FAP-10

PMTC International Limited

PROJECT MANAGEMENT AND TRAINING CONSULTANTS

DANISH HYDRAULIC INSTITUTE

6

TECHNICAL ASSESSMENT

FINAL REPORT

FOR

EXPANSION OF FLOOD FORECASTING AND

WARNING SERVICES (FAP 10)

MODULE 1: WIRELESS COMMUNICATION

SEPTEMBER 1996

PMTC International Limited
House 50, Road 1
Block I, Banani
Dhaka

Progress through People

A Participatory Approach to Human Resource Development

DANISH HYDRAULIC INSTITUTE

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Gregers H. Jorgensen
Danish Hydraulic Institute
Team Leader, FAP 10
House 19, Road 128
Gulshan
Dhaka

17 September, 1996

Dear Sir,

Expansion of Flood Forecasting and Services (FAP 10)
Module 1: Wireless Communication

Attached please find the report for the Flood Forecasting and Warning Services.

Although not in the original TOR's, in the light of recent damage to one of the Orion 7000 transceivers I have added an appendices (15) on lightning protection and EMP. This may help in the protection of the radio equipment currently in use in the future.

Should any further help be required please do not hesitate to contact the undersigned.

Yours faithfully,

Andrew Flint
Senior Consultant
South East Asia

Enclosed 2 copies of Final Report

Progress through People

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TECHNICAL ASSESSMENT OF THE WIRELESS COMMUNICATION SYSTEM FOR EXPANSION OF THE FLOOD FORECASTING AND WARNING SERVICES BANGLADESH (FAP10)

Contents :

SUMMARY

THIS IS A BRIEF SUMMARY OF THE REPORT ON EXPANSION OF FLOOD FORECASTING AND WARNING SERVICES (FAP10)

1. Assessment of communication problem during the period from 25th to 26th May 1996 as described in the attached letter. See appendices 13.

This communication problem was caused by disturbances in the ionosphere related to sun spot activity over which no one has any control. For further information on Ionospheric and sun spot activities connect via Internet (http://space.sgo.fi/). Currently the world is at the bottom the *11- year solar cycle* so communications can be expected to improve from 1997.

2. Assessment of the frequencies (3305, 4442, 4490, 5089, 8157 and 8188 KHz) used at Flood Forecasting and Warning Centre and proposal for required frequencies. At present only the frequency 8157 Khz is used for voice communications.

The FFWC has access to the above six frequencies. There is however a gap between 5089 Khz and 8157 Khz. The attached predictions show a need for additional frequencies in the range of 6 - 7 MHz. To cover this gap it is strongly recommended that two additional frequencies be allocated between 6.9 - 7.0 MHz and 6.0 - 6.1 MHz. If however only one frequency is available then it should be in the range of 6.9 - 7.0 MHz. The greater the choice of frequency the greater the scope for flexibility.

3. Assessment of antennas, broad band and delta loop, used for communication at Flood Forecasting and Warning Services. Performance verification and troubleshooting etc.

The two types of antennas currently used by FFWS namely the Broadband and the Delta loop. Both are quite suitable for communications within Bangladesh. Care must be taken on the orientation of these antennas. Because the short distances in Bangladesh for HF radio use, some experimentation should be undertaken using the same antennas but adjusting their height above the ground. There may be a case for lowering the antennas to about a quarter wave above the ground for the frequency being used. This increases the critical angle of radiation which in turn reduces the skip distances.

4. Provide a schedule for predicted optimal HF-frequency used for communication (signal to noise ratio) during June-August 1996 between Dhaka and the following important stations in Bangladesh. Barisal, Chittagong, Dinajpur, Khulna, Mymensingh, Rajshahi, Sylhet.

Twenty one charts have been provided in the appendices. **See appendices 6 - 12.** While comparing these prediction charts, it can be seen that no matter where the field station is within Bangladesh, **ALL** should be using the same frequency at the same time. However local conditions, such as a storm in Chittagong, will disrupt communications occasionally. If communications are poor, then the FOT frequency should be used as an initial contact frequency. As the predictions are so similar for all seven stations, for ease of use only three consolidated charts based in Khulna for the months of June, July and August 1996 have been prepared. These charts apply to all field stations. **See appendices 4.**

5. Assessment of set-up of new radio system using the Orion 7000 radio with a data collection unit and automatic data transfer at different stations. Material will be delivered as per requirement by the FAP10 office.

There is a very professional set up at the FAP 10 office using the newly acquired Orion 7000 radio which is a great improvement many of the existing sets. The operation to transfer flood data through the use of a modem is well conceived and is running reliably and successfully. It is recommended that fuses of lowest possible value be used to try to safeguard against power surges. There are plugs available that protect against power spikes and consideration should be given in fitting these.

6. Visit to the flood forecasting and warning centre and assessment of their set-up.

Unfortunately this visit could not be undertaken up to the time of writing this report. This visit will be undertaken as and when convenient to the authority concerned.

7. General

Some training recommendations have been made including all radio operators be trained in the use of the SWR meter. This is probably the most useful and easiest piece of equipment for antenna fault finding and diagnostics. Ideally each station should be equipped with one. The field stations radios only power source should be battery. This has two major benefits. It will save the radio from power fluctuations as well as a reduction in noise from power mains interference.

Brief ToR have been given for future Site Survey to designated field stations. To achieve significantly improved performances of the radio and its antenna system, experimentation with the mounting and orientation of the antennas is essential.

LIST OF ABBREVIATIONS USED

DHI	Danish Hydraulic Institute
FAP	Flood Action Plan
FFWC	Flood Forecasting and Warning Centre
FFWS	Flood Forecasting and Warning Services
FOT	Frequency of Optimum Transmission
HF	High Frequency
Khz	Kilohertz
LUF	Lowest Usable Frequency
MHz	Megahertz
Mts.	Meters
MUF	Maximum Usable Frequency
OPMUF	Operational Maximum Usable Frequency
PMTC	Project Management and Training Consultants Limited
SSN	Sun Spot Number
ToR	Terms of Reference
UHF	Ultra High frequency
VHF	Very High Frequency

EXPANSION OF FLOOD FORECASTING AND WARNING SERVICES (FAP 10)

BACKGROUND

Danish Hydraulic Institute (DHI) has requested Mr Andrew Flint to assist with the technical assessment of the wireless communications system, which will be further developed under the project Expansion of Flood Forecasting and Warning Services.

The network of existing stations is attached. See **appendices 1.**

The Flood Forecasting and Warning Centre has permission to use 6 frequencies for wireless communications : **3305, 4442, 4490, 5089, 8157, and 8188 Khz**. Normally 8157 Khz is used.

Data is normally collected in the flood forecasting and Warning Centre each morning and evening via voice communication and on an experimental basis via a modem.

5 different radios are used in the field

CH150	(app. 30)
Orion 5000 from Eddystone	(app. 20)
Motorola	(app. 5)
SGC	(app. 5)
Orion 7000	(app. 12)

The radios have been procured during 1981 - 1986; 1989 - 1992 and 1996

The most common antenna used in the field is the 90 feet broadband antenna and delta loop. In a few places a simple dipole antenna is also used.

During the FAP 10 project period it is planned to expand and improve this network.

SCOPE OF SERVICES FOR PMTC

The total input of the local consultant is 1 man month during July 1996. The activities for the Local Consultant shall include, but not necessarily be limited to the following task :

- Assessment of communication problem during the period from 25 to 26 May 1996 as described in attached letter. **See appendices 13.**

- Assessment of the frequencies (3305, 4442, 4490, 5089, 8157 and 8188 KHz) used at Flood Forecasting and Warning Centre and proposal for required frequencies. At present only the frequency 8157 Khz is used for voice communications.

- Assessment of antennas, broad band and delta loop, used for communication at Flood Forecasting and Warning Services. Performance verification and troubleshooting etc.

- Provide a schedule for predicted optimal HF-frequency used for communication (signal to noise ratio) during June-August 1996 between Dhaka and the following important stations in Bangladesh Sylhet, Rajshahi, Mymensingh, Khulna, Dinajpur, Chittagong, Barisal.

- Assessment of set-up of new radio system using the Orion 7000 radio with a data collection unit and automatic data transfer at different stations. Material will be delivered as per requirement by the FAP10 office.

- Visit to the flood forecasting and warning centre and assessment of their set-up.

The local Consultant will prepare a report regarding the described tasks before July 20.

Confidential material

All material delivered to the consultant shall be kept confidential.

ASSESSMENT REPORT

2.0 ASSESSMENTS REQUIRED

2.10 Assessment of a communications problem during the period for 25th to 26th of May 1996 when wireless communication with all the field stations was seriously disrupted.

Background.

To have a basic understanding of the reasons for the communication problem mentioned above, some background and facts are given.

It may not be commonly know that the sun has sunspot cycles referred to as the *11 - year solar cycle.* 1996 /97 is at the bottom of this cycle and there should be a basic understanding of this solar cycle to appreciate the complexity of the explanation. This cycle has a great influence on the propagation of radio signals in the HF bands (1.8-30 MHz) and to a lesser extent in the VHF UHF frequencies.

FAP 10 uses a number of HF transceivers to collect data on a daily basis from its field stations automatically and by voice.

The HF frequencies are used in preference to the frequencies in VHF/UHF/ Microwaves spectrum as it would be impossible to transmit using the VHF/UHF over the distances between Dhaka and the field stations without the additional help of numerous repeater stations.

Radio signals in the HF frequencies are usually received after they have been reflected by the earth's ionosphere. However where the stations are only a few kilometres apart then the signals are received by *ground wave* which are not reflected from the ionosphere. **See appendices 2 Figure 1.**

Ironically for the HF frequencies, the distances are relatively short in Bangladesh thus necessitating the use of the lower frequencies in the 3 - 8 MHz range of the HF spectrum.

These short distances are prone to a phenomena called "skip" which describes what happens to some radio signals. Basically, transmitted radio signals, return to earth after being reflected by the ionosphere. If the *elevation angle* (critical angle) of those signals leaving the antenna is vertical the signals go off into space. If the angle is much less, say 10-15 degs, then the signals go over the top of the intended destination and this is called "skip". Thus, it is important to select the most reliable frequencies and critical angle for the distances involved. **See appendices 2 Figure 2**

Everything that occurs in radio signal propagation as with life on Earth is the result of the sun's radiation.

The changing nature of radio propagation reflects the ever-changing intensity of ultraviolet and X ray radiation, the ionising agents in solar energy. The *11 - year solar cycle* affects propagation conditions because of the correlation between sunspot activity and ionisation. Every day hydrogen is turned into helium by solar dynamics releasing unimaginable blasts of energy into space.

Why the intensity of this release changes and what the sun is going to do at any time in the future are known only in a general way. The sun's future behaviour cannot be truly calculated only predicted.

Since about 1750 a reasonably reliable record of sun spots has been maintained. It shows the sun is always in a state of change. It never looks exactly the same each day. The obvious changes to the sun watchers is the movement of visible activity centres **(sun spots or groups)** across the face of the sun east to west at a constant rate. This is due to the rotation of the sun taking approximately 4 week (27.5 days) for one rotation.

Originally the systematic observation, the traditional measure of solar activity had been based on a count of sunspots.

Since the middle of the 18th Century it has been realised that the average number of spots increased and decreased in cycles roughly approximating a sinewave on an *11 - year solar cycle.*

In 1848 a method was introduced for the daily measurement of sunspot numbers by the Swiss astronomer Johann Rudolf Wolf and is still used to this day.

Records are kept of daily sunspot counts, monthly and yearly averages calculated. These averages are used to observe patterns and trends. It has been seen the cyclic nature of the sun's activity varies between 9-12.7 years but the average is 11.1 years. The first year of systematic observation started in 1755 and has been labelled as cycle 1.

Activity on the sun's surface changes continuously. Sunspot may vary in size and appearance or even disappear within a day.

Generally the larger the activity the longer it persists, up to periods of two years. Because of the continuous changes in solar activity, there are continuous changes in the state of the ionosphere resulting in changes to propagation conditions. A short term burst of solar activity could start a propagation condition on Earth lasting one hour only.

On any one day, significant changes in solar activity can take place within hours, causing changes in the Maximum Useable Frequency (MUF). The duration may be brief or re occur for several consecutive days.

As will be seen from the above discussion, it is the unpredictable activity of the sunspots that can cause within hours both disruptions/improvements to radio transmission lasting between a few hours to a few days. **It is this phenomena that caused the problems faced on the 25th and 26th of May. It is difficult to predict and little that can be done to prevent it.**

The problem faced on the 25th-26th May was by no means unique to FFWS. It is known, other agencies experienced communication problems during this period within the 7-8 MHz spectrum both in Bangladesh and abroad.

Very reliable confirmation of this event came from another source of information namely the monthly bulletin from the Geophysical Observatory Sodankyla, Finland. This publication "Geomagnetic Ionospheric Auroral Data from Finland" collected from 14 stations confirm there were disturbances in the ionosphere on the 25th of May which supports the findings of this assessment. This information may be assessed via the **Internet (http://space.sgo.fi/)**

2.20 Assessment of frequencies used at the Flood Forecasting and Warning Centre (FFWC) and proposal for additional/ replacement frequencies.

Presently the FFWC uses six frequencies for wireless communication. 3305, 4442, 4490, 5089, 8157, 8188 Khz. Normally 8157 Khz to be used.

It is however strongly recommended that at least one if not two additional frequencies be acquired between 5089 Khz and the 8157 Khz. to take advantage of frequencies in the 6 - 7 MHz range.

It will be seen from the prediction charts accompanying this report, the frequency range between 6 MHz to 7 MHz is a valid frequency for the time of day transmissions are to be made.

If only one frequency can be acquired, it is recommended this should be in the region of 6.9 - 7.0 MHz. If two frequencies are available then it is suggested the second one should be in the region of 6.0 - 6.1 MHz. Because of the proximity of the field stations to Dhaka, the greater choice of frequencies available the greater the flexibility of the system in times of marginal communications. The availability of these additional frequencies is not known.

2.30 Assessment of Broadband and Delta Loop Antennas used for Communications between FFWS and Field Stations together with Performance Verification and Trouble Shooting.

Antennas and Orientation Considerations

There are two types of antennas which are currently in use with FFWS for communicating with their field stations. The Broadband and the Delta Loop.

Each type of antenna has its own unique characteristics. All field stations are not equidistant from Dhaka, so the expected performance from their antenna systems will not be the same. These stations do not all have the same antenna system configuration or even earth systems. It is also very unlikely that stations have similar earth conductivity measurements. This must be taken into account when considering the type of antenna system to be used and its orientation. For this, field visits are essential.

As a guide, all field stations will want two way communications with Dhaka. Dhaka will want two way communications with all field stations. BUT all field stations do not need two way communications with all the other field stations. It is suggested that a second broadband antenna be installed on a different orientation from the existing one so that there is a choice of antenna orientation in times of difficult communications.

Thus orientation of antennas and the type of antenna used has to be considered on a station by station basis. Most field stations however will have similar transmission criteria.

If the field station is directly north or south of Dhaka such as Nakuagoan or Barguna the orientation of their broadband antenna would be East / West. For stations such as Sylhet or Satkhira which are North East and South west of Dhaka respectively, the orientation of their antenna would be North West / South East. Dinajpur will basically want to transmit and receive from Dhaka only, Dinajpur's antenna orientation should be set to approximately NE/SW.

There will be occasions when for climatic or other reasons some stations will not be able to contact Dhaka. In this case there should be a second line of communication to cover such a contingency.

It might be Tangail cannot contact Dhaka but can contact Satkhira. Also Satkhira can contact both Tangail and Dhaka. The solution then is to use in this example, Satkhira as a "repeater" station to pass the information from Tangail to Dhaka.

A number of "repeater" stations could be designated . This would be important for field stations that are very close to Dhaka. Their chances of transmitting data to Dhaka will be improved if there are nominated "repeater" station to transmit through.

As Dhaka has to be able to receive information from all its field stations, the antenna(s) systems in Dhaka should be capable of omni-directional reception and transmission.

If contact with the field stations is unsatisfactory, consideration therefore might be given to erect either two Broadband Antennas in Dhaka one aligned NE/SW and the second antenna running NW/SE or one Broadband and one Delta Loop.

The advantage being in times of difficult communications, there would be two antenna configurations and/or types to choose from.

2.31 Broadband Antenna

A broadband antenna is a radiator and receiver of radio signals that allows a good match over a wide frequency range between the antenna and the transceiver. This removes the necessity of additional equipment such as antenna tuners and extra antennas for use on different frequencies.

The existing broad band antennas in use with FFWS are quite suitable for the purposes of transmitting data over the frequency range of 2-30 MHz. However when used by FFWS, it is unlikely that frequencies above 12 MHz will be used

In other words with a good HF broadband antenna, a successful match can be achieved between transceiver and antenna over the frequency range of 1.8 MHz to 30 MHz in the HF band spectrum.

If one could guarantee all data could always be efficiently transmitted from the field stations at any time of the day/night or year on the same frequency, only then would the requirement for broadband antennas and frequency predictions charts become redundant.

Directivity/Orientation

The basic rule of thumb for broadband, wire antennas is to have the antenna oriented broadside to the direction of the station you wish to contact as in theory that is the direction of the greatest radiation. The polarisation of a broadband antenna is normally horizontal which is what is needed for the shorter distance transmissions in Bangladesh.

To achieve omni-directional characteristics, one end of the broadband antenna should be raised to about 15 Mts. above the ground and the other end just above the ground.

2.32 Delta Loop Antenna

Delta loop, as its name suggests is shaped as the Greek letter Δ (delta). It may be erected with the flat portion at the top or at the base. It takes up relatively less space than a dipole and usually needs only one pole to support it.

This antenna tends to have bi-directional radiation and reception characteristics from the sides of its two legs. One advantage this antenna has over the broadband where space is a constraint, it needs only one pole to support it at the apex of the loop and takes up less space than the broadband. Because of it directivity properties accurate orientation will be needed. Antenna orientation should be as far as possible with one or other of the legs broadside to the direction of the station to be contacted.

The maximum directivity from a Delta loop antenna is broadside from the two legs of the antenna so it is not a truly omnidirectional but rather a bi-directional antenna.

Antenna performance is usually based and calculated on assumed parameters including the height above ground is one half wave (½λ) for the frequency to be used. This allows comparisons to be made.

When transmission distances are short, as is the case in Bangladesh, consideration might be given to lowering the height of the antenna to below a ½λ for the frequency in use. This will increase the radiation angle, contributing towards better short distance communications. Some field experimentation and trials will be needed.

Another important factor to be taken into account is the feed point of the delta loop. The polarisation of the antenna may be changed from vertical to horizontal depending on the feed point.

In Bangladesh horizontal polarisation is preferable. Having the feed point of the delta loop at the apex of the antenna as is the case with the recently acquired delta loop antennas ensures horizontal polarisation. A trouble shooting chart is given in the appendices. **See appendices 14.**

2.33 Trouble shooting. (See appendices 14.)

This very much depends on the training and ability of the operator. There are a few basic visual checks to be made prior to the transmitter and antenna being used especially after high winds.

- is the antenna still standing and not lying down on the roof or ground?
- are all the antenna supports still attached and supporting the antenna?
- is the antenna still in one piece with no wires broken?
- is the coaxial cable attached to the antenna?

If the antenna is still suspected as being the cause of poor performance, then a visual and physical inspection should be undertaken to check:

- the coax cable from the antenna is connected tightly to the transmitter
- the coax cable is connected tightly to the antenna.
- all earth connections are tight and clean
- there has been no intrusion of water into the coax cable
- any coax connectors exposed to the elements are sealed using amalgamating tape
- no part of the antenna is touching any trees, buildings, metal posts
- no possibility of the antenna coming in contact with overhead transmission lines

Depending on the ability of the operator, further checks for SWR readings and power outputs should be undertaken to locate the cause of the problem.

UNDER NO CIRCUMSTANCES SHOULD ANY PHYSICAL CHECK BE MADE OF ANTENNA SYSTEMS PRIOR TO, DURING OR SHORTLY AFTER ANY ELECTRICAL STORM

2.40 Provide a schedule for predicted optimal HF-frequency used for communication (signal to noise ratio) during June-August 1996 between Dhaka and the following important stations in Bangladesh : Barisal, Chittagong, Dinajpur, Khulna, Mymensingh, Rajshahi, Sylhet.

As the maximum and minimum distances between the selected field stations and Dhaka are relatively short in HF terms, between 246km and 50km , all charts would show similar readings for all stations.

For a graphic illustration of the above, a chart comparing the Maximum Useable Frequencies (MUF) of Barisal, Chittagong, Dinajpur, Kulna, Mymensingh, Rajshahi, Sylhet and Tangail has been included. **See appendices 3 fig. 1**

For ease of reading and interpretation, one prediction chart for each month based on Khulna has been created for the months of June, July and August 1996 showing the LUF, MUF, FOT and OPMUF which is generally valid for **all** stations in Bangladesh. **See appendices 4.**

For interest, a chart has been included comparing the maximum and minimum Usable frequencies between Dhaka - Bombay and Dhaka - Chittagong. It will be seen the frequencies for Bombay differ greatly from the inter Bangladesh predictions due entirely to increase in distance. **See appendices 3 fig. 2.**

A further 21 prediction charts have also been included showing LUF, MUF and FOT for the following stations. Barisal, Chittagong, Dinajpur, Kulna, Mymensingh, Rajshahi and Sylhet. As mentioned above the predictions are so similar no direct comparisons have been illustrated except as shown in appendices 3. **See appendices 6-12.**

It should be the FOT frequency that may be selected for an initial contact if established frequencies are not proving satisfactory for communications.

Explanations of FOT, LUF, MUF and OPMUF are given in the appendices. **See appendices 5**.

2.50 Assessment of the FAP 10 communications set-up incorporating the ORION 7000 radio.

Two visits were made to the DHI office to assess the set-up using the newly acquired ORION 7000 radio.

The radio is powered by battery to prevent damage to the radio in times of power fluctuations The battery charger uses a voltage stabiliser directly fed from the mains.

Both charger and stabiliser are fused. A low amperage fuse of the type that will blow quickly and of the minimum possible working amperage must be incorporated. It is better the fuse blows rather than the charger is damaged.

Consideration may also be given to the use of fused plugs fitted to the voltage stabiliser. This would be the first line of defence. As additional protection there are also wall plugs available which will trip at the time of voltage surge. This could well be worth considering if voltage surge causes problems.

2.60 Assessment of set up of the FFWC.

Unfortunately this visit could not be arranged before the submission of the report and will have to be undertaken at a later date.

3.0 Conclusions and Recommendations.

3.10 Communication problem.

The assessment of the communications problem experienced by FFWC on the 25th and 26th May was almost certainly as a result of climatic conditions. The fact that many of the field stations were affected at the same time and secondly normalcy returned after approximately 48 hours supports this. There is very little that can be done during such periods and fortunately they are a rare occurrence.

As 1996 is the bottom of the *11 - year solar cycle* the situation should improve from 1997.

Further information is available on the **Internet (http://space.sgo.fi/)**

3.20 Antennas

3.21 Broadband Antenna

The existing broad band antennas in use with FFWS are quite suitable over the frequency range of 2-30 MHz. It is unlikely that FFWS will use frequencies above 12 MHz.

The antenna should be aligned broadside to the direction of the station to be contacted.

Thought should be given to the establishment of a procedure to transmit data to and from Dhaka via a third station working as a "repeater".

A second broadband antenna be considered for installation on a different orientation in Dhaka for a greater choice of antenna in times of difficult communications.

Consider raising of one end of the broadband antenna to about 45 ft (15 Mts.). To give omni-directional characteristics.

3.22 The Delta loop antenna

The delta loop antenna is also a suitable antenna.

Antenna performance is based on assumed parameters allowing comparisons to be made.

When transmission distances are short, consideration might be given to lowering the height of the antenna to below a ½λ to increase radiation angle, contributing towards better short distance communications.

An important factor to be taken into account is the feed point to change polarisation of the antenna from vertical to horizontal. In Bangladesh horizontal polarisation is preferable.

3.30 Existing frequencies and future requirements

The frequency spread between 3305 and 8818 KHz is sufficient for all communication within Bangladesh using the HF bands. There is however a gap between 5089 KHz and 8188 KHz. The prediction charts show a need for a frequency in the 6000 KHz range and it is recommended that a frequency between 6900 KHz and 7000 Khz be selected. If a second additional frequency can be selected then in the 6000 - 61000 Khz range should be considered.

3.40 Schedules for optimal HF frequency use. See appendices 4, 6-12.

The prediction schedules have been shown in the appendices. These show predictions for one field station is almost similar to another for the same time of day and month. There are seasonal differences but for the months June, July and August the changes are minimal. As mentioned above the charts show a need for at least two additional frequencies between 6900 - 7000 Khz. range and 6000-6100 Khz range .

The charts in **appendices 4** show timings and their related frequencies for **ALL** field stations in Bangladesh, local conditions accepted.

3.50 FAP 10 communications set-up incorporating the ORION 7000 radio.

It is suggested that the value of the fuses used with both the voltage regulator and battery charger be reduced as further protection.

This should reduce the chances of damage due to high voltage fluctuation. The lower the value of the fuse the greater the protection.

Consideration may be given to the use of fused plugs with the voltage stabiliser as a first line of defence or wall plugs which will trip at the time of voltage surge.

4.00 General

It is strongly recommended that:-

1. Suitable training be given to all operators in the use of an SWR meter.
2. Suitable training be given in antenna fault finding and rectification.
3. All stations be issued with an SWR meter to check for antenna faults.
4. Two additional frequencies be sought in the 6000-6100 KHz and 6900 - 7000 KHz range
5. A site survey be undertaken to designated field stations to fine tune and where necessary service the antenna systems for optimum use after a heavy monsoon period.
6. Self amalgamating tape be used on all outside coaxial cable connectors for waterproofing.
7. The transceivers should use batteries as their **only** source of power which will save them from power fluctuations as well as a reduction of noise from power mains interference .

Suggested TORS for Site Survey to designated field stations to include:

1. Check the coaxial cable feeder to the antenna for physical damage from storm or water intrusion
2. Check all outside connectors for watertight connections
3. Check the orientation of the antenna in relation to Dhaka depending on type used
4. Check antenna orientation if the station is to be used as a "repeater" station
5. Check present antenna site with a view to improve communications
6. Check the earthing system of the radio station together with ground conductivity
7. Check the losses in the coax cable to the antenna
8. Check the power output of the transmitter at the antenna end of the coaxial cable
9. Run tests using both delta loop and broad band antenna to determine the most suitable for "repeater" station work.

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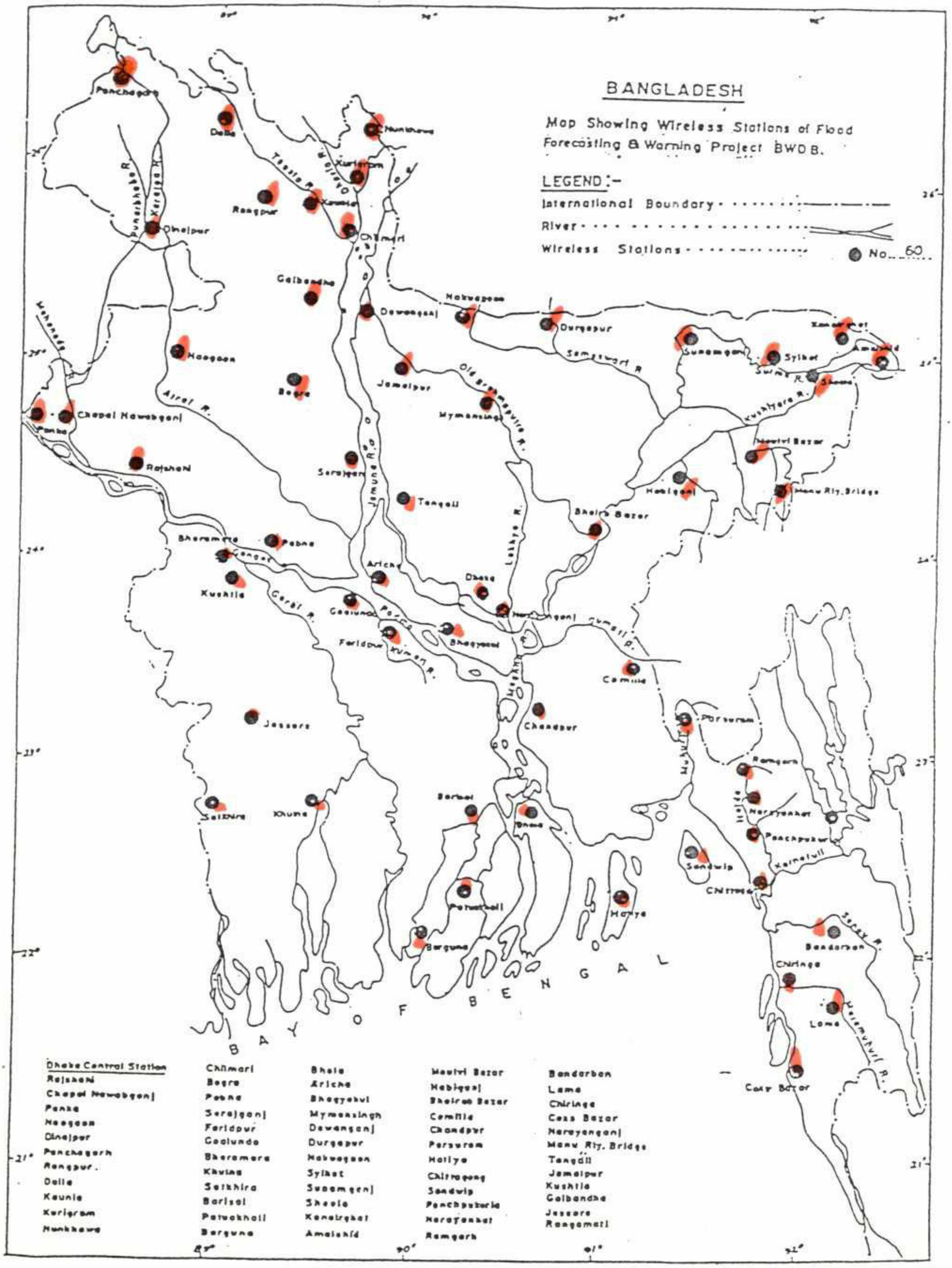
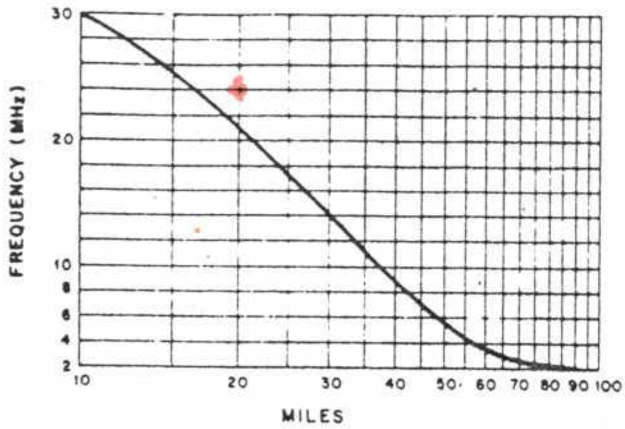
APPENDICES : **NO.**

Appendices 1



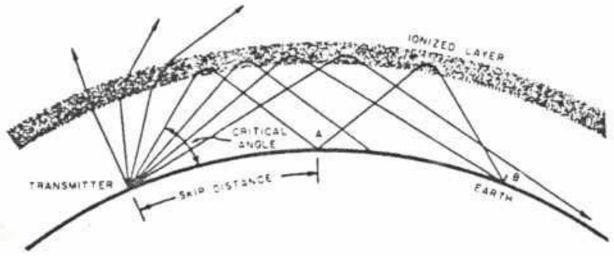
Appendices 2

Figure 1



—Typical HF ground-wave range as a function of frequency.

Figure 2



—Behavior of waves encountering the ionosphere. Rays entering the ionized region at angles above the critical angle are not bent enough to be returned to Earth, and are lost to space. Waves entering at angles below the critical angle reach the Earth at increasingly greater distances as the launch angle approaches the horizontal. The maximum distance that may normally be covered in a single hop is 4000 km. Greater distances are covered with multiple hops.

Appendices 3

Figure 1

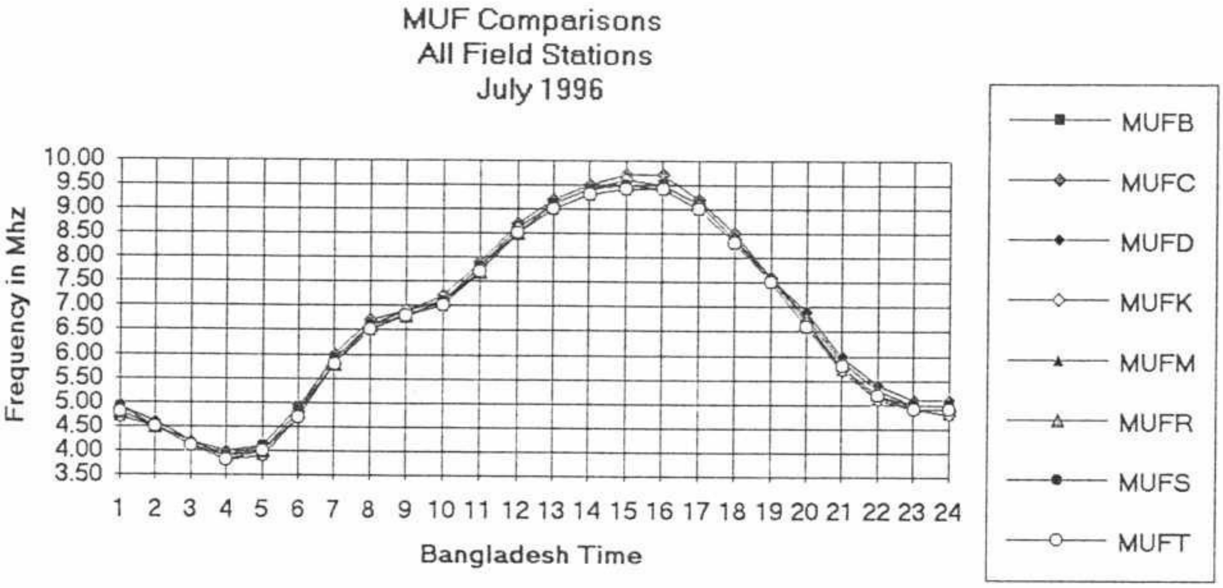
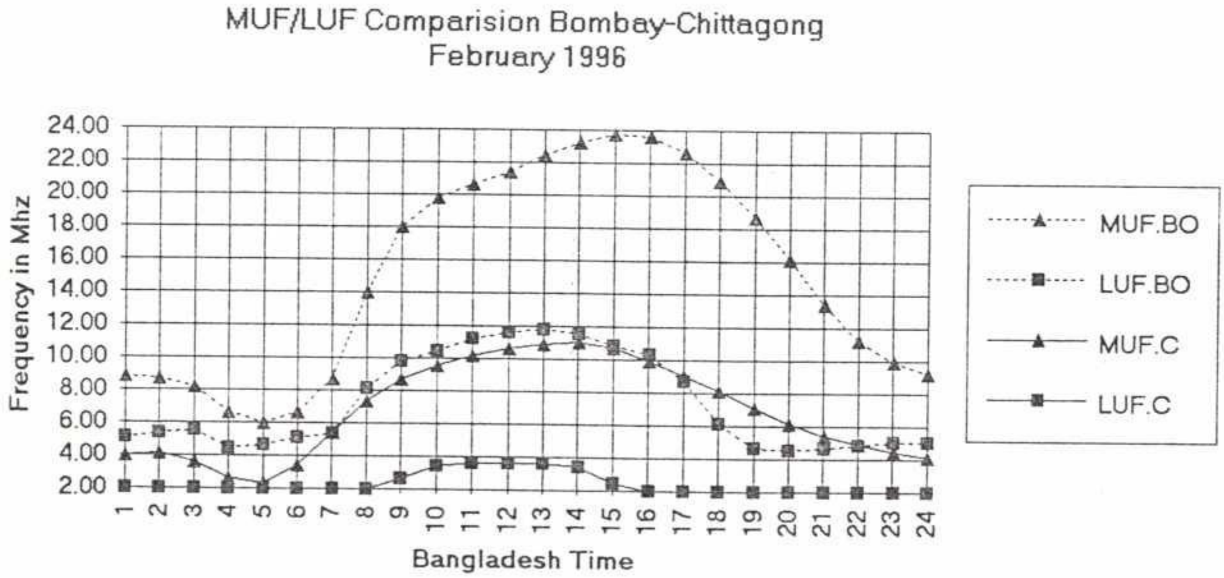
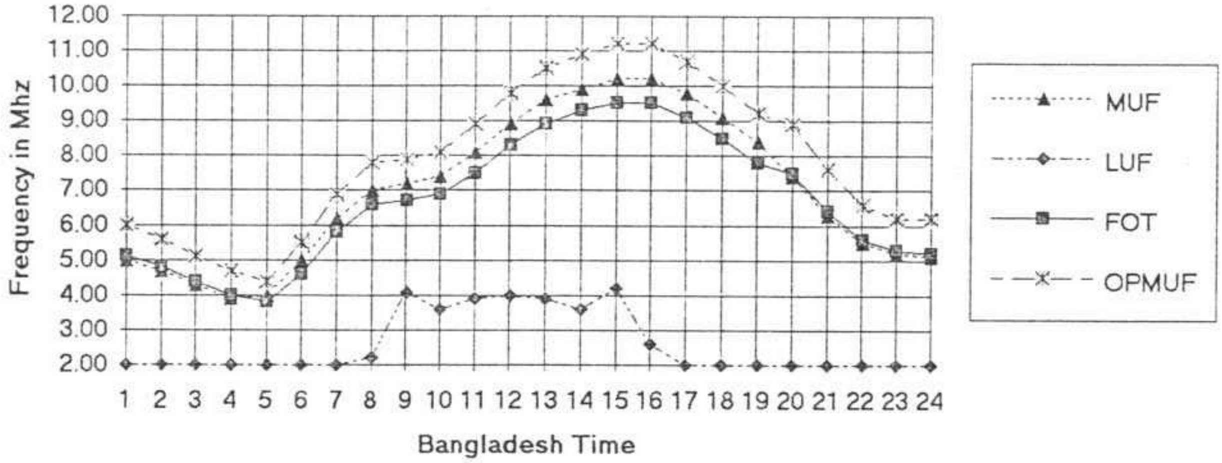


Figure 2

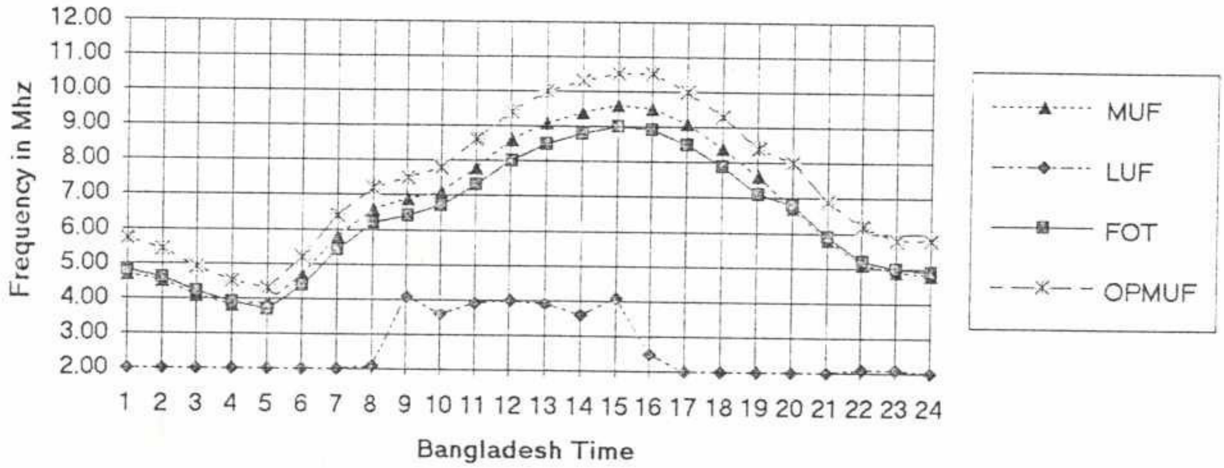


Appendices 4

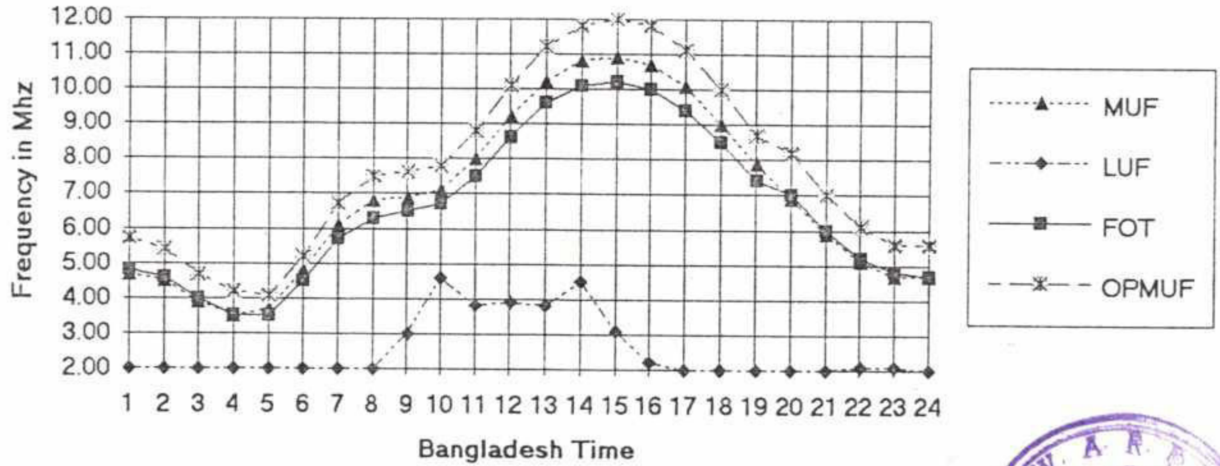
Predicted Optimal HF Frequencies (Bangladesh)
June 1996



Predicted Optimal HF Frequencies (Bangladesh)
July 1996



Predicted Optimal HF Frequencies (Bangladesh)
August 1996



Appendices 5

CHART ABBREVIATIONS AND GUIDANCE

This is a brief operators guide to the prediction charts. **See appendices 3-4, 6 - 12**.

LUF
This is the Lowest Usable Frequency that be considered for use.

MUF/OPMUF
MUF is the Maximum Usable Frequency. OPMUF is Operational MUF. These figures are guides and predictions for most likely maximum and upper range of frequency that will give reliable communications.

MUF(B) Barisal ; **(C)** Chittagong ; **(D)** Dinajpur ; **(K)** Khulna ; **(M)** Mymensingh ; **(R)** Rajshahi ; **(S)** Sylhet ; **(T)** Tongi.

FOT
FOT is the Frequency of Optimum Transmission. This is likely to be a reliable frequency and slightly below the MUF for the period. Contact may be made near or around this frequency. Remember this is not necessarily an indication of the best frequency but a guide to a contact frequency if contact has been lost.

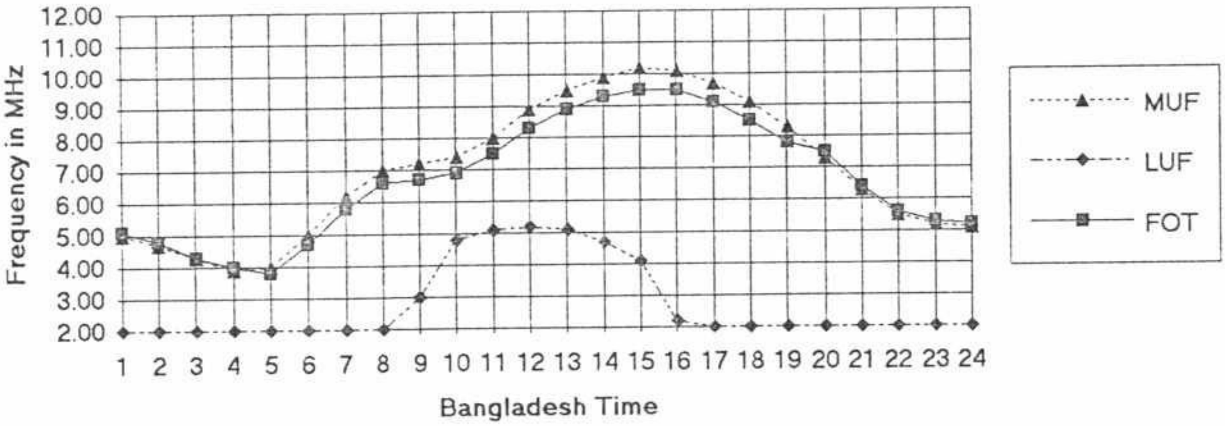
SSN
SSN is Sun Spot Number and is used in calculating these prediction charts. However time of day/night and local seasonal conditions affect these predictions.

The SSN for the months predicted in 1996 are as follows:
June-9, July-7, August-7. As a comparison the SSN for the same period in 1995 are:
June-10, July-11, August 11.

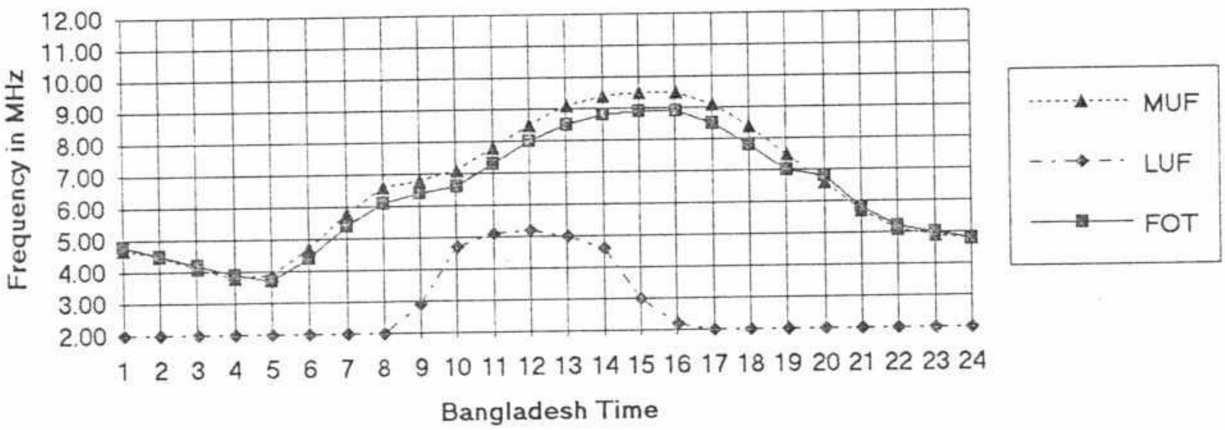
It is assumed that the output of the transmitter is approximately 0.10 KW (100 watts).

Appendices 6

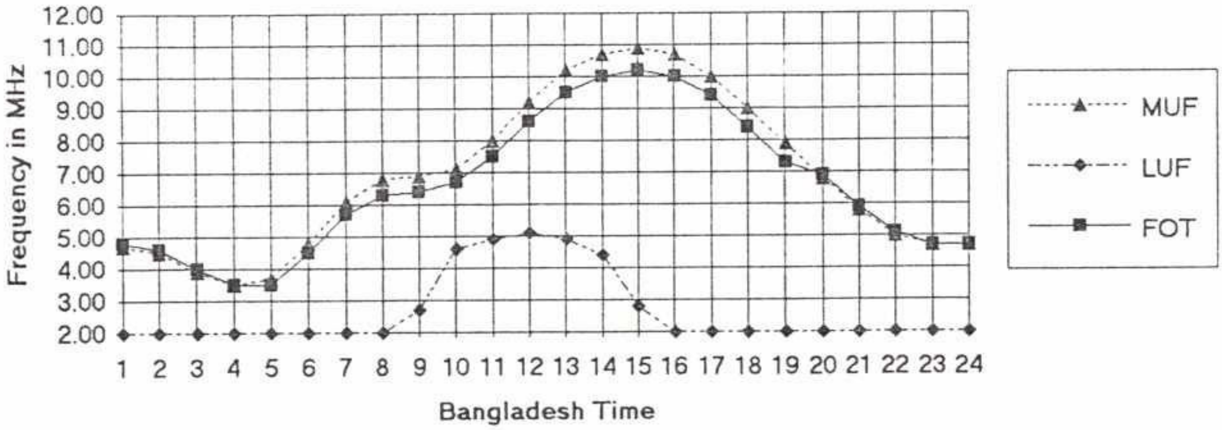
Frequency Prediction Chart
Dhaka - Barisal
June 1996



Frequency Prediction Chart
Dhaka - Barisal
July 1996

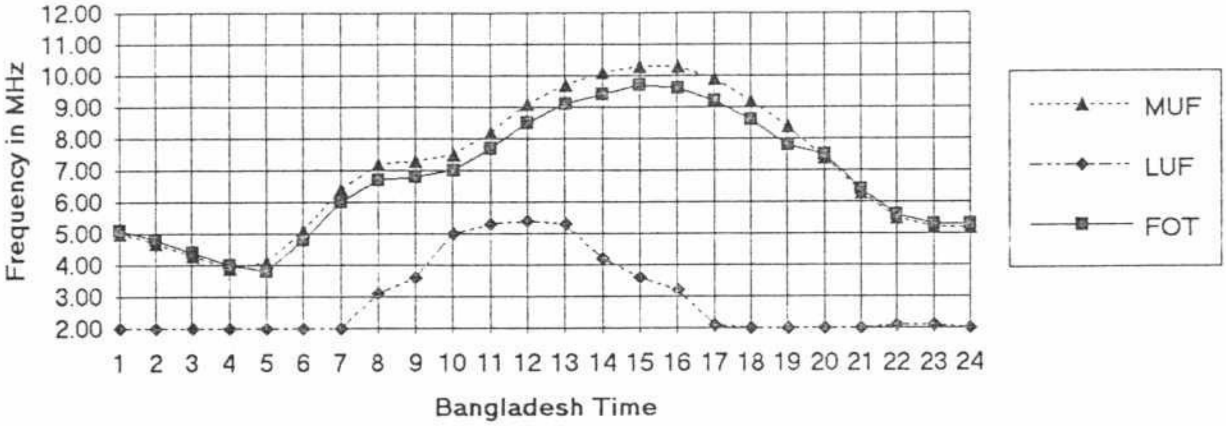


Frequency Prediction Chart
Dhaka - Barisal
August 1996

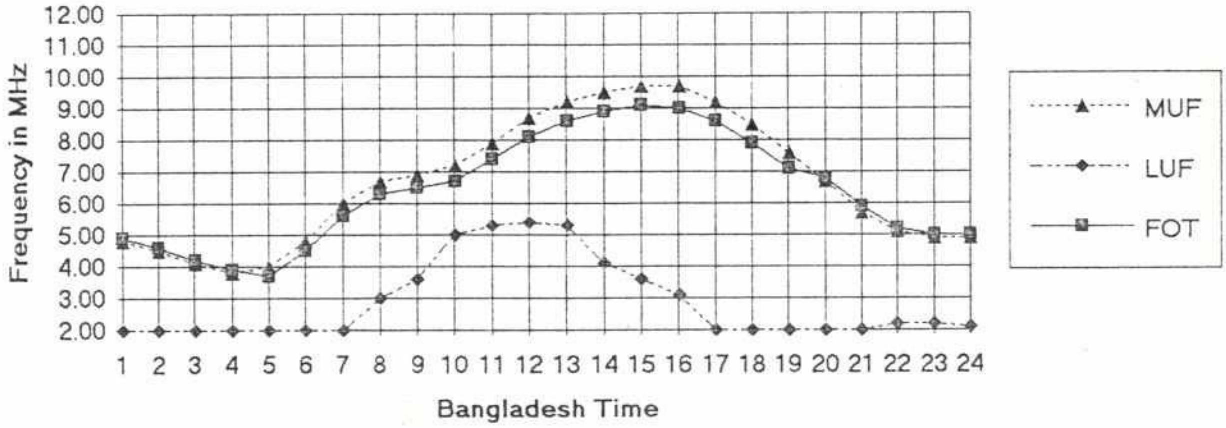


Appendices 7

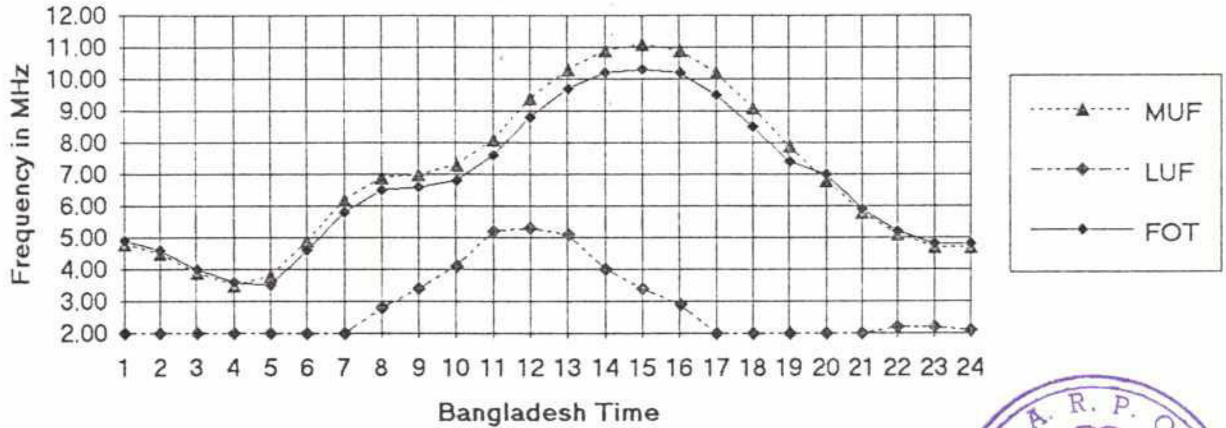
Frequency Prediction Chart
Dhaka - Chittagong
June 1996



Frequency Prediction Chart
Dhaka - Chittagong
July 1996

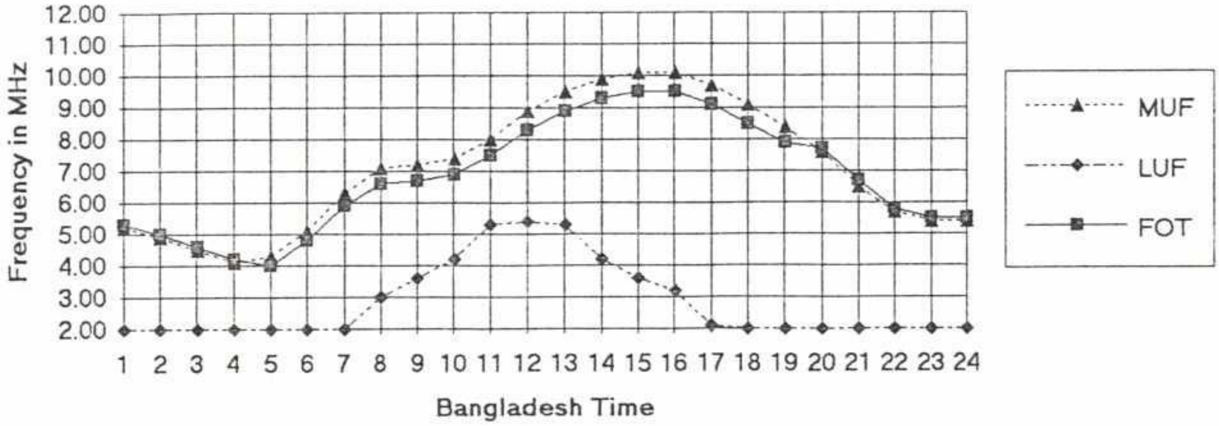


Frequency Prediction Chart
Dhaka - Chittagong
August 1996

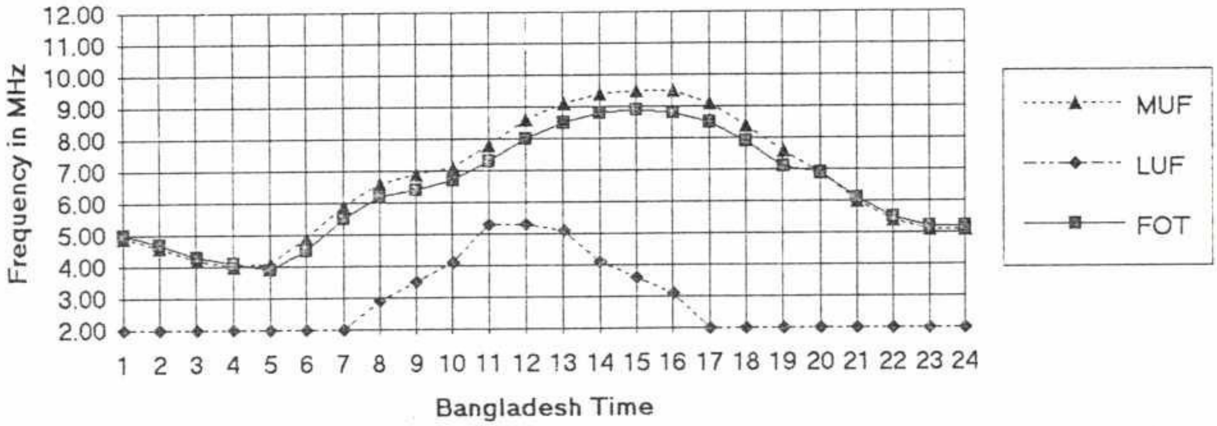


Appendices 8

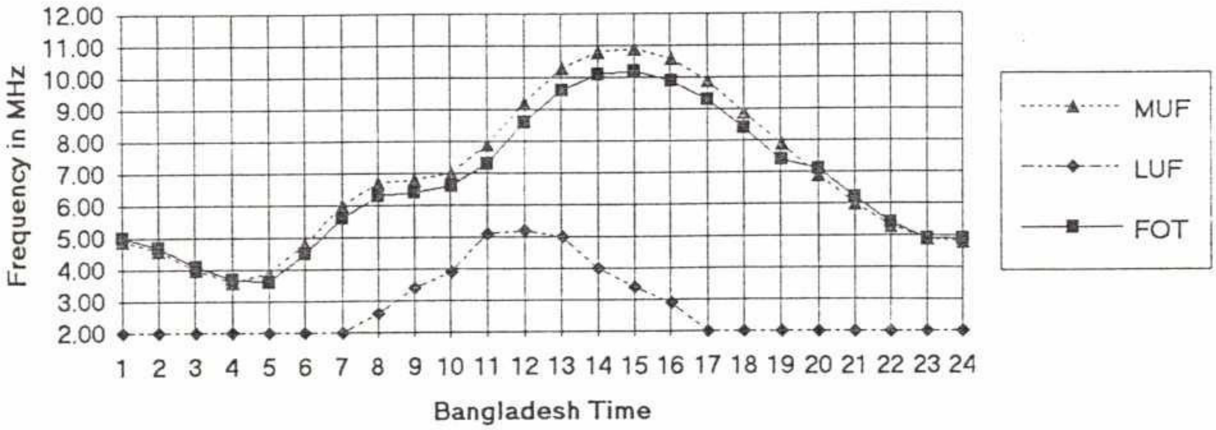
Frequency Prediction Chart
Dhaka - Dinajpur
June 1996



Frequency Predicrtion Chart
Dhaka - Dinajpur
July 1996

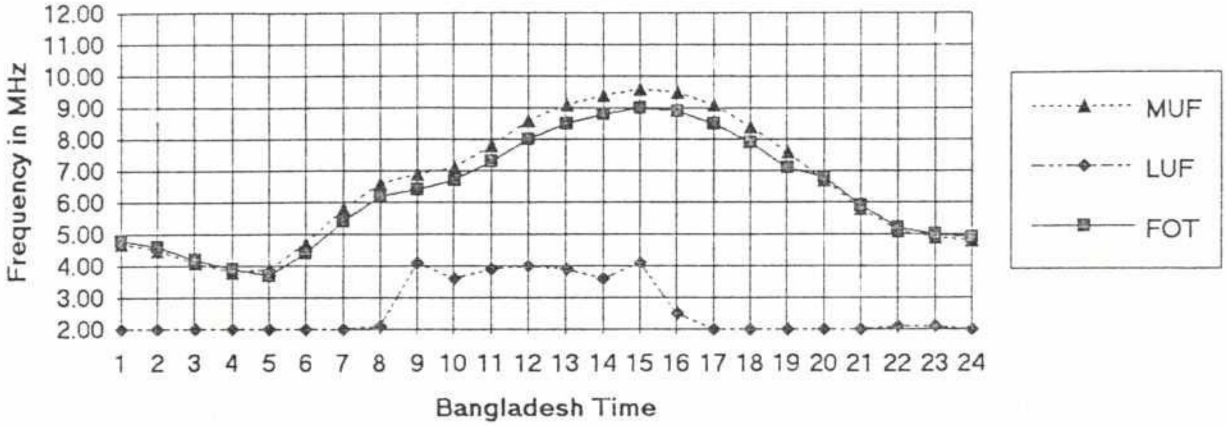


Frequency Prediction Chart
Dhaka - Dinajpur
August 1996

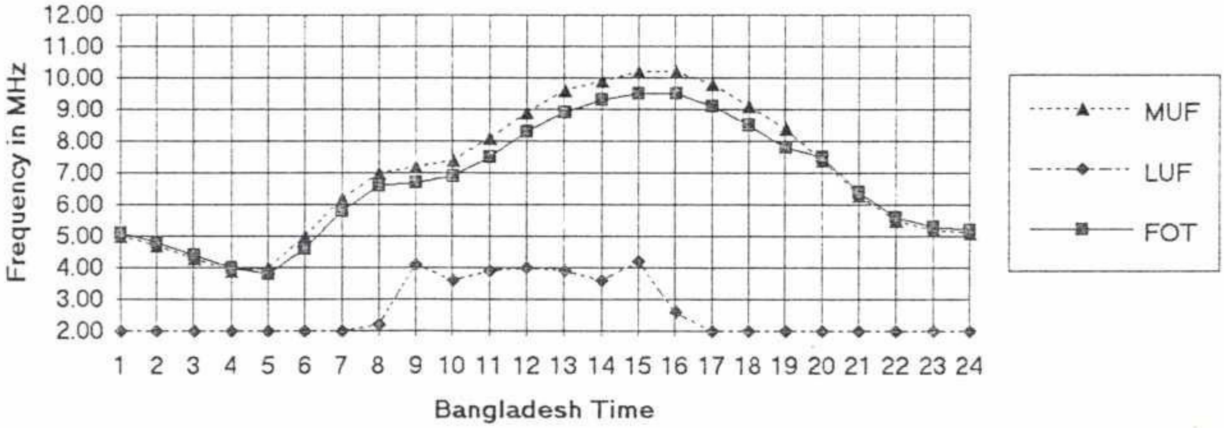


Appendices 9

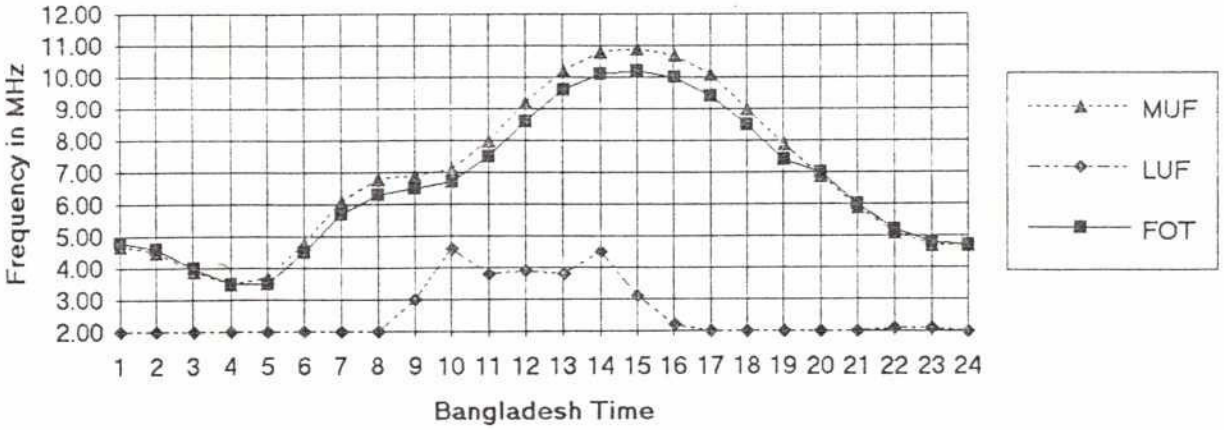
Frequency Prediction Chart
Dhaka - Khulna
July 1996



Frequency Prediction Chart
Dhaka - Khulna
June 1996

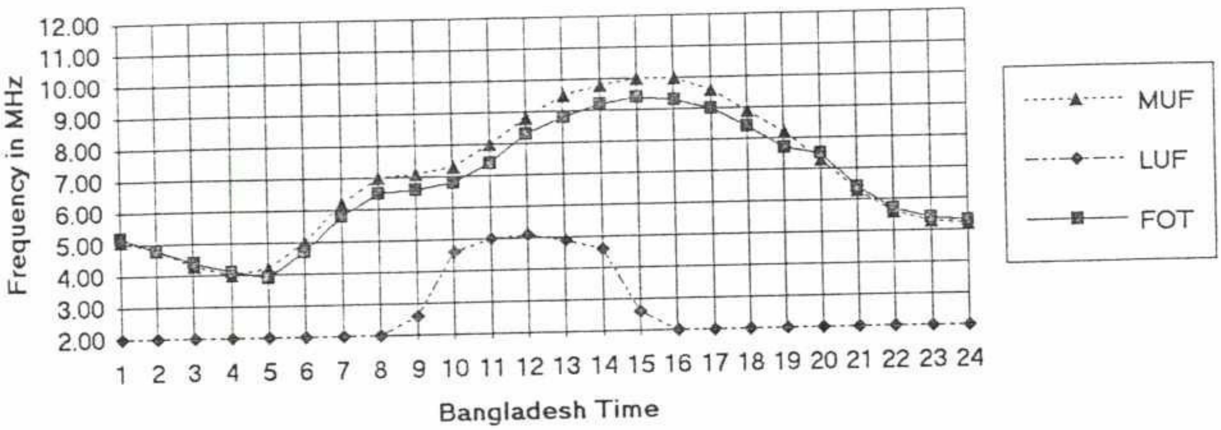


Frequency Prediction Chart
Dhaka - Khulna
August 1996

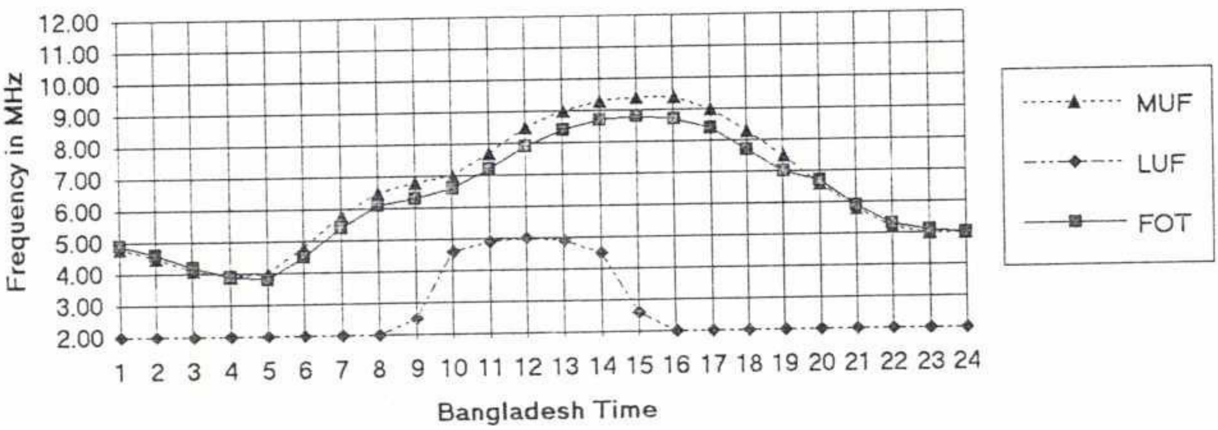


Appendices 10

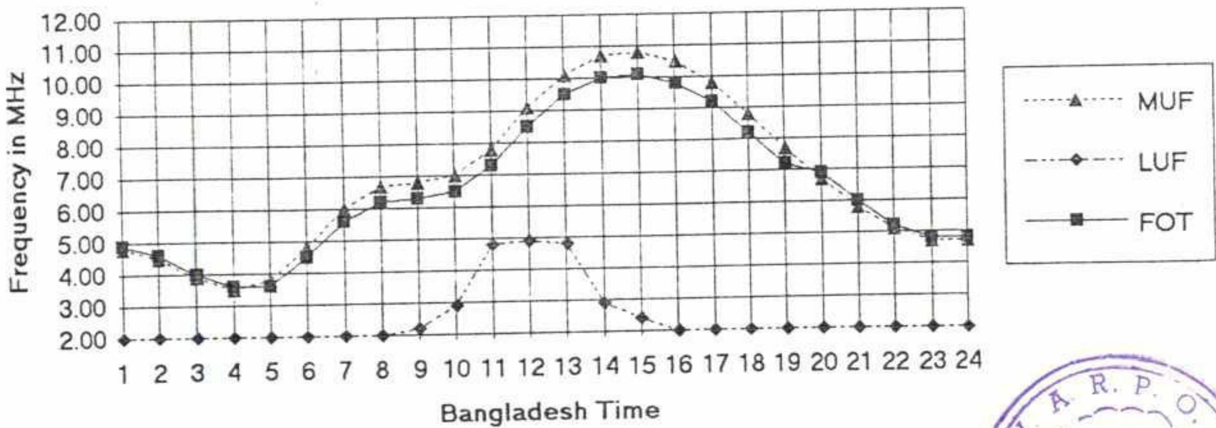
Frequency Prediction Chart
Dhaka - Mymensingh
June 1996



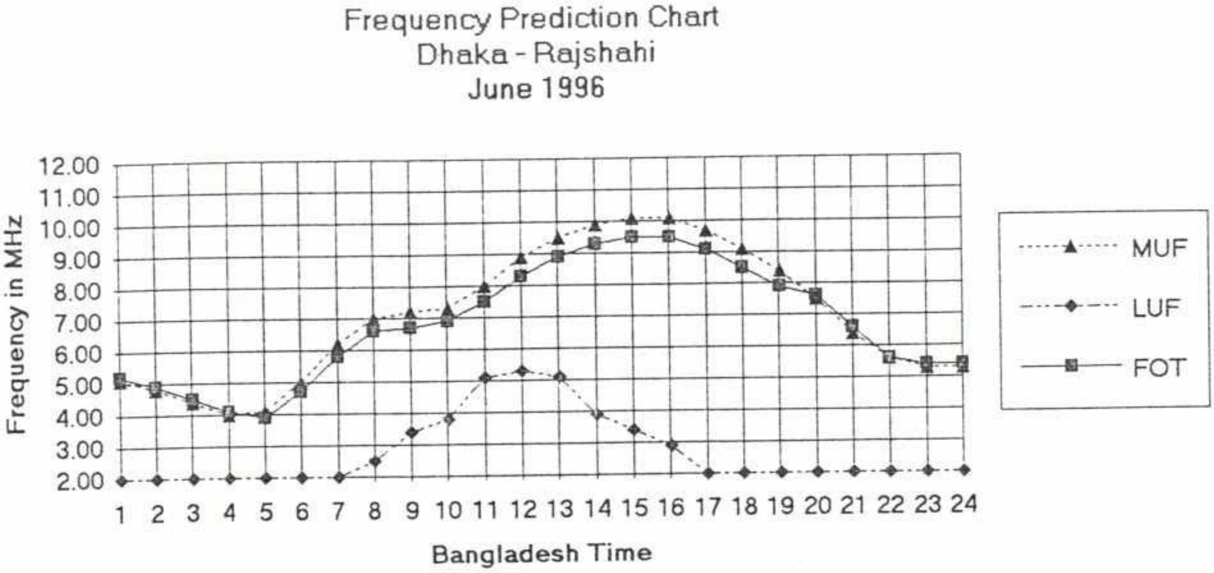
Frequency Prediction Chart
Dhaka - Mymensingh
July 1996

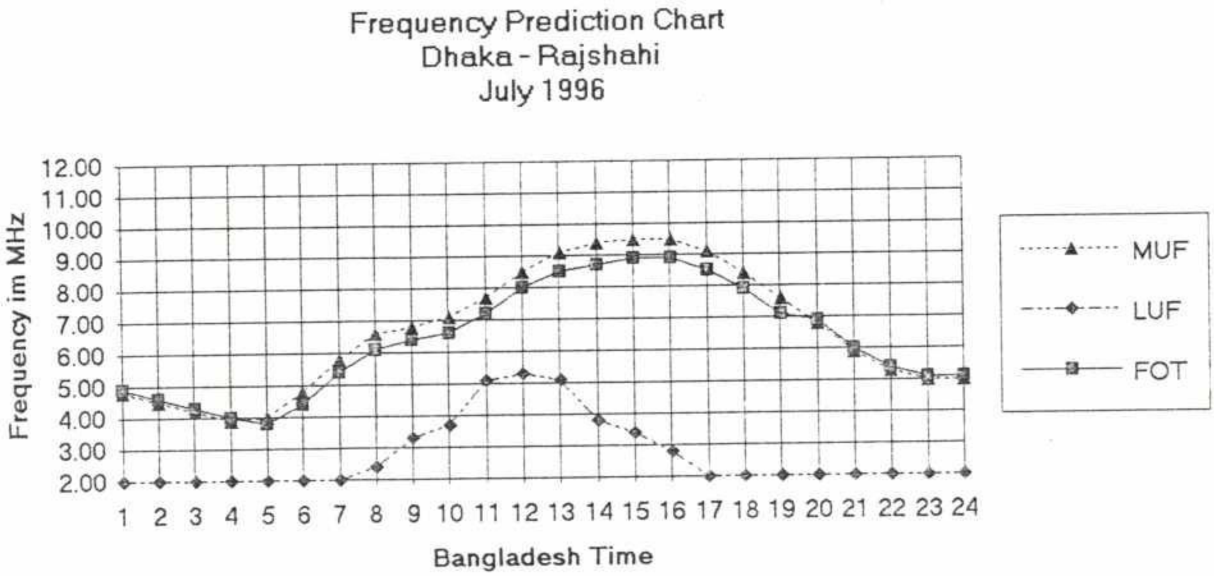


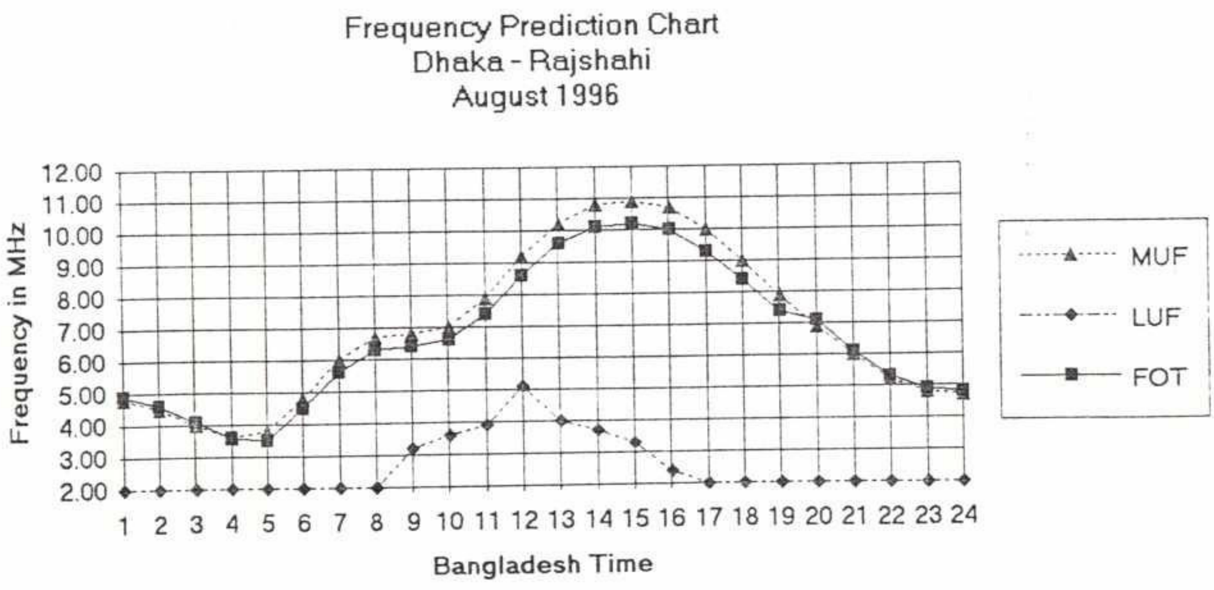
Frequency Prediction Chart
Dhaka - Mymensingh
August 1996



Appendices 11

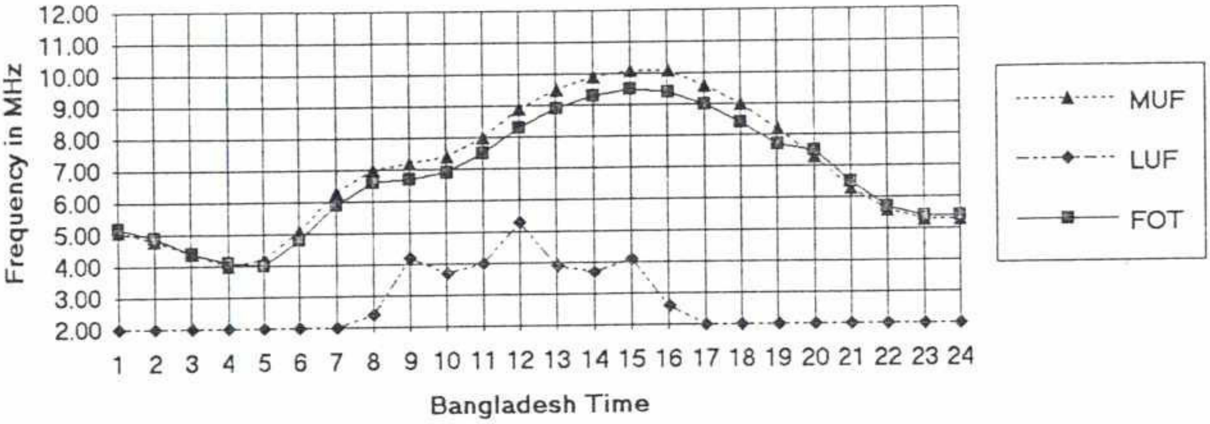




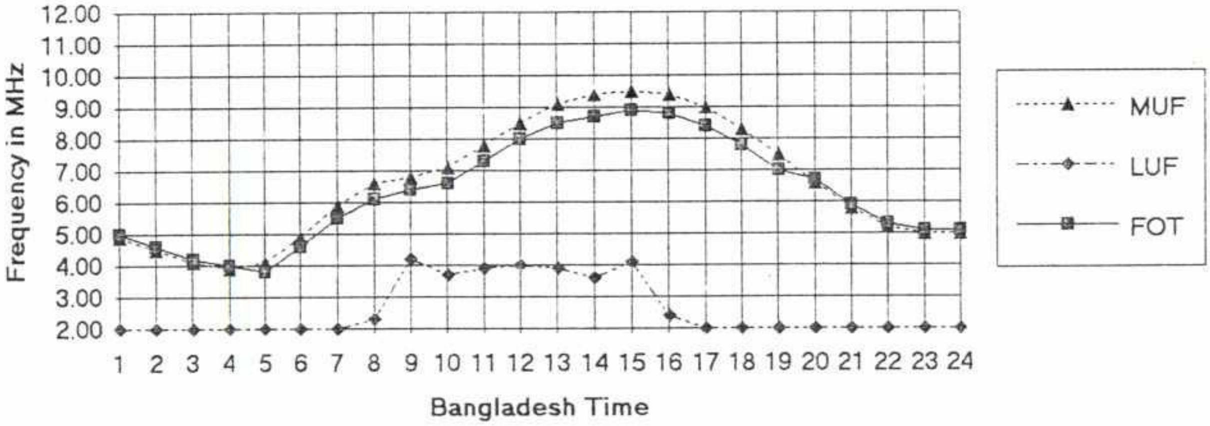


Appendices 12

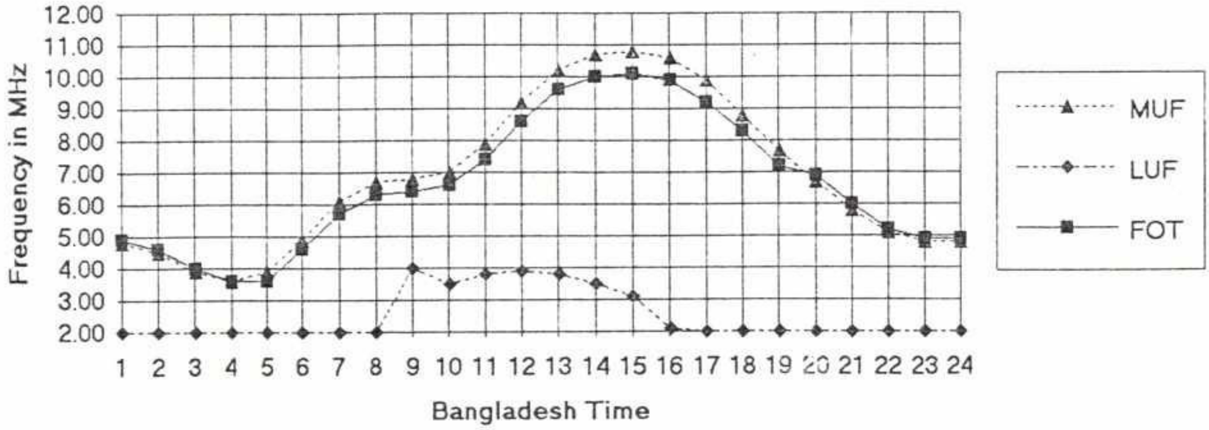
Frequency Prediction Chart
Dhaka - Sylhet
June 1996



Frequency Prediction Chart
Dhaka - Sylhet
July 1996



Frequency Prediction Chart
Dhaka - Sylhet
August 1996



Appendices 13

Office of the Director
Surface Water Hydrology - II
BWDB, 72 Green Road (1st floor),
Dhaka - 1215.
No. SWH-2/FAP-10/747 Dated :26-5-96

To
The Team Leader
FAP 10 (expansion of Flood Forecasting & Warning Services)

Subject : Detection of cause of wireless communication disruption.

This is to inform you that the both way wireless communication of FFWC is completely disrupted from 25th May. The FFWC wireless could not able to connect to the field stations due to unknown reasons in spite of the field stations open their wireless and tried to communicate to FFWC. It is apprehended that the climatic condition is responsible for this disruption. In this circumstances, the real time data collection by wireless at FFWC is totally stopped and the publication of daily bulletin & situation are hampered due to unavailability of real time field data.

You are requested to please take necessary immediate steps to identify the reasons of disruption and find out appropriate solutions.

Thanking you.

Mohammad Alam Mia
Director
Surface Water Hydrology 2, BWDB
and
National Project Director
FAP 10

Memo No. SWH-2/FAP-10/747/1(1)

Copy forwarded for kind information to :

1. The Chief Engineer, Hydrology, BWDB, Dhaka

Appendices 14

Antenna Fault Finding and Trouble Shooting in the Field

For this exercise it is assumed the transceiver is functioning correctly. It would be advisable all operators be taught the use of SWR meters and each station has one available for use by the operator.

LITTLE OR NO SOUND FROM THE TRANSCEIVER AFTER SWITCHING IT ON

Fault /Remedy
The antenna coaxial cable is not connected to the transceiver
Connect the antenna coax cable to the transceiver
The coax cable from the transceiver is not connected to the antenna
Reconnect the coax cable to the antenna
The antenna has fallen down
Check the antenna carefully for damage re -erect and check SWR within limits.
The antenna has broken
Repair the antenna and reconnect to the coaxial cable and check SWR within limits.
The antenna is missing
Search/replace the missing antenna reconnect and check SWR within limits.
Defective coax cable
Replace with new cable and check SWR within limits.
Defective coax plug
Replace connector and check SWR within limits
Defective/loose coax plug connection to coax cable
Re-solder coax plug to coax cable and check SWR within limits

YOU RECEIVE SIGNALS LOUD AND CLEAR BUT THE OTHER STATION CANNOT HEAR YOU

Fault /Remedy
Poor earth connection
Check earth connection is clean and tight
Broken antenna
Repair/replace antenna and check the SWR within limits
Defective coax cable
Replace coax cable and check SWR within limits
Water intrusion into coax cable
Replace coax cable and check SWR within limits
SWR is too high
Check all the above remedies
Weak battery
Replace/recharge battery. Check battery charger
Using low power
Visually check radio display panel for maximum power output

SWR READING FLUCTUATES / IS BEYOND ACCEPTABLE LIMITS (1:3)

Fault /Remedy
All the above faults except weak battery and low power will cause high SWR readings
All the above remedies will contribute to a reduction in SWR readings.

Appendices 15

Lightning and Surge Protection

During the summer months in Bangladesh severe tropical storms of great intensity occur. These storms are often preceded or accompanied by lightning.

Under normal circumstances for improved communications, the higher the antenna is above ground the better. However in some areas where the antenna is the highest point, it is a potential target for atmospheric discharges even if it escapes a direct lightning strike.

Heavy rainstorms without lightning are often heavily charged and cause considerable static discharges. It is therefore sensible to provide proper protection to the antenna system so as to prevent/minimise damage to equipment by static discharges.

To disconnect the antenna from the back of the radio or switching the antenna to earth INSIDE THE RADIO ROOM is not satisfactory. If switching to earth is to be at all useful, it must be done outside the building and preferably away from it. The earth connection should as for as possible be in a straight line to the ground.

If however antenna connections and AC power sources were disconnected from the radio and equipment, it is unlikely they would to be susceptible to static discharges or lightening strikes.

A satisfactory method to protect an exposed antenna system, is to provide a proper discharge path to earth which can be permanently installed. The first essential in this protection is an adequate earth connection of low resistance. This will differ between installations because of the different nature of the ground. The position of the earth connection should be sited, to be directly under the antenna feeder.

The use of coaxial line protectors with low VSWR, wide band width and low insertion losses would be a suitable form of protection provide they

- are adequately earthed
- can handle the maximum transmitting power of the transceiver (200 watts PEP)

The protection element in these, is a low capacitance arrestor filled with rare gas. These arrestors are designed to switch rapidly at a specific voltage level (breakdown voltage/clamping voltage) from a non-conductive to a conductive state (arc mode) when subjected to a fast rising voltage transient, thus earthing potential strikes before they reach the equipment being protected.

The chances of damage from a direct lighting strike are less than from static discharge or by EMP (Electro Magnetic Pulse), which is generated by all types of lightning strokes, coming down the antenna connector or via the AC power line. These 'spikes' can seriously damage the health of solid-state devices in the front end of receiving equipment. However by using a battery as the main source of power for the radio, the EMP threat from the AC power lines is greatly reduced!.

Any protection device which will ground static from the antenna system will reduce the chances of damage to equipment due to the proximity of lightening discharges.

If lightning is still considered a major threat to equipment even after sensible precautions have been taken, there is one other additional installation which will offer about 93% protection to equipment and property.

This device consist of a single mast of sufficient cross-sectional area to stand (guyed if necessary) in the centre of the area to be protected and be 5m higher than any other part of the installation. Top off this mast with a short length of copper rod not less than 25mm², with a sharp point on the top and very securely fitted to the mast with an excellent electrical connection, and fully protected against corrosion. All joints on the mast must be likewise. The mast ought to be of 2 in diameter aluminium or similar.

The base of this mast should be connected to an earth rod of 0.5in galvanised pipe or, better still, hardened copper rod or 'T' section earth rod. This should be not less than 8ft long for normal ground, but in poor conditions two or more spikes or one much longer spike should be used.

This mast will provide a cone of protection for all equipment within a radius of 20m or a circle 130ft across.

Finally DO NOT rely on the building's earthing system to ground your equipment. Fix a small copper bus bar about 15cms X 3cm X 3mm in the radio room. From this bus bar take a connection to good external earth outside the building. Then connect to the bus bar through a nut and bolt system all the radio equipment in use. This means the equipment is then earthed via a system not connected to the building's earthing system.

Recommendations:

<u>1.</u> DO NOT rely on the building's earthing system to connect the radio equipment to
<u>2.</u> Fit a bus bar with an outside earth in the radio room and connect the radio equipment to this
<u>3.</u> Use suitable coaxial line protectors on the antenna coaxial feeders
<u>4.</u> If coaxial line protectors are not available, the use of a locally constructed arc discharge device would be of benefit. A sketch and advice already supplied.
<u>5.</u> Earth connections to an outside earth should be as short and direct as possible
<u>6.</u> If possible disconnect radio, antenna and ac current sources before the arrival of a storm
<u>7.</u> Remember to reconnect the antenna prior to commencing transmission after the storm