社会開発協力部報告書

MALAYSIA

FEASIBILITY STUDY REPORT
ON
VHF/FM BROADCAST COVERAGE
FOR
THE STATES OF SABAH AND SARAWAK

MARCH 1983

JAPAN INTERNATIONAL COOPERATION AGENCY

PREFACE

PREFACE

In response to the request of the Government of Malaysia, the Government of Japan decided to conduct a feasibility study on the VHF/FM Broadcasting Network Coverage Project for the States of Sabah and Sarawak following the project for peninsular Malaysia, as a part of its technical cooperation, and entrusted the study to the Japan International Cooperation Agency (JICA).

The JICA dispatched to Malaysia a study team headed by Mr. Takahiro Kawazoe, Deputy Director, Planning Division, Broadcasting Department, Ministry of Posts and Telecommunications, for a period of 50 days from June 15 to August 3, 1982, to carry out a field survey.

After the field survey, further studies and consultations with the officials concerned of Malaysia were made and this report has been prepared.

I hope that this report will contribute to the improvement of the VHF/FM broadcasting in Malaysia as well as to the promotion of friendly relations between Malaysia and Japan.

I wish to erpress my deep appreciation to the Government of Malaysia and the persons concerned for their full cooperation extended to the team.

March 1983

Keisuke Arita
President
Japan International Cooperation Agency

PLAN A, MAP SHOWING LOCATIONS OF TRANSMITTING STATIONS

SOUTH CHINA SEA

SULU SEA

CELEBES SEA

KUDAT
KOTA KINABALU
RANAU
TAMBUNAN / KENNINGAU
SANDAKAN
SIPITANG
TENOM
NABAWAN
PENSIANGAN
LAHAD DATU
LIMBANG
MIRI
TAWAU
BT. PELAMAU
BARE'O
BINTULU
BELAGA
SIBU
BT. BATU
KAPIT
SARIKEI
SARATOK
KUCHING
BANDAR SRI AMAN

MAXIMUM ELEVATION FIGURES ARE BELIEVED NOT TO EXCEED 8100 FEET

CONTENTS

SUMMARY AND RECOMMENDATION

Summary and Recommendation

1. Summary

The Malaysian Government carried out in 1981 a feasibility study in Peninsular Malaysia in accordance with its plans to reinforce and expand the sound broadcasting in the country by establishing VHF/FM broadcasting networks. The resent feasibility study conducted in the States of Sabah and Sarawak was one to follow up the 1981 survey in Peninsular Malaysia. In view of the fact that the recent survey was conducted as an intergral part of Malaysia's entire plan to establish VHF/FM networks throughout the country, the survey was carried out while giving adequate consideration to its being in line with the survey report on the feasibility study for peninsular Malaysia with respect to the principal standards and conditions.

The survey in the States of Sabah and Sarawak was conducted from two different angles; under plan A (the establishment plan emphasizing coverage of densely populated areas) and under plan B (the establishment plan which aims at achieving service coverage of the entire the States of Sabah and Sarwwak). However, on the basis of the agreement reached with the Malaysian Government, detailed studies were made mainly along the lines set forth under the plan A.

As a result of the survey, it was confirmed that, under the Plan A, the site planning for 24 transmitting stations (at 22 sites) could be carried out and six frequencies could be assigned to those stations. This would be the same number of frequencies assigned in Peninsular Malaysia and would enable broadcasting on six VHF/FM channels in the entire country. From the point of view of programming, too, this would be effective in promoting Malaysia's entire plan to reinforce its broadcasting services. As regards the sites for the FM transmitting stations, considerations were given to the plan of building stations as much as possible in such a way as to use the sites in common with either the existing TV transmitting stations or the existing microwave relay stations, with a view to reducing the financial burdens resulting from the purchasing of land, construction of station buildings and access roads, etc. As a result, a decision was made that, of the 22 sites, 15 would use the ground in common with the existing TV transmitting or other stations, while the remaining 7 sites would be set up on new sites.

In accordance with the above-mentioned policy for site selection, the construction work will be conducted in two phases; in the 1st phase, the construction will take place on 15 sites which will be used in common with the existing TV transmitting or other stations and, in the 2nd phase, 7 sites will be newly built. So, the total period of construction will be 7 years.

The total construction expenses will be M$143,638,000. including the construction of FM transmitting stations and studio facilities. The maintenance and operational expenses after the completion of construction are estimated to total M$31,515,150.a year.

The number of additional staff members required in running the FM broadcasting services after the construction of FM transmitting stations and studio facilities is completed is estimated at 1,099, of which 120 are those at TELECOM and 979 at RTM.

Under the Plan B, the placing of 46 stations on 44 sites will bring the service coverage to 100%. However, in this case, the number of frequencies assignable to each transmitting station would be 2 or 3.

As already mentioned, when the present project is carried out and the construction work completed, the amount of expenses for the maintenance and operation of the FM services would

come up to a considerable level. Neverthless, it is considered that the social contribution of the newly established FM broadcasting networks, including their contribution to national development and enhancement of culture, would be immeasurably large.

2. Recommendations

(1) As regards the construction of transmitting stations in the mountain area, that is, the Phase 2 in the Plan A and the Plan B, it would be desirable to adopt the programme transmission method using the communication satellite, rather than that using the Off-air relay, if it is considered essential to always maintain the unique characteristic (high-quality broadcast) of FM stereophony. In this Report, the calculation of expenses including those for construction has been done mainly for the Off-air relay system. This is because, at the time this project is being carried out, the plan on the use of the communication satellite has not been finalized. It is evident that, in the future, conditions will arise where not only the FM transmitting stations but also the television transmitting stations will have to be constructed in the areas under review in this Report. Then, for the transmission of television programmes, it will be necessary to either construct a new microwave circuit network or to establish a TV/RO to serve as the terminal station for a communication satellite circuit. On the basis of such future perspective, we wish to recommend in this Report that, instead of adhering solely to the off-air relay system, studies be energetically promoted in the future on TV/FM RO system as well. In this era of rapid technological development, it would certainly be essential to maintain flexibility in coping with various problems to be faced from now on.

(2) The composition of the network of circuits for programme transmission to FM transmitting stations has been clarified in this Report. Therefore, as far as the Telecom is concerned, it will be essential that the requirements as mentioned in this Report for programme transmission circuit network and the actual construction plan for FM transmitting stations be examined in consultation with the Ministries concerned so that the actual construction plan – which will not obstruct the operation of any of the FM transmitting stations or that of the regional and local studios – may be established as soon as possible.

(3) When the actual construction plan is to be drawn up, it is necessary to have qualified consultants do the work of preparing a detailed execution and designing schedule.

From the point of view of ensuring efficient and smooth running of construction work, the hiring of capable consultants is most desirable.

PART I INTRODUCTION

Part I. Introduction

1. Outline of the plan to establish FM broadcasting network

The Malaysian Government drew up its plans to expand and reinforce broadcasting networks within the country, on the basis of its high assessment of the role the broadcasting plays, as a means of spreading the knowledge and skills concerning various industrial fields, in enhancing the educational levels of the people that constitute the foundation of national and social developments. In line with their judgment that further expansion of broadcasting network would be difficult with the present method in medium and shortwave in view of the restricted availability of frequencies under the international frequency allocation system and also of interference from foreign radiowaves as well as other unfavorable factors, the Malaysian authorities planned to establish the national, regional, local and educational broadcasting networks in FM in VHF band, which not only is strong against interference but also enables broadcasting service of high sound quality.

2. Objectives, process and policy of the survey

At the request of the Malaysian Government, a preliminary survey team was sent from Japan in March 1982 to the States of Sabah and Sarawak prior to the feasibility study concerning the projected establishment in the two States of FM broadcasting networks. The preliminary survey was conducted from various angles, such as, the confirmation of the scale and content of the present project, the grasping of the current condition of telecommunication facilities and services in the regions concerned, the decision on the Scope of Work for the fullscale survey, the collection of material and data necessary for the undertaking of the feasibility survey, and the checking of actual state of affairs in the local communities concerned.

It was with such a process of work in mind and on the basis of the results of the preliminary survey that the recent feasibility survey was conducted concerning the plan to establish VHF/FM broadcasting networks in the States of Sabah and Sarawak. The objectives of the study team that conducted the field survey for 50 days from June 15 to August 3, 1982, were: to draw up a basic plan necessary for the carrying out of the present project, including the optimum site planning, assigning of frequencies and selection of the most appropriate system; to conduct on-site measuring of field strength and the arriving radiowaves; and to obtain various necessary material and data. The 10-man study team was led by Mr. Takahiro Kawazoe, Deputy Director, Planning Division, Broadcast Department, Radio Regulatory Bureau, Ministry of Posts and Telecommunications.

Accordingly, the field survey was conducted in line with the Scope of Work which was established with the aim of attaining the objectives as mentioned above. Thus, site surveys including measurements of field strength and collection of data relating to the basic designs were carried out and, at the same time, various other surveys were conducted on the items concerned with the carrying out of the present project in accordance with the basic policy that the entire survey shall be conducted in consultation with the Malaysian Government.

3. Composition of the study team

Mr. Takahiro KAWAZOE (General Leader)	Deputy Director Planning Division Broadcast Department Radio Regulatory Bureau Ministry of Posts & Telecommunications
Mr. Hitoshi SHIODA	Technical Official Engineering Division Broadcast Department Radio Regulatory Bureau Ministry of Posts & Telecommunications
Mr. Hiroshi NARITA	Technical Official Frequency Division Radio Regulatory Bureau Ministry of Posts & Telecommunications
Mr. Masayuki HIRATA	Senior Engineer Technical Coordination Division Engineering Headquarters Japan Broadcasting Corporation (NHK)
Mr. Shoji TSUDA	Engineer Planning Division Engineering Headquarters Japan Broadcasting Corporation (NHK)
Mr. Yohsiaki HIGASHI	Engineer Transmitting Engineering Division Engineering Headquarters Japan Broadcasting Corporation (NHK)
Mr. Tetsuya NOHMURA	Engineer Architectural Engineering Division Engineering Headquarters Japan Broadcasting Corporation (NHK)
Mr. Masami DOUCHI	Senior Engineer Consulting Service Division All Japan Television Services Co., Ltd.
Mr. Hogara CHIBA	Chief Engineer Architectural Division All Japan Television Services Co., Ltd.
Mr. Mitsutoshi KIKUCHI (Project Coordinator)	Senior Staff 2nd Development Survey Division Social Development Cooperation Dept. Japan International Cooperation Agency (JICA)

4. Subjects and scope to be surveyed

The basic items of survey are shown in the Scope of Work (Annex 2-D) which was agreed to between the Malaysian Government and the Japan International Cooperation Agency (JICA).

The area to be surveyed is the States of Sabah and Sarawak. The survey was conducted according to the Plan A and Plan B, both of which concern this particular area under survey.

In order to draw up the basic plans for the above-mentioned two scopes, the actual condition of radiowave propagation in the area concerned was measured by using the existing TV waves at a total of 60 points, viz., 32 points in Sabah and 28 points in Sarawak. Through such measurements, (1) the coverage of the FM broadcasting service was estimated, (2) the site planning of FM transmitting stations was conducted, and (3) the decision of the ERP was made, etc.

The outline of the on-the-spot survey is shown in the Annex 2-A and 2-C.

5. Survey schedule

The survey schedule is shown in Annex 2-A and Table 2.

PART II DETAILS

SECTION 1. OUTLINE

SECTION 1. OUTLINE

1-1. Foreword

In this Section, a summarization will be given of the results of studies made in each of the following Sections.

1-2. Technical Standards

The frequencies used in this project range from 87.8 MHz to 108 MHz. The following technical standards are adopted in this project.

(1) Technical standard and system for stereophonic broadcast CCIR Rec. 412-2 and 450 are adopted. The pre-emphasis is 50 μs, and the system is of pilot tone for stereophonic broadcast.

(2) SCA

The SCA is not used.

(3) Estimation of field strength

Results of TV field strength obtained by this Study Team, a calculating equation substituted by the modified index of refraction for Malaysia of 60 is used for estimating field strength, and a value obtained by substracting 2.3 dB from the calculated value is adopted.

(4) Technical standards for transmission

CCIR Rep. 293-4 is adopted.

(5) Technical standards for buildings and towers

For the design of buildings and steel towers, the Architectural Standards Laws and structural design standards of Japan and the Laws and Regulations currently in force in Peninsular Malaysia were employed as reference.

1-3. Site planning

In preparing the plan of station establishment, the following points were taken into account; the plan includes 4 media, namely, national, educational, regional and local; Plan A considers regions of high density of population and Plan B considers all the States of Sabah and Sarawak; in the transmitting points, the existing TV sites or microwave relay sites are utilized as much as possible in consideration of the economy of construction expenses, etc. In determining service areas, the required field strength described in CCIR Rec. 412-2 was adopted.

As a result, Plan A selected 13 existing TV sites (14 stations), 2 existing microwave relay sites (3 stations) and 7 new sites (7 stations) totaling 22 sites (24 stations).

The establishment of the 22 sites (24 stations) results in a population coverage of 96% and a land coverage of 66%. These 22 sites (24 stations) can be classified by the transmitter's power as 1 station of 5 kW, 9 stations of 1 kW, 6 stations of 500 w and 8 stations of 100 w.

In the 22 sites, six channels are intended to be placed at the same site, but in the two sites of Ranau and Saratok, 1 channel for local broadcasting of an other district for each station will be added.

Plan A will be executed in two stages; the first stage uses the existing TV sites or existing

microwave relay sites and the second stage covers relatively large towns populated in the mountain area by settlement, etc.

1-4. Frequency assignment

(1) The frequency spacing for each channel was determined as 200 kHz in consideration of interference protection ratio.

(2) The frequency spacing between transmitting stations was estimated from the results of calculation.

(3) The frequency spacing required in the same transmitting station was determined as 800 kHz.

(4) With regard to measures for radio interferences arriving from foreign countries, which was confirmed by actual field measurement, it was planned to secure necessary interference protection ratio.

(5) 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 would be possible to eliminate any interference by an ordinary method.

With due regard to the above, a frequency for each site was assigned, and thus frequencies for 134 transmitters were decided. As a result, 6-channel broadcasting will be available.

1-5. Transmitting facilities

(1) Transmitters were planned as full solid state type.
For the standby of the tranmitters, a common standby system was adopted.

(2) STL were planned as full solid state type.
For the standby of STLs, it is advisable to select a full standby system instead of the common standby system.
STL antennas will be used for three frequencies in common.

(3) With regard to the polarization plane of transmission, horizontal polarization is adopted.

(4) The FM transmitting antennas will be used in common for all of the FM channels, but not with TV antennas. (For transmitting antennas, 2 dipole-type was adopted as standard.)

(5) The multiplex feeding circuit uses a CIN diplexers for between high power transmitters, and a combination of a CIN diplexer and a circulator for between low power transmitters.

(6) It will be difficult to the electric power supply facilities in common with those of TV transmitters in respect of capacity; therefore, an independent power supply system will be provided.

(7) The supervison and monitoring of FM transmitting stations will be performed at the attended TV or microwave relay stations on the co-site, and placed under joint operation with the existing facilities.
The operation will be done by Telecom branch offices of near by its FM transmitting stations for the existing unattended TV and new sites.

1-6. Station building and tower

With regard to 15 sites (17 stations) from among these 22 sites (24 stations) will be constructed on the co-site with existing TV stations, a study was made to plan to use the existing TV transmitter buildings as far as possible. As a result, it has been found that there are 6 stations whose existing TV transmitter buildings and engine-generator houses will be available, and in other stations, it will be necessary to newly build both or either of the transmitter building and engine-generator house.

Two(2) stations from among the 7 stations to be constructed at new sites, are considered to be used in common with the TV transmitter buildings to be newly constructed in the future. The remaining 5 stations, which will be constructed in places where no existing sites exist, need new building and access roads that will be constructed.

Regarding the structure of the station buildings to be newly constructed, TAMBNAN/ KENINGAU (Layang-Layang) station is built of wood, and the others are of reinforced concrete. The transmitter room is air-conditioned. In case the existing TV transmitter building is used in common, the TV transmitter room is provided with a FM transmitters, and the storehouse is remodelled to install the combiners.

If the steel tower has space for installing the FM antenna and there is no problem in structural strength, common use of the TV and/or microwave tower will be available. The number of steel towers for common use is seventeen(17). The steel towers at the other five(5) sites will be newly built.

The steel tower to be newly built for KUCHING is 13.5 m high and that for the other sites is 65 m high.

The structural design of the steel tower is the self-supporting type with square cross-section. All component materials of the steel tower shall be galvanized and then finished with paint as aviation obstruction markings.

1-7. Programme planning

The number of FM channels that are feasible as a result of a technical study is 6 in Plan A.

The assignment is as follows.

In case of Plan A

FM-1: RTM national programme – 1 (N-1)
FM-2: RTM national programme – 2 (N-2)
FM-3: RTM national programme – 3 (N-3)
FM-4: RTM regional programme (R)
FM-5: RTM local programme (L)
FM-6: PSP educational programme (E)

The Government of Malaysia will be expected for FM broadcasting is as follows:

(1) To improve the existing radio coverage.
(2) To complete the regional and local broadcasting services.
(3) To establish the educational broadcasting services independent from the others.
(4) To realize the FM stereophonic high fidelity broadcasting.

If the current AM programme is applied to FM after the implementation of the FM Project, the characteristics of FM broadcasting can not be brought out. Though temporary channelling of AM broadcast programme on FM is inevitable for some time just after the establishment of FM stations, it is necessary to produce the programmes for FM independent from AM programmes. After that, it is hoped programmes of existing AM broadcasting should be changed into metropolitan-city programmes in accordance with its progress.

Layang-Layang station, which has been operating for the purpose of relaying AM programmes by FM channels, has no influence on the frequency assignment of this project.

1-8. Programme transmission line

(1) As for national and educational broadcasting, Peninsular Malaysia is connected with the States of Sabah and Sarawak by satellite via Kota Kinabalu and Kuching regional studios.

The programme transmission within the States of Sabah and Sarawak adopts the Telecom microwave path. The programme transmission to sites where the Telecom line is not available is effected by off-air relaying.

(2) In principle, between studio and a transmitting station, a STL of 2 GHz band is used for a transmission distance between 10 km and 50 km and a Telecom line is used for a shorter or a longer distance.

(3) For maintaining the technical qulity of the FM programme transmission line, the PCM transmission system is adopted, and its quality complies with the values specified by CCITT Rec. j. 21.

1-9. Staff planning

The staff plan is closely related with the operating organization. In this report, the number of persons required is calculated on assumption that,

(1) RTM will produce all the general programmes

(2) Ministry of Education will produce all the educational programmes

(3) Department of Telecoms will operate and maintain all the FM Transmitters and the facilities concerned.

The number of additional persons required for this project is as follows.

Telecom		120 persons
RTM:	Transmission	12 persons
	Programme production department	356 persons
	Technical department	192 persons
	Administrative department	338 persons
	Training department	65 persons
	Monitor department	16 persons
	Total	1,099 persons

1-10. Construction schedule

According to RTM's intention, the execution of construction is divided into 2 phases. In the first phase, the 15 stations for 1st stage will be constructed and in the second phase, the 9 stations for 2nd stage will be constructed. While it is desirable to make the interval between the 1st and the 2nd phases as short as possible, a period of three years has been set taking into account the need of avoiding the overlapping of construction processes, of eliminating wasteful circuit operation and of training the personnel.

As the preparation and construction needs 3 years in the first phase and 4 years in the second phase, it will take a total of 7 years to put into service.

1-11. Construction cost

The total construction cost is estimated at M$143,638,000. However, since the estimation was made as of October 1982, it would become necessary, at the time the present project is started, to make some alterations by taking into consideration the factors of economic changes that would have occurred in the meantime.

Table 1-11. Estimated Construction Cost

(1) Cost of purchasing equipments and installation on the spot	M$ 80,972,000.
(2) Cost of building construction	33,741,000.
(3) Cost of building construction	5,083,000.
(4) Cost of spare parts	6,542,000.
(5) Consultant fee	4,200,000.
(6) Contingency	13,100,000.
Total	M$143,638,000.

1-12. Operation cost

As a result of the completion of the present project, the following maintenance and operation costs would become necessary each year thereafter.

Table 1-12.

(1) Personnel expenses	M$ 6,600,000.
(2) Expenses of the programme production	6,000,000.
(3) Expenses of the rental fee of programme transmission lines	14,169,000.
(4) Maintenance expenses for equipments	4,746,150.
Total	M$ 31,515,150.

1-13. Basic study of the Plan B

The Plan B is the site-planning aimed at providing the entire area of the States of Sabah and Sarawak with FM broadcasting service coverage. As a result of the basic studies made on this Plan B, it has been confirmed that it would be possible to attain a 100% service coverage with the placement of 46 stations on 44 sites. However, the assignable frequencies would inevitably be restricted to 2–3. Hence, it will be possible to conduct FM broadcast programming on 2 channels for the terminal FM relay transmitting stations and on 3 channels for the major cities.

In this case, a programming plan conceivable would be:

(1) to use one separate channel for the educational service;

(2) to use another channel which could be shared by the national, the regional and the local services; and

(3) to use the third channel for regional or local services for major cities.

1-14. Appraisal

In the States of Sabah and Sarawak of Malaysia, the sound broadcasting has not yet been expanded enough to cover the entire regions and hence much expectations have been placed on further widening of the sound broadcasting service, the enhancement of the technical quality of programmes and the reinforcement of regional broadcasts. We are convinced that the above-mentioned expansion and improvements can be achieved by the Malaysian Government's present project for the establishment of the VHF/FM broadcasting network. Furthermore, in view of the fact that the technological development of FM broadcast-related equipment and program transmission system have already reached the level where the listeners' expectations can be adequately met, the significance is evaluated highly of the present plan being promoted through the introduction of the latest technologies.

As a result of the present survey, a conclusion has been reached that six channels of FM broadcast can be secured under the station-establishment Plan A which is based mainly on population distribution and two(2)–three(3) channels under the station-establishment Plan B which covers the entire regions in the States of Sabah and Sarawak. The promotion of this construction plan and the operation of the network after its completion will mean a considerable financial burden on the Government but, once the project is accomplished, it is expected to contribute greatly to the social progress of the country, including the national development, economic expansion and cultural enhancement.

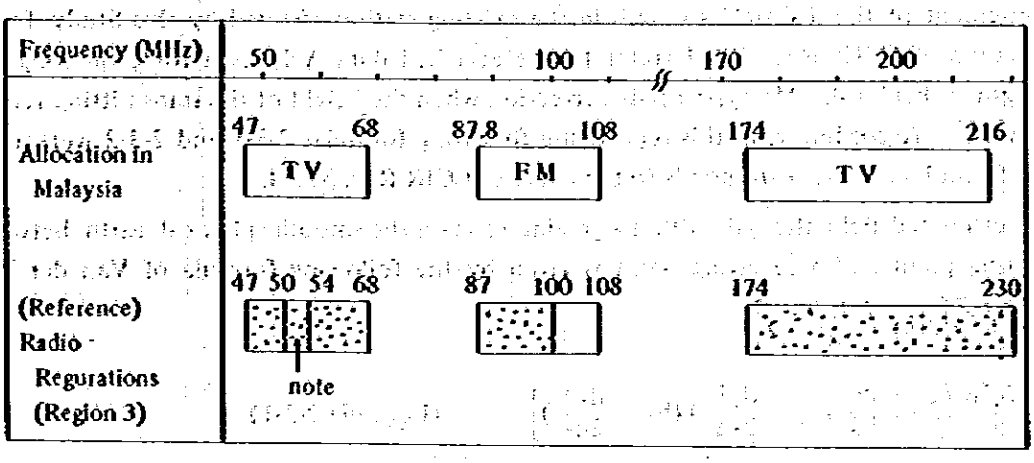
SECTION 2. TECHNICAL STANDARDS

SECTION 2. TECHNICAL STANDARDS

2-1 Frequency assignment to FM broadcasting

The FM broadcasting in this project uses the band of 87.8 MHz – 108 MHz.

Table 2-1 Frequency Assignment for VHF Broadcasting in Malaysia (By WARK-79)



(▨ for common use with other services)

Note: Alternative allocation – in Afghanistan, Bangladesh, Brunei, India, Indonesia, Iran, Malaysia, Pakistan, Singapore and Thailand, the band 50–54 MHz is allocated to the fixed, mobile and broadcasting services on a primary basis.

2-2 Standard system for FM broadcasting

2-2-1 Technical standard for stereophonic broadcasting

According to the desire of the Government of Malaysia and the result obtained by the Study Team, the technical standard and system for stereophonic broadcasting comply with CCIR Rec. 412-2 (VHF/FM broadcasting standard; see the attached data A-1) and Rec. 450 (VHF/FM stereophonic broadcasting system; see the attached data A-2).

(1) With regard to the pre-emphasis characteristic, Rec. 412-2 specifies 50 us or 75 us. However, 50 us is adopted.

a) In Peninsular Malaysia and Layang-layang, 50 us have been adopted, and the corresponding receives are spreading.

b) Judging from the modulation index and occupied band-width.

c) 50 us is used in most of the countries.

(2) Regarding the system, Rec. 450 specifies the polar modulation system or pilot tone system and also FM-FM system with compressor expander. However, since the existing FM stations in Peninsular Malaysia are using pilot tone system and U.S.A. and European countries adopt this system, the pilot tone system is proposed.

2-2-2 SCA

SCA is not considered for use in Malaysia.

2-3 Estimation of service coverage

The estimation of field strength was performed by correcting a calculated value using the topographic factor on the map (1:50000) and a propagation loss estimated from the result of the measurement of the TV field strength in the existing station effected by this Study Team.

The curve of CCIR Rec. 370-4 (refer to the attached data A-4) used for estimating the field strength in Peninsular Malaysia needs correction when the height of the transmitting/receiving point varies. Accordingly, in this report, the following formulas 2-3-1 and 2-3-2 were used. These two formulas almost corresponds to the curve of CCIR Rec. 370-4.

2-3-1 The estimated field strength within a grazing zone on the smooth spherical earth between a transmitting point and a receiving point is given by the following formula of Van der Pol.

$$E = \frac{7\sqrt{W}}{d}\left|2\sin\frac{2\pi h_1 h_2}{\lambda d} j\right|$$

$$= \frac{7\sqrt{W}}{d}\left|2\sin\frac{2\pi}{\lambda d}\left(h_1 - \frac{d_1^2}{2ka}\right)\left(h_2 - \frac{d_2^2}{2ka}\right)\right| \qquad \text{(Formula 2-3-1)}$$

where,

- w ; effective radiation power
- d ; distance between transmitting point and receiving point
- λ ; wave length
- h_1 ; height of transmitting point (height from reflecting point)
- h_2 ; height of receiving point (height from reflecting point)
- d_1 ; distance between transmitting point and reflecting point (Note)
- d_2 ; distance between reflecting point and receiving point ($d-d_1$)
- a ; radius of the earth
- k ; effective radius factor (As the modified index of refraction in Malaysia is 60 throughout the year, the effective radius factor becomes 1.62. Refer to CCIR Rep. 563-1)
- j ; phase difference correction factor

Note: When $S = \frac{d_1}{d}$, obtain d_1 from the following equation:

$$S^3 - \frac{3}{2}S^2 - \left\{\frac{ka}{d^2}(h_1 + h_2) - \frac{1}{2}S\right\} + \frac{kah_1}{d^2} = 0$$

The 40 measured values of TV field strength, in direction of radiation. Within the grazing zone from the transmitting point and smooth reflecting point, were used. When these values are compared with the calculated values of field strength by formula 2-3-1, the distribution of the field strength deviations are as shown in Fig. 2-3-2. This shows a normal distribution with a mean value of −2.3 dB and a standard deviation of 3.1 dB*. (Note)

Note: Supposing that the number of degrees of freedom is 3 and the level of significance is 0.01 according to the calibration of χ^2, the following is formulatized:
$P(\chi^2 > 11.345) = 0.01$.
Accordingly, it is considered to be a normal distribution.

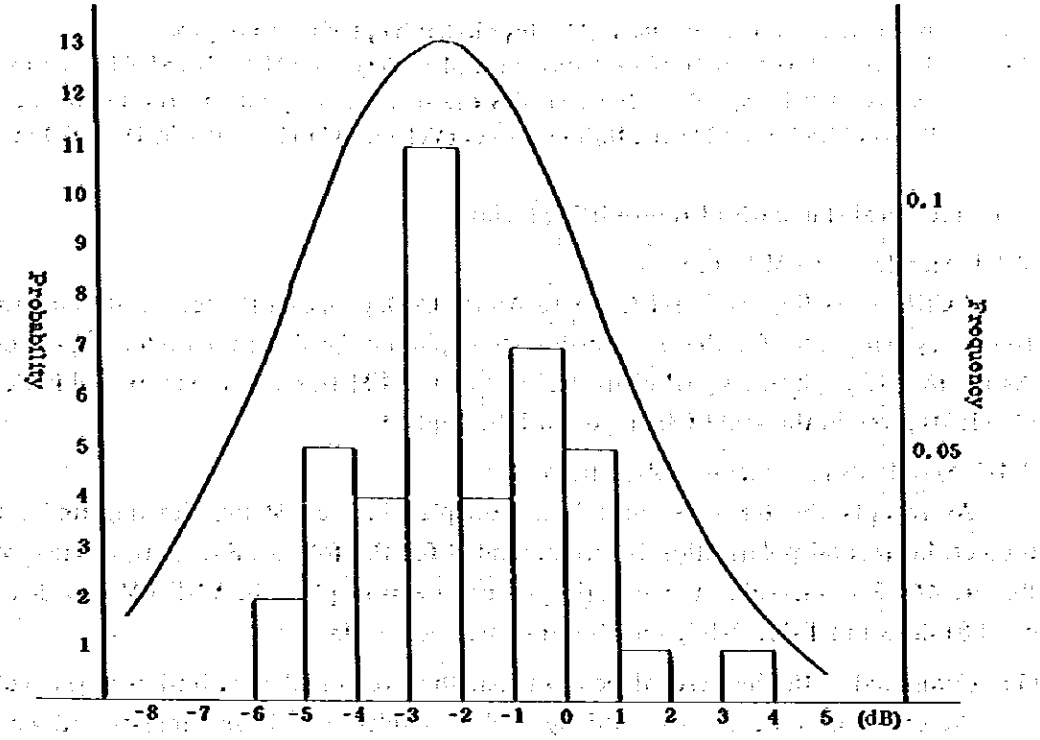


Fig. 2-3-2 Distribution of Differences between Measured Values and Calculated Values

Accordingly, the estimation of field strength for estimating the service coverage and studying the field strength of disturbing wave and Off-Air relaying will hereafter adopt a value obtained by adding a correction value of −2.3 dB to the calculated value.

The list of calculated values and measured values in the survey is shown in the attached data B-1 and the calculation of the diffraction loss caused by mantain ridges and its results are shown in the attached data B-2.

2-3-2 Estimation of field strength at a point out of the grazing zone from the transmitting point

In effecting the estimation of interference disturbance necessary for frequency assignment, it is experimentally known that the field strength at a point out of the grazing zone* (Note-1) can be expressed by Dr. Murakami's equation as follows.

$$E = \frac{56 \times 2^{1/4} \times (ka)^{5/4} \times \sqrt{w} \times (h_1 h_2)^{9/8}}{\sqrt{\lambda}\, d^4}$$

(2-3-2, Dr. Murakami's Equation* (Note-2))

where,

w ; effective radiation power

d ; distance between transmitting point and receiving point

λ ; wave length

h_1 ; height of transmitting point

h_2 ; height of receiving point

a ; radius of the earth

k ; effective radius factor

Note 1: When the distance is more than $\sqrt{2ka}\,(h_1 + h_2)$, it is out of the graging zone.

Note 2: The estimating formula of field strength used in Peninsular Malaysia and this formula make no difference, if it is expanded. However, this equation is more practical. This Equation comes from the Books which is named "Ultra High Frequency (Volume-2)" to be written by Dr. Murakami.

2-4 Technical standards of transmitting facilities

2-4-1 Standard of FM transmitter

CCIR, in its Report 293-4 (refer to Annex C-1), proposes the technical standards for sound frequency parameter for the transmission stereophonic signals and reproduction of sound signals. As for the stereophonic signal characteristics of the FM transmitter mentioned in Section 4, the standards given in the said CCIR report will be applied.

2-4-2 Standards for antenna polarization plan

As regards the transmission polarization plan in the FM broadcasting under the present project, horizontal polarization is recommended for the following reasons, in view of the CCIR Report 464-2 (concerning the selection of polarization plane in VHF/FM broadcast service in band 8) shown in Table 2-4-2, and also of experiences in Japan:

(1) Compared with the vertical polarization, the horizontal polarization is less vulnerable to the effect of reflections caused by such obstacles as hills and forests and, consequently, in horizontal polarization, there is little multi-path distortion and little effect from the noise of automobiles which are the major source of artificial noise. As a result, the advantages of FM broadcast, which aims at high-quality reception, can be made full use of.

(2) Compared with the circular polarization, the horizontal polarization is 3 dB higher in the receiving filed under the same transmission power. Also, in order to achieve a gain of 8 dB for each stack of horizontal-polarization dipole transmitting antenna by using circular-polarization dipole, a total of 4 stacks would be required. For those reasons, when the same service area is to be secured, the horizontal-polarization will be more economical and efficient because the same results can be obtained with a transmitting antenna of smaller composition and with smaller transmitter power.

(3) Since the horizontal-polarization is used in the existing TV service in Malaysia and the horizontal Yagi antennas are already in wide use in this country, the reception guidance for the future FM listeners would be easier if horizontal-polarization were adopted.

Table 2-4-2 Choice of Polarization Appropriate for New Services

Type of service intended	Polarization of existing services	Type of terrain	Preferred polarization of new services
Primarily for highquality receiving installations, probably with stereo, with no improvement to reception conditions for portable or car set 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 recieving any existing transmission	nil or horizontal	flat or rolling	mixed
		rugged	horizontal
	vertical	flat or rolling	vertical
	vertical (3)	rugged	mixed

(CCIR Report 464-2)

(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.

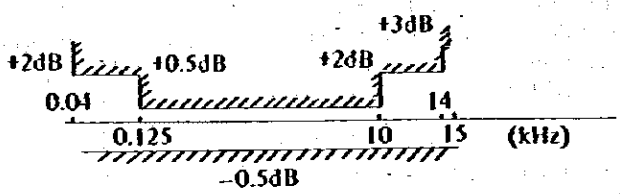
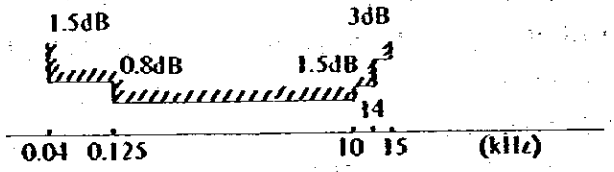
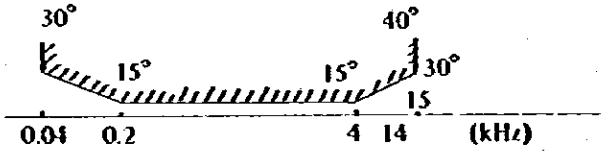
2-5 Technical standard for transmission lines

The quality of each line that is described below should satisfy the overall characteristic (CCIR Rep. 293-4) ranging from studio equipment to receivers and the specification assigned to each one.

2-5-1 Telecom line

The stereophonic transmission line shall comply with CCITT Rec. J. 21 shown in Table 2-5-1. (Refer to the attached data Annex C-2)

Table 2-5-1 Quality of Stereophonic Transmission Line

Item	Standard
Nominal Bandwidth	40 Hz ~ 15 kHz
Attenuation Distortion	
Group Delay	0.04 kHz : less than 55 ms 0.075 kHz : less than 24 ms 4 kHz : less than 8 ms 15 kHz : less than 12 ms
Overall Weighted Noise	less than -47 dBrnpo
Harmonic Distortion	Both second and third harmonies at +9 dBm 0.04 ~ 0.125 kHz less than 0.7% 0.125 ~ 15 kHz less than 0.35%
Level Difference between L, R	
Phase Difference between L, R	
Amount of Cross-talk Attenuation between L, R	better than 50 dB

(from CCITT Rec. J-21, Characteristics of 2,500 km Hypothetical reference circuits)

2-5-2 Off-Air relaying

The off-air relay shall satisfy the values shown in Table 2-5-2.

Table 2-5-2 Specification in Off-air Relay

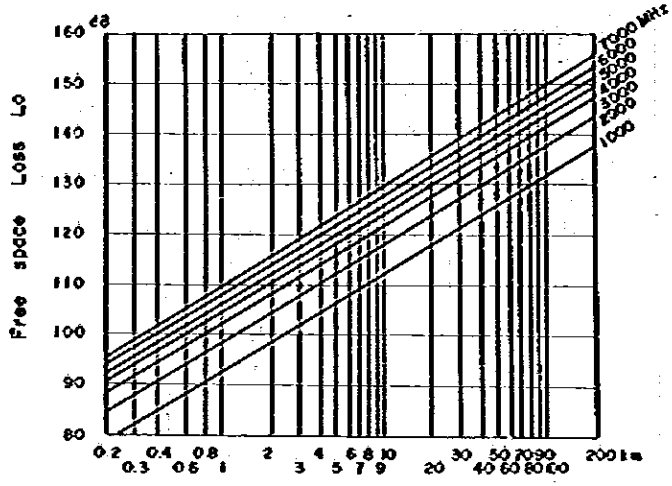
<table>
<tr><td>S/N</td><td>S/N = 60 dB with transmitter output; receiver input: over 42 dB (terminal voltage)</td></tr>
<tr><td>Fading margin</td><td>0.2 dB per 1 km of transmission distance for over 99% of line reliability</td></tr>
<tr><td>D/U required for adjacent stations (including the same station)</td><td>The following shall be satisfied.
$\frac{\text{Field strength of master station}}{\text{Field strength of disturbing wave}} \geqq D'/U' + F - A_1 - A_2$
D'/U' : D/U required of receiver input
<table><tr><th>Δf</th><th>D'/U'</th></tr><tr><td>0</td><td>60 dB</td></tr><tr><td>200</td><td>40</td></tr><tr><td>300</td><td>10</td></tr><tr><td>400</td><td>−20</td></tr><tr><td>600</td><td>−40</td></tr><tr><td>800 or more</td><td>−60</td></tr></table>F : Fading margin
A_1 : Receiving antenna directivity effect (5-element Yagi antenna is used)
A_2 : Receiving antenna diversity effect ..... 15 dB</td></tr>
<tr><td>Multiples propagation path distortion</td><td>No multiplex propagation path distortion shall not be recognized. To be concrete, judgement is made with reference to the profile map of transmission section and the TV received picture appreciation at each transmitting station, excecuted by the Study Team (refer to the attached data Annex B-1)</td></tr>
</table>

2-5-3 STL

As for the specification of the STL, as in the case of the off-air relay, the receiver output shall be S/N = 60 dB (receiver input power: 62 dB), the fading margin shall be 0.2 dB per 1 km and the line reliability shall be over 99.9%.

Table 2-5-3 shows free space loss and Table 2-5-4 shows paraboric antenna gain.

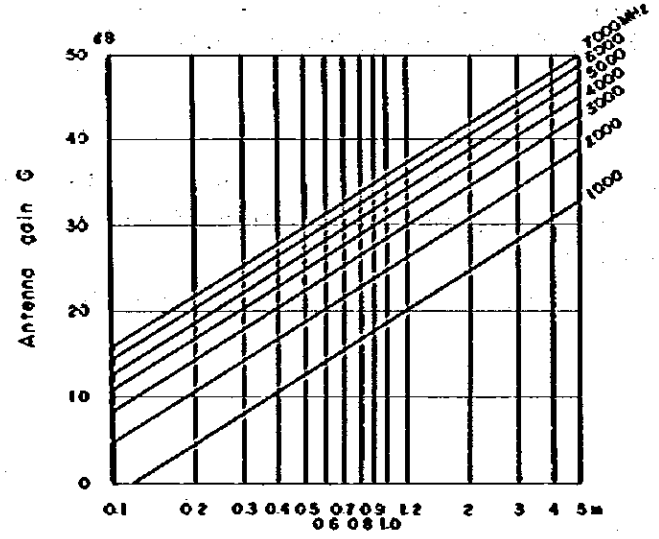
Table 2-5-3 Free Space Loss



$Lo(dB) = 122 + 20\log_{10} d(km) - 20\log_{10}\lambda(cm)$

(foundamental chart of radio-wave propagation
Issued by COLONA CO., LTD 1976)

Table 2-5-4 Paraboric Antenna Gain



$G(dB) = 48 + 20\log_{10} d(m) - 20\log_{10}\lambda(cm)$

where, $\eta = 0.64$

Actually, a loss of 2-3 dB must be considered.

(foundamental chart of radio-wave propagation
Issued by COLONA CO., LTD 1976)

2-6 Minimum field strength

2-6-1 Noise

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

Therefore, it is necessary to obtain the noise level in the states of Sabah and Sarawak, but the relative data can not be obtained by a short-term survey. For this reason, in this report, reference was made to examples of USA and Japan (Table 2-6-1) in CCIR Rep. 258-3 (Fig. 2-6-1).

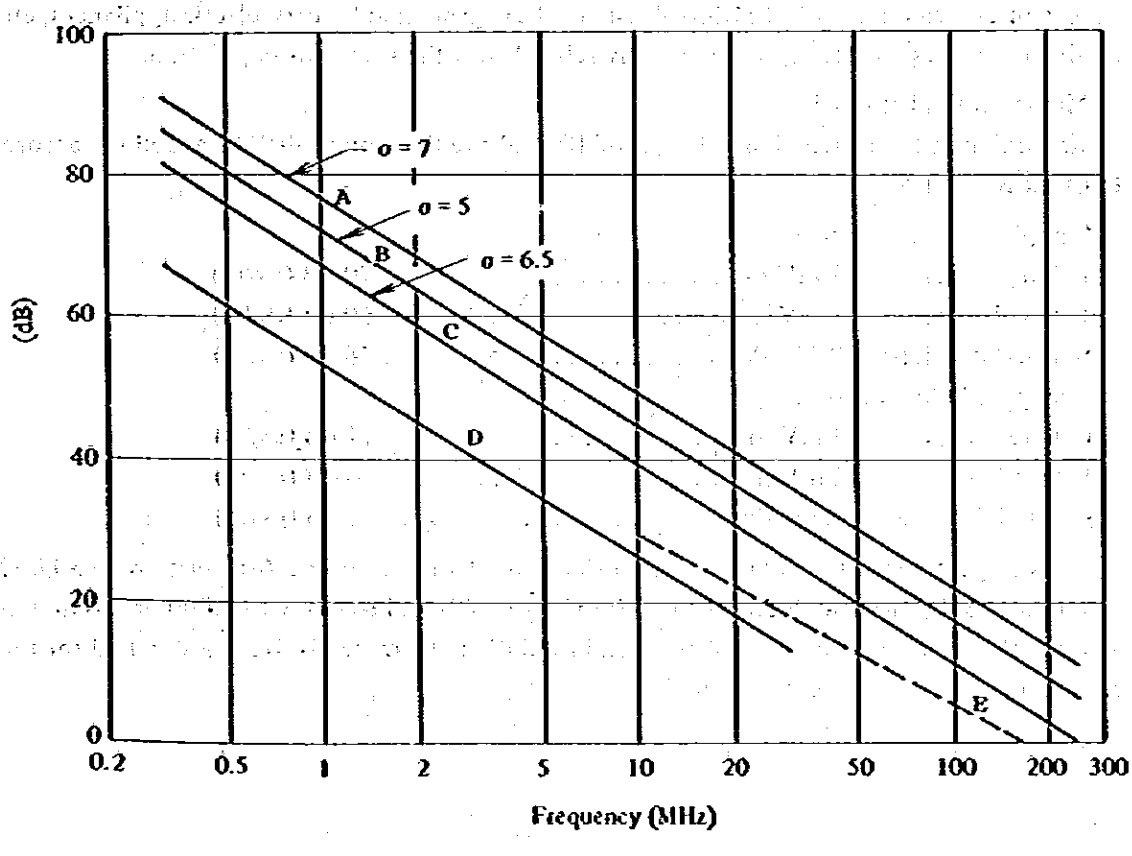


Fig. 2-6-1 Mean values of man-made noise power for a short vertical lossless grounded monopole antenna

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

(CCIR Rep. 258-3)

Table 2-6-1 Noise Level (Mean values at a height of 4 m)

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)

Most of external noises in FM broadcast band are generated by cars, electic appliances, etc. Especially, car noises are dominant and closely related with the spread of population.

2-6-2 Minimum field strength

The minimum field strength at a height of 10 m above the ground shall be as follows according to CCIR Rec. 412-2.

(1) Monophonic broadcasting
   a) Large cities : 3 mV/m ..... 70 dB (μv/m)
   b) Small cities : 1 mV/m ..... 60 dB (μv/m)
   c) Rural districts: 0.25 mV/m ..... 48 dB (μv/m)

(2) Stereophonic broadcasting
   a) Large cities : 5 mV/m ..... 74 dB (μv/m)
   b) Small cities : 2 mV/m ..... 66 dB (μv/m)
   c) Rural districts: 0.5 mV/m ..... 54 dB (μv/m)

In this respect, from the data relative to the noise distribution in 2-6-1, cities with 30,000 or more households, cities with 5,000 to 30,000 households and towns with 5,000 or less households were taken for large cities, small cities and rural districts, respectively, as a standard for the determination of transmitting conditions.

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

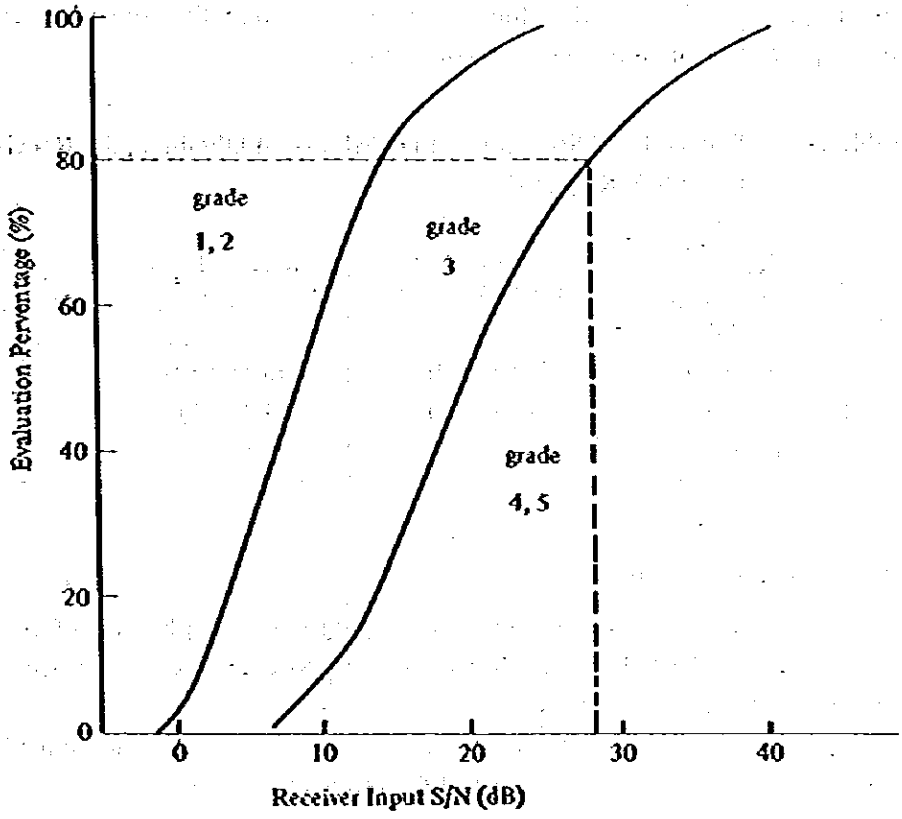


Fig. 2-6-2 Receiver Input S/N and Receiving Evaluation

2-6-3 Receiver input S/N and receiving evaluation

It is known that the relation between receiver input S/N and receiving evaluation by 5-grade evaluation (Table 2-6-2) in monophonic broadcasting is as shown in Fig. 2-6-2. (Survey by NHK) Consequently, the receiver input S/N evaluated as 4 or more by over 80% of listeners is 28 dB.

On the other hand, according to CCIR Rec. 370-3, generally, the service field strength distribution by receiving place is a normal distribution with a standard deviation of 7 dB.

Therefore, the probability of obtaining the receiver input S/N of 28 dB in providing service by the field strength determined in 2-6-2 for large cities, small cities and rural districts becomes 98% or more each, as shown in Table 2-6-3.

Next, in stereophonic broadcasting, it is known that the receiver input to obtain the same receiving quality as in monophonic broadcasting becomes 6 dB higher than the input requierd for monophonic broadcasting. (Survey by NHK).

Consequently, it can be said that the minimum field strength standard specified in 2-6-2 is enough and appropriate for stereophonic broadcasting.

Table 2-6-3 Service Field Strength and Probability of Obtaining the Receiver Input S/N Required

	Service Field Strength ( ): Conductivity dB	Noise Level ( ): Conductivity dB	Receiver Input ( ): Conductivity dB	Probability of obtaining the Receiver Input S/N of 28 dB, %
Large cities	70 (σ = 7)	22 (σ = 7)	48 (σ = 10)	98
Small cities	60 (σ = 7)	17 (σ = 5)	43 (σ = 7)	98
Rural areas	48 (σ = 7)	10 or less	38 or more	98 or more

2-7 Interference protection ratio

The protection of coverage area and Off-Air relaying shall comply with CCIR Rec. 412-2.

For the protection of VHF/FM and TV reception in coverage area, reference was made to EBU Report (refer to the attached data Annex C-3).

In addition, the Japanese specification of the receiver for channel planning for implementation plan is shown in the attached data Annex C-4 for reference.

2-8 Technical standard for construction

2-8-1 Technical standard for buildings

With regard to the structural analysis and design of buildings and load capacity, reference is made to the lays in force in Peninsular Malaysia (Note) and Building Standards Act of Japan, the related laws and regulations, various structural design standards specified by the Architectural Society, etc.

Note: LAWS OF MALAYSIA Act 133
STREET, DRAINAGE AND BUILDING Act 1974
UNIFORM BUILDING BY-LAW 1976

2-8-2 Technical standard for steel towers

With regard to the structural analysis and design of new steel towers, reference was made to the Building Standards Act of Japan, the relative laws and regulations, the structural calculation standard for steel towers specified by the Architectural Society, etc.

SECTION 3. SITE PLANNING

SECTION 3. SITE PLANNING

3-1 Basis of site planning

In this report, the FM broadcasting network coverage in the States of Sabah and Sawarak has been studied from two aspects.

Plan A aims at securing as many channels as possible and gives emphasis on population coverage.

Plan A is divided into 1st stage and 2nd stage; the first is the plan that will permit broadcasting in the districts where the service is provided by the existing TV broadcasting, and the second is the site planning in the districts where population growth is anticipated, such as the mountain regions.

Plan B is a plan for FM network station establishment that will enable service to cover the entire in the States of Sabah and Sarawak. Plan B will be described in Chapter 13.

The following has been taken into account in the selection of transmitting points, determination of transmitting conditions, etc.

(1) The network configuration in this FM broadcasting coverage project consists of national, regional, local and deucational broadcasting, aiming at securing as many channels as possible.
(2) The TV network covers most of the main towns in the States of Sabah and Sarawak.
(3) Transmitting stations are effectively distributed so that the service can be provided to the specified areas through a minimum number of stations. Also the existing TV transmitting stations are utilized as much as possible to ensure economical efficiency.
(4) Unwanted radiation to areas is suppressed to the utmost, in order to secure many frequencies assignable to each transmitting station.

3-2 Network configuration and broadcasting areas

The network configuration consists of 4 kinds of network as shown in Table 3-2-1.

(1) National network where all the states of Sabah and Sarawak comprise a broadcasting area.
(2) Regional network where each of the states of Sabah and Sarawak comprises a broadcasting area.
(3) Local network where the state of Sabah and the state of Sarawak are divided 5 and 8 districts respectively and each of them comprises a broadcasting area.
(4) Educational network where all the states of Sabah and Sarawak comprise a broadcasting area.

Table 3-2-1 Network Configuration and Broadcasting Areas

National Network	Regional Network	Local Network	Educational Network
All the States of Sabah and Sarawak	1. State of Sabah	a) Residenci Pantai Barat b) Residenci Kudat c) Residenci Sangakan d) Residenci Tawau e) Residenci Pendalaman	All the States of Sabah and Sarawak
	2. Sate of Sarawak	a) 1st Division b) 2nd Division c) 3rd Division d) 4th Division-1 (Miri) 4th Division-2 (Bintulu) e) 5th Division f) 6th Division g) 7th Division	

3-3 Spread of population

At the end of 1980, the population of the State of Sabah was 1,000,000 and that of the State of Sarawak was 1,300,000. Most of them are concentrated at several main cities exisiting along the coastal areas. The inland mountainous areas are sparsely populated.

The spread of population was taken into account in selecting transmitting points and deciding transmission conditions.

Note: This report adopted the map of spread of population (MALAYSIA BARAT 1974) issued by the Statistics Bureau, Government of Malaysia.

3-4 Topography

The regional conditions of hilly areas or inland mountainous areas that have a great influence on radio wave propagation were studied through the profile map prepared from the map on a scale of one to fifty thousand and the results of the field survey executed by the Study Team.

3-5 TV transmitting and microwave relay 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 14 stations out of the existing TV transmitting and one (1) microwave stations that are shown in Table 3-5-1. Survey was carried out at these sites.

Table 3-5-1 Existing TV Transmitting Stations and Unattended Radio Relay Stations

1. State of Sabah

Existing station	Altitude (M) (Height of antenna center)	Longitude	Latitude	TV - AVR indicating value (V, A, Phase)	Engine-Generator
1. KOTA KINABALU (Bt. Lawa Mandau)	910	116°12'36"	6°02'42"	415, 35, 3	150 KVA 415, 210, 3
2. KUDAT (Bt. Kelapa)	138	116°50'14"	6°55'22"	400, 43, 3	156 KVA 415, 217, 3
3. SANDAKAN (Trig Hill)	356	118°02'10"	5°48'50"	400, 30, 3	156 KVA 415, 217, 3
4. TAWAU (Mt. Andrassy)	669	117°58'32"	4°20'00"	400, 44, 3	156 KVA 415, 217, 3
5. LAHAD DATU (Mt. Silam)	944	118°09'34"	4°57'23"	405, —, 3	156 KVA 415, 217, 3
6. TANBUNAN/KENINGAU (Layang-Layang)	2978	116°34'40"	6°03'37"	403, 41.7, 3	178.76 KVA 415, 235, 3
7. SIPITANG (Bt. Tampalagus)	348	115°38'30"	5°08'54"	415, 11, 3	75 KVA 415, 194, 3

2. State of Sarawak

1. KUCHING (G. Serapi)	928	110°08'	1°34'	415, 50, 3	160 KVA 415, 240, 3
2. BANDAR SRI AMAN (Bt. Temudok)	292	110°27'08"	1°12'20"	415, 50, 3	160 KVA 415, 240, 3
3. SIBU (Bt. Lima)	117	111°56'	2°18'	400, 40, 3	160 KVA 415, 222, 3
4. MIRI (Bt. Lambir)	298	114°02'40"	4°13'00"	415, 30, 3	160 KVA 415, 222, 3
5. BINTULU (Bt. Nyabau)	259	113°04'47"	3°13'12"	415, 12, 3	75 KVA 415, 105, 3
6. LIMBANG (Bt. Mas)	297	115°00'27"	4°44'44"	405, 10, 3	75 KVA 415, —, 3
7. KAPIT (Kapit)	154	112°56'45"	2°00'50"	400, 13, 3	75 KVA 415, 104, 3
8. SARIKEI (Kayu Malam)	292	111°25'34"	1°56'28"	—	—

3-6 Selection of transmitting sites

As a result of the study made on transmitting sites under the conditions and standards describ-d in and after 2-1, 13 sites (14 stations) for exisiting TV transmitting stations, 2 sites (3 stations) for exisiting microwave relay stations and new 7 sites (7 stations)*note 22 sites (24 stations) in total, were selected.

The following points were paid attention to determining the transmitting sites, and the required ERP was obtained.

(1) The maximum transmitters output is 5 kW.
(2) Solid state type transmitters are adopted to raduce maintainance.
(3) High-gain antenna is adopted.

The above results are shown in Table 3-6-1 and the attached service area map (Estimated field strength: 54 dB (μv/m)).

In addition to the above-selected 22 sites for transmitting sites, the following stations of 2 sites are used in common for local broadcasting service to other districts.

Consequently, the total number of transmitting stations comes to 24. The local service toward Ranau in Residenci Pantai Barat, State of Sabah, and the local service toward Saratok in Second Division, State of Sarawak, are provided from Layang-Layang (Keningau/Tambunan) and Kayu-Malam (Sarikei), respectively.

Note:* It has been decided that the stations of Pensiangan and Tenom in the State of Sabah, from among these 7 new stations, will be installed in the proposed TV sites in future.

Table 3-6-1 List of Transmitting Stations

1. State of Sabah

	Station (TX Site) / Condition	Position (East longitude, North latitude)	Antenna (M)(height of antenna center	Network	Transmitter output	Antenna (2 dipoles)				ERP
						F x Stage	Direction (clockwise)	Power distribution	Gain (dB)	
1st Stage	1. KOTA KINABALU (Bt. Lawa Mandau)	116°12'36" 6°02'42"	910	N, R, L, E	500 W	4 x 2	35°, 90° 215°, 305°	4:1:4:1	4.7	1.5 kW
	2. KUDAT (Br. Kelapa)	116°50'14" 6°55'22"	138	N, R, L, E	1 kW	3 x 8 1 x 2	10°, 100° 190°, 280°	4:4:4:1	9.1	8.1 kW
	3. SANDAKAN (Trig Hill)	118°02'10" 5°48'50"	356	N, R, L, E	1 kW	3 x 8 1 x 2	30°, 120° 210°, 300°	1:4:4:4	9.1	8.1 kW
	4. TAWAU (Mt. Andrassy)	117°58'32" 4°20'00"	669	N, R, L, E	500 W	3 x 2	100°, 190°, 280°	1:1:4	6.9	2.4 kW
	5. LAHAD DATU (Mt. Silam)	118°09'34" 4°57'23"	944	N, R, L, E	500 W	3 x 2	80°, 170°, 260°	4:1:1	6.9	2.4 kW
	6. TAMBUNAN/KENINGAU (Layang-Layang)	116°34'40" 6°03'37"	2978	N, R, L, E	1 kW	2 x 3	90°, 200°	1:4	9.7	9.3 kW
	7. SIPITANG (Bt. Tampalagus)	115°38'30" 5°08'54"	348	N, R, L, E	500 W	3 x 2	30°, 210°, 300°	4:1:4	5.3	1.7 kW
2nd Stage	1. RANAU (Layang-Layang)	116°34'40" 6°03'37"	2958	L (L: to Ranau)	100 W	2 x 2	80°, 140°	1:1	5.7	370 W
	2. PENSIANGAN (G. Antulai)	116°20'42" 4°40'36"	1662	N, R, L, E	100 W	2 x 2	100°, 190°	4:1	6.6	460 W
	3. TENOM (G. Paling-Paling)	116°01'50" 5°06'26"	945	N, R, L, E	100 W	3 x 2	130°, 210°, 330°	4:4:1	4.1	260 W
	4. NABAWAN (Sikatin)	116°23'19" 5°05'11"	995	N, R, L, E	100 W	3 x 2	0°, 60°, 90°	1:1:1	3.9	250 W

2. State of Sarawak

	Condition / Station (TX Site)	Position (East longitude, North latitude)	Antenna (M)(height of antenna center)	Network	Transmitter output	Antenna (2 dipoles)				ERP
						F x Stage	Direction (clockwise)	Power distribution	Gain (dB)	
1st Stage	1. KUCHING (G. Serapi)	110°08′ 1°34′	928	N, R, L, E	1 kW	4 x 2	15°, 105°, 195°, 285°	1:4:4:4	4.5	2.8 kW
	2. BANDAR SRI AMAN (Bt. Temudok)	111°27′08″ 1°12′20″	292	N, R, L, E	500 W	3 x 2	80°, 260°, 350°	1:1:1	4.3	2.7 kW
	3. SIBU (Bt. Singalang)	112°12′39″ 2°27′11″	265	N, R, L, E	1 kW	4 x 4	30°, 120°, 210°, 300°	1:1:1:1	5.8	3.8 kW
	4. MIRI (Bt. Lambir)	114°02′40″ 4°13′00″	298	N, R, L, E	1 kW	3 x 4	110°, 200°, 350°	4:4:1	7.8	6.0 kW
	5. BINTULU (Bt. Nyabau)	113°04′47″ 3°13′12″	259	N, R, L, E	5 kW	3 x 2	50°, 140°, 230°	1:1:1	5.0	16.0 kW
	6. LIMBANG (Bt. Mas)	115°00′27″ 4°44′44″	297	N, R, L, E	500 W	4 x 2	70°, 160°, 250°, 340°	4:1:1:1	6.0	2.0 kW
	7. SARIKEI (Bt. Kayu Malam)	111°25′34″ 1°56′28″	292	N, R, L, E	1 kW	3 x 4	0°, 100°, 230°	1:1:1	7.0	5.0 kW
	8. KAPIT (Kapit)	112°56′45″ 2°00′50″	154	N, R, L, E	1 kW	4 x 2	0°, 90°, 180°, 270°	1:4:4:1	4.4	2.8 kW
2nd Stage	1. SARATOK (Bt. Kayu Malam)	111°25′34″ 1°56′28″	272	L (L: to Saratok)	500 W	1 x 2	230°	1	10.6	5.7 kW
	2. BAREO (Bareo)	115°25′55″ 3°46′59″	1660	N, R, L, E	100 W	1 x 2	180°	1	8.1	650 W
	3. PELAMAU (To Bareo)	114°51′02″ 3°56′48″	1322	N, R, L, E	100 W	2 x 2	100°, 210°	1:1	5.7	370 W
	4. BELAGA (Belaga)	113°48′45″ 2°44′54″	425	N, R, L, E	100 W	2 x 2	90°, 220°	1:4	6.6	500 W
	5. BATU (To Belaga)	113°42′53″ 2°15′05″	2088	N, R, L, E	100 W	2 x 2	40°, 110°	1:4	7.2	520 W

3-7 Coverage

The coverage after the implementation will become approximately 66% in area and 96% in population. The coverage is shown in Table 3-7.

Table 3-7 Coverage

Plan A	Coverage in area (%)	Coverage in population (%)
1st Stage	58	94
2nd Stage	66	96

SECTION 4. FREQUENCY ASSIGNMENT

SECTION 4. FREQUENCY ASSIGNMENT

A maximum number of frequencies to each transmitting station was studied to satisfy the purposes of this project. As a result, the maximum number is six (6).

However, 7 frequencies will be assigned to Bt. Kayu Malam, and 9 frequencies to Layang-Layang including 2 frequencies for exisiting FM stations that will continue to use the present frequencies for relaying AM broadcasts.

The details of the study will be described in the following Chapter.

4-1 Channel numbers and frequencies

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

Since, the band width for FM broadcast is 200 kHz, the maximum frequency spacing becomes 200 kHz.

There is a method to arrange the frequency spacing of 200 kHz or less by means of frequency off-set, but this is not considered for following reasons:

(1) The interference protection ratio of CCIR Rec. 412-2 is most severe near the frequency difference of 50 kHz.

(2) Even if the frequency spacing is narrower than 200 kHz, it cannot be expected to increase the available number of assignment frequencies to each transmitting station.

(3) Various frequencies will be transmitted from each transmitting station, in this project, causing intermodulation products.

Table 4-1 shows channel numbers and frequencies.

Table 4-1 List of Channel Numbers and Frequencies

ch	f (MHz)	ch	f (MHz)	ch	f (MHz)	ch	f (MHz)	ch	f (MHz)	ch	f (MHz)	ch	f (MHz)
1	87.9	16	90.9	31	93.9	46	96.9	61	99.9	76	102.9	91	105.9
2	88.1	17	91.1	32	94.1	47	97.1	62	100.1	77	103.1	92	106.1
3	88.3	18	91.3	33	94.3	48	97.3	63	100.3	78	103.3	93	106.3
4	88.5	19	91.5	34	94.5	49	97.5	64	100.5	79	103.5	94	106.5
5	88.7	20	91.7	35	94.7	50	97.7	65	100.7	80	103.7	95	106.7
6	88.9	21	91.9	36	94.9	51	97.9	66	100.9	81	103.9	96	106.9
7	89.1	22	92.1	37	95.1	52	98.1	67	101.0	82	104.1	97	107.1
8	89.3	23	92.3	38	95.3	53	98.3	68	101.3	83	104.3	98	107.3
9	89.5	24	92.5	39	95.5	54	98.5	69	101.5	84	104.5	99	107.5
10	89.7	25	92.7	40	95.7	55	98.7	70	101.7	85	104.7	100	107.7
11	89.9	26	92.9	41	95.9	56	98.9	71	101.9	86	104.9	101	107.9
12	90.1	27	93.1	42	96.1	57	99.1	72	102.1	87	105.1		
13	90.3	28	93.3	43	96.3	58	99.3	73	102.3	88	105.3		
14	90.5	29	93.5	44	96.5	59	99.5	74	102.5	89	105.5		
15	90.7	30	93.7	45	96.7	60	99.7	75	102.7	90	105.7		

4-2 Frequency spacing required between transmitters at different sites

On the basis of the transmission conditions of each transmitting station, described preceding chapter, it is possible to estimate the undesired field strength from any other transmitting stations. Consequently, the minimum D/U ratio in each service area can be calculated.

Provided that this satisfies the above required interference protection ratio, the minimum frequency spacing to be assigned to each transmitting station can be decided.

The minimum frequency spacing between each two transmitting stations obtained in this way are shown in Table 4-2.

This table only shows a standard, and the detailed verification for performing accurate frequency assignment is described in 4-6.

4-3 Frequency spacing in the same transmitting station

When a plural number of transmitters are installed in the same transmitting site, desired waves and undesired waves arrive at equal level into the receivers of the service area. Therefore, frequency spacing needs to be determined with special attention to interference disturbance and inter-modulation disturbance that may be caused in the receivers.

(1) Interference disturbance

Under a strong field strength higher than 90 dB, it is experimentally known that no actual harm is done if the frequency space is over 800 kHz. Accordingly, the minimum frequency spacing in the same transmitting site may be 800 kHz.

(2) Intermodulation disturbance

The intermodulation disturbance that is caused by non-linearity of the mixer stage in a receiver is greatly affected by the characteristics of each receiver.

Therefore, it is difficult to quantitatively estimate this disturbance.

However, ordinary portable receivers without full selectivity characteristic at high frequency stage, intermodulation disturbance will occur.

Accordingly, in frequency assignment, frequencies that will not cause intermodulation effects shall be assigned.

Even intermodulation by third harmonics distortion that is effectively considered to be enough has been taken into account.

In FM system, there is no necessity for considering cross modulation disturbance.

4-4 Protection against interference arriving from foreign countries

This Study Team took latent field strength measurements in FM broadcast band throughout the States of Sabah and Sarawak, and confirmed the FM radio waves shown in Table 4-4-1.

The FM broadcasting frequencies of Brunei and shown in Table 4-4-2.

Table 4-2 Minimum Frequency Spaces between Each Two Transmitting Stations

Station \ Station	KOTA KINABALU (Bt. Lawa Mandau)	RANAU (Layang-Layang)	KUDAT (Bt. Kelapa)	SANDAKAN (Trig Hill)	TAWAU (Mt. Andrassy)	LAHAD DATU (Mt. Silom)	TAMBUNAN/KENINGAU (Layang-Layang)	SIPITANG (Bt. Tampulagus)	PENSIANGAN (G. Antulai)	TENOM (G. Paling-Paling)	NABAWAN (Sikatin)	Bt. BATU	BELAGA (Belaga)	KAPIT (Kapit)	SARIKEI (Bt. Kayu Malam)	LIMBANG (Bt. Mas)	Bt. PELAMAU	BAREO (Bareo)	BINTULU (Bt. Nyabau)	MIRI (Bt. Lambir)	SIBU (Bt. Singalang)	SARATOK (Bt. Kayu Malam)	BANDARSRI AMAN (Bt. Temudok)	KUCHING (G. Serapi)
KUCHING (G. Serapi)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	1	2	2	4
BANDARSRI AMAN (Bt. Temudok)	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	1	0	1	2	4	
SARATOK (Bt. Kayu Malam)	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	0	0	0	0	0	2	4		
SIBU (Bt. Singalang)	0	0	0	0	0	0	0	0	0	0	0	4	1	2	2	0	0	0	2	1	4			
MIRI (Bt. Lambir)	0	1	0	1	0	0	1	1	0	0	1	0	1	0	0	1	4	1	3	4				
BINTULU (Bt. Nyabau)	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	1	1	4					
BAREO (Bareo)	1	1	0	1	0	0	1	0	1	1	1	1	1	0	0	1	4	4						
Bt. PELAMAU	0	0	0	0	0	0	1	0	0	1	0	1	0	0	0	2	4							
LIMBANG (Bt. Mas)	2	1	0	0	0	0	2	3	2	2	2	0	1	0	0	4								
SARIKEI (Bt. Kayu Malam)	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4									
KAPIT (Kapit)	0	0	0	0	0	0	0	0	0	0	0	4	2	4										
BELAGA (Belaga)	0	0	0	0	0	0	0	0	0	0	0	4	4											
Bt. BATU	0	0	0	0	0	0	0	0	0	0	0	4												
NABAWAN (Sikatin)	2	2	1	2	2	2	3	1	3	4	4													
TENOM (G. Paling-Paling)	2	2	1	1	1	1	4	1	4	4														
PENSIANGAN (G. Antulai)	1	1	1	2	2	2	2	1	4															
SIPITANG (Bt. Tampulagus)	2	1	0	1	1	1	2	4																
TAMBUNAN/KENINGAU (Layang-Layang)	4	4	3	2	2	2	4																	
LAHAD DATU (Bt. Silom)	1	2	1	2	2	4																		
TAWAU (Mt. Andrassy)	1	2	0	2	4																			
SANDAKAN (Trig Hill)	1	2	1	4																				
KUDAT (Bt. Kelapa)	2	2	4																					
RANAU (Layang-Layang)	2	4																						
KOTA KINABALU (Bt. Lawa Mandau)	4																							

Frequency Spacing
(4 ; 800 MHz
3 ; 600
2 ; 400
1 ; 200
0 ; 0)

Table 4-4-1 List of FM Radio Waves Arriving from Foreign Countries

Frequency (MHz)	Name of Country	Remarks
92.3	Brunei	FM broadcasting
93.8	Brunei	FM broadcasting
95.9	Brunei	FM broadcasting
96.9	Brunei	FM broadcasting
90.5	Brunei	FM broadcasting, Spurious, Buang Soil, KPG Bakol
91.8	Brunei	FM broadcasting, Spurious, Buang Soil, KPG Bakol
93.9	Brunei	FM broadcasting, Spurious, KPG Bakol
95.2	Brunei	FM broadcasting, Spurious, Buang Soil
95.5	Brunei	FM broadcasting, Spurious, Niah, Buang Soil, KPG Bakol
87.8	Malaysia	Sibintek, Talk
88.0	Malaysia	Sarikei
88.5	Malaysia	State of Sabah, Carrier
89.5	Malaysia	Miri, Kuala Balam, Music
90.8	Malaysia	Murdi, Lawas, Music
91.5	Malaysia	Lawa Mandau/Kudat
92.9	Malaysia	Lawa Mandau/Kudat
93.5	Malaysia	Layang – Layang
94.0	Malaysia	Buang Soil, Cinese
94.4	Malaysia	Buang Soil, Music
94.7	Malaysia	K.K/Tuaran
97.5	Malaysia	Layang – Layang
100.2	Malaysia	K.K/Layang – Layang
103.7	Malaysia	K.K/Layang – Layang
107.5	Malaysia	Keningau, Carrier

Table 4-4-2 FM Broadcasting Frequencies of Brunei

Frequency (MHz)	Name of Country	Remarks
92.3	Brunei	Current FM broadcasting frequency
93.8	Brunei	Current FM broadcasting frequency
94.4	Brunei	Registered FM broadcasting frequency
94.9	Brunei	Registered FM broadcasting frequency
95.9	Brunei	Current FM broadcasting frequency
96.9	Brunei	Current FM broadcasting frequency

Interference protection ratio described in 2-7 has been satisfied for the 6 current and registered FM broadcasting frequencies of Brunei and the 2 FM broadcasting frequencies of Layang-Layang.

Accordingly, frequencies other than these 8 FM broadcasting frequencies need to be shifted to the other frequency band (e.g., 2 GHz) for STL.

The data obtained from the latent field strength measurements in FM broadcast band is shown in the reference data Annex D.

4-5 Study on disturbance to the existing TV Off-Air relay

In installing a FM transmitting station in the existing TV transmitting station, it is necessary to consider disturbance to the existing TV Off-Air relay.

Cross modulation disturbance, intermodulation disturbance and image frequency interference can be eliminated by the band pass filter of the Receiver for TV Off-Air relay, so that only harmonic spurious has been taken into account as disturbing wave.

4-6 Frequency assignment to each transmitting station

In principle, the frequency assignment to each transmitting station was studied to satisfy the conditions described in and after 4-2 as well as to assign as many frequencies as possible.

Its results are shown in Table 4-6, and the available network consists of a maximum of 6 channels.

Table 4-6 Frequency Assignment Table in Plan A

	f(N-1)		f(N-2)		f(N-3)		f(E)		f(R)		f(L)	
	MHz	CH	MHz	CH	MHz	CH	MHz	CH	MHz	CH	MHz	CH
1 KOTA KINABALU (Bt. Lawa Mandau)	88.1	2	88.9	6	89.9	11	90.7	15	91.9	21	92.7	25
2 RANAU (Layang-Layang)	–		–		–		–		–		98.5	54
3 KADAT (Bt. Kelapa)	94.1	32	94.9	36	95.9	41	96.7	45	98.1	52	98.9	56
4 SANDAKAN (Trig Hill)	91.1	17	92.1	22	92.9	26	94.3	33	95.1	37	96.1	42
5 TAWAU (Mt. Andrassy)	93.9	31	94.7	35	95.7	40	97.1	47	98.9	56	98.1	52
6 LAHAD DATU (Mt. Silam)	87.9	1	88.7	5	89.7	10	90.5	14	91.7	20	92.5	24
7 TAMBUHAN/KENINGAU (Layang-Layang)	99.5	59	100.3	63	104.5	84	105.3	88	106.3	93	107.1	97
8 SIPITANG (Bt. Tampalagus)	95.5	39	96.5	44	97.9	51	99.1	57	99.9	61	102.9	76
9 PENSIANGAN (G. Antulai)	102.7	75	103.5	79	104.9	85	105.7	90	106.7	95	107.5	99
10 TENOM (G. Paling-Paling)	88.5	4	89.3	8	90.3	13	91.1	17	92.3	23	92.1	27
11 NABAWAN (Sikatin)	98.7	55	101.1	67	103.9	81	97.7	50	103.1	77	101.9	71
12 KUCHING (G. Serapi)	92.7	25	88.1	2	88.9	6	89.9	11	90.7	15	91.9	21
13 BANDAR SRI AMAN (Bt. Temudok)	107.1	97	99.5	59	100.3	63	104.5	84	105.3	88	106.3	93
14 SARATOK (Bt. Kayu Malam)	–		–		–		–		–		89.5	9
15 SIBU (Bt. Singalang)	93.3	28	94.1	32	95.1	37	95.9	41	97.1	47	101.1	67
16 MIRI (Bt. Lambir)	91.9	21	92.7	25	88.1	2	88.9	6	89.9	11	90.7	15
17 BINTULU (Bt. Nyabau)	94.7	35	96.7	45	97.5	49	98.5	54	99.3	58	100.5	64
18 BAREO (Bareo)	92.5	24	87.9	1	88.7	5	89.7	10	90.5	14	91.7	20
19 PELAMAU	100.7	65	106.5	94	105.5	89	99.7	60	107.3	98	104.7	85
20 LIMBANG (Bt. Mas)	97.1	47	98.5	54	101.5	69	102.3	73	103.3	78	104.1	82
21 SARIKEI (Bt. Kayu Malam)	91.5	19	92.3	23	93.7	30	94.5	34	95.5	39	96.3	43
22 KAPIT (Kapit)	90.7	15	91.9	21	92.7	25	88.1	2	88.9	6	89.9	11
23 BELAGA (Belaga)	93.1	27	88.5	4	89.3	8	90.3	13	91.1	17	92.3	23
24 BATU	98.3	53	101.3	68	103.1	77	103.9	81	102.1	72	100.1	62

In this case, in the frequency assignment to BAREO, BELAGA and NABAWAN it was assumed that the 1st and 2nd TV channels were 7, 10 ch, 10, 7 ch and 5, 3 ch, respectively.

The list of available frequencies other than those shown in Table 4-6 is found in the attached reference data Annex E.

4-7 Disturbance given to the existing radio stations other than broadcasting service.

In the existing TV transmitting site, radio stations for general purposes are also in operation. A study was made on the disturbance given to these radio facilities by the FM Off-air relay of this project. In general, as the possibility and extent of disturbance depends greatly upon the characteristics of the radio station and upon relation between each location, it is difficult to make and accurate estimate of them.

However, with regard to harmonic spurious disturbance and intermodulation disturbance, it is possible to presume a possibility of occurrence.

As a result of the study on them on the basis of the list of frequencies of the existing radio stations (refer to the attached reference data Annex F) obtained by the Study Team, it seems that any harmonic spurious disturbance to these existing radio stations will not occur in each transmitting station.

The list of disturbing waves in transmitting stations that have a possibility of giving intermodulation disturbance is shown in Table 4-7-1.

Table 4-7-2 shows the list of intermodulated frequencies that are coincident with the frequencies of the existing radio stations listed in Table 4-7-1, and their details.

Even if disturbance has occurred in practice, it is possible to take a measure to meet the situation by means of filters, as the frequency spacing between the VHF receiving frequency and the FM broadcast frequency is 7 MHz or more.

Table 4-7-1. Disturbance to the Existing Radio Stations

Station	Receiving Frequency	Interfering Waves (MHz)
KOTA KINABALU (Bt. Lawa Mandau)	153.25 MHz	153.1, 153.175, 153.3, 153.475, 153.5
KUDAT (Bt. Kelapa)	70.075	69.8, 70.3
SANDAKAN (Trig Hill)	75.55	74.95, 74.975, 75.075, 75.125, 75.15, 75.175, 75.225, 75.275, 75.325, 75.375, 75.4, 75.475, 75.5, 75.6, 75.625, 75.65, 75.675, 75.7, 75.725, 75.775, 75.825, 75.875, 75.9, 75.925, 75.95, 75.975, 76, 76.025, 76.05, 76.075, 76.125, 76.15
	75.775	75.175, 75.225, 75.275, 75.325, 75.375, 75.4, 75.475, 75.5, 75.6, 75.625, 75.65, 75.675, 75.7, 75.725, 75.775*, 75.825, 75.875, 75.9, 75.925, 75.95, 75.975, 76, 76.025, 76.05, 76.075, 76.125, 76.15, 76.175, 76.225, 76.3
TAWAU (Mt. Androssy)	75.6	75.125, 75.725, 76, 76.1
	75.825	75.725, 76, 76.1, 76.225, 76.325, 76.4
	154.775	154.275, 154.95, 155.3, 155.35
	157.3	156.9, 156.95, 157.1, 157.15, 157.35, 157.7, 157.75
	157.35	156.9, 156.95, 157.1, 157.15, 157.35*, 157.7, 157.75
LAHAD DATU (Mt. Silam)	75.525	74.925, 75, 75.1, 75.2, 75.3, 75.35, 75.425, 75.5, 75.505, 75.555, 75.575, 75.8, 75.9, 76, 76.1
	75.75	75.2, 75.3, 75.35, 75.425, 75.5, 75.505, 75.555, 75.575, 75.8, 75.9, 76, 76.1, 76.225, 76.3, 76.35
	155.35	154.75, 154.8, 154.88, 154.9, 154.95, 154.955, 155.225, 155.325, 155.425, 155.55, 155.6, 155.675, 155.725, 155.755, 155.9, 155.95
	155.5	154.9, 154.95, 154.955, 155.225, 155.325, 155.425, 155.55, 155.6, 155.675, 155.725, 155.755, 155.9, 155.95, 156.025, 156.1
	157.25	156.7, 156.75, 156.825, 156.9, 157.225, 157.25*, 157.3, 157.4, 157.7
	157.3	156.7, 156.75, 156.825, 156.9, 157.225, 157.25, 157.3*, 157.4, 157.7, 157.9
SIPITANG (Bt. Tampalagus)	75.6	75.025, 75.2, 75.425, 76.2
	75.825	75.425, 76.2, 76.425
	76.225,	76.2, 76.425

Station	Receiving Frequency	Interfering Waves (MHz)
KUCHING (G. Serapi)	72.15 MHz	71.6, 71.65, 71.95, 72, 72.05, 72.125, 71.375, 72.45, 72.55, 72.6, 72.75
	72.2	71.6, 71.65, 71.95, 72, 72.05, 72.125, 71.375, 72.45, 72.55, 72.6, 72.75, 72.8
	155.025	154.6, 154.7, 154.75, 154.8, 154.825, 154.9, 154.95, 155, 155.1, 155.15, 155.2, 155.25, 155.35, 155.4, 155.625
	155.35	154.75, 154.8, 154.825, 154.9, 154.95, 155, 155.1, 155.15, 155.2, 155.25, 155.35*, 155.4, 155.625, 155.7, 155.75, 155.8, 155.9, 155.95
	166	165.45, 165.5, 165.625, 165.7*, 165.75, 165.8, 165.9, 165.95, 166, 166.1, 166.15, 166.25, 166.3, 166.425
	162.3	161.75, 161.8, 162.025, 162.2, 162.225, 162.3*, 162.35, 162.4, 162.5, 162.55, 162.825
	162.35	161.75, 161.8, 162.025, 162.2, 162.225, 162.3, 162.35*, 162.4, 162.5, 162.55, 162.825
	162.4	161.8, 162.025, 162.2, 162.225, 162.3, 162.35, 162.4*, 162.5, 162.55, 162.825
	162.5	162.025, 162.2, 162.225, 162.3, 162.35, 162.4, 162.5*, 162.55, 162.825, 163.025, 163.1
BANDAR SRI AMAN (Bt. Temudok)	154.1	154, 154.3, 154.7
	157	156.6, 156.9, 157*, 157.4
	158.5	158.2, 158.6, 158.9, 159
MIRI (Bt. Lambir)	71.55	71.95, 72, 72.05
	71.6	71.95, 72, 72.05
	71.65	71.95, 72, 72.05, 72.225
	71.825	71.95, 72, 72.05, 72.225
	72.2	71.95, 72, 72.05, 72.225, 72.75, 72.8
	72.3	71.95, 72, 72.05, 72.225, 72.75, 72.8, 72.85, 72.9
	141.7	141.1, 141.15, 141.2, 141.25, 141.325, 141.35, 141.4, 141.425, 141.45, 141.625, 141.85, 141.9, 141.95, 142, 142.05, 142.1, 142.125, 142.15, 142.2, 142.225, 142.25, 142.3
	142.3	141.85, 141.9, 141.95, 142, 142.05, 142.1 142.125, 142.15, 142.2, 142.225, 142.25, 142.3*, 142.425, 142.7, 142.8, 142.85, 142.9

Station	Receiving Frequency	Interfering Waves (MHz)
MIRI (Bt. Lambir)	142.9 MHz	142.3, 142.425, 142.7, 142.8, 142.85, 142.9*, 142.95, 143, 143.05, 143.1, 143.125, 143.15, 143.2, 143.225, 143.25, 143.4, 143.425
	162	161.875, 162.05, 162.1, 162.15, 162.4, 162.5
BINTULU (Bt. Nyabau)	72.25	71.65, 71.7, 71.85, 71.9, 72.25*, 72.3, 72.85
	72.3	71.7, 71.85, 71.9, 72.25, 72.3*, 72.85, 72.9
	82	81.4, 81.6, 81.7, 81.8, 81.85, 81.9, 82*, 82.05, 82.1, 82.2, 82.3, 82.4, 82.6
	82.2	81.6, 81.7. 81.8, 81.85, 81.9, 82, 82.05, 82.1, 82.2*, 82.3, 82.4, 82.6, 82.65, 82,7, 82.8
	82.5	81.9, 82, 82.05, 82.1, 82.2, 82.3, 82.4, 82.6, 82.65, 82.7, 82.8, 82.9, 83.05, 83.1
	82.8	82.2, 82.3, 82.4 82.6, 82.65, 82.7, 82.8*, 82.9, 83.06, 83.1, 83.2, 83.25, 83.3, 83.4
	155.075	154.475, 154.5, 154.6, 154.65, 154.675, 154.7, 154.75, 154.8, 155.95, 155, 155.05*, 155.075*, 155.1, 155.15, 155.2, 155.3, 155.35, 155.4, 155.45, 155.55, 155.6, 155.675
	155.35	154.75, 154.8, 154.95, 155, 155.05, 155.075, 155.1, 155.15, 155.2, 155.3, 155.35*, 155.4 155.45, 155.55, 155.6, 155.675, 155.7, 155.8, 155.875, 155.9, 155.95
	156.9	156.3, 156.35, 156.4, 156.475, 156.5, 156.6, 156.65, 156.75, 156.9, 156.95, 157, 157.1, 157.15, 157.2, 157.25, 157.275, 157.3, 157.35, 157.4, 157.45, 157.475
	157	156.4, 156.475, 156.5, 156.6, 156.65, 156.75, 156.9, 156.95, 157*, 157.1, 157.15, 157.2, 157.25, 157.275, 157.3, 157.35, 157.4, 157.45, 157.475, 157.55, 157.6
	157.1	156.5, 156.6, 156.65, 156.75, 156.9, 156.95, 157, 157.1*, 157.15, 157.2, 157.25, 157.275, 157.3, 157.35, 157.4, 157.45, 157.475, 157.55, 157.6, 157.675, 157.7
	157.25	156.65, 156.75, 156.9, 156.95, 157, 157.1, 157.15, 157.2, 157.25, 157.275, 157.3, 157.35*, 157.4, 157.45, 157.48, 157.55, 157.6, 157.675, 157.7, 157.75, 157.8
	157.35	156.75, 156.9, 156.95, 157, 157.1, 157.15, 157.2, 157.25, 157.275, 157.3, 157.35*, 157.4, 157.45, 157.475, 157.55, 157.6, 157.675, 157.7, 157.75, 157.8, 157.9, 157.95

Station	Receiving Frequency	Interfering Waves (MHz)
BINTULU (Bt. Nyabau)	162.4 MHz	161.8, 161.9, 162.075, 162.1, 162.2, 162.275, 162.3, 162.35, 162.4*, 162.5, 162.55, 162.6, 162.65, 162.7, 162.75, 162.8, 162.85, 162.875, 162.9, 162.95,
	162.5	161.9, 162.075, 162.1, 162.2, 162.275, 162.3, 162.35, 162.4, 162.5*, 162.55, 162.6, 162.65, 162.7, 162.75, 162.8, 162.85, 162.875, 162.9, 162.95, 163.05, 163.075
	165.9	165.3, 165.35, 165.4, 165.45, 165.475, 165.5, 165.65, 165.7, 165.75, 165.8, 165.875, 165.9*, 166.075, 166, 166.1, 166.15, 166.2, 166.25, 166.3, 166.35, 166.45, 166.5
LIMBANG (Bt. Mas)	86.9	86.3, 86.35, 86.65, 86.7, 86.9*, 86.95, 87.05, 87.1, 87.35, 87.45, 87.5
	87.5	86.9, 86.95, 87.05, 87.1, 87.35, 87.45, 87.5*, 87.75, 87.85
	87.55	86.95, 87.05, 87.1, 87.35, 87.45, 87.5, 87.75, 87.85
	126.1	125.5, 125.65, 125.7, 125.95, 126.1*, 126.3, 126.5
	152.3	152
	155.025	154.6, 154.625, 154.85, 154.95, 155, 155.025*, 155.35, 155.4, 155.425
	155.35	154.85, 154.95, 155, 155.025, 155.35*, 155.4, 155.425, 155.65, 155.75, 155.8, 155.825
	156.8	156.25, 156.4, 156.425, 156.65, 156.75, 156.8*, 157.05, 157.2, 157.225
	157	156.4, 156.425, 156.65, 156.75, 156.8, 157.05, 157.2, 157.225, 157.45, 157.55, 157.6, 157.625
	157.25	156.65, 156.75, 156.7, 157.05, 157.2, 157.225, 157.45, 157.55, 157.6, 157.625, 157.8
SARIKEI/SARATOK (Bt. Kayu Malan)	156.8	156.6, 156.8*, 156.85, 156.95, 157.05, 157.15, 157.4
	157	156.6, 156.8, 156.85, 156.95, 157.05, 157.15, 157.4, 157.6
	157.25	156.8, 156.85, 156.95, 157.05, 157.15, 157.4, 157.6, 157.65, 157.75, 157.8, 157.85
	157.35	156.8, 156.85, 156.95, 157.05, 157.15, 157.4 157.6, 157.65, 157.75, 157.8, 157.85, 157.95
KAPIT (Kapit)	82.75	82.6, 82.65, 82.725, 82.85, 82.9, 83
	155.025	154.425, 154.55, 154.775, 154.9, 155.225, 155.35
	155.15	154.55, 154.775, 154.9, 155.225, 155.35, 155.675, 155.625, 155.7, 155.75
	155.9	155.35, 155.575, 156.625, 155.7, 155.75, 156.425

Note: *Marks indicate the very frequency which might cause intermodulation between the frequencies mentioned in table 4-7-2. Also it may happen, it is easy to reduce the intermodulation using frequency notch filter at the input of the receiver.

Table 4-7-2 List of Intermodulated Frequencies

Station	Receiving Frequency	Intermodulated Frequencies
SANDAKAN	75.775	91.1 + 148.925 – 164.25
TAWAU	157.35	93.9 – 97.1 + 160.55
LAHAD DATU	157.25	87.9 – 92.5 + 161.85
	157.3	87.9 – 92.5 + 161.9
KUCHING	155.35	88.1 – 90.7 + 157.95
	162.3	92.7 – 88.1 + 157.7
	162.35	92.7 – 88.1 + 157.75
	162.4	92.7 – 88.1 + 157.8
	162.5	89.9 – 77.4 + 150
	166	–89.9 + 98.1 + 157.8
BANDAR SRI AMAN	157	–99.5 + 94.9 + 161.6
MIRI	142.3	–90.7 + 77.5 + 155.5
	142.9	–88.9 + 76.6 + 155.2
BINTULU	72.25	100.5 – 105.7 + 77.45
	72.3	100.5 – 105.7 + 77.5
	82	94.7 – 100.5 + 87.8
	82.2	99.3 – 104.9 + 87.8
	82.8	100.5 – 104.9 + 87.2
	155.075	100.5 – 105.7 + 160.275
	155.35	96.7 – 99.3 + 157.95
	157	94.7 – 99.3 + 161.6
	157.1	94.7 – 99.3 + 161.7
	157.25	94.7 – 99.3 + 161.85
	157.35	94.7 – 99.3 + 161.95
	162.4	–94.7 + 99.3 + 157.8
	162.5	–96.7 + 97.5 + 161.7
	165.9	98.5 – 87 + 154.4
LIMBANG	86.9	2 x 104.1 – 121.3
	87.5	–98.5 + 104.1 + 81.9
	126.1	–98.5 + 103.3 + 121.3
	155.025	97.1 – 102.3 + 160.225
	155.35	97.1 – 102.3 + 160.55
	156.8	97.1 – 104.1 + 163.8
SARIKEI/SARATOK	156.8	91.5 – 96.3 + 161.6

SECTION 5 TRANSMITTING FACILITIES

SECTION 5 TRANSMITTING FACILITIES

5-1 Transmitter

A solid state transmitters are recommended for the FM transmitter in this project that can provide high stability, high reliability, compactness and low power consumption. The multi-wave transmitter system has adopted a configuration that can make the most of the wide band characteristic of the solid state transmitters.

5-1-1 Redundant system in multiwave transmitters

In designing a maximum 6-wave transmitter system based on the plan of station establishment, the redundant system is an important factor in respect of reliability, maintainability and economical efficiency. As the redundant system, N + 1 system is recomended by following reason.

(1) N + 1 system has 1 common standby unit for the transmitters for 6 wave.

(2) As a matter of fact, the latest solid state FM transmitters have such high reliability that the probability of simultaneous failures of two transmitters is very low and its system reliability offers no problim with regard to operation and maintenance. However, the switch-over control system will be rather complicated but not handled by the operator and be operated automatically.

(3) As for economical efficiency, only one set of redundant transmitter is enough in the six (6) transmitters system, therefore, the transmitter building may be minimized.

5-1-2 Outline of composition of transmitter system

The transmitter system in each transmitting station is composed as shown Table 5-1-1 and Figs. 5-1-2 to 5-1-23, according to the site planning in Section 3 and Programme Transmission Plan in Section 8.

The composition of transmitter system in each transmitting station is roughly classified into 4 basic patterns by programme transmission system, as shown in Fig. 5-1-1.

(1) A type-modulation transmitter
This is a modulation type transmitter that uses an audio signal of Telecom line as input. (Refer to Fig. 5-1-3, Composition of Transmitter System "Schematic Diagram of KUDAT Station")

(2) B type-transposer, Input Signal through STL
This equipment is a heterodyne type and uses together with an STL receiver for programme signal receiving from the RTM studio. The output signal of the STL receiver is processed as high frequency signal exist. (Refer to Fig. 5-1-2, Composition of Transmitting System in KOTAKINABALU transmitting station).

(3) C type-modulation transmitter, Input Signal through STL
This is a Modulation type transmitter and uses together with an STL receiver for programme signal receiving from the RTM studio. The output signal of the STL receiver is once demodulated. The programme signal from Telecom line and STL are used in changeably, for the transmitter's input. (Refer to Fig. 5-1-5, Composition of Transmitting System in

TAWAU transmitting station).

(4) D type-transposer, Input Signal by Off-Air relay transmitter

This equipment is a heterodyne type and the output signal of Off-Air receiver is processed as high frequency exist. (Refer to Fig. 5-1-9, Composition of Transmitting System in PENSIANGAN transmitting station).

Above mentioned four (4) types of transmitting system are applied to this project.

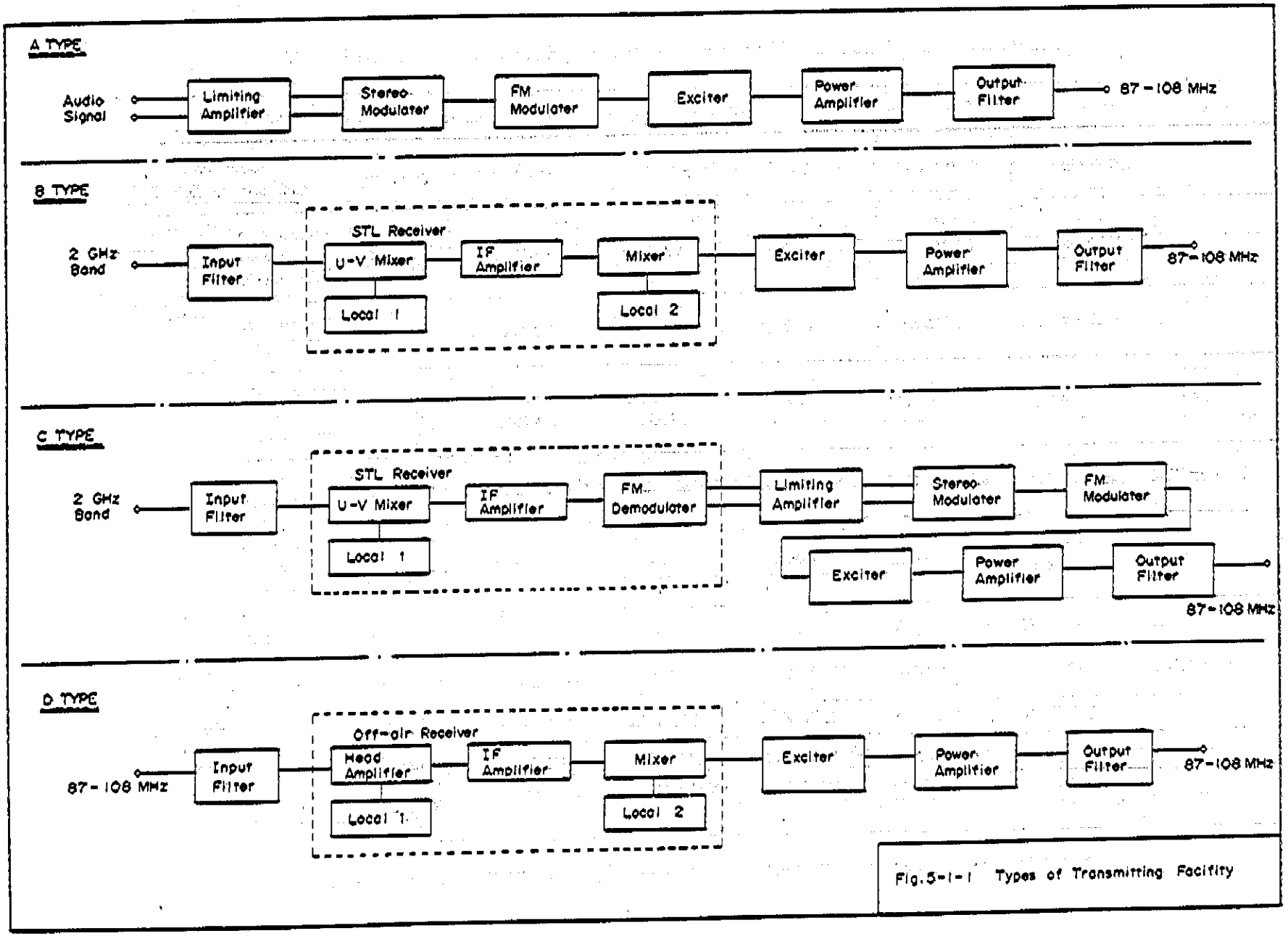


Fig.5-1-1 Types of Transmitting Facility

Table 5-1-1 (1) Transmitting Equipment Configuration List for Each Transmitting Station

Equipment composition \ Transmitting station		KOTA KINABALU (Bt. Lawa Mandau)	KUDAT (Bt. Kelapa)	SANDAKAN (Trig Hill)	TAWAU (Mt. Andrassy)	LAHAD DATU (Mt. Silam)	TAMBUNAN/ KENINGAU	RANAU
							(Layang – Layang)	
Network		N, R, L, E	N, R, L, E	N, R, L, E	N, R, L, E	N, R; L, E	N, R, L, E	L
Trans-mitter	Composition	500W x 6 (6)	1 kW x 6 (1)	1 kW x 6 (1)	500W x 6 (1)	500W x 6 (1)	1 kW x 6 (1)	100W x 1 (1)
	Type	B	A	A	A + C	A	D (L : A)	D
Antenna	Receiving antenna composition	1.8mφp x 2	(line)	(line)	1.8mφ x 1)	(line)	5Y x 2 (L: line)	5Y x 2
	Transmission feeder	39D, 80m x 2	39D, 120m x 2	39D, 120m x 2	39D, 80m x 2	39D, 80m x 2	39D, 40m x 2	20D, 40m x 2
	Transmitting antenna composition	2.2D x 4	8.2D x 3 2.2D x 1	8.2D x 3 2.2D x 1	2.2D x 3	2.2D x 3	3.2D x 2	2.2D x 2
Power supply	AVR composition	30 KVA	35 KVA	35 KVA	30 KVA	30 KVA	40 KVA	
	Non-utility generator composition	35 KVA	45 KVA	45 KVA	35 KVA x 2	35 KVA x 2	50 KVA x 2	
System configuration diagram		Fig. 5-1-2	Fig. 5-1-3	Fig. 5-1-4	Fig. 5-1-5	Fig. 5-1-6	Fig. 5-1-7	

Table 5-1-1 (2) Transmitting Equipment Configuration List for Each Transmitting Station

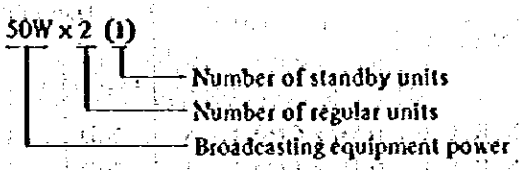
Equipment composition \ Transmitting station		SIPITANG (Bt. Tempalagus)	PENSIANGAN (G. Antulai)	TENOM (G. Paling-Paling)	NABAWAN (Sikatin)	KUCHING (G. Serapi)	BANDAR SRI AMAN (Bt. Temudok)	SIBU (Bt. Singalang)	MIRI (Bt. Lambir)
Network		N, R, L, E	N, R, L, E	N, R, L, E	N, R, L, E	N, R, L, E	N, R, L, E	N, R, L, E	N, R, L, E
Transmitter	Composition	500W x 6 (1)	100W x 6 (1)	100W x 6 (1)	100W x 6 (1)	1 kW x 6 (1)	1 kW x 6 (1)	1 kW x 6 (1)	1 kW x 6 (1)
	Type	A	D	D	D	B	A	A	A + C
Antenna	Receiving antenna composition	(line)	5Y x 2	5Y x 2	5Y x 2	1.8ϕm x 2	(line)	(line)	1.8ϕm x 1
	Transmission feeder	39D, 60mx2	20D, 80mx2	20D, 80mx2	20D, 80mx2	39D, 30mx2	39D, 100mx2	39D, 120mx2	39D, 120mx2
	Transmitting antenna composition	2.2D x 3	2.2D x 3	2.2D x 2	2.2D x 3	2.2D x 4	2.2D x 3	4.2D x 4	4.2D x 3
Power supply	AVR composition	30 KVA	10 KVA	10 KVA	10 KVA	35 KVA	30 KVA	35 KVA	35 KVA
	Non-utility generator composition	35 KVA x 2	20 KVA x 2	20 KVA x 2	20 KVA x 2	45 KVA	45 KVA	45 KVA	45 KVA
System configuration diagram		Fig. 5-1-8	Fig. 5-1-9	Fig. 5-1-10	Fig. 5-1-11	Fig. 5-1-12	Fig. 5-1-13	Fig. 5-1-14	Fig. 5-1-15

Table 5-1-1 (3) Transmitting Equipment Configuration List for Each Transmitting Station

Equipment composition \ Transmitting station		BINTULU (Bt. Nyabau)	BAREO (Bareo)	PELAMAU	LIMBANG (Bt. Mas)	SARIKEI (Bt. Kayu Malam)	SARATOK (Bt. Kayu Malam)	KAPIT (Kapit)	BELAGA (Belaga)	BATU
Network		N, R, L, E	N, R, L, E	N, R, L, E	N, R, L, E	N, R, L, E	L	N, R, L, E	N, R, L, E	N, R, L, E
Trans-mitter	Composition	5 kW x 6 (1)	100W x 6(1)	100W x 6(1)	500W x 6(1)	1 kW x 6 (1)	500W x 1(1)	1 kW x 6 (1)	100W x 6(1)	100W x 6(1)
	Type	A + C	D	D	A	A + C	A	A	D	D
Antenna	Receiving antenna composition	1.8ϕm x 1	5Y x 2	5Y x 2	(line)	1.8mϕ x 1	(line)	(line)	5Y x 2	5Y x 2
	Transmission feeder	77D, 115m x 2	20D, 80m x 2	20D, 80m x 2	39D, 135m x 2	39D, 120m x 2	20D, 100m x 2	39D, 125m x 2	20D, 80m x 2	20D, 80m x 2
	Transmitting antenna composition	2.2D x 3	2.2D x 1	2.2D x 2	2.2D x 4	4.2D x 3	2.2D x 1	2.2D x 4	2.2D x 2	2.2D x 2
Power supply	AVR composition	150 KVA	10 KVA	10KVA	30 KVA	40 KVA		35 KVA	10 KVA	10 KVA
	Engine generator composition	150 KVA	20 KVA x 2	20 KVA x 2	35 KVA	50 KVA		45 KVA	20 KVA x 2	20 KVA x 2
System configuration diagram		Fig. 5-1-16	Fig. 5-1-17	Fig. 5-1-18	Fig. 5-1-19	Fig. 5-1-20		Fig. 5-1-21	Fig. 5-1-22	Fig. 5-1-23

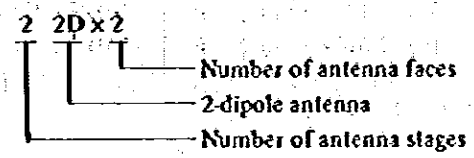
Notes: (1) N – National R – Regional L – Local E – Educational

(2) The indication for broadcasting system is as follows.



(3) For types of transmitter, refer to Fig. 5-1-1.

(4) The indication for transmitting antenna composition is as follows



5-2 STL facilities

The STL facilities to be equiped in the RTM studio are composed as shown in Table 5-2-1, according to the programme transmission Plan in SECTION 8.

5-2-1 Composition of STL transmitter

The adopted STL transmitters are of full solid state type that can provide compact, high performance and high reliability. The STL transmitter system is shown in Fig. 5-2-1, and it uses a programme signal from the studio as an input signal and incorporates a stereophonic modulator.

As a redundant system, the full standby system for STL Transmitter is recommended. (refer to Fig. 5-2-1). The reason why the N + 1 system is not employed is that the direct modulation is technically difficult for such Urtra high frequency of 2 GHz.

That is, in case the N + 1 system is adopted, the multichannelizing of the standby UHF transmitter will need a BPF switchover mechanism for the Local Oscillator and multiplying stage, consequently, the control system will be complicated. In addition, because various kinds of switchover are performed in UHF band, it is not advisable with regard to stability and reliability.

5-2-2 STL transmitting antenna

As a transmitting antenna, a parabolic antenna of 1.8 m diameters is used according to the result of the transmission plan in 8-2 in SECTION 8.

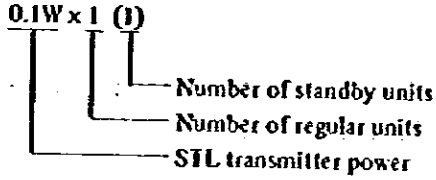
In principle, the multiplex feeding circuit is a composite of three waves for the reasons of leakage between channels insertion loss. Therefore, in 6-waves transmission, it is composed of 2 transmitting antennas as shown in Fig. 5-2-2.

Table 5-2-1 STL Transmitting Equipment Configuration Table

STL Transmitting facilities / Studio (→ Transmitting station)		Network	Transmitter		Transmitting antenna composition	
			Composition	Type	Feeder	Antenna composition
KOTA KINABALU	(→ Bt. Lawa Mondau)	N, R, L, E	0.5W x 6 (6)	A	20D	1.8 mφ x 2
TAWAU	(→ Mt. Andrassy)	N, R, L, E	0.1W x 1 (1)	B	20D	1.8 mφ x 1
KUCHING	(→ G. Serapi)	N, R, L, E	0.5W x 6 (6)	A	20D	1.8 mφ x 2
MIRI	(→ Bt. Lambir)	N, R, L, E	0.5W x 1 (1)	B	20D	1.8 mφ x 1
BINTULU	(→ Bt. Nyabau)	N, R, L, E	0.1W x 1 (1)	B	20D	1.8 mφ x 1
SARIKEI	(→ Bt. Kayu Malam)	N, R, L, E	0.5W x 1 (1)	B	20D	1.8 mφ x 1

Notes: (1) N – National R – Regional L – Local E – Educational

(2) The indication for transmitting equipment configuration is as follows



5-3 FM transmitting antenna system

5-3-1 Multiplex feeding system

The following methods can be considered as antenna feeding methods for six (6) FM waves.

(1) To arrange the antenna of each FM wave on the same tower.

(2) To feed 6 FM waves to the existing TV antenna or the new FM antenna in multiples.

The first method is used when it is difficult to use a wide band antenna in common with various FM waves, and is not advisable from both the technical and economical view points.

Regarding the multiplex feeding system in (2), the common use of the existing TV antenna is technically difficult in light of the band available for the dipole antenna since the TV bands are 44 – 68 MHz and 170 – 216 MHz.

In conclusion, the method of feeding 6 FM waves to an FM antenna (2 dipoles) is proposed for this project.

The multiplex feeding circuit can consist of a combination of duplex feeding circuits such as

(1) 3 dB directional coupler,

(2) circulator composite,

(3) bridge diplexer,

(4) CIN type diplexer,

but in deciding a system, it is necessary to consider the number of FM wave channels, feeding power, channel separation, FM stereophonic characteristic, etc.

With regard to these conditions, the following was fully studied:

(1) Spurious radiation due to cross modulation which occurs by the leakage between the transmitters.
(2) Distortion factor of stereophonic characteristic due to the narraw band characteristics of tuning element, and deterioration of left-right separation in stereophonic characteristics, as channel separation is 800 kHz to 1 MHz.
(3) Insertion loss.
(4) The difference of the antenna power between channels.

As a result, for transmitters of 5 kW, 1 kW and 500 W, the CIN diplexer type multiplex feeding circuit shown in Fig. 5-3-1 is adopted, and for a transmitter of 100 W, the multiplex feeding circuit consisting of a combination of CIN diplexer and circulator shown in Fig. 5-3-2 is adopted. Table 5-3-1 is showns the performance specifications of these multiplex feeding circuits.

Table 5-3-1 Performance Specifications of 6-channel Combiners

Item \ Type	5 kW – use	1 kW, 500 W – use	100 W – use
Frequency Range	87 to 108 MHz	87 to 108 MHz	87 to 108 MHz
Rated Power (Output)	50 kW	10 kW	1 kW
Input VSWR	Less than 1.1	Less than 1.1	Less than 1.1
Insertion Loss	Less than 1 dB	Less than 1.5 dB	Less than 2.0 dB
Decoupling between Transmittions	Less than 50 dB	Less than 50 dB	Less than 50 dB
Carrier Separation	More than 800 KHz	More than 800 KHz	More than 800 KHz

5-3-2 Antenna composition

The antenna composition for each transmitting station is shown in Table 5-1-1.

(1) For the receiving antenna for off-air relay, the stack or diversity connection of a 5-element type Yagi antenna is considered as standard.
(2) For the receiving antenna for STL, a parabolic antenna of 1.8 mϕ is considered as standard, as described in chapter 5-2-2.
(3) For the transmitting antenna, a 2-dipole antenna is employed in consideration of horizontal polarization because of the use of the dipole antenna for the existing TV transmitting antenna and the ease of installation. Fig. 5-3-3 shows the standard antenna composition. It is an even-level composition, and is of a redundant system that permits separated feeding through 2 main feeders by separating between upper and lower level.
(4) For the transmitting feeders, a 20 D coaxial cable, a 39 D coaxial cable and a 77 Dcoaxial cable are used for 100 W, 500 W and 1 kW, and 5 kW, respectively, as standard.

5-4 Power supply facilities

As a result of the feasibility study, it was found that the power supply capacity of the exisiting TV transmitting stations are not sujficient to involve the requirement for 6-wave FM

transmitters are installed independent from the existing power supply for TV transmitters.

The power supply facilities for each FM transmitting station is shown in Table 5-1-1.

5-4-1 AVR equipment

As all the FM transmitters proposed in this project are of solid state type and incorporate with a regulator unit on the purpose of supplying stable power to them, they fundamentally need no AVR equipment.

However, in consideration of the power supply situation in Malaysia, the installation of AVR will provide safer operation and will be able to effectively prevent lighting surge. Accordingly, the AVR will be installed without a redundant system.

The standard AVR capacity per transmitting power in the 6-wave FM transmitter composition is as follows.

Table 5-4-1 AVR Capacity Required

Transmitter's Power	Capacity AVR Capacity
5 kW (6 – waves)	150 KVA
1 kW (6 – wave)	35 KVA
500 W (6 – waves)	30 KVA
100 W (6 – waves)	10 KVA

5-4-2 Main Power Distribution Facilities

(1) As the existing TV transmitting stations are attended stations, switchover operation between the commercial power and stand-by engine generator is performed only manually.

(2) As for each station of PENSIANGAN, TENOM, NABAWAN, SIBU, SARIKEI/SARATOK, BAREO, Pelamau, BELAGA and Batu, the power supply facilities must be operated automatically.

Therefore, the main power distribution facilities for these FM transmitting stations will be provided with an automatic switchover function between the regular and standby engine-generator unit as well as a remote control system.

5-4-3 Engine Generator

The engine generator for each transmitting station shown in Table 5-1-1 is based on the following.

(1) The FM transmitting station with a commercial power supply is provided with a unit of engine generator for an emergency power supply.

(2) The FM transmitting station without a commercial power supply is provided with two units of engine generator which consist of a main and a stand-by.

The engine generator capacity for six (6) FM transmitters is given in the following table.

Table 5-4-2 Engine Generator Capacity Required

Transmitter's Power	Capacity of Engine Generator
5 kW (6 – waves)	150 KVA
1 kW (6 – waves)	45 KVA
500 W (6 – waves)	35 KVA
100 W (6 – waves)	20 KVA

5-5 Control and supervisory system

The operating system of FM transmitting stations which is a very important element to design the supervisary system is stated in section 9, Staff Planning.

Table 5-5-1 shows the kinds of circuits, location and items for supervisory system for the each FM transmitting station, and its basic concept is as follows.

(1) As for the FM transmitting stations to be installed in the attended TV transmitting stations, overall centralized control and monitoring for TV and FM are perfomed in a control room in common.

(2) As for the unattended FM transmitting stations of SIBU, SARIKEI/SARATOK, control and supervision are performed remotely from the RTM studio.

(3) As for the FM transmitting stations of PENSIANGA, TENOM, NEBAWAN, BAREO, Pelamau, BELAGA, and Batu, control and supervision are perfomed in the Telecom sub-stations where the maintenance staff is permanently stationed.

The standard items for control and supervision on FM transmitters are as shown in Tables 5-5-2 and 5-5-3. The following matters have to be noted relating to the difference in the composition of FM transmitters described in Table 5-5-1.

(1) For the A type FM transmitters, control items 1-22, 35 and 36 and supervisory items 1-17, and 42–50 are used as standard.

(2) For the B and C type transmitters, control items 1-36 and supervisory items 1-50 are used as standard.

For unattended FM transmitting stations, the contents of Table 5-5-4 are added as control and supervisory items, because they include the remote control for the power supply system.

Table 5-5-1 Control and Supervision for FM Transmitting Stations

Transmitting station	Control and supervisory line	Control and supervisory place	Control and supervisory items
KOTA KINABALU RANAU KUDAT SANDAKAN TAWU LAHAD DATU TAMBUNAN/KENINGAU SIPITANG KUCHING BANDAR SRI AMAN MIRI BINTULU LIMBANG KAPIT	Telecom line	TV transmitter control room	Table 5-5-2 Table 5-5-3
SARATOK SIBU		RTM Studio (BANDAR SRI AMAN) RTM Studio (SIBU)	
PENSIANGAN TENOM NABAWAN BAREO RELAMAU SARIKEI BALAGA BATU	VHF radio	PENSIANGAN Telecom sub-station TENOM Telecom sub-station NABAWAN Telecom sub-station BAREO Telecom sub-station PELAMAU Telecom sub-station RTM Studio (SARIKEI) BELAGA Telecom sub-station BATU Telecom sub-station	Table 5-5-2 Table 5-5-3 Table 5-5-4

Table 5-5-2 Standard Control Items (1)

Control Item		Control Item	
1. Control Remote	ON	23. N1 receiver	No. 1 used
2. Control Automatic	ON	24. N1 receiver	No. 2 used
3. N1 transmitter	ON	25. N2 receiver	No. 1 used
4. N1 transmitter	OFF	26. N2 receiver	No. 2 used
5. N2 transmitter	ON	27. N3 receiver	No. 1 used
6. N2 transmitter	OFF	28. N3 receiver	No. 2 used
7. N3 transmitter	ON	29. R receiver	No. 1 used
8. N3 transmitter	OFF	30. R receiver	No. 2 used
9. R transmitter	ON	31. L receiver	No. 1 used
10. R transmitter	OFF	32. L receiver	No. 2 used
11. L transmitter	ON	33. E receiver	No. 1 used
12. L transmitter	OFF	34. E receiver	No. 2 used
13. E transmitter	ON	35. Remote control test	
14. E transmitter	OFF	36. Retransmission	
15. Standby transmitter	ON		
16. Standby transmitter	OFF		
17. N1 transmitter ↔ standby transmitter switchover			
18. N2 transmitter ↔ standby transmitter switchover			
19. N3 transmitter ↔ standby transmitter switchover			
20. R transmitter ↔ standby transmitter switchover			
21. L transmitter ↔ standby transmitter switchover			
22. E transmitter ↔ standby transmitter switchover			

N1 – National 1 N2 – National 2 N3 – National 3 R – Regional L – Local E – Educational

Table 5-5-3 Standard Supervisory Items (1)

Supervisory Item	Supervisory Item
1. Fire	26. L receiver No. 1 used
2. Door	27. L receiver No. 2 used
3. Transmitter manual	28. E receiver No. 1 used
4. N1 transmitter used	29. E receiver No. 2 used
5. N2 transmitter used	30. N1 receiver No. 1 abnormal
6. N3 transmitter used	31. N2 receiver No. 2 abnormal
7. R transmitter used	32. N2 receiver No. 1 abnormal
8. L transmitter used	33. N2 receiver No. 2 abnormal
9. E transmitter used	34. N3 receiver No. 1 abnormal
10. Standby transmitter used	35. N3 receiver No. 2 abnormal
11. N1 transmitter abnormal	36. R receiver No. 1 abnormal
12. N2 transmitter abnormal	37. R receiver No. 2 abnormal
13. N3 transmitter abnormal	38. L receiver No. 1 abnormal
14. R transmitter abnormal	39. L receiver No. 2 abnormal
15. L transmitter abnormal	40. E receiver No. 1 abnormal
16. E transmitter abnormal	41. E receiver No. 2 abnormal
17. Standby transmitter abnormal	42. Control manual
18. N1 receiver No. 1 used	43. Control automatic
19. N1 receiver No. 2 used	44. Control remote
20. N2 receiver No. 1 used	45. Remote control test
21. N2 receiver No. 2 used	46. Under remote control
22. N3 receiver No. 1 used	47. Under control
23. N3 receiver No. 2 used	48. Control abnormal
24. R receiver No. 1 used	49. Control line abnormal
25. R receiver No. 2 used	50. Indication line abnormal

N1 – National 1 N2 – National 2 N3 – National 3 R – Regional L – Local E – Educational

Table 5-5-4 Additional Control and Supervisory Items for Unattended Transmitting Stations

Control Item	Supervisory Item
1. Engine generator No. 1 started	1. Engine generator No. 1 Normal generation
2. Engine generator No. 1 stopped	2. Engine generator No.1 Abnormal generation
3. Engine generator No. 2 started	3. Engine generator No. 2 Normal generation
4. Engine generator No. 2 stopped	4. Engine generator No. 2 Abnormal generation
5. Engine generator No. 1 used	5. Engine generator No. 1 used
6. Engine generator No. 2 used	6. Engine generator No. 2 used

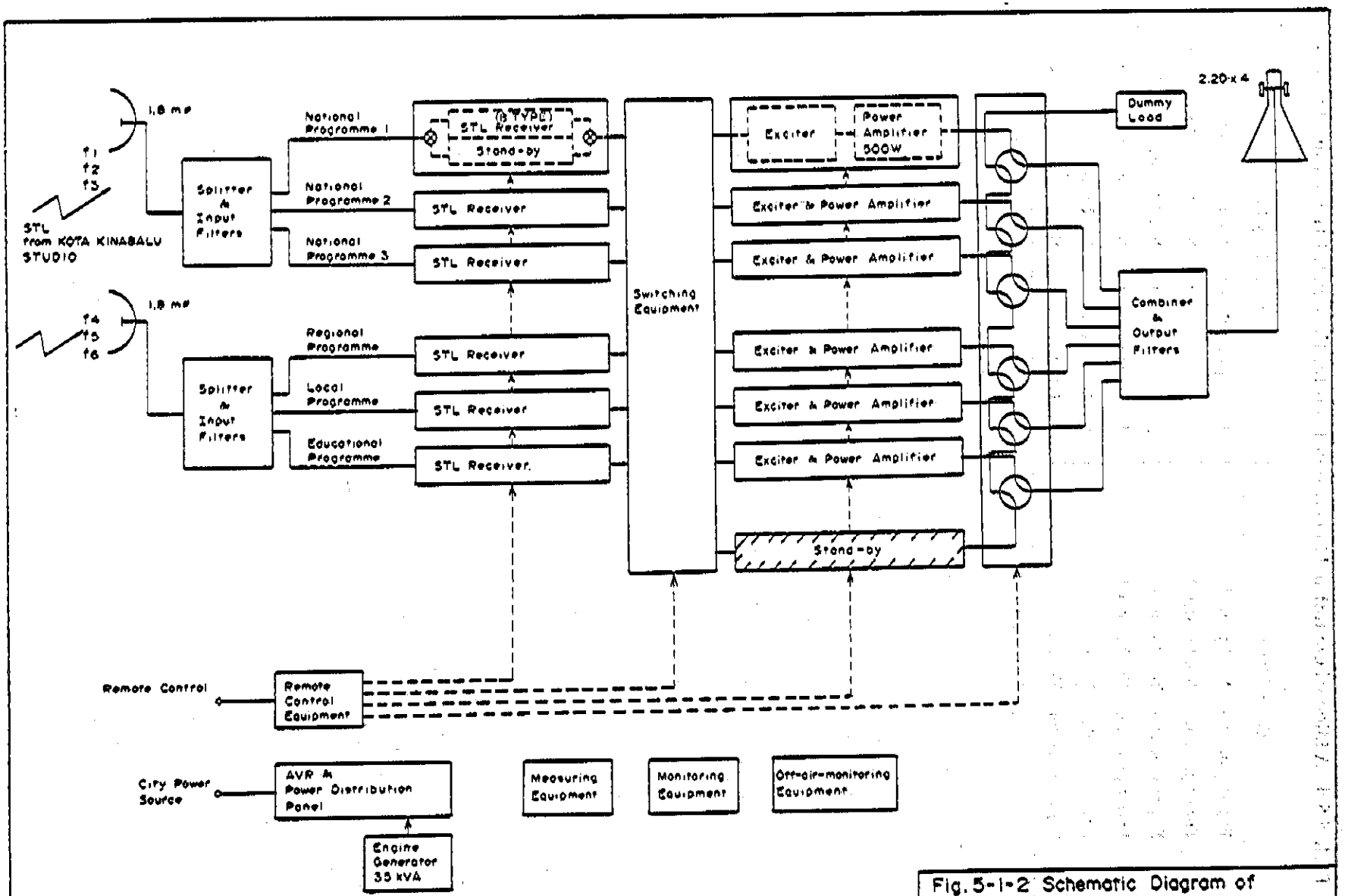


Fig. 5-1-2 Schematic Diagram of KOTA KINABALU Station (Bt. Lawa Mandau)

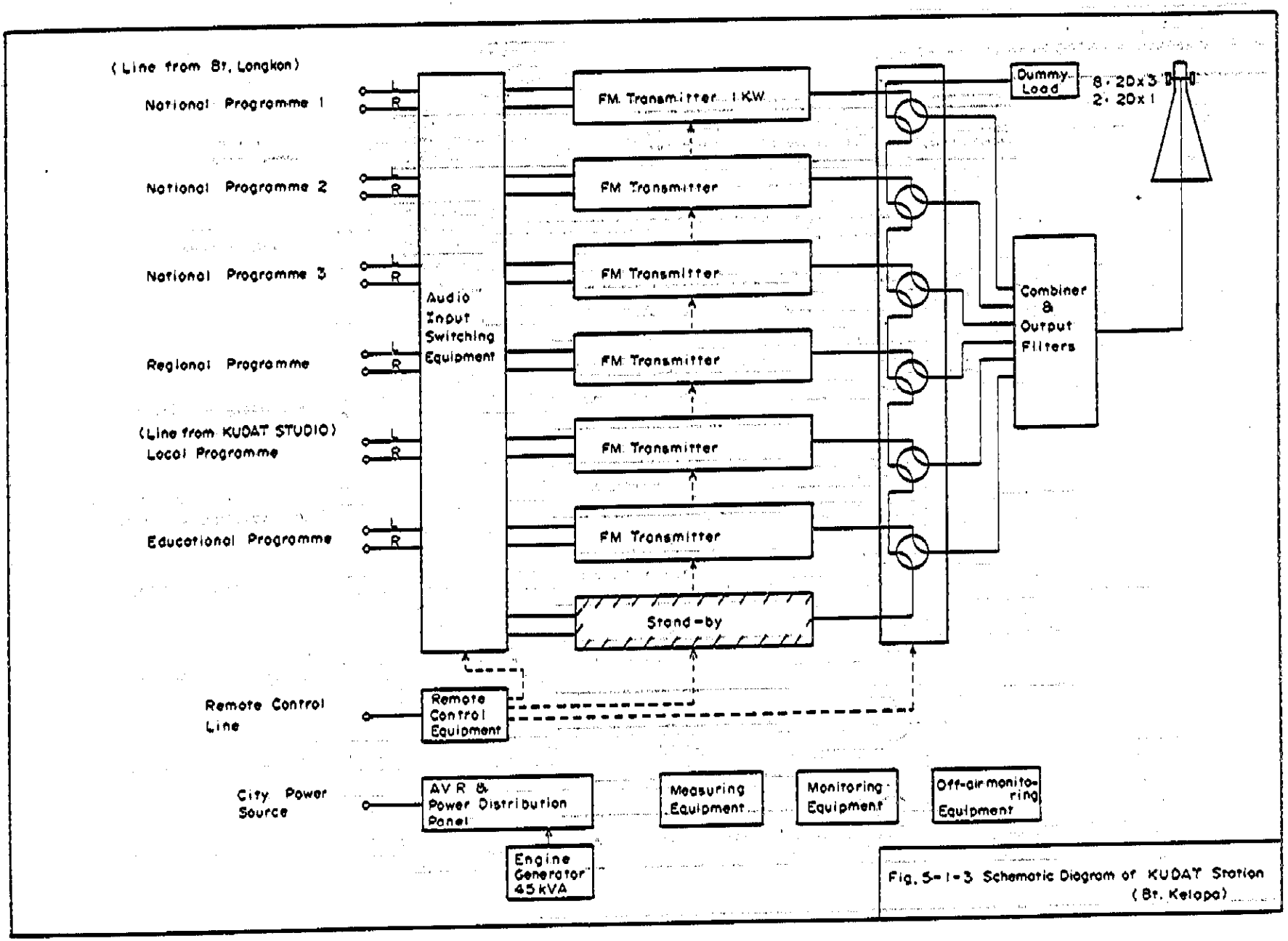


Fig. 5-1-3 Schematic Diagram of KUDAT Station (Bt. Kelapa)

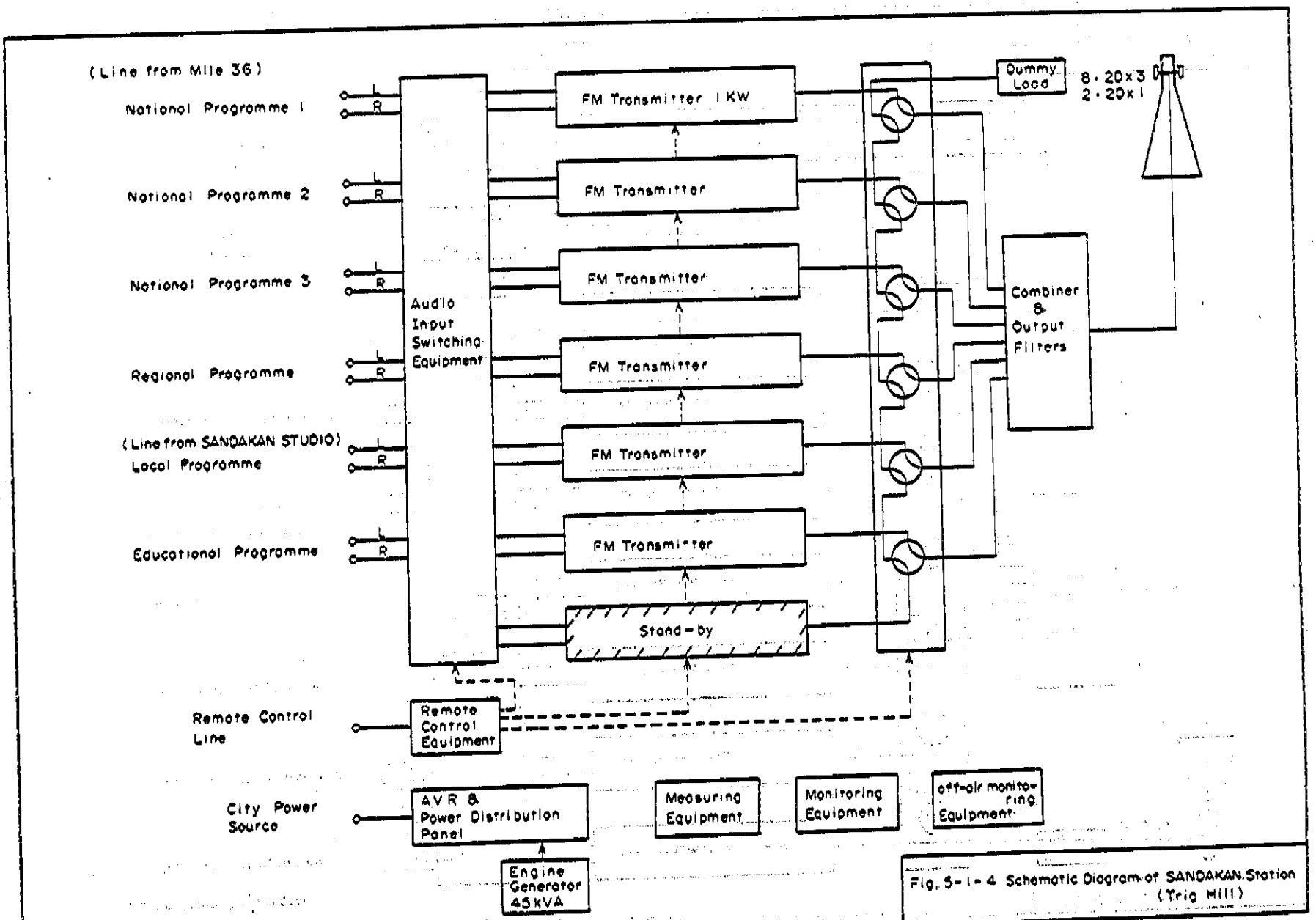


Fig. 5-1-4 Schematic Diagram of SANDAKAN Station (Trig Hill)

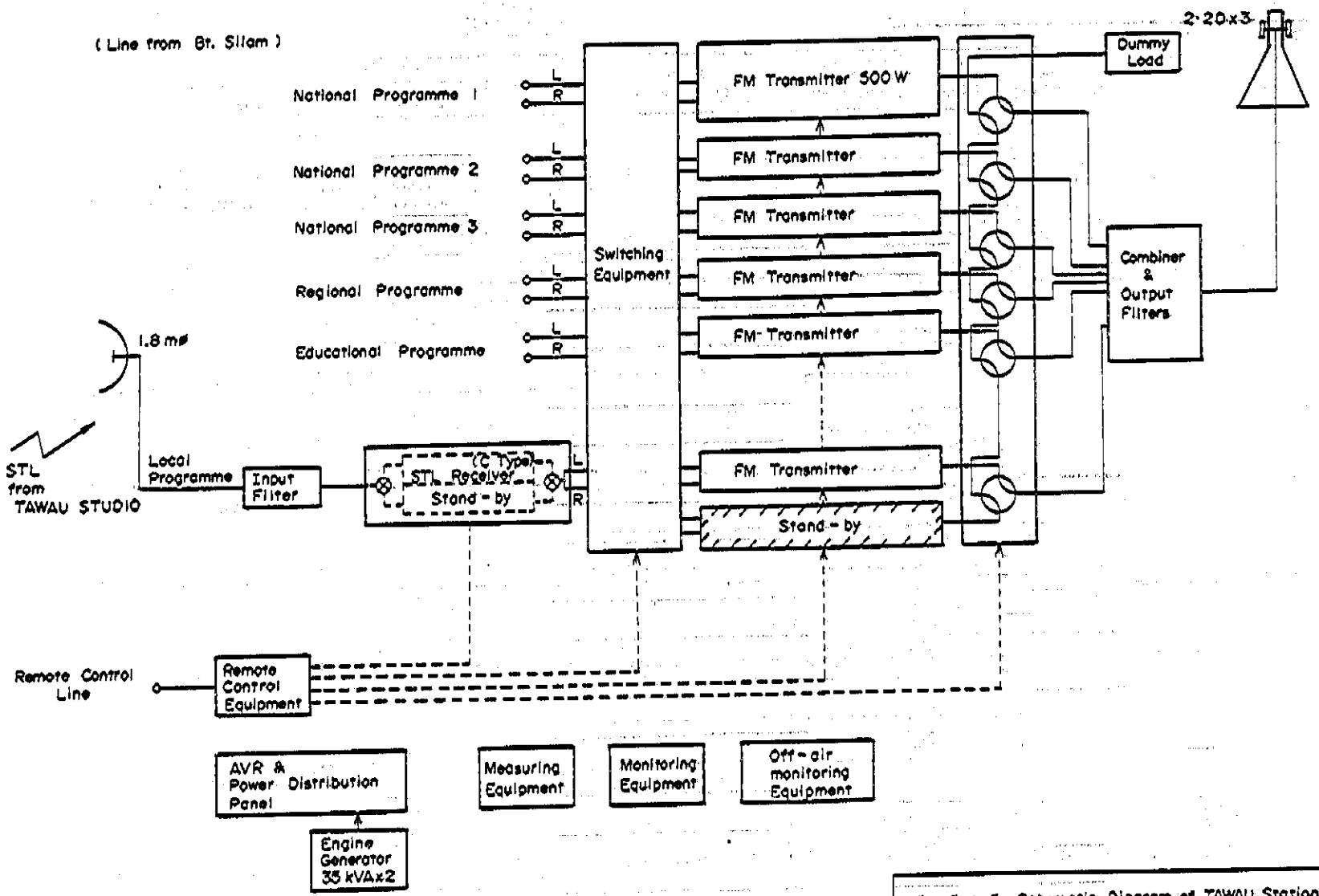


Fig. 5-1-5 Schematic Diagram of TAWAU Station (Mt. Andrassy)

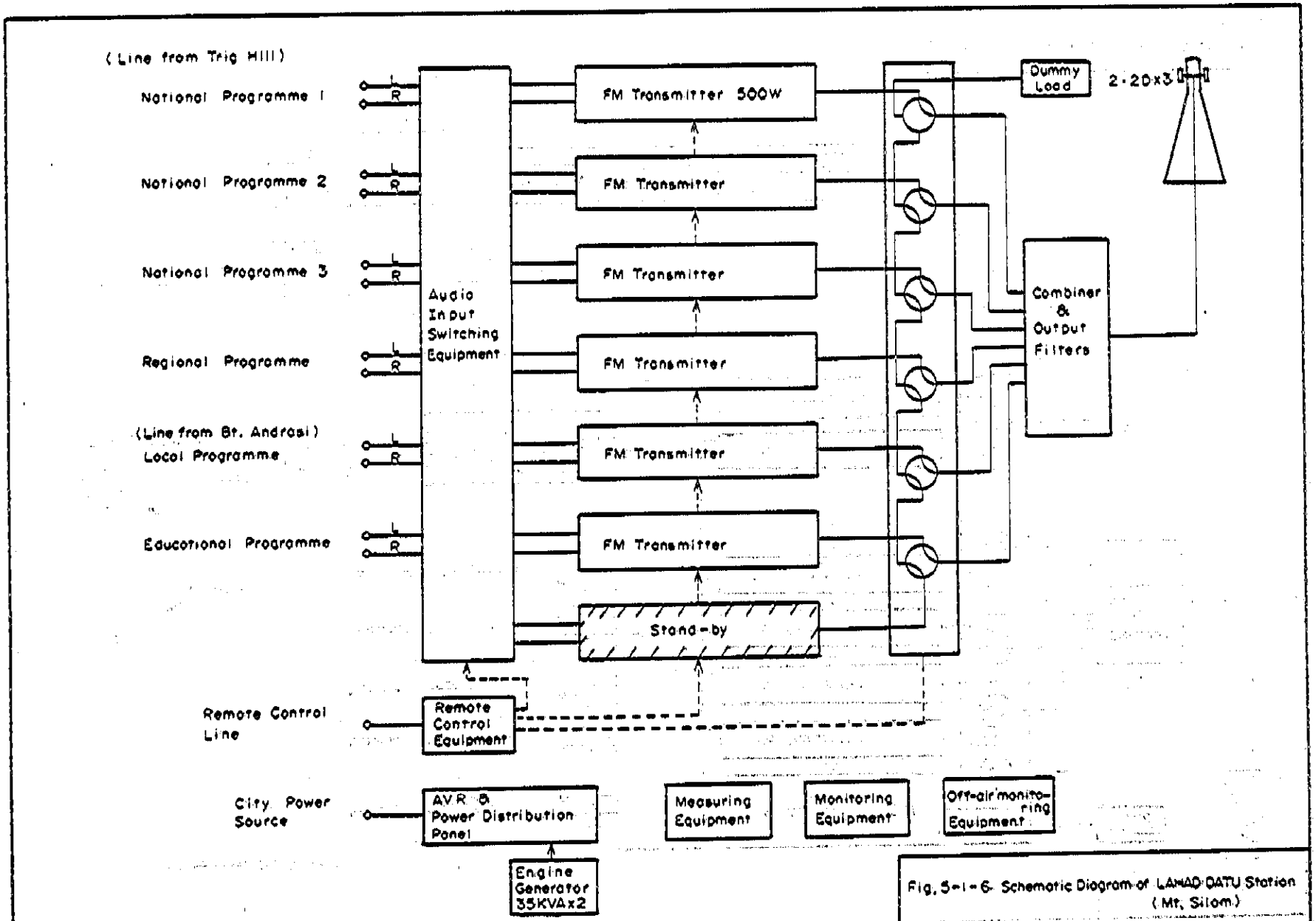


Fig. 3-1-6 Schematic Diagram of LANAD DATU Station (Mt. Silom)

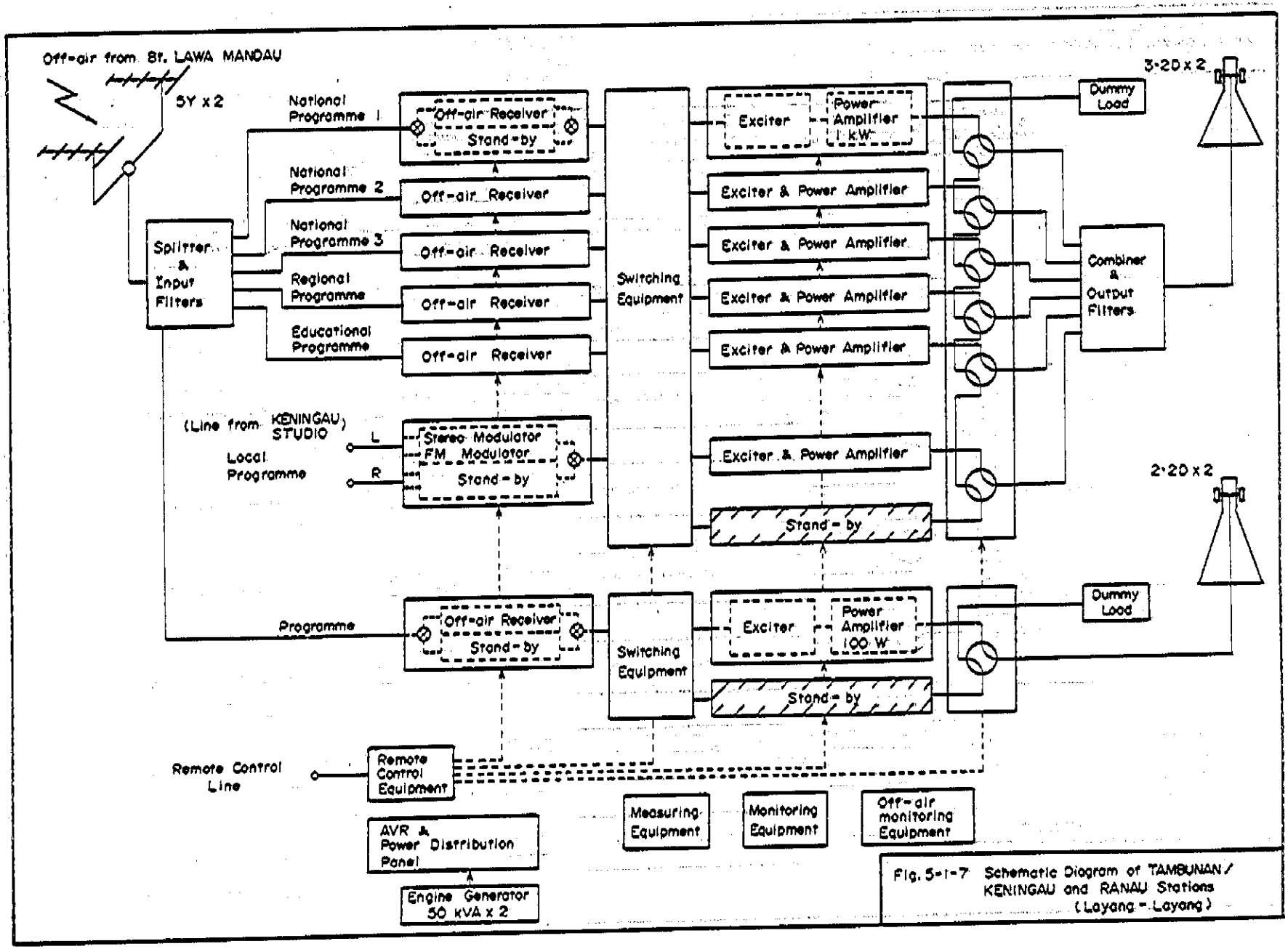


Fig. 5-1-7 Schematic Diagram of TAMBUNAN / KENINGAU and RANAU Stations (Layang - Layang)

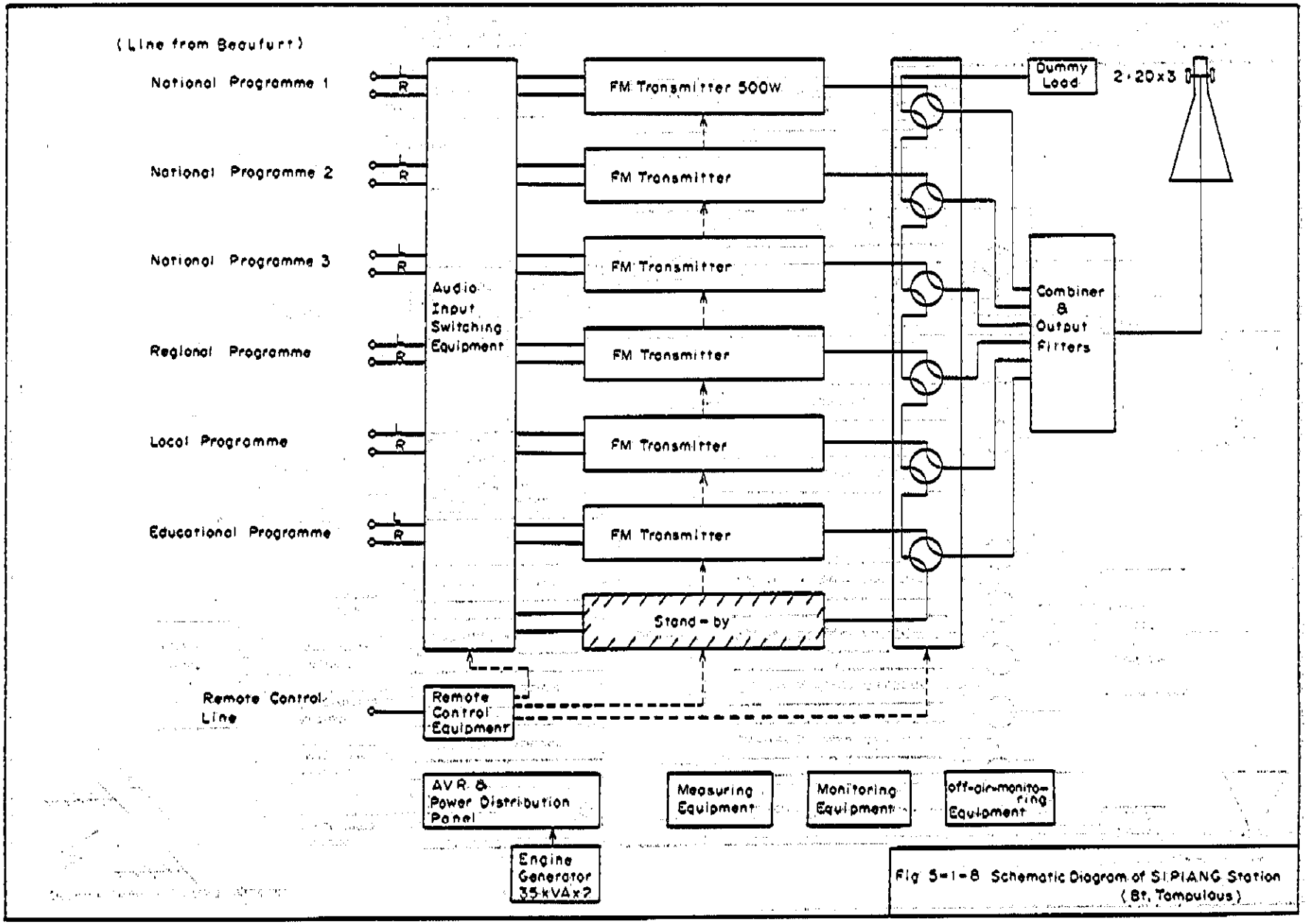


Fig 5-1-8 Schematic Diagram of SI PIANG Station (St. Tamoulaus)

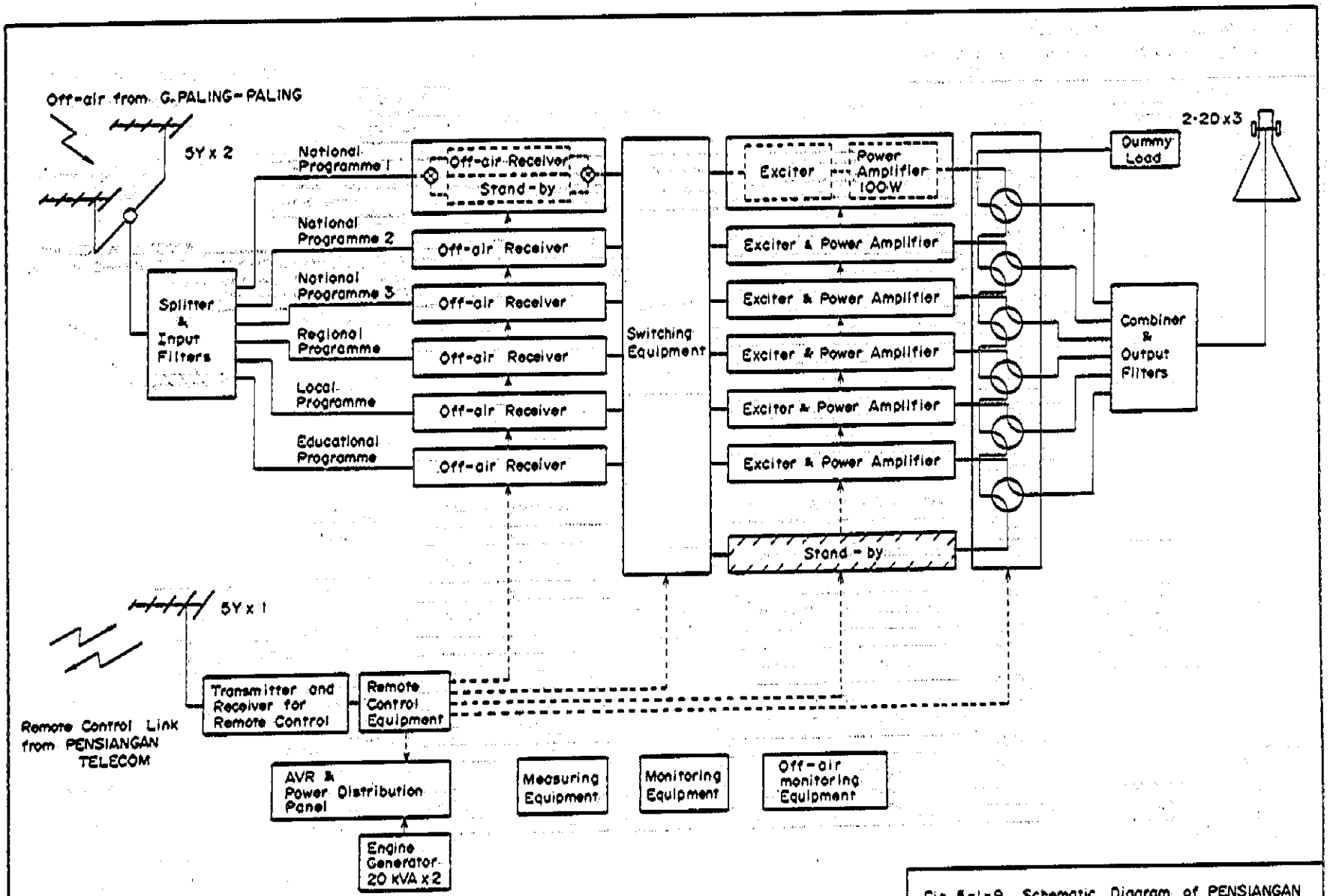


Fig. 5-1-9 Schematic Diagram of PENSIANGAN Station (G. Antulai)

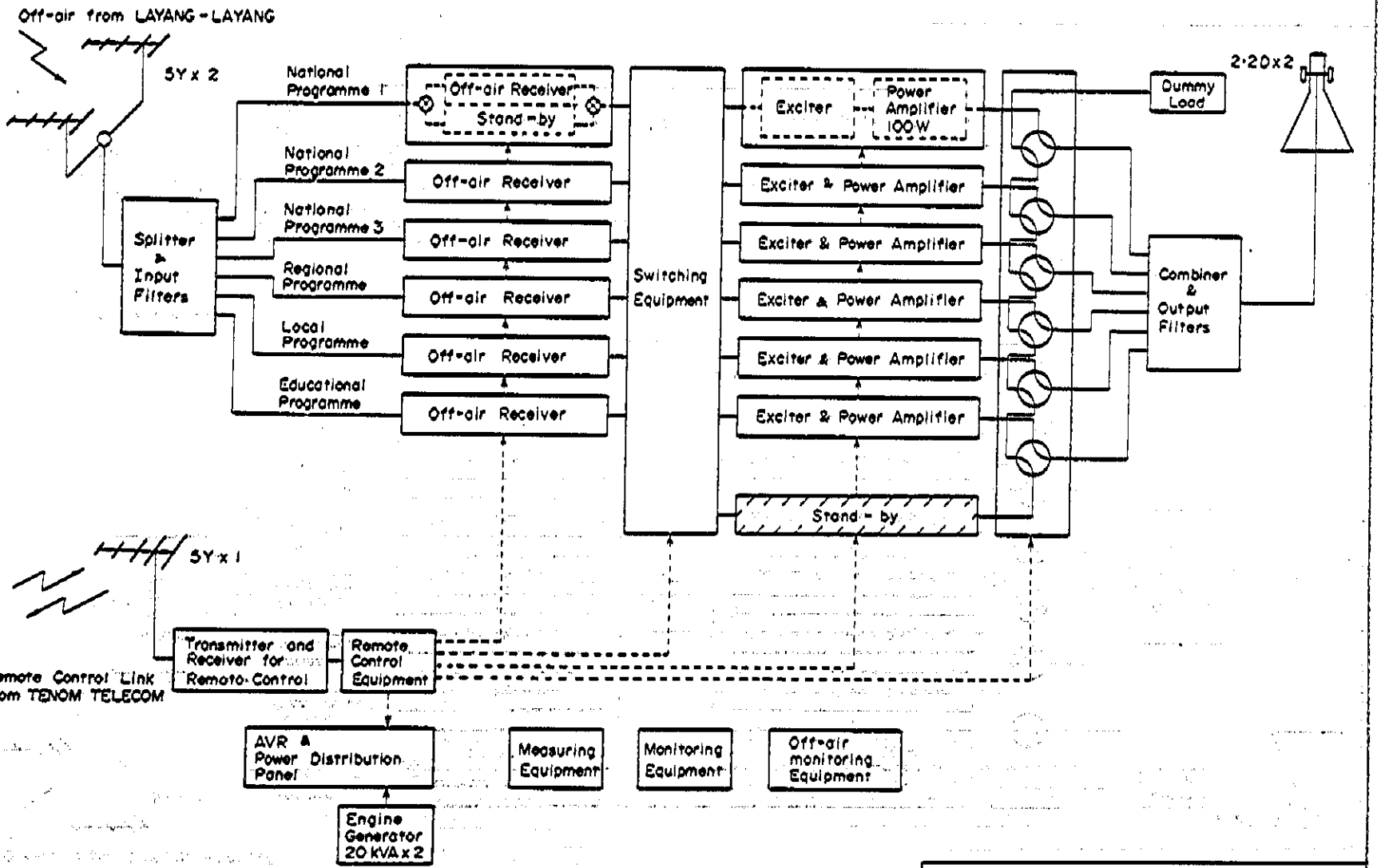


Fig. 5-1-10 Schematic Diagram of TENOM Station (G. Paling - Paling)

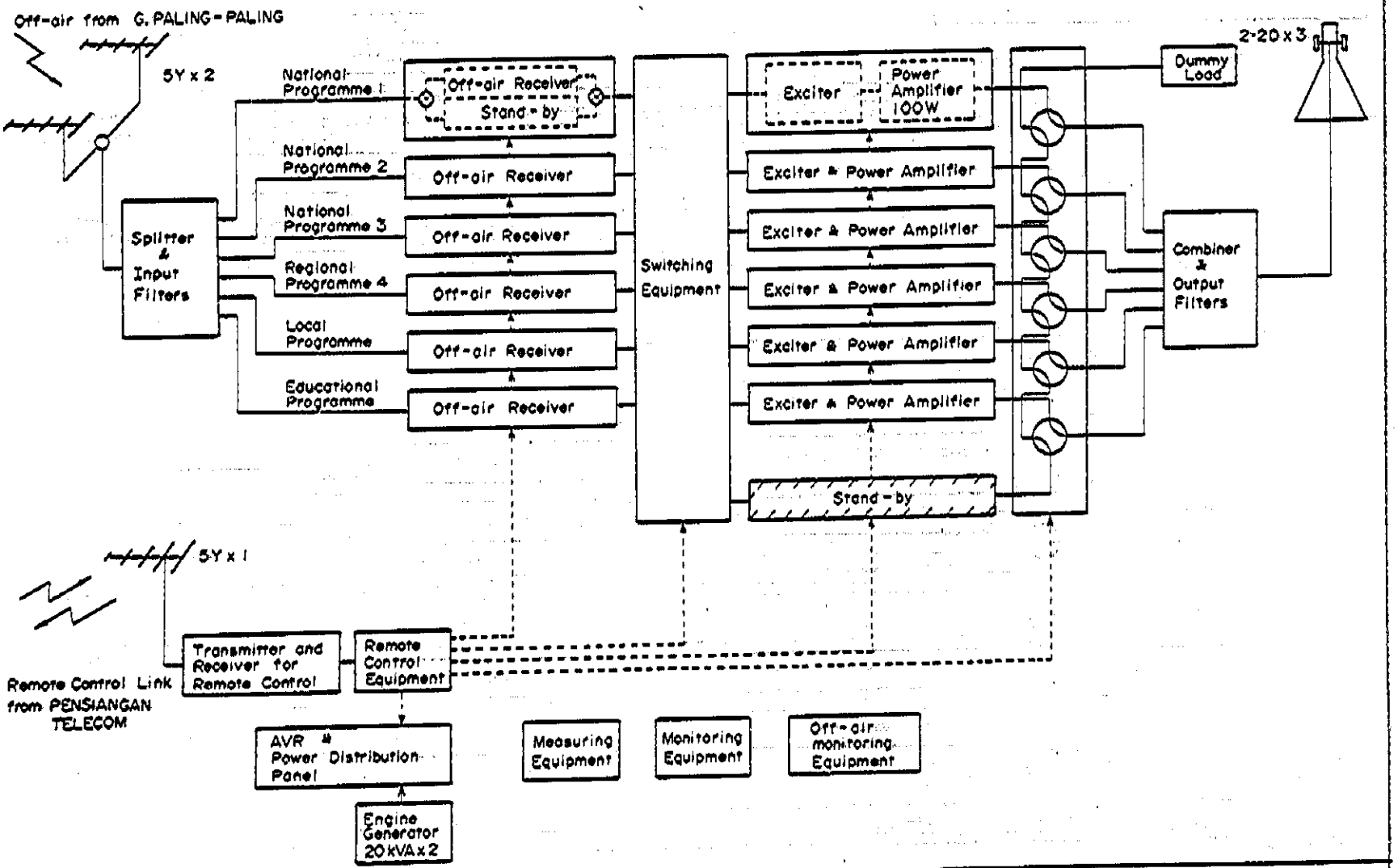


Fig. 5-1-11 Schematic Diagram of NABAWAN Station (Sikatin)

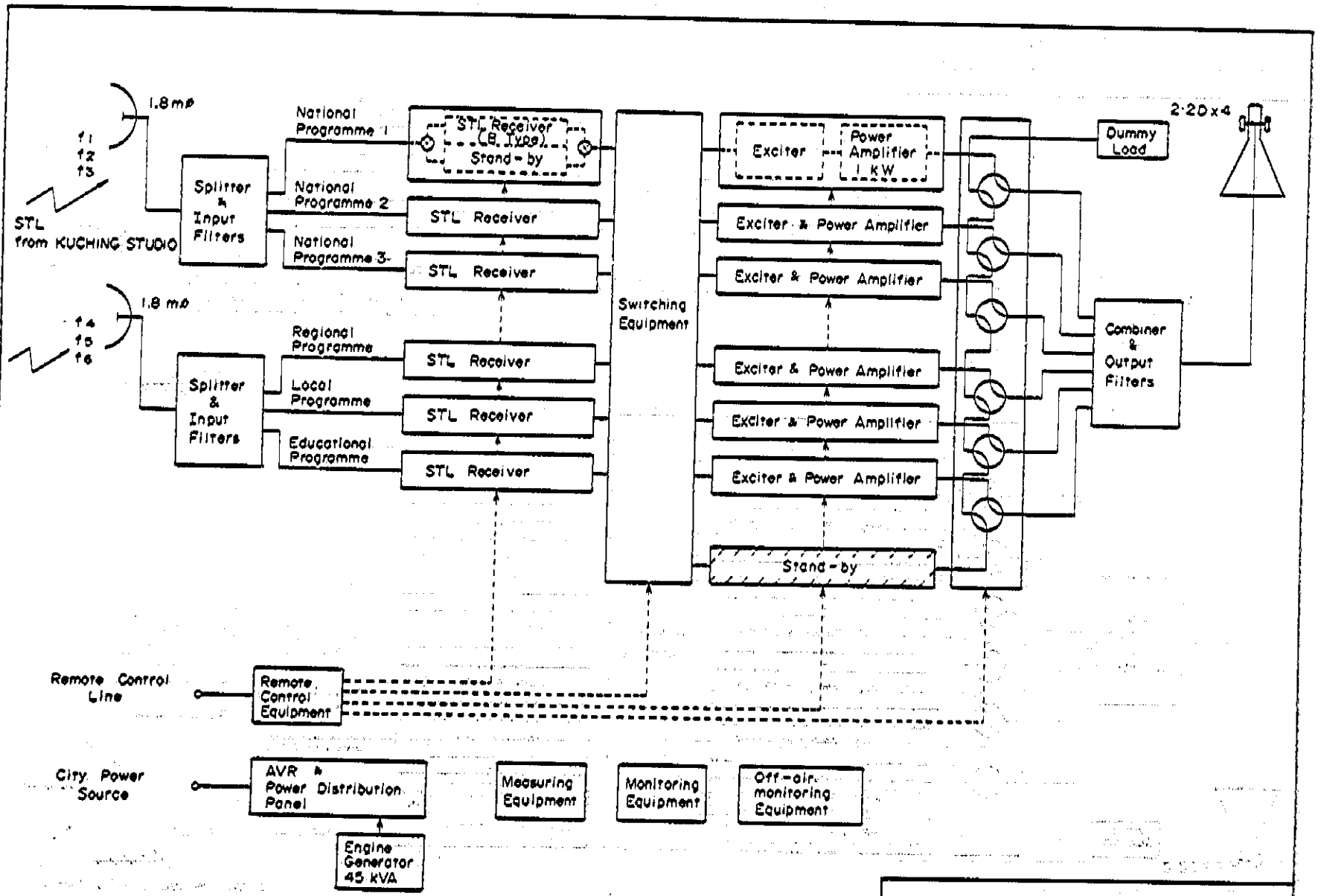


Fig. 5-1-12 Schematic Diagram of KUCHING Station (G. Serapi)

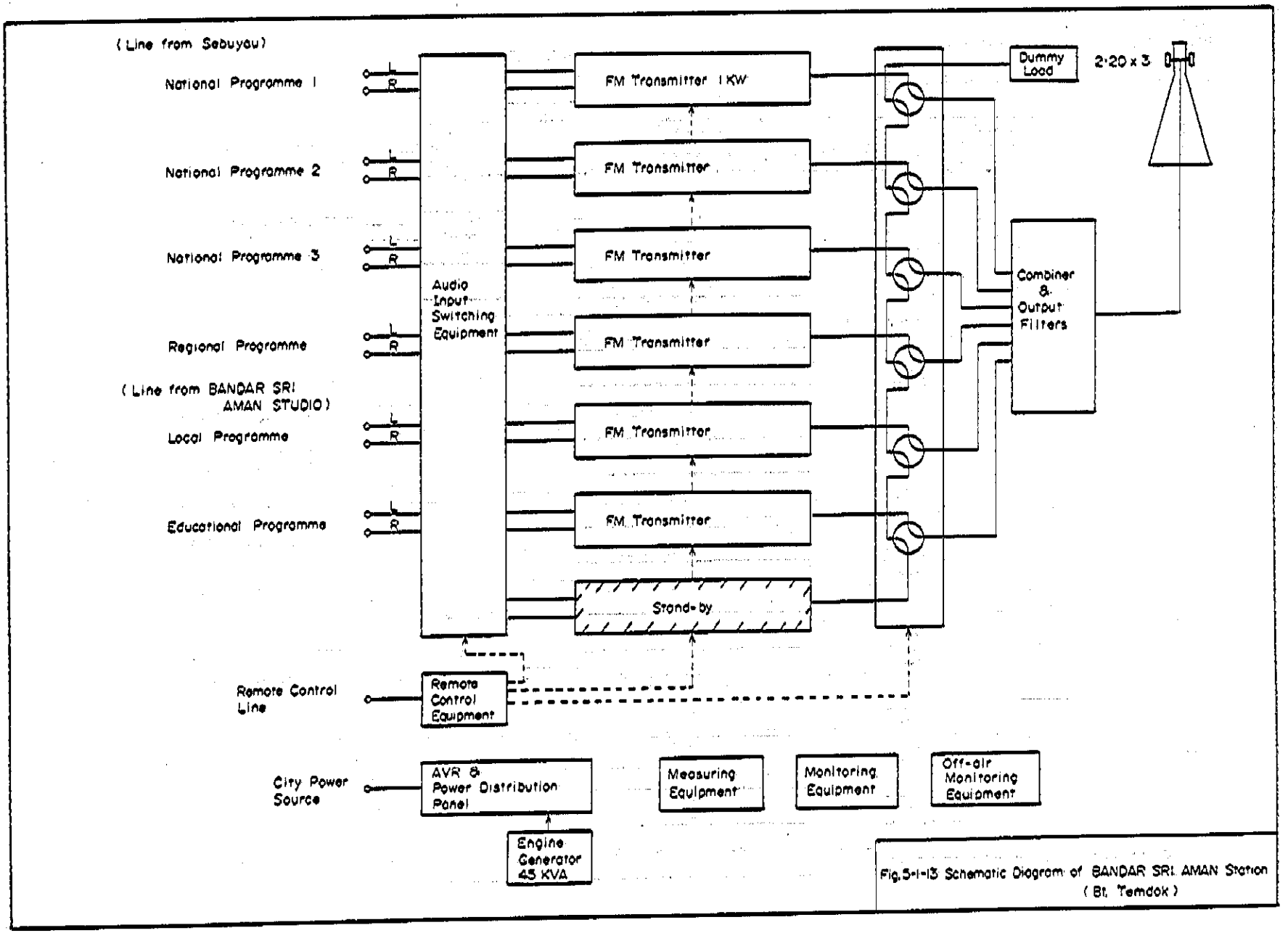


Fig.3-1-13 Schematic Diagram of BANDAR SRI AMAN Station (Bt. Temdok)

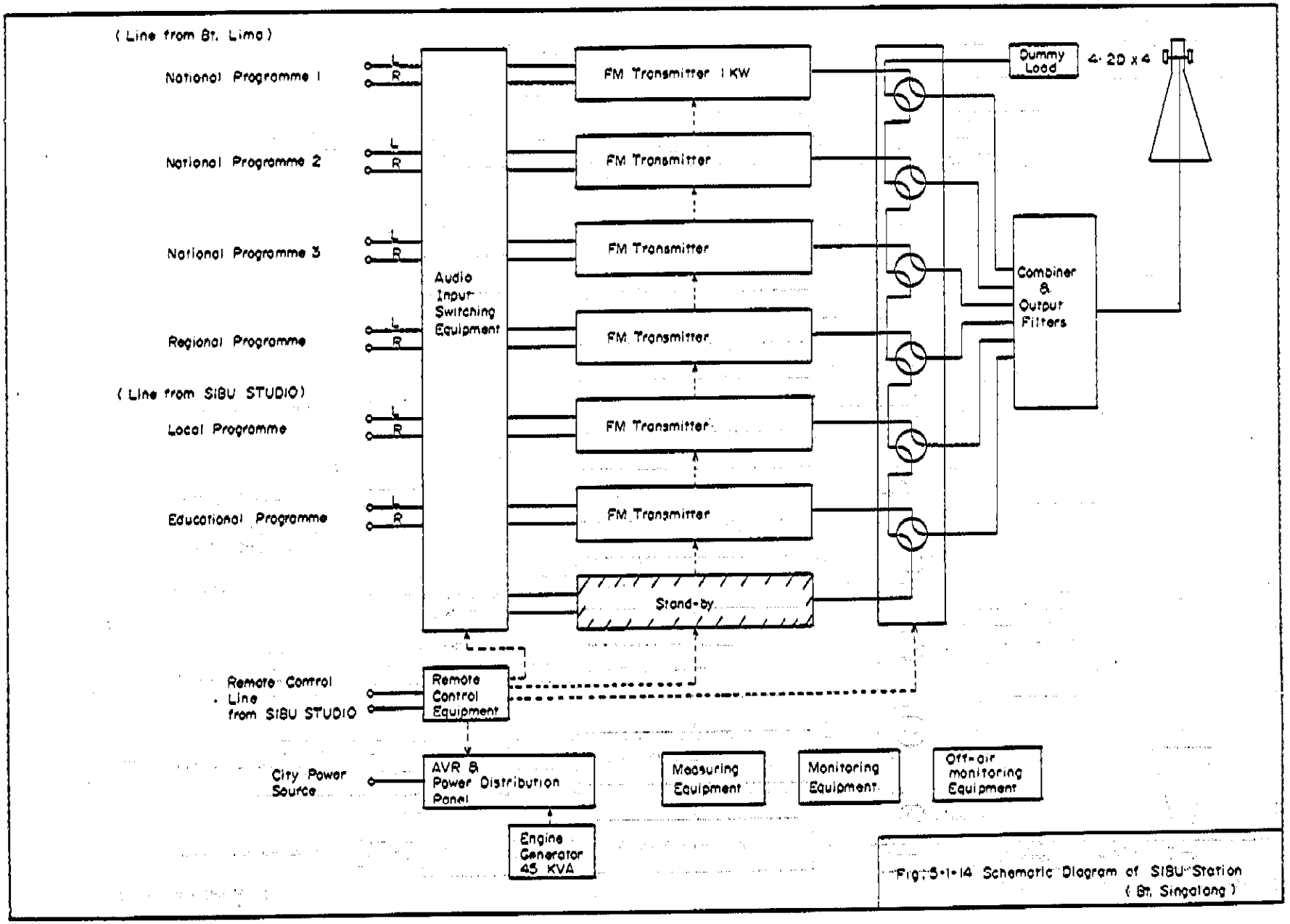


Fig. 5-1-14 Schematic Diagram of SIBU Station (Bt. Singalang)

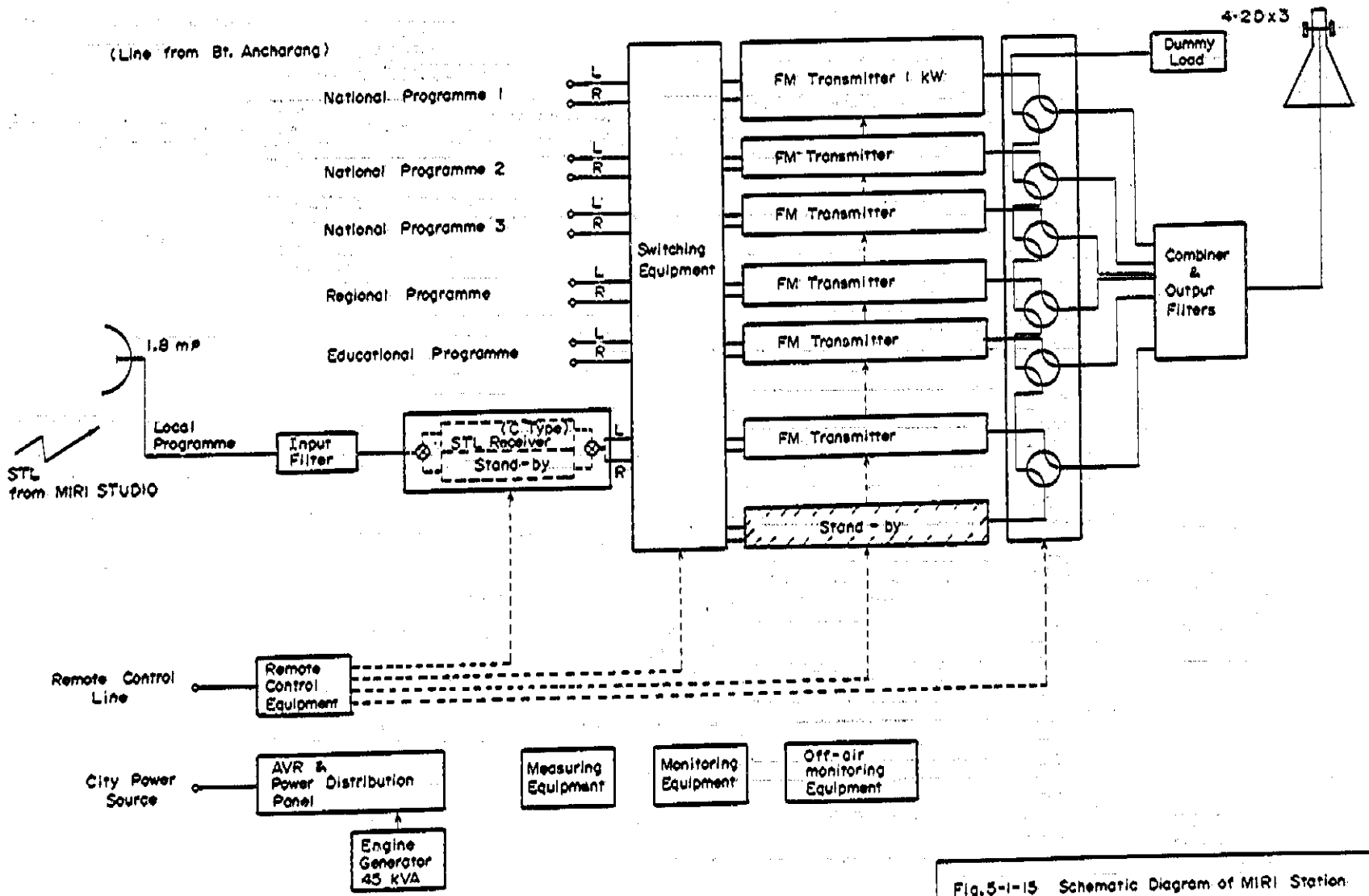


Fig.5-1-15 Schematic Diagram of MIRI Station (Bt. Lambir)

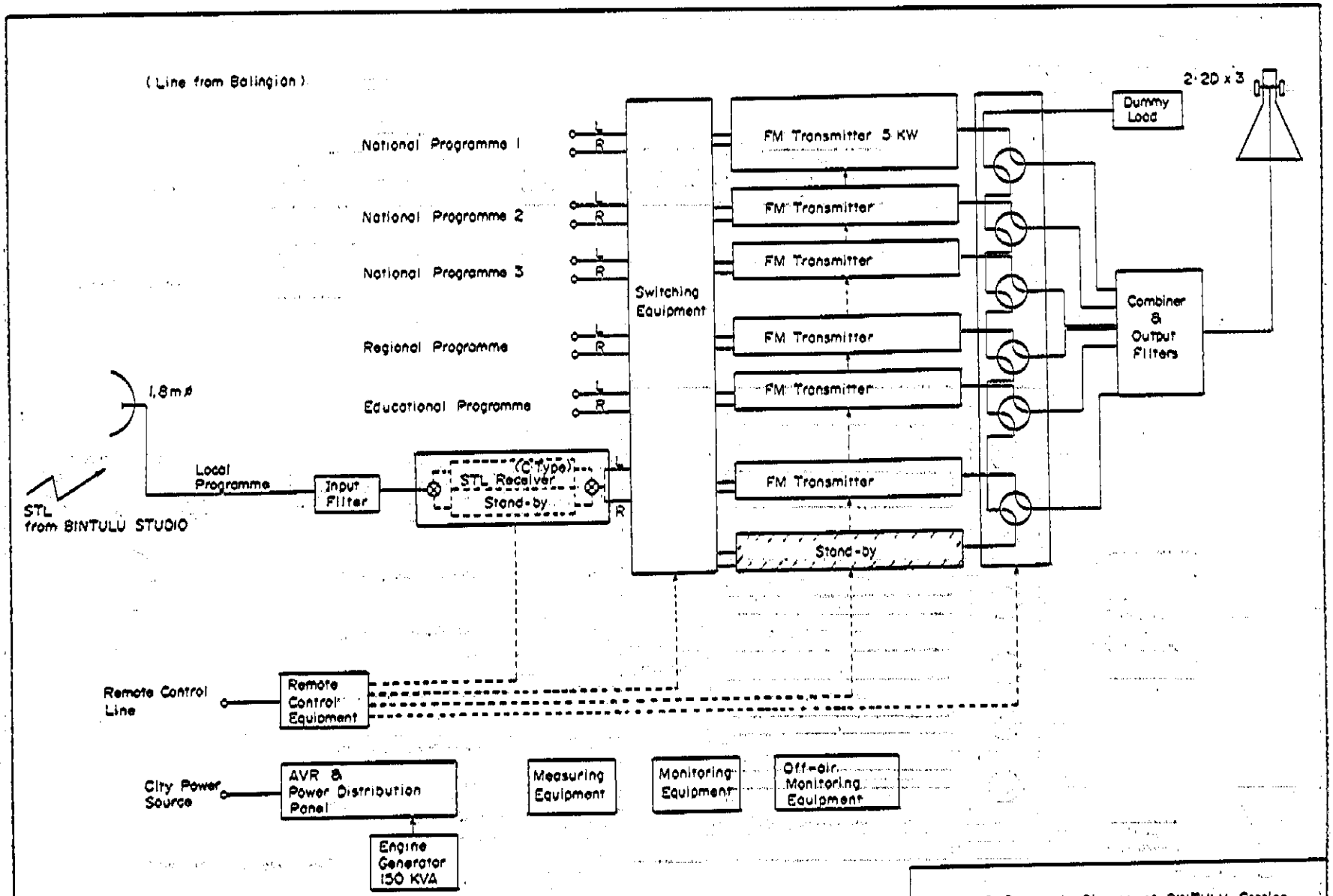


Fig. 5-1-16 Schematic Diagram of BINTULU Station (St. Nyabau)

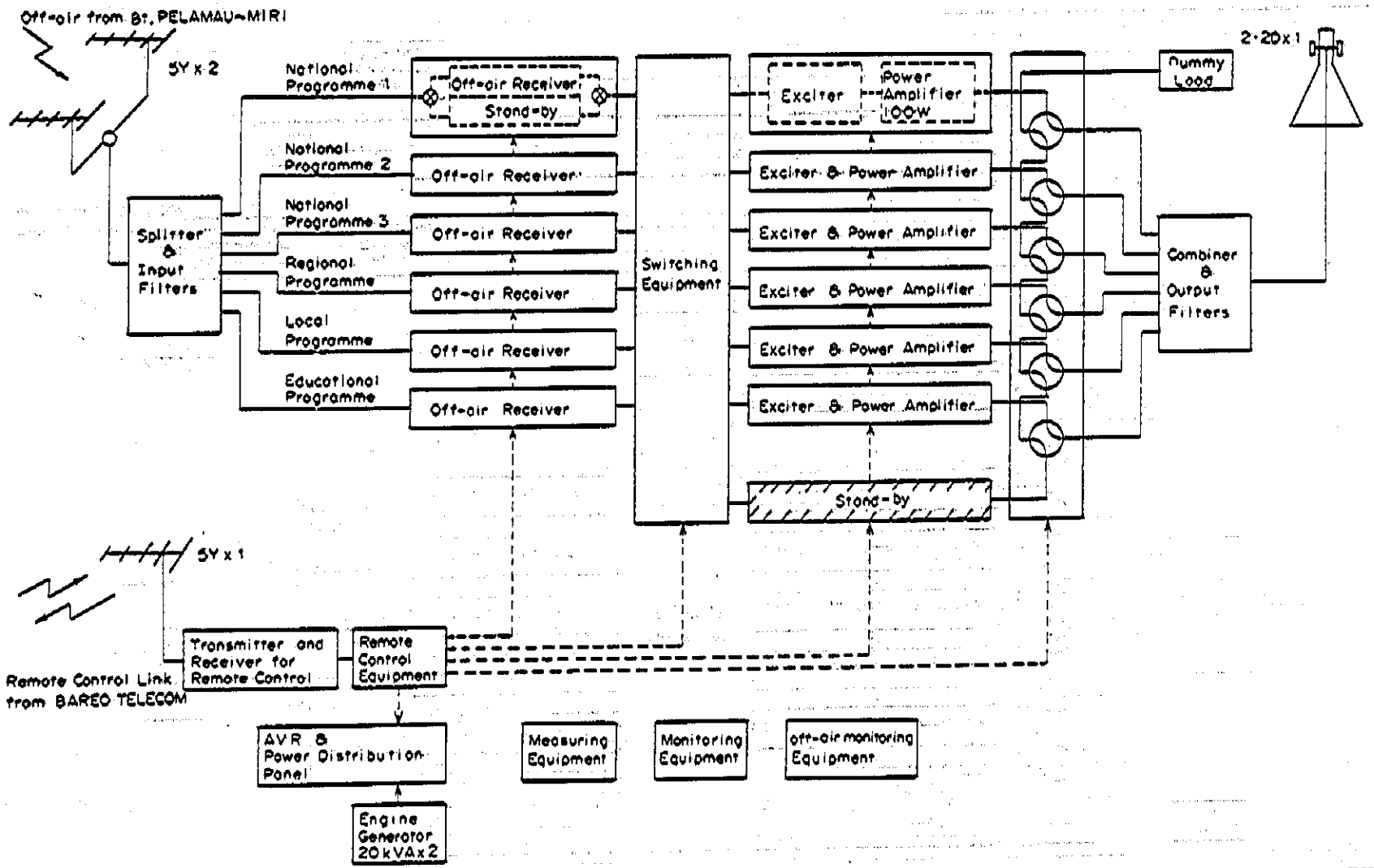


Fig. 5-1-17 Schematic Diagram of BAREO Station (Bareo).

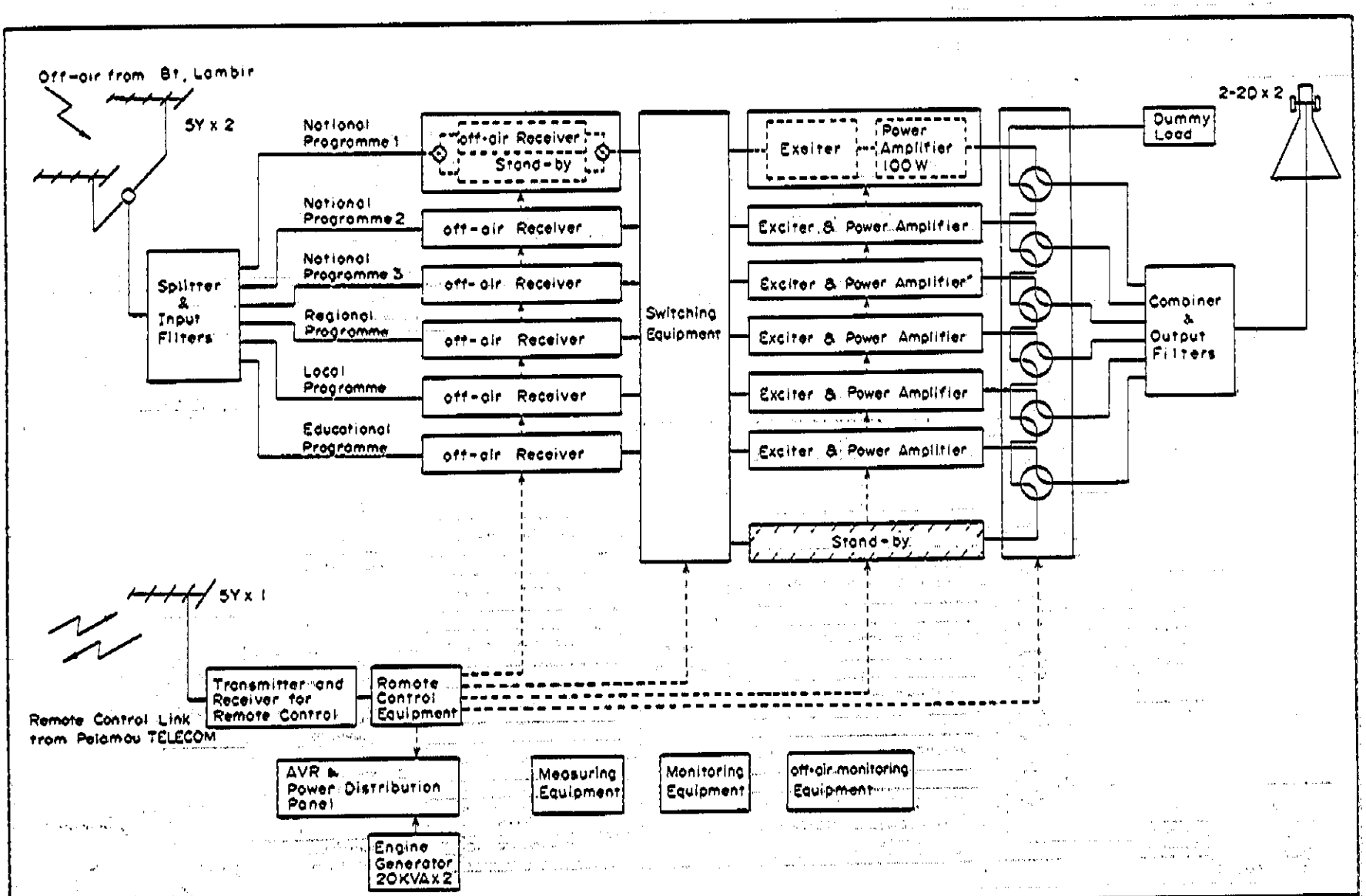


Fig. 5-1-18 Schematic Diagram of PELAMAU Station

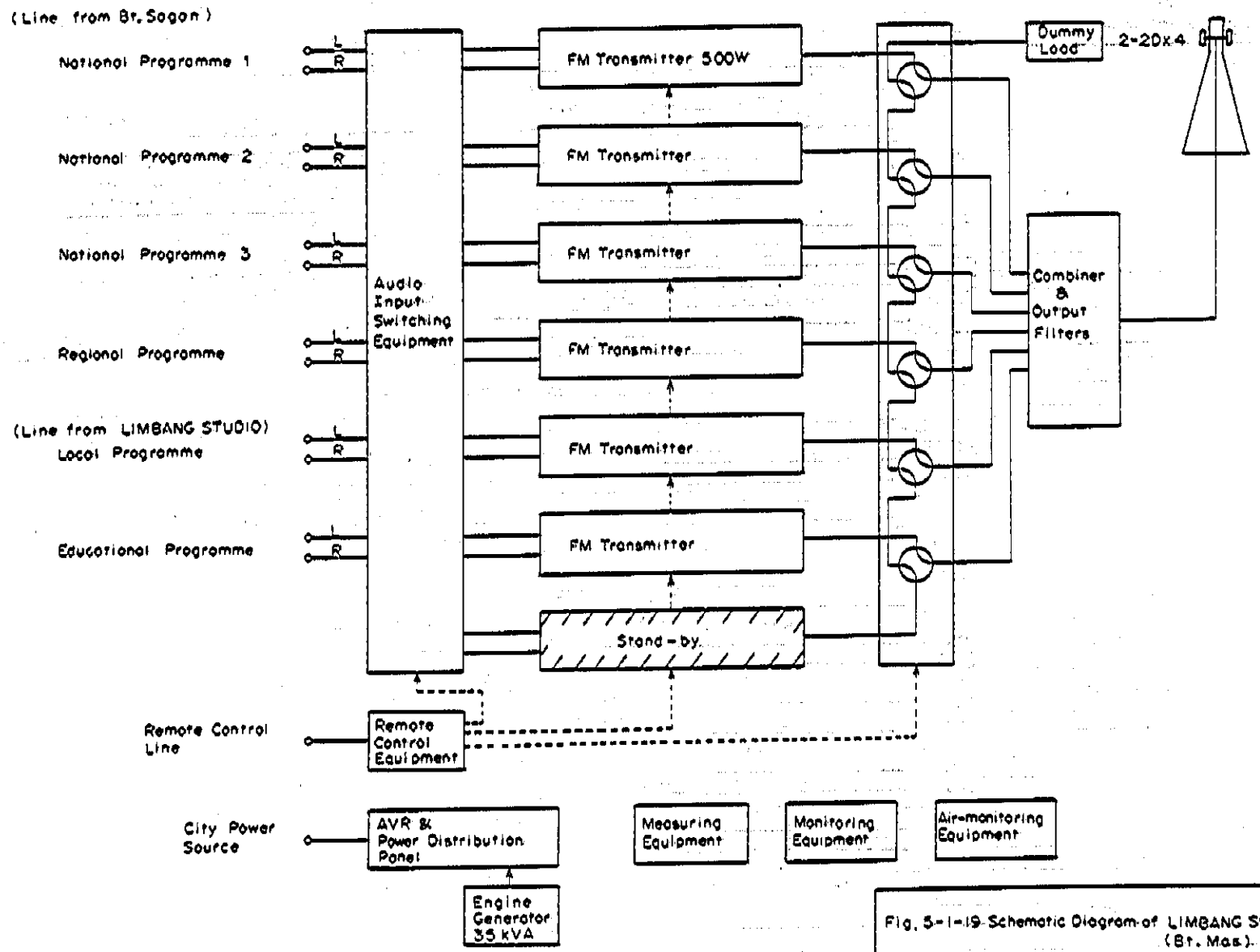


Fig. 5-1-19 Schematic Diagram of LIMBANG Station (Br. Mas).

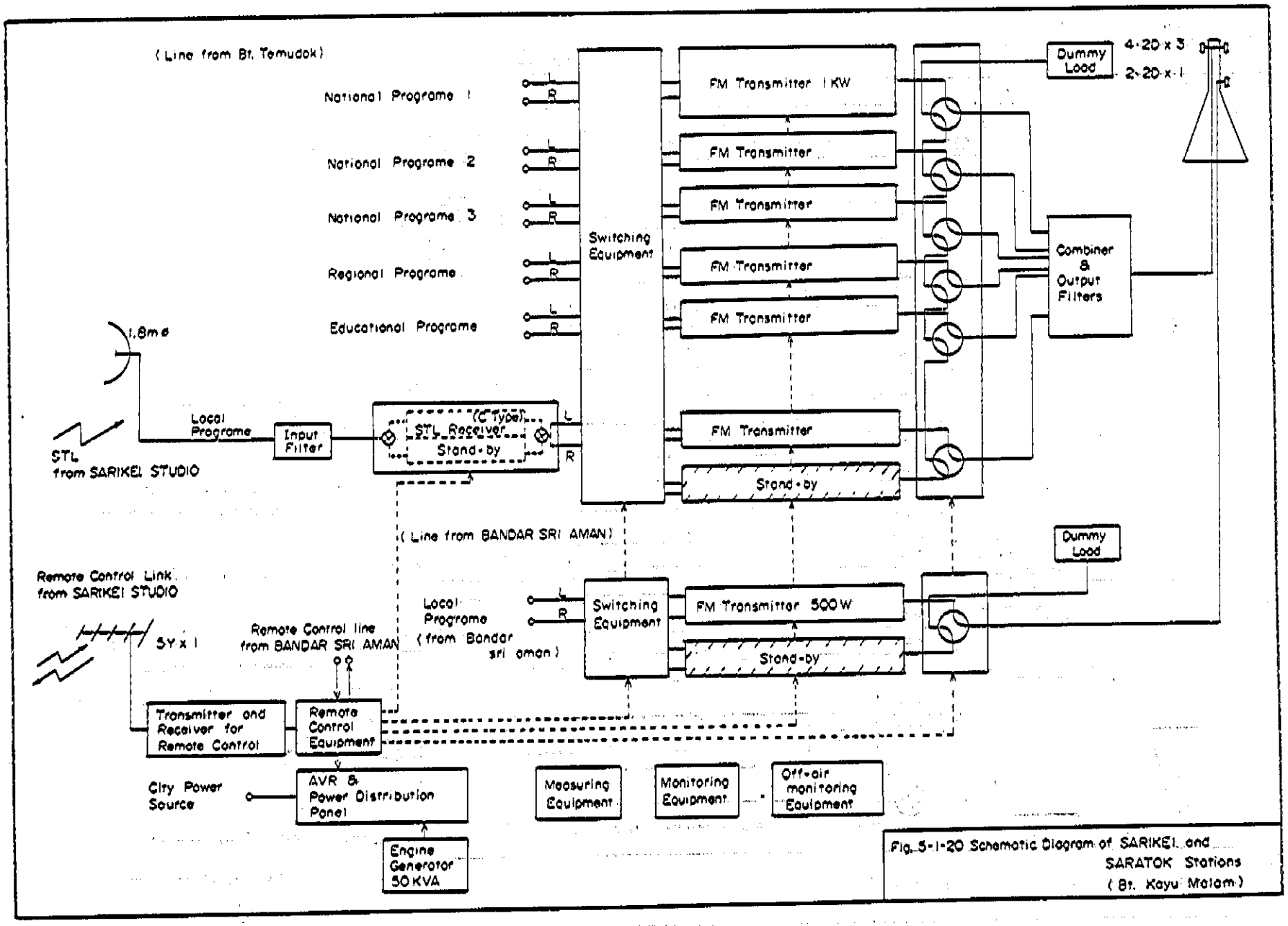


Fig. 5-1-20 Schematic Diagram of SARIKEI and SARATOK Stations (Bt. Kayu Malam)

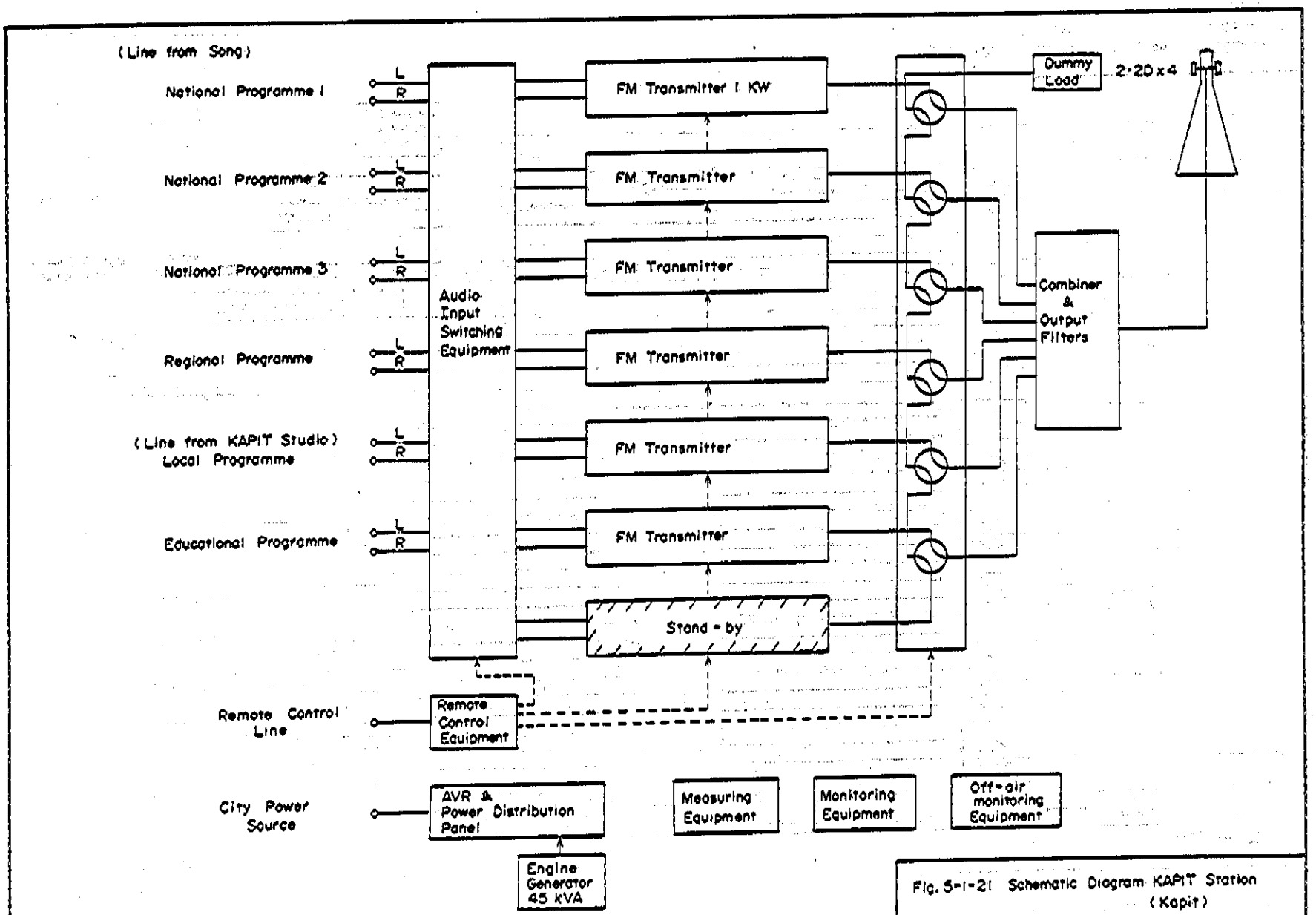


Fig. 5-1-21 Schematic Diagram KAPIT Station (Kapit)

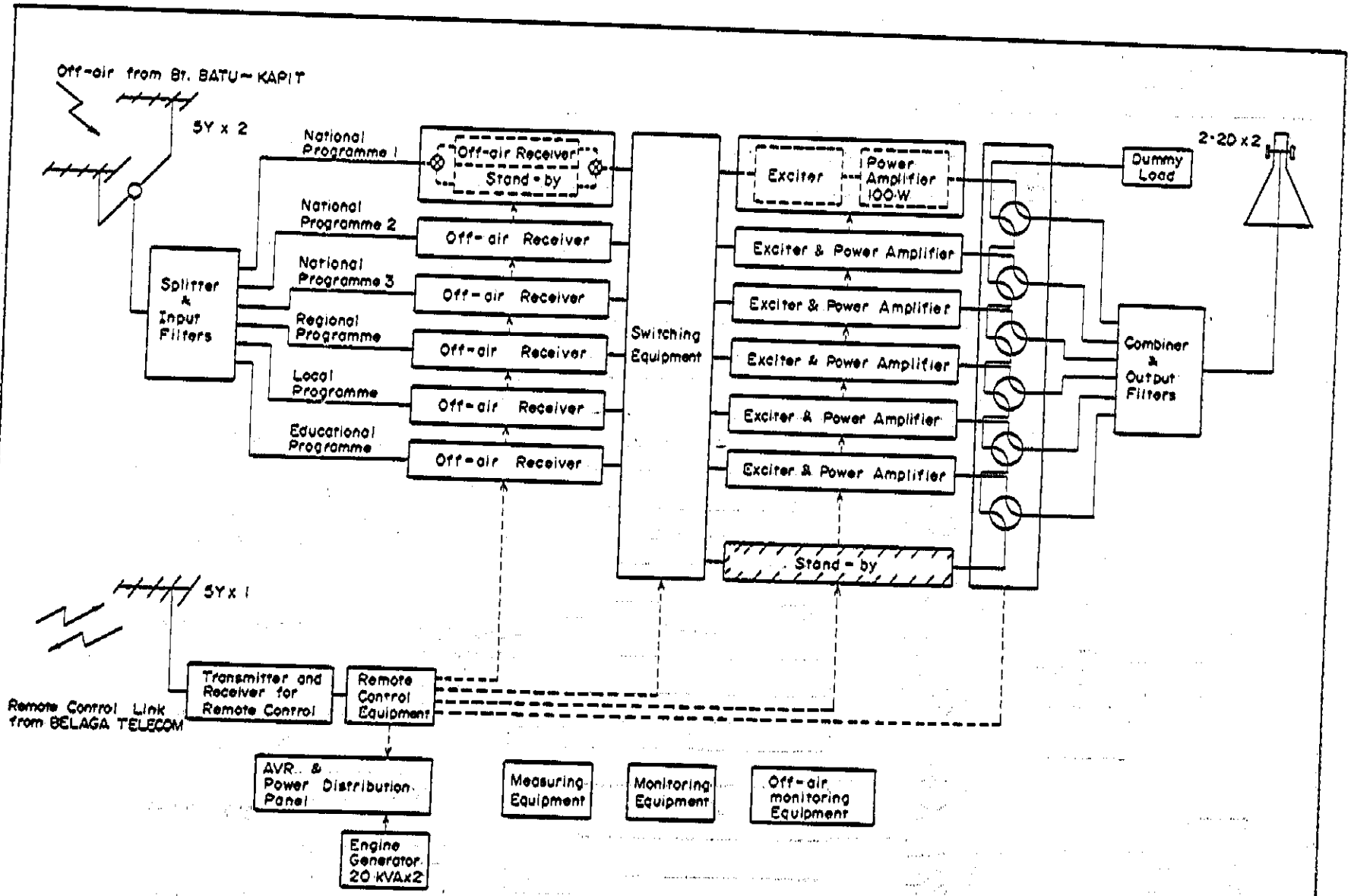


Fig.5-1-22 Schematic Diagram of BELAGA Station (Belaga)

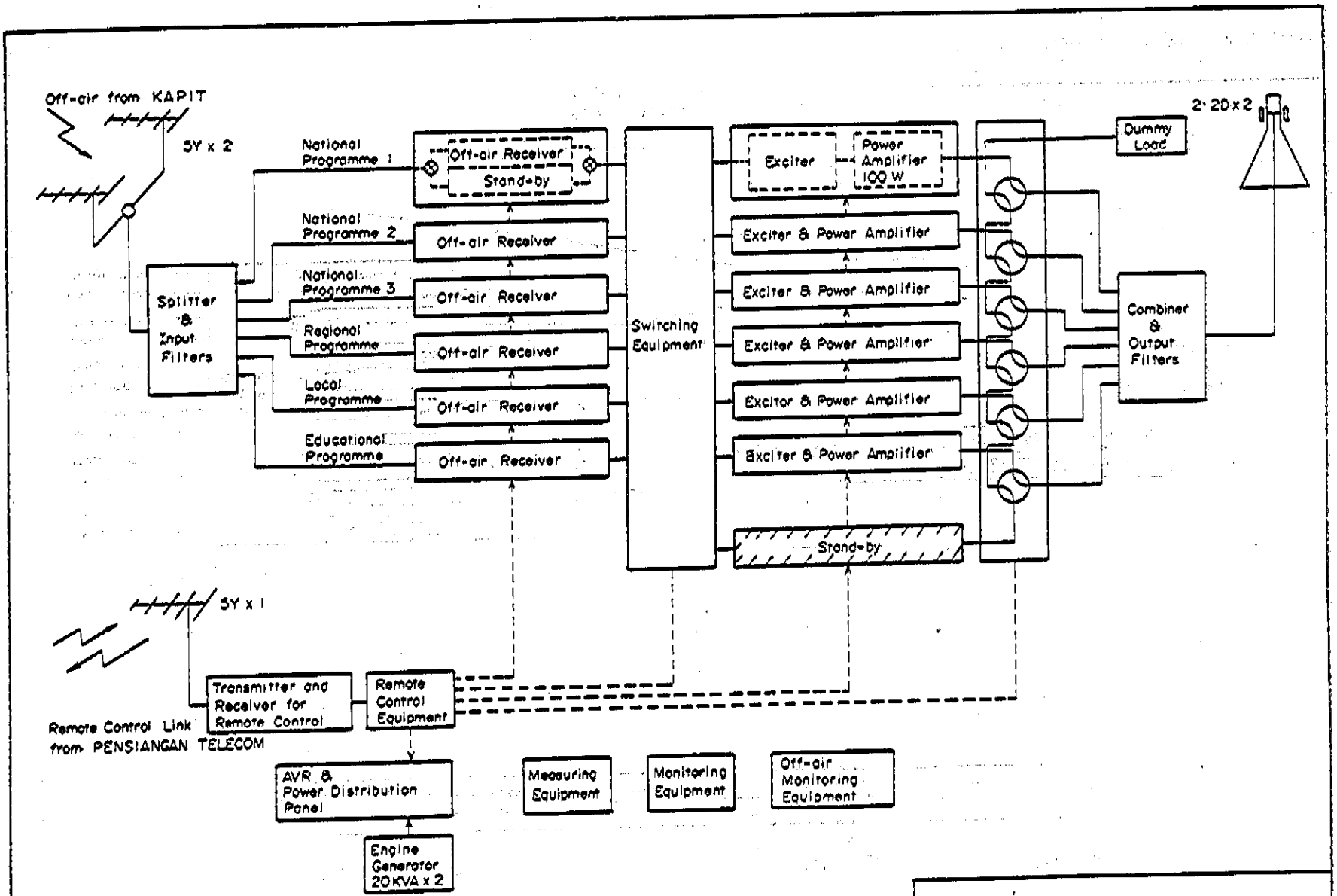


Fig. 5-1-23 Schematic Diagram of St. BATU Station

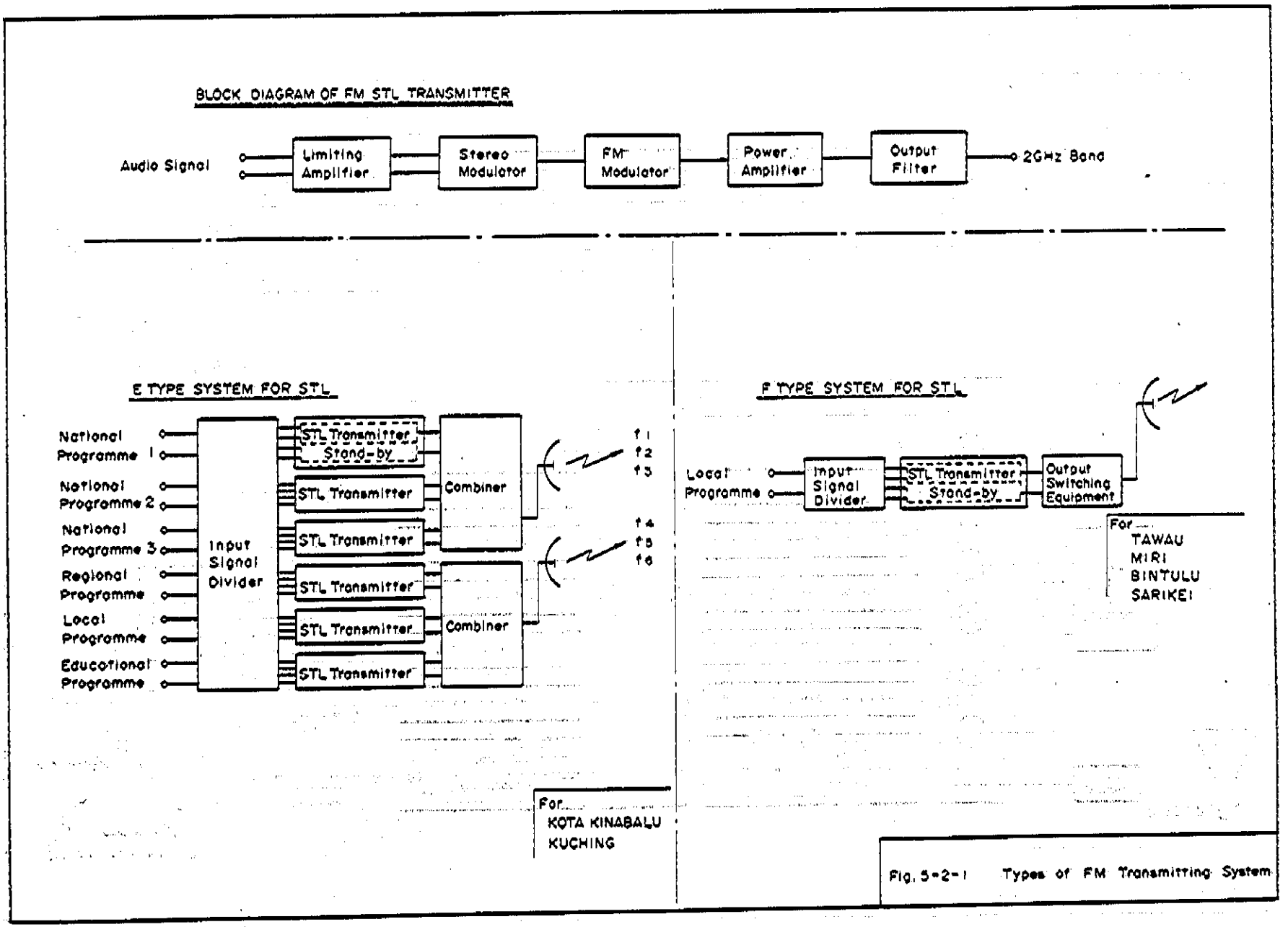


Fig. 5-2-1 Types of FM Transmitting System

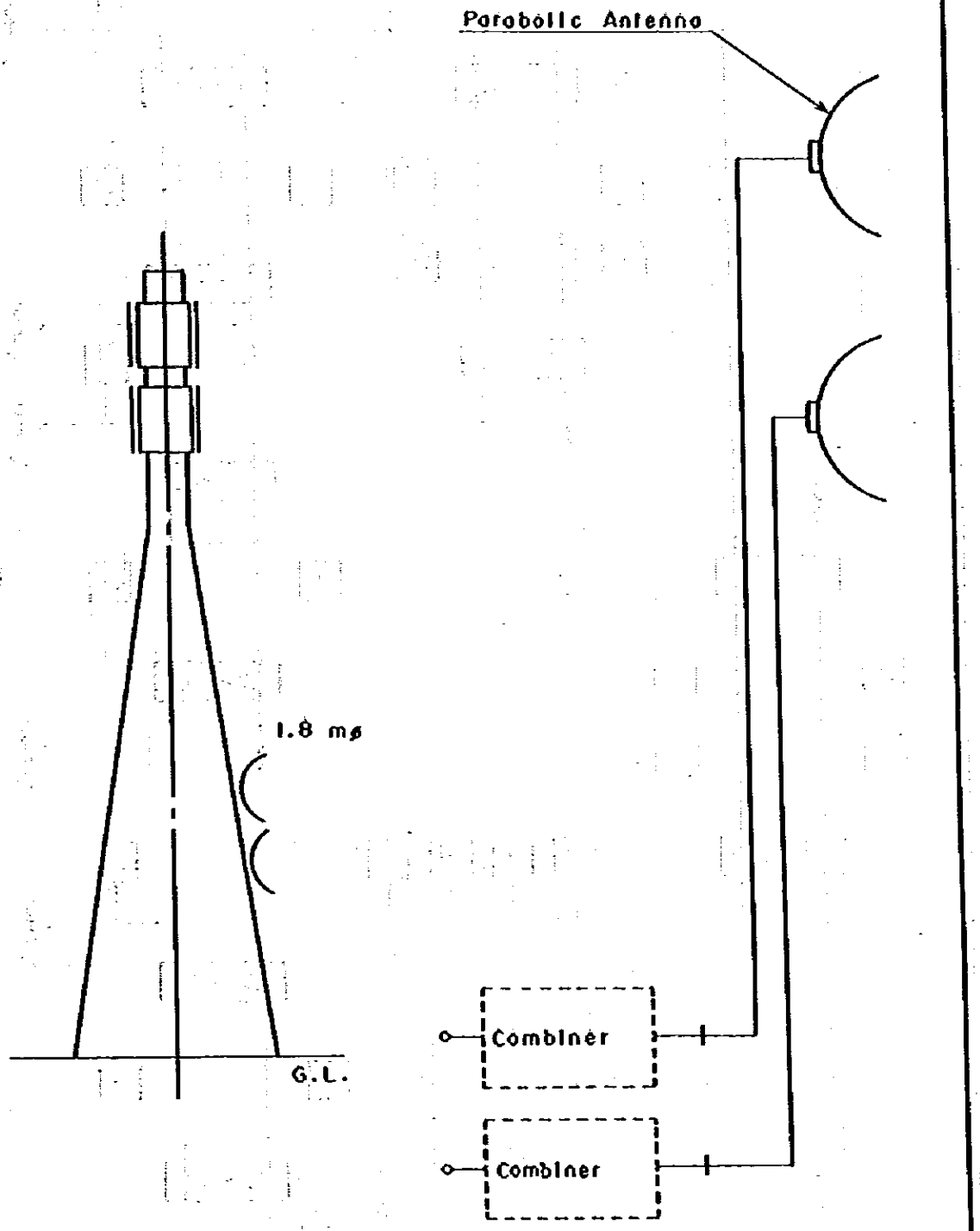


Fig.5-2-2 GENERAL VIEW OF STL TRANSMITTING ANTENNA SYSTEM

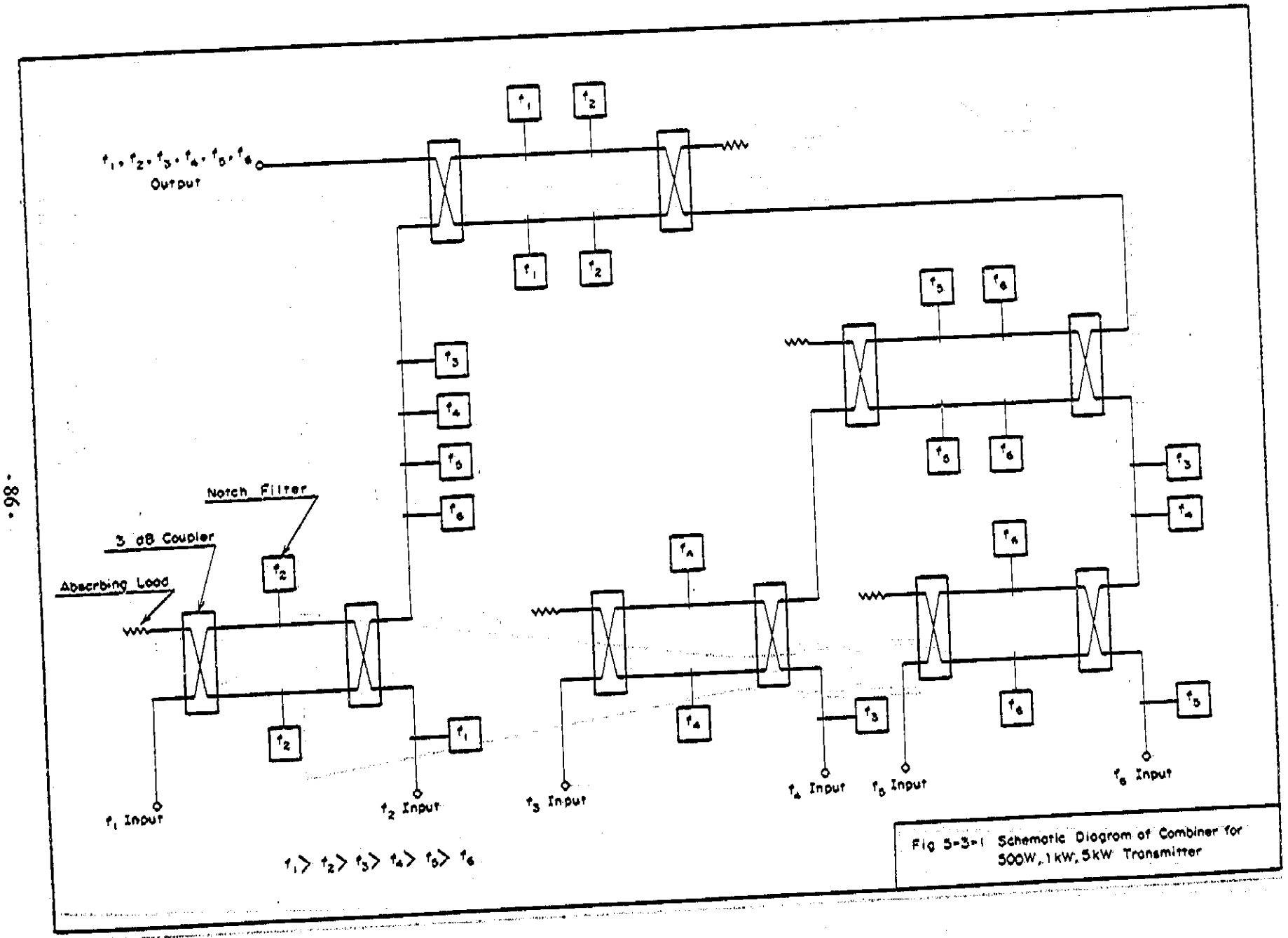


Fig 5-3-1 Schematic Diagram of Combiner for 500W, 1kW, 5kW Transmitter

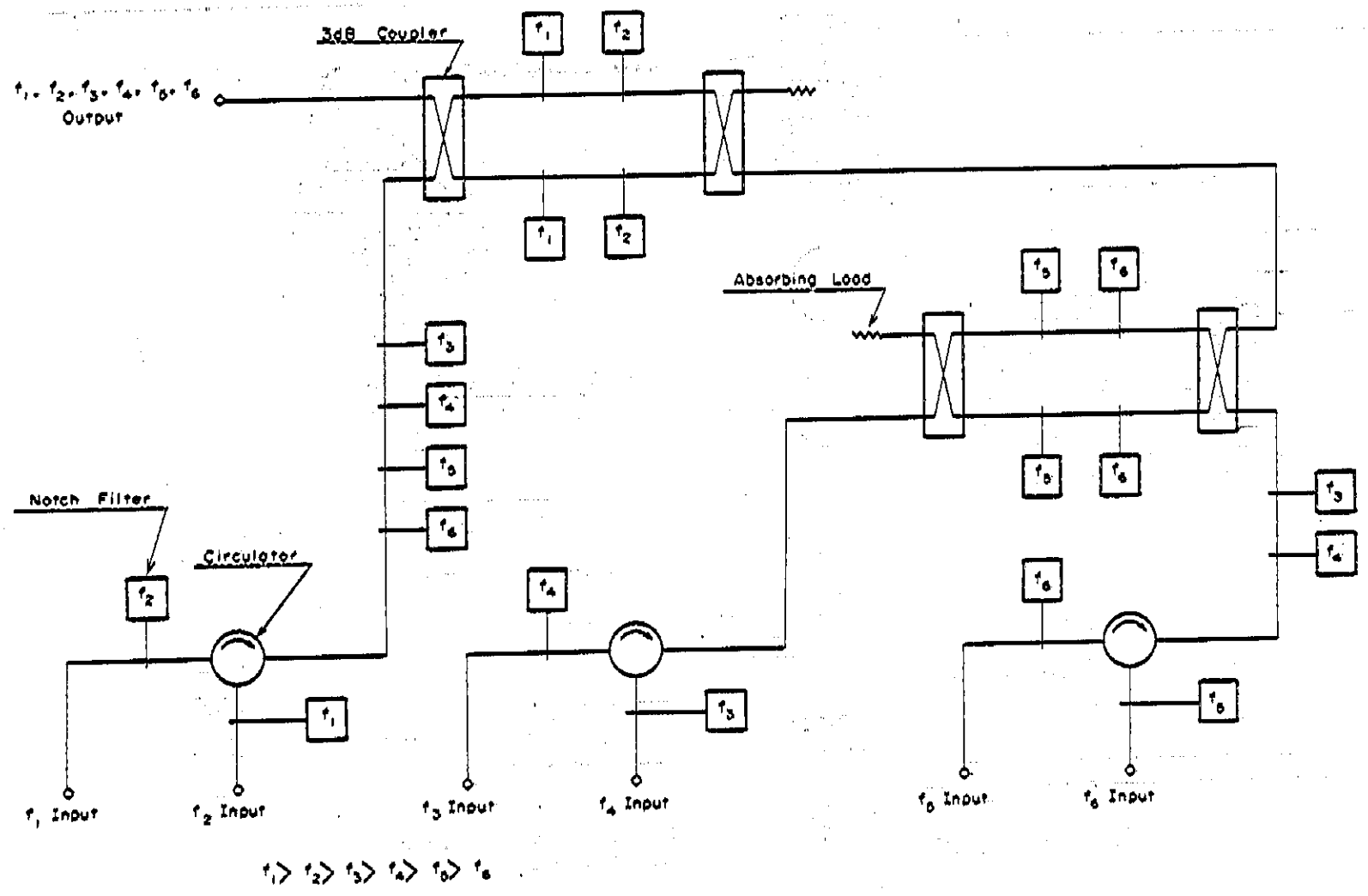


Fig 5-3-2 Schematic Diagram of Combiner for 100W Transmitter

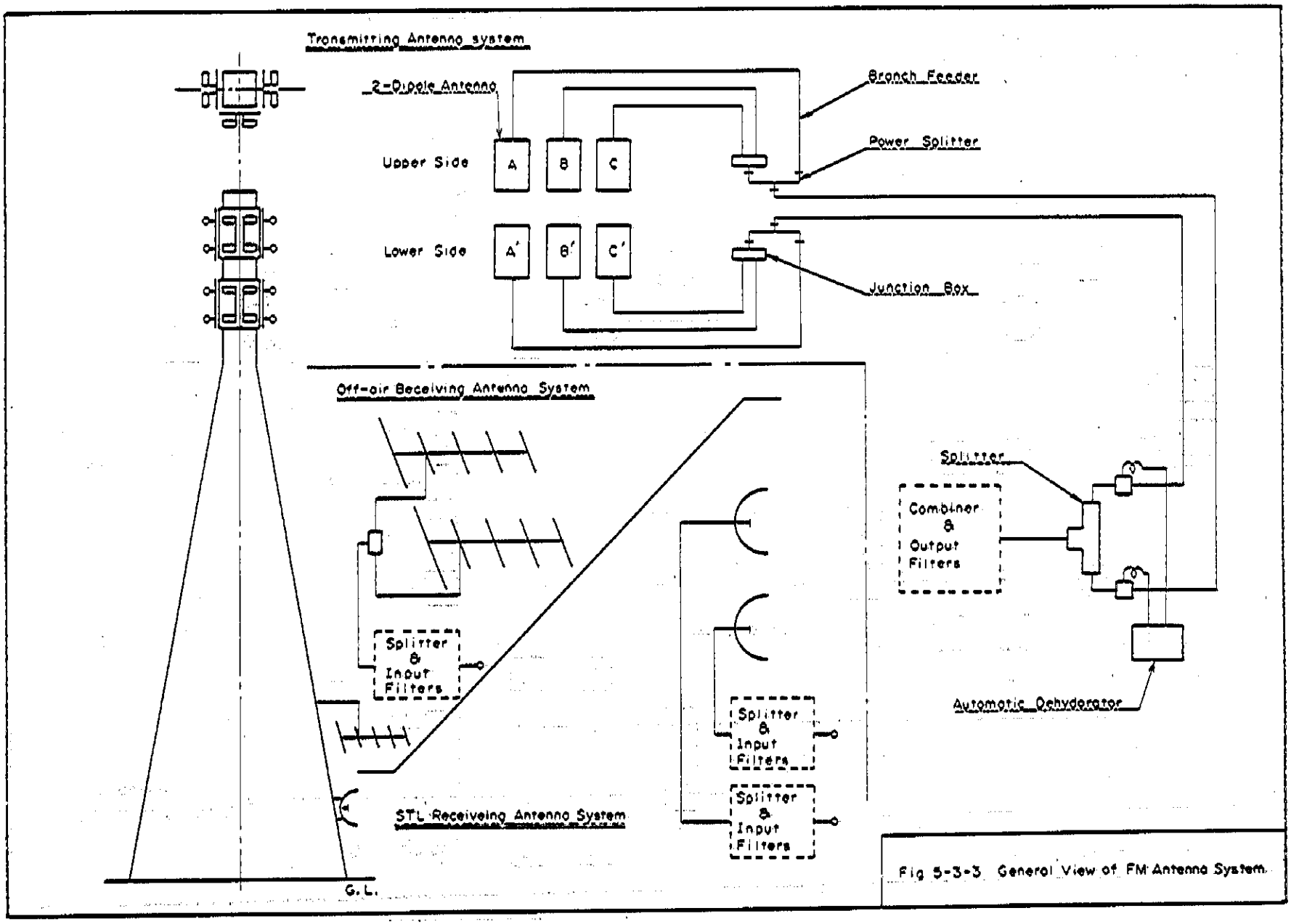


Fig 5-3-3 General View of FM Antenna System