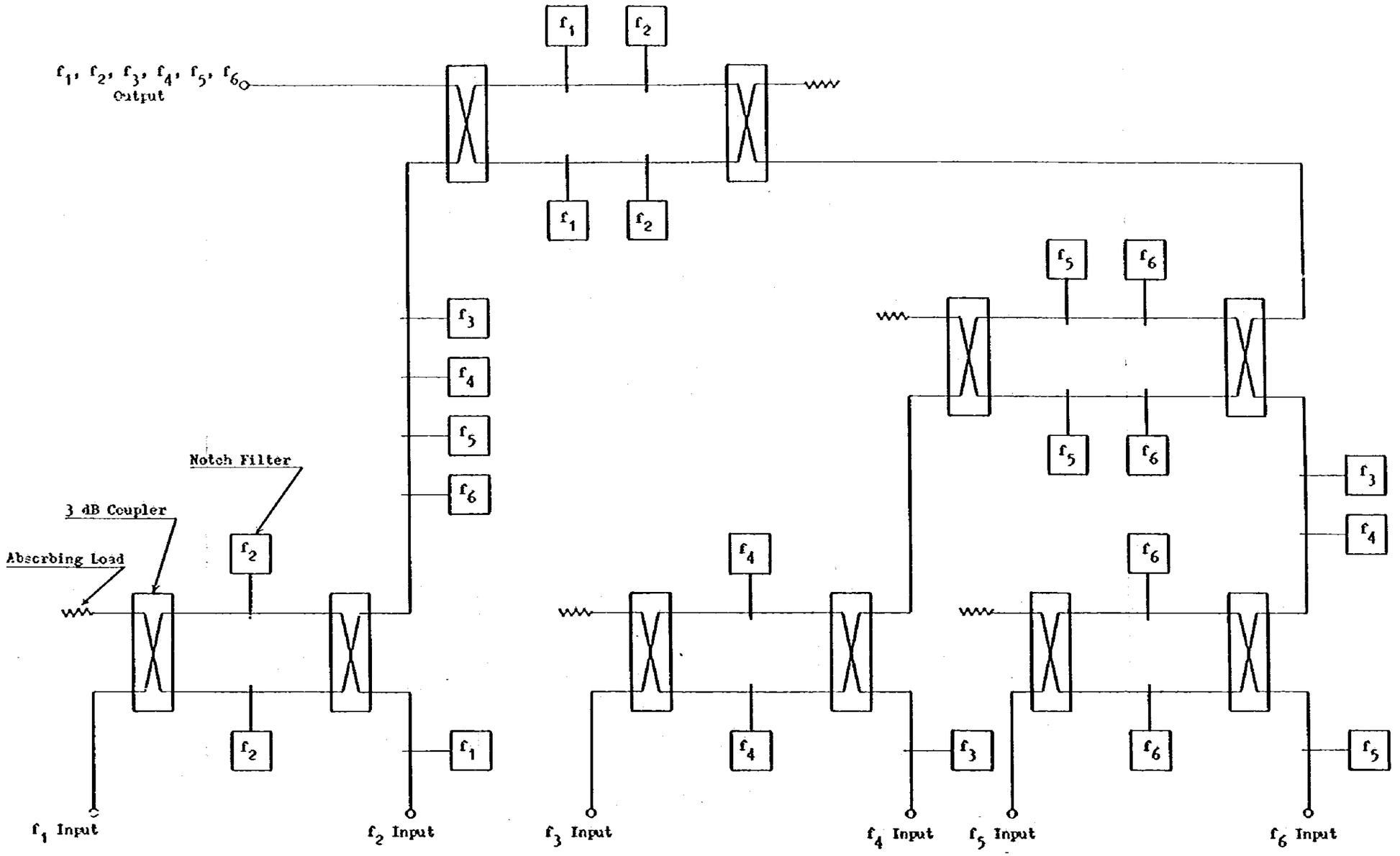


Fig. 4-3-1 Schematic Diagram of Combiner for 500W, 1 kW Transmitter

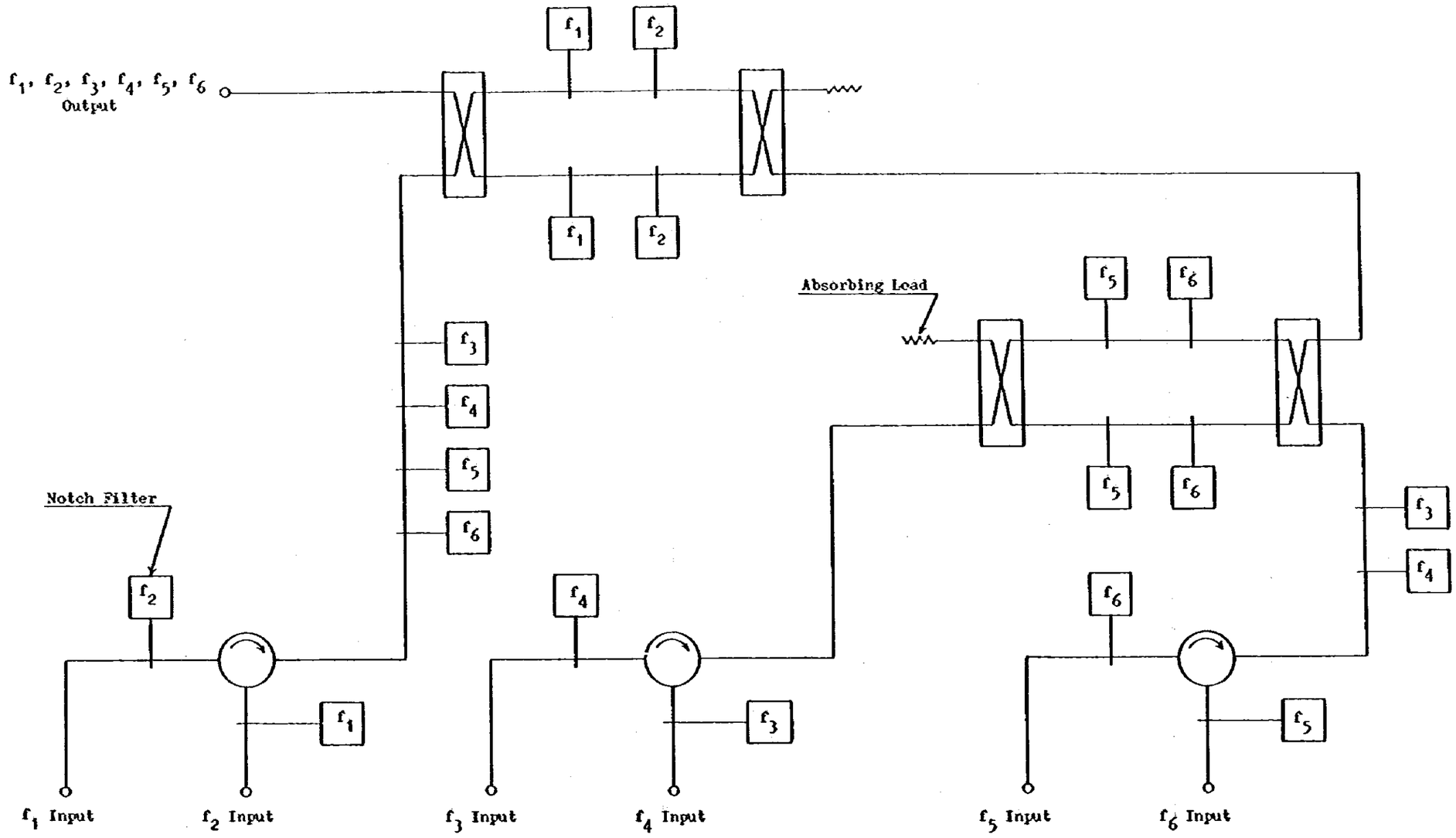


Fig. 4-3-2 Schematic Diagram of Combiner for 100W Transmitter

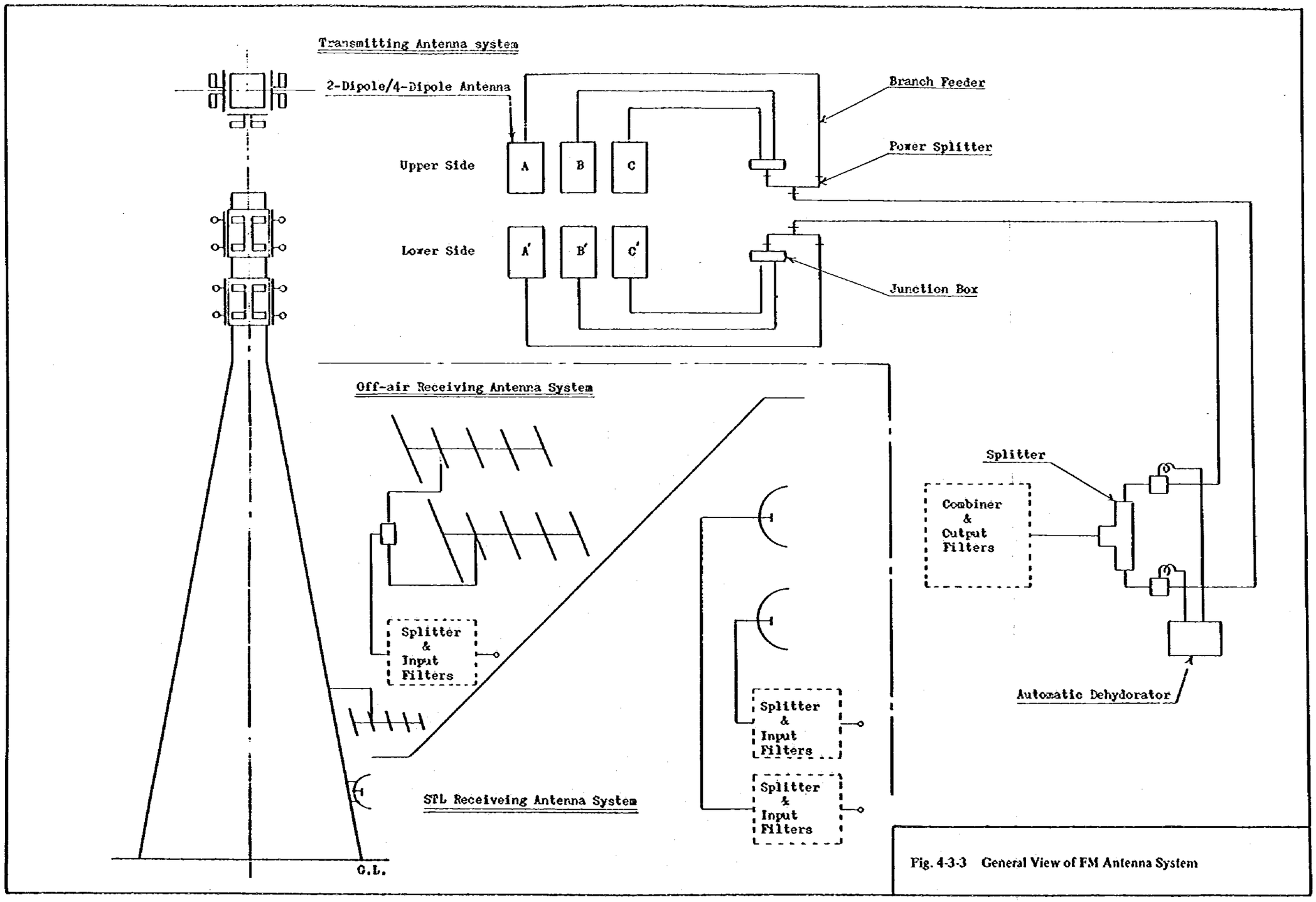


Fig. 4-3-3 General View of FM Antenna System