

Professional Associations (BG)
Regulation for Occupational
Health and Safety at Work

BGV B 1 1

BG-Regulation

Accident Prevention Regulation

Electromagnetic Fields

June 2001



HVBG

Hauptverband der
gewerblichen
Berufsgenossenschaften

*(Central Federation of
Industrial Professional
Associations)*

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Preface

The current situation in workplaces requires a regulation in occupational safety for areas, in which electric, magnetic or electromagnetic fields (EM fields) are applied.

This accident prevention regulation takes these circumstances into account and sets provisions on

- basic regulations
- permissible values for exposure assessment
- measurement and calculation methods
- specific provisions for special installations

such, that by complying with them in accordance with current scientific data, all activities can be performed safely and without too much inconvenience.

I. Scope

§ 1

Scope

(1) This accident prevention regulation applies to insured persons exposed to direct or indirect effects of electric, magnetic or electromagnetic fields (hereinafter called EM fields) in the frequency range from 0 Hz to 300 GHz.

(2) This accident prevention regulation does not apply to the deliberate exposure of patients to EM fields during medical treatment.

(3) This accident prevention regulation does not apply in those cases where the 26th Ordinance Implementing the Federal Emission Control Act (EMF Ordinance – 26th BimSchV) applies.

II. Definitions

§ 2

Definitions

For the purpose of this accident prevention regulation the following definitions apply:

1. **Basic values** are limit values specified on the basis of direct or indirect effects for
 - electric current density, J , in the body, in A/m^2
 - specific absorption, SA , in J/kg
 - specific absorption rate, SAR , in W/kg
 - power density, S , in W/m^2The basic values shall not be exceeded.
2. **Derived values** are values derived from the basic values for
 - electric field strength, E , in V/m
 - magnetic field strength, H , in A/m
 - magnetic flux density, B , in T ($1T = 1 Vs/m^2$)
 - power density, S , in W/m^2
 - body current I in A
 - contact voltage, U , in Vduring whole-body and partial-body exposure to EM fields.
3. **Permissible value** is the upper limit of a quantity that should be complied with.
4. **Impermissible exposure** occurs when insured persons are exposed to EM fields above the permissible values.

5. **Exposure area 2** is the area that comprises all areas within the enterprise, provided they cannot be allocated to exposure area 1, the increased exposure area or the hazardous area (see items 6 to 8).
6. **Exposure area 1** is the area that comprises controlled areas and areas, such as operating areas, in which it is ensured that exposure exceeding the permissible values of exposure area 2 occurs only temporarily, as a result of operation or exposure duration.
7. **Increased exposure area** is a controlled area, in which the values of exposure area 1 are exceeded.
8. **Hazardous area** is a controlled area, in which the values of increased exposure areas are exceeded.
9. **Protective devices** are electrical or mechanical devices that prevent impermissible exposures.

III. Measures to prevent hazards to life and health at work

A. Common provisions

§ 3

General requirements

(1) Unless otherwise specified, provisions of this Section III are addressed to employers and insured persons.

(2) The employer shall ensure that neither impermissible exposure nor impermissible indirect effects due to EM fields occur in work locations and workplaces.

§ 4

Assessment of exposure areas

(1) The employer shall ensure that the permissible values given in Appendix 1 are not exceeded in exposure areas. For this reason the employer should

- determine the exposure areas
- investigate the occurrence of EM fields
- assess the exposure by comparison with the permissible values given in Appendix 1

(2) If it is ensured that permissible values for exposure area 2 are not exceeded, then no measures are required. § 12 does not apply.

(3) If permissible values are exceeded in the determined exposure areas, the employer shall apply immediate measures in order to prevent the occurrence of impermissible exposures.

(4) Following modifications on equipment and installations that can be field-relevant, a new exposure assessment according to Sections 1 to 3 is required.

§ 5

Operating instructions

(1) The employer shall issue operating instructions for installations and equipment where EM fields exceed the permissible values specified for exposure area 2. They should contain the required information for safe operation and point out the possibility of exposure to EM fields.

(2) The insured persons shall comply with the requirements specified in the operating instructions.

§ 6

Increased exposure areas, hazardous areas

(1) The employer shall determine increased exposure areas and hazardous areas. The results shall be recorded.

(2) The employer shall re-determine increased exposure areas and hazardous areas following field-relevant modifications of installations and equipment. The modifications shall be recorded.

(3) The employer shall identify increased exposure areas accordingly.

(4) Section 3 does not apply when the safety of the installation is otherwise ensured, e.g. by means of construction and mode of operation.

(5) The employer shall secure increased exposure areas in such way, that unauthorised persons cannot remain within these areas during the operation of the installation and equipment.

(6) The employer shall ensure that only authorised persons carry out work activities in the increased exposure areas unless

- by technical or organisational measures it is ensured that permissible values for short term and partial-body exposure are not exceeded

or

- personal protective equipment (see § 8) is used in order to prevent impermissible exposure.

(7) The employer shall identify and protect hazardous areas by means of permanent barriers or protective devices in order to ensure that during operation no person can reach into, enter or remain within these areas. In restricted operating areas, which can only be entered by authorised persons, the identification as a hazardous area is adequate.

(8) If a hazardous area depends on the mode of operation of the installation, then the employer shall ensure by means of continuous controls that insured persons are not exposed to impermissible exposures.

(9) If a hazardous area cannot be clearly determined or is subject to temporary changes, then the employer shall ensure by repeated measurements of the EM fields in the working area that no permissible exposure exists to the insured persons.

(10) Deviating from Section 7, insured persons may carry out work activities in hazardous areas when suitable personal protective equipment precludes impermissible exposure.

§ 7

Identification and barriers

(1) The employer shall ensure that the identification in accordance with this accident prevention regulation is permanently fixed in a clearly visible position by means of warning signs, indicating signs or additional signs, as well as prohibition signs and signal lights.

(2) The employer shall ensure that barriers in accordance with this accident prevention regulation shall be installed in such a manner as to provide the required safety.

(3) If permanent barriers have to be removed in order to perform work in accordance with § 15, they must be re-installed after completion of work. If temporary barriers are installed to perform such work, these shall be removed upon completion of this work. Only then the person in control of the installation may give permission for the installation to be released again for operation.

§ 8

Personal protective equipment

(1) The employer shall select and provide personal protective equipment to the insured persons.

(2) The insured persons shall use the personal protective equipment provided to them.

§ 9

Testing

(1) The employer shall ensure that testing is carried out in compliance with the provisions of this accident prevention regulation as follows:

- prior to first-time operation
- following essential modification or maintenance
- at regular time intervals.

(2) The testing shall be carried out by a competent person.

(3) The employer shall ensure that testing intervals are determined so that faults, which are likely to occur, can be detected in a timely manner.

§ 10

Instruction

(1) The employer shall instruct the insured persons on hazards which occur during performing work activities and on preventive measures prior to starting work and then subsequently at appropriate time intervals, but at least once per annum.

(2) The employer shall instruct insured persons working in hazardous areas every 12 months. Such instructions shall be recorded.

§ 11

Installation specific documentation

Data on the installation regarding EM fields, increased exposure areas and hazardous areas, as well as field-relevant modifications and testing reports, shall be

available during the operating time of the installation. These data shall be retained for at least ten years after the installation has been closed down.

B. Special provisions

§ 12

Indirect effects, medical implants

(1) The employer shall prevent with the aid of technical measures that insured persons can be injured by energies, which are generated by EM fields in electrically conducting objects.

(2) If there is a likelihood that systems will fail due to the effects of EM fields and thereby endanger the insured persons, the employer shall prevent this with the aid of technical and organisational measures.

(3) Persons with active or passive medical implants require particular measures in order to avoid interference with the function of the implant or injury to the person. The employer shall advise all insured persons on such possible hazards. The insured persons shall inform the employer on their implants, so that the employer can adopt required measures.

§ 13

Experimental facilities and mobile sources

(1) The employer shall ensure that in the case of experimental facilities and mobile sources, hazardous areas are separated, identified and the operating status „ON“ is indicated by red signal lights.

(2) The employer shall identify the access points to increased exposure areas.

§ 14

Installations with high static magnetic fields

1) In the case of high static magnetic fields, the values given in Table 1 of Appendix 2 can be used for insured persons as a basis for evaluating exposure, instead of the permissible values according to § 4, provided it is ensured that in addition, the provisions of Sections 2 to 8 are met.

(2) The employer shall ensure that hazards resulting from force effects of static magnetic fields are prevented.

(3) The employer shall secure areas, in which permissible values in accordance with Appendix 2 are applied, against unauthorised entry.

(4) Insured persons may only carry out work activities in these areas if this is possible with no risk to them.

(5) The employer shall advise the insured persons on special effects, such as force effects, and effects on electronic and medical devices.

(6) The employer shall advise on special effects and hazards by means of identification.

(7) The employer shall ensure that decisions regarding the exposure of insured persons with active or passive medical implants and ferromagnetic or conductive implants shall be made on individual basis.

(8) The employer shall adopt a clear access regulation for insured persons in accordance with Section 7. He shall clearly identify the boundaries of the permissible areas.

§ 15

Maintenance, testing

(1) The employer shall ensure that maintenance work is carried out in accordance with the requirements of the operating instructions.

(2) The employer shall ensure that maintenance work in increased exposure areas is carried out only under the appropriate supervision of a competent person.

(3) If maintenance work in a hazardous area is unavoidable, then the employer shall ensure that

- EM fields shall be reduced by measures at the source, or if this is impossible for technical reasons, suitable personal protective equipment shall be used
- prior to starting work in the hazardous area insured persons are instructed and supervised by a person in control.

(4) Testing shall be carried out in compliance with Sections 1 to 3.

IV. Infringement

§ 16

Infringement

An infringement of § 209 Section 1, Book Seven of the Social Welfare Code (SGB VII), is a deliberate or negligent violation of the regulations of

- § 3 Section 1 in conjunction with

§ 4 Section 1,

§ 5, 6 Section 1, 2, 5, 6 or 7,

§ 9 Section 1,

§ 10, 13, 14 Section 2, 3, 5 to 8

or

§ 15 Section 1, 2 or 3.

V. Transitional and implementation provisions

§ 17

Transitional and implementation provisions

The Professional Association can decide that in deviation from the transition period according to § 61 of the Accident Prevention Regulation - "General regulations" (BGV A1, to date VBG 1), equipment shall be modified according to the requirements of this regulation, if hazards to life or limb are to be feared without this modification.

VI. Effective Date

§ 18

Effective Date

This accident prevention regulation comes into effect on

Appendix 1

Permissible values for EM fields

Basic values and derived values are specified as permissible values for various exposure areas. These apply to periodic sinusoidal processes of a frequency. For pulsed electromagnetic fields and the application of basic values see Sections 3 and 4.

The permissible values for **Exposure area 1** are aimed towards the concept of avoiding hazards by taking safety factors into account. The effects considered are the stimulation of sensory organs, nerves and muscle cells, disorderly action of the heart and thermal effects. The values are applicable to a working day at the longest.

For **Exposure area 2** values apply which take into account additional safety factors, due to general accessibility and in order to avoid potentially adverse effects.

1 Basic values for direct effects

Basic values for direct effects are the limit values given in Table 1.

Frequency range	Effective value of the electric current density J in A/m^2 ⁽¹⁾	Specific absorption rate SAR in W/kg ⁽⁴⁾			Specific absorption for pulsed fields SA in J/kg ^{(5), (6)}	Power density S in W/m^2 ^{(7), (8)}
		Whole-body average value	Local SAR ⁽⁵⁾			
			Person's head and trunk	Limbs		
>0 - 1 Hz	0.040	(-)	(-)	(-)	(-)	(-)
1 - 4 Hz	$0.040 / f$ ⁽²⁾	(-)	(-)	(-)	(-)	(-)
4 - 1000 Hz	0,010	(-)	(-)	(-)	(-)	(-)
1 - 100 kHz	$f / 100$ ⁽³⁾	(-)	(-)	(-)	(-)	(-)
0,1 - 10 MHz	$f / 100$ ⁽³⁾	0.4	10	20	(-)	(-)
0,01 - 10 GHz	(-)	0.4	10	20	0,01	(-)
10 - 300 GHz	(-)	(-)	(-)	(-)	(-)	50

(1) To be averaged over any cross section of 1 cm^2 perpendicular to the current flow and over any time interval of 1 s; **(2)** f in Hz; **(3)** f in kHz; **(4)** To be averaged arithmetically over any 6 minutes interval; **(5)** Averaged over mass 10 g; **(6)** Carrier frequency $f > 300\text{ MHz}$ and pulse length $T < 30\text{ }\mu\text{s}$; **(7)** To be averaged over any cross section of 20 cm^2 and any time interval of $68/f^{1,05}$ -minutes (f in GHz); **(8)** The maximum local power density averaged over any cross section of 1 cm^2 , shall not exceed 1 kW/m^2 ; **(-)** not relevant at these frequencies.

Table 1 Basic values for direct effects

2 Derived values

The derived values are set in such a way, that even under the most unfavourable exposure conditions to EM fields, basic values are not exceeded. The derived values for exposure area 1 and exposure area 2 were calculated from the basic values given in Table 1, taking into consideration various safety factors.

The derived values shall be adhered to. They may be exceeded provided the basic values are not exceeded.

The compliance with the derived values does not necessarily ensure the safety of wearers of active electronic devices.

The derived values are illustrated in Figures 1 and 2.

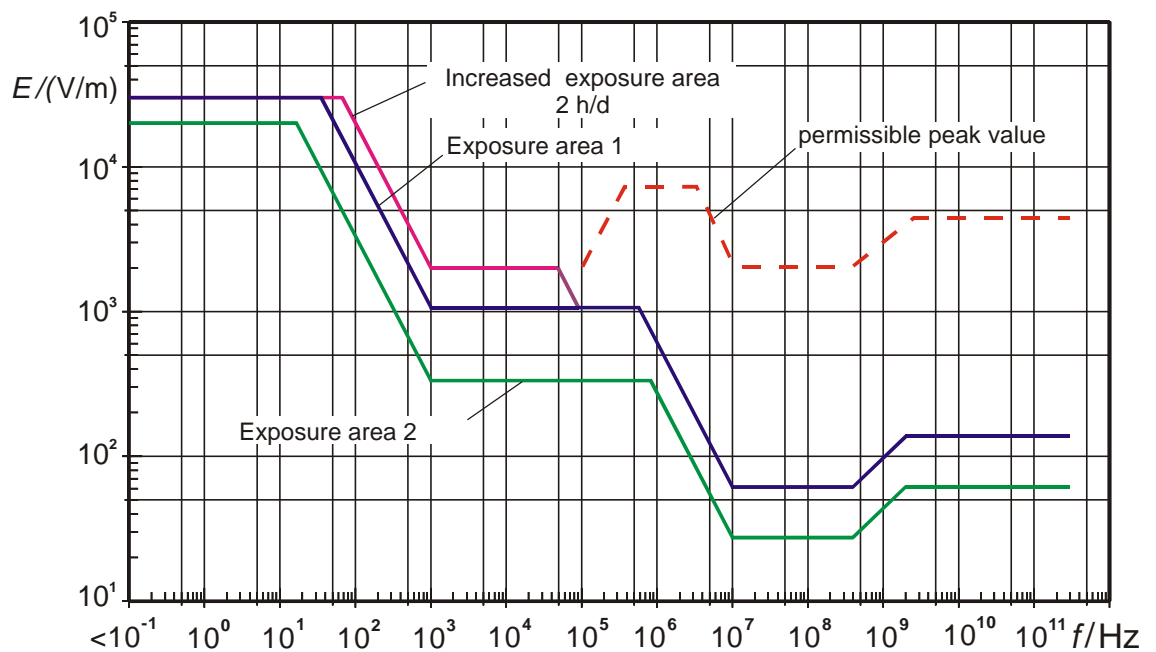


Figure 1 Permissible values of the electric field strength in exposure areas 1 and 2 and in the increased exposure area

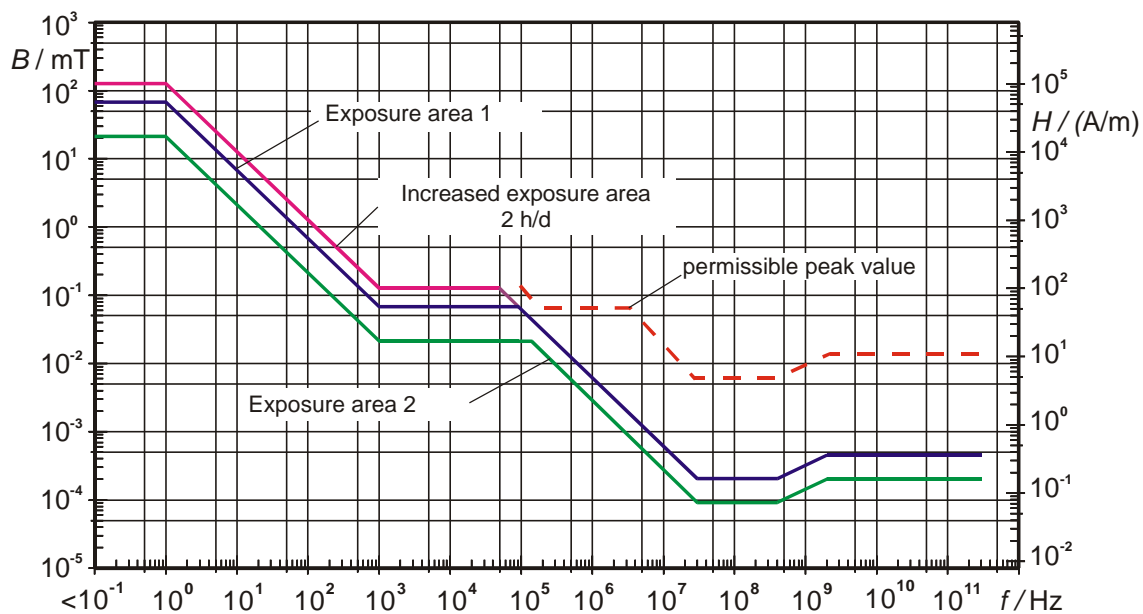


Figure 2 Permissible values of the magnetic flux density in exposure areas 1 and 2 and in the increased exposure area

2.1 Derived values in the frequency range from 0 Hz to 29 kHz

2.1.1 Permissible values in exposure area 1 and in the increased exposure area

When the values for short-time exposure are set, the safety factors of the derived values for exposure area 1 are reduced. This is permissible due to the magnitude of the safety factors and the controlled exposure conditions. In order to limit secondary effects, the electric field shall not exceed a value of 30 kV/m.

Frequency range f / Hz	Effective value of the electric field strength in kV/m	
	Exposure area 1	Increased exposure area 2 h/d
0 - 35.53	30	30
35.53 - 66.67	$1\,066 / f$	30
66.67 - 1000	$1\,066 / f$	$2\,000 / f$
1000 - 29000	1.066	2

Table 2 Effective values of the electric field strength in exposure area 1 and in the increased exposure area

The permissible value of the magnetic flux density in the frequency range 0 to 1 Hz of exposure area 1 was set as a result of induction effects on conductive bodies, moving in a magnetic field. In addition, the force effect on ferromagnetic parts shall be considered in this frequency range.

Frequency range <i>f</i> / Hz	Effective value of the magnetic flux density in mT ⁽¹⁾	
	Exposure area 1	Increased exposure area 2 h/d
0 - 1	67.9 ⁽²⁾	127.3 ⁽²⁾
1 - 1 000	67.9 / <i>f</i>	127.3 / <i>f</i>
1 000 - 29 000	67.9 × 10 ⁻³	127.3 × 10 ⁻³

⁽¹⁾ To be averaged over a cross section of 100 cm².
⁽²⁾ Values above 67,9 mT shall be used in compliance with § 14.

Table 3 Effective values of the magnetic flux density in exposure area 1 and in the increased exposure area

For limbs, the values for magnetic fields given in Table 3 may be exceeded by a factor of 2.5.

2.1.2 Permissible values in exposure area 2

Frequency range <i>f</i> / Hz	Effective value of the electric field strength in kV/m	Effective value of the magnetic flux density in mT ⁽¹⁾
0 - 1	20	21.22
1 - 16.67	20	21.22 / <i>f</i>
16.67 - 1 000	333.3 / <i>f</i>	21.22 / <i>f</i>
1 000 - 29 000	333.3 × 10 ⁻³	21.22 × 10 ⁻³

⁽¹⁾ To be averaged over a cross section of 100 cm²

Table 4 Effective values of the electric field strength and magnetic flux density in exposure area 2

2.2 Transition region 29 kHz to 91 kHz

The provisions for this frequency range take into account the transition from low frequency irritant effects to high frequency thermal effects.

2.2.1 Permissible values in exposure area 1 and in the increased exposure area

Frequency range <i>f</i> / kHz	Effective value of the electric field strength in kV/m	
	Exposure area 1	Increased exposure area 2 h/d
29 - 48.5	1.066	2
48.5 - 91	1.066	97 / <i>f</i>

Table 5 Effective values of the electric field strength in exposure area 1 and in the increased exposure area

Frequency range <i>f</i> / kHz	Effective value of the magnetic flux density in μT ⁽¹⁾	
	Exposure area 1	Increased exposure area 2 h/d
29 - 48.5	67.9	127.3
48.5 - 91	67.9	6 176 / <i>f</i>
⁽¹⁾ To be averaged over a cross section of 100 cm ²		

Table 6 Effective values of the magnetic flux density in exposure area 1 and in the increased exposure area

2.2.2 Permissible values in exposure area 2

Frequency range <i>f</i> / kHz	Effective value of the electric field strength in V/m	Effective value of the magnetic flux density in μT ⁽¹⁾
29 - 91	333.3	21.22
⁽¹⁾ To be averaged over a cross section of 100 cm ²		

Table 7 Effective values of the electric field strength and the magnetic flux density in exposure area 2

2.3 Derived values in the frequency range from 91 kHz to 300 GHz

For exposure times longer than 6 minutes (continuous exposure) values given in Tables 8 or 11 apply. An average time over any 6-minute time interval is required.

Besides the specification of permissible values for continuous exposure times of $t \leq 6$ minutes, higher values are permissible due to the body's thermoregulation. They shall be determined for each individual case by using the formulae given in Table 9. When using values given in Table 9, it shall be ensured that the peak values in Table 10 are not exceeded.

2.3.1 Permissible values in exposure area 1 and in the increased exposure area

Frequency range <i>f</i> / MHz	Effective value of the electric field strength in V/m	Effective value of the magnetic field strength in A/m	Average value of the power density in W/m ²
0.091 - 0.576	1 066	4.9 / <i>f</i>	(-)
0.576 - 10	614 / <i>f</i>	4.9 / <i>f</i>	(-)
10 - 30	61.4	4.9 / <i>f</i>	(-)
30 - 400	61.4	0.163	10
400 - 2 000	3.07 × √ <i>f</i>	8.14 × √ <i>f</i> × 10 ⁻³	<i>f</i> / 40
2 000 - 300 000	137.3	0.364	50

Table 8 Values in exposure area 1 for exposure times ≥ 6 minutes

Frequency range <i>f</i> / MHz	Peak value of $\sum E_i^2 \cdot t_i$ in (V/m) ² · min	Peak value of $\sum H_i^2 \cdot t_i$ in (A/m) ² · min	Peak value of $\sum S_i \cdot t_i$ in (W/m ²) · min
1 - 10	2.26 × 10 ⁶ / <i>f</i> ²	143 / <i>f</i> ²	(-)
10 - 30	22.6 × 10 ³	143 / <i>f</i> ²	(-)
30 - 400	22.6 × 10 ³	0.16	60
400 - 2 000	56.5 × <i>f</i>	0.4 × 10 ⁻³ × <i>f</i>	0.15 × <i>f</i>
2 000 - 300 000	113 × 10 ³	0.8	300

E_i, H_i measured or calculated effective value of the electric or magnetic field strength during *i*-ten interval
S_i measured or calculated average value of the power density during the *i*-ten interval
t_i Duration of the *i*-ten interval

Table 9 Values in the increased exposure area (exposure times < 6 minutes)

Frequency range <i>f</i> / MHz	Peak value of the electric field strength in V/m	Peak value of the magnetic field strength in A/m	Peak value of the power density in W/m ²
0.091 - 0.1	2 222	10 / <i>f</i>	(-)
0.1 - 0.2	22 222 × <i>f</i>	10 / <i>f</i>	(-)
0.2 - 0.3	22 222 × <i>f</i>	50	(-)
0.3 - 3	6 667	50	(-)
3 - 10	20 000 / <i>f</i>	150 / <i>f</i>	(-)
10 - 30	2 000	150 / <i>f</i>	(-)
30 - 400	2 000	5	10 000
400 - 2 000	100 × √ <i>f</i>	0.25 × √ <i>f</i>	25 × <i>f</i>
2 000 - 300 000	4 472	11.2	50 000

Table 10 Peak values in the increased exposure area (exposure times < 6 minutes)

2.3.2 Permissible values in exposure area 2

Frequency range <i>f</i> / MHz	Effective value of the electric field strength in V/m	Effective value of the magnetic field strength in A/m	Average value of the power density in W/m ²
0.091 - 0.14	333.3	16.8	(-)
0.14 - 0.826	333.3	2.35 / <i>f</i>	(-)
0.826 - 10	275 / <i>f</i>	2.35 / <i>f</i>	(-)
10 - 30	27.5	2.35 / <i>f</i>	(-)
30 - 400	27.5	0.073	2
400 - 2000	1.375 × √ <i>f</i>	3.64 × √ <i>f</i> × 10 ⁻³	<i>f</i> / 200
2000 - 300000	61.5	0.163	10

Table 11 Values in exposure area 2 for exposure times ≥ 6 minutes

2.3.3 Permissible values for high frequency currents in the frequency range from 10 MHz to 110 MHz

In the frequency range 10 MHz to 110 MHz high frequency currents can couple with the human body and as a result the SAR values in the limbs can be exceeded. For this reason, additionally to the field strengths, the currents are limited by the limbs.

Exposure area	Permissible current in mA
Exposure area 1	100
Exposure area 2	45

Table 12 Permissible values for coupled high frequency currents

2.3.4 Assessment of exposure to electromagnetic fields at multiple frequencies

In electromagnetic fields at multiple frequencies impermissible exposures in the frequency range 91 kHz to 300 GHz are prevented, if the following conditions are adhered to.

$$\sum_k \left(\frac{E_k}{E_{a,k}} \right)^2 \leq 1; \quad \sum_k \left(\frac{H_k}{H_{a,k}} \right)^2 \leq 1; \quad \sum_k \frac{S_k}{S_{a,k}} \leq 1$$

Where

- E_k, H_k* measured or calculated spectral effective values of the electric or magnetic field strength averaged over any 6-minute interval
- S_k* average value of the power density averaged over any 6-minute interval

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$E_{a,k}$, $H_{a,k}$, $S_{a,k}$ permissible values of the electric or magnetic field strength and power density according to Tables 8 and 11

2.4 Permissible values for indirect effects

Permissible values for body currents and contact currents are given in Table 13.

Frequency f	Permissible body current in mA	Permissible contact voltage in V
0 Hz	10	60
$1 \text{ Hz} \leq f < 100 \text{ Hz}$	3.5	25
$100 \text{ Hz} \leq f < 2 \text{ kHz}$	$1.75 \times (f / \text{kHz}) + 3.3$	25
$2 \text{ kHz} \leq f < 3.8 \text{ kHz}$	$1.4 \times (f / \text{kHz}) + 4.2$	25
$3.8 \text{ kHz} \leq f < 12 \text{ kHz}$	$1.4 \times (f / \text{kHz}) + 4.2$	$1.05 \times (f / \text{kHz}) + 20.5$
$12 \text{ kHz} \leq f < 28 \text{ kHz}$	$1.75 \times (f / \text{kHz})$	$1.05 \times (f / \text{kHz}) + 20.5$
$28 \text{ kHz} \leq f < 100 \text{ kHz}$	50	$1.05 \times (f / \text{kHz}) + 20.5$
$100 \text{ kHz} \leq f < 1 \text{ MHz}$	50	125

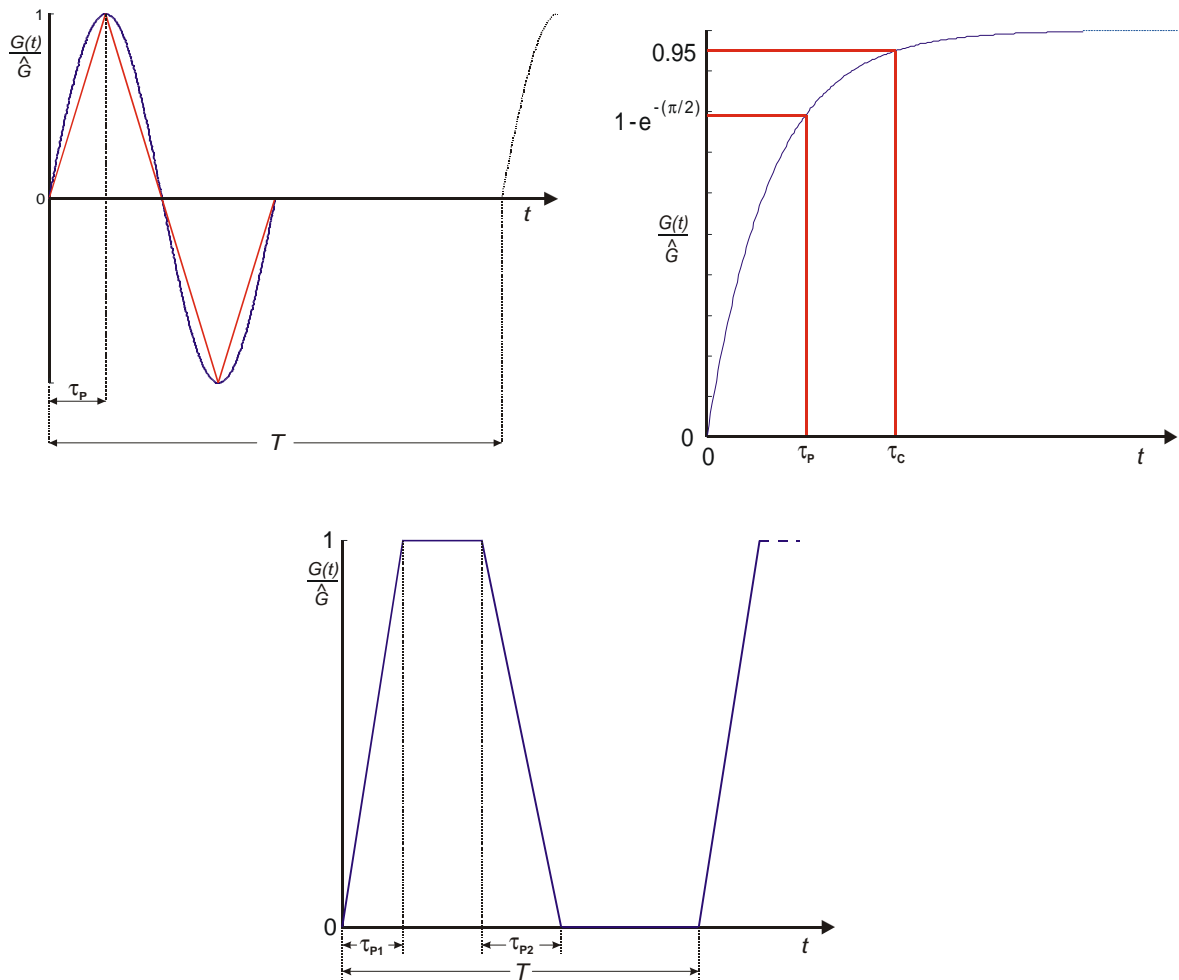
Table 13 Permissible body currents and contact voltages

Values for permissible body currents and permissible contact voltages given in Table 13 do not apply to the influence of pipelines, telecommunication networks and signal equipment, with which voltages can couple, from parallel running high voltage railway installations and the electrical power supply.

3 Pulsed fields

For pulsed fields, which in the sequence of time consist of sinusoidal, trapezoidal, triangular or exponential single and multiple pulses and pauses, or constant field components, a simplified assessment can be performed by using the provisions of the following sections.

3.1 Frequency range from 0 Hz to 91 kHz



These fields are designated by additional parameters as follows:

G	Instead of quantity G use the electric field strength E , the magnetic field strength H or the magnetic flux density B . $G(t)$ indicates the time function, \hat{G} the peak value.
T	Pulse duration or pulse width with the following break.
T_1	Integration time, where: $T_1 = \begin{cases} T & \text{for } T \leq 1\text{s} \\ 1\text{s} & \text{alternative} \end{cases}$
t_p	Time duration of a field change for sinusoidal, triangular or trapezoidal signal curves from zero to the positive or negative peak value or from the positive or negative peak value to zero respectively. The investigation of t_p for exponential signal curves shall be performed according to the above diagram. If the individual time durations t_{p1} differ, then all these values t_{p1} shall be included for further calculations.

t_{pmin}	The smallest value for all time durations t_{Pi} : $t_{pmin} = \min (t_{Pi})$
t_C	Auxiliary quantity for defining exponential signal curves. If the individual time durations t_{Ci} differ, then all these values t_{Ci} shall be included for further calculations.
t_D	Sum of time of all field changes i during a time interval T_i . this concerns: - sinusoidal, triangular, trapezoidal signal curves: $t_D = \sum_i t_{Pi}$ - exponential signal curves: $t_D = \sum_i t_{Ci}$
f_p	Frequency of a field change, where: $f_p = \frac{1}{4 \times t_{pmin}}$
V	Weighting factor, where: $V = \begin{cases} \sqrt{T_i/t_D} & \text{for } \sqrt{T_i/t_D} \leq V_{max} \\ V_{max} & \text{alternative} \end{cases}$
V_{max}	Maximum weighting factor. Where fundamentally: $V_{max} = 8$.

The maximum weighting factor can be increased during operation of magnetic resonance installations in science and research, and in the course of a medical treatment under the following conditions, if

- the installation complies with the obligatory requirements of the national legal regulations, which implement relevant common regulations
- risk assessments for workplaces in accordance with the requirements of the Occupational Health and Safety Law are prepared and recorded under particular consideration of hazards due to exposure to electromagnetic fields
- the required protective measures are implemented
- work activities are carried out under medical supervision or in the presence of a competent person

Values for the permissible time rate changes of the magnetic flux density for pulsed fields in the frequency range 0 Hz to 91 kHz are given in Table 14. At the same time the values given in Table 15, which are averaged over the time duration t_{pmin} of the time rate change of the magnetic flux density, shall not be exceeded.

Frequency range f_p / Hz	Maximum permissible time rate change of the magnetic flux density in T/s	
	Exposure area 1	Increased exposure area 2 h/d
0 - 1	$0.6 \times f_p \times V$	$1.1 \times f_p \times V$
1 - 1 000	$0.6 \times V$	$1.1 \times V$
1 000 - 48 500	$6 \times 10^{-4} \times f_p \times V$	$1.1 \times 10^{-3} \times f_p \times V$
48 500 - 91 000	$6 \times 10^{-4} \times f_p \times V$	$55 \times V$

Table 14 Maximum permissible time rate change of the magnetic flux

density in exposure area 1 and in the increased exposure area

Frequency range f_p / Hz	Average permissible time rate change of the magnetic flux density in T/s	
	Exposure area 1	Increased exposure area 2 h/d
0 - 1	$0.6 \times f_p \times V$	$1.1 \times f_p \times V$
1 - 1 000	$0.6 \times V$	$1.1 \times V$
1 000 - 48 500	$6 \times 10^{-4} \times f_p \times V$	$1.1 \times 10^{-3} \times f_p \times V$
48 500 - 91 000	$6 \times 10^{-4} \times f_p \times V$	$55 \times V$

Table 15 Average permissible time rate change of the magnetic flux density in exposure area 1 and in the increased exposure area, averaged over a time duration t_{pmin} .

For limbs, the values given in Tables 14 and 15 may be exceeded by a factor of 2.5.

The maximum permissible peak values of the magnetic flux density for pulsed magnetic fields result from the values given in Table 15 by multiplying factor t_{pmin} or the values given in Tables 3 and 6 by multiplying formula $\sqrt{2} \times V$ respectively.

3.2 Frequency range from 91 kHz to 300 MHz

The basic values for pulsed fields given in Table 1 are complied with, when the effective values given in Table 9 and the peak values given in Table 10 are applied.

4 Application of basic values

In the case of non-application of derived values for whole-body exposure, it shall be ensured that under all occurring conditions basic values are adhered to. In this case basic values given in Table 1 are multiplied by the factors given in Table 16, for an additional safety factor.

Frequency	Exposure area 1	Exposure area 2
0 Hz – 91 kHz	0.6	0.2
91 kHz – 300 GHz	1.0	0.2

Table 16 Reduction factors for the assessment of basic values

In the increased exposure area and for partial-body exposure, basic values according to Table 1 shall be complied with.

Appendix 2

Permissible values for installations with high static magnetic fields

Exposure	Magnetic flux density
Average value for 8h (averaged over the whole body)	212 mT
Peak value for a person's head and trunk	2 T
Peak value for limbs	5 T

Table 1 Permissible values for the static magnetic flux density

In the field of science and research and in an individual case, e.g. in the course of a medical treatment, the values given in Table 2 can be applied, if the user of the installation ensures that

- the installation complies with the obligatory requirements of the national legal regulations, which implement relevant common regulations
- risk assessments for workplaces in accordance with the requirements of the Occupational Health and Safety Law are prepared and recorded under particular consideration of hazards due to the exposure to electromagnetic fields
- the required protective measures are implemented
- work activities are carried out under medical supervision or in the presence of a competent person.

Exposure	Magnetic flux density
Peak value for a person's head and trunk (maximum 2 h/d) For exposures over 2h/d refer to Table 1	4 T
Peak value for limbs	10 T

Table 2 Permissible values for the static magnetic flux density under consideration of particular requirements