Chapter 2

Contents of the Project

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2-1 Basic Concept of the Project

The Project aims to improve the HF broadcasting facilities (Kundu broadcasting) that were constructed under Japan's Grant Aid in 1988/1989 with the purpose of providing information concerning education, sanitation, public health and agriculture, etc. and thereby improving the standard of living for inhabitants in five targeted provinces.

The anticipated population, that can receive a benefit of Kundu broadcasting in the project provinces, are as follows.

Planned Broadcasting Station	Inhabitant in the province	Benefit population	Benefit population rate
Mt. Hagen (West Highlands Province)	440,025	431,000	98%
Lae (Morobe Province)	539,404	324,000	60%
Kimbe (West New-Britain Province)	184,508	129,000	70%
Vanimo (West-Sepik Province)	185,741	130,000	70%
Goroka (East Highlands Province)	432,972	346,000	80%
Total		1,360,000	

The following equipment shall be supplied by the Project.

Broadcasting Station	Equipment
Mt. Hagen (West Highlands Province)	• FM 3kW Transmitter • FM Transmitting Tower & Antenna • Power-supply • Studio-Equipment
Lae (Morobe Province)	• MF 10kW Transmitter • 80m Transmitting Antenna • Power-supply • Transmitter Shelter • Recording/Player
Kimbe (West New Britain Province)	• MF 10kW Transmitter • 80m Transmitting Antenna • Power-supply • Transmitter Shelter • Recording/Player

Broadcasting Station	Equipment
Vanimo (West Sepik Province)	• MF 10kW Transmitter • 80m Transmitting Antenna • Power-supply • Transmitter Shelter • Studio-Equipment
Goroka (East Highlands Province)	**Goroka Radio Station** • FM 3kW Transmitter • FM Transmitting Tower & Antenna • Power-supply • Transmitter Shelter • Studio-Equipment
	Kainantu FM Relay Station • FM 100W Transmitter& Antenna

Moreover, concerning handling of existing equipment and areas that cannot be covered by the project, NBC has given the following explanation:

- Concerning areas inaccessible from Kundu broadcasting, NBC itself will construct relay stations.
- Concerning handling of existing equipment, it is planed to jointly use with HF equipment in Lae, Vanimo and Kimbe in order to cover inaccessible districts for the time being. Equipment shall be scrapped at Mt. Hagen and Goroka.

2-2 Basic Design of the Requested Japanese Assistance

2-2-1 Design Policy

(1) Site Selection

As the government based broadcasting corporation of PNG, NBC conducts Karai broadcasting (nationwide general broadcasting in English) and Kundu broadcasting (provincial broadcasting in local languages). The Kundu broadcasting is carried out by local stations located in each of the country's 19 provinces. (two were constructed under PNG own fund and 17 were provided under Japan's Grant Aid in 1988/1989).

As a result of basic design study at the eight requested sites, three stations were excepted because acquisition of construction sites and securing of operation and maintenance funding from provincial governments, were difficult, and five stations were eventually selected. (See Table 2-1 Study Summary Sheet for an outline of the survey of the eight sites).

Project Target Sites (5 stations)	Unsuitable Sites (3 stations)
Mt. Hagen (West Highlands Province)	Kundiawa (Chimbu Province)
Lae (Morobe Province)	Wabag (Enga Province)
Kimbe (West New Britain Province)	Wewak (East Highlands Province)
Vanimo (West Sepik Province)	
Goroka (East Highland Province)	

(2) Selection of the Broadcasting Mode

Concerning the selection of broadcasting mode, rather than adhering solely to MF broadcasting as request, it was decided to apply the following criteria taking into account geographical condition for Kundu broadcasting.

HF broadcasting: This mode shall not be adopted in the Project for the following reasons.
Current HF broadcasting will be suspended in 2015 according to ITU recommendations. HF broadcasting adopted in the Project will thus have a remaining service life of 10 years. Moreover, since HF broadcasting has poor sound quality and is in competition with private broadcasting stations in Papua New Guinea, it was deemed more appropriate to select MF and FM at the expense of some geographical coverage in order to attract listeners.

MF broadcasting: In coastal areas, since transmitting station sites can be secured, MF broadcasting is the best option (Lae, Kimbe, Vanimo)

The sound quality of MF broadcasting has improved in recent times due to utilization of pre-emphasis effect with general receiver-transmitter characteristics. In this sense, MF broadcasting is now able to compete with FM broadcasting in terms of sound quality. Decision of whether to select MF broadcasting or FM broadcasting is mainly dictated by topographical conditions.

As coastal parts of Papua New Guinea stretch over relatively expansive plains and have high ground conductivity, MF broadcasting is more advantageous.

FM broadcasting: In highland areas, FM broadcasting is the optimum option because it enables wide service areas to be secured (Mt. Hagen, Goroka).

This media offers good sound quality and high performance against noise. However, in order to secure service areas wider than MF broadcasting, antenna shall be put on high position.

In other words, when the height difference between the service area and antenna installation height is 100 m, the radio wave coverage is limited to 15 km due to curvature of the globe. However, when higher transmitting station positions can be secured in mountain areas, a broadcasting service area can be secured large area.

Mt. Hagen, for example, many people live in valley areas approximately 300 feet (90 m) below the transmitting point. If a 60 m steel tower is constructed here, the height difference becomes 150 m and service coverage of approximately 40 km can be expected.

(3) Determination of Transmission Frequency and Output Power

Determination was carried out according to the following items.

1) MF Broadcasting

According to frequencies and transmission output power registered in the ITU

2) FM Broadcasting

Frequency allocation: Width of 200 kHz shall be adopted within the allocable bandwidth (87.5-108 MHz). Moreover, width of 800 kHz shall be adopted at same transmitting stations.

Transmitter output power: This shall be determined according to the scope and geographical features, etc. of target broadcasting areas.

3) Frequency Assignment

All assigned frequencies in 6 sites are authorized in writing by PANGTEL in PNG.

(4) Service Areas

The required field strengths in the service area of broadcasting are as follows:

1) MF broadcasting

Daytime: 60 dBu V/m (1 mV/m) (In consideration of external noise and receiver performance)

2) FM broadcasting

Monophonic broadcasting: 48 dBu V/m (0.25 mV/m)

Stereophonic broadcasting: 54 dBu V/m (0.5 mV/m) (According to CCIR Rec. 412-3)

(5) Transmitter Equipment Shelters

In the Radio Station Improvement Project that was implemented in 1988/89, the PNG side constructed transmitting station buildings using its own funds, while the Japan side supplied only transmitter equipment by Grant Aid. That equipment has now entered the wear and tear stage of its life cycle, and deterioration of facilities is caused by damp and insect from out side. In implementing the project, no setting up of administration building for transmitting stations. All equipment shall be installed in container type shelter to prevent a problem of damp, salt damage and insect damage come from outside.

(6) Lifespan of Equipment

Average values of equipment lifespan in Japan are as given in the following table.

Equipment	Average Life
Sound console	12-14 years
FPU	10-12 years
Emergency generator	18 years
Power receiving facility	21 years
Storage battery	8-9 years
Air conditioning	15 years
Blower	15 years
Radio transmitter	18 years

The above table is based on provision of an appropriate equipment environment and proper preventive maintenance, and thus cannot be directly applied to PNG.

The lifespan of equipment planned in the Project is as follows.

Equipment	Design Life Span	Basis
Sound console	5-7 years	Use a professional model with guaranteed parts supply of five years.
FPU	7 years	Preventive maintenance is difficult, like in Japan
Emergency generator	12 years	Same as above
Power receiving facility	14 years	Same as above
Air conditioning	7years	Taking climate into account (twice as much usage as in Japan)
Blower	10 years	Preventive maintenance is difficult, like in Japan
Radio transmitter	12 years	Same as above

(7) Spare Parts Supply Guarantee

Supply of genuine spare parts is guaranteed for 5 years in the case of professional equipment and 10 years in the case of broadcasting equipment. These guarantee periods rise to 7 years and 15 years respectively when it comes to equivalent parts to the above.

Fig. 2-1 Project Outline Drawing

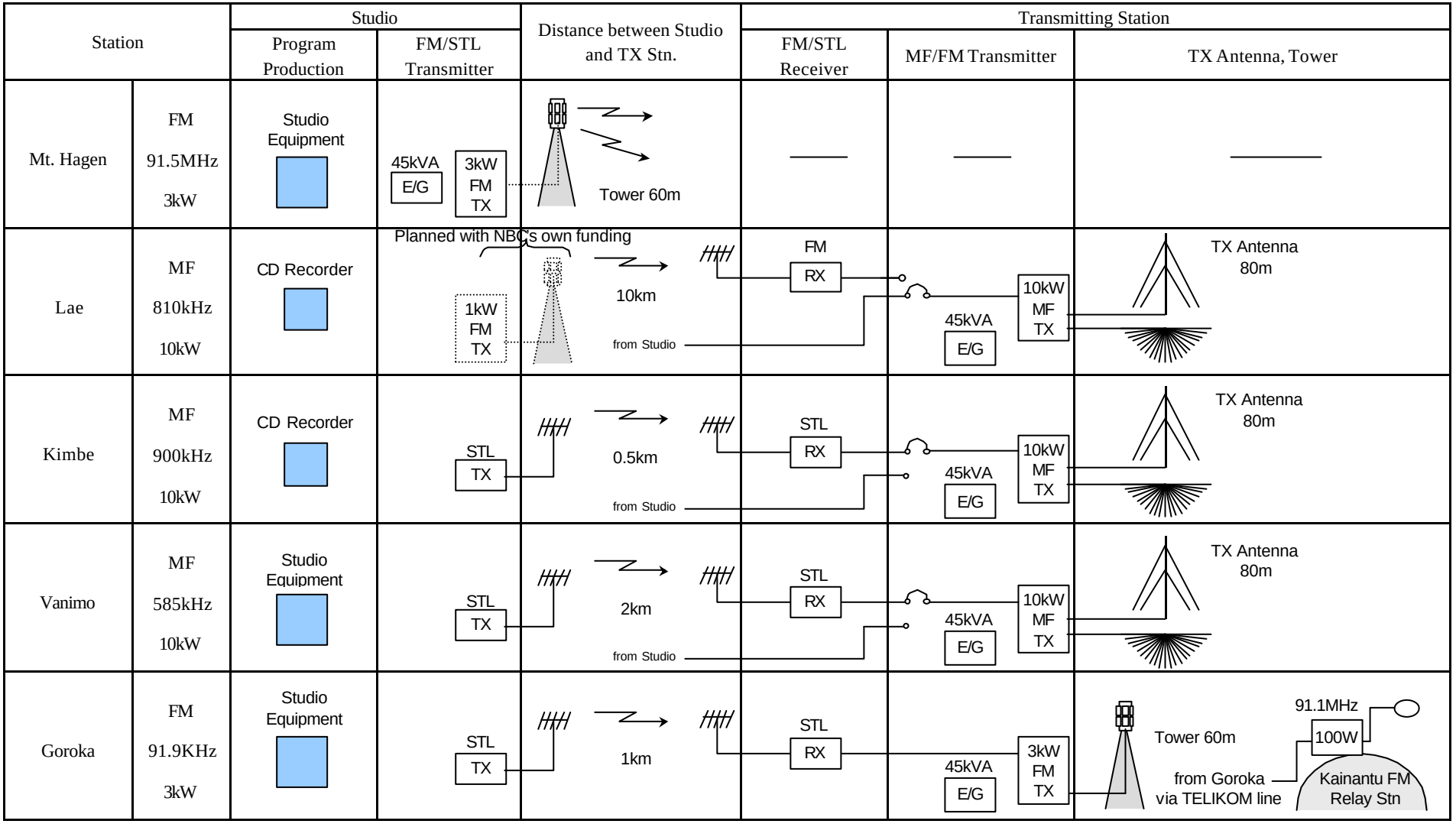


Table 2-1 Study Summary Sheet

Site (Province)	Feasibility of MF/FM Transmitting Station Construction					Broadcasting Current Conditions and Operation and Maintenance Capacity			
	Appropriate Broadcasting Mode		Expected Population Coverage (1,000 people)	Transmitter Installation	Transmitting Tower Transmitter Output	Broadcasting Conditions and Budget Situation	Future Support Policy of Provincial Government (Possibility of Commercial Broadcasting)	Operation and Maintenance	Features and Notes
	MF	FM							
① Kundiawa [Simbu]	× Survey of 2 sites Land is small	× No land	—	—	—	• The current operating cost subsidy is small. • Broadcasting has been suspended for 1.5 months because of non-payment of the electricity tariff.	• The governor is very enthusiastic about enhancing broadcasting. • Increased operating budget is promised, but doubts remain over operation and maintenance.	Difficult	
② Mt. Hagen [West Highlands]	× Land is small	○ Next to station building	FM: 98% (431)	Inside station building	Self-supporting 60 m, 3 kW	• Operating costs are almost totally secured. • Broadcasting is suspended from early morning till 08.00 in order to save on electricity expenses. • Sanitary, economic and social programs are currently broadcast in Kundu Service.	• Commercial broadcasting is scheduled in central commercial areas within the highlands.	Possible	• This area already has two existing FM station, so FM is appropriate. • Population coverage here is the highest in the country. • Coffee production area and tourism area
③ Lae [Morobe]	○	× Expected coverage is low	MF: 60% (323)	Shelter	Guyed-mast 80 m, 10 kW	• Financial support by the provincial government is clearly indicated. • There is enough operating budget. • Equipment renewal using own funds is possible in future.	• The provincial government has promised continued support. • Closer cooperation with NBC is stressed. • Commercials are already underway on a trial basis.	Possible	• Population coverage is second highest. • A commercial city and important base for port transportation
④ Kimbe [West New Britain]	○	× Expected coverage is low	MF: 70% (129)	Shelter	Guyed-mast 80 m, 10 kW	• Financial support changes every year. • In 2001, studio equipment was renewed using provincial funds • Broadcasting is suspended from early morning till 08.00 in order to save on electricity expenses. • There is a large response from listeners.	• The provincial government has promised support of operating expenses. • The province understands the importance of broadcasting in education, sanitation, economic development and disaster countermeasure policies. • Commercials are already underway on a trial basis.	Possible	• Relations are close between the provincial government and NBC. • This year, damage was incurred by volcanic eruption.

Site (Province)	Feasibility of MF/FM Transmitting Station Construction					Broadcasting Current Conditions and Operation and Maintenance Capacity			
	Appropriate Broadcasting Mode		Expected Population Coverage (1,000 people)	Transmitter Installation	Transmitting Tower Transmitter Output	Broadcasting Conditions and Budget Situation	Future Support Policy of Provincial Government (Possibility of Commercial Broadcasting)	Operation and Maintenance	Features and Notes
	MF	FM							
⑤ Vanimo [West Sepik]	○	× Expected coverage is low	MF: 70% (130)	Shelter	Guyed-mast 80 m, 10 kW	• The station receives planned and certain financial support. • There is enough operating budget. • Broadcasting has been suspended for three months because of wait for spare parts.	• The governor highly values broadcasting and has promised continued financial support. • Commercial broadcasting is planned.	Possible	• Equipment renewal in future is certainly possible with own funds. • Tsunami disasters have caused numerous fatalities in past years. Kundu broadcasting is effective for transmitting information in emergencies.
⑥ Wabag [Enga]	× Land is restricted	× Expected coverage is low.	—	—	—	• The station is struggling to raise operating budget. • Broadcasting has been suspended since September 2002 due to troubles with citizens.	• Meeting with the governor was cancelled. • It is not clear if financial support is available.	Difficult	• Civil order is very poor and works execution is difficult in this province. • Telephone lines are disconnected.
⑦ Goroka [E. Highlands]	× Land is restricted	○ NBC land	FM: 70% (346)	Small shelter	Self-supporting 60 m, 3 kW	• Operating cost subsidies are currently small. • Programs are divided between Kundu and Karai programs (using Karai broadcasting equipment) for electricity conservation purposes.	• The governor is very enthusiastic about broadcasting and has committed financial support. • It is planned to implement commercial broadcasting.	Possible	• Installation of Kainantu relay station should raise expected coverage to 80%.
⑧ Wewak [East Sepik]	× Since this site is next to an airport, transmitting antenna cannot be installed.	× Expected coverage is low.	—	—	—	• Financial support is unclear. • The station is having trouble raising operating expenses. • Broadcasting has been suspended for 1 year because of non-payment of the electricity tariff.	• Support from the provincial government is difficult.	Difficult	• Without financial support, even if a station is constructed, it cannot be operated.

(8) Construction Methods Taking Natural and Social Conditions into Account

1) The six sites in the project cover a wide area including coastline, islands and highland areas, and detailed consideration will need to be given to works schedules because natural conditions and even the timing of rainy and dry seasons differ in each region.

2) In particular, construction of MF transmitting antennas as well as radial earth, and FM transmitting antennas and transmitting towers shall be carried out in low rainfall season in each area.

3) MF transmitting antennas in coastal and island areas located close to the seashore will need to have countermeasures against salt damage.

4) In those Project sites that are hot and damp throughout the year, equipment installation sites shall be adequately prepared so as to enable long-term and stable operation of the transmitting equipment.

5) Concerning transmitter shelter installation methods and installation places, measures shall be taken into account against localized torrential rain during the rainy season.

(9) Procurement Plan

- Project equipment is divided between three MF stations and three FM stations. Concerning FM Transmitter, since domestic production in Japan has been greatly reduced, if procurement is limited to domestic products only, they will need to be specially ordered and will be very expensive. Therefore, it is appropriate to also include third-country products (OECD countries).
- Concerning other transmitter, domestic products shall be adopted.

(10) Local Contractor Utilization Plan

Installation methods that local contractors are familiar with shall be adopted. Moreover, it is desirable that existence of local agents be made a selecting condition for maintenance of emergency generator and air conditioners in order to make maintenance more smooth after completion of the project.

Utilization of local contractors shall be considered in the following works.

- Floor foundation works for transmitter shelters and emergency generator
- Antenna and steel tower foundation works
- Inland transportation

- General labor

(11) Works Period

Works shall be completed within 11 months after the contract.

(12) Socioeconomic Conditions

The receiver ownership situation according to UNESCO statistics is as follows.

Year	Radio Receiver		TV	
	Total Owned Number	Number /1000 people	Total Owned Number	Number /1000 people
1970	80,000	33	—	—
1975	110,000	40	—	—
1980	180,000	58	—	—
1985	230,000	67	—	—
1990	280,000	73	9,000	2.3
1991	288,000	73	9,000	2.3
1992	298,000	74	10,000	2.5
1993	310,000	75	12,000	2.8
1994	320,000	76	12,000	2.9
1995	330,000	77	15,000	3.5
1996	400,000	91	40,000	9.1
1997	410,000	91	42,000	9.3

The sales prices of TV sets and radios in supermarkets are as follows:

Portable radio (HF, MF, FM) : 35 kina
Radio cassette (HF, MF, FM) : 240 kina
20 inches TV set : 1052 kina

The following table gives a case of annual salaries at a provincial NBC broadcasting station.

Staff No.	Job Description	Annual Salary (kina)
No.1	Station manager	24,076.00
No.2	Vice station manager	21,840.00
No.3	Senior staff (grade 7)	14,939.00
No.4	Senior staff (grade 7)	14,939.00

Staff No.	Job Description	Annual Salary (kina)
No.5	Senior staff (grade 7)	16,474.00
No.6	Senior staff (grade 6)	12,090.00
No.7	Senior staff (grade 5)	9,821.00
No.8	Senior staff (grade 5)	9,821.00
No.9	Senior staff (grade 6)	10,088.00
No.10	Senior staff (grade 4)	8,990.00
No.11	Driver (grade 2)	7,960.00

Judging from the above receiver prices and salary levels, the UNESCO figures for receiver ownership are too low, because according to interviews carried out in PNG, it seems ownership also including car radios is far more widespread.

If improvement of radio program content it is made as project object as necessary information for improving the standard of living of inhabitants, education, health and agriculture etc., it should be possible to increase the number of audiences.

(13) Policy for the Operation and Maintenance by the Implementing Agency

Following the revision of the low in 1996, the Kundu broadcasting utility has been operated under irregular funding with the central government furnishing personnel expenses and provincial governments covering operation and maintenance costs.

In the Project, in order to ensure definite financial support from provincial governments and to stabilize operation and maintenance of Kundu broadcasting, the Study Team met with provincial governors and officials to confirm the necessity of Kundu broadcasts in each province and secure commitment for financial support.

2-2-2 Basic Plan

2-2-2-1 Equipment Plan

Equipment composition at each station is as follows.

Station	Description	Expected coverage
Mt. Hagen (Western Highlands Province)	3kW FM Transmitter	98%
Lae (Morobe Province)	10kW MF Transmitter	60%
Kimbe (West New Britain Province)	10kW MF Transmitter	70%
Vanimo (West Sepik Province)	10kW MF Transmitter	70%
Goroka (Eastern Highlands Province)	3kW FM + 100W FM Relay	80%

Major items of equipment in the project are outlined below.

- MF transmitter

  The output power of transmitter is 10 kW. Adopt digital AM modulation and cut down on floor space and power consumption. Use clock control and manual control for starting and stopping transmitter.

- MF transmitting antenna

  An 80 m stayed base-insulation antenna with top loading having a regular triangular angular steel truss structure is adopted.

  Lightning conductor and airplane warning lights shall be attached to the top of the tower, and the tower body is painted referred to ICAO Regulations. When designing this antenna and the transmitting tower are referred to the EIA (Electric Industries Association) internationally widespread guideline RS-222.

- FM transmitter

  The output power of transmitter is 3 kW. Adopt AM-FM stereophonic modulation. Use clock control and manual control for performing transmitter start and stop.

- FM transmitting tower

  The tower is a 60 m high self-supporting type, and a 2-dipole FM transmitting antenna is installed on top. In order to minimize weight of the tower body and enable easy transportation and assembly of members, an angular steel truss structure is adopted.

  A ladder is fitted to the top of the tower to house the cable feeder rack. Lightning conductor and airplane warning lights shall be attached to the top of the tower, and the

tower body is painted referred to ICAO Regulations.

- FM Relay station

  Out put power of FM repeater transmitter is 100W, and program signal is transmitted from Goroka station using TELICOM line. Clock control and manual operation shall be used to start and stop of the repeater.

- Transmitter shelter

  In consideration of room temperature rise caused by heat dissipation of Equipment and radiation of sunlight, adopt sealed circuit air-cooling with room temperature set at 26 °C. Air conditioners, ventilation equipment, fluorescent lights and sockets shall be set up, however, shelters shall only accommodate transmitters and peripheral equipment and shall not combine office functions.

- Engine generator

  No automatic functions are adopted for starting and stopping. During power outages, station staff will start generator manually, and the reverse procedure is followed to stop generator when power is restored.

  In particular, concerning emergency generator installed in highland areas, it is given to reduced capacity resulting from high altitude.

  Moreover, main fuel tanks shall have enough capacity to hold a 7-day supply taking into account broadcasting time, frequency of power outages and methods of refueling.

- Studio Equipment

  Studio equipment consists of DAT, CD Rec/Rep and CD Rep based around 12 ch audio mixer. The purpose is to improve the sound quality of studio production and enable continuous transmission of spot programs.

Equipment	Notes
Audio mixer	Input 12ch (Stereophone 8ch Monophonic 4ch)
Digital audiotape recorder/player	Utilizing free write and erase functions to record general studio programs and other materials for program production.
CD Rec/Rep	Utilize the paging function to freely access to required programs. The objective is to edit general program recorded on DAT into one day's programs.
CD Player	
Other	Headphones, ADA, Jack panels, Racks

Moreover, concerning stations where network studio equipment has already been installed by NBC (Lae, Kimbe), it has been decided to install only CD recorders/players.

2-2-2-2 Basic Plan of Equipment for Each Station

(1) Mt. Hagen (West Highlands Province) Improvement Plan

Attach an FM transmitting station to the existing studio and build a 60m steel tower with a 2 dipole 2:2 antenna (1:1:1:1), in order to secure expected coverage of 98%.
The equipment composition is as follows:

Audio equipment for studio	1 set
3 kW FM transmitter	1 set
Transmitting tower 60 m	1 set
Transmitting antenna 2 dipole (1:1:1:1)	1 set
Engine generator 45 kVA	1 set

Table 2-2 Mt. Hagen FM Station Equipment

	Name of Equipment	Quantity	Description
A	**Network Studio Equipment**		
1	Audio Mixer with Console	1 set	with console Input 12 (Mono 4, stereo 8), Prog. Output 2(mono 1, stereo 1)
2	Digital Audio Tape Rec/Rep	1 set	DAT format
3	Compact Cassette Tape Rec/Rep	1 set	
4	CD Rec/Rep	2 sets	Rec: CD-R/CD-RW, Rep:CD/CD-R/CD-RW
5	CD Player	1 set	
6	Telephone Pick-up	1 set	With Telephone Set
7	Audio Monitor Speaker	1 set	For mixing 2, for MCR output 2
8	Headphone	2 sets	For both ears
9	Audio Distribution Amplifier	1 lot	More than 4 output for 1 input, necessary numbers for system construction
10	Audio Jack Panel	1 lot	Necessary numbers for system construction
11	Patch Code	1 set	30cm cable bounded 5 cables × 4, 60cm cable bounded 5 cables × 4
12	Equipment Rack	1 set	
13	Equipment Wagon	1 set	
14	Microphone	1 set	Dynamic type 2, Condenser type 1
15	Microphone Stand	1 set	DJ type 1, Desk type 1, Boom type 1
16	Cough Box	2 sets	
17	Earphone	2 sets	For single ear
18	Microphone Cable	1 set	5m × 3
19	Microphone Connector Panel	1 set	With Box
20	On-air Lamp	2 sets	
21	Guest Table	1 set	
22	Chair for Operation	3 sets	For Studio staff
23	Clock	1 set	Wall type, Quartz

	Name of Equipment	Quantity	Description
B	**Transmitting Station**		
1	Program Input and Monitoring Equipment	1 set	Line transformer, limiting amplifier, level meter, audio monitor
2	FM Transmitter	1 set	3kW, 91.5MHz
3	Output Change-over Switch	1 set	For antenna/dummy load
4	Dummy Load	1 set	3kW
5	Feeder Cable	1 set	With Dehydrator
6	Transmitting Antenna	1 set	2 dipole antenna (1:1:1:1), Power divider, FM Transmitting tower with obstruction light & obstruction marking by ICAO (60m height)
7	Clock	1 set	Wall type, quartz
8	Monitor Receiver	2 sets	FM band for transmitter and studio side
9	Air Conditioner	1 set	Cooling only, Wall type (8,000kcal/hour), for new TX room
10	Power Distribution Facility	1 set	Isolation transformer (35kV), automatic voltage regulator (30kVA), power distribution board
11	Exhaust Fan		With hood & shutter ($45m^3$/min, operation at more than 40°C), for new TX room
12	Engine Generator	1 set	Outdoor type engine generator (45kVA), with sunshade, fuel tank, fuel pump, city power/generator power change-over switch
13	Measuring Instrument	1 set	
	Audio Character Test Equipment	1	Audio frequency band, level & distortion, measurement with Oscillator
	Oscilloscope	1	150mm, more than 2 channel
	Variable Attenuator	1	Audio frequency band
	VHF Electric Field Strength Meter	1	VHF band
	FM Liner Detector	1	
	FM Demodulator	1	
	Circuit Tester	1	Voltage: AC/DC, current: DC, resistance
	Insulation Resistance Tester	1	500V/100MΩ
	Clump Meter	1	AC/DC Current
14	Tool Set	1 set	30 kinds of tool
15	Standard Accessories	1 set	
16	Essential Spare Parts	1 set	
17	Consumable Spare Parts	1 set	CD-R/CD-RW disc, digital audio tape, compact cassette tape
18	Installation Materials	1 set	Co-axial feeder, copper plate for earthling work, earthing wire, audio cable, power cable, all kinds of connector

(2) Lae (Morobe Province) Improvement Plan

Broadcasting frequency is used 810kHz assigned by ITU. New MF antenna is installed on land 170m away from the existing antenna (for Karai broadcasting), in order to reduce mutual interference. Also, install rejection coils in the existing and new ATU station in order to eliminate induced power. Transmitter output is 10 kW and aim for a service area of 60%. Use the existing TELICOM lines as program lines. Receive FM signals from Lae station when the FM station there planned by NBC is completed, and use this line as the main program line and the existing Telecom line as backup. Install an FM receiver in order to receive FM signals from Lae station.

Concerning the studio, no additional installation is required because a studio constructed under support by the provincial government can be used. However, two CD Rec/Rep are installed for spot program transmission.

The equipment composition is as follows:

CD Rec/Rep	2 sets
FM receiver	1 set
10 kW MF transmitter	1 set
MF Transmitting antenna (top loading type) 80 m	1 set
Engine generator 45 kVA	1 set
Transmitter shelter	1 set

Table 2-3 Lae MF Station Equipment

	Name of Equipment	Quantity	Description
A	**Network Studio Equipment**		
1	CD Rec/Rep	2 sets	Rec: CD-R/CD-RW, Rep:CD/CD-R/CD-RW
B	**Studio Transmitter Link**		
1	FM Receiver	1 set	FM band, Monaural output
2	FM Receiving Antenna	1 set	Yagi antenna with supporting , Feeder cable
C	**Transmitting Station**		
1	Program Input and Monitoring Equipment	1 set	Line transformer, line equalizer, limiting amplifier, level meter, audio monitor
2	Medium Frequency Transmitter	1 set	10kW, 810kHz
3	Output Change-over Switch	1 set	For antenna/dummy load
4	Dummy Load	1 set	15kW
5	Feeder Cable	1 set	with Dehydrator
6	Antenna Tuning Unit	1 set	Outdoor type, feeder/antenna matching, with existing TX frequency (675kHz) Rejecter
7	Medium Frequency Transmitting Antenna	1 set	Angle truss type, top loading. Base insulated guyed mast with obstruction light & obstruction marking by ICAO (80m height), radial earth (120 wires, radius 80m)
8	Clock	1 set	Wall type, quartz
9	Monitor Receiver	1 set	Medium frequency band for studio side
10	Air Conditioner	1 set	Cooling only, wall type (8,000kcal/hour), for TX shelter
11	Power Distribution Facility	1 set	Isolation transformer (45kVA), automatic voltage regulator (40kVA), power distribution board
12	Transmitter Shelter	1 set	Approx. size: 6m (D) × 2.5m (W) × 2.5m (H), with exhaust fan and Sunshade
13	Engine Generator	1 set	Outdoor type engine generator (45kVA) with sunshade, fuel tank, fuel pump, city power/generator power change-over switch
14	Tool Set	1 set	30 kinds of tool
15	Standard Accessories	1 set	

	Name of Equipment	Quantity	Description
16	Essential Spare Parts	1 set	
17	Consumable Spare Parts	1 set	CD-R/CD-RW disc
18	Installation Materials	1 set	Co-axial feedercopper plate for earthing work, earthing wire, audio cable, power cable, all kinds of connector

(3) Kimbe (West New Britain Province) Improvement Plan

Broadcasting frequency is used 900kHz assigned by ITU. New MF antenna is install existing transmitting station. Transmitter output is 10 kW and aim for a service area of 70%. Also, a UHF 470MHz band STL wireless line is provided for transmitting programs between studio and transmitting station.

Concerning the studio, no additional installation is required because a studio constructed under support from the provincial government can be used. However, two CD Rec./Rep for commercial sending-out shall be installed.

The equipment composition is as follows:

CD Rec/Rep	2 sets
STL equipment	1 set
10 kW MF transmitter	1 set
MF Transmitting antenna (top loading type) 80 m	1 set
Engine generator 45 kVA	1 set
Transmitter shelter	1 set

Table 2-4 Kimbe MF Station Equipment

	Name of Equipment	Quantity	Description
A	**Network Studio Equipment**		
1	CD Rec/Rep	2 sets	Rec: CD-R/CD-RW, Rep: CD/CD-R/CD-RW
B	**Studio Transmitter Link**		
1	Transmitter	1 set	470MHz band FM
2	Transmitting antenna	1 set	Corner reflector antenna with Supporting pole, Feeder cable
3	Receiver	1 set	470MHz band FM
4	Receiving Antenna	1 set	Corner reflector antenna with supporting pole, Feeder cable
5	Limiting Amplifier	1 set	
C	**Transmitting Station**		
1	Program input and monitoring equipment	1 set	Line transformer, line equalizer, limiting amplifier, level meter, audio monitor
2	Medium frequency transmitter	1 set	10kW, 900kHz
3	Output change-over switch	1 set	For antenna/dummy load
4	Dummy load	1 set	15kW
5	Feeder cable	1 set	With dehydrator
6	Antenna tuning unit	1 set	Outdoor type, feeder/antenna matching
7	Medium frequency transmitting antenna	1 set	Angle truss type, top loading. Base insulated guyed mast with obstruction light & obstruction marking by ICAO (80m height), radial earth (120 wires, radius 80m)
8	Clock	1 set	Wall type, quartz
9	Monitor Receiver	1 set	Medium frequency band for studio side
10	Air Conditioner	1 set	Cooling only, wall type (8,000 kcal/hour) for TX shelter
11	Power Distribution Facility	1 set	Isolation transformer (45kVA), automatic voltage regulator (40kVA), power distribution board
12	Transmitter Shelter	1 set	Approx. size: 6m (D) × 2.5m (W) × 2.5m (H) with exhaust fan and Sunshade

	Name of Equipment	Quantity	Description
13	Engine Generator	1 set	Outdoor type engine generator (45kVA) with sunshade, fuel oil tank, fuel oil pump, city power/generator power change-over switch
14	Measuring Instrument	1 set	
	Audio Character Test Equipment	1	Audio frequency band, level & distortion measurement with Oscillator
	Oscilloscope	1	150mm, more than 2 channel
	Variable Attenuator	1	Audio frequency band
	Medium Frequency Electric Field Strength Meter	1	MF band
	Circuit Tester	1	Voltage: AC/DC, Current: DC, resistance
	Insulation Resistance Tester	1	500V/100MΩ
	Clump Meter	1	AC/DC current
15	Tool Set	1 set	30 kinds of tool
16	Standard Accessories	1 set	
17	Essential Spare Parts	1 set	
18	Consumable Spare Parts	1 set	CD-R/CD-RW disc
19	Installation Materials	1 set	Co-axial feeder, copper plate for earthling work, earthing wire, Audio cable, power cable, all kinds of connector

(4) Vanimo (West Sepik Province) Improvement Plan

Broadcasting frequency is used 585kHz assigned by ITU. New MF antenna is installed on the position of 130 m away from the existing antenna (for Karai broadcasting), in order to reduce mutual interference. Moreover, in order to handle the frequency of use, this new MF antenna shall be a top loading type utilizing part of the top branch line, and antenna gain shall be increased by uniformly extending the antenna height. Also, install rejection coils in the existing and new ATU in order to eliminate induced power. Transmitter output is 10 kW and aim for a service area of 70%. Also, a 470 MHz band STL wireless line shall be provided for transmitting programs between studio and transmitting station.

The equipment composition is as follows:

Audio equipment for studio	1 set
STL equipment	1 set
10 kW MF transmitter	1 set
MF Transmitting antenna (top loading type) 80 m	1 set
Engine generator 45 kVA	1 set
Transmitter shelter	1 set

Table 2-5 Vanimo MF Station Equipment

	Name of Equipment	Quantity	Description
A	**Network Studio Equipment**		
1	Audio Mixer	1 set	With Console Input 12 (mono 4, stereo 8), Prog. Output (mono 1, stereo 1)
2	Digital Audio Tape Rec/Rep	1 set	DAT format
3	Compact Cassette Tape Rec/Rep	1 set	
4	CD Rec/Rep	2 sets	Rec: CD-R/CD-RW, Rep: CD/CD-R/CD-RW
5	CD Player	1 set	
6	Telephone Pick-up	1 set	With Telephone set
7	Audio Monitor Speaker	1 set	For mixing 2, for MCR output 2
8	Headphone	2 sets	For both ears
9	Audio Distribution Amplifier	1 lot	More than 4 output for 1 input, necessary numbers for system construction
10	Audio Jack Panel	1 lot	Necessary numbers for system construction
11	Patch Code	1 set	
12	Equipment Rack	1 set	
13	Equipment Wagon	1 set	
14	Microphone	1 set	Dynamic type 2, condenser type 2
15	Microphone Stand	1 set	DJ type 1, desk type 1, boom type 1
16	Cough Box	2 sets	
17	Earphone	2 sets	For single ear
18	Microphone Cable	1 set	5m × 3
19	Microphone Connector Panel	1 set	With Box
20	On-air Lamp	2 sets	
21	Guest Table	1 set	
22	Chair for Operation	3 sets	For studio stuff
23	Clock	1 set	Wall type, quartz

	Name of Equipment	Quantity	Description
B	**Studio Transmitter Link**		
1	Transmitter	1 set	470MHz band FM
2	Transmitting Antenna	1 set	Corner reflector antenna with Supporting pole, Feeder cable
3	Receiver	1 set	470MHz band FM
4	Receiving Antenna	1 set	Corner reflector antenna with, Feeder cable
5	Limiting Amplifier	1 set	
C	**Transmitting Station**		
1	Program Input and Monitoring Equipment	1 set	Line transformer, line equalizer, limiting amplifier, level meter, audio monitor
2	Medium Frequency Transmitter	1 set	10kW, 585kHz
3	Output Change-over Switch	1 set	For antenna/dummy load,
4	Dummy Load	1 set	15kW
5	Feeder Cable	1 set	With Dehydrator
6	Antenna Tuning Unit	1 set	Outdoor type, feeder/antenna matching with existing TX frequency (1,593kHz) rejecter
7	Medium Frequency Transmitting Antenna	1 set	Angle truss type, top loading, Base insulated guyed mast with obstruction light & obstruction marking by ICAO (80m height), radial earth (120 wires, radius 80m)
8	Clock	1 set	Wall type, quartz
9	Monitor Receiver	1 set	Medium frequency band, for studio side
10	Air Conditioner	1 set	Cooling only, wall type (8,000kcal/hour) for TX shelter
11	Power Distribution Facility	1 set	Isolation transformer (45kVA), automatic voltage regulator (40kVA), power distribution board
12	Transmitter Shelter	1 set	Approx. size: 6m (D) × 2.5m (W) × 2.5m (H) with exhaust fan and Sunshade
13	Engine Generator	1 set	Outdoor type engine generator (45kVA) with sunshade, fuel tank, fuel pump, city power/generator power change-over switch
14	Tool Set	1 set	30 kinds of tool
15	Standard Accessories	1 set	

	Name of Equipment	Quantity	Description
16	Essential Spare Parts	1 set	
17	Consumable Spare Parts	1 set	CD-R/CD-RW disc, digital audio tape, compact cassette tape
18	Installation Materials	1 set	Co-axial feeder, cooper plate for earthing work, earthing wire, audio cable, power cable, all kind of connector

(5) Goroka (East Highlands Province) Improvement Plan

A Karai broadcasting antenna has been constructed in the middle of the transmitting station yard, but there is no construction space for a Kundu broadcasting antenna. Therefore, joint use of the existing MF transmitting antenna was investigated, however, antenna gain will fall because the ratio of the new frequency length to antenna height (h/λ) will be smaller. Accordingly, construction of a MF transmitting antenna was concluded to be difficult.

60m FM transmitting self supporting tower is installed newly on the Mt. Kiss, behind the government office building. 470MHz band STL for program line is installed between studio and transmitting station. Population coverage of 80% will be aimed Goroka main station and construction of 100W Kainantu relay station with using TELICOM building and tower.

The equipment composition is as follows:

Audio equipment for studio	1 set
STL Equipment	1 set
3 kW FM transmitter	1 set
Transmitting tower 60 m	1 set
Transmitting antenna 2 dipole 1:4:1:2	1 set
Engine generator 45 kVA	1 set
Transmitter shelter	1 set

Composition of the FM relay station equipment is as follows:

100 W FM transmitter	1 set
Transmitting antenna Ring 4	1 set

Table 2-6 Goroka FM Station Equipment

	Name of Equipment	Quantity	Description
A	**Network Studio Equipment**		
1	Audio Mixer	1 set	With console Input 12 (mono 4, stereo 8), Prog. output (mono 1, stereo 1)
2	Digital Audio Tape Rec/Rep	1 set	DAT format
3	Compact Cassette Tape Rec/Rep	1 set	
4	CD Rec/Rep	2 sets	Rec: CD-R/CD-RW, Rep: CD/CD-R/CD-RW
5	CD Player	1 set	
6	Telephone Pick-up	1 set	With Telephone set
7	Audio Monitor Speaker	1 set	For mixing 2, for MCR output 2
8	Headphone	2 sets	For both ears
9	Audio Distribution Amplifier	1 lot	More than 4 output for 1 input, necessary numbers for system construction
10	Audio Jack Panel	1 lot	Necessary numbers for system construction
11	Patch Code	1 set	30cm cable bounded 5 cable × 4, 60cm cable bounded 5 cable × 4
12	Equipment Rack	1 set	
13	Equipment Wagon	1 set	
14	Microphone	1 set	Dynamic type 2, Condenser type 1
15	Microphone Stand	1 set	DJ type 1, Desk type 1, Boom type 1
16	Cough Box	2 sets	
17	Earphone	2 sets	For single ear
18	Microphone Cable	1 set	5m × 3
19	Microphone Connector Panel	1 set	With Box
20	On-air Lamp	2 sets	
21	Guest Table	1 set	
22	Chair for Operation	3 sets	For Studio stuff
23	Clock	1 set	Wall type, Quartz

	Name of Equipment	Quantity	Description
B	**Studio Transmitter Link**		
1	Transmitter	1 set	470MHz band FM
2	Transmitting Antenna	1 set	Corner reflector antenna with supporting pole, Feeder cable
3	Receiver	1 set	470MHz band FM
4	Receiving Antenna	1 set	Corner reflector antenna with Feeder cable
5	Limiting amplifier	1 set	
C	**Transmitting Station**		
1	Program Input and Monitoring Equipment	1 set	Line transformer, limiting amplifier, level meter, audio monitor
2	Transmitter	1 set	3kW, 91.9MHz
3	Output Change-over Switch	1 set	For antenna/dummy load
4	Dummy Load	1 set	3kW
5	Feeder Cable	1 set	With Dehydrator
6	Transmitting Antenna	1 set	2 dipole antenna (1:4:1:2), power divider, FM Transmitting tower with obstruction light & obstruction marking by ICAO (60m height)
7	Clock	1 set	Wall type, Quartz
8	Monitor Receiver	2 sets	FM band, for transmitter and studio side
9	Air Conditioner	1 set	Cooling only, wall type (8,000kcal/hour) for TX shelter
10	Power Distribution Facility	1 set	Insulation transformer (35kVA), automatic voltage regulator (30kVA), power distribution board
11	Transmitter Shelter	1 set	Approx. size: 3m (D) × 2.5 (H) × 2.5m (H), with exhaust fan and Sunshade
12	Engine Generator	1 set	Outdoor type engine generator (45kVA), with sunshade, fuel tank, fuel pump, city power/generator power change-over switch
D	**Kainantu FM Relay Station**		
1	Input Equipment	1 set	Line transformer, Limiting Amplifier
2	FM Transmitter	1 set	100W, 91.1MHz
3	FM Transmitting Antenna	1 set	Ring antenna × 4, Power divider

	Name of Equipment	Quantity	Description
4	Feeder Cable	1 set	
5	Dummy Road	1 set	100W with power meter
6	Monitor Receiver	1 set	FM band
E	**Common Use**		
1	Tool Set	1 set	30 kinds of tool
2	Standard Accessory	1 set	
3	Essential Spare Parts	1 set	
4	Consumable Spare Parts	1 set	CD-R/CD-RW disc, Digital audio tape, Compact cassette tape
5	Installation Materials	1 set	Co-axial feeder, copper plate for earthing work, earthing wire, audio cable, power cable, all kinds of connector

2-2-3 Basic Design Drawing

(1) Mt. Hagen FM Radio Station

- Site Layout of FM Transmitting Station
- Block Diagram of Program Production System
- Block Diagram of Network Studio
- Equipment Layout of Network Studio
- Block Diagram of FM Transmitting Station
- General View of FM Transmitting Antenna
- Schematic Diagram of FM Power Supply System
- Equipment Layout of FM Transmitter Room
- General View of FM Transmitting Tower

(2) Lae MF Radio Station

- Site Layout of MF Transmitting Station
- Block Diagram of Program Production System
- Block Diagram of MF Transmitting Station
- General View of MF Transmitting Antenna
- Schematic Diagram of MF Power Supply System
- Equipment Layout of MF Transmitter Shelter
- Equipment Layout of MF Transmitter Shelter (Section)

(3) Kimbe MF Radio Station

- Site Layout of MF Transmitting Station
- Block Diagram of Program Production System
- Block Diagram of MF Transmitting Station
- General View of MF Transmitting Antenna
- Schematic Diagram of MF Power Supply System
- Equipment Layout of MF Transmitter Shelter
- Equipment Layout of MF Transmitter Shelter (Section)

(4) Vanimo MF Radio Station

- Site Layout of MF Transmitting Station
- Block Diagram of Program Production System
- Block Diagram of Network Studio
- Equipment Layout of Network Studio
- Block Diagram of MF Transmitting Station
- General View of MF Transmitting Antenna
- Schematic Diagram of MF Power Supply System
- Equipment Layout of MF Transmitter Shelter
- Equipment Layout of MF Transmitter Shelter (Section)

(5) Goroka FM Radio Station

- Site Layout of FM Transmitting Station
- Block Diagram of Program Production System
- Block Diagram of Network Studio
- Equipment Layout of Network Studio
- Block Diagram of FM Transmitting Station
- General View of FM Transmitting Antenna
- Schematic Diagram of FM Power Supply System
- Equipment Layout of FM Transmitter Shelter
- Equipment Layout of FM Transmitter Shelter (Section)
- General View of FM Transmitting Tower

(6) Kainantu FM Relay Station

- Site Layout of FM Relay Station
- Block Diagram of FM Relay Station
- General View of FM Transmitting Antenna
- Equipment Layout

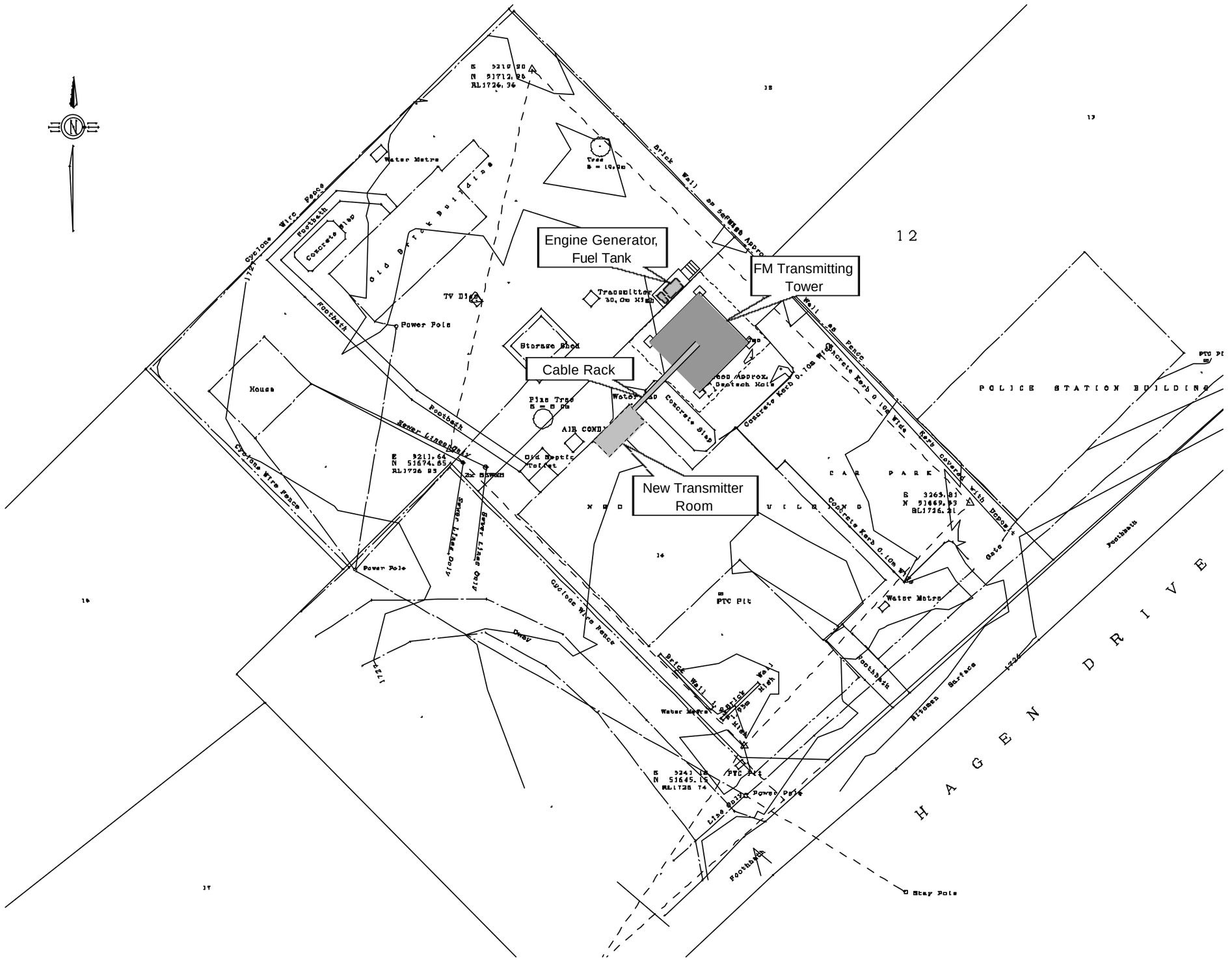


Fig. 2-2	**Mt. Hagen FM Radio Station**	**Site Layout of FM Transmitting Station**	**S=1:400**

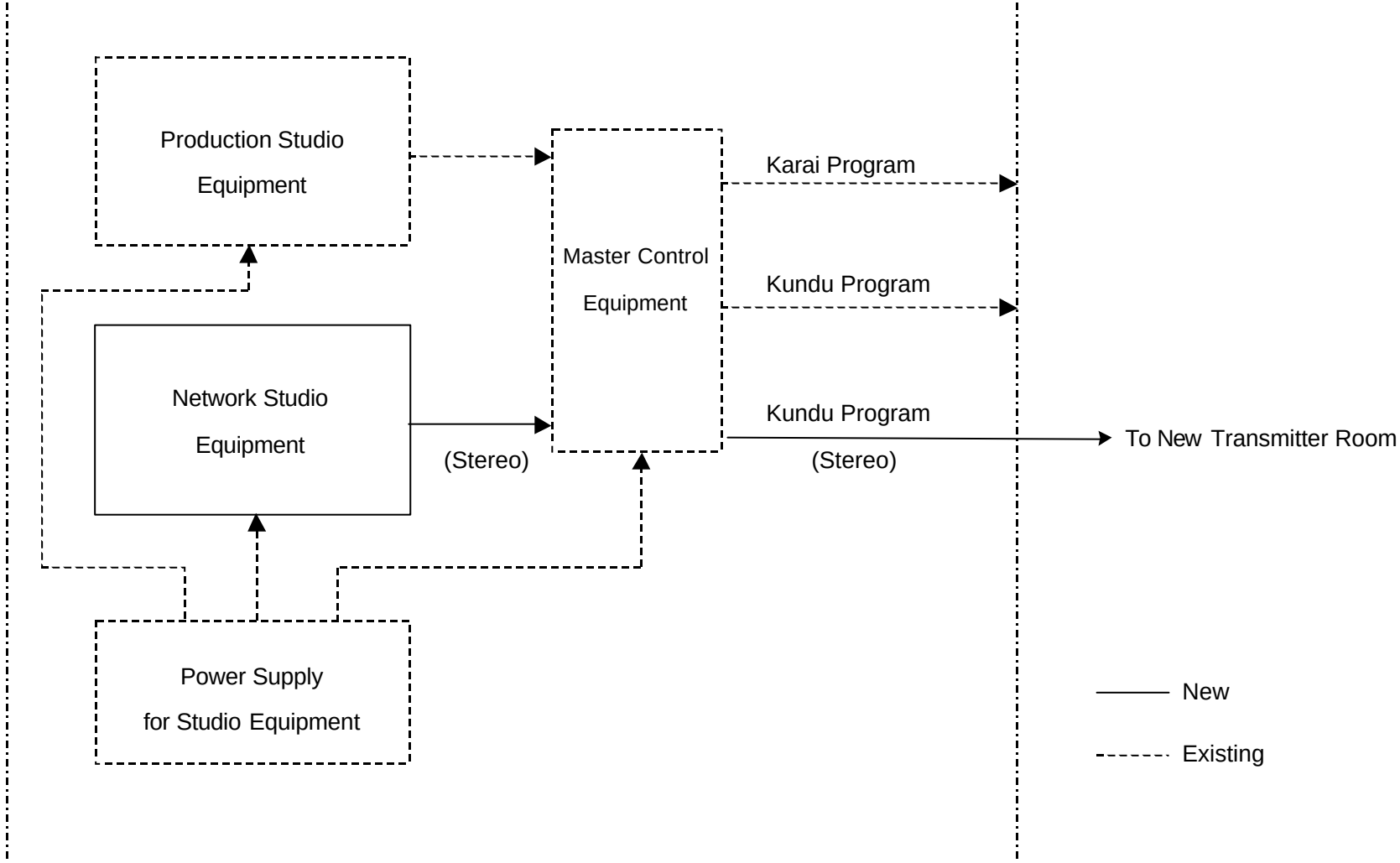


Fig. 2-3	Mt. Hagen FM Radio Station	Block Diagram of Program Production System	

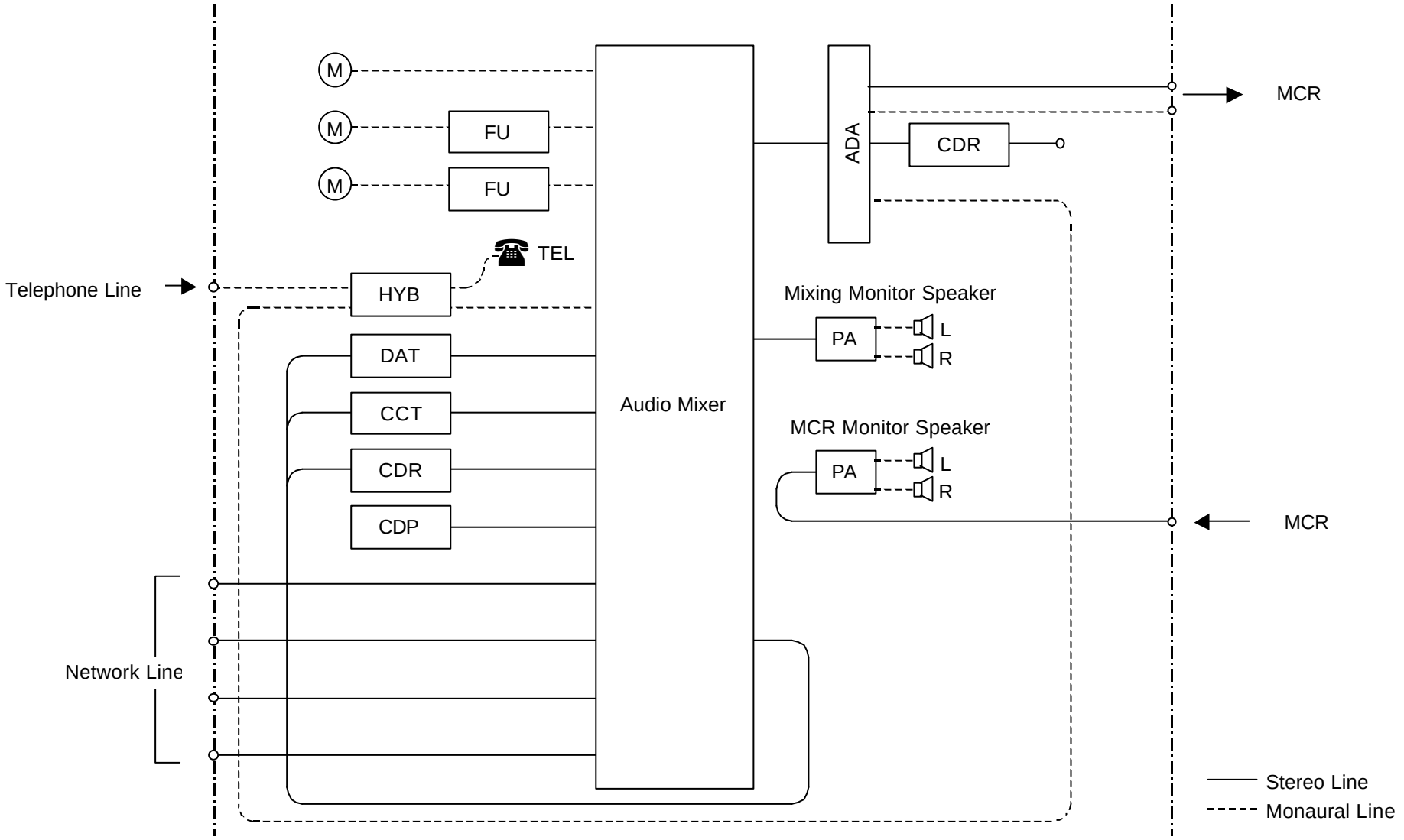


Fig. 2-4	Mt. Hagen FM Radio Station	Block Diagram of Network Studio	

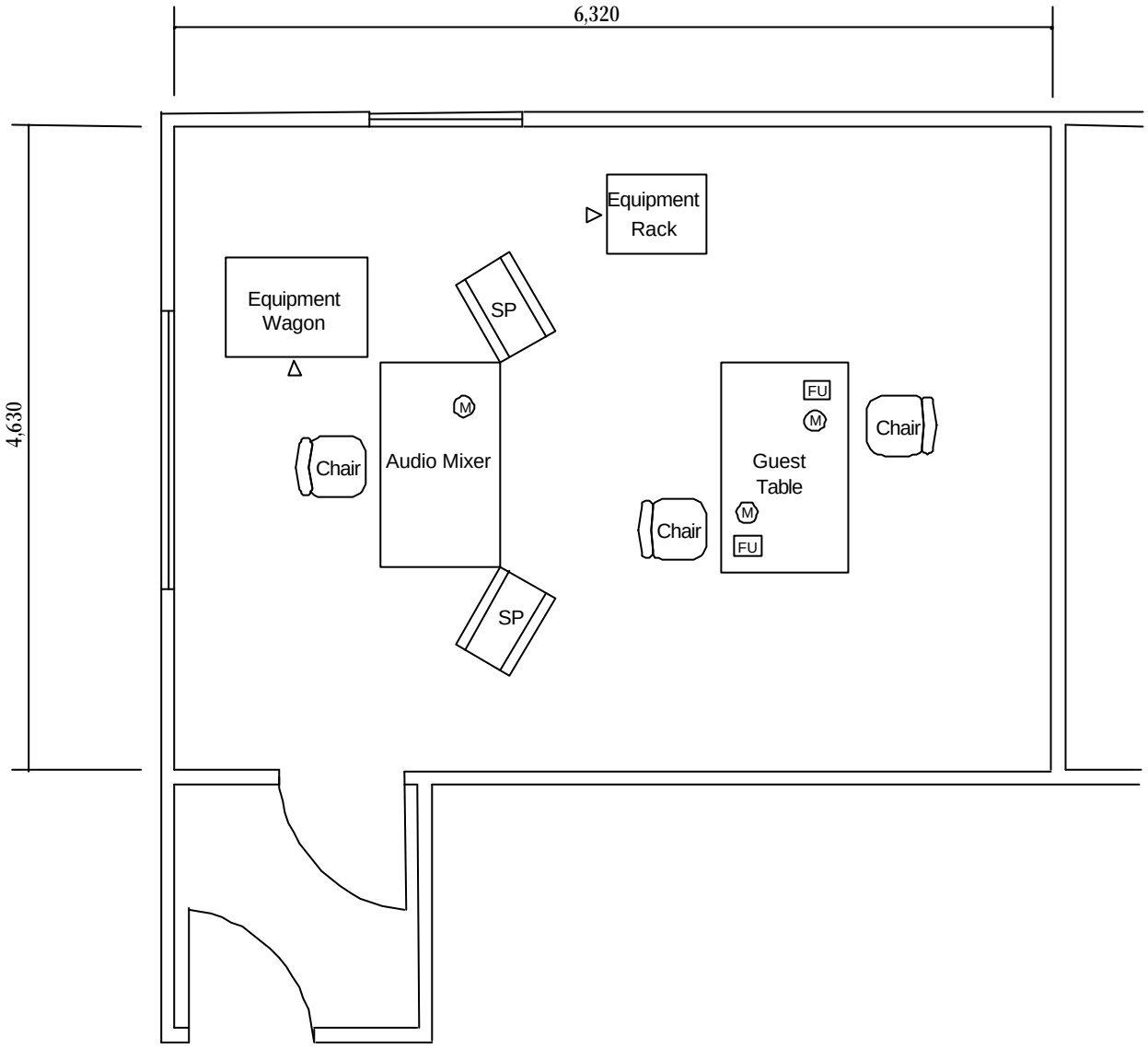


Fig. 2-5	Mt. Hagen FM Radio Station	Equipment Layout of Network Studio	S=1:50

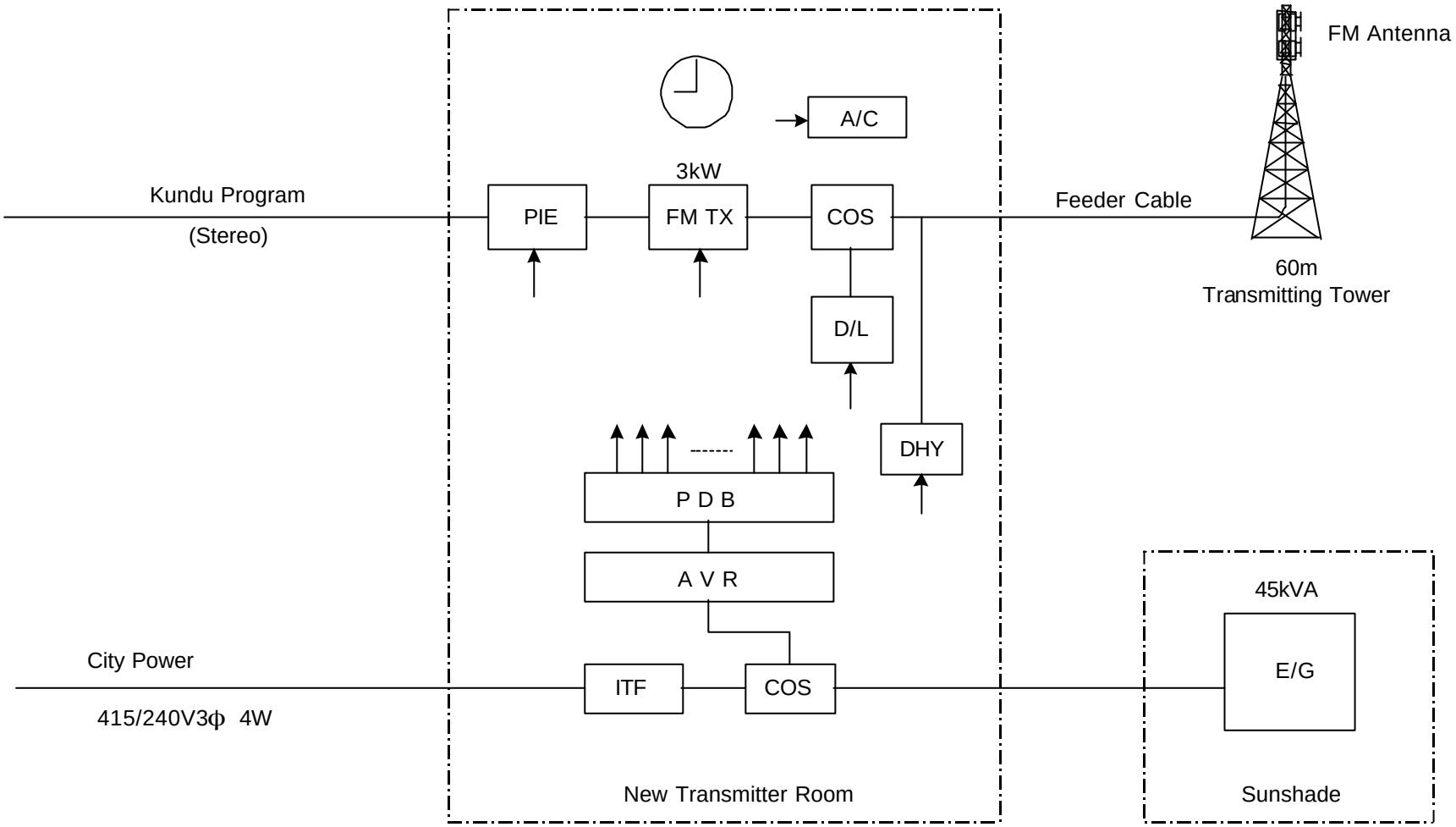


Fig. 2-6	Mt. Hagen FM Radio Station	Block Diagram of FM Transmitting Station	

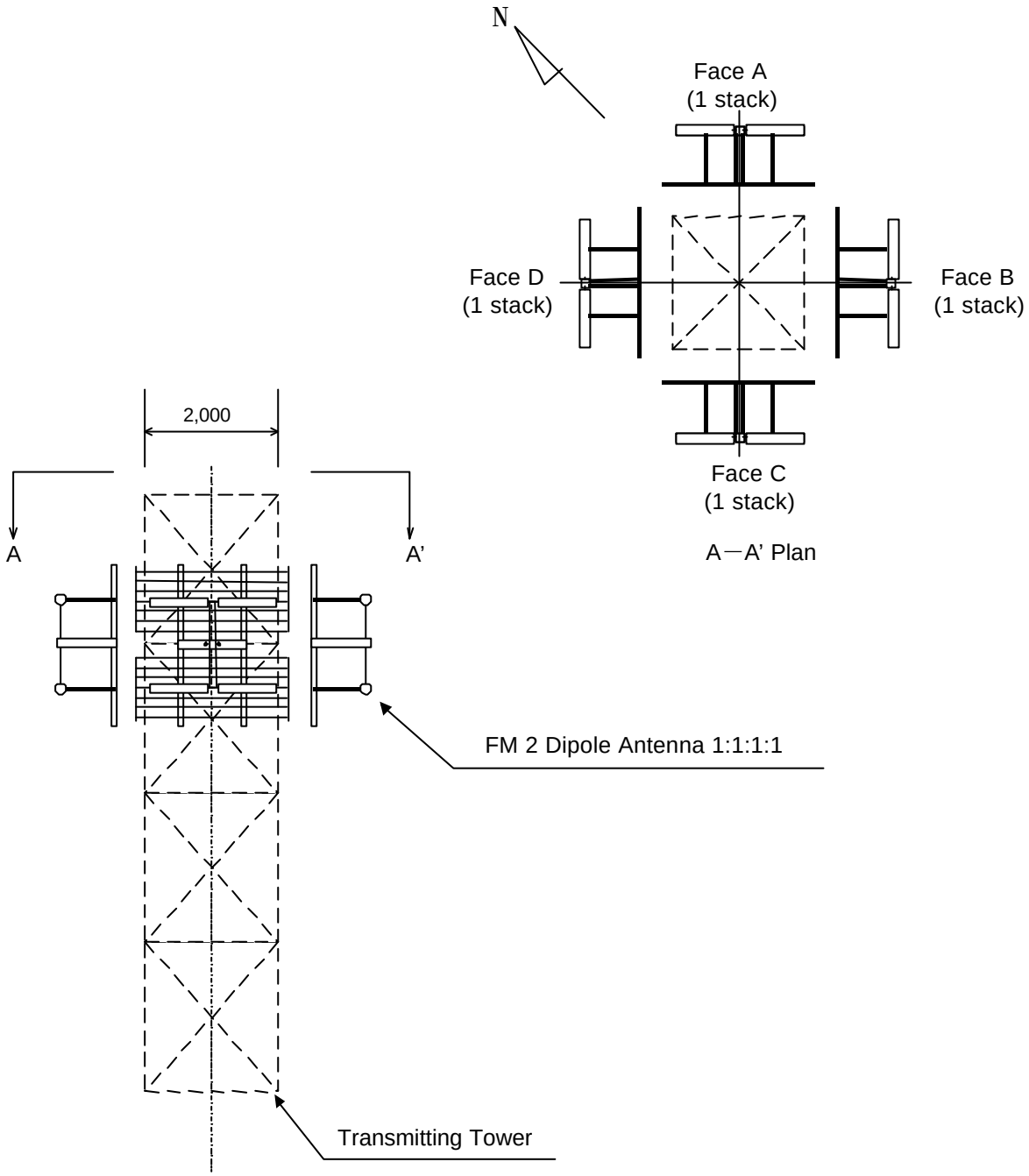


Fig. 2-7	Mt. Hagen FM Radio Station	General View of FM Transmitting Antenna	

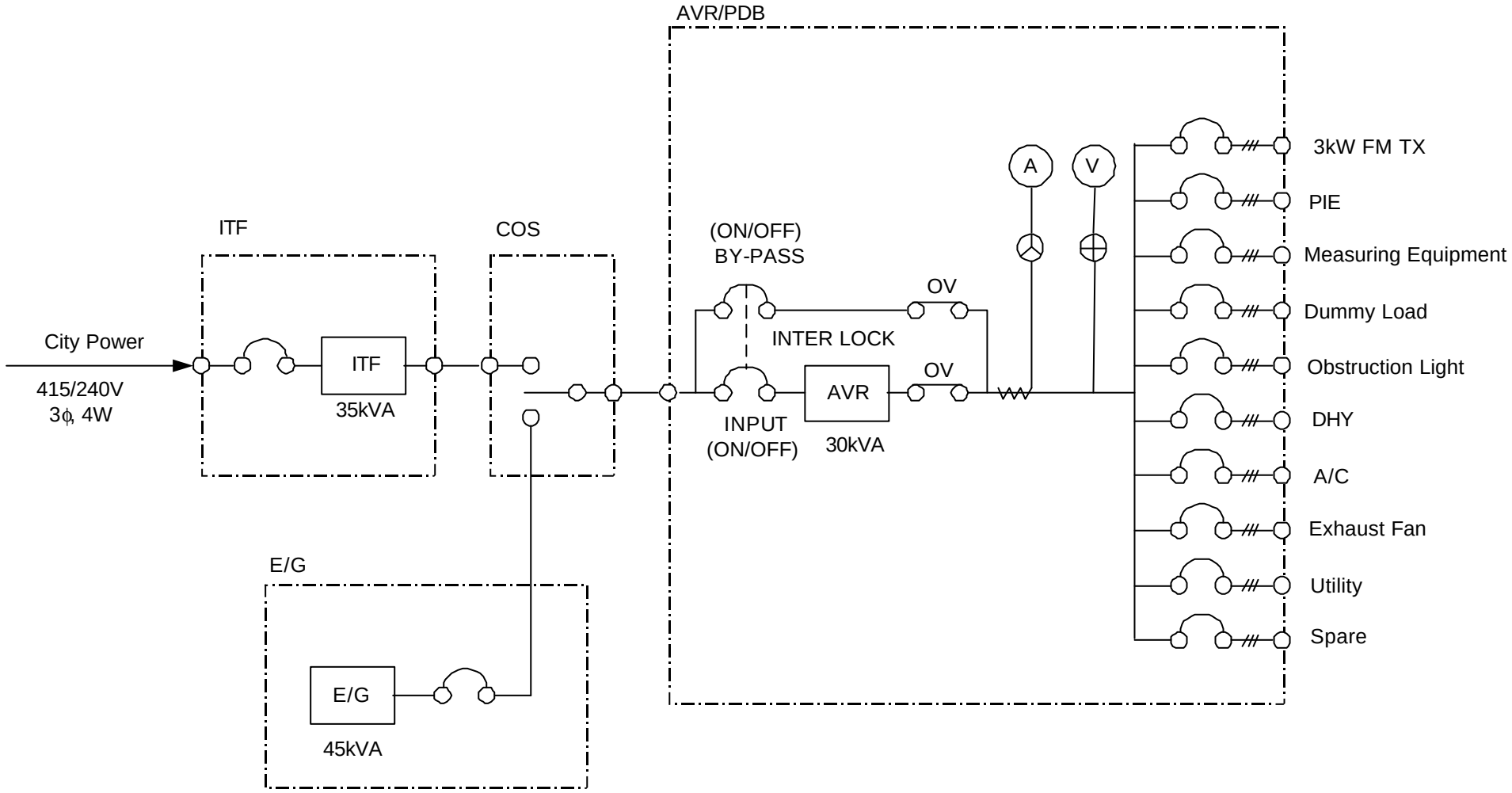


Fig. 2-8	Mt. Hagen FM Radio Station	Schematic Diagram of FM Power Supply System	

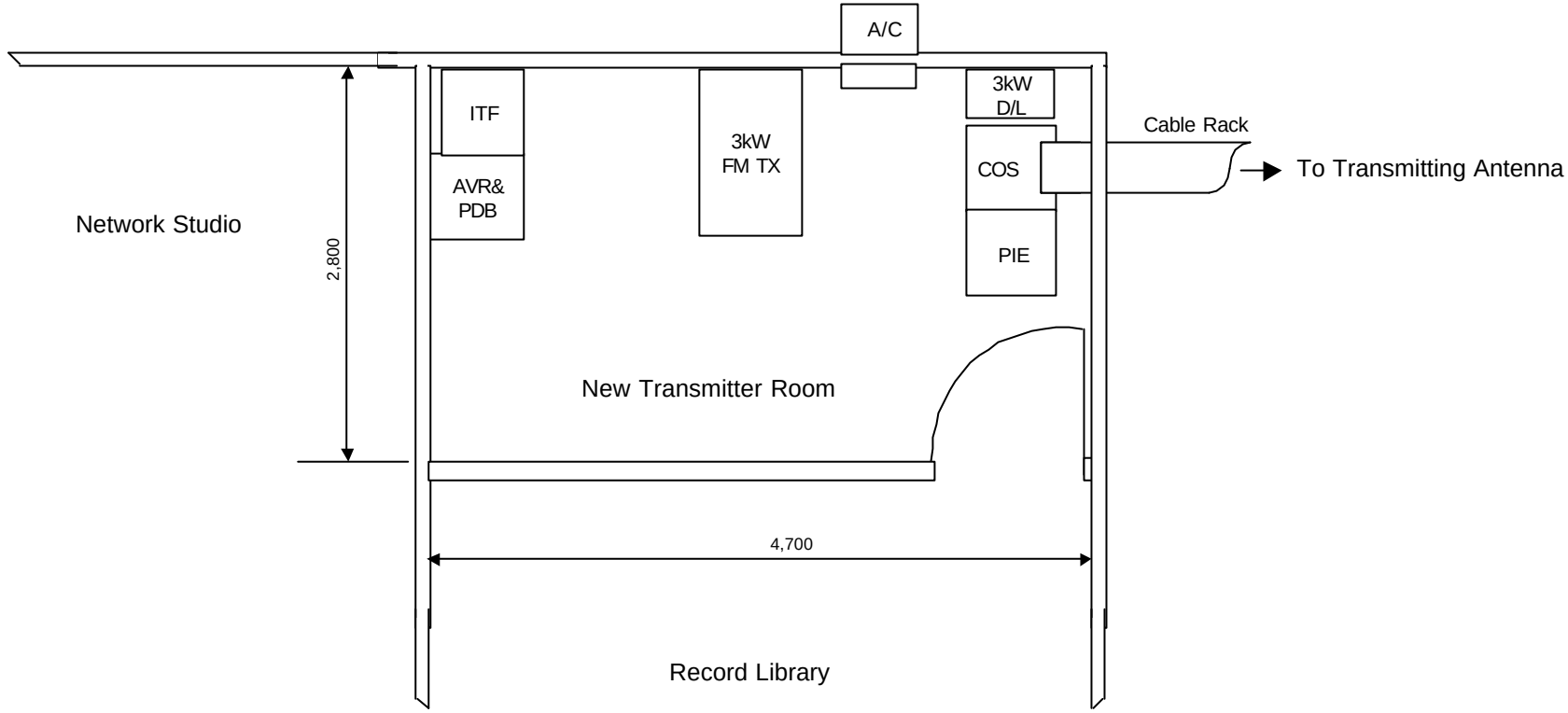


Fig. 2-9	Mt. Hagen FM Radio Station	Equipment Layout of FM Transmitter Room	S=1:50

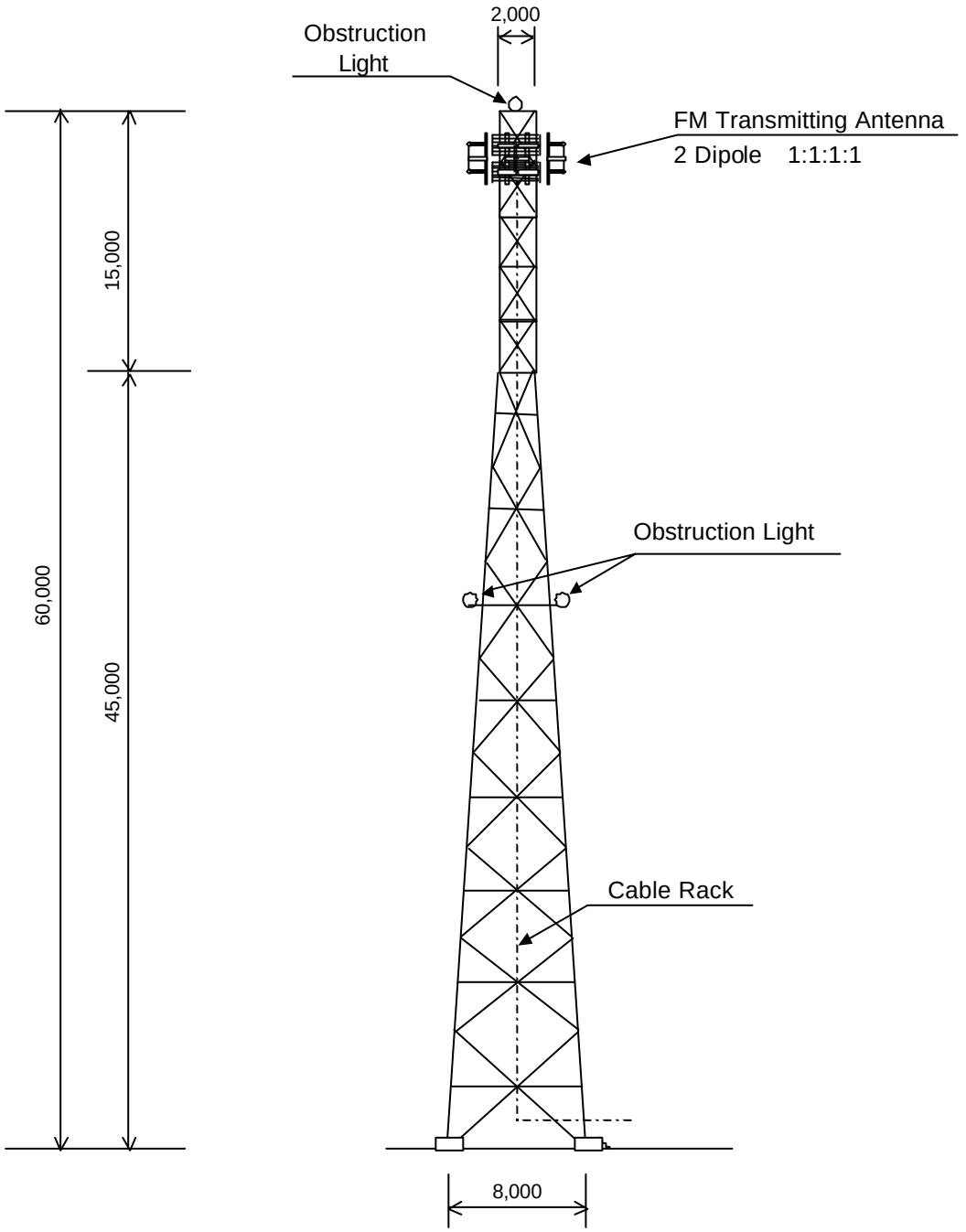


Fig. 2-10	Mt. Hagen FM Radio Station	General View of FM Transmitting Tower	S=1:400

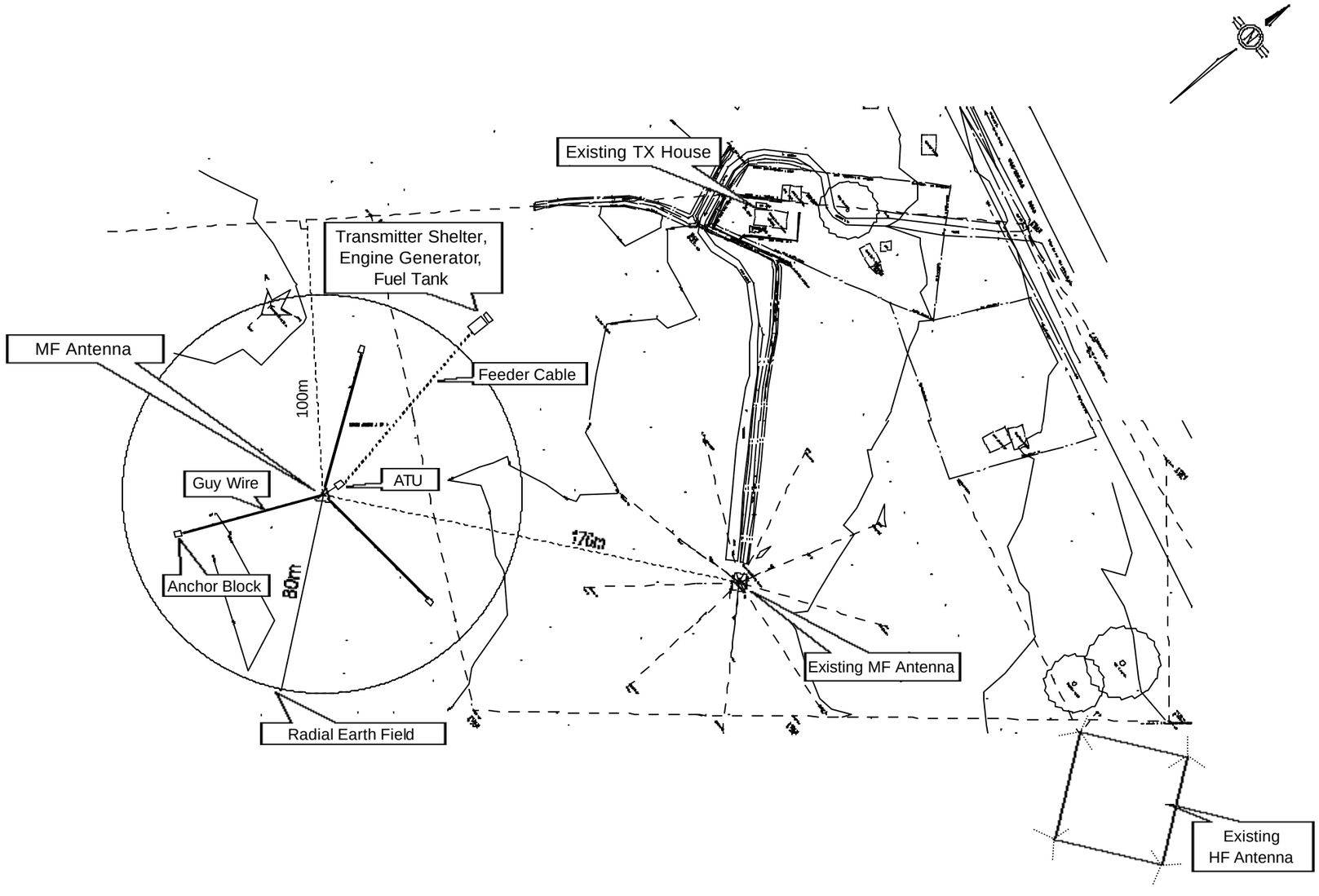


Fig. 2-11	Lae MF Radio Station	Site Layout of MF Transmitting Station	S=1:2,000

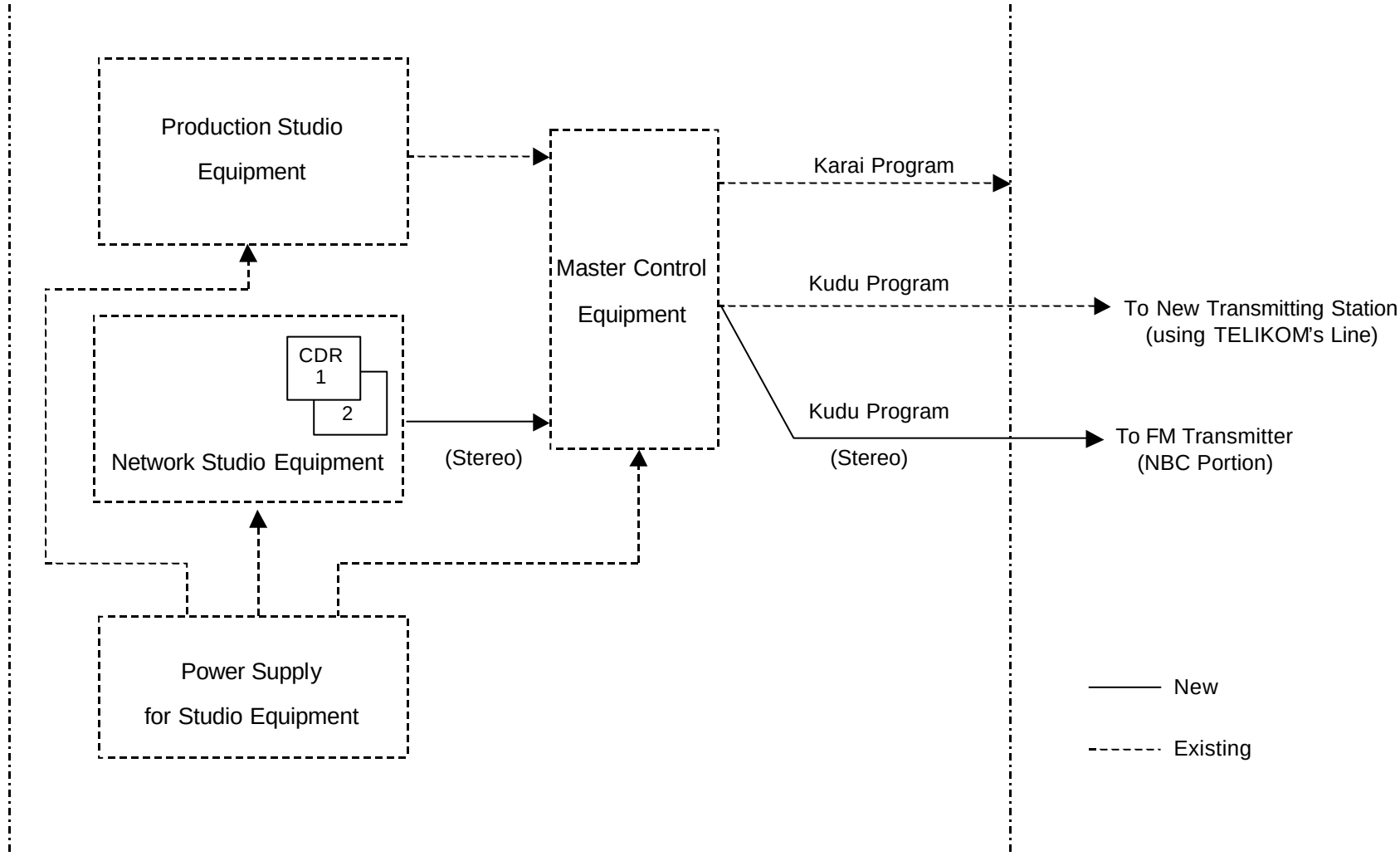


Fig. 2-12	Lae MF Radio Station	Block Diagram of Program Production System	

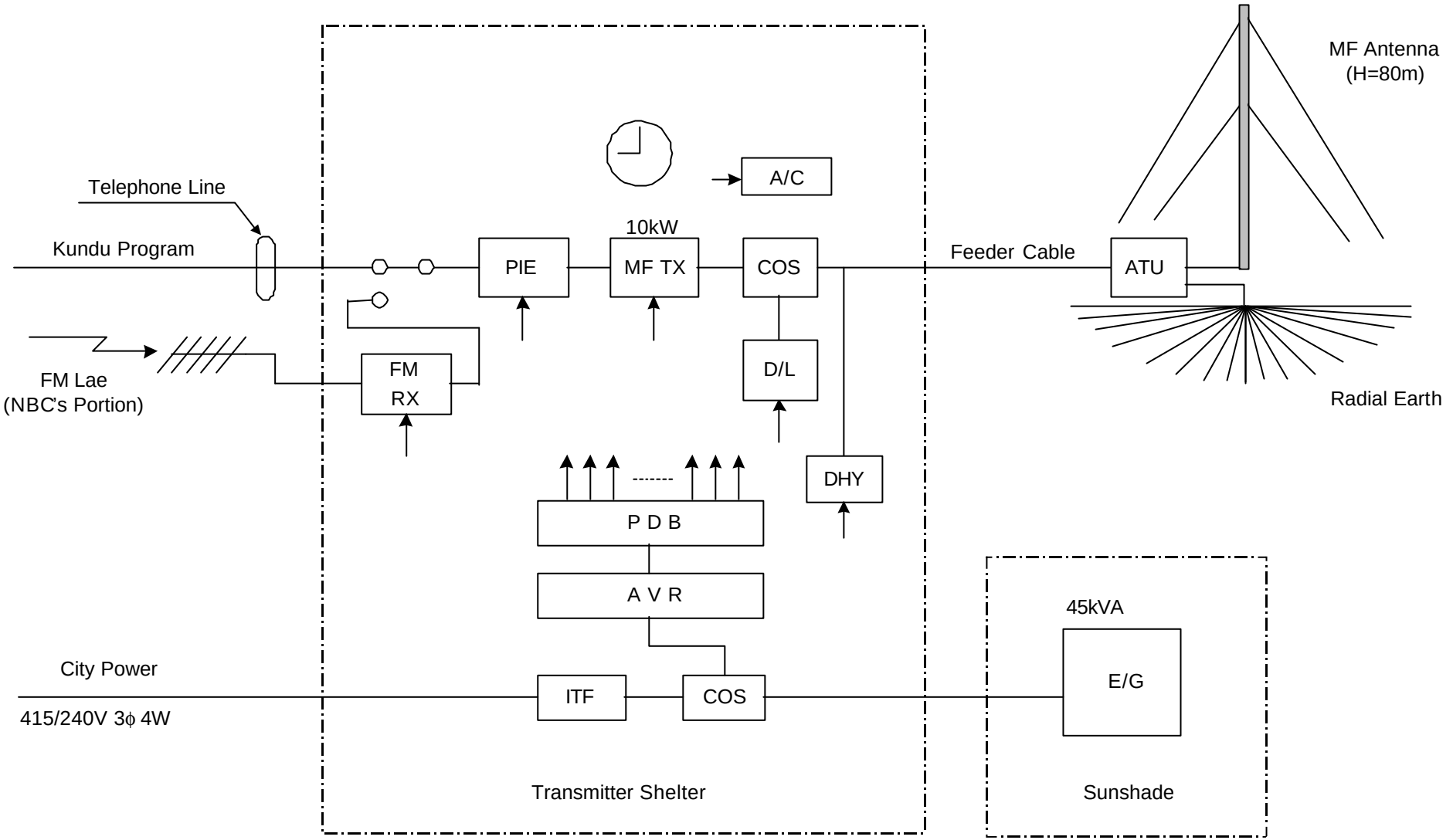


Fig. 2-13	Lae MF Radio Station	Block Diagram of MF Transmitting Station	

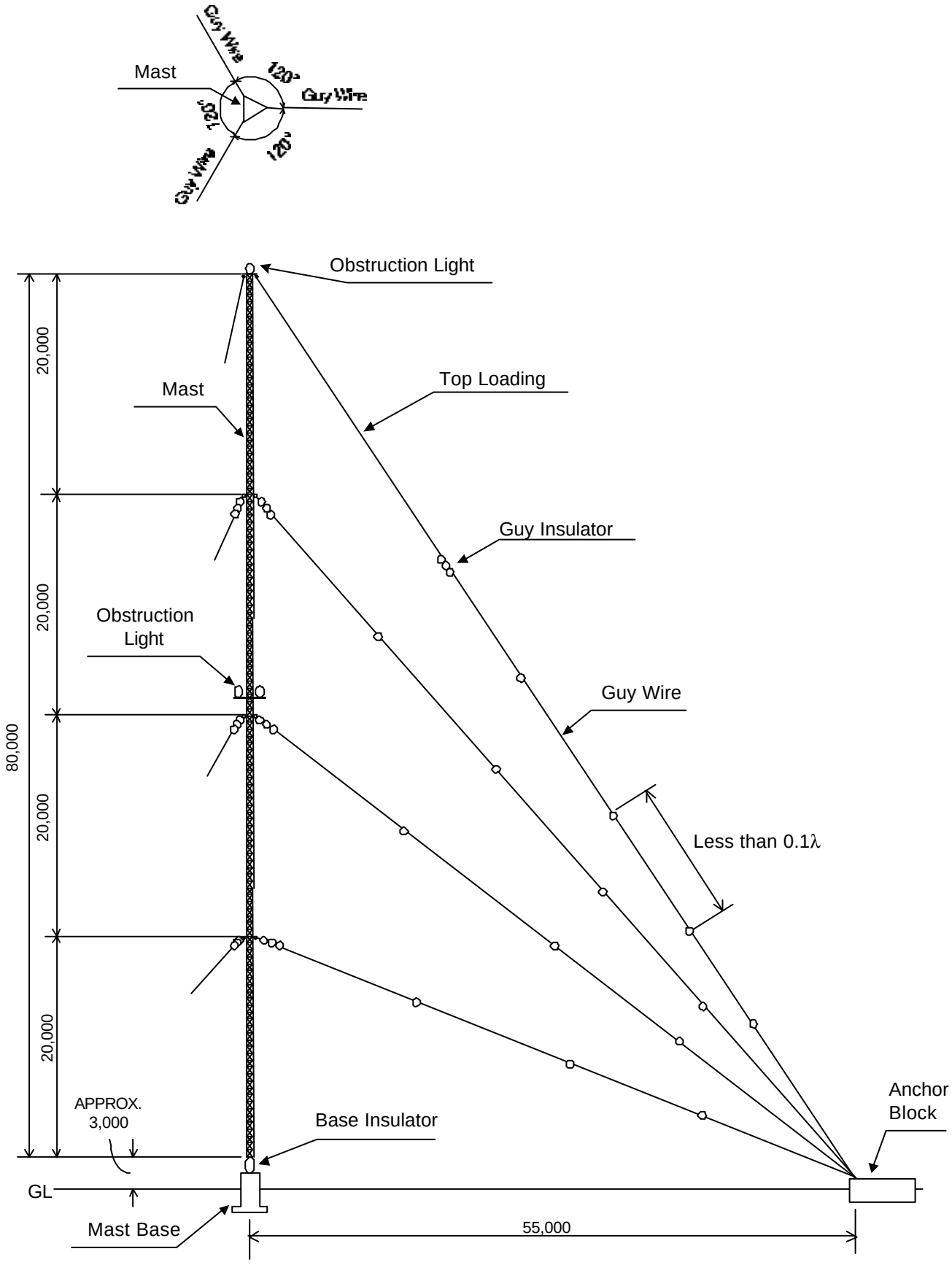


Fig. 2-14	Lae MF Radio Station	General View of MF Transmitting Antenna	S=1:500

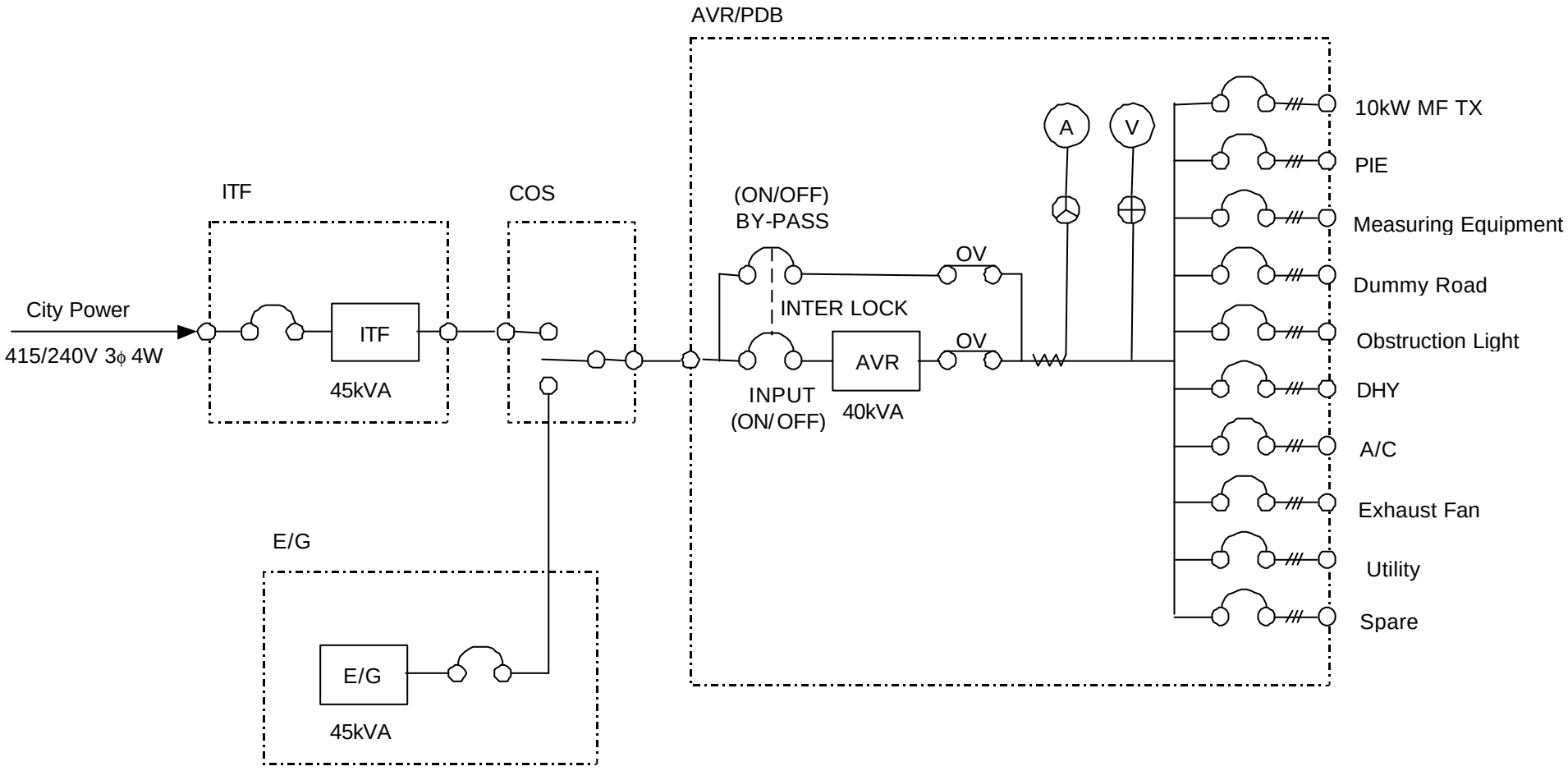


Fig. 2-15	Lae MF Radio Station	Schematic Diagram of MF Power Supply System	

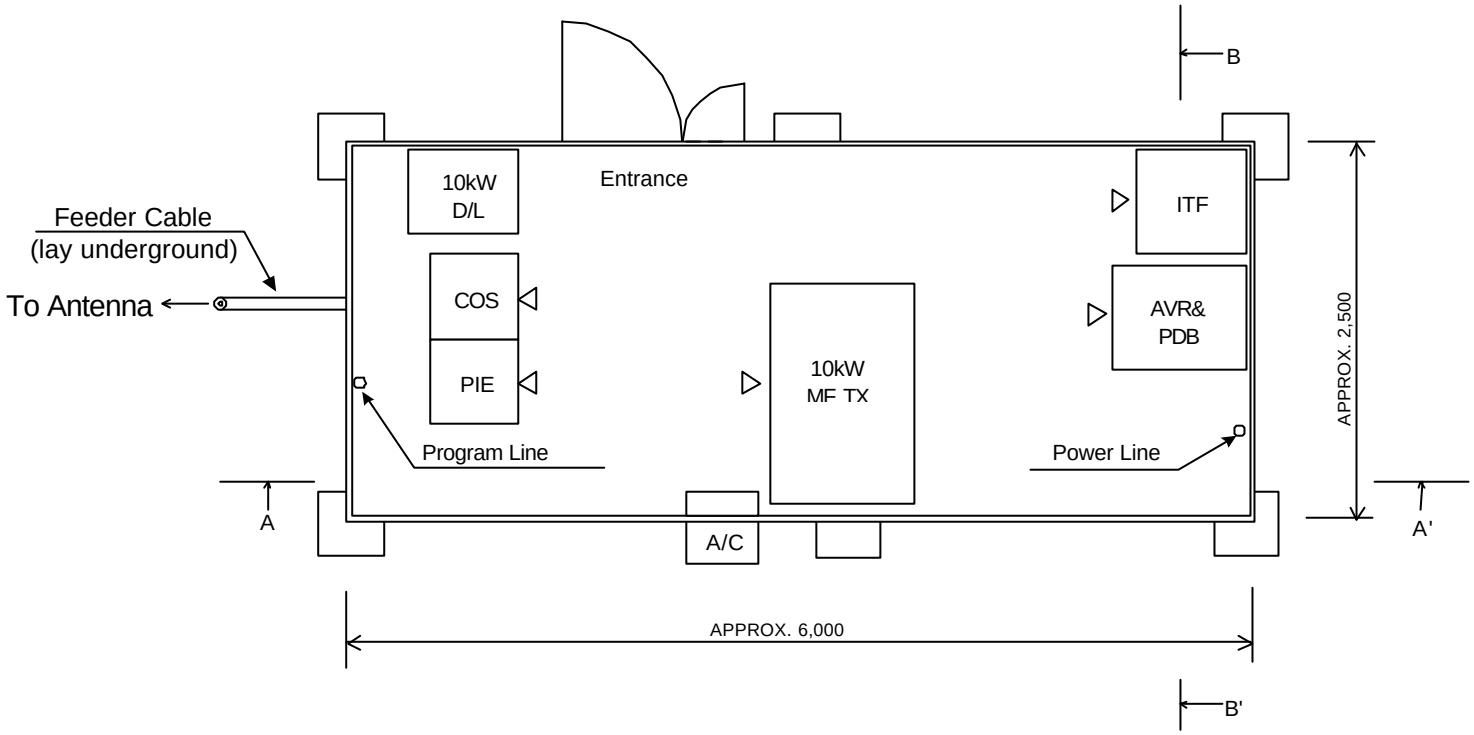


Fig. 2-16	Lae MF Radio Station	Equipment Layout of MF Transmitter Shelter	S=1:50

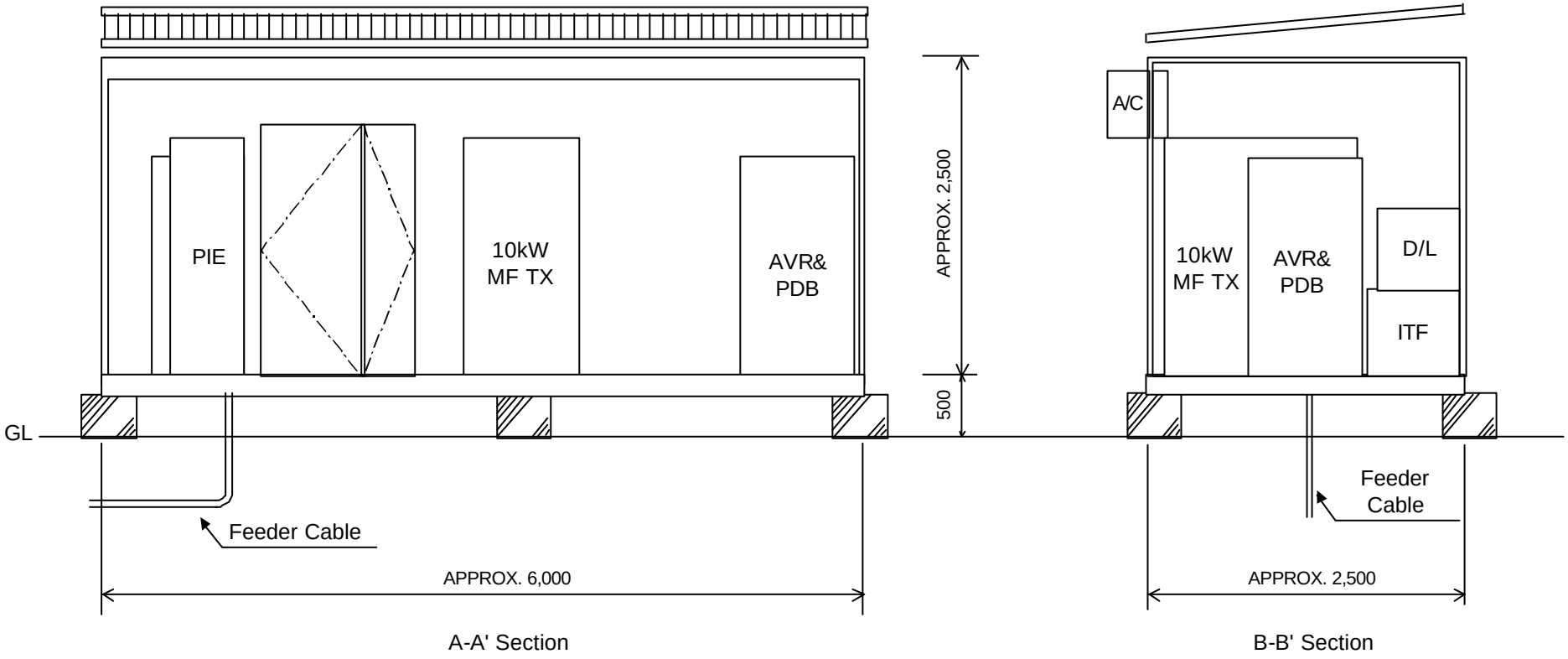


Fig. 2-17	Lae MF Radio Station	Equipment Layout of MF Transmitter Shelter (Section)	S=1:50

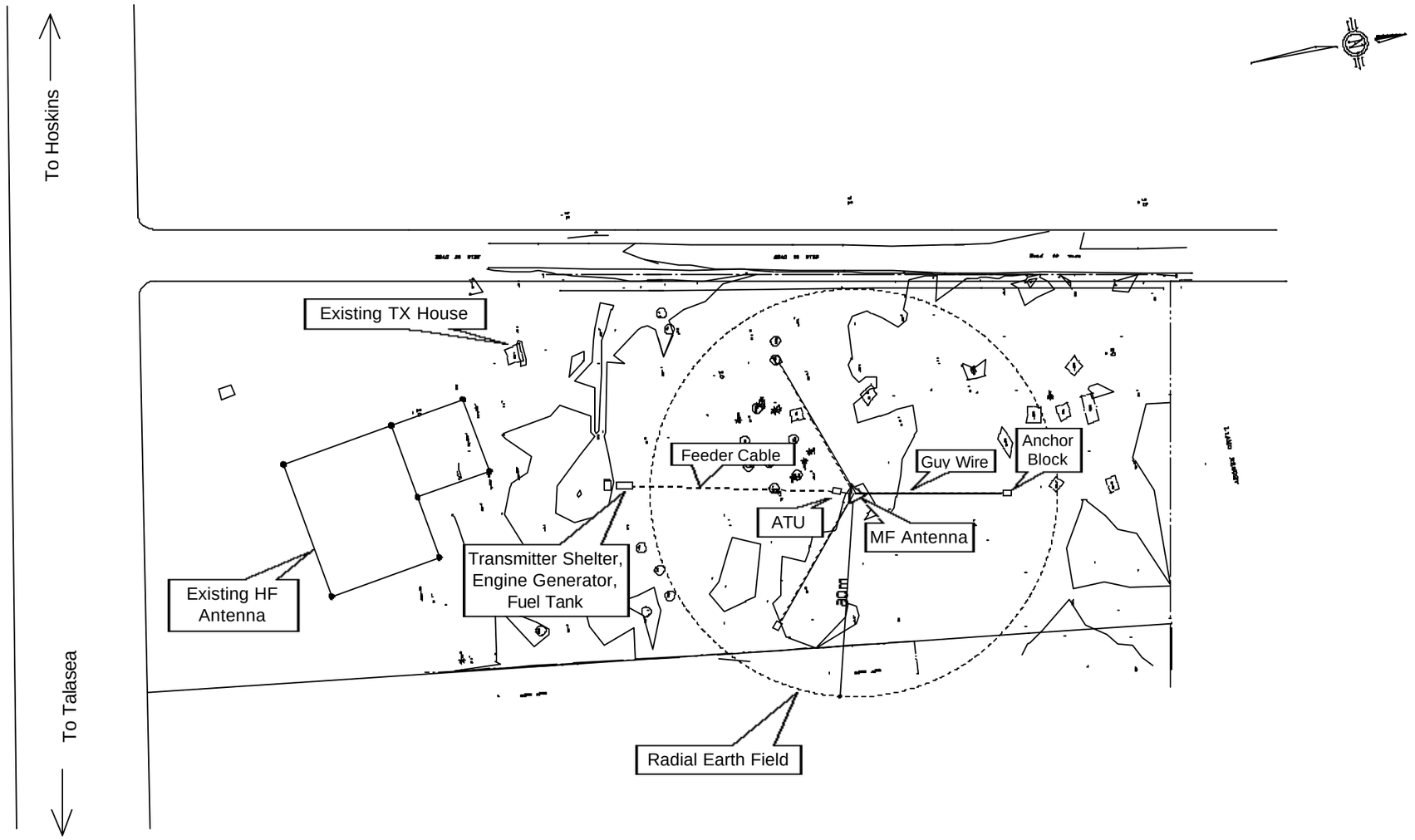


Fig. 2-18	Kimbe MF Radio Station	Site Layout of MF Tranmitting Station	S=1:2,000

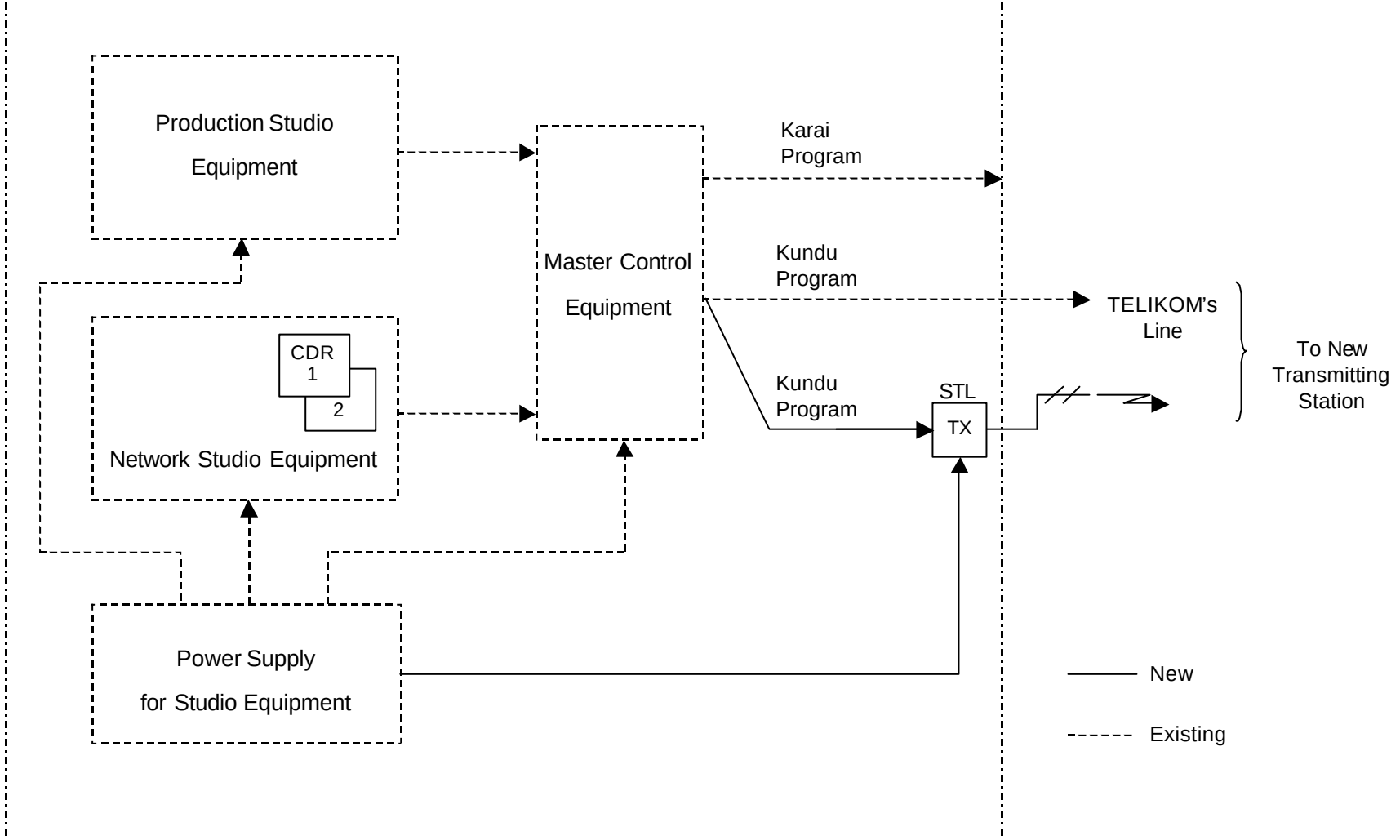


Fig. 2-19	Kimbe MF Radio Station	Block Diagram of Program Production System	

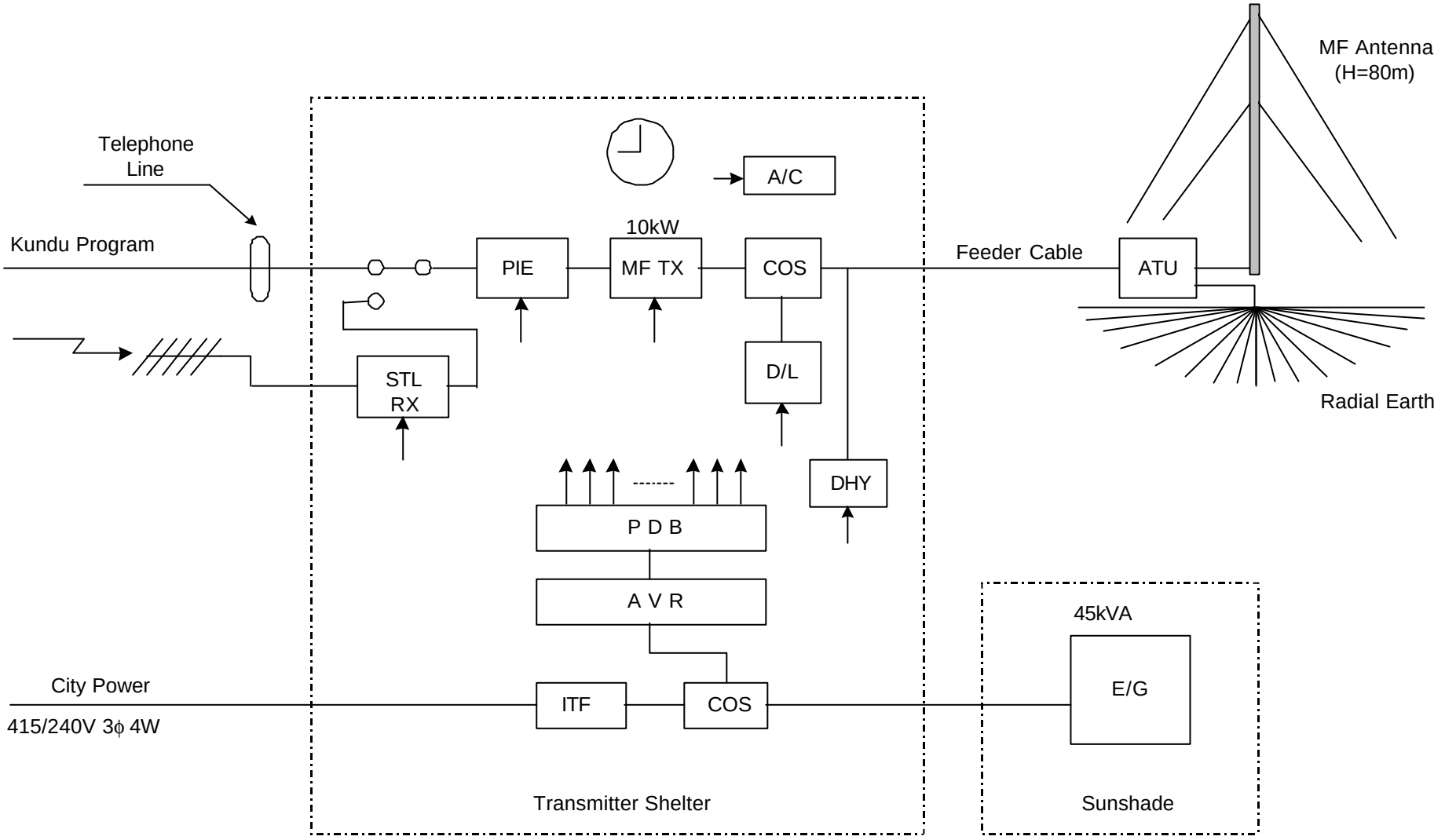


Fig. 2-20	Kimbe MF Radio Station	Block Diagram of MF Transmitting Station	

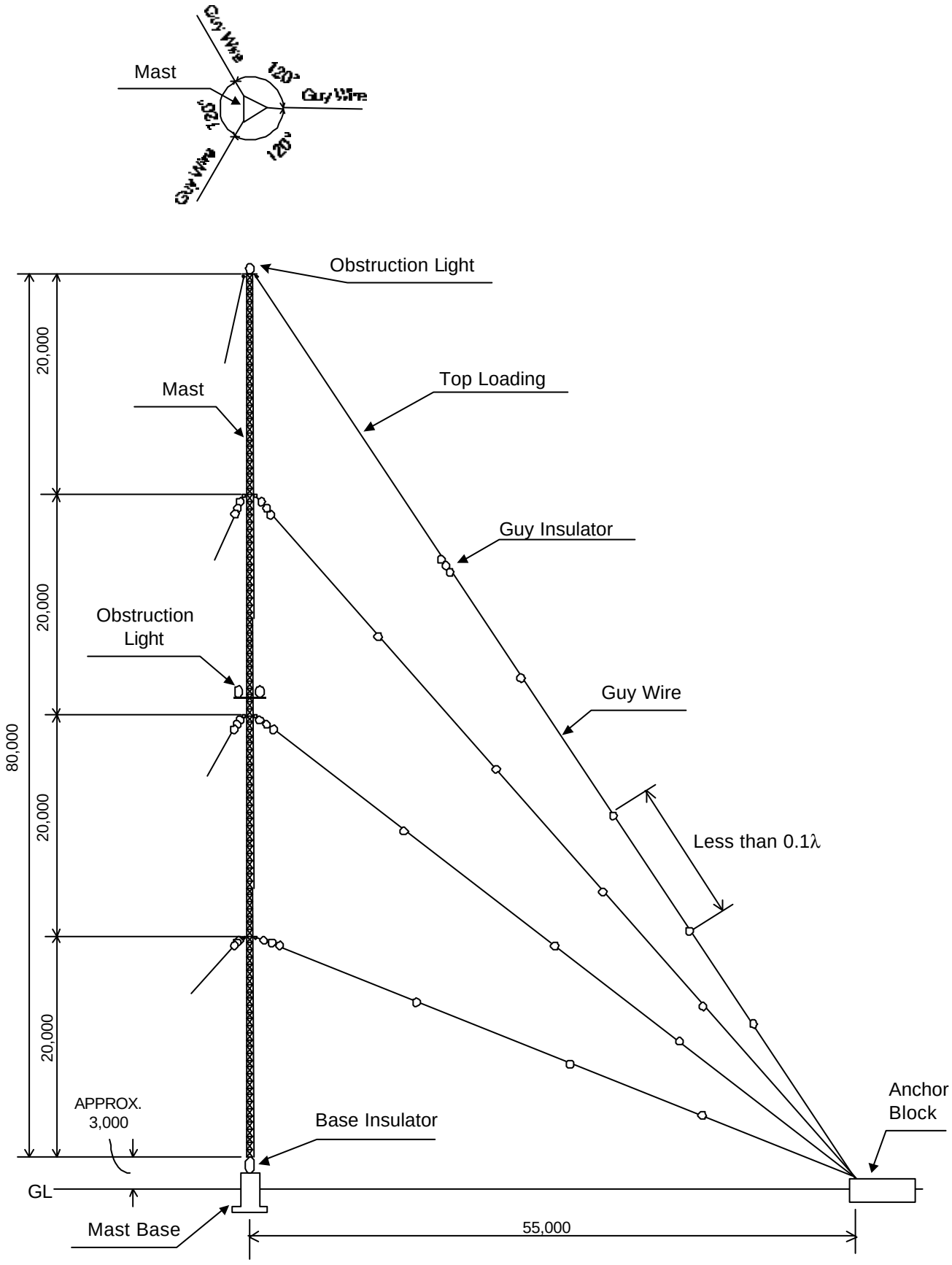


Fig. 2-21	Kimbe MF Radio Station	General View of MF Transmitting Antenna	S=1:500

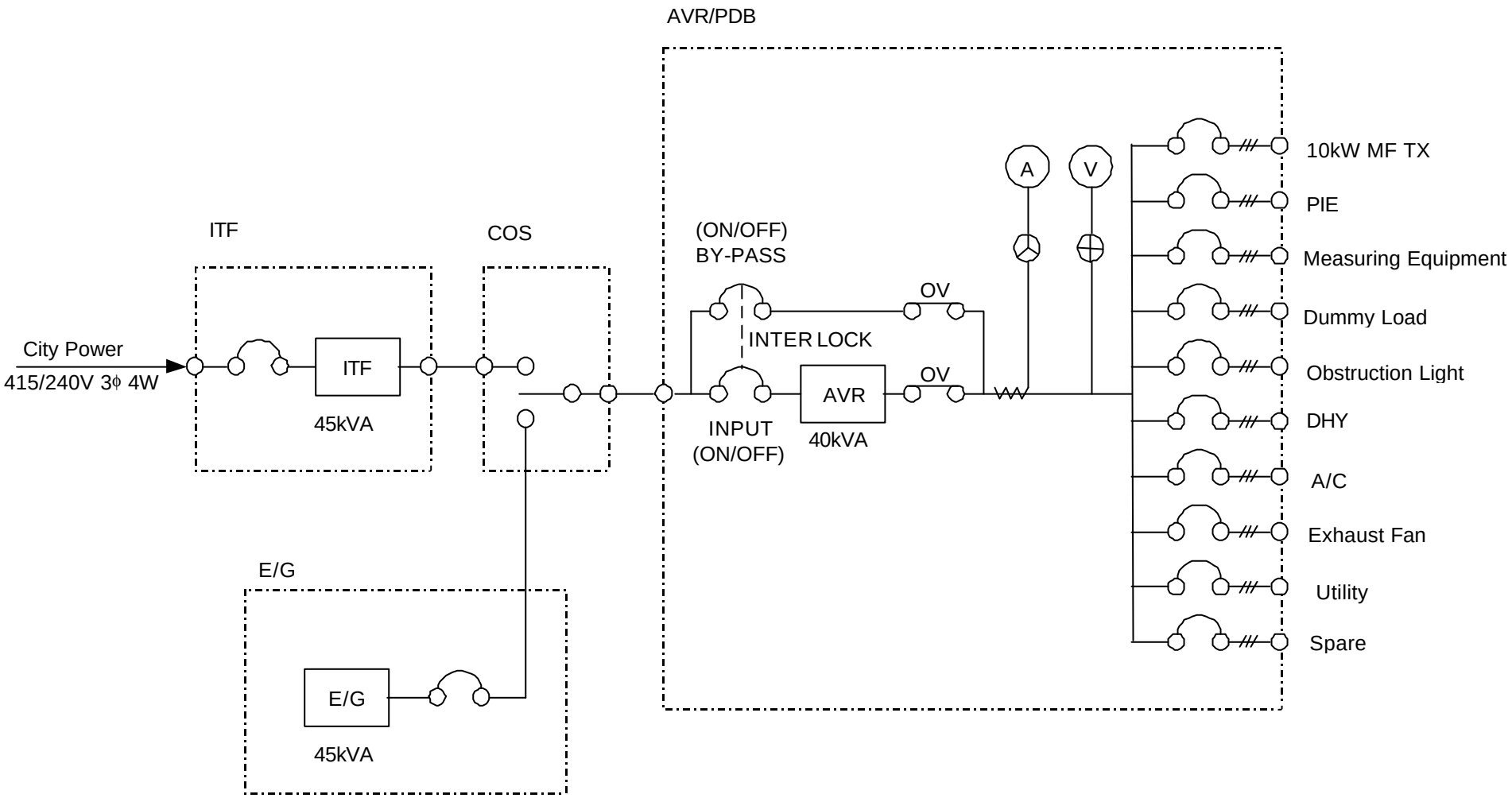


Fig. 2-22	Kimbe MF Radio Station	Schematic Diagram of MF Power Supply System	

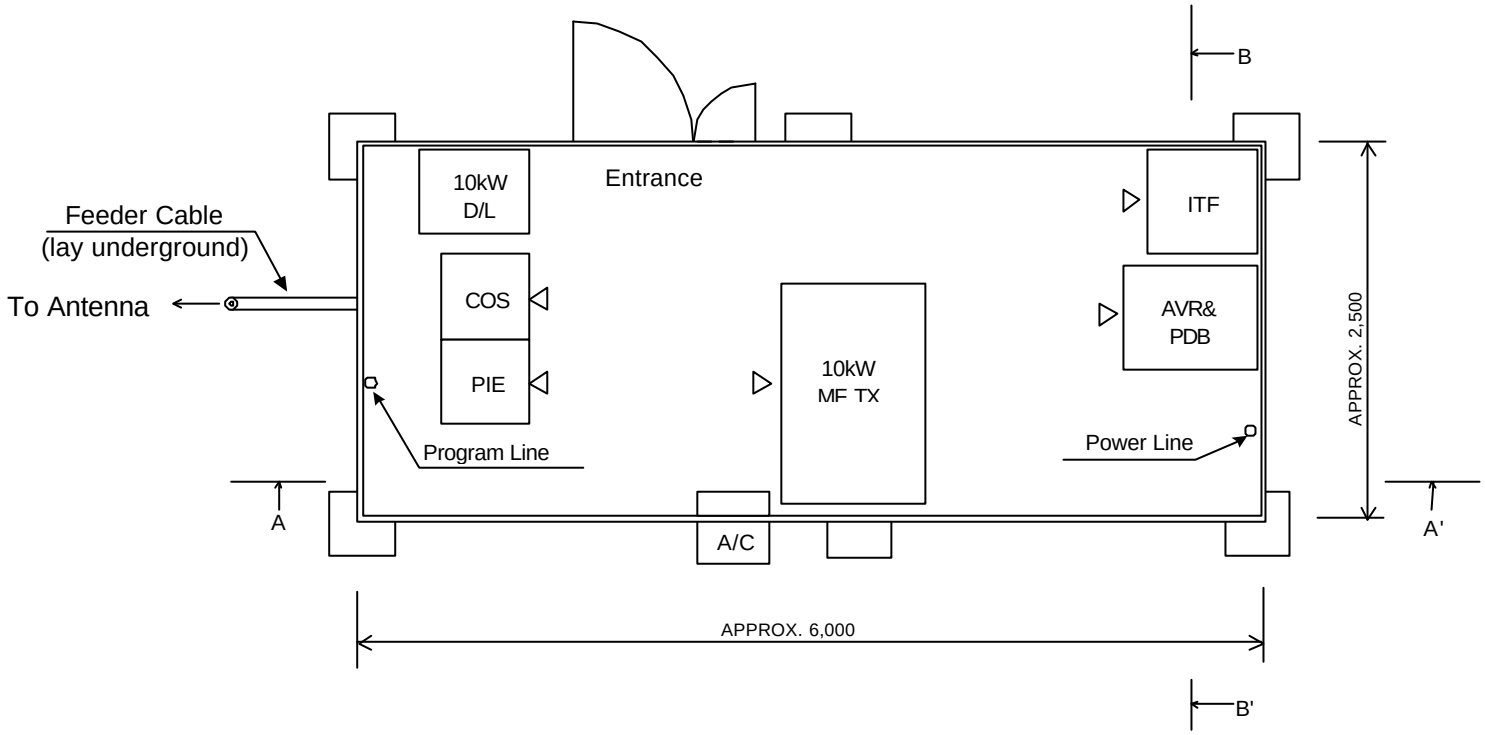


Fig. 2-23	Kimbe MF Radio Station	Equipment Layout of MF Transmitter Shelter	S=1:50

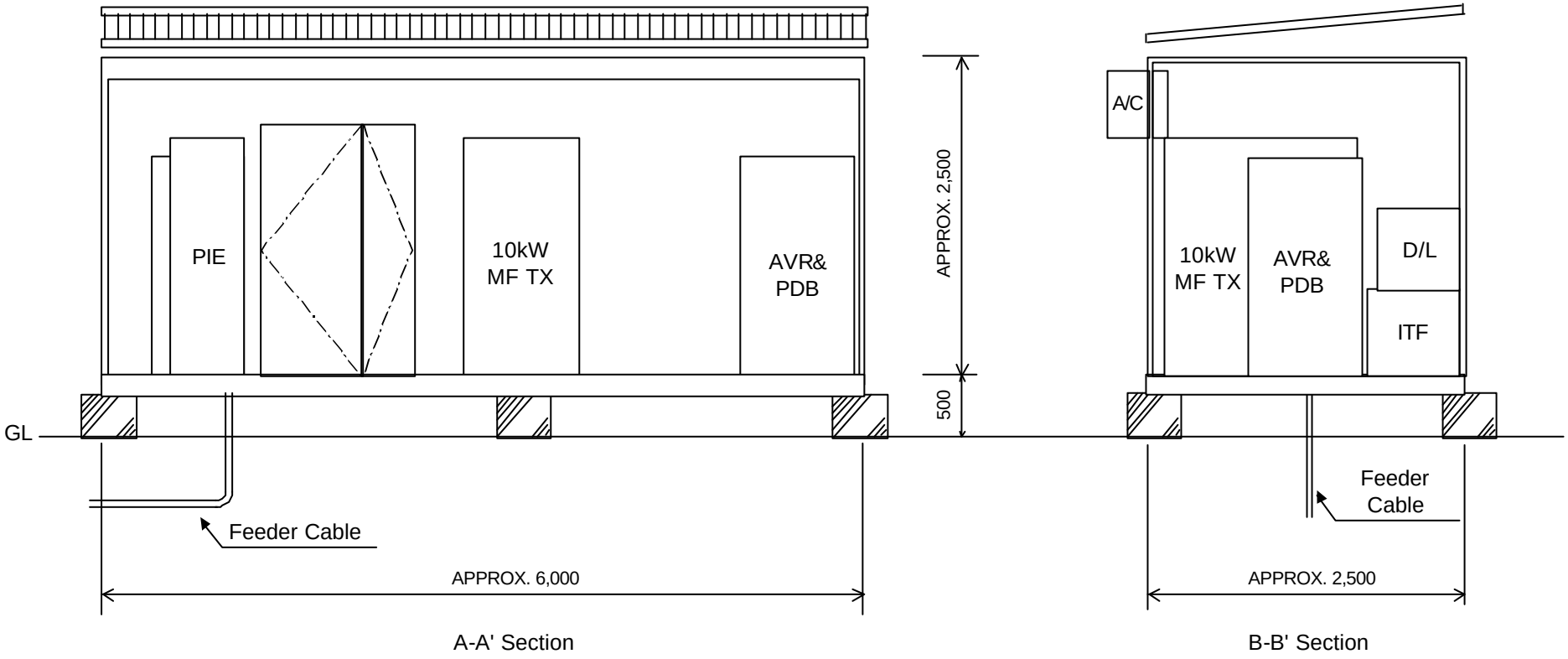


Fig. 2-24	Kimbe MF Radio Station	Equipment Layout of MF Transmitter Shelter (Section)	S=1:50

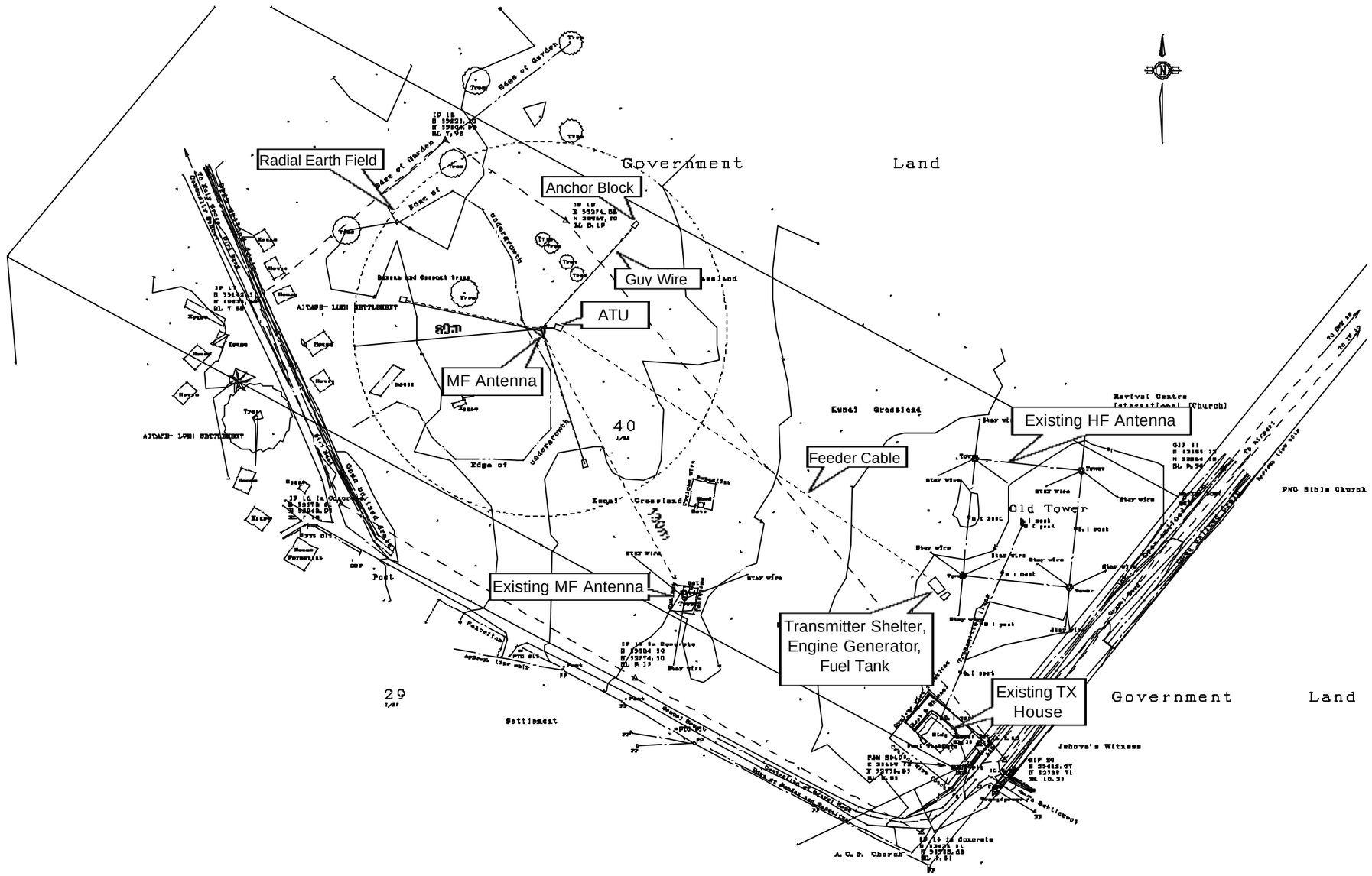


Fig. 2-25	Vanimo MF Radio Station	Site Layout of MF Transmitting Station	S=1:2,000

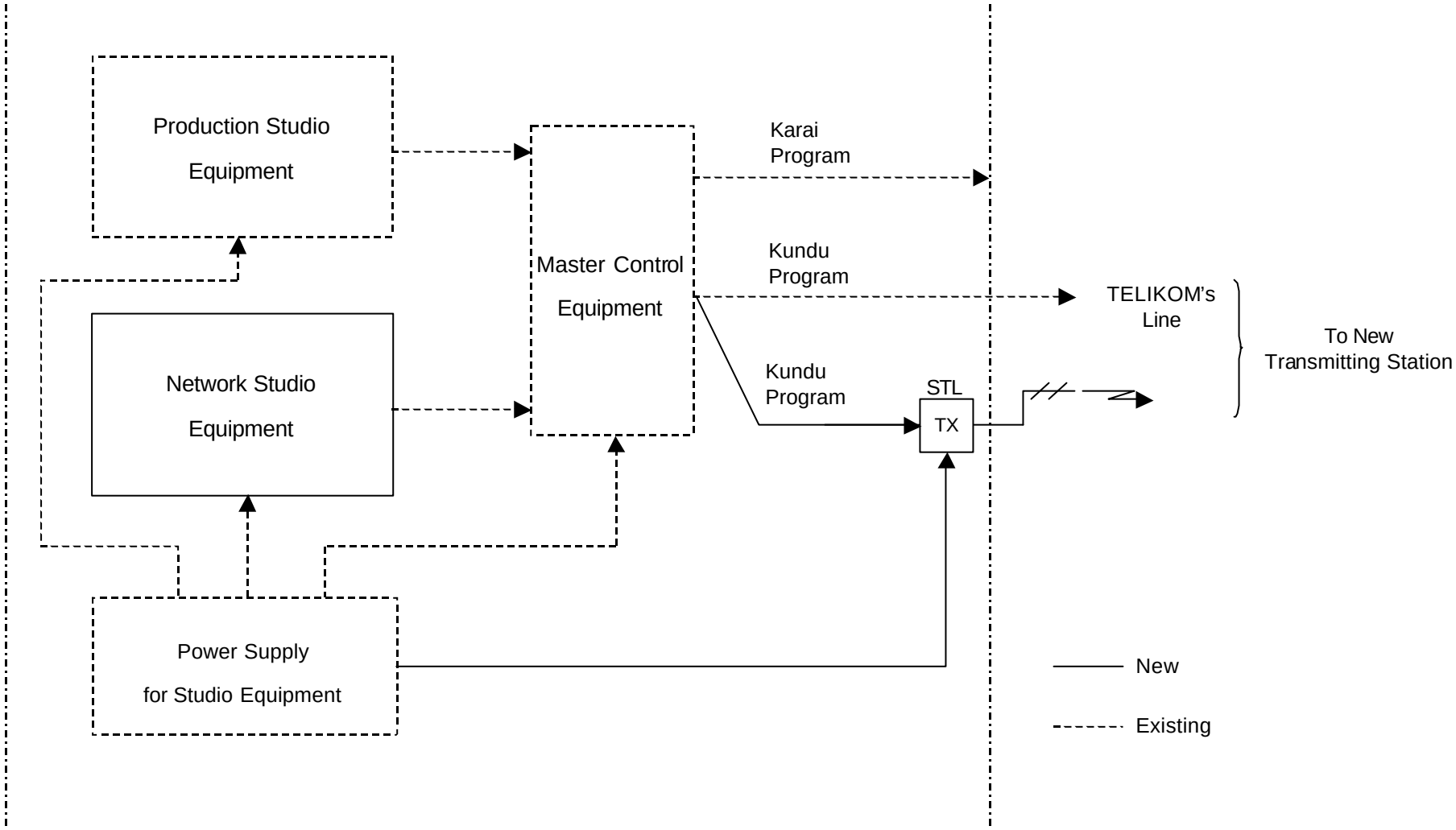


Fig. 2-26	Vanimo MF Radio Station	Block Diagram of Program Production System	

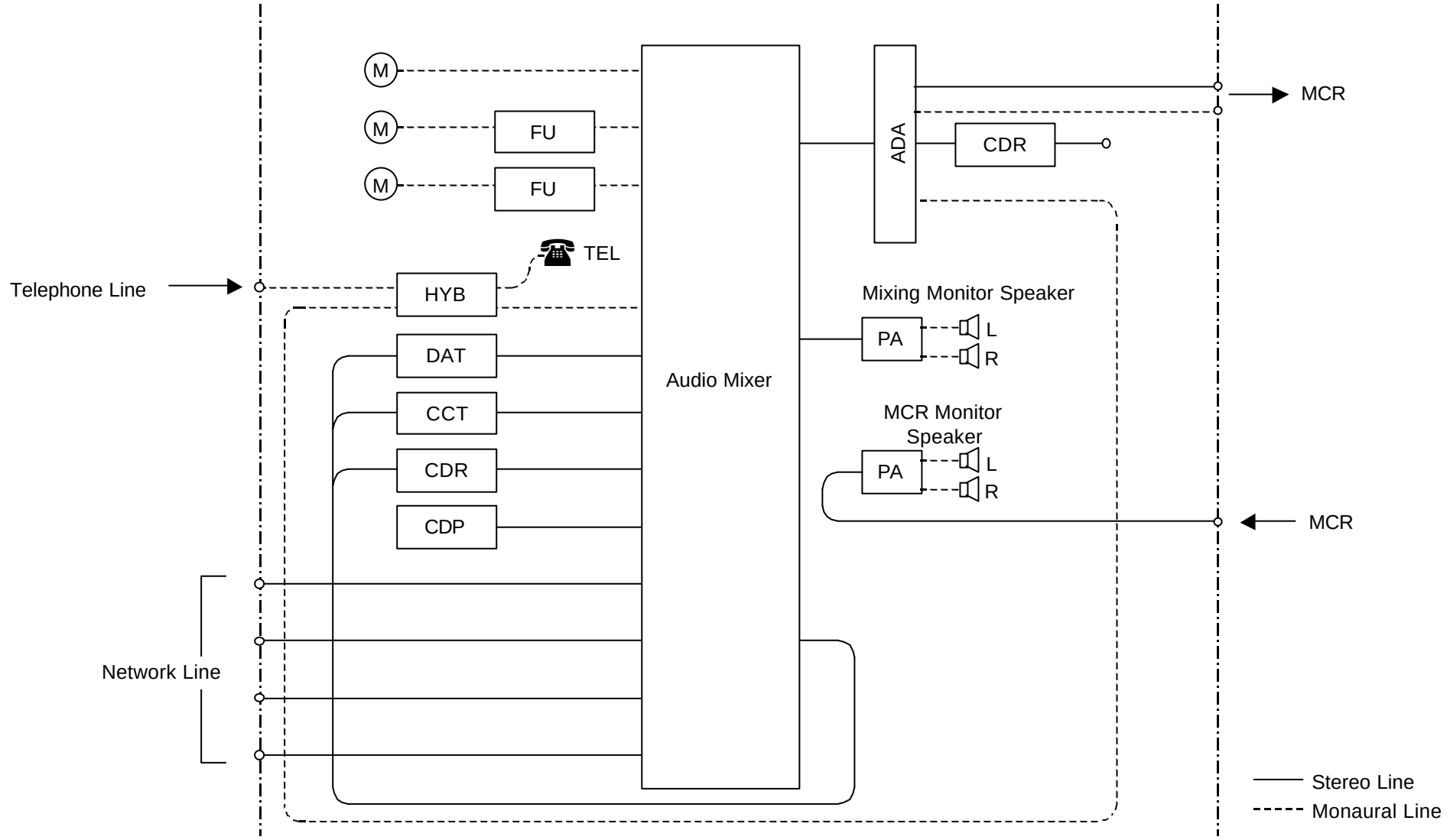


Fig. 2-27	Vanimo MF Radio Station	Block Diagram of Network Studio	

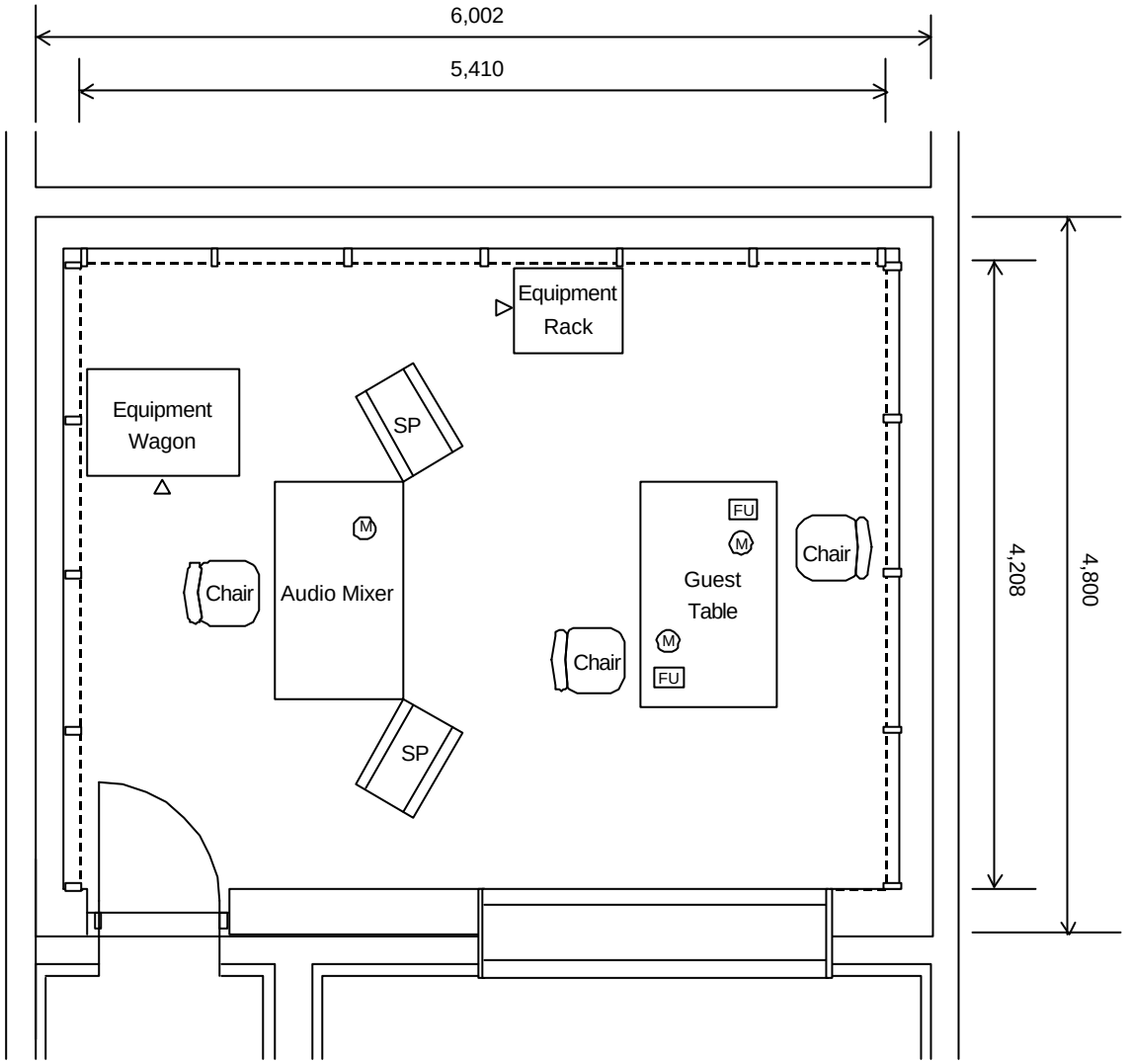


Fig. 2-28	Vanimo MF Radio Station	Equipment Layout of Network Studio	S=1:50

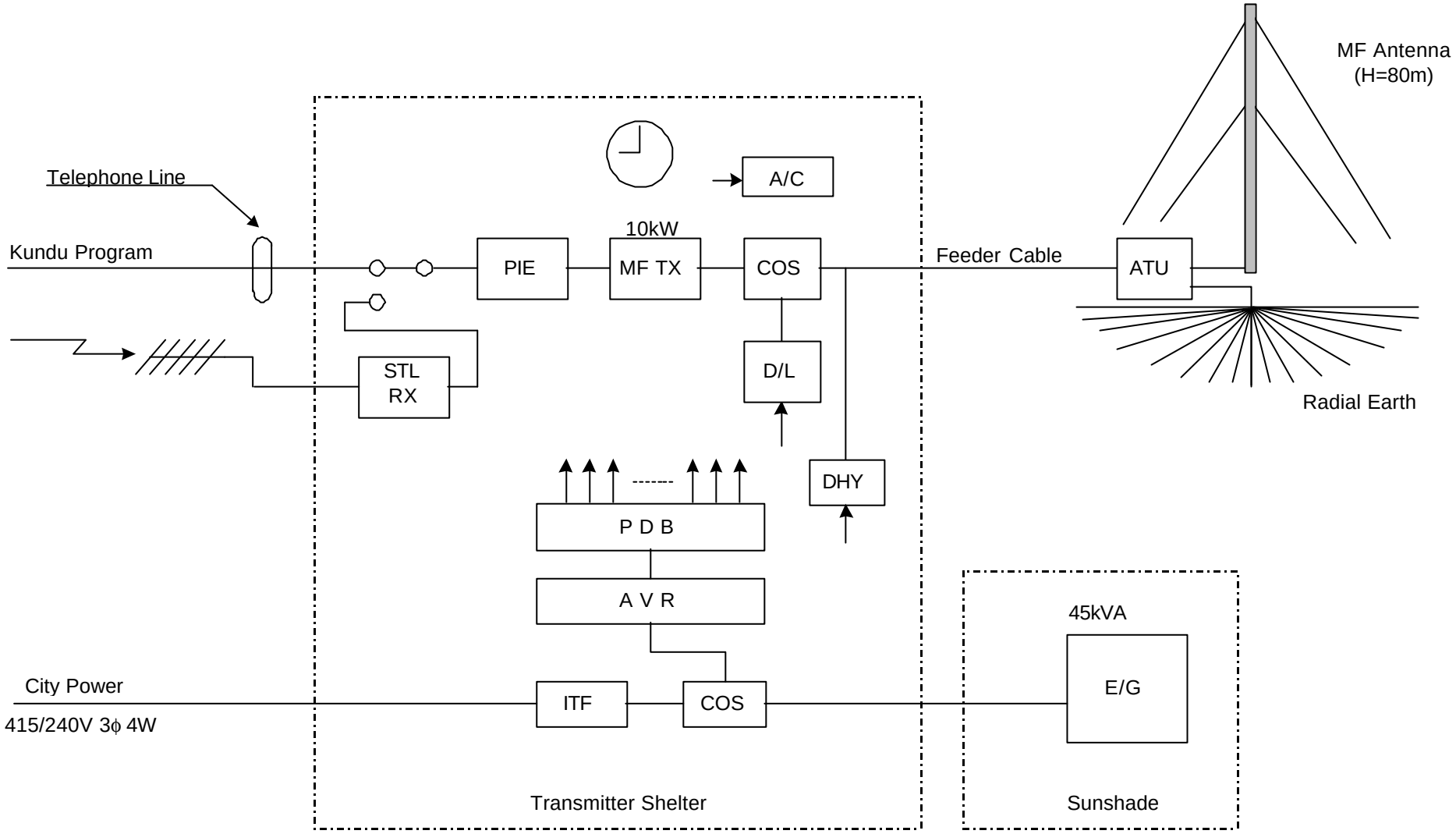


Fig. 2-29	Vanimo MF Radio Station	Block Diagram of MF Transmitting Station	

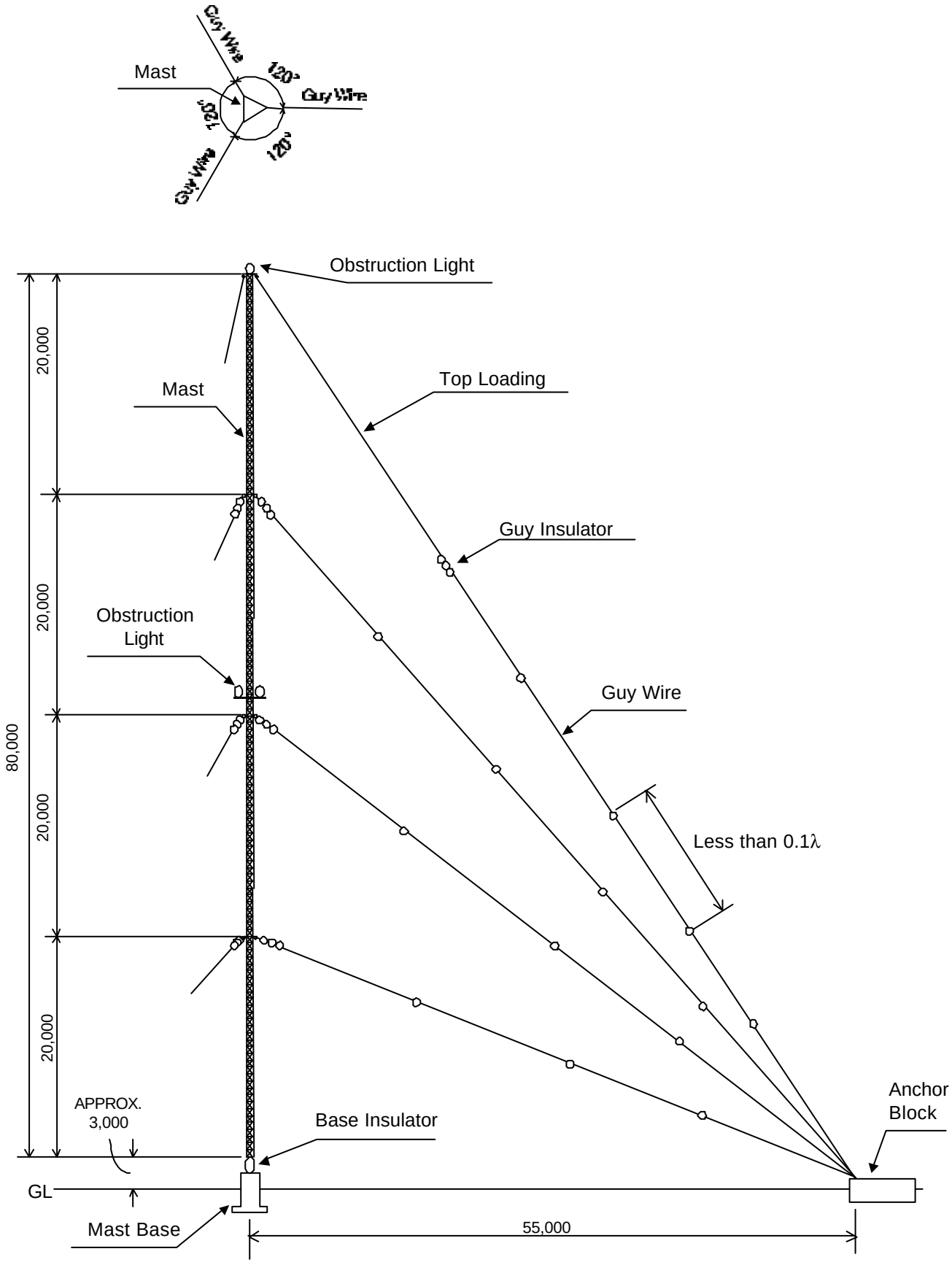


Fig. 2-30	Vanimo MF Radio Station	General View of MF Transmitting Antenna	S=1:500

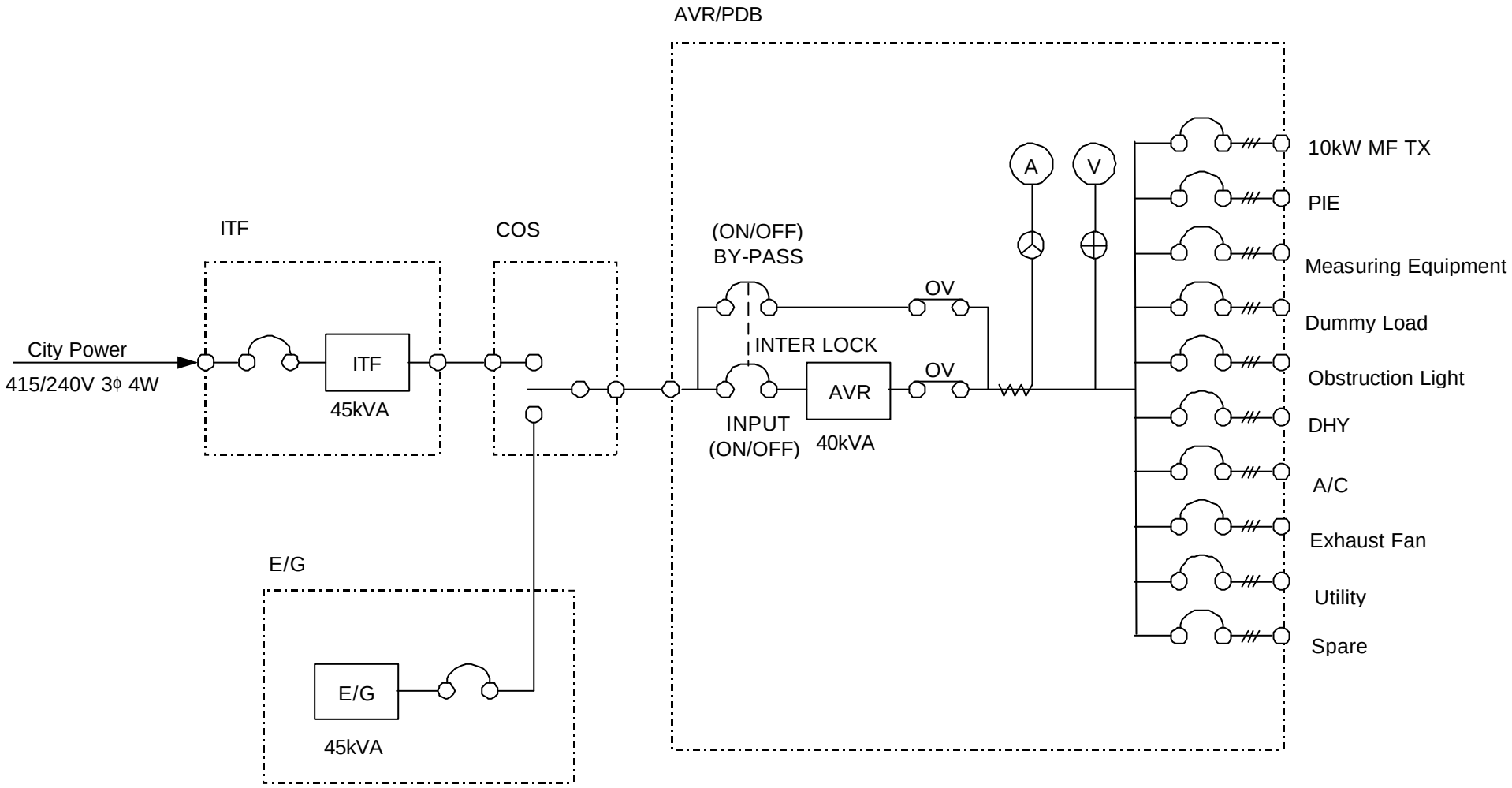


Fig. 2-31	Vanimo MF Radio Station	Schematic Diagram of MF Power Supply System	

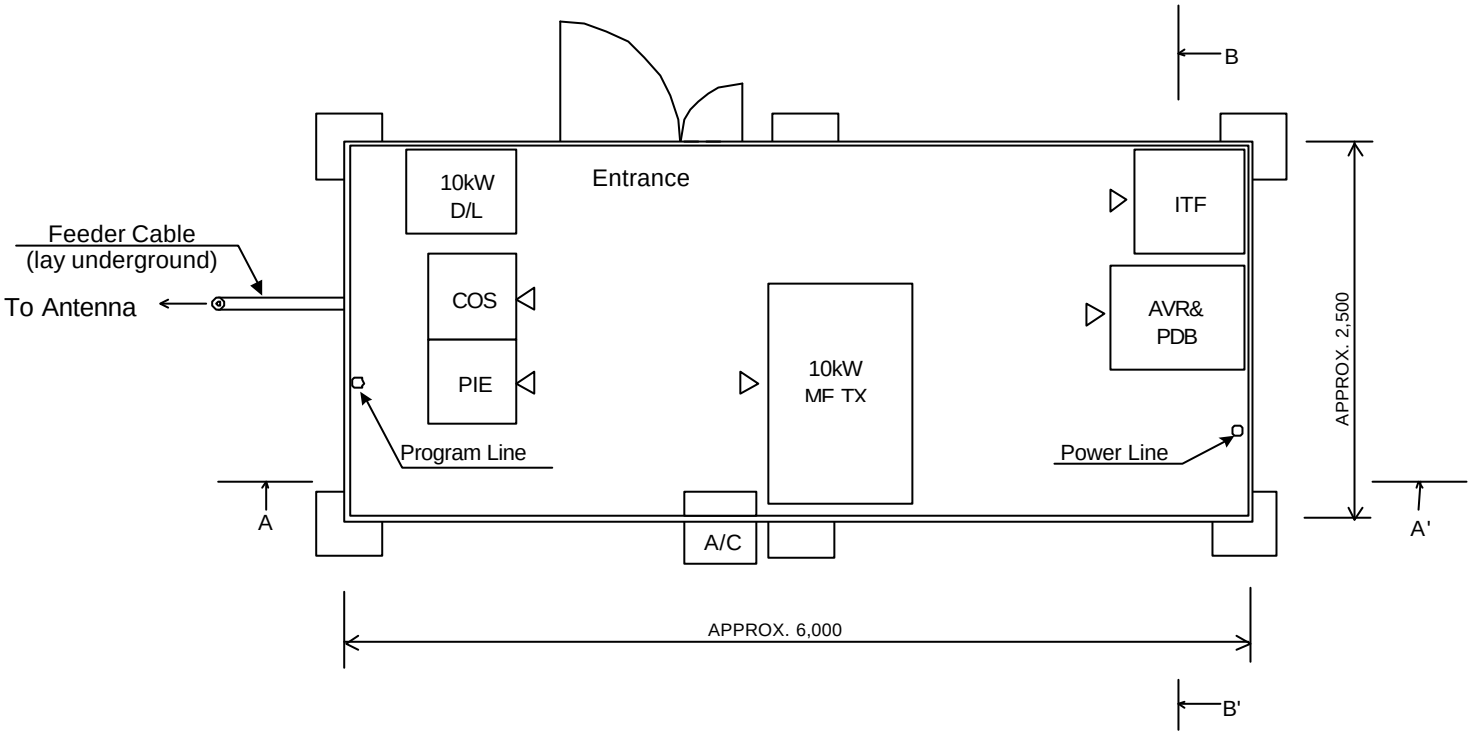


Fig. 2-32	Vanimo MF Radio Station	Equipment Layout of MF Transmitter Shelter	S=1:50

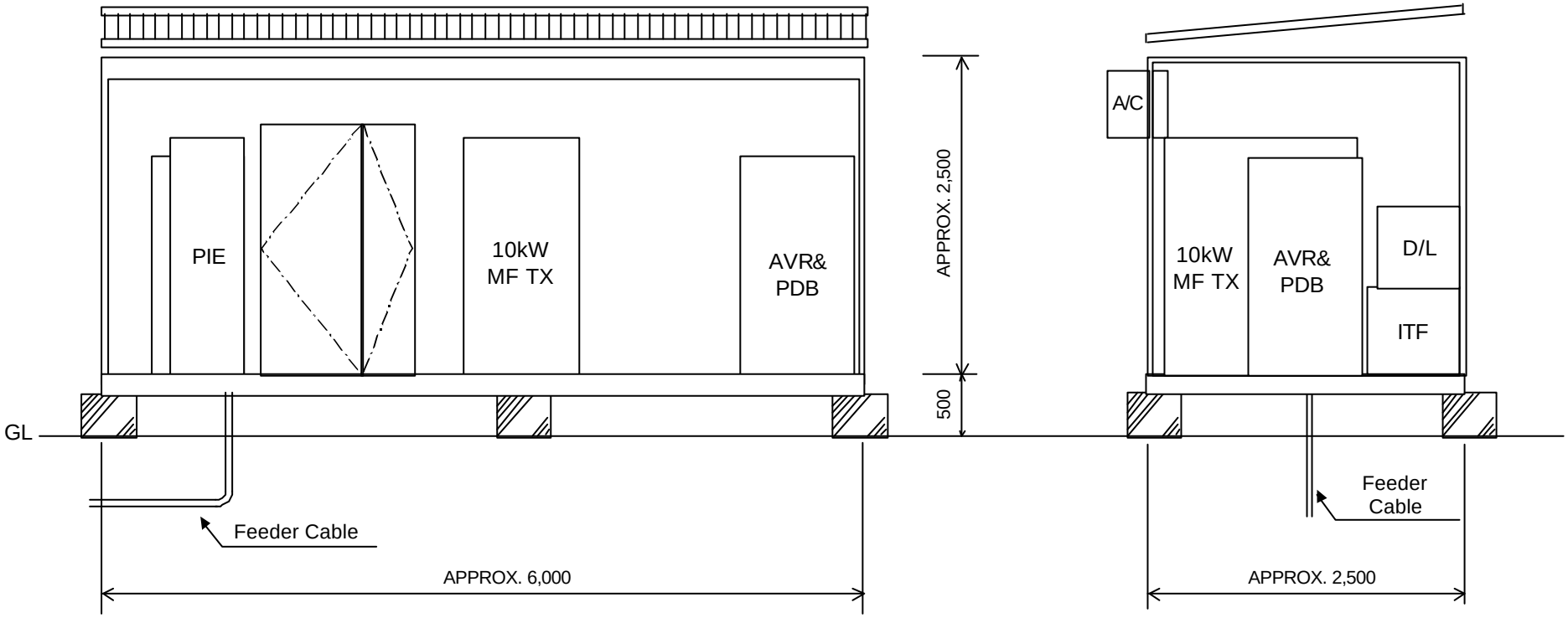


Fig. 2-33	Vanimo MF Radio Station	Equipment Layout of MF Transmitter Shelter (Section)	S=1:50

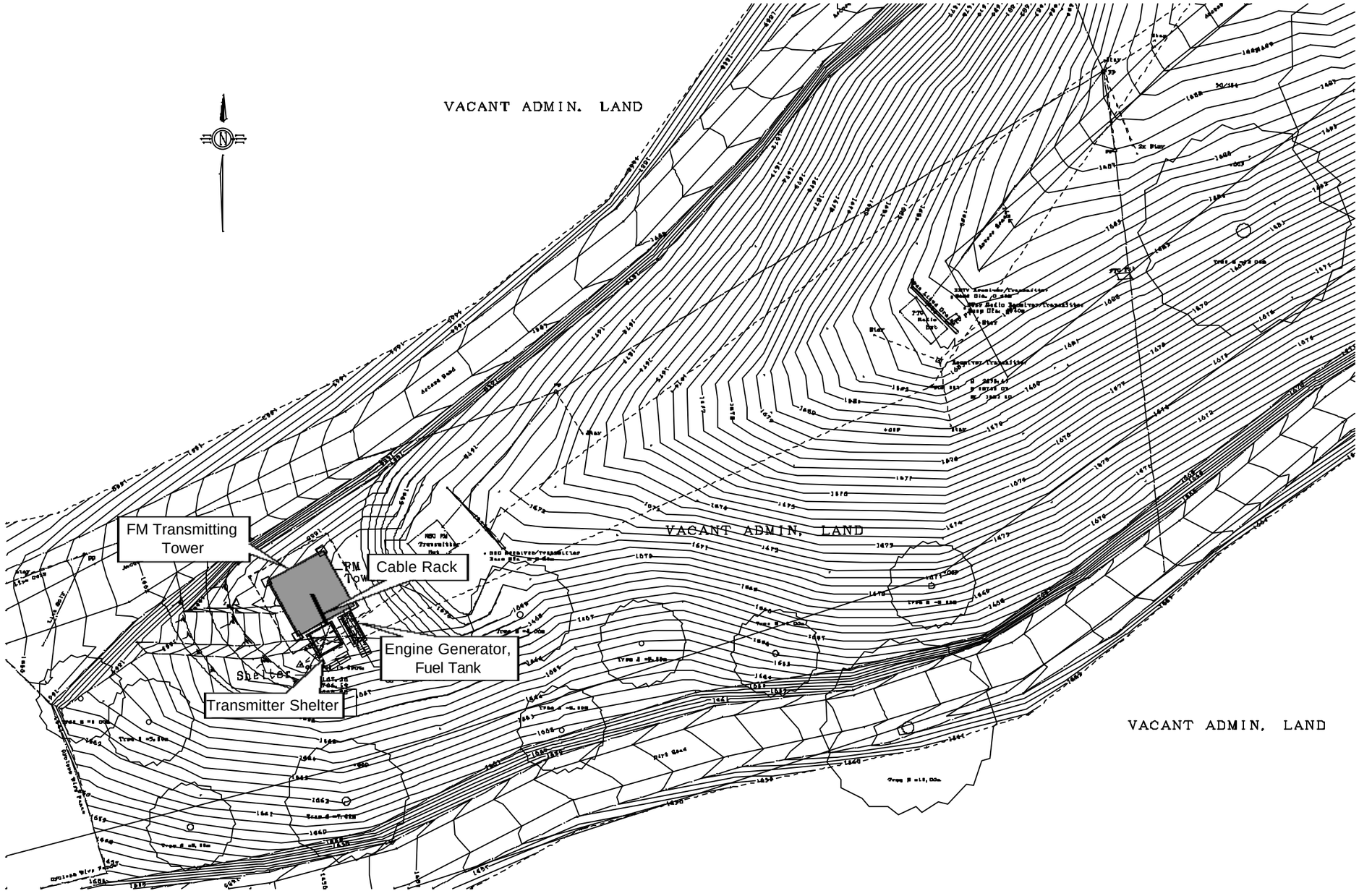


Fig. 2-34	Goroka FM Radio Station	Site Layout of FM Transmitting Station	S=1:500

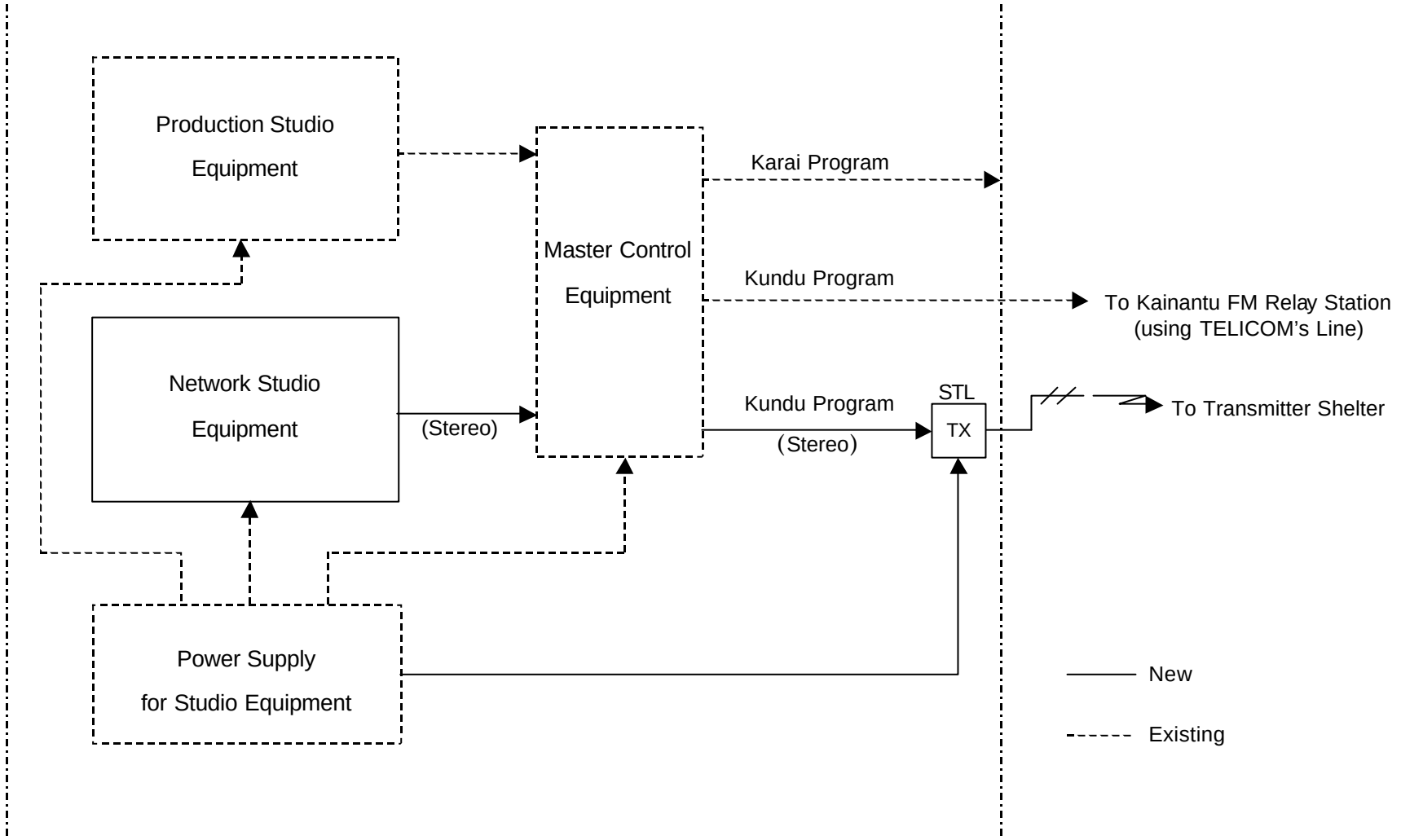


Fig. 2-35	Goroka FM Radio Station	Block Diagram of Program Production System	

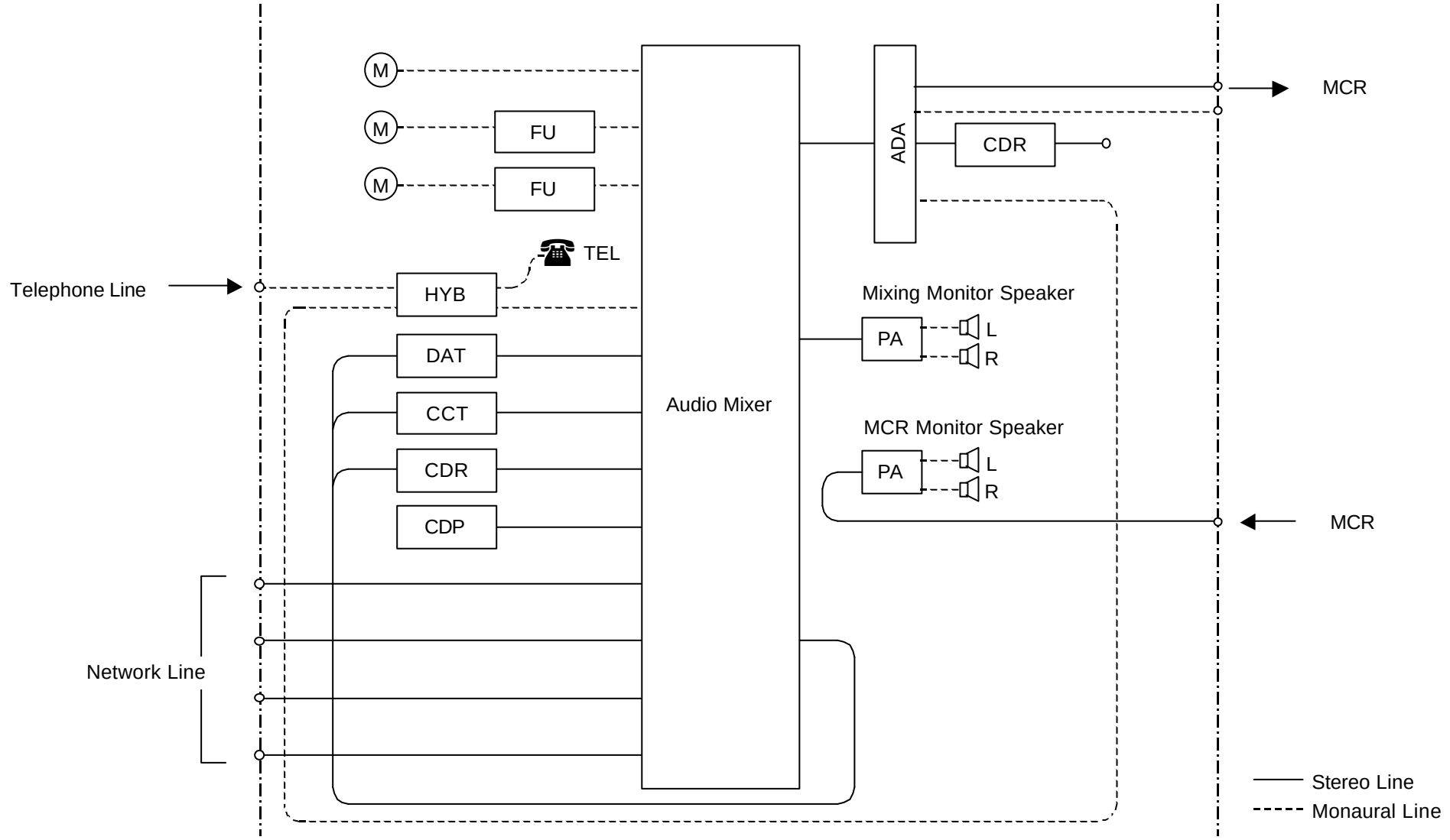


Fig. 2-36	Goroka FM Radio Station	Block Diagram of Network Studio	

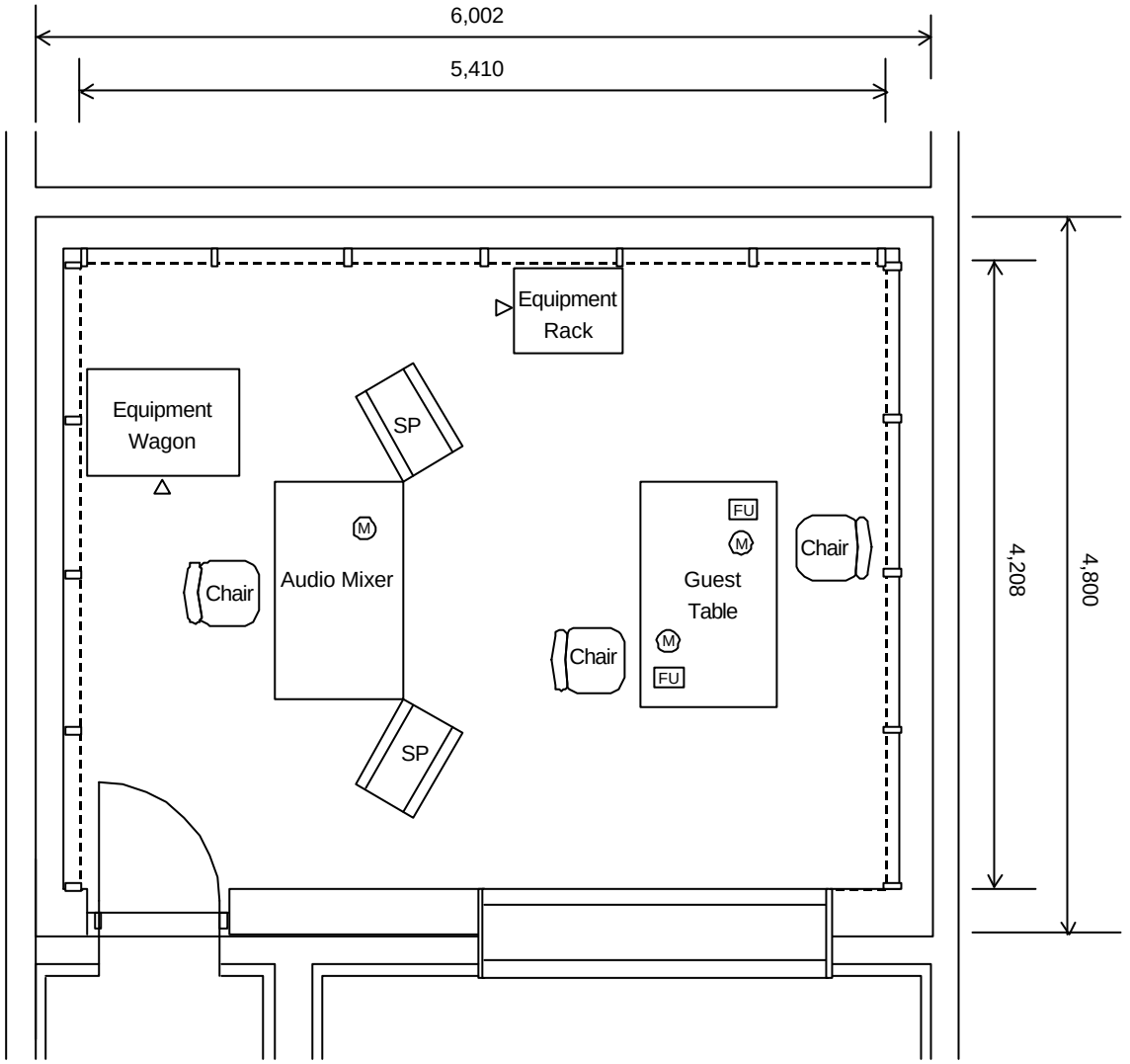


Fig. 2-37	Goroka FM Radio Station	Equipment Layout of Network Studio	S=1:50

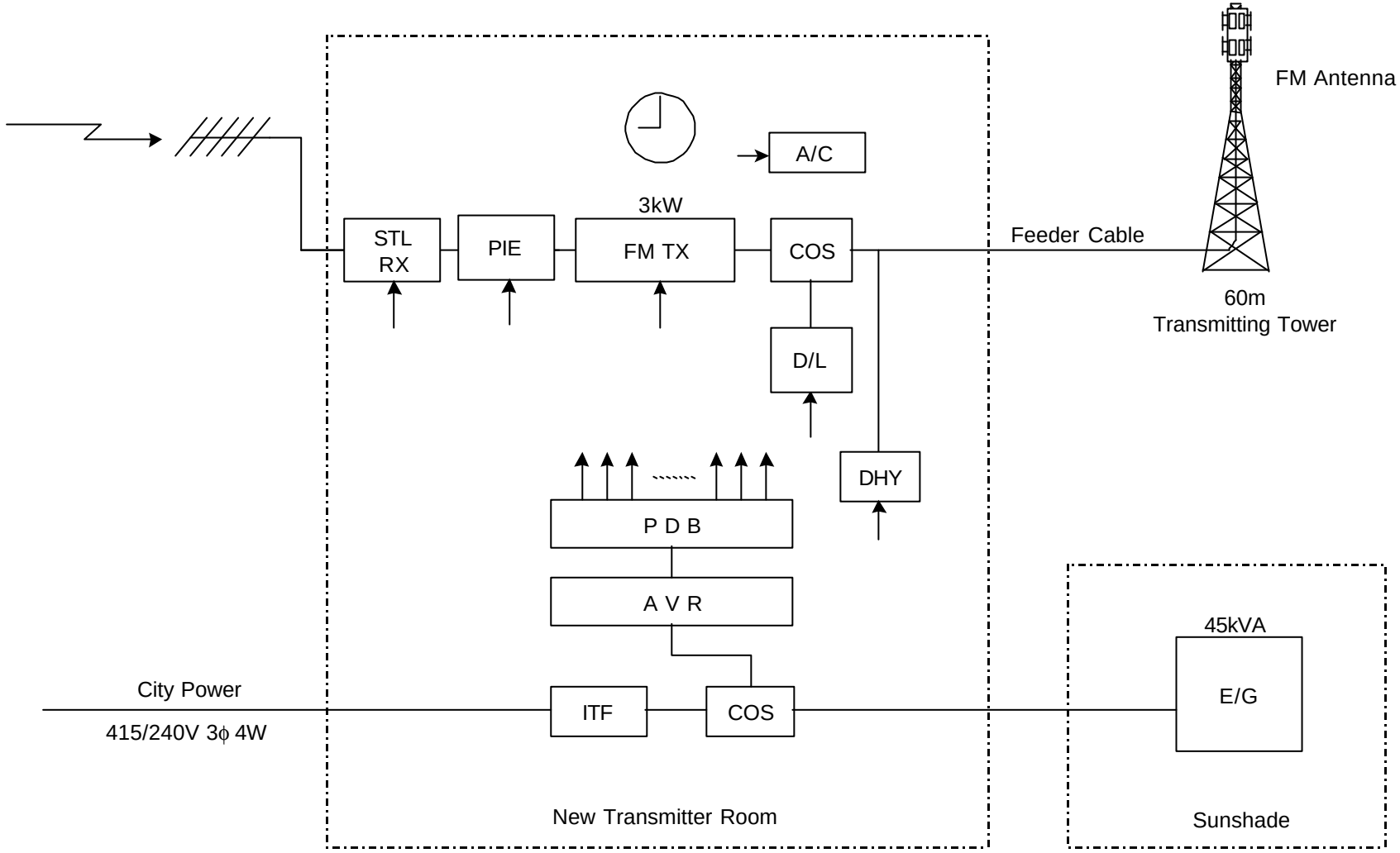


Fig. 2-38	Goroka FM Radio Station	Block Diagram of FM Transmitting Station	

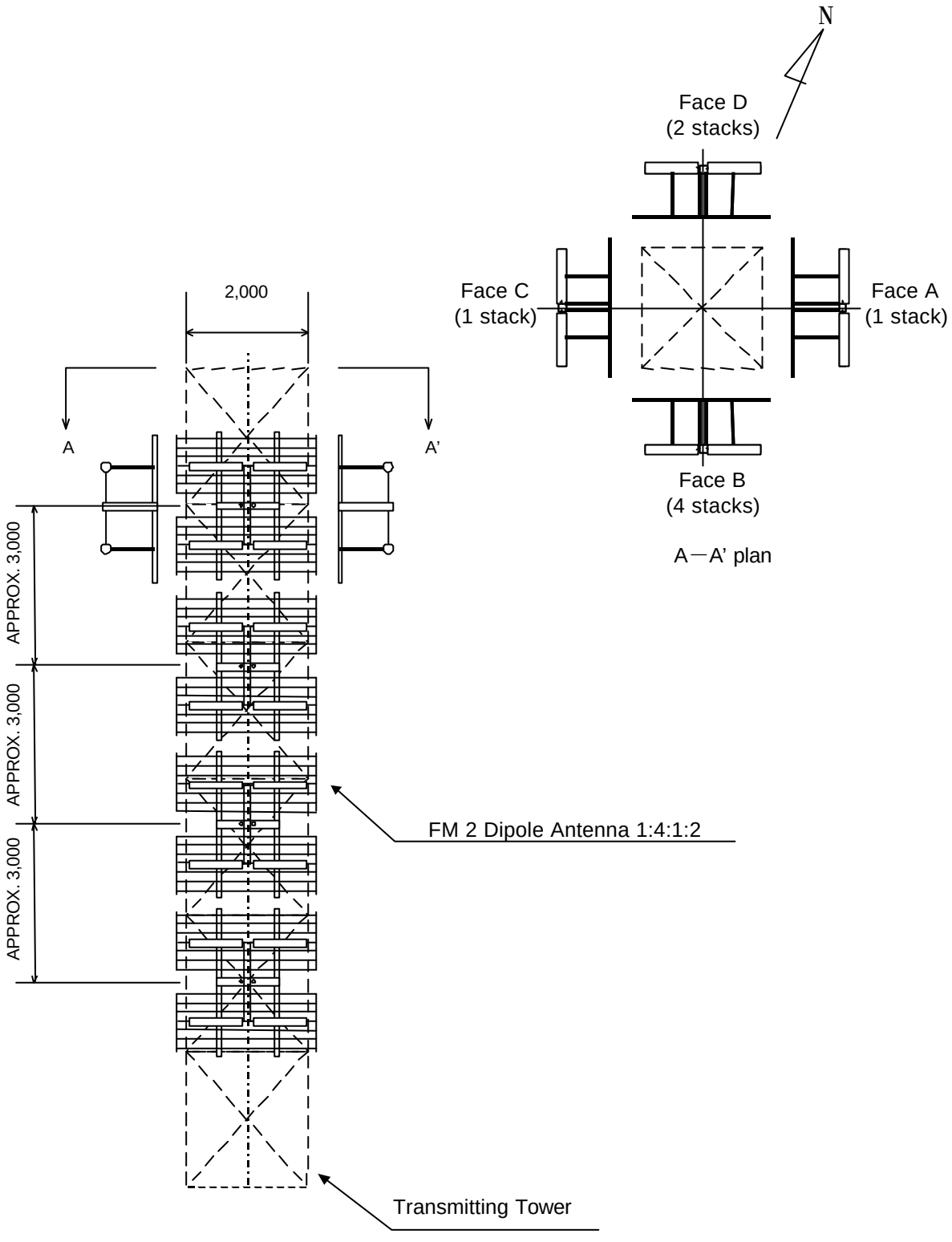


Fig. 2-39	**Goroka FM Radio Station**	**General View of FM Transmitting Antenna**	

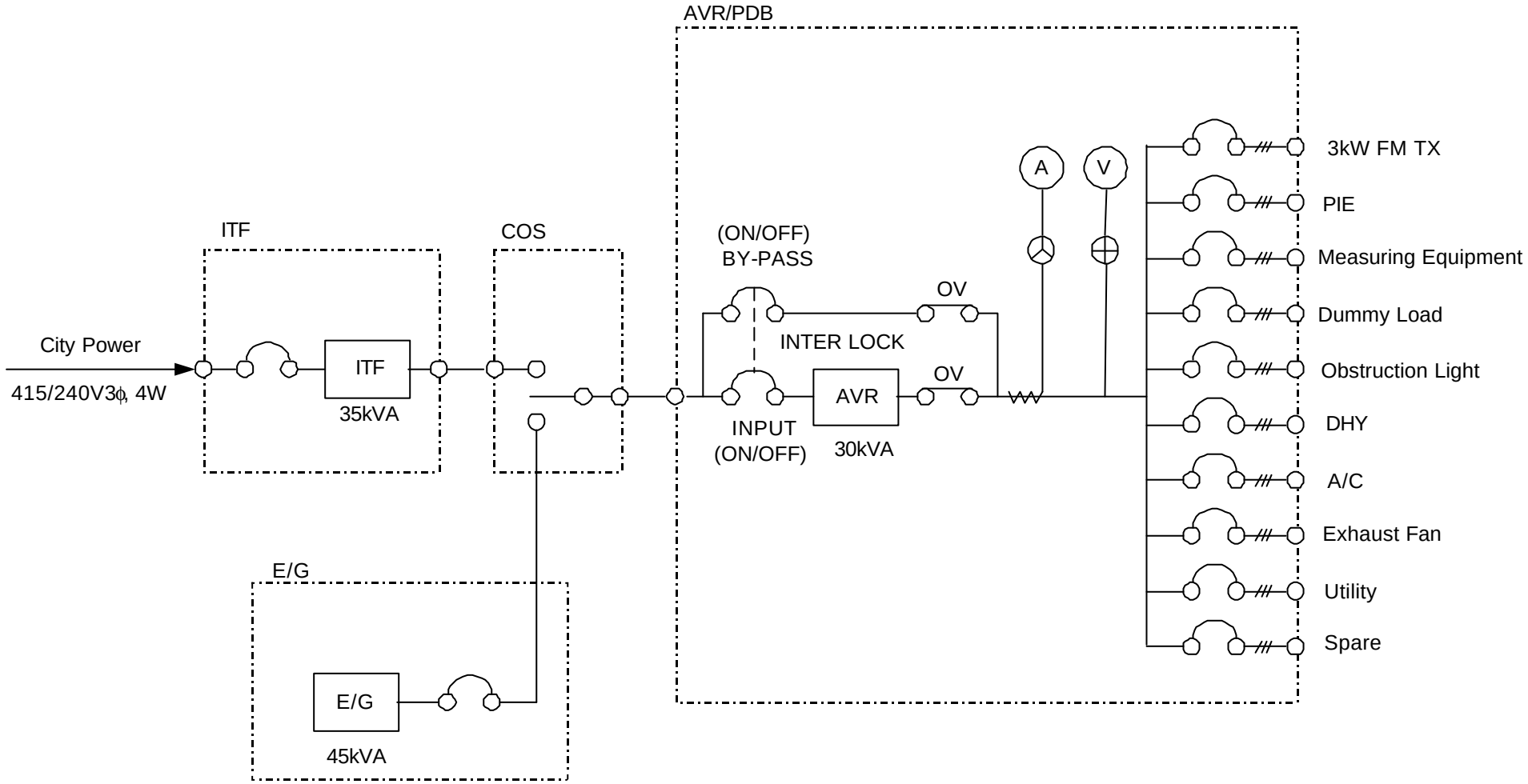


Fig. 2-40	Goroka FM Radio Station	Schematic Diagram of FM Power Supply System	

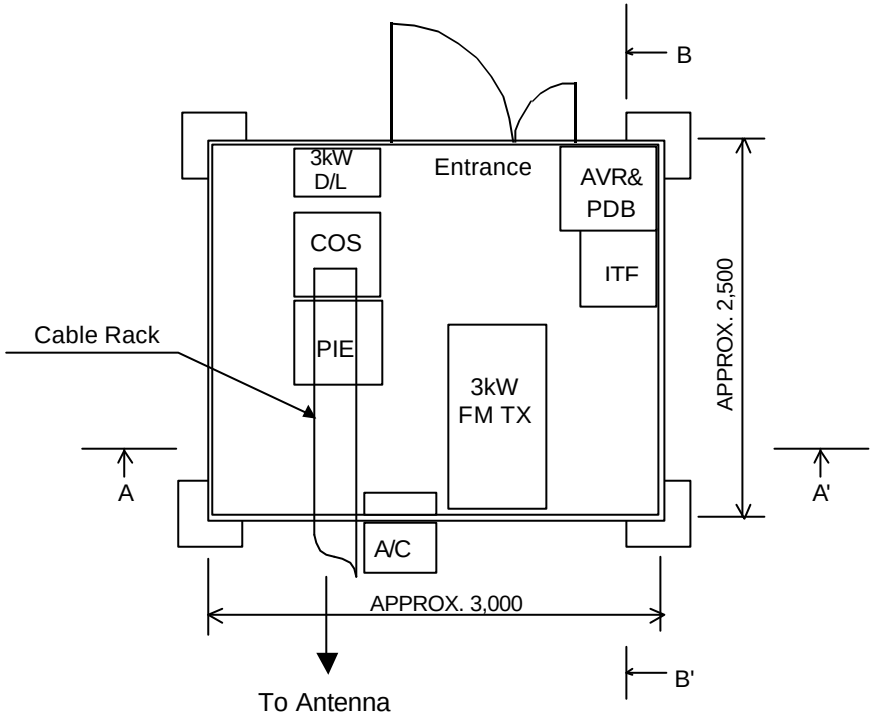
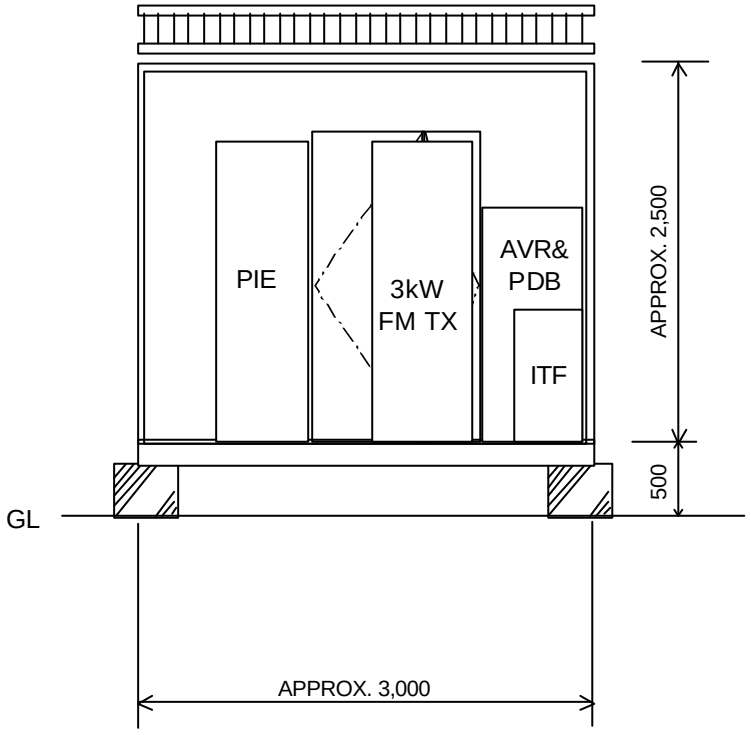
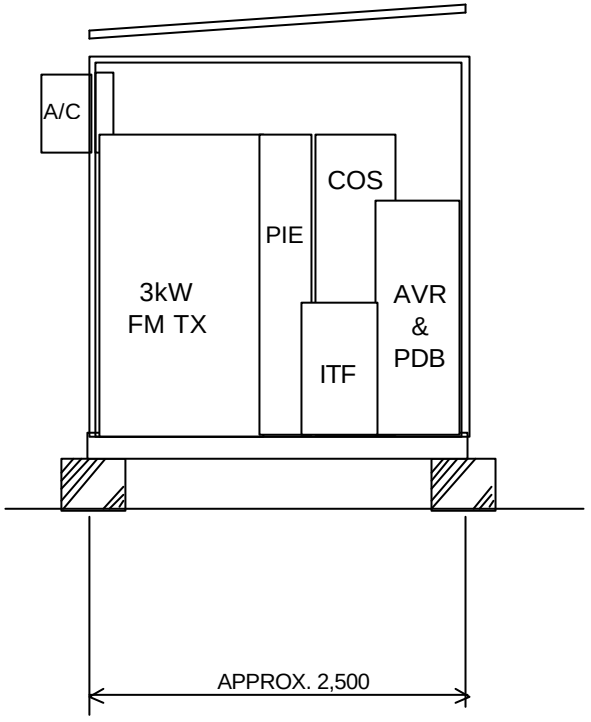


Fig. 2-41	Goroka FM Radio Station	Equipment Layout of FM Transmitter Shelter	S=1:50



A-A' Section



B-B' Section

Fig. 2-42	Goroka FM Radio Station	Equipment Layout of FM Transmitter Shelter (Section)	S=1:50

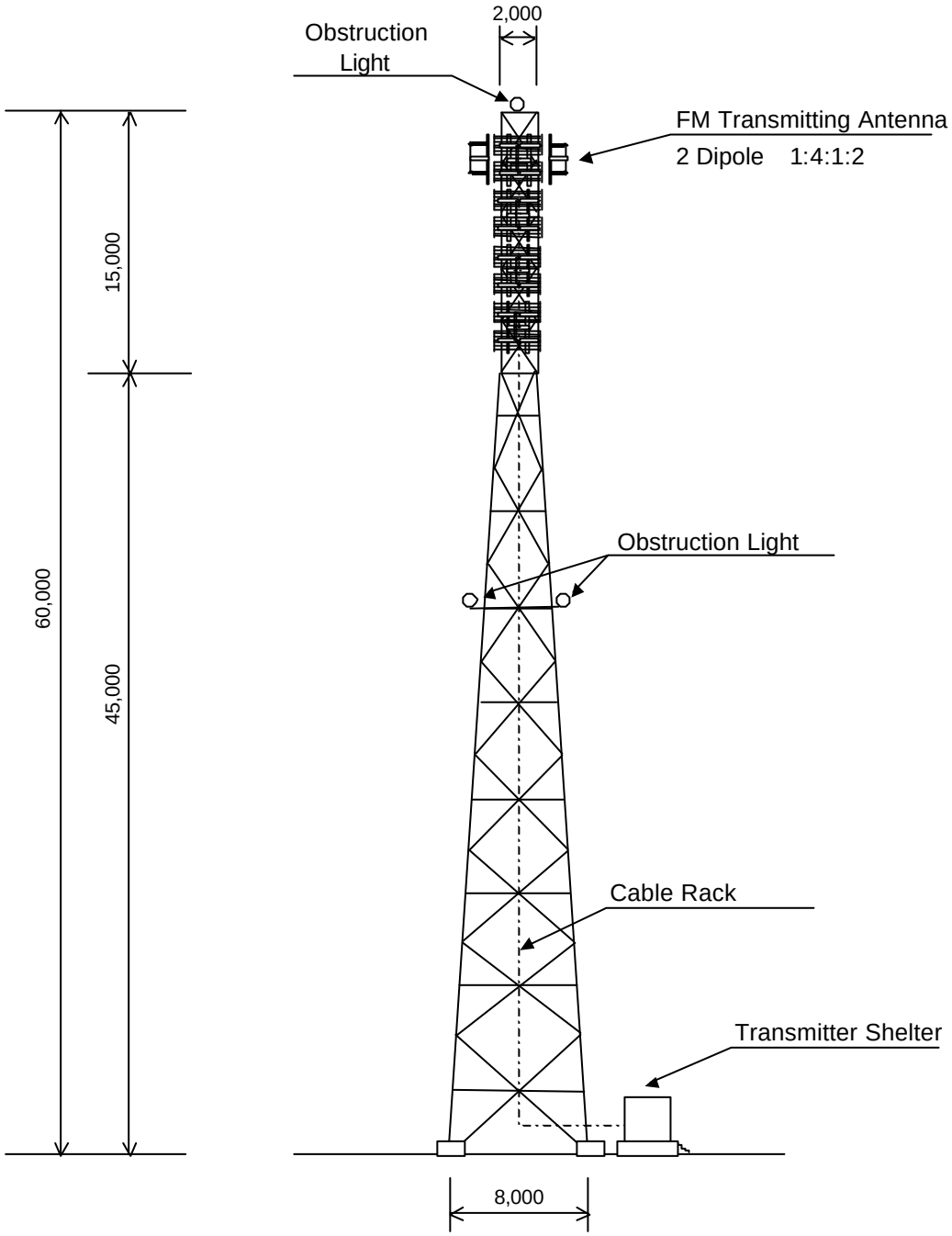


Fig. 2-43	Goroka FM Radio Station	General View of FM Transmitting Tower	S=1:400

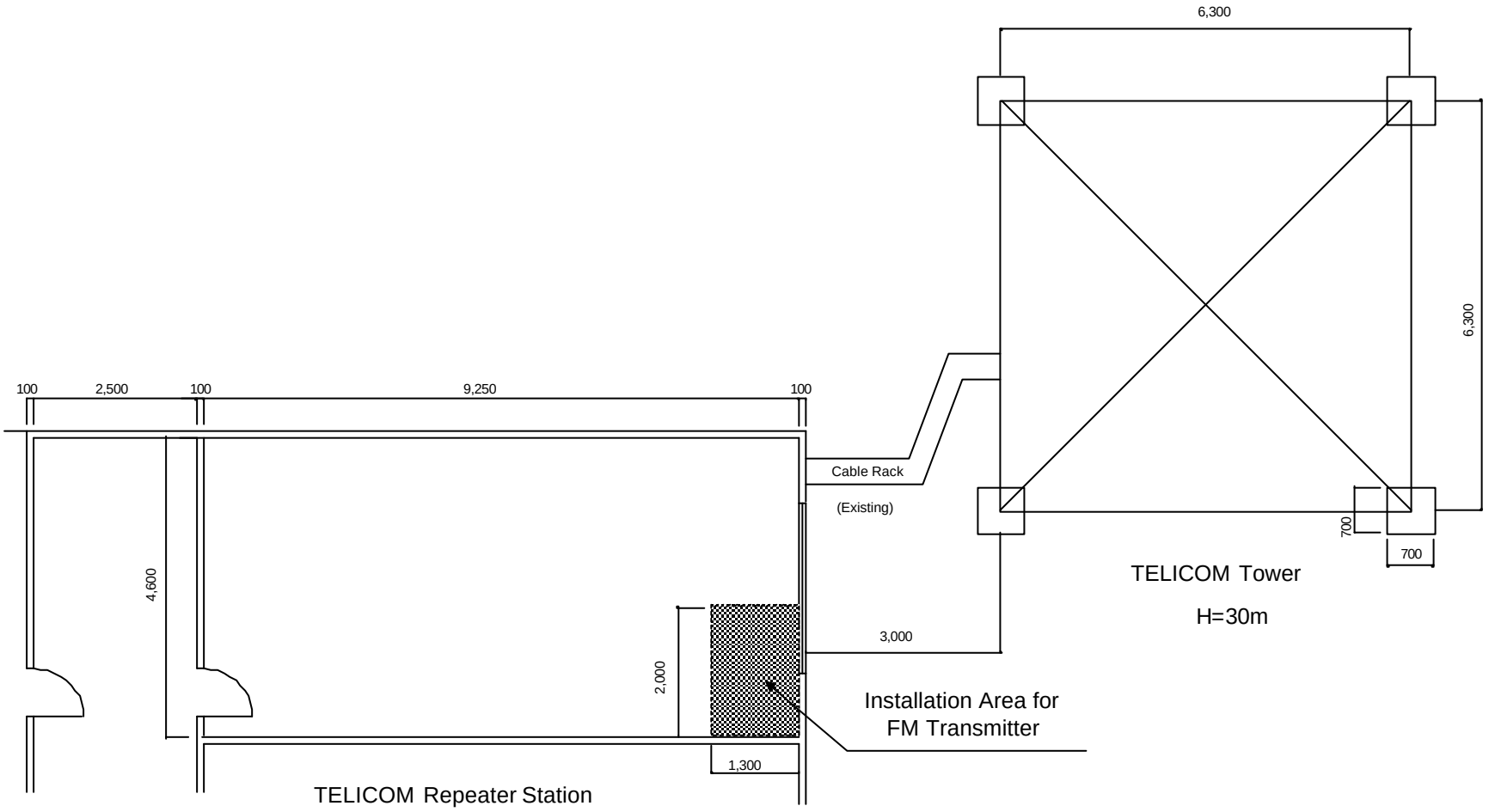


Fig. 2-44	Kainantu FM Relay Station	Site Layout of FM Relay Station	S=1:100

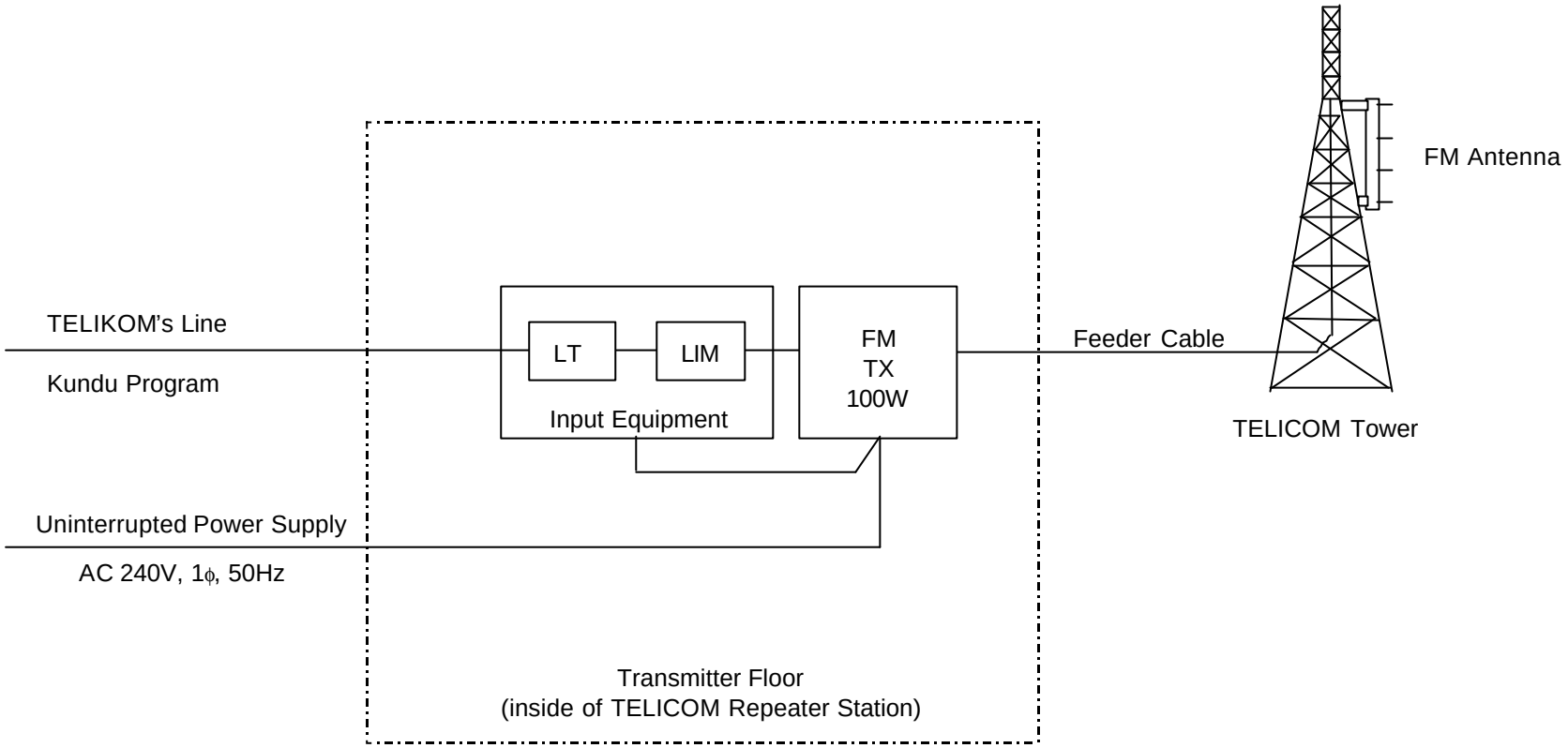


Fig. 2-45	Kainantu FM Relay Station	Block Diagram of FM Relay Station	

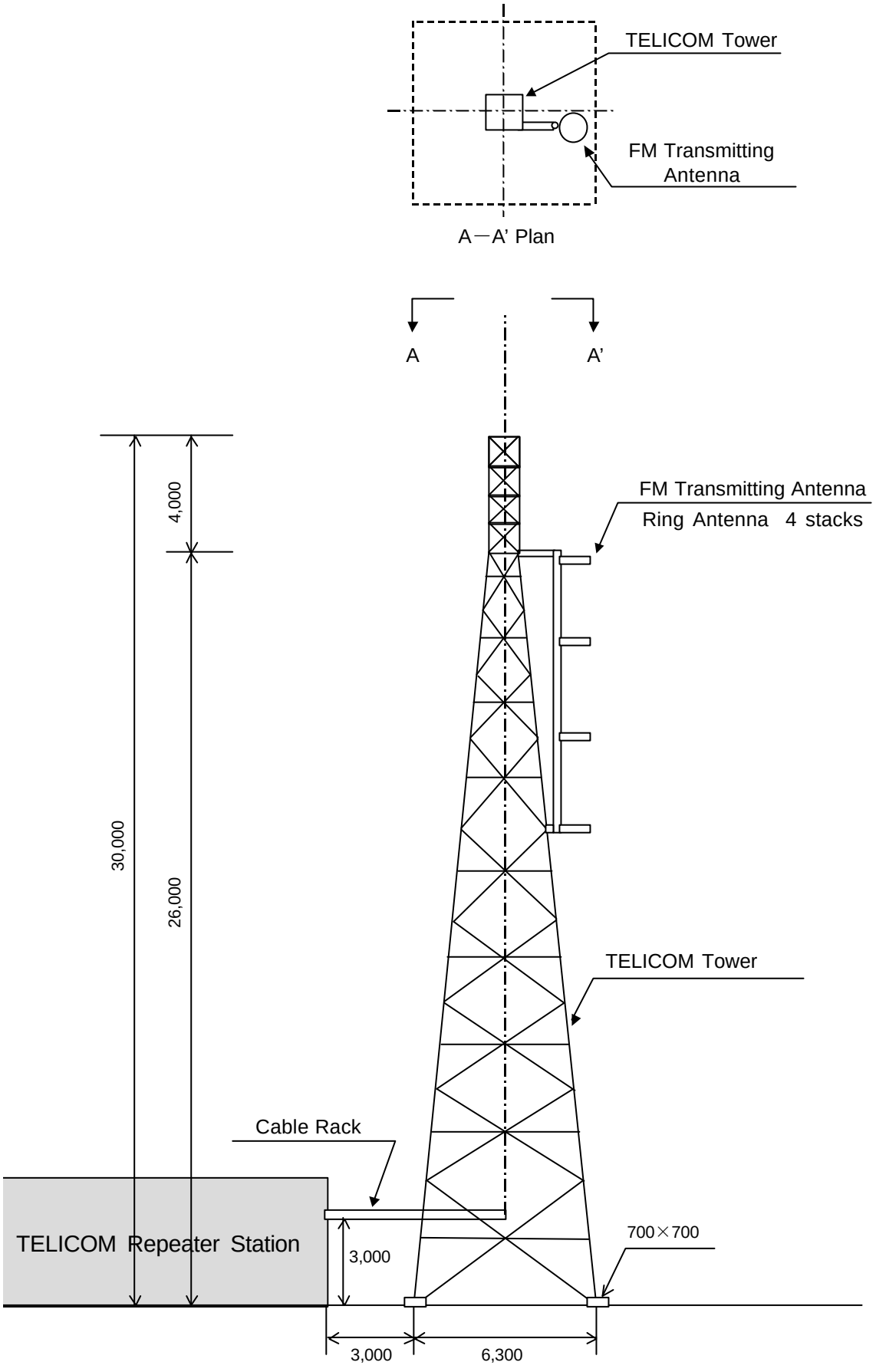


Fig. 2-46	Kainantu FM Relay Station	General View of FM Transmitting Antenna	S=1:200

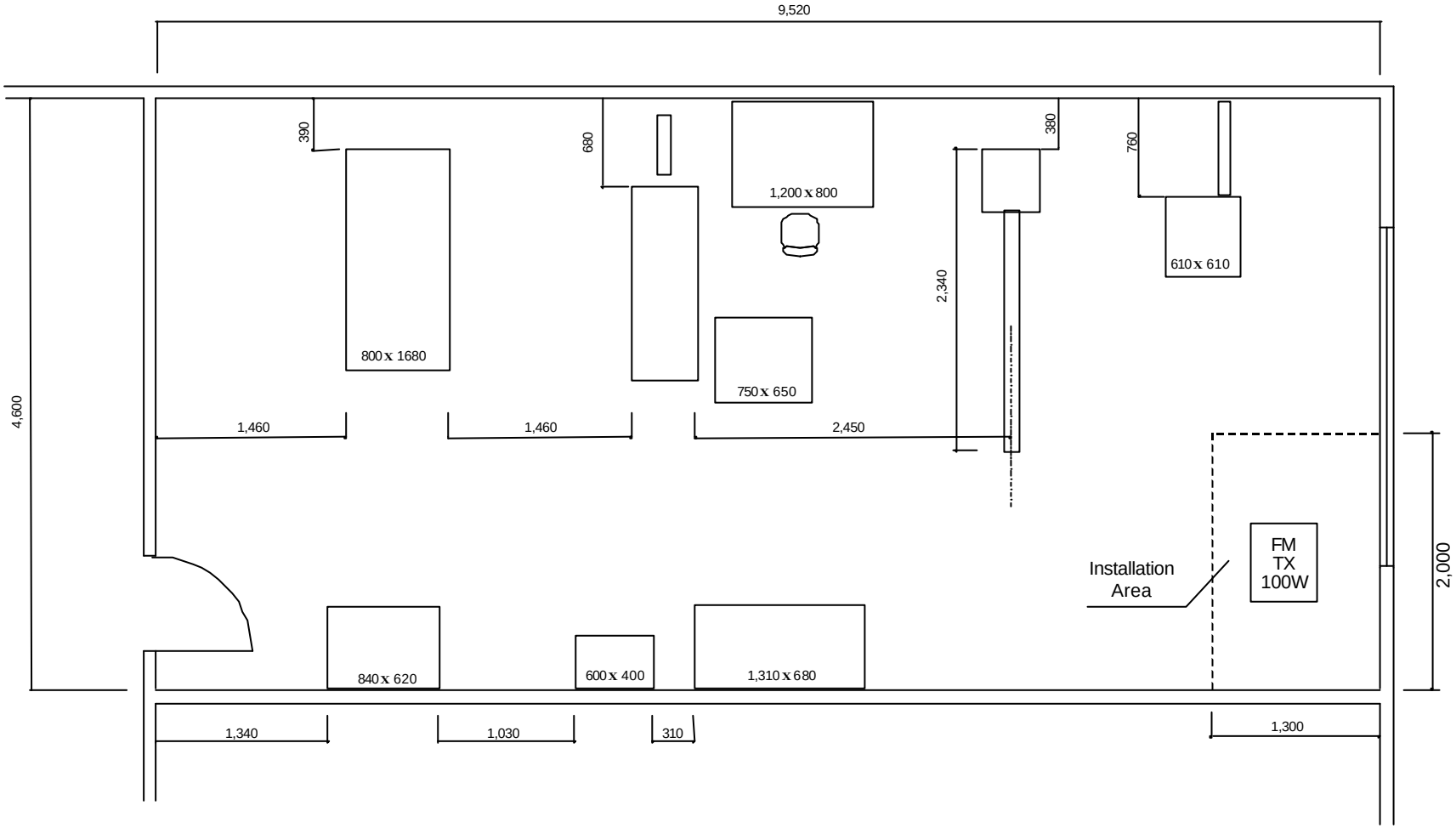


Fig. 2-47	Kainantu FM Relay Station	Equipment Layout	S=1:50

2-2-4 Implementation Plan

2-2-4-1 Implementation Policy

(1) Consideration of Works Progress in Six Sites

The Project entails installation of three MF transmitting stations in coastal areas, and three FM transmitting stations (including a repeater station) in highland areas. Two or three working parties shall simultaneously implement the works. The distance between the FM transmitting station construction sites in Goroka and Mt. Hagen is approximately 180 km, and overland transportation from Lae is available. However, the MF station sites of Vanimo and Lae are separated by approximately 800 km, and the sites of Lae and Kimbe (New Britain Island) by approximately 390 km. Not only are these sites widely dispersed, but also it is necessary to rely on marine transportation from Lae.

In consideration of these special circumstances, it is important to formulate detailed implementation plan, transportation plan and process schedule, and consultant to take an initiative in securing coordination and cooperation with the client and contractor.

(2) Procurement of Construction Materials and Skilled Workers

As mentioned above, the dispersed location of construction sites, make it very difficult to procure not only high quality local construction contractors, but also skilled workers such as formwork carpenters, electrical engineers and antenna installation workers, and construction machines and materials.

Accordingly, it will be necessary to either contract works out to established contractors based on Port Moresby, or to permanently employ skilled workers and dispatch them to the sites.

(3) Dispatch of Technical Expert

In Papua New Guinea, it is very difficult to secure personnel for positions that require very special technology, for example, installation of broadcasting equipment, construction of transmitting towers and antennas, and so on. Therefore, concerning execution of these works, these personnel shall be dispatched from Japan in order to implement work while at the same time transferring technology to the local technicians.

2-2-4-2 Implementation Conditions

(1) Consideration of Natural Conditions

Natural conditions on the five sites are various, and even the rainy and dry seasons are different. Therefore, it is necessary to formulate the works schedule in consideration of these conditions.

MF antenna installation works will be carried out in coastal and island areas for the transmitting antennas and radial earths, etc.

In highland areas, FM broadcasting will be adopted, however, it will be appropriate to implement steel tower works in the dry season from May to June.

Concerning humidity, relative humidity in both morning and afternoon is at between 70-90% throughout the year in coastal areas. In highland areas, on the other hand, relative humidity changes greatly from 60% to 90% between the morning and afternoon. As for island areas, humidity changes between morning and afternoon according to the season, however, it is generally stable at between 75-85%.

Since average temperatures on the Project sites are high, tropical region specifications shall be adopted in design of Project equipment. Concerning transmitter shelters, specifications that take air tightness and temperature control into account shall be adopted.

Moreover, since average monthly rainfall of 640 mm has been recorded in coastal areas during the rainy season, the effects of heavy rainfall shall be countered by installing transmitter shelters at GL +800 mm and so on.

(2) Construction Machine, Materials and Labor Procurement Plan

Only basic materials can be procured at the project sites. Since heavy construction machines and special materials can only be obtained in the capital city of Port Moresby and the second city of Lae, it will be necessary to implement preliminary survey and collect information as well as procure skilled workers and conduct site preparations, etc.

2-2-4-3 Scope of Works

The major undertakings of each government in the event where the Project is implemented as the Grant Aid undertaken by the Government of Japan are indicated in Table 2-5.

Table 2-7 Major Undertaking of Each Government

No.	Work Area	Japan	PNG
Facilities-related items			
1.	Securing of project sites		●
2.	Leveling of project sites		●
3.	Extension of power lines and program input lines to transmitter shelters		●
4.	Temporary works spaces such as site offices and materials stockyards, etc.		●
5.	Power receiving equipment for receiving additional power		●
6.	Construction of fences and gates around sites		●
7.	Preparation of access roads		●
8.	Removal of existing HF antennas		●
9.	Studio renovation (excluding Lae and Kimbe)		●
Equipment-related items			
1.	Equipment procurement, transportation, installation and adjustment	●	
2.	Transfer of Kalang FM antenna (Goroka)		●
3.	Transfer of EM TV antenna (Goroka)		●
4.	Transfer of commercial FM antenna (Goroka)		●
5.	Securing of designated frequency		●
General items			
1.	Renewal plans including depreciation cost of the new equipment		●
2.	Acquisition of all required legal authorizations in Papua New Guinea		●
3.	Tariff exemption measures for imported equipment and materials		●
4.	Banking commissions required for issue and revision of the authorization to pay.		●
5.	Appropriate and efficient operation of the provided equipment		●
6.	Recipient country work designated in the exchange of notes.		●

2-2-4-4 Consultant's Supervision

Based on the Grant Aid scheme of the Government of Japan, the consultant shall organize a project team that is dispatched project sites to manage the implementation design and works supervision based on the purpose of the basic design and ensure smooth execution of the project. The basic concept of the supervision work shall be as follows.

(1) Basic Concept of Supervision

To maintain close communications with agencies and officials in both countries and aim for Project completion based on the implementation schedule.

- offer appropriate guidance and advice to related officials to ensure that equipment is installed meeting the project specifications.
- carry out enough guidance to NBC on operation and maintenance of equipment.
- offer appropriate guidance and advice on equipment and maintenance of after completion of installation.

(2) Contents of Consultant's Supervision

- Contract related work

  Consultant shall prepare and carry out ① tender document, ② handling of bidders from announcement of tender through to opening of bids, ③ assessment of tenders and selection of contractor, ④ holding of contract negotiations, and ⑤ witnessing of the contract, etc. and report on the progress and results of such as work to the client at appropriate stage.

- Confirmation and inspection of items submitted by equipment suppliers

  The consultant shall confirm the contents of shop drawings and materials samples submitted by equipment suppliers, and implement inspections where necessary.

- Confirmation of Implementation Plan

  The consultant shall examine and confirm the implementation plan such as work schedule submitted by contractor, and offer guidance to contractor, and submit report to the implementing agency.

- Cooperation Regarding Payment Approval Procedure

  Concerning contract fees to be paid to contractors, the consultant shall examine all requests for payment, etc. that are submitted by the contractor, and issue the necessary certificates.

- Witnessing of Inspections

  Consultant shall inspect the quality and completion work in each installation stage, and also, witness for all test, including inspections and final inspection that are implemented on the contract.

  Also, consultant reports all necessary items concerning work's progress payment procedures and completion and handing over to related agencies in the Government of Japan side.

The consultant work shall be completed after obtaining approval from the client.

(3) Supervision Staffing Plan

Although the Project is an equipment supply, since it deals with radio transmitting stations, works include numerous foundation and installation works for steel towers, antennas, transmitter shelters and engines generator, etc. Moreover, the said works shall be completed efficiently with uniform quality at five different sites scattered around PNG. Lae, one of five sites, is the second largest city in PNG, so it will be possible to procure subcontractors, laborers and materials, etc., however, remaining four sites will be in a much more difficult condition.

The consultant will monitor the overall execution situation while keeping close communications with contractor and local government officials, and patrol between five construction sites to ensure the quality of works according to the overall implementing schedule.

Accordingly, consultants have been assigned so that one supervisor is stationed at each site to oversee foundation works and steel tower and antenna installation works, and one more supervisor is assigned to oversee transmitters, installation of studio equipment and program transmission equipment according to the stage of works. However, since works will be simultaneously done at five sites at peak times, the plan has been compiled so that one supervisor for facilities and one supervisor for equipment shall be assigned timely to sites as required. Requirement for the selection of the supervision staff in both fields shall be possession abundant experience, appropriate technical judgment, wide perspective, and coordinating capacity.

2-2-4-5 Quality Control Plan

The consultant shall carry out quality control in the Project implementation stage based on the purport of the basic design. Quality control here is defined as 'the system of means for economically producing goods and services that comply with buyer requirements', and this definition shall be adopted as the basic line of thinking for Project implementation.

The consultant shall implement the following quality control work.

(1) Quality Control Plan for Installation Work

1) Quality control items for concrete work shall be as follows:

- Cement: confirm quality by carefully checking plant shipping certificates and the contents of plant work result.

- Decision of mixing proportions: carry out trial kneading and determine the mix proportions of kneaded materials to ensure that the designated strength and workability are secured.
- Concrete strength: consign a public or private test agency to carry out compression testing when the concrete is 1 and 4 weeks old.
- Concrete placement: check that the required workability is secured before placement by inspecting slump and airflow.
- Curing after placement: confirm that appropriate curing by water sprinkling is carried out after placement.

2) Imported reinforcing bars can be procured in PNG, however, the manufacturer's 'Mill Sheet' guaranteeing quality is frequently not attached. Therefore, the strength of bars shall be confirmed by consigning tensile testing to public or private test agencies.

3) Concerning steel tower and MF antenna materials, the quality and strength of materials, bolt strength and precision, etc. shall be confirmed based on Mill Sheets and materials presented by manufacturers.

4) Concerning transmitter shelters, working drawings presented before fabrication shall be checked, and inspections shall be carried out at the fabricating factory.

(2) Quality Control Plan for Equipment and Materials Procurement

1) To review the working drawings, shop drawings, technical materials and samples, etc. submitted by the contractors, and make sure that contents conform with the plans and standards, etc. contained on design drawings and specifications.

2) Before shipping materials and equipment from factories, consign pre-shipping inspections to a reputable inspection agency:
   - Checking of the contract equipment and materials list with shipping documents,
   - Checking of shipping documents with actual equipment and materials,
   - Issue of inspection certificates.

2-2-4-6 Procurement Plan

(1) Materials Procurement Plan

Procurement destinations in Japan's Grant Aid are limited as a rule to Japan or the recipient country, however, procurement considering after service in PNG is desirable.

Foundation works materials will be procured in Papua New Guinea. The following table gives an outline of materials procurement divisions.

Materials	Source			Reason for Selection
	PNG	Third Country	Japan	
Sand	✓			Supply of mountain sand is possible.
Cement	✓			Local products have a proven quality record.
Reinforcing bars	✓			Local products have a proven quality record.
Steel-frame			✓	Securing of quality and performance and certainty of supply
Timber	✓			There are no problems in terms of quality.
Steel tower			✓	Securing of quality and performance and certainty of supply
Transmitter shelter			✓	Securing of quality and performance and certainty of supply
Transformer			✓	Securing of quality and performance and certainty of supply
Main panel			✓	Securing of quality and performance and certainty of supply
Distribution panel			✓	Securing of quality and performance and certainty of supply
Engine generator			✓	After-sales service
Oil tank			✓	Securing of quality and performance and certainty of supply
Power line and cable			✓	Securing of quality and performance and certainty of supply

(2) Equipment Procurement Plan

Equipment shall be procured in Papua New Guinea or Japan, however, since it is not possible to obtain appropriate performance guarantees, quality assurance and after-sales service in Papua New Guinea, Japanese products will make up the bulk of equipment.

Since almost existing equipment of NBC are made in Japan, they have a good reputation for high levels of performance, quality and after service and are easy to use. So, NBC is strongly requesting that Japanese equipment shall be supplied.

However, the Japanese market for transmitters has finished shifting over to solid-state transmitters, and shipments of FM transmitters are almost non-existent as there are still no direction for terrestrial digital sound broadcasting. Therefore, transmitter manufacturers no longer produce FM transmitters.

In these circumstances, since it is not advisable in terms of economy and time to persist on Japanese products, procurement from third countries shall also be considered for FM transmitters and peripheral equipment.

(3) Equipment and Materials Transportation Plan

The first landing port for Project equipment and materials will be Lae Port in Morobe Province. To Kimbe, equipment and materials can be transported along the coast by small boat from Lae to Kimbe. Concerning transportation to Vanimo, since landing facilities at this port are not completed, equipment and materials shall be landed at Wewak by small boat from Lae and transported overland to Vanimo Station.

Transportation lead-times from Japan to the Project sites are as follows.

- Lae (Morobe Province) Approx. 45 days
- Goroka (East Highlands Province) Approx. 50 days
- Mt. Hagen (West Highlands Province) Approx. 50 days
- Vanimo (West Sepik Province) Approx. 50 days
- Kimbe (West New Britain Province) Approx. 60 days

2-2-4-7 Implementation Schedule

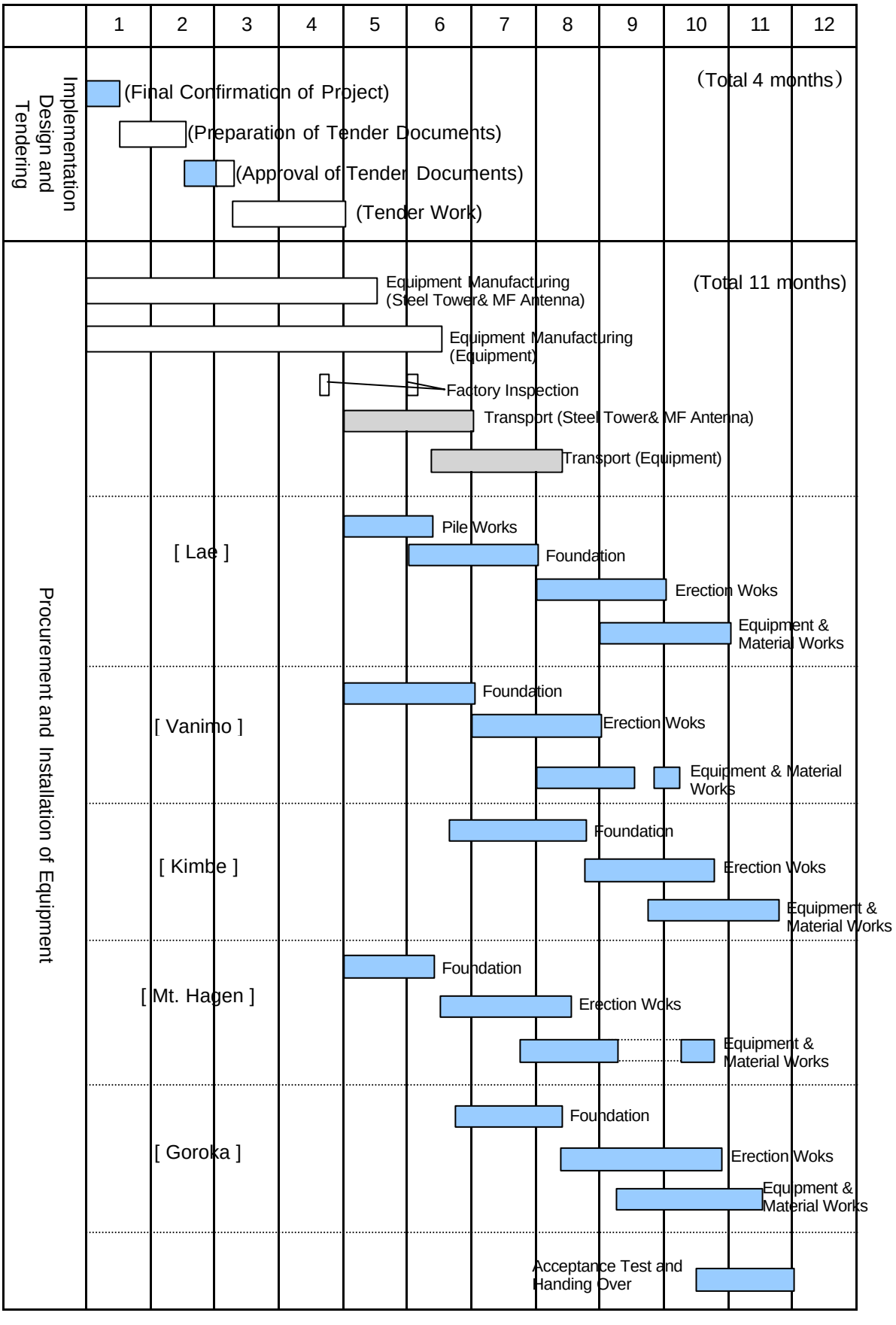
The Project implementation schedule is as indicated on the following page.

It is estimated that 15 months will be required from the consultant contract through to completion and handing-over of facilities and equipment

1) Detail design and tendering : 4 months

2) Procurement and installation of Equipment : 11 months

Table 2- 8 Work Implementation Schedule



2-3 Obligations of Recipient Country

Obligations of the Papua New Guinea side in the event where the Project is implemented under the Grant Aid scheme of the Government of Japan are as follows.

(1) Securing of Project Sites

Land problems frequently develop into serious disputes in Papua New Guinea. Some of the Project sites in this project are on existing stations, however, it is necessary to confirm newly official letters for the sites.

Project Site	Notes
Mt. Hagen (West Highlands Province)	NBC land
Lae (Morobe Province)	None in particular
Kimbe (West-New Britain province)	The provincial government has given verbal permission concerning extension of the NBC development period for the MF antenna construction site, however, written permission is required.
Vanimo (West Sepik Province)	A project road is designated within the NBC land. Revision of the project road route will be confirmed in writing.
Goroka (East Highlands Province)	Mt. Kiss behind the government offices building has been newly designated. Corroboration will be required.
Kainantu relay station (Goroka)	Lease the TELICOM satellite station building and steel tower. Permission is required to use the building and steel tower.

(2) Preparation of Project Sites

Leveling of construction sites shall be completed before the start of site works in the Project.

(3) Temporary Works Space for Site Offices and Stockyards, etc.

Temporary office sites and materials stockyards shall be secured on each transmitter site.

(4) Power Receiving Equipment for Additional Power

It is planned that Vanimo (West Sepik Province) will jointly use a HF transmitter for the time being. In this case, power supply to the new facility will be added on existing power receiving facility.

(5) Site Fences and Gates

There is a possibility that the Project transmitting stations will be unmanned at night due to reductions of maintenance staff. In order to prevent theft and sabotage of equipment, fences and gates around the stations must provide adequate protection.

(6) Preparation of Access Roads

It is forecast that equipment works will take place in the rainy season. In order to promote smooth works progress, the foundations of roads leading from main roads to Project sites shall be consolidated with gravel, etc.

(7) Removal of Existing HF Antennas

Since the HF antenna poles that will no longer be needed at Kimbe, Lae and Vanimo will obstruction MF propagation, they shall be removed.

(8) Acquisition of All Legal Authorizations in Papua New Guinea

In Papua New Guinea, decentralization has been in progress since 1996 and revisions are expected in all tax systems. NBC must meet with officials of the Ministry of Information, Ministry of Finance and Ministry of Construction, etc. and make sure that all necessary procedures concerning building office registration, project tax, income tax and building permits, which could potentially hinder the Project, are complete by the start of the works.

(9) Tariff Exemption Measures for Import of Equipment and Construction Materials

Project equipment and materials will be trans-shipped via Lae to Kimbe and Vanimo. They will also be transported to Goroka and Mt. Hagen in highland regions.
NBC shall conduct prior explanations to related ministries and agencies and promote the Project to ensure that no problems occur in transportation at transit points.

(10) Bank Commissions Concerning Issue and Revision of Authorization to Pay

The authorization to pay will be issued according to banking arrangement between the representative bank on the Papua New Guinea side and the representative bank on the Japan side. The bank commissions amount to around 0.1% of the total grant and must be prepared at the expense of the local side.

(11) Appropriate and Efficient Operation of Supplied Facilities and Equipment

The local side must save appropriate funds to cover equipment operation and maintenance expenses including depreciation costs, so that it is able to renew equipment at its own expense following the stable operation term after installation.

(12) Execution of Other Work Prescribed in the Exchanged Notes

See Appendices 4 "Minutes of Discussion dated November 1, 2002".

(13) Cost estimate of works to be prepared by PNG side

Total amount of the cost to be prepared by PNG side is 495,000kina.
Breakdown of the cost is as follows.

1) PNG Cost Burden: 495,000 kina (15,300,000 yen)

①	Leveling of Project sites:	130,000 kina (4,000,000 yen)
②	Gate and fence building and renovation of buildings:	175,000 kina (5,500,000 yen)
③	Laying of power lines to transmitter rooms:	125,000 kina (3,800,000 yen)
④	Laying of program line to transmitter rooms:	65,000 kina (2,000,000 yen)

Above cost have been estimated by NBC.

2) Execution period: implementation design and execution and procurement are as indicated in the Work Implementation Schedule.

2-4 Project Operation Plan

2-4-1 Operation and Maintenance for Kundu Broadcasting Stations

NBC headquarters are composed of the departments of Personnel, Engineering, Kundu broadcasting, Karai broadcasting, News and Accounting.

Kundu broadcasting Department manages regional broadcasting stations to operate Kundu service in each of the country's 19 provinces. This department has 210 staff members including the Director at headquarters and 11 staff members at each of the regional broadcasting stations. Each regional broadcasting station has a Station Manager, program production staff, engineers, drivers and secretaries, etc.

Since decentralization in 1996, NBC regular staff expenses have been covered by the budget of NBC headquarters, while provincial governments have covered operation and maintenance expenses at the regional broadcasting stations.

According to NBC, average of operation and maintenance expenses (excluding expenses of equipment purchase) are planned approximately 250,000 Kina per regional station.

Actual operating conditions at each station are as follows.

Station	Staff	TX Equipment	Provincial Government's Assistance
Mt. Hagen (West-Highlands Province)	Regular: 11 Casual: 2	HF ：10kW	2001：K 71,000.00 2002：K 252,000.00
Lae (Morobe Province)	Regular: 11 Casual: 4	HF ：10kW MW ：10kW	2002：K 576,800.00 2003：K 500,000.00
Kimbe (West-New Britain Province)	Regular: 11 Casual: 2	HF ：10kW	2001：K 286,736.00 2002：K 274,248.00
Vanimo (West Sepik Province)	Regular: 11 Casual: 2	HF ：10kW MW ：10kW	2001：K 48,000.00 2002：K 40,000.00
Goroka (East Highlands Province)	Regular: 11 Casual: 3	HF ：10kW MW ：10kw	2001： — 2002：K 60,000.00

NBC plans to cover all operation and maintenance budget including current Kundu broadcasting budget supplied by provincial government from central Government budget. And it is currently in negotiations with related Government agencies with a view to achieving this issue.

2-4-2 Operation and Maintenance Cost

Operation and maintenance cost that will need to be borne on the PNG side after completion and handing over of the Project is estimated as follows. However, equipment expenses for expansion of maintenance vehicles and facilities are not included in the estimations.

(1) Personnel Expenses

The staff plan of 11 members at regional stations was put into the calculation.

(2) Power Tariff

Concerning transmitting stations, only equipment operation cost constructed in the Project was estimated. Concerning operation time of transmitting stations and studios, 12 hours (9 hours broadcasting time + 3 hours preparation time) was assumed.

MF Station	Power consumption (kW)	Broadcasting Hours	Number of days	Unit price / kWh (Kina)	Total (Kina)
MF Station					
10kW MF Station	60	12	365	0.3	78,840
Studio	50	12	365	0.3	65,700
FM Station					
3kW FM Station	30	12	365	0.3	39,420
Studio	50	12	365	0.3	65,700
Relay Station					
100W Rep Station	1	9	365	0.3	986

Telephone charges were estimated as follows.

Area	Unit price /min. (Kina)	Hour	Times / Year	Total (Kina)
In District	0.3	3	3285	2,956.5
Neighbor'	0.6	5	365	1,095.0
Long Dist	0.9	10	48	432.0
International	4.0 (Ave.)	5	12	240.0
Total				4,723.5 (Approx. 5,000.0)

(3) Office Supplies, Operating Expendables, Program Production Costs, Equipment Costs

Mean values were put into the calculation.

The estimated operation and maintenance costs at each station are as follows.

Operation and maintenance Cost	Mt. Hagen	Lae	Kimbe	Vanimo	Goroka	Total (Kina)
Personnel expenses	160,000.00	160,000.00	160,000.00	160,000.00	160,000.00	800,000.00
Telephone, Fax, power charges	110,120.00	149,540.00	149,540.00	149,540.00	111,106.00	669,846.00
Office supplies	7,000.00	7,000.00	7,000.00	7,000.00	7,000.00	35,000.00
Operating expendables (site grass cutting, gasoline costs, etc.)	30,000.00	35,000.00	35,000.00	35,000.00	32,000.00	167,000.00
Maintenance parts	5,000.00	10,000.00	10,000.00	10,000.00	5,000.00	40,000.00
Program production costs (artist appearance costs)	5,000.00	5,000.00	5,000.00	5,000.00	5,000.00	25,000.00
Equipment cost	10,000.00	10,000.00	10,000.00	10,000.00	10,000.00	50,000.00
Total	327,120.00	376,540.00	376,540.00	376,540.00	330,106.00	1,786,846.00

In order to ensure Project sustainability, each provincial government shall supply to cover the annual operation and maintenance expenses (obtained by deducting personnel expenses from the operation and maintenance expenses shown above) at each of the said broadcasting stations.

(Unit: kina)

	West-Highlands (Mt. Hagen)	Morobe (Lae)	West-New Britain (Kimbe)	West Sepik (Vanimo)	East Highlands (Goroka)
Operation and maintenance costs	167,120.00	216,540.00	216,540.00	216,540.00	170,106.00