Table 3-1 GDP and Population

	1988	1989	1990	1991	1992
GDP (Billion Kips) (Growth rate)	186	213 (14.5%)	228 (7%)	236 (3.5%)	253 (7.2%)
Population (thousand) (Growth rate)	3,909	4,023 (2.9%)	4,140 (2.9%)	4,261 (2.9%)	4,384 (2.9%)

Table 3-2 Paid minutes of International Services (thousand min.)

	1990	1991	1992	1993
International telephone (Growth rate)	1,267	1,645 (29.8%)	2,048 (24.5%)	2,592 (26.6%)
International telex (Growth rate)	188	184 (-2.1%)	198 (7.6%)	196 (-1.0%)

(2) Demand Estimation Technique

Outgoing and incoming yearly paid minutes are estimated from 1994 to 2011. For basic data, yearly outgoing and incoming paid minutes are used. The data is international accounting data in the Lao PDR. Historical data of paid minutes from 1990 to 1993 and a part of 1994. The traffic is increasing steadily by 26.7% in average per year. This reliably coincides with a linear regression curve. Considering Laos status, though traffic showed a high growth rate after the introduction of the new economic policy, it is natural that the traffic demand grows at a moderate rate. Accordingly, in this estimate, a linear regression model method was applied.

(3) Estimate Result

Estimate of international telephone demand is shown in Table 3-3 and Figure 3-1.

3-2-2 Prediction of Number of International Lines

(1) Traffic Prediction

Prediction was made on the routes on which 90% of the total traffic in 1993 was carried, and

Table 3-3 Demand Forecast of International Telephone Service

Year	Chargeable Time (million minutes)	Growth Rate (%)
1990	1.27	
1991	1.65	29.83
1992	2.05	24.50
1993	2.59	26.56
1994	3.53	36.13
1995	4.33	22.76
1996	5.13	18.54
1997	5.94	15.64
1998	6.74	13.52
1999	7.54	11.91
2000	8.35	10.65
2001	9.15	9.62

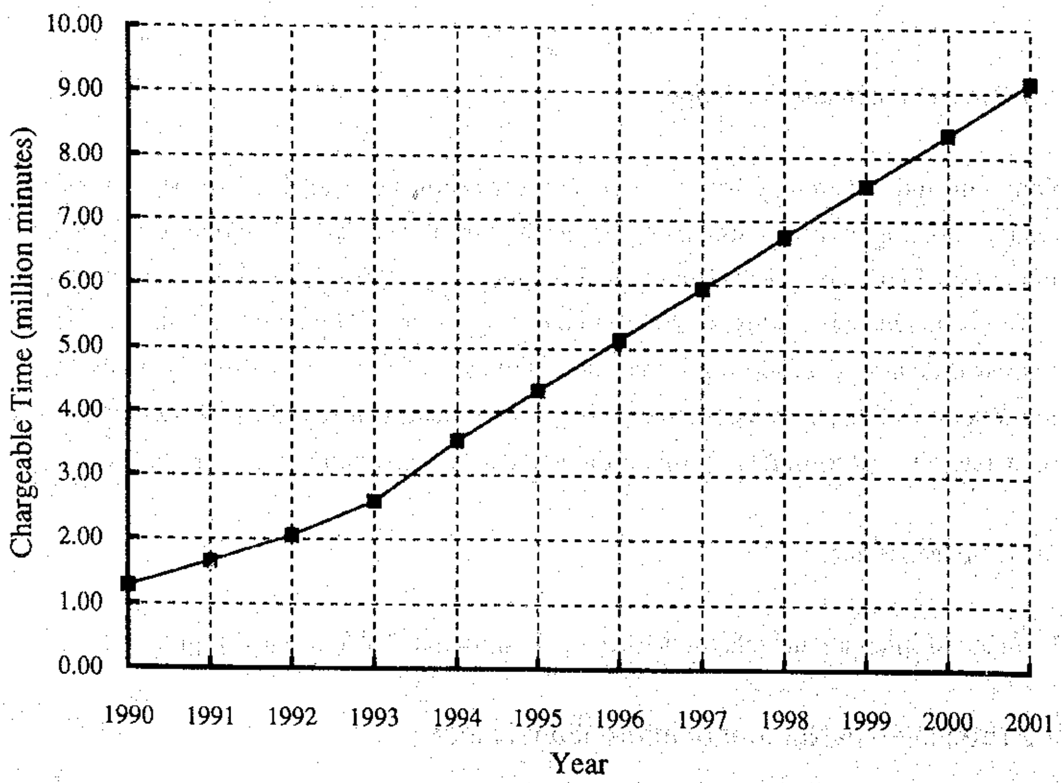


Figure 3-1 Demand Forecast of International Telephone Service

the prediction of the remaining 10% was made in bundle. Just as in the demand prediction, a linear regression model was applied to outgoing and incoming paid minute data from 1990 to 1994. Data for the first half of the year 1994 and predicted data for 1994 are adjusted. Busy hour traffic ("A" in Erlang) is calculated based upon ITU-T recommendation E-506.

$$A=Ydh/12x60e$$

Y: yearly paid minutes
d: day to month ratio : 0.048
h: most busy hour concentration ratio : 0.11
e: line efficiency factor : 0.7

(2) Study on Break-Even Point of Direct Transit Routes

The traffic of most of the routes with Laos is now connected through Australia. Comparison of transit connection and direct connection is determined by the following formulae.

Transit connection: direct line operation cost > transit operation cost
Direct connection : direct line operation cost < transit operation cost

Each cost is as follows:
Direct line operation cost
= satellite segment charge + IDR modem maintenance charge
Transit operation cost
= chargeable minutes x transit charge/minutes x 1/2

For Laos and for this project, the direct connection is economical when busy hour traffic exceeds 0.7 Erlang (yearly chargeable minutes : 80 thousand minutes or 4 lines equivalent).

(3) Line per Route Plan

According to the predicted busy hour traffic per route, destinations with traffic volume of more than 0.7 Erlang should be connected direct and other destinations should be connected by transit operation. Number of necessary lines is calculated using the Erlang B equation with loss probability 1/100. The traffic forecast for destinations is shown in Table 3-4. The forecasted number of lines for destinations is shown in Table 3-5. Destinations and number of lines to be implemented by this project are shown in Table 3-6.

3-2-3 Determining Scale and Grade of Facilities

Table 3-4 Traffic Forecast by Destinations

(Forecasted Busy-Hour Erlang)

Destinations／Year	1994	1995	1996	1997	1998	1999	2000	2001
Thailand	21.84	22.76	24.60	26.44	28.28	30.12	31.95	33.79
U.S.A	8.80	9.46	10.79	12.11	13.43	14.75	16.08	17.40
Australia	4.61	5.00	5.80	6.60	7.39	8.19	8.99	9.78
France	3.34	3.57	4.03	4.49	4.95	5.41	5.87	6.32
Japan	2.11	2.35	2.82	3.29	3.77	4.24	4.71	5.18
Vietnam	1.70	1.86	2.19	2.51	2.83	3.16	3.48	3.81
Canada	1.42	1.55	1.81	2.07	2.33	2.58	2.84	3.10
Taiwan	1.11	1.22	1.45	1.67	1.89	2.12	2.34	2.56
Sweden	0.74	0.82	0.98	1.14	1.30	1.46	1.62	1.78
Singapore	1.24	1.34	1.54	1.75	1.96	2.16	2.37	2.58
China	1.01	1.10	1.27	1.44	1.61	1.78	1.95	2.13
Hong Kong	0.80	0.86	0.98	1.11	1.23	1.35	1.48	1.60
Indonesia	0.56	0.62	0.72	0.83	0.93	1.04	1.14	1.25
Germany	0.94	1.01	1.16	1.30	1.44	1.59	1.73	1.87
U.K.	0.62	0.66	0.75	0.84	0.93	1.01	1.10	1.19
Malaysia	0.30	0.46	0.54	0.63	0.72	0.81	0.89	0.98
Others	3.98	4.30	4.93	5.57	6.20	6.84	7.47	8.11

Table 3-5 Forecast of Number of Circuits by Destinations

Destinations／Year		1994	1995	1996	1997	1998	1999	2000	2001	Remarks
Thailand	BH Erlang	21.84	22.76	24.60	26.44	28.28	30.12	31.95	33.79	via Terestrial
	Circuits	32	33	35	38	40	42	44	46	Microwave
U.S.A	BH Erlang	8.80	9.46	10.79	12.11	13.43	14.75	16.08	17.40	via a third country
	Circuits			19	21	22	24	25	27	
Australia	BH Erlang	29.93	31.63	10.73	12.17	13.60	15.03	16.46	17.89	
	Circuits	42	43	19	21	22	24	26	28	
France	BH Erlang	3.34	3.57	4.03	4.49	4.95	5.41	5.87	6.32	
	Circuits			10	11	11	12	12	13	
Japan	BH Erlang	2.11	2.35	2.82	3.29	3.77	4.24	4.71	5.18	
	Circuits	7	7	8	9	9	10	11	12	
Vietnam	BH Erlang	1.70	1.86	2.19	2.51	2.83	3.16	3.48	3.81	
	Circuits			7	8	8	9	9	10	
Canada	BH Erlang	1.42	1.55	1.81	2.07	2.33	2.58	2.84	3.10	via a third country
	Circuits			6	7	7	8	8	8	
Taiwan	BH Erlang	1.11	1.22	1.45	1.67	1.89	2.12	2.34	2.56	
	Circuits			6	6	7	7	7	8	
Sweden	BH Erlang	0.74	0.82	0.98	1.14	1.30	1.46	1.62	1.78	
	Circuits			5	5	5	6	6	6	
Singapore	BH Erlang	1.24	1.34	1.54	1.75	1.96	2.16	2.37	2.58	
	Circuits	5	5	6	6	7	7	8	8	
China	BH Erlang	1.01	1.10	1.27	1.44	1.61	1.78	1.95	2.13	
	Circuits			5	6	6	6	7	7	
Hong Kong	BH Erlang	0.80	0.86	0.98	1.11	1.23	1.35	1.48	1.60	
	Circuits		4	5	5	5	5	6	6	
Indonesia	BH Erlang	0.56	0.62	0.72	0.83	0.93	1.04	1.14	1.25	
	Circuits			4	4	5	5	5	5	
Germany	BH Erlang	0.94	1.01	1.16	1.30	1.44	1.59	1.73	1.87	
	Circuits			5	5	6	6	6	6	
U.K.	BH Erlang	0.62	0.66	0.75	0.84	0.93	1.01	1.10	1.19	
	Circuits			4	4	5	5	5	5	
Malaysia	BH Erlang	0.30	0.46	0.54	0.63	0.72	0.81	0.89	0.98	
	Circuits			4	4	4	4	5	5	
Others	BH Erlang	3.98	4.30	4.93	5.57	6.20	6.84	7.47	8.11	
	Circuits									
Sub Total	Satellite	54	59	113	122	129	138	146	154	
	Micro	32	33	35	38	40	42	44	46	
GRAND TOTAL		86	92	148	160	169	180	190	200	

(Note.1) U.S.A. and Canada are estimated to use direct circuits via third country (ies)
(Note.2) Australia, Japan and Singapore have established direct circuits by1994. Hong Kong has established direct circuits in 1995.
(Note.3) Traffic to "Others" is supposed to be routed via Australia up to 2001(switched transit)

Table 3-6 International Telephone Circuits Plan

No.	Destination	Number of Circuits	Remarks
1	USA	27	via a third country
2	Australia	28	
3	France	13	
4	Japan	12	
5	Vietnam	10	
6	Canada	8	via a third country
7	Taiwan	8	
8	Sweden	6	
9	Singapore	8	
10	China	7	
11	Hong Kong	6	
12	Indonesia	5	
13	Germany	6	
14	UK	5	
15	Malaysia	5	
Total		154	

Table 3-7 Main Feature of Earth Station Standards

Item	Old A	New A	B	F	D
G/T at 4 GHz (dB/K)	40.7	35.0	31.7	F-1: 22.7 F-2: 27.0 F-3: 29.0	D-1: 22.7 D-2: 31.7
Typical antenna diameter (m)	32	16	11	F-1: 4.5 F-2: 6 F-3: 9	D-1: 4 D-2: 11
Available modulation	FDM/FM SCPC TDMA FM TV IDR IBS	FDM/FM SCPC TDMA FM TV IDR IBS	CFDM/FM SCPC FM TV IDR IBS	IDR IBS	SCPC/CFM
Applications	Large scale for country gate	Large scale for country gate	Medium scale for country gateway	Small scale for business communications	Small scale for rural communications
Circuit capacity	more than 100	more than 100	20-100	less than 50	less than 50

(1) Earth Station Standards

INTELSAT has five different earth station standards (Old Standard-A, New Standard-A, Standard-B, Standard-F, Standard-D, in order of performance) for international public telecommunications in the C band (6/4GHz band). The principal specifications of each Earth Station Standard are shown in Table 3-7. Larger scale earth stations will result in higher initial investment, but lower space segment charge from INTELSAT, which reduces operation cost.

INTELSAT New Standard-A (hereinafter referred to as "Standard A") should be adopted for the earth station type in view of the following considerations.

· The initial number of lines will be 154.

· In comparing Standard-A earth stations and Standard-B earth stations, the difference in initial investment cost between the two standards can be made up within 2 years by the difference in space segment charges, making Standard-A earth stations be more advantageous in the long term.

(2) Telecommunication System

The trend of world-wide telecommunication facilities is moving from Analog to Digital, which has higher circuit quality and reliability, also enabling minimization of cost of facilities and operations. Intermediate Data Rate (IDR) should be employed for the this project. Low Rate Encoding equipment, which can effectively increase the channel capacity per carrier, should also be employed to minimize the satellite charge.

Based on the estimated traffic demand in Laos, the initial transmission capacity should handle 15 destinations; the transmission rate of each line should be 512 kbit/s, 1 Mbit/s or 2 Mbit/s in accordance with traffic volume.

(3) The Choice of Satellite

From skyline measurement at the time of the site survey, it has been confirmed that telecommunication with INTELSAT satellites at each of 60, 63, 66 and 174 degrees from the intended earth station location was possible. An INTELSAT satellite located at 66 degrees east longitude should be used, as other satellites suffer from a shortage of available capacity and cannot provide an additional frequency band necessary to transmit the 15 carriers in the present plan. Since INTELSAT Satellite VIII will be positioned at this location in the latter half of 1996 and later, the design of earth station facilities and circuits must assume the use of

Satellite VIII.

For the frequency band, C band should be used, for establishing effective telecommunication circuits.

For destinations with which this satellite cannot communicate directly, transit circuits via a third country should be established.

(4) Determining the Scale of the Earth Station Telecommunication Building

In general, telecommunication buildings endure over 30 years. Though floor space of the earth station building should satisfy the minimum requirement, future expandability should be considered in designing the equipment rooms. Such consideration includes the following:

- sufficient space for future television transmission facilities
- minimum sufficient space to provide for expected expansion of international lines (more than 230 in 15 years) and power for them, established by Laos
- sufficient space for the replacement of a set of rechargeable batteries which have about a 7 year life time

(5) Approach Link

Although there are several alternative methods for establishing an approach link, the following four methods are regarded as applicable to this project:

1) Connecting the earth station and Numphou Exchange directly via microwave transmission
2) Connecting the earth station and Numphou Exchange via optical fiber cable
3) Constructing a link composed of microwave and fiber-optic cable systems making use of the existing TV broadcasting tower
4) Constructing a link composed of microwave and fiber-optic cable systems making use of a tower to be built near Numphou Exchange

Appendix-6 shows the result of careful comparison of these alternatives.

In conclusion, the approach link should go via the HF transmission station (hereinafter referred to as "the repeater station") in Vientiane City, with a digital microwave system for communicating between the earth station and the repeater station, and an optical fiber cable system between the repeater station and Numphou Exchange.

The handling capacity of the approach link should be a 34 Mbit/s system which is the minimum requirement for handling the initial number of lines.

(6) Frequency Interference

Two types of frequency interference were examined: between the earth station to be built in this project for the INTELSAT satellite and the existing terrestrial microwave transmission system, and between the microwave transmission system to be built in this project and the existing terrestrial microwave transmission system.

In conclusion, it has been confirmed that, within the scope of all available information, there should be no frequency interference problems. The sum-up and result of examinations are as follows:

1) The Earth Station for the INTELSAT Satellite

The earth station for the INTELSAT satellite transmits carriers in the 6 GHz band and receives carriers in the 4 GHz band. It has been confirmed in the site survey that these bands are not used at present for terrestrial microwave transmission in Laos.

Moreover, since EPTL operates a Standard F-3 earth station for the INTELSAT satellite using the frequency in the same band on the site where the new station of this project is planned to be built, it has also been expected that the new station will not have interference problems.

2) Microwave Transmission System

The digital microwave transmission system to link the earth station and the repeater station should use the 7 GHz (7,125-7,425 MHz) band among the bands recommended for medium capacity digital radio-relay systems by ITU-R. In Laos this band is not presently allocated to the terrestrial microwave transmission system and will be used for the first time in this project.

Though this band is already used in Thailand in the three links from Udong Tani, it has been confirmed that interference is negligible, judging from the distance and angle of the link planned in this project. However, as several telecommunication companies are developing national telephone networks in Thailand, with an expected increase in band use, it is preferable that this matter should be bilaterally negotiated.

Incidentally, we have decided against using 7 GHz (7,425-7,725MHz) band in this project because of severe interference with Thai terrestrial microwave transmission system.

(7) Switching System

The switching system should be expanded to handle the initial number of lines.

The existing switching facilities and billing system are only equipped with limited international functions, which require prompt improvement. However, costs must be restricted by limiting the added and improved functions.

The following should be accomplished:
- international account processing
- statistical data collection for international traffic
- distribution of return traffic
- improvement of signaling system

Additional trunks needed for the newly opened international routes should be installed at the same time as the introduction of the above improvement.

(8) General Standards

The standards of the telecommunication facilities, as international connections are required, should comply with ITU-T and ITU-R Recommendations and INTELSAT Standards. As there are no construction standards in Laos, buildings should comply with Japanese construction standards.

3-3 Basic Plan

3-3-1 Site and Layout Plan

1) Earth Station

Located about 13 km north of the city of Vientiane, the site of the earth station faces a 4-meter-wide road (unpaved) on its west side. The site is a deformed rectangle about 280 m wide and 140 m deep and slopes toward the northeast. The conditions of the planned location of the earth station are shown in Figure 3-14.

At the time of the site investigation it was assumed that the earth station was to be located in the northern part of the project site because there was an HF antenna that was in use for domestic communications. Because a later survey revealed that the existing antenna might be moved, the central part of the site, which is advantageous, was finally selected. The reasons why the central part of the site was selected are given below:

· Since the original project site slopes considerably toward the northeast, it would require considerable filling work. The foundation for the building would have to be large, and that would be more expensive than moving the antenna and related facilities.
· Use of the central part of the site will permit the existing access road and yard roads to be used without modifications.
· The central part, which is higher than the northern part, is more suitable for construction of an approach link.
· The central part, which is higher than the surrounding area, drains rainwater well.

The layout of the facilities was planned so that other facilities, such as the existing earth station antenna, would not be affected. Under the plan, the satellite communication building will be located in the middle of the site, and the INTELSAT earth station antenna will be erected to the south of the building. An area to the east of the building will be set aside for a future earth station antenna.

Since the power generator uses a diesel engine, the generator will be housed in a separate building located in the southeastern part of the project site, in order to reduce noise and vibration from the engine.

The layout of the earth station is shown in Figure 3-15.

2) Repeater Station (HF Transmitting Station)

The site for the repeater station is on the premises of an existing HF transmission station located in the center of the city of Vientiane. Like the site of the earth station, this site is owned by EPTL. Facilities such as HF transmitters are also now in use there.
Figure 3-20 shows the locations of the microwave communications tower and the engine generator house.

3-3-2 Architectural Design

1) Floor Plan

(1) Functions and Floor Area of Rooms

a) Satellite Communication Building

・Communication Equipment Room

Houses satellite communications equipment, approach link equipment, and other equipment. According to the layout of equipment (refer to Figure 3-16) which was derived using a method adopted by Japanese telecommunications carriers, the floor area is decided to be about 90 m^2.

・Operation room

Houses a control and monitor system and is adjacent to the communications equipment room. According to the layout of equipment (refer to Figure 3-16) which was derived using a method adopted by Japanese telecommunications carriers, the floor area is decided to be about 30 m^2.

・UPS room

Houses low-voltage switchboards, UPS, rectifiers, etc., and is adjacent to the communications equipment room. According to the layout of equipment (refer to Figure 3-16) which was derived using a method adopted by Japanese telecommunications carriers, the floor area is decided to be about 63 m^2.

・Workshop

The workshop will be used for repair and maintenance of communications equipment and will have a floor area of about 20 m^2 (= 2 servicemen x 10 m^2/person).

・Air conditioning plant room

An individual air conditioning system will be used. To control humidity in the communications equipment room and the control room and filter fresh air, the room will also house an outdoor air filter system and a power control panel. The required floor area is about 20 m^2.

・Office

An office with a floor area of about 54 m^2 (= 9 persons x 6 m^2/person) for the staff.

・Meeting room

A room with a floor area of about 15 m^2 (= 5 persons x 3 m^2) for meetings and operator training.

・Storage

A storage area of about 15 m^2 for storing spare parts and components for communications equipment.

· Bunk room

Has floor area to house three bunks for shift workers.

· Pantry

Has minimum pantry space for shift workers.

· Common use space

Common use space, such as bathrooms, corridors, and entrance hall, designed to suit the function and size of the facilities.

b) Engine Generator House (Earth Station)

· Engine generator room

Houses engine generators, AVR, power receiving board, etc. The floor area necessary for the equipment about 90 m^2.

(c) Engine Generator House (Repeater Station)

· Engine generator room

Houses engine generators, AVR, rectifiers, etc. The floor area necessary for the equipment about 25 m^2.

(2) Floor Plan

The satellite communications station is divided into a machine room zone (e.g., communications equipment room, control room, power room) and a living space zone by locating the entrance between the two zones.

(3) Floor Area of Each Room and Equipment

Figure 3-16 is the plan of the Satellite Communication Building.

The floor area of each room and its equipment are summarized in Table 3-8.

Table 3-8 Floor Area of Rooms

Buildings	Room	Floor area (m²)	Remarks
Satellite Communication Building	Communication Equipment Room	88.93	Cable trenches, insert bolts
	Operation room	33.08	Cable trenches
	UPS room	62.84	Cable trenches
	Workshop	20.88	
	Air Conditioner Plant	19.44	
	Office	57.68	
	Meeting Room	20.60	
	Bunk room	22.21	
	Storage	15.12	
	Pantry	6.72	
	Bathroom	14.16	
	Entrance/corridor	73.22	
	Entrance porch	18.72	
Total floor area		453.60	
Engine generator house (Earth/Station)	Engine generator room	92.40	Cable trenches, hydraulic pipe trenches, foundations for engine generators, oil-retaining wall
Engine generator house (Repeater Station)	Engine generator room	24.75	Cable trenches, hydraulic pipe trenches, foundations for engine generators, oil-retaining wall

2) Section Plan

The building will be one story in size. Considering the height of the communications equipment (2,100 mm) and the overhead wiring space requirement, the required under-beam clearance is 3,500 mm. Therefore, the height, including the beam, is 4,200 mm.
In view of the climate of Laos and the rarity of flat-roof waterproofing in the country, sloping tile roofs will be employed. To reduce air-conditioning load and prevent rainwater intrusion through walls and openings, roofs will also be used as eaves.

3) Structural Plan

(1) Type of Structure

(a) Buildings

Common local practice is to employ reinforced-concrete rigid-frame structures using bricks for exterior walls and partition walls, and timber or steel for roofs.

For construction efficiency and ease of maintenance, a standard construction method in Laos will be employed.

According to a soil survey conducted as part of the site survey, the bearing capacity of the soil at a depth of 1 m below ground surface is about 10 t/m^2. Therefore, independent spread foundations will be employed for buildings. The ground floors of the buildings are of slab-on-grade concrete type, which directly transfers the weight of the floor to the ground below.

(b) Foundations for Antenna and Tower

Foundations for the antenna and the tower are reinforced concrete. These foundations are designed taking into account the weight of the antenna and the tower, and wind horizontal force.

(2) Design Loads and External Forces

(a) Dead Loads

Station building: Weight of the building.

Antenna/tower foundation: Weight of the foundations and weight of antenna and tower.

(b) Live Loads

Live loads for the communications equipment room, power room, and power generator room are determined on the basis of the weights of the equipment housed in each room and historical data of communications facilities in Japan.

Live loads for other rooms are determined in accordance with the design standards of the Architectural Institute of Japan.

Communications equipment room, control room 500 kg/m^2

Power room, power generator room 1,000 kg/m^2

Office, etc. 300 kg/m^2

Although the roofs are not supposed to support humans or things, 90 kg/m^2 is allowed for construction and maintenance activity.

(c) Wind Loads

The highest instantaneous wind speed observed by the meteorological observatory in Vientiane in the past 34 years is 37 m/s (observed at a height of 18 m). The wind speed the EPTL used in calculating wind loads on similar microwave towers is 160 km/h (44.4 m/s). This value corresponds to the expected value of 46 m/s for 50-year interval derived from yearly strongest winds for past 34 years.

Therefore, in view of the social and economic importance of the communications facilities, a wind speed of 160 km/h (44.4 m/s) is employed.

(d) Earthquake Loads

According to the local meteorological observatory, possible earthquake-induced ground acceleration in Vientiane is 20 - 50 gal. Generally, under the Standard Building Law of Japan, the acceleration of buildings similar to those now planned is 2.5 to 3 times the maximum acceleration of earthquake motion. For purposes of this project, therefore, a standard shear coefficient of 0.1 is used.

(3) Structural Design Standard

The design standard used in Japan is applied because there is no applicable design standard in Laos.

4) Building Equipment

(1) Electrical Equipment

Electrical equipment for buildings on the secondary side of low-voltage switchboards communications equipment will be provided.

(a) Trunk/Motor Circuit

For construction efficiency, trunk lines and motor circuit lines are wired using cable and cable rack.

(b) Lighting Installation

To lower operating costs, fluorescent lamps are used. Using the Japanese illuminance standards and illuminance data from communications facilities in Japan, the following indoor illuminance is used:

Communication equipment room, UPS Room, office, etc. 500 lx
Air conditioner room 200 lx
Bunk room, corridors, toilets, etc. 150 lx

(c) Receptacles

Receptacles for general use and maintenance of communications equipment will be provided as necessary in each room.

(d) Grounding

Low-voltage equipment for buildings and electric circuits will be grounded. Grounding resistance is to be 100 Ohms or less.

(e) Lightning Conductors

Since the buildings are covered by the lightning conductor for the microwave communications tower (angle of protection: 60 degrees), no lightning conductor exclusive to the buildings will be provided.

(f) Automatic Fire Alarm System

Considering the importance of the facilities, automatic fire alarm systems will be provided. Detectors for each room will be employed.

(g) Piping Installations for Telephone Lines

Piping and outlets to appropriate locations in each room will be installed.

(2) Plumbing System

(a) Water Supply System

At present, city water is not available at the project site. Instead, groundwater is pumped to an elevated reinforced concrete tank which supplies water to the existing facilities.
For this project, a gravity water supply system composed of a receiving tank, pumps, and an elevated tank will be installed, because the existing elevated tank is not high enough (7.5 m)

to generate the water pressure required. Well water will be delivered to the receiving tank by Laos.

(b) Drainage System

Gray water and sewage in the facilities are conveyed separately to a combined treatment system outdoors. Treated water is conveyed to a filtration tank for on-site filtration.

(c) Pluming Fixture Facilities

The bathroom will have water corsets, washhand basins, mirrors and a cleaning sink. The pantry will have a water-boiling facility.

(d) Fire Extinguishing System

Fire extinguishers will be provided at proper locations in the satellite communications building and the engine generator house.

(3) Air Conditioning and Ventilation Systems

(a) Air Conditioning System

In order to achieve the required quality and reliability of service, it is very important to maintain constant environmental conditions for the communications equipment. Therefore, the communications equipment room and the UPS Room will be equipped with an air-cooled air conditioner. To ensure reliable air conditioning, each room will be provided with a backup unit.

Habitable rooms will also be air conditioned because temperature and humidity in Laos are high and habitable rooms are usually air conditioned.

- Design Conditions for Air Conditioning System

Outdoor air temperature and indoor air temperature are determined based on meteorological data and environmental conditions specified for communications equipment.

· Outdoor air temperature

Dry-bulb temperature: 35 degrees C

Relative humidity: 66 %

· Indoor air temperature

Communications equipment room
Dry-bulb temperature: 26 +/- 2 degrees C
Relative humidity: 55 +/- 15 %
Power room and other rooms
Dry-bulb temperature: 26 degrees C
Relative humidity:

- Rooms to be air conditioned and air conditioning load

The rooms to be air conditioned and cooling loads from people and heating equipment are shown in Table 3-9.

Table 3-9 People Load and Equipment Load

Room	People Load	Equipment Load (kW)	Remarks
Communication equipment room	3	19	Cooled year-round
Operation room	3	4.5	
UPS Room	3	10	Cooled year-round
Workshop	2		
Office	9		
Meeting room	5		
Bunk room	3		

(b) Ventilation System

Rooms in which heat, dust, odor or moisture are generated will be ventilated. Class 3 mechanical ventilation will be used. The rooms to be ventilated and the air change rates for those rooms are shown below.

Table 3-10 Air Change Rate

Room	Air Change Rate
Engine generator house	5 changes/hour
Air conditioning plant	5 changes/hour
Bathroom	10 changes/hour
Pantry	5 changes/hour

5) Construction Material

(1) Basic Policy

The exterior must meet the durability and waterproofing requirements of the communications station buildings, suit the natural features and climate of the area, and be easy to maintain. Interiors of machine rooms must be compatible with machines and be durable. Interiors of the other rooms must be easy to maintain.

(2) Exterior Finish

Roof: concrete slab + mortar + liquid-applied membrane waterproofing + wooden timber truss + roof + roof tiles
External wall: brick masonry with mortar rendering and wall coating
Floor: Entrance porch --> porcelain floor tiles
Scarcement --> troweled concrete
Opening: aluminum sashes, steel doors

(3) Interior Finish of Principal Rooms

Communications equipment room, power room:
Floor: vinyl tiles
Wall: mortar undercoat, synthetic resin emulsion paint
Ceiling: exposed concrete finish

Control room, office, etc.:
Floor: vinyl tiles
Wall: mortar undercoat, synthetic resin emulsion paint
Ceiling: rock wool soundproofing

Air conditioner room:
Floor: floor coating
Wall: mortar undercoat, synthetic resin emulsion paint
Ceiling: concrete finish

Entrance hall, corridors:
Floor: terrazzo tiles
Wall: mortar undercoat, synthetic resin emulsion paint
Ceiling: rock wool soundproofing

3-3-3 Equipment Plan

[1] Earth Station Equipment Plan

The INTELSAT earth station consists of the following. Configuration diagram of earth station is shown in Figure 3-2, floor layout of earth station in Figure 3-3, and floor layout of engine generator house in Figure 3-4.

(1) Antenna System

The antenna which transmits 6 GHz signals to the satellite and receives 4 GHz from it should comply with INTELSAT new Standard-A performance characteristics.

1) System G/T:	More than 35.0 dB/K at 4 GHz
2) Operational frequency range:	a. Transmission 5,850 to 6,425 MHz b. Reception 3,625 to 4,200 MHz
3) Polarization:	Left hand and right hand circular polarizations for both transmission and reception
4) Diameter of antenna:	16 m
5) Tracking and Driving:	Step-tracking, limited motion
6) Wind resistance:	No damage from instantaneous wind velocity of 35 m/s at operational position or 55 m/s at storage position.

(2) Ground Communication Equipment (GCE)

1) High Power Amplifier (HPA)

The HPA amplifies the 6 GHz signal to a required power level for transmitting to the satellite. The transmitting amplifier uses an amplifier which consists of a TWT (Traveling Wave Tube) and linearizer convenient for the frequency rearrangement conducted by INTELSAT every few years. Saturated output power of the HPA situated in the heart of the earth station decides the transmitting capability. Because modification of its output is not easy, more than 600 W of output power is adopted in the project.

a) Amplifier : TWT amplifier
b) Capacity : Saturated output power is more than 600 W
c) Redundant configuration : Dual on-line and one standby configuration to meet dual polarization requirement.

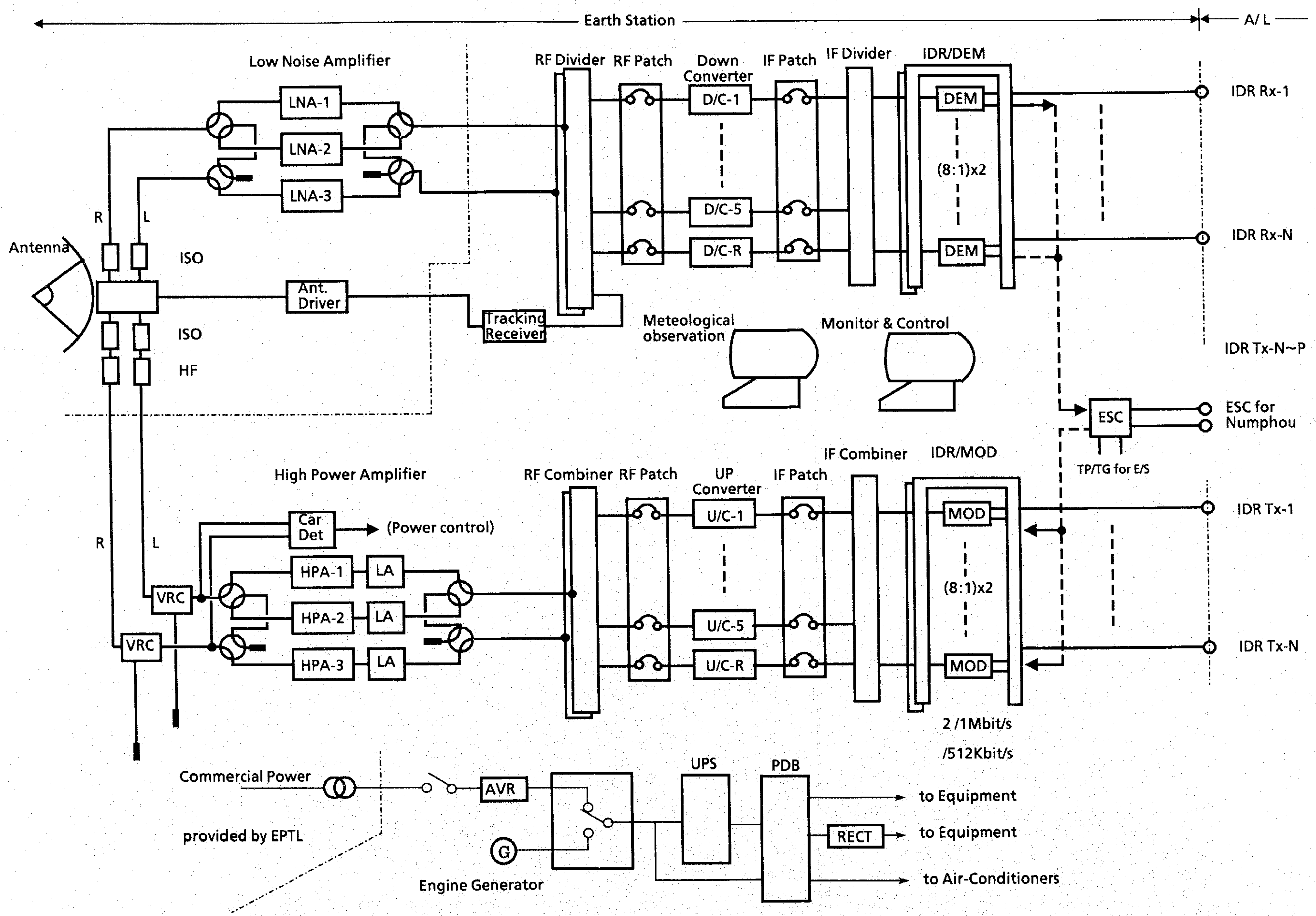
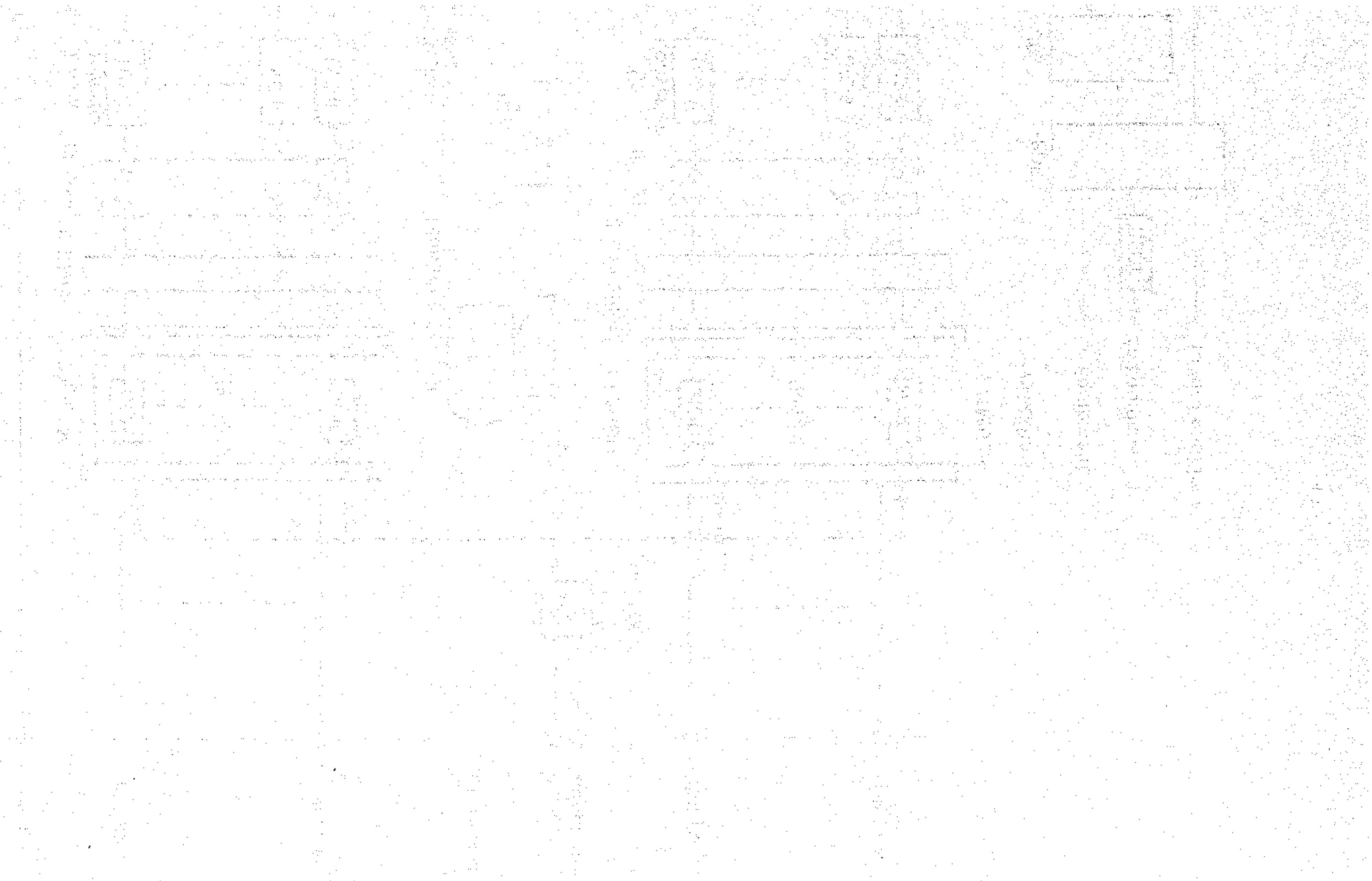


Figure 3-2 Configuration Diagram of Satellite Communication System



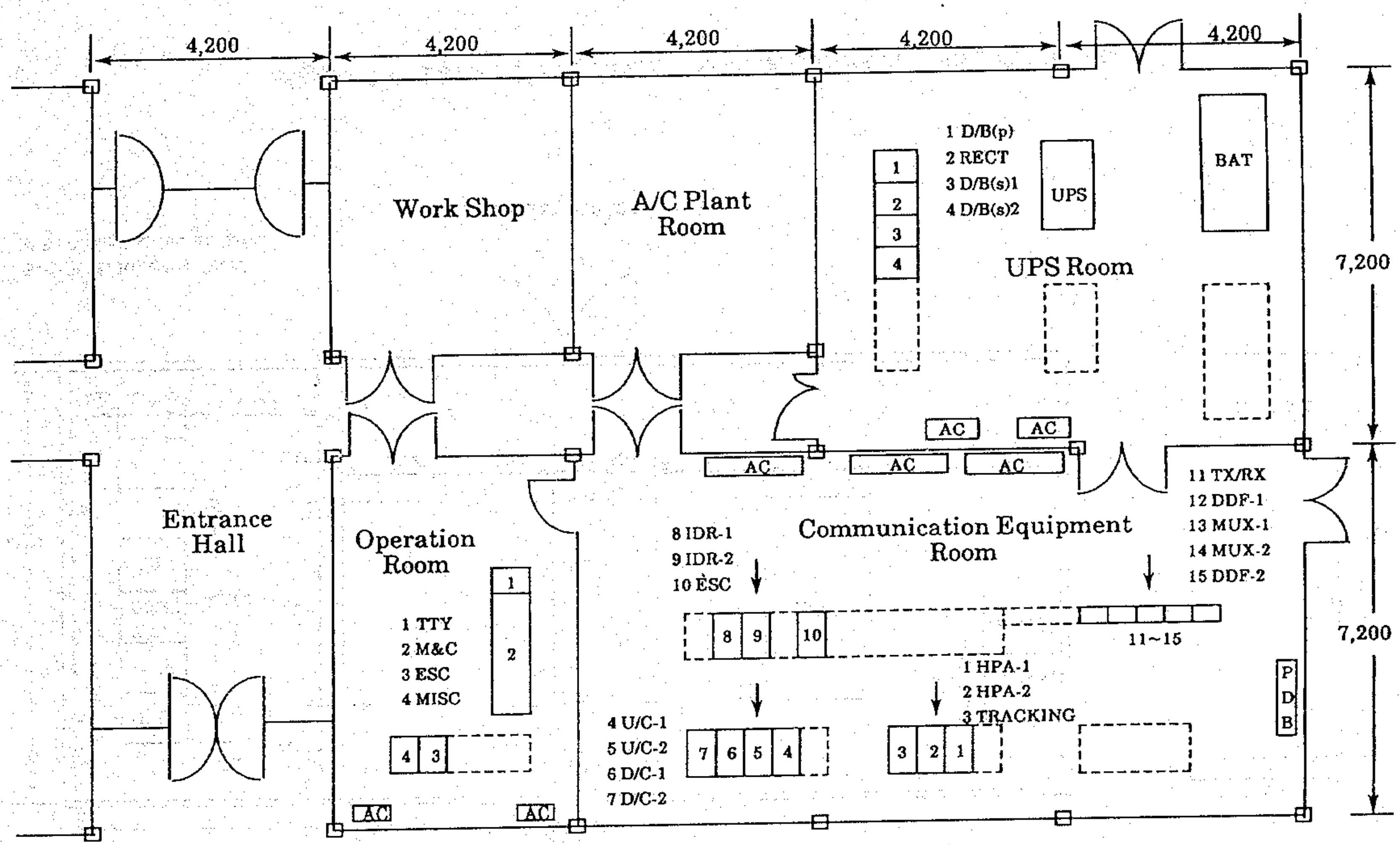


Figure 3-3 Layout of Equipment in Satellite Communication Building

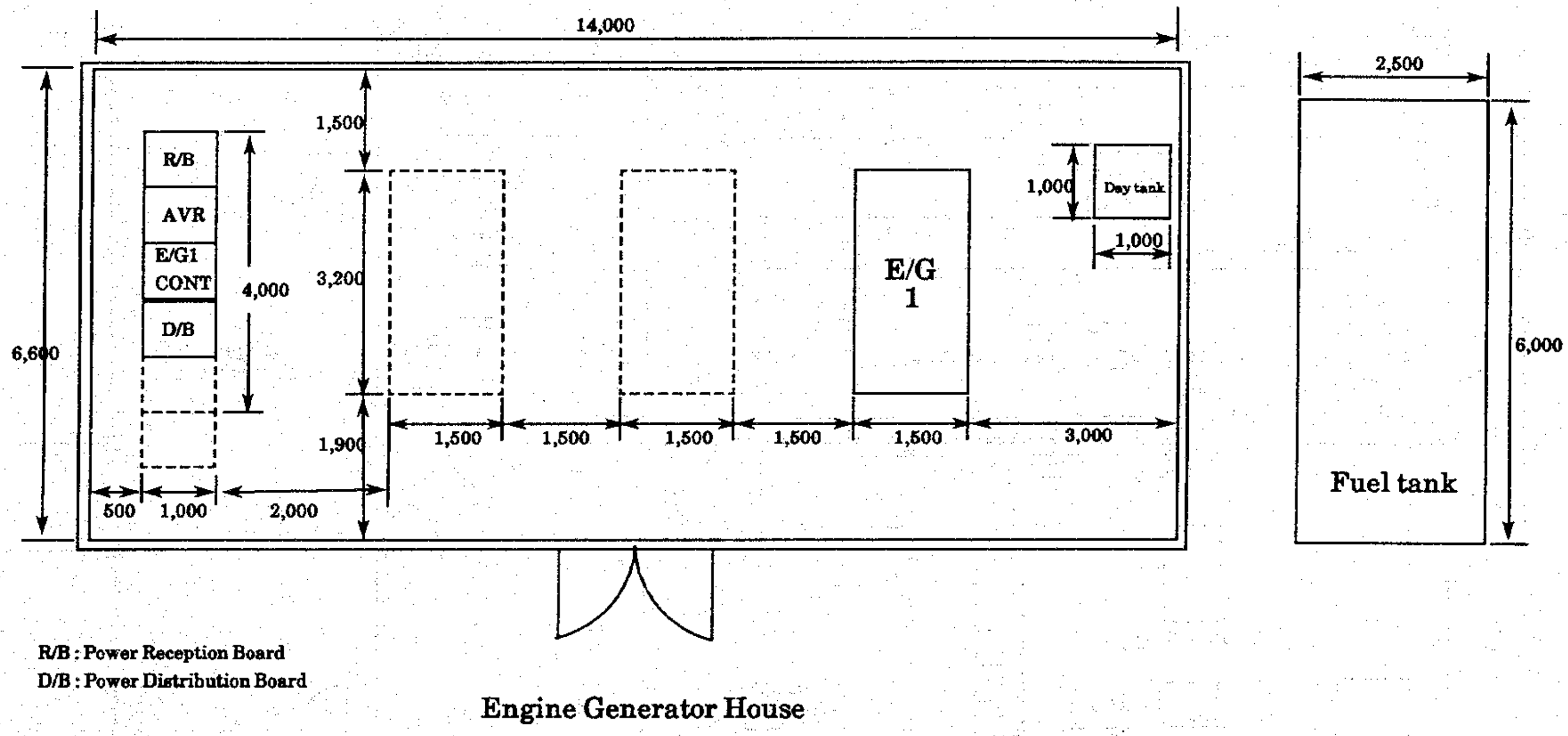


Figure 3-4 Layout of Equipment in Engine Generator House (Earth Station)

d) Transmission waveguide circuit : To enable transmission of TV signals in the future, a VRC (Variable Ratio Combiner) is equipped in the wave guide circuit.

2) Low Noise Amplifier (LNA)

The LNA amplifies the 4 GHz weak signal from the satellite.

a) Amplifier : non-cooling FET amplifier it maintained
b) Noise temperature : A system G/T of more than 35.0 dB/K with antenna facilities.
c) Redundant configuration : Dual on-line and one standby configuration to meet dual polarization requirement.

3) Transmission Power Controller

The unit, which controls the transmission power, should be accessible to five IDR frequency converters and form a redundant configuration with five on-line and one standby.

4) IDR Frequency converter

For transmission, the unit converts the intermediate frequency output carriers from the modulator to 6 GHz carriers, and for reception, 4 GHz band output carriers from LNA to intermediate frequency carriers. It should be accessible to five transponders for transmission and reception and have redundant configuration with five on-line and one standby.

5) IDR Modulator and Demodulator

For transmission, the unit converts 2 Mbit/s digital signals from telephone lines to IDR intermediate frequency carriers, and for reception, it converts IDR intermediate frequency carriers to 2 Mbit/s digital signals of telephone lines.

a) Number of satellite carriers
a. 15 carriers in accordance with communication demand for 15 routes.
b. Equipment for 18 carriers including spare 512 Kbit/s, 1 Mbit/s, and 2 Mbit/s units.

b) Redundant configuration
Redundant configuration with eight on-lines and one standby.

6) Engineering Service Circuit Unit (ESC)

The unit sets up a talker channel with other earth stations. The talker channel is extended to the central office and enables conversation over telephone and teleprinter unit in ITMC room.
The ESC unit is installed in the satellite communication equipment room. Telephones are installed in the satellite communication equipment room and the operation room. The teleprinter is installed in the operation room.
The function of the unit is as follows:

a) Number of satellite trunks: Initially for each trunk, one telephone line and one teleprinter line 17 lines.

b) Number of terminals: 3 telephone lines and 2 teleprinter lines initially.

(3) Monitor and Control System

The computerized monitor and control system is for labor saving and centralized supervision of system operation. The main unit is installed in the satellite communication equipment room, and interface units such as display and teleprinters are installed in the operation room. Main functions of the system are as follows:

1) Monitor unit : To monitor status of facilities in the earth station.

2) Control unit : To control facilities in the earth station.

3) Measuring unit : To measure operational status of facilities in the earth station.

(4) Power Supply

1) Power Receiving Facility

AC 380V, 3-phase, 4-wire 50Hz power is supplied from a transformer to be built by Laos. 250m underground cable should connect the 22 kV/380 V transformer to the new building by way of the Engine Generator House. A power receiving board and intermediate power supply racks should be installed.

2) Engine Generator

Because of power failures about 2 or 3 times a month, an engine generator should be installed. The output of the engine generator should be 200 kVA given the power consumption of communication facilities and building.

3) Uninterruptible Power Supply (UPS)

During the time it takes to start up the engine generator, UPS maintains the principal function in the earth station. The capacity of the unit should be 60 kVA given power requirement. The capacity of battery for UPS should manage minimum power supply for communications equipment until the engine generator gets started to feed power.

4) Automatic Voltage Regulator (AVR)

AVR should be installed in the power supply circuit for reducing possible fluctuation in voltage of the commercial power. The capacity should be 200 kVA.

5) Rectifier

A DC - 48 V rectifier should be installed for the communication facilities which need direct current power supply. The capacity should be 2 kVA given required power. The unit consists of one on-line and one standby.

(5) Grounding System

Grounding for lightning, for communication equipment, and for power supply equipment are provided.

(6) Maintenance Facilities

1) Spare Parts

Spare parts necessary for reliable maintenance for the initial three years will be furnished.

2) Maintenance Instruments and Tools

Necessary instruments and tools for maintaining line quality in the earth station should be supplied.

3) Documents

Six sets of operation and maintenance manuals, system handling manuals, and inspection documents should be supplied.

(7) Cable Route

The cable route for this project is shown in Figure 3-5. For connecting existing facilities, new communication cables should be installed between new and existing buildings.

(8) Facility list

The facilities, instruments and tools for this project are as follows:

1) Antenna system	1
2) Ground communication equipment	
a) High power amplifier	3
b) Low noise amplifier	3
c) Transmission power controller	5
d) IDR frequency converter	5
e) IDR modulator-demodulator	18
f) ESC unit	1
3) Monitor and control system	1
4) Power supply facilities	
a) Power receiving facility	1
b) Engine generator	1
c) UPS	1
d) AVR	1
e) Rectifier	2
5) Grounding system	1
6) Maintenance facilities	
a) Spare parts	1
b) Maintenance instruments and tools	1
c) Documents	6
7) Materials for installation	1

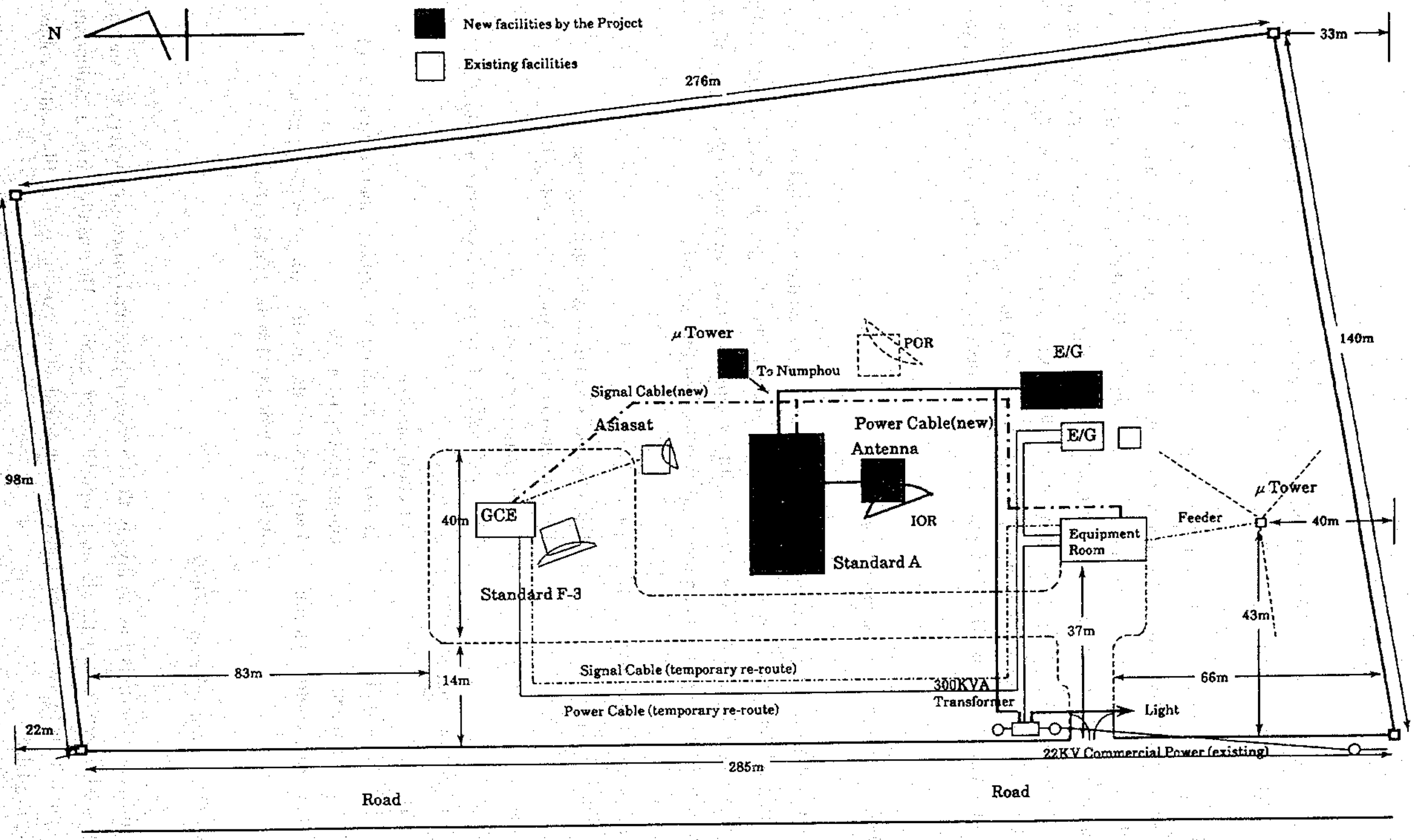


Figure 3-5 Location of Cable Routes at Earth Station

[2] Approach Link Facility Plan

The approach link from the central office to the earth station is designed with two links via a repeater station because a single direct link connection is difficult.

The repeater station will be installed in the existing HF transmitting station in Vientiane. Fiber-optic cable system will connect the central office Numphou Exchange to the repeater station, and a microwave transmission system will connect the repeater station to the earth station. The repeater station is an unattended station, and a facility alarm is supervised in the central office. The configuration diagram of the approach link is shown in Figure 3-6, the floor layout of equipment room in the repeater station in Figure 3-7, the floor layout of terminals in the central office in Figure 3-8, and the floor layout of Numphou ITMC in Figure 3-9.

(1) Digital Microwave Transmission Facilities

The digital microwave transmission facility installed between the earth station and the repeater station sends and receives microwave signals through line of sight propagation. The 7GHz band is selected so as not to interfere with existing terrestrial microwave systems. Antenna will be mounted higher than 38 meters to clear the first Fresnel zone.

1) Propagation distance:	12.5 km
2) Microwave tower:	Earth station: 43 m high, self standing type Repeater station: 60 m high, self standing type
3) Antenna:	1.8 m diameter parabolic V+H
4) Frequency:	7,125 to 7,425MHz (max. 4+1 system configuration)
5) Transmission capacity:	34Mbit/s
6) System:	1+1 configuration
7) Waveguide length:	Earth station; about 62 m, Repeater station; about 75 m
8) Radio equipment:	Output power; over 1W
9) Supervisory control system:	Earth station is the master. Alarms in the repeater station are monitored in the central office.

(2) Fiber-Optic Transmission Facility

The fiber-optic transmission facility installed between the central office and the repeater station sends and receives signals through optical fiber cables. The facility has a redundant configuration using two routes. Cables are installed along existing optical fiber cable routes where available.

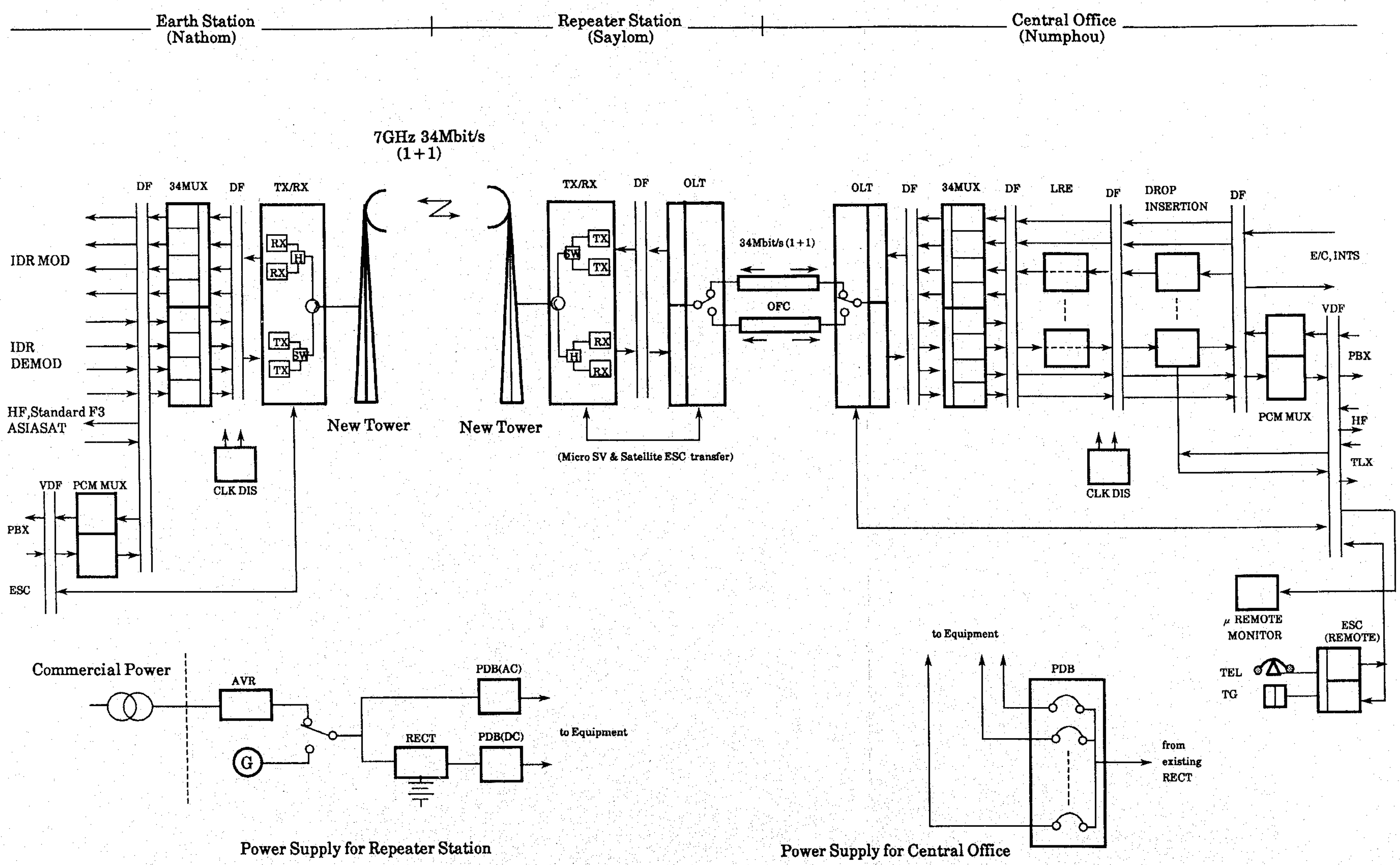
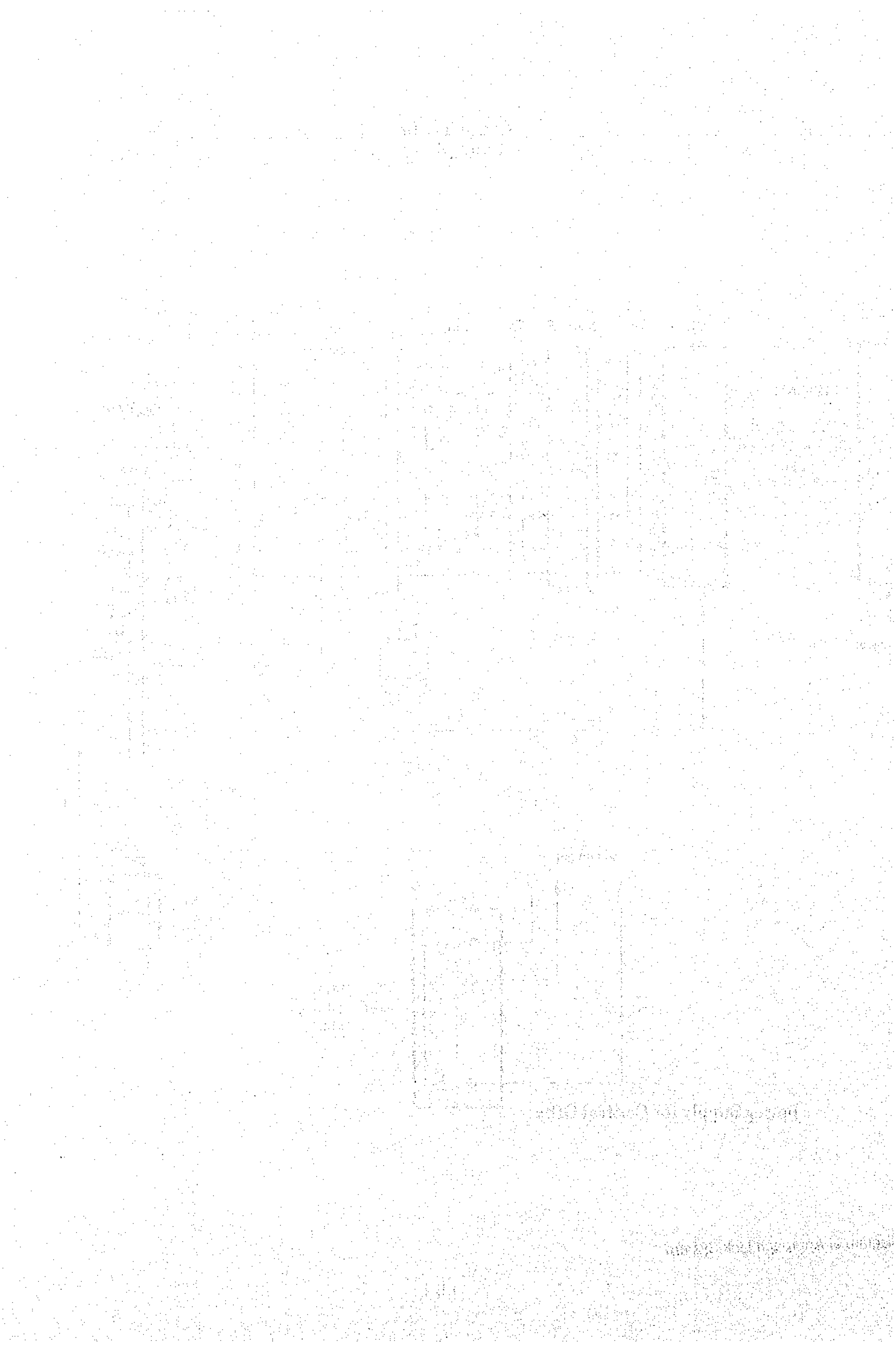


Figure 3-6 Configuration Diagram of Approach Link System



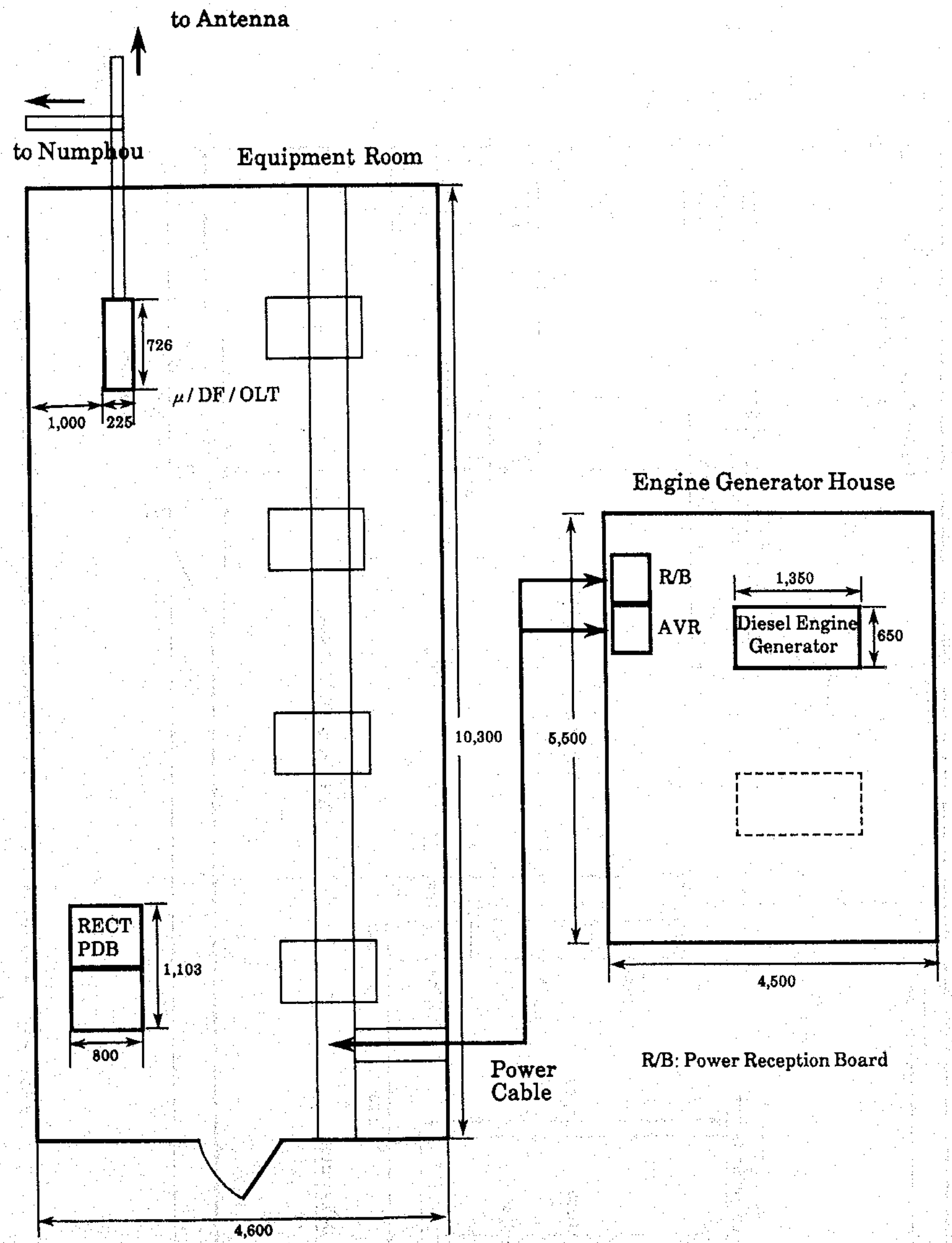
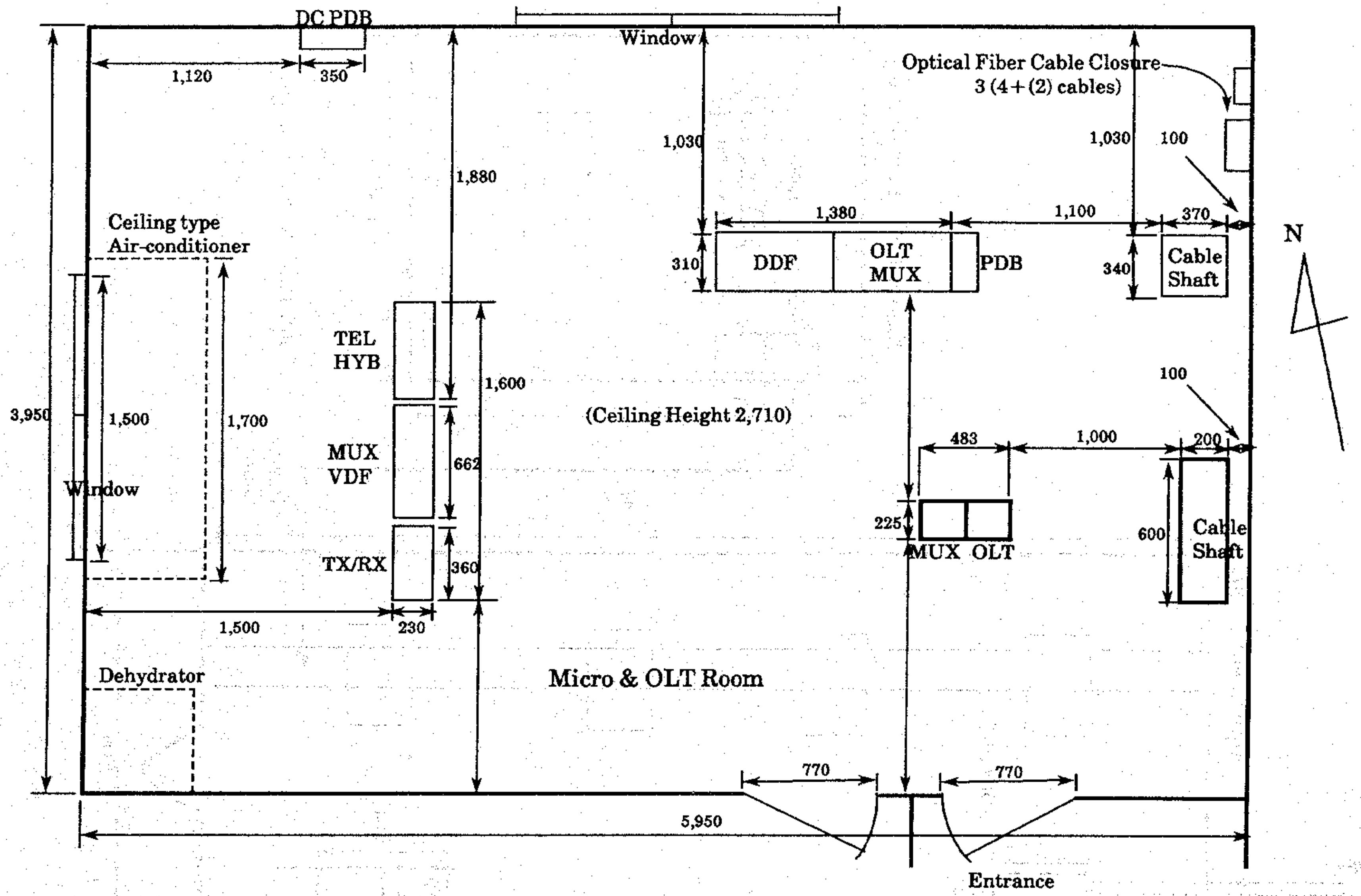


Figure 3-7 Layout of Equipment in Equipment Room and Engine Generator Room (Repeater Station)



(Unit :mm)

Figure 3-8 Layout of Equipment of Optical Fiber System (Numphou Station)

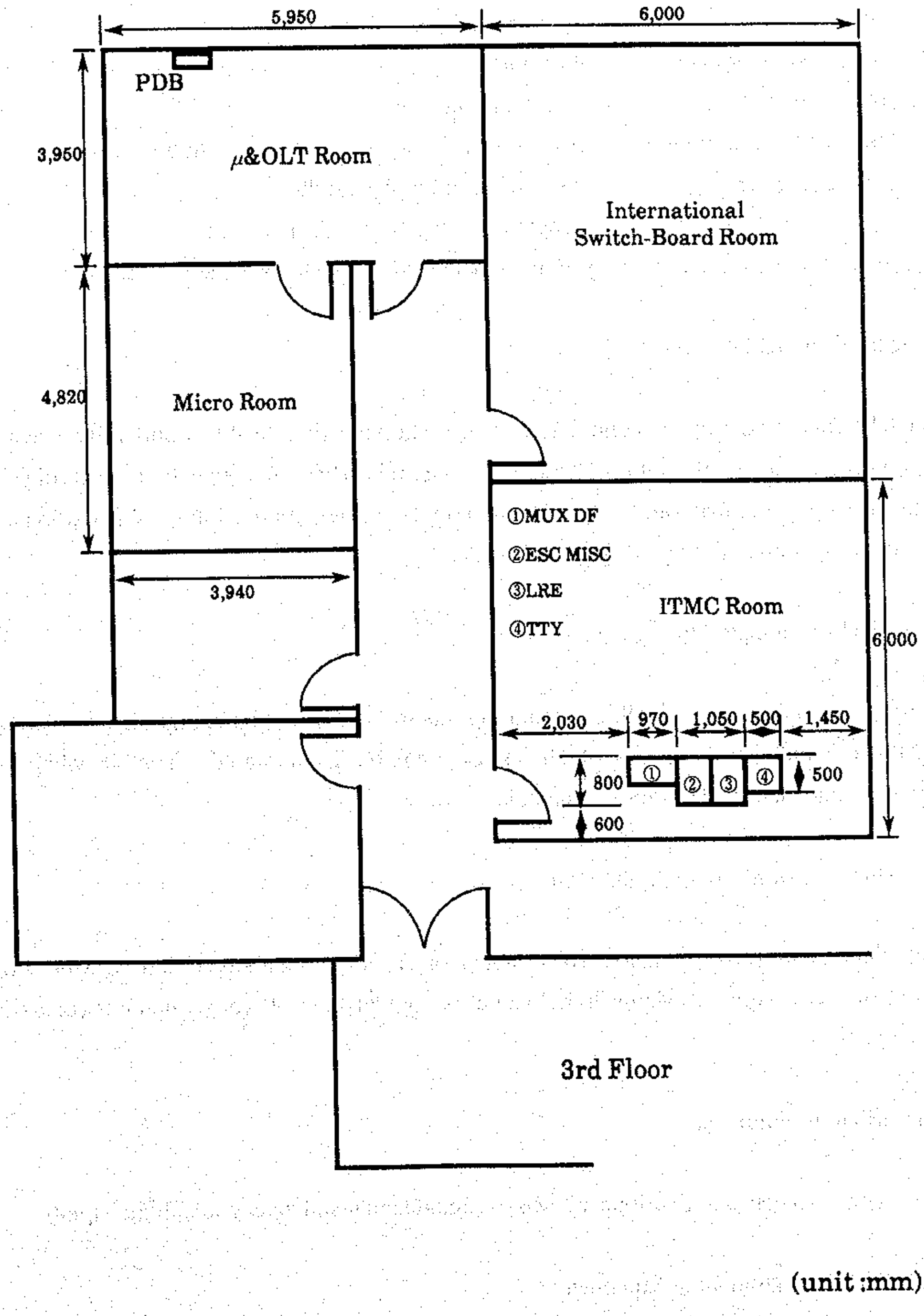


Figure 3-9 Layout of Equipment in ITMC (Numphou Station)

1) Transmission distance:	First route; about 1.2 km, Second route; about 1.8 km
2) Wave length:	1.3 μm
3) Cable:	12 pairs (6 systems), 1 line
4) Transmission bit rate:	34 Mbit/s
5) Optical terminal:	1+1 configuration
6) Redundant configuration:	First route on-line, Second route standby
7) Cable laying method:	Installed in underground duct Length of newly buried duct; 1.5 km

8) Connection with microwave system : Connected at 34 Mbit/s at the repeater station

(3) Digital Terminal Equipment

Digital terminal equipment connects satellite communication facilities and microwave radio equipment at the earth station. And at the central office, it connects optical fiber cable transmission equipment and international telephone switching system, international telex switching system, leased line equipment, etc.

1) 2 M/34 M Multiplex Equipment

This equipment converts 2 Mbit/s digital signals to 34 Mbit/s digital signal, and vice versa. 34Mbit/s digital signal consists of 16 sets of 2 Mbit/s digital signals. The 34 Mbit/s digital signal is equivalent to 480 voice channels.

2) 2 Mbit/s PCM Multiplex Equipment

This equipment converts analog voice signal or 64 kbit/s data signal into 2 Mbit/s digital signal, and vice versa. 2 Mbit/s digital signal is equivalent to 30 voice channels (or 64 kbit/s data signal).

3) Distribution Frame

This frame connects and distributes 2 Mbit/s digital signal and analog telephone signal.

4) 2 Mbit/s Line Branching Equipment

This equipment branches 2 Mbit/s digital signal into individual channels. It is installed in the central office to branch telex signals and leased line signals.

5) Low Rate Encoder Equipment (LRE)

This equipment encodes and compresses telephone signals into half rate digital signals using Adaptive Differential Pulse Code Modulation (ADPCM), and doubles transmission capacity.

This equipment is installed in the central office and used for telephone lines.

(4) Power Supply Equipment

The following equipment is installed in the repeater station:

1) Engine generator (diesel engine generator):	15 kVA	1
2) AVR :	15 kVA	1
3) UPS (- 48 V):	2 kVA rectifier 30 minutes battery	1

(5) Grounding System

Grounding for lightning, for communication equipment, and for power equipment provided at the repeater station.

(6) Facility List

Facilities are as follows:

1) Earth Station

a) Digital Microwave Transmission Facility

a. 1.8 m antenna:	1
b. Wave guide (62 m):	1
c. Microwave radio equipment:	1
d. Supervisory control equipment:	1
e. Dehydrator:	1

b) Digital Terminal Equipment

a. 2M/34M multiplex equipment:	1
b. 2M PCM multiplex equipment:	1
c. Distributing frame:	1

2) Repeater Station

a) Digital Microwave Transmission Facility

a. 1.8 m antenna:	1
b. Waveguide (75 m):	1
c. Microwave radio equipment:	1
d. Supervisory control equipment:	1
e. Dehydrator:	1

b) Fiber-Optic Transmission Facility

a. Optical terminal equipment:	1

c) Power Supply

a. Engine generator:	1
b. AVR:	1
c. UPS:	1

d) Grounding Facilities:	1

3) Central Office

a) Digital Microwave Transmission Facility

a. Remote monitor equipment:	1

b) Fiber-Optic Transmission Facility

a. Optical terminal equipment:	1

c) Digital Terminal Equipment

a. 2 M/34 multiplex equipment:	1
b. 2 Mbit/s PCM multiplex equipment:	1
c. 2 Mbit/s line branching equipment:	1
d. LRE:	8
e. Distributing frame:	1

4) Materials for Installation	1

5) Maintenance Facilities

a. Measuring equipment:	1
b. Spare parts:	1
c. Documents:	6

[3] Switching System and Billing System Plan

(1) Upgrade Plan

This plan is for upgrading the international switching functions of the existing system.

1) Upgrading Functions

a) Upgrading the Signaling System

The specifications of the signals in the Standard No.5 International Signaling System will be upgraded to the latest international standards.

b) Upgrading Traffic Measurement

Monthly statistical processing of international traffic has been dependent on the transit center in Australia, as all the satellite traffic passes through there. The improvement involves processing data at Numphou Exchange.

This should have been covered by Numphou Exchange from the start, but was shelved to reduce construction cost, as there was only this direct route to Australia and no other international direct route was planned at the time. However, this function, requires urgent installation, since the country has opened direct routes to Japan and Singapore, as well as to Australia, and the lines to neighboring Thailand have been upgraded to an international line. Presently, printouts of maintenance data from the switching system are processed manually, retarding processing and obstructing operations.

c) Upgrading the International Accounting

This function is a must for an international switching system, but was shelved to reduce construction cost, and requires urgent installation. It is manually processed monthly by a dozen employees.

d) Return Traffic Distribution Processing Function

If there is more than one international telecommunication business in any one country, as in Japan or the US, and more than one of them opens an international direct line with Laos at the same time, traffic from Laos should be controlled in accordance with traffic received, to standardize operational efficiency of the direct line.

Since many international telecommunication businesses are being privatised, more than one international telecommunication business may well connect a service line to the same destination at the same time. Therefore, this function should be performed promptly.

2) Expansion of Facilities

a) Expansion of Main Equipment

An expansion of international line equipment (Digital Trunk Interface = DTI) is required. In order to provide for international line demand in 2001, as is shown in Table 3-6, seven additional satellite line DTIs (required number of DTIs with two for terrestrial transmission system for Thailand and two for the existing satellite circuits, subtracted from the total of eleven DTIs required) will be implemented.

Two terrestrial line DTIs will be added in order to accommodate the DTI for the Thai international lines. This DTI is at present in the domestic line facilities, in the rack dedicated to international lines, to provide for better maintenance and operation of the additional international line facilities.

b) Expansion of Switchboards

Out of approximately 700 international calls, in one busy hour in Laos (9 am - 10 am, see Table 3-11 and Figure 3-10), 300 calls or approximately half the maximum number go through operators. The handling of a call by an operator normally takes 40 seconds; 30 seconds for the operator and 10 seconds extra time. The number of international calls that can be handled by the existing three international desks is 3600sec/hour/40sec/call x 3 desks= 270calls per hour. As is apparent, the international switching facilities are insufficient at present, and many of the subscribers presumably give up on making international calls via operators.

Although automatic international calls are increasing, the operators will need to handle 450 international calls in one busy hour in 2001, due to increased subscribers (projected 20,000 in fiscal year 1995) and the trend of international call services (decreased operator calls), and for higher service quality.

Therefore, the number of operator's desks required for international calls will be 450/90 = 5. International operators also offer international call reservation and information services, but are too busy to handle these services as shown above. Ordinary telephones are installed to

Table 3-11 International Out-going Traffic for a Week

Sunday	0-am	1-am	2-am	3-am	4-am	5-am	6-am	7-am	8-am	9-am	10-am	11-am	12-pm	13-pm	14-pm	15-pm	16-pm	17-pm	18-pm	19-pm	20-pm	21-pm	22-pm	23-pm
Thai rou	6	1	0	0	0	3	5	55	65	42	53	70	65	57	36	26	48	68	84	41	69	44	12	0
Japan ro	0	0	0	0	0	0	1	2	2	1	3	0	3	1	3	2	4	5	8	5	1	1	7	0
Sydney r	11	15	0	7	0	3	17	9	45	42	24	48	27	41	40	45	53	45	64	84	61	48	20	0
Singapor	0	0	0	0	0	0	0	0	0	5	2	0	1	0	0	0	1	0	1	2	0	2	0	0
Total	17	16	0	7	0	6	23	66	112	90	82	118	96	99	79	73	106	118	157	132	131	95	39	0

Monday	0-am	1-am	2-am	3-am	4-am	5-am	6-am	7-am	8-am	9-am	10-am	11-am	12-pm	13-pm	14-pm	15-pm	16-pm	17-pm	18-pm	19-pm	20-pm	21-pm	22-pm	23-pm
Thai rou	2	0	0	0	0	1	14	45	168	245	215	207	79	134	196	155	231	133	137	102	80	33	18	3
Japan ro	0	0	0	0	0	0	1	3	16	18	24	10	10	8	14	8	13	5	13	6	3	6	8	2
Sydney r	13	8	0	0	0	1	26	52	204	206	150	136	76	109	191	218	221	192	109	101	108	87	64	58
Singapor	0	0	0	0	0	0	1	0	62	9	9	21	0	9	6	11	17	8	0	2	0	0	0	0
Total	15	8	0	0	0	2	42	100	450	478	398	374	165	260	407	392	482	338	259	211	191	126	90	63

Tuesday	0-am	1-am	2-am	3-am	4-am	5-am	6-am	7-am	8-am	9-am	10-am	11-am	12-pm	13-pm	14-pm	15-pm	16-pm	17-pm	18-pm	19-pm	20-pm	21-pm	22-pm	23-pm
Thai rou	0	0	0	0	0	0	0	0	0	252	345	276	123	211	299	191	28	132	92	106	93	0	0	0
Japan ro	0	0	0	0	0	0	0	0	0	19	13	23	2	5	13	15	1	9	14	30	0	0	0	0
Sydney r	32	37	13	10	23	12	55	204	478	260	223	206	124	118	144	201	43	123	104	71	82	0	0	0
Singapor	0	0	0	0	0	0	0	0	0	8	2	6	9	4	4	5	1	3	0	1	1	0	0	0
Total	32	37	13	10	23	12	55	204	478	539	583	511	258	338	460	412	73	267	210	208	176	0	0	0

Wednesday	0-am	1-am	2-am	3-am	4-am	5-am	6-am	7-am	8-am	9-am	10-am	11-pm	12-pm	13-pm	14-pm	15-pm	16-pm	17-pm	18-pm	19-pm	20-pm	21-pm	22-pm	23-pm
Thai rou	4	2	0	0	0	3	21	78	247	298	363	323	171	241	374	226	237	201	101	152	70	94	25	0
Japan ro	0	0	0	0	0	0	0	2	12	19	18	11	1	0	10	6	12	6	10	2	4	8	1	0
Sydney r	31	5	8	0	0	5	23	81	195	226	260	184	77	143	209	170	215	123	141	64	109	85	29	0
Singapor	0	0	0	0	0	0	0	1	18	25	20	11	2	7	17	6	3	3	0	1	5	1	1	0
Total	35	7	8	0	0	8	44	162	472	568	661	529	251	391	610	408	467	333	252	219	188	188	56	0

Thursday	0-am	1-am	2-am	3-am	4-am	5-am	6-am	7-am	8-am	9-am	10-am	11-am	12-pm	13-pm	14-pm	15-pm	16-pm	17-pm	18-pm	19-pm	20-pm	21-pm	22-pm	23-pm
Thai rou	0	0	0	2	0	7	19	74	199	313	323	223	105	170	262	248	213	113	104	144	138	88	24	0
Japan ro	0	0	0	0	0	0	0	0	9	12	7	13	2	11	9	7	10	17	7	5	5	1	0	0
Sydney r	14	13	4	1	10	0	31	51	151	190	207	217	131	113	193	212	177	143	170	97	107	172	54	0
Singapor	0	0	0	0	0	0	0	0	3	16	12	9	1	2	7	8	24	3	5	2	0	1	0	0
Total	14	13	4	3	10	7	50	125	362	531	549	462	239	296	471	475	424	276	286	248	250	262	78	0

Friday	0-am	1-am	2-am	3-am	4-am	5-am	6-am	7-am	8-am	9-am	10-am	11-am	12-pm	13-pm	14-pm	15-pm	16-pm	17-pm	18-pm	19-pm	20-pm	21-pm	22-pm	23-pm
Thai rou	2	2	0	0	1	1	10	53	168	323	264	204	106	136	278	217	271	147	91	73	52	72	33	3
Japan ro	0	0	0	0	0	0	4	5	16	16	9	15	7	2	22	24	18	12	6	3	0	0	2	2
Sydney r	11	0	0	0	3	2	23	56	204	264	293	263	82	115	189	265	224	136	136	62	87	58	49	58
Singapor	0	0	0	0	0	0	0	12	62	22	21	1	0	0	0	0	8	0	2	0	0	1	0	0
Total	13	2	0	0	4	3	37	126	450	625	587	483	195	253	489	506	521	295	235	138	139	131	84	63

Saturday	0-am	1-am	2-am	3-am	4-am	5-am	6-am	7-am	8-am	9-am	10-am	11-am	12-pm	13-pm	14-pm	15-pm	16-pm	17-pm	18-pm	19-pm	20-pm	21-pm	22-pm	23-pm
Thai rou	2	0	0	0	0	1	14	45	65	42	174	137	74	84	83	64	96	58	74	74	78	23	19	0
Japan ro	0	0	0	0	0	0	1	3	2	1	10	9	4	2	2	8	2	8	10	3	0	0	0	0
Sydney r	13	8	0	0	0	1	26	52	45	42	130	105	104	62	70	60	39	44	47	74	53	60	11	0
Singapor	0	0	0	0	0	0	1	0	0	5	9	4	0	0	0	0	0	1	1	0	0	0	1	0
Total	15	8	0	0	0	2	42	100	112	90	323	255	182	148	155	132	137	111	132	151	131	83	31	0

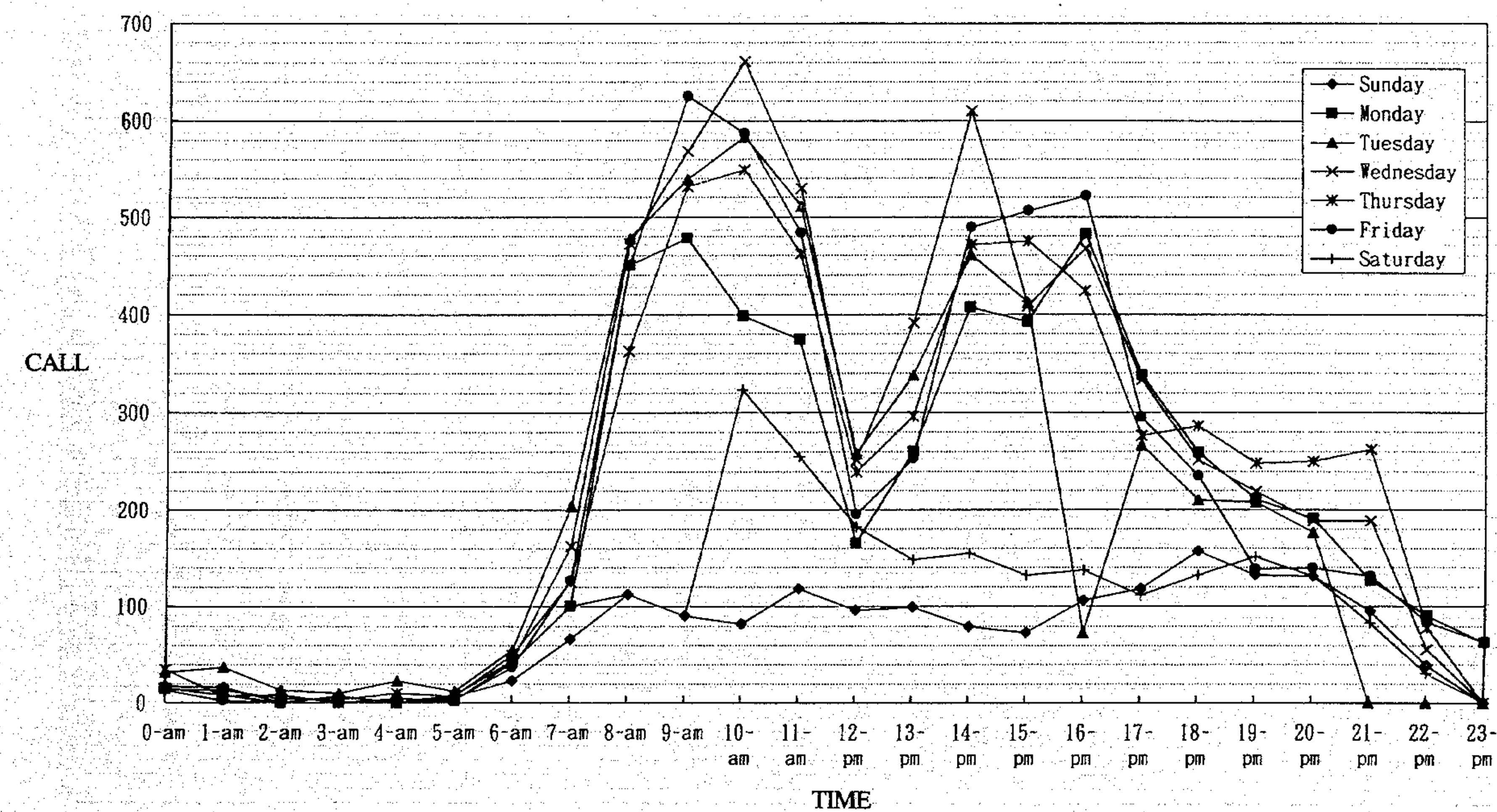


Figure 3-10 International Out-going Traffic for a Week

cover the above services, but there are constant complaints from subscribers.

Two more operator's desks for international service information and one for international reservation will be installed to improve international telephone service. Since, out of the eight operator's desks required in the year 2001, three already exist, five new international operator's desks should be installed in this project.

c) Expansion of Other Necessary Equipment

As well as improving international switching functions, this project should consider operation and maintenance. In order to provide better service, domestic and international services will be separated wherever possible and an independent international operations and maintenance staff will be created.

Since international switching functions are included in the domestic switching system at present, international telecommunication services were affected by a mistake by domestic telephone network maintenance activities (an accidental interruption of the international lines occurred because of a mistake made during construction of additional domestic lines).

Therefore, by separating international functions, such problems should be avoided, and international telecommunication services should be improved. To provide for the above improvement, necessary status indicators and Input/Output devices should also be installed.

3) Installation of Equipment

a) Standard Clock

The existing switching system does not have an accurate standard clock for network synchronization. The switching network is synchronized by a crystal oscillator in the existing switching system. Although such crystal oscillators are relatively cheap and have sufficient accuracy for telephone service, they are not appropriate for digital data transmission.

Digital data transmission is getting popular. Given the future socio-economic development of Laos, demand for digital data transmission cannot be neglected. Accordingly, a standard clock having accuracy of 10^{-11} should be installed, as recommended by ITU, in this project.

b) Echo Canceler

Eleven echo cancelers for international satellite communications will be installed, corresponding to the number of DTI's installed.

The configuration diagram of the existing switching system is shown in Figure 3-11. The layout of switching system and of international switchboards are shown in Figure 3-12, and Figure 3-13, respectively.

(2) Equipment List

Principal equipment and materials for the project is as follows:

1) Equipment for Expansion

a) Digital trunk interface	9
b) Switchboard (for international operator)	5
c) Display equipment (alarm indicator for international traffic)	1
d) Input/output interface (for international switching)	1
e) Measuring equipment (for international switching)	1

2) Materials for Upgrading Functions

a) Materials for upgrading signaling	1
b) Materials for upgrading traffic measurement	1
c) Materials for upgrading billing system	1
d) Materials for upgrading return traffic function	1

3) Equipment to be installed

a) Standard clock	1
b) Echo canceler	11

(3) Spare Parts and Consumables

1) Spare Parts

Spare parts will be supplied in this project, given data on maintenance to date. The most important point to consider is protection against lightning. There has been no damage from direct lightning in the past five years, but indirect lightning strikes have occurred frequently, especially in the past year. There were as many as eight cases of damage caused by indirect strikes from June through September this year.

Lightning damages mostly come from three sources: conducted via commercial power supply into the facilities, conducted via subscriber cables into the facilities, and conducted via transmission lines into the facilities. However, damage varied greatly, from blown fuses to

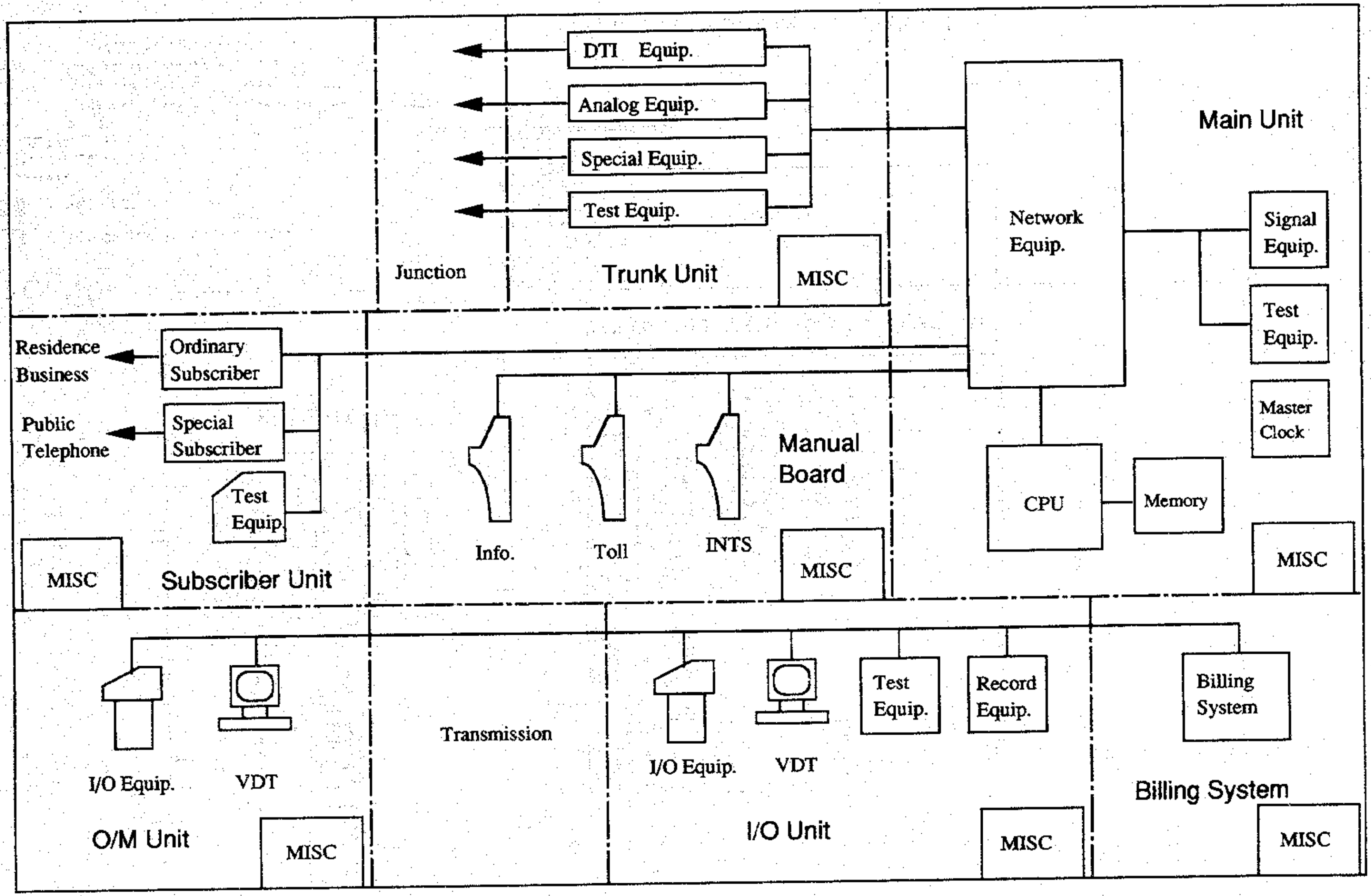


Figure 3-11 Configuration Diagram of Telephone Switching System

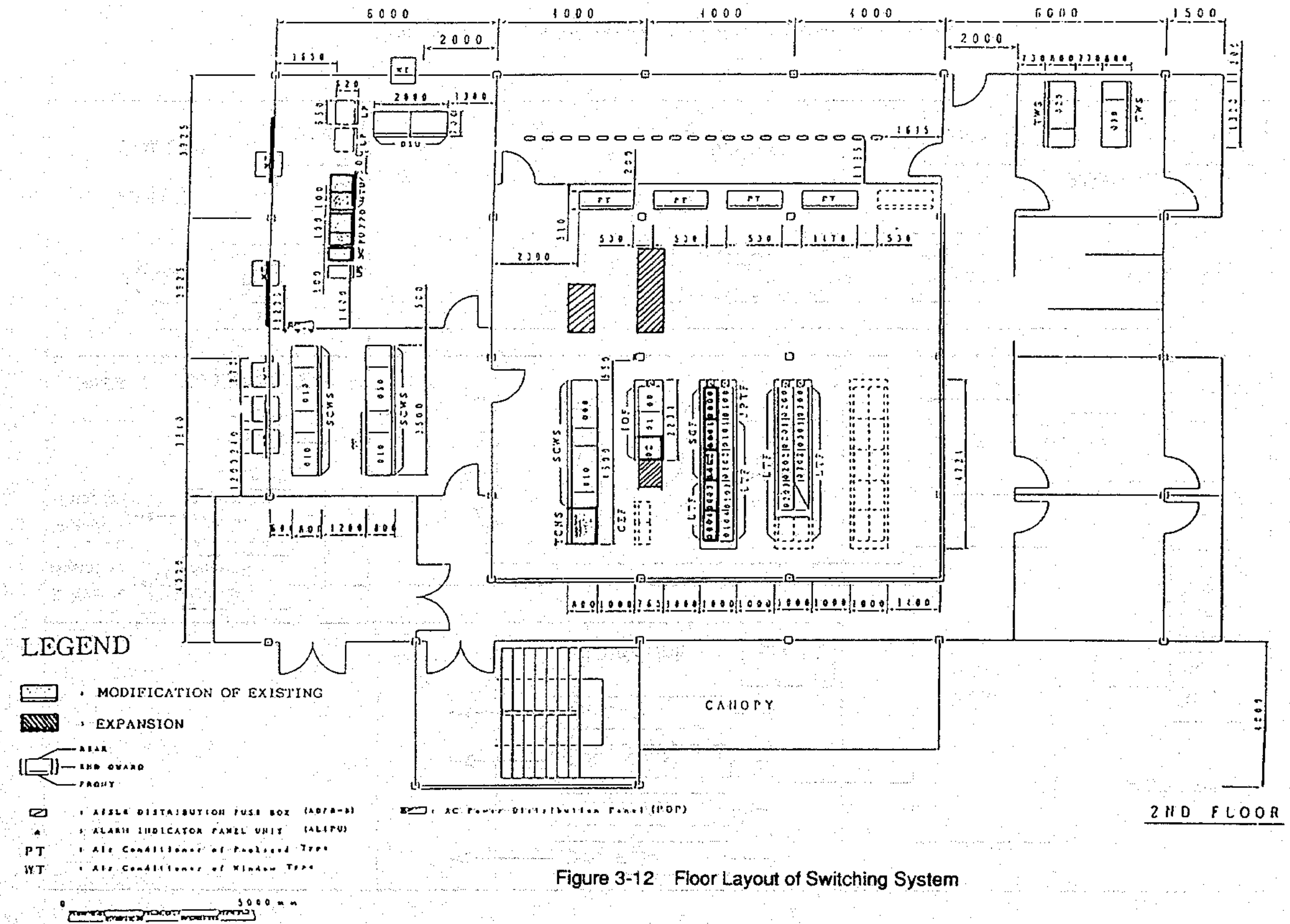


Figure 3-12 Floor Layout of Switching System

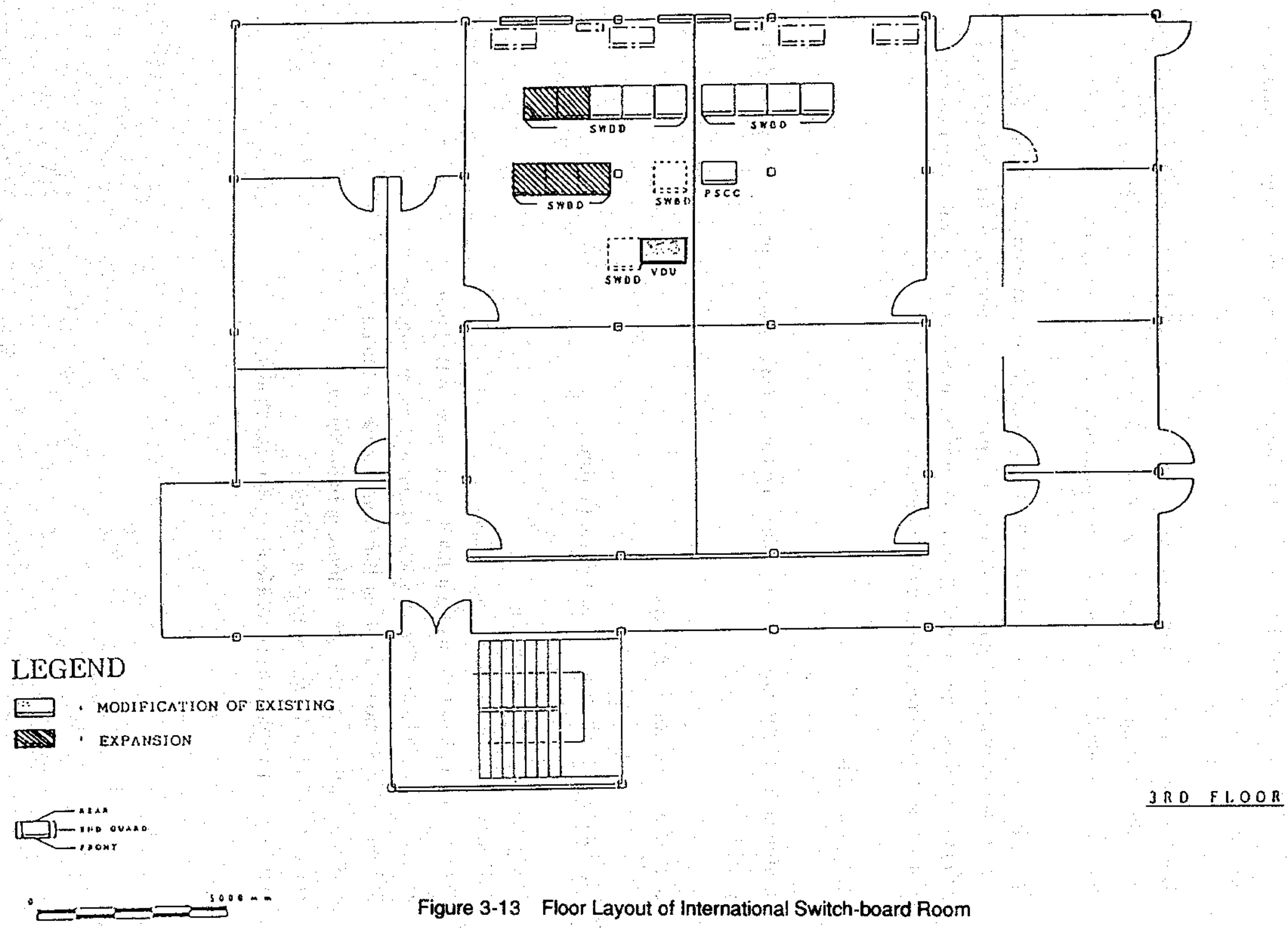


Figure 3-13 Floor Layout of International Switch-board Room