هيئة تنظيم الاتصالات
TELECOMMUNICATIONS REGULATORY AUTHORITY
Kingdom of Bahrain - مملكة البحرين

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

Measurement mechanism

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 proximity 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. It is also worth mentioning there are naturally occurring sources of electromagnetic fields such as static discharges.

1.3. As per conditions defined in licenses granted by the Telecommunications Regulatory Authority of Kingdom of Bahrain (hereinafter the Authority), licensed public operators are required to ensure that emissions from each radio installation are within the limits set by the International Commission for Non- losing Radiation Protection (ICNIRP) and are 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 order No.

1.6. (4) of the Year 2009 with respect to regulating and monitoring of non-ionizing radiation emitted from electromagnetic fields, where it adopted the guidelines of the International Commission on Non-Ionizing Radiation Protection (ICNIRP). (Official Gazette, April 2,2009)

1.7. In 1992, the International Commission for Non Ionizing Radiation Protection (ICNIRP) was formally 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.

1.8. 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.

1.9. 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.

1.10. ICNIRP exposure limits are based on experimental and epidemiological evidence identifying the lowest exposure level at which adverse health effects could occur. For public exposure, additional safety margins — reducing a factor of 50 — are applied to ensure protection for the General public.

1.11. In line with global best practices, the Authority uses specialized EMF measurement equipment to monitor ambient levels from telecom base stations and verify compliance with ICNIRP limits in both public and occupational areas in Bahrain.

2. Objectives & Boundaries

Objectives:

2.1. To continue The Authority's role of measuring and monitoring the radiation level emitted from the public operators radio base stations.

2.2. To ensure that licensed operators are in compliance with the terms of the license related to the level of emissions permitted.

Boundaries:

2.3. This project will be limited to measuring emissions from mobile frequency bands used by 2G, 3G, 4G and 5G technologies operating from radio base stations.

2.4. This project is limited to measure the field strength that the general public is exposed to.

3. Measurements Methodology

a. Mathematical calculations

In this comprehensive measurement exercise, the methodology of measuring the areas ambient to the telecom base stations was calculated to determine the area surrounding the telecom base stations where potentially the field strength could be at high 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 isotopically transmitted power is calculated by:

$E = P_t - 20\,log10\,d + 74.8$ ..... (1)

P_t: isotopically radiated power (dB(W))

E: electric field strength (dB(μV/m))

d : radio path length (km)

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

…… (2)

Band (MHz)	Electrical Field Strength (V/m)	Electrical field strength dB(μV/m)**
800*	38.7	151.7
900*	41.8	152.4
1800*	58.4	155.3
2100	61	155.7
2600	61	155.7
3500	61	155.7

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

*For the bands 800, 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 Isotopically 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 a base station operates with a transmitting power of 20-30 Watts, however, the worst case scenario is assumed as a cautionary measure to take into account all possibilities. Furthermore, 17 dBi antenna is a widely used antenna in mobile networks, therefore;

$P_{tx} = 10\ log\ 60 = 17.78\ dBW$

$G_{max} = 17\ dBi$

$P_t = P_{tx} + G_{max} = 34.78\ dBW$ …….. (3)

From (1), (2) and (3), we can determine the maximum distance the field strength can travel and still maintain its power to possibly be at high levels as follow:

(Field strength related to 800 MHz band will be used as an example)

$E = P_t - 20\ Log_{10}\ d + 74.8$

$20\ Log_{10}\ d = P_t - E + 74.8$

$d = 10^{\frac{P_t - E + 74.8}{20}} = 10^{\frac{34.78 - 151.7 + 74.8}{20}} = 0.00783\ km = 7.83\ m$

After applying the same formulas for the remaining bands, we can determine the following values for radius(s) of potential higher field strength values around base stations:

Band (MHz)	Radius of potential higher field strength (Meters)
800	7.83
900	7.23
1800	5.18
2100	4.94
2600	4.94
3500	4.94

Table [2] "Bands & Distances of potential high field strength"

b. Field measurement

The EMF measurement team conducts field measurements across the Kingdom of Bahrain's areas and locations, adjacent to telecom base stations' antennas within the distances that are reachable by the general public. Each (telecom base station/measurement location)* will be examined for a period of 6 minutes. The telecom base stations that are going to be examined will be predetermined and their locations will be provided to the measurement team prior to commencement of the measurements.

*Typically, a telecom base station consists of 3 sectors, providing coverage of 360 degrees. So each sector theoretically provides 120 degrees of coverage which is measured by the field team. However, in some conditions:

- 360 Degrees coverage is not needed due to the coverage requirements of a specific location, and therefore there is no need for all 3 sectors when setting up the base station.
- No direct view of the 3 sectors from the field due to condensed buildings

In these instances, the measurement team will still consider an examination time of 6 minutes based on the best location available to examine the field strength.