SURVEY REPORT

OF

TELEVISION NETWORK CONSTRUCTION PROJECTS

IN

EASTERN AND WESTERN PROVINCES OF PAKISTAN

APRIL 1968

GOVERNMENT OF JAPAN

FOREWORD

Upon the request of the Government of Pakistan, as a project of Overseas Economical and Technical Cooperation activities in the fiscal year 1967, the Government of Japan entrusted the conduction of an actual field survey relating to the construction of nationwide Television network both in Eastern and Western provinces of Pakistan to the Overseas Technical Cooperation Agency (OTCA), which is the executive agency of the Japanese Government for overseas technical cooperation.

In view of the importance of developing Television network in Pakistan, the Agency dispatched a survey team consisting of eight experts headed by Mr. Shinzaburo TANAKA,Deputy Chief, Broadcast Engineering Division, Radio Regulatory Bureau, Ministry of Posts and Telecommunications from October 25, 1967 through February 8, 1968.

In many cities and districts of Pakistan, the team actively conducted the propagation tests and paper studies to select the most suitable sites for main broadcasting stations and to determine the relaying means between those stations.

Based on the test results obtained, an interim report was already submitted to the authorities of Pakistan concerned before the term's leaving. This detailed report, however, is ready to be finally submitted after thorough examinations to the field data from every point of economical and technical views.

For overseas technical cooperation, the Agency was inaugurated in 1962 as the implementing institution under the direct control of the Government of Japan. Since then it has been executing various technical aids and cooperations on the Governmental basis by sending experts, accepting trainees and providing consulting services for the developing countries, and is steadily accomplishing its purpose. Nothing would be more gratifying to our Agency than if this survey report could be any help of to contribute to the completion of Television network in Pakistan and at the same time to aid in the promotion of friendly relations between Pakistan and Japan.

In conclusion, I would like to take this opportunity to express my gratitude to the officials of the Pakistan Government and the Pakistan Television Corporation, who generously gave their support and cooperation to the team in the execution of our survey.

Shinichi Shibusawa
Director General
The Overseas Technical Cooperation Agency

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ABBREVIATIONS

Some of the abbreviations cited in this report are as follows:

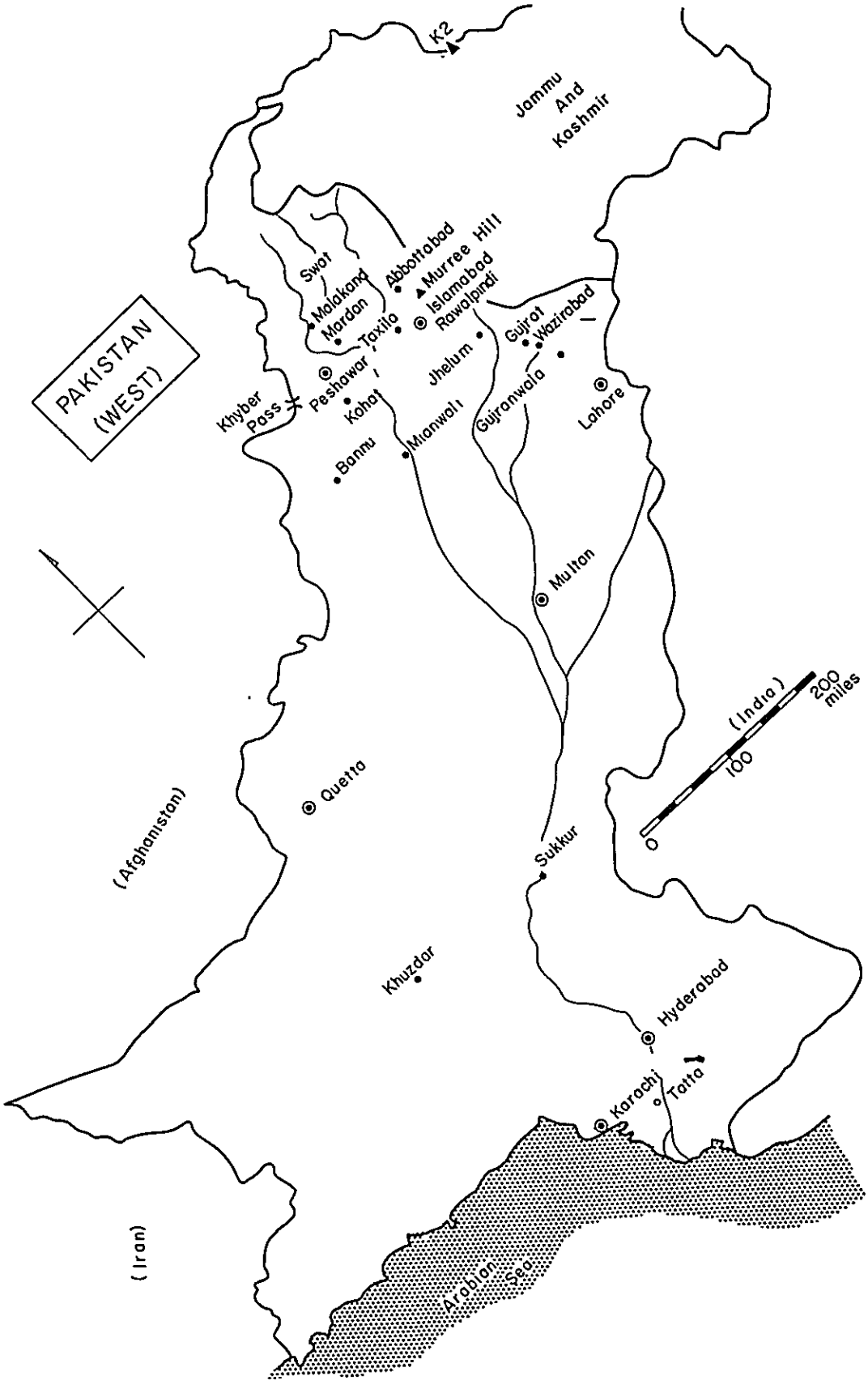
Abbreviations	Stands for
PTC	Pakistan Television Corporation Limited
T & T	Telegraph and Telephone Department, Government of Pakistan
CCIR	International Radio Consultative Committee
EBU	European Broadcasting Union
FCC	Federal Communications Commission, U.S.A.
RRB	Radio Regulatory Bureau, Japanese Government
NHK	Nippon Hoso Kyokai (Japan Broadcasting Corporation)
NEC	Nippon Electric Company Limited
ERP	Effective Radiated Power
Mc	Megacycle
Ch.	Channel
Q.P.	Quasi Peak
JRTC	Japan Radio Technical Council

In this report, the units of miles, feet and pounds are used, because such units are used in Pakistan. Theoretical equations, however, are presented in the units of MKS for convenience.

1 inch : 25.4mm

1 foot : 0.305m

1 mile : 1.609km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Swat
Malakand
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Abbottabad
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Islamabad
Rawalpindi
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Jhelum
PAKISTAN
(WEST)
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Pass
Peshawar
Kohat
Bannu
Mianwali
Gujranwala
Lahore
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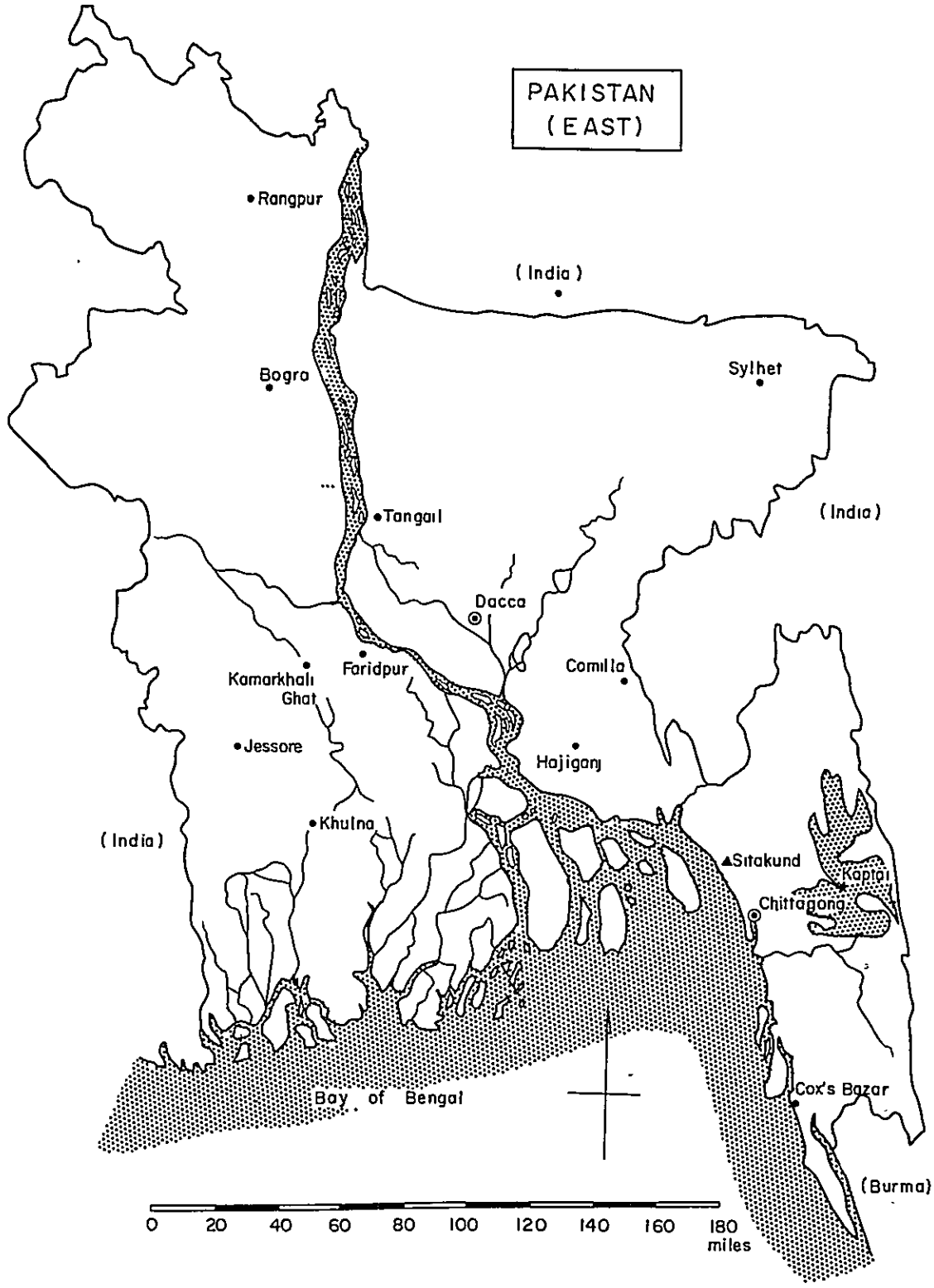
PAKISTAN
(EAST)
Rangpur
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Comilla
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Cox's Bazar
(Burma)
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miles

I. SUMMARY OF RECOMMENDATIONS AND ACKNOWLEDGEMENTS

I. SUMMARY OF RECOMMENDATIONS AND ACKNOWLEDGEMENTS

This report and its recommendations are submitted for the exparison planning of television networks in Eastern and Western Provinces of Pakistan on the basis of the results of an actual survey by a Japanese team consisting of eight engineers, who conducted field survey using transmitters, receivers and various measuring equipment for approx. one hundred days from October 1967.

The tasks given the Japanese television survey team are as follows.

West Pakistan

(1) Selection of a site for the station and determination of its dimensions with view to offering excellent television service to areas of Islamabad, Rawalpindi and their environs.

(2) Relaying means to Peshawar from the Capital station

(3) Simultaneous direct program exchange between the Capital station and Lahore station.

(4) Relaying means between Karachi and Hydrabad and dimensions of Hyderabad station.

East Pakistan

(1) Relaying means from Dacca main station to Khulna and its dimensions

(2) Connecting means between Dacca and Bogra stations, and Bogra station's dimensions

(3) Connecting means between Dacca and Chittagong and site selection for Chittagong station

Summary of recommendations for the aforementioned survey items is shown below. As for details of the recommendations and their reasons, see other chapters, especially Chapter III (West Pakistan) and Chapter IV (East Pakistan).

I-1. SUMMARY OF RECOMMENDATIONS RELATING TO WEST PAKISTAN

I-1-1. Capital Station

A suitable location site for a national Capital station has been found at the top of the so-called Pindi Point *7, 242 feet above sea level) on Mt. Murree, 20 miles northeast of Islamabad. Pindi Point is sufficiently high enough to obtain a coverage greater than usual and also transportation to Islamabad is good. Especially, it is a great advantage to be able to cover the whole of Islamabad with a good quality picture. If the station were to be installed at Changla Gali Point instead of Pindi Point, reception quality in Islamabad would deteriorate due mainly to ghost images.

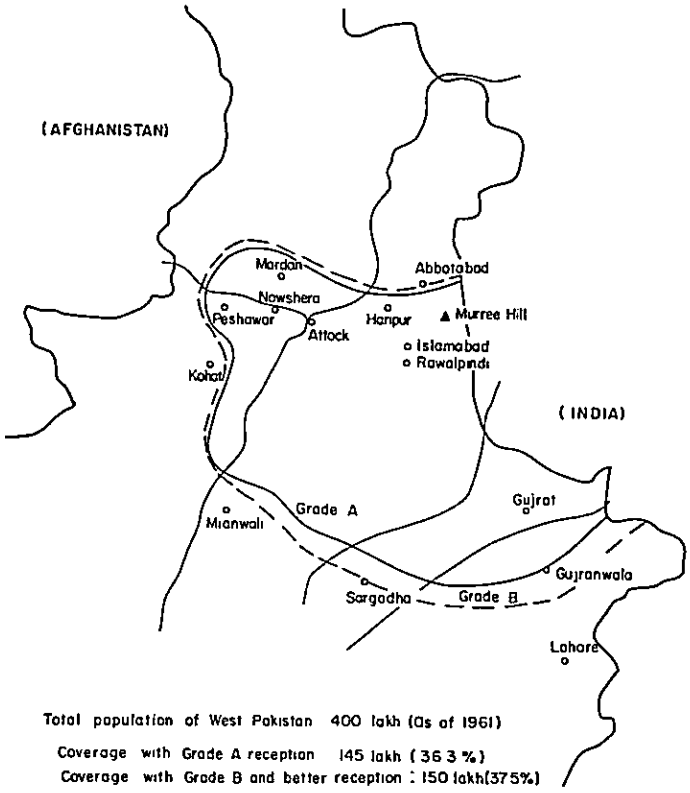
(1) The transmitter power of the Capital station should be 10kw rather than 6kw. To obtain a better understanding of this situation read the latter part of Para. II-3-3. An 80～100 foot antenna height above ground level would be sufficient. Ch. No. 8 is usable for this station. If it is, however, still feasible to change Ch. No. 5 to this station and Ch. No. 8 to the Lahore station.

(2) The border line of service area of the proposed Capital station is shown in Fig. I 1-1. Peshawar and Gujranwala are included. In other words, this national Capital station, with 10kw power, if installed on Pindi Point can cover a population of 145 lakh with a better quality television picture (grade A reception) and 150 lakh with a second and or better quality television picture (grade B reception). This is just a general summariza tion. As to picture quality for incividual cities within this area, refer to Table II-3-2-1.

I-1-2. Peshawar Rebroadcast Station

People living in Peshavar and its suburbs will be able to receive the programs from the Capital station, proposed above, without the need of rebroadcasting. It would not be necessary, therefore, to envisage a hasty installation of the Peshawar station. The power of the Capital station should be 10kw or more, also in this meaning.

Fig. I. 1–1 Predicted Service Area of the Capital Station



I-1-3. The Program Exchange Means between the Capital Station and Lahore Station

In order to exchange programs between the Capital station and Lahore station, there are two or three feasible technical means. The first is to utilize micro-wave link of the Telegraph and Telephone Department and the second is to construct another broadcasting station (e.g., Gujranwala relay station) between the Capital station and Lahore. Both means are considered reliable from a technical viewpoint. Apart from these means direct exchange is also possible between Pindi Point and Lahore station by receiving each other's programs. This on-air reception method is inexpensive and expeditious, but is less reliable due to seasonal and daily capricious modes of propagation. (See Para. II-3-4)

Summarizing, we recommend that the third means stated above be utilized at this time even as an interim method and either the first or second means be chosen at a later date on the basis of the results of the interim method.

I-1-4. Hyderabad Rebroadcast Station (on-air relay)

In order to offer the television programs from Karachi station to the people of Hyderabad city and its environs without depending on T & T's facilities, it is

more practical to construct one more relay station somewhere between Karachi and Hyderabad. (e.g., at Tatta)

(1) Tattạ Rebroadcast Station

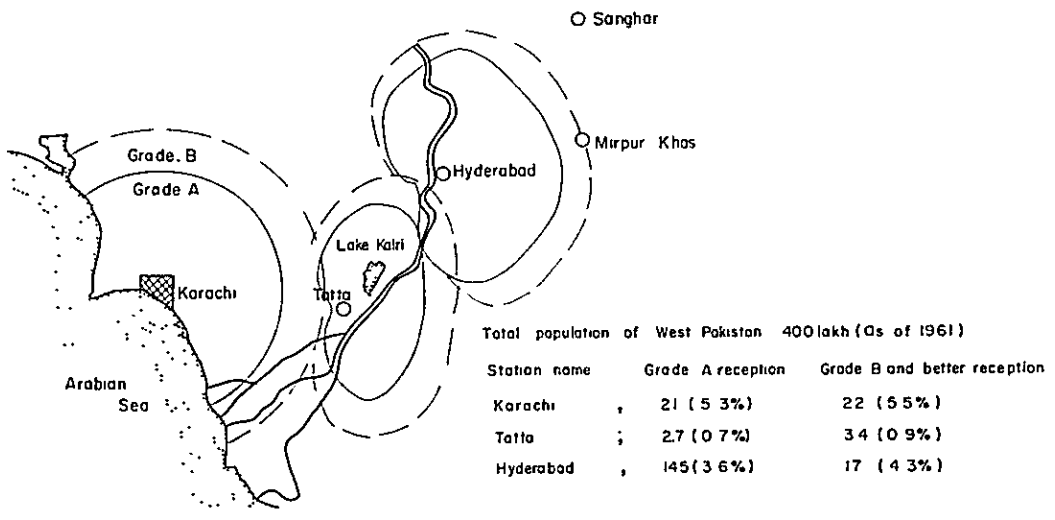
This relay station should be constructed west of Tatta (where is nearer Karachi) with transmitting power in excess of one Kilowatt. Ch. No. 5, which has the lowest frequency in the broadcast band III, is to be utilized. The height of the antennas for both transmitting and receiving is assumed to be 300 feet.

(2) Hyderabad Rebroadcast Station

Located south of Kotri 47 miles northeast of Tatta Station, the Hyderabad relay station can deliver sufficient television signal to cover the entire city of Hyderabad and its environs, while receiving Tatta station strongly. Its transmitter power should be one kilowatt or more. Ch. No. 8 or a higher channel, separated by two television channel widths or more from that of Tatta relay station, Ch. No. 5, is recommended. Antenna is approx. 300 feet.

(3) Service area boundaries of these rebroadcast stations and that of Karachi Main Station are shown in Fig. I-1-2. Hyderabad can cover a population of 17 lakh with a video signals of grade B quality or better, and Tatta, 3.4 lakh.

Fig. I. 1–2 Predicted Service Area of Karachi, Hyderabad and Tatta Station (on-air relay)



I-1-5. Hyderabad Rebroadcast Station (by T & T facilities)

In the case where microwave relay link or cable facilities of T & T are to be utilized, the Hyderabad rebroadcast station should be constructed on a hill (approx. 100-feet high) 3 miles south of Hyderabad.

One kilowatt transmitter (E.R.P. 17kw) with omni-directional antenna is recommended.

Predicted service area is shown in Fig. I-1-3. Population of 14.7 lakh would be included in grade A area and 17.4 lakh in grade B.

Far-reaching plans to relay to Lahore from Karachi via Sukkar, Multan and Lylapur utilizing T & T's facilities should be taken into account as these are considered more reasonable.

Summary of recommendations relating to West Pakistan is tabulated in Tables I-1-1 and I-1-2. Total coverage of existing Karachi and planned Lahore stations including the Capital station, Hyderabad and Tatta rebroadcast stations proposed herewith will amount to 222.2 lakh (grade A) and 242.4 (grade B), corresponding to 56% and 61% of the total population of West Pakistan respectively. The expenditure for construction of the Capital station and Hyderabad and Tatta rebroadcast stations is estimated to be approx. 45.3 lakh rupees. (see Appendix V-10)

On the other hand, total coverage in the case of the use of T & T facilities will amount to 219.7 lakh persons (55%) and 239.4 lakh (60%) respectively. The construction expenditure is approx. 31.8 lakh rupees.

Fig. I. 1–3 Predicted Service Area of Hyderabad Station (by T & T's facifities)

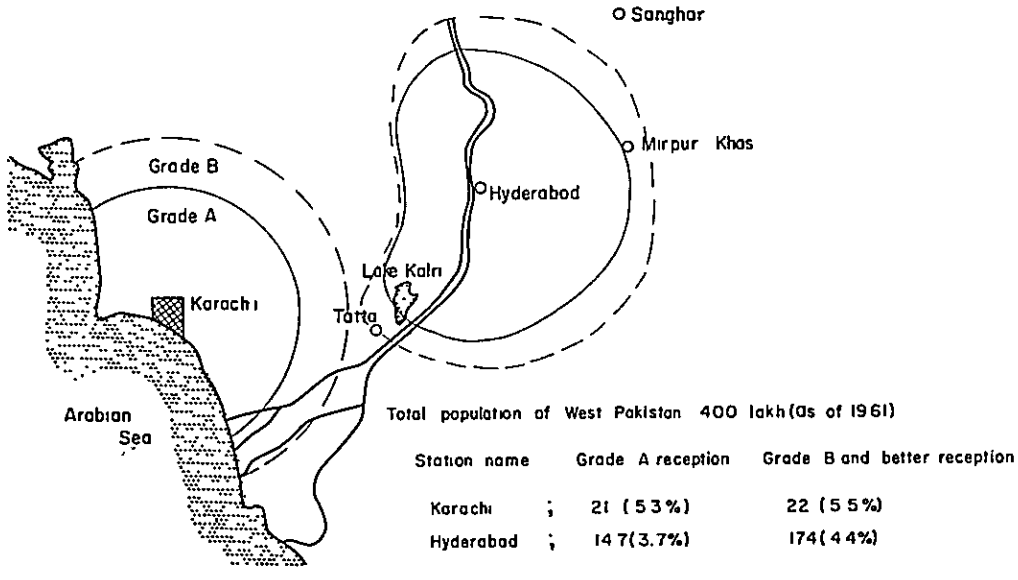


Table I-1-1. Summary of Recommendations (West Pakistan) (On-air relay)

Station Name	Ground Level(ft.)	Antenna Height(ft.)	Ch.No.	Transmitter Power(kw) (ERP)	Coverage A (B) (lakh)	Directivity
the Capital	7,242	80	8 (5)	10 (100)	145 (150)	directional
Karachi	60	240	4	6 (24)	21 (22)	non-directional
Lahore	700	300	5 (8)	5 (70)	39 (50)	non-directional
Hyderabad	30	300	8	1 (13)	14.5 (17)	directional
Tatta	30	300	5	1 (12)	2.7 (3.4)	directional

total coverage 222.2(242.4)
percentage 56% (61%)

Note 1. Frequency versus Ch. No.

Band	Ch. No.	Frequency (Mc)
I	2	47 - 54
I	3	54 - 61
I	4	61 - 68
III	5	174 - 181
III	6	181 - 188
III	7	188 - 195
III	8	195 - 202
III	9	202 - 209
III	10	209 - 216
III	11	216 - 223

Note 2 A : Grade A reception, field intensity is above 55dB, assuming 30-foot receiving antenna is utilized.

B : Grade B reception, field intensity is above 45dB, assuming 30-foot receiving antenna is utilized.

Table I-1-2. Summary of Recommendations (West Pakistan) (by T & T's facilities)

Station Name	Ground Level(ft.)	Antenna Height(ft.)	Ch. No.	Transmitter Power (kw) (ERP)	Coverage A (B) (lakh)	Directivity
the Capital	7,242	80	8 (5)	10 (100)	145 (150)	directional
Karachi	60	240	4	6 (24)	21 (22)	non-directional
Lahore	700	300	5 (8)	5 (70)	39 (50)	non-directional
Hyderabad	100	300	5	1 (17)	14.7 (17.4)	non-directional

total coverage 219.7 (239.4)
percentage 55% (60%)

I-2. Summary of Recommendations Relating to East Pakistan

Contents of construction planning of relay stations largely depend upon whether we propose to rent T & T facilities or to use on-air reception as a means of obtaining the program source. Network composition, utilizing only the equipment and facilities which PTC itself installs and operates, will be stated below first.

I-2-1. Case of On-air Relay Means

In East Pakistan, the Dacca station is always the main station the program of which the other stations are to receive directly or through another relay station or stations and rebroadcast. The dimensions of Dacca main station are assumed to be 6kw, 70kw E.R.P., 450 feet in height (temporarily 300 feet) and Ch. No. 5.

(1) Fig. I-2-1 shows the predicted service areas of Dacca and other stations.

(2) Rebroadcast stations which need to receive directly the signal of Dacca station should have their sites within an area of 50 to 60 miles from the new Dacca station. These figures are calculated on the assumption that the transmitting antenna height of Dacca station is 450 feet and that of the receiving antenna of the rebroadcast stations is 300 feet.

(3) The rebroadcast station to cover the southwestern part of East Pakistan (Khulna and Jessore areas) should be located near Bhatiapara Ghat, 55 miles from Dacca and 30 miles from Khulna. It is best that the

Table I-2-1 Summary of Recommendations (East Pakistan)

(on-air relay)

Station Name	Ground Level (Ft.)	Antenna Height (Ft.)	Ch. No.	Transmitter Power (kw) (ERP)	Coverage A (B) (Lakh)	Directivity
Dacca	20	450	5	6 (70)	110 (139)	non-directional
Hajiganj	10	300	9	1 (10)	23 (27)	directional'
Sitakund	1, 152	60	4	2 (9. 6)	16 (21)	directional
Chitta-gong	150	30	2	0. 1 (1)		directional
Tangail	20	300	10	1 (13)	29 (43)	directional
Khulna	20	300	*8 (11)	1 (13)	37 (60)	directional

Total Coverage ; 215 (290)

Percentage ; 42% (57%)

* When a Rajshai Station is to be planned, it is proper to assign Ch. No. 8 to Rajshahi and Ch. No. 11 to the Khulna Station.

Table I-2-2 Summary of Recommendations (East Pakistan)

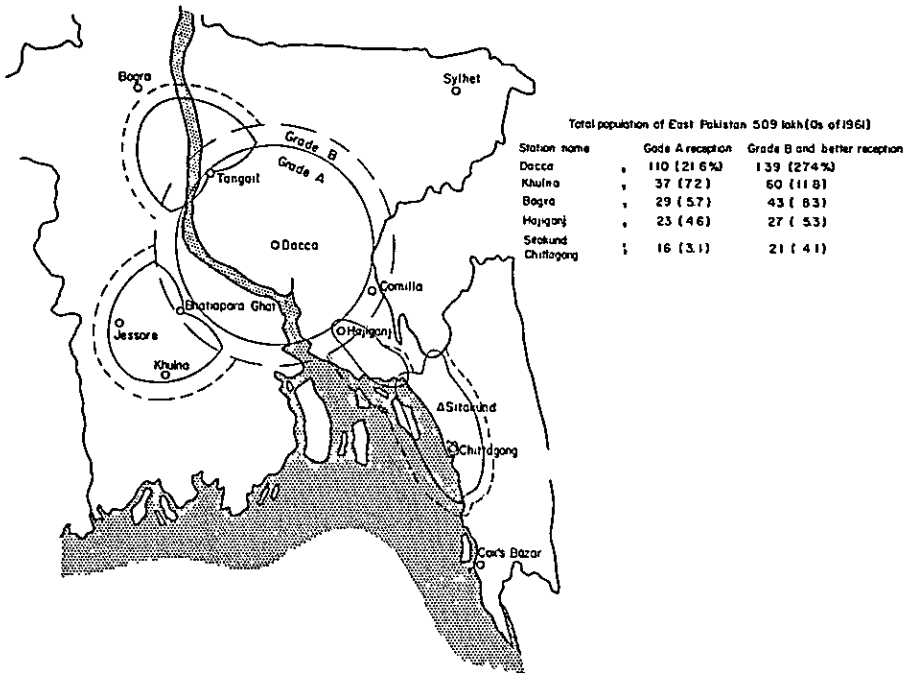
(by T & T's facilities)

Station Name	Ground Level (Ft.)	Antenna Height (Ft.)	CH. No.	Transmitter Power (kw) (ERP)	Coveriage A (B) (Lakh)	Directivity
Dacca	20	450	5	6 (70)	110 (139)	non-directional
Chitta-gong	120	120	4	1 (1)	10 (12)	non-directional
Khulna	20	300	7	1 (17)	30 (60)	non-directional
Bogra	20	300	9	1 (17)	50 (73)	non-directional

Total Coverage ; 200 (284)

Percentage ; 40% (57%)

Fig. I. 2–1 Predicted Service Areas of Dacca and other rebroadcast stations (on-air relay)



transmitter power be 1kw (E.R.P. 13kw) or more and to use a directional antenna, which should be directed to Khulna and Jessore, but not to Dacca. The distribution of transmitter power to Dacca is not necessary. Ch. No. 8 or 11, for example, separated by a width of two or more channels from that of Dacca station is the recommended frequency.

This Khulna rebroadcast station covers 37 lakh people with grade A quality and 60 with B or better.

(4) The site of the rebroadcast station to cover the northwestern part of East Pakistan (Bogra Area) should be near Tangail or Khalihati. It is best that the transmitter power is over 1 kw (E.R.P. over 6 kw) and directional antenna be used, which should be directed to Bogra, that is, to Rangpur. No feeding of transmitter power back to Dacca is necessary, the same as in the case of Khulna station. The channel should be separated by two channel widths (14 Megacycles) or more from that of Dacca main station (Ch. No. 5) and should not be the same as that of neighbouring Khulna and/or Rajshahi; therefore Ch. No. 10 is recommended.

This Tangail rebroadcast station, tentatively designated, covers 29 lakh people with grade A quality and 43 lakh with B or better.

(5) In order to offer Dacca's program to people in Chittagong city and its environs without depending on T & T facilities, it is more practicable to construct some more stations between Dacca and Chittagong. A relay station should be constructed near Hajiganj to receive and rebroadcast signals from Dacca. One more relay station should be constructed on the Sitakund Hill (1152 feet above sea level) 20 miles north of Chittagong in order to receive the signals from Hajiganj station and rebroadcast to Chittagong city.

(i) The site for the first station to relay to the Chittagong area from Dacca must be found near Hajiganj or Mudaharganj 50 to 55 miles southeast of Dacca. No eminent site from a point of radio propagation view could be found near there, so factors must be taken into consideration, such as the ground, transportation facilities, etc. This station is tentatively designated Hajiganj rebroadcast station. The transmitter power should be above one kilowatt (E.R.P. is above 10kw) and directed only to the succeeding relay station. The frequency to be used should be decided, taking into consideration those of Dacca (No. 5) and Khulna (No. 8 or No. 11); Ch. No. 9 is recommended.

(ii) The location for the succeeding relay station to receive the signals from Hajiganj station and retransmit it to the area of Chittagong should be on the Sitakund Hill (1, 152 feet above sea level) 20 miles north of Chittangong city. Transmitting power of 2kw (E.R.P. is about 10kw) is recommended for this station. The height above ground level of the centre of the antenna elements should be approx. 60 feet. Because the terrain of Chittagong area is fairly complex and likely to cause much wave attenuation, Ch. No. 4 in the broadcast band I is recommended for the use at this second station, tentatively named Sitakund station. Television channels in Band III attenuate more than those in the Band I due to the hill terrain.

(iii) Sitkund rebroadcast station can cover a relatively large portion of Chittagong city, but approximately one lakh people could not enjoy a better picture than grade B. In order to make up this deficiency, one more station of small power should be planned. This small station (we will call it Chittagong rebroadcast station) should be constructed on Tree Point (150 feet above sea level) south of Chittagong city. A transmitter of 100 W power would be sufficient. (E.R.P. is approx. one kilowatt). It is better to chose a channel in Band I (Ch. No. 2) which is neither the same as, nor adjacent to, that of Sitakund station.

As outlined above, the network construction planning in East Pakistan is tabulated as in Table I-2-1. This plan shows that the total coverage of these rebroadcast stations including the new Dacca station is 215 lakh people with grade A and 290 lakh with grade B or better, corresponding to 42% and 57% respectively of the total population of East Pakistan.

I-2-2. Case of T & T's Relaying Facilities

The broadcasting network in East Pakistan should be planned as stated below in the case where a microwave link or a coaxial cable system operated by T & T is to be utilized as its relaying means. This method might be valuable if it is planned on the basis of accurate information concerning T & T facilities, that is, completion date, capacity, quality of the system by T & T. In this case it should not be forgotten that transmission of television signals requires the utilization of 960 ordinary telephone channels exclusively.

(1) Predicted service areas of Dacca station and other rebroadcast stations are shown in Fig. I-2-2.

(2) The site for the transmitters of every rebroadcast station should be decided at the approximate centre of the entire circular service area. As the program is obtained from the T & T facilities, it is better that the site is not so far from the T & T relaying stations (less than approx. 10 miles).

(3) The transmitting power of each rebroadcast station should be more than one kilowatt.

(4) It is best that the directivity of transmitting antennae of each rebroadcast station is omni-directional.

(5) The channel to be used by each rebroadcast station, except Chittagong, should be separated by at least one channel (7 Mc) apart from that of Dacca station (Ch. No. 5). The Chittagong station channel should be in the Band I, e.g., Ch. No. 4.

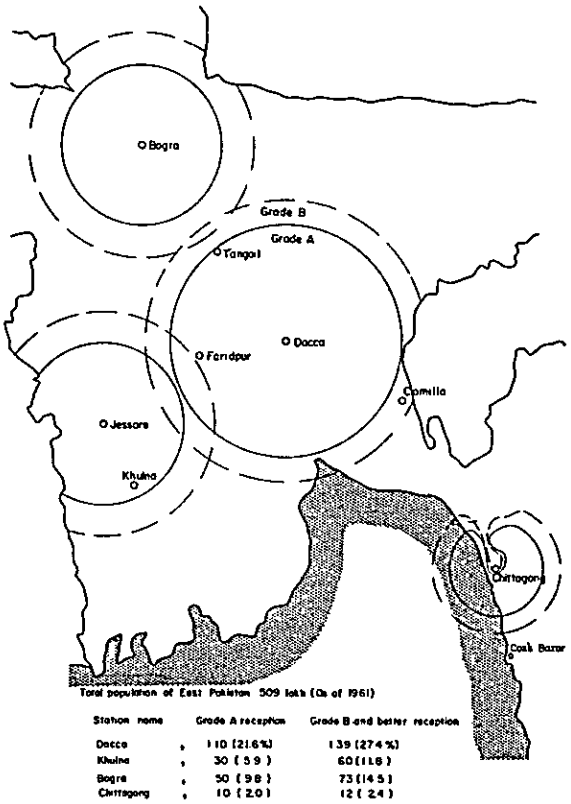
(6) Even when T & T's relaying facilities are used, only one rebroadcast station is not sufficient to cover the whole of the Chittagong city and its environs. Supposing that one station is to be constructed in the centre of Chittagong city, for example, on the top of the court hill, those people living in the shadowed area of this site must devise some means for receiving, such as the utilization of community receiving facilities.

Summarizing the above, the network plan in East Pakistan is shown in Table I-2-2. Total coverage of each rebroadcasting station including new Dacca station will be 200 lakh people with grade A reception and 284 lakh with grade B.

Total expenditure necessary for construction of these broadcasting networks in East Pakistan will amount to about 61.3 lakh rupees in the case of on-air relay system and about 43.7 lakh rupees in the case of T & T's relaying facilities. (see Appendix V-9).

If, and when, T & T's facilities are to be utilized as relaying means, rental fee to be paid annually to T & T by PTC must be taken into account.

Fig. I. 2–2 Predicted Service Areas of Dacca and other rebroadcast stations (by T & T's facilities)



I-3. Acknowledgement

It goes without saying that this report was compiled with much effort by all eight members of the third Japanese Television Survey Team. First, we would like to heartily thank His Excellency, the Japanese Ambassador in Rawalpindi, Hiroto TANAKA, First Secretary of Japanese Embassy, Shoichi BAN and Consul-General of Dacca, Jiro NISHIKAWA and other officials concerned. Their kind and careful arrangements offered officially and privately played an important role in seeing that our activities went smoothly in Eastern as well as the Western Provinces of Pakistan. Friendly acceptance, cooperation and conveniences shown us by the authorities concerned of Pakistan Television Corporation were greatly appreciated. Many talks and discussions were held with A. Musa S. AHMAD, managing Director, Pakistan Television Corporation and these were useful to our survey so that its report might reflect strong effects felt on the extension and advancement of television broadcasting services in both provinces of Pakistan. Broadcasting requires not only a high standard of engineering but also careful consideration from many points of views in social, educational and political fields. Discussions exchanged with Riaz AHMAD, Chief Engineer were also very fruitful in making up detailed survey schedules. Lt. Cdr. A.M.M. Aabad, Operation and Maintenance Engineer of PTC, who continued to be our best liaison officer during the entire period of the survey, will long be remembered by individual members of the team. Sarwar JAN of Dacca Station who speaks Japanese surprisingly well, was our second liaison officer while making the survey in the Eastern Province.

We are well aware that many Pakistani and Japanese people have shown us much favour, notwithstanding the omission of citing of particular names. Almost all Pakistani people whom we met in every day life were very kind and polite to us. We are most grateful to all of them.

II. DETAILS

II DETAILS

II-1 INTRODUCTION

II-1-1 History

Japanese cooperation with Pakistan concerning her Television Pojects began when the President of Pakistan, Mohamed Ayub Khan visited Japan in February 1961 and Japanese former Prime Minister Hayato Ikeda, paid a visit to Pakistan in November of the same year. In December, 1961, three Colombo Plan experts, headed by Yoshitoshi Tanabe chief engineer of NHK, were dispatched to make basic research on the introduction of television broadcasting in Pakistan. In June 1964, the second Japanese survey team, consisting of four experts in the fields of television headed by Yoshihiko Noguchi, of the Japanese Ministry of Posts and Telecommunica - tions, made its fundamental and comprehensive plans covering every field of television broadcasting. Therefore, this survey team from Japan may be called the third one to visit Pakistan, which carried out investigation for approx. 100 days from October 1967 to February 1968.

II-1-2 Tasks of Third Japanese Television Survey Team

The tasks of the third survey team in Pakistan were finally decided during some forty days prior to December 19th 1967 through discussions with the authorities of the Pakistan Television Corporation Limited. Even after the December, 19th decision some modification to the survey schedule was considered necessary to make it more practicable.

The final tasks for the team were as follows, roughly divided into seven items.

(1) Determination of a suitable site for the transmitter so that good television service could be provided for the people living in Islamabad, Rawalpindi and environs.

(2) Relaying means to Peshawar from the station which includes the new capital, Islamabad, in its service area.

(3) Direct and instantaneous program exchange, means between Islamabad and Lahore.

(4) Relaying means of the Dacca program to the Khulna station and proposed dimensions of the Khulna station.

(5) Relaying means between the Dacca and Bogra stations and proposed dimensions of the Bogra station.

(6) Relaying means between Dacca and Chittagong and selection of the site for the Chittagong station.

(7) Relaying means between Karachi and Hyderabad and proposed confines of the Hyderabad station.

Among the items listed above, items (4), (5) and (7) are additional requirements proposed by the Pakistan authorities and finally approved by the Japanese Government on the condition that the total period and costs necessary for the survey do not exceed the estimate.

We believe it is most important, that the most useful and proper assistance should be provided on the basis of accurate understanding of the requirements sought for by the countries concerned.

Concerning the dispatch of this survey team, considerable correspondence has been exchanged between the Pakistan and Japanese authorities. One engineer from the Pakistan Television Corporation happened to visit Japan and was able to discuss the requirements proposed by PTC. These facts enabled us to understand the full requirements of the Pakistan side.

It goes without saying that the exchange of correspondence and discussions were useful in making the requirements more concrete and the assistance more practicable and significant.

II-1-3 Members of the third survey team

The survey team was composed of eight members from Ministry of Posts and Telecommunications, NHK, Overseas Technical Cooperation Agency and the manufacturer concerned. All members are top class engineers with long experience in such fields as television, VHF and UHF radio wave propagation, and micro-wave engineering. The chief of the team states that he is very proud of them and believes that their activities are very valuable and fruitful for the important work of expansion of television network in Pakistan.

Member List

Shinzaburo Tanaka, Chief of the survey team, Vice Director of Broadcast Engineering Division, Radio regulatory Bureau, Ministry of Posts and Telecommunications. He has eighteen years experience in radio regulation, that is eight years with frequency allocation, four years with television channel planning, etc. Itinerary Period: 92 days.

He was responsible for overall survey activities as team leader.

Eiichi Yaguchi, member of the Engineering Headquarters, staff of NHK. He has fifteen years of experience in broadcasting engineering, eight years of which he was in charge of construction planning of television network. Itinerary Period : 92 days. He was responsible for survey planning (engineering).

Isamu Ishikawa, member of Broadcast Engineering Division, RRB. He has nineteen years of experience in radio regulation work, that is, eight years in standard frequency, eight years in noise measurement, two years in drawing up specifications and one year in broadcasting. Itinerary Period : 92 days.

He was in charge of obtaining results for survey equipment and reduction of the same.

Yoichi Kobayashi, member of Radio-Communication Division, RRB. He has eighteen years of experience in radio regulation work, that is, eight years in regulation and inspection of all kinds of radio stations on land as well as maritime services (including micro-wave stations).

Itinerary Period : 80 days. He was in charge of field survey activities (measuring reception).

Sakari Hoshina, Engineering Division staff, Sapporo Regional Central Station, NHK. He has thirteen years of experience field engineering work, that is, seven years in construction of broadcasting facilities, etc. Itinerary period ; 80 days. He was in charge of field survey activities (measuring reception).

Ryohei Yamashita, Deputy Director of Sales Section, in charge of southeastern part of Asia, NEC. He was temporarily attached as consultant to the Ministry of Posts and Telecommunications. He has fourteen years of experience after graduation from Institute of Technology, that is, five years in sales engineering, etc. Itinerary period : 92 days. He was in charge of cost estimation of broadcasting facilities and coordination among agencies concerned.

Keizo Yamamuro, member of Broadcasting Equipment Inspection Division, NEC. He was temporarily attached as consultant to the Ministry of Posts and Telecommunications. He has ten years of experience and is in charge of inspection and adjustment of all kinds of broadcasting equipment. Itinerary period : 80 days. He was in charge of field survey activities (operation of transmitters).

Hachiro Kamiyama, Staff of Development and Research Division, Overseas Technical Cooperation Agency. He has twenty five years of experience in tele-

communication work, that is, ten years in overseas technical assistance. Itinerary period : 106 days. He was in charge of survey costs, material superintendance and coordination.

As for Yamashita and Yamamuro, members of the Ministry of Posts and Telecommunications, Japanese Government asked Overseas Technical Cooperation Agency for its recommendation for candidates from manufacturing circles and approved them as survey members among recommended condidates by the society. The fact that the Japanese Government requested them to be consultants of the Ministry of Posts and Telecommunications temporarily during its survey period means that all survey members clearly declare to devote themselves to their duties and to behave like Japanese government officials and equivalents.

II-1-4 Survey Diary

Daily diary of the survey mission is shown in the Table II-1-4-1 as follows. Office work will not be detailed.

Table II-1-4-1 Survey Diary

Order of the day	Date	Day of the week	Main activities
1	Oct. 25 '67	Wed.	Kamiyama started for Pakistan to make preliminery arrangements in advance.
2	26	Thur.	Customs procedure, previous arrangements.
3	27	Fri.	↓
4	28	Sat.	↓
5	29	Sun.	↓
6	30	Mon.	↓
7	31	Tues.	↓
8	Nov. 1	Wed.	↓
9	2	Thur.	↓
10	3	Fri.	↓
11	4	Sat.	↓
12	5	Sun.	↓
13	6	Mon.	↓
14	7	Tues.	Kamiyama, Karachi for Rawalpindi.

15	Nov. 8	Wed.	Tanaka, Yaguchi, Ishikawa and Yamashita started for Pakistan.
16	9	Thur.	Inspection of Hongkong TV station
17	10	Fri.	Inspection of Thailand TV station
18	11	Sat.	Inspection of Karachi TV station, Met with Managing Director & Chief Engineer of PTC.
19	12	Sun.	
20	13	Mon.	Tanaka, Yaguchi left for Pindi. Ishikawa, Yamashita remained for customs procedure.
21	14	Tues	Previous arrangements.
22	15	Wed.	↓
23	16	Thur.	↓
24	17	Fri.	Meeting with M. D. A. M. S. Ahmad and Chief Engineer Riaz Ahmad. Completion of customs procedure.
25	18	Sat.	Ishikawa, Yamashita for Pindi.
26	19	Sun.	Equipment sent for Pindi by Land.
27	20	Mon.	Kobayashi, Hoshina, Yamamuro left Japan for Pakistan.
28	21	Tues.	Test Equipment arrives at PTC, Pindi.
29	22	Wed.	Adjustment and consolidation of test equipment.
30	23	Thur.	Adjustment and consolidation of test equipment.
31	24	Fri.	Preliminary site survey of Mt. Murree (Yaguchi, Ishikawa)
32	25	Sat.	Team meeting for for briefing.
33	26	Sun.	Equipment consolidation.
34	27	Mon.	↓
35	28	Tues.	↓
36	29	Wed.	Transmitter set-up on Mt. Murree. Transmission at Mt. Murree, Reception in Peshawar area.
37	30	Thur.	↓
38	Dec. 1	Fri.	↓
39	2	Sat.	↓
40	3	Sun.	↓ Much snow at Mr. Murree. (Snowed Approl. 2 feet deep).
41	4	Mon.	↓ Traffic stopped, forced to proceed on foot.
42	5	Tues.	↓ Sunset fading test between Mt. Murree and Peshawar city.
43	6	Wed.	Moved to Government Hostel at Islamabad.
44	7	Thur.	Meeting on survey schedule in West Pakistan.
45	8	Fri.	Transmission at Mt. Murree, Reception in Lahore area.
46	9	Sat.	↓ Sunset fading test between Mt. Murree and Gujranwala.
47	10	Sun.	↓
48	11	Mon.	Islamabad ghost test in case of Mt. Murree transmission.

49	12	Tues.	Khairi Murat site survey (Yaguchi, Isjikawa)
50	13	Wed.	Changla Gali site survey (Yaguchi, Ishikawa)
51	14	Thur.	Islamabad ghost test in case of Shakar Parian Transmission.
52	15	Fri.	
53	16	Sat.	Noise measurement in Peshawar city.
54	17	Sun.	
55	18	Mon.	Visit to Haripur telecommunication research centre.
56	19	Tues.	Survey tasks finally decided and approved.
57	20	Wed.	Receiving test at Gujrat, Karian and Shaker Parian in case of Khairi Murat transmission.
58	21	Thur.	Propagation test between Khairi Murat and Islamabad
59	22	Fri.	Noise measurement at Rawalpindi and Islamabad
60	23	Sat.	Survey in Malakand and Swat area. (Receiving test of present Pindi station at Malakand)
61	24	Sun.	
62	25	Mon.	
63	26	Tues.	Movement preparation to East Pakistan.
64	27	Wed.	Equipment packaging for sending to East Pakistan
65	28	Thur.	Equipment packaging for sending to East Pakistan
66	29	Fri.	Holiday. Visit to Taxila.
67	30	Sat.	Equipment transported by air to Dacca
68	31	Sun.	Forced to transport equipment to Lahore by land.
69	Jan. 1 (1968)	Mon.	
70	2	Tues.	Ramazan Eid Holidays.
71	3	Wed.	"
72	4	Thur.	All members except the chief left for East Pakistan. Chief Engineer Riaz Ahmad left Pindi for Japan.
73	5	Fri.	
74	6	Sat.	Reception party at managing director's residence Equipment arrives at Dacca, opening packages. :es.
75	7	Sun.	
76	8	Mon.	Tanaka reaches Dacca. Inspection of Dacca TV station.
77	9	Tues.	Equipment adjustment.
78	10	Wed.	Yaguchi, Ishikawa move to Chittagong by air.
79	11	Thur.	Hoshina, Kamiyama move to Chittagong by land. Sitakund site survey.
80	12	Fri.	All other members move to Chittagong, making propagation measurement on the way.

81	13	Sat.	Chittagong ghost test in case of Sitakund transmission.
82	14	Sun.	Visit to Cox's-Bazzar.
83	15	Mon.	Chittagong ghost test in case of Court-Hill transmission.
84	16	Tues.	Chittagong ghost test in case of Tree Point transmission.
85	17	Wed.	All members return to Dacca.
86	18	Thur.	Equipment consolidation and understanding meeting.
87	19	Fri.	Field intensity measurement of Present Dacca Station (ERP and Antenna Pattern)
88	20	Sat.	Propagation test between Tangail and Bogra.
89	21	Sun.	Noise measurement in Dacca.
90	22	Mon.	After finishing continuous noise measurement, move to Khulna and Faridpur.
91	23	Tues.	Propagation test between Khulna, Faridpur and Dacca.
92	24	Wed.	Propagation test between Khulna, Faridpur and Dacca.
93	25	Thur.	Equipment packaging. Meeting with Managing Director at DIT Bldg.
94	26	Fri.	Yamamuro, Kamiyama went to Chittagong to send out equipment to Japan.
95	27	Sat.	Luncheon party by A. M. S. Ahmad, M. D., at Hotel Inter-continental.
96	28	Sun.	Meeting with Chief Engineer, Riaz Ahmad.
97	29	Mon.	Re-export customs procedure at Chittagong.
98	30	Tue.	Interim Report Meeting at Hotel Inter-continental, Dacca. Yaguchi moves to Pindi. Hoshina moves to Karachi.
99	31	Wed.	Tanaka, Kamiyama move to Pindi. Yaguchi to Karachi.
100	Feb. 1	Thur.	Propagation test between Karachi and Hyderabad.
101	2	Fri.	↓ Tanaka moves to Karachi from Pindi.
102	3	Sat.	All survey activities completed.
103	4	Sun.	
104	5	Mon.	Karachi group leaves Pakistan.
105	6	Tues	Dacca group leaves Pakistan.
106	7	Wed.	
107	8	Thur.	Arrived at Tokyo.

II-1-5 Preliminary Arrangements

Sufficient preliminary arrangements are very important in this kind of field survey to make it successful. The dispatch of this mission was requested by the government of Pakistan in April 1965 and delayed for various reasons. On the other hand, it meant suffcient time was available to make previous arrangements. The contents of the survey requests which had not been clearly understood previously were made clear by discussions and conversations between Japanese Government officials in charge and Nazir Ahmad Warraich, PTC engineer, who visited Japan at the end of March, 1967. These discussions, however, were informal. Therefore, a formal letter was sent at the beginning of June 1967 in order to reconfirm the survey requests. Afterwards, another letter requesting the authorization of radio transmission and survey maps (one to 50,000 and one to 200,000 scale) was also sent on July 25.

The Survey items at first were as follows :

(a) Site determination for the transmitting station of Rawalpindi (Islamabad) area and measurement, to outline its service area, especially, to ascertain the existence of ghost deterioration in the Islamabad area.

(b) Survey mainly by paper work in order to decide relaying means between Rawalpindi and Lahore.

(c) Measuring survey to determine relaying means between Rawalpindi and Peshawar.

(d) Site determination for transmitting station covering Peshawar area and measuring survey to ascertain its service area.

(e) Survey mainly by paper work to decide relaying means between Dacca and Chittagong.

(f) Site determination for transmitting station of Chittagong area and measuring survey to ascertain its service area.

Permission of radio transmission by the survey team was requested to the government of Pakistan as follows:

Frequency (M_c)	Power (W)	Type of emission	Area to be used	Remarks
194 ~ 204 (video carrier 199.25)	10	A5F3	Rawalpindi and its environs.	Ghost test transmitter
153.33	50 10 1	F3	Rawalpindi, Peshawar, Chittagong and their environs.	Transmitter for use of field intesity measurement.
55.25	5	F3	Peshawar and its environs	Transmitter for use of Field intensity measurement.
27.04	0.1	A3	All areas to be surveyed	For contact use

Replying to these letters, additional items to be surveyed were requested as follows :

(a) Relaying means between Dacca and Khulna as well as between Karachi, Hyderabad and Sukkur.

(b) Survey concerning transmitting station to be constructed at a certain point fo North Bengali area (Assumed to be at Bogra)

Concerning the permission of radio transmission, a frequency change was requested of the ghost test transmitter from $198 - 204^{Mc}$ to $202 - 209^{Mc}$. (Reply was received on September 15). But at that time, all test equipment were already put on board a cargo ship. After careful deliberation, we planned to examine the possibility of frequency change by means of interchange of plug-in units after arrival. (We found we could do it). As for the map request, on September 29 we received a letter stating that it was impossible to send to Japan in advance.

The survey reports of the second survey mission and of micro-wave construction planning in West Pakistan made by the Japanese team were very useful for our preliminary arrangements and our prosecution of field survery on the spot.

Much useful information (climate, living condition, etc.) about Pakistan was sent to the Overseas Technical Cooperation Agency by Kaoru Oka colombo plan expert.

II-1-6 Survey of Test Equipment

The material and equipment necessary for this survey were discussed and examined from July 1967 in advance of forming the survey team. It was ready finally by borrowing or purchasing as shown in Table II-1-6-1. They amounted to ten transmitters, field intensity meters, etc., 1,160 recorders, power meters,etc., 30 receivers, generators, etc., 80 reels of recording paper, photographic film, etc., 300 meters of cable or cords, 60 pairs of work clothes, etc., 40 volumes of paper, one bottle of recording ink; and 12 dozen writing pencils, etc., Packaged in eleven boxes, they weighted approx. 5,000 pounds. Shipped from Yokohama September 18, they arrived at Karachi October 18. Because of some misunderstanding in customs procedure, however, the receiving date was delayed until November 21. (Completion date of customs entry was Nov. 17 at Karachi)

In spite of long transportation by sea, only five gasoline generators were slightly damaged in their starter gear because of rust. The wooden packing boxes were a little damp, so dry cells or other might be badly afeected to some dgree.

On the other hand, equipment damage happened rare during the entire survey period except for 2B29, output tube of 50 watt VHF radio telephone equipment which was cracked twice due to the moves.

Table II-1-6-1 Survey Test Equipment

Name	Manufacturer	Volume
Ghost Test Transmitter, 10w, Ch. No.10, A5	Japan Radio Co., Ltd.	1 set
Exciter		
Poser Amplitier		
Antenna (3-element Yagi)		
Power meter		
Pattern Generator	Matsushita Electric Industrial Co., Ltd.	1 set
Portable Television Reciever (transistorized)	Sony Corporation	4 sets
7-element Yagi Antenna	Yagi Antenna Co., Ltd.	5 pairs
VHF Radio Telephone Equipment, 50w, 153.33 Mc F3	Japan Radio Co., Ltd.	1 set
Power control		
Exciter		
Antenna (half-wavelength doublet)		
Power meter		

VHF Radio Telephone Equipment, 10w, 153.33 Mc, F3	Japan Radio Co., Ltd.	2 sets
* VHF Radio Telephone Equipment, 5w, 55.25 Mc, F3	Nippon Electric Co., Ltd.	1 set
Nami-E17 VHF Field Intensity Meter, 25-230 Mc band, transistorized. dry cell operation.	Anritsu Electric Co., Ltd.	1 set
C Type Television Band Field Intensity Meter, Television Ch. 1-12 and 153.33 MC dry cell operation.	Kyoritsu Electrical Works, Ltd.	1 set
FIV-2 Type VHF Field Intansity Meter, 50-25- Mc band, measuring part signal generating part antenna.	Kyoritsu Electrical Works, Ltd.	1 set
Direct current recorder (5 mA)	Yokogawa Electric Works, Ltd.	1 set
Portable adding jointed antenna pole	Yagi Antenna Co., Ltd.	3 pairs
E300 Generator, AC 100 v, 300w	Honda motor Co., Ltd.	6 sets
Portable VHF 1w Tranceiver, 153.33 Mc F3, with battery charger	Nippon Electric Co., Ltd.	2 pairs.
Tranceiver, 27.04 Mc, A3, 0.1w, dry cell operation.	Matsushita Electric Industrial Co., Ltd.	3 pairs.
Power Transformer, 100v to 200v, 2kvA		
Polaroid camera and 35mm camera		
Compass, binoculars, tools, tent and sheet cover, etc.		

Note: * This equipment was to be used for survey of the Peshawar area. However, the result of the propagation test from Mt. Murree revealed that the Mt. Murree station can cover the Peshawar area. Therefore, this equipment was not used.

II-2. Survey Activities

II-2-1. Capital Station and Survey for Determining Its Service Area

The inclusion of the new capital Islamabad in the area of optimum service is considered to be the most important subject, and from this standpoint, many profiles of the various anticipated possible locations for the broadcast station were drawn and a detailed on paper study was conducted. When it is only necessary to over Islamabad and its environs, it was easily discovered that Shakar Parian (1, 952 feet above sea level) is the most suitable location. However, another proposed location, the so-called Pindi Point (7, 242 feet above sea level) on the top of Murree mountain was selected and a study of the location was made.

Although this Pindi Point is located high on the top of the mountain, there is a good road leading to the point and securing of power supply is easy. In addition, considering the topography of the surrounding area, we though it is possible to make the most of the features of the mountain-top station with respect to relaying to Peshawar and good services. However, the on-paper study showed that the occurrence of ghost was suspected in Islamabad, therefore, a full scale ghost test became necessary.

In the study of various plans to find another possible location for serving Islamabad, Khairi Murat (3104 feet above sea level) was selected to be tested.

II-2-1-1. Ghost Test at Islamabad

To study the possibility of any ghost occurring in Islamabad when the station is located at Pindi Point, a 10 W TV test transmitter was installed at Pindi Point to transmit dummy TV signals suitable for ghost observation, and reception tests were conducted at more than a dozen points in Islamabad. For transmitting, a frequency of about 200 MC which is approximately the frequency of the anticipated channel of the main station was selected and the measurements of height pattern utilizing a wide band, 7-element Yagi antenna and observations of ghost employing TV receivers were made.

Also, survey tests similar to those described above were conducted with Shakar Parian and Khairi Murat as transmitting points.

In addition, the survey team actually conducted a field survey and an on-paper study of Changla Gali (8, 730 feet above sea level) which is located 7

Fig. II. 2–1 Survey points in Northern Parts of West Pakistan

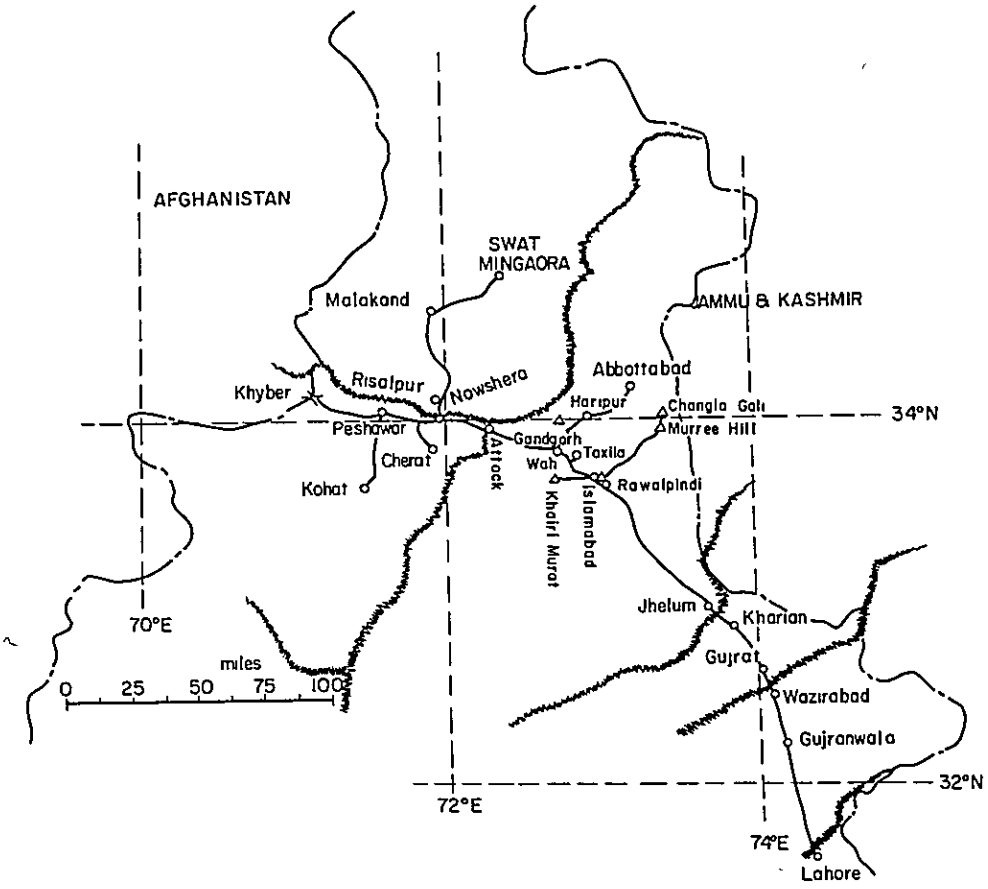
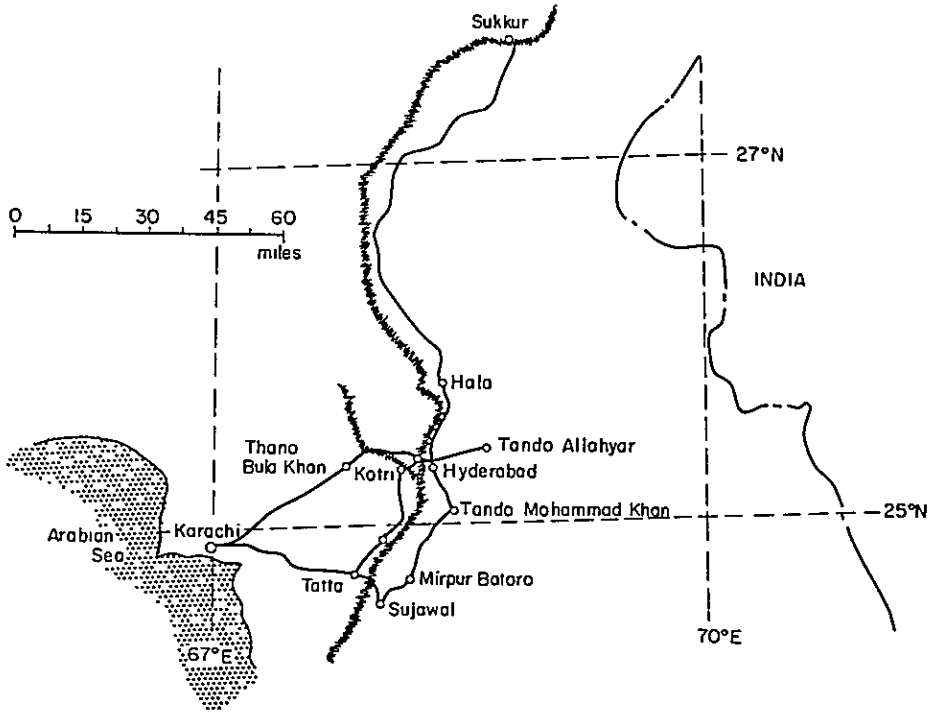


Fig. II. 2–2 Survey points in Southern Parts of West Pakistan



miles to the north of Pindi Point.

During the survey of Pindi Point and Changla Gali, they saw snow up to a depth of approximately 3 feet and experienced much difficulty in conducting the survey and maintenance of test equipment.

II-2-1-2. Propagation Test and Estimation of Service Area of Pindi Point Station

In order to determine the service area of the Pindi Point station and to study the receiving quality in the principal cities within the service area, the team carried out an extensive propagation test for principal cities of Peshawor, Nowshera, Attock, Islamabad, Gujrat, Gujranwala and Lahore, as well as conducting theoretical calculations at Abbotabad, Haripur, Wah, Taxila and Wazirabad.

Regarding Peshawar and Gujranwala, especially, because the propagation distance is more than 100 miles, the team carried out fading observations during the sunset hours when the atmosphere cools rapidly even during the dry season.

II-2-2. Survey of Relaying Means to Peshawar from Islamabad

Simultaneously with the surveys described in II-2-1 and II-2-3, the team conducted an on-paper study and planned, as one of the team's initial activities, a survey of Cherat as a relaying point for Peshawar. However, it was discovered from the results of the propagation test conducted for the Pindi Point transmitting point, that Peshawar is actually included in the service area of the Pindi Point station and the necessity of constructing a station for the purpose of relaying to Peshawar was minimized.

The candidate location Khairi Murat, referred to in II-2-3, initially had some significance as a location for the above relaying; however, for the same reason stated above, this site survey became meaningless.

II-2-3. Survey on Relaying Means from Islamabad to Lahore

The team carried out the study and measurements on the possibility of direct relaying of programs between Islamabad and Lahore and on the means of indirect relaying when a relay station is to be constructed between the above two stations.

For Pindi Point, together with the propagation test for determining the service area described in II-2-1-2, the team measured the field intensity at Gujrat,Gujranwala and Lahore.

Because Lahore is approximately 170 miles from Pindi Point and the propagation mode of this path is an out of line of sight propagation, the team received the TV signals from Pindi Point by especially selecting high towers such as the WAPDA building, Badshai Mosque, etc.

Also, the team made a study of the relay means to Lahore when Khairi Murat was selected as a possible location for the transmission station. It installed a test transmitter at Khairi Murat and carried out measurements at Gujrat and Kharian.

II-2-4. Survey of Relaying Means to Hyderabad from Karachi

The team measured radio signals of the Karachi TV station at Tatta, Hilaya and on a hill (about 500 feet above sea level) near Jorewall Regi. In addition, the team carried out a reception test on the roof of the Oriental Hotel (approximately 80 feet above sea level) in Hyderabad, using a 3-element antenna for Ch. No. 4.

II-2-5. Survey for Serving the Southwestern Area (including Khulna) in East Pakistan

In this survey, the test transmitter was set up in Khulna and receiving measurements were performed at Kamarkhali Ghat, about 20 miles to the east from Faridpur Chaulia (near Lohagra). At the same time, in order to study relaying means from the Dacca station to the Khulna area, the team received and measured the field intensity of the present Dacca TV station at Faridpur and Kamarkhari Ghat.

The geographical feature of the area between Dacca and Khulna is practically flat, and for installation of a TV station, all locations are similar and no eminent location which is advantageous with respect to services exists. Consequently, the propagation characteristic in this area is extremely simple, except the effect of trees which are dense near every village.

The simple topographical profile of the area made the estimation of the service area easy, and even though sufficient time could not be allotted to this survey because of the tight survey schedule, the reliability of this report has not been reduced in the least.

II-2-6. Survey for Serving the Northwestern Area (including Bogra)of East Pakistan

The significance of this survey is the same as that in the case of Khulna cited in II-2-5.

The team installed the test transmitter on the roof of a building (about 80 feet above sea level) located at the center of Tangail and conducted measurements at Sherpur and Raiganj. Also, in order to study the relaying means to the Bogra area, the team received and measured the field intensity of the Dacca station at Tangail.

II-2-7. Survey on Relaying Means to Chittagong from Dacca and on Serving the Chittagong Area

For this survey, labor, number of days and survey accuracy required far exceeded the team's estimation.

The reason for the above was that the geographical terrain within the city of Chittagong and between Comilla and Chittagong is rather complex compared with other areas.

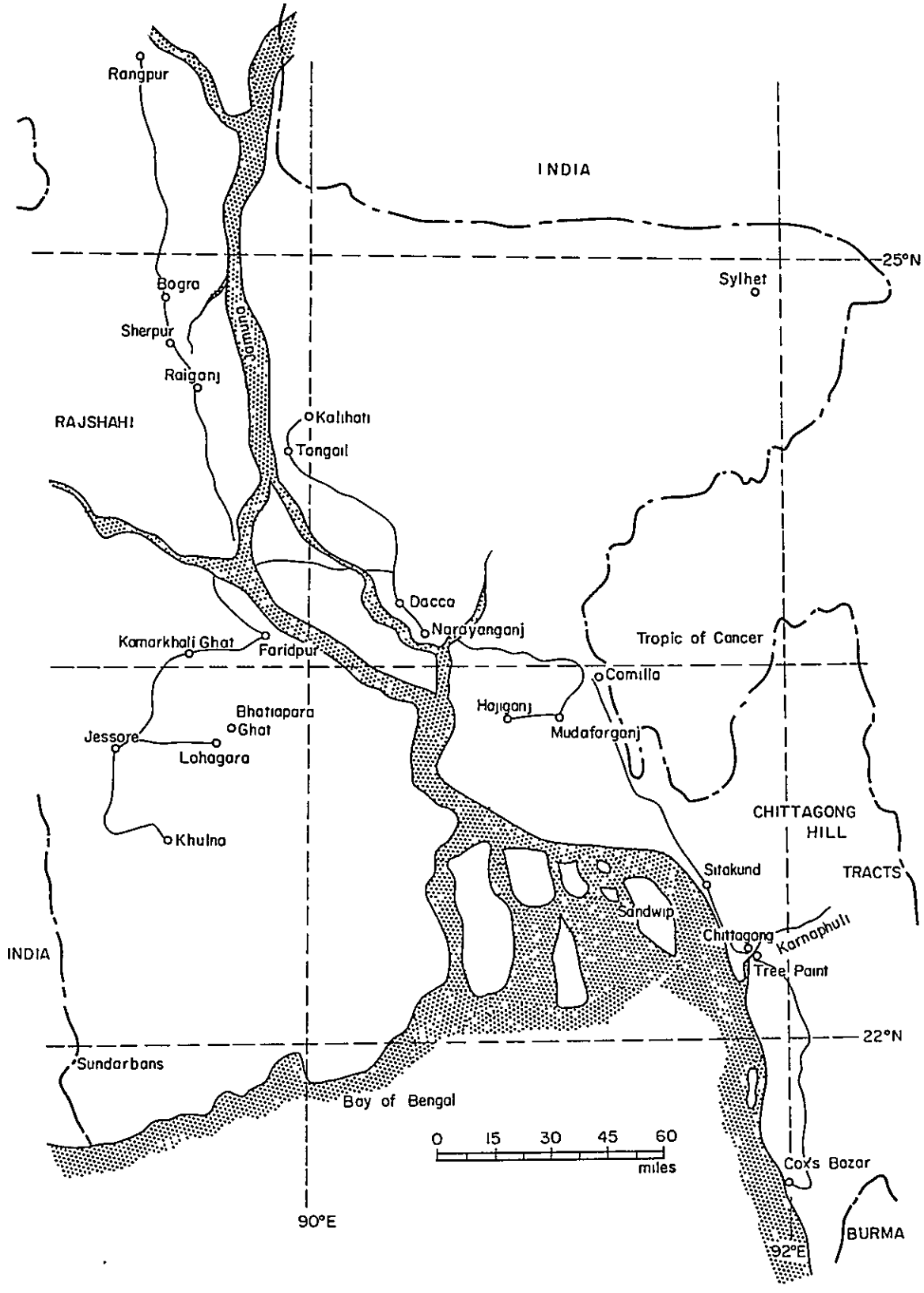
As is referred to in the report of the Noguchi survey team, many hills lay scattered throughout the city of Chittagong and the condition was such that it was very difficult to make any prediction on the characteristics of TV wave propagation.

Consequently, the team carried out a detailed study on the service, including the problem of ghost occurrence, within the city. It set up its test transmitter at Sitakund (1,152 feet above sea level) 20 miles northwest of Chittagong, on the roof of the courthouse building (approx. 120 feet above sea level) located in the central part of Chittagong and at the so-called Tree Point (approx. 150 feet above sea level) near the Chittagong Air Port and conducted precision measurements of field strength and occurrence of ghost in the areas which are mostly in the shadows of the hills.

The equipment used in the transmission and reception in the above ghost tests was exactly the same as the equipment used at Islamabad.

Relative to the study on the relaying means between Dacca and Chittagong, the TV waves of the Dacca station and of Sitakund test transmitter were received and measured at Hajiganj.

Fig. II. 2–3 Survey points in East Pakistan



Also, at Sitakund, the team attempted to receive the radio waves of the existing Dacca station, but no reception was possible.

Unlike West Pakistan, in East Pakistan, the efficiency of the field survey activities was restricted by the necessity of crossing rivers numerous times. However, the team's activity plan which was made adaptable to all circumstances, enabled it to attain all objectives.

II-2-8. Survey on Man-made Noise in Principal Cities

In surveying noise (mainly man-made noise) in cities, the determination of the objective cities, definite points for measurement, height of the antenna above ground to be used and method of processing the data gathered are an important factors.

First, the team selected, as the objective for measurement, the cities of Rawalpindi, Islamabad and Peshawar in West Pakistan as well as the cities of Dacca and Chittagong in East Pakistan.

Even though time was limited, this noise measurement was conducted for the downtown area, residential areas and green belts of the cities selected. The survey team measured noise at points about 30 — 70 feet away from the edges of roads or where houses are normally located in those areas.

In the same way as in the case of the field strength of TV signals, the team recorded the quasi-peak detected output (band width: 80kc at the -6dB points; Electrical charge and discharge time constant: 0.12ms and 600ms) of noise (antenna was pointed in the direction of maximum noise strength) at the time when the height of antenna above ground is 30 feet (10m) at each measuring site. (For the city of Chittagong, the above noise measurement was performed using the meter indication reading method because other measuring instruments were being used elsewhere.

According to our experience, to understand the actual noise condition at any given point, the data obtained in the measurement of 20 minutes is necessary and sufficient for the VHF band. Thus, the team decided to perform continuous recordings of longer than 20 minutes and to read the maximum value, 5%, and 50% values for the certain 20 minutes interval. (The 5% value is the value in the case when the total time during which the values of a 20 minute period exceed the value is 20 minutes x 0.5 = 1 minute.) For the survey result on Chittagong, the team from its past experience, decided to adopt the 10th peak value as 5% value.

Moreover, for the city of Dacca, continuous measurements which lasted over 24 hours were conducted. Except for the measurements which were interrupted for calibration and so forth, the data obtained was processed in the same way as that described above for the intervals of 00 minute - 20 minute and 30 minute - 50 minute every hour.

The results of measurements are given in II-3-8.

II-3. Survey Results

II-3-1. Results of Ghost Test at Islamabad

II-3-1-1. Measuring Results for Pindi Point

It can be said that there is no worry at all regarding the occurrence of ghosts at Islamabad when TV signals are transmitted from Pindi Pint. The results of measurements are shown in Table II-3-1-1-1 and Fig. II-3-1-1-1.

First, the service field intensity of 100 kw conversion reaches 98 - 110 dB and is sufficient. On the other hand, in the above case, the attenuation due to the Marghala mountain chain which lies close to Islamabad and the occurrence of ghost due to multiple reflections posed some problems.

In Fig. II-3-1-1-1, the hatched portion is the shadow area. For instance, measuring point No. 9 is shadowed by Shakar Parian and measuring point No. 5 is shadowed by Marghàla mountain chain. However, actual measurements at these measuring points showed no occurrence of ghost at all. Even at measuring point No. 1 near the secretariat and close to the shadow area, the occurrence of ghost was not observed. This means that when the station is constructed at Pindi Point, the entire are of Islamabad will be served with a good picture. The same thing can be said for the time when Islamabad fully becomes a capital city with the future development of the city project.

II-3-1-2. Measuring Results for Shakar Parian

In this case, from the transmitting point of Shakar Parian, the entire area of Islamabad is in the line-of-sight and the results of actual measurements showed no ghost at all. The results are shown in Table II-3-1-2-1 and Fig. II-3-1-2-1. The service field intensity when Shakar Parian is made a transmitting point is 73 - 101dB at E. R. P. 1kw conversion and this means that there is no cause for worry concerning ghost even at the time of some reflections from the Marghala mountain range.

TABLE II.3.1-1-1

GHOST TEST

FROM PINDI POINT TO ISLAMABAD

No.	PLACE	TEST 10 W	ERP 100 kW	REMARKS
1	Secretariat	60 dB	100 dB	Line of sight No ghost
2	45 point	63	103	〃
3	35 point	58	98	〃
4	46 point	64	104	〃
5	F - 5	56	96	Shadow area No ghost
6	34 point	60	100	Line of sight No ghost
7	17 point	65	105	〃
8	0 point	67	107	〃
9	H - 8	58	98	Shadow by shakar parian No ghost
10	11 point	63	103	Line of sight No ghost
11	13 point	68	108	〃
12	G - 5	63	103	〃
13	Shakar parian (east point)	70	110	〃

H_2 = 30 Feet

Fig. II. 3.1.1–1 Pindi Point Islamabad Ghost Test

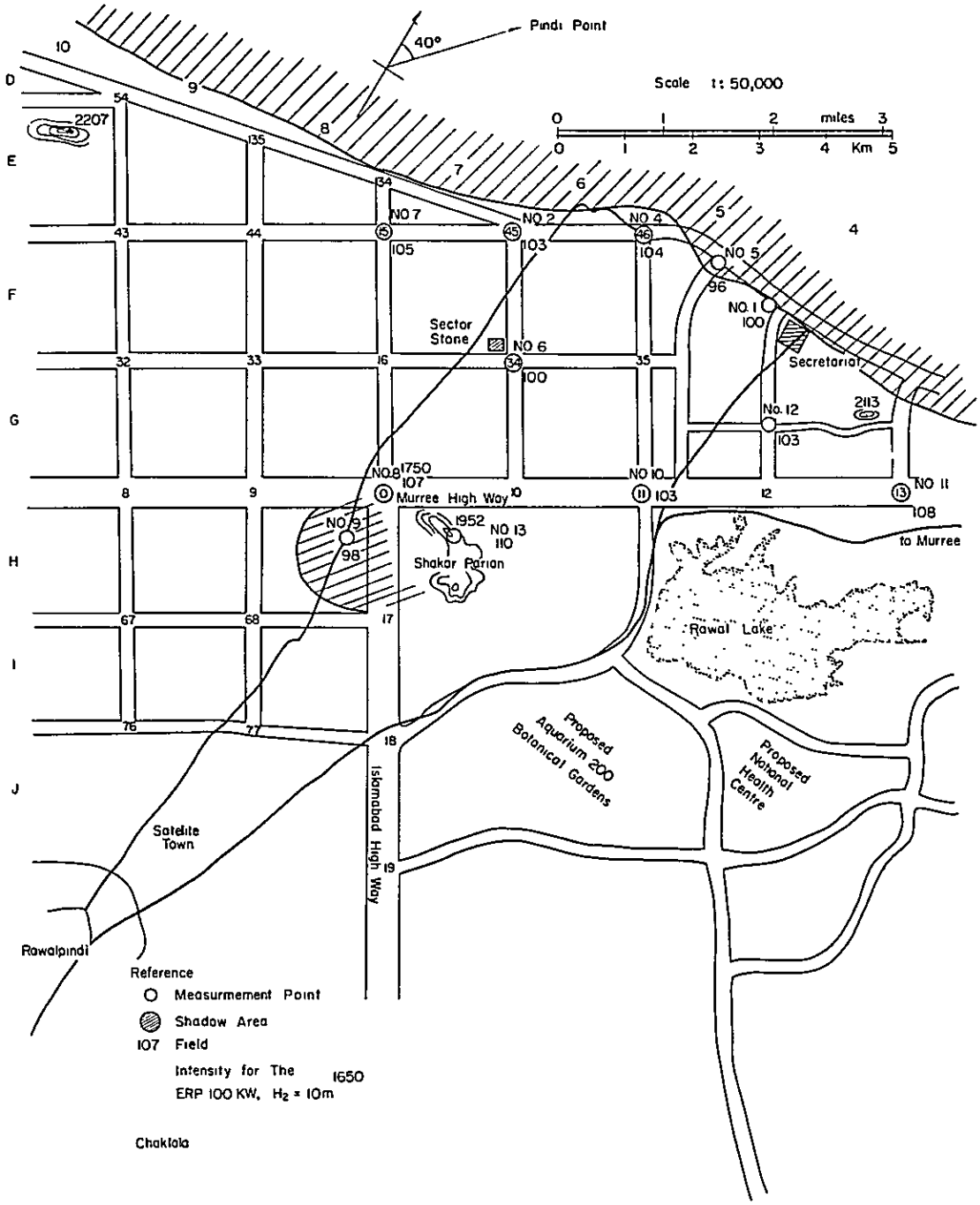


TABLE II.3.1-2-1

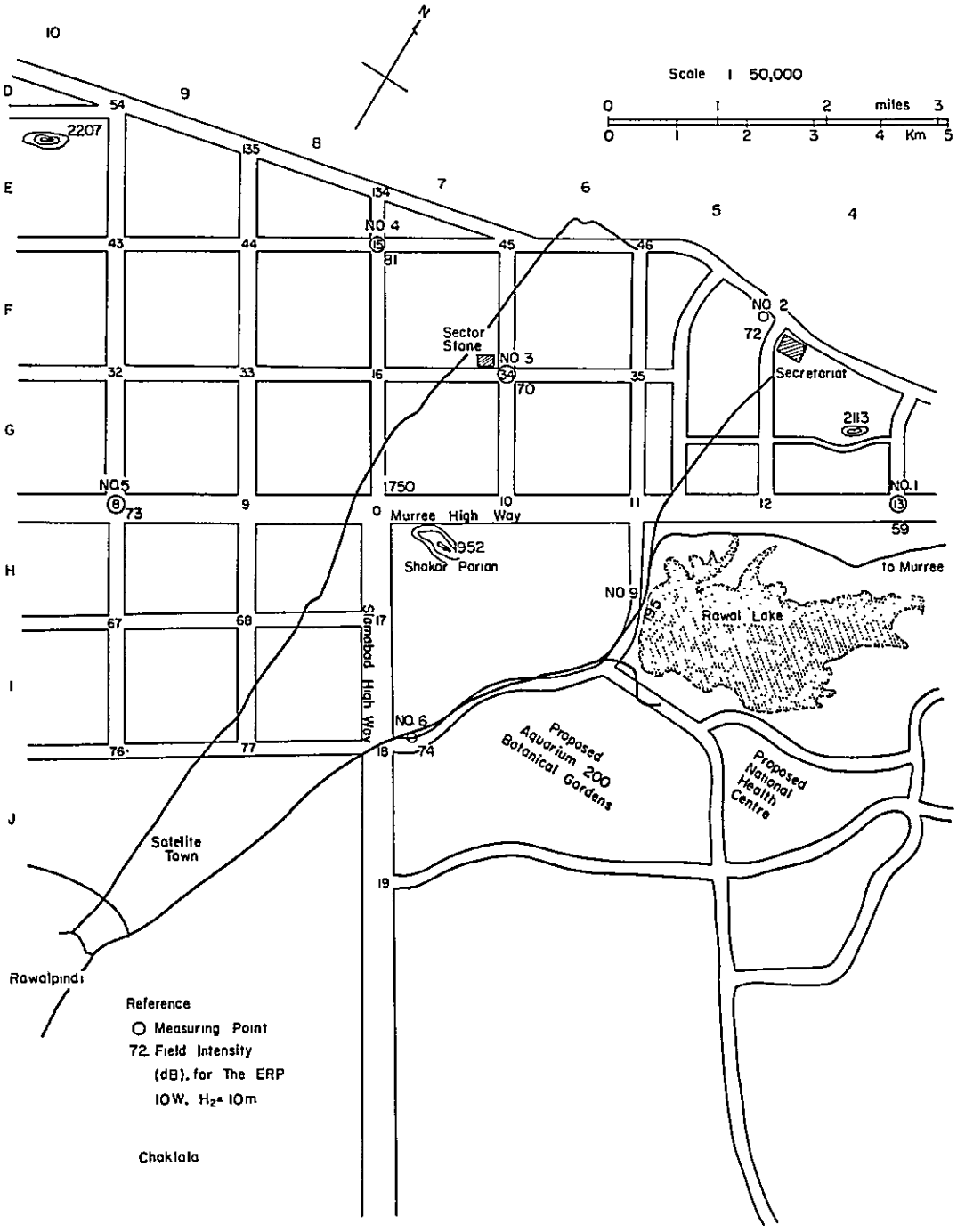
GHOST TEST

FROM SHAKAR PARIAN TO ISLAMABAD

No.	PLACE	TEST 10 W	ERP 1 kW	REMARKS
1	13 point	59 dB	79 dB	Shadow area No ghost
2	Secretariat	72	92	Line of sight No ghost
3	34 point	70	90	〃
4	15 point	81	101	〃
5	8 point	73	93	〃
6	18 point	74	94	Shadow area No ghost
7	Rawalpindi (G.P.O.)	53	73	〃
8	Ayub national park	63	83	Line of sight No ghost
9	H - 6	79	99	〃

H_2 = 30 Feet

Fig. II. 3.1.2–1 Shakar Parian Islamabad Ghost Test



II-3-1-3. Measuring Results for Khairi Murat

The results are shown in Table II-3-1-3-1 and Fig. II-3-1-3-1. When Khairi Murat is made the transmitting point, the northeastern section of Shakar Parian becomes a shadow area. However, as shown by the results of actual measurements, even at measuring points No. 3 and No. 4, a field intensity which is the same as that of the line-of-sight area is obtained. This means that the shadow effect of Shakar Parian is not large. The service field intensity at E.R.P. of 100kw conversion is 87 – 93dB.

II-3-1-4. Ghost Prediction of Changla Gali

If a TV transmitting station of approximately 100kw E.R.P. is constructed at Changla Gali, its service radius may become approximately 130 miles. However, if the city of Islamabad of today is considered, about 70% of its area may be out of line of sight and the receiving quality in the 30% area of the city may be below grade B and poor or impossible reception may be predicted. The reason for this is that, compared to Pindi Point, because Changla Gali is located farther to the north by 7 miles, the shadow effect of the Marghala mountain range increases, causing a lowering of field intensity and rising multiple reflections. This can be understood clearly by comparing the profiles of Figs. II-3-1-4-1 and II-3-1-4-2.

When the above problem is considered with respect to the entire area of the proposed future capital city, 15% of its area becomes shadow area and in about 7% of this area, the receiving quality will be below grade B.

When it is considered that the service of Changla Gali station in cities other than Islamabad is almost the same as that of the Pindi Point station, it can be said that the merit of Changla Gali as a possible location for transmitting point is very small because of the reasons previously mentioned.

TABLE II.3.1.3-1

PROPAGATION TEST

FROM KHAIRI MURAT TO ISLAMABAD

No.	PLACE	TEST 10 W	ERP 100 kW	REMARKS
1	Secretariat	53	93	Line of sight
2	G - 5	53	93	〃
3	11 point	52	92	Shadow area (by shakar parian)
4	H - 6	51	91	〃
5	18 point	53	93	Line of sight
6	34 point	53	93	〃
7	Rawalpindi (horse race course)	48	88	Shadow area (by building and tree)
8	Rawalpindi (G.P.O.)	47	87	〃
9	Ayub national park	47	87	Shadow area (by forest)

H_2 = 30 Feet

Fig. II. 3.1.3–1 Khairimurat Islamabad Propagation Test

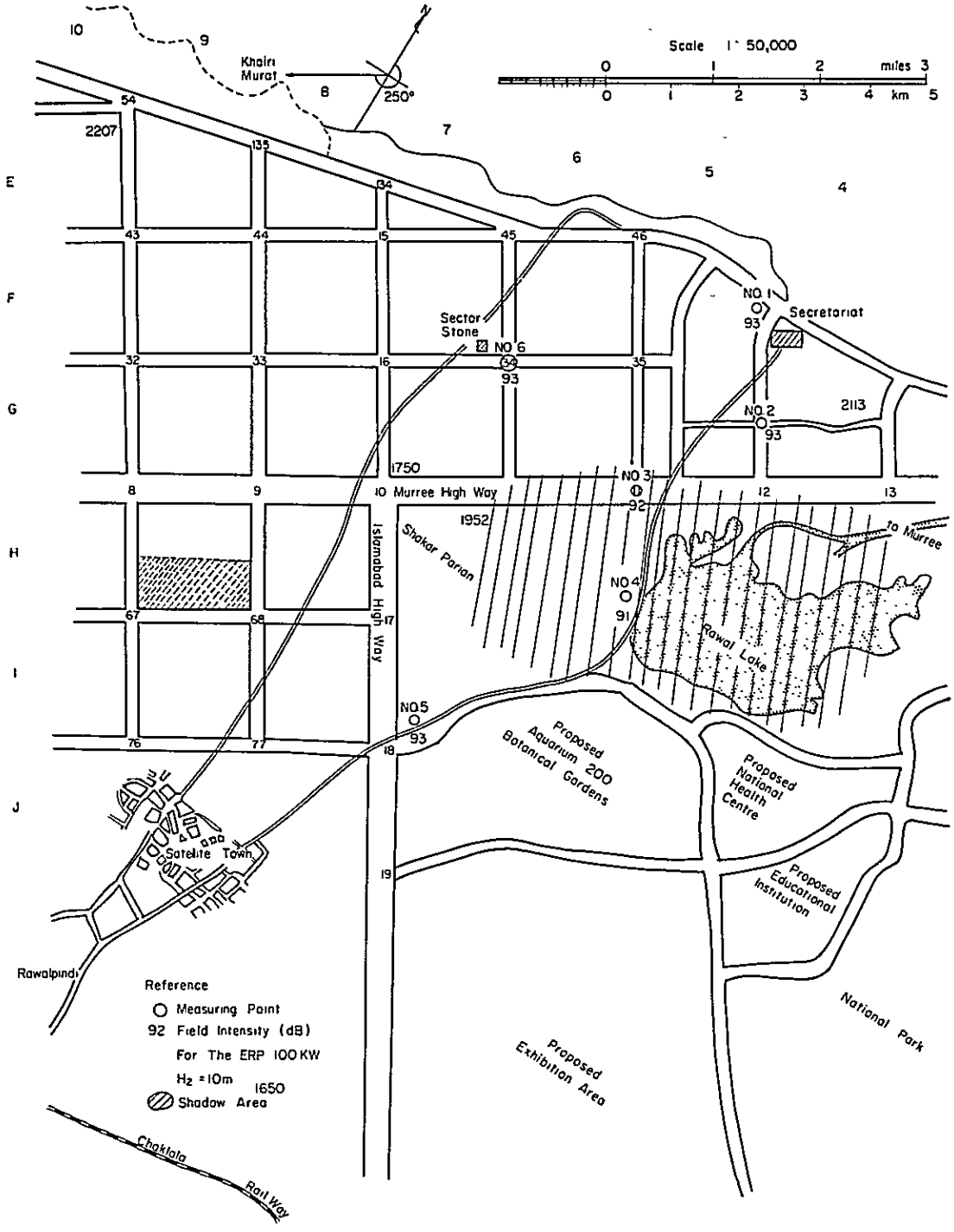


Fig. II. 3.1.4–1

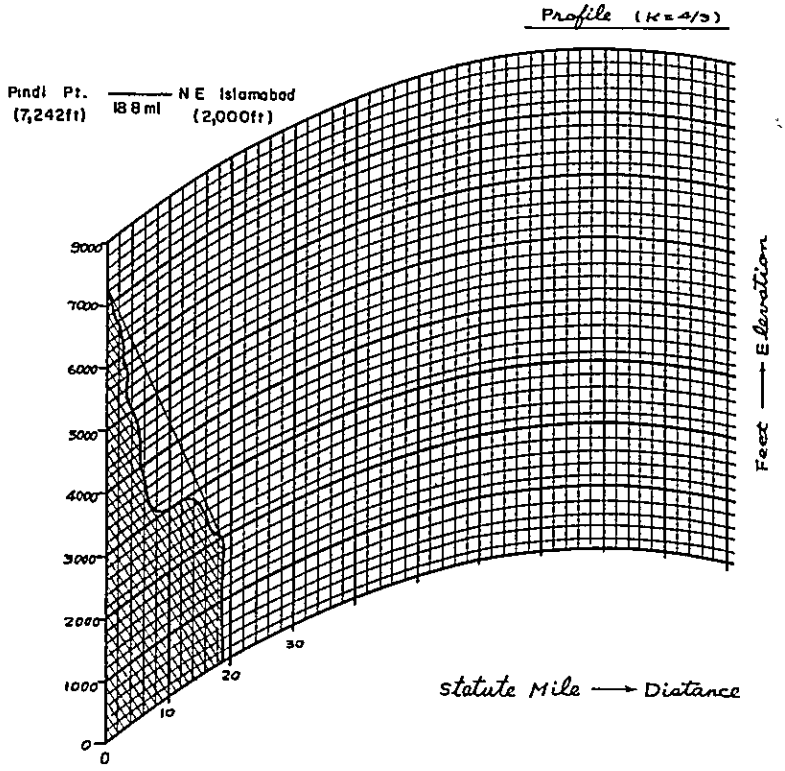
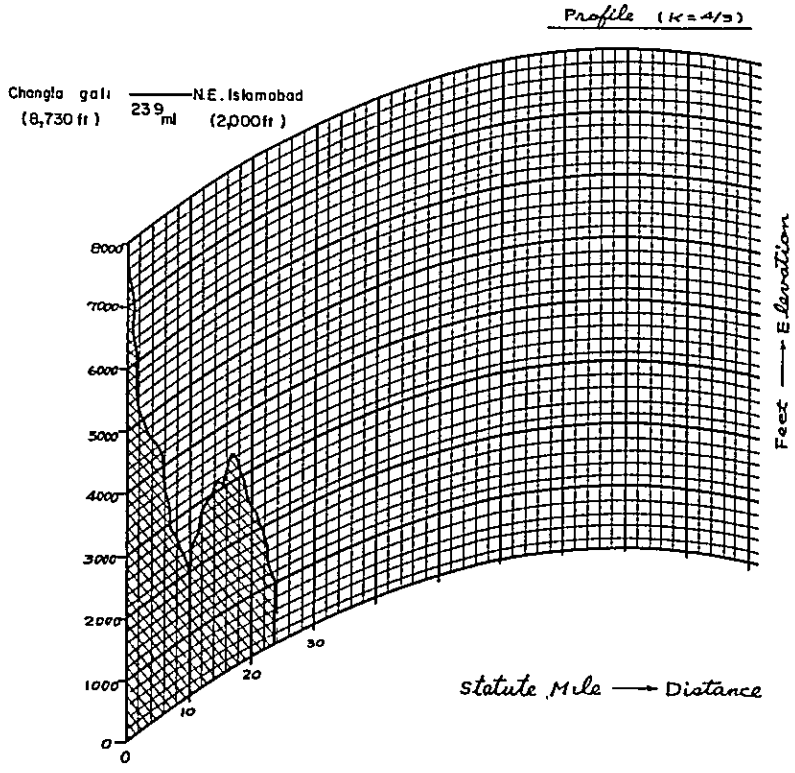


Fig. II. 3.1.4–2



II-3-2. Prediction on Coverage of Pindi Point Station and Results of Propagation Test

If a 6kw transmitter, the same output as the ones of the Karachi and the Dacca stations (which is expected to increase its power), is installed on Pindi Point and its E.R.P. is assumed to be 60kw, then the maximum service radius in the direction of comparatively level area becomes approximately 120 miles. The topographical profile of Pakistan, when seen from the standpoint of radio wave propagation, belongs to the simple class and the prediction of the receiving field intensity can be made with sufficient accuracy.

However, for principal cities, detailed propagation tests were carried out to obtain the actual conditions. In Table II-3-2-1, the results of actual measurements for several cities in the service area and theoretical calculations for the environ cities are shown. The relative positions of the various cities are shown in Fig. II-3-2-1. The height of the receiving antenna used was 30 feet. This is the same as the standard antenna of C.C.I.R. The reason for the selection of this antenna is described later together with the propagation theory which should be recommended for the topographical profile of Pakistan. (See appendixes V-2 and V-4) The expressions of grade 5, 4, 3, 2 and 1 denote excellent, good, passable, poor and no reception possible respectively. Moreover, in consideration of the various conditions such as interference and noise in Pakistan, the team decided to indicate a field intensity of 55dB or greater as grade A and field intensity of 45dB as grade B. Table II-3-2-1 and Fig. II-3-2-1 suppose an E.R.P. of 100kw for the Pindi Point station. The profiles from Pindi Point to the principal cities are shown in Figs. II-3-2-2 ~ II-3-2-10. In order to correctly understand the values and service grade of Table II-3-2-1, including the above profiles, a profound knowledge concerning radio wave propagation may be required.

TABLE II.3.2-1

Field Intensity Values (measured and calculated) and predicted quality grade; (Pindi Point site, ERP 100 kW. Height of Receiving antenna, 30 ft.)

City Name	Measured Value	Calculated Value			Predicted Grade (Remarks)
		Japan Std.	CCIR	FCC	
Peshawar	59.5 - 71	69	56	66	fairy good
Nowshera	61 - 69.5	55	-	-	good
Attock.	85.5	88	75	82	good
Islamabad	96 - 108.5	99	97	95	excellent
Gujrat	59.5	56	53	51	good
Gujranwala	54.5	55	44	50	fairy good
Wazirabad	-	67	50	62	good
Lahore	-	38	32	28	poor
Abbotabad	-	45 - 57	-	-	poor with ghost
Haripur	-	79 - 85	-	-	good
Wah	-	48 - 55	-	-	poor with ghost
Taxila	-	57 - 80	-	-	fair with ghost
Shakar Parian	110	103	-	-	excellent

Fig. II. 3.2–1 Field intensity map (Pindi Pt. site, 100^{kw} E.R.P.)

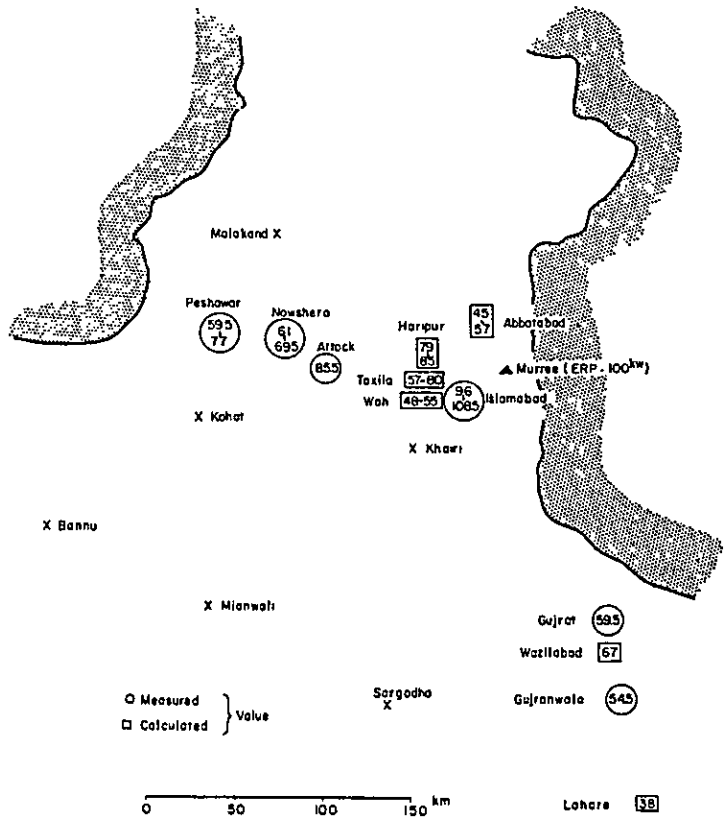


Fig. II. 3.2–2

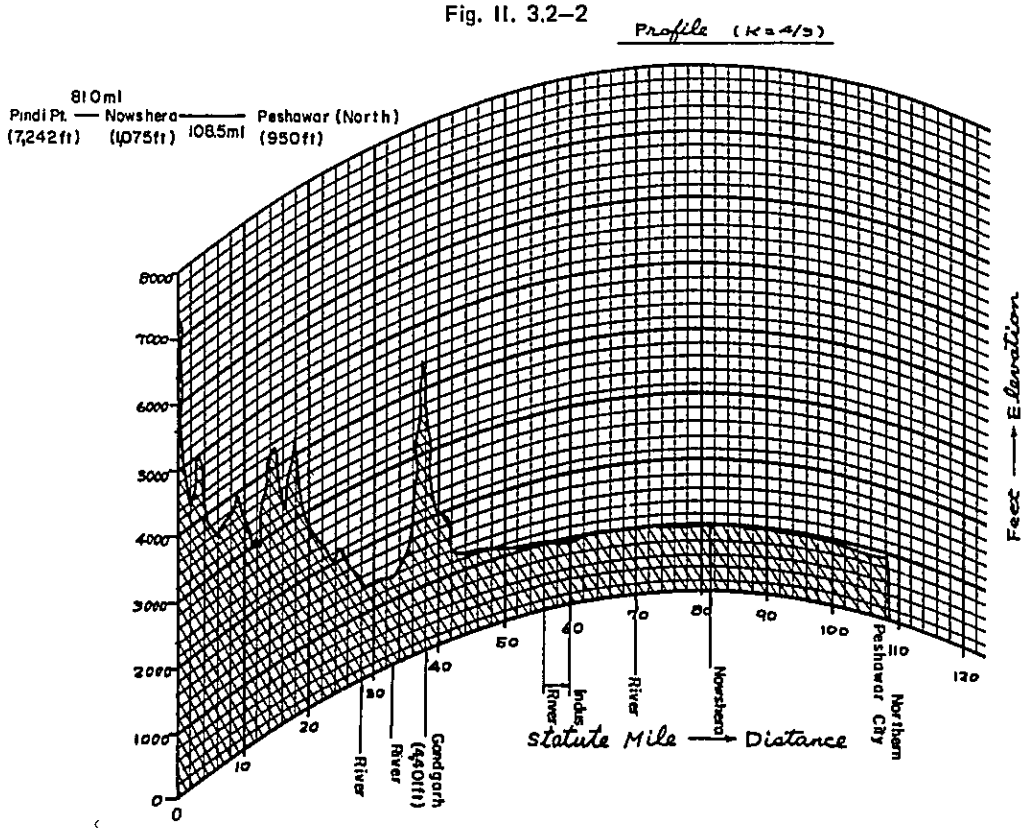


Fig. II. 3.2–3

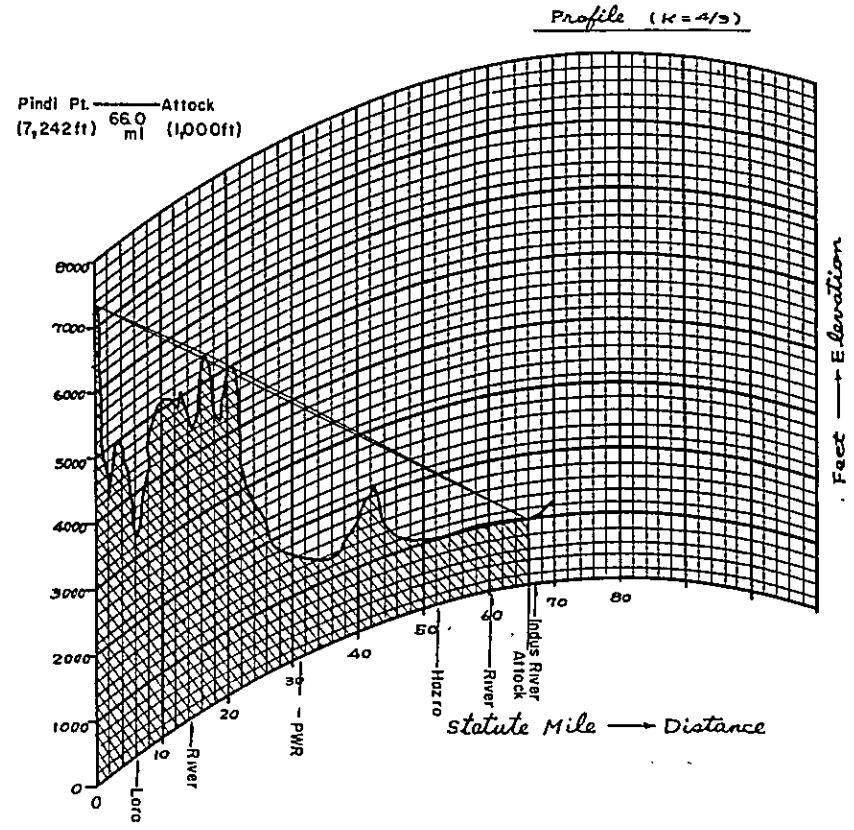


Fig. II. 3.2–4

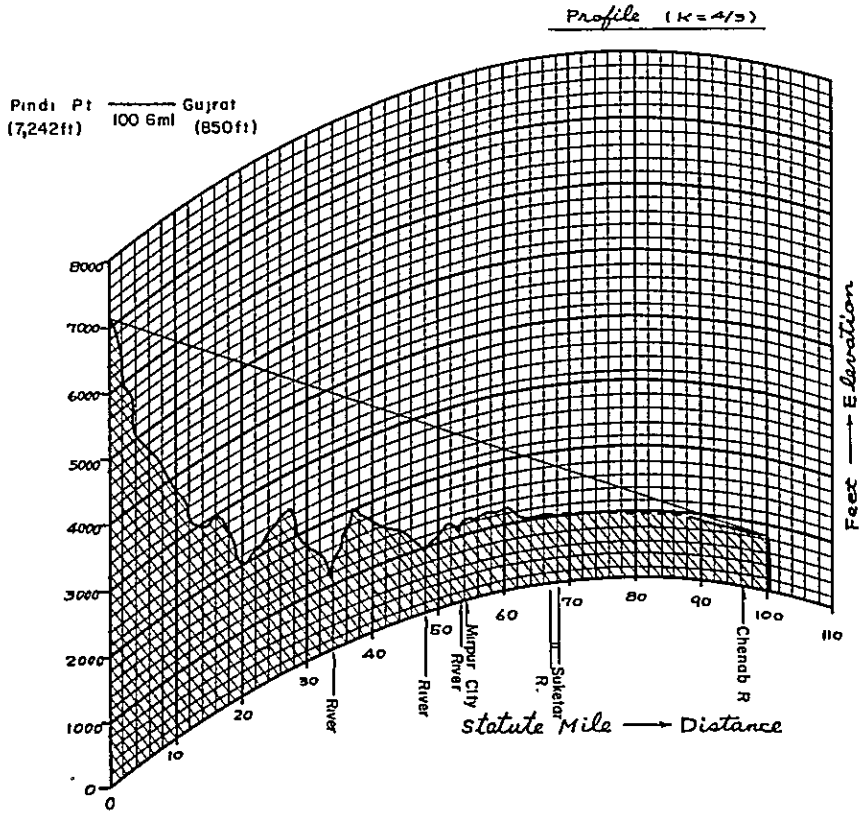


Fig. II. 3.2–5

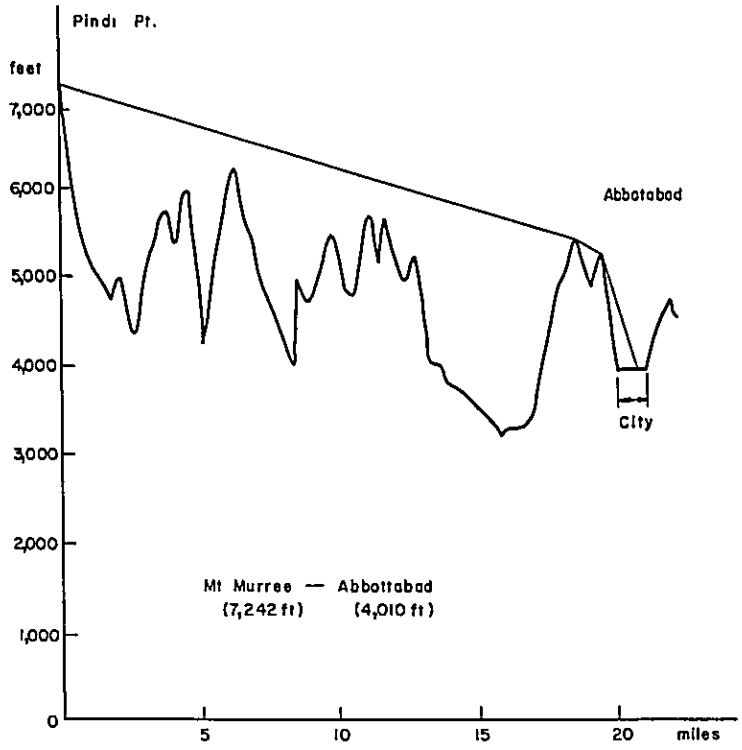


Fig. II. 3.2–6

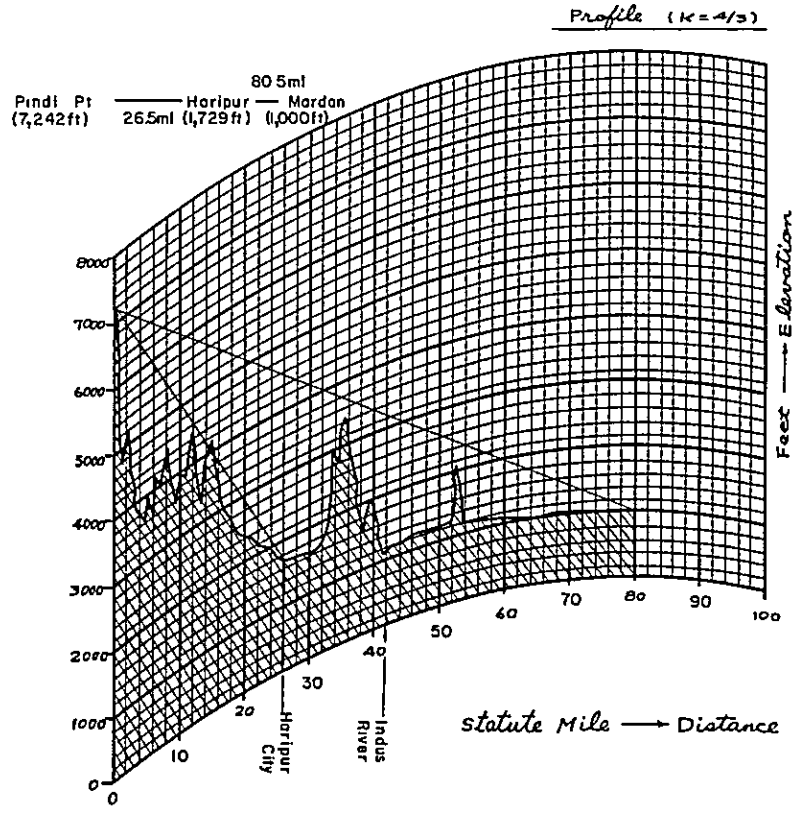


Fig. II. 3.2–7

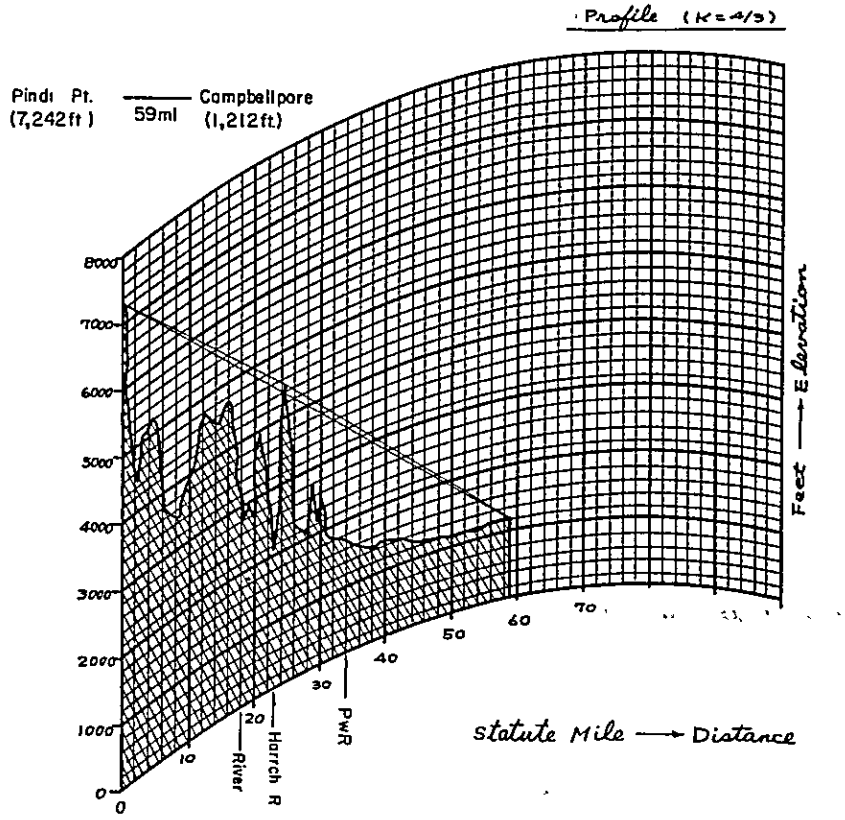


Fig. II. 3.2–8

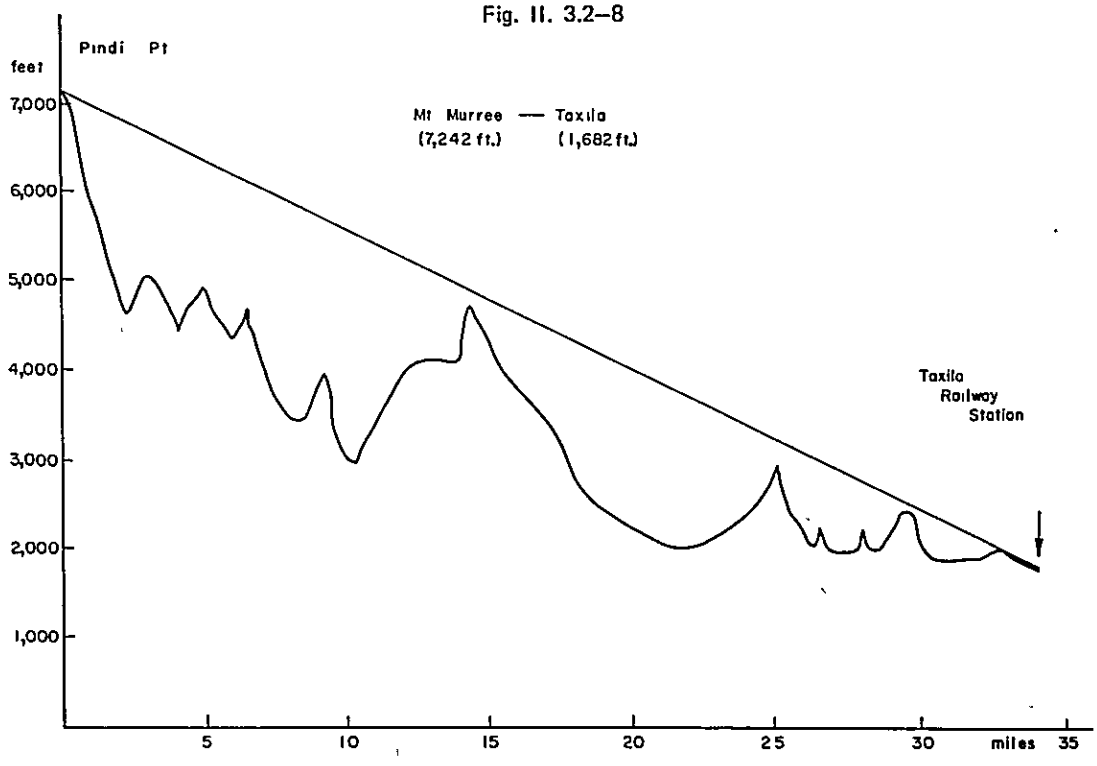


Fig. II. 3.2–9

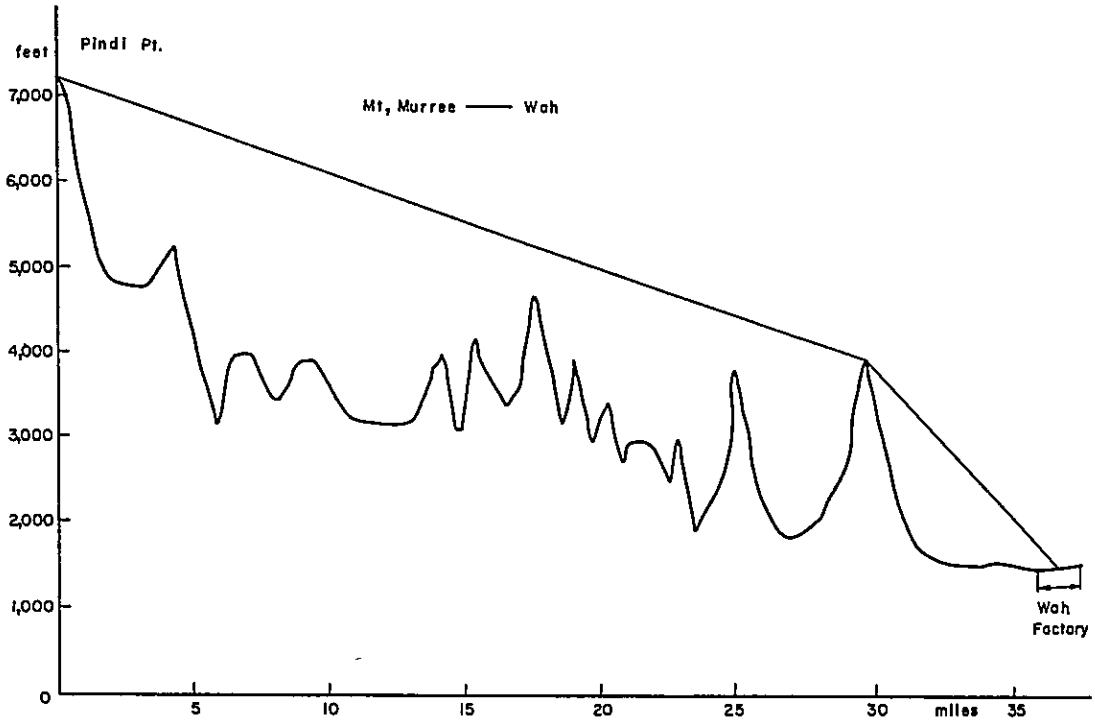
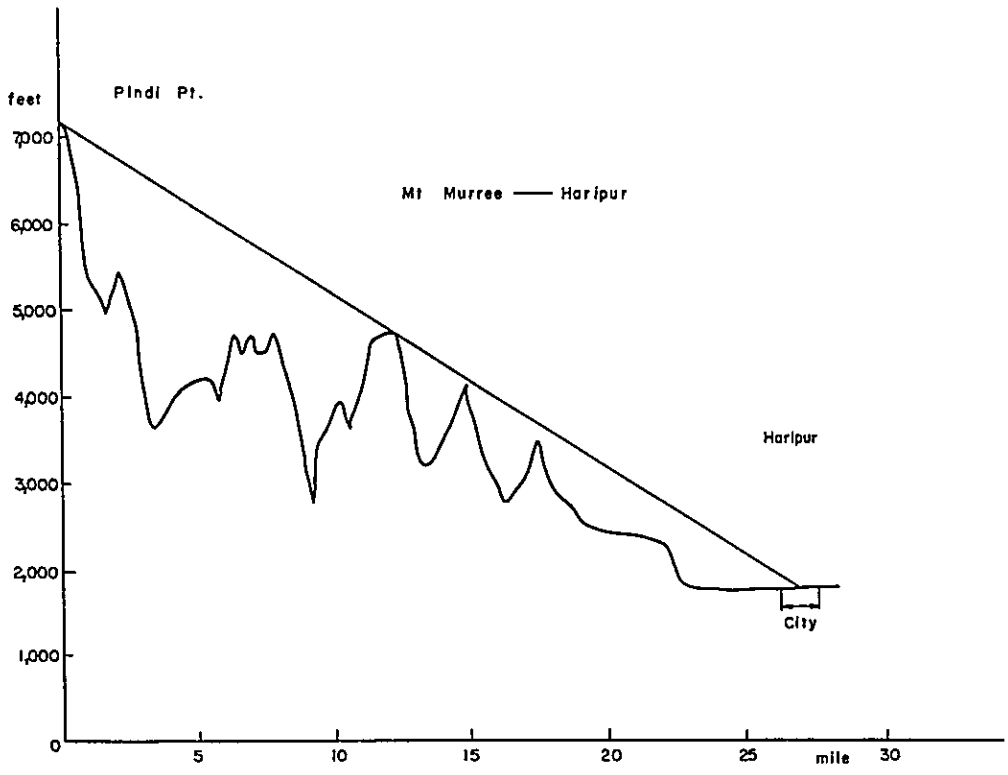


Fig. II. 3.2–10



II-3-3. Results of Survey on Relaying Means to Peshawar from Islamabad

With the installation of a station at Pindi Point, it is possible to provide Islamabad with very good service. At the same time, from the result of this survey and propagation test, it has been found that the Peshawar area also can be served directly by the Pindi Point station. Also, Attock and Nowshera between Islamabad and Peshawar can be included in the service area. The measurement results are shown in Tables II-3-3-1 and II-3-3-2 and Fig. II-3-3-1.

In the on-paper study stage, we knew that Nowshera and Peshawar are out of line-of-sight because of Gandgarh (4, 401 feet above sea level) located about 38 miles from Pindi Point. However, the profile (Fig. II-3-2-2) is a typical one-step diffraction, over-the-mountain propagation and in the case of 100kw E.R.P., we expected a field intensity of over 60dB for Peshawar. To describe in greater detail about the Peshawar area, the central part and the south side of the city measuring points No. 2, No. 3 and No. 7 are actually in the line-of-sight from Pindi Point and the area which starts at the Grand Trunk Road and extends to the north side for about 3 miles (including measuring points No. 8, No. 9, No. 4 and No. 6) is the shadow area due to the over-the-mountain propagation. Even on the north side of the city, measuring point No. 5 is again in the line of sight. Also, between measuring points No. 1 and No. 2 there exists a shadow area one mile wide. The reason that shadow areas exist alternately in the area which runs north and south for 10 miles is that the ridge of Gandgarh, which is the diffraction point, is sharp. The measurement results for Peshawar show, roughly speaking, a field intensity distribution which corresponds to the shadow areas. In this case, regarding measuring points No. 8 and No. 9, because of shielding and scattering due to houses and trees, a lowering of field intensity to some degree is shown. The height pattern is practically linear and the difference in the field intensity for receiving antenna heights of 30 feet and 15 feet was approximately 6dB. Consequently, the field intensity received in Peshawar is proportional to the actual antenna height and will be within a range of 59.5 – 71dB with a 30 foot antenna. From the above, it can be said that there is not much difficulty in the selection of the location and height of the receiving antenna. For Nowshera and Risalpur, the field intensity is over 60dB and sufficient service is possible.

The propagation distance from Pindi Point to Peshawar is approximately 108 miles and is equivalent to the radio wave in line-of-sight limit with the height difference of approximately 6, 200 feet. This means that the field intensity of the Peshawar area is affected greatly by the variation of the equivalent earth radius K at the standard atmosphere. In other words, the above means an occurrence

of fading. Some portion of the record of fading tests we carried out, in order to know the above condition during sunset hours when the variation of atmosphere is greatest, is shown in Fig. II-3-3-2.

The test transmitter installed at Pindi Point was operated with a stopping period of 5 minutes every 10 minutes.

The measurement results showed that the receiving field intensity was extremely stable and no fading was observed. This may be due to the fact that this measurement was carried out during the winter time and the atmospheric variation which affects the radio wave propagation was less, but if the fading, including that of the summer time, for Peshawar be predicted statistically, it may be that the variation width of the receiving field intensity might be held to about 4dB at a time rate of 90% and to within 10dB at a time rate of 99%. The above can be said of the fading measuring point No. 3, Dean's Hotel, which is in the line-of-sight from Pindi Point, but in the shadow areas, the variation width generally will be smaller because of the propagation mechanism of this path.

TABLE II.3.3-1

PROPAGATION TEST

FROM PINDI POINT TO NOWSHERA

No.	PLACE	DISTANCE	TEST 50 W	ERP 100 kW	REMARKS
1	MANKI HILL	79.3 Mile	36.5 dB	69.5 dB	3 MILE SOUTHWARD FROM NOWSHERA
2	NOWSHERA GARDEN	79.6	29	62	INSIDE OF CITY
3	RISALPUR	77.7	29.5	62.5	
4	DERI KATIKHAL	74.0	33.5	66.5	5 MILE EASTWARD FROM NOWSHERA
5	KUND	65.9	52.5	85.5	NEAR ATTOCK

H_2 = 10 m (30 Feet)

TABLE II.3.3 - 2.

PROPAGATION TEST

FROM PINDI POINT TO PESHAWAR

No.	PLACE	DISTANCE	TEST 50 W	ERP 100 kW	REMARKS
1	GLAVITY FLOW CANAL	102.8 Mile	33.5 dB	66.5 dB	4 MILE SOUTHWARD FROM PESHAWAR
2	LANDI	102.6	38	71	1 MILE SOUTHWARD FROM PESHAWAR
3	DEAN'S HOTEL	103.9	33.5	66.5	CENTER OF CITY
4	SHIKA KATHA	102.3	29.5	62.5	1 MILE NORTH WARD FROM PESHAWAR
5	BAK SUPUL	101.7	36.5	69.5	4 MILE NORTHWARD FROM PESHAWAR
6	NISHAT SARHAD	102.2	28.5	61.5	2 MILE NORTHWARD FROM PESHAWAR
7	ARMY ATADIUM	104.3	31.5	64.5	INSIDE OF CITY
8	ARMY GROUND	104.0	26.5	59.5	" "
9	JINNAH PARK	103.3	26.5	59.5	" "

H_2 = 10 m (30 Feet)

Fig. II. 3.3–1 Sketch Map of Peshawar (Measuring Point)

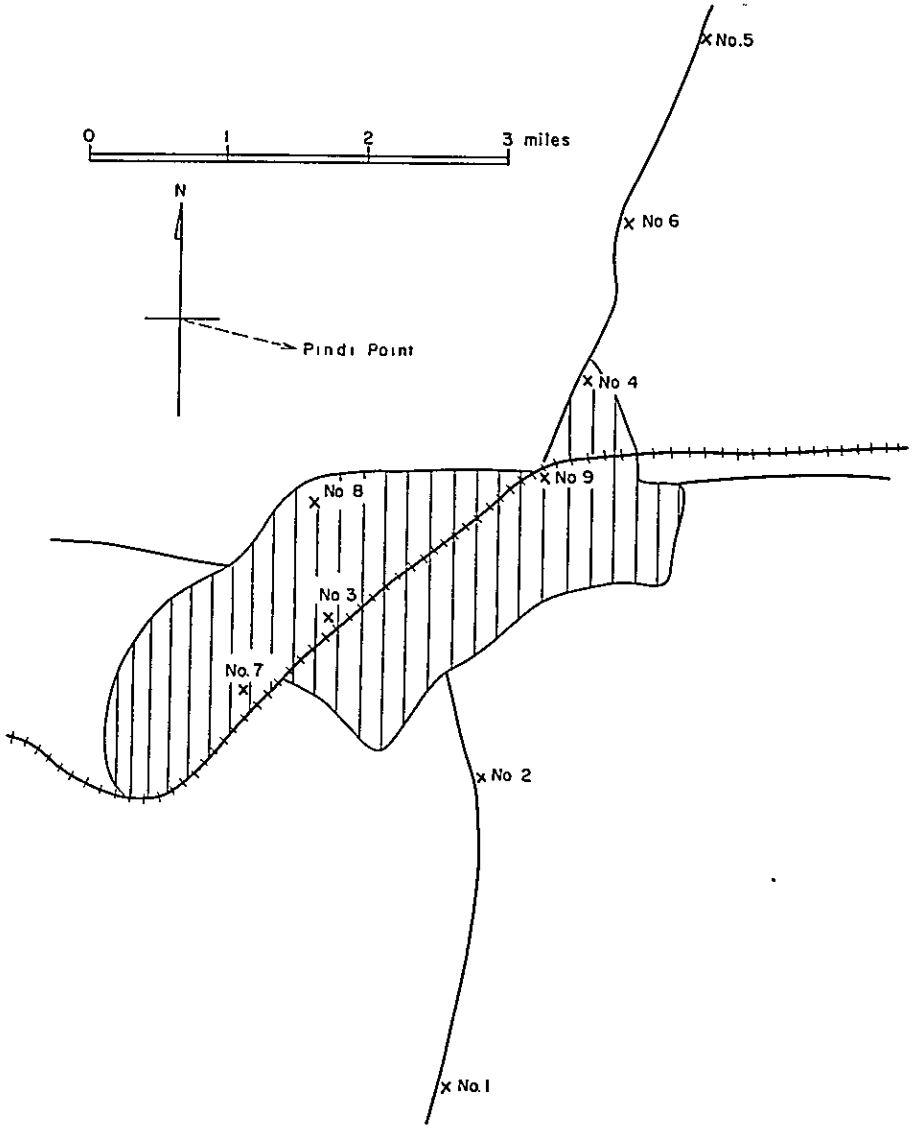
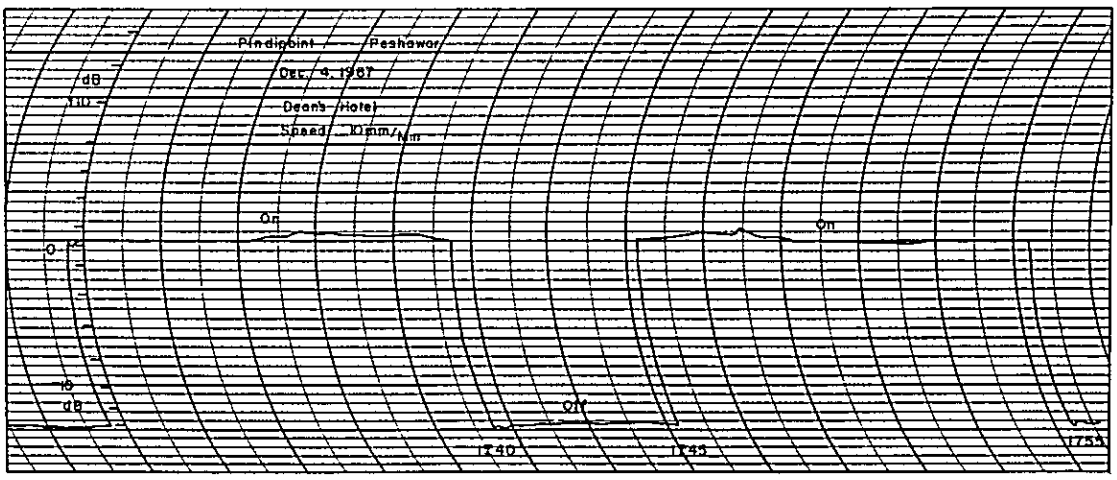


Fig. II. 3.3–2 Fading Test



II-3-4. Results of Survey on Relaying Means to Lahore from Islamabad

The results of propagation tests in the direction of Lahore with the transmitting point located at Pindi Point are shown in Table II-3-4-1. The points at which measurements were made were distant places out of the line-of-sight from Pindi Point. For this reason, for Lahore especially, measurements were made with a receiving height of 100 – 150 feet.

When a study is made on the direct program exchange between Islamabad and Lahore based on the above measurement results, the following may be said:

Related to the planned power increase for the Lahore station, by utilizing the transmitting antenna tower with a height of approximately 300 feet to be newly constructed for reception, the receiving field intensity of the Pindi Point station at the Lahore station is approximately 64dB. If E.R.P. due to the proposed power increase of the Lahore station is assumed to be approximately 70kw, judging from the reversibility of radio wave propagation, the receiving field intensity of the Lahore station at Pindi Point becomes approximately 63dB. When the receiving antenna height is 300 feet, the line-of-sight distance with respect to radio waves from Pindi Point is 118 miles. Compared with the above, since the actual distance between Pindi Point is approx. 171 miles, the inverse opticality is 1.44 times. Because of this out-of-line-of-sight propagation, the above-mentioned receiving field intensity is accompanied with an effect of atmospheric varioation or fading, and during the summer time, especially, the above variation may influence the feasibility of direct program relaying.

In the above case, if this fading is estimated statistically throughout all seasons, the variation width at a time rate of 90% is approx. 8dB, and at 99%, the variation width becomes approx. 15dB. Consequently, a receiving field intensity of 55dB = 63 - 8dB which corresponds to the reception of grade A is secured at a time rate of 90%. In other words, the direct exchange relaying of program is possible at a time rate of 90%. When the importance of programs increases and it is necessary to make constant exchange relaying possible, a rebroadcast station must be constructed somewhere (for instance at Gujranwala) between Pindi Point and Lahore. In this case, the receiving field intensity of Pindi Point at the Gujranwala station becomes, with a receiving height of 300 feet, approximately 74dB.

Also, since the inverse opticality is 0.98 times or since the station is within the line-of-sight distance, constant relaying becomes possible. The

distance between Gujranwala and Lahore also is within the line-of-sight distance and a receiving field intensity higher than 70dB can be secured.

However, as has been stated in the recommendations which follow, the required E.R.P. of Gujranwala is 50kw in the direction of Pindi Point and 6kw in the direction of Lahore. Furthermore, in order to make the Gujranwala station an unmanned station, the transmission of control signals to change over the input received at Gujranwala may become necessary.

A part of the record of fading tests, conducted as a part of the study on relaying means is shown in Fig. II-3-4-1. These tests of course were conducted during sunset hours and the results of these tests showed a variation of about $\pm$ 2dB.

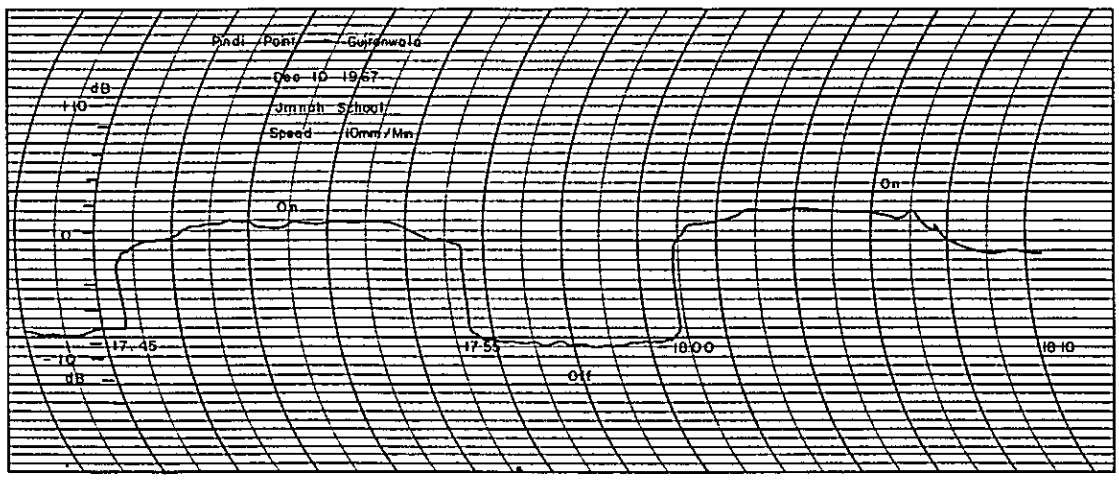
TABLE II.3.4-1

PROPAGATION TEST

FROM PINDI POINT TO LAHORE

No.	PLACE	DISTANCE	TEST 50 W	ERP 100 kW	REMARKS
1	GUJRAT	100 Mile	26.5 dB	59.5 dB	BUS CENTER H_2 = 30 FEET
2	GUJRANWALA	129	21.5	54.5	3 MILE NORTHWARD FROM GUJRANWALA H_2 = 30 FEET
3	LAHORE	172	22.5	55.5	ROOF OF WAPDA BUILDING H_2 = 109 FEET
4	LAHORE	171	24.5	57.5	TOWER OF BADSHAI MOSQUE H_2 = 176 FEET
5	GUJRANWALA	129	20.5	53.5	JINNAH HIGH SCHOOL H_2 = 60 FEET

Fig. II. 3.4–1 Fading Test



II-3-5. Results of Survey on Relaying Means to Hyderabad from Karachi

The measurement results are shown in Table II-3-5-1, while related profiles are shown in Figs. II-3-5-1 ~ II-3-5-5.

The propagation between Karachi and Hyderabad is a 1 – 2 step diffraction propagation of over 80 miles, and the maximum receiving field intensity does not exceed approx. 28dB. Moreover, the signal received is accompanied with fading whose period is approx. 3 – 5 minutes; even with a multiple element antenna erected on the roof of a tall building, the reception quality is about 2 and the time during quality 3 is extremely short. At times during the tests no reception was possible at all. At present, approximately 20-30 receiving antennae are seen in Hyderabad, but their reception condition is the same as that stated above. The fading phenomenon is also observed in Hylaya which is about 60 miles from Karachi and the field intensity becomes stable at Tatta nearer to Karachi.

Consequently, it is necessary that the first relay station for Hyderabad to be constructed at Tatta. As here, the receiving field intensity becomes greater than 60dB with a 300-foot antenna.

Because the distance from Tatta to Hyderabad is approximately 53 miles, in order to include Hyderabad in an excellent service area, a rebroadcast station should be constructed at some location south of Kotri and it is best to simultaneously serve both Kotri and Hyderabad with sufficiently high field intensity.

TABLE II.3.5-1

PROPAGATION TEST

FROM KARACHI TO HYDERABAD

No	PLACE	DISTANCE	ERP 24 kW	REMARKS
1	TATTA	50 8 Mile	36 dB	H_2 = 15 FEET RECEPTION GRADE FAIR OR POOR
2	HILAYA	59 6	25 - 31	H_2 = 30 FEET WITH FADING NEAR THE KALRI LAKE
3	KOTRI	67	25 - 36	H_2 = 500 FEET JOREWALI REGI WITH FADING
4	HYDERABAD	82	16 - 26	H_2 = 100 FEET SOUTHERN HILL OF HYDERABAD (3 MILES)
5	HYDERABAD	83 5	16 - 28	H_2 = 70 FEET ROOF OF HOTEL ORIENTAL FADING PERIOD 3 - 5 MIN

Fig. II. 3.5–1

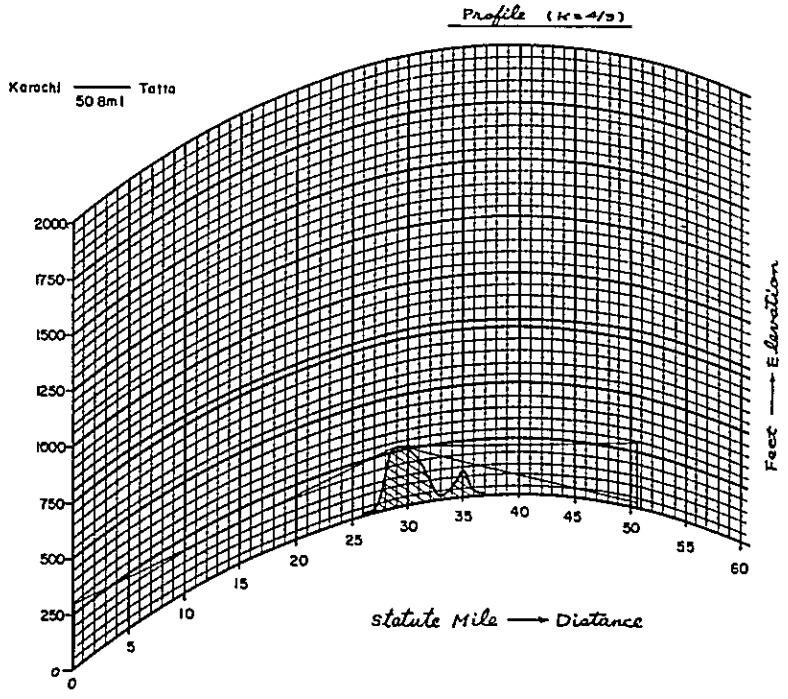


Fig. II. 3.5–2

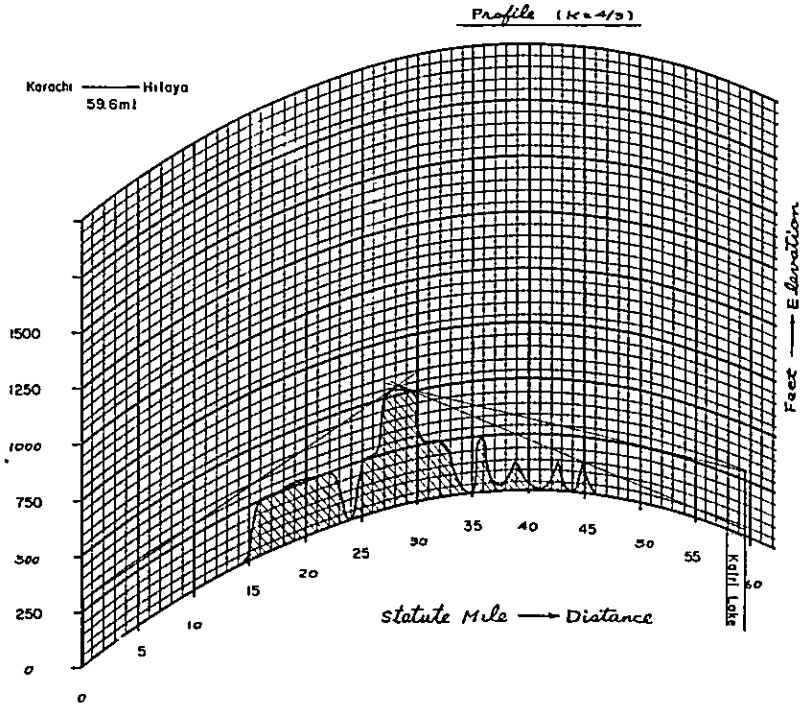


Fig. II. 3.5–3

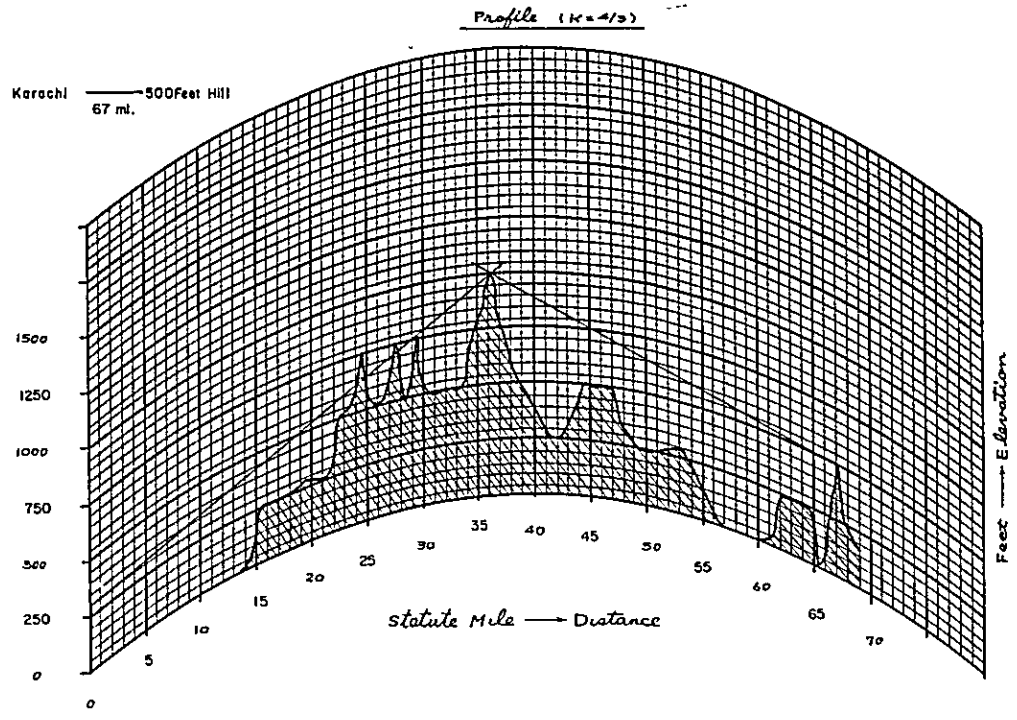


Fig. II. 3.5–4

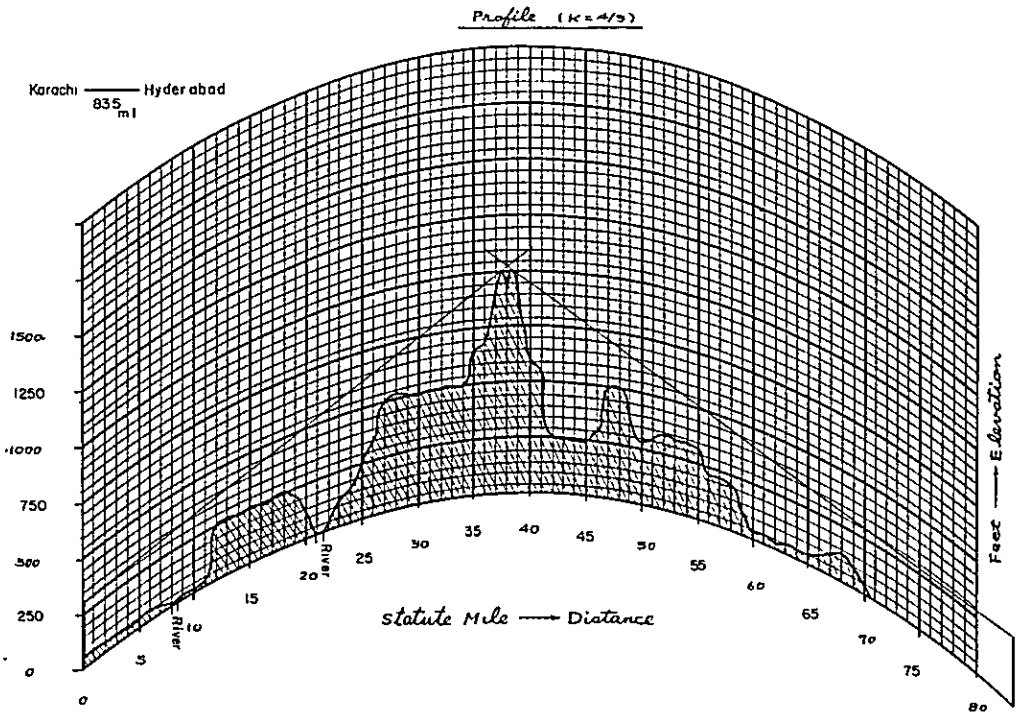
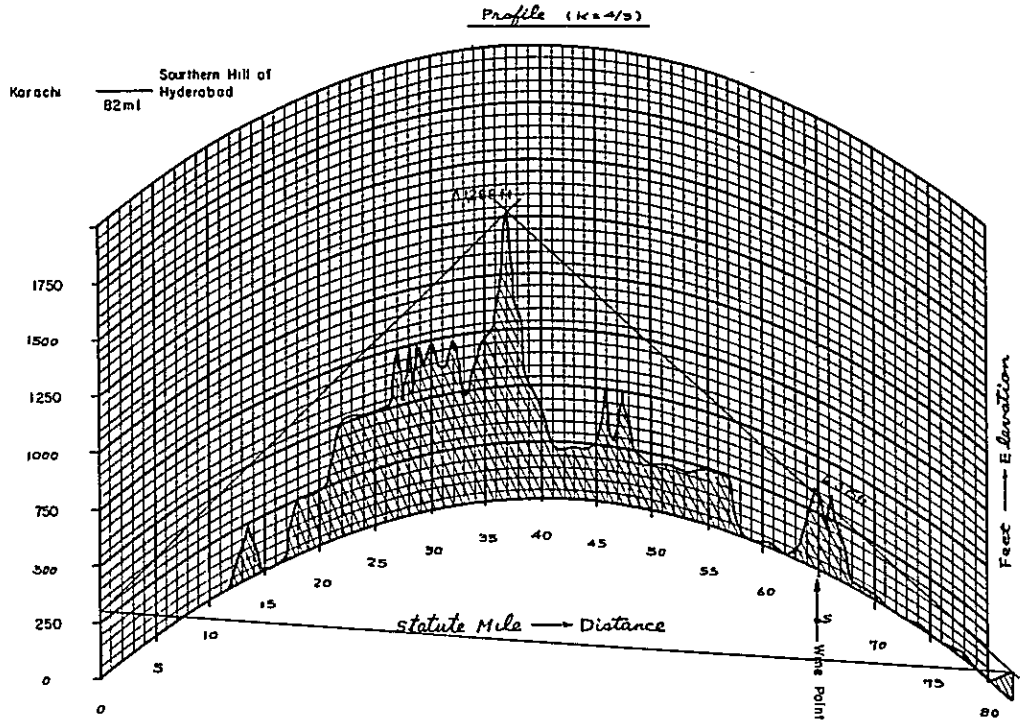


Fig. II. 3.5–5


Profile (K=4/3)
Karachi
82ml
Southern Hill of Hyderabad
1750
1500
1250
1000
750
500
250
0
0
5
10
15
20
25
30
35
40
45
50
55
60
70
75
80
Statute Mile → Distance
Feet → Elevation
Point

II-3-6. Results of Survey on Relaying Means from Dacca to Northwest and Southwest Areas

Results of the survey are shown in Tables II-3-6-1 and II-3-6-2. And related profiles in Figs. II-3-6-1 ~ II-3-6-5. The topographical profile of the above two areas is extremely flat, and so planning is possible on paper to some extent.

However, as a peculiarity of radio wave propagation in these areas, the problem of fading cannot be disregarded. There are many rivers in East Pakistan and due to the effect of them in many cases, the result of propagation tests showed fading of over 10dB even during the dry season. For instance, in the case of the area between Bogra and Tangail, it is clear, as shown in Table II-3-6-1, that fading occurs because of the effect of the atmosphere above the surface of Jamuna River.

The average annual rainfall in East Pakistan reaches 70 – 100 inches. Especially, from June to September as it is the rainy season, practically all low areas are submerged under water. Consequently, consideration which is similar to that given to the over-sea propagation must be taken.

With respect to the antenna height of 450 feet to be used after the power of Dacca station has been increased, relay stations may be placed within 50 – 60 miles of Dacca station. Also, compared with West Pakistan, there are many trees in East Pakistan and the attenuation effect of these trees may have to be taken into consideration in some cases. This is especially important when the distance is great and the incidence of radio waves is near horizontal.

With a comprehensive study of items such as described above, the team recommends the construction of relay station, as stated in latter paragraphs, at Kalihati and Bhatiapara Ghat. However, the problem of fading during the summer season may require further careful consideration.

TABLE II.3.6-1

PROPAGATION TEST

FROM TANGAIL TO BOGRA DIRECTION

No	PLACE	DISTANCE	E.R.P 25 W	REMARKS
1	SHERPUR	43 Mile	11 - 15 dB	H_2 = 45 FEET WITH FADING SOMETIMES NO RECEPTION
2	RAIGANJ	32	14 - 18	H_2 = 40 FEET WITH FADING. NORTHWARD 2 MILES FROM RAIGANJ.
3	ULAPALA	21	22	H_2 = 30 FEET SOUTHWARD 1 MILE FROM ULAPALA

TABLE II.3.6-2

PROPAGATION TEST

FROM DACCA STATION TO TANGAIL, FARIDPUR & HAJIGANJ.

No.	PLACE	DISTANCE	E.R.P. 550 W	REMARKS
1	TANGAIL	44.6 Mile	20 dB	NEAR THE BINDUBASHINI HIGH SCHOOL H_2 = 75 FEET
2	FARIDPUR	38.5	20.5	CIRCUIT HOUSE H_2 = 30 FEET
3	KAMARKHALI GHAT	57	16.5	ROOF OF NATIONAL BANK H_2 = 60 FEET FRADING. ± 8 dB.
4	HAJIGANJ	45	19.5	ROOF OF HAJIGANJ HAMEDIAJUTE MILL. H_2 = 60 FEET FADING ± 4 dB
5	HAJIGANJ	46	19.5	MAKINABAD. SOUTHWARD 1 MILE FROM HAJIGANJ H_2 = 30 FEET

Fig. II. 3.6–1

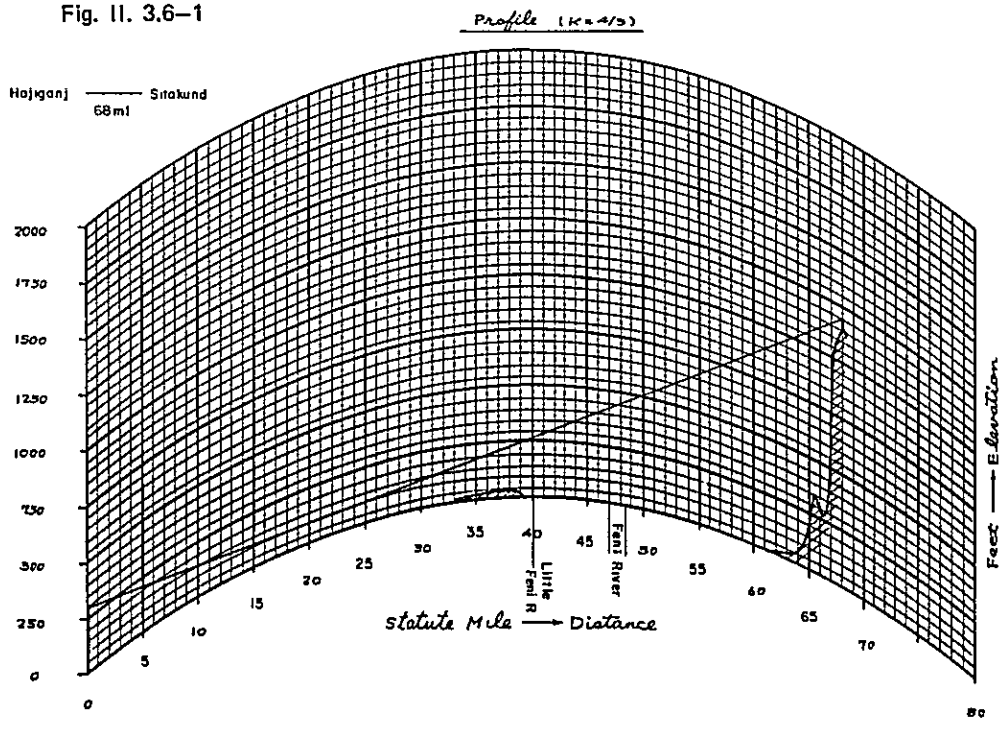


Fig. II. 3.6–2

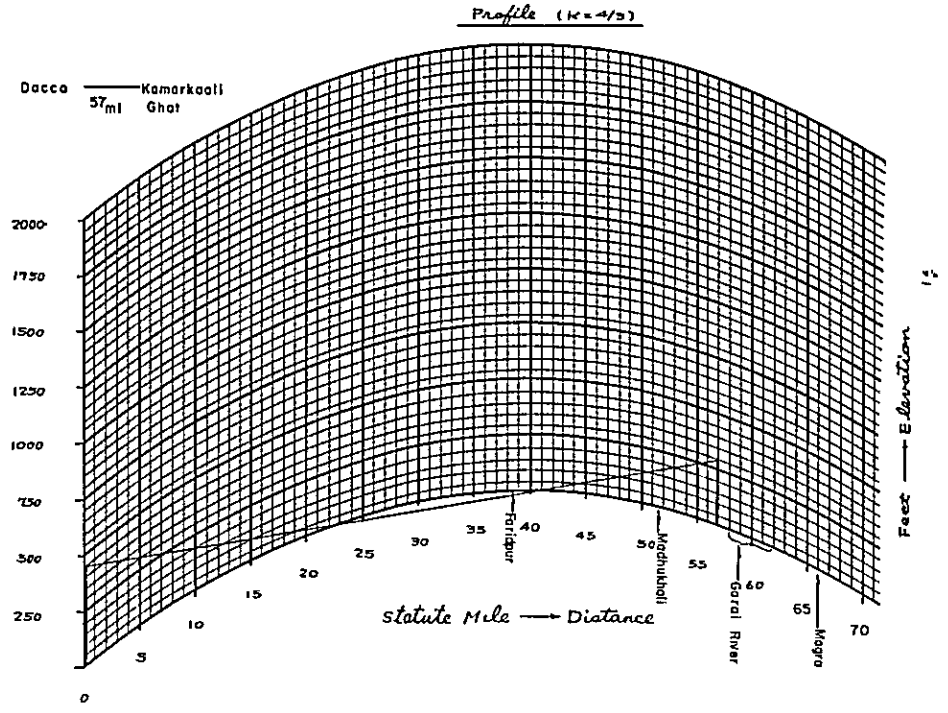


Fig. II. 3.6–3

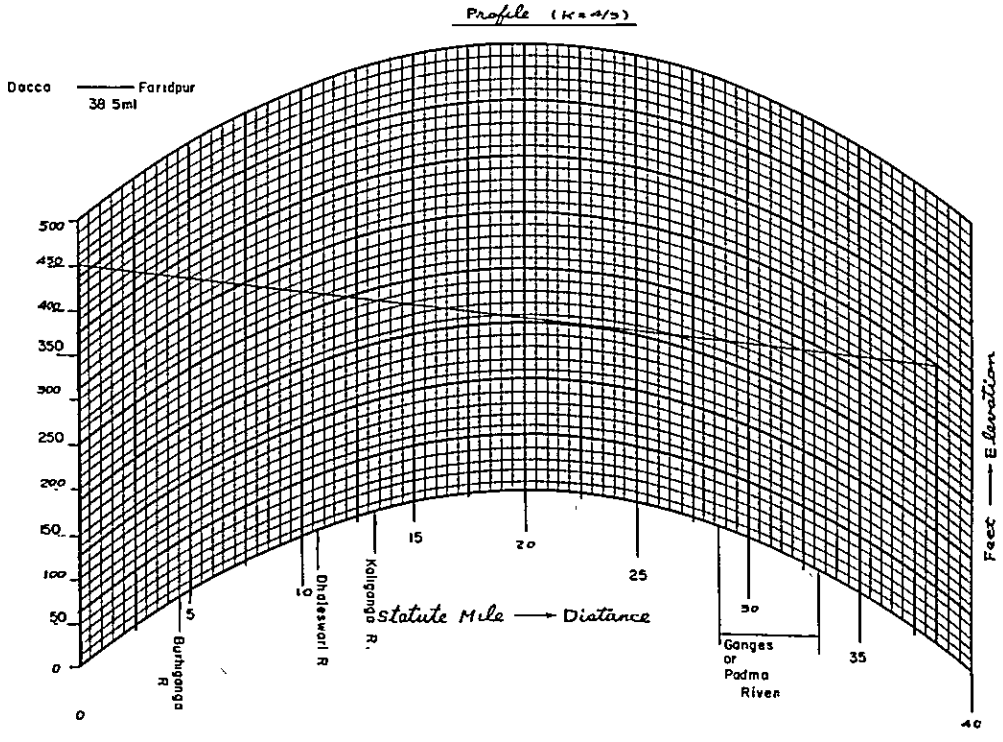


Fig. II. 3.6–4

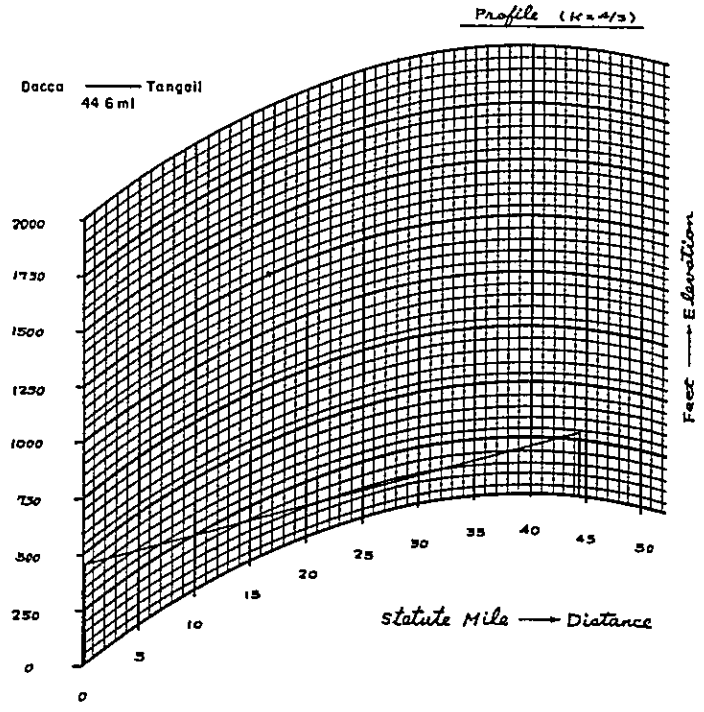
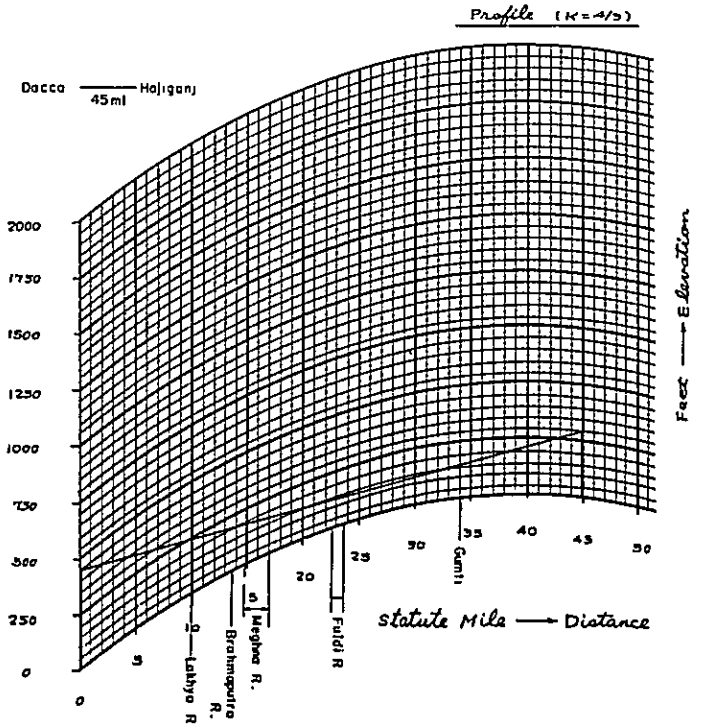


Fig. II. 3.6–5



II-3-7. Survey Results on Relaying Means to Chittagong from Dacca and on Condition of Service in Chittagong Area.

With respect to the survey on relaying means, measuring results are shown in Table II-3-6-2. The result concerning Sitakund to Hajiganj path is shown in Table II-3-7-1. Frankly speaking, it will be necessary for a rebroadcast station to be installed at Hajiganj or Mudafarganj between Dacca and Sitakund.

A Sitakund rebroadcast station is not sufficient to cover the entire city of Chittagong, partly because Chittagong is about 22 miles from Sitakund as shown in Fig. II-3-7-1, also because in Chittagong city there are numerous hills. Therefore, another Tree Point station near Chittagong City will be necessary to cover the entire city with good quality signals.

For comprehensive study of these statements, measurement results are shown in Tables II-3-7-1 to II-3-7-3 and Figs. II-3-7-2 to II-3-7-5.

In case of Sitakund transmission with 1kw E.R.P., the field intensity received at Court hill, which is in line-of-sight from Sitakund, will be 78dB while that at measuring point No. 3 is only 47dB with shadow attenuation of approx. 30dB (≒ 78 - 47dB).

As shadowed areas in case of the Sitakund transmission are shown in Fig. II-3-7-3, thick hatched areas by Buttali and Court hills will deteriorate owing to ghost and lowered signals. In summary, only a Sitakund station can offer good television signals to the people of Chittagong City of 70% (total population is 3.6 lakh). In other words, 30% of the Chittagong population can not enjoy the good reception. (0.8 lakh people with grade B and 0.25 lakh people with less than grade B).

In order to relieve these shadowed areas, it is best to transmit from the so-called Tree Point located south of Chittagong, that is, opposite Sitakund). The test result from Tree Point is shown in Table II-3-7-3 and Fig. II-3-7-5. Putting Fig. II-3-7-3 upon Fig. II-3-7-5 will clearly show that the shadowed areas do not appear to be compensated. Finally, both Sitakund and Tree Point stations only can cover the entire city of Chittagong with grade A quality pictures.

Measuring result, in the case of the court hill transmission are shown in Table II-3-7-2 and Fig.II-3-7-4. In this case, approx.25% of the total population of Chittagong will receive grade B or worse pictures. Even both Sitakund and Court hill stations can not cover the shadow area of Buttali Hill (approx. 10% of total population).

However, if it is necessary to serve Chittagong City in haste by utilizing T & T microwave link, this Court hill station will have some advantages such as power source, transportation conveniences, etc.

Fig. II. 3.7–1 Sketch Map

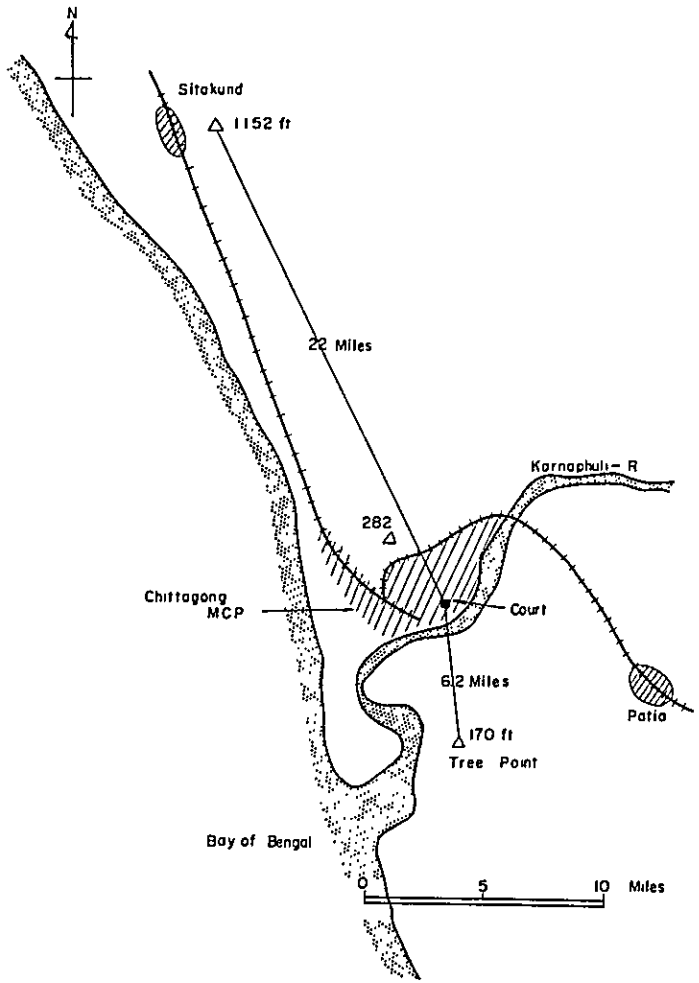


Fig. II. 3.7–2 Ghost Test Point of Chittagong

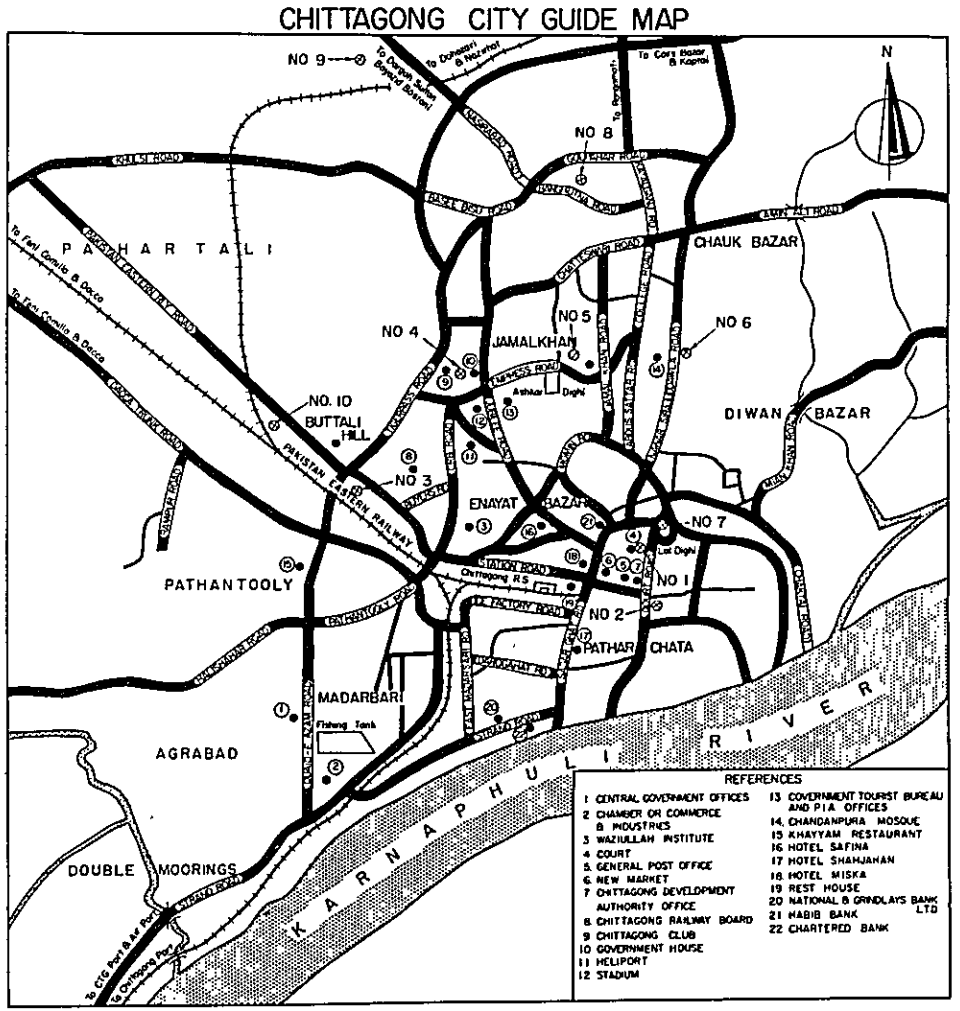


TABLE II.3.7-1

GHOST TEST

FROM SITAKUND TO CHITTAGONG & HAJIGANJ

(TO CHITTAGONG)

No.	PLACE	DISTANCE	TEST 10 W	ERP 1 kW	REMARKS
1	COURT.	22 Mile	58 dB	78 dB	ROOF OF COURT LINE OF SIGHT. H_2 = 120 FEET
2	ST. PLACID'S SCHOOL	22	33	53	SHADOW AREA NO GHOST H_2 = 30 FEET
3	RAIL WAY INSTITUTE	21	27	47	〃 〃
4	CIRCUIT HOUSE	21	43	63	LINE OF SIGHT NO GHOST H_2 = 30 FEET
9	WIRELESS COLONY	19	43	63	SHADOW AREA NO GHOST H_2 = 30 FEET

NOTE: SHADOW DEPTH 15 ~ 30 dB UNDER FREE SPACE INTENSITY

(TO HAJIGANJI)

No.	PLACE	DISTANCE	TEST 24 W	ERP 1 kW	REMARKS
1	HAJIGANJ	68 Mile	20 dB	36.2 dB	H_2 = 60 FEET HAMEDIA JUTE MILL
2	HAJIGANJ	68	14	30	H_2 = 30 FEET MAKINABAD

Fig. II. 3.7–3 Shadow Area (Transmitted from Sitakund)

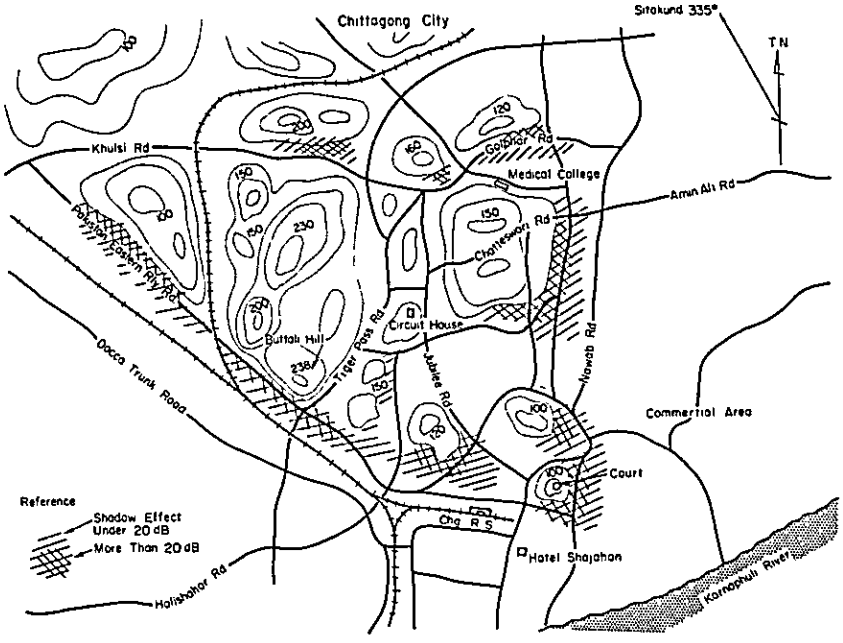


TABLE II.3.7-2

GHOST TEST

FROM COURT BUILDING TO CHITTAGONG

No.	PLACE	DISTANCE	TEST 10 W	ERP 1 kW	REMARKS
10	TIGER PASS (AAMBAGAN)	2.4 Mile	46 dB	66 dB	SHADOW AREA WEAK GHOST
9	WIRELESS COLONY	3.2	58	78	SHADOW AREA NO GHOST
8	NEAR THE MEDICAL COLLEGE	2.2	56	76	〃
4	CIRCUIT HOUSE	2.0	86	106	LINE OF SIGHT NO GHOST
5	ISPAHANI MANJIL'S GARDEN	1.1	72	92	〃
6	CHANDANPUR FIRE STATION	1.1	78	98	SHADOW AREA NO GHOST

NOTE: RECEIVING HEIGHT H_2 = 30 FEET
SHADOW DEPTH 15 ~ 40 dB
UNDER FREE SPACE INTENSITY.

Fig. II. 3.7–4 Shadow Area (Transmitted from Court)

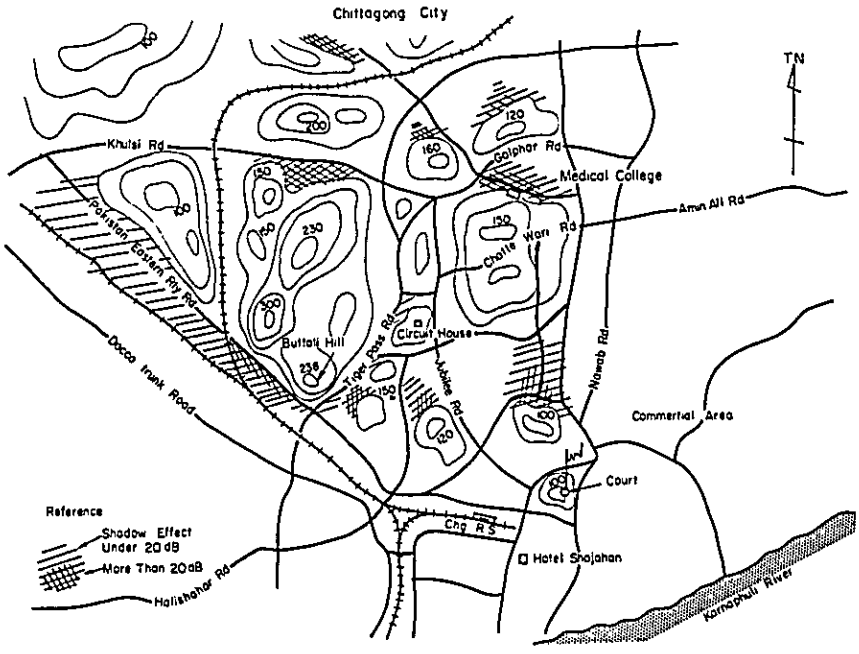


TABLE II.3.7-3

GHOST TEST

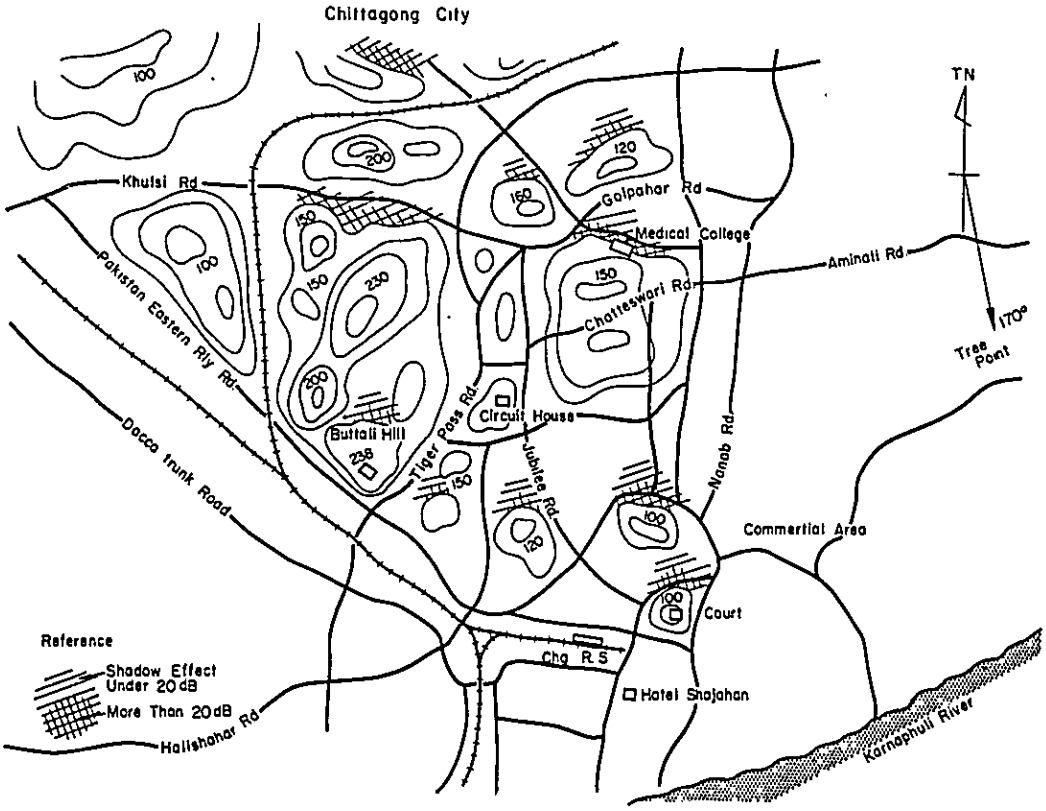
FROM TREE POINT TO CHITTAGONG

No.	PLACE	DISTANCE	TEST 10 W	ERP 1 kW	REMARKS
4	CIRCUIT HOUSE	7.2 Mile	64 dB	84 dB	LINE OF SIGHT NO GHOST
9	WIRELESS COLONY	9.0	51	71	SHADOW AREA NO GHOST
8	NEAR THE MEDICAL COLLEGE	8.0	43	63	〃 〃
5	ISPAHANI MANJIL'S GARDEN	7.2	57	77	〃 〃
6	CHANDANPUR FIRE STATION	7.2	53	73	〃 〃
7	LALDIGHI PARK	6.3	56	76	〃 〃

NOTE: RECEIVING HEIGHT H_2 = 30 FEET

SHADOW DEPTH 10 ~25 dB UNDER FREE SPACE INTENSITY

Fig. II. 3.7–5 Shadow Area (Transmitted from Tree Point)



II-3-8. Man-made Noise Measurement Results

The man-made noise values measured at different locations (such as down-town areas, residential areas, etc.) in the cities of Peshawar, Rawalpindi, Islamabad, Chittagong and Dacca are shown in Table II-3-8-1, II-3-8-2, II-3-8-3 and II-3-8-4.

The read-off values of timely distribution at the city of Dacca are shown in Tables II-3-8-5 and II-3-8-6. Also, the graphs of the variations by the time of the day are shown in Figs. II-3-8-1 and II-3-8-2. An example of the actual record is shown in Fig. II-3-8-3.

When the above results are integrated, we came to the conclusion that even in the typical Pakistan cities good reception is possible for over 95% of the time, provided that the amount of traffic does not exceed that of today and that the signal strength is over 45 dB at band III and over 55dB at band I.

As is well known, the man-made noise of VHF band is due mainly to internal combustion engines (so-called automobile noise) and its strength is proportional to the number of automobiles which pass. Because this survey team had very limited time to spend, we cannot say that the number of surveys conducted has been very large. However, when it is estimated that the number of automobiles passing one point in 5 minutes is about 100, (of cource, this figure is not small and yet it is not large even for today), 5% value of the time distribution is estimated to be approx. 35dB at 200 MC band and approx. 45dB at 70MC band.

On the other hand, when the required S/N ratio is considered, for impulse type noise, the repetitive rate of automobile noise which causes interference is within a range of 10 - 200PPS, even though this may change with the number of passing automobiles.

When the average value of the above is assumed to be 50PPS, the required S/N ratio under conditions in which the noise will affect the TV picture but not bothersome, is approx. 10dB (noise is expressed in peak value). (See Appendix V-6)

By integrating the above, the required signal intensity in 200MC band is estimated to be 35dB + 10dB = 45dB or greater and that for 75MC band is estimated to be 45dB + 10dB = 55dB or greater.

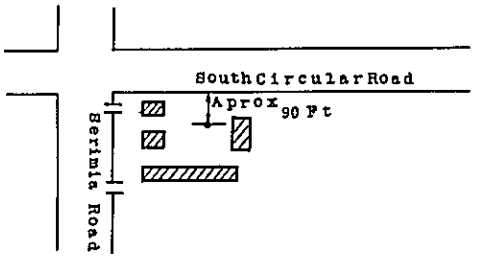
However, because the intensity of external noise changes with time and variation in space, the necessary field intensity also changes with location and time. In fact, it will change as society advances and develops.

Table II. 3-8-1(a)

16. Dec. 1967 (Sat.) Fine

Peshawar City

Dean's Hotel Garden (Residential area)



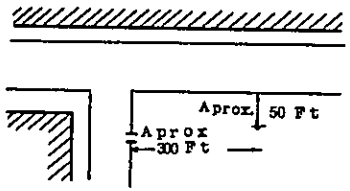
70 MC : 9.45～10.05	max : 44.1	dB
	5% : 39.1	dB
	50% : 29.6	dB
200 MC : 10.22～10.42	max : 30.7	dB
	5% : 22.2	dB
	50% : 12.7	dB
No of Auto	14/5 min.	
Antenne Height	30 feet (10 m)	
Meter	FIV-2 (Q.P.)	

Table II. 3-8-1(b)

16. Dec. 1967 (Sat) Fine

Peshawar City

Kaningangham Park (Most Crowded area)



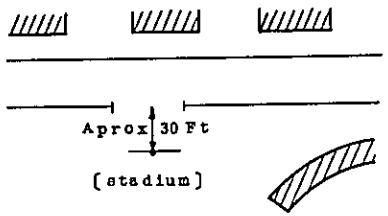
70 MC : 12.37～12.57	max : 42.6	dB
	5% : 37.6	dB
	50% : 35.1	dB
200 MC : 12.05～12.25	max : 36.7	dB
	5% : 30.2	dB
	50% : 19.2	dB
No. of Auto	82/5 min.	
Antenne Height	30 feet (10 m)	
Meter	FIV-2 (Q.P.)	

Table II: 3-8-1(c)

16. Dec. 1967 (Sat.) Fine

Peshawar City

Army Stadium (Green belt-residential area)



70 MC : 1340～1400 max : 37.6 dB

5% : 31.1 dB

50% : 28.6 dB

200 MC : 1412～1432 max : 30.7 dB

5% : 17.2 dB

50% : 14.2 dB

No. of Auto	8/5 min.
Antenne Height	30 feet (10 m)
Meter	FIV-2 (Q.P.)

(Ref) LED4183

(Distance 30 feet. antenne height 30 feet) 200 MC: 21.2 dB (max/1 min)

LED844. Antenne height

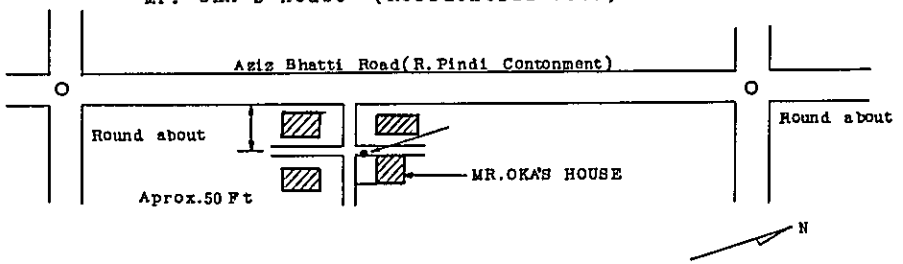
(Distance 30 feet. antenne height 30 feet) 200 MC: 24.2 dB (max/1 min.)

Table II. 3-8-2(a)

22. Dec. 1967 (Fri.) Fine

Rawalpindi City

Mr. OKA'S House (Residential area)



70 MC : 1050～1100 max : 30.0 dB

5% : 22.5 dB

50% : 20.0 dB

200 MC : 1138～1158 max : 29.0 dB

5% : 23.8 dB

50% : 19.0 dB

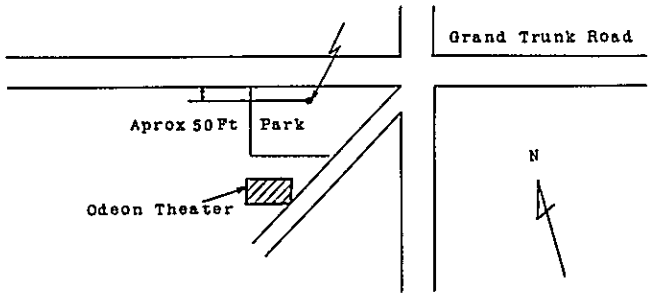
No of Auto	13 5 min
Antenne Height	30 feet (10 m)
Meter	FIV-2 (Q.P.)

Table II. 3-8-2(b)

22. Dec.1967(FRi)FINE

Rawalpindi city

In front of Odeon Theater (most crowded area)



70 MC : 1322～1342 max: 380dB

5%: 385dB

50%: 255dB

200 MC 1252～1312 max: 315dB

5%: 275dB

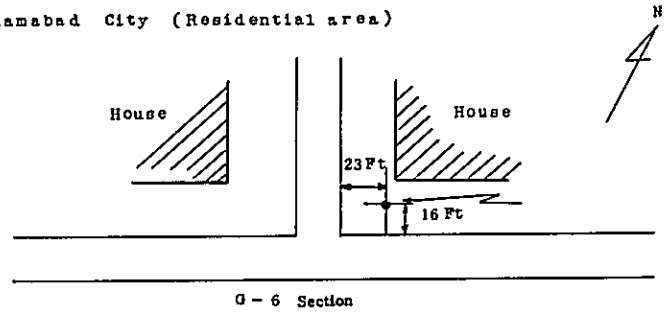
50%: 220dB

No. of Auto	60/5 min.
Antenne Height	30 feet (10 m)
Meter	FIV-2 (Q.P.)

Table II. 3-8-2(c)

22. Dec.1967 (FRi) FINE

Islamabad City (Residential area)



70 MC : 1610～1630 max: 365 dB

5%. 330 dB

50%: 245 dB

200 MC : 1543～1603 max: 390 dB

5%: 290 dB

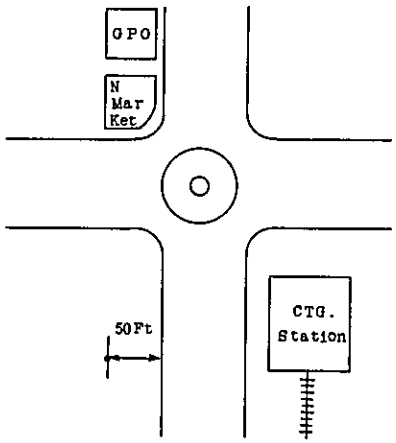
50%: 120 dB

No. of Auto	8/5 min.
Antenne Height	30 feet (10m)
Meter	FIV-2 (Q.P.)

Table II. 3-8-3

15 . Jan. 1968 (Man.) Fine

Chittagong City : Near New Market (Most crowded area)



75 MC : 1510～15 (Indication Reading)

max : 16 dB以上

5% : 16 dB

200 MC : 1520～25 (Indication Reading)

max : 21 dB

5% : 18 dB

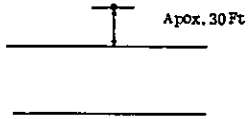
No. of Auto	45/5 min.
Antenne Height	30 Ft (10 m)
Meter	E17 (Q.P.)

Table II. 3-8-4

19 , Jan, 1968 (Fri) Fine

Dacca City

Jinnah Avenue (Most Crowded area)



70 MC : 1705～17.25 max : 565 dB

5% : 505 dB

50% : 455 dB

200 MC ; 17.30～1750 max : 55 dB

5% : 50 dB

50% : 45 dB

No. of Auto	152/5 min.
Antenne Height	30 feet (10 m)
Meter	FIV-2 (Q.P.)

Table II. 3-8-5

1. East Pakistan, Dacca City, Hotel Shabbagh No. 319 Room Antenne Height Approx 50 Ft., Distance Approx 60 Ft. 200 MC; FIV-2 Meter (Q.P.)

Date	Time	max	5%	50%
1968. 1. 20. (Sat.)	17.10～ 30	33	29	23
	30～ 50	335	285	22.5
	18.00～ 20	35	285	22.5
	30～ 50	35	29	235
	19.00～ 20 ※	335	30	23
	30～ 50	35	30	235
	2015～ 30	32.5	28.5	208
	30～ 50	31.5	28	215
	21.00～ 20	37	29	205
	40～22.00	33	255	18
	2200～ 20	30	255	17.5
	30～ 50	35	253	17
	23.00～ 15 ※※	32	29	21
	30～ 50	33	23	11
1. 21. (Sun.)	0000～ 15	28	22	85
	30～ 50	31	21.5	Under 5
	01.00～ 20	32	17	〃
	30～ 50	23.8	9	〃
	02.00～ 20	22.8	10	〃
	30～ 50	25	Under 5	〃
	0300～ 20	15	〃	〃
	30～ 45	23	〃	〃
	04.40～ 00	23	65	Under 5
	05.00～ 20	25	11	〃
	30～ 50	225	12	〃
	06.00～ 20	31.5	85	〃
	30～ 50	34.5	18	〃

※ No. of Auto 80/2 min.

※※ About 23.10 Party finish, much car start.

Date	Time	max	5 %	5 0 %
1968 1 21. (Sun.)	00 ~ 20	3 0 5	2 0.0	Under 5
	07. ~ 30	2 9 5	2 2	〃
	50 ~ 00	3 0	2 1 5	〃
	20 ~ 08	3 4.5	2 4	1 1
	30 ~ 50	3 1.5	2 5.5	1 6
	00 ~ 20	3 5	2 7	1 9
	09. ~ 30	3 2	2 8	2 1
	50 ~ 10	3 0 3	2 7.3	2 1
	00 ~ 30	3 2	2 6 5	2 1 8
	20 ~ 11.	3 5	2 7 3	2 1.8
	30 ~ 00	3 4.8	3 0 5	2 1
	20 ~ 12.	3 4.5	2 9	1 8 5
	30 ~ 00	4 0.5	3 0 8	2 1
	20 ~ 13	3 8 5	2 9	1 9
	30 ~ 00	3 7	2 9 5	1 5
	20 ~ 14.	3 6	2 7	1 5
	30 ~ 00	3 7.3	2 8	1 4
	20 ~ 15	3 9	3 0.5	1 7
	30 ~ 00	3 4	2 6	1 8
	20 ~ 16	3 6	2 8 5	2 0
	30 ~ 00	3 3	2 9	2 0 5
	20 ~ 17.	3 2 5	2 7.8	2 0
	30 ~ 00	3 6	2 9	2 1
	20 ~ 18.			

200 MC; No. 112 Room Antenne Height Approx 16 Ft. Distance Approx 60 Ft

1968 1. 24 (Wed.)	20 ~ 30	2 2 8	2 0.	1 3
	12 ~ 30	2 6 5	2 0	1 2 3
	50 ~ 00	2 5 3	2 1.5	1 1.5
	20 ~ 13.	2 4	2 0 5	1 1 5
	30 ~ 50	2 5 3	2 0 8	1 2 0
	00 ~ 20	2 5.3	2 0	1 1
	14. ~ 30	2 7.8	2 0	1 1
	50 ~ 00	3 0 8	1 9 8	9.5
	20 ~ 15.			
	30 ~ 40			

Table II. 3-8-6

2. East Pakistan, Dacca City, Hotel Shahbagh, No. 19 Room
Ant. H. approx 50 Ft., Distance Approx 60 Ft. 70 MC; FIV-2 Meter (Q.P.)

Date	Time	max	5 %	50 %
1968. 1 21. (Sun.)	1851 ~ 1900	56	525	465
	1900 ~ 20	55.5	51.8	445
	30 ~ 50	585	53.8	465
	2000 ~ 20	57.3	51	41
	30 ~ 50	565	52	43.8
	2100 ~ 20	57.5	51.8	39.5
	30 ~ 50	53.5	50.3	37
	2205 ~ 25	505	44	375
	30 ~ 40	49	44	35
	2300 ~ 20	51.5	435	32.5
	30 ~ 50	488	425	295
1. 22. (Mon)	0000 ~ 20	45	405	14
	30 ~ 50	468	42	19
	01.00 ~ 20	47	39.8	Below 14
	30 ~ 50	49	37	〃
	02.00 ~ 20	47	37	〃
	30 ~ 50	47	30	〃
	0300 ~ 20	44.3	27.5	〃
	30 ~ 50	425	24	〃
	04.00 ~ 20	49	Below 14	〃
	30 ~ 50	35.5	〃	〃
	0500 ~ 20	43	25.5	〃
	30 ~ 50	48	36.5	〃
	0600 ~ 20	523	37.5	〃
	30 ~ 50	52	41	14
	07.00 ~ 20	53	435	28
	40 ~ 0800	555	48.5	28

TABLE II.3.8-6(b)

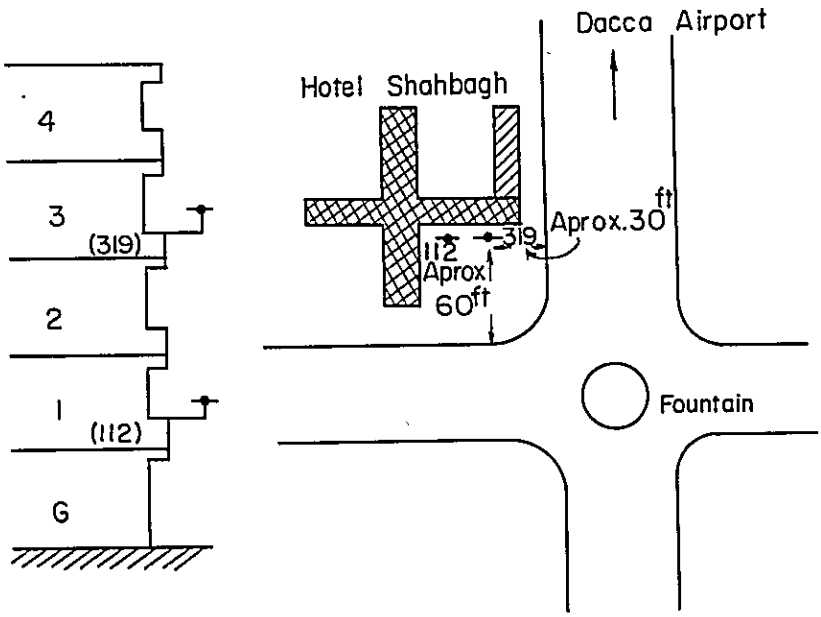


Fig. II. 3.8–1

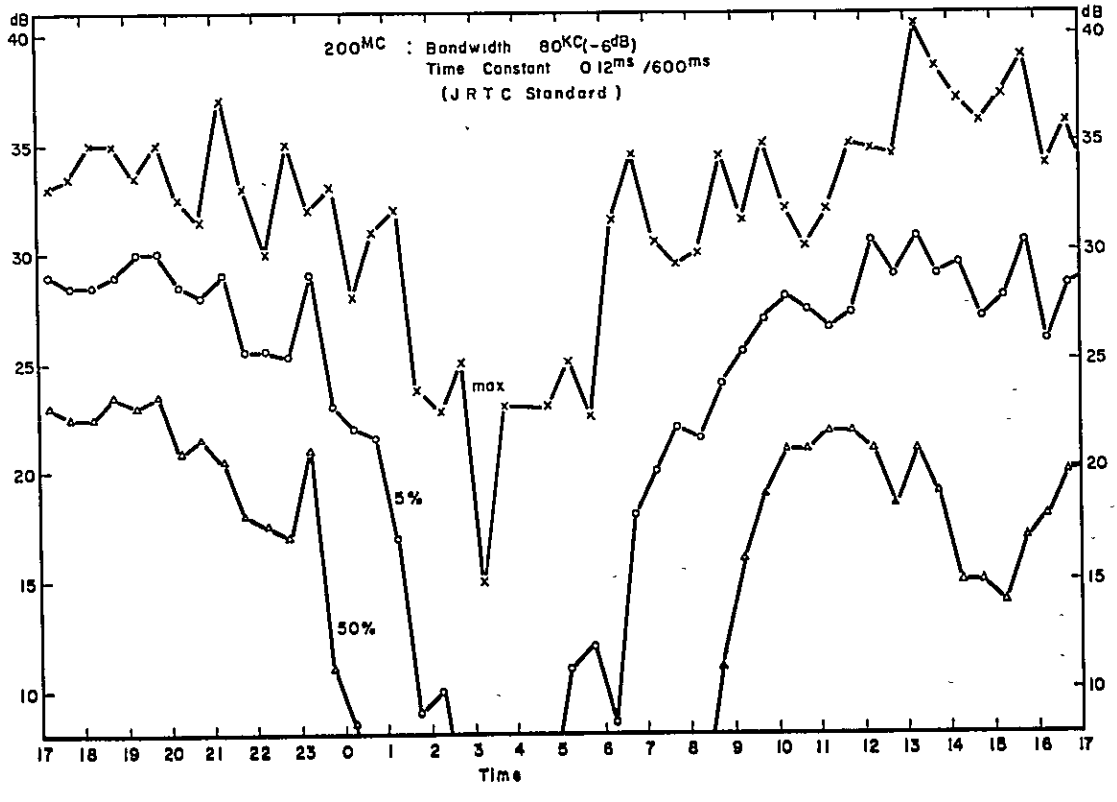


Fig. II. 3.8.–2

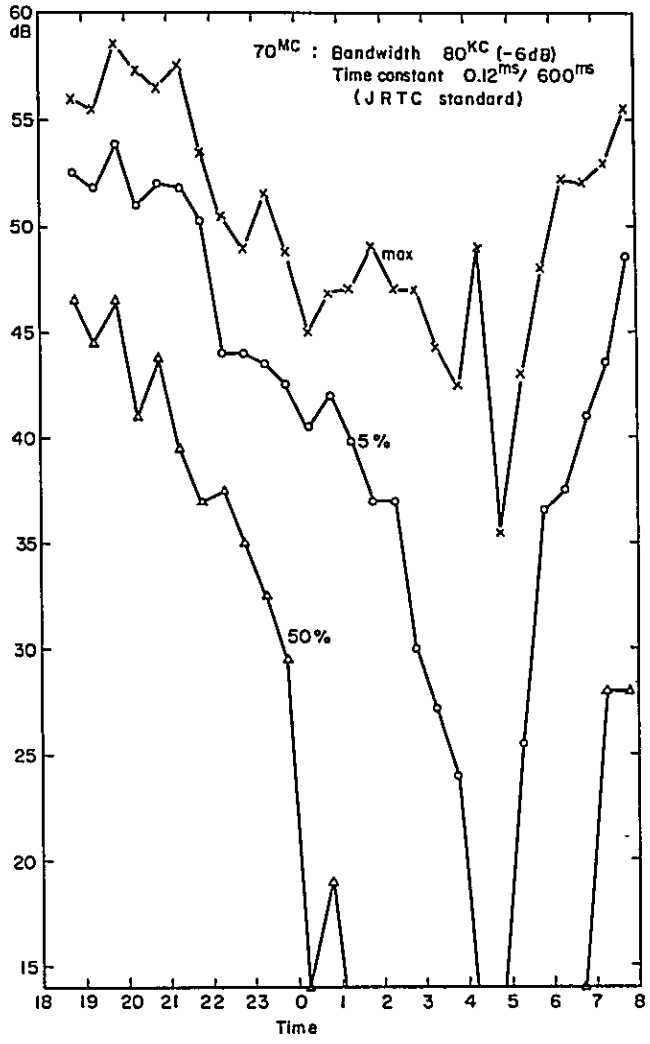
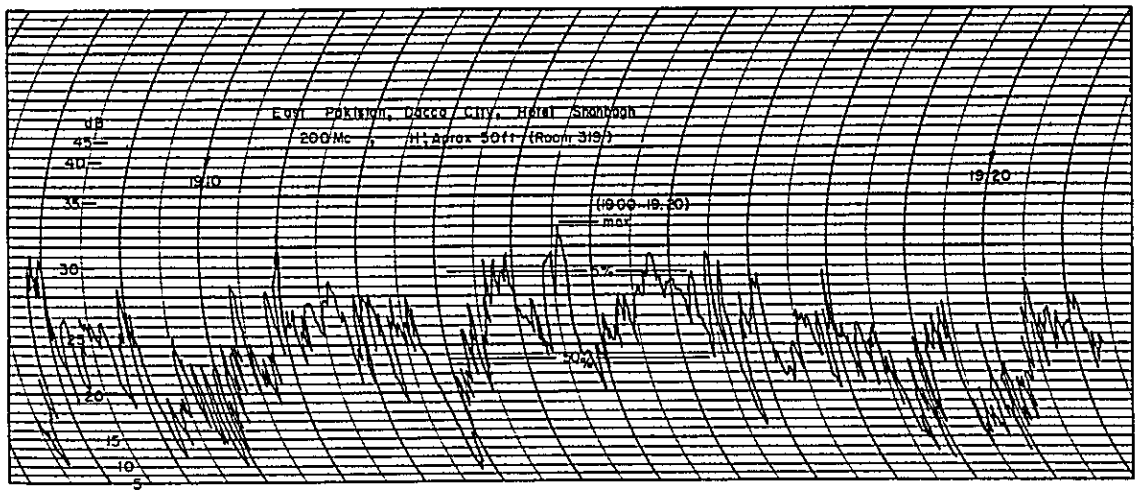


Fig. II. 3.8–3



III. RECOMMENDATIONS (WEST PAKISTAN)

III. RECOMMENDATIONS (WEST PAKISTAN)

III-1. Installation Site and Dimension of Capital Station

III-1-1. Installation Site

The conditions important for site selection areas follows:

(1) The line-of-site area from the transmitting point must be wide enough to get greater coverage because of high altitude.

(2) The site must be close enough to the capital city of Islamabad so that good service can be obtained.

(3) The site must be in the line-of-sight of Islamabad studio, to set up a good S-T link.

(4) Closer to P.T.C. headquarters, there is no fear of any traffic shut down due to snow in winter. The site is also better to be close to houses and to offer easy maintenance even when the station is an unmanned one.

(5) It is still better if the line-of-sight in the direction of Lahore from the site is clear and providing a direct programme exchange with Lahore station is possible when necessary.

As the site which satisfies the above conditions, we recommend Pindi Point for the capital station.

III-1-2. Transmitter Power

The transmitter power for the capital station should be decided based on the following factors:

(1) Even if it is not sufficient, the transmitter power must be large enough to be able to cover the city of Peshawar with fairly good signals.

(2) The transmitter power must fully cover the entire line-of-sight distance of radio wave. (When a television signal is beyond the line-of-sight distance it attenuates rapidly and fading increases. However, a good and, stable service within this distance is more economical).

(3) To completely cover Peshawar and to serve the areas of the over-mountain propagation in addition, it is better to have a large transmitter power. However, a transmitter with a power larger than 10kw is expensive and its maintenance is more troublesome. Thus, it is necessary to

take economical matters such as the above into consideration.

For the reasons explained above, we have recommended 60 - 100kw as the ERP required for the capital station.

III-1-3. Frequency to Be Used

As is stated in Appendix V-1, a channel in band III is desirable. The area covered by the Pindi Point station should be extensive and it should include many cities distant from Pindi Point which are sometimes behind the mountains. For these seasons, we should like to recommend, the lowest Ch. No. 5 of band III which has a comparatively low attenuation. However, P.T.C. has already allocated Ch. No. 5 to the Lahore station. Meanwhile, for a direct programme exchange with the Lahore station, it is necessary to reduce the mutual interference between the transmitting and receiving signals. Therefore, we recommend Ch. No. 8 which is separated by two channel widths from that of Lahore Station. If possible, it is most desirable that Ch. No. 8 be assigned to the Lahore station and Ch. No. 5 to the Pindi Point station.

III-1-4. Transmitting Antenna

From the northeast to the east is the Kashmir district which is mountainous. No detailed map was available, however, we consider a good and full coverage of this district to be difficult. Also, the radio wave radiation in this district requires the consent of the Pakistan Government, and for these reasons, no movement has been made fowards establishing antenna elements for the northeast direction. In order to secure ERP of 60 - 100kw with a 6-10kw transmitter, a gain of 10dB is necessary, and for these recommendations, a 12 bay, dipole with reflector panel, 3-face antenna has been adopted. For a station of large power, we consider the same type of antenna is the most economical. If the number of bays is increased in excess of 12 bays, the width of the main beam in the vertical plain becomes thin, the service area tends to narrow, and in addition, the cost of steel tower construction increases. On the other hand, when the number of bays is small, the transmitter output must be greater than 10kw. Moreover, the dipole with reflector panel antenna is just an example; other antennae with the same characteristics such as the unit dipole antenna may also be used.

III-1-5. Main Feeder

As shown in the diagrams (Fig. III-1-1 and III-1-2) for steel tower arrangement, it is assumed that the length of the main feeder will be 240 feet. When the use of two W X -20D feeders is adopted for a 6 - 10kw station, the loss at 200MC becomes 0.4dB. Also, when the losses of the diplexer, branch cables, etc., are estimated to be 1.8dB and if the tilt loss of 0.5dB, to be described later, is added to the above, then the total loss of the coaxial and antenna systems is estimated to be 2.7dB. The angle of the horizon in the direction of the Lahore area, the furthest in the area covered, as seen from Pindi Point is 1.2°. The main beam is to be pointed in the above direction. To accomplish this, the phase of the elements of the lower half of the antenna is changed by -40° with respect to that of the upper half.

III-1-6. Null Fill-in

As has been stated previously, when the antenna gain is large, the vertical pattern of the main beam becomes thin and a null point of field intensity appears at a short distance. In the case of the Pindi Point station, the point of 6° is the null point and the distance to that point is 10 miles. The field intensity at that point is extremely low. In order to improve the reception quality at the null point, the power ratio between the elements of the upper and lower halves of the antenna is made 7:3. With this method, it is possible to perform a null fill-in up to 15% of the main beam.

Fig. III. 1–1 Aerial Dimension of Pindi-Point Station

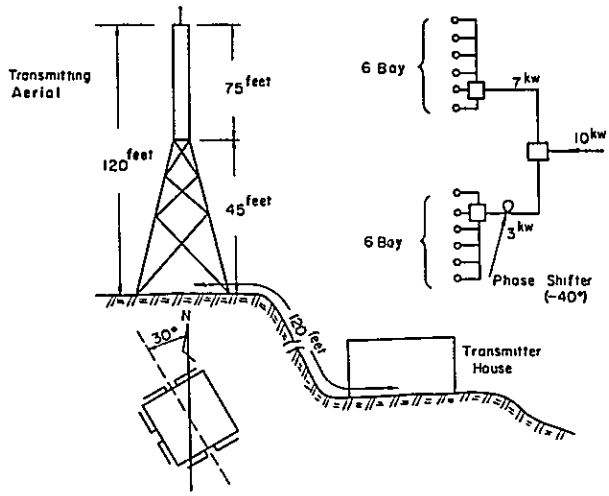


Fig. III. 1–2 Sketch of Pindi (7242 Feet) (TV Transmitting Station)

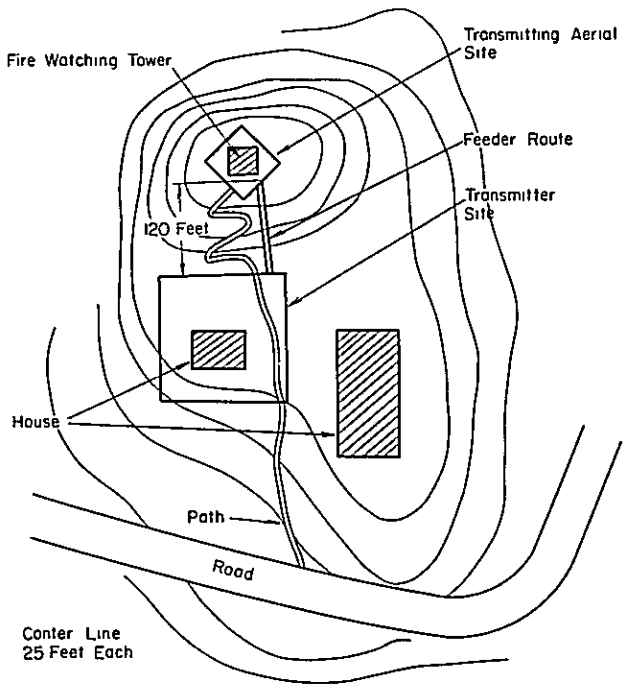


TABLE III. 1-1

TX DIMENSIONS

STATION NAME	PINDI PT.			
FREQ. (CHANNEL)	No. 8	MOTHER STATION	S-T LINK	
TX POWER	10 kW or 6 kW			
ANTENNA STYLE	12 Bay Dipole with Reflector Panel, 3 Faces			
EFFECTIVE HEIGHT	G.L. 7,242	+ (CENTER PT.) ANTENNA HT. 83	- Av. L. of SERVICE AREA 1,000	
	= 6,325 Ft.			
ANTENNA GAIN	12.7 dB			
FEEDER LOSS	2.7 dB			
BEAM TILT	1.2°			
NULL FILL-IN	15 %			
EFFECTIVE RADIATED POWER	100 kW or 60 kW			

Fig. III. 1–3

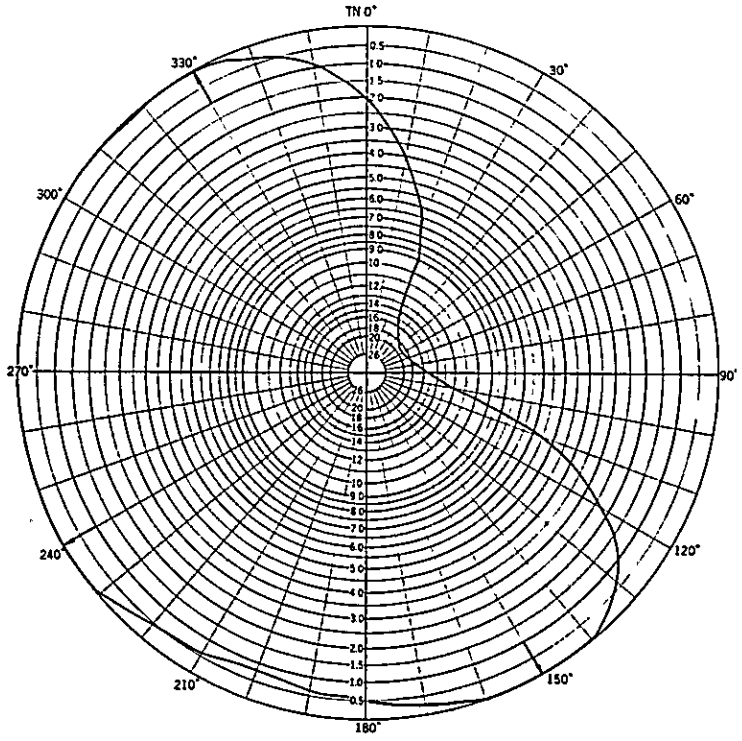
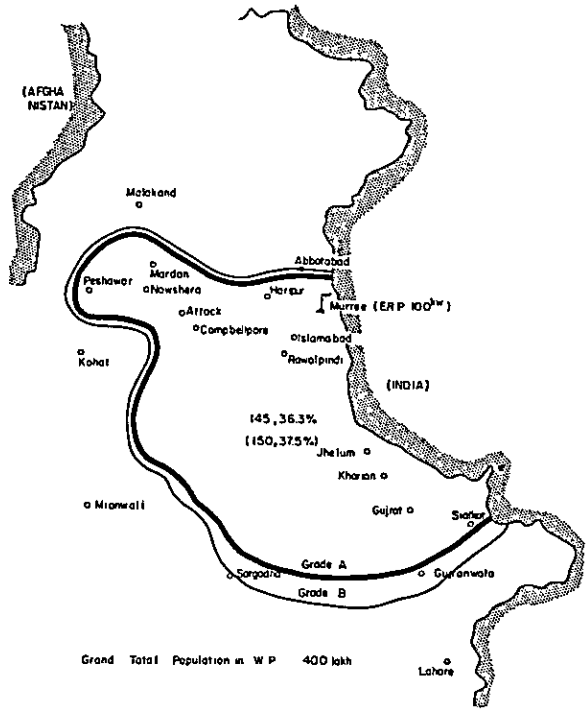


Fig. III. 1–4 Pindi Pt. Service Area Map



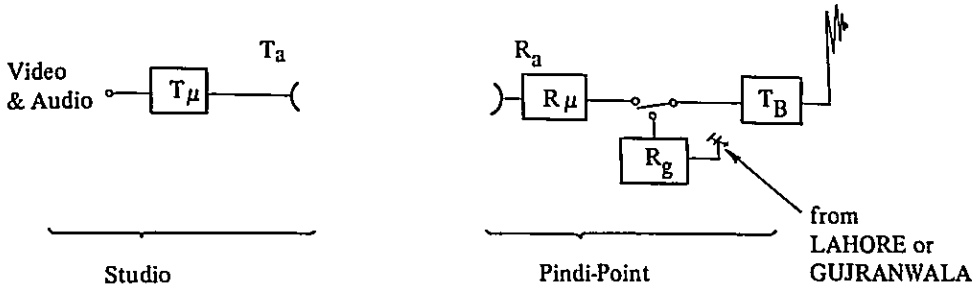
III-1-7. Relay Link between Studio of Capital Station and its Transmitting Station

As the relaying means between the proposed studio at Islamabad and the Pindi Point transmitter station, the following can be considered: (1) a method using microwaves and (2) a method using coaxial cables. However, the method of (1) is suitable. The reasons for recommending the method of (1) mainly are the expenses for the method of (1) are lower and the construction work for this method is easier as compared with those of the method of (2).

The specifications of the facilities in the case of microwave link are shown in Table III-1-2. The distance between the above two points is 24 miles and is in the line-of-sight. (Fig. III-1-5) With a frequency of 6 - 7GC band and transmitter output of 1w, it is only necessary to design a parabolic antenna which has a diameter of 10 feet.

The installation of spare transmitter and receiver (excepting the antenna system) is desirable. However, while the broadcast time is comparatively short, no absolute need for installing spare transmitter and receiver can be seen.

TABLE Ⅲ · 1—2



T_μ	:	7 G_c Band μ-wave Transmitter
T_a	:	10 feet ϕ para-bolic Antenna
R_a	:	〃 〃
R_μ	:	7 G_c Band μ -wave Receiver
T_B	:	10 kW VHF Television Broadcasting Transmitter
R_g	:	VHF Television Receiver (2 sets)

Distance 24 miles (Profile Fig. Ⅲ · 1—5)

L_f (free space loss) 141 dB

P_t (Transmitting Power) 30 dBm (1W)

Gat (〃 Antenna Gain) 45 dB .....10 feet

Gar (receiving 〃) 45 dB ..... 〃

L_F (feeder loss) max. 10 dB

P_r (receiving power)

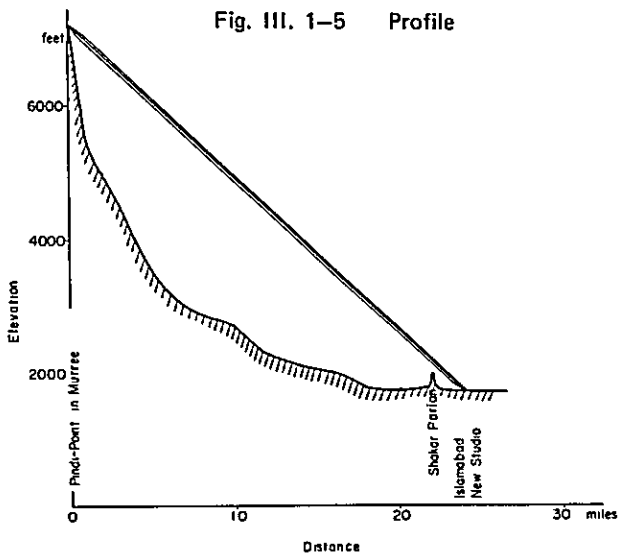
$= P_t - (L_f + L_F) + (Gat + Gar) = -31$ dBm

Prn (noise power) -85 dBm (25 Mc Band, N_F (Noise figuer) 15 dB)

I (S/N Improvement factor) 15 dB

S/N = Pr + I - Prn = 69 dB

Fig. III. 1—5 Profile



III-2. Means for Direct Programme Exchange between Islamabad and Lahore

III-2-1. Utilization of T &T's Microwave Facilities

The method of performing programme exchanges with highest fidelity and good characteristics is to use the microwave system of T & T. However, it is necessary to examine the planning of T & T, circuit accommodation capacity and rental cost for their exclusive use.

III-2-2. Direct Programme Exchange with Minor Additional Facilities

As has been stated in the survey results, II-3-4, it is not impossible to receive the Television signal of the capital station (ERP 100kw at Pindi Point) at the Lahore station and the Television signal of the Lahore station at Pindi Point.

In this case, it is needless to say that receivers must be installed at the two stations. However, it is desirable that the height of the receiving antenna above ground be made as high as possible. Since the propagation path is out of line-of-sight, the receiving quality deteriorates because of fading, and at times, the picture quality may be so bad that it is not suitable to rebroadcast. To shorten such hours, a diversity receiving device will be absolutely necessary. Regarding receiving antenna, see Appendixes V-5-4 and V-5-5.

III-2-3. Method of Installing Rebroadcast Station between Two Stations

It is feared that an area of poor reception may exist between the capital and Lahore stations. To dissolve any area such as this, it is desirable to install a comparatively small-scale transmitter for rebroadcasting.

The above transmitter can be used to cover the aforementioned area of poor reception, and at the same time, the transmitter can also be utilized to improve the direct programme exchange between the capital and Lahore stations.

As the installation site for the above transmitter, a location in the vicinity of Gujranwala will be suitable. Two sets of receivers (one set exclusively for the Capital station and the other set for the Lahore station) must be in operation continuously, and by transmitting the output of one receiver as required, an on-air relaying to the other station could be accomplished.

Because the two stations are within the line-of-sight distance (K = 4/3) from Gujranwala rebroadcast station a stronger beam can be expected and good quality relaying will be possible.

The transmitter specifications and necessary antenna directivity of the Gujranwala station are given in Table III-2-1 and Fig. III-2-1.

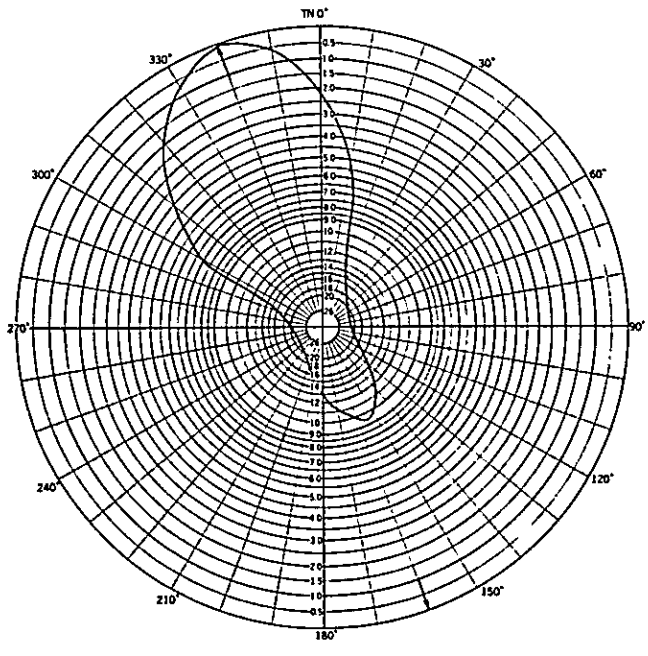
Moreover, the Gujranwala station can be made an unmanned station by providing some additional equipment, and the station can be controlled either from the capital station or from the Lahore station. However, in consideration of easy maintenance, the Gujranwala station should be a manned station at least for the time being.

TABLE III.2-1

TX DIMENSIONS

STATION NAME	Gujranwala		
FREQ. (CHANNEL)	No. 11	MOTHER STATION	Lahore Pindi Point
TX POWER	3 kW		
ANTENNA STYLE	4 Bay Dipole with Corner Reflector		
EFFECTIVE HEIGHT	G.L. 700 + (CENTER PT.) ANTENNA HT. 300 - Av. L. of SERVICE AREA 700 = 300 Ft.		
ANTENNA GAIN	14 dB for North, 4.5 dB for South		
FEEDER LOSS	1.5 dB		
BEAM TILT	-1.2° (N) and 0° (S)		
NULL FILL-IN	No		
EFFECTIVE RADIATED POWER	53 kW (N) 6 kW (S)		

Fig. III. 2–1



III-3. Relaying Means between Karachi and Hyderabad Stations and Dimensions of Relay Station

III-3-1. Location and Transmitter Specifications of Tatta Rebroadcast Station

The Tatta rebroadcast station receives the signal of the present Karachi TV station and rebroadcasts it for relaying to the Hyderabad relay station. At the same time, while supplementing any service insufficiency of the Karachi station, the Tatta station serves the town of Tatta and its environs, Hilaya and Mirpur Batoro. Grade A reception is expected for about 2.7 lakh persons and grade B reception is expected for about 3.4 lakh persons. A location west of the town of Tatta is suitable as the installation site of the Tatta rebroadcast station.

a. Installation Site

According to the survey results, in the area located beyond Tatta at a distance of 53 miles or greater, much fading occurs; the field intensity is insufficient and the area is not suitable for the construction of a relay station. Bared on calculations, the line-of-sight distance from the Karachi TV station to a receiving point which has a height of 300 feet, is 49 miles; it is considered that Tatta is the farthest point at which a relay station can be installed. At Tatta, the field intensity of the Karachi station is 62dB at a height 300 feet above ground level. When fading of 5dB is taken into account with respect to the 99% value, the field intensity is calculated to be 57dB.

When the required minimum field intensity for relaying is considered to be 53dB for band I, then the margin is 4dB. At Hilaya which is 11 miles from Tatta, it already drops to 51dB and so the field intensity is not sufficient.

On the other hand, if a translator is installed on the hill with a height of 1298 feet, located 5 miles to the east of Thano Bula Khan, no relay station will be necessary in between and at the same time a direct service to Hyderabad is possible. However, this hill is inconveniently located and construction and maintenance of the translator would be difficult.

(b) Transmitter Power

The distance between Tatta and Hyderabad is 53 miles, and because Hyderabad is out of the line-of-sight, direct service to Hyderabad from Tatta is difficult. When the installation of the Hyderabad TV station at a site south of Kotri located 47 miles from Tatta is assumed, then in order to give a field intensity of 65dB at a height of 300 feet, the required ERP of Tatta must be 8kw. If the minimum required field intensity for relaying at band III is to be 60dB and 99% value /50% value is to be 5dB, the ERP required is 8kw.

(c) Frequency to be used

Because of the reasons stated in Appendix V-1-2, band III is to be used. Especially, a steel tower for flat ground such as for the Tatta station entails a higher construction cost when band I is used, and the use of band III which is different from that of the Karachi station is unavoidable.

The terrain between Tatta and Kotri has low hills, and the attenuation of TV singals in greater than across flat terrain. Therefore, a lower frequency which has lower attenuation is more advantageous.

The adoption of Ch. No. 5, the lowest frequency in band III is recommended.

(d) Transmitting Antenna

The main transmitting direction is the direction of Hilaya and Hyderabad located in the northeast. However, in consideration of the good service for Mirpur Batoro in the east and Sujawal in the southeast a 3-bay, dipole antenna with corner reflector is to be provided for the direction of Hyderabad and a single-bay, dipole antenna with corner reflector is to be arrayed for the direction of east-southeast. These antennas can be of another type provided they have the same characteristics. In the present case, the dipole antennae with corner reflector has been selected from the standpoint of expense and light weight.

The transmitting gain, including feeder loss, is 9dB. Thus, when a 1kw transmitter is used, the ERP is 8kw.

(e) Tilt and Null Fill-in

The angle with respect to the horizon is 0.3°, and since the main vertical beam is sufficiently wide against this angle, no tilt is necessary.

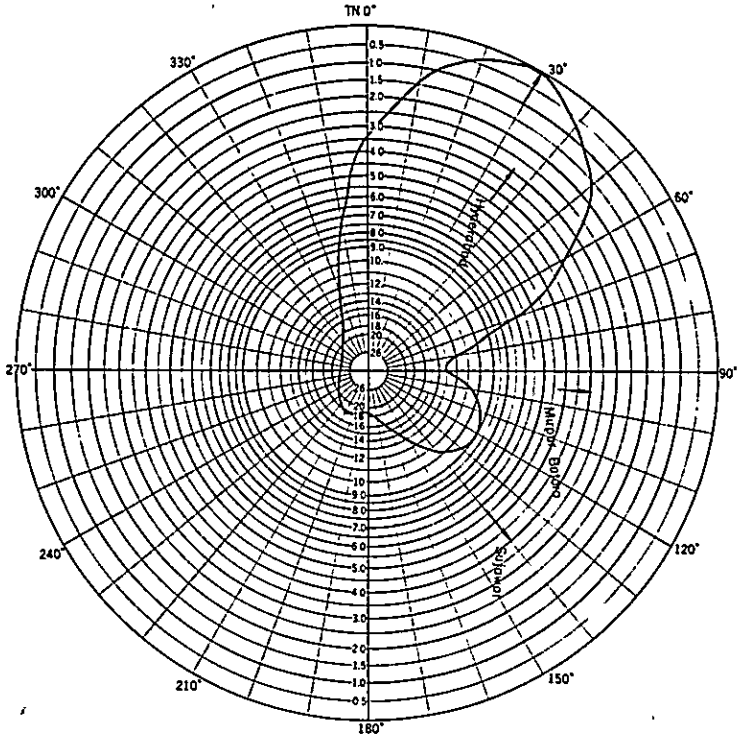
The first null point occurs at 1000 feet. Thus, if the site for the transmitter is selected at a point about 1500 feet away from the densely populated area, there is no need for any null fill-in.

TABLE III.3-1

TX DIMENSIONS

STATION NAME	TATTA				
FREQ. (CHANNEL)	No. 5		MOTHER STATION	Karachi	
TX POWER	1 kW				
ANTENNA STYLE	3 Bay Dipole with Corner Reflector 1 Bay Dipole with Corner Reflector				
EFFECTIVE HEIGHT	G.L. 30	+ (CENTER PT.) ANTENNA HT. 300	-	Av. L. of SERVICE AREA 30	
	= 300 Ft.				
ANTENNA GAIN	11.0 dB				
FEEDER LOSS	2.0 dB				
BEAM TILT	0°				
NULL FILL-IN	No				
EFFECTIVE RADIATED POWER	8 kW				

Fig. III. 3–1


TN 0°
30°
60°
90°
120°
150°
180°
210°
240°
270°
300°
330°
HORIZONTAL
MAJOR LOBE
SIDELOBES

III-3-2. Location of Hyderobad Rebroadcast Station and Transmitter Specifications

The Hyderabad station receives and rebroadcasts the signal of the Tatta rebroadcast station to serve Hyderabad and the towns and villages in its environs.

Grade A reception is possible for about 14.5 lakh persons and grade B reception is possible for about 17 lakh persons. For the location of the Hyderabad rebroadcast station, a site in the south of Kotri is suitable.

(a) Installation Site

The distance between Tatta and Hyderabad is 53 miles which exceeds the line-of-sight distance. If a site south of Kotri is selected as the transmitting point, the distance is reduced to 47 miles and thus to relay the Tatta signal to Kotri becomes possible. Also, since the area to be covered by this Kotri station extends in the direction of 30°~160° , as seen from the above transmitting point (south of Kotri), a 2-face antenna array would be sufficient. On the other hand, if the 1298-foot hill located 5 miles east of Thano Bula Khan is selected as the transmitting point of the Hyderabad station, the rebroadcast station (Tatta station) between Karachi and Hyderabad becomes unnecessary. However, the conditions of this location are poor, and it is considered that the construction and maintenance of the station would be difficult.

(b) Transmitter Power

When the height of the transmitting antenna is to be 300 feet, mainly from the standpoint of an economical construction of the antenna tower, the line-of-sight distance is calculated to be 34 miles. When the distance is over 34 miles, the stability of TV signal received deteriorates. Thus, the line-of-sight area should receive grade A. The required ERP is 6kw.

(c) Frequency to Be Used

Since this station receives and rebroadcasts the signal of Tatta, Ch. No.8 is to be used to avoid any interference between retransmission and reception.

(d) Transmitting Antenna

The service area of this station includes the towns of Hala in the

north, Tando Allahyar in the east and Tando Muhammad Khan in the southeast.

With a dipole with reflector panel antenna installed, directed to the southeast and northeast, service for these towns becomes possible. When a 12-bay, dipole with reflector panel antenna is used for economical reasons, the ERP becomes 13kw in case of a 1kw transmitter.

Depending on the future requirements, even if this station is to be utilized for relaying to Sukkur, 13kw ERP will be relatively enough.

(e) Tilt and Null Fill-in

The angle in the horizontal direction is 0.3°, and no tilt is necessary as the vertical beam of the antenna is comparatively wide.

Since the first null point occurs at 0.75 mile, when the transmitter is installed within about 1.2 miles from the city zone, null fill-in measures should be taken.

TABLE III.3-2

TX DIMENSIONS

STATION NAME	HYDERABAD				
FREQ. (CHANNEL)	No. 8			MOTHER STATION	TATTA
TX POWER	1 kW				
ANTENNA STYLE	12 Bay Dipole with Reflector Panel, 2 Faces				
EFFECTIVE HEIGHT	G.L. 30	+	(CENTER PT.) ANTENNA HT. 300	-	Av. L. of SERVICE AREA 30
	= 300 Ft.				
ANTENNA GAIN	13.6 dB				
FEEDER LOSS	2.5 dB				
BEAM TILT	0^{O}				
NULL FILL-IN	15%				
EFFECTIVE RADIATED POWER	13 kW				

Fig. III. 3–2

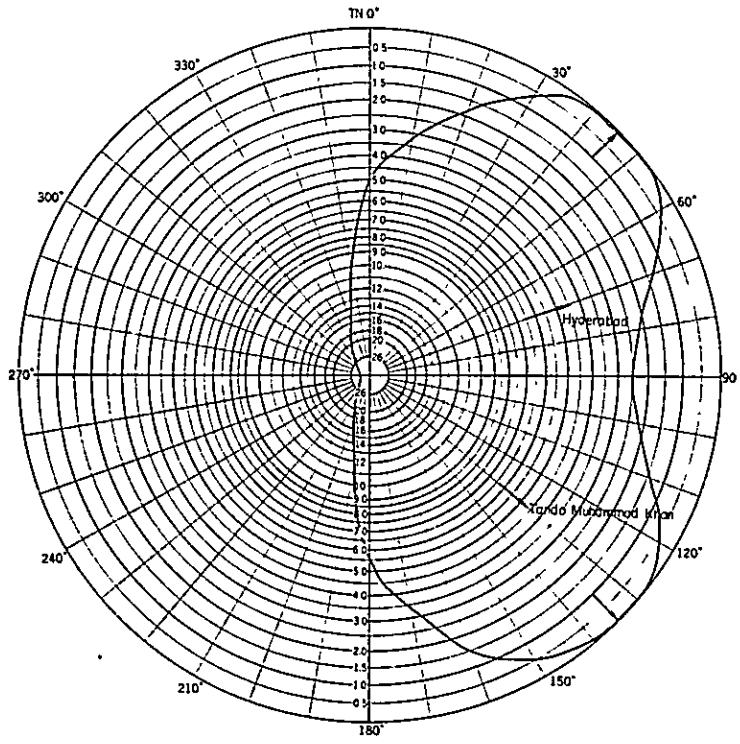
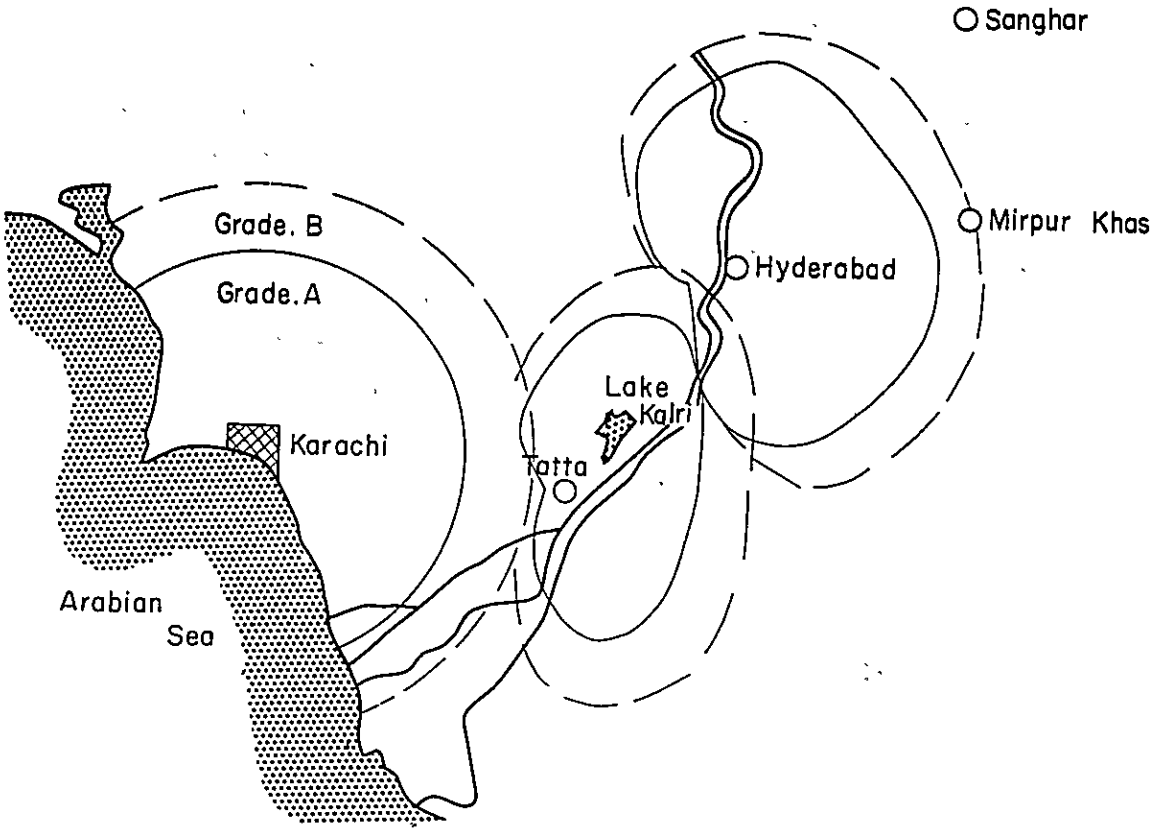


Fig. III. 3–3 Predicted Service Area of Karachi, Hyderabad and Tatta Station (In case of on-air relay)



Total population of West Pakistan; 400 lakh (As of 1961)

Station name		Grade A reception	Grade B and better reception
Karachi	;	21 (5.3 %)	22 (5.5 %)
Tatta	;	2.7(0.7 %)	3.4 (0.9%)
Hyderabad	;	14.5(3.6%)	17 (4.3 %)

III-3-3. Means of Relaying to Sukkur

Although it is outside of the tasks of the survey team, an on-paper study of the relaying means from Hyderabad to Sukkur was conducted. The results are given below.

Between Hyderabad and Larkana, the Indus River flows from north to south. West of the Indus River, a mountain range with suitable height for rebroadcast station exists. However, since this mountaneous area is sparsely populated and undeveloped, the construction and maintenance of a rebroadcast station would encounter inconveniences.

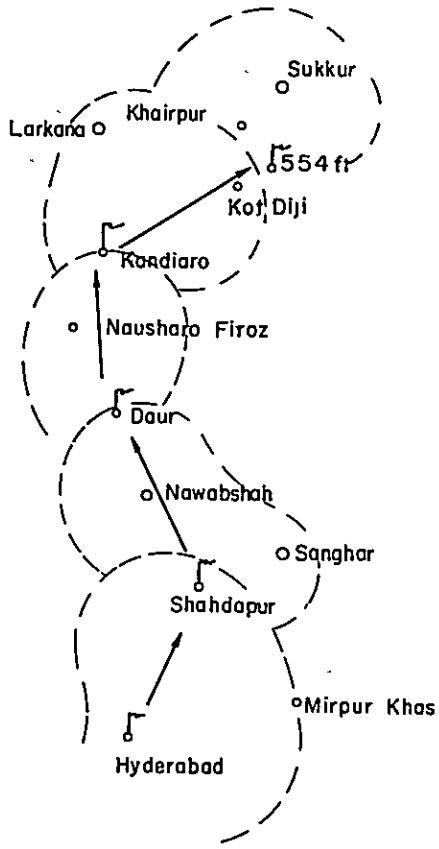
On the other hand, there are many cities on the east bank of the Indus River to be covered by a rebroadcast station. Since the roads and railways are well developed in this area, the construction and maintenance of the station would be facilitated. Because the terrain of the above area is practically flat, when a 300-foot steel tower is constructed, the line-of-sight distance is 34 miles. The area up to this distance is to be grade A area and the required ERP will be about 10kw.

When a 1kw transmitter and transmitting antenna with a gain of about 10dB are used, relaying to Sukkur can be made possible by installing rebroadcast stations at Shahapur, Daur and Kandiaro.

As the site for the Sukkur transmitting station, the 554-foot hill located 8 miles to the east of northeast of Kot Diji would be suitable. When the station is constructed on this hill, the southern part of Sukkur will be cut off by the mountain with likelihood of poor reception. However, since no other suitable location could be found the above site will have to be used. The defect of this station can be supplemented by installing a small station within the city of Sukkur.

When relaying from Karachi to Sukkur by means of on-air relaying, the total number of stations, including Tatta, becomes six, and due to fading and multi-stage relaying, the picture quality will deteriorate. For this reason, when planning a high quality broadcast, microwaves should be used as a relaying means.

Fig. III. 3–4



III-3-4. Transmitting Point and Transmitter Specifications of Hyderabad Station when Utilizing Microwave Relaying Facilities of T & T

Programmes are received by means of T & T microwave relay facilities. This station serves Hyderabad and the towns and villages in its environs.

Grade A reception is possible for about 14.7 lakh persons, and grade B reception is possible for about 17.4 lakh persons.

(a) Installation Site

For the reasons explained below, the location for the TV rebroadcast station for serving Hyderabad and its environs, the 100-foot hill located 3 miles south of Hyderabad, is desirable. Or, the station can be located near Kotri without any trouble if and when such installation is necessary for any reason.

1. Since the area between Karachi and Hyderabad is also populated, it is desirable that the service areas of Karachi and Hyderabad are close to each other. The distance between the cities is approximately 100 miles and grade B reception areas between the two stations extends to 50 miles. Thus, when the station is constructed in the environs of Hyderabad, the service areas of the two stations come closer. Since there is no other large city between the above two cities, main object of Hyderabad station is to serve Hyderabad city with good pictures, so a site close to Hyderabad is desirable.

2. Mainly from an economical standpoint, it is desirable to limit the height of the transmitting antenna steel tower of the Hyderabad station to about 300 feet. However, the higher this steel tower is, the wider the service area becomes. On the other hand, the fort located in the central part of the city of Hyderabad may hinder the propagation of TV wave, but this hindrance becomes less when the transmitting antenna tower is made higher. Practically no mountains exist around Hyderabad. Only a few low hills are located south of the city. Thus, if the antenna is installed on one of these hills, the effective height of the antenna increases by the height of the hill.

3. The location of the microwave terminal station for TV transmission has not been determined. However, even when the environs of Kotri where the present T & T's facilities are located are selected, the distance from there to the above hill is less than 10 miles and relaying of TV signal from microwave terminal to TV station is easily possible.

(b) Transmitter Power

The line-of-sight distance in case of a 300-foot transmitting antenna steel tower and 30-foot high receiving antenna is 34 miles.

Since TV waves become unstable when the distance is over the line-of-sight distance, the power which gives grade A service up to the above distance is the minimum required ERP. In this case, 10kw is the minimum required ERP.

(c) Transmitting Antenna

Since the cities to be covered are scattered in every direction, the

horizontal directivity of the transmitting antenna should be omnidirectional. As an omnidirectional antenna for band III, a 12-bay, dipole with reflector panel antenna is the most efficient. When a 1kw transmitter is used, the ERP is 17kw.

(d) Frequency to be used

As is stated in Appendix V-1-2, the use of band III is desirable. Because several hills are scattered around Hyderabad, Ch. No. 5 which is a frequency with less attenuation, is suitable.

(e) Tilt and Null Fill-in

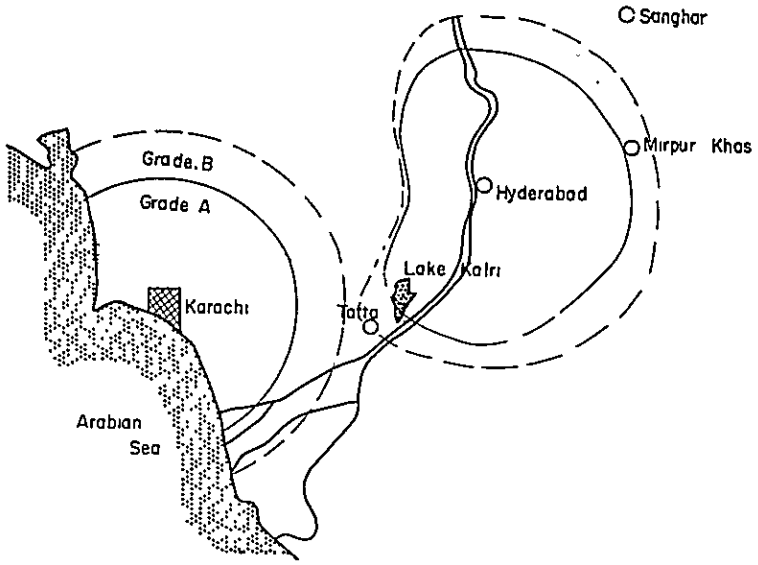
The service area up to the horizon is of the first consideration. The depression angle at which the horizon is seen from the transmitting antenna, in the case of this station, is 0.3°. This direction is included in the main vertical beam of the transmitting antenna. Therefore, no tilt is necessary.

The distance to the first null point of the above antenna is about 0.75 mile. For this reason, null fill-in becomes necessary when the transmitting point selected is within about 1.2 miles from the city zone.

TABLE III. 3-3

TX DIMENSIONS			
STATION NAME	HYDERABAD		
FREQ. (CHANNEL)	No. 5	MOTHER STATION	T&T- μ WAVE
TX POWER	1 kW		
ANTENNA STYLE	12 Bay Dipole with Reflector Panel		
EFFECTIVE HEIGHT	G.L. (CENTER PT.) ANTENNA HT. 100 + 300 = 370 Ft.	Av. L. of SERVICE AREA 30	
ANTENNA GAIN	13.8 dB		
FEEDER LOSS	1.5 dB		
BEAM TILT	-0.5°		
NULL FILL-IN	15 %		
EFFECTIVE RADIATED POWER	17 kW		

Fig. III. 3–5 Predicted Service Area of station (by T & T's facilities)



Total population of West Pakistan : 400 lakh (As of 1961)

Station name	Grade A reception	Grade B and better reception
Karachi	21 (5.3%)	22 (5.5%)
Hyderabad	14.7 (3.7%)	17.4 (4.4%)

IV. RECOMMENDATIONS (EAST PAKISTAN)

IV RECOMMENDATIONS (EAST PAKISTAN)

First, the means in the case of on-air relaying will be discussed, and the means when the facilities of T & T are used for relaying are discussed after IV-5.

IV-1 Relaying Means between Dacca and Khulna Station and Dimensions of the Relay Station.

IV-1-1 Installation Site.

The distance between Dacca and Khulna is 81 miles. According to our survey, the receiving field intensity of the new Dacca Station (300 feet high) at Kamarkhali Ghat located at a distance of 55 miles is estimated to be 80 dB. This value is sufficient for an on-air relaying, but it is very close to the line-of sight distance of 57 miles. Actually, in our measurements, considerable fading was observed. Therefore, the station should not be constructed at a site which exceeds the above distance (57 miles from Dacca). The distance from Dacca to Kamarkhali Ghat is 55 miles, and from here to Khulna is 50 miles. If the transmitter is installed here (at Kamarkhali) and to cover Khulna with the field intensity of 55 dB, an ERP of 250 kw is necessary. On the other hand, Bhatiapara Ghat, in the south of Kamarkhali Ghat, is located at a distance of 55 miles from Dacca, and the distance from here to Khulna is 30 miles. Because the topography of this path is similar to that of the path between Kamarkhali Ghat and Dacca, a similar good reception as the above can be expected.

With an ERP of 13 kw, the field intensity at Khulna is 60 dB with grade A service. Thus, a site around Bhatiapara Ghat where location conditions are suitable can be selected for the transmitter.

IV-1-2 Transmitter Power and Transmitting Antenna

For the same reasons stated in Paragraph IV-2-2 on Tangail, this station can be a 1kw transmitter with 12-bay, dipole with reflector panel, 2-face antenna. The directivity can be the same as that of Tangail. However, it should be arrayed so that it can cover from the northwest to the southeast with the southwest as the center. (See Fig. IV -1-1)

IV-1-3 Frequency to be Used, Tilt and Null Fill-in.

As is stated in Paragraph on Tangail, Ch. No. 8 is to be used. (When a Rajshahi station is to be planned, it is proper to assign Ch. No. Rajshahi and Ch. No. 11 to the Khulna Station)

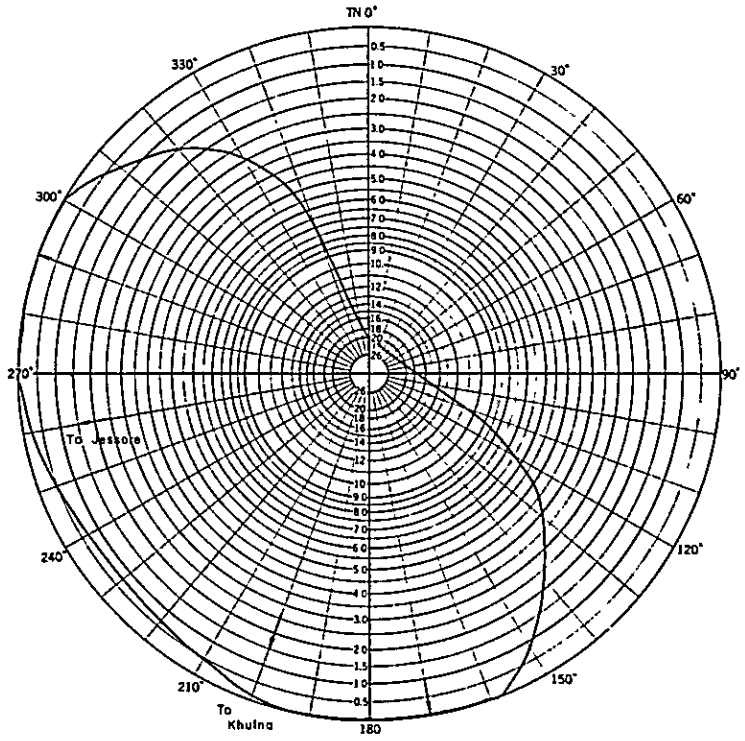
Tilt and null fill-in can be exactly the same as those of Tangail.

TABLE IV. 1-1

TX DIMENSIONS

STATION NAME	KHULNA		
FREQ. (CHANNEL)	No. 8 or No. 11	MOTHER STATION	DACCA
TX POWER	1 kW		
ANTENNA STYLE	12 Bay Dipole with Reflector Panel, 2 Faces		
EFFECTIVE HEIGHT	G.L. 20 + (CENTER PT.) ANTENNA HT. 300 - Av. L. of SERVICE AREA 20		
	= 300 Ft.		
ANTENNA GAIN	13.6 dB		
FEEDER LOSS	2.5 dB		
BEAM TILT	0		
NULL FILL-IN	15 %		
EFFECTIVE RADIATED POWER	13 kW		

Fig. IV. 1–1



IV-2 RELAYING MEANS BETWEEN DACCA AND BOGRA AND DIMENSIONS OF BOGRA REBROADCAST STATION.

IV-2-1 Installation Site.

When considering an on-air relay network for the densely-populated areas of the northeastern part of East Pakistan, it is necessary to install the first rebroadcast station in the northeast direction of Dacca.

If the transmitting and receiving steel tower for the rebroadcast station is to be 300 feet, in consideration of economy and the effect of cyclones of East Pakistan, then the field intensity at Tangail is 75 dB. This value is reduced when assumed that the new Dacca station is 450 feet high with ERP of 70 kw. When the minimum required field intensity of the rebroadcast station is taken as 60 dB and the fading value as 5 dB at 99%, the margin at Tangail is 10 dB=75-5-60 dB. The point with the field intensity of 70 dB is 53 miles from Dacca, where it corresponds to the environs of Kalihati. However, because of instability of over-water propagation during summer in East Pakistan and the future necessity of constructing another rebroadcast station in the direction of Bogra and Rangpur, it is desirable that the station be installed near Tangail where the receiving field intensity is sufficient.

IV-2-2 Transmitter Power

When the transmitting antenna height is 300 feet and receiving antenna height is 30 feet, the line-of-sight, distance with respect to radio waves, is 34 miles. Since the stability of TV broadcast waves deteriorates beyond the line-of-sight distance, the ERP necessary to cover the distance of 34 miles with grade A is the minimum required power and its value is 10 kw.

IV-2-3 Frequency to Be Used

Because the station receives and rebroadcasts the signal of Dacca (Ch. No. 5), Ch. No. 8 or higher is desirable in order to avoid the mutual interference between the transmitter and receiver.
If adjacent channels are not to be used for this station and Khulna station , then the channel for Bogra should be Ch. No. 10 and that for Khulna should be Ch. No. 8.

IV-2-4 Transmitting Antenna

As the economical limit for building a 300-foot steel tower, a 12-bay, di-

pole with reflector panel antenna should be considered. Since the south of Tangail is already in the service area of Dacca, the directivity of the antenna can be in the east and west directions with the north as the center. Therefore, a dipole with reflector panel, 2-face antenna should be used (See Fig. IV-2-1)

Since the gain of the above antenna is approximately 11 dB including the feeder loss, a 1kw transmitter can obtain an ERP of 13kw.

IV-2-5 Tilt and Null Fill-in

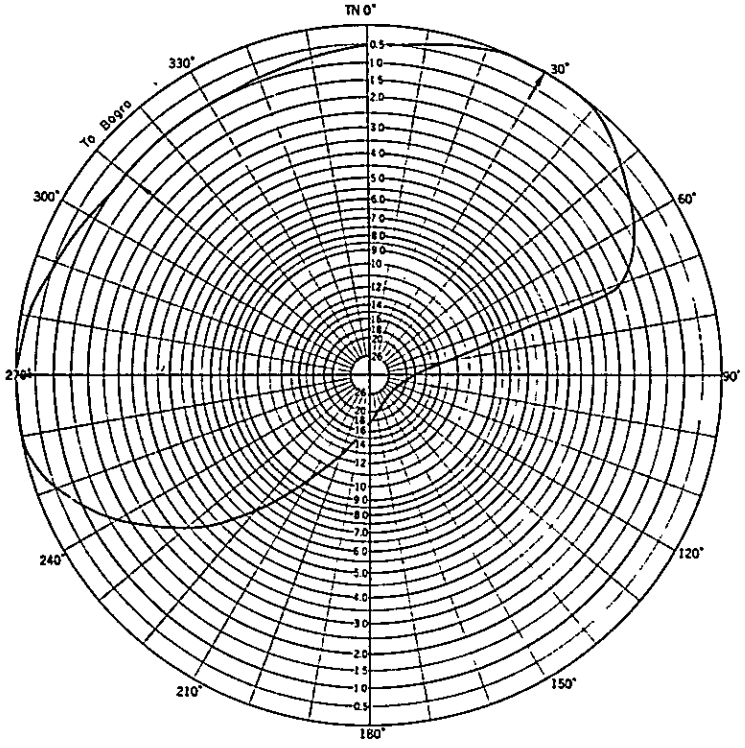
The service area up to the horizon is to be considered first. The depression angle at which the horizon is seen from the transmitting antenna, in the case of this station, is 0.3°, and this direction is included in the main vertical beam of the transmitting antenna. So, no tilt is necessary.

The distance of the first null point of the above antenna is about 0.75 mile ; null fill-in measures should be taken when the transmitting point is within about 1.2 miles of the city zone.

TABLE IV.2-1

TX DIMENSIONS			
STATION NAME	BOGRA		
FREQ. (CHANNEL)	No. 10	MOTHER STATION	DACCA
TX POWER	1 kW		
ANTENNA STYLE	12 Bay Dipole with Reflector Panel, 2 Faces		
EFFECTIVE HEIGHT	G.L. (CENTER PT.) ANTENNA HT. Av. L. of SERVICE AREA 20 + 300 - 20 = 300 Ft.		
ANTENNA GAIN	13.6 dB		
FEEDER LOSS	2.5 dB		
BEAM TILT	0		
NULL FILL-IN	15%		
EFFECTIVE RADIATED POWER	13 kW		

Fig. IV. 2–1



IV-3 Relaying Means between Dacca and Chittagong and Dimensions of Rebroadcast Station.

The distance between Dacca and Chittagong is greater than 130 miles, and in the case of an on-air relaying, it is necessary to construct a rebroadcast station somewhere between the two cities, for instance, near Hajiganj.

IV-3-1 Location of Hajiganj Station and Transmitter Specifications.

IV-3-1-1 Installation Site

At VHF, fading rapidly increases when the path length exceeds the line-of-sight distance due to the curvature of the earth. For this reason, it is desirable that the installation site of the Hajiganj rebroadcast station be in the line-of-sight from Dacca. When the transmitting antenna of the new Dacca TV Station (to be 450 feet) and the transmitting antenna of the rebroadcasting station (to be 300 feet)

are built (this height is recommended mainly for the reason of economy), the line-of-sight distance, from the standpoint of radio waves, is calculated to be 57 miles, while the line-of-sight distance to Sitakund from Hajiganj is 74 miles. On the other hand, since the distance between Dacca and Sitakund is 111 miles, the site for the rebroadcast station must be selected somewhere between Hajiganj and and Mudafarganj.

According to our actual measurements, the values of the Dacca station measured at Hajiganj far exceeded the estimated values and those of Hajiganj station at Sitakund were lower than the estimated values. When these facts are considered, Mudafarganj is more desirable as a site than Hajiganj.

IV-3-1-2 Transmitter Power and Transmitting Antenna

In the case of on-air relaying, the minimum required field intensity at band III is considered to be 60 dB. On the other hand, the time rate 99% value around the line-of-sight distance is considered to be 5 dB above 50% value.

Converted from the values measured for Hajiganj to Sitakund path, when ERP of Hajiganj station is 1 kw, the field intensity at Sitakund is calculated to be 50 dB, and it is 60 dB when ERP is 10 kw. In the case of Mudafarganj rebroadcast station as recommended, since the value is estimated to be higher than the above by 7 dB (that is, 67 dB), the fading margin is sufficient.

The northern part of this rebroadcast station is covered by Dacca and its eastern section is mountainous area. In other words, the main area to be covered by this translator is situated in the southeast direction. Because Sitakund to be relayed to from this station, is also in the southeast direction, the directivity of the transmitting antenna can be unidirectional. A 3-bay, dipole antenna with corner reflector (See Fig. IV-3-1) is recommeded. However, other antennas if the characteristics are the same as the above can also be used. When the wind velocity of East Pakistan is considered, a light and compact antenna is desirable.

IV-3-1-3 Frequency to be used

This station receives Ch. No. 5 of Dacca and rebroadcasts using some other channel in band III.

At the same time, to avoid the interference with signals of Khulna and Rajshahi stations, Ch. No. 9 is suitable.

IV-3-1-4 Tilt and Null Fill-in.

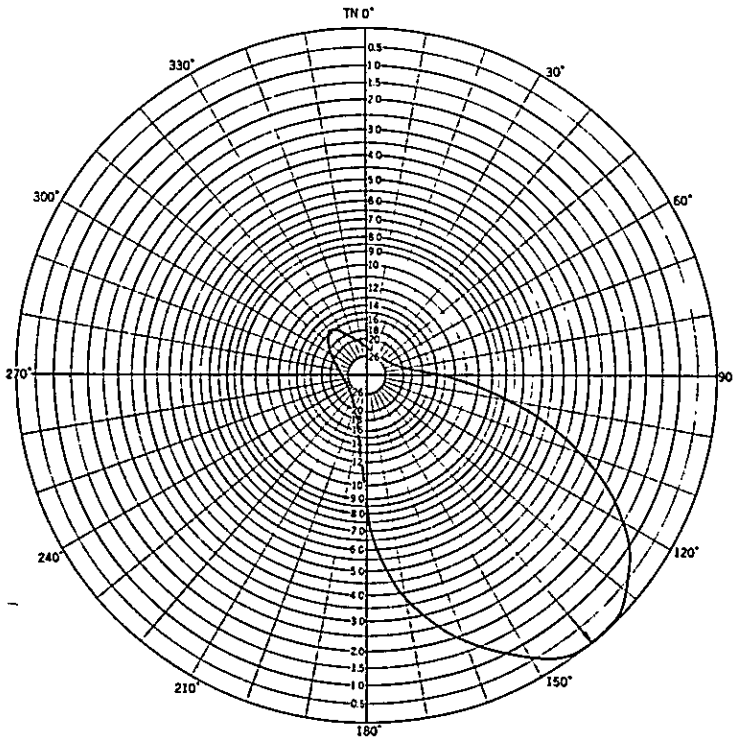
Since the vertical beam width of a 3-bay antenna is wide and Sitakund is in the horizontal direction, there is no need of tilting. The first null point of the 3-bay antenna is 20° which corresponds to 1000 feet (0.19 miles). distance in this case. If only the transmitting site is selected at a distance greater then 1000 feet (0.19 miles) from the densely-populated area, no null fill-in is necessary.

TABLE IV. 3-1

TX DIMENSIONS

STATION NAME	Hajiganj					
FREQ. (CHANNEL)	No. 9			MOTHER STATION		Dacca
TX POWER	1 kW					
ANTENNA STYLE	3 Bay Dipole with Corner Reflector					
EFFECTIVE HEIGHT	G.L. 10	+	(CENTER PT.) ANTENNA HT. 300	-	Av. L. of SERVICE AREA 10	
	= 300 Ft.					
ANTENNA GAIN	12 dB					
FEEDER LOSS	2 dB					
BEAM TILT	0°					
NULL FILL-IN	No					
EFFECTIVE RADIATED POWER	10 kW					

Fig. IV. 3–1



IV-3-2 Location of Sitakund Station and Transmitter Specifications.

IV-3-2-1 Installation Site

Most of East Pakistan is topographically flat, and it is necessary to construct high steel towers in forming the network by means of on-air relay. However, the northern part of Chittagong is a hilly district of an average height of about 1000 feet, and when one of the hills of this area is utilized for transmission and reception, the construction of a high steel tower is unnecessary. Even when one of the above hills is utilized, however, since this area does not fall within the line-of-sight distance from the steel tower of the Dacca TV station, a rebroadcast station (the aforementioned Hajiganj station) becomes necessary between Dacca and this area. Also, from the above hills, the entire area of the city of Chittagong does not fall in to the line-of-sight.

Sitakund station, however, can be situated on one of the hills of comparatively high altitude. It is expected that a greater area can be covered. Because, long range broadcasting is possible; also it is possible to serve most of the Chittagong City Area ; the construction of new roads is uncessary ; the construction of the station is easy. At Sitakund

(a) Long range broadcasting can be made.

(b) Most of the area can be served.

(c) The construction of new roads is unecessary.

(d) The construction of the station is easy.

Because of these advantages Sitakund is the most reasonable location and the station can be situated on one of the hills of comparitively high altitude.

At Sitakund, a T & T microwave relay station is under construction, and it may be necessary to consult with T & T authorities regarding the selection of site, arrangement of the steel tower, etc.

IV-3-2-2 Transmitter Power

The transmitter Power of 2kw and maximum ERP of approximately 10kw are suitable for this station.

The maximum required ERP for the direction of Chittagong is to be determined on the conditions below.

(1) Relaying to the Chittagong station must be possible. The field intensity at Chittagong relay station is estimated to be 73 dB in case of ERP of 1kw. This value is big enough to overcome the noise of the city area in Chittagong

which is in the propagation path and also enough against the summer-time K type fading of the propagation path which passes over Karnaphulli River and along the Bay of Bengal.

(2) For the Chittagong and Sitakund Stations, we should like to use channels in band I, as referred to in a later paragraph. The required field intensity of band I is 48 dB (CCIR Recomendation 417-1). As a result of the measurments conducted in the various cities of Pakistan, however it has been found that a field intensity of 55dB is necessary in the cities. On the other hand, because the city of Chittagong is surrounded by hills, diffraction loss due to mountains could be feared.

Since is possible, a shaded area with a diffraction loss of up to approximately 20 dB could be and if there is a field in tensity of 75 dB in the area which is in the line-of-sight distance, the field intensity in the shaded area just behind there would be 55 dB. On the other hand, if band I channel with 1kw ERP is transmitted from Sitakund, the field intensity in the city area which is in the line-of-sight is 66dB. Consequently, the ERP of + 9 dBk or 8kw is necessary for the direction of Chittagong.

The distance between Hajiganj and Sitakund is 68 miles, while the service area of Hajiganj extends only up to 36 miles. However, if 2kw of ERP is transmitted from Sitakund in this direction, the service area of Sitakund extends to 39 miles ; thus this gap area can be covered completely by the two stations of Hajiganj and Sitakund. Since in the west is the Bay of Bengal, the side beams directed to the north of the direction of Hajiganj and south of the direction of Chittagong would be sufficient. For the northeast, a part of the Chittagong Hill Tracts is to be served by the same ERP as that of Hajiganj. (See Fig. IV-3-2)

IV-3-2-3 Frequency to Be Used

For the reasons stated in detail in appendix V-1, as a rule, in Pakistan band III is desirable. However, for the reasons cited below, we can recommend band I for Sitakund and Chittagong without any hesitation.

Inside the city of Chittagong and in the area between Sitakund and Chittagong, there are quite a few hills. It is feared that the TV signals are attenuated to some extent and the diffraction loss is estimated to be 20-50 dB at some locations if band III is used. On the other hand, if band I is used, the attenuation is expected to be less than the above by 5-10 dB. This difference in attenuation is equivalent to 3-10 times with respect to transmitter output.

The Chittagong station is a station for rebroadcasting Sitakund, and the radio waves of the two stations will exist together in the city area of Chittagong. For this reason, it is desirable that the transmitting and receiving frequencies of the two stations are not close to each other. The channels in band I are No. 2, 3 and 4. Thus, Ch. No. 2 and No. 4 should be used. Since the antenna composition of the Sitakund station is more complex, it is proper that Ch. No. 4 for which the lengths of antenna elements can be short is used for Sitakund.

IV-3-2-4 Transmitting Antenna

Because the Sitakund station is to use band I, the size of the transmitting antenna becomes large and its weight tends to be rather great. For these reasons, the antenna composition should be made as simple as possible and the number of the bays should be made small. Thus, we decided to use a 3-bay, dipole with reflector panel, 3-face style antenna. With the above, in order to secure ERP of 10kw (for the south) and ERP of 2kw (for the north), we decided to use a 2kw transmitter.

IV-3-2-5 Tilt and Null Fill-in

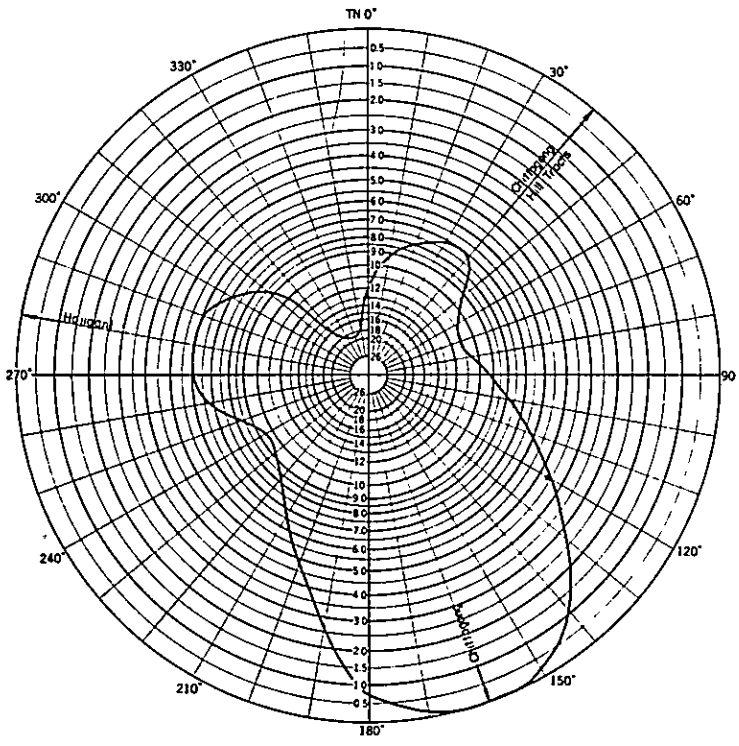
Because the main vertical beam of a 3-bay antenna has sufficient width, no tilting is necessary. Moreover, the angle of the null point is 20°, and since this null point falls in the Sitakund mountain, no null fill-in is necessary.

TABLE IV. 3-2

TX DIMENSIONS

STATION NAME	SITAKUND				
FREQ. (CHANNEL)	No. 4			MOTHER STATION	HAJIGANJ
TX POWER	2 kW				
ANTENNA STYLE	3 Bay, 1 Bay, 1 Bay Dipole with Reflector Panel, 3 Faces				
EFFECTIVE HEIGHT	G.L. 1,152	+ (CENTER PT.) ANTENNA HT. 60	-	Av. L. of SERVICE AREA 10	
	= 1,200				
ANTENNA GAIN	7.3 dB, 1.2 dB, 1.2 dB				
FEEDER LOSS	0.5 dB				
BEAM TILT	0				
NULL FILL-IN	No				
EFFECTIVE RADIATED POWER	9.6 kW 2.2 kW 2.2 kW				

Fig. IV. 3–2



IV-3-3 Location of Chittagong Station and Transmitter Specifications

IV-3-3-1 Installation Site

The program reception is below grade B at Chittagong for 105,000 out of a population of 360,000. If another rebroadcast station (called the Chittagong station) is planned at Tree Point located in the south of Chittagong, all the above 105,000 persons can enjoy better reception. For this purpose, any other site would do and a site where the construction of the station can be carried easily should be selected south of the Chittagong city.

IV-3-3-2 Transmitter Power and Transmitting Antenna

For the same reasons cited for Sitakund, an ERP of 1kw is necessary to convert the area of 20 dB diffraction loss into an area of 55 dB field intensity. Since the construction of a high-gain antenna is not economical for band I, a 100w transmitter is necessary to obtain an ERP of 1kw with a 2-element Yagi antenna. Moreover, since the area south of Tree Point is covered by Sitakund, no transmission for this area is necessary from Tree Point. (See Fig IV-3-3)

IV-3-3-3 Frequency to Be Used

As has been cited in the paragraphs on Sitakund, Ch. No. 2 is suitable for the Chittagong station.

IV-3-3-4 Tilt and Null Fill-in

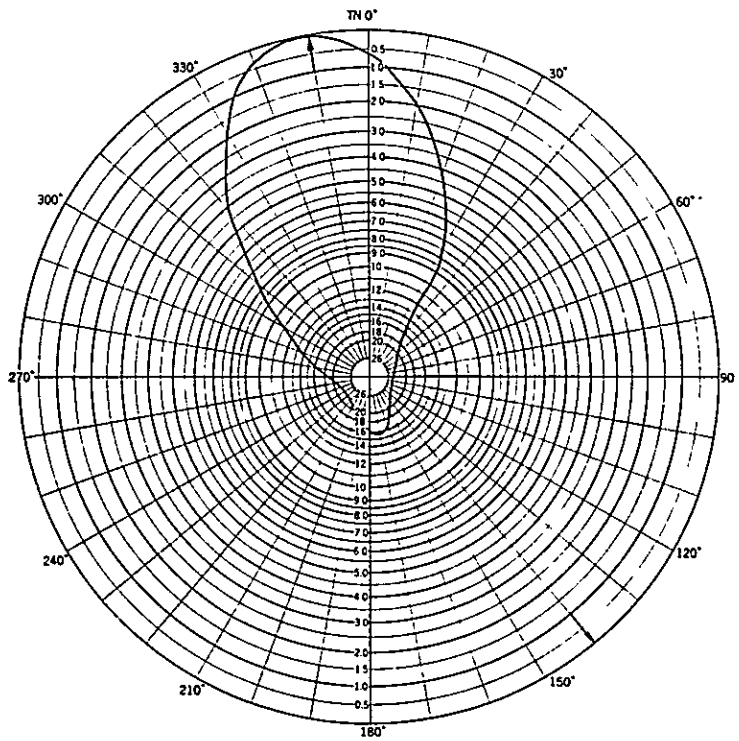
Because the transmitting height is low, the service area extends in the horizontal direction. Also, since the first null point falls arround 0.12 mile (650 feel), the station should be located over 0.12 mile (650 feet) away from the city area. Thus, no null fill-in and tilting are necessary.

TABLE IV. 3-3

TX DIMENSIONS

STATION NAME	CHITTAGONG (TREE PT.)			
FREQ. (CHANNEL)	No. 2		MOTHER STATION	SITAKUND
TX POWER	0.1 kW			
ANTENNA STYLE	2 Stacked Yagi			
EFFECTIVE HEIGHT	G.L. 150	+ (CENTER PT.) ANTENNA HT. 30	- Av. L. of SERVICE AREA 10	
	= 170 Ft.			
ANTENNA GAIN	10.5 dB			
FEEDER LOSS	0.5 dB			
BEAM TILT	0			
NULL FILL-IN	No			
EFFECTIVE RADIATED POWER	1 kW			

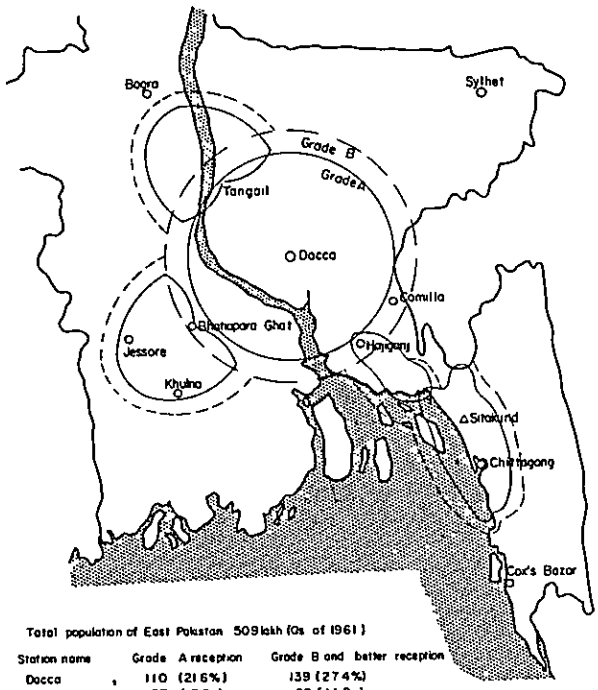
Fig. IV. 3-3



IV-4 AREAS COVERED BY VARIOUS STATIONS IN EAST PAKISTAN (IN CASE OF ON-AIR RELAYING)

When the Dacca, Khulna, Bogra, Hajiganj, Sitakund and Chittagong (Tree Point) stations are installed based on the foregoing recommendations, the approximate outer edges of the areas covered by these stations will be as shown in Fig. IV-4-1. Grade A areas are those where the field intensity of 55 dB or greater can be obtained with a receiving antenna height of 30 feet, and grade B areas are those where the field intensity is 45 dB or greater with the same antenna height of 30 feet.

Fig. IV. 4—1 Predicted Service Area of Dacca and other rebroadcast station (on-air relay)



Total population of East Pakistan 509 lakh (Os of 1961)

Station name	Grade A reception	Grade B and better reception
Dacca	110 (21.6%)	139 (27.4%)
Khulna	37 (7.2)	60 (11.8)
Bogra	29 (5.7)	43 (8.3)
Hajiganj	23 (4.6)	27 (5.3)
Sitakund Chittagong	16 (3.1)	21 (4.1)

IV-5 AREAS COVERD BY VARIOUS STATIONS IN EAST PAKISTAN (IN CASE T & T MICROWAVE RELAY SYSTEM IS USED)

IV-5-1 General Conditions to be considered

As means for relaying the programmes of the mother station (Dacca station) to the satellite stations, in addition to the aforementioned on-air relaying, utilization of the microwave links or cable facilities installed by T & T can be envisaged. In such a case, it is very important and necessary to fully understand all of the planning of T & T in advance. It is necessary to find out

(a) Whether or not the utilization of T & T relay facilities is possible by the time P.T.C. constructs its rebroadcast stations and is ready to start their operation.

(b) Whether or not the T & T facilities (including antenna towers) have sufficient capacity and quality necessary for relaying television signals.

(c) Whether or not the T & T facilities can be utilized freely during the hours of the day desired by P.T.C (for example, from five o'clock in the afternoon to ten o'clock at night). In other words, (perhaps) the normal telephone communications might be interrupted while P.T.C. is in use of the facilities of T & T. The answer to the above question must be ascertained because 960 circuits of the telephone system are normally required just to relay one television channel.

(d) The rental fee to be paid by P.T.C. to T & T. Whether the fee is greater or less than the cost incurred when P.T.C. itself constructs and operates on-air translator stations.

IV-5-2 Specifications of Khulna and Bogra Stations

a. Installation site.

Since programmes are to be supplied by the microwave link, the site should be located not too far from the T & T terminal station and at an approximate center of the area to be covered. As the terrain of these areas is almost flat, the site can be selected at any place as far as the TV signal propagation is concerned. The transmitting point should be determined mainly by considering the ease of construction and maintenance of the station.

b. Transmitter power

From the standpoint of economy and in consideration of possible damage from cyclones in East Pakistan, it is assumed that the height of the antenna steel tower of the rebroadcast station will be about 300 feet. Then, the line-of-sight distance, with a 30-foot receiving height, is calculated to be 34 miles. Since television signals become unstable when the path length is over the line-of-sight distance and if the area extending up to the above distance is made as grade A reception area, then the minimum required ERP becomes 10 kw.

c. Transmitting antenna

Unlike the case of on-air relaying, no directivity is required for the ant antenna in this instance. To cover the area as far as possible, and to make construction easier and economical we recommend a 12-bay, dipole with reflector panel antenna. Since the gain of this antenna is approximately 12 dB including the feeder loss, an ERP of 17kw can be obtained with a transmitter of 1kw.

d. Frequency to be used, tilting and null fill-in

To avoid the mutual interference among the Dacca (Ch. No. 5), Bogra and Khulna stations, a frequency which is separated from other frequencies by more than one channel is desirable. Therefore, the Khulna station is to use Ch. No. 7 and Bogra station is to use Ch. No. 9. (when the Rajshahi station is layed-out in the future, Ch. No. 11 can be used.) Regarding null fill-in and tilting they are the same as in the case of on-air relaying. The transmitter specifications are shown in Table IV 5-1.

IV-5-3 Transmitter Specifications for Chittagong Station

(a) Installation site

Since Chittagong and its environs are hilly, even when the T & T facilities are utilized as a programme source, it is difficult to serve the entire area with one station. Among the hills inside the city of Chittagong. Court Hill can have the largest service area. Since the T & T microwave terminal station is expected to be constructed 1/3 mile north of Court Hill, relaying by means of cables is completely possible. Because the roof of the Court building seems to be too weak to support a television station, the station should be constructed in the front garden.

(b) Frequency to be used

As is stated in Appendix V-1, generally the use of band III is desirable in Pakistan. However, for Chittagong, we should like to use Ch. No. 4 of band I.

As has been cited in the preceding paragraph, there are many hills in Chittagong and there are many sections where the transmitted TV signals propagate over hills.

When band III is used in Chittagong, the diffraction loss is larger in the over-hill propagation areas and the field intensity decreases. Compared with band I, the difference is 5-10 dB and a transmitter power larger by 3-10 times will be required.

On the other hand, the disadvantage of using band I is that the transmitting and receiving antennas must be made larger. As is stated in latter paragraphs, the antenna for the Chittagong station is 1-bay, dipole with reflector panel antenna, and because of its simple composition, the construction is easy and the cost is low. Since most of the receiving area will be covered by the signals of high field intensity, the viewers have only to provide a simple receiving antenna.

(c) Transmitter power

When the distance from one end to the other of the city area of Chittagong is 6 miles, the field intensity, in the case of line-of-sight, is 95 dB. However, areas of large diffraction loss also exist here. If only one station is to be installed in Chittagong, it is necessary to compensate for the above diffraction loss with more power. According to the results of city noise measurements cited elsewhere, the minimum required field intensity for band I in the city areas of Pakistan is 55 dB. With an ERP of 1kw, Court Hill Station to areas of up to 40 dB diffraction loss. Moreover, where the diffraction loss increases to more than 40 dB the receiving quality will deteriorate because of the occurrence of ghost. Then, the viewers must be instructed in the ways to adjust their sets.

(d) Transmitting antenna

The service area closest (accurately the area of the largest angle of depression) to Court Hill is around the GPO building at a distance of 400 feet.

The angle of depression is 35°. There are many offices but only a few residences is this area. The south side of Jinnah street where there are many houses is situated at a distance of 500 feet and the angle of depression to this area is 24°.

Since the first null point of the vertical directivity of a 2-bay transmitting antenna is approximately 30°, the transmitting antenna to be used for this station must be a single-bay antenna. Because the objective service area extends in all directions, it is desirable that the horizontal directivity of the antenna be nondirectional. For the above reasons, we recommend a single-bay, dipole with reflector panel antenna. The gain of this antenna is 0 dB. When 2 dB is considered for various losses including the feeder loss, the ERP is 630w when a 1kw transmitter is used.

The Court Building is approximately 60 feet high. To avoid the effect of this building, the height of the antenna must be 120 feet above ground level.

Construction of the station building and steel tower in the front garden space is possible.

Furthermore, because the antenna is a single-bay, dipole with reflector panel antenna, tilting and null fill-in can not be made and also they are not necessary.

TABLE IV. 5-1

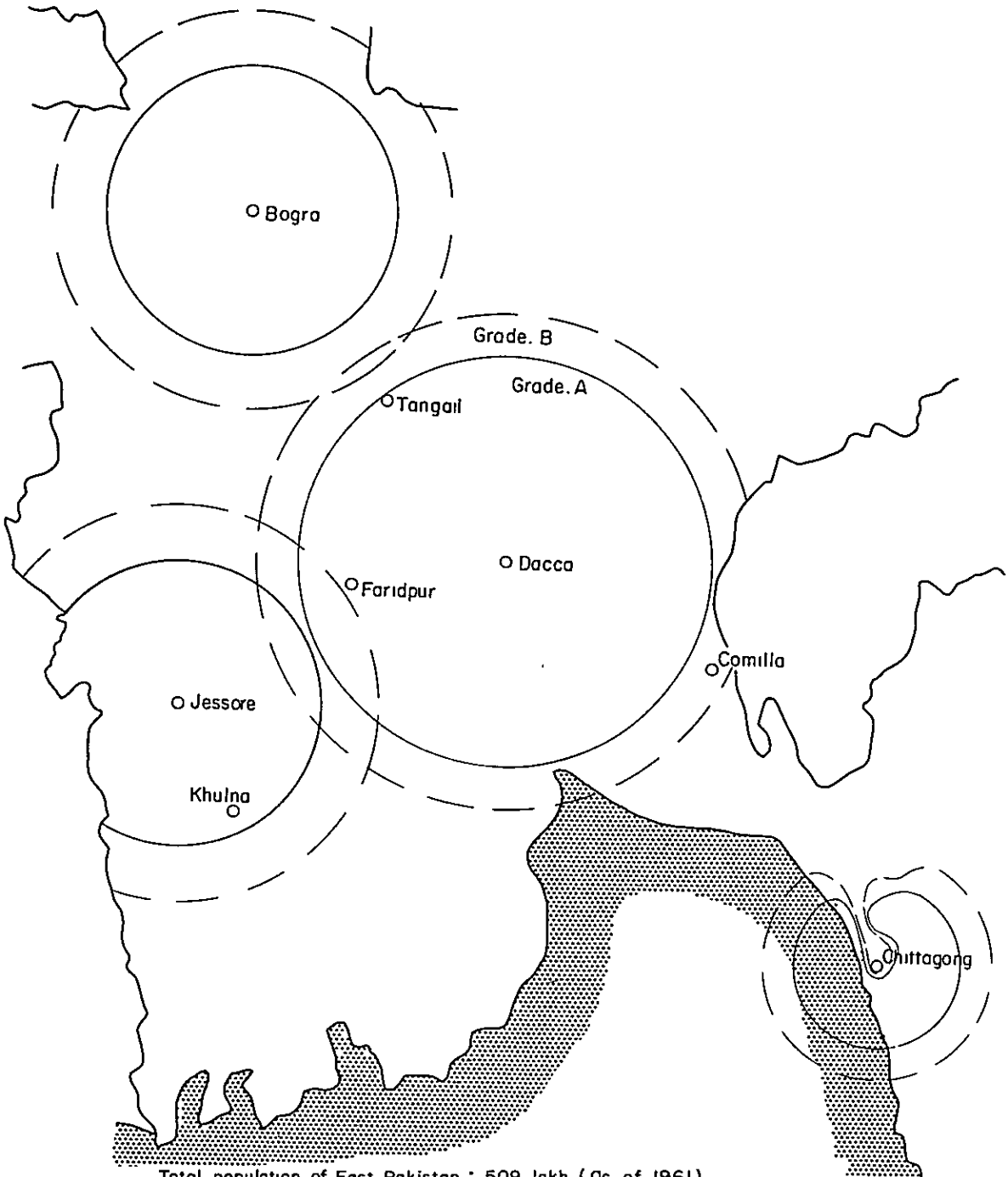
TX DIMENSIONS			
STATION NAME	Khulna, Bogra		
FREQ. (CHANNEL)	No. 7, No. 9	MOTHER STATION	μ - Wave
TX POWER	1 kW		
ANTENNA STYLE	12 Bay Dipole with Reflector Panel, Omni-Directional		
EFFECTIVE HEIGHT	G.L. 20 + (CENTER PT.) ANTENNA HT. 300		Av. L. of SERVICE AREA 20
	= 300 Ft.		
ANTENNA GAIN	13.8 dB		
FEEDER LOSS	1.5 dB		
BEAM TILT	-0.5		
NULL FILL-IN	15 %		
EFFECTIVE RADIATED POWER	17 kW		

TABLE IV. 5-2

TX DIMENSIONS

STATION NAME	CHITTAGONG (Court Hill)				
FREQ. (CHANNEL)	No. 4		MOTHER STATION	μ	- Wave
TX POWER	1 kW				
ANTENNA STYLE	1 Bay Dipole with Reflector Panel, Omni-Directional				
EFFECTIVE HEIGHT	G.L. 120	+	(CENTER PT.) ANTENNA HT. 120	-	Av. L. of SERVICE AREA 10
	= 230 Ft.				
ANTENNA GAIN	dB				
FEEDER LOSS	dB				
BEAM TILT					
NULL FILL-IN					
EFFECTIVE RADIATED POWER	1 kW				

Fig. IV. 5–1 Predicted Service Area of Dacca and other rebroadcast station (by T & T's facilities)



Total population of East Pakistan ; 509 lakh (As of 1961)

Station name		Grade A reception	Grade B and better reception
Dacca	;	110 (21.6%)	139 (27.4 %)
Khulna	;	30 (5.9)	60 (11.8)
Bogra	;	50 (9.8)	73 (14.5)
Chittagong	;	10 (2.0)	12 (2.4)

V. APPENDIX

V. APPENDIX

V-1 Frequencies for Television Broadcasting

V-1-1 The country of Pakistan has adopted CCIR-B System (See CCIR Report-308-1) as the standard system for television broadcasting. Therefore, the frequencies for television broadcasting are as shown in the table below.

BAND	CHANNEL No.	FREQUENCY BAND (MC)	VIDEO	AUDIO
I	2	47 ~ 54	48.25	53.75
	3	54 ~ 61	55.25	60.75
	4	61 ~ 68	62.25	67.75
III	5	174 ~ 181	175.25	180.75
	6	181 ~ 188	182.25	187.75
	7	188 ~ 195	18925	194.75
	8	195 ~ 202	196.25	201.75
	9	202 ~ 209	203.25	208.75
	10	209 ~ 216	210.25	215.75
	11	216 ~ 223	21725	222.75

V-1-2 The existing Karachi station is using Ch. No. 4. The Lahore and Dacca stations are using Ch. No. 9 (both stations are to change their channel number from No. 9 to No. 5). The temporary station at Rawalpindi is using Ch. No. 6.

Because of the reasons stated below, we recommend the use of band III (Ch. No. 5-12) as much as possible for the TV broadcasting in Pakistan.

1) For effective utilization and control of frequencies, use of only one continuous band for television is preferable.

2) Band III has more channels than band I.

3) The use of bands I and III in the same country makes the manufacture a and supply of receiving antennas more complex.

4) Because the dimensions and weights of transmitting and receiving antennas of band I are greater than those of the antennas for band III, the cost of the antennas and their installation is higher than that of band III.

5) Band I waves sometimes propagate abnormally due to sporadic E layer.

In the Chittagong area, however, many propagation paths suffer from mountain-diffraction because of complicated topography. In a case like this, band I is more adventageous from the viewpoint of TV wave propagation. Therefore we dare recommend the use of band I for Chittagong area in spite of reasons mentioned in (1) - (5) above.

V-2 Height of Receiving Antenna Above Ground

V-2-1 In most cases, the field intensity of television singnals is proportional to the height of receiving antenna above ground. Thus, when we plan a television broadcast network, it is necessary to assume the height of receiving antenna. In this report, a height of 30 feet has been assumed to be the height of the receiving antenna.

CCIR and EBU assume the above value as 10 m. FCC assumes it to be 30 feet. The Japanese Government uses 4m for the above value. The reason for this was as follows. The usual houses in Japan are much smaller than those in the various European and American countries. So the height of receiving antenna is determined in CCIR, EBU and FCC standards. Moreover, the distribution of houses which form obstacles to TV wave propagation is much less in Japan than in the European and American countries. Thus, in most cases the height of receiving antennas erected on the roofs of Japanese houses was thought to be about 4 m.

V-2-2 Pakistan cities resemble Japanese Cities more closely than they resemble European ones. However, in West Pakistan many houses are constructed of brick and stone like the European Ones. Because of this an antenna height of 30 feet is recommended. Note the following points :

1) The houses in West Pakistan are strong enough to support comparatively high receiving antennas.

2) Because there are many stone and brick buildings which are obstacles to TV wave propagation, installation of comparatively high receiving antenna is desirable.

3) There will be less chance of receiving antennas being damaged by strong winds and salt.

On the other hand in East Pakistan ; there are many wooden buildings, a strong wind blows often and many houses are constructed near seashores. Accordingly, we

would suggest the adoption of a height of 4m for receiving antennas. However, it is not desirable to have two standard values in one country. Moreover, when 4m antennas are used it is necessary to have a transmitter output generally of five times comparing with that of a 30 foot antenna, thus causing a large increase in expense.
For the above reasons, 30 feet high antennas should be used throughout Pakistan. But, in East Pakistan there are many high trees on the fringes of TV service areas.
There might be attenuation of TV signals at the fringe areas where the angle of incidence of TV waves is small, and it must be taken into account. Therefore, practically all viewers at fringe areas will be expected to install a receiving antenna which is higher than 30 feet to overcome such attenuation.

V-3 Required Field Intensity

V-3-1 The required field intensities for band III are as follows :

CCIR : Normally 55 dB (Recommendation 417-1).
In sparsley-populated regions the field-intensity required is 49 dB. (Report 409)
At 40 dB the public begin to lose interest in installing television reception equipment.

FCC : Grade A
71 dB (FCC regulation 3.683)

Grade B
56 dB

Japan : 54 dB (Japanese Government regulation, the 3rd article of the basic requisites for establishiment of broadcast stations)
However, for the city areas where the man-made noise level is high, other values are designated.

V-3-2. The European countries which use the same standard system as Pakistan have adopted 55 dB as the required field intensity. In Japan the buldings and T.V. wave propagation phenomenon are similar to those in Pakistan and the Japanese have adopted 54 dB as the required field intensity. We recommend 55 dB as the required field intensity. In Japan and also in other countries, television viewers exist, even though scattered, in the areas which has the field intensity below the requirement or outside of the service areas. In Pakistan, there are few satellite cities. There are mostly agricultural areas around the large cities. Since tall buildings are few, viewers will be expected to receive TV programmes even in the

areas where the field intensity is below 55 dB. Thus, in these recommendations, when we regarded 55 dB as grade A, we designated 45 dB as grade B. The significance of grade B, that is 45 dB, may be understood from the explanation given below.

(1) Normally, in Band III the receiving antenna gain of TV viewers can be considered as 6dB. However, in weaker field intensity areas such as grade B it can be assumed that most viewers use a YAGI-antenna with eight or more elements which the gain is more than 9 dB. Then the difference of the gain of receiving antenna is 3 dB. (Note : In Japan and Europe, the gain of a normal receiving antenna, in band III, is assumed to be 6dB. FCC designates the receiving antenna gain of grade A as 0dB and that of grade B as 6dB. Since it is assumed that super wide-band receiving antennas are not necessary in Pakistan because viewers need not receive many channels at the same point, we think that is is proper to consider 6dB as the standard gain.) Also, by increasing the receiving antenna height to 60 feet, the field intensity can be increased by 6dB. The total is 9dB and the required field intensity becomes $55 - 9 = 46 \fallingdotseq 45$ dB.

(2) Now, let us explain in another way.

When the field intensity is 55 dB, S/N ratio at the receiver is considered to be 30dB. However, when a viewer in grade B areas wants reception using the same receiving facilities as those for grade A areas, then S is lower by 55 - 45 = 10dB. S/N ratio is 20dB. An admissible picture can be enjoyed if there is no interference.

(3) CCIR reported that the public begins to lose interest in installing television reception equipment when median field intensity falls below 40 dB. However, in the areas such as grade B areas located far from a transmitting station, or in East Pakistan where there is much over-water propagation, fading will often occur.

According to CCIR Recommendation No. 370 or the result of research in Japan (NHK Technical Research No. 101, Page 22), the difference between 90% and 50% values near 100km in case of band III is 4dB. Consequently, the field intensity required in grade B area is 40 + 4 = 44dB $\fallingdotseq$ 45dB

V-3-3. In the cities where man-made noise level is high, it is necessary to add extra field intensity to overcome the man-made noise. For Pakistan, however,

according to the results obtained by actual measurements at several cities, it is not necessary to add any extra field intensity to overcome the man-made noise for the time being.

V-4. Television Wave Propagation (Method of Calculation)

V-4-1. When the transmitting and receiving antennas are in the line-of-sight and TV waves spread over a flat terrain, the field intensity near the receiving antenna is expressed by the formula below.

$$E = \frac{7\sqrt{W}}{d} 2 \sin \frac{2\pi h_T h_R}{\lambda d}$$

W : transmitting E.R.P. (watt)

d : distance between transmitting and receiving points

E : field intensity (V/m)

h_T : height of transmitting antenna (m)

h_R : height of receiving antenna (m)

In principle, all calculations are based on the above theoretical formula. However, the ambient conditions in actual TV wave propagation are not always similar to those of a flat terrain and the following can be considered:

1) The Ground is not flat and smooth.

2) When the transmitting antenna height is low or the distance is great the curvature of the earth must be taken into account.

3) Because of the earth's curvature, the transmitting and receiving antennas are not in the same line-of-sight.

4) The propagation path is not over land, but it is over water.

5) The propagation path is obstructed by a mountain or mountains.

Considering the various items listed above, various countries, organs and scientists have published many calculation methods supplementing the above theoretical formula.

V-4-2. Except for the north of Rawalpindi and the environs of Chittagong, the topography of Pakistan is mostly flat. The most propagation path can be considered as the propagation over smooth curvature of the earth. Thus, first we shall compare the measured values with the calculated values based on the spheric pro-

pagation charts of CCIR Recommendation No. 370, FCC (FCC regulation) and Japan (Radio Regulatory Bureau).

Transmitting point	Receiving point	Distance (km)	Measure value (dBμ)	Calculated value (dBμ)		
				Japan	CCIR	FCC
Murree Hill Pindi Point	Peshawar 9 places	165	39.5 - 51	* 49	33	46
	Islamabad 12 places	32	76 - 88.5	* 79	77	*75
	Gujrat	161	39.5	36	33	31
	Gujranwala 2 places	207	34.5	35	24	30
Dacca TV station	Northwest	6.3	87	88	-	73
	North	19.5	62	65.5	55	54
	North	29.5	53	57	45	46
	Tangail	75	29	28	23	18
Khairi Murat	Islamabad 6 places	40	71.2 - 73.7	72	58	64
Sitakund	Hajiganj 2 places	110	30	34	28	27
Chittagong Tree Point	Chittagong	9	84	82	72	65

Note : ERP = 1kw and h_R = 10m

~~~ Figures underlined with * indicate calculated values which are the most similar ones to measured values.

As is clear from the above table, the calculating method used in Japan is likely to be the most suitable to the conditions existing in East and West Pakistan relating to the propagation curve over the earth's curvature. For this reason, we have decided to use the Japanese method in these recommendations.

V-4-3. For other cases, the calculating method shown below is used.

(1) When the propagation path is obstructed by mountains the ordinary knife edge diffraction theory is used.

(2) For calculating the field intensity when the distance for exceeds the horizon, the formula below is used.

$$E = 56 \times 2^{1/4} \frac{(ka)^{5/4} W^{1/2} h_T^{9/8} h_R^{9/8}}{\lambda^{1/2} d^4}$$
~~~

K : earth's equivalent radius rate. Normally, it is 4/3

a : radius of the earth (m)

Other symbols are the same as those of the formula in V-4-1.

By actual measurements, the above were confirmed as shown below. Because of different calculating method, the values differ slightly from the calculated values of the previous table.

Transmitting point	Receiving point	Distance (km)	Measured value (dBu)	Calculated value (dBu)
Murree Hill, Pindi Point	Lahore	270	43	44
Dacca TV station	Tangail	75	29	30
Sitakund	Hajiganj	110	30	34

ERP = 1kw

h_R = 100m (Lahore), 10m (for other points)

V-4-4. In the case of a long distance, especially when the TV wave propagation path has to pass over water propagation path, fading sometimes occurs. This fact has also been ascertained in Pakistan. For estimating fading, we refered to CCIR Recommendation No. 370 and the results of the research conducted by NHK Technical Research Laboratory and Ministry of Postal Services' Radio Research Laboratory.

V-5. Receiving Antenna for On-Air Relay Station

V-5-1. Gain

In Pakistan, weather change due to seasons is great. During summer a considerable part of the propagation path is over water. And because the propagation path is long, the fading will often occur. Consequently the use of high gain antennae is desirable. The types of antennas, that can be considered are given below.

5-element Yagi antenna	Gain	8 dB
8-element Yagi antenna	Gain	10.5 dB
12-element Yagı antenna	Gain	11.5 dB
Dipole antenna with corner reflector	Gain	9 dB
Parabolic antenna	Gain	16 dB

V-5-2. Load and Weight

Because the receiving antenna is installed on an elevated location, the structure of the tower must be considered from the standpoint of load. Generally the wind pressure poses a greater problem than the weight of the antenna itself. The parabolic antenna is not desirable in VHF because its diameter is greater than 10m and the wind pressure it receives is large. For the above reasons, it is desirable that antenna which is to be installed on the top of a 300-foot tower be a Yagi antenna.

V-5-3. S/N Ratio and Required Field Intensity

When S/N ratio of 40dB of a video signal is the required S/N ratio of the on-air relay station and if a receiving antenna with a gain of 10dB is used, the required field intensity at band III is 60dB.

When the TV signal of the capital station is received at Lahore, the fading width, as has been cited in II-3-4, is 8dB at time rate of 90% and 15dB at 99%. Because the field intensity of 50% at Lahore is 64dB; it is 64 - 8 = 56 dB at time rate of 90% and 64 - 15 = 49dB at time rate of 99%. These figures are less by 4 dB and 11dB respectively than the required intensity of 60dB and the time rate during which 60dB can be secured is less than 90%. When using a normal receiving antenna whose gain is 10dB, S/N ratio becomes 29dB at 99% and noise in the received picture is noticeable.

The gain of 12-element Yagi antenna, installed in 2-stack, 2-row style, is 16dB. When this antenna is used as the receiving antenna of the Lahore station, the above values become +2dB and -5dB. The time rate during which the quality of normal 60dB can be secured is 92%; at 99%, S/N ratio becomes 35dB and a picture which is of practical use can be obtained. However, because during the time of 1% the value is lower than the value cited above, sometimes the picture received may not be of practical use.

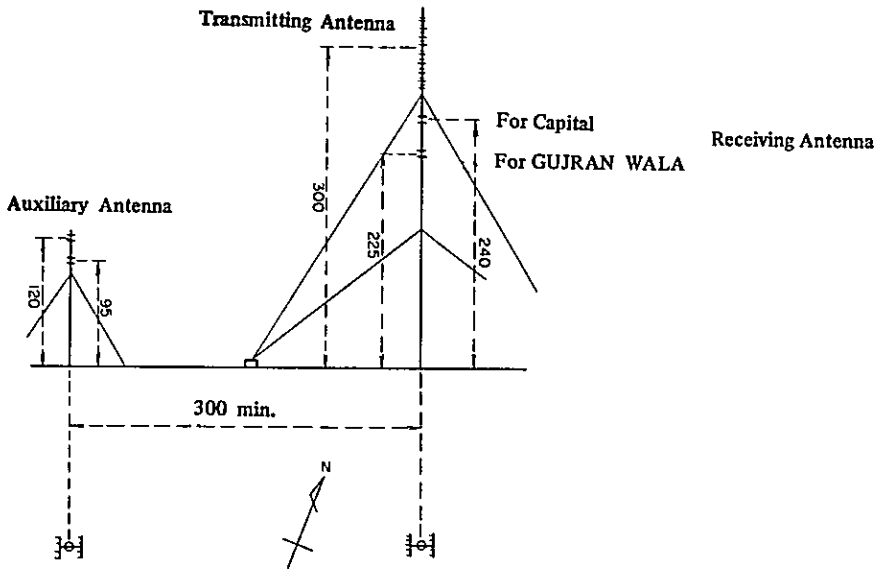
V-5-4. Receiving Antenna of Lahore Station

Based on the above grounds, we would like to recommend a 12-element, 2-stack, 2-row Yagi antenna as the receiving antenna of the Lahore station. When installing the Gujranwala station between the Lahore and capital stations, the receiving field intensity at the Lahore station is 65dB and it is 60dB even at 99% value. A 12-element, 2-bay Yagi antenna can be considered as sufficient. However, since the 1% value may be below 60dB, a 2-stack, 2-row antenna is

desirable. For the above reason, it is preferable that the transmitting and receiving tower is as shown in the diagram below.

As shown in the diagram, in addition to the main tower, an auxiliary tower construction is useful for prevention of fading by space diversity. The auxiliary tower should be constructed as far away from the main tower as possible and it should be as high as possible. The designation of a location 300 feet from the main tower in this diagram is in consideration of the size of the lot. Against the distance of 160 miles between Pindi Point and Lahore, the distance of 300 feet is too small, and it is considered that this is not quite sufficient for the prevention of fading. After the Pindi Point station opens, the location of the auxiliary antenna should be determined after investigating the simultaneity of fading by actual measurements at the locations of the main and auxiliary antennas. Depending on conditions, the utilization of structures such as the WAPDA Building as the location for the auxiliary antenna and wireless relaying between it and the transmitting station can be considered.

Also, the utilization of the tower of the temporary station or the medium wave steel tower of Radio Pakistan can be considered.



V-5-5. Receiving Antenna of Capital Station

Because of the reversibility of propagation, the same antenna facilities as those of the receiving antenna at the Lahore station are necessary for the capital station. Since the capital station is located on high ground, a 300-foot tower is not necessary. The antenna can be installed at the transmitting tower, otherwise a 300-foot tower, exclusive use for reception can be constructed easily. For space diversity, a point in the west of Pindi Point is the best place to install an auxiliary antenna. Even in this case, Kashmir Point or the microwave steel tower of T & T may not be suitable.

V-5-6. Receiving Antennas of Other Stations for Relaying

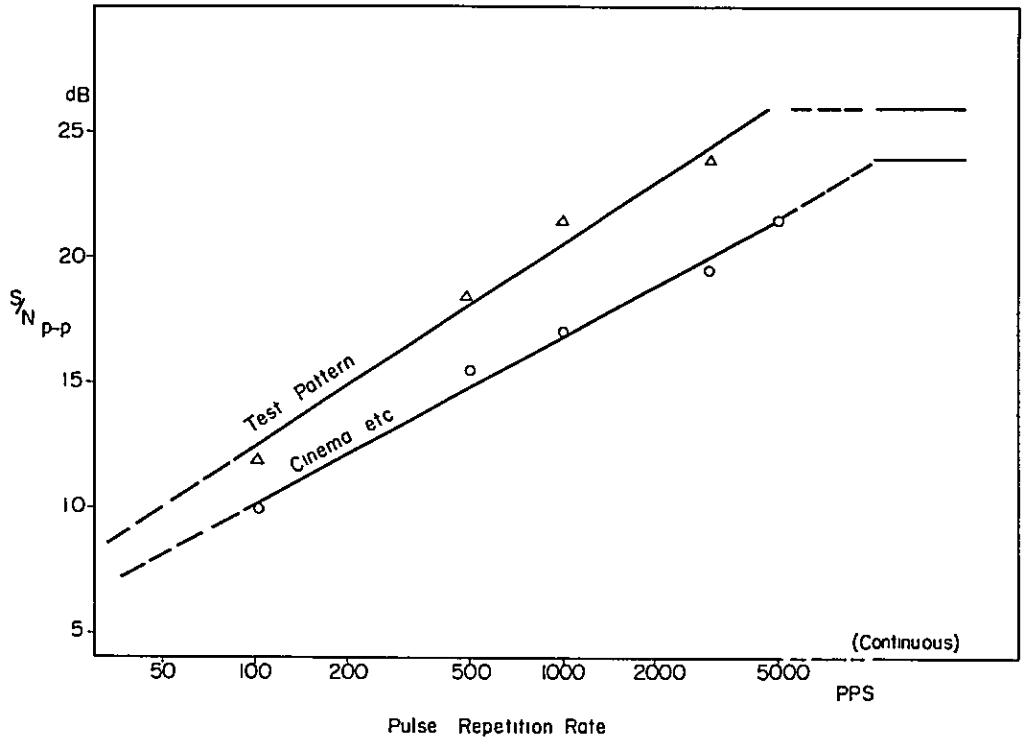
For the Tangail, Khulna, Hajiganj, Gujranwala and Hyderabad stations, the facilities which are similar to those of the Lahore station are desirable. However, since the cost rises when the load is large, an 8-element Yagi antenna can be used to save expenses. Since the Sitakund station is not required to have a high tower, for the time being an 8-element, single-bay antenna can be used and additional antennas, if necessary, can be constructed later depending on the condition of fading.

Because they receive band I, the Tatta and Chittagong stations' receiving antennas are to be large. However, since fading in these areas is less compared with that of other areas, 5-element, single-bay antennas are to be used for these stations. For the fading caused by the Karnaphuli River and the Bay of Bengal, a space diversity is more effective than a multiple-bay antenna.

V-5-7. Preamplifier for the Receiver

The stations with low towers such as the capital, Sitakund and Chittagong stations, have short receiving feeders. However, since the feeders of other stations are rather long, it is desirable to install preamplifiers close to the receiving antennas. Because of its compact size, a preamplifer using semiconductors can be attached to the tower. In this case, a device to avoid the interference from the station's own transmitting waves is necessary.

V-6. Some Results of the Experiment Relating to Required S/N Ratio of Man-Made Noise



V-7. Interferance to TV reception Due to Buildings

The trouble caused by tall buildings was not conducted during this survey. However, the trouble due to high buildings has been posing problems increasingly in Japan and other countries recently.

These are many tall buildings in Karachi, Rawalpindi, Dacca, Chittagong, etc. In the future, when the number of television viewers increases, the presence of many tall buildings will affect even the areas which are located at a distance several times the height of each building, though the degree may differ somewhat according to the size of buildings, distance from the station, topography, etc. Furthermore, in the case of a station such as the one in the city of Dacca where the transmitting antenna can only be installed on flat ground and its height is limited because of the nature of the ground on which it is installed, the effect of tall buildings would be greater.

To counteract this shadow trouble, increasing the antenna heights, use of multiple elements, change in location, installation of receiving antennas on the tops of buildings distribution of the received signal through cables buried in building walls, etc., may be necessary in the near future.

At the initial stage of construction of the television broadcast network, it may be better to consider some legal countermeasures for the effect of tall buildings, together with the noise which is due to internal combustion engines.

II-8. Difference in Quality of Received Picture Due to Generator and Commercial Power Supply

Experiments were performed at Hotel Shahbagh in Dacca, when Honda's E 300 generator was used as power supply and Dacca city's commercial power line was used as power source. When the generator frequency was adjusted properly, no clear difference could be observed in the quality of the picture of the TV receiver.

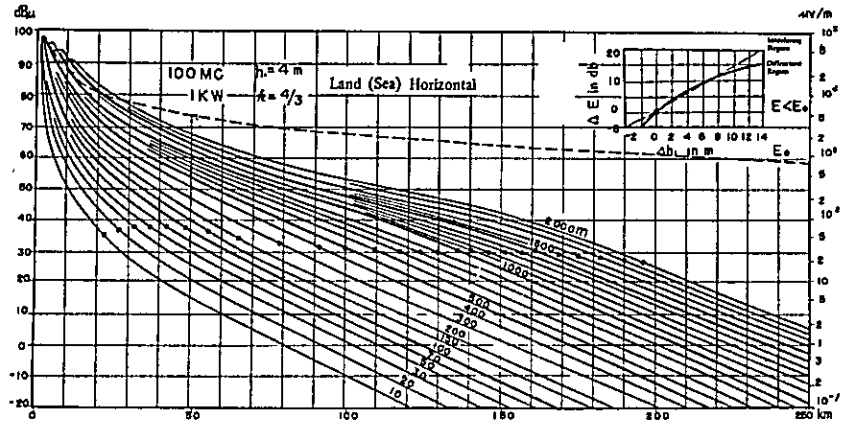
Regarding the ignition plug noise which originated from the generator, the operation of the receiver used in the ghost tests during this survey period was checked. The intensity of the noise was extremely weak, and we think that the generator can be used without any trouble, as a power source for TV receivers in the areas where no commercial power is available.

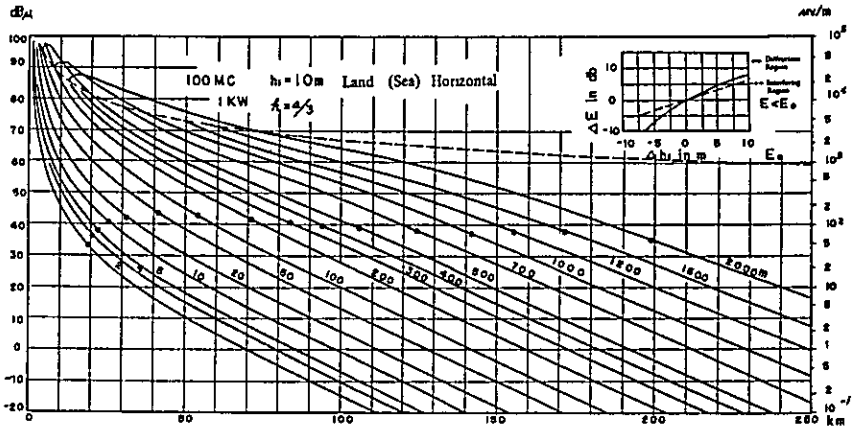
V-9. Propagation Curve

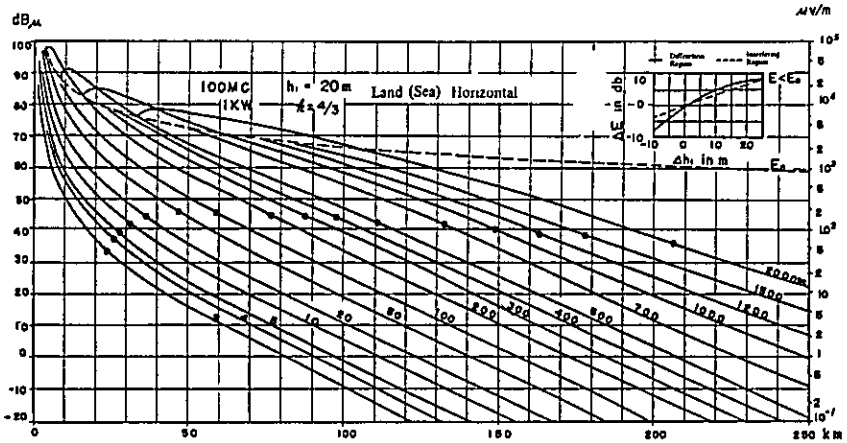
The field intensity curve at f = 100 MC and 200 MC over the earth's curved surface when one antenna height is fixed and the other antenna height is as parameters, is shown below.

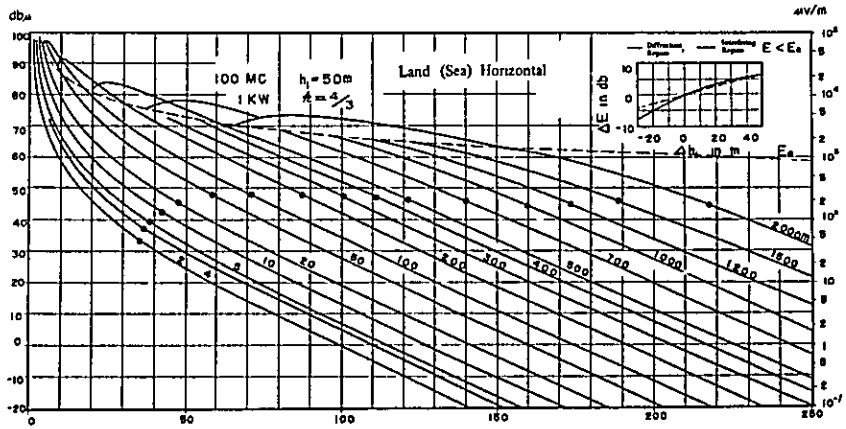
The points of the line-of-sight distance are shown by black dots in each diagram. When any antenna height differs from h_1, a correction can be made with the correction curve shown at the top of each diagram. This curve is divided into interference and diffraction areas.

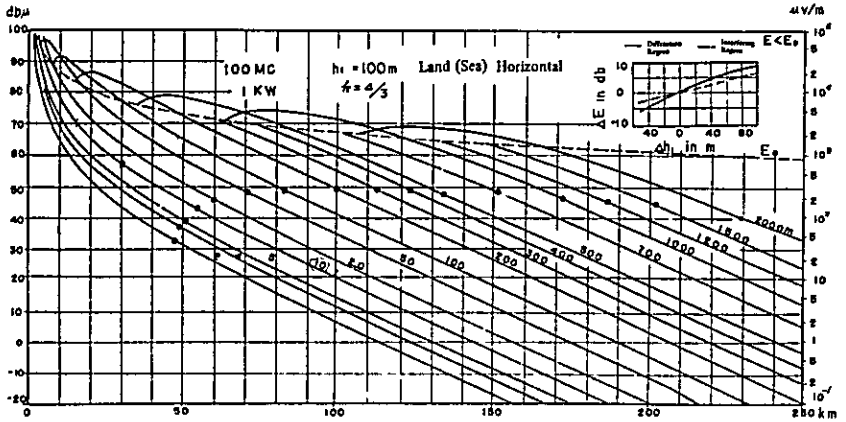
Also, a method of correction by frequency is shown separately. With the above method, regarding TV waves, correction can be obtained for any desired height and frequency by an adjustment to the diagram, utilizing this group of curves.

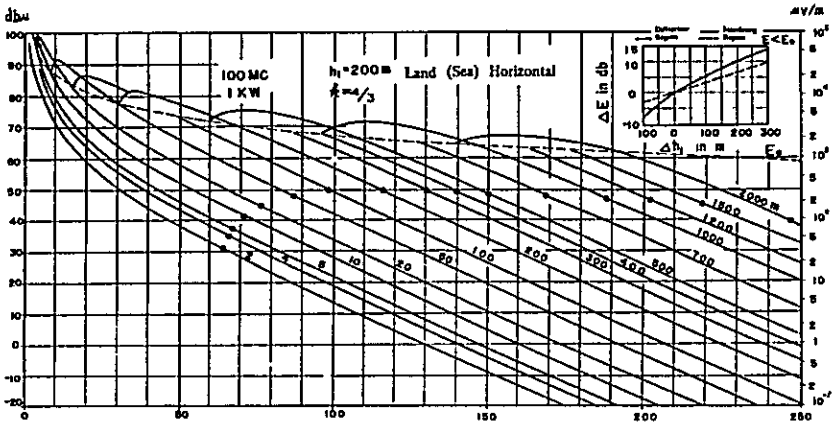

dBμ
μV/m
100 MC
1 KW
h₁ = 4 m
k = 4/3
Land (Sea) Horizontal
E<E₀
Δh in m
E₀
4000m
1000
800
600
400
300
200
150
100
80
50
40
30
20
10
0
50
100
150
200
250 km

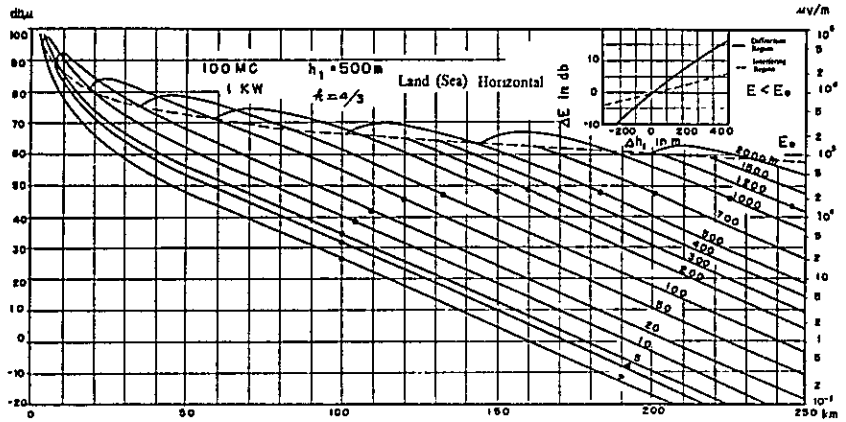

dBμ
μV/m
100 MC
1 KW
h₁ = 10m
k = 4/3
Land (Sea) Horizontal
E<E₀
Δh in m
E₀
2000m
1800
1600
1400
1200
1000
700
500
400
300
200
100
80
50
40
30
20
10
8
6
4
0
50
100
150
200
250
km

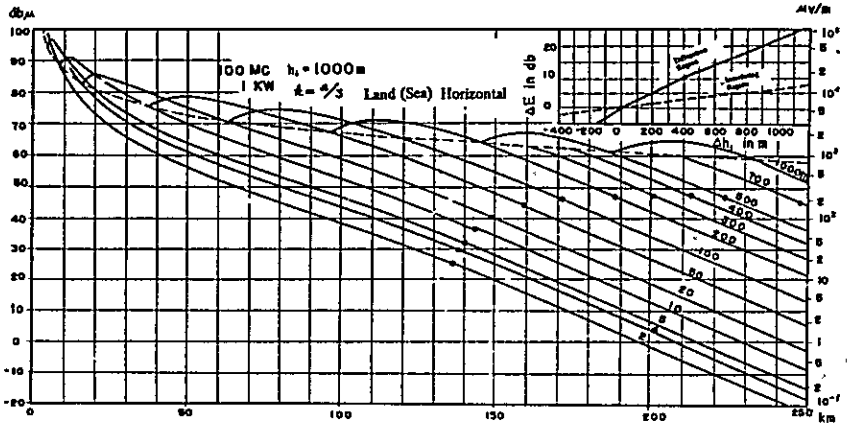

dBμ
μV/m
100MC
1KW
h₁ = 20m
k = 4/3
Land (Sea) Horizontal
E<E₀
Δh in m
E₀
2000m
1800
1600
1400
1200
1000
700
500
400
300
200
100
80
50
40
30
20
10
8
6
4
0
50
100
150
200
250 km

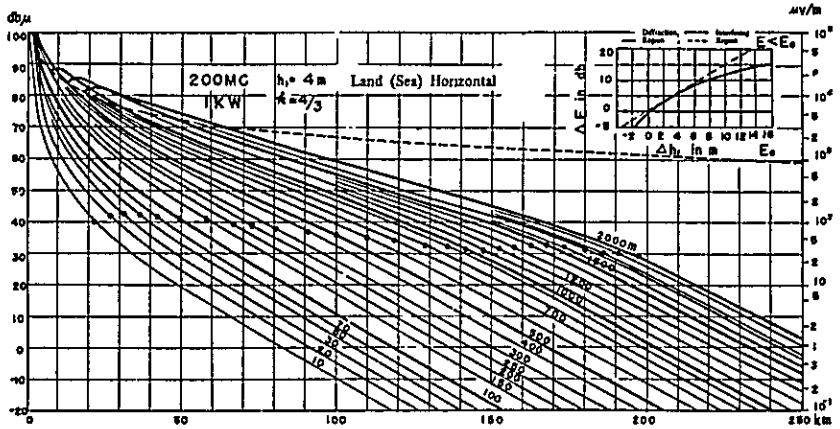

dbμ
μV/m
100 MC
1 KW
h₁ = 50m
k = 4/3
Land (Sea) Horizontal
E < E₀
Δh in m
E₀
2000m
1800
1600
1400
1200
1000
700
500
400
300
200
100
80
50
40
30
20
10
8
6
4
0
50
100
150
200
250

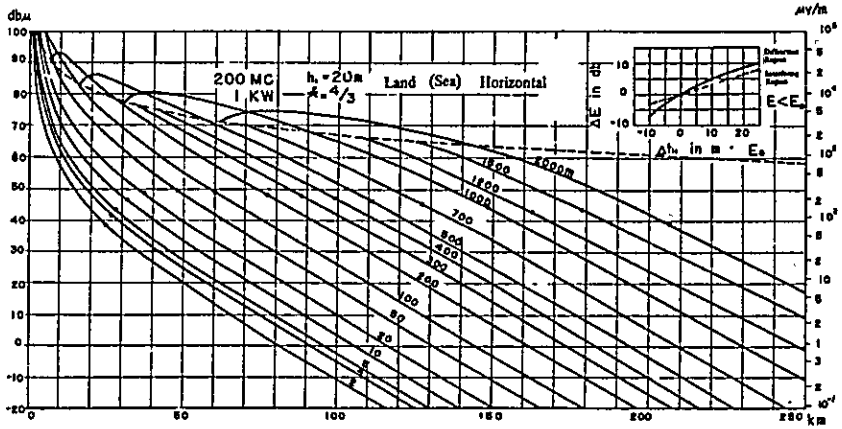

dbμ
μV/m
100 MC
1 KW
h₁ = 100 m
Land (Sea) Horizontal
k = 4/3
E < E₀
ΔE in db
Δh₁ in m
E₀
km

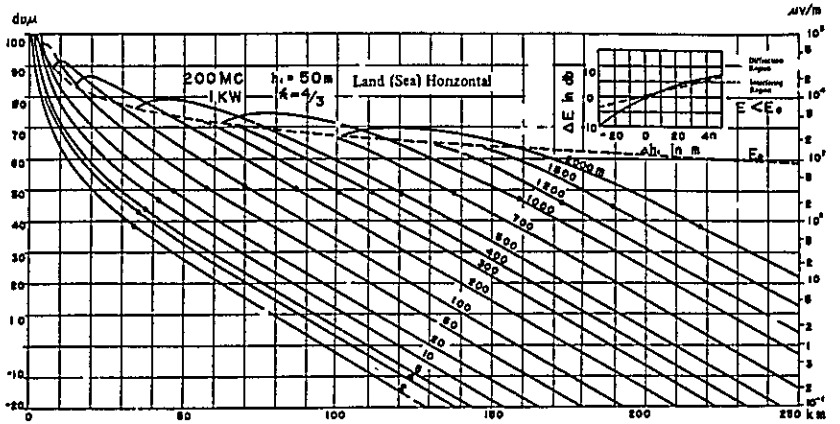

dbμ
μV/m
100 MC
1 KW
h₁ = 200 m
Land (Sea) Horizontal
k = 4/3
E < E₀
ΔE in db
Δh₁ in m
E₀

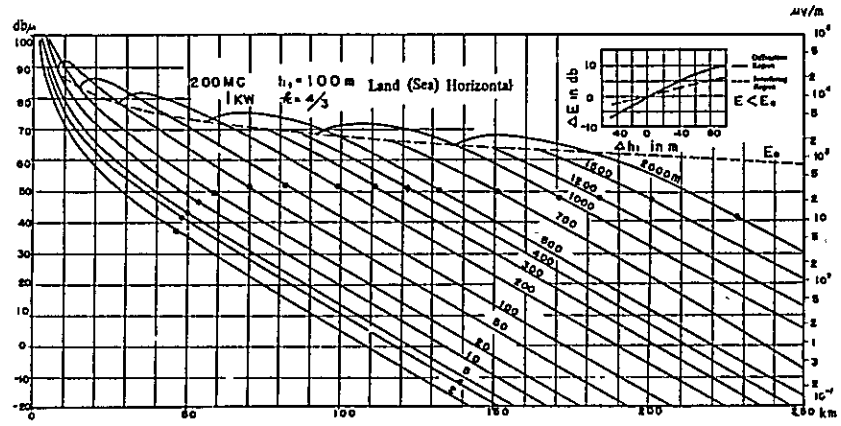

dbμ
μV/m
100 MC
1 KW
h₁ = 500 m
Land (Sea) Horizontal
k = 4/3
E < E₀
ΔE in db
Δh₁ in m
E₀
km

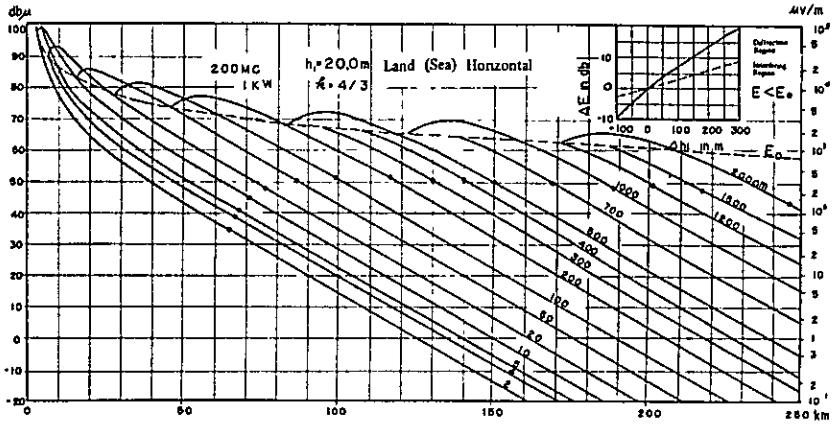

dbμ
μV/m
100 MC
1 KW
h₁ = 1000 m
Land (Sea) Horizontal
k = 4/3
ΔE in db
Δh₁ in m
km

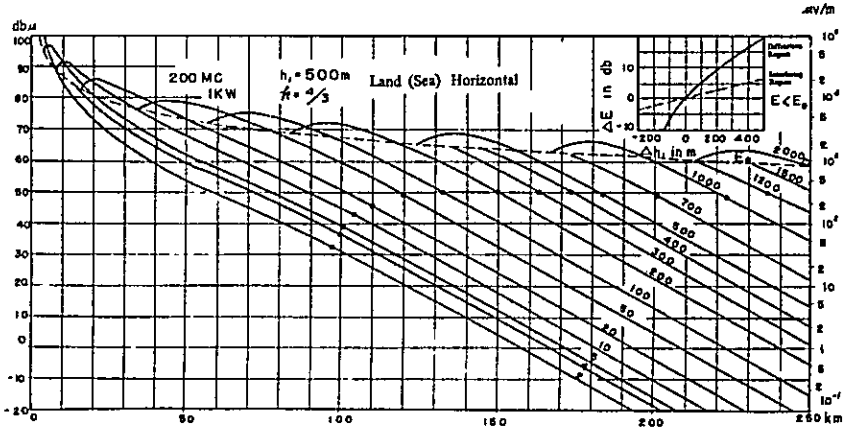

200MC
1KW
h₁= 4m
k=4/3
Land (Sea) Horizontal
dbμ
μV/m
ΔE in db
Δh₁ in m
E<E₀
E₀
2000m
1800
1600
1400
1200
1000
700
600
500
400
300
200
100
80
50
30
20
10
0
50
100
150
200
250 km

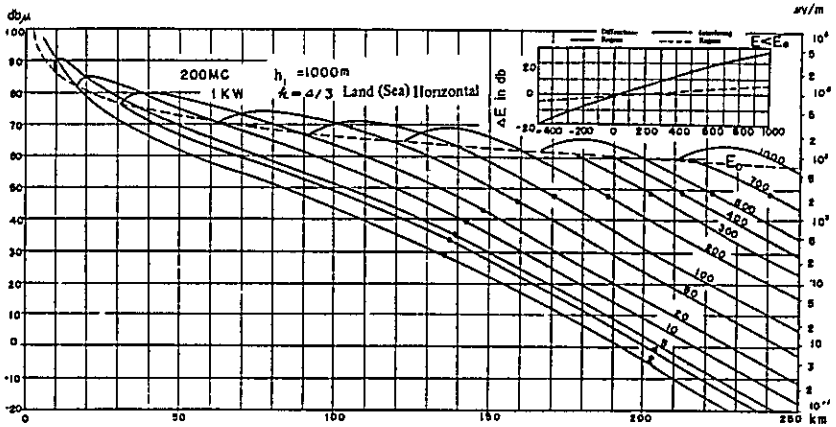

200 MC
1 KW
h₁=20m
k=4/3
Land (Sea) Horizontal
dbμ
μV/m
ΔE in db
Δh₁ in m
E₀
E<E
2000m
1800
1600
1400
1200
1000
700
600
500
400
300
200
100
80
50
30
20
10
0
50
100
150
200
250 km

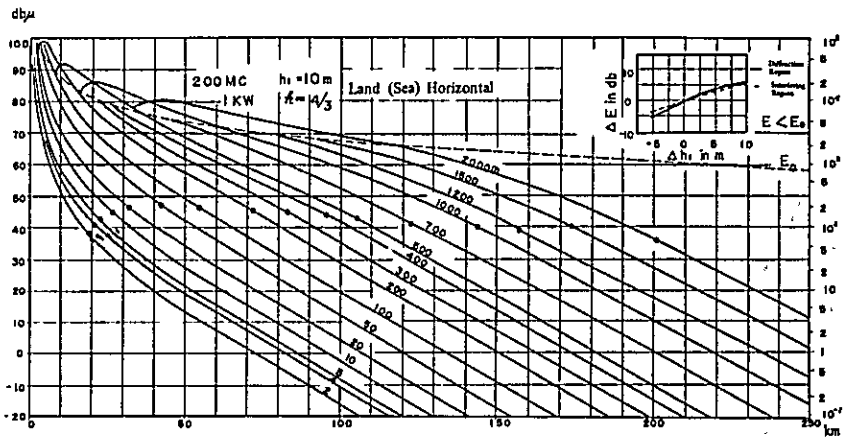

200MC
1KW
h₁= 50m
k=4/3
Land (Sea) Horizontal
dbμ
μV/m
ΔE in db
Δh₁ in m
E<E₀
E₀
2000m
1800
1600
1400
1200
1000
700
600
500
400
300
200
100
80
50
30
20
10
0
50
100
150
200
250 km

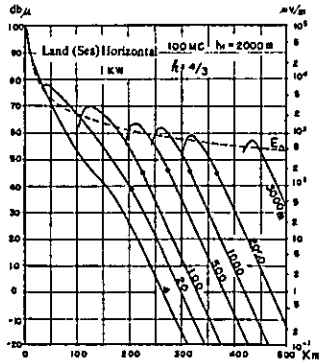

200MC
1KW
h₁=100m
k=4/3
Land (Sea) Horizontal
dbμ
μV/m
ΔE in db
Δh₁ in m
E<E₀
E₀
2000m
1800
1600
1400
1200
1000
700
600
500
400
300
200
100
80
50
30
20
10
0
50
100
150
200
250 km

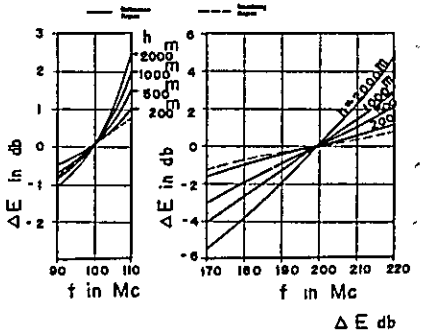

dbμ
μV/m
200MC
1KW
h₁=20,0m
k=4/3
Land (Sea) Horizontal
ΔE in db
Δh₁ in m
E<E₀
E₀
2000m
1800
1600
1000
700
600
500
400
300
200
100
50
20
10
5
2
0
50
100
150
200
250 km

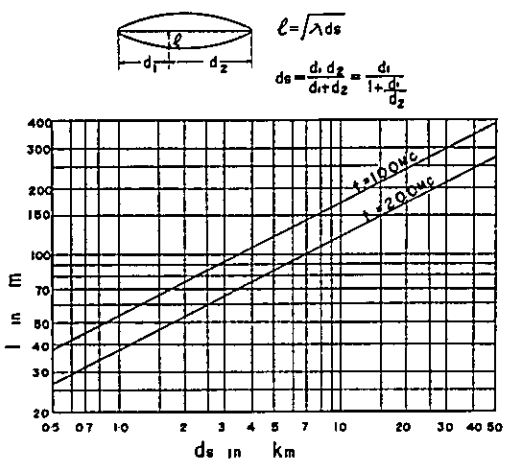

dbμ
μV/m
200 MC
1KW
h₁=500m
k=4/3
Land (Sea) Horizontal
ΔE in db
Δh₁ in m
E<E₀
E₀
2000
1800
1600
1000
700
600
500
400
300
200
100
50
20
10
0
50
100
150
200
250 km

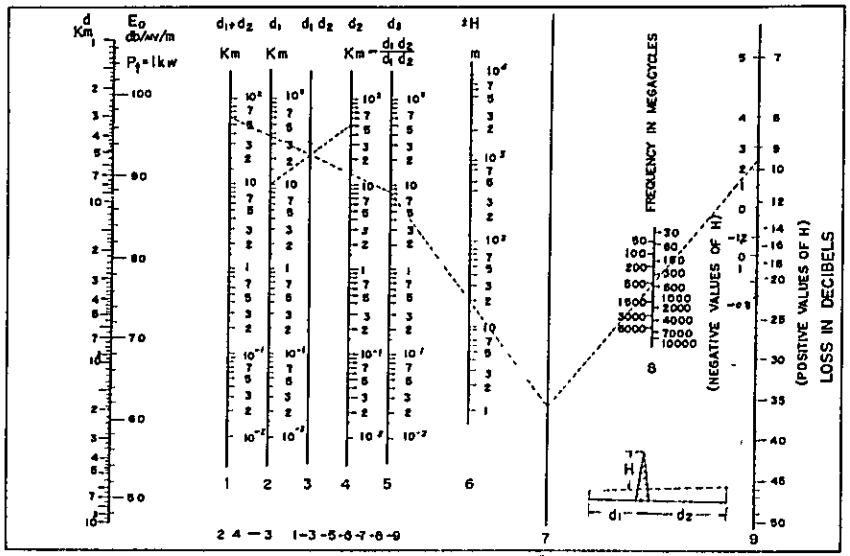

dbμ
μV/m
200MC
1KW
h₁=1000m
k=4/3
Land (Sea) Horizontal
ΔE in db
E<E₀
E₀
1000
700
600
500
400
300
200
100
50
20
10
5
2
0
50
100
150
200
250 km


dbμ
200 MC
1KW
h₁=10m
k=4/3
Land (Sea) Horizontal
ΔE in db
Δh₁ in m
E<E₀
E₀
2000m
1800
1600
1000
700
600
500
400
300
200
100
50
20
10
5
2
0
50
100
150
200
250
km









Nomograpk for Diffraciton Loss

V-10. Estimate of Construction Cost

The total cost is divided into a portion which requires foreign currency and a portion which requires only the domestic currency. Then, for each station, a rough estimate is made in Japanese yen and Pakistani rupee. (The unit of Japanese yen in the table is a thousand yen.)

Foreign currency will be needed for purchasing of broadcasting equipment, materials and expenses of foreign technical supervisors.

Domestic currency will be spent for import tax, import custom fee, land, station building, mounting and construction expenses.

Regarding the main equipment and materials, the values shown are the cost at CIF Pakistan ports. The domestic currency portion of the cost is estimated at being 130% of the broadcast materials at CIF cost. The breakdown is as follows:

Import custom fee	70%
Land and station building	30%
Cost of mounting and construction	30%
Total	130%

In the above table,

Because of strong tornado type winds especially in East Pakistan and because the condition of the soil is not known, the cost for towers will vary much.

One auxiliary set of power generators for each station is included. However, when commercial power supply is available in most stations (except Sitakund and Tree Point in Chittagong), the generator can be used as a spare, or in some cases, it may not be necessary at all.

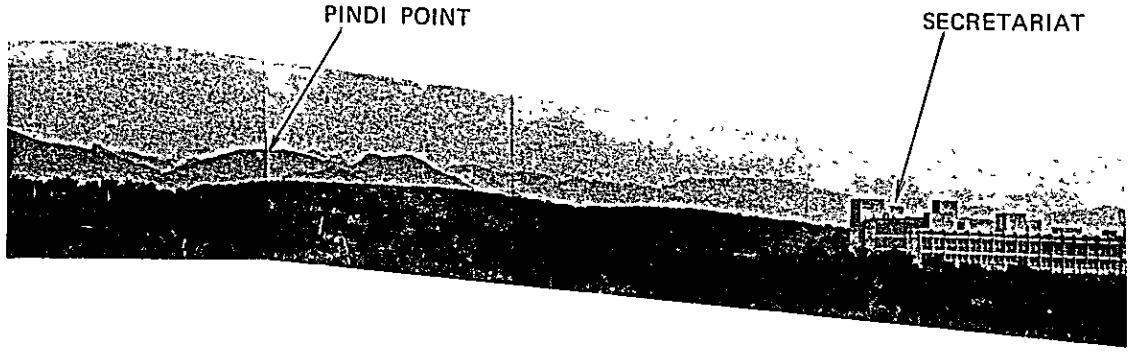
SUMMARY ESTIMATION OF TOTAL COST
FOR
PAKISTAN TV NETWORK

	Station			TV Equipment (A) (CIF Pakistan)		Foreign Engineers (B)		Foreign Currency Sub-total (A + B)		Local Currency (C)		Total (A + B + C)	
				Yen x 1,000	Rs	Yen x 1,000	Rs	Yen x 1,000	Rs	Yen x 1,000	Rs	Yen x 1,000	Rs
(1)	Rebroad system												
	MURREE HILL 40m Self	10kW	Main Station	55,090	728,800	4,680	61,900	59,770	790,700	71,617	947,500	131,387	1,738,200
	GUJRANWALA 100m Stay	5kW	Rebroad Station	49,030	648,700	6,300	83,300	55,330	732,000	63,739	843,300	119,069	1,575,300
	TATTA 100m Stay	1kW	〃	41,870	554,000	5,940	78,600	47,810	632,600	54,431	720,100	102,241	1,352,700
	HYDERABAD 100m Stay	1kW	〃	44,870	593,700	5,940	78,600	50,810	672,300	58,331	771,700	109,141	1,444,000
	Sub-total for W-Pak.			190,860	2,525,200	22,860	302,400	213,720	2,827,600	248,118	3,282,600	461,838	6,110,200
	〃 (excluding Gujranwala)			141,830	1,876,500	16,560	219,100	158,390	2,095,600	184,379	2,439,300	342,769	4,534,900
	KHULNA 100m Stay	1kW	Rebroad Station	44,870	593,700	5,940	78,600	50,810	672,300	58,331	771,700	109,141	1,444,000
	BOGRA 100m Stay	1kW	〃	44,870	593,700	5,940	78,600	50,810	672,300	58,331	771,700	109,141	1,444,000
	HAJIGANJ 100m Stay	1kW	〃	41,720	552,100	5,940	78,600	47,660	630,700	54,236	717,500	101,896	1,348,200
	SITAKUND 20m Self	2kW	〃	40,180	531,500	4,860	64,300	45,040	595,800	52,234	691,100	97,274	1,286,900
	CHITTAGONG 10m Stay	0.1kW	〃	18,840	249,300	2,700	35,700	21,540	285,000	24,492	324,000	46,032	609,000
	Sub-total for E-Pak.			190,480	2,520,300	25,380	335,800	215,860	2,856,100	247,624	3,276,000	463,484	6,132,100
	Total							429,580		495,742		925,322	12,242,300
(1')	MURREE HILL	5kW (6kW)	Main Station	52,180	690,300	4,680	61,900	56,860	752,200	67,834	897,400	124,694	1,649,600
(2)	Microwave Transmission for East Pakistan												
	KHULNA 100m Stay	1kW		49,470	654,600	5,940	78,600	55,410	733,200	64,311	850,800	119,721	1,584,000
	BOGRA 100m Stay	1kW		49,470	654,600	5,940	78,600	55,410	733,200	64,311	850,800	119,721	1,584,000
	CHITTAGONG 20m Self	1kW		37,250	492,800	4,860	64,300	42,110	557,100	48,425	640,700	90,535	1,197,800
	Sub-total for E-Pak. in case (2)			136,190	1,802,000	16,740	221,500	152,930	2,023,500	177,047	2,342,300	329,977	4,365,800

SUMMARY ESTIMATE OF TV EQUIPMENT FOR PAKISTAN TV NETWORK

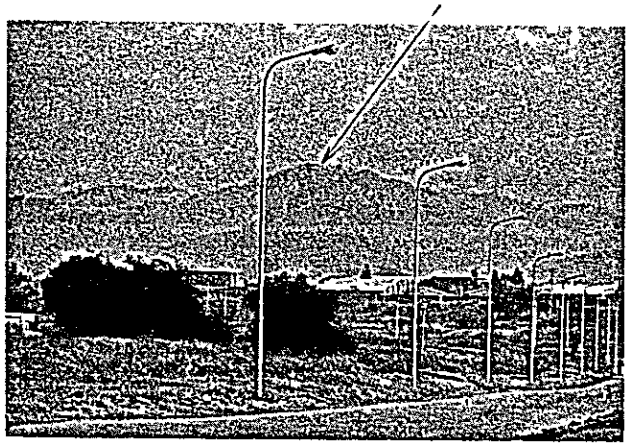
CIF Pakistan

	Station	Type of Antenna	Transmitter		Antenna & Feeder		Tower		Other Equip. & Test Gear		Engine Generator		STL (include one spare)		Receiver for Rebroadcast		Total	
			Yen x 1,000	Rs	Yen x 1,000	Rs	Yen x 1,000	Rs	Yen x 1,000	Rs	Yen x 1,000	Rs	Yen x 1,000	Rs	Yen x 1,000	Rs	Yen x 1,000	Rs
(1)	Rebroad system																	
	MURREE HILL 10kW Ch8 40m Self	12SG3F	21,770	288,000	9,020	119,300	3,730	49,300	11,420	151,100	4,860	64,300	4,290	56,800			55,090	728,800
	GUJRANWALA 5kW Ch11 100m Stay	4 Stack-Dip. & Corner Ref.	19,600	259,300	2,430	32,100	9,000	119,100	11,040	146,100	4,860	64,300			2,100	27,800	49,030	648,700
	TATTA 1kW Ch5 100m Stay	Yagi 3 Stack + 1	14,700	194,500	1,900	25,100	9,000	119,100	10,420	137,900	3,750	49,600			2,100	27,800	41,870	554,000
	HYDERABAD 1kW Ch8 100m Stay	12SG2F	14,700	194,500	4,900	64,800	9,000	119,100	10,420	137,900	3,750	49,600			2,100	27,800	44,870	593,700
	Sub-total for W-Pak.		70,770	936,300	18,250	241,300	30,730	406,600	43,300	573,000	17,220	227,800	4,290	56,800	6,300	83,400	190,860	525,200
	KHULNA 1kW Ch8 100m Stay	12SG2F	14,700	194,500	4,900	64,800	9,000	119,100	10,420	137,900	3,750	49,600			2,100	27,800	44,870	593,700
	BOGRA 1kW Ch10 100m Stay	12SG2F	14,700	194,500	4,900	64,800	9,000	119,000	10,420	137,900	3,750	49,600			2,100	27,800	44,870	593,700
	HAJIGANJ 1kW Ch9 100m Stay	Yagi3St.	14,700	194,500	1,750	23,200	9,000	119,100	10,420	137,900	3,750	49,600			2,100	27,800	41,720	552,100
	SITAKUND 2kW Ch4 20m Self	SG 3+1+1	16,700	220,900	3,100	41,000	3,730	49,300	10,800	142,900	3,750	49,600			2,100	27,800	40,180	531,500
	CHITTAGONG 0.1kW Ch2 10m Stay	Yagi 2Stack	7,000	92,600	1,680	22,200	300	4,000	6,560	86,800	3,300	43,700			-		18,840	249,300
	Sub-total for E-Pak.		67,800	897,000	16,330	216,000	31,030	410,600	48,620	643,400	18,300	242,100			8,400	111,200	190,480	2,520,300
	Total		138,570	1,833,300	34,580	457,300	61,760	817,200	91,920	1,216,400	35,520	469,900	4,290	56,800	14,700	194,600	381,340	5,045,500
(1')	MURREE HILL 5/6kW		19,600	259,300	8,280	109,500	3,720	49,300	11,420	151,100	4,860	64,300	4,290	56,800			52,180	690,300
(2)	Microwave Transmission for East Pakistan																	
	KHULNA 1kW Ch7 100m Stay	12ST Omni-Dir	14,700	194,500	11,600	153,500	9,000	119,100	10,420	137,900	3,750	49,600	-		-		49,470	654,600
	BOGRA 1kW Ch9 100m Stay	〃	14,700	194,500	11,600	153,500	9,000	119,100	10,420	137,900	3,750	49,600	-		-		49,470	654,600
	CHITTAGONG 1kW Ch4 20m Self	1ST Omni-Dir	16,700	220,900	2,650	35,100	3,730	49,300	10,420	137,900	3,750	49,600	-		-		37,250	492,800
	Sub-total for E-Pak. in case (2)		46,100	609,900	25,850	342,100	21,730	287,500	31,260	413,700	11,250	148,800	-		-		136,190	1,802,000



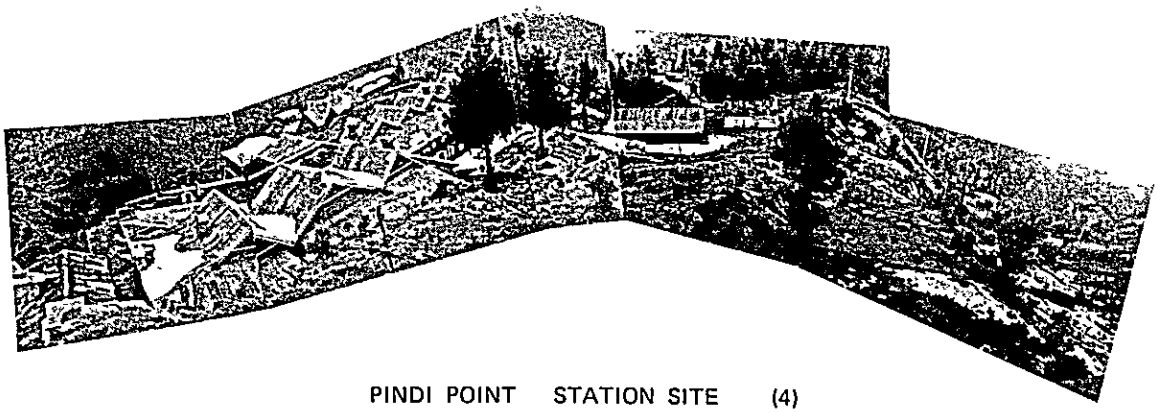
(1)

PINDI POINT, MURREE



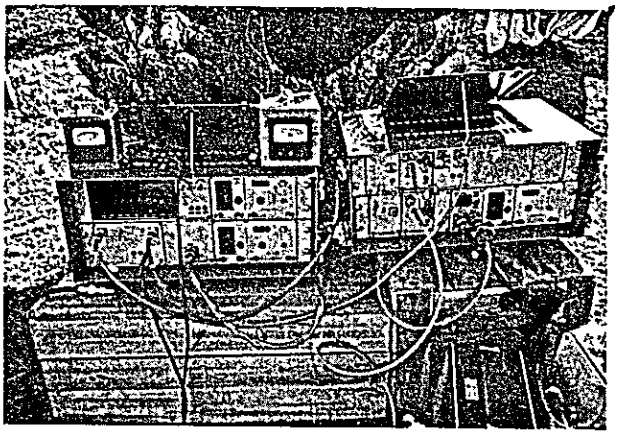
(2)

(3)

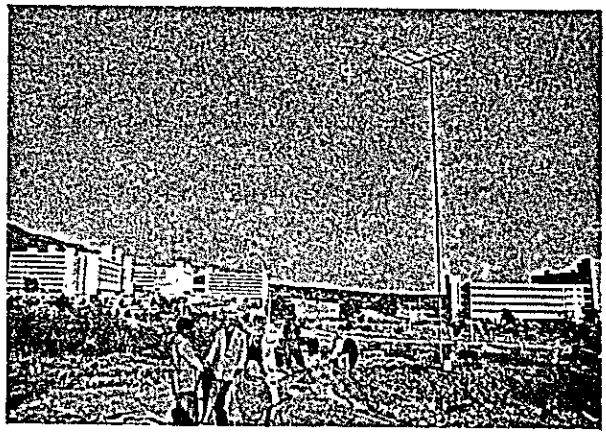


PINDI POINT STATION SITE (4)

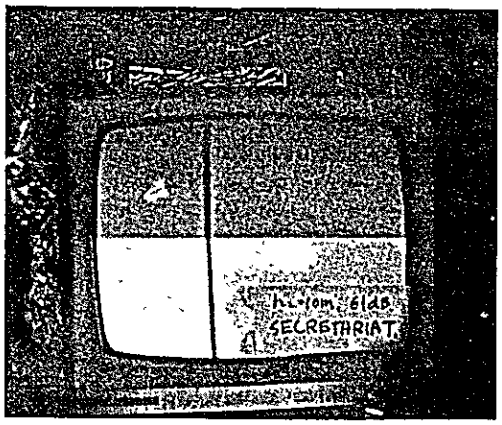
(5)



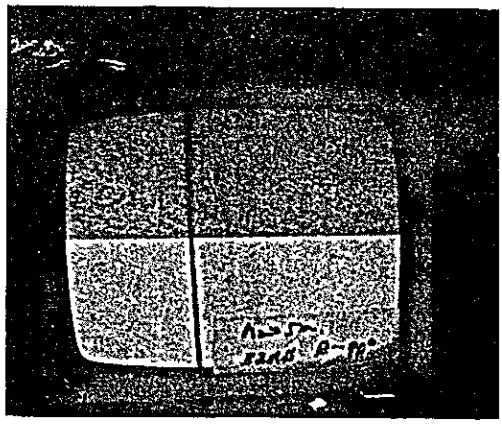
(6)



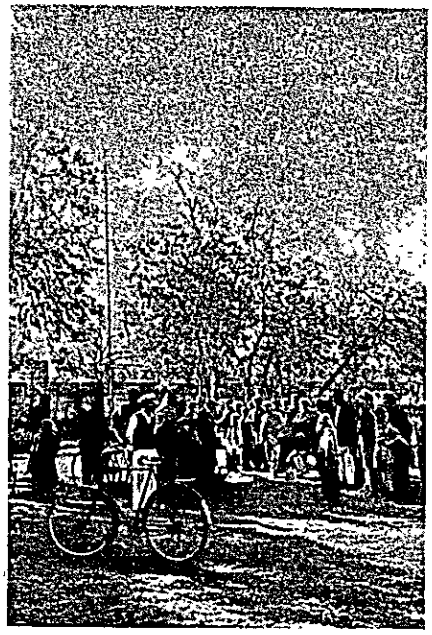
(7)



GHOST TEST
ISLAMABAD (8)
SECRETARIAT

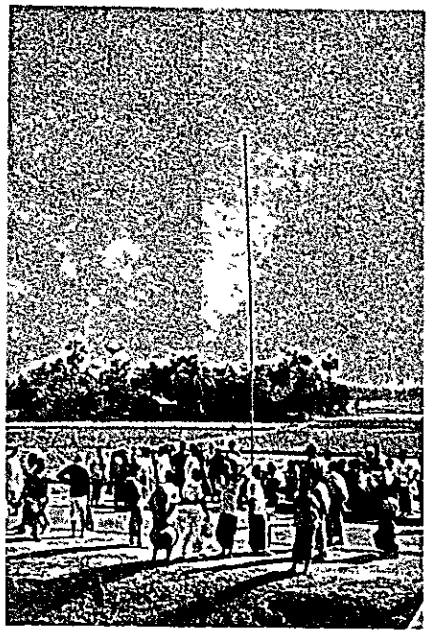


GHOST TEST
ISLAMABAD (9)
SECRETARIAT



NOISE MEASUREMENT PESHAWAR

(10)



PROPAGATION TEST HAJIGANJ

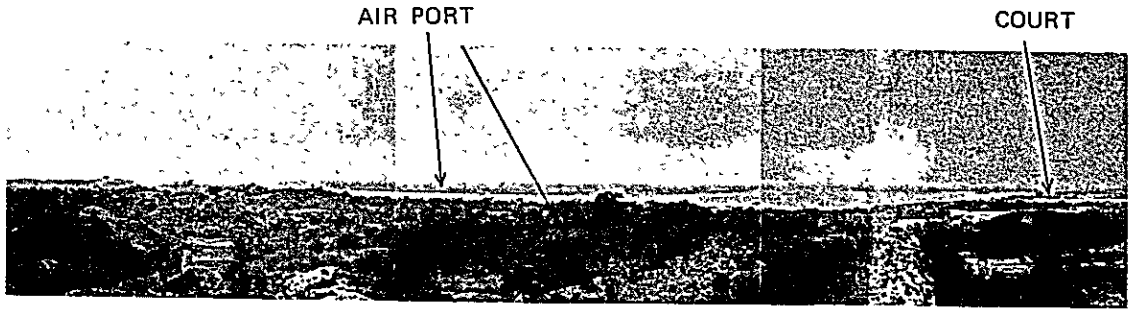
(11)

SITAKUND STATION SITE

(12)

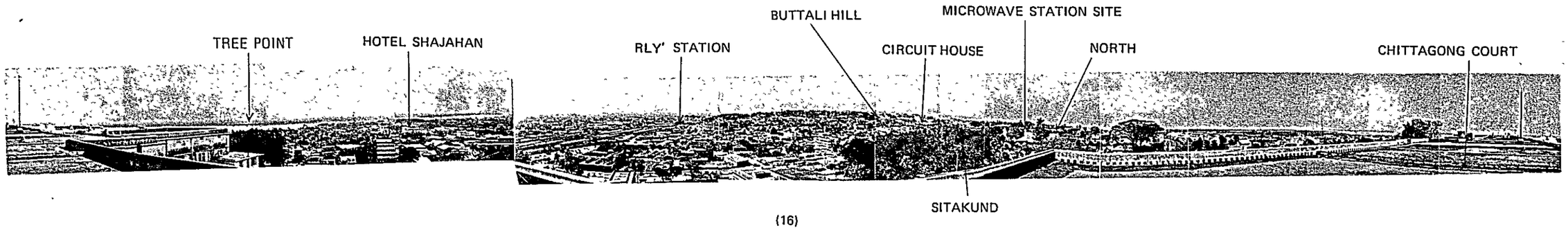
PROPAGATION TEST SITAKUND

(13)

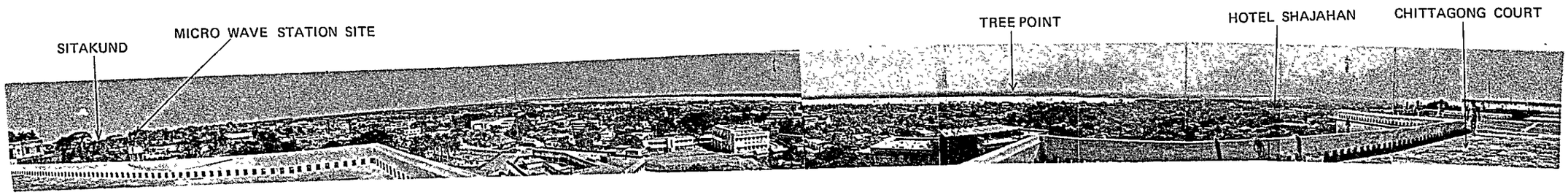


TREE POINT --> CHITTAGONG (14)

(15)


TREE POINT
HOTEL SHAJAHAN
RLY' STATION
BUTTALI HILL
CIRCUIT HOUSE
MICROWAVE STATION SITE
NORTH
CHITTAGONG COURT
SITAKUND

(16)


SITAKUND
MICRO WAVE STATION SITE
TREE POINT
HOTEL SHAJAHAN
CHITTAGONG COURT

(17)