هيئة تنظيم الاتصالات
Telecommunications Regulatory Authority

Monitoring Radio Emissions from Base Stations of Public Operators in the Kingdom of Bahrain

Measurement mechanism and its scientific basis

A Report prepared and issued by the Telecommunications Regulatory Authority

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Purpose:

To present the mechanism of measuring RF field strength generated by the Base Stations of Public Operators in public and occupational areas in the Kingdom of Bahrain

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1. Introduction

1.1. The last decade has seen a rapid increase in the usage and development of radio technologies and as a result more and more base stations have been deployed in close proximities to public and occupational areas. This has resulted in concerns regarding radio frequency emissions.

1.2. There are numerous sources of such emissions for a variety of purposes, including: TV and Radio broadcasting, private/public companies and government entities operating radio communications systems, aeronautical and maritime communications or radar applications. In addition to these 'intentional radiators' there are also electronic or electrical systems which radiate electromagnetic fields (EMF) unintentionally, examples include: microwave ovens, computers, electricity power lines and associated sub-stations and transformers. And finally, there are naturally occurring sources of electromagnetic fields such as static discharges.

1.3. As per the condition stated in licenses granted by the Telecommunications Regulatory Authority of Kingdom of Bahrain (hereinafter the Authority), the public operators are required to ensure that emission from each radio installation is within the limits set by the International Commission for Non-losing Radiation Protection (ICNIRP) and to comply with any future radiation emission standards which may be set by ICNIRP, or have been or will be adopted in the Kingdom of Bahrain.

1.4. Article 3 (c) (4) of the Telecommunications Law gives the Authority the power to monitor and enforce compliance with License terms and conditions by Licensees.

1.5. The Public Commission for the protection of marine resources, environment and wildlife of the Kingdom of Bahrain, issued the order No. (4) of the Year 2009 with respect to regulation and monitoring of non-ionizing radiation emitted from electromagnetic fields which adopted the guidelines of the International Commission on Non-Ionizing Radiation Protection (ICNIRP). (Official Gazette, April 2,2009)

1.6. In 1992, the International Commission for Non Ionizing Radiation Protection (ICNIRP) was established to research and study the effects of non-ionizing radiation on human health. ICNIRP is an independent scientific organization that works purely on the basis of science and research with no consideration for any economical, commercial, social or political aspects.

1.7. ICNIRP provides its recommendations, guidelines, and research results to the World Health Organization (WHO), which adopts these recommendations and guidelines as a basis for its health regulations and notices concerning protection from EMF radiation.

1.8. Following extensive research, ICNIRP has produced guidelines setting out levels of non-ionizing radiation (which includes EMF radiation discussed above), at or below which, there is no scientific evidence to show any danger to human health. These levels have been accepted and adopted by the WHO.

1.9. It is important to note that the ICNIRP levels are based on experimental data to establish a level of exposure at which there is no scientific evidence to show any danger to human health and that this level is then reduced by a factor of 50 to establish the exposure limit for the general public.

1.10. In response to the increasing levels of concern regarding emissions, the Authority acquired equipment to measure (and compare with INCIRP guidelines) the ambient level of emissions produced by the base stations of public operators in public and occupational areas in Bahrain.

2. Objectives & Boundaries

Objectives:

2.1. To protect people from getting exposed to hazardous radiation.

2.2. To Continue TRA's role of monitoring the radiation level emitted from the licensees radio base stations.

2.3. To ensure that the licensees are in compliance with the terms of the license related to the level of emissions permitted.

Boundaries:

2.4. This project will be limited to measuring emissions of the 2G, 3G, 4G and WiMAX radio base stations.

2.5. This project is limited to measuring the electromagnetic fields that the general public is exposed to and not the workers.

3. Measurements Methodology

a. Mathematical calculations

In this comprehensive measurement exercise, the methodology of measuring the areas ambient to the telecom base stations (source of emission) was adopted instead of measuring random areas.

To determine the area surrounding the telecom base stations were potentially the emissions of base stations could exceed "acceptable field strength" values; an ITU propagation model (Rec. ITU-R P.525-2, propagation over free space) was considered and applied as follow:

Field strength for a given isotropically transmitted power is calculated by:
$E = P_t - 20\,log10\,d + 74.8$ ..... (1)
P_t: isotropically radiated power (dB(W))
E: electric field strength (dB(µV/m))
d : radio path length (km)

Reference levels for limiting exposure to electromagnetic fields for the general public according to Order No. (4) of the Year 2009 with respect to regulation and monitoring of non-ionizing radiation emitted from electromagnetic fields ..... (2)

Band (MHz)	Electrical Field Strength (V/m)	Electrical Field Strength dB(µV/m)**
900*	41	152.26
1800*	58	155.27
2100	61	155.7
3500	61	155.7

Table [1] "Reference levels for limiting exposure to electromagnetic fields"

*For the bands 900 and 1800 MHz, the lower edge of the down link was considered for calculating the field strength.

**The field strength is recalculated in dB(μV/m) for the sake of easiness in calculating the radio path from (1).

Equivalent Isotropically Radiated Power (Pt): Transmitter power (P_{tx}) + Antenna Gain (G_{max})

The transmitter power is assumed to be 60 Watts and the antenna gain is 17dBi. Normally the base station operates with a transmitting power of 20-30 Watts, however worst case scenario is assumed as a cautionary step towards covering all the possibilities. The 17 dBi antenna is a widely used antenna in mobile and fixed wireless access technologies in considered frequency bands.

$$P_{tx} = log10\ 60 = 17.78\ dBW$$
$$G_{max} = 17\ dBi$$
$$P_t = P_{tx} + G_{max} = 34.78\ dBW \quad \text{..... (3)}$$

From (1), (2) and (3), we can calculate the maximum distance the radiation can travel and still maintain its power to possibly exceed the acceptable levels of field strength as follow:

(Field strength related to 900 MHz band will be used as an example)

$$E = P_t - 20\ Log_{10}\ d + 74.8$$
$$20\ Log_{10}\ d = P_t - E + 74.8$$
$$d = 10^{\frac{P_t - E + 74.8}{20}} = 10^{\frac{34.78 - 152.26 + 74.8}{20}} = 0.00735\ km = 7.35\ m$$

After applying the same formulas for the remaining bands, we will have the following values for radius of potential risks around base stations:

Band (MHz)	Radius of potential risks around base stations (Meters)
900	7.35
1800	5.2
2100	4.5
3500	4.5

Table [2] "Bands & Distances of potential risks"

b. Field measurement

The measurement team will conduct the measurements in the areas and buildings adjacent to the telecom base stations' antennas within the distances mentioned in table 2. Each building will be examined for a period of 10 minutes. For the buildings with in-building-solutions (IBS) / distributed antenna systems, each story shall be measured separately regardless of the period required. The base stations that are going to be examined will be predefined and their locations will be provided for the measurement team prior to commencement of the measurements.