



IOSH Webinar

**Control of Electromagnetic Fields at
work regulations 2016**

Part 2 EMF exposure assessment

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Previously...

Webinar part one covered:

- Definition of EMF and the electromagnetic spectrum
- Intentional and unintentional sources
- Direct & indirect effects
- Articles of the EMF Directive
- Implementation; CEMFAW Regulations 2016
- **Workers at particular risk**
- EU practical Guide
- A small amount on assessment and measurement

Workers at particular risk

- Workers wearing active implanted medical devices
- Workers with passive implanted medical devices
- Workers with medical devices worn on the body e.g. hormone infusion pumps
- Pregnant workers
- Workers in any of these groups may be at greater risk from EMF than the general working population and should be subject to a specific risk assessment

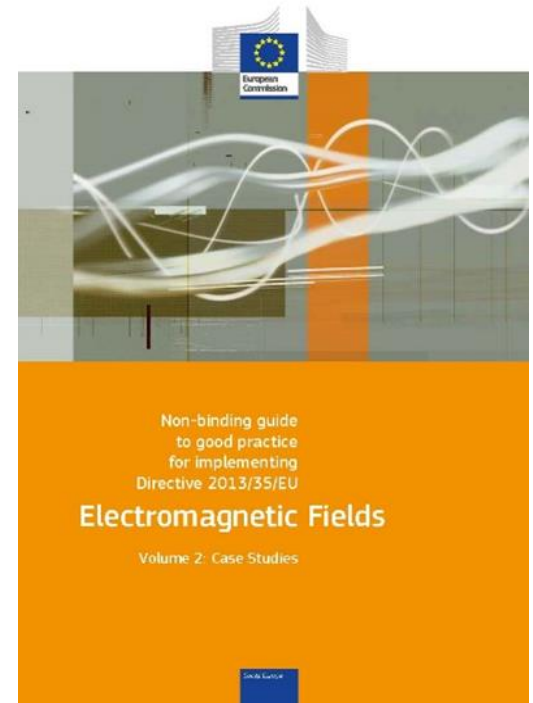
Article 4

Assessment of risks & determination of exposure

- Requires employers to identify & assess EMF in the workplace
- Employers can take advice from other sources e.g. equipment manufacturers, published databases of generic assessment
- Where it is necessary for an employer to determine exposure this can be performed by measurement or calculation
- Note it is not sufficient just to demonstrate compliance with ALs or ELVs as this may not be sufficient to protect workers at particular risk or avoid risks from indirect effects

Practical Guide

- EU practical guide volume 1 gives step by step guidance on how to do your assessment
- <https://osha.europa.eu/en/legislation/guidelines/non-binding-guide-good-practice-implementing-directive-201335eu>
- Guide for SMEs is a great starting point for the terrified
- Volume 1 provides more detailed information
- Volume 2 lists a number of case studies; Check if one is relevant to your industry



What do I do?

Take it a step at a time!

- Read section 1 of the EU Practical guide
- Identify workers at particular risk and where they are in relation to EMF Sources
- Identify all of your EMF sources, even the trivial ones
- Refer to the table 3.2 (page 24 onwards) to determine which of your sources need assessment for everyone, or specific workers at particular risk
- Work your way through every EMF source, using the table to determine which if any need further assessment
- Iterative process for anything needing further assessment

Table 3.2 — Requirements for specific EMF assessments in respect of common work activities, equipment and workplaces

Type of equipment or workplace	Assessment required for		
	Workers not at particular risk*	Workers at particular risk (excluding those with active implants)**	Workers with active implants***
	(1)	(2)	(3)
Wireless communications			
Phones, cordless (including base stations for DECT cordless phones) — use of	No	No	Yes
Phones, cordless (including base stations for DECT cordless phones) — workplaces containing	No	No	No
Phones, mobile — use of	No	No	Yes
Phones, mobile — workplaces containing	No	No	No
Wireless Communication Devices (e.g. Wi-Fi or Bluetooth) including access points for WLAN — use of	No	No	Yes
Wireless Communication Devices (e.g. Wi-Fi or Bluetooth) including access points for WLAN — workplaces containing	No	No	No
Office			
Audio-visual equipment (e.g. televisions, DVD players)	No	No	No
Audio-visual equipment containing radiofrequency transmitters	No	No	Yes
Communication equipment and networks, wired	No	No	No
Computer and IT equipment	No	No	No
Fan heaters, electric	No	No	No
Fans, electric	No	No	No
Office equipment (e.g. photocopiers, paper shredders, electrically operated staplers)	No	No	No
Phones (landline) and fax machines	No	No	No
Infrastructure (buildings and grounds)			
Alarm systems	No	No	No
Base station antennas, inside operator's designated exclusion zone	Yes	Yes	Yes
Base station antennas, outside operator's designated exclusion	No	No	No

The assessment process

- If risks from EMF in the workplace are low then no further action is required. Employers should record that they have reviewed their workplace and reached this conclusion.
- If risks from EMF are not low, or the risk is unknown, employers should follow a process to assess the risk and implement appropriate precautions, if necessary.
- It is possible that the conclusion is that there is no significant risk. In this case the assessment should be recorded and the process goes no further.
- To assist with the risk assessment generally and specifically to assess compliance with ALs or ELVs values, employers may need information on the level of EMF. This may be available from databases or manufacturers or it may be necessary to perform calculations or measurements.
- Preventative and protective measures may need to be taken where it is necessary to reduce the risk.

Other sources of information

- “To assist with the risk assessment generally and specifically to assess compliance with ALs or ELVs values, employers may need information on the level of EMF. This may be available from databases or manufacturers or it may be necessary to perform calculations or measurements.”
- Clear message is try to do desktop assessment first
- Consult documentation from supplier, contact the supplier and ask the question “what level of EMF is the user of this equipment exposed to?”
- Industry guidance e.g. The Welding Institute, MATS group for broadcast and telecoms, other trade bodies
- Once other options are exhausted move to calculation, modelling or measurement

Exposure assessments

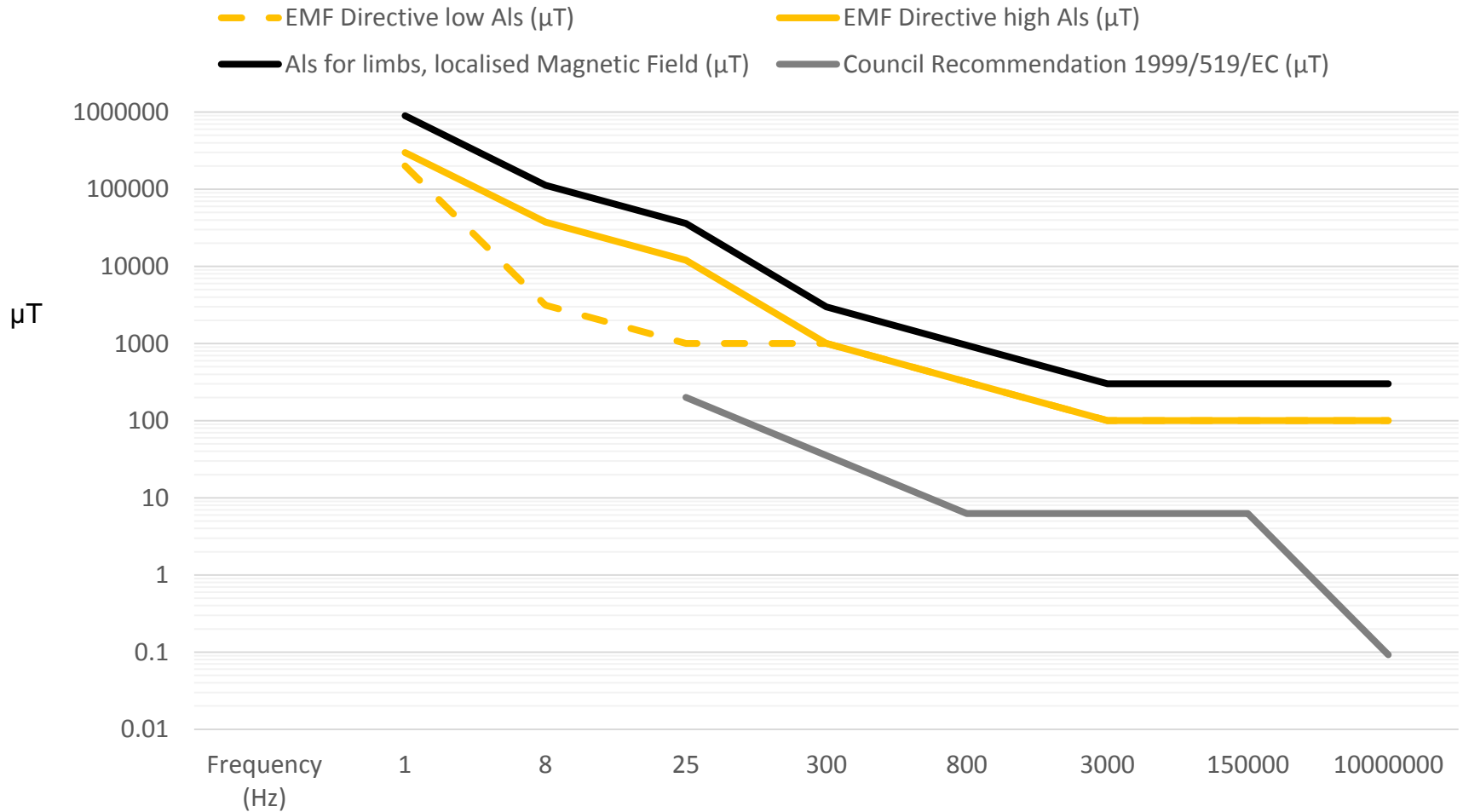
- You don't always need to perform measurements but if you do the process is often surprisingly easy.
- Measurement equipment available to covers from static fields all the way through to microwave or mm wave frequencies. Can often provide a result in % of the AL i.e. easy comparison/assessment.
- Depending on the result of your assessment personal monitors can be a useful additional measure.



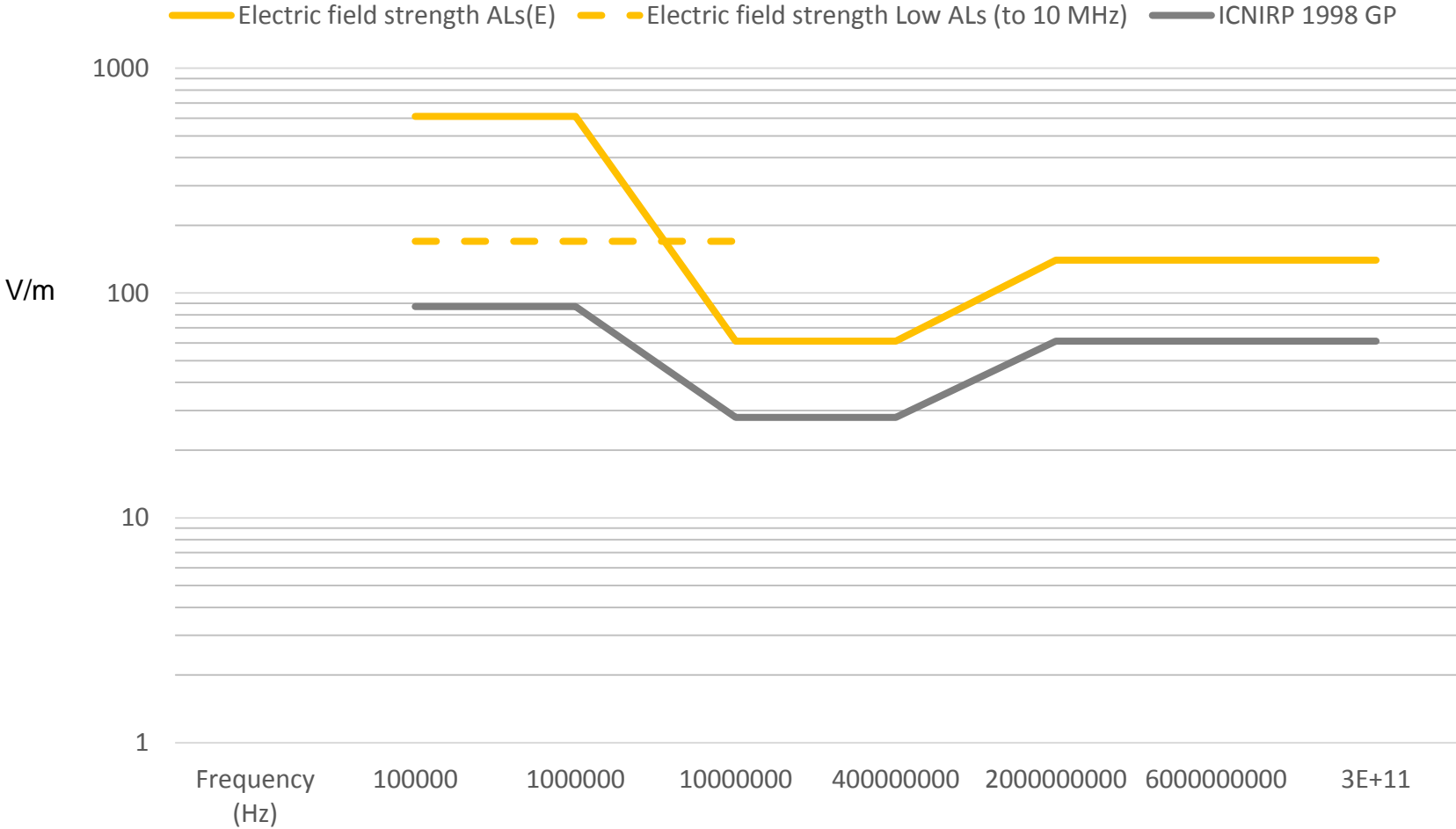
Assessments; quantifying field levels

- All electromagnetic emissions have an electric and magnetic component. Relevant values are listed in the EMF Directive/CEMFAW regulations.
- Electric fields are specified in V/m
- Magnetic fields are specified in T or A/m
- Power Density ($E \times H$) in W/m^2 (or mW/cm^2)
- Some measurement equipment simplifies this by providing a result in % of the AL

EMF Directive magnetic field (1Hz to 10 MHz)



Electric field ALs 100 kHz to 300 GHz



Survey equipment



- Provides a relatively accurate assessment of field strength and can be used to assess compliance with a particular standard e.g. EMF Directive/CEMFAW Action Levels
- Requires a little training before it can be used with confidence but in itself generally easy to use
- Does not provide continuous monitoring against sudden equipment failure or other changes in field strength.

Frequency selective survey instrument

- Combines the features of a hand-held spectrum analyser and an isotropic probe
- Utilises an active antenna ideal for high sensitivity applications
- Expensive compared to conventional broadband equipment
- Frequency range 9kHz to 6GHz.
- Complex measurement capability or can be setup using simple routines to de-skill measurement process



Broadband survey equipment



- Designed specifically for safety assessments e.g. isotropic, provides average values (as opposed to peak detectors)
- Not frequency selective; will attempt to sum all signals across a frequency range
- Relatively insensitive but capable of measuring down to low % of the AL

Types of field probe

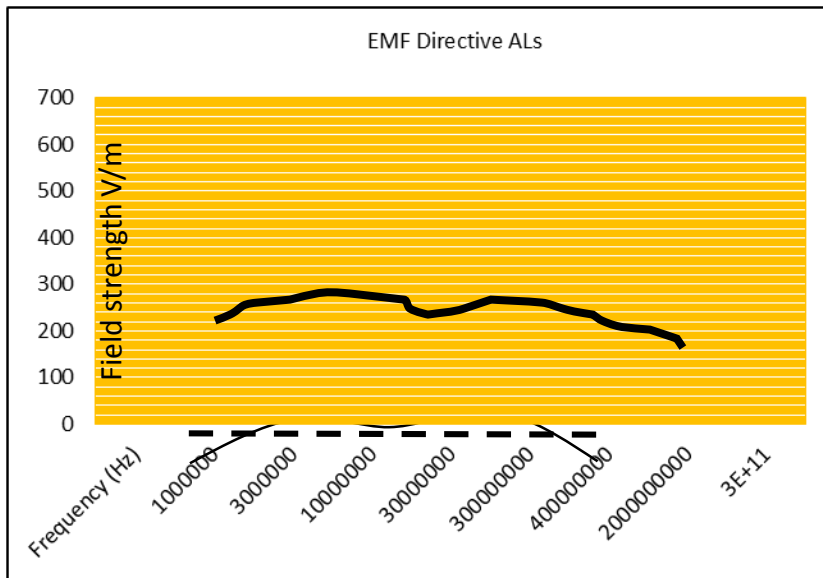


- Usually probes measure either the Electric (E) field or Magnetic (H) field but some have E & H capability over a relatively narrow frequency range.
- Probes are expensive (generally the wider the frequency range the higher the cost) and define the quality of the measurement as opposed to the meter.
- May provide 'flat' or 'shaped' response.

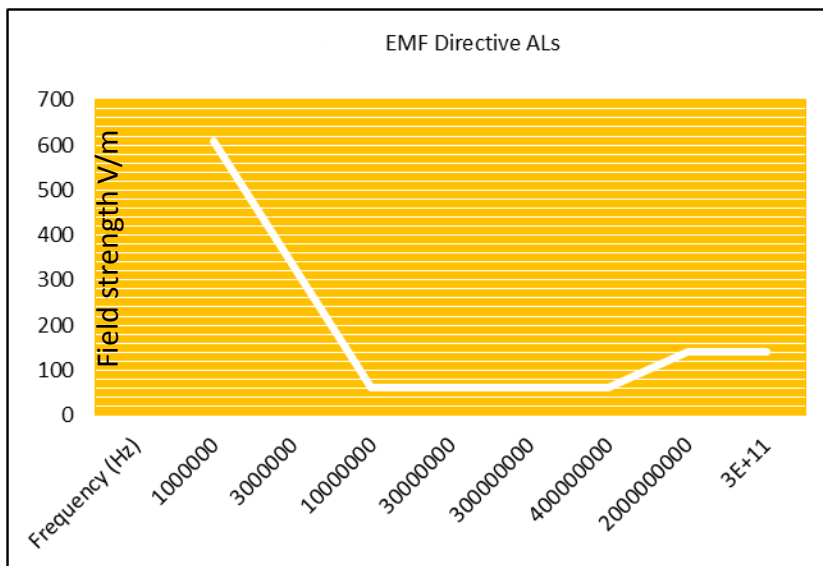
Typical high frequency field probes

Type	Frequency	Probe
E-field, shaped ICNIRP	300 kHz to 50 GHz	ED5091
E-field, flat (320 V/m)	100 kHz to 3 GHz	EF0391
E-field, flat (1300 V/m)	100 kHz to 3 GHz	EF0392
E-field, flat	100 kHz to 6 GHz	EF0691
E-field, flat	3 MHz to 18 GHz	EF1891
E-field, flat	40 MHz to 40 GHz	EF4091
E-field, flat	300 MHz to 50 GHz	EF5091
E-field, flat	27 MHz to 60 GHz	EF6091
E-field, flat	100 MHz to 60 GHz	EF6092
E-field, flat	100 MHz to 90 GHz	EF9091
H-field, flat	27 MHz to 1GHz	HF0191
H-field, flat	300 kHz to 30 MHz	HF3061

Types of field probe



'Flat' Response



Shaped Response

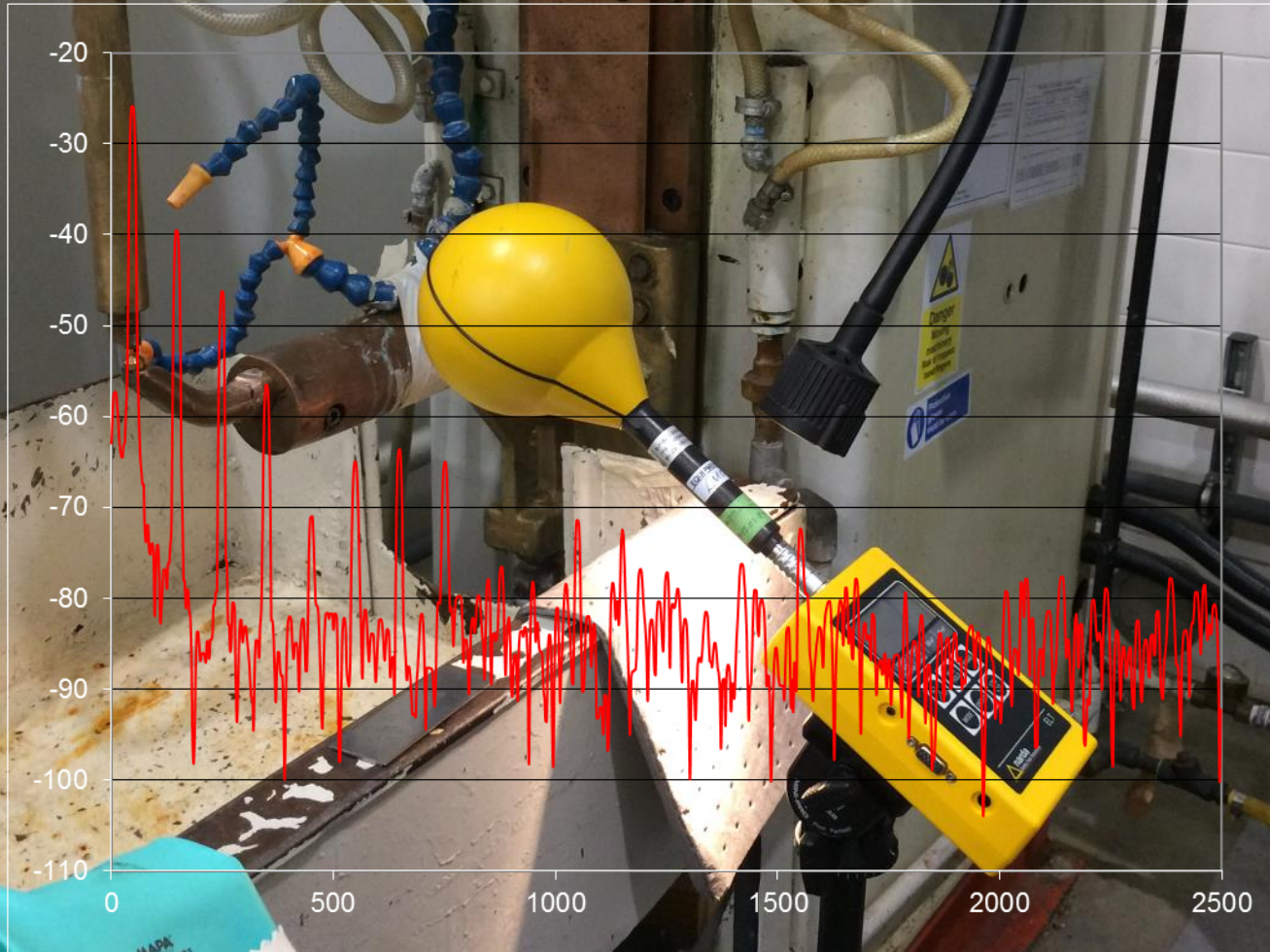
Shaped probes

- Shaped probes have a frequency response weighted in accordance with a given safety guideline or standard. Shaped probes read out in ‘% of Std.’ e.g. % of AL rather than normal field units.
- Useful for multiple emitter environments (multiple frequencies with different permissible exposure levels).
- Also useful when surveying unknown or classified frequencies.

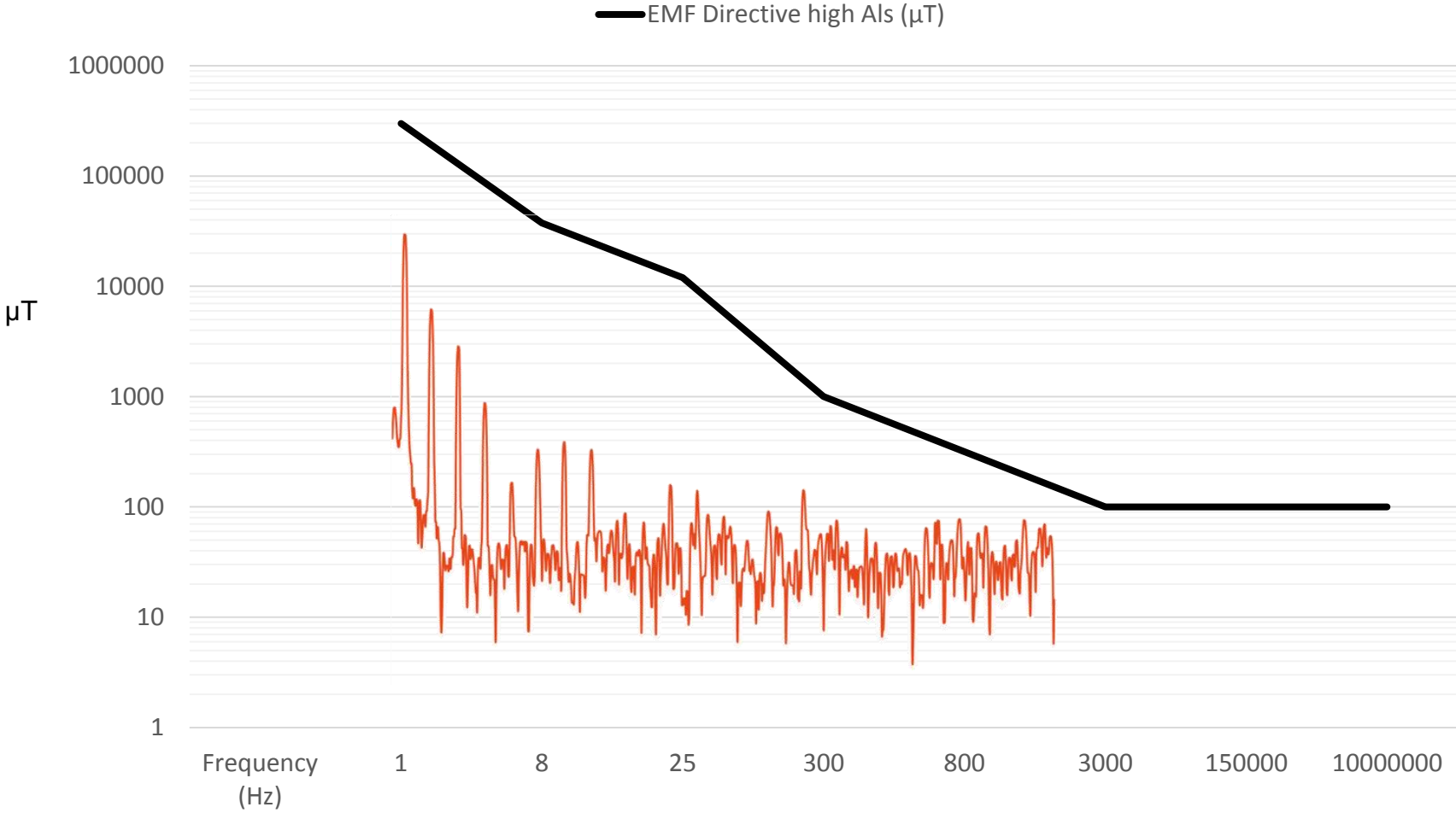


Low frequency magnetic field assessment

- Usually significant harmonic contribution so 'weighted peak' measurement required.

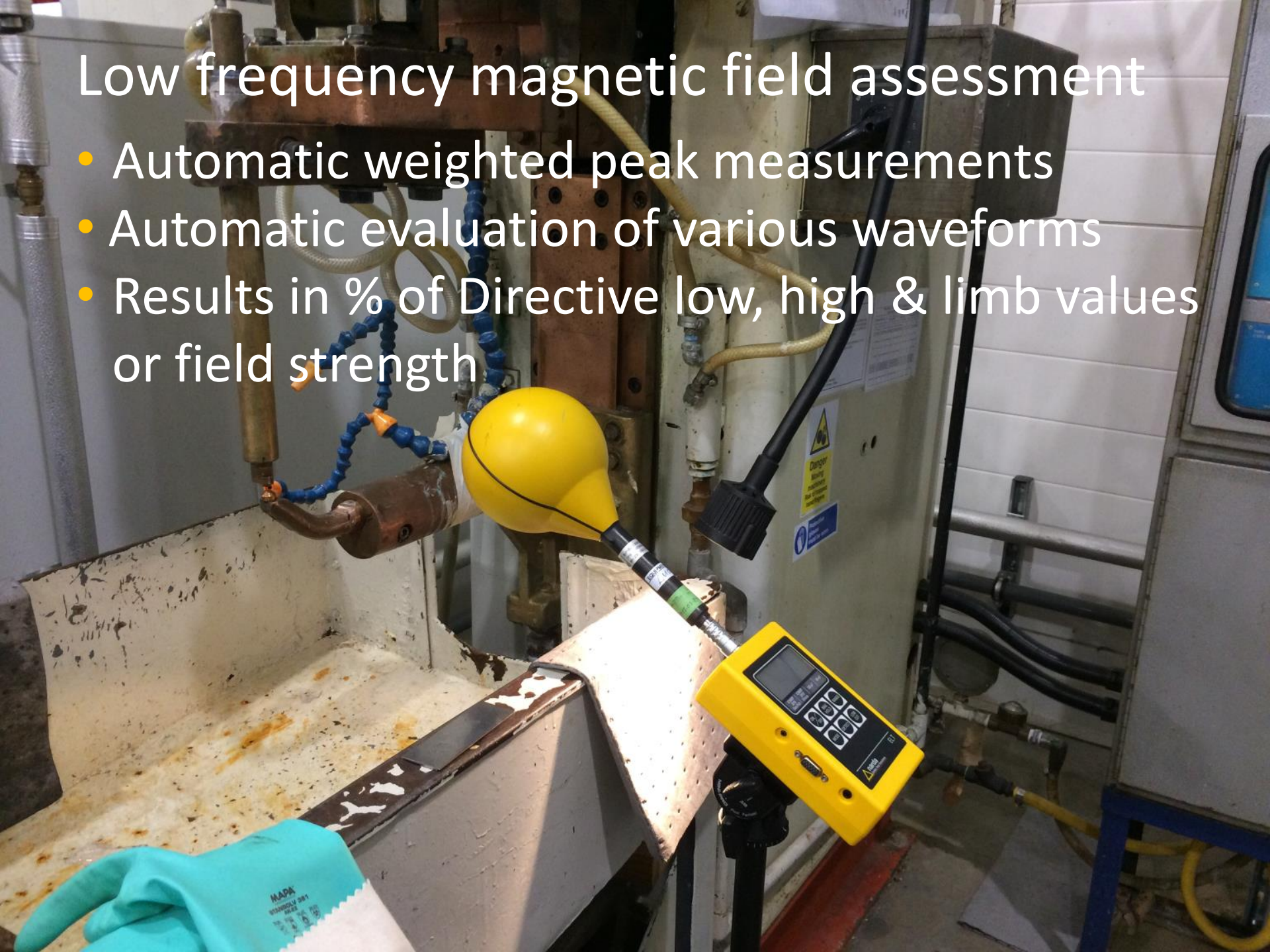


Low frequency magnetic field assessment



Low frequency magnetic field assessment

- Automatic weighted peak measurements
- Automatic evaluation of various waveforms
- Results in % of Directive low, high & limb values or field strength



Static field measurement

- Sometimes it's necessary to measure static magnetic fields; applications include MRI, some rail & subways, industrial processes that use high levels of DC.
- Frequency range DC to 1 kHz
- Measurement range 10 μ T to 10 T.
- Easy operation by meter or laptop.



Measurements

Two basic measurement scenarios:

- Intentional emitters e.g. antennas may be appropriate to perform pre-survey calculations.
- Unintentional emitters e.g. waveguide leaks, industrial equipment etc. Impossible to calculate field strengths.

For either case always gain as much information as possible before performing measurements.

Pre-measurement information

Before you take any measurements it's important to gather as much information as you can;

- Power level of equipment?
- Frequencies?
- If it's an antenna based system it will be possible to get information about field strength for a given input power?
- Is output intermittent?
- Do you need to measure the electric or magnetic field or both?
- **Make sure you know the AL for the frequencies of interest**

Power levels



Induction heating	(1200kW)
TV transmitter	(50 - 500kW)
FM national broadcast radio	(250kW)
Industrial dielectric heater	(20kW)
DAB	(0.1 - 10kW)
Domestic microwave oven	(800W)

Macrocell Base Station	(25 - 70W)
Mobile radio	(5 - 50W)
CB radio	(4W)

Smart meter	(1W)
Telecoms microwave link	(0.1 - 1W)
GSM mobile phone	(0.002 – 0.25W)
Wi-Fi	(0.1W)
DECT handset	(0.01W)
Bluetooth	(0.0025W)

All values are approximate

Measurements

Selection of measurement instrument depends on a number of factors but main points are;

- Required frequency range?
- Measurement range?
- Electric or magnetic field or both?
- Overload limits?
- Reputable equipment will have a detailed specification listing frequency sensitivity, isotropy, linearity, temperature response, calibration uncertainty and will be supplied with a calibration certificate traceable to national standards.

Measurements

Measurement techniques:

- Begin the survey from beyond the calculated hazard distance
- At low frequencies e.g. ELF to HF the measuring device should be mounted on a tripod to avoid body reflections
- Where possible point the probe at the source of radiation but try to minimise body reflections
- Hold probe at arms length away from your body
- Move slowly towards a suspected source.

Measurements

Measurement techniques:

- Move probe through an area in a slow and controlled up and down manner to find maximum reading
- The minimum measurement distance between a radiating surface and the probe head is approx. 10cm. Measurements inside this distance may be inaccurate
- Consider uncertainty budget (often approx. +/- 50%) when interpreting results.

Measurements

Interpreting results

- Take worst case measurement and compare against AL / Maximum Permissible Exposure Level (MPE).
- Consider measurement uncertainty.
- If value exceeds the AL consider if spatial or time averaging is applicable. Note this is not necessary if worst case measurement is below the AL/MPE. Otherwise consider compliance with ELV.

Reporting measurement results

A safety measurement report should include:

- specific location of measurement(s)
- relevant specification details, type and serial number of measurement equipment
- calibration dates of measurement equipment.
- measurement uncertainty
- if and how calibration/correction factors have been applied
- measurement results
- comparison with permissible exposure levels

Reporting measurement results

A full report should also include:

- comments on any large discrepancy with any calculated values
- values recorded in areas normally accessible by people (a distinction should be made between public and occupational access)
- information on any 'hot spots'
- notes on existence of any warning signs, engineering controls etc.
- temperature and weather during survey

Reporting measurement results

A report may include:

- Emitter information
- Site map/GPS co-ordinates
- Operational procedures to control exposure, permits to work etc.
- Outline of hazardous areas
- Existence of other hazards, fuel etc.
- Attitude of workers to EMF hazards.

Summary; measurements

- ✓ Check equipment is appropriate for use e.g. E or H field, frequency range, measurement range, overload level, weighted peak capability etc.
- ✓ Check equipment is functioning correctly, preferably with an RF source
- ✓ Check calibration status and that you have calibration/ correction factors
- ✓ Decide on the units of measurement that you will be using e.g. V/m, W/m², % of AL
- ✓ Check the MPE i.e. the value that you will be measuring against
- ✓ If possible calculate a hazard distance
- ✓ Take measurements in a slow and controlled manner
- ✓ Check anomalies

Summary; reports

- ✓ In any written report include equipment details;
 - Manufacturer
 - Model number
 - Serial number
 - Calibration dates
- ✓ Whether or not calibration/correction factors have been applied
- ✓ Estimate of measurement uncertainty

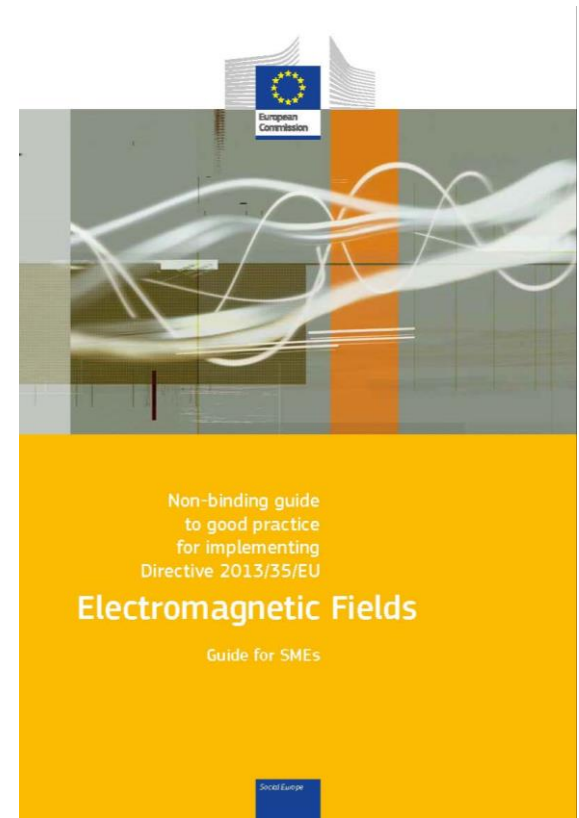
Summary

When performing measurements do not put yourself at risk of over exposure, remember;

- Lowest MPE levels over the frequency range 10 to 400 MHz because of whole body heating. Be aware of ALs for the frequency of your measurements
- Minimise time in potentially hazardous areas e.g. in front of/adjacent to an antenna
- Maximise distance between yourself and all sources
- Assume sources are active
- Be aware of warning notices, exclusion zones etc.

Last but not least

- EMF safety issues are usually easy to resolve, rather than rely on external advice try to take some ownership in-house, we are more than happy to help that process.
- Guide for SMEs is an excellent place to start.
- If necessary, most measurements are easy to perform.
- Remember that basic risk assessment (sanity check); is the equipment high power, how close to people have to get to the source, how long to they have to be there.
- Remember to consider workers at particular risk



Any Questions?

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www.linkmicrotek.com/emf-safety