ActewAGL

NETWORKS DIVISION

ELECTROMAGNETIC FIELD (EMF) PROFILES STUDY

1.0 OBJECTIVE

To provide the magnetic and electric field profiles of the Williamsdale 132kV subtransmission lines.

2.0 SCOPE

The magnetic and electrical fields calculated vary depending on such things as environment, objects present in fields, and the line configuration. This analysis is based on flat ground surface and no structures or trees nearby.

3.0 CONTENTS

4.0 VARIABLES AFFECTING TRANSMISSION LINE MAGNETIC AND ELECTRIC FIELDS

4.1 Line Loading

The proposed imitial load of the Williamsdale lines is 100MVA under the preferred operational arrangement. The 2 single circuit lines are rated at 800MVA, and could handle the loading of both half (300MVA) and full loading (600MVA) of the current ACT demand if required. For the basis of this report the typical loading is assumed.

4.2 Line Design

4.2.1 Structure, Conductor and Earthwire Geometry

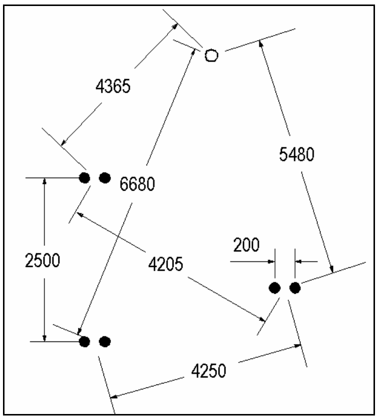


Figure 4.0 Williamsdale Pole Configuration

4.2.2 Specifications

Conductor Type and Parameters	**Earthwire Type and Parameters**	**Minimum Ground Clearance**
Type: 2 x 61/3.25mm ACC "URANUS" *Separation:* 200mm *Conductor Diameter:* 29.3mm	*Type:* 1 x 7/3.25mm GALVANISED STEEL	6.7m

4.3 Wire Height Above the Ground

The following *assumptions* have been made regarding wire height:

1. The terrain over which the electric and magnetic fields were calculated was regular, with effects of steep terrain ignored.
2. The fields are calculated at a distance of 1m above the ground to coincide with height of vital organs within adults and children.
3. The minimum clearance height is **6.7m.** This was assumed as a worst-case scenario with full loading conditions and rated ambient temperatures. As a

result of this, wind velocity and conductor temperature have been ignored. This type of scenario would be infrequent or virtually non-existent, and therefore to gain a scope of the effect of varying conductor heights, three different heights were calculated.

5.0 FULL CHARACTERISTICS OF FIELDS ASSOCIATED WITH THE LINE(S)

5.1 Electric Field

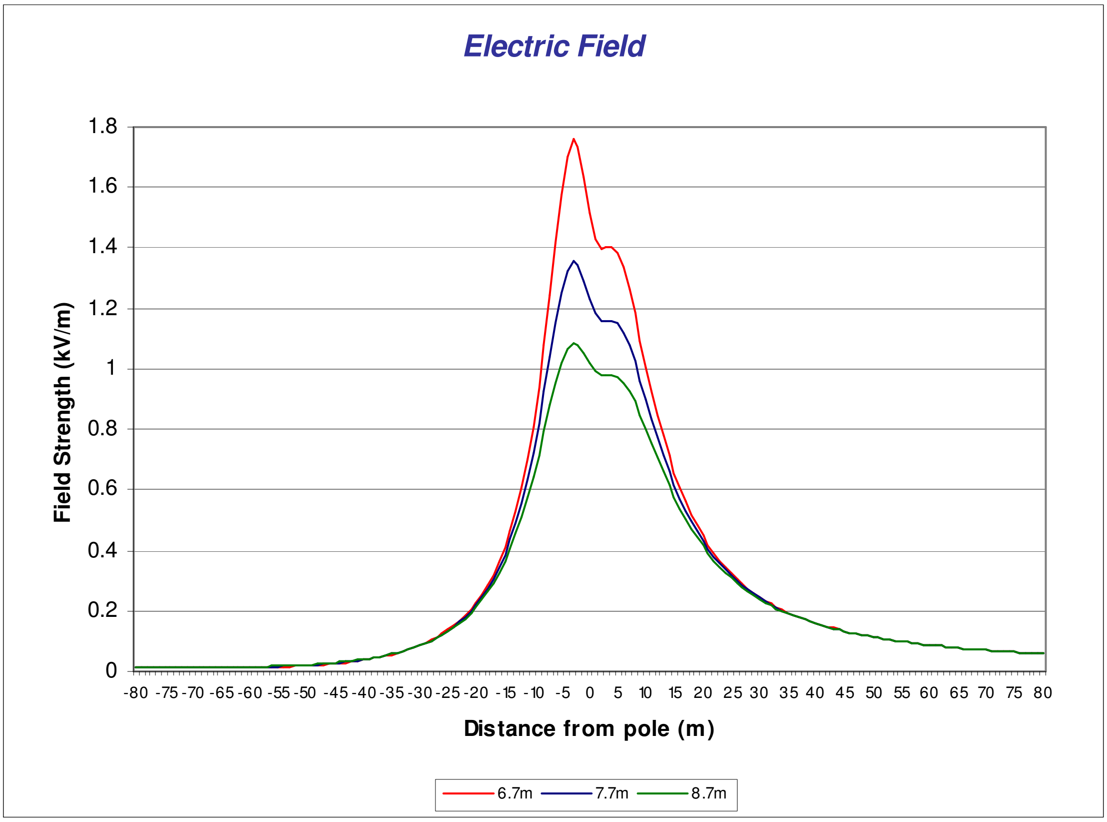


Fig 2.1 (a) Field Profile of a singular single-circuit line.

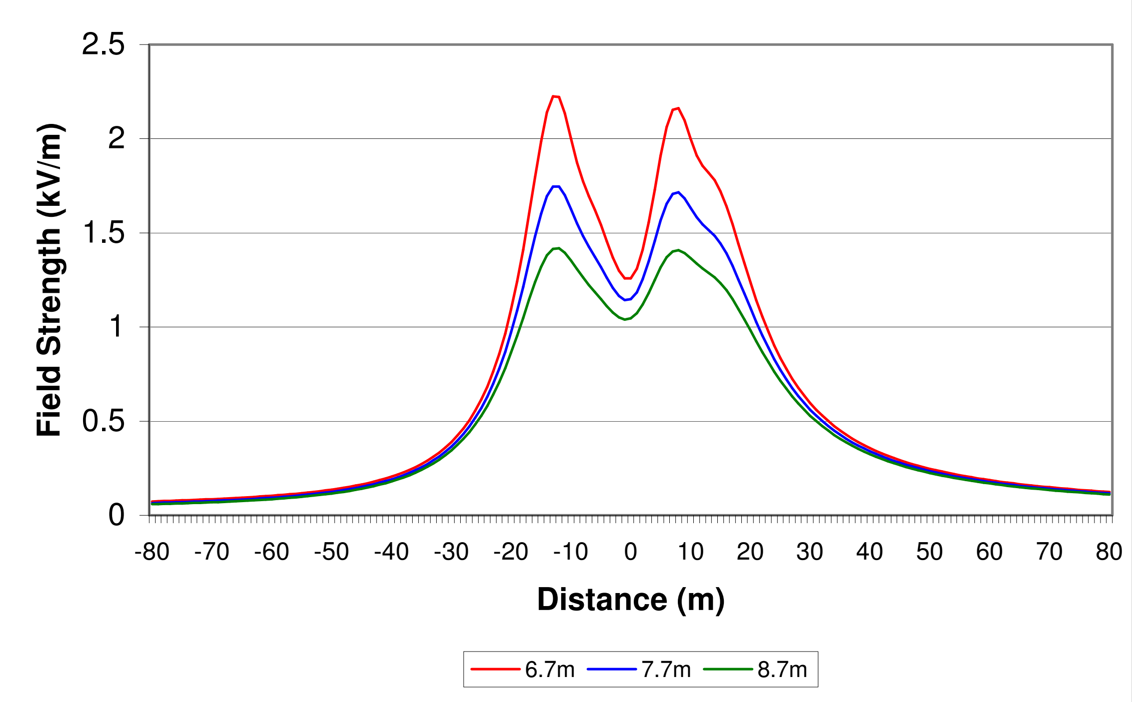


Fig 2.1 (b) Field Profile of a single-circuit double line.

Conductor Height (m)	Max E (kV/m)		E at Edge of Easement ±30m* (kV/m)	
	Single Line	Double Line	Single Line	Double Line
6.7	1.854	2.23	0.23	0.60
7.7	1.45	1.75	0.22	0.55
8.7	1.17	1.42	0.22	0.50

** Calculated as the average of the LHS and RHS of the curve at ±20m.*

5.2 Magnetic Fields

The magnetic fields were calculated using the annual 2006 data for the demand of the ACT Network. To determine the Williamsdale loading the total demand of the ACT network was re-calibrated for the proposed initial loading of the Williamsdale line of 100MVA. From this the current can be calculated and thus the resultant magnetic field.

5.2.1 Time Weighted Average

As the 100MVA is carried by two lines, the resultant current is half of the total calculated.

$$TWA = \frac{Average\,Demand \times Typical\,Demand}{Maximum\,Demand}$$

$$= \frac{355.1 \times 100}{666.39} \quad MVA$$

$$= 53.28\ MVA$$

$$\therefore\ I = \frac{53.28M}{\sqrt{3} \times 132k} = 233\,A$$

$$Each\ Line\ is = 116A$$

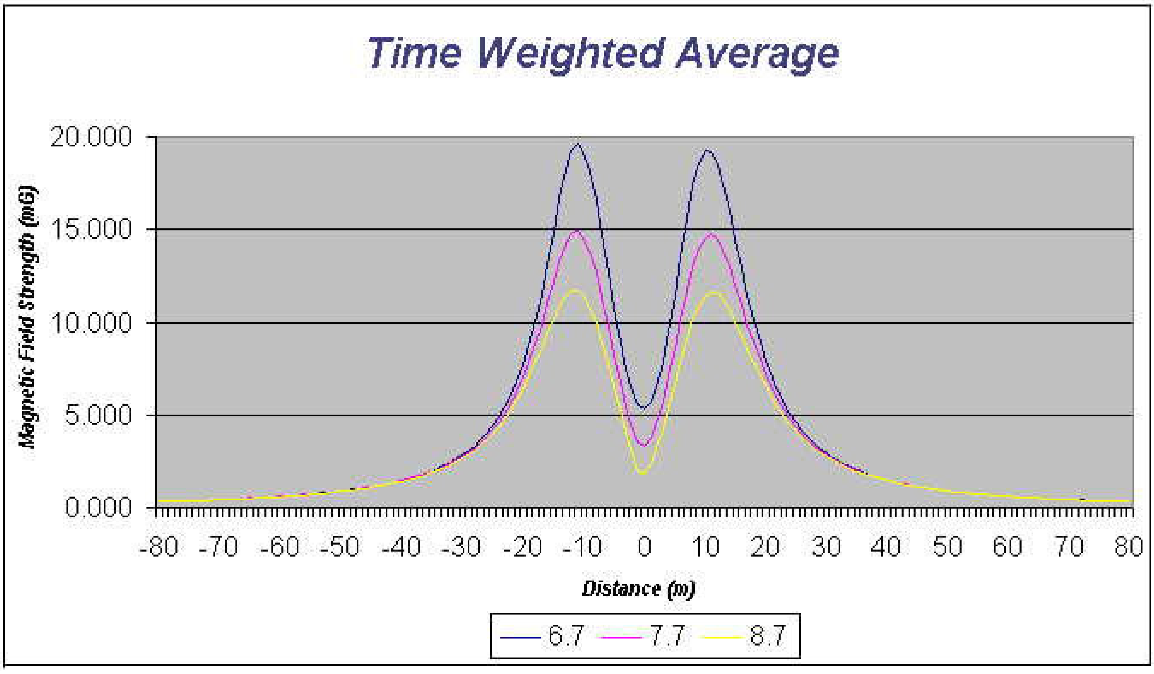


Fig 2.2.1 Time Weighted Average Magnetic Field Profile of 2 single-circuit lines.

Conductor Height (m)	Max Field Strength	Edge of Easement ±30m	±80m
6.7	19.6	3.0	0.33
7.7	14.9	2.9	0.33
8.7	11.7	2.8	0.33

*All values in milliGauss

5.2.2 Typical Loading of 100MVA

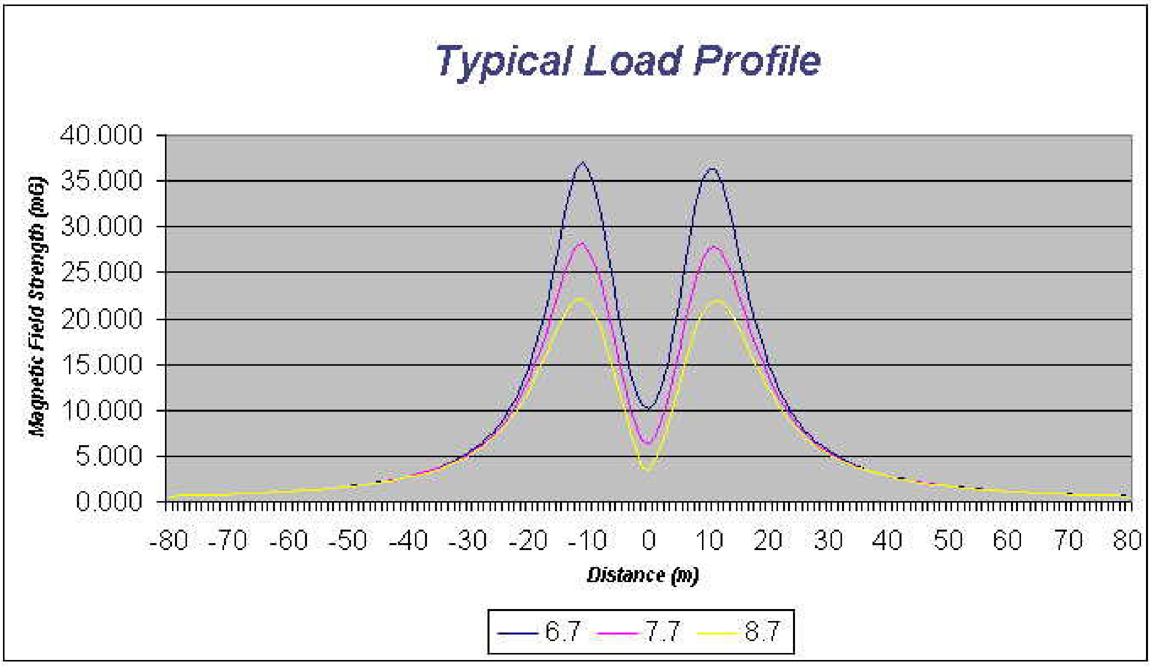


Fig 2.2.2 Magnetic Field Profile for the Typical Loading of the 2 lines.

Conductor Height (m)	Max Field Strength	Edge of Easement ±30m	±80m
6.7	37.0	5.7	0.63
7.7	28.2	5.5	0.62
8.7	22.2	12.18	0.62

*All values in milliGauss

5.2.3 Typical Daily Maximum

The typical daily maximum magnetic field profiles are of interest as these give a value for long term exposure - representing the highest magnetic fields experienced per day. As MD varies between seasons, a summer and winter profile (see below) were calculated. These were based on January and June figures respectively. The values were determined by the maximum of each day, and then an average of these maximums.

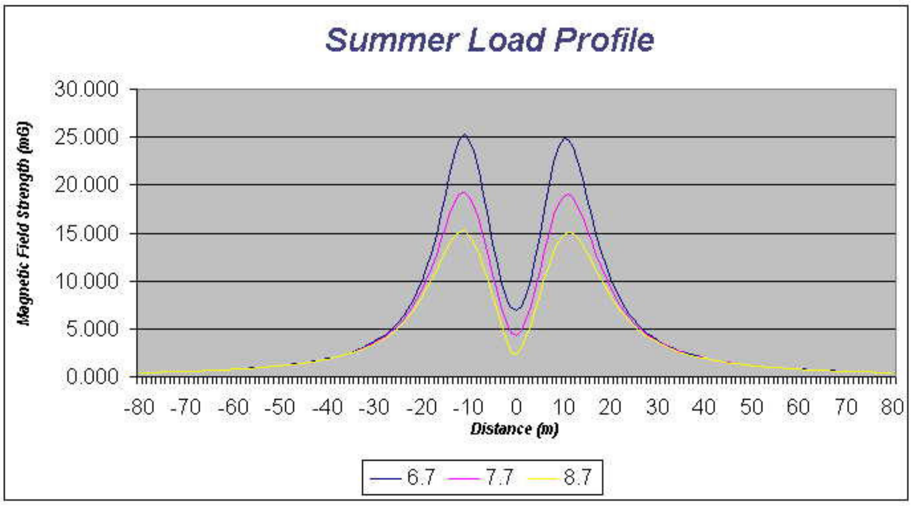
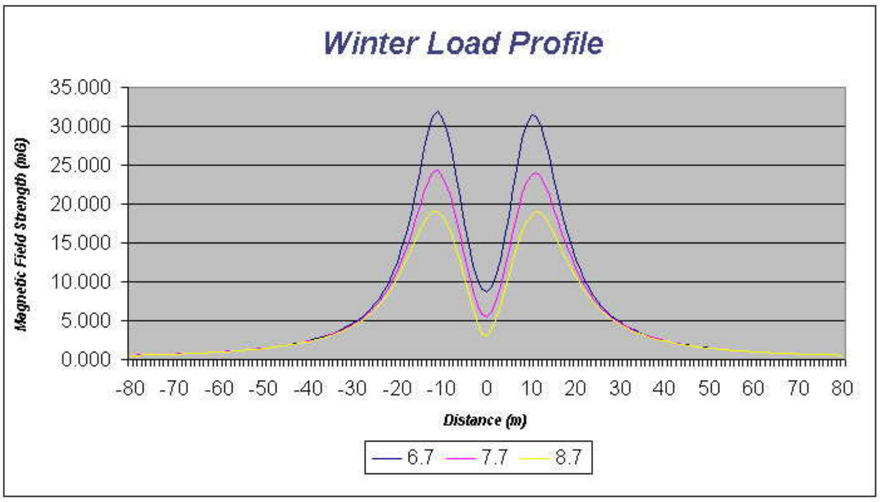


Fig 5.2.3.1 (a) Summer Profile calculated for MD = 68.38MVA



(b) Winter Profile calculated for MD = 86.28MVA

	Summer			**Winter**		
Conductor Height (m)	**Max Field Strength**	**Edge of Easement ±30m**	**±80m**	**Max Field Strength**	**Edge of Easement ±30m**	**±80m**
6.7	25.28	3.8	0.43	31.90	4.9	0.54
7.7	19.24	3.7	0.43	24.28	4.7	0.54
8.7	15.14	3.6	0.43	19.10	4.5	0.54

*All values in milliGauss

6.0 RATINGS FOR ELECTRIC AND MAGNETIC FIELDS

The National Health and Medical Research Council's (NH&MRC) guidelines (1989) defines the limits of exposure to power frequencies (50/60 Hz) for electric and magnetic fields. These guidelines are based on the induced current density in the body when present in these fields (defined as no more than $10mA/m^2$). In Appendix A, the summary of the exposure limits for both occupational and general public exposures to the power frequencies, are shown. For electric fields the NH&MRC defines the occupational safe limits of electric field exposure is $5*10^5/f$ = **10kV/m** and general public safe limits are **5kV/m.** For magnetic fields, the governed ratings for continual exposure for Occupational is **5000mGauss** and for the general public **1000mGauss**.

There has been some concern regarding magnetic fields of 4mGauss and childhood lukemia, however epidemilogical studies have not proven there is a causal effect between these, however there may be the possibility. As a member of the ENA, ActewAGL adopts the policy set by the association whereby it states "[utility] members… design and operate their electricity generation, transmission and distribution systems prudently." Prudent avoidance is a control measure to limit the exposure to EMF, within capital expenditure justification, even if scientific evidence has not validated the casual relationship.

A report by the ARPNSA concluded that "the scientific evidence does not indicate that exposure to 50Hz EMFs found near power lines is a hazard to human health"

Calculated Fields at Easement (±20m)
Electric
For a single line the electric field at the edge of the easement was **0.23kV/m** and a double line was 0.6**kV/m**, at a clearance height of 6.7m. It should be noted however, this is a worst case scenario and these are well *below* the recommended 5kV/m.

Magnetic
Below is a summary of the magnetic fields under different loading conditions. The maximum was found was **5.7milliGauss** under ideal 100MVA loading, while the TWA for the lowest clearance was **3.0milliGauss**. These are well *below* the rated 1000mGauss.

	6.7m	***7.7m***	***8.7m***
TWA	*3.0*	*2.9*	*2.8*
Typical Loading	*5.7*	*5.5*	*5.3*
Summer	*3.8*	*3.7*	*3.6*
Winter	*4.9*	*4.7*	*4.5*

Appendix A

(Sourced from NH&MRC 1989 guidelines for EMF exposure)

RECOMMENDED EXPOSURE LIMITS FOR ELECTRIC AND MAGNETIC FIELDS

Table 1.calculation is given in mG, the figures in this table needs to be converted to mG.

Exposure Characteristics	Electric Field Strength kV/m (rms)	Magnetic Flux mT (rms)
OCCUPATIONAL		
Whole Working Day (8Hrs)	10	0.5
Short Term	30[a]	5[b]
For Limbs	--	25
GENERAL PUBLIC		
Up to 24 hours/day[c]	5	0.1
Few hours per day[d]	10	1

Notes:

a) Short-term occupational exposure to rms electric field strengths between 10 and 30 kV/m is permitted provided the rms electric field strength (kV/m) times the duration of exposure (hours per work day) does not exceed 80.

b) Maximum exposure duration is 2 hours per work day.

c) This restriction applies to open spaces in which members of the general public might reasonably be expected to spend a substantial part of the day, such as recreational areas, meeting groups and the like.

d) These values can be exceeded for a few minutes per day provided precautions are taken to prevent indirect effects.

e) Magnetic field strengths may be expressed in Tesla or Gauss. These are different units for the same quantity

Conversion is: 0.1 milli Tesla = 1000 milli Gauss