The above three stations are interconnected by a UHF multiplex radio communication link which, however, is not functioning normally.

The present SSB, consisting only of a single radio wave of 7995 KHz, causes the radio transmitted messages from each weather station to be concentrated at the observation hours and may not permit the quick collection of data. In addition, it may be impossible to collect observed data if the conditions for radio propagation are deteriorated at sunrise or sunset.

For the operation related to foreign countries, data exchange with Tokyo and Singapore is carried out via the GTS circuit.

3.1.2 Study on Meteorological Telecommunication System

(1) Study policy

The PFC need not be directly connected to each of the Philippine observation stations scattered around over the Luzon island and its peripheral region, Visaya region, and Mindanao region. It is more economical and effective to divide each area into blocks, to set up a center for collecting data within its blocks, and to connect the PFC to each of these centers than the direct connection of the PFC to each of all the stations is made.

In order to constitute a meteorological telecommunication system, then, we assumed the network routes where data-collection centers are connected to the PFC via main trunks (multiplex radio communication) while connection to other weather stations is made via subordinate links (VHF or HF links).

The study policy is specifically described below in detail.

(i) Survey items

Link estimation
Station site survey
Radiowave propagation test
Analysis and estimation

(ii) Link composition

This meteorological telecommunication system consists of main trunks and branch links. The main trunk shall be a multiplex radio communication link while the branch link shall be a VHF communication link. Any link that can hardly be established as a VHF link shall be a HF link.

(iii) Multiplex radio communication link

As each span of multiplex radio communication links has a long path, and in the case of some links spanned over the sea where no relay station can be established, the multiplex radio communication links shall be over-horizon multiplex radio communication links.

The basic quality and reliability for multiplex radio communication links required for the trunk routing is as follows:

a. Unweighted signal to noise ratio under the standard condition (time rate 50%):

55dB/Hop or above (Aimed at 60 dB/Hop or above)

b. Reliability in ensuring an unweighted signal to noise ratio of 35 dB or above:

99.95%/Hop or above

(2) OH telecommunication system

Since the Philippines are scattered over a wide area, and have complicated geographical features, it is considered economical and effective to adapt a UHF-band over-horizon multiplex radio communication system (OH communication system) using the diffraction due to mountain obstructions and the troposcatter.

Based upon the above concept, we routed the OH telecommunication network trunk on the map and performed the propagation test and propagation route survey to check whether the selected routes can be put into practice or not. The results and analytic estimation are described below.

(i) Link estimation

A. Examination for routing and selected routes

The trunk routing plan is shown in Fig. 3.1 where dashed-line routes are alternative routes. This is a result of the routing which was made with a map on a scale of 1 to 50,000 and based on the following basic conditions:

a. The number of radio links should be as small as possible.

b. The radio station site should be within the weather station premises or near them if possible.

c. The VHF-band or HF-band radio communication network for weather stations connected to main trunks should be designed to have an optimum configuration.

In practice, the level of basic quality and reliability for multiplex radio communication links, the efficiency in management including maintenance and operation, the economy and other items are also examined, and 49 radio links are checked and examined on the map. These networks of links are combined to select 12 routes, and the overall examination is further made to conclude the routing as follows:

PFC —— SCIENCE GARDEN —— TANAY ① Mt. MACLAYAO ② LEGASPI ③ CATARMAN ④ TINAMBACAN ⑤ CATABALOGAN ⑥ TACLOBAN ⑦ MACTAN ⑧ MAASIN ⑨ CAGAYAN DE ORO
(The existing multiplex radio communication link is used between PFC - SCIENCE GARDEN - TANAY.)
The profile for each link is shown in Appendix (Fig. A.1, (1/19) - (19/19)).

However, the examination has revealed that it is difficult to obtain the basic quality and reliability for the ②, ④, ⑦ and ⑧ links in the above route even if large-scaled facilities are provided. Therefore, the following additional examination is made:

. Since Mt. MACLAYAO is distant from the main road, it will be slightly difficult to maintain the facility at this site. We then re-examine GAPAS in terms of radiowave propagation and maintenance.

. Since LEGASPI is skirted by mountains in the three quarters, it is geographically difficult for the site to be directly linked to a distant station. This problem will be solved by setting up a relay station near LEGASPI to help establish a communication link. We re-examine whether MALABOG can be a site for the relay station or not.

. The link between CATARMAN and TINAMBACAN, though having a relatively short span, will suffer much shadow loss caused by their surrounding mountains, and will not be provided with the basic quality and reliability. Therefore, BALOD near CATARMAN is selected to be the site for a relay station, and a 6.7 GHz-band microwave multiplex radio communication link is re-examined on the route from BALOD through a passive relay to TINAMBACAN. A high-land place near CAPACUAN is considered suitable for the passive relay site.

The route between LEGASPI and TINAMBACAN was also examined. This route will undergo much shadow loss caused by mountains and will prove not to ensure the basic quality and reliability for the multiplex radio communication link. So we discard this route.

. The basic quality and reliability cannot be obtained for the bidirectional links, 7 and 8 , from MACTAN. Furthermore, CATABALOGAN, TACLOBAN and MAASIN are not necessarily required to be included in the trunk route. To meet the basic condition of minimizing the number of radio links, therefore, we re-examine the route from TINAMBACAN through DANAO and MALASAG to CAGAYAN DE ORO. DANAO is selected in place of MACTAN as a relay station site. This will solve the problem (much reflection loss due to the surface of the sea) posed by both propagation routes directed to TINAMBACAN and MALASAG, and thus improve the propagation conditions.

. For the additionally examined and selected route, MALABOG - BALOD - a passive relay station TINAMBACAN, we prepare the alternative route, MALABOG - MASBATE - TINAMBACAN, in case that the passive relay site can be unsuitable for the installation of a station because of the conditions of the site.

B. Link estimation on selected routes

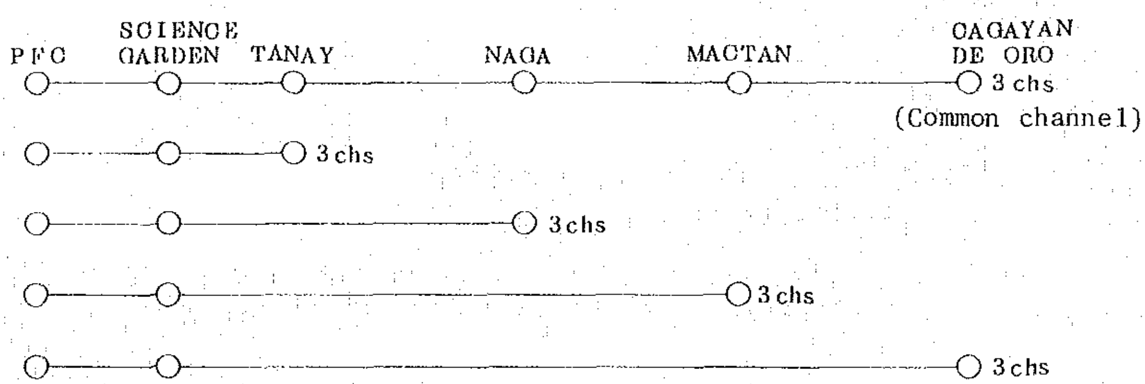
Link estimation is performed on the following conditions, and the results are shown in Table 3.1. The terrain profile for each link is shown in Appendix (Fig. A.1, (1/19) - (19/19)).

a. To prepare the terrain profile, the map on a scale of 1 to 50,000 is used if possible.

Trees of 20 meters in height are assumed to be growing thick along the propagation route.

b. The antenna is assumed to be 15 m above the ground while feeders are assumed to be equally 50 m.

c. Channel capacities are as follows:



d. Multiplex radio relay equipment models are as follows:

. Standard type

6
PM 12 - 800 - 5
24

. High output power type diversity system (NF is 3 dB)

6
PM 12 - 800 - 70 FD or SD
24

PM	:	Phase Modulation method
6 12 24	:	Channel capacity (chs)
800	:	Frequency band (MHz)
5 70	:	Transmission output (W)
FD or SD	:	Diversity system (FD: Frequency Diversity) (SD: Space Diversity)

. The 6.7 GHz-band SS-FM multiplex radio communication equipment has a channel capacity of 60 chs and a transmission output of 1 W.

e. Link estimation must take account of the following corrective values:

. Corrective value based on the propagation test -6dB (Presumed)
. Safety Factor -3dB

(ii) Station site reconnaissance

In Item A of the preceding section "Link estimation," the plans for multiplex radio communication trunk routings were examined with the map on a scale of 1 to 50,000, and Fig. 3.1 was prepared.

Of these station sites, a site reconnaissance was performed respectively at TANAY, GAPAS, Mt. MACLAYAO, MALABOG (LEGASPI), NAGA, BALOD (CATARMAN), TINAMBACAN, CAGAYAN DE ORO (MALASAG), DANAO (MACTAN RADAR) and MASBATE at which the propagation test was made, according to the schedules shown in Table 3.2. The purpose of this site reconnaissance was to determine whether the map survey points were suitable for the performance of radio-wave propagation tests and suitable for the sites of relay stations operating on multiplex radio communication links. The information required in future for the installation of station is shown in Table 3.3 for nine of the above sites excluding the five station sites of Mt. MACLAYAO, MASBATE, LEGASPI, CAGAYAN DE ORO and MACTAN RADAR.

Appendix Fig. A.2, (1/12) - (12/12), shows the map on which the above sites are located.

(iii) Propagation test and propagation route survey

OH communication systems are roughly divided into two types, those utilizing the diffraction due to mountain obstruction or to smooth earth surface and those utilizing the troposcatter. For either type of systems, the basic propagation loss can be predicted to some extent by obtaining the terrain profile based upon detailed maps. However, it is eventually required to make the propagation test, to obtain "the corrective value based on the propagation test" as compared with the calculated value, and to determine "the basic propagation loss based on the propagation test."

For 6.7 GHz-band microwave communication routes and for UHF-band routes affected by little obstructions and having short whole spans, the survey of obstructions to propagation routes can be made, instead of propagation tests, to obtain accurate terrain profiles in order to determine basic propagation loss and the minimum required antenna height.

An outline of the methods and results of the propagation test of the OH communication system and those for the propagation route survey are described below.

A. Propagation test schedule

The propagation test schedule is shown in Table 3.4, (1/4) - (4/4).

B. Propagation test method, propagation route survey method and related links

a. Propagation test method and data analysis method

The items to be measured for the propagation test and measuring methods are as follows. The test was made with vertical polarized antenna polarization.

The arrangement of the equipments used in making the above test is shown in Figs. 3.2, 3.3 and 3.4 while their principal specifications are given in Table 3.5.

. Receiving input power

Measurement of receiving input power was made five or more times per day. The standard measurement time for each measurement is 30 min or more. Measurement was made at intervals of two hours and for five or more days. Fading status is observed by means of records with a recorder.

. Atmospheric reflectivity on the ground surface

Measurements of atmospheric elements such as air temperature, air pressure and relative humidity were made during the measurement of the receiving power. The atmospheric reflectivity on the ground surface was calculated by use of the above measured values, which was referrenced when the results of the propagation test were examined.

The details of obtaining receiving input power, corrective values based on the test and atmospheric reflectivity are shown in Appendix A(*1).

b. Propagation route survey method and data analysis method

The height (above the sea level) of an obstruction on the propagation route was obtained through the geometrical equations (see Appendix A(*2)) by making necessary measurement with a transit compass and other instruments.

The above results were used to prepare a terrain profile which was referenced in order to determine the minimum antenna required height to ensure the clearance on the obstruction to the propagation route, and to obtain the shadow loss caused by the obstruction.

The details of method of obtaining minimum required antenna height are shown in Appendix A(*3).

c. Links tested and surveyed

Links tested and surveyed are shown in Fig. 3.5. The terrain profiles for these links, and the system data sheets for the propagation test are shown in Appendix (Fig. A.1, (1/19) - (19/19) and Table A.1, (1/11) - (11/11)).

Fig. 3.6 shows the summary of standard receiving power and basic transmission loss during the propagation test, based on the results of the system data sheet on map.

C. Results of propagation test and propagation route survey

The methods of obtaining terrian profile (Appendix Fig. A.1, (1/19) - (19/19)), system data sheet (Appendix Table A.1, (1/11) - (11/11)), receiving power and fading rise/depth (Appendix Fig. A.3, (1/32) - (32/32)) and receiving power with respect to time rate (Appendix Fig. A.4, (1/22) - (22/22)) are described in the Appendix A(*4).

Various results obtained are summarized below.

a. Of the 13 links scheduled to undergo the 800 MHz-band propagation test, the six links marked as main links composed of multiplex radio relay equipments, TANAY - GAPAS, GAPAS - NAGA, NAGA - MALABOG, MALABOG - BALOD, TINAMBACAN - DANAO and DANAO -

MALASAG, were tested to obtain the "corrective values based on the propagation test" and "basic propagation loss" which are summarized in Table 3.6.

The "corrective values based on the propagation test" and "basic propagation loss" are expressed by the following equations:

(Corrective value based on propagation test)
= (Receiving power at a time rate of 50% based on test results) - (Standard receiving power based on estimated value on site for propagation test)

(Basic propagation loss)
= (Free space loss based on estimated value on site for propagation test) + (Additional loss based on estimated value on site for propagation test) + (Corrective value based on propagation test)

The receiving power at a time rate of 50% for this accumulative percentage curve is shown in Appendix (Fig. A.5, (1/6) - (6/6)).

b. Of the six links marked as alternative routes, the four links, MALABOG - MASBATE, MASBATE - TINAMBACAN, TINAMBACAN - MACTAN RADAR and MACTAN RADAR - MALASAG, were tested to obtain the "corrective values based on the propagation test" and "basic propagation loss" as shown in Table 3.7.

These links have been marked as alternative routes for reasons specified below to each of them: The estimation based on map survey revealed bad conditions of power supply and maintenance at MASBATE as well as problems (much reflection loss due to the surface of the sea) posed by the propagation route between MACTAN RADAR and TINAMBACAN. Normal data collection was scheduled to be performed only when the propagation routes were judged to be under good conditions sufficient to offset these disadvantages. However, since each route was considered not to provide an effective link because of its great basic propagation loss, data collection was performed only for about one day. Therefore, the "corrective values based on the propagation test" and "basic propagation loss" as shown in Table 3.7, are treated only as reference data.

c. For the remaining two alternative routes, TANAY - Mt. MACLAYAO and Mt. MACLAYAO - MALABOG, Mt. MACLAYAO is far away from the main trunk road, and it takes an extremely great length of time to walk up to the proposed site as expected during the map survey. So it was concluded that Mt. MACLAYAO was not suitable for a relay station site on the multiplex radio communication routes and that no propagation test should be performed on the two links, TANAY - Mt. MACLAYAO and Mt. MACLAYAO - MALABOG.

d. According to the estimation based on the map survey, the BALOD-TINAMBACAN route, though having a relatively short length, suffers much shadow loss caused by the diffraction due to mountain obstructions, and it is difficult to establish a direct link between these two station sites. The installation of a passive relay site was planned to establish a 6.7 GHz-band microwave multiplex radio communication link with a reflector plate on a summit near CAPACUAN. When a site survey was made, however, it was found out that an obstruction (mountain) about 8.2 km from CAPACUAN toward BALOD which had not been detected during the map survey. If a passive relay site using a reflector plate is installed according to the original plan, then the minimum required antenna height at the BALOD station is more than 60 m. Thus it was found that the original plan could hardly be realized. Tests and surveys were then performed to examine the following additional plans to make a multiplex radio communication link on this route.

- 6.7 GHz-band microwave multiplex radio communication link along the BALOD-CAPACUAN-TINAMBACAN route where a passive relay site with a reflector plate is sited at CAPACUAN (original plan).

- 6.7 GHz-band microwave multiplex radio communication link along the same route as above where a passive relay site with a back-to-back coupling antenna system is sited at CAPACUAN.

- 800 MHz-band multiplex radio communication link along the same route as above where the CAPACUAN relay station is powered by a solar battery system.

- 6.7 GHz-band microwave multiplex radio communication link along the BALOD-490 m highland-TINAMBACAN route where a relay site (with either a reflector plate or a back-to-back coupling antenna system) is located at the 490 m highland site.

The 490 m highland site was selected in place of CAPACUAN and is localed at about 6 km westnorthwest of CAPACUAN.

The results of measurement on obstructions on selected routes such as BALOD - CAPACUAN, CAPACUAN - TINAMBACAN, BALOD - 490 m Highland - TINAMBACAN and CAPACUAN - BALOD and those for the approach links are summarized in Appendix A(*5).

(iv) Analytic estimation

A. Analysis of the survey results

The results of the propagation test and propagation route survey are analyzed and discussed as follows:

a. For each of the 11 links subjected to the 800 MHz propagation test, "the corrective value based on the propagation test" is below 6 dB. This shows that the results of map survey on the propagation routes are almost equal to the results of the propagation test performed at the actual sites. Therefore, it is considered that the multiplex radio communication link can be established for each route by using almost the same value as the system data estimated with the map.

See Tables 3.6 and 3.7, and Appendix Table (A.1, (1/11) - (11/11)) for "the corrective value based on the propagation test" for each route.

b. As had been expected, fluctuations were frequently observed in the receiving power for the TINAMBACAN - DANAO and DANAO - MALASAG links which consist mostly of propagation route on the sea.

On the other hand, the observed receiving power fluctuations were not so great for the TANAY - GAPAS and MALABOG - BALOD links which contain propagation routes under the conditions similar to the above.

Since fluctuation in the receiving power is closely related to the natural environmental conditions affected by seasonal characteristics and weather, it is considered difficult to determine the amounts of receiving power fluctuation only from the data obtained within this measurement period, including the data on the GAPAS - NAGA and NAGA - MALABOG links. In designing the operating links, therefore, Rayleigh fading and measures to be taken against this should be examined in the same manner as the system data estimation based on a map survey is made.

c. Minimum required antenna height is evaluated for each link between BALOD - TINAMBACAN, namely BALOD - CAPACUAN - TINAMBACAN, BALOD - CAPACUAN, CAPACUAN - TINAMBACAN and BALOD - 490 m highland - TINAMBACAN. The details of evaluation are shown in Appendix A(*6).

The results of analysis of the minimum required antenna height are listed in Table 3.8, (1/2) - (2/2) for each routing and system plan.

. For the routes subjected to the propagation test and propagation route survey, the system data sheet for practical links is prepared while taking account of the above survey results and analysis, and outlined in Fig. 3.7.

The detailed system data sheets for practical links are shown in Appendix (Table A.2, (1/20) - (20/20)), based on the following conditions:

① Basic quality and reliability for the multiplex radio communication link

. Unweighted signal to noise ratio under the standard condition (time rate: 50%)

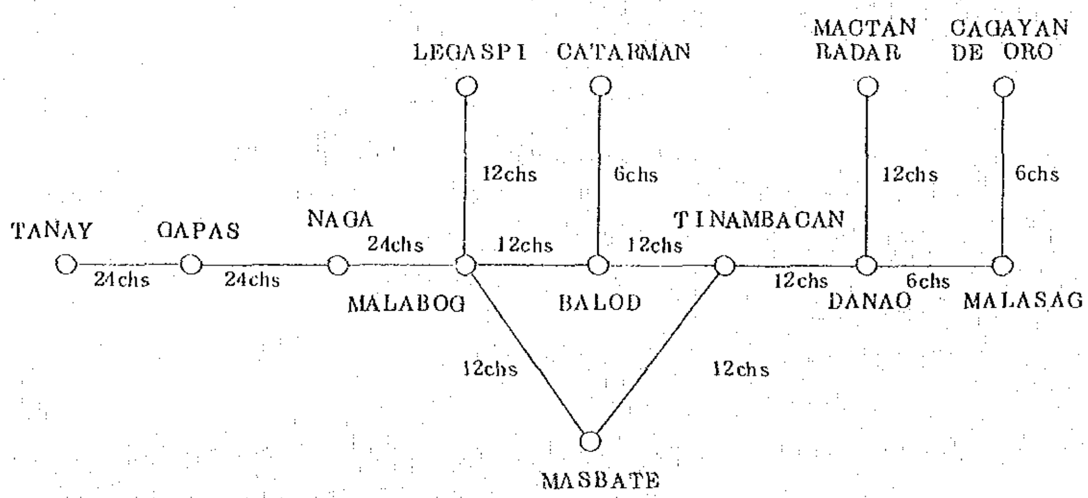
55 dB/Hop or above (Aiming at 60 dB/Hop or above)

. Reliability for ensuring an unweighted signal to noise ratio of 35 dB or more

99.95%/Hop or above.

② Channel capacity

Channel capacity for each radio link is the same as that determined during link estimation.



③ Multiplex radio relay equipment model

Same as those determined during link estimation. For the diversity system, the space or frequency diversity is selected depending upon the following conditions:

. Basically, the space diversity is employed in order to minimize the use of a finite asset of frequency and to facilitate the acquisition of frequency.

. For the existing station at NAGA, however, since the sub-antenna facilities cannot be sited within the same premises, the frequency diversity is employed.

④ The antenna height is basically the height at which the antenna was set up during the propagation test. Therefore, the antenna height shown in the system data sheet for a practical link is regarded as the minimum required antenna height.

⑤ The feeder has a length of antenna height plus 15 m.

⑥ For the over-horizon multiplex radio communication link, "-3dB" is allowed for as a safety factor because of its propagation characteristics.

⑦ For each link subjected to the propagation test, the respective "corrective value based upon the propagation test" is used.

For the other links, "6dB" is estimated to be valid. (For the microwave multiplex radio link, "3dB" is assumed.)

⑧ The sub-antenna for space diversity has an aperture grade at one rank below in size that of the main antenna. Though this results in unequal diversity, in which the receiving power from the main antenna is not equal to that from the sub-antenna and thus deteriorates diversity, the economy takes priority.

B. Evaluation

Evaluation in the link estimation, various site tests and surveys were performed on main links composed of multiplex radio relay equipments. Based upon the results of these examinations, the system data sheet for practical routes, as shown in Fig. 3.7, has been prepared. We examined which route is the best with regard to the following items, and concluded that the TANAY - GAPAS - NAGA - MALABOG - BALOD - CAPACUAN - TINAMBACAN - DANAO - MALASAG - CAGAYAN DE ORO route is the best multiplex radio communication link. Examined routes are shown in Fig. 3.8. The superiority or inferiority for the routes was examined.

. Size of antenna and relay equipment

. Basic quality and reliability

. Size of steel tower

. Propagation route conditions

. Site conditions during station construction

. Power supply conditions

. Access conditions from Manila by car and ship

a. MASBATE route

The comparative table of propagation characteristics between the main route, MALABOG-BALOD-TINAMBACAN, and the alternative route, MALABOG-MASBATE-TINAMBACAN, is shown in Table 3.9, (1/2). The MALABOG-BALOD-TINAMBACAN route is considered better as a whole.

In particular, MASBATE does not seem to be expected of the improvement on its power supply conditions in future, and also is considered worse in the maintainance and in the access from Manila by car and ship. (See Table 3.9, (2/2)).

The conditions of the MASBATE propagation route are also not so good, as can be seen in Table 3.9, (1/2), and in addition to the above the route would require a large antenna.

b. MACTAN RADAR route

According to the comparison similar to that with the MASBATE route, the MACTAN RADAR route is also considered unfavorable as a whole. Particularly, the propagation route is under bad conditions. The basic quality and reliability is not ensured between TINAMBACAN and MACTAN RADAR.

c. BALOD-TINAMBACAN routing and associated system

As shown in Table 3.8 (1/2), five plans have been made for the BALOD-TINAMBACAN route. The system powered by a solar battery, though generally requiring not so great maintenance, is obviously more unfavorable for maintenance as compared with other passive relay systems. The passive relay systems both at CAPACUAN and at the 490m highland site using a reflector plate would require a BALOD-station tower of about 60 m in height, which can also hardly be put into practice.

This examination is that we consider the BALOD-CAPACUAN-TINAMBACAN route with a passive relay using a back-to-back coupling antenna system at CAPACUAN to be the best. The superiority or inferiority of these routes is shown in Table 3.8, (2/2).

d. LAGASPI, CATARMAN, MACTAN RADAR, and CAGAYAN DE ORO route. There is no problem for the practical route.

(3) VHF communication system

(i) Link estimation

A. Routing

The routing was made on the following basic conditions, and the terrain profile was made with a map on a scale of 1 to 50,000.

a. The installation site should be within the observation station premises if possible.

b. In principle, no radio relay station should be newly constructed except when the construction of any new relay station permits a VHF communication link to be made with multiple observation stations.

In the late routing, ROMBLON (Mt) and AMPUCAO were selected as new sites for relay stations.

B. Prerequisites for link estimation

The predictive design of a VHF radio communication link was made using the prepared terrain profile and supposing the use of a set of associated devices set shown as follows:

Frequency, Radiowave type	150 MHz, F3E
Transmitter output	25W (14 dBw)
Antenna	8-element Yagi antenna (Gain: 11dB)
Feeder	8D2V, 25 m (Loss: 0.1 dB/m)
Receiver noise figure	9.5 dB
Threshold level	-144.7 dBw
Threshold S/N	21.2 dB
Expective value of fading	0.1 dB/km
External noise level	Ignorable level

C. Link estimated values

The terrain profiles made for use in the project for the VHF link establishment are shown in Appendix (Fig. A.8, (1/31) - (31/31)). The estimated values on VHF link calculated with these profiles are shown in Table 3.10, (1/2) - (2/2).

D. Selection of routes to be subjected to propagation test

Of the selected VHF communication routes, our examination of the results of link estimation leads to the conclusion that the propagation test must be performed with the following 16 routes:

V-6	BAGUIO RADAR - DAGUPAN
V-4	BAGUIO RADAR - VIGAN
V-30	BAGUIO RADAR - LAOAG
V-24	MALABOG - MASBATE
V-3	VIGAN - LAOAG
V-10	CARMEN ROSALES - MUNOZ
V-11	MUNOZ - BALER RADAR
V-13	BALER RADAR - CASIGURAN
V-15	TANAY - AMBULONG
V-16	TANAY - CALAPAN
V-18	TANAY - ALABAT
V-19	TANAY - JOMALIG
V-20	TANAY -INFANTA
V-25	ROMBLON (Mt) - MASBATE
V-26	ROMBLON (Mt) - SAN FRANCISCO
V-29	TACLOBAN - GUIUAN RADAR

(ii) Radio propagation test

Schedule of VHF radio wave propagation test is shown in Table 3.11, (1/2) - (2/2).

A. Purpose of propagation test

The propagation test was actually performed by transmitting a radiowave in order to check whether the estimated link values are valid or not. The measured values obtained from the test, the additional loss of which is modified, will form reference data when the transmission power required for the link, the types of antennae to be used, and the heights above sea level of the antennae are finally determined.

B. Propagation test items

a. Directional pattern of antenna

b. Antenna height pattern

c. Signal-to-noise ratio with the radio equipment for propagation test

d. Receiving input voltage

e. Fading (if it occurs frequently)

The equipments used for the propagation test are listed in Table 3.12.

C. Results of propagation test

The antenna height pattern obtained from the propagation test is shown in Appendix (Fig. A.9, (1/36) - (36/36)), the antenna rotation pattern in Appendix (Fig. A.10, (1/38) - (38/38)), the basic propagation loss and the S/N in Table 3.13, and the link level diagram in Appendix (Table A.3, (1/16) - (16/16)).

(iii) Analysis and evaluation

A. Analysis of propagation test results

The comparison between the measured values obtained from the propagation test and the estimated link design values has revealed that for most links, the difference in basic propagation loss is within a few decibels. For some links, however, the difference is about 10 dB. We consider that this is due to the discrepancy between the actual geographical features and the predetermined terrain profile because:

a. The geographical configurations printed on some maps we used were incomplete.

b. For some areas, maps on a scale of 1 to 250,000 were used, because maps on a scale of 1 to 50,000 were not available.

Some portions of the profile were left blank, because the related maps were not available.

c. Some data indicating the location (longitude/latitude) and height above sea level of the observation station were not sufficiently detailed. Other data were considered to be misprinted.

B. Evaluation of results

The results of the propagation test showed 15 links with a S/N of 40 dB or more and one link with the S/N of 20 to 30 dB. It is considered technically possible to establish 2-channel multiplex radio communication links along the routes with the S/N of 40 dB or more. Fading was not noticeable for each route.

(4) HF communication system

(i) Radiowave propagation test

A. Methods of test

At present, data collection and dissemination are performed between PAGASA and each weather station via the HF-SSB link. The late propagation test was performed by selecting the following routes in order to check the state of communication via the HF link and to obtain the data used to estimate the radio propagation state of the planned HF links. The test was performed as follows: The error rate and the time required for communication were fixed on the reception records obtained by transmitting and receiving test messages. The propagation state was checked by rating the levels of QSA (signal strength), QRN (disturbance due to noise), and QRM (interference) with 5-grade figures. Since the equipment currently operated for data collection and dissemination was used for the propagation test, the test was carefully made to give as lesser effect on the operations as possible. A single day of the propagation test to each terminal weather station was assigned and the test was performed twice: 0900 GMT and 2100 GMT.

The equipment used was the existing equipment, and the directional pattern and height of antenna was not always optimum for the opposite station.

The test messages used for the test are consisted of 100 numerics and 50 alphabets to form meaningless groups of characters (see Table 3.14).

The days and routes (links) on which the tests were performed are as follows.

March 1	PFC-GUIUAN RADAR MACTAN RADAR-GUIUAN RADAR
March 2	PFC-TACLOBAN MACTAN RADAR-TACLOBAN
March 3	PFC-SAN JOSE MINDORO MACTAN RADAR-SAN JOSE MINDORO
March 4	PFC-PUERTO PRINCESA MACTAN RADAR-PTO. PRINCESA
March 5	PFC-ILOILO MACTAN RADAR-ILOILO
March 6	PFC-DAVAO MACTAN RADAR-DAVAO

March 7 PFC-ZAMBOANGA
CAGAYAN DE ORO-ZAMBOANGA

B. Results of propagation test

The propagation test results (reception record paper and communication state) were reported from observation stations, and checked against transmission records to obtain the reception error rate. The time required for communication and the communication state were also checked and totalized. These test results are shown in Table 3.16, (1/2) - (2/2). Explanation of the Q Code is shown in Table 3.15.

(ii) Analysis and assessment

A. Analysis of propagation test results

a. As shown in the table of test results, the HF communication is not under good conditions; particularly, the communication state in the 2100 GMT time zone is put in very bad. These communication conditions do not occur accidentally during the late propagation test, but are in an almost steady state, judging from the data obtained in other investigations.

b. The weak receiving power of radiowave depends mainly on the only use of a single frequency of the 7 MHz band. Since the propagation of HF-band radiowave greatly depends upon the electron density and its variation in height in the ionosphere, the operating frequency shall be generally changed according to these factors. Unfortunately, this frequency-changing operation is not performed in all the HF weather stations.

c. It is natural that interference occurs when many weather stations make communication through the same frequency. Therefore it is necessary to use different frequencies in every local area.

d. It is also considered that the directional pattern of the operating antenna or its radio radiation angle (also depending on the antenna height) is not set in the right way. However, in the case that the station has to communicate with many other stations, these factors cannot always be satisfied for all the other stations.

e. The HF propagation test must be performed under various conditions with parameters such as the time of day, season, the number of sunspots, communication coverage, and frequency to be used.

The test carried out this time, however, satisfied almost none of these required conditions, and then could provide no sufficient data.

B. Evaluation of transmission system

It is considered that the present data transmission system through voice calls poses many problems about the amount of data that can be transmitted, the time required for communication, and the labor required for operation.

Since HF communication is primarily susceptible to disturbances including noise and interference, some counter-measures must be taken to reduce these disturbances (e.g., by using a directional antenna or by avoiding reception at a place where much urban noise occurs) while the use of a transmission system withstanding these disturbances (e.g., a teletype communication system with an ARQ equipment or a facsimile communication system) must be examined.

C. Calculation of electric field intensity with computer simulation

The results of calculation of HF electric field intensities under various conditions provided by the computer simulation are shown in Appendix (Table A.4, (1/40) - (40/40)). Though S/N cannot be given as a numeric figure because noise was not included in the conditions for the calculation, it is estimated that communication is possible if the electric field intensity exceeds 10 dBμ, and that a desired state of communication can be attained if the field intensity is more than 20 dBμ.

(5) Overall evaluation of each communication system

Based on the results presented in the previous sections, the overall evaluation of these links is summarized as follows:

(i) For each OH link, the measured values were almost equal to the estimated basic propagation loss.

Therefore, it is considered that the links can be established along the pre-planned routes. However, counter-measures must be taken to reduce fading for long communication links.

(ii) For some VHF links, the difference between the estimated basic propagation loss and the measured value was about 10 dB. This is considered to have resulted from errors in the preparation of terrain profiles. Besides one link, all other links subjected to the propagation test are considered to provide the desired communication quality and reliability.

(iii) Though quantitative results could not be obtained from the propagation tests of these HF links because the existing facilities were used, it is concluded that the antennae to be used must be improved and the number of operating frequencies of radiowave must be increased to maintain the desired communication quality and reliability.

From the above discussion, a conclusion is drawn that a meteorological communication system organically connecting each type of radio communication link can be implemented and put into practice.

3.2 Present Situation of Weather Observation Network and Forecast Services

3.2.1. Site Survey

The study team carried out the site survey for every weather station for the purpose of implementating the project. The results of site survey are described below.

Meteorological observations are carried out at 64 stations located in various parts of the Philippines, with 10 stations for weather radar observation, 10 for upper air observation, 7 for aeronautical observation, 8 for seismological purpose and 3 for marine meteorological observation. The receiving station MDUS (Medium Data Utilization Station) installed at Typhoon Moderation Research and Development office (TMRDO) Building is operated to receive the pictures transmitted from the Geostational Meteorological Satellite (GMS) of Japan.

(1) PAGASA Central Office (PCO)

The PCO carries out extensive activities including weather forecasts, warnings/bulletin, observations, statistics, seismology, flood forecasts/advisories and warning, and training etc. Research works are also being undertaken. In addition, an experimental field on Agro-Meteorology is provided at the SCIENCE GARDEN where the measurements of micro-meteorological observation and the measurement of long/short wave radiation are also made.

(2) Weather station

A site survey was performed in almost all weather stations to investigate the station buildings, observation instruments, facilities, and access roads to the stations. The sketch maps for selected stations are shown in Appendix (Fig. A.11, (1/86) - (86/86)), while the photographs of representative stations are shown in Appendix (Fig. A.12, (1/3) - (3/3)).

3.2.2. Meteorological Observations

The meteorological observation includes surface observation, upper-air observation, weather radar observation, and aeronautical weather observation.

(1) Observation programme

(i) Surface meteorological observation

The fundamental weather elements such as atmospheric pressure, air temperature, wind, rainfall, relative humidity, visibility and cloud etc are observed every three hours (00Z through 21Z).

(ii) Upper air observation

These include radiosonde/rawin observations and pilot balloon observations. It is performed every 6 hours, four times (00Z through 18Z) a day.

(iii) Weather radar observation

Routine observation is performed eight times (00Z through 21Z) a day. In addition, extra observation is performed under the direction of the PFC when typhoons come near the country.

(iv) Aeronautical weather observation

These are carried out at the Manila International Airport (MIA) and local airport weather stations outside the Metro Manila Area.

A. MIA

MIA carries out synoptic surface and aeronautical weather observation at intervals of one hour. Special observations are carried out when certain weather elements affect airport operations, e.g. beginning and ending of thunderstorm and rain, changes in visibility ranges, cloud heights, wind direction and speed changes, gustiness, etc.

B. Local airport weather stations

Besides synoptic surface meteorological observations being carried out eight times a day, extra observations are carried out for aircraft take off and landing operations.

(v) Marine meteorological observation

At the Manila Port Meteorological Office, aside from synoptic weather observations, the sea water temperature, swell tide levels, wave height and direction are also observed every three hours.

(iv) Seismological observation

Seismic equipment paper is changed every day/week. Whenever a tremor occurs, a report is sent to the PFC in the form of an earthquake bulletin.

(vii) MDUS

Eight times (00Z through 21Z) a day: visible and/or infra-red observations.

(2) Observation instruments

(i) Instruments specific to each type of observation

Table 3.17 shows the table of classification of instruments used generally for observation including the surface meteorological observation, upper-air observation, radar weather observation, and seismological observation.

(ii) Instruments used at each weather station
(Mainly for surface meteorological observation)

The instruments used at each station are shown in Table 3.18, (1/5) - (5/5).

As indicated in the table, the instrument models used particularly for surface weather observation have been diversified. Most of them have been used for more than ten years. They cannot be repaired because spare parts are not available in the market or not manufactured any more. Procurement of new equipment is difficult due to budgetary realities.

3.2.3. Weather Forecasting Services

The forecasting work includes the collection of meteorological data, map plotting and analyses, prognoses and weather forecasts and bulletins, the preparation of various types of meteorological information and the dissemination of weather forecast and information to local weather stations as well as to the public and mass media.

(1) Collection of meteorological data

The NWO (National Weather Office) at PAGASA obtains the observed meteorological data from the surface observation stations and weather radar observation stations via the SSB multiplex radio communication link, and the necessary meteorological data from foreign countries via the GTS communication link (Fig.3.9).

The Forecasting Division of the NWC analyzes the above data to make weather charts.

(2) Data analysis

The following data are prepared for weather forecasting analysis.

(i) Surface weather charts every 6 hrs (00, 06, 12, and 18Z) and upper-air weather charts (for five layers at 850, 700, 500, 300, and 200mb) at 00Z and 12Z.

(ii) Auxiliary charts

A. 24 HR-Issalobaric charts every 6 hrs at selected grid points

B. 24 HR rainfall distribution charts

C. Cross-section chart

(Clark Field, LAOAG, MACTAN, Guam, Truck Is., Yap Is., Ishigaki Is., Naha)

D. Surface charts at every intermediate times (03, 09, 15 and 21Z)

(iii) Other data

Pictures from the GMS are received at the MDUS. If there is a breakdown of the GMS receiving station, facsimile of satellite picture and interpretation are intercepted from Japan.

(3) Meteological information and period of issuance.

A. Public forecast: 4:30 am, 9:30 am and 3:30 pm.

B. Typhoon information: every 6 hrs at 5 am, 11 am, 5 pm and 11 pm, if a tropical cyclone is within the PAR, (More often if Metro Manila and other big cities are threatened.)

C. Flood warning and/or advisory: 2 times a day at 8 am and 8 pm.

D. 3 days weather outlook: every Monday, Wednesday and Friday.

E. Special weather forecast: by request.

F. Shipping forecasts: every 5 am and 5 pm.

G. Airway and terminal forecasts for domestic aviation: any time.

H. Flight documentation for outgoing international aircraft: any time.

I. SIGMET information within the Flight Information Region (FIR).

(4) Dissemination of weather forecasts and other meteorological information

The method for dissemination of the meteorological information prepared at PAGASA is shown in Fig. 3.10. The information is disseminated to the general public and the institutions that are requiring them.

(i) To the public, the weather information is disseminated through radios, TVs, and newspapers. In big cities such as Manila and Quezon, however, the weather forecast and meteorological information are disseminated to the OCD's disaster prevention service twice per day at 8 am and at 5 pm.

At small local cities, weather stations receive the meteorological information from the PFC via the SSB communication link, and transmit the information to news organs and local government officers through telephone directly or by messengers. When a typhoon exists or approaches, bulletins/warnings and other related information are rapidly disseminated to the related services and agencies. There are predetermined Storm Warning Signals of three categories in accordance with the storm strength, and a siren is sounded to inform the public in case of emergency. The criteria for Warnings are shown in Fig. 3.11.

(ii) For ships and airplanes

For ships and airplanes, the information required for safe navigation is transmitted to the related services through the coastal radio stations and as SIGMETS by the Bureau of Air Transportation (BAT).

3.2.4. Analysis and Evaluations

(1) Observing instruments

(i) As shown in Table 3.18, various instrument models are used particularly for the surface meteorological observations, and some of them are very old. To improve the precision of observation, it is desirable to employ a better system, like new or modern instruments as required by the WMO regulations in the future.

(ii) Timely transmission of the data obtained from weather radars is not readily made to the PFC.

(iii) While the upper-air observation data ranging from Part 1 to Part 4 must be reported according to the WMO regulation, the data actually transmitted via the GTS communication link are only up to Part 2. This can not be avoided with the present communication situation.

(2) Weather forecasting

The dissemination of weather forecasts and other meteorological information to local areas must be made more promptly. Whether in the event of a disaster or in normal conditions, the meteorological information should be kept on track of the changing meteorological phenomena and must be disseminated further to wider ranges of areas and purposes.

4. Outline of the Project

4.1 Definition of the Project

As already described in Chapters 1 and 2, this feasibility study is designed to provide a plan of establishing the meteorological telecommunication network covering the Luzon, Visayas and Mindanao regions. The aim of the Project, based on the study, is to establish a meteorological telecommunication system that allows the quick and accurate collection of meteorological observation data from each weather station, and the dissemination of various kinds of meteorological information, which are made after the processing and analysis of collected data, to each weather station.

Fig. 2.8 shows the location of weather stations in the Philippines.

4.2 Configuration of Meteorological Telecommunication System

4.2.1 Meteorological Telecommunication System

(1) Total system

The total system of the meteorological telecommunication network in the Philippines is shown in Fig. 4.1. This total system consists of 64 weather stations, each of which is connected to each other through a main trunk and branch lines in order to transmit meteorological data from local weather stations to the PFC in Manila and

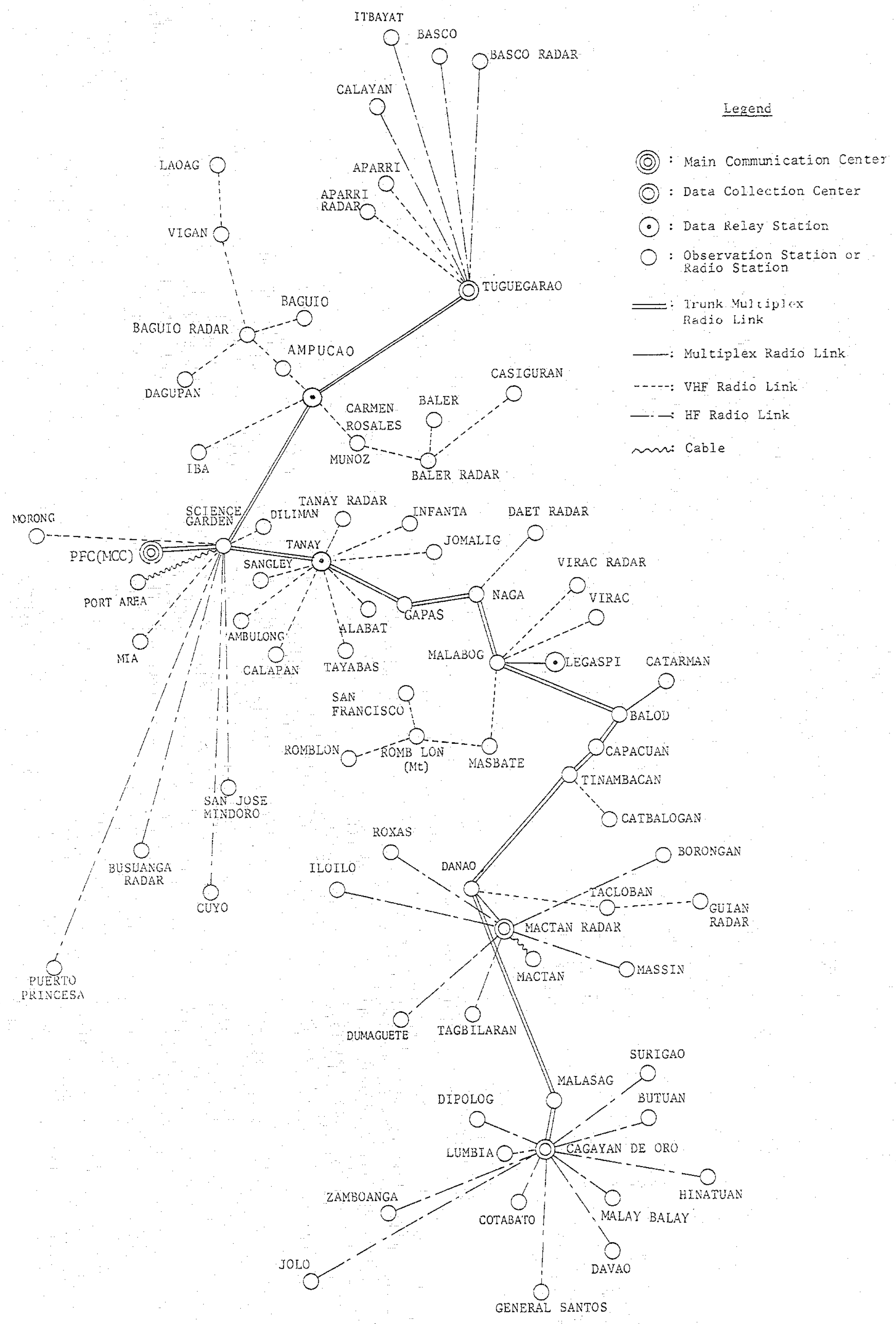


Fig. 4.1 Meteorological Radio Communication System

disseminate various meteorological informations, which are made after the processing and analysis of the collected data at the PFC, to each weather station.

The main trunk is about 1,300 km in total length between TUGUEGARAO in the northern part of Luzon and CAGAYAN DE ORO in Mindanao and links 3 DCCs (Data Collection Centers), 3 DRSs (Data Relay Stations) and 8 relay weather stations to the PFC.

The Main Communication Center (MCC) in Manila plays a central role in the collection and distribution of meteorological data, and provides analysis/processing services of the collected data using mini-computers, which is mentioned later (See subsection 4.2.2.).

DCCs and DRSs are responsible for the relaying services of data collection/dissemination from and to their related weather stations through individual branch links. DCCs are always attended by operators to answer economic and social needs, particularly in case of emergency, while DRSs automatically provide data collection/dissemination service.

This system is designed so as to use in common the existing link of FFWS (Flood Forecasting and Warning System) between TUGUEGARAO in the northern part of Luzon and NAGA in the Bical region. Therefore, a new trunk line should be constructed as an extention for the section between NAGA and CAGAYAN DE ORO in Mindanao.

(2) Main trunk system

The main trunk system consists of lines of connecting the following stations from the northern part of Luzon to Mindanao via Manila:

		Remarks
TUGUEGARAO	(DCC)	
CARMEN ROSALES	(DRS)	
SCIENCE GARDEN		
PFC	(MCC)	
TANAY	(DRS)	
GAPAS		
NAGA		
MALABOG		(LEGASPI) (DRS)
BALOD		(CATARMAN)
CAPACUAN	(Passive relay site)	
TINAMBACAN		
DANAO		MACTAN RADAR (DCC)
MALASAG		
CAGAYAN DE ORO	(DCC)	

(i) Trunk lines will principally be available for the construction of an OH multiplex transmission system with a 800 MHz band.

(ii) The trunk system is composed of independent data dissemination channels, connected directly to DCCs and DRSs, and telephone channels using lines of the facsimile distribution system in common. Each channel is of the full duplex type.

(3) Branch networks

(i) Branch networks are connected to DCCs or DRSs, excepting that some branch lines are directly connected to SCIENCE GARDEN.

(ii) Branch networks are composed of VHF (150 MHz band) or HF band (SSB).

(iii) VHF branch networks are of the full duplex type and each of their terminal stations has two radio frequencies; a specified one for data dissemination, and the other for telephone channels using in common the facsimile system.

(iv) HF branch networks are of the half-duplex telecommunication type, but in case of using a teletype equipment with ARQ (automatic repeat request system), digital data transmission is made possible.

(v) Weather radar stations in HF branch networks are to be equipped with facsimiles.

(vi) The SSB transmitting/receiving station in SCIENCE GARDEN is to provide back up links with weather stations equipped with SSB during times when the main system is out of order.

4.2.2 Controlling Equipment of Telecommunication

Two mini-computers (one for extra use) are to be installed in the MCC to control the collection/dissemination of data over the trunk lines and to edit/compile them. The reserved mini-computer may be used to process the data received from local weather stations and compile statistical data, including monthly and annual reports and others.

4.2.3 Stand-by Power Supply

(1) Each station related to the main trunk uses commercial power to facilitate a 24-hour operation. Then, it should be equipped with a backup power source activated by an automatic switching in cases of power suspension.

(2) Each station related to the branch network is not always expected to be operated on a 24-hour basis. If commercial power is not available, an independent power generator or batteries should be provided. A solar cell is also planned to be used on two sites, one is AMPUCAO and the other in ROMBLON (Mt).

4.2.4 Observation Instruments

(1) Updating for most of meteorological instruments currently in use is very necessary and PAGASA strongly hopes this will be done.

(2) The results of the Site Survey suggest that about one-third of the instruments should be replaced.

(3) Instruments to be updated are wind vanes, anemometers, self-recording rain gauges, psychrometers, pyranometers, Fortin barometers, panzer masts, etc.

4.3 Operation and Maintenance

4.3.1 Operational System

The effectiveness should be principally ensured on the basis of the following items:

(1) Intensified organization and well-defined management
(2) Adequate budget support
(3) Well-directed placement of personnel
(4) Improvement of personal performance by well-timed training and others.

The results of examination based on the above fundamental concept are presented in Chapter 6 in detail.

4.3.2 Maintenance System

As to the maintenance system, the reliability should be principally ensured on the basis of the following items:

(1) Introduction of the conception of reliability-oriented engineering

(2) Establishment of maintenance procedures to secure regular inspections and repairs
(3) Intensification of maintenance system (including the establishment of repair centers)
(4) Security of qualified maintenance operator and improvement of personal performance

The results of examination based on the above fundamental concept are present in Chapter 6 in detail.

5. Preliminary Design of the Project

5.1 Fundamental Concepts of Preliminary Design

5.1.1 Objective of Preliminary Design

Field studies and subsequent analyses clarified that it was necessary to consolidate equipment and facilities for meteorological observation, telecommunication and data processing and to establish the system of operation and maintenance so that the meteorological operations prescribed by the WMO regulations can be fully implemented.

This chapter deals with the preliminary design of the system which covers all the necessary hardware and software to be in line with the WMO regulations so that the feasibility of this project can be confirmed and rough technological specifications required for the execution of this project can be clarified.

5.1.2 Preconditions of Preliminary Design

In preparation for the preliminary design, the following items were taken into consideration.

(1) (Minimum) standards of the preliminary design shall be in conformity with the WMO regulations*.

(2) Technological levels both at present and at time of operations shall be taken into consideration.

* Manual on the Global Telecommunication System

(3) Rational meteorological operations and long-term, stable maintenance shall be taken into account so as to realize actual implementation.

5.1.3 Scope of Preliminary Design

The preliminary design is classified into two major categories; one is relevant to such as equipment and facilities, and the other to systems to operate such hardware. The scope of each category is as follows:

(1) Preliminary design of hardware

(i) Meteorological observation equipment
(ii) Facilities and equipment related to the meteorological telecommunication systems and their incidental facilities
(iii) Civil engineering works related to meteorological telecommunication facilities

(2) Preliminary design of operational system

(i) Meteorological data transmission system
(ii) Editing, processing and statistical compiling system for meteorological data
(iii) Dissemination system of meteorological information
(iv) Operation system of facilities
(v) Maintenance system of facilities

5.2 Design of Meteorological Telecommunication System

5.2.1 Designing Condition

(1) Volume of data to be transmitted and required time

(i) Data collection

Three kinds of data, AN data, picture data, and communication messages are presented as follows:

A. Meteorological observation data

(a)	Surface observation	3-hour intervals
(b)	Upper air observation	4 times daily
(c)	Radar observation data	8 times daily picture mode (facsimile) or AN mode
(d)	Other meteorological information	anytime AN mode

B. Emergency information such as that relating to earthquakes and volcanic eruptions — anytime AN mode

C. Business communication telephone calls — anytime

(ii) Data dissemination

Kinds of data dissemination are divided into three, AN data, picture data and communication messages.

A. Information related to weather forecast

a.	Weather forecast	several times daily AN mode
b.	Warning/bulletins and precautionary measure	anytime AN mode
c.	Other meteorological information	anytime AN mode
d.	Weather chart	several times daily picture mode
e.	Radar echo picture	anytime picture mode
f.	GMS picture	several times daily picture mode

B.	Emergency information such as that relating to earthquakes and volcanic eruptions	anytime AN mode
C.	Business communication telephone calls	anytime

(iii) Required transmission time

A. AN mode

The required time is aimed to be within 15 minutes from the start of the observation to the completion of the data transmission.

B. Picture mode

About 3 minutes per one picture (G-II mode)

About 10 minutes per one picture (G-I mode)

(2) Composition of telecommunication networks and transmission quality

(i) Preconditions of network composition

A. All data observed at weather stations (64 plus future increase) shall be collected at the PFC.

B. The method to collect observation data shall be one which keeps the format of the original data as much as possible. That is, AN data shall be transmitted and collected by digital signals while picture data will be transmitted and collected by the picture mode.

C. Weather information compiled at the PFC shall be distributed to each weather station in a form and with contents suitable for the weather information supply capacity of each respective station.

(ii) Transmission quality

Required S/N are shown below.

A.	Main trunk	per link	50% link reliability about 60 dB
		overall	99.95% more than 35 dB
			more than 35 dB
B.	Branch line	VHF	more than 30 dB
		HF	more than 20 dB

(3) Outline of equipment configuration

(i) Manila area

A. SCIENCE GARDEN

a. Northern main trunk radio equipment (for CARMEN ROSALES)
b. Southern main trunk radio equipment (for TANAY)
c. Manila links (for PFC)
d. VHF transmitter/receiver
e. HF SSB transmitter/receiver and teletype terminal with ARQ
f. Intelligent terminal
g. Facsimile
h. Telephone

B. PFC

a. Manila link radio equipment (for SCIENCE GARDEN)
b. Mini-computer for communication control
c. Facsimile
d. Telephone

C. DILIMAN, MIA, MORONG

a. VHF transmitter/receiver (including speech equipment)
b. Intelligent terminal (except DILIMAN)
c. Facsimile

(ii) DCC

A. Main trunk or approach link radio equipment and terminals

B. HF SSB transmitter/receiver and teletype terminal with ARQ

C. VHF transmitter/receiver (if VHF networks are included)

D. Intelligent terminal

E. Facsimile

F. Telephone

(iii) DRS

A. Main trunk or approach link radio equipment and terminals

B. VHF transmitter/receiver (except LEGASPI)

C. Intelligent terminal (except LEGASPI)

D. Facsimile (only at LEGASPI)

E. Telephone

(iv) CATARMAN

A. Approach link radio equipment

B. Intelligent terminal

C. Facsimile

D. Telephone

(v) Relay station

A. Relay equipment

(vi) VHF branch network terminals

A. VHF transmitter/receiver (including speech equipment)

B. Intelligent terminal

C. Facsimile

(vii) HF branch network terminals

A. HF SSB transmitter/receiver (including speech equipment)
B. Teletype terminal with ARQ
C. Facsimile (at the radar station only)

(4) Teletype, facsimile and radio frequency system for details, please refer to Appendix B (*1).

5.2.2 Telecommunication System of Main Trunk

As previously mentioned, communications between the PFC and each weather station shall be conducted via DCC or DRS. Main trunks refer to the following.

. Circuit between SCIENCE GARDEN and CAGAYAN DE ORO.
. Approach link
. Jointly used section of the existing FFWS link

(1) Telecommunication route of main trunks

Fig. 5.1 illustrates the overall picture of the main trunks. Outline of each trunk is as follows.

(i) Main trunks

The line covering 9 links, SCIENCE GARDEN - TANAY - GAPAS - NEGA - MALABOG - BALOD - TINAMBACAN - DANAO - MOLASAG -

CAGAYAN DE ORO is referred to as the trunk. The total length of this main trunk is approximately 950 km.

The channel of the existing telecommunication line of the FFWS between SCIENCE GARDEN and TANAY will be expanded for use in the execution of the project.

The existing telecommunication link which provides the passive relay site of a back-to-back coupling antenna 6.7 GHz SS-FM multiplex telecommunication link will be considered to be fully utilized for this project.

As the multiplex link between TANAY and NAGA does not sufficiently provide the appropriate level of quality required to function as a meteorological telecommunications network, a new relay station will be constructed on the GAPAS site and the route should be changed to TANAY - GAPAS - NAGA. The existing 800 MHz band SS-PM frequency diversity system multiplex radio equipment used between TANAY and NAGA is similar to the multiplex telecommunication equipment proposed in the project. The plan provides for the modifications of the transmitter's channel capacity as well as the receiver's band for the purpose of using the existing equipment.

The route from NAGA - MALABOG - BALOD - TINAMBACAN - DANAO - MALASAG - CAGAYAN DE ORO will be planned and designed as a part of the project, and will cover the telecommunication from Luzon Island through Samar Island via Cebu Island to Mindanao Island. The route between BALOD and TINAMBACAN will use a 6.7 GHz band SS-FM multiplex radio link based on a back-to-back coupling antenna relay, while the other routes will use a multiplex telecommunication link based on an 800 MHz band SS-PM frequency or a space diversity system. The routes, which cover an extremely long distance and which are subject to interference by mountains, will be based on a design allowing use of an OH telecommunication system in order to achieve the appropriate quality of the radio link.

(ii) Approach link

The approach link refers to the routes between MALABOG and LEGASPI, BALOD and CATARMAN, and DANAO and MACTAN RADAR. These are multiplex links used as approaches to the trunk's multiplex links, and they use an 800 MHz band SS-PM standard-type multiplex telecommunication equipment. The routes of the approach links will use a relatively small-sized multiplex telecommunications link due to the short distances. Also, it is anticipated that shadow loss will be minimal.

(iii) Existing FFWS link utilization

The basic guideline for telecommunications from TUGUEGARAO (DCC) and CARMEN ROSALES (VHF link DRS for agencies such as BAGUIO RADAR) located in the northern area of Manila allows the use of existing FFWS channels. It is not necessary to add any of the existing FFWS channels.

The route between SCIENCE GARDEN and the PFC utilizes the existing FFWS system's multiplex link equipped with six 800 MHz band SS-PM channels. The basic configuration of the meteorological telecommunication network for the

PFC and each DCC and DRS makes it impossible to cover the entire telecommunication capacity by merely enhancing the channel capacity of the existing multiplex link. Thus, the route requires the installation of a radio link with a capacity of about 60 channels; the 800 MHz band SS-FM 60 channel capacity multiplex radio telecommunication line to be designed to provide good maintainability is highly economical and permits easy frequency allocation. The link will make it possible to obtain the capacity of 40 channels required for the route between SCIENCE GARDEN and the PFC. The existing equipment will be transferred to the route between LEGASPI and MALABOG for effective utilization, provided that the capacity of channel is modified and improved.

(2) Preliminary design of main trunks

Circuit shall be designed in such a manner to allow the transmission of "necessary data" in compliance to the standards proposed herein. The results of link design are shown in Table 5.1. As to the level diagram for each span, please refer to Appendix A.

(3) Trunking plan

A trunking plan for the main trunk telecommunication system is shown in Fig. 5.2. The following are the fundamental conditions for trunking plan preparations:

(i) PFC - DCC (MACTAN RADAR, CAGAYAN DE ORO), LEGASPI and SCIENCE GARDEN

2 channels	---	Call (Connected to a switching system at the PFC. Connected to a telephone set at DCC, SCIENCE GARDEN and LEGASPI.)
1 channel	---	Data (Connected to a data processing equipment.)
1 channel	---	Call with FAX and HF/VHF station (Connected to a telecommunication console.)

(ii) PFC - DCC (TUGUEGARAO) and DRS (CARMEN ROSALES and TANAY)

1 channel	---	Data. (Connected to data processing equipments at the PFC and TUGUEGARAO. Connected to a VHF equipment at DRS.)
1 channel	---	Call with FAX and HF/VHF station. (Connected to a console at the PFC and TUGUEGARAO. Connected to a VHF equipment at DRS.)

(iii) Others

The channels in other stations will be designed as follows.

A. CAGAYAN DE ORO
In addition to the 4 channels required to allow a telecommunication link with the PFC, 2 back-up channels will also be employed.

B. MACTAN RADAR

In addition to the 4 channels linking the PFC, four channels for DANAO and TINAMBACAN will be provided.

C. DANAO and TINAMBACAN

2 channels linking MACTAN RADAR will be provided for each station.

D. CATARMAN

2 channels linking LEGASPI will be provided.

E. BALOD

2 channels linking CATARMAN will be provided.

F. LEGASPI

In addition to the 4 channels required for the telecommunication link with the PFC, 2 back-up channels will be provided. Furthermore, 2 channels for CATARMAN and 2 channels for MALABOG and NAGA will be utilized.

G. MALABOG

2 channels link NAGA, BALOD (CATARMAN) and LEGASPI respectively. 6 channels in total will be provided.

H. NAGA

2 channels link MALABOG (LEGASPI) will be provided. The 6 channels of the existing FFWS will remain unchanged.

I. TANAY

2 channels linking the PFC will be provided. The one existing channel will remain unchanged.

J. TUGUEGARAO and CARMEN ROSALES

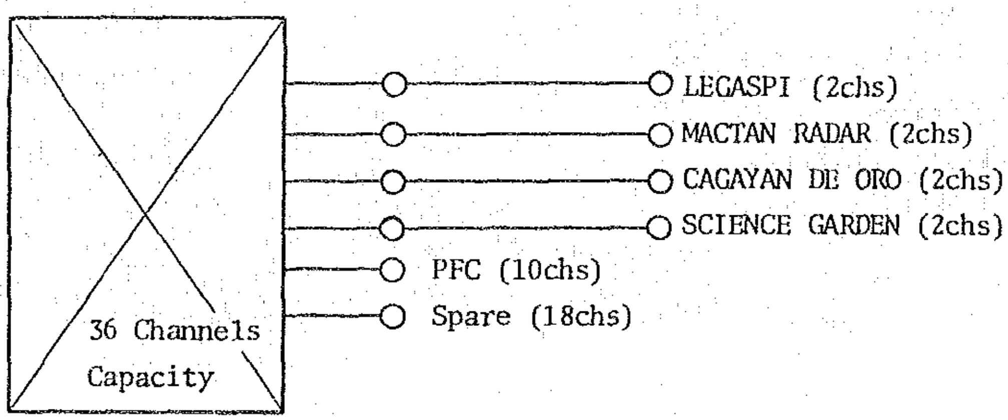
Of the channel routes of the existing FFWS, 2 channels will be utilized by each station.

K. MALASAG and GAPAS

Linkage by a base band relay.

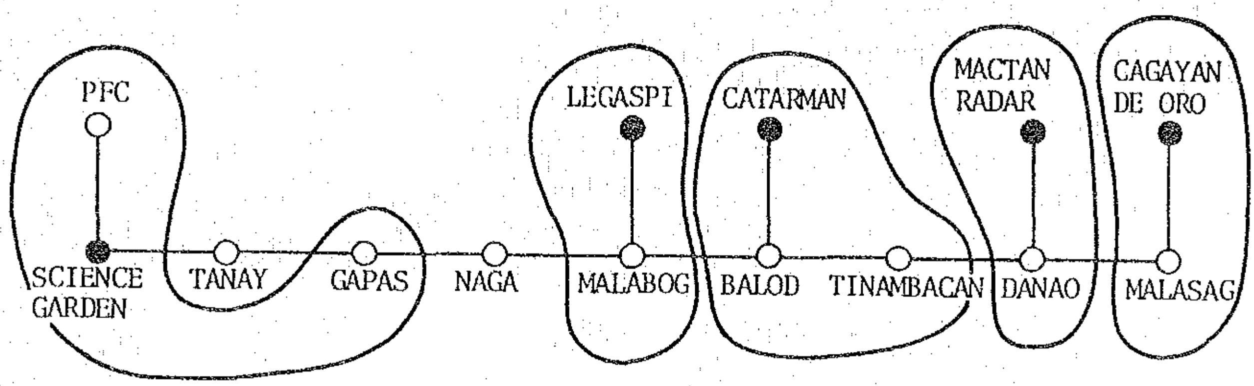
(4) Exchange

A PABX, which has the capability to accommodate 36 links, will be installed in the PFC to realize station switching. The following are the schematics:



(5) Control and monitor system

For maintenance and operational purpose, a remote control equipment should be installed in order to allow monitoring, selection and control of the telecommunications and power supply equipment of relay stations, etc., by the DCC (excluding TUGUEGARAO), LEGASPI, CATARMAN, SCIENCE GARDEN and the PFC. It seems to be the best if signals from a remote control equipment are not transmitted through a dedicated channel. Instead, part of the engineer order wire band should be used. The following are the schematics for the control and monitor system:



The black circle shows the controlling and monitoring station of each area.

(6) Telecommunication Equipments and Peripheral Facilities

As for telecommunication equipments, facilities and power generation facilities, please refer to Appendix B (*2).

5.2.3 Telecommunication System in Luzon Region

(1) Link configuration

(i) As mentioned in 5.3.2, the main trunk from TUGUEGARAO to MALABOG is being planned in the Luzon region. TUGUEGARAO (DCC), CARMEN ROSALES (DRS), and TANAY (DRS) are on this main trunk, to which LEGASPI (DRS) is connected by the multiplex approach link.

(ii) In TUGUEGARAO, 2 weather stations are connected to the main trunk via the VHF link, and 4 weather stations via the HF link.

(iii) In CARMEN ROSALES (DRS), 10 weather stations are connected to the main trunk via the VHF link. Since CARMEN ROSALES and BAGUIO RADAR cannot be connected directly by the VHF link, an unmanned relay station must be established in AMPUCAO, the middle section of the link.

(iv) In TANAY, 8 weather stations are connected to the main trunk via the VHF link.

(v) In LEGASPI (DRS), 6 weather stations are connected via MALABOG.

(vi) Since the link in SAN FRANCISCO and ROMBLON cannot be connected directly to MALABOG, it is connected to MALABOG via MASBATE by establishing an unmanned relay station in ROMBLON (Mt).

(vii) 4 weather stations (SAN JOSE MINDORO, BUSUANGA RADAR, CUTYO and PTO. PRINCESA) are connected to SCIENCE GARDEN via the HF link. Besides SCIENCE GARDEN is the back-up station for DCC link failure. In order to perform new services as mentioned above, a new office building (100 m^2 in area) should be established at SCIENCE GARDEN.

(viii) 3 stations (MORONG, DILIMAN and MIA) are connected to SCIENCE GARDEN by the VHF link.

The route for the Luzon region telecommunication system is shown in Fig. 4.1.

(2) Telecommunication equipments and peripheral facilities

As for telecommunication equipments, facilities and power generation facilities, please refer to Appendix B (*3).

5.2.4 Telecommunication System in Visayas Region

(1) Link configuration

(i) As described in 5.2.2, the main trunk from BALOD to DANAO is planned in the Visayas.

(ii) MACTAN RADAR (DCC) is connected to the main trunk at DANAO via the multiplex approach link.

(iii) To MACTAN RADAR (DCC), 3 weather stations are connected via the VHF link through DANAO, and 6 stations are connected via the HF link.

The route for the Visayas region telecommunication system is shown in Fig. 4.1.

(2) Telecommunication equipments and peripheral facilities

As for telecommunication equipments, facilities and power generation facilities, please refer to Appendix B (*3).

5.2.5 Telecommunication Systems in Mindanao Region

(1) Link configuration

(i) In the Mindanao region, the main trunk from MALASAG to CAGAYAN DE ORO are planned.

(ii) To CAGAYAN DE ORO (DCC), a weather station is connected by the VHF link, and 10 weather stations by the HF link.

The route for the Mindanao region telecommunication system is shown in Fig. 4.1.

(2) Telecommunication equipments and peripheral facilities

As for telecommunication equipments, facilities and power generation facilities, please refer to Appendix B (*3).

5.2.6 Telecommunications Controlling System in the PFC

By preparing this new meteorological telecommunication network, various weather data accumulated from throughout the country will be immediately available to the PFC. Also, these data can be relayed, edited, and distributed to the required locations.

The GTS links serve as the overseas telecommunication medium, exchanging weather data with TOKYO and SINGAPORE. The daily data volume obtained from TOKYO reaches approximately 600,000 characters.

Under these circumstances, a telecommunication control system using mini-computers is to be introduced to the PFC to accumulate, distribute, and supply weather data through an on-line real-time system.

The telecommunication control system is presented in detail in Appendix B(*4) in terms of its functions, configuration and data processing.

5.2.7 Radio Frequency Plan

(1) On the secure of radio wave frequencies

Radio wave frequencies which are required for the implementation of meteorological telecommunication system are shown as follows:

Main trunk and approach link

UHF band	(800 MHz)
SHF band	(6.7 GHz)

Branch link

VHF band	(150 MHz)
HF band	(3---12 MHz)

The radio wave frequency band to be used plays a very important role for the design of telecommunication system. If there exist big differences between a requested frequency band and a real allocated frequency band, it will affect not only the constitution of antenna tower but also the whole design of telecommunication network. The allocated radio wave frequency bands to PAGASA are shown as follow;

HF Band	(2---11 MHz)	9 waves	For meteorological data collection
VHF	(130---140 MHz)	4 "	
UHF	(400 MHz)	2 "	For flood forecasting
UHF	(800--900MHz)	12 "	operation
SHF	(6.7 GHz)	2 "	
VHF	(130---170 MHz)	13 "	
UHF	(700---900 MHz)	16 "	For dam operation
UHF	(2 GHz)	2 "	
SHF	(6.7 GHz)	4 "	

Even if all the above-mentioned frequency bands were used for the new telecommunication network, it is still not enough for meeting the demands of the new telecommunication network, because it is likely to lead to the mutual interference. Therefore, it is required to get newly allocated frequencies (refered to sub section (2)---(4)), each of which is kept out of mutual interferences.

PAGASA should be negotiated with the National Telecommunication Commission (NTC) and other agencies concerned, in order to secure the allocation of the above radio-wave frequency bands.

(2) Multiplex link

(i) UHF link (800 MHz)

TAMAU	- GAPAS	2 pairs	(Frequency
GAPAS	- NAGA	2 pairs	Diversity)
NAGA	- MALABOG	2 pairs	
MALABOG	- BALOD	1 pair	
TINAMBACAN	- DANAO	1 pair	
DANAO	- MALASAG	1 pair	

SCIENCE GARDEN	- PFC	1 pair	
MALASAG	- CAGAYAN DE ORO		
DANAO	- MACTAN RADAR	1 pair	(Commonly
MALABOG	- LEGASPI		use for
BALOD	- CATARMAN		4 links)

The UHF band frequencies are required 11 pairs, namely 22 waves.

Frequency separation between transmitting and receiving should be about 130 -- 60 MHz. In case of frequency diversity system, two transmitting frequencies should be separated more than about 10 MHz.

(ii) SHF link (6.7 GHz)

BALOD	- TINAMBACAN	1 pair

The SHF band frequencies requires 2 waves.

Frequency separation between transmitting and receiving should be about 150 MHz.

(3) VHF link

A 150 MHz band is used for the VHF link. Since two full duplex single links are used for the weather stations, two frequencies for sending and two frequencies for receiving, namely four frequencies are used in total. There are 44 weather stations and relay stations in Luzon, Visayas, and Mindanao. Since the remote stations can employ the same frequency because of the nonexistence of interference, all the VHF links can be established with 24 frequencies. The allocation plan for 24 frequencies is presented in Fig. 5.3. Plan of Frequency Allotment (VHF) is shown in Fig. 5.4.

(4) HF link

The span of HF link must be within 80 - 600 km. In addition, in order to enable 24-hours communications, one frequency of 3 MHz band (3-4 MHz), one of 7 MHz band (6-8 MHz) and one of 10 MHz band (9-12 MHz), depending on the operating time and season, must be provided for each station. When there is poor communication, preferably the weather station can communicate with other stations. For this, the frequency plan is shown below.

. TUGUEGARAO (DCC) and its weather stations;

Frequency for TUGUEGARAO:	3T, 7T, 10T	6 fre-
Frequency for SCIENCE GARDEN	3S, 7S, 10S	quencies
		in total

where the numeric character represents the frequency band and the alphabetic represents the first character of DDC or SCIENCE GARDEN.

Frequency for SCIENCE GARDEN	3S, 7S, 10S	3 fre-
		quencies

. Weather stations link to SCIENCE GARDEN.

Frequency for SCIENCE GARDEN	3S, 7S, 10S	6 fre-
Frequency for MACTAN RADAR	3M, 7M, 10M	quencies
		in total

. MACTAN RADAR (DCC) and its weather stations:

Frequency for MACTAN RADAR	3M, 7M, 10M	6 fre-
Frequency for SCIENCE GARDEN	3S, 7S, 10S	quencies
		in total

. CAGAYAN DE ORO (DCC) and its weather stations:

Frequency for CAGAYAN DE ORO	3C, 7C, 10C	7 fre-
Frequency for MACTAN RADAR	7M, 10M	quencies
Frequency for SCIENCE GARDEN	7S, 10S	in total

Number of the frequencies in use are 12 in total.
The frequency allocating conditions are as follows:

Frequency interval among 3T, 3S, 3M, and 3C:
10 KHz - 150 KHz
Frequency interval among 7T, 7S, 7M, and 7C:
10 KHz - 350 KHz
Frequency interval among 10T, 10S, 10M, and 10C:
10 KHz - 500 KHz

5.3 Design of Meteorological Observation Services

5.3.1 Updating of Meteorological Observation Instruments

Every country has recently shown a tendency to modernize its meteorological observation facilities. In the Republic of the Philippines, however, rapid modernization is not possible because of its bad power supply and communication conditions. We considered, therefore, the updating of instruments at 23 stations, mostly located in the Principal Land Stations.

Besides, it was newly planned to arrange pyranometers at the selected 15 stations, according to the request of PAGASA.

The names of instruments for each stations, which are scheduled to be updated, are shown in Table 5.2, (1/2), and the names of stations to be installed with additional instruments are shown in Table 5.2, (2/2).

The names, standards, and measurement precision of the instruments to be updated are shown in Table 5.3. The exterior view of these instruments are given in Appendix (Fig. B.31).

6. Operation and Maintenance System

6.1 Operation System

6.1.1 Intensification of Operation System

Each of MCC, DCC and SCIENCE GARDEN should be intensified to improve its performance.

Since the operation system will be a 24 hour operation, 3-shift-a-day system including members in charge of meteorological telecommunication will be required.

It is enforced to bring up the operators with comprehensive training and so on. Particularly as most officers of PAGASA are meteorological experts who are generally expected to serve both observation and telecommunication, it is important to promote them with practical training.

6.1.2 Security of Operator

The operators to be secure are needed as follows.

(1) PFC: 13 persons in total with a supervisor and with 4 groups under 3-shift-a-day system will be required. The composition of 3 operators in each group will be 2 communication operators and one computer operator.

(2) DCCs (3 stations) and SCIENCE GARDEN:

9 operators in total with a chief and with 4 groups (2 operators in each group) under 3-shift-a-day system will be required.

(3) Other stations: 5 operators with a chief and with 4 groups (one operator in each group) under 3-shift-a-day system will be required.

These operators will be also in charge of observation.

6.2 Maintenance System

6.2.1 Intensification of Maintenance Organization

In the PCO, the division in charge of maintenance and repair should be intensified. For this purpose, a Repair Center should be set up at DILIMAN.

The DCCs and DRS (except TANAY) should be intensified by assigning technical engineers who are in charge of maintenance and minor repairs at the attached weather stations.

The above-mentioned divisions should be equipped with various tools for the maintenance of meteorological services, including meters, spare parts and materials, and also provided with a service car for mobile maintenance.

6.2.2 Security of Maintenance Workers

In order to ensure smooth operation, it is inevitable to maintain a sufficient level of performance of various kinds of equipments concerned in meteorological services. The security of persons is a key factor for keeping appropriate maintenance.

Maintenance workers must regularly inspect the used equipments on basis of predetermined procedures for the purpose of detecting possible causes of failure and take necessary action.

Each of DCCs (3 stations), DRSs (2 stations except TANAY) and SCIENCE GARDEN will require one maintenance worker, and the PFC will require three. The work for the Repair Center needs 5 personnel.

Training for these workers will be classified into two; one is carried out on a contract basis and the other on an official time basis.

In order to cope with increased demands for workers upon the commencement of the operation of new facilities, advanced training facilities and sufficient staff members should be provided. In the tests, adjustments and others during the implementation of this Project, arrangements should be made to realize the active participation of numerous field workers. This will give opportunities for them to become familiar with the relevant operational techniques and to smoothly take over the administrative responsibilities for maintaining and operating the new equipment.

6.2.3 Repair Center

Maintenance workers should be responsible for the maintenance of the system, but not for the repair of equipment related to the system. Malfunctioning equipments should be in principle repaired at a repair center, which will be newly established in DILIMAN. Mobile service will also be provided for certain equipment which is immobile or to be transported.

The repair center should keep a continuous supply of spare parts, materials and expendables to be managed in the maintenance of the total system in a unified manner.

6.3 Feasibility of General Operation

To eliminate waste due to disintegrated operations, all operators should be generally familiar with meteorological observation instruments, communication equipment and electronics to realize integrated operation. Then, official training and technical guidance given in on-job-training should be intensified.

A list of training courses is shown in Table 6.1, and the needed personnel plan for operation and maintenance in Table 6.2.

7. Cost Estimate

7.1 General

The direct cost of the Project was estimated by CIF-at-site bases based on the price level in June, 1984. The direct cost does not include any kind of tax and duty and was considered to be economic cost of the Project. Engineering and administration cost and physical contingency were assumed at 10% each of the total direct cost respectively. In obtaining the total project cost (financial cost), annual inflation of 2% for foreign currency and 15% for local currency were assumed. The exchange rate applied were: US$1 = ₱18.002 = ¥237.50, ₱1 = ¥13.19.

7.2 Cost Estimation of the Project

The estimated cost of the Project is shown in Table 7.1, (1/2) - (2/2) and is classified into foreign and local currencies in Table 7.2.

The renewal and newly establishment of the meteorological instrument was planned for the weather stations shown in Table 5.2 and its cost was estimated as shown in Table 7.3.

7.3 Operation and Maintenance Cost and Training Cost

The operation and maintenance cost was estimated at 3% of the total project cost excluding construction works, commercial power facilities and transportation costs. The operation and maintenance cost will cover annual expenditures for maintenance materials and spare parts and inspection costs.

The operation and maintenance cost was estimated as shown below.

$$(255.198 - 49.577) \times 0.03 = 6,169 \ (₱10^3)$$

The training cost was estimated as shown below.

Training cost of hardware	5.825
Training cost of software	3.732
Total	9.557 (₱10^3)

Table 7.1 (1/2)

Cost Estimation

Unit: ₱10^3

Items	Luzon Area			Visayas & Mindanao Area			Total		
	*1 F	*1 L	Total	F	L	Total	F	L	Total
OH equipment	(7)*3 31,016		31,016	(8) 34,011		34,011	65,027		65,027
Improvement of OH equipment	(3) 3,548		3,548				3,548		3,548
VHF equipment	(37) 15,000		15,000	(7) 2,646		2,646	17,646		17,646
HF equipment	(10) 3,260		3,260	(18) 5,868		5,868	9,128		9,128
FAX equipment	(35) 2,881		2,881	(7) 531		531	3,412		3,412
Peripheral or ARQ	(41) 9,765		9,765	(22) 6,566		6,566	16,331		16,331
Mini computer	(4) 43,381		43,381	(2) 1,880		1,880	45,261		45,261
Stand-by power supply	(44) 5,970		5,970	(27) 7,908		7,908	13,878		13,878
Installation cost for all the aboves	21,406	357	21,763	19,913	371	20,284	41,319	728	42,047
Transportation cost for all the aboves	2,080	281	2,361	2,014	257	2,271	4,094	538	4,632
Antenna tower *2	(2) 1,818	908	2,726	(5) 4,454	2,852	7,306	6,272	3,760	10,032
Commercial power		(3) 987	987		(4) 1,911	1,911		2,898	2,898
Station building		(13) 4,048	4,048		(6) 2,957	2,957		7,005	7,005
Access road		(3) 2,617	2,617		(5) 4,363	4,363		6,980	6,980
Meteorological *2 instrument	(23) 7,183	190	7,373				7,183	190	7,373
Total	147,308	9,388	156,696	85,791	12,711	98,502	233,099	22,099	255,198

Notes:
*1 F: Foreign currency portion
L: Local currency portion

*2 Including installation and transpartation cost.

*3 ( ) shows the number of setting place.

Table 7.1 (2/2)

Cost Estimation

Unit: ₱ 10^3

Items	OH		VHF		HF		Mateorological Instruments		Total		
	*1 F	*1 L	F	L	F	L	F	L	F	L	Total
OH equipment	(15)*3 65,027								65,027		65,027
Improvement of OH equipment	3,548								3,548		3,548
VHF equipment			(44) 17,646						17,646		17,646
HF equipment					(28) 9,128				9,128		9,128
FAX equipment	(4) 379		(36) 2,730		(2) 303				3,412		3,412
Peripheral or ARQ	(5) 1,168		(34) 7,096		(24) 8,067				16,331		16,331
Mini computer	(5) 44,321		(1) 940						45,261		45,261
Stand-by power supply	(12) 11,543		(35) 1,607		(24) 728				13,878		13,878
Installation cost for all the aboves	26,459	607	7,733	53	7,127	68			41,319	728	42,047
Transportation cost for all the aboves	2,957	212	606	136	531	190			4,094	538	4,632
Antenna tower *2	(7) 6,272	3,760							6,272	3,760	10,032
Commercial power		(6) 2,819		(1) 79						2,898	2,898
Station building		(7) 4,013		(8) 1,478		(4) 1,514				7,005	7,005
Access road		(7) 6,889		(1) 91						6,980	6,980
Meteorological *2 instrument							(23) 7,183	190	7,183	190	7,373
Total	161,674	18,300	38,358	1,837	25,884	1,772	7,183	190	233,099	22,099	255,198

Notes: *1 F: Foreign currency portion, L: Local currency portion *3 ( ) show the number of setting cost.
*2 Including installation and transportation cost.

Table 7.2

Break Down of Cost Estimation

Classification	Foreign Portion	Remarks	Local Portion	Remarks
OH equipment	○	Cost		
Improvement of OH equipment	○	Improved cost		
VHF equipment	○	Cost		
HF equipment	○	Cost		
Facsimile equipment	○	Cost		
Peripheral or ARQ	○	Cost		
Mini computer	○	Cost of computer and programming cost		
Stand-by power supply	○	Cost		
Installation cost for all the aboves	○	Installation cost	○	Labor fee
Transportation cost for all the aboves	○	Shipping fare	○	Inland
Antenna tower	○	Cost	○	Construction cost
Commercial power			○	Wiring of commercial power
Station building			○	Construction of building
Access road			○	Construction cost
Meteorological instrument	○	Instrument cost and installation cost	○	Labor fee and shipping fare

Table 7.3

Estimation Cost of Meteorological Observation Instruments and their related Matters

Unit: ₱10^3

Name of Instrument	Specification	Unit	Quantity	Unit Cost	Total Cost
Propeller and vane type wind sensor and recorder	FF3R - 13	set	23	72,500	1,667,500
Tilting-Bucket type rain gauge Recorder (1 month)	LRT - 100 1 pulse 0.5 mm	set	23	30,700	706,100
Psychrometer	HP-2 SY-H5 B	set	23	11,900	273,700
Fortin barometer	PM-2 M10-A	set	23	29,300	673,900
Pyranometer (Epply) including Recorder	MS - 42	set	15	55,500	832,500
Transformer	(AC-220V-100V)	set	32	4,900	156,800
Packing cost	1: 50 kg. 38 2: 70 kg. 23		61	6,000	366,000
Transportation cost	Tokyo - Manila		3,510	76	266,760
Installation cost	Panza mast	set	23	97,380	2,239,740
Total					7,183,000

8. Implementation Plan of the Project

8.1 Principles for Making Implementation Plan

° Construction period is to be planned within three years.

° Implementation plan is to be reasonable and realizable from the point of view of economic, social and technical evaluation.

° Two alternatives are to be planned: the first phase for the Luzon region and the first phase for the OH main trunk line throughout the country. The optimal plan was selected after comparing these two alternatives.

8.2 Implementation Plan of Meteorological Telecommunication System

Two alternative plans were examined as stated in the following sub-sections. The work schedules are presented in Table 8.1, (1/2) - (2/2) and the disbursement schedules are presented in Table 8.2, (1/4) - (4/4).

8.2.1 Alternative Plan 1

In the alternative plan 1, the meteorological telecommunication system will first be improved in the Luzon region followed by the Visayas and Mindanao regions.

The works in the first year include the manufacturing of OH equipment, VHF equipment, stand-by power facilities,

Table 8-1 (1/2)

Schedule of Implementation Plan on the Project

1st Plan

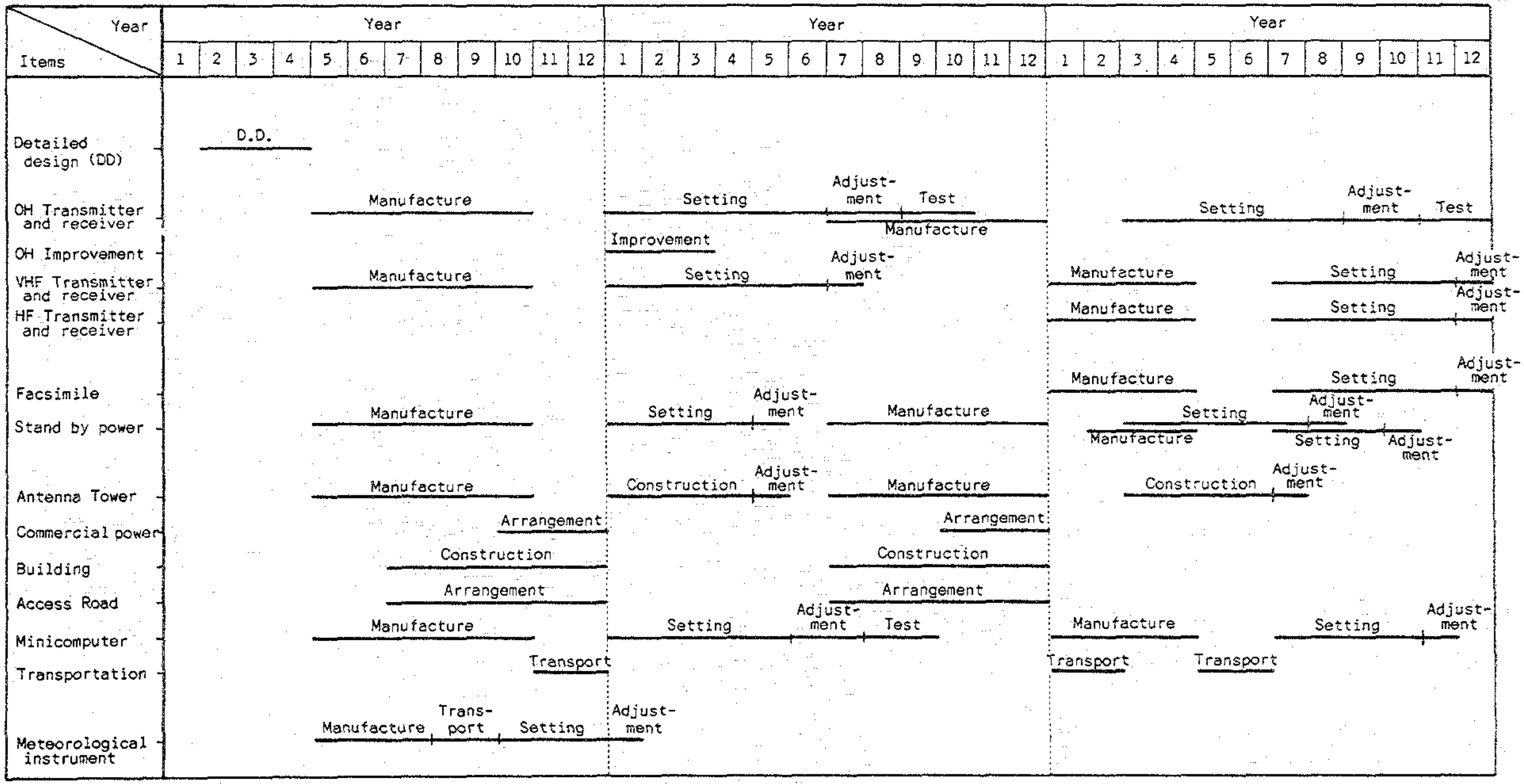
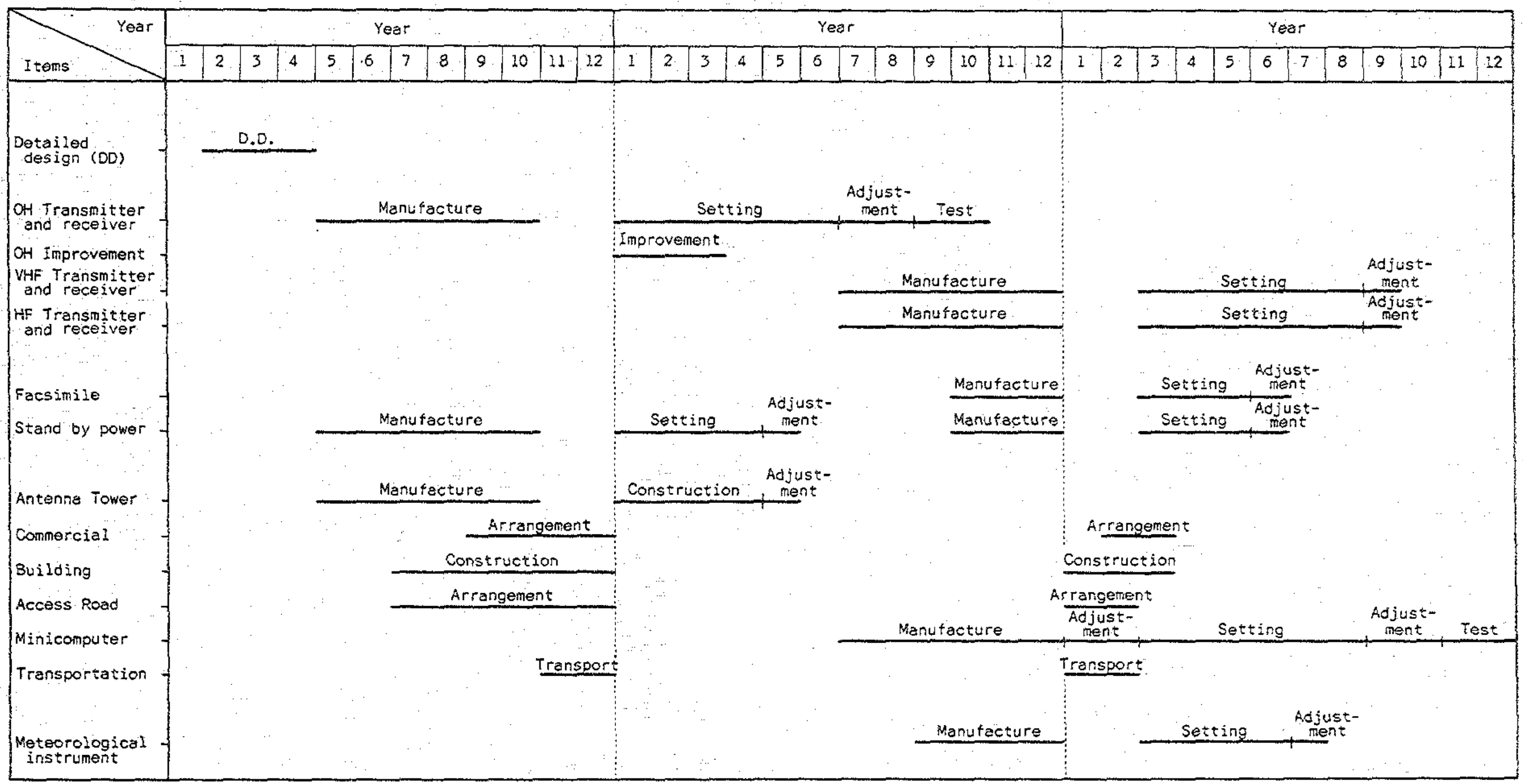


Table 8-1 (2/2)

Schedule of Implementation Plan on the Project

2nd Plan



(Manufacture: OH main trunk equipments)

(Setting: OH equipments
Manufacture: VHF & other equipments)

(Setting: VHF, HF, equipments and Minicom.)

Table 8.2 (1/4)

1st Plan

Cost Estimation

Unit: ₱10^3

Items	1st Year		2nd Year		3rd Year		Total	
	*1 F	*1 L	F	L	F	L	F	L
OH equipment	31,016		34,011				65,027	
Improvement of OH equipment			3,548				3,548	
VHF equipment	15,000				2,646		17,646	
HF equipment					9,128		9,128	
FAX equipment					3,412		3,412	
Peripheral or ARQ	6,884		395		9,052		16,331	
Mini computer	32,009		13,252				45,261	
Stand-by power supply	5,728		7,301		849		13,878	
Installation cost for all the aboves			18,860	333	22,459	395	41,319	728
Transportation cost for all the aboves	1,890			213	2,204	325	4,094	538
Antenna tower *2	1,818		4,454	908		2,852	6,272	3,760
Commercial power		987		1,911				2,898
Station building		2,957		4,048				7,005
Access road		2,617		4,363				6,980
Meteorological instrument *2	7,183	190					7,183	190
Total	101,528	6,751	81,821	11,776	49,750	3,572	233,099	22,099
Engineering & Administration	10,152	675	8,182	1,178	4,975	357	23,309	2,210
Physical contingency	10,152	675	8,182	1,178	4,975	357	23,309	2,210
Sub Total	121,832	8,101	98,185	14,132	59,700	4,286	279,717	26,519
Price contingency	4,922	2,612	6,010	7,361	4,921	3,210	15,853	13,183
Grand Total	126,754	10,713	104,195	21,493	64,621	7,496	295,570	39,702
Grand Total	137,467		125,688		72,117		335,272	

Notes: *1 F: Foreign currency portion, L: Local currency portion

*2 Including installation and transportation cost.

Table 8.2 (2/4)

Luzon Area

Unit: ₱10³

Items	1st Year		2nd Year		3rd Year		Total	
	*1 F	*1 L	F	L	F	L	F	L
OH equipment	31,016						31,016	
Improvement of OH equipment			3,548				3,548	
VHF equipment	15,000						15,000	
HF equipment					3,260		3,260	
FAX equipment					2,881		2,881	
Peripheral or ARQ	6,884				2,881		9,765	
Mini computer	32,009		11,372				43,381	
Stand-by power supply	5,728				243		5,971	
Installation cost for all the aboves			18,860	333	2,545	24	21,405	357
Transportation cost for all the aboves	1,890			213	190	68	2,080	281
Antenna tower *2	1,818			908			1,818	908
Commercial power		987						987
Station building		2,957		1,091				4,048
Access road		2,617						2,617
Meteorological instrument *2	4,789	127					4,789	127
Total	99,134	6,688	33,780	2,545	12,000	92	144,914	9,325
Engineering & Administration	9,913	669	3,378	255	1,200	9	14,491	933
Physical contingency	9,913	669	3,378	255	1,200	9	14,491	933
Sub Total	118,960	8,026	40,536	3,055	14,400	110	173,896	11,191
Price contingency	4,806	2,588	2,481	1,591	1,187	82	8,474	4,261
Grand Total	123,766	10,614	43,017	4,646	15,587	192	182,370	15,452
Grand Total	134,380		47,663		15,779		197,822	

Notes: *1 F: Foreign currency portion, L: Local currency portion
*2 Including installation and transportation cost.

Table 8.2 (3/4)

Visayas and Mindanao Area

Unit: ₽10^3

Items	1st Year		2nd Year		3rd Year		Total	
	*1 F	*1 L	F	L	F	L	F	L
OH equipment			34,011				34,011	
Improvement of OH equipment							-	
VHF equipment					2,646		2,646	
HF equipment					5,868		5,868	
FAX equipment					531		531	
Peripheral or ARQ			395		6,171		6,566	
Mini computer			1,880				1,880	
Stand-by power supply			7,301		606		7,907	
Installation cost for all the aboves					19,914	371	19,914	371
Transportation cost for all the aboves					2,014	257	2,014	257
Antenna tower *2			4,454			2,852	4,454	2,852
Commercial power				1,911				1,911
Station building				2,957				2,957
Access road				4,363				4,363
Meteorological instrument *2	2,394	63					2,394	63
Total	2,394	63	48,041	9,231	37,750	3,480	88,185	12,774
Engineering & Administration	239	6	4,804	923	3,775	348	8,818	1,277
Physical contingency	239	6	4,804	923	3,775	348	8,818	1,277
Sub Total	2,872	75	57,649	11,077	45,300	4,176	105,821	15,328
Price contingency	116	24	3,529	5,770	3,734	3,128	7,379	8,922
Grand Total	2,988	99	61,178	16,847	49,034	7,304	113,200	24,250
Grand Total	3,087		78,025		56,338		137,450	

Notes: *1 F: Foreign currency portion, L: Local currency portion
*2 Including installation and transportation cost.

Table 8.2 (4/4)

2nd Plan

Cost Estimation

Unit: ₱10^3

Items	1st Year		2nd Year		3rd Year		Total	
	*1 F	*1 L	F	L	F	L	F	L
OH equipment	65,027						65,027	
Improvement of OH equipment			3,548				3,548	
VHF equipment			17,646				17,646	
HF equipment			9,128				9,128	
FAX equipment			3,412				3,412	
Peripheral or ARQ	1,168		15,163				16,331	
Mini computer			33,889		11,372		45,261	
Stand-by power supply	11,543		2,335				13,878	
Installation cost for all the aboves			26,459	607	14,860	121	41,319	728
Transportation cost for all the aboves	2,957			212	1,137	326	4,094	538
Antenna tower *2	6,272			3,760			6,272	3,760
Commercial power		2,819				79		2,898
Station building		4,013				2,992		7,005
Access road		6,889				91		6,980
Meteorological instrument *2					7,183	190	7,183	190
Total	86,967	13,721	111,580	4,579	34,552	3,799	233,099	22,099
Engineering & Administration	8,697	1,372	11,158	458	3,455	379	23,310	2,209
Physical contingency	8,696	1,372	11,158	458	3,455	380	23,309	2,210
Sub Total	104,360	16,465	133,896	5,495	41,462	4,558	279,718	26,518
Price contingency	4,216	5,310	8,196	2,862	3,418	3,414	15,830	11,586
Grand Total	108,576	21,775	142,092	8,357	44,880	7,972	295,548	38,104
Grand Total	130,351		150,449		52,852		333,652	

Notes: *1 F: Foreign currency portion, L: Local currency portion
*2 Including installation and transportation cost.

meteorological instruments and mini-computer for telecommunication control and the construction of access-road and station buildings in the Luzon region.

The works in the second year include the installation of the equipment manufactured in the first year, the manufacturing of OH equipment for the Visayas and Mindanao regions and the construction of the access-road and the station buildings of the remaining weather stations.

The works in the third year include the installation of the equipment manufactured in the second year and the manufacturing and installation of the remaining VHF equipment and all the HF equipment and facsimile.

According to this alternative plan 1, the telecommunication and voice message will be possible within the second year in the Luzon region and will be possible within the third year in the Visayas and Mindanao regions.

The characteristics of the alternative plan 1 are as follows:

(1) The economic benefit is anticipated large because many (63%) of the typhoon visiting the Philippines cross the Luzon region.

(2) Unlike the alternative plan 2, the manufacturing of the equipment will not be made simultaneously. However, this will not make a big difference in cost.

(3) The total cost is evenly allotted in the three years of the construction period.

8.2.2 Alternative Plan 2

In the alternative plan 2, an OH main trunk line will be installed first followed by VHF and HF branch lines.

The works in the first year include the manufacturing of the OH equipment and stand-by power facilities and the construction of the access-road and station buildings of the relay stations.

The works in the second year include the installation of the OH equipment manufactured in the first year and the manufacturing of VHF equipment, HF equipment, mini-computer for telecommunication control and meteorological instrument.

The works in the third year include the construction of the access-road and the station buildings of VHF relay stations and the installation of the equipment manufactured in the second year.

According to this alternative plan 2, the main trunk line can be available and the telecommunication and voice message of the eight weather stations can be possible within the second year and the telecommunication and voice message of the remaining weather stations can be possible within the third year.

The characteristics of the alternative plan 2 are as follows:

(1) Since the mini-computer for telecommunication control is not needed for the construction of OH

main trunk line, its installation can be postponed until the VHF branch line is installed.

(2) Since the manufacturing of the equipment can be made simultaneously, the scale merit can be expected.

(3) Disbursement concentrates in the first and second years.

8.2.3 Results of Comparison Study

The implementation plan in the feasibility study requires to be reasonable and realizable in terms of construction cost and period. As a result of comparison study mentioned hereunder, the alternative plan 1 was adopted as the implementation plan of the Project.

(1) In the alternative plan 1 in which the meteorological telecommunication system in the Luzon region can be completed, the data and message transmissions can be available within the second year. Therefore, the plan 1 may have more benefit than the alternative plan 2.

(2) A pattern common to both the alternatives is that the handling of equipment can be studied in the first year and the operation of the system can be started immediately after their installation in the second year. Since OH and VHF equipments will be installed simultaneously, the plan 1 may have more benefit the plan 2.

(3) As a result of the economic comparison in which the present value of net benefit discounted by 10% was compared, it was found that the said present value of the plan 1 was bigger than that of the plan 2. This shows that the plan 1 is preferable to the plan 2. The derivation of the value of net benefit is shown in Tables 8.3 and 8.4.

In this economic comparison, the followings were assumed:

(i) The benefit of the completion of OH main trunk line was estimated at 8/64 of the total benefit by assuming that eight stations out of the total 64 stations can be operational.

(ii) The benefit of the completion of meteorological telecommunication system in the Luzon region was estimated at 64% of the total benefit based on the historical frequency of typhoon crossing the Luzon region as shown in Table 2.15.

(iii) As the benefit of the Project, 17.4% of the forecasted typhoon damage was adopted based on the Delfi Method survey (cf. 9.1.2)

(4) The alternative plan 1 coincides with the development plan of PAGASA.

9. Evaluation of the Project

9.1 Conceivable Benefit of the Project

9.1.1 Preventive and Productive Effects of the Project

The completion of the Project is expected to make weather information more accurate and more quick in its collection and dissemination; and consequently more reliable forecasting and warning information will be conveyed to the general public more quickly. This effect of the Project can be divided into two; one is the preventive effect which can be defined as the effect of the Project to mitigate the damage of natural disaster and another is the productive effect which can be defined as the effect of the project to increase positively the production of, for example, agriculture.

The preventive effects of the Project are described in the preceeding sub-section 2.4.3 and are summarized hereunder.

(1) Mitigation of the direct damage to farm products, livestock and fish culture caused by either typhoon or flood.

(2) Mitigation of the direct damage to housings and buildings caused by either typhoon or flood.

(3) Facilitation of the restoration of railway, roads, and bridges damaged and broken by either typhoon or flood.

(4) Savings of fuel cost and other expenditures of aircrafts and vessels.

(5) Facilitation of restoration of power facilities damaged by lightning and consequent shortening of black-out time.

(6) Decrease in the number of casualties including deaths and missings caused by typhoon, flood and earthquake.

The decrease in casualties may be, among others, the biggest effect of the Project. The accurate forecastings and warnings will make people rely on a typhoon warning, which will make people well prepared to the coming of typhoon. The warnings will be able to conveyed to people quickly enough through the Project to take protective measures for the typhoon. According to the questionnaire (cf. 9.1.2) made in this Study to the well experienced personnels responsible for natural disaster prevention, the casualties of typhoon is anticipated to decrease to 70% of the present casualties on conditions that all the dam construction, the flood forecasting and warning system and the meteorological telecommunication system are completed.

From the global point of view, the Project will contribute to the world-wide improvement of weather information by its dissemination through GTS and will also enhance the safety of aircrafts and vessels in their world-wide navigations.