




Slide 1

		
<p>SWINBURNE UNIVERSITY OF TECHNOLOGY</p>	<h1>Philosophy of Standard Setting</h1>	
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	<p><b>Australian Government</b> <b>Australian Radiation Protection and Nuclear Safety Agency</b></p>	

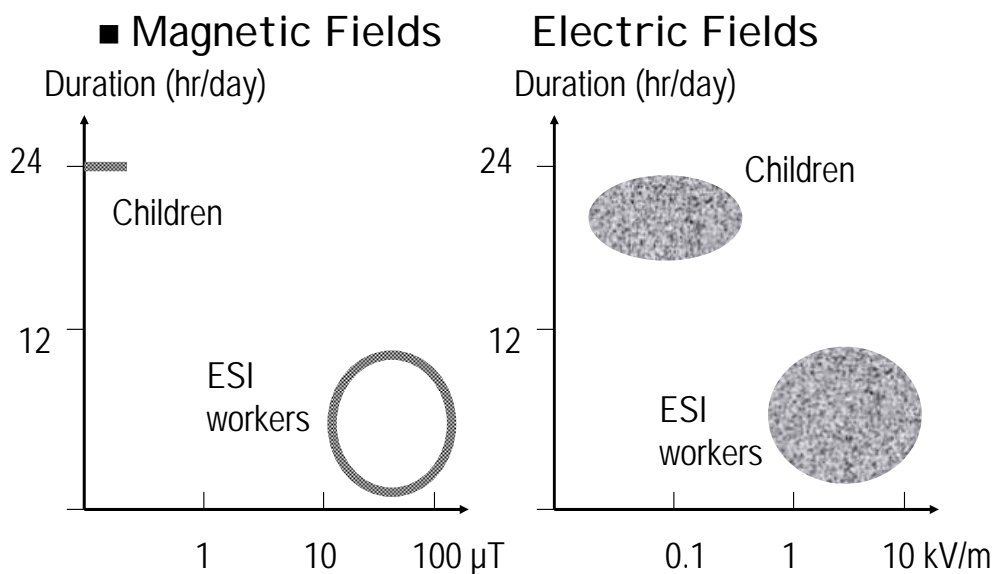
Slide 2

<h2>Synopsis</h2> <hr/> <ul style="list-style-type: none"><li>■ Overview of current draft standard</li><li>■ Main changes to Standard and the limits in response to submissions</li></ul> <p>ARPANSA ELF Standard Forum 27/2/08</p> <p>2</p>
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## Excerpts from DDP for ELF Standard

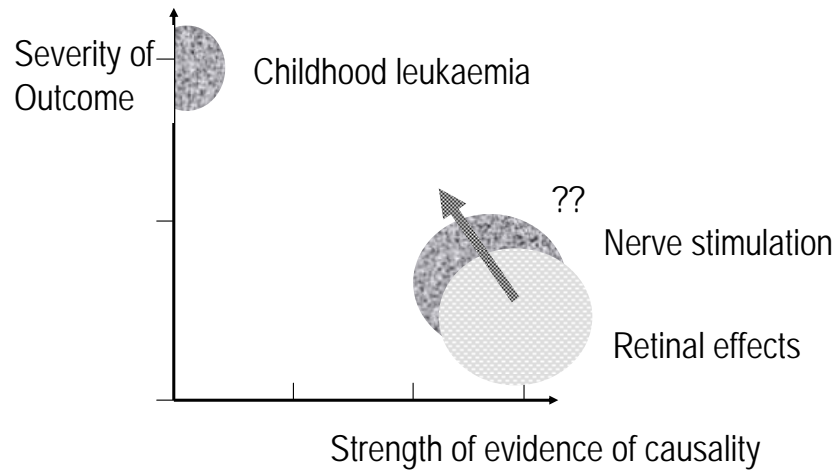
- Action proposed: withdraw NHMRC 50/60 Hz Guidelines, replace with EMF Standard for 0 - 3 kHz
- Aim: to develop a **scientific limits**-based approach to restricting human ELF exposure; to ensure protection against **established adverse** health effects
- Affected parties: mainly industries producing/using high power/current electrical apparatus - **not just 50 Hz**.
- Consideration of both **occupational** and **general public** exposure categories
- Originally: Public comment draft by **Sept/Oct 2004**: Publication 2005

## Exposures



## Health Risks of EMFs

- Concerns for children & workers quite different



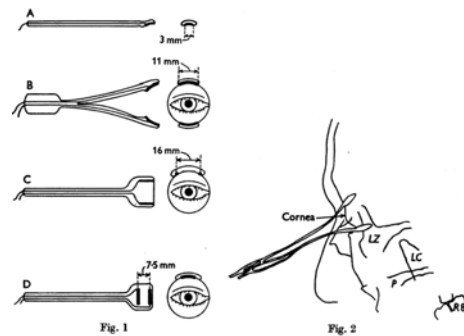
## Role of limits

- Sets boundaries on hazards where there is some degree of understanding: ELF: at high enough fields muscle spasm will result

What do we do about suspected, but unproven, hazards?: Role of precaution – take care!



## Retinal/nerve stimulation limits

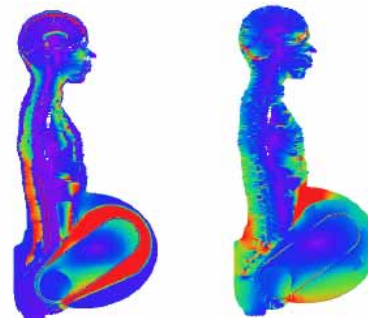


ARPANSA ELF Standard Forum  
27/2/08

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## Determining reference levels

- Hazardous effects for *external* 50 Hz fields estimated at
  - 17 mT magnetic
  - 500 kV/m electric
- Determined from math. modelling of internal currents and fields
- These are easier for determining compliance



$J_{int}$

$E_{int}$

(UK HPA data)

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## Issues

### ■ Basic Restrictions

- Phosphene data not easily converted to  $E_{int}$
- Phosphene data mostly in range 10 – 40 Hz, and dc
- MRI stimulation thresholds due to ramped fields (dB/dt) rather than sinusoids (however, the two are linked.....)

### ■ Reference Levels

- Some dependency on model used (e.g. Cech et al. vs Dimbylow)
- $E_{int}$  refers to organs assumed to be homogeneous (e.g. retina actually many-layered)

## How consistent are models?

- Comparison of 3 modelling approaches for foetus:  
J in mA/m<sup>2</sup> for 1 mT side-to side (1 cm<sup>2</sup> average)

	Foetus	CNS mother	Whole body
Cech et al. 08	6.0	4.1	22.6
Dimbylow 06	5 – 7 (body) 2 – 3 (brain)	3	
Xue et al. 04	3.6		22.5 (placenta) 30 amniotic fluid

## Changes:

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### ■ Title

- Original: Exposure Limits for Electric & Magnetic Fields — 0 Hz to 3 kHz
- Amended: Limits and Precautionary Measures for Reducing Exposure to Electric & Magnetic Fields — 0 Hz to 3 kHz

## Changes:

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### ■ Magnetic Field limits

- Original: Had a 'Controlled Activity' category and 'Normal' category which was harmonised to ICNIRP at 50 Hz for General Public
- Amended:
  - No 'Controlled Activity' category
  - No harmonisation with ICNIRP: 50 Hz General Public limit now 300  $\mu$ T
  - For Occupational exposure, addition of 50 Hz limb limit of 9 mT (5 x 'torso' limit) under consideration as a recommendation, with more detailed analysis for e.g. exposures with high harmonic content

## Changes:

### ■ Electric Field limits

- Original: had a rather artificial reduction in 'Normal' limits to give approximate harmonisation with RF standard at 3 kHz
- Amended:
  - 'Controlled Activity' now 'Controlled Circumstance'
  - Controlled Circumstance now has no reference to time; it is now linked to management measures
  - Now a discontinuity between ELF/RF standards at 3 kHz: Occupational 1100/614 V/m; General Public 220/86.8 V/m
  - Margin of 5 consistent with derivation from direct, rather than indirect effects (where 2 is used)

## Side-by-side:

REFERENCE LEVELS FOR EXPOSURE TO RMS ELECTRIC FIELDS (UNPERTURBED FIELDS)

Exposure category	Frequency range	Efield strength (V/mrms)	Controlled Activity E field strength (V/mrms)
Occupational	0.1 – 25 Hz	20,000	20,000
	25 – 165 Hz	$5 \times 10^3/f$	20,000
	165 – 825 Hz	$5 \times 10^3/f$	$3.3 \times 10^3/f$
	820 – 3,000 Hz	614	$3.3 \times 10^3/f$
	50 Hz	10,000	20,000
General Public	0.1 – 25 Hz	10,000	10,000
	25 – 66 Hz	$2.5 \times 10^3/f$	10,000
	66 – 3,000 Hz	$2.5 \times 10^3/f$	$6.6 \times 10^3/f$
	50 Hz	5,000	10,000

NOTES:  $f$  is the frequency in Hz.  
For explanation of Controlled Activity see Glossary/Schedule 1.  
For explanation of frequency ranges, see Schedule 1.

REFERENCE LEVELS FOR EXPOSURE TO RMS ELECTRIC FIELDS (UNPERTURBED FIELDS)

Exposure category	Frequency range	Efield strength (V/mrms)	Controlled Circumstance <sup>a,b</sup> E field strength (V/mrms)
Occupational	0.1 – 165 Hz	10,000	20,000
	165 – 330 Hz	10,000	$3.3 \times 10^3/f$
	330 – 820 Hz	$3.3 \times 10^3/f$	$3.3 \times 10^3/f$
	820 – 3,000 Hz	$3.3 \times 10^3/f$	$3.3 \times 10^3/f$
	50 Hz	10,000	20,000
General Public	0.1 – 66 Hz	5,000	10,000
	66 – 132 Hz	5,000	$6.6 \times 10^3/f$
	132 – 3,000 Hz	$6.6 \times 10^3/f$	$6.6 \times 10^3/f$
	50 Hz	5,000	10,000

NOTES:  $f$  is the frequency in Hz.

## Definition of Controlled Circumstance

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For explanation of frequency ranges, see Schedule 1.

a. **Controlled Circumstance (occupational)** means the following circumstances:

- training & information (including field levels) are provided to employees;
- suitable screening for implants is undertaken;
- the possibility of indirect hazard is removed; and
- advisory signage is placed in appropriate locations.

b. **Controlled Circumstance (general public)** means the following circumstances:

- the possibility of indirect hazard is removed and advisory signage is placed in appropriate locations. [It is likely that in practice this will only occur on easements under transmission lines].

## Controlled Circumstance & Basic Restriction

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	Excitable?	Tissue E-field induced by 10 kV/m external field (Vertical)		Tissue E-field induced by 0.3 mV external field (Side-to-side)	
		99 <sup>th</sup> percentile mV.m <sup>-1</sup>	Limit exceeded?	99 <sup>th</sup> percentile mV.m <sup>-1</sup>	Limit exceeded?
Bone		494.00	&&	15.27	**
Tendon		379.00	&	2.81	
Skin	?	331.00	&	10.80	**
Fat		252.00	&	10.05	**
Trabecular bone		151.00		7.29	*
Muscle	√	81.40		6.90	*
Bladder	?	64.90		13.74	**
Heart muscle	√	39.80		8.40	*
Spinal	√	29.20		8.10	*
Liver		28.80		11.46	**
Pancreas		27.60		4.08	
Lung		25.40		7.32	*
Spleen		24.90		5.52	*
Vagina	?	23.40		3.60	
Uterus	?	21.30		2.83	
Thyroid		20.30		6.54	*
White matter	√	20.20		9.42	*
Kidney		18.60		6.75	
Stomach	?	18.60		4.50	
Adrenals		18.30		5.76	*
Ovaries		16.90		1.59	
Blood		16.60		5.25	*
Grey matter	√	16.20		9.06	*
Oesophagus		16.10		3.00	
Duodenum	?	16.00		4.23	
Lower LI	?	15.30		3.66	
Breast		14.60		9.30	*
Gall bladder		13.60		2.89	
Small intestine	?	12.00		3.12	
csf		11.50		4.44	
Thymus		10.90		5.88	*
Cartilage nose		10.30		9.45	*
Upper LI	?	9.89		3.81	
Bile		8.05		1.99	
Urine		7.00		1.41	
Lunch		6.21		1.94	
Sclera		5.67	*	4.89	
Retina	√	5.52	*	4.05	
Humour		2.76		2.22	
Lens		2.68		2.01	

BRs:

5 mV/m in eye tissue (GP);

200 mV/m in excitable tissue (Occ)

## But what about leukaemia?

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### ■ Epidemiological Evidence

- Association seen for TWA magnetic fields above 0.4  $\mu$ T (measured in child's bedroom)
- If due to induced current, would also be seen above 12 V/m, but no evidence of this
- IEEE, ICNIRP, WHO do not consider the evidence strong enough to be considered **causal**, thus it doesn't form basis for limits
- **Risk estimate: Approx. 6 of the 230 cases of childhood leukaemia pa could be due to high EMF exposure (most will survive...)**
- **Justifies Precautionary Approach**

### ■ BUT.....

## But what about leukaemia?

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- **Laboratory Experiments:** A number of 'effects' at low levels reported: hard to replicate and link to cancer dubious
- **Animal experiments:** almost entirely no cancer excess (even at really high levels)
- **Mechanism:** no credible mechanism identified for low level effects

## Mandating Precaution

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- Aim is to reduce leukaemia risk, even if EMF **not causal**
- Precaution advocated for Occupational Exposures (?parental risk). Now emphasised by new paragraph
- Original: Measures for .....**general public**.....**must include**  
....  
Minimising... electric and magnetic field exposure **provided this can be readily achieved without undue inconvenience and at reasonable expense.**
- Amended: New sub-section on 'precautionary measures' and the addition of requirement to provide advisory signs in certain locations

## Mandating Precaution (ii)

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### 5.7 PROTECTION OF THE GENERAL PUBLIC

5.7.1 Measures for the protection of members of the general public **occupational as well** who may be exposed to ELF and/or static fields due to their proximity to high ELF and/or static sources must include the following:

- (a) Determination of the boundaries of areas where general public exposure limits levels may be exceeded.
- (b) Restriction of public access to those areas where the general public exposure limits may be exceeded.
- (c) Appropriate provision of warning signs or notices
- (d) Notification to the competent authority, as required, in the event of the exposure exceeding the relevant limits.

## Mandating Precaution (iii)

### 5.7.2 Precautionary measures must include:

- (a) minimising, as appropriate, ELF and/or static electric and magnetic field exposure provided this can be readily achieved without undue inconvenience and at reasonable expense. Any such precautionary measures should follow good engineering and risk minimisation practice. Planning practice and relevant codes of practice should also be followed. Precautionary measures should be proportional to the risk. (e.g. where children are involved). Important principles underlying appropriate precautionary measures are discussed in Annex 6. The incorporation of arbitrary additional prescriptive safety factors beyond the exposure limits of this Standard is not supported.
- (b) Provision of advisory signs in areas of **unusually high fields** which may be occupied by people for a substantial period of time.

**Comment:** Add something about context?? To help people minimise exposure

**These measures are included with the aim of reducing the risk of cancer, but in the absence of a clear indicator for this association the reduction of risk is not guaranteed. Discussed further in Schedule 1 (Rationale)**

## Regulatory Impact

- **Introducing a standard (even if non-regulated) has resource implications**
- **Cost-Benefit Analysis (done for ARPANSA)**
  - Costs: Industry compliance & governmt. admin.
  - Benefits: 'Willingness to pay' to avoid possibility of some lives lost AND/OR less than perfect health
- **Regulatory Impact Statement**
  - Modest benefit from **non-regulatory** option (\$4M)
  - Educational material on leukaemia issue for ARPANSA website being developed

## Summary: The Draft ELF Standard

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- **Title: Limits & Precautionary Measures**
- **Limits** for short-term neurostimulatory effects
- **Mandatory Precautionary Measures** entail:
  - Exposure minimisation via low-cost or no cost (including building design regs.)
  - Advisory signs of 'unusually high' field locations
  - Education material on 'leukaemia issue'
  - (For both Occupational groups and General Public)

## Summary (more):

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- **But is it *effective* protection?** Assumption that 'factor X' (which is what *causes* raised leukaemia rate) will be lowered by the measures just listed
- **Will a non-regulated standard *ensure* protection?**
  - How is precaution enforced?
  - Will a non-regulated standard acquire the same status as a regulated standard?

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**Thank you**