

**Safety, Health and Welfare at Work (Electromagnetic Fields) Regulations 2016**

I, ....., Minister of State for Business and Employment at the Department of Jobs, Enterprise, and Innovation, in exercise of the powers conferred on me by Section 58 of the Safety, Health and Welfare at Work Act 2005 (No. 10 of 2005), (as adapted by the Enterprise, Trade and Innovation (Alteration of Name of Department and Title of Minister) Order 2011 (S.I. No. 245 of 2011)), and for the purpose of giving effect to Directive 2013/35/EU of The European Parliament and of The Council of 26 June 2013 on implementing the 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, after consultation with the Health and Safety Authority, hereby make the following regulations:

### **Citation and Commencement**

1. These Regulations may be cited as the Safety, Health and Welfare at Work (Electromagnetic Fields) Regulations 2016 and shall come into operation on their making.

### **Interpretation**

2. In these Regulations –

"Act of 2005" means the Safety, Health and Welfare at Work Act 2005, (No.10 of 2005).

"Action levels (ALs)" means operational levels established for the purpose of simplifying the process of demonstrating the compliance with relevant exposure limit values (ELVs) or, where appropriate, to take relevant protection or prevention measures specified in these Regulations.

In Schedule II -

- (i) for electric fields, "low ALs" and "high ALs" means levels which relate to the specific protection or prevention measures specified in these Regulations; and
- (ii) for magnetic fields, "low ALs" means levels which relate to the sensory effects ELVs and "high ALs" means levels which relate to the health effects ELVs;

"Authority" means the Health and Safety Authority

"direct biophysical effects" means effects in the human body directly caused by its presence in an electromagnetic field, including:

- (i) thermal effects, such as tissue heating through energy absorption from electromagnetic fields in the tissue;
- (ii) non-thermal effects, such as the stimulation of muscles, nerves or sensory organs. These effects might have a detrimental effect on the mental and physical health of exposed employees. Moreover, the stimulation of sensory organs may lead to transient symptoms, such as vertigo or

- phosphenes. These effects might create temporary annoyance or affect cognition or other brain or muscle functions, and may thereby affect the ability of an employee to work safely; and
- (iii) limb currents;

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

“exposure limit values (ELVs)” means values established on the basis of biophysical and biological considerations, in particular on the basis of scientifically well-established short-term and acute 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;

“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:

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

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

## **Application**

3. (1) These Regulations shall apply to activities in which employees are or are likely to be exposed to risks to their safety and health arising from exposure to electromagnetic fields during their work.

(2) These Regulations cover all known direct biophysical effects and indirect effects caused by electromagnetic fields.

(3) The exposure limit value (ELVs) laid down in these Regulations cover only scientifically well-established links between short-term direct biophysical effects and exposure to electromagnetic fields.

(4) These Regulations do not cover suggested long-term effects.

(5) These Regulations do not cover the risks resulting from contact with live conductors.

(6) Obligations and duties arising under these Regulations are in addition to obligations and duties arising under any other enactment.

(7) In this Regulation, “enactment” means—

- (a) an Act of the Oireachtas,

(b) a statute that was in force in Saorstát Éireann immediately before the date of the coming into operation of the Constitution and that continues in force by virtue of Article 50 of the Constitution, or

(c) an instrument made under—

(i) an Act of the Oireachtas, or

(ii) a statute referred to in subparagraph (b).

### **Exposure Limit Values and Action Levels**

4. (1) An employer shall ensure that exposure of employees to electromagnetic fields is limited to the health effects ELVs and sensory effects ELVs set out in Schedule II, for non-thermal effects, and in Schedule III, for thermal effects.

(2) An employer shall establish compliance with health effects ELVs and sensory effects ELVs by use of the relevant exposure assessment procedures referred to in Regulation 5.

(3) The employer shall take immediate action in accordance with Regulation 6(5) where the exposure of employees to electromagnetic fields exceeds the ELVs,

(4) The employer shall act in accordance with Regulation 6(2) where the exposure exceeds the ALs, unless the assessment carried out in accordance with Regulation 5(1), (2), (4) and (5) demonstrates that the relevant ELVs are not exceeded and that safety risks can be excluded.

(5) Without prejudice to paragraphs 2, 3, 4, and 6, exposure may exceed:

(a) low ALs for electric fields (Schedule II, Table B1), where justified by the practice or process, provided that either the sensory effects ELVs (Schedule II, Table A3) are not exceeded; or

(i) the health effects ELVs (Schedule II, Table A2) are not exceeded;

(ii) the excessive spark discharges and contact currents (Schedule II, Table B3) are prevented by specific protection measures as set out in Regulation 6(8); and

(iii) information on the situations referred to in Regulation 7(2)(f) has been given to employees;

(b) low ALs for magnetic fields (Schedule II, Table B2) where justified by the practice or process, including in the head and torso, during the working day, provided that either the sensory effects ELVs (Schedule II, Table A3) are not exceeded; or

(i) the sensory effects ELVs are exceeded only temporarily;

(ii) the health effects ELVs (Schedule II, Table A2) are not exceeded;

- (iii) action is taken, in accordance with Regulation 6(10), where there are transient symptoms under point (a) of that paragraph; and
  - (iv) information on the situations referred to in Regulation 7(2)(f) has been given to employees.
- (6). Without prejudice to paragraphs 2, 3, 4, 5, and 7, exposure may exceed:
- (a) the sensory effects ELVs (Schedule II, Table A1) during the working day, where justified by the practice or process, provided that:
    - (i) they are exceeded only temporarily;
    - (ii) the health effects ELVs (Schedule II, Table A1) are not exceeded;
    - (iii) specific protection measures have been taken in accordance with Regulation 6(9);
    - (iv) action is taken in accordance with Regulation 6(10), where there are transient symptoms under point (b) of that paragraph; and
    - (v) information on the situations referred to in Regulation 7(2)(f) has been given to employees;
  - (b) the sensory effects ELVs (Schedule II, Table A3 and Schedule III, Table A2) during the working day, where justified by the practice or process, provided that:
    - (i) they are exceeded only temporarily;
    - (ii) the health effects ELVs (Schedule II, Table A2 and Schedule III, Table A1 and Table A3) are not exceeded;
    - (iii) action is taken in accordance with Regulation 6(10), where there are transient symptoms under point (a) of that paragraph; and
    - (iv) information on the situations referred to in Regulation 7(2)(f) has been given to employees.

(7) For the purpose of these Regulations, where it is demonstrated that the relevant ALs set out in Schedules II and III are not exceeded, the employer shall be deemed to be in compliance with the health effects ELVs and sensory effects ELVs.

### **Assessment of Risks and Determination of Exposure**

5. (1) An employer shall make a suitable and appropriate assessment of the risks arising from activities where employees are liable to be exposed to electromagnetic fields at work.

(2) An employer shall, if necessary, in carrying out the risk assessment referred to in paragraph (1), measure or calculate the levels of electromagnetic field to which his or her employees are exposed.

(3) Without prejudice Regulation 7, the risk assessment referred to in paragraph (1) can be made public on request in accordance with relevant European Union and Irish laws. In particular, in the case of processing the personal data of employees in the course of such an assessment, any publication shall comply with the Data Protection Act 1988 and the Data Protection (Amendment) Act 2003, on the protection of individuals with regard to the processing of personal data and on the free movement of such data. Unless there is an overriding public interest in disclosure, public authorities that are in possession of a copy of the risk 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. Employers may refuse to disclose or make public the risk assessment under the same conditions in accordance with the relevant European Union and Irish Laws.

(4) An employer, in carrying out the risk assessment referred to in paragraph (1), shall identify and assess electromagnetic fields at the workplace, taking into account the practical guides produced by the European Commission and other relevant Irish standards or guidelines, including exposure databases.

(5) An employer shall be responsible for the risk assessment referred to in paragraphs (1), (2), (4) and (10) being planned and competently carried out at suitable intervals.

(6) An employer shall record in the safety statement drawn up in pursuant to Section 20 of the Act of 2005—

(a) the findings of the risk assessment as soon as practicable after it is made and

(b) the steps which he or she has taken to meet the requirements of Regulations 6 and 7.

(7) An employer shall review the risk assessment, and if necessary measurements or calculations referred to in paragraphs (1), (2), (4) & (10), at suitable intervals and, in particular, where either of the conditions specified in section 19(3) (a) and (b), of the Act of 2005 are met, or if the results of the health surveillance referred to in Regulation 8 show this to be necessary.

(8) An employer shall give particular attention when carrying out the risk assessment referred to in paragraph (1) to the following —

- (a) the health effects ELVs, the sensory effects ELVs and the ALs referred to in Regulation 4 and Schedules II and III to these Regulations,
- (b) the frequency, the level, duration and type of exposure, including the distribution over the employee's body and over the volume of the workplace,
- (c) any direct biophysical effects,
- (d) any effects on the health and safety of employees at particular risk, in particular employees who wear active or passive implanted medical devices, such as cardiac pacemakers, employees with medical devices worn on the body, such as insulin pumps, and pregnant employees,
- (e) any 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 8,
- (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.

(9) (a) In workplaces open to the public it is not necessary to carry out the assessment of the levels of electromagnetic fields to which the employees are exposed -

- (i) if an evaluation has already been undertaken in accordance with the provisions on the limitation of exposure of the general public to electromagnetic fields, and
- (ii) if the restrictions specified in those provisions are respected for employees and if the health and safety risks are excluded.

(b) Where equipment intended for the public use is used as intended and complies with relevant Community Directives that establish stricter safety levels than those provided for by these Regulations, and no other equipment is used, these conditions are deemed to be met.

(10) Where the ELVs cannot be reliably determined on the basis of readily accessible information, the assessment of the levels of electromagnetic fields to which employees are exposed shall be carried out on the basis of measurements or calculations, and this assessment shall take into account uncertainties concerning the measurements or calculations, such as numerical errors, source modelling, phantom geometry and the electrical properties of tissues and materials, determined in accordance with relevant good practice.

(11) Without prejudice to their obligations under this Regulation, the employer may, where relevant, take into account the emission levels and other appropriate safety-related data provided by the manufacturer or distributor for the equipment in accordance with relevant Community Directives, including an assessment of risks, if applicable to the exposure conditions at the workplace or place of installation.

### **Provisions aimed at Avoiding Risks**

6. (1) An employer shall ensure, so far as is reasonably practicable, that the risk from exposure of his or her employees to electromagnetic fields is either eliminated at source or reduced to a minimum.

(2) Where the risk assessment carried out under Regulation (5) for employees exposed to electromagnetic fields indicates -

- (a) any possibility that the relevant ALs, referred to in Regulation 4 and in Schedules II and III, are exceeded, and
- (b) unless the assessment carried out in accordance with Regulation 5(1), (2), (4) and (10) demonstrates that the relevant ELVs are not exceeded and
- (c) that safety risks can be excluded,

the employer shall prepare and implement an action plan comprising either or both technical and organisational measures designed to prevent the exposure exceeding the health effects ELVs and sensory effects ELVs, taking into account in particular:

- (i) other methods of work which reduce the risk from exposure to electromagnetic fields,
- (ii) the choice of work equipment which, taking account of the work to be done, emits less intense electromagnetic fields including the possibility of making available to employees work equipment in compliance with section 16 of the Act of 2005 with the aim or effect of limiting exposure to electromagnetic fields,
- (iii) technical means to reduce the emission of electromagnetic fields, including, where necessary, the use of interlocks, shielding or similar health protection mechanisms,
- (iv) appropriate delimitation and access measures, such as signals, labels, floor markings, barriers, in order to limit or control access,
- (v) in 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,
- (vi) appropriate maintenance programmes for work equipment, the place of work, workstations and systems of work,
- (vii) the design and layout of places of work and workstations,
- (viii) limitation of the duration and intensity of the exposure to electromagnetic fields and
- (ix) provision of appropriate personal protection equipment.

(3) An employer shall, where a risk assessment carried out pursuant to Regulation 5 indicates that there are workstations within the place of work where employees are likely to be exposed to electromagnetic fields above the relevant ALs,–



- (a) display mandatory signs, in accordance with Chapter 1 of Part 7 of the Safety, Health and Welfare at Work (General Application) (Amendment ) Regulations 2007, which convey that the electromagnetic field is likely to exceed that AL, and
- (b) ensure that such workstations are identified and are protected from unauthorised access, by barriers or other suitable measures, where such measures are technically feasible and where there is a risk that the AL could be exceeded,

unless access to such workstations is suitably restricted for other reasons and employees are informed of the risks from electromagnetic fields, in which case signs and access restrictions specific to electromagnetic fields shall not be required.

(4) An employer shall ensure that his or her employees are not exposed above the health effects ELVs and sensory effects ELVs, unless the conditions under either Regulation 9(1) or (3) or Regulation 4(5) are fulfilled.

(5) If, despite the measures taken to comply with this Regulation, the health effects ELVs and sensory effect ELVs are exceeded, the employer shall –

- (a) take immediate action to reduce exposure to electromagnetic fields to below these ELVs,
- (b) as soon as practicable, identify the reason for these ELVs being exceeded, and
- (c) amend either or both the technical and organisational measures taken in accordance with paragraph (2) to prevent these ELVs being exceeded again.

(6) An employer shall adapt any measures taken in compliance with the requirements of this Regulation to take account of any employee whose safety or health is at particular risk from exposure to electromagnetic fields and to take account of any risks due to indirect effects, referred to in Regulation 5(8)(e).

(7) In addition to providing information set out in Regulation 7 of these Regulations, the employer shall adapt the measures referred to in this Regulation to the requirements of employees at particular risk and, where applicable, to individual risks assessments, in particular in respect of –

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

(8) An employer shall take specific protection measures where regulation 4(5)(a) applies, such as the training of employees in accordance with Regulation 7 and the use of technical means and personal protection, for example

- (a) the grounding of work objects,

(b) the bonding of workers with work objects (equipment bonding) and, where appropriate (c) the use of insulating shoes, gloves and protective clothing in accordance with Safety, Health and Welfare at Work (General Application) Regulations 2007, Chapter 3 of Part 2, Personal Protection Equipment..

(9) An employer shall take specific protection measures where regulation 4(6)(a) applies, , such as controlling movements.

(10) (a) Where Regulation 4(5) and (6) apply and where the employee reports transient symptoms, the employer shall, if necessary, update the risk assessment and the prevention measures.

(b) For the purposes of this Regulation transient symptoms may include:

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

### **Employee Information, Training and Consultation**

7. (1) An employer shall, where his or her employees are exposed to risk from electromagnetic fields, provide them with suitable and sufficient information and training relating to the outcome of the risk assessment made pursuant to Regulation 5.

(2) Without prejudice to the generality of paragraph (1), the information and training provided under this regulation shall include -

- (a) the technical and organisational measures taken in order to comply with these Regulations,
- (b) the values and concepts of the ELVs and ALs, the associated potential risks and the preventive measures taken;
- (c) the possible indirect effects of exposure;
- (d) the results of the assessment and either or both the measurement or calculations of the levels of exposure to electromagnetic fields carried out in accordance with Regulation 5 and an explanation of their significance and potential risks,
- (e) how to detect and report signs of adverse health effects,
- (f) the possibility of transient symptoms and sensations related to effects in the central or peripheral nervous system;
- (g) the circumstances in which health surveillance is made available to employees and its purpose, in accordance with Regulation 8,

- (h) safe working practices to minimise risks from exposure to electromagnetic fields,
- (i) employees at particular risk, as referred to in Regulation 5(9)(d) and Regulation 6(6) and (7) of these Regulations, and
- (j) proper use of appropriate personal protective equipment.

## **Health Surveillance**

8. (1) An employer shall ensure that appropriate health surveillance, intended to prevent or diagnose rapidly any adverse health effects due to exposure to electromagnetic fields, is made available to those employees for whom a risk assessment referred to in Regulation 5 reveals a risk to their health.

(2) An employer shall ensure that a health record in respect of each of his or her employees who undergoes health surveillance is made and maintained and that that record or a copy thereof is kept available in a suitable form so as to permit appropriate access at a later date, taking into account any confidentiality concerns.

(3) An employer shall –

- (a) on request, allow an employee access to his or her personal health record,
- (b) provide the Authority, or a person designated in writing by the Authority under Section 63 of the Act of 2005, including an inspector, who is a registered medical practitioner, with copies of such health records as the Authority may require,
- (c) provide the registered medical practitioner, under whose responsibility an employee receives health surveillance, with the results of the risk assessment referred to in Regulation 5 where such results may be relevant to the health surveillance, and
- (d) if he or she ceases to trade, notify the Authority forthwith in writing and make available to the Authority all health records kept by him or her in accordance with this Regulation.

(4) An employer shall, without prejudice to the generality of paragraph (1), in the case of an employee whose exposure exceeds the relevant ELVs, make available to that employee the services of a registered medical practitioner to carry out, or to have carried out at his or her responsibility a medical examination.

(5) Without prejudice to the generality of paragraph (1), where as a result of health surveillance an employee is found to have an identifiable illness or adverse health effect which, in the opinion of a registered medical practitioner, is as a result of exposure at work to electromagnetic fields –

- (a) the registered medical practitioner shall;

- (i) inform the employee of the results which relate to him or her personally, including information and advice regarding such health surveillance which he or she should undergo following the end of the exposure,
  - (ii) inform the employer of any significant findings of the health surveillance, taking into account any medical confidentiality,
- (b) the employer shall;
- (i) review the risk assessment made under Regulation 5,
  - (ii) review the measures provided to eliminate or reduce the risk under Regulation 6,
  - (iii) take account of the advice of the registered medical practitioner or a relevant competent person, or the Authority, in implementing any measures required to eliminate or reduce risk in accordance with Regulation 6,
  - (iv) arrange continued health surveillance and provide for a review of the health status of any employee who has been similarly exposed, and
  - (v) take account of the recommendations of the registered medical practitioner or a relevant competent person regarding further medical examination.

## **Exemptions**

9. (1) Subject to paragraph (2) an exemption from Regulation 4 but without prejudice to Regulation 6(1) shall apply where exposure may exceed the ELV's 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.

(2) The exemption referred to in paragraph (1) shall only apply if all the following conditions are met:

- (i) the risk assessment carried out in accordance with Regulation 5 has demonstrated that the ELVs are exceeded;
- (ii) given the state of the art, either or both the technical and organisational measures have been applied;
- (iii) the circumstances duly justify exceeding the ELVs;
- (iv) the characteristics of the workplace, work equipment, or work practices have been taken into account; and
- (v) the employer demonstrates that workers are still protected against adverse health effects and against safety risks, including by ensuring that the instructions for safe use

provided by the manufacturer in accordance with Council Directive 93/42/EEC of 14 June 1993 concerning medical devices are followed;

(3) Subject to paragraph (4) an exemption from Regulation 4 but without prejudice to Regulation 6(1) shall apply where exposure may temporarily exceed the ELV's if the exposure is in specific sectors or for specific activities outside the scope of paragraph (1).

(4) The exemption referred to in paragraph (3) shall only apply if all the following conditions are met and for only as long as they remain to be met:

- (i) the risk assessment carried out in accordance with Regulation 5 has shown that the ELVs are exceeded;
- (ii) given the state of the art, either or both the technical and organisational measures have been applied;
- (iii) the specific characteristics of the workplace, work equipment, or work practices have been taken into account; and
- (iv) the employer demonstrates that his or her employees are still protected against adverse health effects and safety risks, including by using comparable, more specific and internationally recognised standards and guidelines.

## **SCHEDULE I**

### PHYSICAL QUANTITIES

#### REGARDING THE EXPOSURE TO ELECTROMAGNETIC FIELDS

The following physical quantities are used to describe the exposure to electromagnetic fields:

Electric field strength (E) is a vector quantity that corresponds to the force exerted on a charged particle regardless of its motion in space. It is expressed in volt per metre ( $\text{Vm}^{-1}$ ). A distinction has to be made 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.

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. It is expressed in ampere (A).

Contact current ( $I_c$ ) is a current that appears when a person comes into contact with an object in an electromagnetic field. It is expressed in ampere (A). A steady state contact current occurs when a person is in continuous contact with an object in an electromagnetic field. In the process of making such contact, a spark discharge may occur with associated transient currents.

Electric charge (Q) is an appropriate quantity used for spark discharge and is expressed in coulomb (C).

Magnetic field strength (H) is a vector quantity that, together with the magnetic flux density, specifies a magnetic field at any point in space. It 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). 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  $B = 4\pi \cdot 10^{-7} \text{ T}$  (approximately 1.25 microtesla).

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

Specific energy absorption (SA) is an energy absorbed per unit mass of biological tissue, expressed in joule per kilogram ( $\text{Jkg}^{-1}$ ). In these Regulations, it is 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. 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.

Of these quantities, 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.

**SCHEDULE II**

NON-THERMAL EFFECTS

EXPOSURE LIMIT VALUES AND ACTION LEVELS

IN THE FREQUENCY RANGE FROM 0 Hz TO 10 MHz

A. EXPOSURE LIMIT VALUES (ELVs)

ELVs below 1 Hz (Table A1) are limits for static magnetic field which is not affected by the tissue of the body.

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

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

The health effects ELV for controlled working conditions (Table A1) is applicable on a temporary basis during the working day when justified by the practice or process, provided that preventive measures, such as controlling movements and providing information to employees, have been adopted.

Table A1. ELVs for external magnetic flux density ( $B_0$ ) from 0 to 1 Hz	
	Sensory effects ELVs
Normal working conditions	2 T
Localised limbs exposure	8 T
	Health effects ELVs
Controlled working conditions	8 T

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

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
$1 \text{ Hz} \leq f < 3 \text{ kHz}$	$1.1 \text{ Vm}^{-1}$ (peak)
$3 \text{ kHz} \leq f \leq 10 \text{ MHz}$	$3.8 \times 10^{-4} f \text{ Vm}^{-1}$ (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 Regulation 5 shall be based on the weighted peak method (filtering in time domain), explained in the practical guides produced by the European Commission, 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

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.

Table A3. Sensory effects ELVs for internal electric field strength from 1 Hz to 400 Hz	
Frequency range	Sensory effects ELVs
$1 \text{ Hz} \leq f < 10 \text{ Hz}$	$0.7/f \text{ Vm}^{-1}$ (peak)
$10 \text{ Hz} \leq f < 25 \text{ Hz}$	$0.07 \text{ Vm}^{-1}$ (peak)
$25 \text{ Hz} \leq f \leq 400 \text{ Hz}$	$0.0028 f \text{ Vm}^{-1}$ (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  $\sqrt{2}$  for sinusoidal fields. In the case of non-sinusoidal fields, the exposure evaluation carried out in accordance with Regulation 5 shall be based on the weighted peak method (filtering in time domain), explained in the practical guides produced by the European Commission, 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)

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 Regulation 6 shall be taken:

- Low ALs(E) and high ALs(E) for electric field strength E of time varying electric fields as specified in Table B1;
- Low ALs(B) and high ALs(B) for magnetic flux density B of time varying magnetic fields as specified in Table B2;
- ALs(I<sub>c</sub>) for contact current as specified in Table B3;
- ALs(B<sub>0</sub>) for magnetic flux density of static magnetic fields as specified in Table B4.

ALs correspond to calculated or measured electric and magnetic field values at the place of work in the absence of the employee.

Action levels (ALs) for exposure to electric fields

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.

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 Regulation 6(8) are taken.

Table B1. ALs for exposure to electric fields from 1 Hz to 10MHz		
Frequency range	Electric field strength Low ALs (E)[Vm <sup>-1</sup> ] (RMS)	Electric field strength High ALs (E) [Vm <sup>-1</sup> ] (RMS)
1 Hz ≤ f < 25 Hz	2.0 × 10 <sup>4</sup>	2.0 × 10 <sup>4</sup>
25 Hz ≤ f < 50 Hz	5.0 × 10 <sup>5</sup> /f	2.0 × 10 <sup>4</sup>
50 Hz ≤ f < 1.64 kHz	5.0 × 10 <sup>5</sup> /f	1.0 × 10 <sup>6</sup> /f
1.64 kHz ≤ f < 3 kHz	5.0 × 10 <sup>5</sup> /f	6.1 × 10 <sup>2</sup>
3 kHz ≤ f ≤ 10 MHz	1.7 × 10 <sup>2</sup>	6.1 × 10 <sup>2</sup>

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 Regulation 5 shall be based on the weighted peak method (filtering in time domain), explained in the practical guides produced by the European Commission, 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 employee's 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 Regulation 5, in specific non-uniform conditions, criteria for the spatial averaging of measured fields based on established dosimetry has been laid down in the practical guides produced by the European Commission. 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.

Action levels (ALs) for exposure to magnetic fields

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).

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, Regulation 6(8) applies.

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.

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)
$1 \text{ Hz} \leq f < 8 \text{ Hz}$	$2.0 \times 10^5 / f^2$	$3.0 \times 10^5 / f$	$9.0 \times 10^5 / f$
$8 \text{ Hz} \leq f < 25 \text{ Hz}$	$2.5 \times 10^4 / f$	$3.0 \times 10^5 / f$	$9.0 \times 10^5 / f$
$25 \text{ Hz} \leq f < 300 \text{ Hz}$	$1.0 \times 10^3$	$3.0 \times 10^5 / f$	$9.0 \times 10^5 / f$
$300 \text{ Hz} \leq f < 3 \text{ kHz}$	$3.0 \times 10^5 / f$	$3.0 \times 10^5 / f$	$9.0 \times 10^5 / f$
$3 \text{ kHz} \leq f \leq 10 \text{ MHz}$	$1.0 \times 10^2$	$1.0 \times 10^2$	$3.0 \times 10^2$

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  $\sqrt{2}$  for sinusoidal fields. In the case of non-sinusoidal fields the exposure evaluation carried out in accordance with Regulation 5 shall be based on the weighted peak method (filtering in time domain), explained in practical guides produced by the European Commission, 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 employee's 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 Regulation 5, in specific non-uniform conditions, criteria for the spatial averaging of measured fields based on established dosimetry has been laid down in the practical guides produced by the European Commission. 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
$2.5 \text{ kHz} \leq f < 100 \text{ kHz}$	$0.4 f$
$100 \text{ kHz} \leq f \leq 10\,000 \text{ kHz}$	40

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

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

Table B4. ALs for magnetic flux density of static magnetic fields	
Hazards	ALs( $B_0$ )
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

### **SCHEDULE III**

#### THERMAL EFFECTS

##### EXPOSURE LIMIT VALUES AND ACTION LEVELS

##### IN THE FREQUENCY RANGE FROM 100 kHz TO 300 GHz

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

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.

Sensory effects ELVs for frequencies from 0.3 GHz to 6 GHz (Table A2) are limits on absorbed energy in a small mass of tissue in the head from exposure to electromagnetic fields.

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	
Health effects ELVs	SAR values averaged over any six-minute period
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; 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

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

Table A2. Sensory effects ELVs for exposure to electromagnetic fields from 0.3 GHz to 6 GHz	
Frequency range	Localised specific energy absorption (SA)
$0.3 \text{ GHz} \leq f \leq 6 \text{ GHz}$	$10 \text{ mJkg}^{-1}$

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

Table A3. Health effects ELVs for exposure to electromagnetic fields from 6 GHz to 300 GHz	
Frequency range	Health effects ELVs related to power density
$6 \text{ GHz} \leq f \leq 300 \text{ GHz}$	$50 \text{ Wm}^{-2}$

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 GHz to 10 GHz are to be averaged over any six-minute period. Above 10 GHz, the power density shall be averaged over any  $68/f^{1.05}$ -minute period (where f is the frequency in GHz) to compensate for progressively shorter penetration depth, as the frequency increases.

## B. ACTION LEVELS (ALs)

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 Regulation 6 shall be taken:

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

ALs correspond to calculated or measured field values at the place of work in 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

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) [Vm <sup>-1</sup> ] (RMS)	Magnetic flux density ALs(B) [μT] (RMS)	Power density ALs(S) [Wm <sup>-2</sup> ]
100 kHz ≤ f < 1 MHz	6.1 × 10 <sup>2</sup>	2.0 × 10 <sup>6</sup> /f	-
1 MHz ≤ f < 10 MHz	6.1 × 10 <sup>8</sup> /f	2.0 × 10 <sup>6</sup> /f	-
10 MHz ≤ f < 400 MHz	61	0.2	-
400 MHz ≤ f < 2 GHz	3 × 10 <sup>-3</sup> f <sup>½</sup>	1.0 × 10 <sup>-5</sup> f <sup>1/2</sup>	-
2 GHz ≤ f < 6 GHz	1.4 × 10 <sup>2</sup>	4.5 × 10 <sup>-1</sup>	-
6 GHz ≤ f ≤ 300 GHz	1.4 × 10 <sup>2</sup>	4.5 × 10 <sup>-1</sup>	50



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

Note B1-2:  $[ALs(E)]^2$  and  $[ALs(B)]^2$  are to be averaged over a six-minute period. For RF pulses, the peak power density averaged over the pulse width shall not exceed 1000 times the respective  $ALs(S)$  value. For multi-frequency fields the analysis shall be based on summation, as explained in the practical guides produced by the European Commission.

Note B1-3:  $ALs(E)$  and  $ALs(B)$  represent maximum calculated or measured values at the employee's 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 Regulation 5, in specific non-uniform conditions, criteria for the spatial averaging of measured fields based on established dosimetry has been laid down in the practical guides produced by the European Commission. 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  $20 \text{ cm}^2$  of exposed area. Spatial maximum power densities averaged over  $1 \text{ cm}^2$  should not exceed 20 times the value of  $50 \text{ Wm}^{-2}$ . Power densities from 6 GHz to 10 GHz are to be averaged over any six-minute period. Above 10 GHz the power density shall be averaged over any  $68/f^{1.05}$ -minute period (where  $f$  is the frequency in GHz) to compensate for progressively shorter penetration depth as the frequency increases.

Table B2. ALs for steady state contact currents and induced limb currents		
Frequency range	Steady state contact current, $ALs(I_c)$ [mA] (RMS)	Induced limb current in any limb, $ALs(I_L)$ [mA] (RMS)
$100 \text{ kHz} \leq f < 10 \text{ MHz}$	40	-
$10 \text{ MHz} \leq f \leq 110 \text{ MHz}$	40	100

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