<table>
<thead>
<tr>
<th>Source</th>
<th>Size</th>
<th>Spatial Variation</th>
<th>Experienced by</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power lines</td>
<td>Medium (&lt;10 µT)</td>
<td>Slow (10’s m)</td>
<td>&lt;1% (all of the time)</td>
</tr>
<tr>
<td>Appliances</td>
<td>High (&lt;1000 µT)</td>
<td>Rapid (&lt;1 m)</td>
<td>100% (usually rarely)</td>
</tr>
<tr>
<td>Background (distribution)</td>
<td>Low (&lt;1 µT)</td>
<td>Medium (1-10 m)</td>
<td>100% (all of the time)</td>
</tr>
</tbody>
</table>
Magnetic field in UK home

National Grid Transco
24 hour personal exposure

**24 hour personal exposure**

- **Mean:** 0.11 µT
- **Peak:** 149 µT

![Graph showing magnetic field over time](image-url)

- Y-axis: Magnetic field / µT
- X-axis: Time / hours

National Grid Transco
Contribution of appliance peak to exposure

Appliance: 150 µT 30 seconds
Background: 0.1 µT 24 hours

- B: 5%
- B^2: 800 times
- For appliance=background: B^{1.09}
Possible metrics for ELF

- Average
  - B
  - $B^2$
- Threshold
- Peak
- Polarisation
- Waveform
  - harmonics
  - transients
- Rate of change/intermittency
- AC/DC

- Power line specific
  - characteristic of the field
  - SES
  - mobility
  - E field
  - corona ions
- Contact currents

National Grid Transco
Personal exposure compared to field in home
USA, children

24 hour mean personal exposure / mG

24 hour mean field in bedroom / mG

Friedman et al 1996
Personal exposure compared to field in home
USA, children

Total personal exposure
- $R=0.94$ <9 years
- $R=0.59$ >9 years

Personal exposure in home
- $R=0.76$ <9 years
- $R=0.72$ >9 years

24 hour Bedroom field
- $R=0.75$ <9 years
- $R=0.41$ >9 years

Friedman et al 1996 NCI study
Exposure variation with age

USA

Estimated Distributions of 24-Hour Average Magnetic Fields for Different Age Groups

% of population with field ≥

24 hour average field / mG

From Zafanella Thousand Person Survey 1998
# Exposure variation with age

**USA**

<table>
<thead>
<tr>
<th>Age</th>
<th>50&lt;sup&gt;th&lt;/sup&gt; percentile</th>
<th>90&lt;sup&gt;th&lt;/sup&gt; percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-school</td>
<td>65</td>
<td>276</td>
</tr>
<tr>
<td>School age</td>
<td>68</td>
<td>200</td>
</tr>
<tr>
<td>Working age</td>
<td>94</td>
<td>245</td>
</tr>
<tr>
<td>Retirement age</td>
<td>79</td>
<td>232</td>
</tr>
</tbody>
</table>

nT

*From Zafanelia Thousand Person Survey 1998*
Time above thresholds
USA, whole population

Length of Time within a 24-Hour Period with Field Exceeding Specified Level
Estimates for the U.S. Population

% of population with exposure time ≥

From Zafanella Thousand Person Survey 1998
Maximum magnetic field
0.5 second sampling

From Zafanella Thousand Person Survey 1998
Residential fields in different countries

magnetic field / nT

Sweden  USA  Finland  New Zealand  UK  Germany  Norway

GM+1 sd  GM  GM-1 sd

Swanson and Kaune 1998
Time variations

Diurnal

Annual

National Grid Transco
Long-term variations
England and Wales 1949-1989, calculated

1989=1.0
# RF: sources of exposure

<table>
<thead>
<tr>
<th>Frequency (Hz)</th>
<th>Other sources:</th>
</tr>
</thead>
<tbody>
<tr>
<td>VLF TV/VDU</td>
<td>Acute vs chronic?</td>
</tr>
<tr>
<td>LF Article surveillance</td>
<td>Waveform / modulation?</td>
</tr>
<tr>
<td>MF AM radio</td>
<td>Weighting of frequencies?</td>
</tr>
<tr>
<td>HF Short-wave broadcast</td>
<td>Chosen metric?</td>
</tr>
<tr>
<td>VHF FM radio</td>
<td>0.5-1 x 10⁹</td>
</tr>
<tr>
<td>TV</td>
<td>0.4-2 x 10⁹</td>
</tr>
<tr>
<td>UHF Cellular comms</td>
<td>0.2-2 x 10⁹</td>
</tr>
<tr>
<td>Microwave cooking</td>
<td>Microwave diathermy</td>
</tr>
<tr>
<td>SHF Radars</td>
<td>0.1-4 x 10¹⁰</td>
</tr>
<tr>
<td>EHF Microwave comms</td>
<td>0.1-4 x 10¹⁰</td>
</tr>
</tbody>
</table>

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**National Grid Transco**
Measured rf spectrum

From Mann et al NRPB 2000
Base stations compared to other sources

From Mann et al NRPB 2000
Field distribution from base station
Calculated ground-level power from base station

From Mann et al NRPB 2000
Base stations: exposure vs distance

From Mann et al NRPB 2000
RF exposure levels

**Broadcast**
- Maximum: 100 mW m\(^{-2}\)
- Typical: 0.05-0.2 mW m\(^{-2}\)

**Base station**
- Maximum: 10 mW m\(^{-2}\)
- Typical outdoors: 0.01-1 mW m\(^{-2}\)
- Typical indoors: <0.1 mW m\(^{-2}\)

Children? spend more time indoors
- use of handsets
- dosimetry different

National Grid Transco
RF fields inside buildings
variation over 1 m cube

\[ \frac{E_{\text{max}}}{E_{\text{mean}}} \quad \text{and} \quad \frac{E_{\text{max}}}{E_{10\%}} \]

2-5

2-14

Neubauer 2004
Base station: time variation

![Graph showing time variation of base station readings. The graph illustrates fluctuations over a week, with labels for dates and times.](image)

Silvi et al., Radiat Protect Dosimetry, 2001
Base stations: long-term variation