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Experimental Investigation Related To Some Predicted Results Of Reliable High Frequency Radio Communication Links Between Benghazi-Libya And Cairo-Egypt.

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ABSTRACT
In this study, the central radio propagation laboratory (CRPL) method of ionospheric prediction of the National Bureau of Standards (NBS) in U.S.A was used in practical calculations of the optimal working frequencies for reliable high frequency (HF) radio communication links between Benghazi-Libya and Cairo-Egypt. The results were drawn in the form of curves by using the computer. The computer was used to measure the received signal level variation of frequencies 11.980 MHz, 11.785 MHz which were transmitted with a power of 250 KW, 100 KW respectively from the Egypt Arabic Republic Broadcasting station in Cairo city, directed to the North Africa and South Europe regions. The measurements were taken during daytime's for winter (December, January& February) and summer (June, July & August) seasons.
Keywords - The optimal working frequency, reliable HF radio communication links, the ionospheric prediction method, the National Bureau of Standards, the Central Radio Propagation Laboratory.

I. INTRODUCTION

The optimal working frequencies (FOT) for reliable HF radio communications links between Benghazi-Libya and Cairo-Egypt were determined by using the CRPL method of NBS [1]. The effects of the ionospheric variations on the performance of the short wave (HF wave), which transmitted with frequencies 11.980 MHz, 11.785 MHz with a power of 250 KW, and 100 KW [2] respectively, from the Egypt Arabic Republic Broadcasting station in CAIRO city, directed to the North Africa and South Europe regions [3] and they were received by the VLF - HF - Receiver EK 070 which operates on the frequency range from 10KHz to 30 MHz, with 20 dB(µv) threshold level, and with a class of emission A3(AM, double sideband with full carrier, bandwidth = 6 KHz), with this class of emission its sensitivity < 2.0 µv [4]. This receiver is available at the communication laboratory- Engineering-Faculty-Benghazi University- Benghazi city-Libya.

This study includes measuring the variation of the signal level received during daytime's for the winter and the summer seasons of the year by using computer.

The study results demonstrated that the decrease and the increase in the signal level received when its frequency near to or far from the predicted FOT (the Frequency of Optimum Transmission) of Benghazi-Libya and Cairo-Egypt radio communications links.

II. THE OPTIMAL WORKING FREQUENCIES FOR RELIABLE HIGH FREQUENCY RADIO COMMUNICATION ESTIMATION BETWEEN BENGHAZI-LIBYA AND CAIRO-EGYPT ROUTES.

The calculations relevant to the optimal working frequencies of the point to - point HF communication between Benghazi-Libya and Cairo-Egypt using the CRPL method of the ionospheric prediction were taken. In those calculations; the Zurich monthly sunspot numbers for the periods of; December, January, February, and June, July, August, are as shown in Table 1 [5].

The results are shown in Table II and are plotted in Fig.1.

Period of the year (Month)	Sun Spot number
December	128.5
January	136.9
February	167.5
June	170.7
July	174.1
August	175.5

Table I. Zurich monthly sunspot numbers of the corresponding month of the years

LOCAL TIME (hours)	Summer Season	Winter Season
	FOT * (MHz)	FOT * (MHz)
00	3.4	2
02	3.1	2
04	8.5	3.3
06	12.6	9.1
08	14	11.6
10	14.8	12.8
12	14.4	12.1
14	13	10.2
16	9.4	5.6
18	5.4	3.6
20	4.8	2.3
22	3.7	2

Table II. The calculations of the predicted Frequency of Optimum Transmission of the Benghazi-Libya and Cairo-Egypt link. FOT*= the Frequency of Optimum Transmission & MHz = Megahertz.

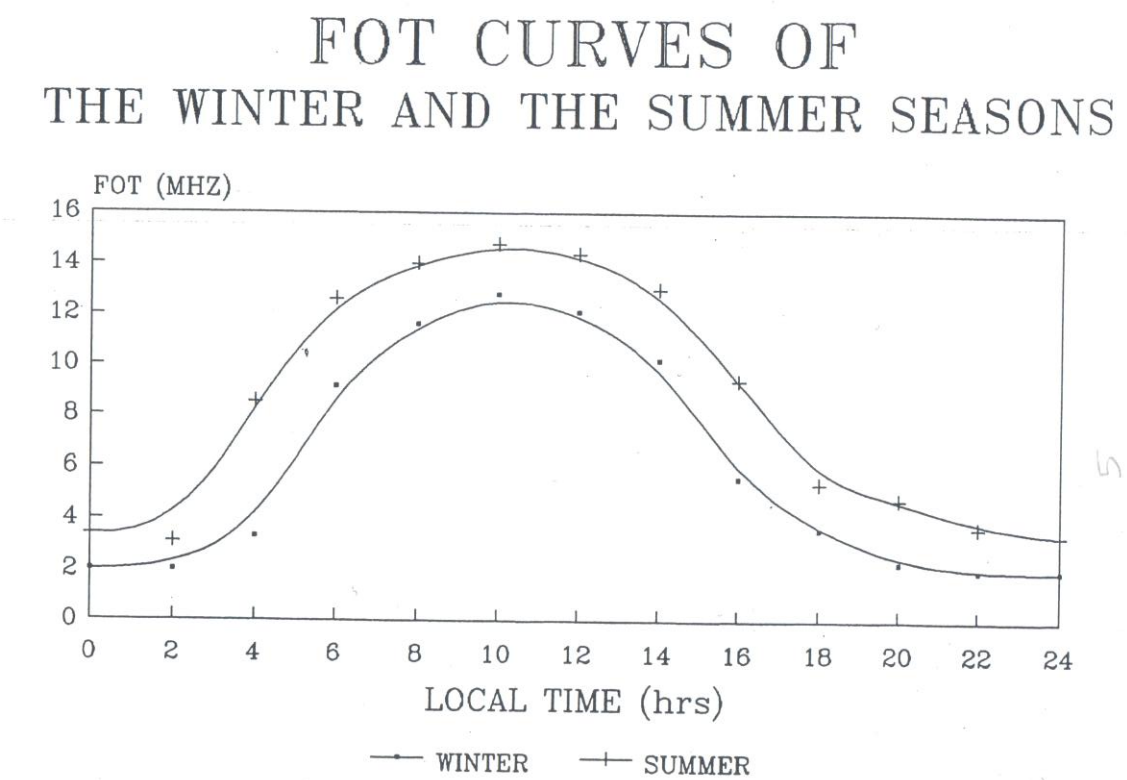

Figure 1. The Frequency of Optimal Transmission curves for Benghazi-Libya and Cairo-Egypt link. FOT=Frequency of Optimal Transmission& MHz = Megahertz.

III. THE EXPERIMENTAL WORK DESCRIPTION

(1) The receiving antenna was designed as a horizontal wire multiple frequency dipoles antenna (rnultiband antenna) at the frequencies; 7, 15 and 21 MHz by using the following formula (1) [6].

$$\textbf{Total Length in meters} = 142.5 / f_{MHz} \quad (1)$$

The physical resonant lengths were calculated for straight horizontal dipoles centered on the higher frequency bands (Table III).

Band (MHz)	Length (m)
07	20.4
15	09.5
21	06.8

Table III. The calculated physical resonant lengths for straight horizontal dipoles with the correspondent Band frequency.

The wires which were cut at the above resonant lengths and joined together at the common center which was connected by a single feed line (coaxial cable) to the VLF-HF-Receiver EK070. The dipoles were mounted horizontally on six masts beside the communication laboratory at the height 12 meters above the ground.

Fig. 2 shows a block diagram of the experimental set-up.

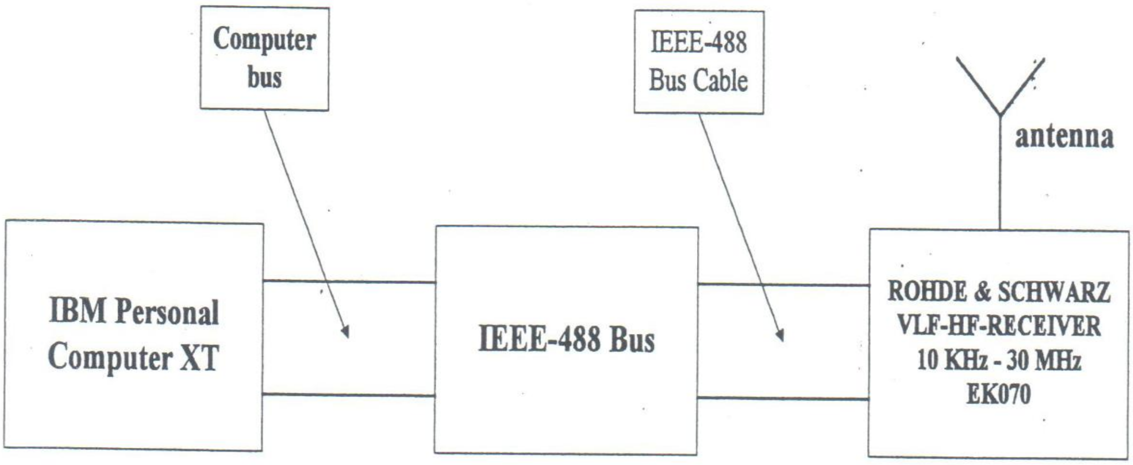

Figure 2. The block diagram of the experimental setup.

(2) The VLF-HF-Receiver EK070 was interfaced with IBM personal computer by using the interface-bus system IEEE-488. The IEEE-488 bus system will only permit the remote control and data call-up of the receiver by the computer (Controller). This bus system was designed in the communication laboratory.

IV. THE SIGNAL LEVEL VARIATIONS MEASUREMENT AND RECORDING

The signals were received by the receiver. Each' even two hours, the computer read the data of the signals levels which their frequencies were under study and equal to; 11.980 MHz and 11.785 MHz.

The computer gave the output on the screen. These data were recorded and stored in the hard disc of the computer. The recorded data were printed on a copy by the printer after some interval of times (from three to seven days). This was achieved using 8088 assembly language program, its flow chart is shown in Fig. 3.

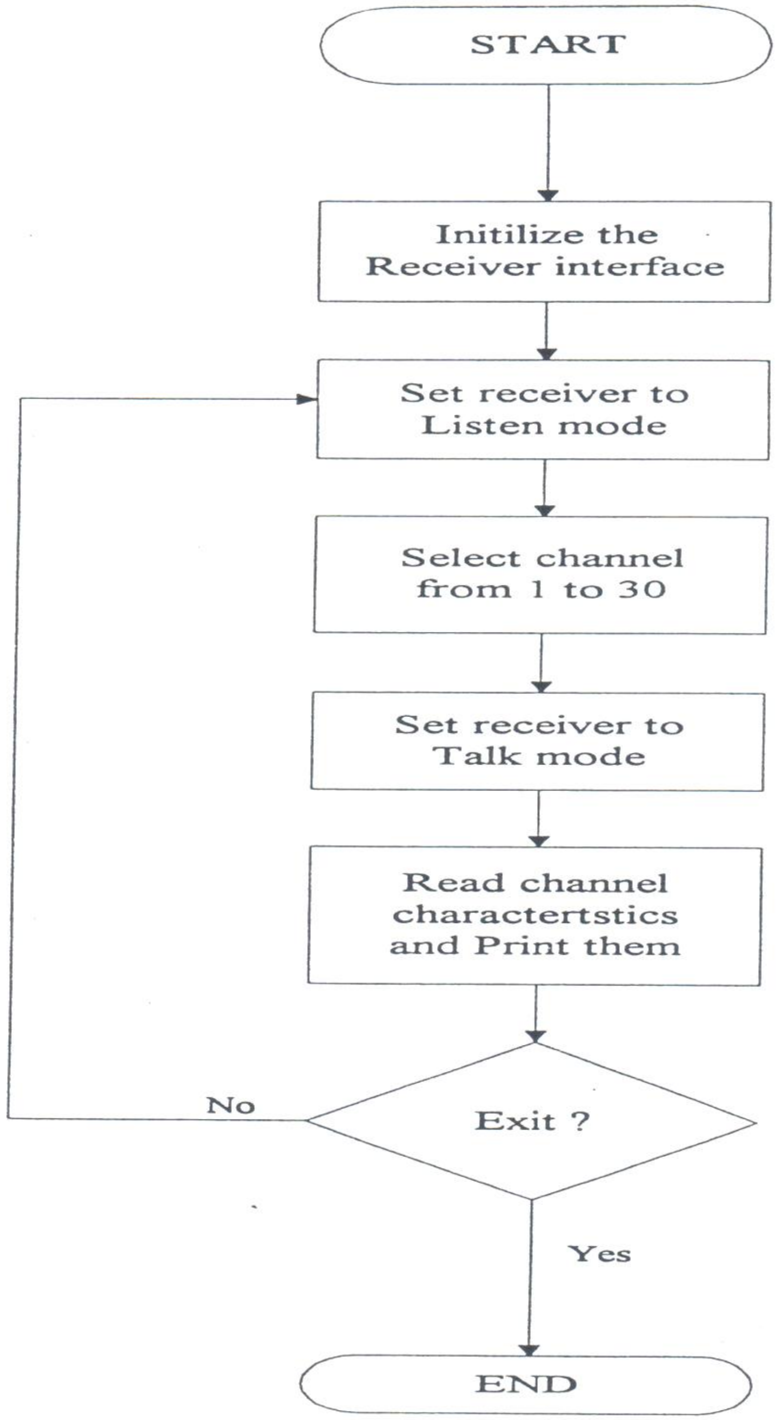

Figure 3. The Flow chart of the received signal level measurements.

These records were made at a time interval of even two hours each. The two hours intervals were used to follow up the significant variations of the ionosphere, which affect the signal level of the propagated HF wave within and through it.

Fig. 4 shows a block diagram of VLF - HF - Receiver EK070 and the output where measurements are taken.

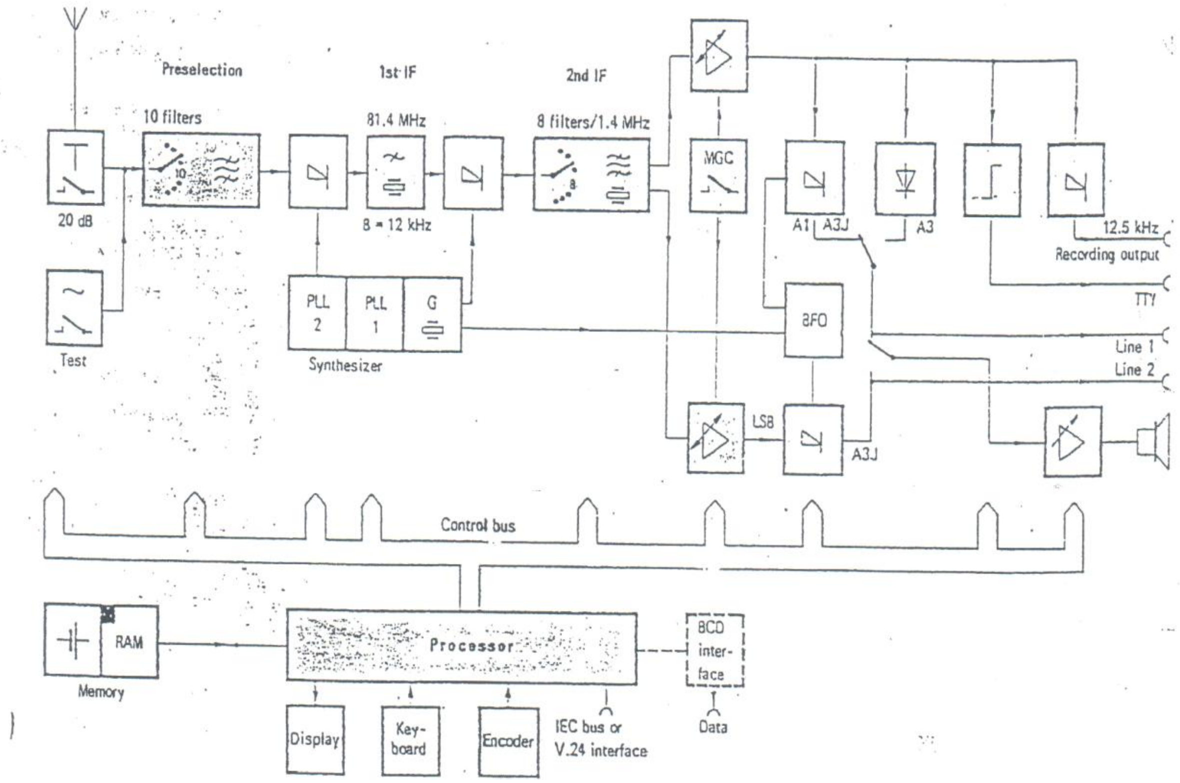

Figure 4. The block diagram of the VLF - HF – Receiver (EK070) with a microprocessor control.

V. THE EXPERIMENTAL RESULTS

The data were recorded during the winter and the summer seasons of the year at the time interval (08 - 16 hrs) at which the Egypt Arabic Republic broadcasting short waves working at the frequencies; 11.980 MHz and 11.785 MHz [3]. The results are presented in Tables IV, V and are plotted in Figs. 5 and 6.

Local Time (Hours)	**Summer Season**				**Winter Season**			
	Signal Level [dB* (μv**)]				Signal Level [dB* (μv**)]			
	June	July	August	Median Value	December	January	February	Median Value
00								
02								
04								
06								
08	35	25	40	**35**	60	60	50	**60**
10	35	15	25	**25**	50	55	55	**55**
12	30	15	35	**30**	65	70	50	**65**
14	45	20	40	**40**	35	45	45	**45**
16	35	15	45	**35**	30	40	40	**40**
18								
20								
22								

Table IV. The signal level measurements of the received short wave with a frequency 11.980 MHz at Benghazi city-Libya. * dB=Decibel & ** μv=microvolts.

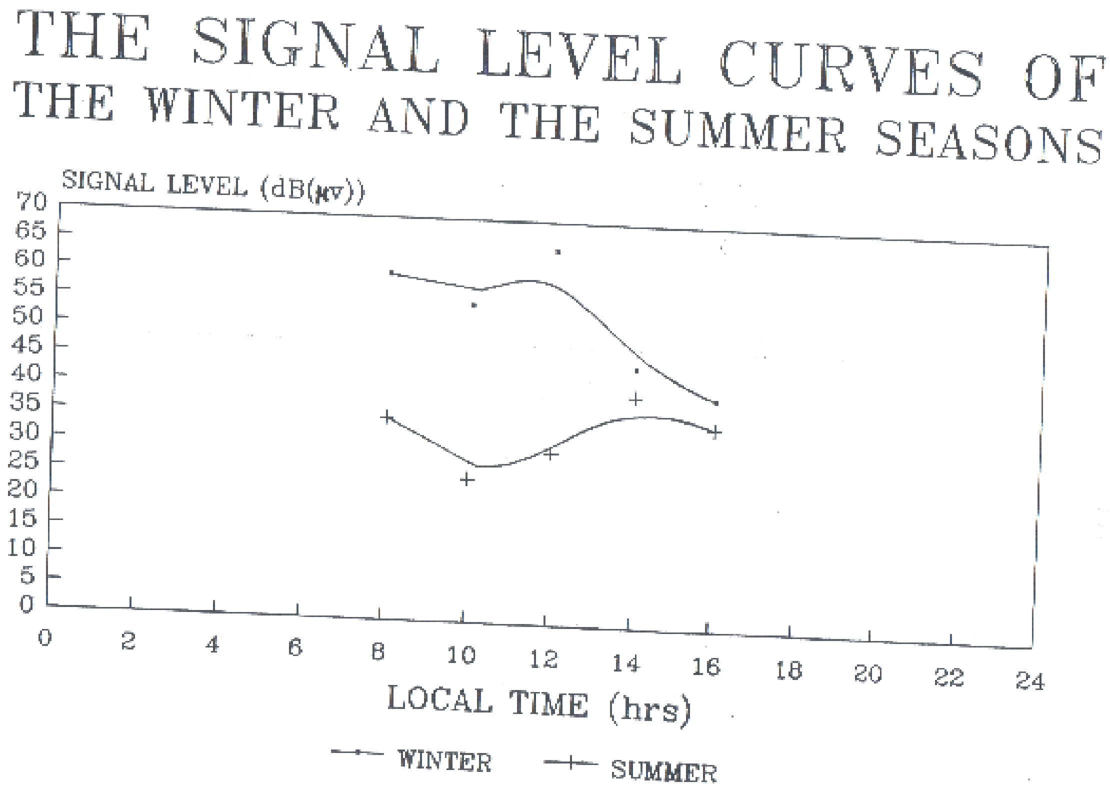

Figure 5. The median values of the signal level measurements of the received short waves with a frequency 11.980 MHz at Benghazi city-Libya. dB=Decibel & μv=microvolts.

Local Time (Hours)	Summer Season				Winter Season			
	Signal Level [dB* (µv**)]				Signal Level [dB* (µv**)]			
	June	July	August	Median Value	December	January	February	Median Value
00								
02								
04								
06								
08								
10	35	30	15	**30**	50	45	50	**50**
12	40	25	15	**25**	55	55	45	**55**
14	20	20	15	**20**	40	40	45	**40**
16	35	15	5	**15**	35	30	20	**30**
18								
20								
22								

Table V. The signal level measurements of the received short wave with a frequency 11.785 MHz at Benghazi city-Libya. * dB=Decibel & ** µv=microvolts.

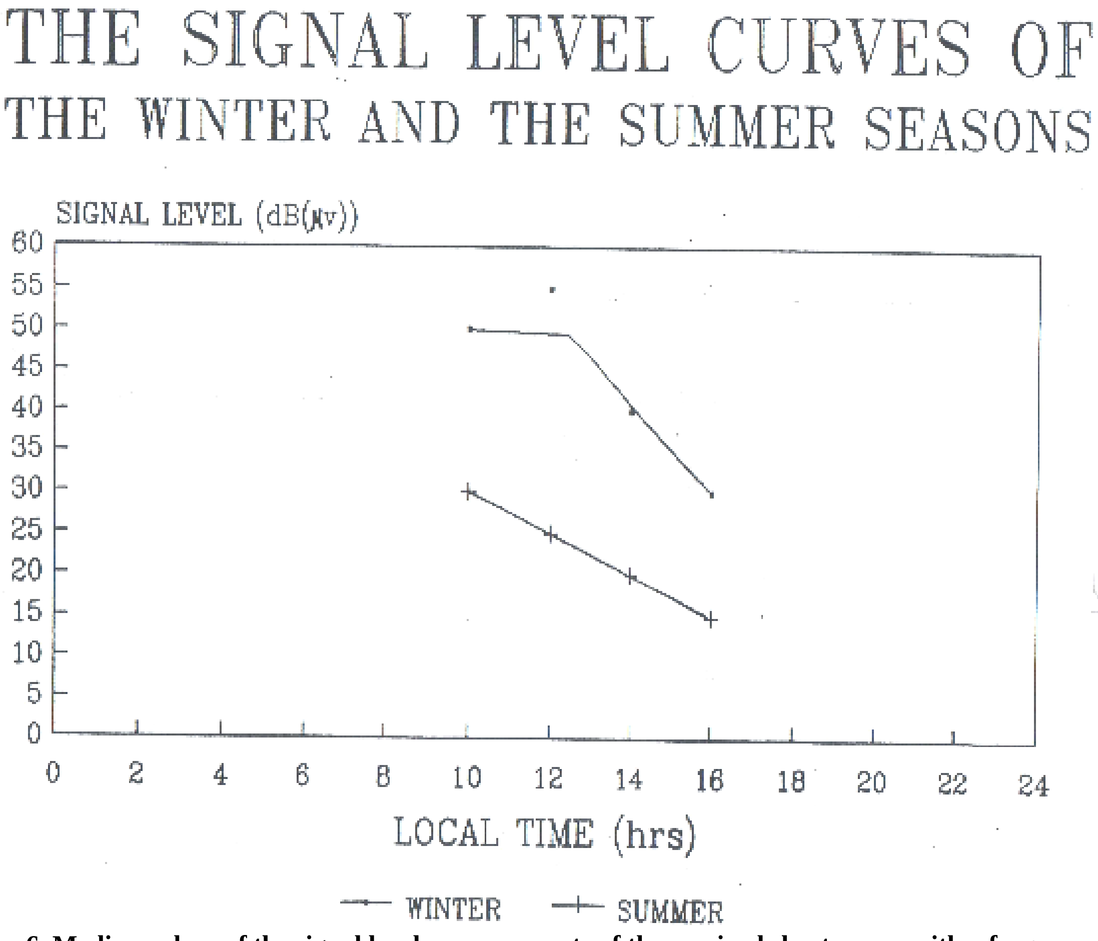

Figure 6. Median values of the signal level measurements of the received short waves with a frequency 11.785 MHz at Benghazi city-Libya. dB=Decibel & µv=microvolts

VI. CONCLUSION

The experimental work of this study has showed that:

(a) The received signal level decreased and consequently the attenuation increased as the span between the operating frequency and the predicted FOT increased.

(b) The received signal level increased and consequently the attenuation decreased as the operating frequency approached the predicted FOT.

(c) The attenuation of the received signal leve1 in the summer season is greater than the attenuation of the received signal level in the winter season.

(d) When the received signal-level decreased, the received message was low and when the received signal level increased, the received message was high.

(e) The signal level of the frequency 11.980 MHz was greater than the signal level of the frequency 11.785 MHz because the power of the first is greater than the power of the second.

(f) The study results point to the possible recommendation to change the frequencies 11.980, 11.785 MHz of the transmitted signals of the Egypt Arabic Republic broadcasting station with a power 250 KW, and 100 KW respectively according to the predicted FOT values of Table II during the time interval (12 - 16 hrs) in the winter season, and during the time intervals (10 - 16 hrs) to the frequency 11.785 MHz and (08 -10 hrs) to the frequency 11.980 MHz in the summer season to improve the quality service.

VII. ACKNOWLEDGMENT

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