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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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

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, ...)
  - ...
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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, ...
### Example 1: field levels

<table>
<thead>
<tr>
<th>Environment</th>
<th>Broadband (713 measurements)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average</td>
</tr>
<tr>
<td>Schools</td>
<td>0.34</td>
</tr>
<tr>
<td>Houses</td>
<td>0.29</td>
</tr>
<tr>
<td>Public places</td>
<td>0.45</td>
</tr>
<tr>
<td>Offices</td>
<td>0.50</td>
</tr>
<tr>
<td>Summary</td>
<td>0.41</td>
</tr>
</tbody>
</table>

- 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

Results of measurements in technical room and MRI control room:

- **Own measurements**
  - No excessive magnetic field values measured.
  - Electric field main contribution of 50Hz mains and 48KHz fluorescent 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

Diverse spectral components

Example 4: Fluorescent lighting

- Diverse spectral components

500Hz spa

100KHz span / 5cm from source

Field [V/m]

Frequency [Hz]
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Example 4: Fluorescent lighting
Example 4: Fluorescent lighting

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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
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
  - Specifications of the source
    - Frequency
    - Power
    - Duty cycle
    - ...
Software tool: parts

Comparison with guidelines

Scaling to power input
Software tool: parts

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

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?