

## **GOVERNMENT NOTICE**

### **MINISTRY OF HEALTH AND SOCIAL SERVICES**

No.

2015

#### **ELECTROMAGNETIC FIELDS EXPOSURE REGULATIONS: ATOMIC ENERGY AND RADIATION PROTECTION ACT, 2005**

Under section 43(1) of the Atomic Energy and Radiation Protection Act, 2005 (Act No. 5 of 2005), on the recommendation of the Atomic Energy Board, I have made the regulations set out in the Schedule.

**Dr. Bernhard Haufiku**

**Minister of Health and Social Services**

**Windhoek,**

**2018**

#### **SCHEDULE**

##### **ARRANGEMENT OF REGULATIONS**

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## **Definitions**

1. In these regulations a word or an expression to which a meaning has been assigned in the Act has that meaning and unless the context otherwise indicates -

“adverse health effect” means a biological effect that has a short or long term detrimental effect on mental, physical or general wellbeing of exposed people;

“basic restrictions” means restrictions on exposure to electric, magnetic and electromagnetic fields that are based on established health effects and depending on the frequency of the electromagnetic field the physical quantities used to specify these restrictions are current density (J), specific energy absorption rate (SAR), and power density (S), and only power density in air and outside the body can be readily measured in exposed individuals;

“compliance” means conformity with the requirements of the Act or a regulation made in terms of the Act;

“declaration of compliance” means a document signed by a supplier or manufacturer that attests that the device or installation to which the declaration refers meets the requirements of the Act;

“device” means a manufactured product that produces electromagnetic field;

“electromagnetic fields” means a physical entity carrying or storing energy in empty space and manifesting itself by exerting forces on electric charges which includes static electric and magnetic fields as well as time-varying electric, magnetic and electromagnetic fields with frequencies in the range 0 to 300GHz;

“electro-medical equipment” means electrical devices, instruments or prostheses employed to investigate or treat patients under medical supervision;

“equipment” means manufactured industrial, commercial, consumer or medical products that produce electromagnetic fields;

“exposure” means the subjection of a person to electric, magnetic or electromagnetic fields or to contact currents other than those originating from physiological processes in the body and other natural phenomena;

“exposure limit” means an upper limit placed on human exposure to electromagnetic fields to protect against adverse physiological responses that are causally related to the fields which limits are not intended to provide protection against other effects such as psychological arising from fear of such exposures.

“health” means a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity;

“installation” means a construction that incorporates a source of electromagnetic fields;

“owner” means the person or company who owns, or is responsible for, the operation of an installation emitting EMF into the environment or workplace;

“phantom” means a physical model containing tissue-equivalent material used to imitate the body in an experimental dose measurement;

“public” means a person who is not a worker, member of the military or a patient under medical care;

“public exposure” means the exposure of public to electromagnetic fields, excluding occupational exposure and exposure during medical procedures;

“reference level” means the electromagnetic fields exposure level provided for practical exposure assessment purposes to determine whether the basic restrictions are likely to be exceeded which some of the reference levels are derived from relevant basic restrictions using measurement or computational techniques and some address perception and adverse indirect effects of exposure to electromagnetic field;

“sources” means devices or installations that produce electromagnetic fields;

“surveillance” means to monitor human exposure to electromagnetic fields or to monitor an electromagnetic fields emitting source;

“the Act” means the Atomic Energy and Radiation Protection Act, 2005 (Act No. 5 of 2005);

“trained worker” means an employee or self-employed individual who is exposed to electromagnetic fields exposure at work and who receives any necessary information and training about the electromagnetic fields protective measures; and

“worker” means a person who works and who has recognised rights and duties in relation to occupational radiation protection (as defined in the Act with reference to ionising radiation)

## **Purpose**

2. (1) The purpose of these regulations is -
  - (a) to protect the public and workers from adverse health effects arising from exposure to electromagnetic fields in the living or working environment;
  - (b) to set electromagnetic fields exposure limits for -
    - (i) the public in areas that are exposed to electromagnetic field and to which the public have access; and
    - (ii) workers in the work place where the work place is exposed to an electromagnetic field.
  - (c) to establish limits on human exposure to electromagnetic fields, which limits provide protection against the known adverse health effects from any installation or device emitting the electromagnetic fields.

- (d) to establish minimum requirements for the protection of the public and workers from health risk arising or likely to arise from being exposed to electromagnetic fields in the frequency range 0 to 300 GHz.

### **Prescribed Non-ionizing Radiation Sources**

3. These regulations apply to sources which emit electromagnetic fields in the frequency range 0 to 300 GHz.

### **Electromagnetic fields exposure limits**

(1) The guidelines by the International Commission on Non-Ionizing Radiation Protection(ICNIRP), **GUIDELINES FOR LIMITING EXPOSURE TO TIME-VARYING ELECTRIC, MAGNETIC, AND ELECTROMAGNETIC FIELDS (UP TO 300 GHz)**, with respect to Basic Restrictions and Reference Levels are adopted as the relevant electromagnetic fields exposure limits for the purposes of these regulations.

(2) The Authority must ensure that any installation or device that emits electromagnetic fields complies with the exposure limits contemplated in subregulation (1) and must designate appropriate measures to ensure compliance.

(3) The Authority must implement the relevant recommendations of the International Commission on Non-Ionizing Radiation Protection, the necessary compliance measures as well as any other requirements that gives effect to the relevant provisions of the Act.

(4) In these regulations there are two kinds of electromagnetic fields exposure limits-

(a) the basic restrictions that must always be complied with; and

- (b) reference levels that may be exceeded provided that the basic restrictions are not exceeded.
  
- (5) The electromagnetic fields exposure limits for the -
  - (a) basic restrictions for public exposure in areas to which the public have access are set out in Table 1 of the Annexure; Table 1 as adopted from ICNIRP guidelines
  - (b) reference levels for public exposure in areas to which the public have access are as set out in Table 2 of the Annexure;
  - (c) basic restrictions for trained workers in their work are as set out in Table 3 of the Annexure; and
  - (d) reference levels for trained workers in their occupation are as set out in Table 4 of the Annexure.

## **Compliance**

**4.** (1) The Authority, in designating appropriate compliance arrangements under Regulation 4(2), may -

- (a) determine the surveillance requirements to measure or calculate and monitor the exposures of the public and workers;
- (b) determine the mitigating actions where sources are not in compliance with the electromagnetic fields exposure limits;
- (c) require the measurement and monitoring of sources of electromagnetic fields; or

(d) include any other measure necessary to ensure compliance with the exposure limits.

(2) In addition to the provisions of Regulation 4 (1) the Authority may require a manufacturer, supplier, importer, installer or operator of any installation to demonstrate compliance with the exposure limits by means of measurement, declaration of compliance or by a certificate of compliance by an external expert referred to in section 37 of the Act.

(3) The Authority, in establishing compliance procedures, must take into account any relevant agreements relating to the mutual recognition and acceptance of testing of products emitting electromagnetic field.

### **Public exposure protection**

5. (1) Areas to which members of the public have access and in or at which the electromagnetic field exposure is at or below the reference levels set out in Table 2 of the Annexure complies with these regulations.

(2) Areas to which members of the public have access and in or at which the reference levels set out in Table 2 are exceeded, an evaluation must be undertaken by the operator to establish if the electromagnetic field exposures exceed the basic restrictions.

(3) Areas to which members of the public have access and in or at which electromagnetic fields exposure is at or below the basic restrictions set out in Table 1 of the Annexure complies with these regulations.

(4) Areas to which members of the public have access and in or at which electromagnetic exposure exceeds the basic restrictions set out in Table 1 of the Annexure are not in compliance with these regulations and such area is subject to the measures specified in Regulation 7 of this regulations.

(5) The following categories of workers must have their exposures to electromagnetic field in their working environment subject to the same limits as those applicable to members of the public, namely basic restrictions as set out in Table 1 of the Annexure and reference levels as set out in Table 2 of the Annexure:

- (a) workers who share the same area or environment with the public by virtue of the nature of the service being provided to the public;
- (b) women who have informed their employer of their pregnancy;
- (c) workers who have metallic prostheses, cardiac pacemakers, defibrillators and other electro-medical devices that are known to suffer adverse interference from the electromagnetic field exposure levels; or
- (d) workers who have not received appropriate training regarding workplace procedures in areas where the basic restrictions, set out in Table 1 of the Annexure, may be exceeded.

### **Occupational exposure protection**

6. (1) Workplaces at which workers, other than those in the worker categories listed in Regulation 5 (5), are exposed to electromagnetic field at or below the reference levels set out in Table 4 of the Annexure comply with these regulations.

(2) For workplaces at which workers, other than those in the worker categories listed in Regulation 5 (5), are exposed to electromagnetic field that exceeds the reference levels set out in Table 4 of the Annexure an evaluation must be undertaken by the operator to establish if the electromagnetic field exposures exceed the basic restrictions.

(3) If the electromagnetic field exposure is at or below the basic restrictions set out in Table 3 of the Annexure, such workplace is in compliance with these regulations.

(4) Workplaces at which workers, other than those in the worker categories listed in Regulation 5 (5), are exposed to electronic field in excess of the basic restrictions set out in Table 3 of the Annexure, do not comply with these regulations and are subject to the measures set out in Regulation 7.

### **Applications, Registration, Licensing, Inspection and Enforcement**

7. Provision for the above are as stipulated in the Atomic Energy and Radiation Protection Act, chapter 4 and 5.

### **Reporting and management**

8. (1) All measurements or evaluations to establish compliance with these regulations must be made or authorised by the Authority.

(2) After the Authority has measured or evaluated under subregulation (1) and where the electromagnetic field exposure level is not subsequently increased, the result of the measurement and evaluation remains valid for a duration determined by the Authority.

(3) The verification of compliance is based on the conditions that lead to the highest electromagnetic field exposure, worst-case conditions, produced under normal operating conditions and employ appropriate internationally recognised measurement and evaluation protocols.

(4) If measurements are not made under worst-case conditions, the electromagnetic field exposure for the worst-case conditions is calculated or extrapolated on the basis of the measured values and measurements or calculations must take account of exposures to multiple sources and multiple frequencies using the appropriate protocols. Projections of beyond the limit

(5) The measurements or evaluations may be required following any changes likely to significantly increase the electromagnetic field exposure to the public or workers such as additions of equipment or installations generating the electromagnetic field in an area.

(6) The measurement or evaluation methods are those developed by international standards setting agencies such as the International Electrotechnical Commission (IEC), European Committee for Electrotechnical Standardization (CENELEC) or Institute of Electrical and Electronics Engineers (IEEE).

ANNEXURE

Table 1: Basic Restrictions – Public Exposure

Table 2: Reference Levels – Public Exposure

Table 3: Basic Restrictions – Occupational Exposure

Table 4: Reference Levels - Occupational Exposure

**Basic Restrictions and Reference Levels, Tables 1 – 4.**

**Table 1.**

**Basic Restrictions – Public Exposure**

(Basic restrictions for time varying electric and magnetic fields for frequencies up to 10 GHz)

Exposure characteristics	Frequency range	Current density for head and trunk (mA m <sup>-2</sup> ) (rms)	Whole-body average SAR (W kg <sup>-1</sup> )	Localized SAR (head and trunk) (W kg <sup>-1</sup> )	Localized SAR (limbs) (W kg <sup>-1</sup> )
General public exposure	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

Basic restrictions for power density for frequencies between 10 and 300 GHz.

Exposure characteristics	Power density (W m <sup>-2</sup> )
General public	10

Note (a):

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<sup>2</sup> 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 exceed 10 mJ kg<sup>-1</sup> for workers and 2mJ kg<sup>-1</sup> for the general public, averaged over 10 g tissue.

Note (b):

1. Power densities are to be averaged over any 20 cm<sup>2</sup> of exposed area 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<sup>2</sup>, should not exceed 20 times the values above.

**Table 2.**  
**Reference Levels – Public Exposure**

(Reference levels for general public exposure to time-varying electric and magnetic fields  
(unperturbed rms values))

Frequency range	E-field strength(V m <sup>-1</sup> )	H-field strength (A m <sup>-1</sup> )	B-field (μT)	Equivalent plane wave power density Seq (W m <sup>-2</sup> )
up to 1 Hz	—	3.2 x 10 <sup>4</sup>	4 x 10 <sup>4</sup>	—
1–8 Hz	10,000	3.2 x 10 <sup>4</sup> /f <sup>2</sup>	4 x 10 <sup>4</sup> /f <sup>2</sup>	—
8–25 Hz	10,000	4,000/f	5,000/f	—
0.025–0.8 kHz	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 <sup>1/2</sup>	0.73/f	0.92/f	—
10–400 MHz	28	0.073	0.092	2
400–2,000 MHz	1.375f <sup>1/2</sup>	0.0037f <sup>1/2</sup>	0.0046f <sup>1/2</sup>	f/200
2–300 GHz	61	0.16	0.20	10

Note:

1.  $f$  as indicated in the frequency range column.
2. Provided that basic restrictions are met and adverse indirect effects can be excluded, field strength values can be exceeded.
3. For frequencies between 100 kHz and 10 GHz, Seq, E2, H2, and B2 are to averaged over any 6-min period.
4. For peak values at frequencies up to 100 kHz see Table 4, note 3.
5. For peak values at frequencies exceeding 100 kHz see Figs. 1 and 2. Between 100 kHz and 10 MHz, peak values for the field strengths are obtained by interpolation from the 1.5-fold peak at 100 kHz to the 32-fold peak at 10 MHz. For frequencies exceeding 10 MHz it is suggested that the peak equivalent plane wave power density, as averaged over the pulse

width does not exceed 1,000 times the  $S_{eq}$  restrictions, or that the field strength does not exceed 32 times the field strength exposure levels given in the table.

6. For frequencies exceeding 10 GHz,  $S_{eq}$ , E2, H2, and B2 are to be averaged over any  $68/f$  1.05-min period ( $f$  in GHz).
7. No E-field value is provided for frequencies, 1 Hz, which are effectively static electric fields. Perception of surface electric charges will not occur at field strengths less than 25 kV/m<sup>21</sup>. Spark discharges causing stress or annoyance should be avoided.

**Table 3.**

**Basic Restriction Levels – Occupational Exposure**

(Basic restrictions for time varying electric and magnetic fields for frequencies up to 10 GHz – Occupational Exposure).

Exposure characteristics	Frequency range	Current density for head and trunk (mA m <sup>-2</sup> ) (rms)	Whole-body average SAR (W kg <sup>-1</sup> )	Localized SAR (head and trunk) (W kg <sup>-1</sup> )	Localized SAR (limbs) (W kg <sup>-1</sup> )
Occupational exposure	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

Basic restrictions for power density for frequencies between 10 and 300 GHz.

Exposure characteristics	Power density (W m <sup>-2</sup> )
Occupational exposure	50

Note:

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<sup>2</sup> 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 exceed 10 mJ kg<sup>-1</sup> for workers and 2mJ kg<sup>-1</sup> for the general public, averaged over 10 g tissue.
8. Power densities are to be averaged over any 20 cm<sup>2</sup> of exposed area and any  $68/f$  1.05-min period (where  $f$  is in GHz) to compensate for progressively shorter penetration depth as the frequency increases.
9. Spatial maximum power densities, averaged over 1 cm<sup>2</sup>, should not exceed 20 times the values above.

**Table 4****Reference Levels – Occupational Exposure**

(Reference levels for occupational exposure to time-varying electric and magnetic fields  
(unperturbed rms values).

Frequency range	E-field strength (V m <sup>-1</sup> )	H-field strength(A m <sup>-1</sup> )	B-field (μT)	Equivalent plane wave power density Seq (W m <sup>-2</sup> )
up to 1 Hz	—	1.63 x 10 <sup>5</sup>	2 x 10 <sup>5</sup>	—
1–8 Hz	20,000	1.63 x 10 <sup>5</sup> /f <sup>2</sup>	2 x 10 <sup>5</sup> /f <sup>2</sup>	—
8–25 Hz	20,000	2 x 10 <sup>4</sup> /f	2.5 x 10 <sup>4</sup> /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
400–2,000 MHz	3f <sup>1/2</sup>	0.008f <sup>1/2</sup>	0.01f <sup>1/2</sup>	f/40
2–300 GHz	137	0.36	0.45	50

Note:

1.  $f$  as indicated in the frequency range column.
2. Provided that basic restrictions are met and adverse indirect effects can be excluded, field strength values can be exceeded.
3. For frequencies between 100 kHz and 10 GHz, Seq, E2, H2, and B2 are to be averaged over any 6-min period.
4. For peak values at frequencies up to 100 kHz see Table 4, note 3.
5. For peak values at frequencies exceeding 100 kHz see Figs. 1 and 2. Between 100 kHz and 10 MHz, peak values for the field strengths are obtained by interpolation from the 1.5-fold peak at 100 kHz to the 32-fold peak at 10 MHz. For frequencies exceeding 10 MHz it is suggested that the peak equivalent plane wave power density, as averaged over the pulse

width, does not exceed 1,000 times the  $S_{eq}$  restrictions, or that the field strength does not exceed 32 times the field strength exposure levels given in the table.

6. For frequencies exceeding 10 GHz,  $S_{eq}$ , E2, H2, and B2 are to be averaged over any  $68/f$  1.05-min period ( $f$  in GHz).
  7. No E-field value is provided for frequencies, 1 Hz, which are effectively static electric fields. Electric shock from low impedance sources is prevented by established electrical safety procedures for such equipment.
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