

# Health and safety during demagnetization

## 1. Overview

This White Paper provides an overview of the guidelines and specifications for occupational safety regarding the demagnetization of generated electromagnetic fields.

### 1.1. Damaging and interfering mechanisms

In the area of health protection against non-ionizing radiation, frequency ranges of up to 300 GHz are handled. Demagnetization devices are usually operated in low frequency ranges (power frequency 50/60Hz or lower). If a low frequency magnetic alternating field passes through an electrically conductive object, such as the human body, this induces eddy currents in the body. If these currents are strong enough, they can stimulate nerves and muscles or influence other biological processes, such as energy absorption in tissues.

These biological effects in the body can be differentiated between sensory disorders and health effects:

- > Sensory disorders describe the influence of magnetic fields on the human nervous system. These disorders are temporary.
- > Health effects describe verifiable impairments to the health of the exposed person or their offspring.

### 1.2. Sources and basic principles of damaging and interfering mechanisms

- > FSM Research Foundation for biology – unidirectional fields and low frequency alternating fields: <https://www.emf.ethz.ch/de/emf-info/themen/biologie/gleichfelder-und-niederfrequente-wechselfelder/wirkungen-niederfrequenter-magnetfelder/>
- > World Health Organization: Health effects of electromagnetic fields: <http://www.who.int/peh-emf/about/en/whatareemfgerman.pdf>
- > <http://www.emfs.info>: Information page of the British network operator National Grid plc

## 2. Guidelines

Various nongovernmental as well as governmental stakeholders have published guidelines and recommended exposure limits to protect the safety and health of people in the public and private area.

### 2.1. Overview of national exposure limits

Location	Occupational protection	Personal protection	Implants
ICNIRP 1998	ICNIRP Occupational protection	ICNIRP Public	
ICNIRP 2010	ICNIRP Occupational protection	ICNIRP Public	
EU	2013/35/EU	EU 1999	
Germany	DGUV-V 15	26th BImSchV	BGI/GUV-I 5111
Switzerland	SUVA	NISV	
USA	No exposure limits on a federal level. Some states have guidelines. <sup>1</sup>		
United Kingdom	The Control of Electromagnetic Fields at Work Regulations 2016 <sup>2</sup>	ICNIRP 1998	
Additional countries	<a href="http://www.emfs.info/limits/world/">http://www.emfs.info/limits/world/</a>		

Table 1: Overview Guidelines non-ionizing radiation

### 2.2. ICNIRP

The most relevant guidelines come from the International Commission on Radiological Protection. The ICNIRP is an international commission that carries out research on the effects of non-ionizing radiation. It prepares guidelines with exposure limits. These guidelines are only recommendations, however many countries and organizations use them as the basis for national and international directives and standards.

The 1998 ICNIRP Guidelines are the most extensive to which many countries and organizations refer. A revised version was published in 2010, to which Germany and the EU refer. In a typical frequency range of demagnetization (0-50 Hz), the exposure limits of the 1998 guidelines are lower than the 2010 guidelines. The ICNIRP Guidelines differentiate between public exposure and occupational protection.

The exposure limit for public exposure is approx. 5 times lower than the exposure limit at the workplace. These exposure limits apply to whole body exposure. This means that the field is averaged over the entire body.

<sup>1</sup> <http://www.emfs.info/limits/limits-usa/>

<sup>2</sup> <http://www.emfs.info/limits/limits-organisations/regulations-2016/>  
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### 2.3. EU: Personal Safety Directive 2013/35/EU

The Directive 2013/35/EU was published by the European Council and by the Council on the health and safety requirements regarding the exposure of workers to the risks arising from physical agents (electromagnetic effects). This directive defines the minimum requirements for the protection of workers against actual or possible hazards to their health and safety due to the effect of electromagnetic fields while working. The minimum requirements are the subject matter of an agreement of the individual nations in the EU. They obligate themselves to adapt their laws and ordinances to these minimum requirements. However individual member states can pass stricter directives.

The 2013/35/EU directive, which refers to ICNIRP 2010, differentiates between low trigger levels, high trigger levels as well as exposure of limbs.

- > Low trigger thresholds: Exposure limits for sensory disorders. They are noticeable for sensitive people and must be avoided by people at risk (pacemakers, implants)
- > High trigger thresholds: Exposure limits for health effects. A possible health risk in the case of continuous, long-term exposure. To be established and further clarified for work at fixed workstations.
- > Exposure of limbs: Lower exposure levels apply for limbs.

### 2.4. Germany: DGUV V-15/BGV B11 Occupational protection

The German statutory accident insurance regulates occupational protection for areas in which electrical, magnetic or electromagnetic fields are used. The regulation defines the permissible values for the evaluation of exposures (impact of electromagnetic fields on persons) and the measurement and evaluation procedure. The professional association regulations for occupational safety and health (BGV B11) is identical to DGUV V-15. This guideline, which refers to the ICNIRP 2010, differentiates between exposure area 2, exposure area 1, area of increased exposure for limbs.

- > Exposure area 1: This is the area that includes controlled areas as well as areas in which, due to the operating method or due to the duration of stay, it is ensured that exposure lies above the permissible values of exposure area 2 only temporarily. Exposure area 1 corresponds to a production environment, for example.
- > Exposure area 2: This is the area that includes all areas of a company, providing that they are not assigned as exposure area 1, an area of increased exposure or a hazard area. Exposure area 2 corresponds to an office environment, for example.
- > Area of increased exposure: This is a controlled area in which the values of exposure area 1 are exceeded.
- > Limbs: For limbs, the limit values may be exceeded by a factor of 2.5.

### 2.5. Switzerland: SUVA

The exposure limits correspond to the references values for the workplace of the 1998 ICNIRP Guidelines.

### 2.6. Unites States of America: No directives

In the United States, no limits for worker exposure to electromagnetic fields are recommended or established. Some states have issued guidelines and private organizations have developed guidelines to protect workers from the known effects of high exposure.

### 2.7. Protection of implants

Medical implants are subject to regulations and the risks from predictable environmental conditions must be minimized (90/385/EEC). Therefore no interference due to electromagnetic radiation must be expected below the exposure limits defined in ICNIRP 1998. The safety distances for a specific case must however be determined in contact with the manufacturer of the implant.

In Germany, specific exposure limits for implants were published by the German statutory accident insurance (BGI/GUV-I 5111).

### 2.8. BGI/GUV-I 5111

BGI/GUV-I 5111 is the German statutory accident insurance and evaluates the influence of a magnetic field on a pacemaker. The exposure limits apply for persons with pacemakers or similar devices.

### 2.9. Personal protection

In certain cases (pregnancy, public access to the demagnetizer, etc.), the directives and exposure limits for the public area are used.

The following directives and recommendations adopt the exposure limits of ICNIRP 1998:

- > EU 1999
- > Germany 26th BImSchV
- > NISV (Ordinance on Protection against Non-Ionizing Radiation)

## 3. Examples of exposure areas of different conventional demagnetizers (Germany/EU)

In order to make a use-oriented statement about demagnetizers, the exposure limits for occupational protection in Germany were considered. The exposure limits were divided into different exposure areas.

The exposure limits can be found in Table 5. In other countries with other exposure limits according to ICNIRP 1998, the larger safety distances shall be observed.

The measurements for the examples were performed using a Narda ELT-400 measuring device.

The following probes were used to determine the safety distances:

- > Limbs: 3cm<sup>2</sup> probe
- > Whole body exposure: 100cm<sup>2</sup> probe.

### 3.1. Tabletop unit

The magnetic field of the tabletop unit directly exits the surface. The exposure limits were measured accordingly from the surface.



Illustration 1: Exposure measurement of a tabletop unit

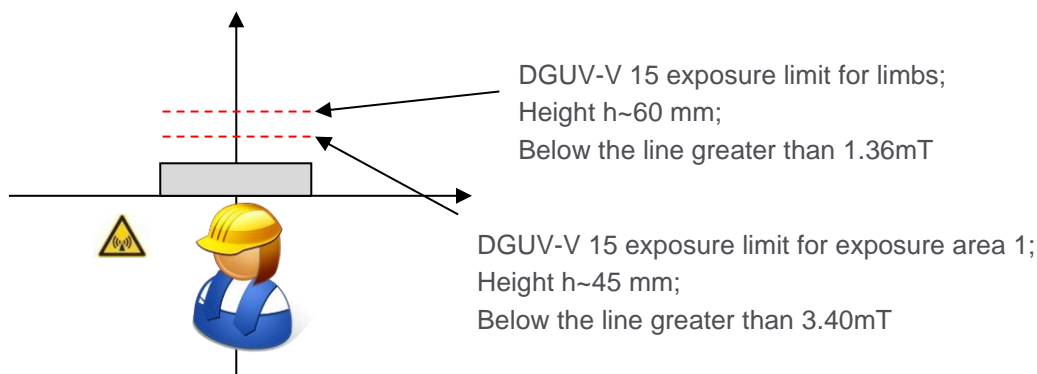


Illustration 2: Exposure measurement of a tabletop unit

Since the measurement is averaged across the entire volume of the probe, the safety distance for whole body exposure is smaller in spite of a clearly lower exposure limit. It is recommended to comply with the larger safety distance.

### Conclusion

The permissible exposure limits are exceeded when the parts to be demagnetized are pulled over the plate manually. In order to comply with the exposure limits, the distance of the user and their limits from the demagnetizing system must be increased. This can be achieved by means of automation or auxiliary devices.

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### 3.2. Manual device

The utilized manual demagnetizer HE2 generates a small-sized leakage flux.

The assessment is performed based on the exposure limits for limbs in the area of the handle using the 3cm<sup>2</sup> probe. The values measured in the area of the handle lie below this exposure limit.



Illustration 3: Measure of exposure for limbs

### Conclusion

As long as the operating area on the bottom of the demagnetizer is not touched, the exposure limits for workers according to DGUV-V 15 are not exceeded.

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### 3.3. Air coil

The generated magnetic field flows around the coil. Therefore the defined safety distances around the coil shall be observed.

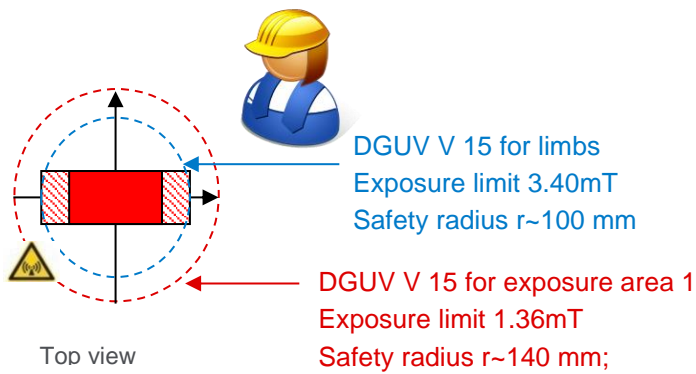


Illustration 4: Whole body exposure measurement of an air coil

### Conclusion:

When people are located close to the coil, the defined exposure limits are exceeded. For standard-conforming work a handling device (e.g. conveyor belt) must be provided.



### 4. Maurer degaussing pulse demagnetizer

#### 4.1. Safety by means of distance

Maurer degaussing pulse demagnetization takes place according to the following process:

1. Positioning the component in the coil
2. Activating demagnetization using the control panel on the power module
3. Demagnetization of the component (within 7 seconds). The maximum field intensity occurs within the first seconds after starting. Afterwards, the field intensity decreases quickly.
4. Removing the demagnetized component.

Worker safety can be ensured by positioning the power module outside of the exposure area of the coil.

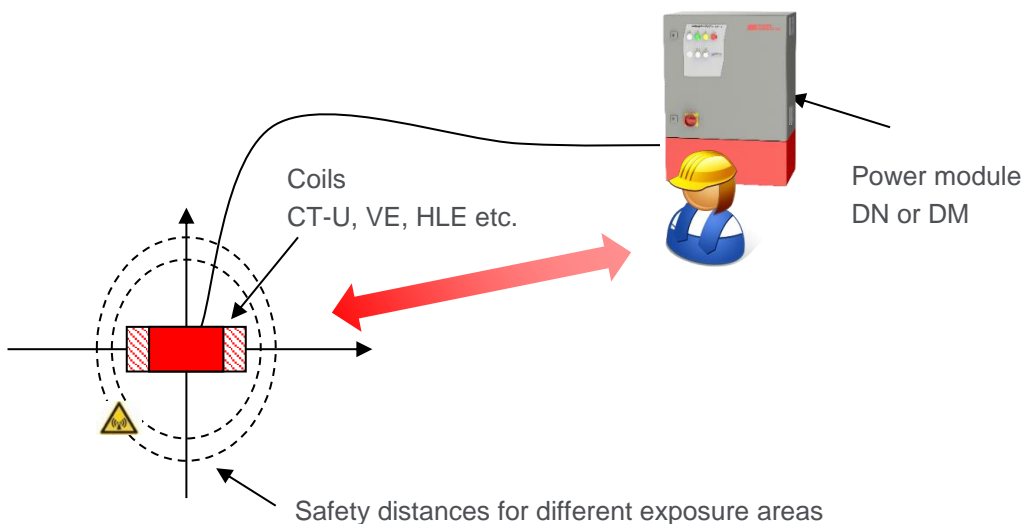


Illustration 5: Setup for Maurer degaussing pulse demagnetizing

### 4.2. Protection by means of shielding

As an option for the demagnetization system, Maurer Magnetic offers its in-house developed shielding chamber. The demagnetizing coil is positioned in the shielding chamber and exposure is reduced.



Illustration 6: Coil module installed in the shielding chamber

By installing the coil in the shielding chamber, the safety distances are decreased and the interferences on adjacent processes are reduced.

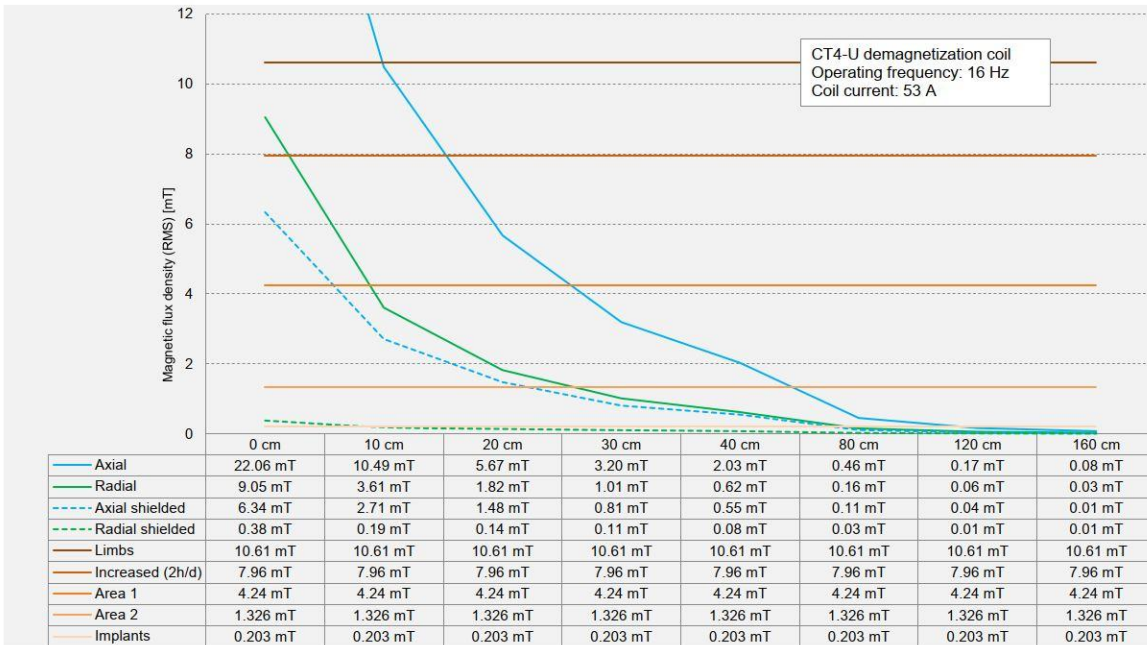
### 4.3. Field exposure measurements

Field exposure measurements are performed and supplied for all demagnetizing systems delivered by Maurer Magnetic. This makes it easier for customers to determine the safety distances. Illustration 7 contains an example of field exposure measurement.



Field exposure measurement

### Field exposure measurement Project P-18-00005



Field exposure measurement

### Measuring Process

<b>Measuring Instrument</b>	Narda ELT-400 with B-Field Probe; 100 cm <sup>2</sup> cross section	Setup: Detect: PEAK; Low Cut: 1Hz - 8mT...80mT: Mode 80 mT; Range: High - 320µT...8mT: Mode 80 mT; Range: Low - 32µT...320µT: Mode 320µT; Range: High
<b>Label</b>	<b>Directive</b>	<b>Annotation</b>
Limbs	DGUV-V 15/BGV B11 Exposure area 1 Limbs	For limbs, the exposure area 1 and area of increased exposure may be exceeded by a factor of 2.5
Increased (2h/d)	DGUV-V 15/BGV B11 Area of increased exposure (2h / day)	2h are not exceeded in pulse mode during a working day
Area 1	DGUV-V 15/BGV B11 Exposure area 1	Controlled area (e.g. production)
Area 2	DGUV-V 15/BGV B11 Exposure area 2	Remaining areas (e.g. office)
Implants	BGI / GUV-I 5111 Implants	Danger zone for persons with cardiac pace makers

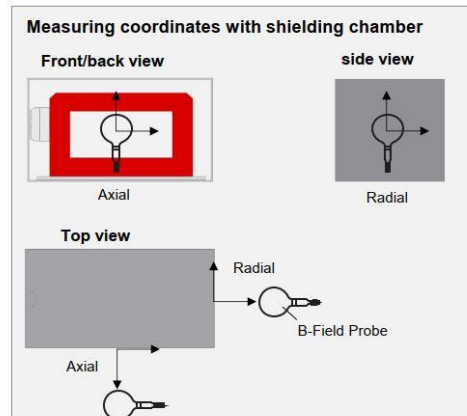
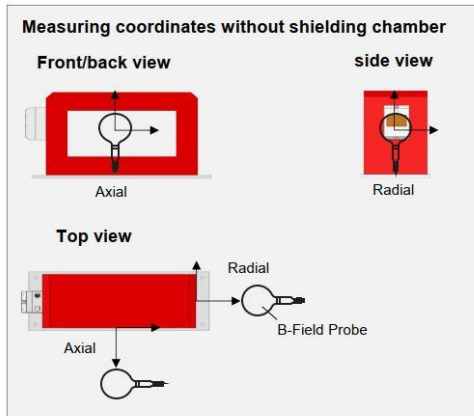


Illustration 7: Example of field exposure measurement

## 5. Exposure limits for low frequency magnetic fields

### 5.1. ICNIRP

Frequency [Hz]	ICNRP 1998 public exposure [mT]	ICNRP 1998 occupational exposure [mT]
1-8	40/f	200/f <sup>2</sup>
8-800	5/f	25/f
16	0.3	1.5
25	0.2	1.0
50	0.1	0.5

Table 2: ICNIRP 1998 Limit value (RMS)

Frequency [Hz]	ICNRP 2010 public exposure [mT]	ICNRP 2010 occupational exposure [mT]
1-8	40/f	200/f <sup>2</sup>
8-25	5/f	25/f
25-300	0.2	1.0
16 ⅓	0.3	1.5
25	0.2	1.0
50	0.2	1.0

Table 3: ICNIRP 2010 Limit value (RMS)

### 5.2. European Union 2013/35/EU

Frequency [mT]	Low action level [mT]	High action level [mT]	Limb exposure [mT]
1-8	200/f <sup>2</sup>	300/f	900/f
8-25	25/f	300/f	900/f
25-300	1.0	300/f	900/f
16 ⅓	1.5	18.0	54.0
25	1.0	12.0	36.0
50	1.0	6.0	18.0

Table 4: EU limit values (RMS)

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## 5.3. Germany DGUV V15 and BGV B11

Frequency [mT]	Exposure area 1 [mT]	Exposure area 2 [mT]	2 h/d [mT]	Extremity exposure area 1 [mT]
1-1000	67.9/f	21.22/f	127.3/f	169.75/f
16 2/3	4.07	1.27	7.64	10.18
50	1.36	0.42	2.55	3.40

Table 5: Limit value DGUV V 15 (RMS)

## 5.4. Germany BGI GUV-I 5111

Frequency [Hz]	Limit value [mT]
1-300 GHz	0.065*50/f
16 2/3	0.19
25	0.13
50	0.07

Table 6: Limit value BGV B11 (RMS)

## 5.5. Switzerland SUVA

The SUVA exposure limits correspond to the occupational limits of the ICNIRP 1998 Guidelines.

### 6. List of references

- [1] ICNIRP Guidelines; For limiting exposure to time-varying electric, magnetic and electromagnetic fields (up to 300 GHz); ICNIRP Publication - 1998
- [2] ICNIRP Guidelines; For limiting exposure to time-varying electric and magnetic fields (1 Hz - 100 kHz); ICNIRP Publication - 2010
- [3] Directive 2013/35/EU of the European Parliament and of the Council; Official Journal of the European Union; 06/29/2013
- [4] DGUV Provision 15; Accident prevention regulation for electromagnetic fields; June 1, 2001
- [5] BGV B11; Accident prevention regulation for electromagnetic fields; professional association regulations for occupational safety and health; April 1, 2002
- [6] BGI/GUV-I 5111; Influence of electromagnetic fields on implants; DGUV German statutory accident insurance; June 2009
- [7] 26th BImSchV; Twenty-sixth ordinance for the implementation of the Federal Immission Protection Act; 12/16/1996
- [8] Ordinance on Protection against Non-Ionizing Radiation; NISV; December 23, 1999
- [9] Exposure limits at the workplace 2015; SUVA; January 2015
- [10] Recommendation of the Council; For limiting the exposure of the public to electromagnetic fields (0 Hz – 300 GHz); July 12, 1999
- [11] 90/385/EEC; Council Directive to approximate the laws of the Member States relating to electromagnetic fields; June 20, 1990

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