Electric and Magnetic Fields

ESI Safety Workshop

October 2014

Matthew Walker

Environmental Specialist

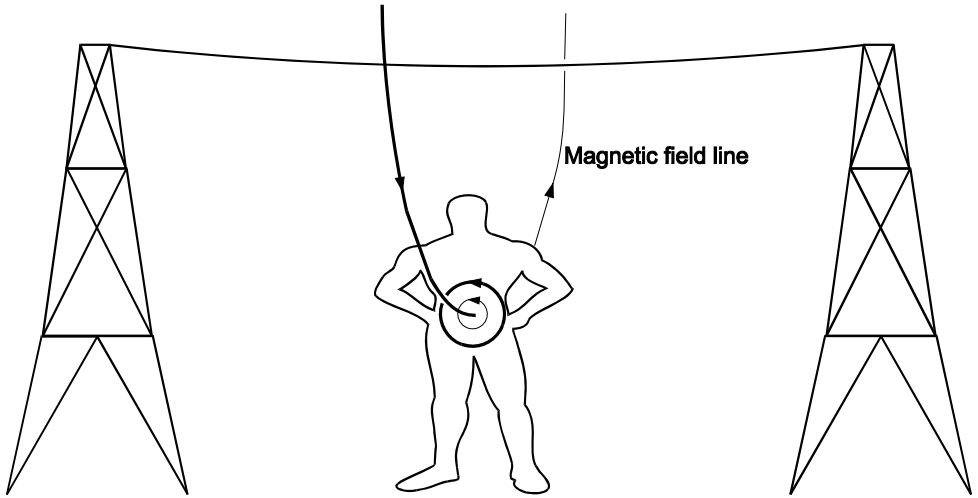
TRANSPOWER

What I will cover

- Characteristics of Electric and Magnetic Fields (EMF)
- Health effects and guidelines
- Live line work
- NAaN cable
- Implanted Medical Devices
- Long-term exposures
- Substations (if time)

Electric and magnetic field exposure

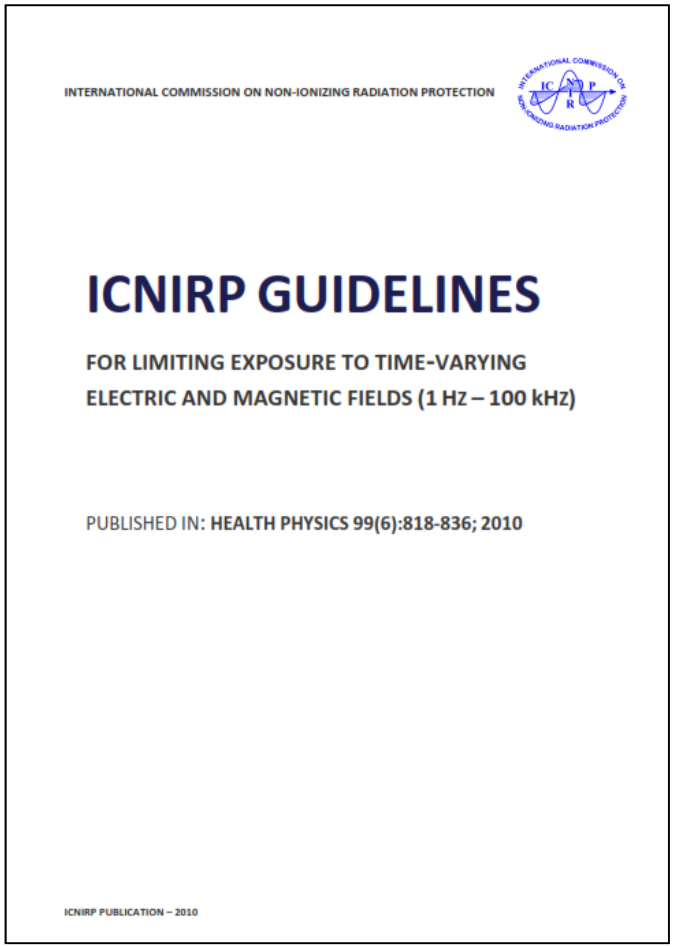
- Known biological effects due to the induction of an electric field in the body by the external fields



The effects first seen are:

- Induction of retinal phosphenes, (flashes of light in the periphery of vision); and at higher levels
- Peripheral nerve stimulation

Health protection guidelines


INTERNATIONAL COMMISSION ON NON-IONIZING RADIATION PROTECTION

ICNIRP GUIDELINES

FOR LIMITING EXPOSURE TO TIME-VARYING ELECTRIC AND MAGNETIC FIELDS (1 Hz – 100 kHz)

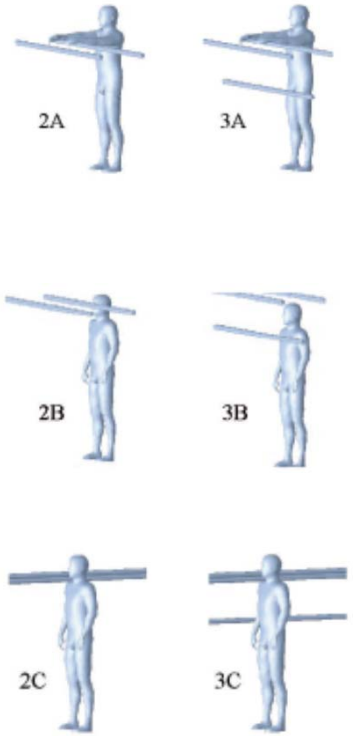
PUBLISHED IN: HEALTH PHYSICS 99(6):818-836; 2010

ICNIRP PUBLICATION – 2010

Basic restrictions and reference levels for occupational and public exposures to 50Hz ELF electric and magnetic fields

	Occupational exposures	General public exposures
Basic restrictions:		
CNS tissues	0.1 V/m	0.02 V/m
All tissues of head and body	0.8 V/m	0.4 V/m
Reference levels:		
Electric fields	10 kV/m	5 kV/m
Magnetic fields	1,000µT (10,000 mG)	200µT (2,000 mG)

Modelling of UK live-line workers



- Dawson TW, et al
- Calculation of induced E field for 1,000A current, for a range of conductor configurations and body postures.
- Can pro-rata the dosimetry for other currents
- 3.6mm voxels and 80 tissue types

Basis for NZ assessment

- Compared model to NZ live line practice and currents to assess compliance with ICNIRP basic restriction

- NZ postures not anticipated to be worse than study scenarios

Compliant conductor currents

Exposure Scenario	Predicted induced electric field[1] (mV/m)	Sub-conductor current which meets ICNIRP basic restriction (A)
Simplex/duplex conductors	49.2	<2033
Triplex conductors	34.8	<2874
Basic restriction	**100**	

Notes: 1. For 1000A sub-conductor current

Operation in NZ

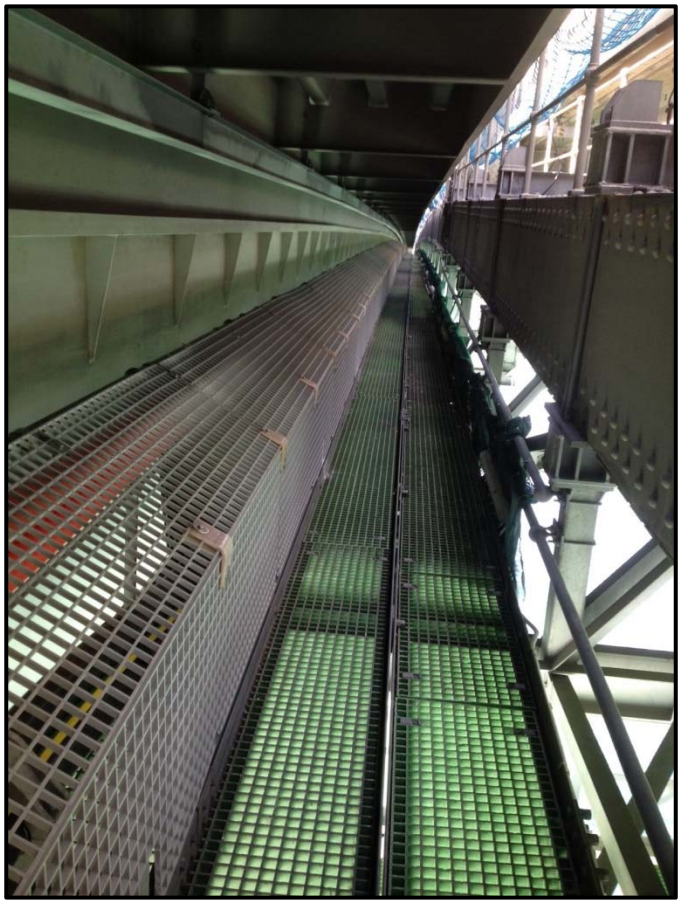
Circuit	Bundle count	Recorded amps per conductor excluding planned outages	Induced electric field mV/m
HEN-OTA-1	2	678	33.2
HEN-SWN-1	2	580	33.3
OTA-SWN-1	2	508	24.9
INV-MAN-2	2	308	15.1
	1	616	30.2
MAN-NMA-1	2	312	15.3
	1	624	30.6
MAN-NMA-2	2	306	15.0
	1	612	30.0
MAN-NMA-3	2	455	22.3
	1	910	44.6
HLY-OHW-1	2	630	30.9
HLY-OHW-2	2	442	21.7
OHW-OTA-1	2	556	27.2
OHW-OTA-2	2	564	27.6
OHW-WKM-1	2	637	31.2
Limit		**2033**	**100**

Operation in NZ (cont)

- 2008 projected loads and induced electric field for the 400kV capable NIGUP line

Year	Current (A) winter peak per sub-conductor	Induced electric field mV/m	Line operating condition
2012	207	**7.2**	220 kv
2015	240	**8.4**	
2020	323	**11.2**	
2025	627	**21.8**	
2030	780	**27.1**	
2035	593	**20.6**	400kV
2040	690	**24.0**	
2042	740	**25.8**	
Limit	**2874**	**100**	

NAaN 220kV cable across the Auckland harbour bridge



Implanted medical devices

Long term effects?

- Epidemiology
  - how often diseases occur in different groups of people and why
  - looks for differences between health of populations exposed and less exposed (for example to power frequency EMF)
  - can find effects which might otherwise be missed

- Many health studies of populations occupationally exposed to EMF

Long term effects? (cont)

- ICNIRP 2010
  - "The epidemiological and biological data concerning chronic conditions were carefully reviewed and it was concluded that there is no compelling evidence that they are causally related to low-frequency EMF exposure"

Transient effects

- “ICNIRP considers that there are occupational circumstances where, with appropriate advice and training, it is reasonable for workers voluntarily and knowingly to experience transient effects such as retinal phosphenes and possible minor changes in some brain functions, since they are not believed to result in long-term or pathological health effects… Exposure …should be limited in order to avoid peripheral …nerve stimulation”

Transient effects (cont)

Reference Level (μT)	Comment
1,000	Prevents all effects (sensory and peripheral nerve stimulation).
6,000 head	Prevents peripheral nerve stimulation, but staff may experience transient retinal phosphenes or visual processing effects if the head and trunk are exposed. Staff who may be exposed up to these levels should be informed of the possibility of such effects and their transient nature
18,000 limbs	Prevents peripheral nerve stimulation of limbs. Staff should be informed where such areas exist, and the importance of not exposing the head or trunk to such levels.

These values adopted by Directive 2013/35/EU minimum H&S requirements regarding the exposure of workers to the risks arising from physical agents (electric and magnetic fields)

Substation exposures

- Measurement survey at 12 substations on
  - power cables
  - air-core reactors
  - outdoor high current bus-bars
  - indoor high current bus-bars
  - indoor GIS
  - power transformers
  - SVC
  - transmission line terminal spans

- Measurements taken and scaled up to maximum rating

Substation exposures (cont)

- LV cables - measurements over 1000µT on 2 of 8 LV cables, scaled values on most over 1000µT but well within 6,000µT. Compliant mostly by 10-20cm
- Air-cored reactors - measured and scaled values on 2 of 5 over 1000µT, but well within 6,000µT
- GIS - scaled values only above 1000µT but well within 6,000µT