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FACULTEIT INGENIEURSWETENSCHAPPEN

Exposure assessment / Software tool

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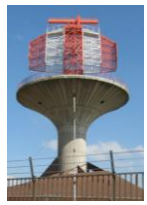
Overview

- **Context**
- **Classification of RF sources**
- **Assessment of the exposure levels around different sources**
- **Definition of safety rules**
  - e.g. safety distances / desactivation during maintenance
- **Implementation of software tool:**
  - Assess the exposure / risks around sources

Context: electromagnetic sources

- **Electric equipment generates electromagnetic waves**
  - Equipment for wireless communication





  - BUT also other sources generate RF radiation





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Context: Classification based on risk

- **Working environments / EM sources can be divided into 3 categories** (based on a study of Bolte and Pruppers)
  - Category 1
    - **Under normal conditions the action values will not be exceeded**
  - Category 2
    - **Action values can be exceeded but the exposure limit values will not be exceeded under normal conditions**
  - Category 3
    - **Exposure limit values can be exceeded**

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Classification based on application

- **Based on the application**
  - Quick overview based on the sector
    - **Broadcasting sector (radio and television)**
    - **Telecommunications sector (base stations, WiFi, ...)**
    - **Aviation (surveillance, ...)**
    - **Medical sector (MRI,...)**
    - **...**

2.4 Telecommunications sector

Category	Source available	Source	Typical frequency	Other general specifications	Remarks (e.g. actual specifications)
Personal handheld GSM devices		Mobile phones: GSM900, GSM1800, UMTS, LTE	900 MHz / 1800 MHz / 2100 MHz / 2400 MHz	Powers of 2 W for GSM900 an 1 W for GSM1800	
Base stations		GSM900 base station	880 MHz - 960 MHz		
		GSM1800 base station	1770 MHz - 1880 MHz		
		UMTS base station	1920 MHz - 2170 MHz		
		LTE base station	2400 MHz - 2483,5 MHz / 1800 MHz band		
Cordless phone		Cordless phones + cordless base stations	1880 MHz - 1900 MHz	Powers of 250 mW	
WiFi		WiFi access points	2,4 GHz to 2,5 GHz	Powers of 100 mW	
		WiFi access points	5.150 GHz – 5.825 GHz /	Powers of 200 mW	

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Exposure Levels

- **Exposure around electric equipment**
  - Measurements
    - **Number of measured / identical sources is limited**
    - **Time consuming**
    - **Different measurement protocol and equipment depending on the technology, frequency, ...**
  - Simulations and literature
    - **International papers and studies**
    - **Information available for general used sources: e.g. broadcasting, telecommunication, ...**

Exposure levels: examples

- **Example 1: General accessible places in homes, schools, offices and on public places**
- **Example 2: Simulations close to a multiband antenna**
- **Example 3: MRI scanner**
- **Example 4: Fluorescent lighting**
- **....**

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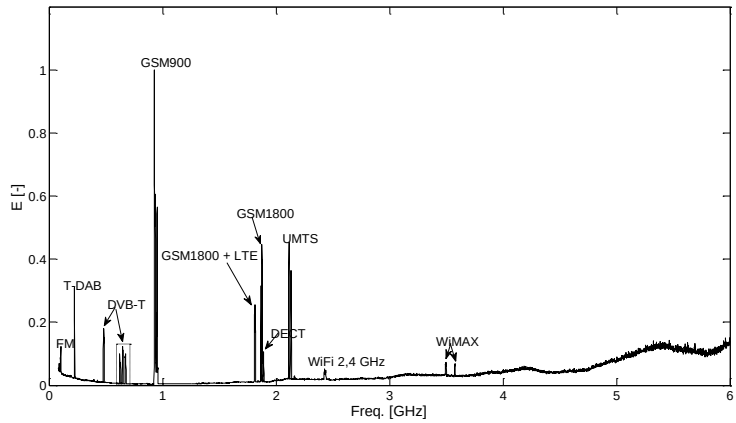
Example 1: General accessible places

- **Typical spectrum overview between 80 MHz and 6 GHz (Belgium)**
- **Dominant sources:**
  - Internal sources: WiFi, DECT
  - External sources: FM, TV, GSM900, GSM1800, UMTS, LTE, WiMAX, …



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Example 1: field levels

Environment	Broadband (713 measurements)	
	Average	Max
Schools	0.34	2.52
Houses	0.29	1.00
Public places	0.45	2.20
Offices	0.50	3.50
Summary	0.41	3.50

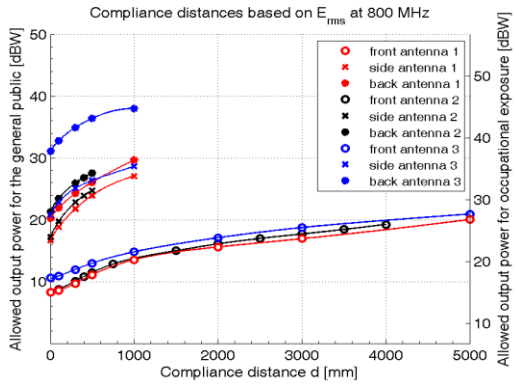
- **Maximum electric field value is 3.50 V/m**
- **Maximum values in offices, lowest values in houses**

Exposure levels: examples

- **Example 1: General accessible places in homes, schools, offices and on public places**
- **Example 2: Simulations close to a multiband antenna**
- **Example 3: MRI scanner**
- **Example 4: Fluorescent lighting**
- **....**

Example 2: Multiband telecom antenna

Compliance distances based on E_{rms}



- Similar results in front of the antennas
  ↓
  Averaging over box smooths out differences
- At the back of the antennas large differences can occur
- Compliance distances are highest in front of the antenna
  ↓
  Direction of antenna's main lobe

Exposure levels: examples

- Example 1: General accessible places in homes, schools, offices and on public places
- Example 2: Simulations close to a multiband antenna
- **Example 3: MRI scanner**
- Example 4: Fluorescent lighting
- ....

Example 3: MRI scanner

Example 3: MRI scanner

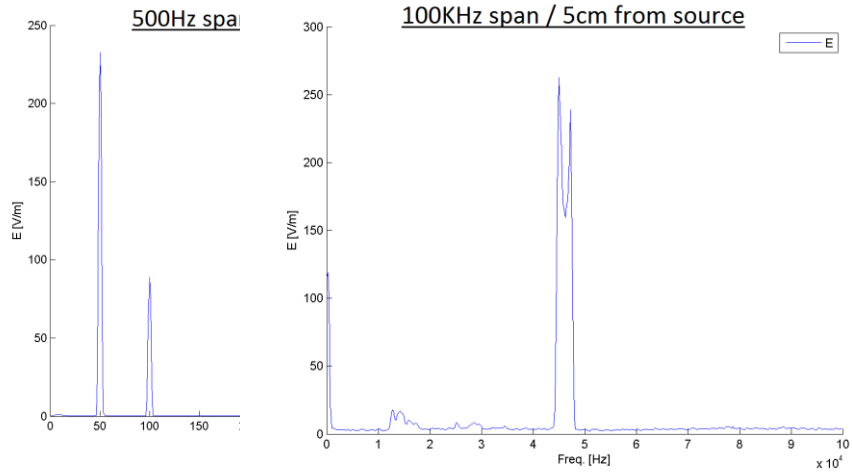
- Results of measurements in technical room and MRI controlroom.
  - **Own measurments**
    - No excessive magnetic field values measured.
    - Electric field main contribution of 50Hz mains and 48KHz fluorecent lighting
- Results of measurements in MRI operation room:
  - **paper: experimental investigation on workers' exposure to EM fields.... Giovanni Betta (2011)**
  - **Paper: field measurements of a 1.5T clinical MR scanner… S F Riches (2006)**
    - Greatly depending on scanner
    - Magnetic and electric fields only exceeds the values of 2004/40/EC in close proximity of het scanner. Can not Exceed 2013/35/EU as its excluded in the directive

Exposure levels: examples

- Example 1: General accessible places in homes, schools, offices and on public places
- Example 2: Simulations close to a multiband antenna
- Example 3: MRI scanner
- **Example 4: Fluorescent lighting**
- ....

Example 4: Fluorescent lighting

- Diverse spectral components



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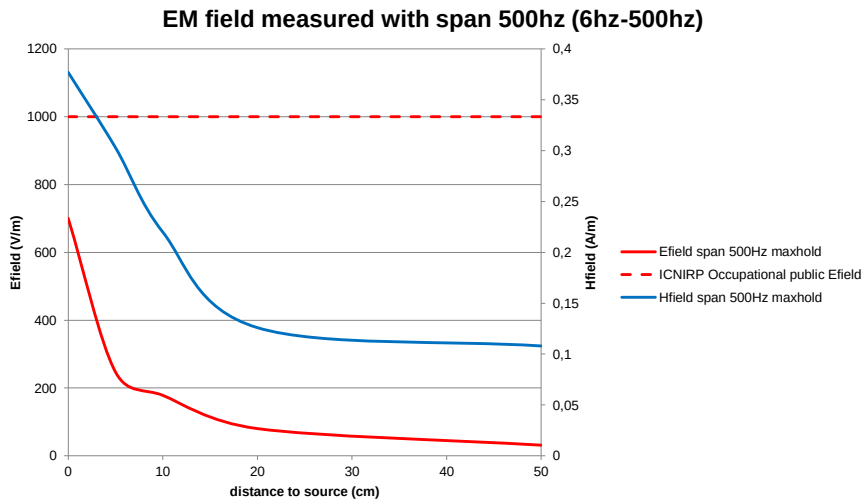
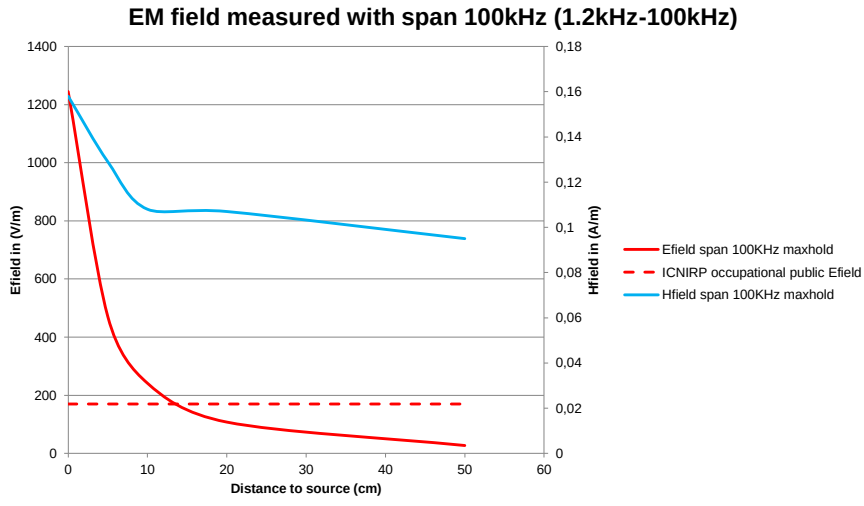
Example 4: Fluorescent lighting



Example 4: Fluorescent lighting



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Software tool: general

- **Electric / magnetic field values as function of distance for each source**
  - Comparison with different laws
    - **EU Directive**
    - **ICNIRP occupational**
    - **ICNIRP general public**
    - **Law Flanders, Brussels Capital Region, Walloon**

    ⇒**DETERMINATION of SAFETY DISTANCES**

    ⇒**SUGGESTION of ACTIONS to decrease exposure**

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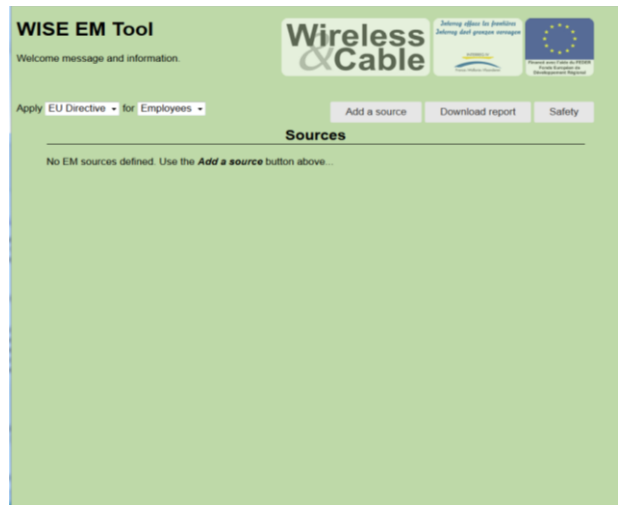

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Software tool: general

- **Electric field values as function of distance for each source**
  - REMARKS
    - **Only evaluation of action values (electric or magnetic fields)**
    - **Restricted number of measurements / field values**
    - **Exact specifications of sources are not always available**

    ⇒**Worst-case data will be presented**

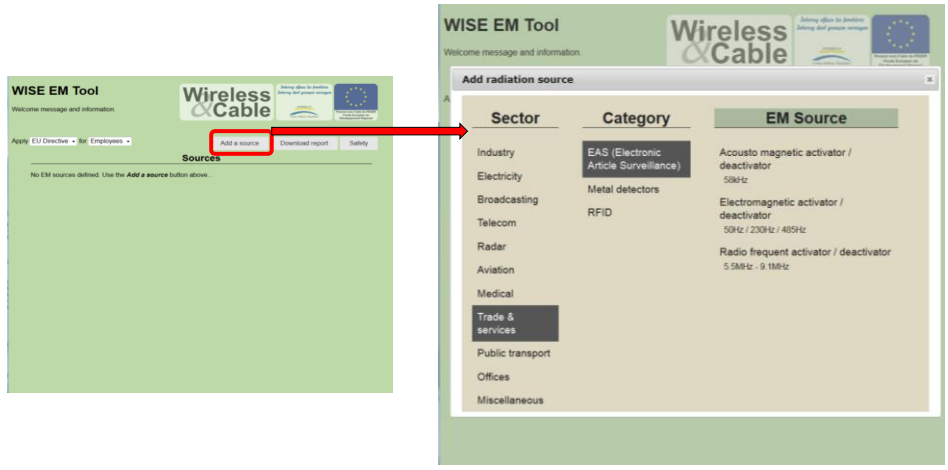
    ⇒overestimation is possible

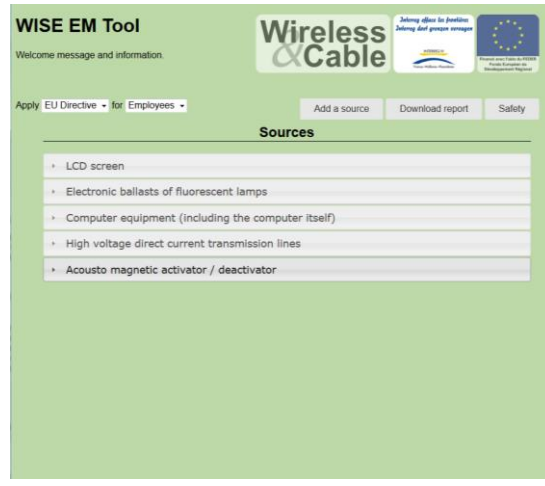
    ⇒**Prevention advisers have an idea about the exposure levels**

    ⇒**To know in-situ exposure around specific source: PERFORM MEASUREMENT**

Software tool: parts

- **DATABASE**
  - Field values as function of distance for each source
    - **Front/back measurements**
    - **Left/right measurements**
  - Specificiations of the source
    - **Frequency**
    - **Power**
    - **Duty cycle**
    - **…**





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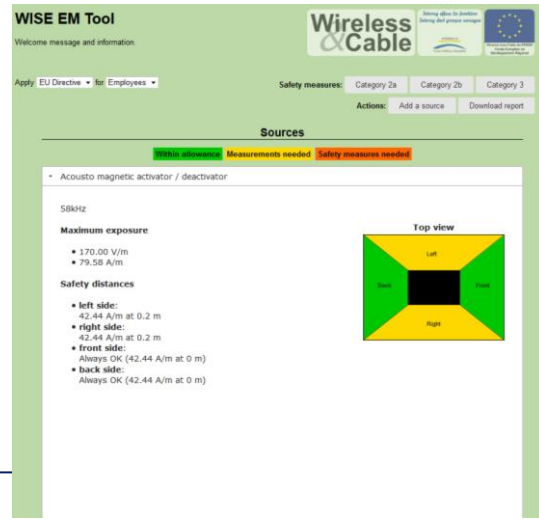
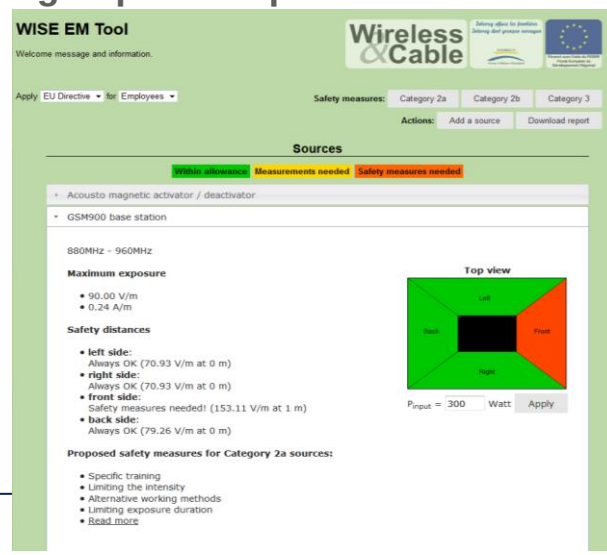
Software tool: parts

- **Comparison with guidelines**



Software tool: parts

- **Scaling to power input**



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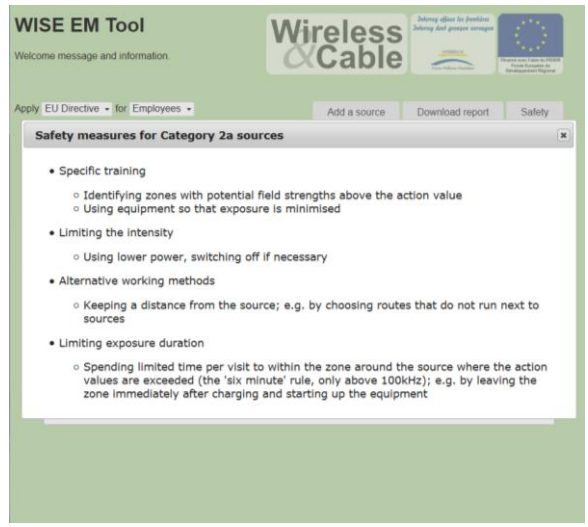

Software tool: parts

- **Final report**
  - Safety distances
  - Actions to take
  - ....

    - http://wicaserv2.intec.ugent.be/EmTool/

Conclusions

- **Exposure**
  - Suggestions for field measurements around special sources
    - **e.g. measurements around wireless camera (VRT): to do**
  - Are there field values available for some sources that we can use for our database?

- **Software tool**
  - Feedback?