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Compliant Considerations
in relation to the 1989 NHMRC Interim Guidelines and the ARPANSA Draft ELF Standard

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OUTLINE

Introduction
- 50 Hz Electric Fields
- 50 Hz Magnetic Fields

1989 INIRC/NHMRC 50/60Hz Interim Guidelines

ARPANSA Draft ELF Standard (0 – 3000 Hz)

Compliant Considerations

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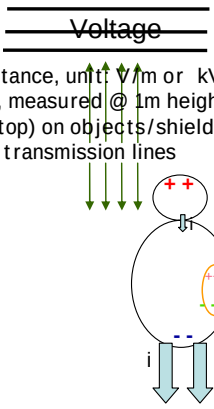
50 Hz ELECTRIC FIELDS - General

Detour



- voltage & distance, unit: V/m or kV/m
- unperturbed, measured @ 1m height
- terminate (stop) on objects/shielding
- main source: transmission lines

Protective considerations:
- **Capacitive-coupling:**

(charges induced on body/objects)
+ first contact: transient discharge → discharge shocks
+ steady state: current, in-situ E field
→ electrotimulation (synapses, PN..)

Protective metrics:
- Environmental E field (unperturbed fields)
- Induced internal E field as Basic Restrictions

examples of electrical / indirect effects:
- discharges from/to body-objects:
  - roof, fence, clothes line, wet clothes, metallic objects, trellis
  - vehicles, equipment, tools, structures/objects in occupational setting.
  - land use compatibility (road, farms, parking/commercial areas, sport/play grounds, backyards ...
- skin sensation: vibration of hairs.
- sparks: fire risk, fuel ignition, RF interference; corona: audible & RF noises

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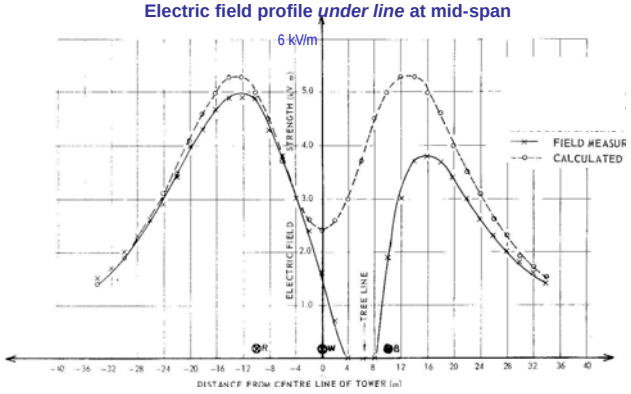
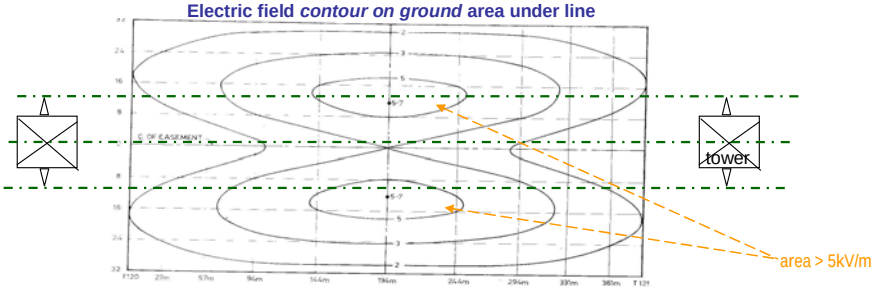
Example of electric fields – under a HV transmission line

Detour

Electric field profile *under line* at mid-span



Electric field *contour on ground* area under line



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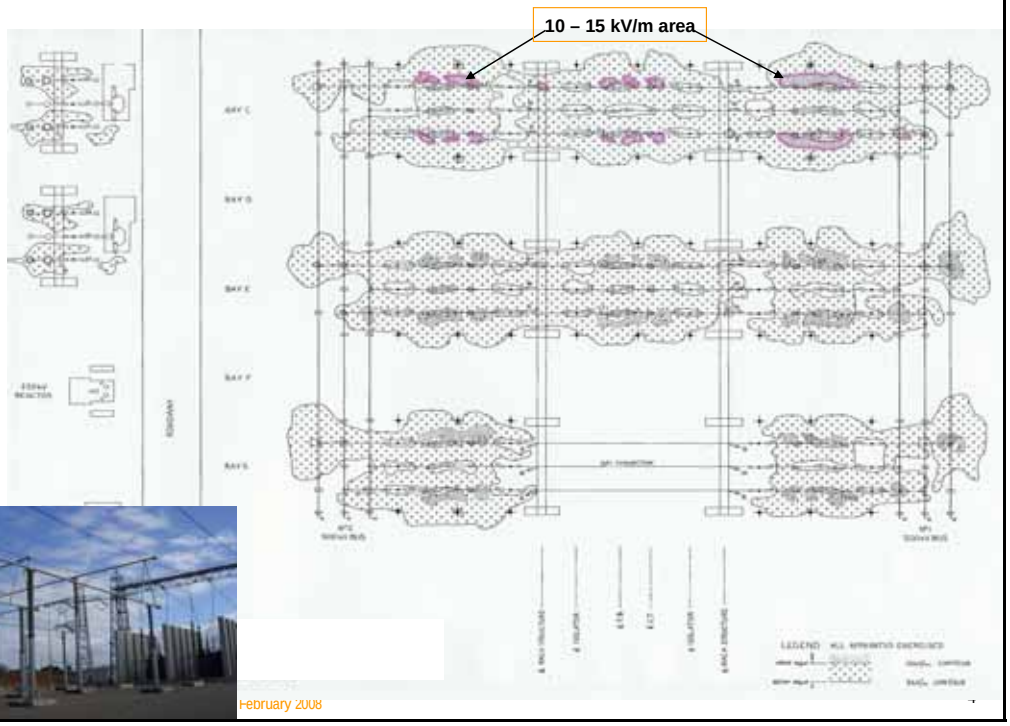
Example of electric fields – a HV switchyard/station

Detour



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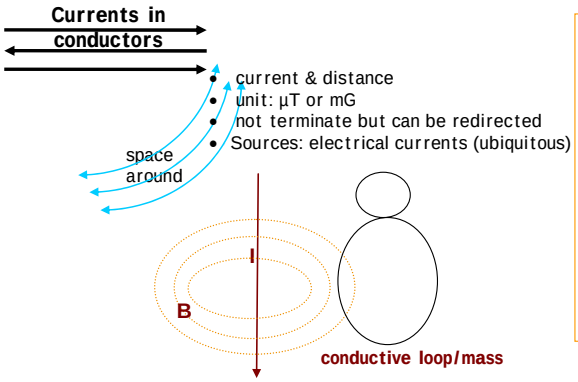
50Hz MAGNETIC FIELDS - General

Detour



• Protective considerations:

- Induced voltage, E field, I or J for electrotimulation of synapses or peripheral nerves

• Protective metrics:

- Basic Restrictions = internal E_{int} (mV/m)

- Reference Levels: external uniform magnetic field over relevant part of body.

Other electrical effects:

• **Induced voltages**: pipe, wire, fence, rail...electronic implants.

• **EMC:** interference with electronic implants, equipment e.g CRT-based monitors .., audible hums

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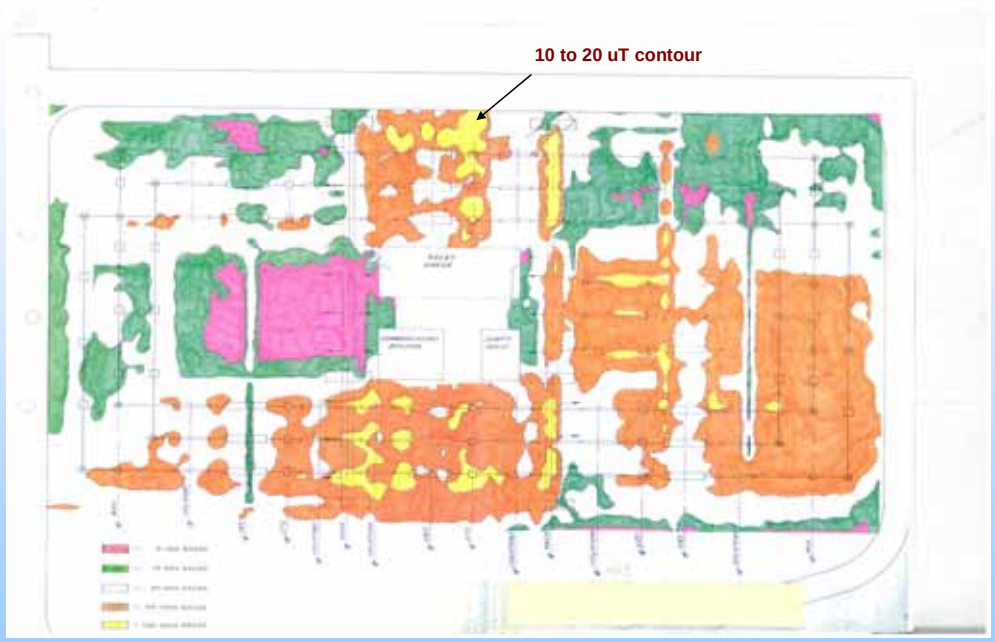
Detour

Example of Magnetic Fields – a HV Switchyard



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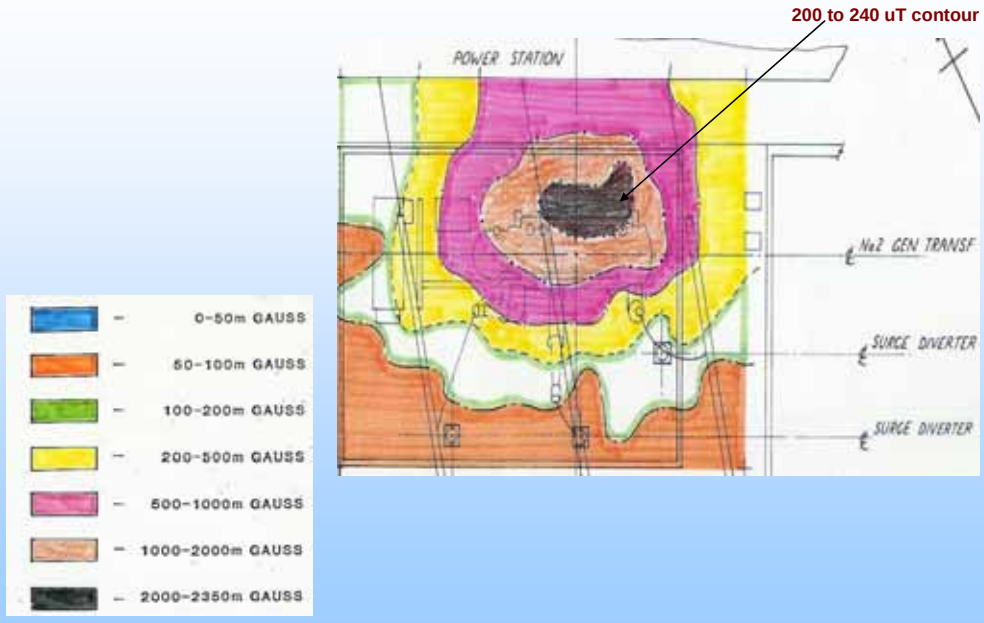
Detour

Example of Magnetic Fields – around a large power transformer



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Detour

More examples of elevated 50 Hz magnetic field sources (closed proximity of high current cables & apparatus)

Next to heavy current carrying cables/apparatus:

- underground cables in pits, substations, cable risers
- busbars & equipment in generation facilities
- electrolysis, electro-induction industrial plant
- air-core coils/reactors, conductors next to live-line working
- large motors, transformers,
- ...

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Human exposure & electromagnetic safety standards/guidelines – Historical Development

Australia		Notes
1970's	Utility electric field practices/guidelines	- E field only, discharge shock considerations. - short durations (minutes/hours, not TWA) for elevated E field locations.
1989	INIRC of IRPA NHMRC (adopted): "Interim guidelines on limits of exposure to 50/60 Hz electric and magnetic fields (1989)"	- simple 50/60 Hz, reference-level limits only - reference to measurement standard (IEC, IEEE (1987)) - short durations (minutes-hours) for elevated fields - neurons/excitable tissues response in order of second / less. - superceded by ICNIRP 1998 (INIRC became ICNIRP)
present	ARPANSA Draft ELF Standard	- 0 to 3000 Hz. - wider electrophysiology basis, various types of limits, induced E based. - 2-tier: GP and Occupational + sub-tiers. - reference to several IEC, IEEE, CIGRE documentation for field measurement/calculation …

Others		Notes
1998	ICNIRP "Guidelines for limiting exposure to time-varying electric, magnetic,and electromagnetic fields (up to 300 GHz)"	- large spectrum, discharge shock & electrostimulation basis, various types of limits, J based - adopted in various formats by a number of countries - accompanied by several IEC/Cenelec standards for field measurement/calculation, compliant evaluation
2002	IEEE/ICES Standard C95.6 "Safety Levels with Respect to Human Exposure to Electromagnetic Fields, 0 to 3 kHz"	- discharge shocks & electrostimulation basis, various types of limits, induced E based - 2-tier: GP and "controlled environment" - reference to measurement Std IEEE1460 (1996) & draft standard (IEEE C95.3) on measurement computation techniques 0-100 KHz is in progress.

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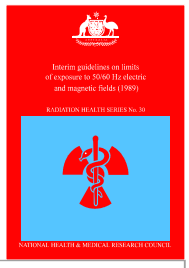
1989 NHMRC Interim guidelines on limits of exposure to 50/60Hz electric and magnetic fields

- 50/60 Hz only, interim nature.
- higher limits given for short occasional exposure (few hours) and incidental exposure (few minutes).
- highlight importance of internally induced fields but limits focus on environmental or ambient fields.
- can compare to 50Hz "Reference Levels" of recent standards/guidelines.



General Public / Exposure Condition	Electric Field (kV/m)	Magnetic Field (uT)
Up to 24-hour/day	5 (in area of 5 or less)	100 (in area of 100 or less)
Few hours/day	10 (in area of >5 to 10)	1000 (in area of >100 to 1000)

Occupational / Exposure Condition	Electric Field (kV/m)	50 Hz Magnetic Field (uT)
Whole working day	10 (in area of 10 or less)	500 (in area of 500 or less)
Short-term (up to two / few hours)	30 (in area of >10 to 30)	5000 (in area of >500 to 5000)
Limbs	-	25000

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Comparison: Electric Field Reference Levels

Population / Nature of exposure	NHMRC Interim Guidelines (1989) Electric Field (kV/m)	ARPANSA Draft ELF Standard Electric Field (kV/m)
General Public -Living environment, HV transmission-line's easements	**5** (>0 to 5) (up to 24-hour/day)	**5** (>0 to 5)
General Public - Higher field locations, some areas on easements	**10** (>5 to 10) (short term) - few hours/day - require known hi-field locations and process to monitor durations of activities.	**10** (>5 to 10) (controlled activity/circumstance) - no hour limit, not require monitoring of time spent in high-field locations. - require signage (e.g. for high field locations & relevant information)
Occupational - High-voltage installations/switch-yards	**10** (>0 to 10) (whole working day)	**10** (>0 to 10)
Occupational - Hi-field locations - Some pocket areas in HV switch-yards (10-20 kV/m)	**30** (>10 to 30) (short term) - up to few hours per working day (8hrs decreases to 2.7 hours) - require known fields & monitoring of time spent in high-field locations	**20** (>10 to 20) (controlled activity/circumstance) - no hour limit, not require monitoring of time spent in high-field locations. - require signage (e.g. for high field locations & relevant information ...)

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Comparison: Magnetic Field Reference Levels General Public

Population / Nature of exposure	1989 NHMRC Interim Guidelines Magnetic flux density (uT)	ARPANSA ELF Draft Standard Magnetic flux density (uT)
General Public - living environments - high-field locations	**100** (>0 to 100: up to 24-hour/day)	**300**
General Public -higher field locations -closer proximity of hi-current sources	**1000** (few hours/day) **100 to 300** - few hours/day) - require known field locations and durations of activities **>300 to 1000** - few hours/day) - require known field locations and durations of activities	**100 to 300** - within reference level - not require duration monitoring as per NHMRC **>300 to 1000** - above reference level - require compliant evaluation to BR or other measures

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Comparison: Magnetic Field Reference Levels Occupational

Population / Nature of exposure	NHMRC Interim Guidelines (1989) Magnetic flux density (uT)	ARPANSA ELF Draft Standard Magnetic flux density (uT)
Occupational - close to high-current sources / high-field locations - close to hi-magnetic field apparatus	**500**	**1500** (head) **1800** (torso)
Occupational - close to higher-current sources / higher-field locations - closer to hi-magnetic field apparatus	**5000** (>500 to 5000: 2hrs/day) **>500 to 1500:** - up to 2 hours/day -require known field contours of the installation & monitoring of time spent in high-field locations **>1500 to 5000:** - up to 2 hours/day -require known field contours of the installation & monitoring of time spent in high-field locations	**>500 to 1500 (head)** - within reference level - not require duration monitoring as per NHMRC **>1500 to 5000** - above reference level - require compliant evaluation to BR or other measures
Limbs	**25000**	**9000*** * under ongoing development/consideration

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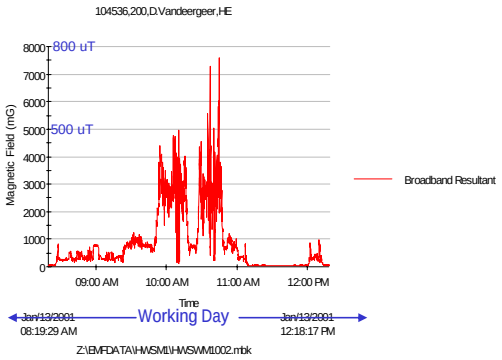
An example: live-live working on transmission line and compliant considerations



Case 1: Highest torso MDF = 800 uT & exposure time = 1 hour over working day
Case 2: Highest torso MDF = 2000 uT & exposure time = 1 hour over working day

Nature of exposure	NHMRC Interim Guidelines	ARPANSA ELF Draft Standard
Case 1	**In area: > 500 to 5000uT** **Control of duration for 2 hours/day**	**No special requirement**
Case 2	**In area: > 500 to 5000uT** **Control of duration for 2 hours/day**	**>1800 (torso)** **- above reference level** **- require compliant evaluation to BR or other measures**

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Thank You !