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Evaluation and Analysis of Electromagnetic Field Strength of NTA Signal in Port Harcourt

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ABSTRACT

This research work presents the measurement of electromagnetic field strength conducted within the transmitter of Nigerian Television Authority Port Harcourt. The position of the transmitter was taken as the reference point for the measurement. The measuring was conducted in the North, South, West and East directions of the transmitter, with the first measuring point being one kilometer from the transmitter on both directions. The total measurement points were 52, which was 13 points from each of the directions with the transmitter as the reference point. The result of the research work showed that there was more signal loss in the direction of South than in the other directions, while signal transmission was best in the East direction of the transmitter. Terrain, diffraction and scattering of signal by obstacles, and signal reflections due to the earth surface were responsible for the low penetration of signal in certain directions.

INTRODUCTION

The worldwide development of thousands of terrestrial broadcasting networks over the past 90 years, depended crucially upon the prediction, analysis and measurement of radio field strength. In view of the importance of television broadcasting to the socio-economic development of the populace and the competition in the business in Nigeria, viewer's interest has grown from just watching anything on screen to qualitative, clean and sharp signals on television screen. Hence, this has prompted the need to research, by way of evaluating and analyzing the Electromagnetic Field Strength of Broadcasting Televisions stations like Nigeria Television Authority (NTA). Strength of Broadcasting Televisions stations like Nigeria Television Authority (NTA). Electromagnetic field strength can be defined as a quantitative measure of the strength of an electric field at a given point in space, equal to the force the field will induce on a unit of positive electric charge at that point. It can also be called electric field intensity. Electromagnetic radiation (EM radiation or EMR) refers to the waves (or their quanta, photons) of the electromagnetic field, propagating (radiating) through space, carrying electromagnetic radiant energy according to [1] It includes radio waves, microwaves, infrared, (visible) light, ultraviolet, X-rays, and gamma rays. A radio wave is an Electromagnetic wave which emanates from a radiating source. The radio wave assumes all the properties of a plane wave; the wave-front is the plane which contains the

Electric (E) and Magnetic (H) vectors and is at right angle to the direction of propagation and power flow. Usually, it is convenient to carry out studies in terms of the electric component, E of the wave, which is known as the electric field strength of the wave (Radio wave). Radio waves have the least amount of energy and the lowest frequency. When radio waves impinge upon a conductor, they couple to the conductor, travel along it and induce an electric current on the conductor surface by moving the electrons of the conducting material in correlated bunches of charge. Such effects can cover macroscopic distances in conductors (such as radio antennas), since the wavelength of radio waves is long. Electromagnetic radiation phenomena with wavelengths ranging from as long as one meter to as short as one millimeter are called microwaves; with frequencies between 300 MHz (0.3 GHz) and 300 GHz. The quantitative measure of the strength of an Electric field is known as the Electric field strength (Intensity) measurement as noted in [2]

The Nigerian Television Authority or NTA Port Harcourt is located at NTA Choba Road and transmits at a frequency of 98.5MHz, 210.25 MHz vision, 215.75MHzAudio and Channel: 10VHF. The radio signal is propagated using space wave propagation mode. The measurement of electromagnetic field strength of NTA Port Harcourt is signals at different locations, that is, locations due north South, West and East of the Transmitter respectively with 1Km interval will be carried out by using an automated mobile Band Scanner GPS system.

Review of Related Work

[3] conducted a study on the Signal Strength Variation and Propagation Profiles of UHF Radio Wave Channel in Ondo State, Nigeria. The study investigated the received signal strength and the propagation profiles for UHF channel 23, broadcast signal in Ondo State, Nigeria, at various elevation levels. The signal strength was measured quantitatively across the state along several routes with the aid of a digital field strength meter. A global positioning system (GPS) receiver was used to determine the elevation above ground level, the geographic coordinates and the line of sight of the various data points from the base station. Data obtained were used to plot the elevation and propagation profiles of the signal along measurement's routes. The results showed that the signal strength was strongest towards the northern parts with respect to distance compared to other routes with the same distance contrary to inverse square law.

[4] carried out a study that investigated the coverage areas of VHF and UHF signals from three television stations in Niger State, Nigeria, by quantitatively measuring the signal levels of these signals. The signal levels of the transmitters of Nigeria Television Authority (NTA), Minna, Channel 10, (210.25MHz); NTA, Kotangora, Channel 8, (196.25 MHz) and Niger State Television, Minna, Channel 25, (503.25 MHz), and the corresponding distances were measured along some radial routes with the transmitting stations at focus. These measurements were taken using Digital Signal Level Meter and

Global Positioning System (GPS). From the data obtained, Surfer 8 software application was used to draw contour maps of the signal levels around the transmitting stations to determine the coverage areas of the stations. The results obtained shows that the present configurations of the transmitters of the three television stations do not give an optimal coverage of the state. Only 25.82% of the entire land mass of the state has television signal coverage. Consequently, greater percentage of Niger State is completely out of television signal coverage.

[5] carried out a study on the Precipitation Effect on the Coverage Areas of Terrestrial UHF Television Stations in Ondo State, Nigeria. The research investigates the coverage areas of UHF television signals in Ondo State, Nigeria, and the effect of precipitation on signal strength through quantitative measurement of the electric field strength of these signals. The signal strength of the transmitters of the Ondo State Radiovision Corporation (OSRC), Akure, (CH 23, transmitting frequency of 487.25 MHz); OSRC, Oka Akoko, (CH 25, of transmitting frequency 503.25 MHz); and OSRC, Okitipupa, (CH 27, of transmitting frequency 519.25 MHz); were taken radially along several routes with the transmitting stations as reference. These measurements were taken using Digital Signal Level Meter, Dagatron TM 10 type and a GPS MAP 76– personal navigator for determining the geographical coordinates as well as the line of sight distances of the various data points from the base stations. Data were taken during the onset of raining season, period of intense rains and the early part of dry season around the towns and villages in all the Local Government Areas of the State as far as road accessibility permits until the signal faded away completely. For channels 23, 25 and 27. The study revealed that coverage areas of 53.5%, 10.0% and 9.0% respectively were possible with the present configuration of the transmitters over the Ondo State land mass during the onset of the raining season.

Historical Overview of Analogue Terrestrial Television

Terrestrial television is a type of television broadcasting in which the television signal is transmitted by radio waves from the terrestrial (Earth-based) transmitter of a television station to a TV receiver having an antenna. The term *terrestrial* is more common in Europe and Latin America, while in the United States it is called *broadcast* or **over-the-air television** (**OTA**). The term "terrestrial" is used to distinguish this type from the newer technologies of satellite television (direct broadcast satellite or DBS television), in which the television signal is transmitted to the receiver from an overhead satellite; cable television, in which the signal is carried to the receiver through a cable; and Internet Protocol television, in which the signal is received over an Internet stream or on a network utilizing the Internet Protocol. Terrestrial television stations broadcast on television channels with frequencies between about 52 and 600 MHz in the VHF and UHF bands. Since radio waves in these bands travel by line of sight, reception is generally limited by the visual horizon to distances of 40–60 miles (64–97 km), although under better conditions and with tropospheric ducting, signals can sometimes be received hundreds of miles distant errestrial television was the first technology used for television broadcasting. The BBC began broadcasting in 1929 and by 1930 many radio stations had a regular schedule of experimental television programmes. However, these early experimental systems had insufficient picture quality to attract the public, due to their mechanical scan technology, and television did not become widespread until after World War II with the advent of electronic scan television technology. The television broadcasting business followed the model of radio networks, with local television stations in cities and towns affiliated with television networks, either commercial (in the US) or government-controlled (in Europe), which provided content. Television broadcasts were in black and white until the transition to color television in the 1950s and 60s.

1950s saw the beginning of cable television and *community antenna television* (CATV). CATV was, initially, only a re-broadcast of over-the-air signals. With the widespread adoption of cable across the United States in the 1970s and 1980s, viewing of terrestrial television broadcasts has been in decline; in 2018, it was estimated that about 14% of US households used an antenna (Neilsen, 2013). However in certain other regions terrestrial television continue to be the preferred method of receiving television, and it is estimated by Deloitte as of 2020 that at least 1.6 billion people in the world receive at least some television using these means (Jacobson, 2019). The largest market is thought to be Indonesia, where 250 million people watch through terrestrial.

By 2019, over-the-top media service (OTT) which is streamed via the internet had become a common alternative (Jacobson, 2019).

MATERIALS AND METHOD

The materials used for this work included the following:

A Personal Computer

A Band Scanner

NTA Port Harcourt transmitter

EMF Meter

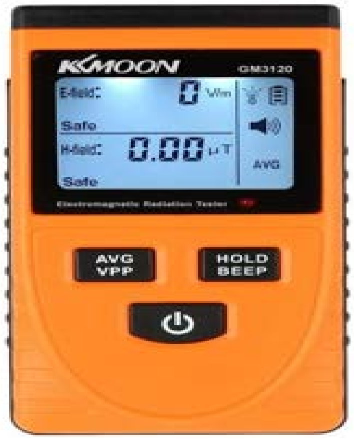

Figure 1: An EMF Meter

Method of Data Collection

The position of the transmitter of NTA Port Harcourt was taken as the reference point, and measurement was taken around the transmitter at different positions from the transmitter. The first measurement was taken approximately one kilometer (1km) away from the transmitter in the North, South, West, and East sides of the transmitter. The second (2nd) measurement was taken two kilometers (2km) away from the same NTA Port Harcourt transmitter, still in the North, South, West, and East directions of the transmitter. The third (3rd) measurement was taken approximately three kilometers (3km) away from the transmitter in the four directions, North, South, West, and East directions. The forth (4th) measurement was taken approximately four kilometer (4km) away from the same transmitter of NTA Port Harcourt. This measurement was also on the North, South, West, and East directions relative to the transmitter. The fifth (5th) measurement was taken approximately five kilometers (5km) away from the transmitter of NTA transmitter in Port Harcourt in the North, South, West, and in the East directions relative to the transmitter. The sixth measurement point was carried out six kilometers (6km) from the position of the transmitter in the directions of the North, South, West, and East. The seventh measurement taken in the directions of North, South, West, and East was seven kilometers from the transmitter and 1km from the previous measured point. In the North, South, West, and East directions to the eighth measurement was taken approximately eight kilometers from the transmitter and 1km from the seventh point. Then, the ninth point of measurement was at nine kilometers from the transmitter in the directions of North, South, West, and East, 1km from the eighth point. The tenth point of measurement was 10km due North, South, West, and East of the transmitter. At eleven kilometers in the directions of North, South, West, and East of the transmitter, the eleventh measurement was taken. The twelfth measurement position was 12km away from the transmitter in the direction due North, South, West, and East relative to the transmitter. The last measurement point, the thirteenth, was carried out 13km away from the transmitter due North, South, West, and East. The total points of measurement in the four directions, North, South, West, and East were 52 points, thirteen points from each direction.

Figure 2: Front View of NTA Transmitter

Table 1: Day 1 Measurement in the North Direction

S/NO	Time (S)	Received Power (kw)	Distance (Km)	Voltage (μV)
1	8:00 AM	10	1	45.6
2	8:30	10	2	48.8
3	9:00	10	3	51.9
4	9:30	10	4	49.6
5	10:00	10	5	52.8
6	10:30	10	6	52.3
7	11:00	10	7	51.7
8	11:30	10	8	50.6
9	12:00 PM	10	9	48.4
10	12:30	10	10	42.0
11	1:00	10	11	42.1
12	1:30	10	12	38.3
13	2:30	10	13	32.7

Table 2: Day 1 Measurement in the South Direction

S/NO	Time (S)	Received Power (kw)	Distance (Km)	Voltage (μV)
1	8:00 AM	10	1	52.0
2	8:30	10	2	52.7
3	9:00	10	3	51.6
4	9:30	10	4	52.2
5	10:00	10	5	53.9
6	10:30	10	6	50.7

7	11:00	10	7	48.6
8	11:30	10	8	44.3
9	12:00 PM	10	9	40.6
10	12:30	10	10	42.8
11	1:00	10	11	39.1
12	1:30	10	12	38.4
13	2:30	10	13	34.1

Table 3: Day 1 Measurement in the East Direction

S/NO	Time (S)	Received Power (kW)	Distance (KM)	Voltage (μV)
1	8:00 AM	10	1	46.6
2	8:30	10	2	48.8
3	9:00	10	3	51.2
4	9:30	10	4	52.3
5	10:00	10	5	46.8
6	10:30	10	6	48.2
7	11:00	10	7	50
8	11:30	10	8	51.9
9	12:00 PM	10	9	42.5
10	12:30	10	10	41.1
11	1:00	10	11	35.1
12	1:30	10	12	34.9
13	2:30	10	13	31.3

Table 4: Day 1 Measurement in the West Direction

S/NO	Time (S)	Received Power (kW)	Distance (KM)	Voltage (μV)
1	8:00 AM	10	1	45.8
2	8:30	10	2	47.3
3	9:00	10	3	49.9
4	9:30	10	4	50.3
5	10:00	10	5	51.7
6	10:30	10	6	52.3

7	11:00	10	7	44.7
8	11:30	10	8	42.6
9	12:00 PM	10	9	43.1
10	12:30	10	10	39.8
11	1:00	10	11	36.2
12	1:30	10	12	37.4
13	2:30	10	13	35.4

RESULT AND DISCUSSION

The result of the research work is presented in graphical form.

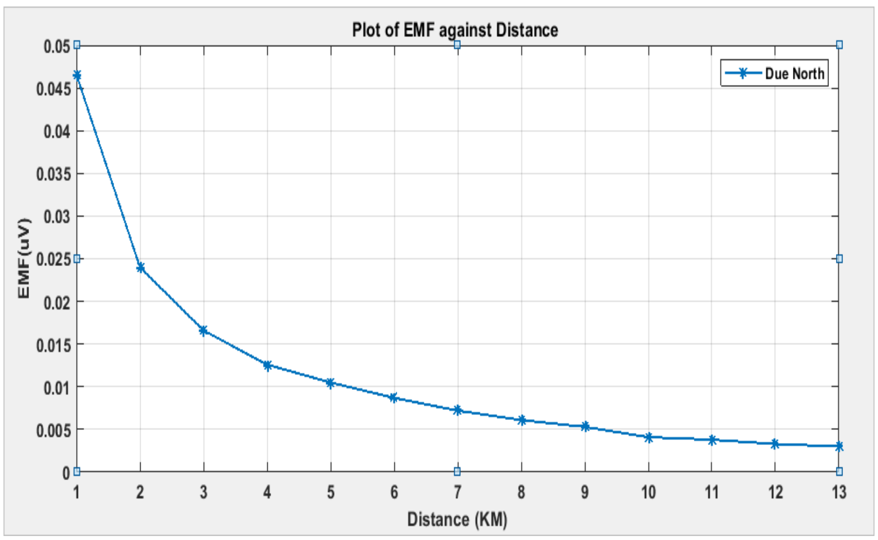

Figure 1: A Plot of EMF against Distance due North of NTA Port Harcourt Transmitter

Figure 1 is a plot of electromagnetic field strength against the distance from the NTA Port Harcourt transmitter in the north direction. As can be seen from the graph, the value of the electromagnetic force EMF decays with distance. Between 1km and 3km, a very sharp decay of the EMF was observed. However, beyond 3km distance from the transmitter, the decay in the value of the EMF was no longer sharp. A slight decay was observed. The highest value of signal strength was at 1km distance due north of the transmitter.

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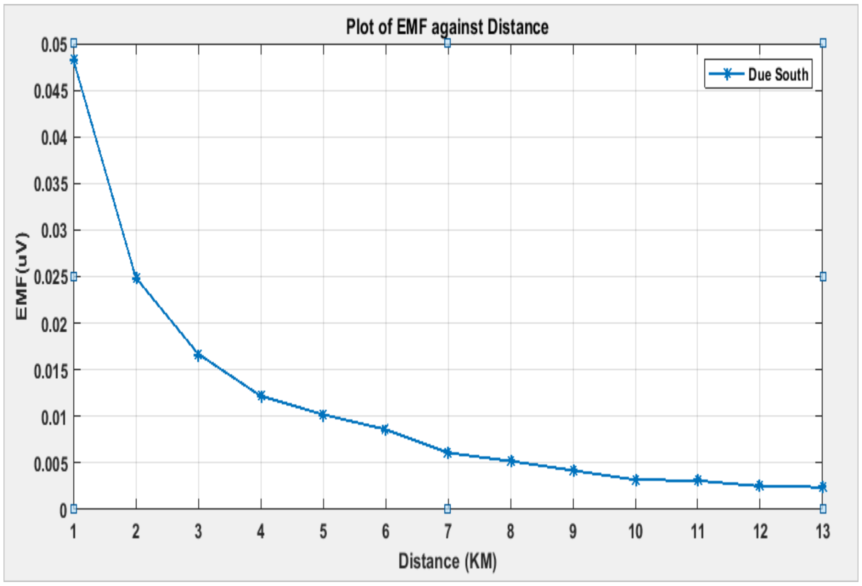

Figure 2: A Plot of EMF against Distance due South of NTA Port Harcourt Transmitter

Figure 2 presents a graph of electromagnetic field strength against the distance measured in kilometers from the NTA Port Harcourt transmitter. As can be deduced from the graph, the value of the electromagnetic force EMF sharply decays within 3km distance but slowly decays as one goes away from the transmitter. Between 1km and 3km, a very sharp decay of the EMF was observed. However, beyond 3km distance from the transmitter, the decay in the value of the EMF was no longer sharp. A slight decay was observed. The highest point of signal strength was at 1km distance due South of the transmitter while the least point of signal strength was at a distance 13km from the transmitter.

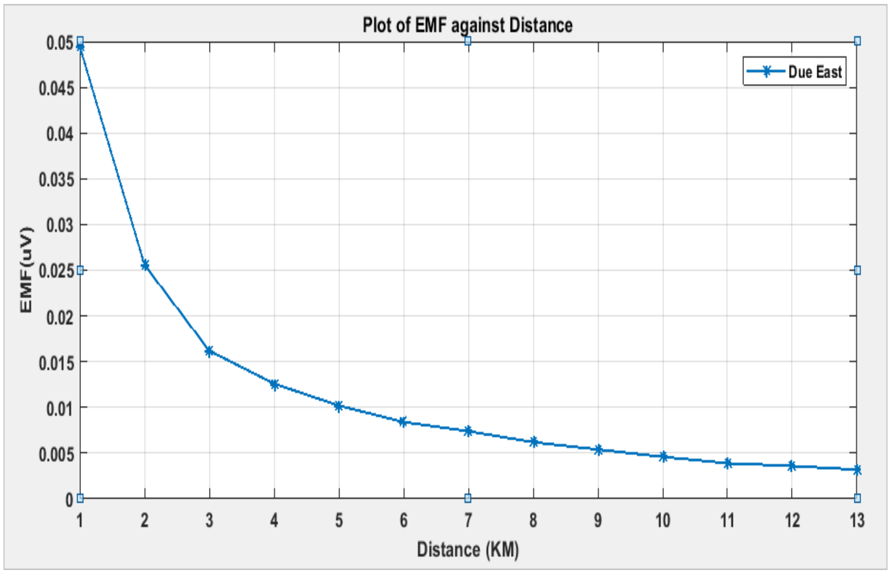

Figure 3: A Plot of EMF against Distance due East of NTA Port Harcourt Transmitter

Figure 3 is a plot of electromagnetic field strength against the the distance from the NTA Port Harcourt transmitter. The graph shows that the value of the electromagnetic force EMF is decreasing with distance. The decrease in the value of EMF, from the graph, is not the same throughout the distance covered. Between 1km and 3km, a very sharp decay of the EMF was observed. However, beyond 3km distance from the transmitter, the decay in the value of the EMF was no longer as sharp as it was.

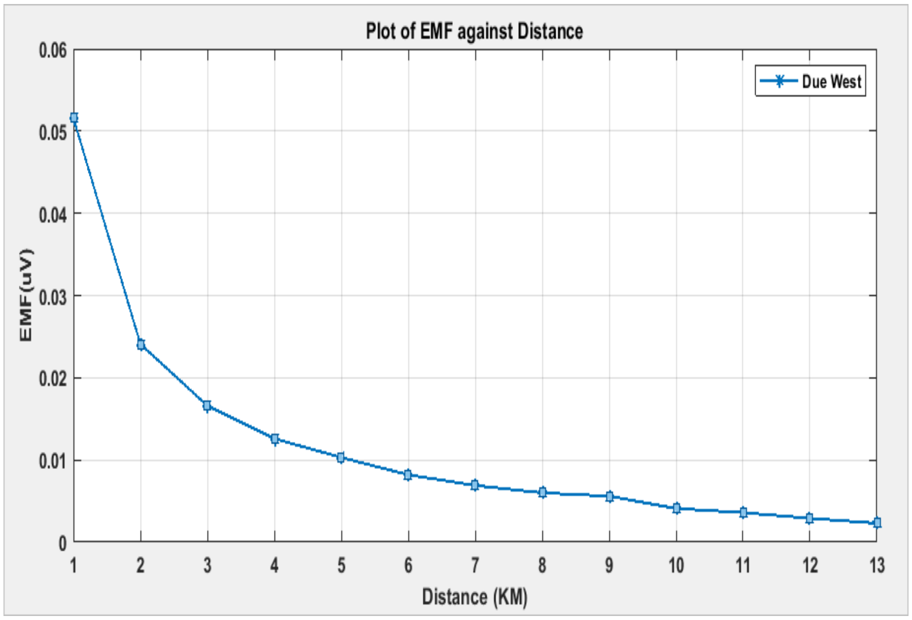

Figure 4: A Plot of EMF against Distance due West of NTA Port Harcourt Transmitter

Figure 4 is a presentation of the graph of electromagnetic field strength against the distance from the NTA Port Harcourt transmitter. Looking at the graph, it is observed that the value of EMF is not constant as distance increased, rather, increase in distance brought about a decrease in the value of the electromagnetic force EMF. At 13km due west of the transmitter, the value of the electromagnetic force was the least while at 1km die west, the value of the electromagnetic force EMF was highest. Again, as can be seen from the graph, the value of the electromagnetic force EMF decays with distance. Between 1km and 3km, a very sharp decay of the EMF was observed. However, beyond 3km distance from the transmitter, the decay in the value of the EMF was no longer sharp. A slight decay was observed.

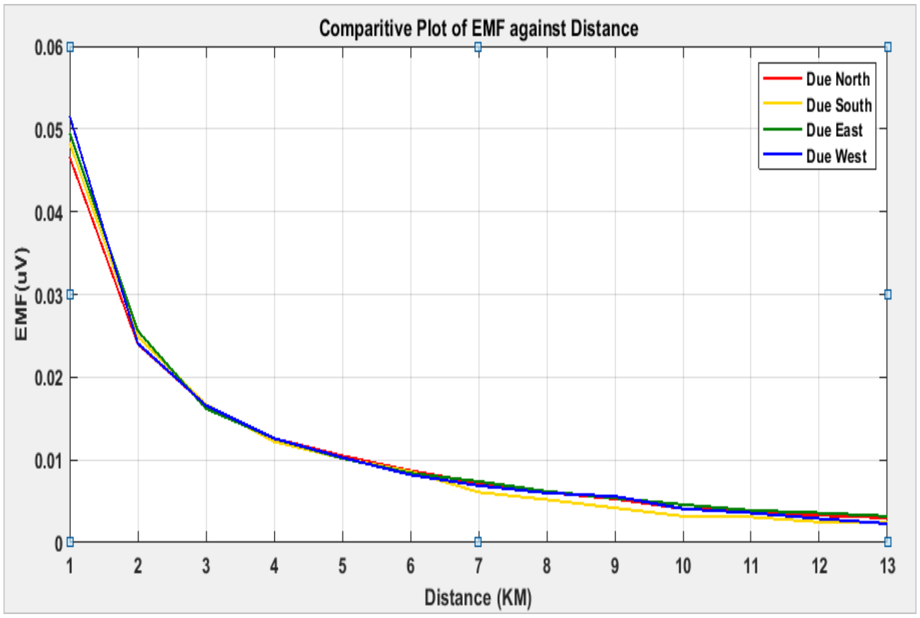

Figure 5: A Comparative plot of EMF against Distance due North, South, East and West.

The comparative graph of electromagnetic force against distance in the four directions of north, south, east and west is presented in figure 5. The graph reveals that the electromagnetic force EMF due west had the highest value at the distance of 1km and the least value of electromagnetic force at the distance of 13km. EMF due east had the second highest value at 1km distance but the highest value of EMF at 13km distance. Electromagnetic force EMF due South had the third highest value at 1km away from the transmitter and at 13km away from the transmitter it was the third highest in terms of value of EMF. Finally, EMF due north was the least in value at 1km distance, but at 13km distance it was the second highest in value. Therefore, it could be deduced from the comparative graph that the signal strenght for East direction was the best while the worst compared to others was the signal strength in the South direction of the transmitter.

CONCLUSION

The result obtained shows that some factors mitigated against the effectiveness of NTA transmitter at far distances away from the transmitter. Such factors include things like the terrain, signal reflection due to the earth surface, diffraction and scattering of signal by certain obstacles, parameters associated to the transmitter such as power of the transmitter, height of the transmitter and the Antenna Gain. That is the reason why at points closer to the transmitter, the value of electromagnetic field strength was high but the values got smaller and smaller as the distance from the transmitter increased. This research would then help operators of NTA Port Harcourt to improve its transmission to ensure customers satisfaction for using the services of

NTA Port Harcourt.

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