

Effects of EMF on Health and the Environment

Standards for Occupational Exposure to Electromagnetic Energy

David Black MD FAFOEM MARPS MRSNZ

iTmedical Ltd, Auckland

Senior Lecturer in Environmental Medicine

School of Population Health

University of Auckland

d.black@auckland.ac.nz

Environmental Medicine

Nature of Effects

- Deterministic
 - Predictable in an individual
- Stochastic
 - Predictable in a population
- Acute
 - Immediate and reversible
- Chronic
 - May not be readily reversible
- Cumulative
 - Effect accrues with added dose

Deterministic Effect

- A deterministic health effect has
 - Severity that is dependent on dose
 - Threshold level usually below which no effect is seen.
 - Common example is alcohol

Stochastic Effects

- Stochastic health effects
 - Appear as if by chance in an individual, sometimes occurring without an apparent threshold level of minimum dose.
 - Probability proportional to the dose but severity is usually independent of the dose.
 - An example is cancer caused by ionising radiation

Acute Effects

- Occurs while exposure persists
 - Effect is driven by the mechanism of action
 - Example is electro-stimulation
- Disappears when exposure stops
 - Easy to establish cause and effect
- Usually no lasting damage
 - Most effects do not damage tissue at typically encountered levels

Chronic or Cumulative Effects

- Long term effects
 - Alteration of tissue structure or chemistry
- Possible accrual of irreversible damage
- Effect of gradual onset may not be noticed until advanced and irreversible
- An example of a cumulative effect is noise induced hearing loss.

Biological effects of EMF

- Electric fields have surface effects such as:
 - the movement of hair
 - electric shocks
- Magnetic fields induce small circulating currents in conductive tissue
 - The resulting currents may have neuro-stimulatory effects such as retinal flashing



Identification of Effects

(in general)

2010
YEAR

PRESENTATION

The University of Auckland | New Zealand

	Acute	Chronic & cumulative
Deterministic	Depends on reporting, then can be monitored in an individual. Readily understood and controlled	Can be found by screening. Baselines are important. Need to define effect and means of detection
Stochastic	Can be transient and scattered, can often be missed.	Result is accrued and persistent effect, may be noticed in a group. Serious consequences are possible.

Identification of Effects

(first effects at ELF)

2010
YEAR

PRESENTATION

The University of Auckland | New Zealand

	Acute	Chronic & cumulative
Deterministic	Sensation of electric fields Retinal flashing	None known at low levels
Stochastic	Hypersensitivity to electrical stimulation	Small increase in childhood leukaemia rate (not proven, worst case RR <2)

Identification of Effects

(first effects at <10Mhz RF)

2010
YEAR

PRESENTATION

The University of Auckland | New Zealand

	Acute	Chronic & cumulative
Deterministic	Electrostimulation & RF burns	None known at low levels
Stochastic	None established	None established

Identification of Effects

(first effects at >10Mhz RF)

2010
YEAR

PRESENTATION

The University of Auckland | New Zealand

	Acute	Chronic & cumulative
Deterministic	Tissue heating	None known at low levels
Stochastic	None established	None established

Standards protect against

- Acute electrostimulation
 - Deterministic & reversible
- Acute Tissue Heating
 - Deterministic & reversible



Standards do not protect against

- Any known cumulative effect
 - None are established
 - Suggestions of such effects have been at very low levels
- Any established chronic effect
 - All effects are acute and reversible, short of actual tissue damage

Workers Fitness & Health

- A worker must be fit to establish and maintain a commercially sustainable employment relationship
- Employer must take the worker as they find him or her
- Employer has a duty of care not to harm the worker
- Egg-shell skull principle

Medical Assessment

- Baseline is always important
 - Vision
 - Hearing
 - Neurological
 - History
- Medical devices
- Electro-sensitivity or electro-phobia
- Important to retain records

Past issues (resolved)

Bioelectromagnetics Supp 6 (2003)

- Cataracts no longer an issue (Elder)
- Thermal load well enough understood
 - (Adair and Black)
- Effects on blood and hormones irrelevant
 - (Black & Heynick)
- All these (and others) published in Bioelectromagnetics, released to the public domain).
- WHO EHC 137 and 238 (www.who.int)

Pre-employment & Routine Medical Assessments

- Baseline measurements are important
- Routine reviews looking for changes
- Don't mix up with "wellness"
- Exit reviews recommended
- Rationale
 - The employer is depending on an assumption of a separate population.
 - RF workers are not the general public.
- Often combined with other procedures

Safety Margins

- Wide safety margins are often advocated for public standards to
 - Allow for a wide range of sensitivities
 - Convey confidence
 - Make allows for errors and malfunction
- Lower safety margins are acceptable for workers
 - The origin of this may have been exposure time, but the rationale is different now

What is different about workers?

- Electrical and radio workers are a controlled group of known and generally favourable health status which can be monitored.
- A reasonable expectation of training and trade skills to keep safe
 - The magnitude of safety margins is therefore less important
- A precautionary approach to rare and uncertain risks is replaced by a hierarchy of control

The Precautionary Principle

- The consequences of an established risk of low probability but high potential impact can be decreased by:
 - Increased precaution in all cases, over and above each individual requirement
 - Measures which can be shown to decrease population exposure where hazards are not established but suspected

Precautionary Principle

- Likely to achieve something
 - Double skinning of oil tankers
 - Ongoing reduction of SO₂ levels (WHO)
- Unlikely to achieve anything but still worth considering (WHO 238)
 - Phase cancellation wiring of electrical supply cables
 - Increasing voltage of LV supplies (to reduce magnetic field exposure)
 - Requiring demonstration of exposure minimisation in public RF applications

Pointless and Purely Political

- Setting lower standards for the same technology
- Manoeuvres which defeat power minimisation
 - Cellphone shields
 - Moving base station to less optimal sites
- Providing indecisive public information to minimise risk of being wrong

Advice and questions..

- Advice is often *“If you are worried then these are the things you can do”*
- The workers question will likely be
 - *“Should I be worried?”*
- The correct answer is
 - ***“These are the things you must do to work safely with EMF”***

Hierarchy of Control

2010
YEAR

PRESENTATION

The University of Auckland | New Zealand

Priority	Measure	
1	Eliminate	Cannot eliminate, by definition EMF workers are working with EMF
2	Substitute	Not relevant, still have to work with EMF
3	Enclose	Sometimes can screen, but the best attenuator for fields is distance . For charge, insulation or grounding .
4	Personal Protection	Combination of trade skills and sometimes personal protective equipment

Risk of Over-exposure

- One important difference in the occupational exposure scenario is the risk of further over exposure and procedures required for managing this if it occurs.
- A recent area of particular concern and interest surrounds the inevitable exposure to time varying fields to workers managing the use of magnetic resonance scanners (MRI).
- The manner in which this should be controlled and managed particularly in Europe is still far from agreed.

Occupational vs Control

2010
YEAR

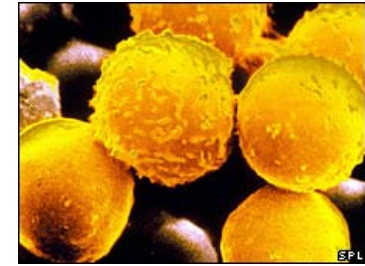
PRESENTATION

The University of Auckland | New Zealand

- There is a marked difference in the categorisation of occupational versus public exposure between the ICNIRP derived standards and the method recommended by IEEE.
- Whilst ICNIRP define classification of the personnel, IEEE suggests control of areas of higher than public exposure limits.
- Some standards allow for both approaches and there seems no reason to argue against that approach as both have merit.

Rare Stochastic Effects

(eg Childhood Leukaemia)



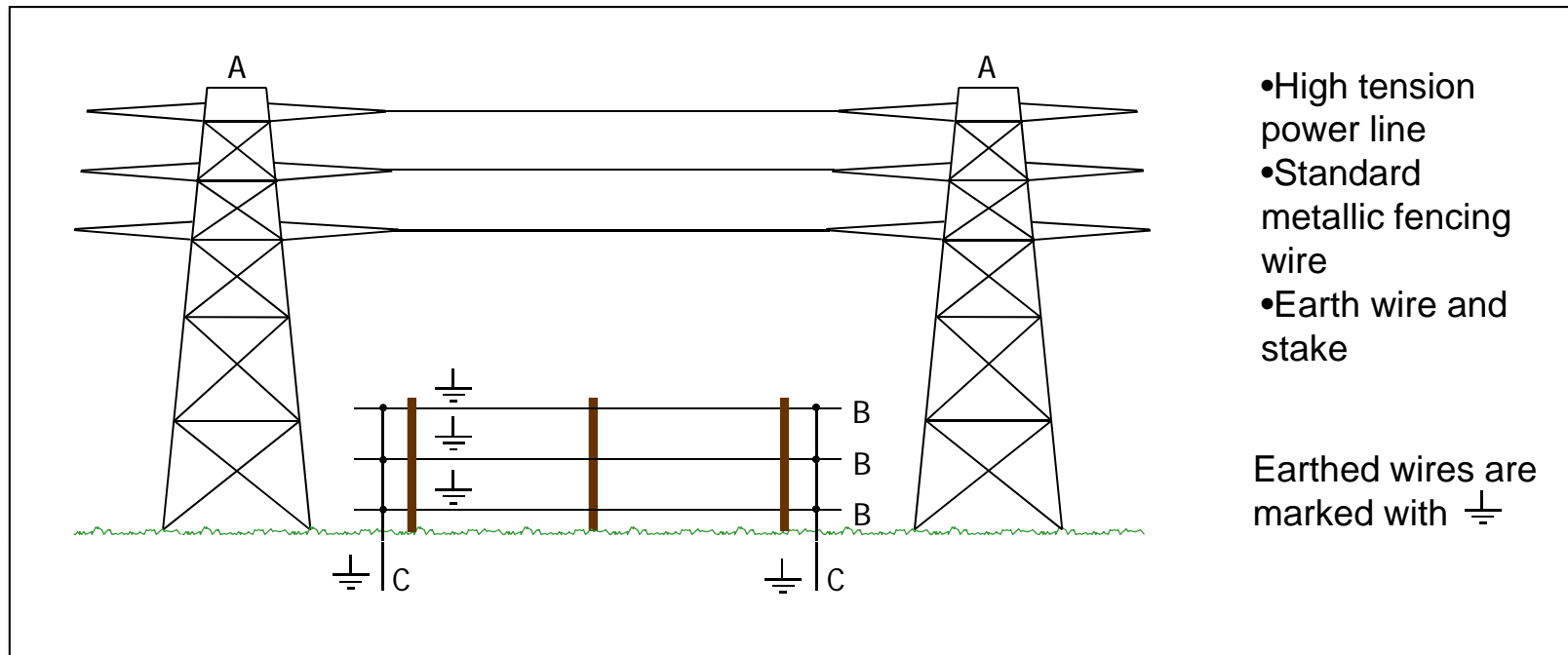
- Not relevant for working population
- Not covered by standards
- Population (possible) risk
- Not a matter for occupational standards
- Trade skills and application of the hierarchy of control should minimise exposure
- No other measures are indicated or practical.

Indirect Effects

- Fields can charge intermediate conductors which can deliver more biologically significant doses of acute energy than fields alone.
- Limiting field strengths is not a practical way of preventing indirect effects.
- Situations where these effects can occur are important to predict

Some Indirect Effects can only be Prevented by Mitigation

- Grounding of metallic structures such as wire fences prevents them from charging up and causing electric shocks



Medical Management

- Fears in workers about over-exposure invariably arise from catastrophic thinking.
- Catastrophic thoughts are cognitive distortions, first identified by Burns at Stanford.
- Burns used correction of cognitive distortions to treat depression.
- It is relatively straightforward to apply these techniques to treat electrophobia

Summary

- Occupational standards are well based, coherent, consistent and stable
- Generally with a good safety margins.
- “First effects” are sometimes variable and remain arguable.
- Medical screening and monitoring whilst important and useful remains but is in need of further revision.
- Electrophobia is a real and disabling psychiatric disorder which is readily treatable.