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**FACTORIES (PROTECTION OF WORKERS FROM PHYSICAL AGENTS) (ELECTROMAGNETIC FIELDS) REGULATIONS 2016**Subsidiary  
2016/180

Subsidiary Legislation made under s.58.

**FACTORIES (PROTECTION OF WORKERS FROM PHYSICAL AGENTS) (ELECTROMAGNETIC FIELDS) REGULATIONS 2016****(LN. 2016/180)***Commencement*      **15.9.2016**

Amending enactments	Relevant current provisions	Commencement date
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**Transposing:**

Directive 2013/35/EU

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**ARRANGEMENT OF REGULATIONS.**

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**1956-12**

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**PART 3  
Thermal effects**

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*In exercise of the powers conferred upon it by section 58 of the Factories Act, and in order to transpose into the law of Gibraltar, Directive 2013/35/EU of the European Parliament and of the Council of 26 June 2013 on minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (electromagnetic fields) (20<sup>th</sup> individual Directive within the meaning of Article 16(1) of Directive 89/391/EEC) and repealing Directive 2004/40/EC, the Minister has made the following Regulations—*

**Title.**

1. These Regulations may be cited as the Factories (Protection of Workers from Physical Agents) (Electromagnetic Fields) Regulations 2016.

**Commencement.**

2. These Regulations come into operation on the day of publication.

**Interpretation.**

- 3.(1) In these Regulations—

“action levels” or “ALs” means operational levels established for the purpose of simplifying the process of demonstrating the compliance with relevant ELVs or, where appropriate, to take relevant protection or prevention measures specified in these Regulations;

“direct biophysical effects” means effects in the human body directly caused by its presence in the electromagnetic field including—

- (a) thermal effects, such as tissue heating through energy absorption from electromagnetic fields in the tissue;
- (b) non-thermal effects, such as the stimulation of muscles, nerves or sensory organs; and
- (c) limb currents;

“Directive 89/391/EEC” means Council Directive 89/391/EEC of 12 June 1989 on the introduction of measures to encourage improvements in the safety and health of workers at work as amended from time to time;

“Directive 2013/35/EU” means Directive 2013/35/EU of the European Parliament and of the Council of 26 June 2013 on the minimum

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health and safety requirements regarding the exposure of workers to the risks arising from physical agents (electromagnetic fields)(20<sup>th</sup> individual Directive within the meaning of Article 16(1) of Directive 89/391/EEC) and repealing Directive 2004/40/EC as amended from time to time;

“electromagnetic fields” means static electric, static magnetic and time varying electric, magnetic and electromagnetic fields with frequencies up to 300 GHz;

“exposure limits value” or “ELVs” means values established on the basis of biophysical and biological considerations, in particular on the basis scientifically well-established short-term and acute direct effects, i.e. thermal effects and electrical stimulation of tissues;

“health effects ELVs” means those ELVs above which employees might be subject to adverse health effects, such as thermal heating or stimulation of nerve and muscle tissue;

“high ALs” means–

- (a) for electric fields, those levels which relate to the specific protection or prevention measures specified in these Regulations; and
- (b) for magnetic fields, those levels that relate to the health effects ELVs;

“indirect effects” means effects, caused by the presence of an object in an electromagnetic field, which may become the cause of a safety or health hazard, such as–

- (a) interference with medical electronic equipment and devices, including cardiac pacemakers and other implants or medical devices worn on the body;
- (b) the projectile risk from ferromagnetic objects in static magnetic fields;
- (c) the initiation of electro-explosive devices (detonators);
- (d) fires and explosions resulting from the ignition of flammable materials by sparks caused by induced fields, contact currents and discharges; or
- (e) contact currents;

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“low ALs” means–

- (a) for electric fields, those levels which relate to the specific protection or prevention measures specified in these Regulations; and
- (b) for magnetic fields, those levels that relate to the sensory effects ELVs;

“sensory effects ELVs” means those ELVs above which employees might be subject to transient disturbed sensory perceptions and minor changes in brain function;

(2) Non-thermal effects may–

- (a) have a detrimental effect on the mental and physical health of exposed employees;
- (b) lead to transient symptoms through the stimulation of sensory organs; and
- (c) create a temporary annoyance or affect cognition or other brain or muscle function which may affect the ability of an employee to work safely.

**Application.**

4.(1) These Regulations apply–

- (a) minimum requirements for the protection of employees from risks to their health and safety arising, or likely to arise, from exposure to electromagnetic fields during their work;
- (b) to all known direct biophysical effects and indirect effects caused by electromagnetic fields; and
- (c) to exposure limit values relating to scientifically well-established links between short-term direct biophysical effects and exposure to electromagnetic fields.

(2) These Regulations do not apply to–

- (a) suggested long-term effects of exposure to electromagnetic fields; or
- (b) risks resulting from contact with live conductors.

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(3) Except where these Regulations impose more stringent or specific requirements, Directive 89/391/EEC as transposed into the law of Gibraltar continues to apply to the matters set out in these Regulations.

**Exposure to electromagnetic fields.**

5.(1) Subject to subregulation (3), employers must ensure that exposure of employees to electromagnetic fields does not exceed the ELVs set out in the Schedule.

(2) The level of exposure to electromagnetic fields must be determined in accordance with the exposure assessment prescribed in regulation 6.

(3) Where the level of electromagnetic fields determined in accordance with the exposure assessment prescribed in regulation 6 does not exceed the ALs set out in the Schedule, that exposure assessment is sufficient proof that subregulation (1) has been complied with.

(4) Exposure to electromagnetic fields may exceed the ALs or ELVs in those circumstances prescribed in the Schedule.

(5) Exposure to electromagnetic fields may exceed the ELVs if the exposure is related to the installation, testing, use, development, maintenance of or research related to magnetic resonance imaging (MRI) equipment for patients in the health sector, provided that the following conditions are met—

- (a) the exposure assessment carried out in accordance with regulation 6 has demonstrated that the ELVs are exceeded;
- (b) all technical or organisational measures have been applied in view of the state of the art;
- (c) the circumstances duly justify exceeding the ELVs;
- (d) the characteristics of the workplace, work equipment or work practices have been taken into account; and
- (e) the employer demonstrates that employees are still protected against adverse health effects and against safety risks, including by ensuring that the instructions for safe use provided by the manufacturer are followed.

(6) Employers may implement protection systems that are equivalent or more specific than those provided under these Regulations, for personnel working in operational military installations or involved in military

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activities, including in joint international military exercises provided that adverse health effects and safety risks are prevented.

(7) Exposure to electromagnetic fields may temporarily exceed the ELVs in specific sectors or specific activities where the following conditions are met—

- (a) the exposure assessment carried out in accordance with regulation 6 has shown that the ELVs are exceeded;
- (b) all technical or organisational measures have been applied in view of the state of the art;
- (c) the specific characteristics of the workplace, work equipment or work practices have been taken into account; and
- (d) the employer demonstrates that employees are still protected against adverse health effects and safety risk, including using comparable, more specific and internationally recognised standards and guidelines.

(8) Where an employer intends to rely on subregulations (6) or (7), he shall inform an inspector appointed under the Factories Act.

(9) Where a report is made in accordance with Article 15 of Directive 2013/35/EU, the Minister with responsibility for employment will ensure that the report includes information on any occasions where the exemptions under subregulations (6) and (7) have been used, and the reasons that justify that use.

**Exposure Assessment.**

6.(1) In carrying out the obligations laid down in the Management of Health and Safety at Work Regulations, 1996, the employer must carry out an exposure assessment that—

- (a) identifies and assesses risks to employees arising from electromagnetic fields in the workplace, and
- (b) where necessary, measure and calculate the levels of electromagnetic fields to which employees are exposed.

(2) The exposure assessment must identify and assess electromagnetic fields in the workplace taking into account—

- (a) relevant practical guides issued by the European Commission pursuant to Article 14 of Directive 2013/35/EU;

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- (b) other standards or guidelines produced by the Government; and
  - (c) exposure databases.
- (3) Where relevant, the employer may take into account–
- (a) emissions levels;
  - (b) safety related data provided in accordance with European Union law by the manufacturer or distributor for the equipment including an assessment of risk if applicable to the exposure conditions at the workplace or place of installation.
- (4) Where the level of ELVs cannot be determined on the basis of readily available information, exposure levels must be assessed–
- (a) on the basis of measurements or calculations; and
  - (b) taking into account uncertainties concerning the measurements or calculations such as–
    - (i) numerical errors;
    - (ii) source modelling;
    - (iii) phantom geometry; and
    - (iv) the electrical properties of tissues and materials;
- determined in accordance with relevant good practice.
- (5) An exposure assessment need not be carried out in workplaces open to the public if–
- (a) an evaluation has been carried out in accordance with Gibraltar or European Union law on the limitation of exposure of the general public to electromagnetic fields, provided–
    - (i) restrictions specified in those laws are respected for employees, and
    - (ii) health and safety risks are excluded; or
  - (b) where equipment intended for public use is used as intended and complies with European Union law that establishes stricter

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safety levels than those provided in these Regulations, and no other equipment is used.

(6) When carrying out a risk assessment under regulation 7 of the Management of Health and Safety at Work Regulations, 1996, the employer must give particular attention to-

- (a) the ALs and ELVs referred to in regulation 5 and prescribed in the Schedule;
- (b) the frequency, level, duration and type of exposure including the distribution over the employee's body and over the volume of the workplace;
- (c) direct biophysical effects;
- (d) effects on the health and safety of employees at particular risk, in particular-
  - (i) employees who wear active or passive implanted medical devices such as cardiac pacemakers;
  - (ii) employees with medical devices worn on the body, such as insulin pumps; and
  - (iii) pregnant employees;
- (e) indirect effects;
- (f) the existence of replacement equipment designed to reduce the level of exposure to electromagnetic fields;
- (g) appropriate information obtained from the health surveillance referred to in regulation 14;
- (h) information provided by the manufacturer of equipment;
- (i) other relevant health and safety related information;
- (j) multiple sources of exposure; and
- (k) simultaneous exposure to multiple frequency fields.

**Authority.**

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7. The exposure assessment, measurement and calculations referred to in regulation 6 must be planned and carried out by competent services or persons at suitable intervals, taking account of–

- (a) guidance issued under Directive 2013/35/EU;
- (b) regulation 10 and 13 of the Management of Health and Safety at Work Regulations, 1996.

**Data Protection.**

8.(1) An exposure assessment may be made public on request, provided that such publication is–

- (a) without prejudice to–
  - (i) regulation 12 of the Management of Health and Safety at Work Regulations, 1996; or
  - (ii) regulation 12 of these Regulations;
- (b) made in accordance with European Union and Gibraltar law; and
- (c) made in accordance with the Data Protection Act 2004 where an employee's data is processed in the course of the exposure assessment.

(2) Unless there is an overriding public interest in disclosure, employers or public authorities in possession of a copy of an exposure assessment may refuse a request for access to it or a request to make it public, where disclosure would undermine the protection of commercial interests of the employer, including those relating to intellectual property.

**Records.**

9.(1) The employer must maintain a record of–

- (a) risk assessments in accordance with regulation 7 of the Management of Health and Safety at Work Regulation, 1996;
- (b) measures that must be taken in accordance with regulation 10 and 11;
- (c) data obtained from the exposure assessment prescribed in regulation 6; and

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(d) measurements or calculations of the level of exposure.

(2) The information recorded under subregulation (1) (b), (c) and (d) must be preserved for a period of 6 years in a suitable durable and traceable form so as to permit consultation at a later stage.

(3) Records maintained under subregulation (1)(a) and (b) may include the reasons why the employer considers that the nature and extent of risks related to electromagnetic fields make a further detailed risk assessment unnecessary.

(4) A risk assessment must be reviewed and updated by the employer who made it on a regular basis, in particular if–

- (a) there have been significant changes that could render it out of date; or
- (b) the results of the health surveillance referred to in regulation 14 show that it is necessary.

**Avoiding or reducing risk.**

10.(1) The employer must, so far as reasonably practicable, take the necessary actions to ensure that risks arising from electromagnetic fields at the workplace are eliminated or reduced to a minimum.

(2) Actions taken under subregulation (1) must–

- (a) take account of technical progress and the availability of measures to control the production of electromagnetic fields at the source; and
- (b) be based on the general principles of prevention set out in the Schedule to the Management of Health and Safety at Work Regulations, 1996.

(3) On the basis of the exposure assessment, workplaces where employees are likely to be exposed to electromagnetic fields that exceed the ALs must–

- (a) be indicated by appropriate signs in accordance with the Schedule and the Health and Safety (Safety Signs and Signals) Regulations, 1996; and
- (b) be identified and access to those areas restricted as appropriate.

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(4) Where access to the areas identified in subregulation (3) are suitably restricted for other reasons and employees are informed of the risks arising from electromagnetic fields, signs and access restrictions specific to electromagnetic fields are not required.

**Action plan.**

11.(1) On the basis of the exposure assessment, the employer must devise and implement an action plan that includes technical and organisational measure to prevent risks–

- (a) due to indirect effects; or
- (b) to employees at particular risk,

(2) In addition to providing the information set out in regulation 12, the employer must, pursuant to Article 15 of Directive 89/391/EEC, adapt measures adopted pursuant to this regulation, regulation 10 and the Schedule in order to meet the requirements of employees at particular risk and, where applicable, of individual risk assessments, in particular in respect of employees who–

- (a) have declared the use of active or passive implanted medical devices such as cardiac pacemakers;
- (b) have declared the use of medical devices worn on the body such as insulin pumps;
- (c) are pregnant and have informed their employer of their condition.

(3) Where the exposure assessment shows that–

- (a) ALs have exceeded levels prescribed in the Schedule;
- (b) ELVs exceed the levels required by regulation 5; and
- (c) safety risks may not be excluded;

the employer must implement an action plan including technical and organisational measures to ensure compliance with regulation 5.

(4) The action plan implemented under subregulation (3) must take into account–

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- (a) other working methods that entail less exposure to electromagnetic fields;
- (b) the choice of equipment emitting less intense electromagnetic fields, taking account of the work to be done;
- (c) technical measures to reduce the emission of electromagnetic fields, including, where necessary, the use of interlocks, shielding or similar health protection mechanisms;
- (d) appropriate delimitation and access measures, such as signals, labels, floor markings, barriers, in order to limit or control access;
- (e) in the case of exposure to electric fields, measures and procedures to manage spark discharges and contact currents through technical means and through the training of employees;
- (f) appropriate maintenance programmes for work equipment, workplaces and workstation systems;
- (g) the design and layout of workplaces and workstations;
- (h) limitations of the duration and intensity of the exposure; and
- (i) the availability of adequate personal protection equipment.

(5) If, despite the measures taken by the employer, the ELVs exceed the levels prescribed in the Schedule, the employer must—

- (a) take immediate action to comply with regulation 5; and
- (b) identify and record the reasons why the ELV levels have been exceeded and amend the protection and prevention measures accordingly.

**Employee information and training.**

12. The employer must ensure that employees who are likely to be exposed to risks from electromagnetic fields at work or their representatives receive information and training considered necessary as a result of the exposure assessment, including training concerning—

- (a) measures taken under these Regulations;

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- (b) the concepts and values of ELVs and ALs;
- (c) the possible risks associated with ELVs and preventative measures taken;
- (d) possible indirect effects of exposure;
- (e) the results of the most recent assessment, including measurement or calculation of the levels of exposure to electromagnetic fields;
- (f) how to detect and report adverse health effects of exposure;
- (g) the possibility of transient symptoms and sensations related to the effects in the central or peripheral nervous system;
- (h) the circumstances in which employees are entitled to health surveillance;
- (i) safe working practices to minimise risks resulting from exposure; and
- (j) employees at particular risk.

**Consultation and participation.**

13. Consultation and participation of employees or representatives must take place in accordance with regulation 8 of the Management of Health and Safety at Work Regulations, 1996.

**Health Surveillance.**

14.(1) Employers shall ensure employees are provided with health surveillance in accordance with regulation 9 of the Management of Health and Safety at Work Regulations, 1996.

(2) Health surveillance provided under subregulation (1) must have the particular objective of preventing or the early diagnosis of adverse health effects due to exposure to electromagnetic fields.

(3) The employer must ensure appropriate medical examinations or individual health surveillance is provided to relevant employees where—

- (a) an undesired or unexpected health effect is reported by an employee; or

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- (b) exposure to electromagnetic fields above the ELV level prescribed in the Schedule is detected.
- (4) Examinations or surveillance must—
- (a) take place, as far as reasonably possible, during hours chosen by the employee; and
  - (b) be free of charge to the employee.
- (5) Results of health surveillance must be preserved for a period of 6 years in a suitable form that can be consulted at a later date, subject to compliance with confidentiality requirements.
- (6) Employees may, at their request, be entitled to access to their own personal health records.

**SCHEDULE****PART 1****Physical quantities regarding the exposure to electromagnetic fields.**

1. The following physical quantities describe exposure to electromagnetic fields—

“contact currents ( $I_C$ )” is a current that appears when a person comes into contact with an object in an electromagnetic field and is expressed in ampere (A);

“steady state contact current” occurs when a person is in continuous contact with an object in an electromagnetic field and in the process of making such contact, a spark discharge may occur with associated transient currents;

“electric discharge” is a quantity used for spark discharge and is expressed in coulomb (C);

“electric field strength (E)” is a vector quantity that corresponds to the force exerted on a charged particle regardless of its motion in space that is expressed in volt per metre ( $Vm^{-1}$ ), and a distinction must be drawn between the environmental electric field and the electric field present in the body (in situ) as a result of exposure to the environmental electric field;

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“limb current ( $I_L$ )” is the current in the limbs of a person exposed to electromagnetic fields in the frequency range from 10 MHz to 110 MHz as a result of contact with an object in an electromagnetic field or the flow of capacitive currents induced in the exposed body expressed in ampere (A);

“magnetic field strength (H)” is a vector quantity that, together with the magnetic flux density, specifies a magnetic field at any point in space and is expressed in ampere per metre ( $\text{Am}^{-1}$ );

“magnetic flux density (B)” is a vector quantity resulting in a force that acts on moving charges, expressed in tesla (T);

“power density (S)” is the radiant power incident perpendicular to a surface, divided by the area of the surface expressed in watt per square metre ( $\text{Wm}^{-2}$ ), and is an appropriate quantity used for very high frequencies, where the depth of penetration in the body is low;

“Specific energy absorption (SA)” is an energy absorbed per unit mass of biological tissue, expressed in joule per kilogram ( $\text{Jkg}^{-1}$ ) used for establishing limits for effects from pulsed microwave radiation;

“Specific energy absorption rate (SAR)”, averaged over the whole body or over parts of the body, is the rate at which energy is absorbed per unit mass of body tissue and is expressed in watt per kilogram ( $\text{Wkg}^{-1}$ );

“Whole-body SAR” is a widely accepted quantity for relating adverse thermal effects to radio frequency (RF) exposure.

2. Besides the whole-body average SAR, local SAR values are necessary to evaluate and limit excessive energy deposition in small parts of the body resulting from special exposure conditions. Examples of such conditions include: an individual exposed to RF in the low MHz range (e.g. from dielectric heaters) and individuals exposed in the near field of an antenna.

3. In free space and in biological materials, magnetic flux density and magnetic field strength can be interchanged using the magnetic field strength of  $H = 1 \text{ Am}^{-1}$  equivalence to magnetic flux density of  $B = 4 \cdot 10^{-7} \text{ T}$  (approximately 1,25 microtesla).

4. Of the quantities prescribed in paragraph 1, magnetic flux density (B), contact current ( $I_C$ ), limb current ( $I_L$ ), electric field strength (E), magnetic field strength (H), and power density (S) can be measured directly.

**PART 2**

**Non-thermal effects****Exposure limit values and action levels in the frequency range from 0 hz to 10 mhz****A. EXPOSURE LIMIT VALUES (ELVs)**

1. ELVs below 1 Hz (Table A1) are limits for static magnetic field which is not affected by the tissue of the body.
2. ELVs for frequencies from 1 Hz to 10 MHz (Table A2) are limits for electric fields induced in the body from exposure to time-varying electric and magnetic fields.

**ELVs for external magnetic flux density from 0 to 1 Hz**

3. The sensory effects ELV is the ELV for normal working conditions (Table A1) and is related to vertigo and other physiological effects related to disturbance of the human balance organ resulting mainly from moving in a static magnetic field.
4. The health effects ELV for controlled working conditions (Table A1) is applicable on a temporary basis during the shift when justified by the practice or process, provided that preventive measures, such as controlling movements and providing information to employees, have been adopted.
5. Exposure to electromagnetic fields may exceed the sensory effects ELVs (Table A1) during a shift, where justified by practice or process provided that—
  - (a) the ELVs are exceeded only temporarily;
  - (b) the health effects ELVs are not exceeded;
  - (c) specific protection measures such as controlling movements have been taken;
  - (d) the employer updates the exposure assessment and prevention measures if an employee reports transient symptoms such as static magnetic field effects, vertigo and nausea;
  - (e) regulation 12(g) has been complied with.

**Table A1****ELVs for external magnetic flux density ( $B_0$ ) from 0 to 1 Hz**

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	<b>Sensory effects ELVs</b>
Normal working conditions	2 T
Localised limbs exposure	8 T
	<b>Health effects ELVs</b>
Controlled working conditions	8 T

**Health effects ELVs for internal electric field strength from 1 Hz to 10 MHz**

6. Health effects ELVs (Table A2) are related to electric stimulation of all peripheral and central nervous system tissues in the body, including the head.

**Table A2****Health effects ELVs for internal electric field strength from 1 Hz to 10 MHz**

Frequency range	Health effects ELVs
1 Hz $f < 3$ kHz	$1,1 \text{ Vm}^{-1}$ (peak)
3 kHz $f \leq 10$ MHz	$3,8 \times 10^{-4} f \text{ Vm}^{-1}$ (peak)

Note A2-1:  $f$  is the frequency expressed in hertz (Hz).

Note A2-2: The health effects ELVs for internal electric field are spatial peak values in the entire body of the exposed subject.

Note A2-3: The ELVs are peak values in time which are equal to the Root-Mean-Square (RMS) values multiplied by  $\sqrt{2}$  for sinusoidal fields. In the case of non-sinusoidal fields, exposure evaluation carried out in accordance with Article 4 shall be based on the weighted peak method (filtering in time domain), explained in the practical guides referred to in Article 14 but other scientifically proven and validated exposure evaluation procedures can be applied, provided that they lead to approximately equivalent and comparable results.

**Sensory effects ELVs for internal electric field strength from 1 Hz to 400 Hz**

7. The sensory effects ELVs (Table A3) are related to electric field effects on the central nervous system in the head, i.e. retinal phosphenes and minor transient changes in some brain functions.

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8. Exposure to electromagnetic fields may exceed the sensory effects ELVs (Table A3) during a shift, where justified by practice or process, provided that—

- (a) the ELVs are exceeded only temporarily;
- (b) the health effects ELVs in Table A2 of this Part and Table A1 and A3 of Part 3 are not exceeded;
- (c) the employer updates the exposure assessment and prevention measures if an employee reports transient symptoms such as sensory perceptions and effects in the functioning of the central nervous system in the head evoked by time varying magnetic fields; and
- (d) regulation 12(g) has been complied with.

**Table A3**  
**Sensory effects ELVs for internal electric field strength from 1 to 400 Hz**

Frequency range	Sensory effects ELVs
1 f < 10 Hz	0,7/f Vm <sup>-1</sup> (peak)
10 f < 25 Hz	0,07 Vm <sup>-1</sup> (peak)
25 f 400 Hz	0,0028 f Vm <sup>-1</sup> (peak)

Note A3-1: f is the frequency expressed in hertz (Hz).

Note A3-2: The sensory effects ELVs for internal electric field are spatial peak values in the head of the exposed subject.

Note A3-3: The ELVs are peak values in time which are equal to the Root-Mean-Square (RMS) values multiplied by 2 for sinusoidal fields. In the case of non-sinusoidal fields, the exposure evaluation carried out in accordance with Article 4 shall be based on the weighted peak method (filtering in time domain), explained in the practical guides referred to in Article 14, but other scientifically proven and validated exposure evaluation procedures can be applied, provided that they lead to approximately equivalent and comparable results.

## **B. ACTION LEVELS (ALs)**

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1. The following physical quantities and values are used to specify the action levels (ALs), the magnitude of which are established to ensure by simplified assessment the compliance with relevant ELVs or at which relevant protection or prevention measures specified in regulations 10 and 11 must be taken—
  - (a) Low ALs(E) and high ALs(E) for electric field strength E of time varying electric fields as specified in Table B1;
  - (b) Low ALs(B) and high ALs(B) for magnetic flux density B of time varying magnetic fields as specified in Table B2;
  - (c) ALs(I<sub>c</sub>) for contact current as specified in Table B3;
  - (d) ALs(B<sub>0</sub>) for magnetic flux density of static magnetic fields as specified in Table B4.
2. ALs correspond to calculated or measured electric and magnetic field values at the workplace in the absence of the employee.

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3. Low ALs (Table B1) for external electric field are based on limiting the internal electric field below the ELVs (Tables A2 and A3) and limiting spark discharges in the working environment.

4. Below high ALs, the internal electric field does not exceed the ELVs (Tables A2 and A3) and annoying spark discharges are prevented, provided that the protection measures referred to in Article 5(6) are taken.

5. Exposure to electromagnetic fields may exceed low ALs for electric fields (Table B1) where justified by the practice or process, provided that either–

- (a) the sensory effects ELVs (Table A3) are not exceeded; or
- (b) the following requirements are met-
  - (i) the health effects ELVs (Table A2) are not exceeded;
  - (ii) the excessive spark discharges and contact currents (Table B3) are prevented by specific protection measures; and
  - (iii) regulation 12(g) has been complied with.

6. In paragraph 5(b)(ii), specific protection measures include–

- (a) training of employees in accordance with regulation 12;
- (b) the use of technical means and personal protection including where appropriate–
  - (i) the grounding of work objects,
  - (ii) the bonding of employees with work objects, and
  - (iii) the use of insulating shoes, gloves and protective clothing.

7. The employer must, if necessary, update the exposure assessment and prevention measures if employee reports transient symptoms which may include–

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- (a) sensory perceptions and effects in the functioning of the central nervous system in the head evoked by time varying magnetic fields; and
- (b) static magnetic field effects, such as vertigo and nausea.

**Table B1**  
**ALs for exposure to electric fields from 1 Hz to 10 MHz**

<b>Frequency range</b>	<b>Electric field strength Low ALs (E)[Vm<sup>-1</sup>] (RMS)</b>	<b>Electric field strength High ALs (E) [Vm<sup>-1</sup>] (RMS)</b>
1 f < 25 Hz	$2,0 \times 10^4$	$2,0 \times 10^4$
25 f < 50 Hz	$5,0 \times 10^5/f$	$2,0 \times 10^4$
50 Hz f < 1,64 kHz	$5,0 \times 10^5/f$	$1,0 \times 10^6/f$
1,64 f < 3 kHz	$5,0 \times 10^5/f$	$6,1 \times 10^2$
3 kHz f < 10 MHz	$1,7 \times 10^2$	$6,1 \times 10^2$

Note B1-1: f is the frequency expressed in hertz (Hz).

Note B1-2: The low ALs (E) and high ALs (E) are the Root-Mean-Square (RMS) values of the electric field strength which are equal to the peak values divided by  $\sqrt{2}$  for sinusoidal fields. In the case of non-sinusoidal fields, the exposure evaluation carried out in accordance with Article 4 shall be based on the weighted peak method (filtering in time domain), explained in the practical guides referred to in Article 14, but other scientifically proven and validated exposure evaluation procedures can be applied, provided that they lead to approximately equivalent and comparable results.

Note B1-3: ALs represent maximum calculated or measured values at the employees' body position. This results in a conservative exposure assessment and automatic compliance with ELVs in all non-uniform exposure conditions. In order to simplify the assessment of compliance with ELVs, carried out in accordance with Article 4, in specific non-uniform conditions, criteria for the spatial averaging of measured fields based on established dosimetry will be laid down in the practical guides referred to in Article 14. In the case of a very localised source within a distance of a few centimetres from the body, the induced electric field shall be determined dosimetrically, case by case.

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8. Low ALs (Table B2) are, for frequencies below 400 Hz, derived from the sensory effects ELVs (Table A3) and, for frequencies above 400 Hz, from the health effects ELVs for internal electric field (Table A2).

9. High ALs (Table B2) are derived from the health effects ELVs for internal electric field related to electric stimulation of peripheral and autonomous nerve tissues in head and trunk (Table A2). Compliance with the high ALs ensures that health effects ELVs are not exceeded, but the effects related to retinal phosphenes and minor transient changes in brain activity are possible, if the exposure of the head exceeds the low ALs for exposures up to 400 Hz. In such a case, Article 5(6) applies.

10. ALs for exposure of limbs are derived from the health effects ELVs for internal electric field related to electric stimulation of the tissues in limbs by taking into account that the magnetic field is coupled more weakly to the limbs than to the whole body.

11. Exposure to electromagnetic fields may exceed low ALs for magnetic fields (Table B2) where justified by the practice or process, including in the head and torso, during the shift, provided that either–

- (a) the sensory effects ELVs (Table A3) are not exceeded; or
- (b) the following requirements are met–
  - (i) the sensory effects ELVs are exceeded only temporarily;
  - (ii) the health effects ELVs (Table A2) are not exceeded;
  - (iii) the employer updates the exposure assessment and prevention measures if an employee reports transient symptoms such as sensory perceptions and effects in the functioning of the central nervous system in the head evoked by time varying magnetic fields; and
  - (iv) regulation 12(g) has been complied with.

**Table B2**  
**ALs for exposure to magnetic fields from 1 Hz to 10 MHz**

Frequency range	Magnetic flux density Low ALs(B)[ $\mu$ T] (RMS)	Magnetic flux density High ALs(B) [ $\mu$ T] (RMS)	Magnetic flux density ALs for exposure of limbs to a localised magnetic field [ $\mu$ T] (RMS)

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1 f < 8 Hz	$2,0 \times 10^5/f^2$	$3,0 \times 10^5/f$	$9,0 \times 10^5/f$
8 f < 25 Hz	$2,5 \times 10^4/f$	$3,0 \times 10^5/f$	$9,0 \times 10^5/f$
25 f < 300 Hz	$1,0 \times 10^3$	$3,0 \times 10^5/f$	$9,0 \times 10^5/f$
300 Hz f < 3 kHz	$3,0 \times 10^5/f$	$3,0 \times 10^5/f$	$9,0 \times 10^5/f$
3 kHz f < 10 MHz	$1,0 \times 10^2$	$1,0 \times 10^2$	$3,0 \times 10^2$

Note B2-1: f is the frequency expressed in hertz (Hz).

Note B2-2: The low ALs and the high ALs are the Root-Mean-Square (RMS) values which are equal to the peak values divided by 2 for sinusoidal fields. In the case of non-sinusoidal fields the exposure evaluation carried out in accordance with Article 4 shall be based on the weighted peak method (filtering in time domain), explained in practical guides referred to in Article 14, but other scientifically proven and validated exposure evaluation procedures can be applied, provided that they lead to approximately equivalent and comparable results.

Note B2-3: ALs for exposure to magnetic fields represent maximum values at the employees' body position. This results in a conservative exposure assessment and automatic compliance with ELVs in all non-uniform exposure conditions. In order to simplify the assessment of compliance with ELVs, carried out in accordance with Article 4, in specific non-uniform conditions, criteria for the spatial averaging of measured fields based on established dosimetry will be laid down in the practical guides referred to in Article 14. In the case of a very localised source within a distance of a few centimetres from the body, the induced electric field shall be determined dosimetrically, case by case.

**Table B3**  
**ALs for contact current  $I_C$**

Frequency	ALs ( $I_C$ ) steady state contact current [mA] (RMS)
up to 2,5 kHz	1,0
2,5 f < 100 kHz	0,4 f
100 f < 10 000 kHz	40

Note B3-1: f is the frequency expressed in kilohertz (kHz).

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**Action levels (ALs) for magnetic flux density of static magnetic fields**

**Table B4  
ALs for magnetic flux density of static magnetic fields**

<b>Hazards</b>	<b>ALs(B<sub>0</sub>)</b>
Interference with active implanted devices, e.g. cardiac pacemakers	0,5 mT
Attraction and projectile risk in the fringe field of high field strength sources (> 100 mT)	3 mT

**PART 3**

**Thermal effects**

**Exposure limit values and action levels in the frequency range from 100 khz to 300 ghz**

**A. EXPOSURE LIMIT VALUES (ELVs)**

1. Health effects ELVs for frequencies from 100 kHz to 6 GHz (Table A1) are limits for energy and power absorbed per unit mass of body tissue generated from exposure to electric and magnetic fields.
2. Sensory effects ELVs for frequencies from 0,3 to 6 GHz (Table A2) are limits on absorbed energy in a small mass of tissue in the head from exposure to electromagnetic fields.
3. Health effects ELVs for frequencies above 6 GHz (Table A3) are limits for power density of an electromagnetic wave incident on the body surface.

**Table A1  
Health effects ELVs for exposure to electromagnetic fields from 100 kHz to 6 GHz**

<b>Health effects ELVs</b>	<b>SAR values averaged over any six-minute period</b>
ELVs related to whole body heat stress expressed as averaged SAR in the body	0,4 Wkg <sup>-1</sup>
ELVs related to localised heat stress in head and trunk expressed as localised SAR in the body	10 Wkg <sup>-1</sup>
ELVs related to localised heat stress in the limbs expressed as localised SAR in the limbs	20 Wkg <sup>-1</sup>

Note A1-1: Localised SAR averaging mass is any 10 g of contiguous tissue;

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the maximum SAR so obtained should be the value used for estimating exposure. This 10 g of tissue is intended to be a mass of contiguous tissue with roughly homogeneous electrical properties. In specifying a contiguous mass of tissue, it is recognised that this concept may be used in computational dosimetry but may present difficulties for direct physical measurements. A simple geometry, such as cubic or spheric tissue mass, can be used.

**Sensory effects ELVs from 0,3 GHz to 6 GHz**

4. This sensory effects ELVs (Table A2) is related to avoiding auditory effects caused by exposures of the head to pulsed microwave radiation.

5. Exposure to electromagnetic fields may exceed the sensory effects ELVs (Table A2) during a shift, where justified by practice or process, provided that—

- (a) the ELVs are exceeded only temporarily;
- (b) the health effects ELVs in Table A2 of Part 2 and Table A1 and A3 of this Part are not exceeded;
- (c) the employer updates the exposure assessment and prevention measures if an employee reports transient symptoms such as sensory perceptions and effects in the functioning of the central nervous system in the head evoked by time varying magnetic fields; and
- (d) regulation 12(g) has been complied with.

**Table A2**  
**Sensory effects ELVs for exposure to electromagnetic fields from 0,3 to 6 GHz**

Frequency range	Localised specific energy absorption (SA)
0,3 f 6 GHz	10 mJkg <sup>-1</sup>

Note A2-1: Localised SA averaging mass is 10 g of tissue.

**Table A3**  
**Health effects ELVs for exposure to electromagnetic fields from 6 to 300 GHz**

Frequency range	Health effects ELVs related to power density
6 f 300 GHz	50 Wm <sup>-2</sup>

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Note A3-1: The power density shall be averaged over any 20 cm<sup>2</sup> of exposed area. Spatial maximum power densities averaged over 1 cm<sup>2</sup> should not exceed 20 times the value of 50 Wm<sup>-2</sup>. Power densities from 6 to 10 GHz are to be averaged over any six-minute period. Above 10 GHz, the power density shall be averaged over any 68/f<sup>1.05</sup>-minute period (where f is the frequency in GHz) to compensate for progressively shorter penetration depth, as the frequency increases.

**B. ACTION LEVELS (ALs)**

1. The following physical quantities and values are used to specify the action levels (ALs), the magnitude of which are established to ensure by simplified assessment the compliance with the relevant ELVs or at which relevant protection or prevention measures specified in regulations 10 and 11 must be taken–

- (a) ALs(E) for electric field strength E of time varying electric field, as specified in Table B1;
- (b) ALs(B) for magnetic flux density B of time varying magnetic field, as specified in Table B1;
- (c) ALs(S) for power density of electromagnetic waves, as specified in Table B1;
- (d) ALs(I<sub>C</sub>) for contact current, as specified in Table B2;
- (e) ALs(I<sub>L</sub>) for limb current, as specified in Table B2;

2. ALs correspond to calculated or measured field values at the workplace in the absence of the employee, as maximum value at the position of the body or specified part of the body.

**Action levels (ALs) for exposure to electric and magnetic fields**

3. ALs(E) and ALs(B) are derived from the SAR or power density ELVs (Tables A1 and A3) based on the thresholds related to internal thermal effects caused by exposure to (external) electric and magnetic fields.

**Table B1**
**ALs for exposure to electric and magnetic fields from 100 kHz to 300 GHz**

Frequency range	Electric field strength ALs(E)	Magnetic flux density ALs(B)	Power density

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	[V $m^{-1}$ ] (RMS)	[ $\mu$ T] (RMS)	ALs(S) [W $m^{-2}$ ]
100 kHz 1 MHz	$f < 6,1 \times 10^2$	$2,0 \times 10^6/f$	—
1	$f < 10$ MHz	$6,1 \times 10^8/f$	—
10 400 MHz	$f < 61$	0,2	—
400 MHz 2 GHz	$f < 3 \times 10^{-3} f^{1/2}$	$1,0 \times 10^{-5} f^{1/2}$	—
2	$f < 6$ GHz	$1,4 \times 10^2$	—
6 300 GHz	$f$	$1,4 \times 10^2$	50

Note B1-1: f is the frequency expressed in hertz (Hz).

Note B1-2: [ALs(E)]<sup>2</sup> and [ALs(B)]<sup>2</sup> are to be averaged over a six-minute period. For RF pulses, the peak power density averaged over the pulse width shall not exceed 1 000 times the respective ALs(S) value. For multi-frequency fields, the analysis shall be based on summation, as explained in the practical guides referred to in Article 14.

Note B1-3: ALs(E) and ALs(B) represent maximum calculated or measured values at the employees' body position. This results in a conservative exposure assessment and automatic compliance with ELVs in all non-uniform exposure conditions. In order to simplify the assessment of compliance with ELVs, carried out in accordance with Article 4, in specific non-uniform conditions, criteria for the spatial averaging of measured fields based on established dosimetry will be laid down in the practical guides referred to in Article 14. In the case of a very localised source within a distance of a few centimetres from the body, compliance with ELVs shall be determined dosimetrically, case by case.

Note B1-4: The power density shall be averaged over any 20 cm<sup>2</sup> of exposed area. Spatial maximum power densities averaged over 1 cm<sup>2</sup> should not exceed 20 times the value of 50 Wm<sup>-2</sup>. Power densities from 6 to 10 GHz are to be averaged over any six-minute period. Above 10 GHz, the power density shall be averaged over any 68/f<sup>1.05</sup>-minute period (where f is the frequency in GHz) to compensate for progressively shorter penetration depth as the frequency increases.

**Table B2**

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**ALs for steady state contact currents and induced limb currents**

<b>Frequency range</b>	<b>Steady state contact current, ALs(I<sub>C</sub>) [mA] (RMS)</b>	<b>Induced limb current in any limb, ALs(I<sub>L</sub>) [mA] (RMS)</b>
100 kHz    f < 10 MHz	40	—
10            f 110 MHz	40	100

Note B2-1:  $[ALs(I_L)]^2$  is to be averaged over a six-minute period.