

THE SCHEDULE **U.K.**

Regulations 2, 5, 6, 7 and 20.

PART 1 **U.K.**

Introduction to Parts 2 and 3

1. In this schedule—

“contact current (I_C)” is the current created when a person comes into contact with an object in an electromagnetic field, expressed in amperes (A);

“external electric field strength (E)” is a vector quantity corresponding to the force exerted on a charged particle in the environment, irrespective of its motion in space, expressed in volts per metre (Vm^{-1});

“internal electric field strength (E)” is a vector quantity corresponding to the force exerted on a charged particle inside the human body, irrespective of its motion in space, expressed in volts per metre (Vm^{-1});

“limb current (I_L)” is the current induced in the limbs of a person exposed to electromagnetic fields in the frequency range from 10 MHz to 110 MHz, expressed in amperes (A);

“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 watts per square metre (Wm^{-2});

“specific energy absorption (SA)” is the energy absorbed per unit mass of biological tissue, expressed in joules per kilogram (Jkg^{-1}); and

“specific energy absorption rate (SAR)” is the rate at which energy is absorbed per unit mass of body tissue, expressed in watts per kilogram (Wkg^{-1}).

2. The ALs and ELVs set out in tables are grouped according to their potential effects, being—

(a) thermal effects, related to the heating of tissue due to its absorption of electromagnetic fields; and

(b) non-thermal effects, related to the stimulation of muscles, nerves or sensory organs due to the presence of electromagnetic fields.

3. The low ALs in Table AL1 in Part 2, and the ALs in Part 3, specify the electromagnetic field levels above which specific indirect effects may occur.

4. The remaining ALs in Part 2 are defined physical quantities related to the direct biophysical effects of exposure to electromagnetic fields. Employers may, as part of their exposure assessment, assess electromagnetic field levels against these ALs. Each AL table states which ELV or ELVs will be complied with if electromagnetic field levels at a particular frequency do not exceed the specified AL. Exposure to electromagnetic field levels that exceeds an AL may still be below the relevant ELV, but in order to determine this the employer will need to undertake a further assessment under regulation 6.

5. Except where otherwise indicated—

(a) “f” is the frequency expressed in hertz;

(b) the ALs and ELVs relate to exposure in any part of the body; and

(c) notes to the tables apply only to the table under which they appear.

Status: Point in time view as at 21/11/2016.

Changes to legislation: There are currently no known outstanding effects for the The Merchant Shipping and Fishing Vessels (Health and Safety at Work) (Electromagnetic Fields) Regulations 2016, THE SCHEDULE. (See end of Document for details)

6. The applicable safety measures referred to in regulation 5(2) are those required by the notes to the table or tables containing the sensory effect ELV which is to be exceeded, being the note to Table ELV1, and note 2 to Tables ELV3 and ELV5.

PART 2 U.K.

Direct biophysical effects of exposure

Action Levels – non-thermal effects

Table AL1 – ALs for exposure to electromagnetic fields from 1 Hz to 10 MHz

<i>Frequency range</i>	<i>External electric field strength Low ALs (E) [Vm⁻¹]</i>	<i>External electric field strength High ALs (E) [Vm⁻¹]</i>
1 ≤ f < 25 Hz	2.0 × 10 ⁴	2.0 × 10 ⁴
25 ≤ f < 50 Hz	5.0 × 10 ⁵ /f	2.0 × 10 ⁴
50 Hz ≤ f < 1.64 kHz	5.0 × 10 ⁵ /f	1.0 × 10 ⁶ /f
1.64 ≤ f < 3 kHz	5.0 × 10 ⁵ /f	6.1 × 10 ²
3 kHz ≤ f ≤ 10 MHz	1.7 × 10 ²	6.1 × 10 ²
Exposure levels not exceeding Tables ELV2 and ELV3 the ALs will be compliant with:		

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NOTES

1. Between the Low and High ALs, exposure will be below the ELVs but spark discharges may occur. These can be prevented through the provision of information and training under regulation 19 and the use of suitable technical and personal protection measures.

2. The ALs in Tables AL1 and AL2 are root mean square (RMS) values of the field strength. These RMS values are equal to the peak values divided by √2 for sinusoidal fields. The corresponding ELVs in Tables ELV2 and ELV3 are peak values in time, which are equal to the RMS values multiplied by √2 for sinusoidal fields. In the case of non-sinusoidal fields, the exposure assessment under regulation 6 must be based on the weighted peak method (filtering in time domain) or on a scientifically proven and validated exposure evaluation procedure which produces comparable results to the weighted peak method.

3. The ALs represent the maximum field values at any place where a worker may be working, before the entry of any person into the field. In the case of an electromagnetic field source in the immediate vicinity of the body, compliance with the ELVs must be determined dosimetrically on a case by case basis.

Table AL2 – ALs for exposure to electromagnetic fields from 1 Hz to 10MHz

<i>Frequency Range</i>	<i>Magnetic flux density Low ALs (B) [μT]</i>	<i>Magnetic flux density High ALs (B) [μT]</i>	<i>Magnetic flux density ALs for exposure of limbs to</i>
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			<i>a localised magnetic field (B) [μT]</i>
$1 \leq f < 8 \text{ Hz}$	$2.0 \times 10^5/f^2$	$3.0 \times 10^5/f$	$9.0 \times 10^5/f$
$8 \leq f < 25 \text{ Hz}$	$2.5 \times 10^4/f$	$3.0 \times 10^5/f$	$9.0 \times 10^5/f$
$25 \leq f < 300 \text{ Hz}$	1.0×10^3	$3.0 \times 10^5/f$	$9.0 \times 10^5/f$
$300 \text{ Hz} \leq f < 3 \text{ kHz}$	$3.0 \times 10^5/f$	$3.0 \times 10^5/f$	$9.0 \times 10^5/f$
$3 \text{ kHz} \leq f \leq 10 \text{ MHz}$	1.0×10^2	1.0×10^2	3.0×10^2
Exposure levels not exceeding the ALs will be compliant with:	At and below 400 Hz: The health effect ELVs in Table ELV2 the sensory effect ELVs in Table ELV3 Above 400 Hz: the health effect ELVs in Table ELV2		

NOTES

1. Between the Low and High ALs for exposure up to 400 Hz, exposure in the head of the worker will be below the health effect ELVs but may exceed the sensory effect ELVs in Table ELV3.

2. Notes 2 and 3 to Table AL1 apply.

Action levels – thermal effects

Table AL3 – ALs for exposure to electromagnetic fields from 100 kHz to 300 GHz

<i>Frequency Range</i>	<i>External electric field strength ALs (E) [Vm^{-1}]</i>	<i>Magnetic flux density ALs (B) [μT]</i>	<i>Power density ALs (S) [Wm^{-2}]</i>
$100 \text{ kHz} \leq f < 1 \text{ MHz}$	6.1×10^2	$2.0 \times 10^6/f$	
$1 \leq f < 10 \text{ MHz}$	$6.1 \times 10^8/f$	$2.0 \times 10^6/f$	
$10 \leq f < 400 \text{ MHz}$	61	0.2	
$400 \text{ MHz} \leq f < 2 \text{ GHz}$	$3.0 \times 10^{-3} f^{1/2}$	$1.0 \times 10^{-5} f^{1/2}$	
$2 \leq f < 6 \text{ GHz}$	1.4×10^2	4.5×10^{-1}	
$6 \leq f \leq 300 \text{ GHz}$	1.4×10^2	4.5×10^{-1}	50
Exposure levels not exceeding the ALs will be compliant with:	Up to 6 GHz: the health effect ELVs in Table ELV4 6 to 300 GHz: the health effect ELV in Table ELV6 The health effect ELV in Table ELV6		

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NOTES

1. The electric field strength and magnetic flux density ALs are root mean square values.

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2. For radiofrequency pulses, the peak power density averaged over the pulse width must not exceed 1000 times the respective AL (S) value. For multi-frequency fields, the analysis must be based on summation.

3. Note 3 to Table AL1 applies in relation to the ALs for electric field strength and magnetic flux density.

4. The power density is the maximum level averaged over any 20cm² of exposed area. Spatial maximum power densities averaged over 1cm² must not exceed 20 times the value of 50 Wm⁻².

5. From 6 to 10 GHz, power density must be averaged over a six minute period. Above 10 GHz, it must be averaged over a 68/f^{1.05}-minute period (where f is the frequency in GHz).

Table AL4 – AL for exposure to electromagnetic fields from 10 to 110 MHz

<i>Frequency range</i>	<i>Limb current AL (I_L) [mA]</i>
10 ≤ f ≤ 110 MHz	100
Exposure levels not exceeding the ALs will be compliant with:	The health effect ELV in table ELV4 - localised SAR in the limbs

NOTE

The AL is a root mean square value.

Exposure Limit Values – non-thermal effects

Table ELV1 – ELVs for exposure to electromagnetic fields from 0 to 1 Hz

<i>Area of exposure</i>	<i>Sensory effect ELVs –magnetic flux density (B₀) [T]</i>
Head and Trunk	2
Limbs	8
	<i>Health effect ELV –magnetic flux density (B₀) [T]</i>
Any part of the body	8

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NOTE

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The sensory effect ELVs may be exceeded during a worker's shift where the employer ensures that—

- (a) they are only exceeded temporarily;
- (b) protection measures have been adopted which minimise, so far as is reasonably practicable, the sensory effects related to movement in static magnetic fields, including nausea and vertigo;
- (c) adequate information is provided to the worker on the possibility of those sensory effects; and

- (d) where any of those sensory effects are reported to the employer, the exposure assessment under regulation 6 and the protection measures are updated where necessary.

Table ELV2 - Health effect ELVs for exposure to electromagnetic fields from 1 Hz to 10 MHz

<i>Frequency range</i>	<i>Health effect ELVs – internal electric field strength (E) [Vm^{-1}]</i>
$1 \text{ Hz} \leq f < 3 \text{ kHz}$	1.1
$3 \text{ kHz} \leq f \leq 10 \text{ MHz}$	$3.8 \times 10^{-4} f$

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NOTES

1. The ELVs are limits for electric fields induced in the body from exposure to time-varying electric and magnetic fields.
2. The ELVs are spatial peak values in the entire body of the worker.
3. Note 2 to Table AL1 applies in relation to methods of determining exposure.

Table ELV3 - Sensory effect ELVs for exposure to electromagnetic fields from 1 to 400 Hz

<i>Frequency range</i>	<i>Sensory effect ELVs- internal electric field strength (E) [Vm^{-1}]</i>
$1 \leq f < 10 \text{ Hz}$	$0.7/f$
$10 \leq f < 25 \text{ Hz}$	0.07
$25 \leq f \leq 400 \text{ Hz}$	$0.0028 f$

NOTES

1. The ELVs are spatial peak values induced in the head of the exposed worker, and can arise from exposure to either external electric or external magnetic fields.
2. The ELVs may be exceeded during a worker's shift where the employer ensures that—
 - (a) they are only exceeded temporarily;
 - (b) hazardous spark discharges and contact currents in excess of those in Table AL5 are prevented through the provision of information and training under regulation 19 and the use of suitable technical and personal protection measures;
 - (c) adequate information is provided to the worker on the possibility of sensory effects related to time-varying magnetic fields, including retinal phosphenes; and
 - (d) where any of those sensory effects are reported to the employer, the risk assessment is updated where necessary.
3. Note 2 to Table AL1 applies in relation to methods of determining exposure.

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Exposure Limit Values – thermal effects

Table ELV4 - Health effect ELVs for exposure to electromagnetic fields from 100 kHz to 6 GHz

<i>Area of exposure</i>	<i>Health effect ELVs – specific energy absorption rate (SAR)[Wkg⁻¹]</i>
Whole body	0.4 (averaged SAR in the body)
Head and trunk	10 (averaged SAR in the head and trunk)
Limbs	20 (averaged SAR in the limbs)

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NOTES

1. The ELVs correspond to the SAR values averaged over a six minute period.
2. Localised SAR in the body and limbs can be assessed by either computational dosimetry or physical measurement of 10g of tissue. For computational dosimetry, 10 grams of contiguous tissue with approximately homogeneous electrical properties must be used for the SAR average. For direct physical measurements, a simple geometry, such as cubic or spherical tissue mass, may be used. The maximum value obtained must be assessed against the ELVs.

Table ELV5 - Sensory effect ELVs for exposure to electromagnetic fields from 300 MHz to 6 GHz

<i>Frequency range</i>	<i>Sensory effect ELV - specific energy absorption in the head (SA)[mJkg⁻¹]</i>
300 MHz ≤ f ≤ 6 GHz	10

NOTES

1. When determining SA, energy absorption must be averaged over 10 grams of tissue.
2. The ELV may be exceeded during a worker's shift where the employer ensures that—
 - (a) it is only exceeded temporarily;
 - (b) adequate information is provided to the worker on the possibility of sensory effects related to pulsed microwave radiation, including auditory sensations; and
 - (c) where any of those sensory effects are reported to the employer, the risk assessment is updated where necessary.

Table ELV6 – Health effect ELVs for exposure to electromagnetic fields from 6 to 300 GHz

<i>Frequency range</i>	<i>Health effect ELVs - power density (S) [Wm⁻²]</i>
6 GHz ≤ f ≤ 300 GHz	50

NOTES

1. The power density is the maximum level averaged over any 20cm² of exposed area. Spatial maximum power densities averaged over 1cm² must not exceed 20 times the value of 50 Wm⁻².
2. From 6 to 10 GHz, power density must be averaged over a six-minute period. Above 10 GHz, it must be averaged over a $68/f^{1.05}$ -minute period (where f is the frequency in GHz).

PART 3 U.K.

Indirect effects of exposure

Action levels – non-thermal effects

Table AL5 - ALs for contact currents

<i>Frequency of electromagnetic field in which an object is present</i>	<i>Contact current ALs (I_c)[mA]</i>
up to 2.5 kHz	1.0
$2.5 \leq f < 100$ kHz	0.4 f
$100 \leq f \leq 10,000$ kHz	40

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NOTES

1. “f” is the frequency expressed in kHz.
2. The ALs are root mean square values.
3. The ALs represent the maximum steady state current created during a continuous contact with an object in an electromagnetic field.

Table AL6 – ALs for static magnetic fields

<i>Potential indirect effect</i>	<i>Magnetic flux density ALs (B₀)[mT]</i>
Interference with active implanted medical devices	0.5
Attraction and projectile risk in the fringe field of high field strength sources (> 100 mT)	3

NOTE

The AL for interference with active implanted medical devices represents the maximum field value at any place where a worker may be working.

Action levels – thermal effects

Table AL7 - AL for contact currents

<i>Frequency of electromagnetic field in which an object is present</i>	<i>Contact current ALs (I_c) [mA]</i>
$100 \text{ kHz} \leq f < 110 \text{ MHz}$	40

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NOTES

1. The AL is a root mean square value.
2. The AL represents the maximum steady state current created during a continuous contact with an object in an electromagnetic field.

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