2. EMF Exposure

Electric and magnetic fields are everywhere and are generated by any electric activity, be it close to household electrical appliances, radio transmitters, or even inside the human body. The fields generated by the sources mentioned do, however, differ in strength, frequency, waveform, etc. The fields that we are interested in, are those generated by an electrical network as indicated in the figure below.



2.1 Electric Fields in Nature

Natural electric fields are produced on earth. These electric fields are DC (static) fields. On a calm, clear day, the electric field near the earth may typically be of the order of 200V/m. During thunderstorm activity, this field may rise to several thousands of volts per metre.



2.2 Magnetic Fields in Nature

Scientists believe that the earth's magnetic field is caused by the electric currents flowing within the inner molten core of the earth. The value of the earth's magnetic field in Johannesburg is of the order of 30μ T. The magnetic field is stronger at the North and South Poles. The earth's magnetic field is also a static (DC) field.



2.3 Power Line Electric Fields

The electric fields caused by overhead power lines are generated by the voltage on the conductors of the line. The level of the electric field is dependent on the voltage of the line, the tower configuration and the height of the conductors above ground. The figure below illustrates a typical electric field profile measured at head height above the ground. Because the voltage of power lines is kept fairly constant, the electric field at ground level is fairly constant.



The table below indicates typical electric field values measured in the vicinity of overhead power lines. Electric fields drop rapidly to lower levels with an increase in distance from the line.

These levels are still considerably lower than the maximum limit of 5kV/m which is suggested for continuous general public exposure by the International Radiation Protection Association (IRPA), which forms part of the World Health organisation.

Voltage (kV)	Max E-Field (kV/m)	E-Field at Servitude Boundary(kV/m)	Servitude Width (m)						
765	7,0	2,5	40,0						
400	4,7	1,5	23,5						
275	3,0	0,5	23,5						
132	1,3	0,5	15,5						
88	0,8	0,3	15,5						

Electric fields are easily shielded by buildings, trees, etc. The figure below illustrates electric field shielding by trees.



2.4 Power Line Magnetic Fields

The magnetic fields caused by overhead power lines are generated by the current flowing on the conductors of the line. The level of the magnetic field is dependent on the current flowing on the line, the tower configuration and the height of the conductors above ground. The figure below illustrates a typical magnetic field profile measured at head height above the ground.



Magnetic fields fall rapidly to lower levels with an increase in distance from the line. The table below indicates typical magnetic field values measured in the vicinity of overhead power lines.

Voltage (kV)	Current (A)	Max M-Field (µT)	M-Field at Servitude Boundary (µT)	Servitude Width (m)				
765	560	6,0	1,5	40,0				
400	650	10,5	2,5	23,5				
275	350	6,0	1,0	23,5				
132	150	4,0	1,0	15,5				
88	60	1,3	0,2	15,5				

The suggested IRPA limit for continuous general public exposure is 100µT.

Because the magnetic field is dependent on the line current, the magnetic field will vary as the demand for power (current on the line) varies.

2.5 Fields Close to Substations

Measurements have indicated the magnetic field levels outside the outer perimeter of various substations to be less than 1μ T. The field levels close to power lines entering or leaving the substation will be dominated by the power line magnetic fields as indicated in the table above.

2.6 Fields Close to Appliances and In Other Environments

The following graph presents a comparison of electric field levels found in the vicinity of power lines with typical electric field levels associated with electrical appliances and other environments.



The following graph presents a comparison of magnetic field levels found in the vicinity of power lines with typical magnetic field levels associated with electrical appliances and other environments.

Transmission																			
Lines															_				 _
Distribution														 	_			_	 _
Lines															_				
In Homes and																			 _
Buildings																			
Electrical Appliances																			
Electric Blankets																			
Some																			
Occupations																			 _
													_		_				
0	.01		(D.1	I			1	tic	Fie	1	0		1	00		10(00	
						- 0	045	-ne	m.	- 1e	 in i	· · · ·							_

2.7 Electric and Magnetic Field Exposure

The following Figure illustrates the electric and magnetic field levels that the author was exposed to during a typical day (36h period). The text and numbers in the Figure are described in the Table below :

Ref	Environment	Typical Activities Included / Exposure Period									
1	Occupational	Performing EMF measurements underneath a 275kV power line.									
2	Office	Using a telephone.									
3	Office	Working on a PC.									
4	Office	Making Photocopies.									
5	Home	Heating food in a microwave oven.									
6	Home	Watching TV.									
7	Home	Using an electric shaver.									
8	Home	Sleeping on an electric blanket.									
9	Occupational	Performing EMF measurements in a 275kV substation.									
10	Occupational	Performing EMF measurements underneath a 275kV line.									
А	Home and Occupational	24h Exposure period.									
В	275kV Power Line	1h Exposure period.									
С	Home	14h Exposure period.									
D	Office and 275kV Line	8,5h Exposure period.									
E	Office	1h Exposure period, working on PC.									
F	Home	1h Exposure period, watching TV.									
G	Home	1h Exposure period, sleeping on an electric blanket.									