Order No. (4) of the Year 2009With Respect to Regulating and Monitoring ofNon-Ionizing Radiation emitted from Electromagnetic Fields

The President of the Public Commission for the Protection of Marine Resources, Environment and Wildlife,

Having reviewed Legislative Decree No. (21) of 1996 with respect to the Environment, as amended by Legislative Decree No. (8) of 1997,

And Decree No.(45) of 2002 with respect to the Appointment of a President of the Public Commission for the Protection of Marine Resources, Environment and Wildlife,

And Legislative Decree No. (48) of 2002 with respect to Promulgating the Telecommunications Law,

And Legislative Decree No. (50) of 2002 with respect to the Establishment of the Public Commission for the Protection of Marine Resources, Environment and Wildlife,

And Decree No. (10) of 2005 with respect to the Manner of the Exercise by the Public Commission for the Protection of Marine Resources, Environment and Wildlife of its Powers,

And Resolution No. (2) of 2001 with respect to Environmental Inspection Procedures and Nomination of the Necessary Officers to Undertake its Duties, as amended,

And Resolution of the Minister of Justice No. (4) of 2007 with respect to Empowering Some Officers of the Public Commission for the Protection of Marine Resources, Environment and Wildlife to become Judicial Officers,

And based on the proposal submitted by the Director General of the General Directorate for the Protection of the Environment and Wildlife,

Hereby Orders the Following:

Article (1):
Definitions

In the application of the provisions of this Order, the following words and expressions shall have the meanings assigned against each unless the context otherwise requires:

Non-Ionizing Radiation: Radiation which does not cause ionization of the material, for example ultraviolet rays, shortwave, radio frequencies, infrared rays. One of its most important sources is external base stations.

Antenna: The equipment for transmitting and receiving radiofrequency fields.

Basic restrictions: Restrictions on exposure to time-varying electric, magnetic, and electromagnetic fields that are based directly on established health effects. Depending upon the frequency of the field, the physical quantities used to specify these restrictions are current density (J), specific energy absorption rate (SAR), and power density (S). Since most basic restrictions cannot be measured outside a laboratory, to determine compliance with them, reference levels that are approximately equivalent to the basic restrictions are given. **Reference levels** can easily be measured with normal equipment outside the laboratory (see definition below).

Concerned Authorities: Any government authority, other than the General Directorate for the Protection of the Environment and Wildlife, to be referred within its powers and responsibilities with respect to the laws and orders which it enforces.

Current density (J): A vector of which the integral over a given surface is equal to the current flowing through the surface; the mean density in a linear conductor is equal to the current divided by the cross-sectional area of the conductor. Expressed in ampere per square meter (A/m^2).

Electric field strength (E): The force on a stationary unit positive charge at a point in an electric field; measured in volt per meter (V/m).

Electromagnetic Field (EMF): A physical entity carrying or storing energy in empty space and manifesting itself by exerting forces on electric charges. For purposes of this Order EMF includes time-varying electric, magnetic and electromagnetic fields with frequencies from > 0 to 300 GHz.

Equipment: Any equipment that deliberately emits electromagnetic fields as part of its intended purpose.

Exposure: The subjection of a person to electromagnetic fields other than those originating from physiological processes in the body and other natural phenomena.

Frequency: The number of sinusoidal cycles completed by electromagnetic waves in 1 s; usually expressed in hertz (Hz). 1 Hz = 1 cycle per second, 1kHz = 10^3 Hz, 1 MHz = 10^6 Hz and 1 GHz = 10^9 Hz.

Low frequency electric and magnetic fields: Electric and magnetic fields in the frequency range > 0 - 100 kHz

Magnetic field strength (H): An axial vector quantity which, together with magnetic flux density, specifies a magnetic field at any point in space, and is expressed in ampere per meter (A/m).

Magnetic flux density (B): A vector field quantity that results in a force that acts on a moving charge or charges, and is expressed in tesla (T). 1 T = 10^3 mT = 10^6 μT.

Power density (S): The power crossing a unit area normal to the direction of wave propagation; expressed in watt per square meter (W/m^2).

Worker exposure: All exposure to EMF experienced by individuals in the course of performing their work. Worker exposure occurs for the duration of the working day (normally 8 hr/day).

Public exposure: All exposure to EMF experienced by members of the general public, excluding workers exposure and exposure during medical procedures. Public exposure occurs for 24 hr/day.

Radiofrequency (RF) fields: Electromagnetic fields useful for telecommunication. The frequency range for RF fields for this Order is 100 kHz to 300 GHz

Reference levels: EMF exposure level provided for practical exposure assessment purposes to determine whether the basic restrictions are likely to be exceeded. Some reference levels are derived from relevant basic restrictions using measurement and/or computational techniques and some address perception and adverse indirect effects of exposure to EMF.

Root mean square (rms): Certain electrical phenomena is proportional to the square root of the mean of the square of a periodic function (over one period). This value is known as the effective, or root-mean-square (rms) value, since it is derived by first squaring the function, determining the mean value of the squares obtained, and taking the square root of that mean value.

Specific absorption (SA): The energy absorbed per unit mass of biological tissue, expressed in joule per kilogram (J/kg); specific energy absorption is the time integral of the specific absorption rate.

Specific Energy Absorption Rate (SAR): The rate at which energy is absorbed in body tissues, in watt per kilogram (W/kg); SAR is the dosimetric measure that has been widely adopted at frequencies above about 100 kHz.

Supporting Structure: The structure erected at ground level, or on or inside a building, for carrying one or more antennas.

Article (2):Order's Objective

Objective: This Order aims to regulate monitoring of exposure to electromagnetic fields by conducting regular and random inspections of equipment that emits electromagnetic fields. This is to ensure that the electromagnetic field emitting equipment and their installations comply with the environmental standards to protect the general public and

workers (in the course of performing work) from possible health effects of exposure to electromagnetic fields with frequencies between > 0 and 300 GHz. This order does not apply to electromagnetic field exposures received by patients during medical procedures.

Article (3):Environmental Conditions and Standards

A: Basic restrictions of exposure to time-varying electric, magnetic, and electromagnetic fields up to 300 GHz:

In all equipment emitting electromagnetic fields in the frequency range >0 to 300 GHz, the specific energy absorption rate (SAR) or power density (S) of its electromagnetic fields in all cases shall not exceed the basic restrictions given in Annexes 1 and 2 attached to this Order.

B: Low frequency electric and magnetic fields reference levels (up to 100 kHz):

If equipment emitting low frequency electric and magnetic fields in the frequency range up to 100 kHz, these fields strength shall not exceed the reference levels given in Annex 3 attached to this Order unless it can be shown that these reference levels do not exceed the basic restrictions as set out in Annex 1 attached to this Order

C: Radiofrequency fields reference levels (from 100 kHz to 300 GHz:
Radiofrequency field emitting equipment shall be subject to the following:

1. If equipment emitting radiofrequency radiation in the frequency range from 100 kHz to 300 GHz, electric and magnetic fields strength and/or power density shall not exceed the reference levels given in Annex 3 unless it can be shown that these reference levels do not exceed the basic restrictions (Annexes 1 and 2).
2. Any antenna fixed on or inside buildings shall be located in a place high enough to ensure that there is no public access to areas above the relevant exposure limits given in Annex 3.
3. Antennas' locations and heights shall be determined according to the environmental standards and requirements and to the standards approved by the Environmental Monitoring Directorate at the General Directorate for the Protection of the Environment and Wildlife.

Article (4):

Basic restrictions and reference levels for the general public and workers exposed to electromagnetic fields given in Annexes 1, 2 and 3 shall depend on the document issued by the International Commission on Non-Ionizing Radiation Protection (**ICNIRP)** in 1998 entitled**: "**Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz)". Therefore, these Annexes shall be updatable according to the ICNIRP's updates and to the scientific and technical development and any other researches in this field.

Article (5):
Registration of EMF devices

All industries or establishments using devices that can expose either workers or the general public to electromagnetic fields must register their EMF emitting devices with the Environmental Monitoring Directorate at the General Directorate for the Protection of the Environment and Wildlife within one year of publication of this Order.

Article (6):
Inspections

The Environmental Monitoring Directorate at the General Directorate for the Protection of the Environment and Wildlife shall undertake periodic inspection and monitoring of equipment and places of its installation to ensure that they are in compliance with the environmental standards and requirements mentioned in this Order. Authorities using this equipment shall permit the staff of the mentioned Directorate to inspect this equipment, request information and edit minutes.

Article (7):

Recordkeeping

The Environmental Monitoring Directorate at the General Directorate for the Protection of the Environment and Wildlife shall maintain all records of EMF emitting devices in the Kingdom of Bahrain and the results of any inspections conducted to determine compliance with this Order.

Article (8):

Subject to the provisions of Article (26) of the Environment Law promulgated by Legislative Decree No.21 of 1996, the penalties provided for in Article 29 thereof shall be inflicted upon everyone engaged in the activities subject to its provisions that violate the provisions of this Order.

Article (9):

The Director General of the General Directorate for the Protection of the Environment and Wildlife shall implement this Order, which shall come into effect one year after the date of its publication in the Official Gazette. **Abdulla bin Hamad bin Essa Al Khalifa PresidentPublic Commission for the Protectionof Marine Resources, Environment and WildlifeIssued on 27 Rabie Al Awal 1430 Hijra Corresponding to 24 March 2009 AD**

Annex (1)
Basic restrictions for radiofrequency fields up to 10 GHz[a]

Exposure	Frequency range	Current density for head and trunk (mA/m^2) (rms)	Whole body SAR (W/kg)	SAR (head and trunk) (W/kg)	SAR (limbs) (W/kg)
Workers	Up to 1 Hz	40	---	---	---
	1-4 Hz	40/f	---	---	---
	4 Hz-1 kHz	10	---	---	---
	1-100 kHz	f/100	---	---	---
	100 kHz-10 MHz	f/100	0.4	10	20
	10 MHz-10 GHz	---	0.4	10	20
Public	Up to 1 Hz	8	---	---	---
	1-4 Hz	8/f	---	---	---
	4 Hz-1 kHz	2	---	---	---
	1-100 kHz	f/500	---	---	---
	100 kHz-10 MHz	f/500	0.08	2	4
	10 MHz-10 GHz	---	0.08	2	4

Notes:
1. f is the frequency in hertz.
2. Because of electrical inhomogeneity of the body, current densities should be averaged over a cross-section of 1 cm^2 perpendicular to the current direction.
3. For frequencies up to 100 kHz, peak current density values can be obtained by multiplying the rms value by $\sqrt{2}$ (≈1.414). For pulses of duration t_p the equivalent frequency to apply in the basic restrictions should be calculated as $f = 1/(2t_p)$.
4. For frequencies up to 100 kHz and for pulsed magnetic fields, the maximum current density associated with the pulses can be calculated from the rise/fall times and the maximum rate of change of magnetic flux density. The induced current density can then be compared with the appropriate basic restriction.
5. All SAR values are to be averaged over any 6-min period.
6. Localized SAR averaging mass is any 10 g of contiguous tissue; the maximum SAR so obtained should be the value used for the estimation of exposure.
7. For pulses of duration t_p the equivalent frequency to apply in the basic restrictions should be calculated as $f = 1/(2t_p)$. Additionally, for pulsed exposures in the frequency range 0.3 to 10 GHz and for localized exposure of the head, in order to limit or avoid auditory effects caused by thermoelastic expansion, an additional basic restriction is recommended. This is that the SA should not exceed10 mJ/kg for workers and 2 mJ/kg for the general public, averaged over 10 g tissue.

Annex (2)
Basic restrictions for radiofrequency fields between 10 and 300 GHz[a]

Exposure	Power density (W/m^2)
Workers	50
General public	10

Notes:
1. Power densities are to be averaged over any 20 cm^2 of exposed area to the electromagnetic field and any $68/f^{1.05}$-min period (where f is in GHz) to compensate for progressively shorter penetration depth as the frequency increases.
2. Spatial maximum power densities, averaged over 1 cm^2, should not exceed 20 times the values above.

Annex (3)
Reference levels for limiting exposure to electromagnetic fields for workers and the general public

Type of Exposure	Frequency Range	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Magnetic Flux Density (B) (μT)	Power Density (S_{eq}) (W/m^2)
Workers	Up to 1 Hz	---	$1.63x10^5$	$2x10^5$	---
	1-8 Hz	20,000	$1.63x10^5/f^2$	$2x10^5/f^2$	---
	8-25 Hz	20,000	$2x10^4/f$	$2.5x10^4/f$	---
	0.025-0.82 kHz	500/f	20/f	25/f	---
	0.82-65 kHz	610	24.4	30.7	---
	0.065-1 MHz	610	1.6/f	2.0/f	---
	1-10 MHz	610/f	1.6/f	2.0/f	---
	10-400 MHz	61	0.16	0.2	10
	400-2000 MHz	$3f^{1/2}$	$0.008f^{1/2}$	$0.01f^{1/2}$	f/40
	2-300 GHz	137	0.36	0.45	50
General Public	Up to 1 Hz	---	$3.2x10^4$	$4x10^4$	---
	1-8 Hz	10,000	$3.2x10^4/f^2$	$4x10^4/f^2$	---
	8-25 Hz	10,000	4,000/f	5,000/f	---
	0.025-0.8kHz	250/f	4/f	5/f	---
	0.8-3 kHz	250/f	5	6.25	---
	3-150 kHz	87	5	6.25	---
	0.15-1 MHz	87	0.73/f	0.92/f	---
	1-10 MHz	$87/f^{1/2}$	0.73/f	0.92/f	---
	10-400 MHz	28	0.073	0.092	2
	400-2000 MHz	$1.375f^{1/2}$	$0.0037f^{1/2}$	$0.0046f^{1/2}$	f/200
	2-300 GHz	61	0.16	0.2	10

Notes:
1. f is the frequency indicated in the frequency range column.
2. For frequencies between 100 kHz and 10 GHz, S_{eq}, E^2, H^2, and B^2 are to be averaged over any 6-min period
3. For frequencies exceeding 10 GHz, S_{eq}, E^2, H^2, and B^2 are to be averaged over any $68/f^{1.05}$-min period (f in GHz).

Reference

1. **ICNIRP (1998):** International Commission on Non-Ionizing Radiation Protection.
2. Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz).
3. Health Phys 74:494 –522; 1998.