Electric And Magnetic Field Measurements of Transmission Lines and Substations

Energy Commission Malaysia

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- Measurement Results
- Residential Magnetic Field Exposure Study
- Exposure Guidelines
- Discussions and Conclusions

Introduction

- The public is concern with adverse health effect from electric power facilities.
- Education program is seen as one way to alleviate this problem.
- The purpose of this project is to collect electric and magnetic field data from overhead transmission lines and substations and compare these values with international exposure standard.
- EMF data from home appliances will also be presented for comparison purposes.

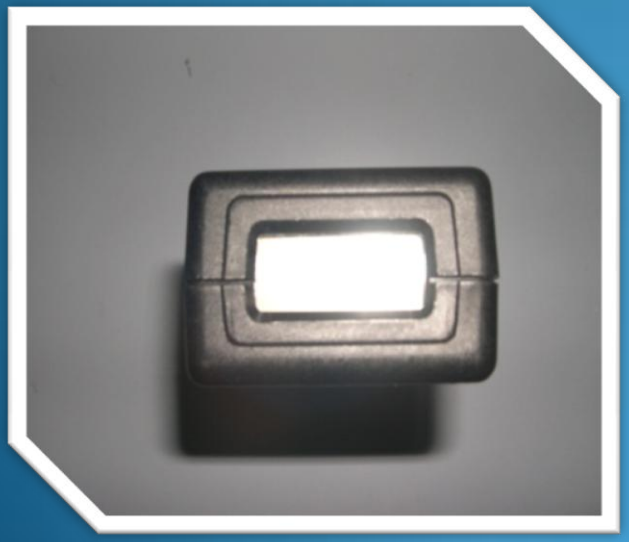
Measuring Equipment and Measurement Protocol

- For the specification of measuring equipment and measurement protocol, an IEEE Std. 644: 1994 “Standard Procedure for Measurement of Power Frequency Electric and Magnetic Field from AC Power Lines” is used for this study.
- This is for the purpose of integrity of data collected and comparative purposes.

Measuring Equipment

a) EMDEX-II Meter

b) LINDA Wheel



Range: 0.1mG to 3000mG

Resolution: 0.1mG

Frequency: 40Hz – 800Hz

Used with LINDA wheel for magnetic field profile measurement and area measurement (zig-zag)

Measuring Equipment (cont.)

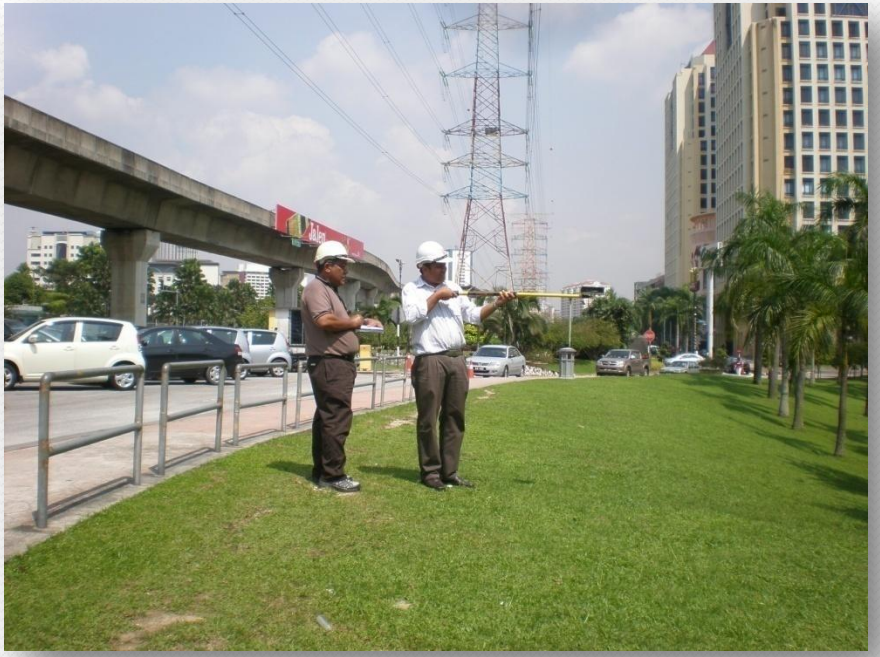
E- Probe

Range: 1V/m to 200kV/m

Resolution: 1V/m

Frequency: 40Hz to 1000Hz

Used to measure electric field.



Calibration Certificates

Measurement Protocol Briefing Session

Measurement Results

- Electric and Magnetic Field measurements were conducted at 18 sites.
- 10 sites of overhead transmission lines comprising of various configurations
  - One double circuit transmission lines of 132 kV, 275 kV and 500 kV
  - One quadruple circuit transmission lines
  - One double circuit lines in parallel to one quadruple circuit lines
  - Multiple double and quadruple circuit lines
- 8 sites of substations
  - P/E
  - PPU
  - PMU

Measurement Results

Site 1: 275 kV Double Circuit Lines Parallel with 132 kV/132 kV Quadruple Circuit Lines, Persint 14, Putrajaya

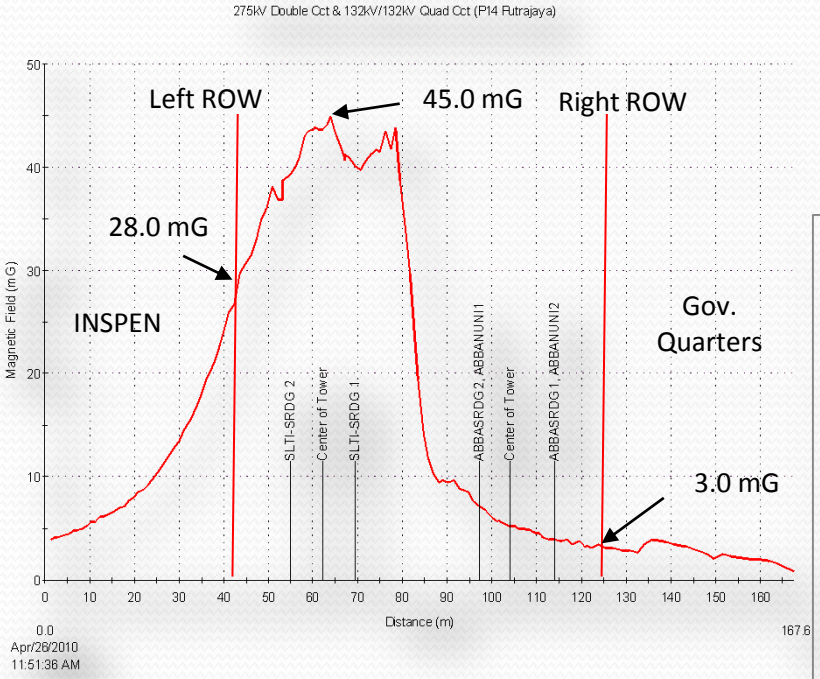
Arial Photograph of Site 1

Measurements Path along Jalan P14, Putrajaya

Measurement Results (cont.)

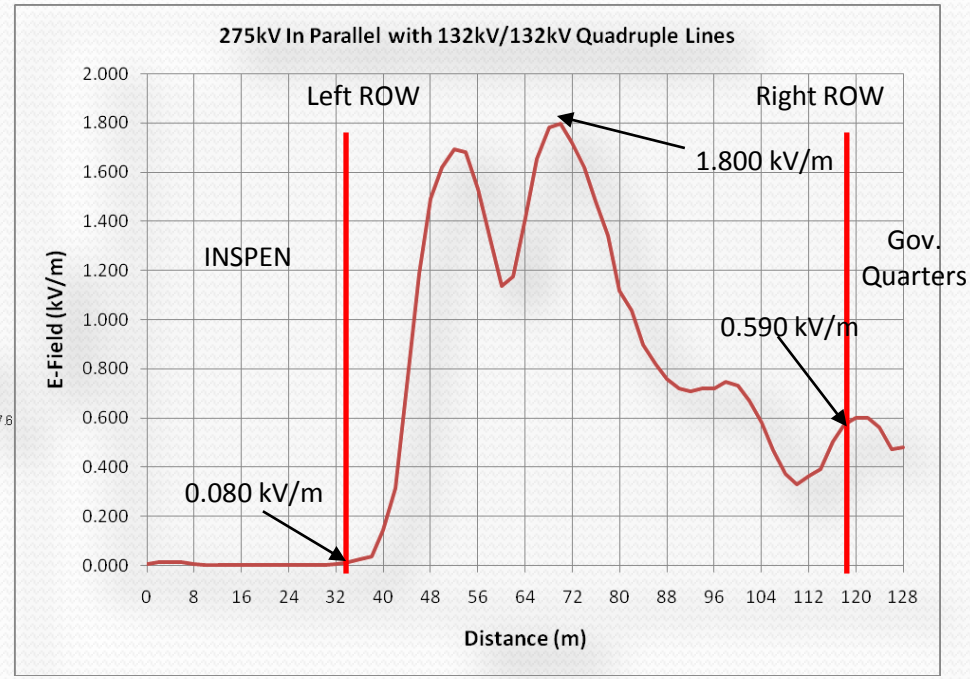
Electric and Magnetic Field Measurements Conducted Underneath the Transmission Lines

Measurement Results (cont.)



Magnetic Field Measurement Result for Site 1

Electric Field Measurement Result for Site 1



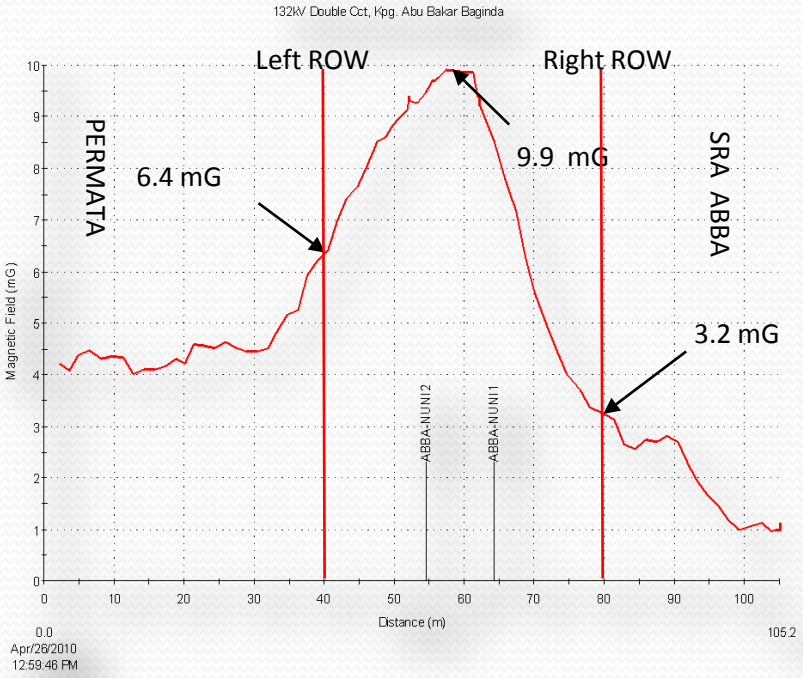
Measurement Results (cont.)

Site 2: 132kV Double Circuit Lines, Kpg. Datuk Abu Bakar Baginda, Bangi, Selangor

Arial Photograph of Site 2

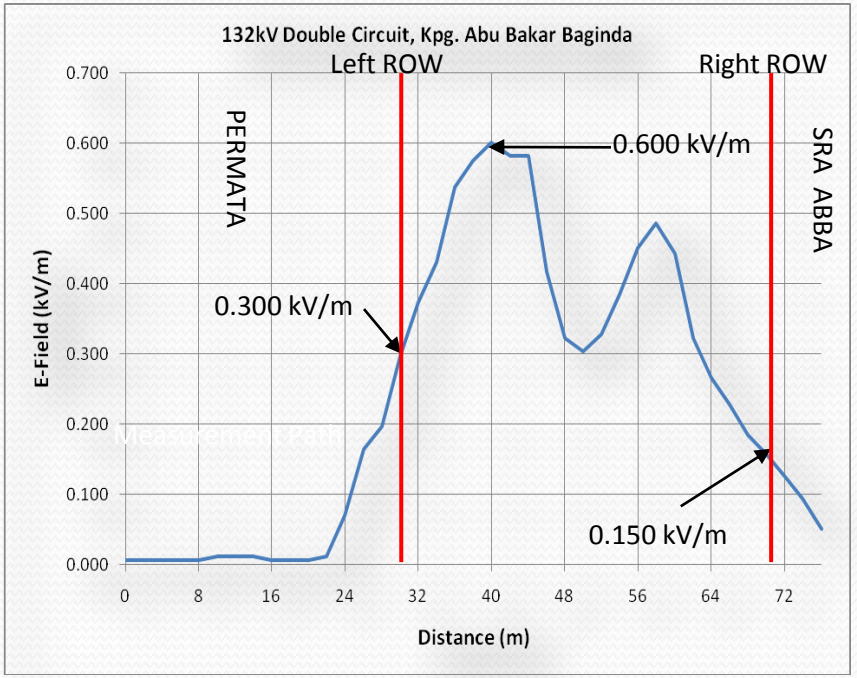
Measurements Path along Jalan Anggerik off Jalan Air Jitam, Kpg. Abu Bakar Baginda

Measurement Results (cont.)



Magnetic Field Measurement Result for Site 2

Electric Field Measurement Result for Site 2



Measurement Results (cont.)

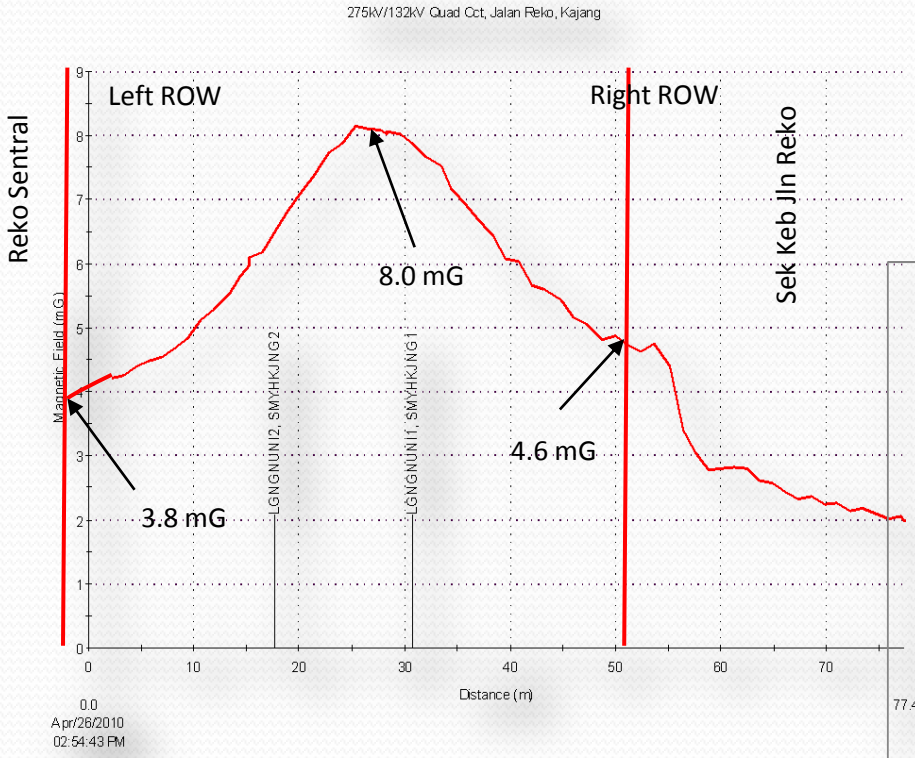
Site 3: 275kV/132kV Quadruple Circuit Lines, Persiaran Bangi, Bandar Baru Bangi, Selangor

Arial Photograph of Site 3

Measurements Path along Persiaran Bangi, Bandar Baru Bangi, Selangor

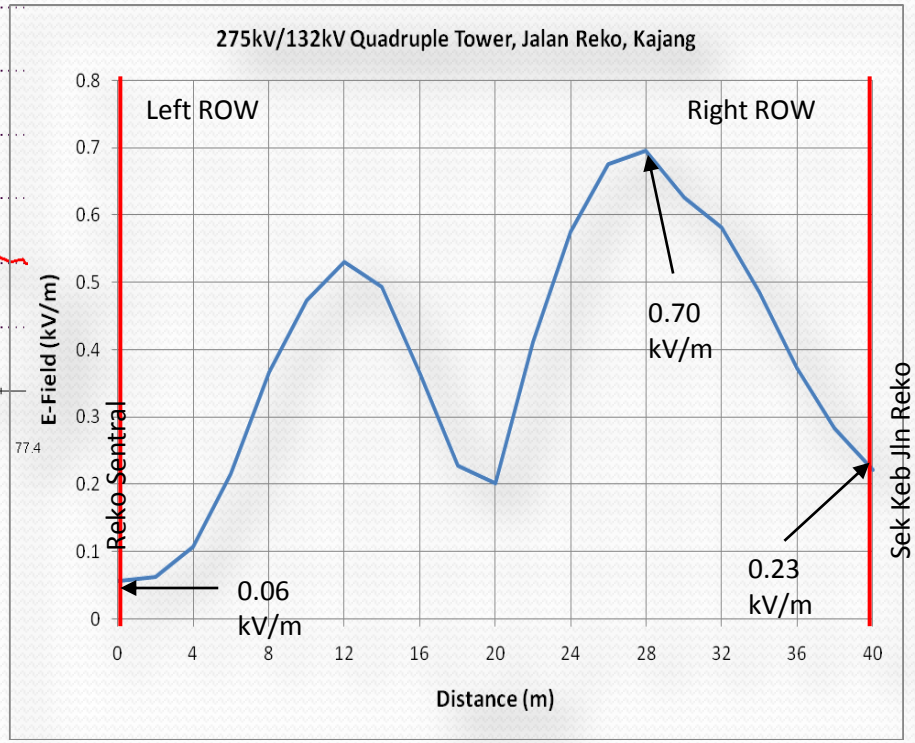
Measurement Results (cont.)

Measurement Results (cont.)



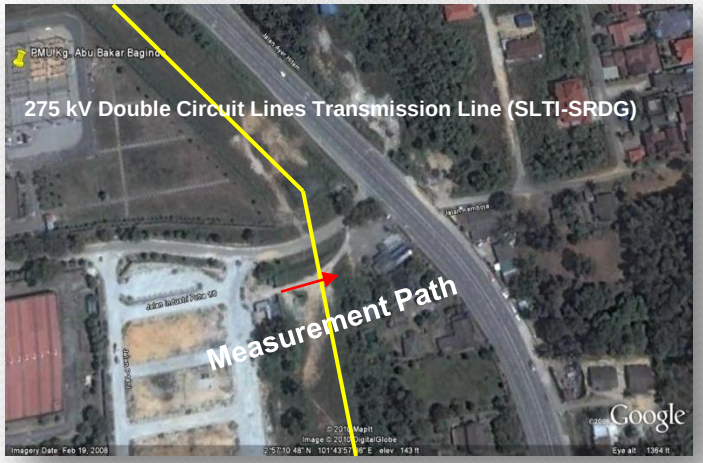
Magnetic Field Measurement Result for Site 3

Electric Field Measurement Result for Site 3



Measurement Results (cont.)

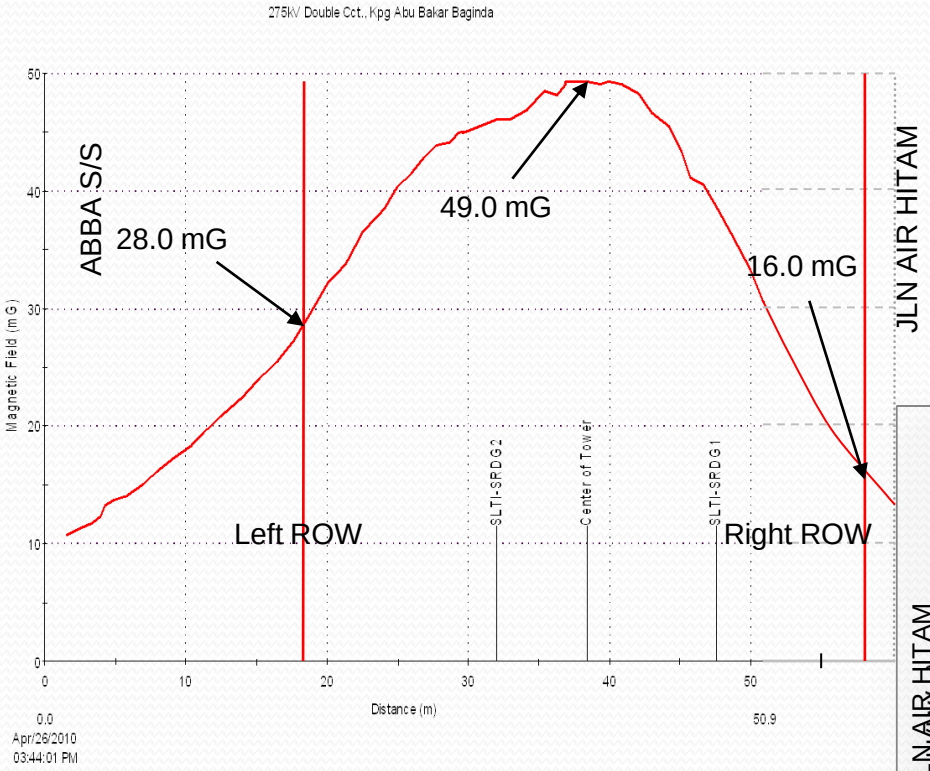
Site 4: 275kV Double Circuit Lines. Kpg. Datuk Abu Bakar Baginda, Bangi, Selangor



Measurement Results (cont.)

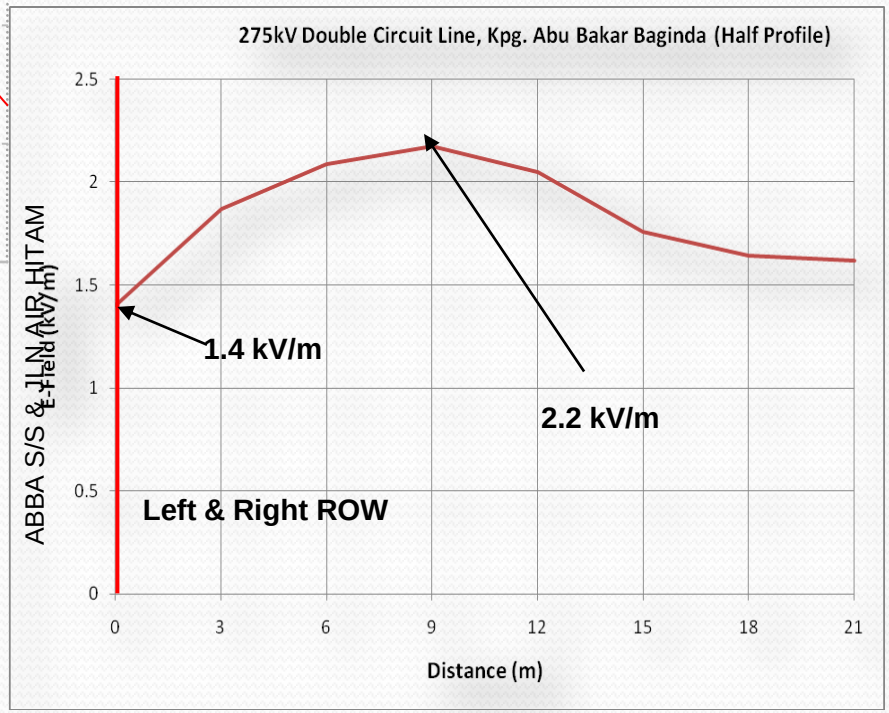
Electric and Magnetic Field Measurements Conducted Underneath the Transmission Lines

Measurement Results (cont.)



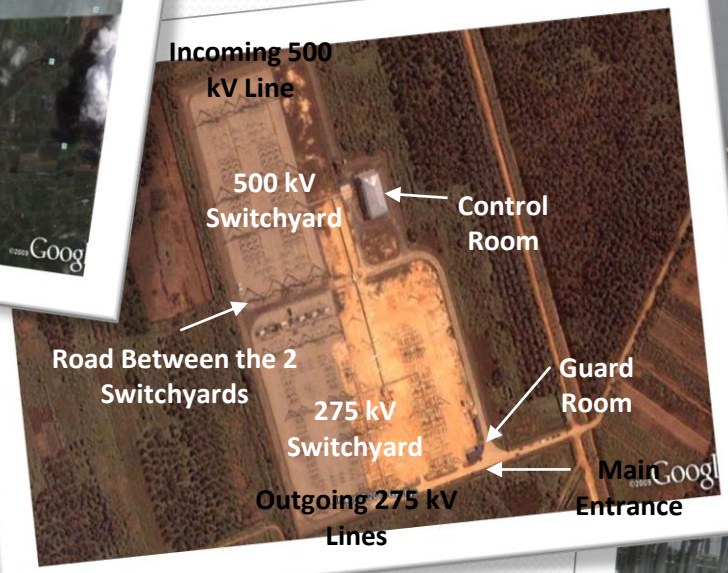
Magnetic Field Measurement Result for Site 4

Electric Field Measurement Result for Site 4

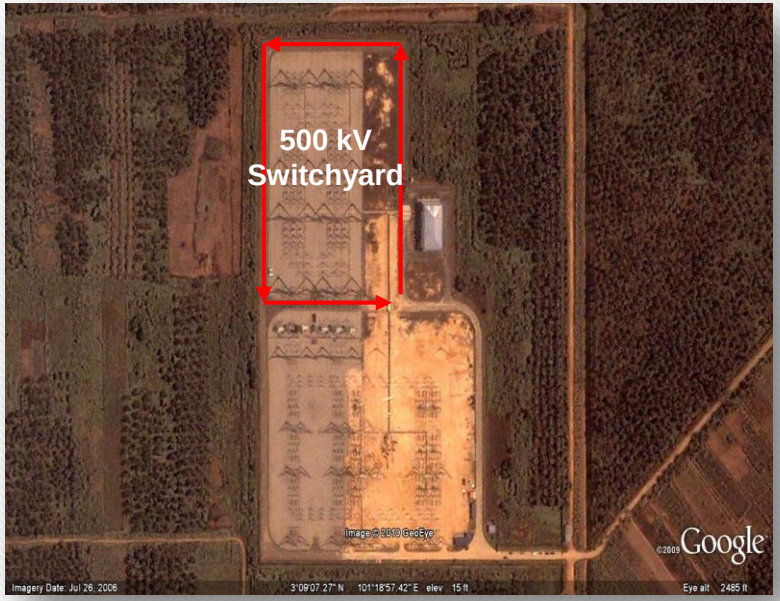


Measurement Results (cont.)

Site 5: PMU 500 kV Kapar, Selangor



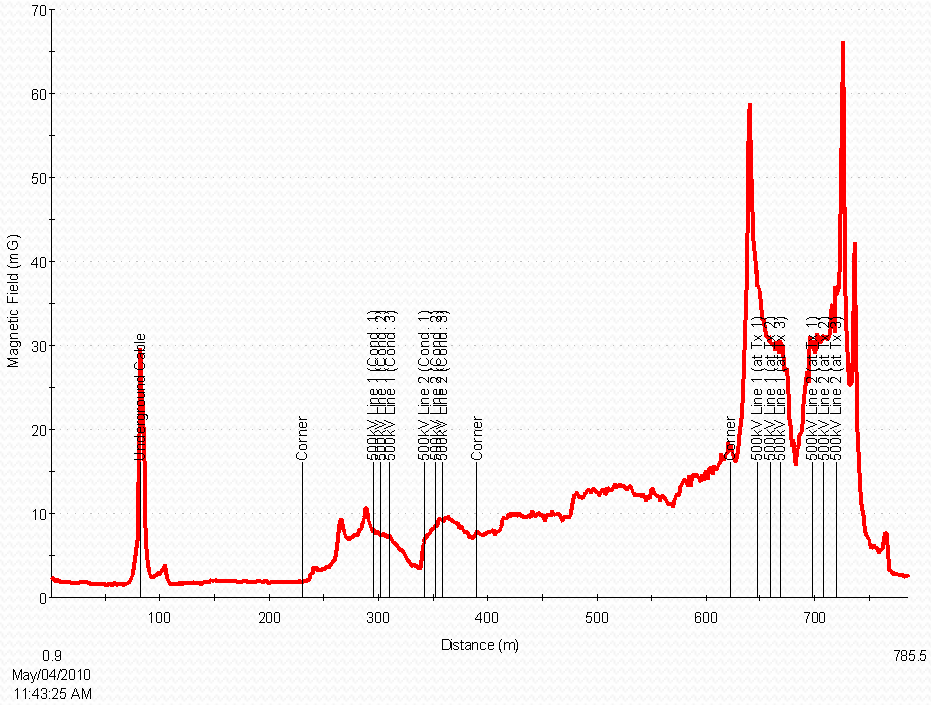
Measurement Results (cont.)



Measurement Path for the Magnetic Field Measurement at the Perimeter of the 500 kV Switchyard of Site 5

Magnetic Field Measurement at the Perimeter of the 500 kV Switchyard of Site 5

Measurement Results (cont.)

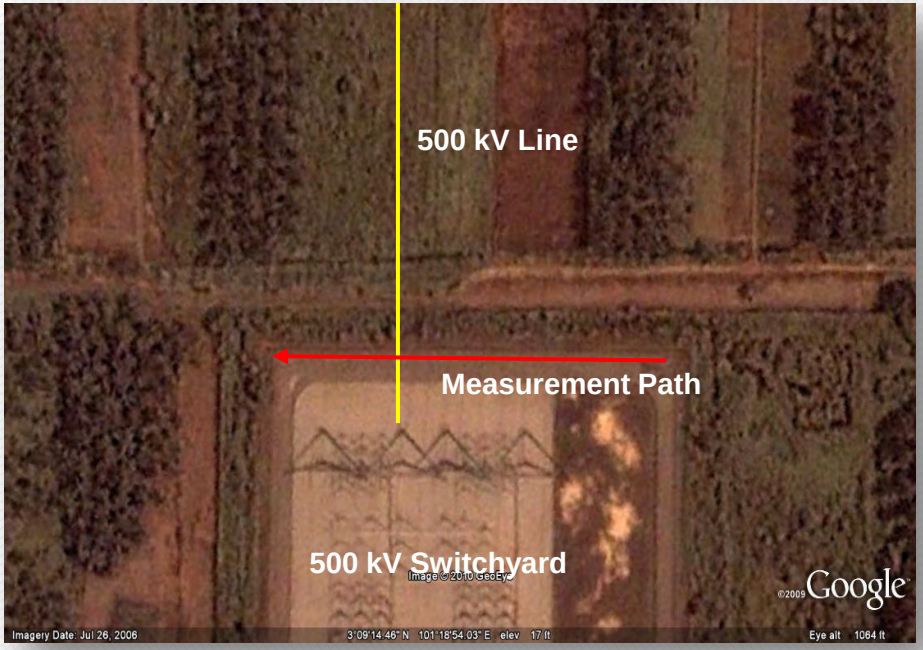


Magnetic Field Measurement Result at the Perimeter of the 500 kV Switchyard of Site 5

Descriptive Statistic for Magnetic Field Measurement at the Perimeter of the 500 kV Switchyard of Site 5

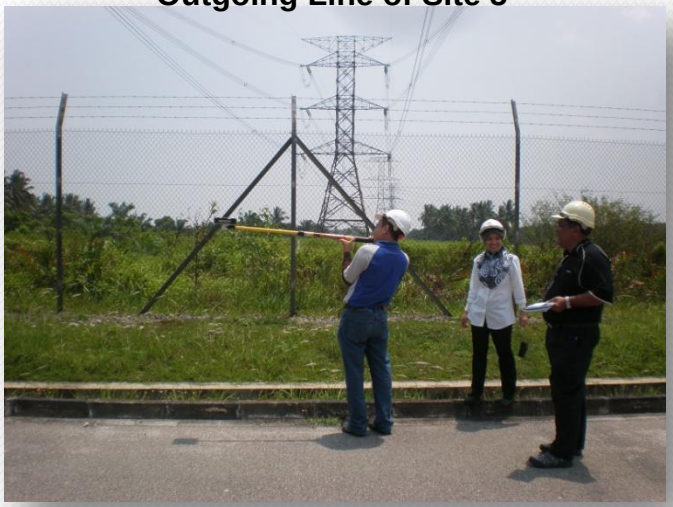
Descriptive	Minimum	Maximum	Mean	Standard Deviation	Median
Broadband Resultant (mG)	1.46	66.30	10.09	10.16	7.66

Measurement Results (cont.)



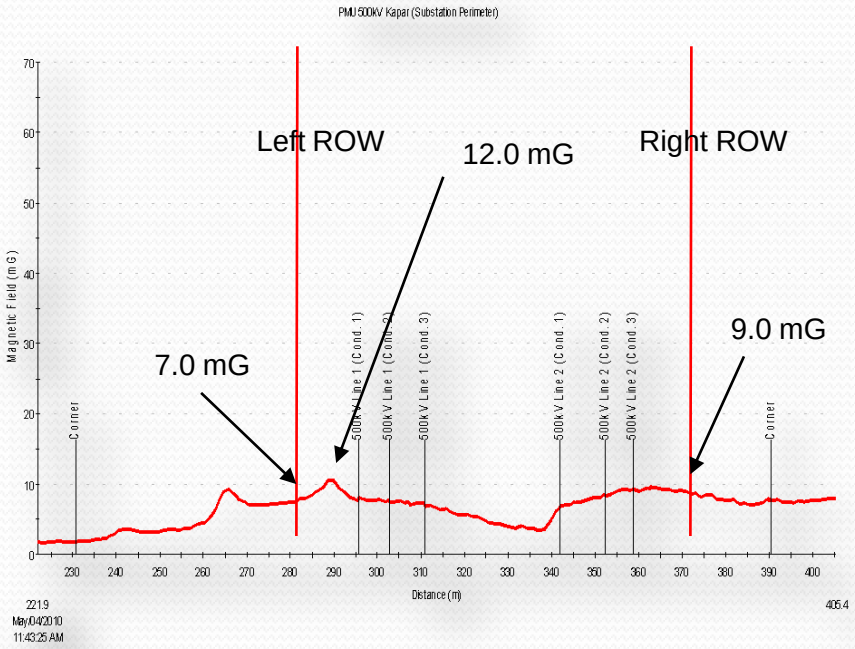
Measurement Path for the Electric and Magnetic Field Measurement at the 500 kV Outgoing Line of Site 5

Magnetic Field Measurement at the 500 kV Outgoing Line of Site 5



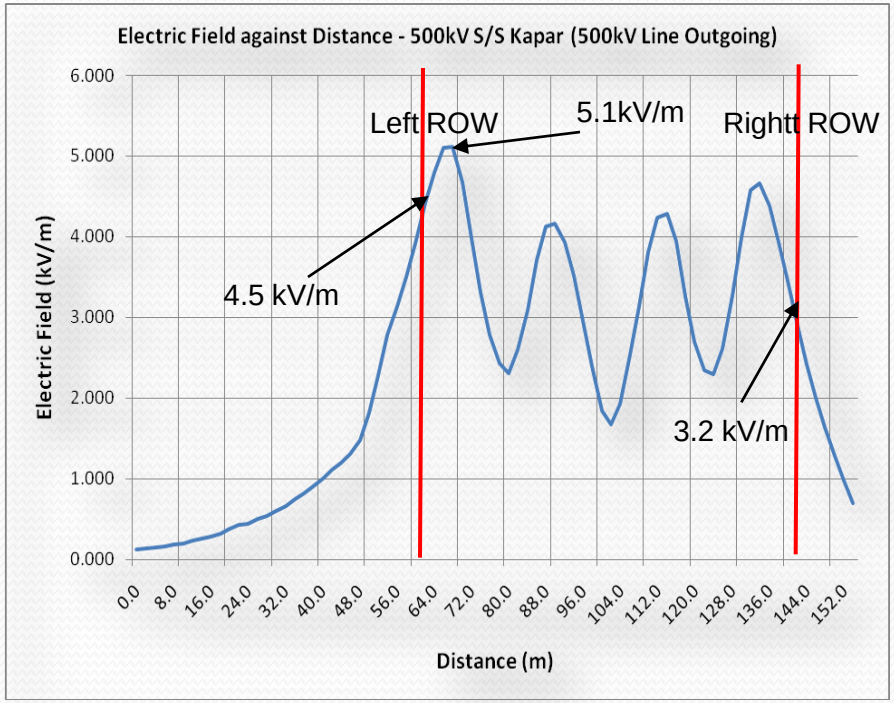
Electric Field Measurement at the 500 kV Outgoing Line of Site 5

Measurement Results (cont.)

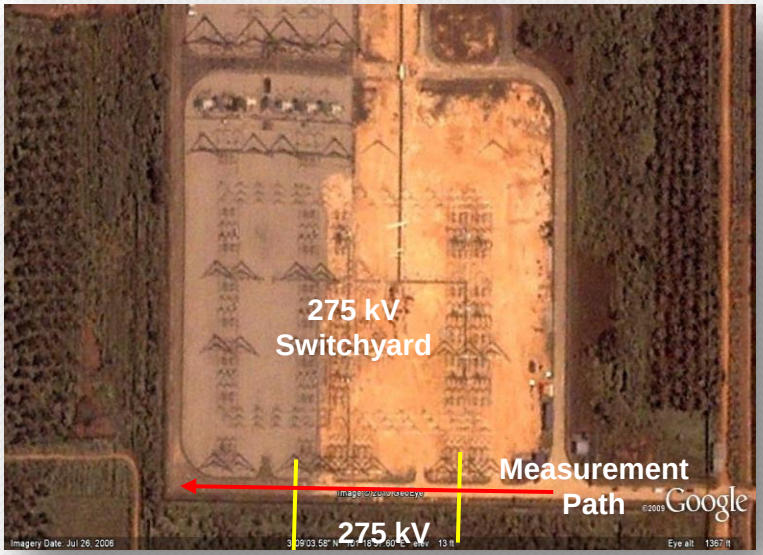


Magnetic Field Measurement Result at the 500 kV Outgoing Line of Site 5

Electric Field Measurement Result at the 500 kV Outgoing Line of Site 5



Measurement Results (cont.)

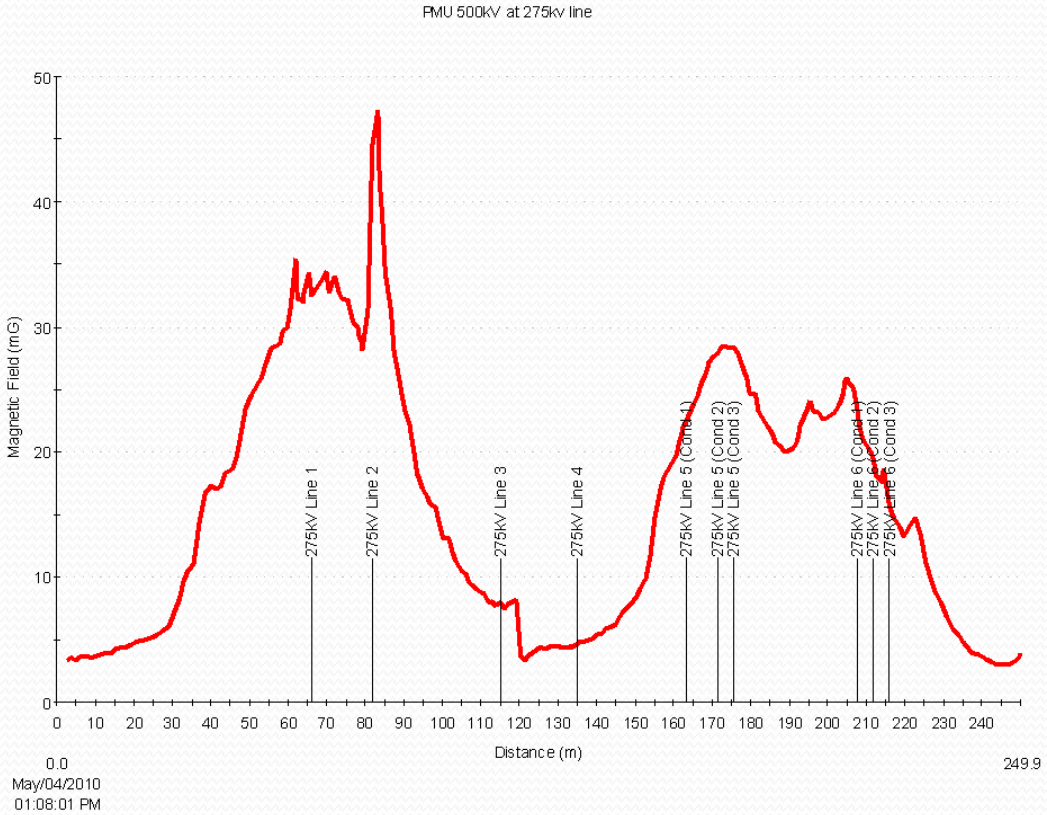


Measurement Path for the Electric and Magnetic Field Measurement underneath the 275 kV Incoming Lines of Site 5

Magnetic Field Measurement underneath the 275 kV Incoming Lines of Site 5

Electric Field Measurement underneath the 275 kV Incoming Lines of Site 5

Measurement Results (cont.)

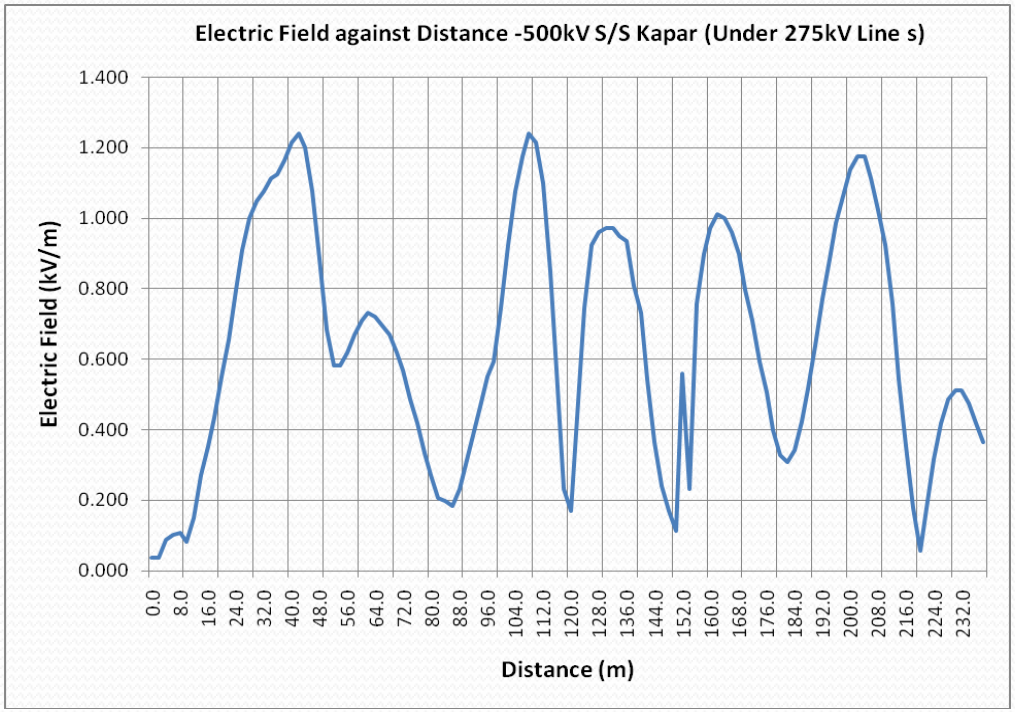


Magnetic Field Measurement Result underneath the 275 kV Incoming Lines of Site 5

Descriptive Statistic for Magnetic Field Measurement underneath the 275 kV Incoming Lines of Site 5

Descriptive	Minimum	Maximum	Mean	Standard Deviation	Median
Broadband Resultant (mG)	2.96	47.30	16.54	10.44	17.10

Measurement Results (cont.)



Magnetic Field Measurement Result underneath the 275 kV Incoming Lines of Site 5

Descriptive Statistic for Electric Field Measurement underneath the 275 kV Incoming Lines of Site 5

Descriptive	Minimum	Maximum	Mean	Standard Deviation	Median
Broadband Resultant (kV/m)	0.04	1.24	0.64	0.34	0.62

Measurement Results (cont.)

Site 6: 500 kV Lines, Kota Puteri, Ijok, Kuala Selangor, Selangor

Measurement Results (cont.)

Site 6: 500 kV Lines, Kota Puteri, Ijok, Kuala Selangor, Selangor

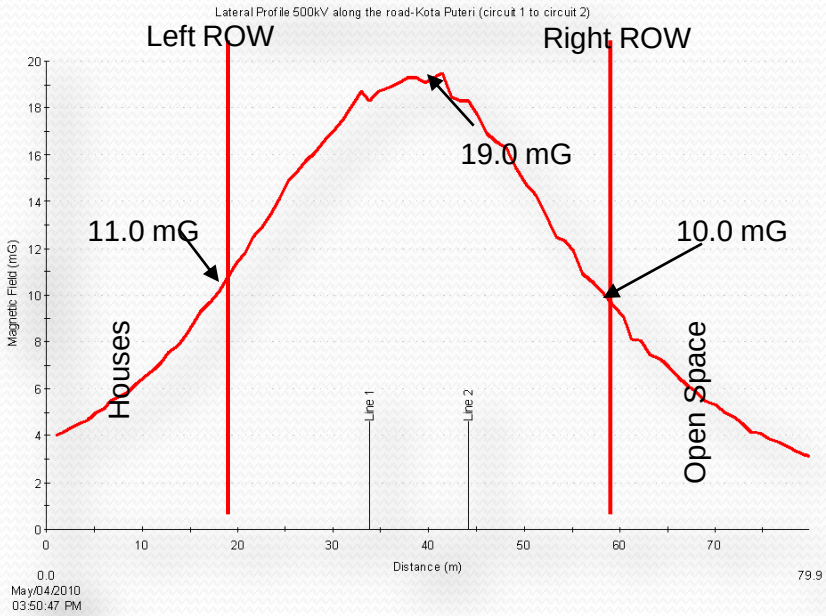
Magnetic Field Measurement underneath the 500 kV Lines of Site 6

Electric Field Measurement underneath the 500 kV Lines of Site 6

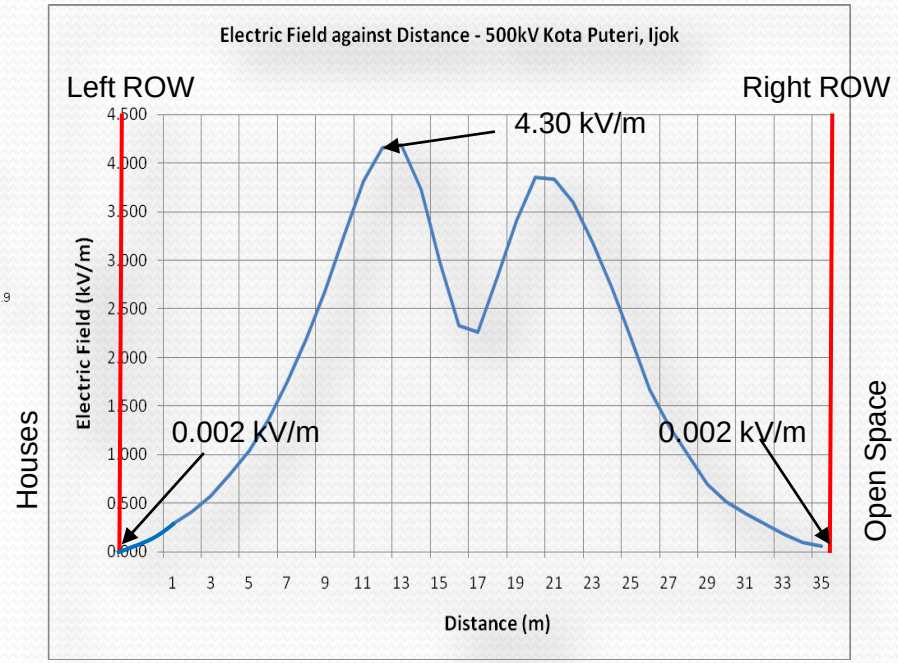
Measurement Results (cont.)

Site 6: 500 kV Lines, Kota Puteri, Ijok, Kuala Selangor, Selangor

Magnetic Field Lateral Profile

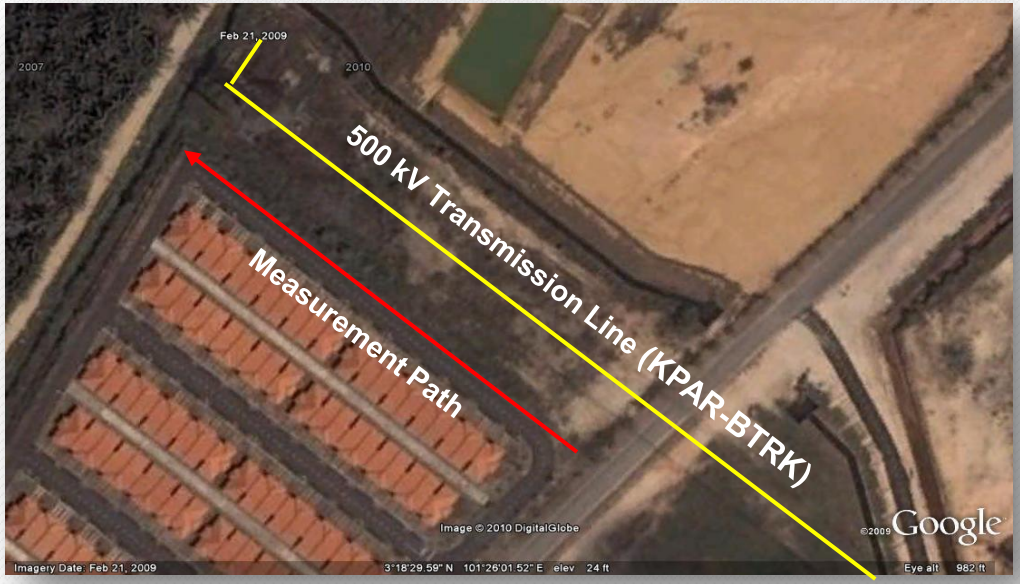


Electric Field Lateral Profile



Measurement Results (cont.)

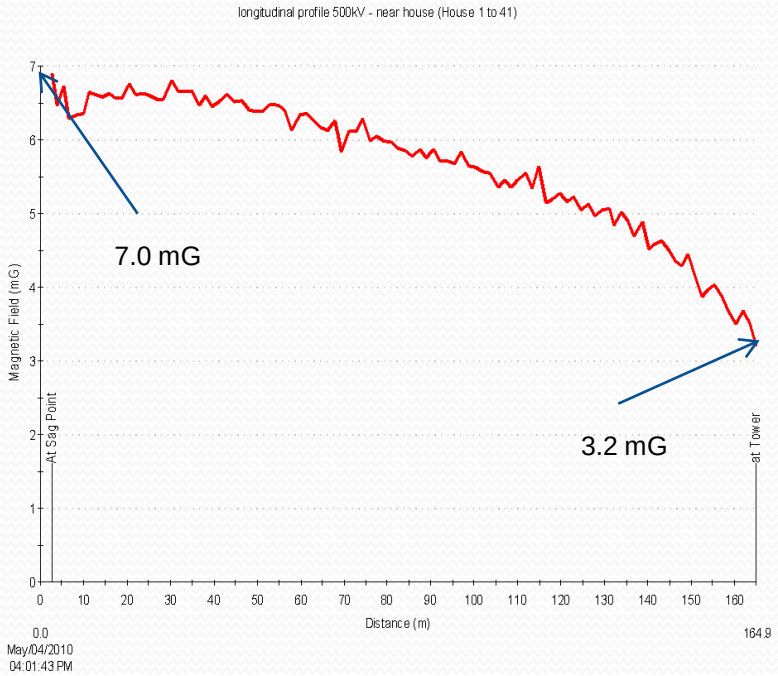
Site 6: 500 kV Lines, Kota Puteri, Ijok, Kuala Selangor, Selangor



Magnetic Field Longitudinal Profile Measurement

Measurement Results (cont.)

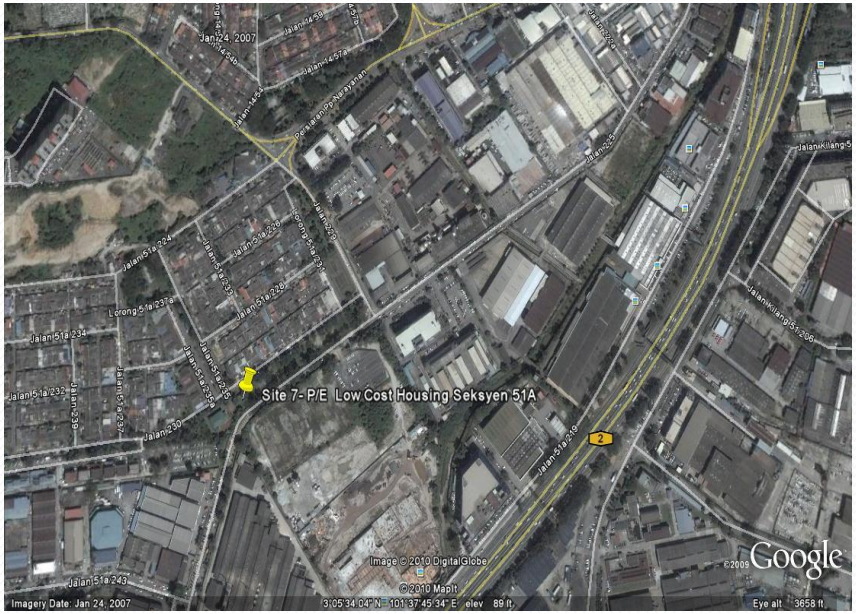
Site 6: 500 kV Lines, Ijok, Kuala Selangor, Selangor
Electric and Magnetic Field Longitudinal Profile

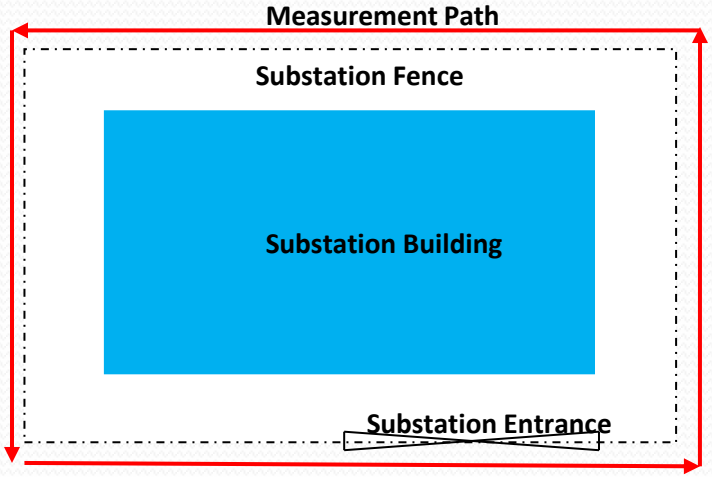


Electric field measurements conducted at this location shows an almost zero readings.

Measurement Results (cont.)

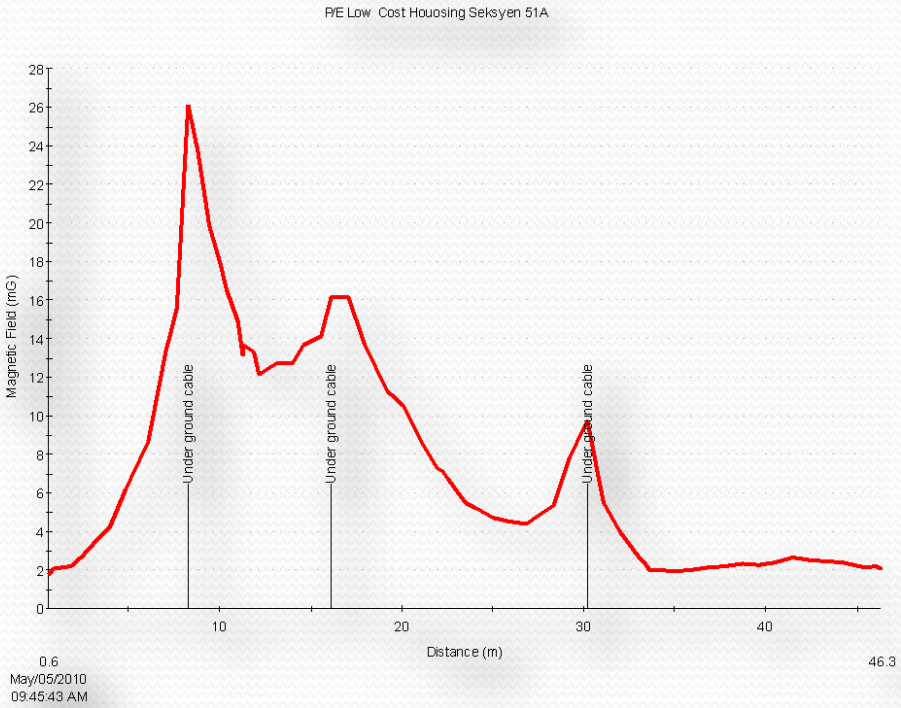
Site 7: P/E Low Cost Housing Seksyen 51A, Petaling Jaya, Selangor





Measurement Results (cont.)

Measurement Results (cont.)



Magnetic Field Measurement Result for the Low Cost Housing Seksyen 51A Substation of Site 7

Descriptive Statistic for Magnetic Field Measurement at the Perimeter of P/E Low Cost Housing Seksyen 51A of Site 7

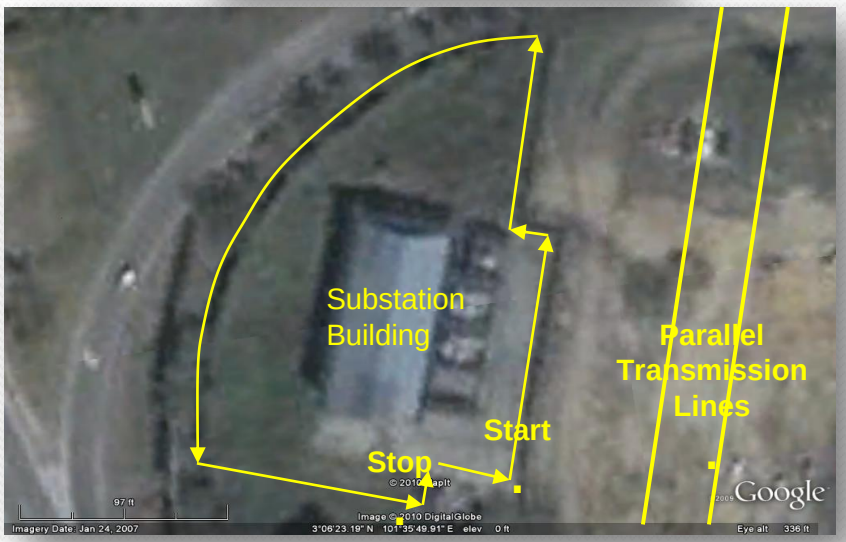
Descriptive	Minimum	Maximum	Mean	Standard Deviation	Median
Broadband Resultant (mG)	1.76	26.10	7.70	6.11	5.33

Measurement Results (cont.)

Electric field measurement conducted around this substation shows all zero readings

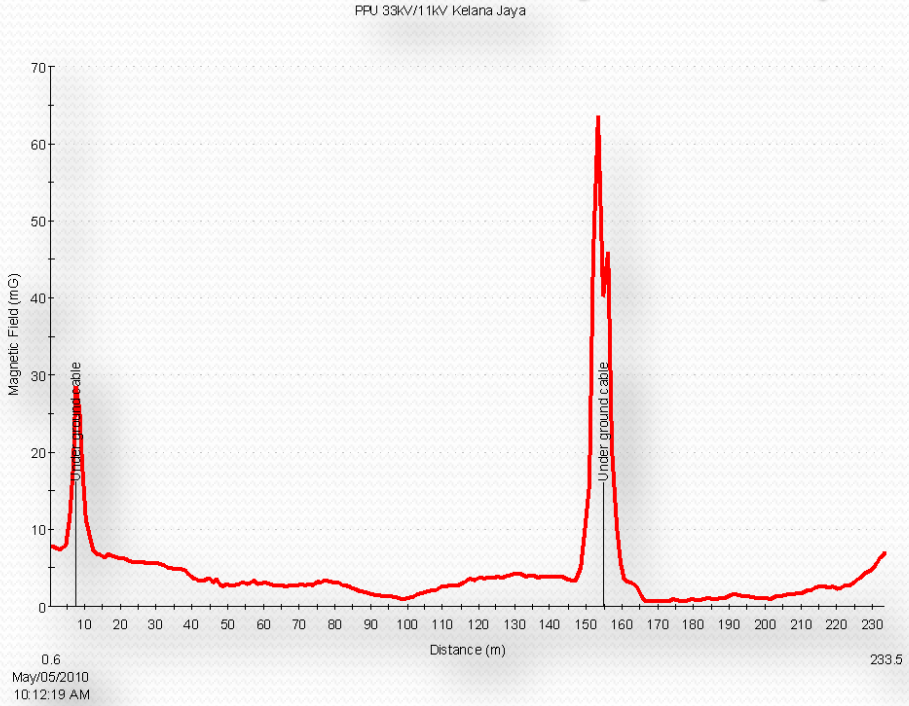
Measurement Results (cont.)

Site 8: PPU 33/11kV Kelana Jaya



Measurement Results (cont.)

Measurement Results (cont.)



Magnetic Field Measurement Result for Perimeter measurement at PPU 33/11 kV Kelana Jaya

Descriptive Statistic for Magnetic Field Measurement at the Perimeter PPU 33/11kV Kelana Jaya of Site 8

Descriptive	Minimum	Maximum	Mean	Standard Deviation	Median
Broadband Resultant (mG)	0.59	63.70	4.72	7.13	3.12

Measurement Results (cont.)

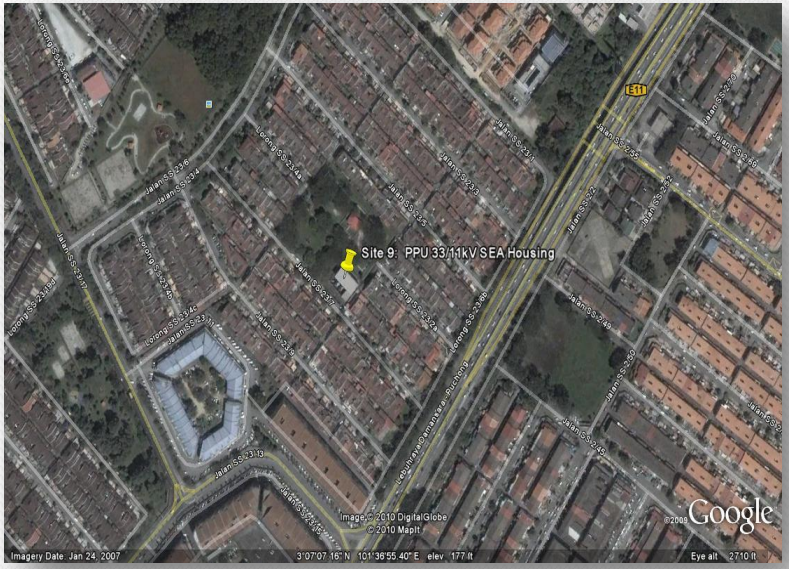
Electric Field Magnitudes at Several Locations Around the PPU 33/ 11 kV Kelana Jaya of Site 8

Descriptive Statistic for the Measurement of Electric at the Perimeter PPU 33/11kV Kelana Jaya of Site 8

Descriptive	Minimum	Maximum	Mean	Standard Deviation	Median
Broadband Resultant (kV/m)	0.000	0.050	0.021	0.021	0.017

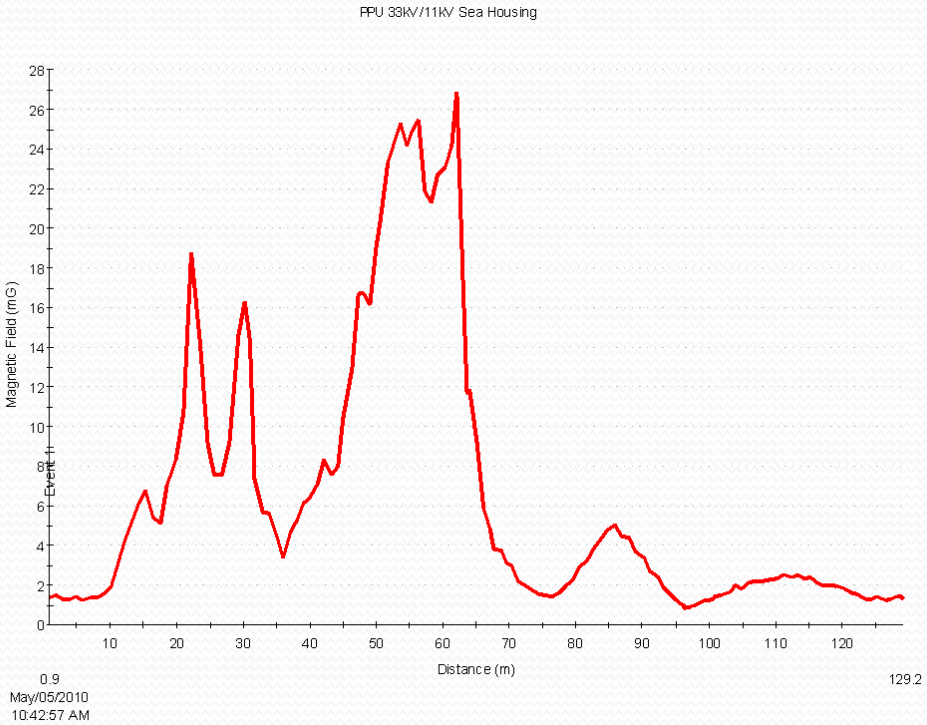
Measurement Results (cont.)

Site 9: PPU 33/11kV SEA Housing



Measurement Results (cont.)

Measurement Results (cont.)



Result for Magnetic Field Measurement Conducted around PPU 33/11kV SEA Housing of Site 9

Descriptive Statistic for Magnetic Field Measurement at PPU 33/11kV SEA Housing of Site 9

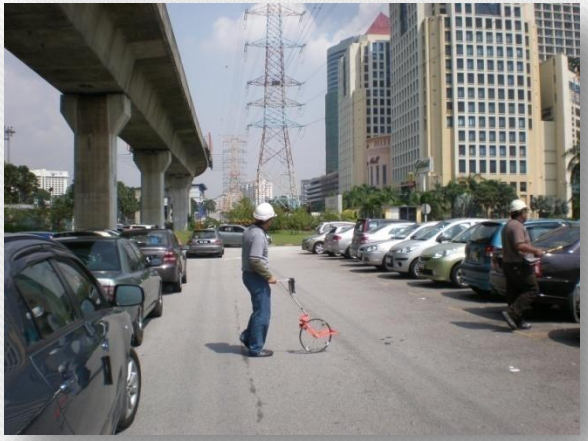
Descriptive	Minimum	Maximum	Mean	Standard Deviation	Median
Broadband Resultant (mG)	0.87	26.90	6.52	7.04	3.22

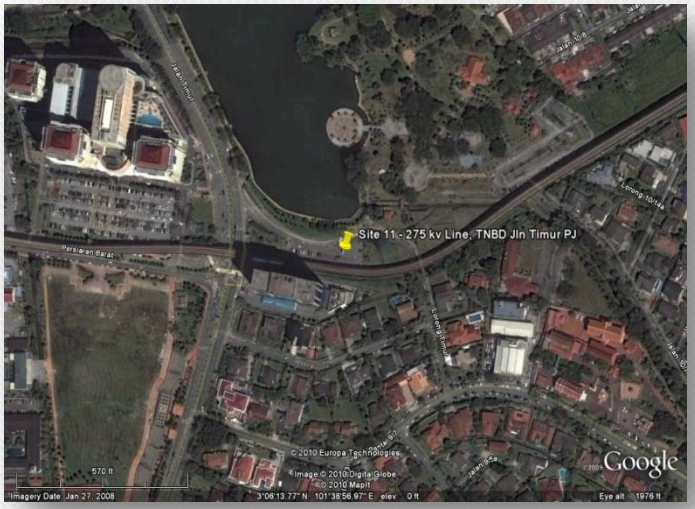
Measurement Results (cont.)

Results of electric fields measurements around this location show all zero readings.

Measurement Results (cont.)

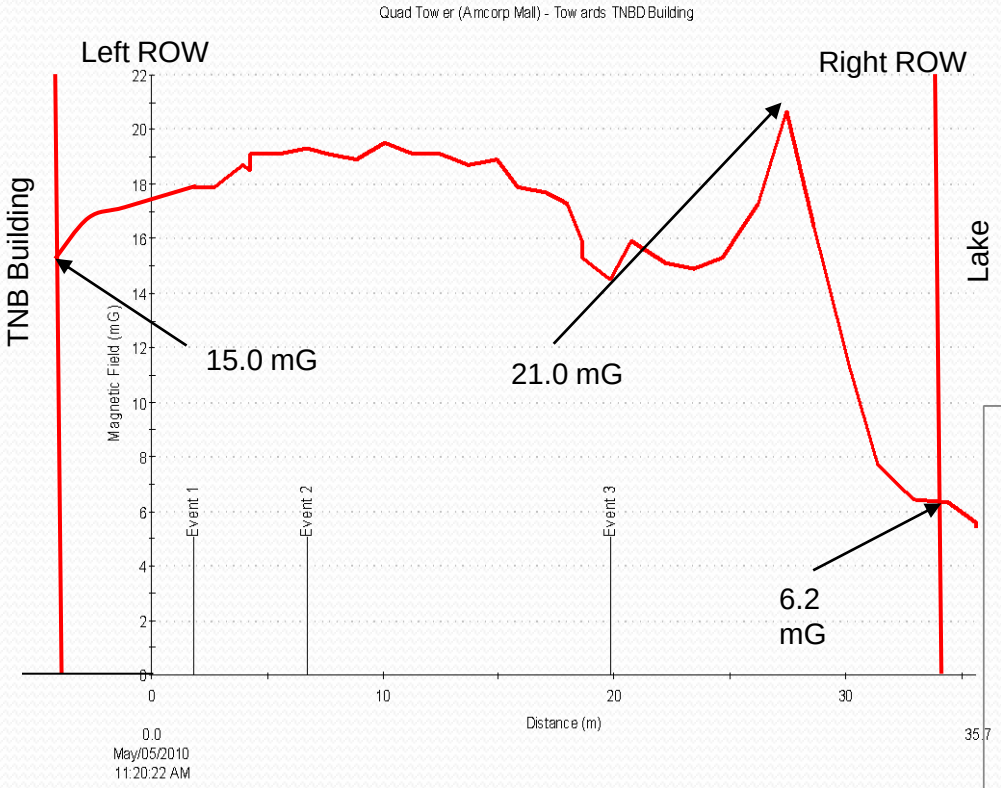
Site 10: Quadruple Tower In-front of TNBD Jalan Timur, Near Amcorp Mall

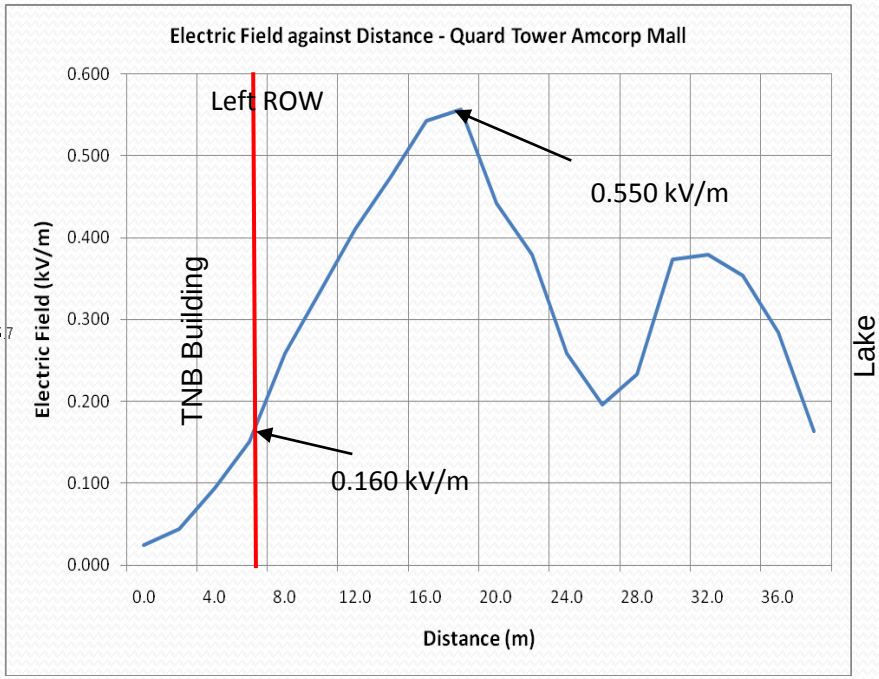




Measurement Results (cont.)

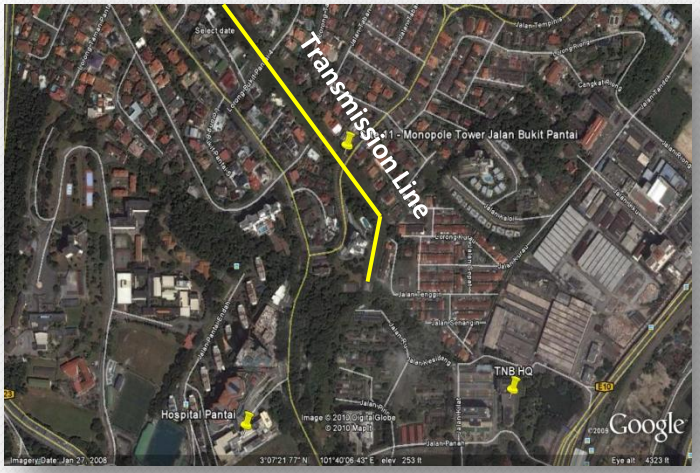
Measurement Results (cont.)





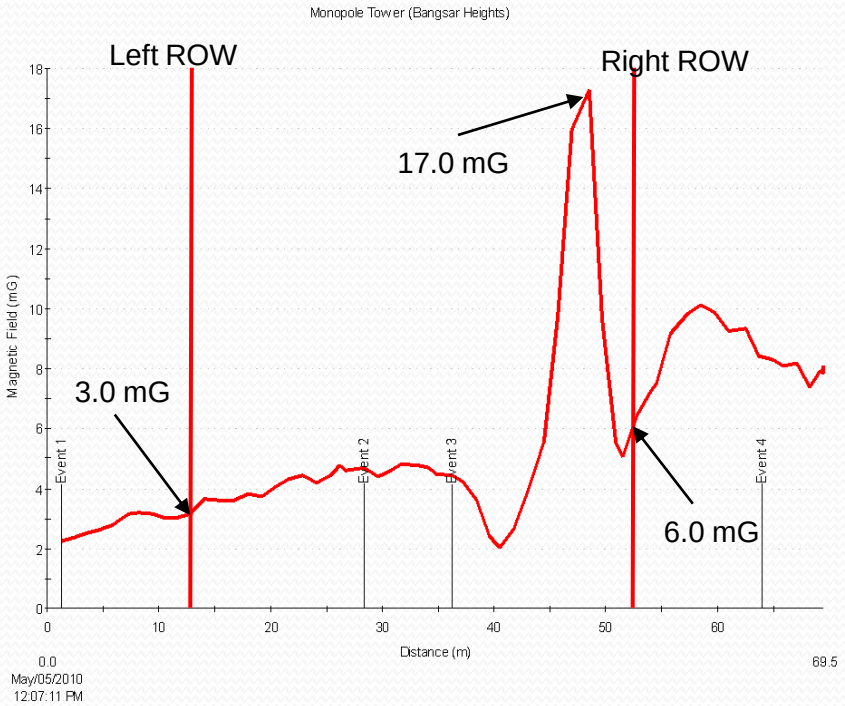
Measurement Results (cont.)

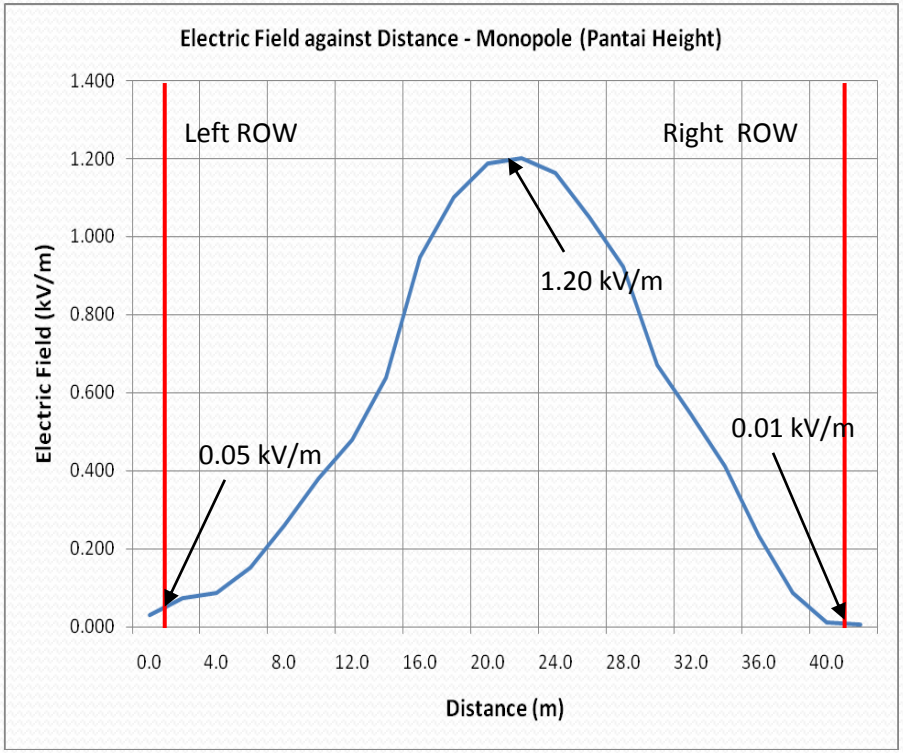
Site 11: Monopole Tower Transmission Lines at Jalan Bukit Pantai, Bangsar, Kuala Lumpur



Measurement Results (cont.)

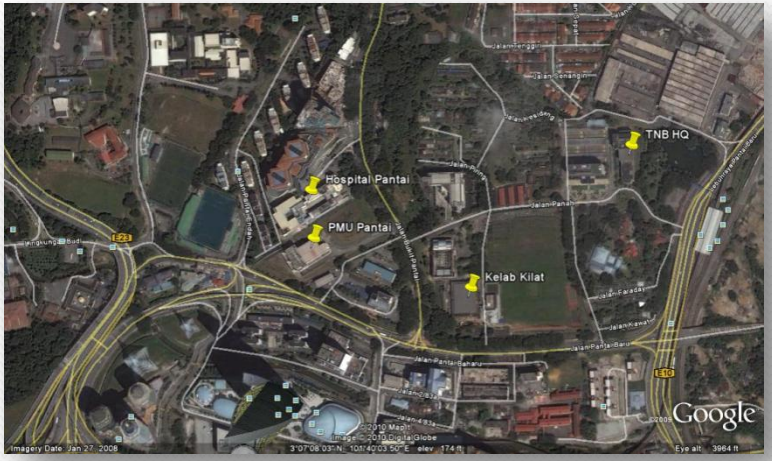
Measurement Results (cont.)





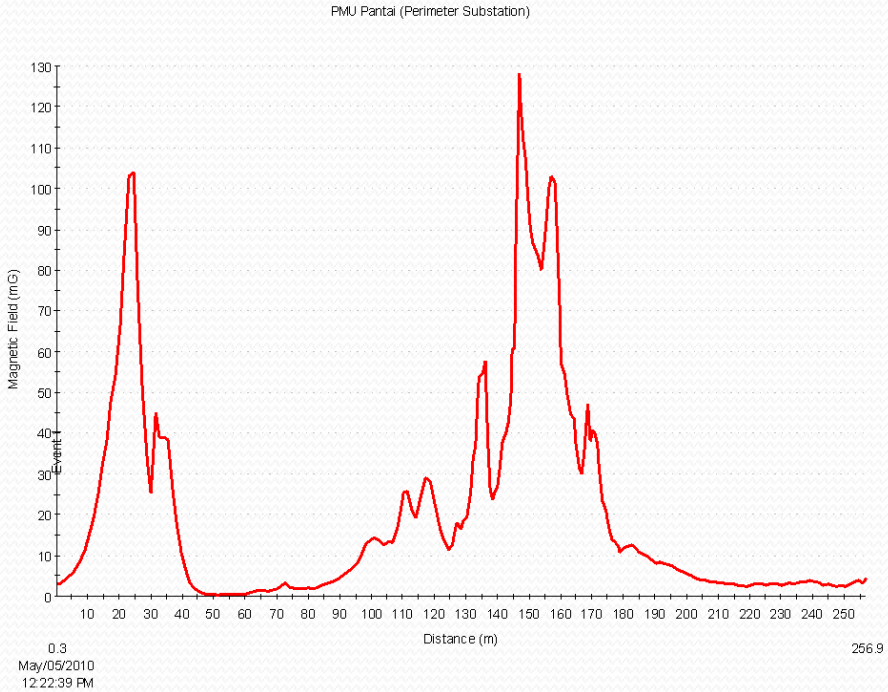
Measurement Results (cont.)

Site 12: PMU Pantai, Bangsar, Kuala Lumpur



Measurement Results (cont.)

Measurement Results (cont.)



Descriptive	Minimum	Maximum	Mean	Standard Deviation	Median
Broadband Resultant (mG)	0.38	128.30	23.31	28.64	11.45

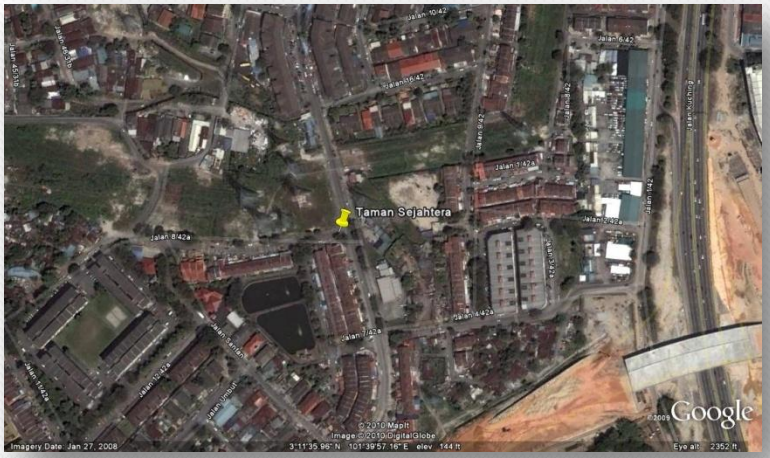
Measurement Results (cont.)

Electric field measurement was conducted at locations around this substation and reading was found to be very low, varying at around 6V/m to 44V/m.

Descriptive	Minimum	Maximum	Mean	Standard Deviation	Median
Broadband Resultant (kV/m)	0.006	0.044	0.025	0.027	0.025

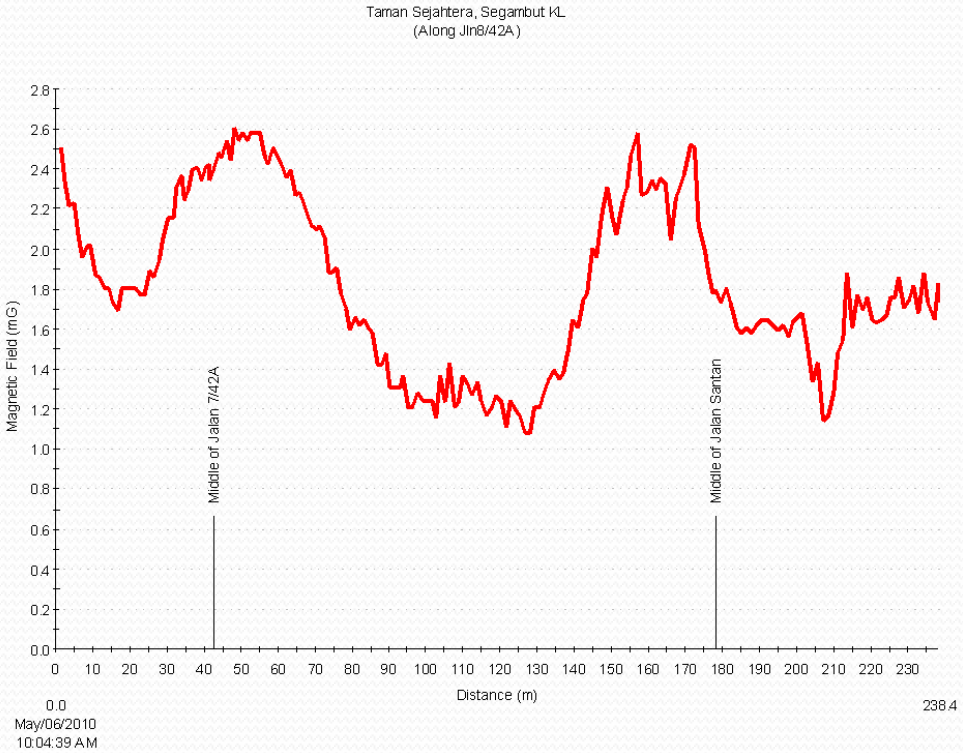
Measurement Results (cont.)

Site 13: Taman Sejahtera, Segambut along Jalan 8/42A



Measurement Results (cont.)

Measurement Results (cont.)



Descriptive	Minimum	Maximum	Mean	Standard Deviation	Median
Broadband Resultant (mG)	1.08	2.61	1.83	0.43	1.78

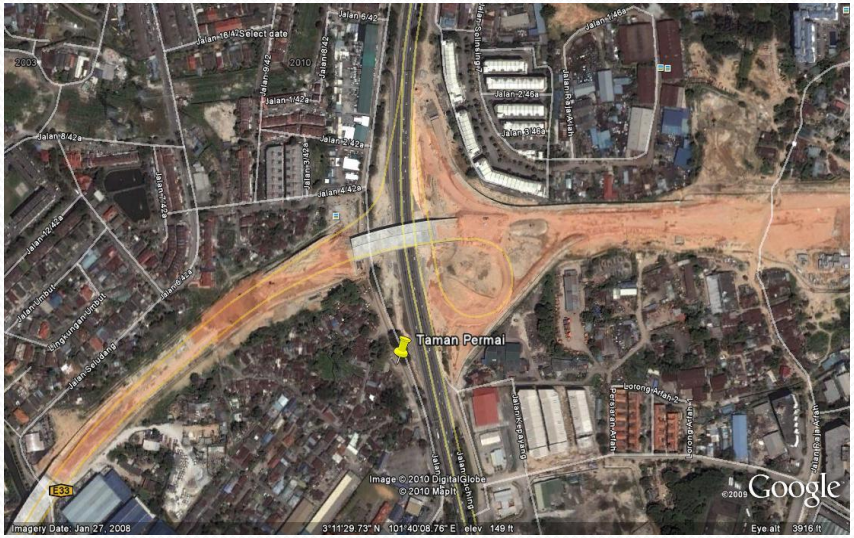
Measurement Results (cont.)

N0.	Location	Electric Field (kV/m)
1	At the junction of Jalan 6/42A an Jalan 8/42A	0.012
2	Midway between start point at Jalan 7/42A	0.025
3	At the junction of Jalan 8/42A and Jalan 7/42A	0.107
4	In front of House No. 12	0.031
5	In front of House No. 18	0.113
6	In front of House No. 24	0.056
7	In front of House No. 30	0.170
8	In front of House No. 38	0.177
9	In front of House No. 42	0.017
10	At the junction of Jalan 8/42A and Jalan Santan	0.012
11	In front of Dewan Sivik Flat Taman Segahtera	0.006
12	Stop	0.008

Descriptive	Minimum	Maximum	Mean	Standard Deviation	Median
Broadband Resultant (kV/m)	0.006	0.177	0.061	0.064	0.028

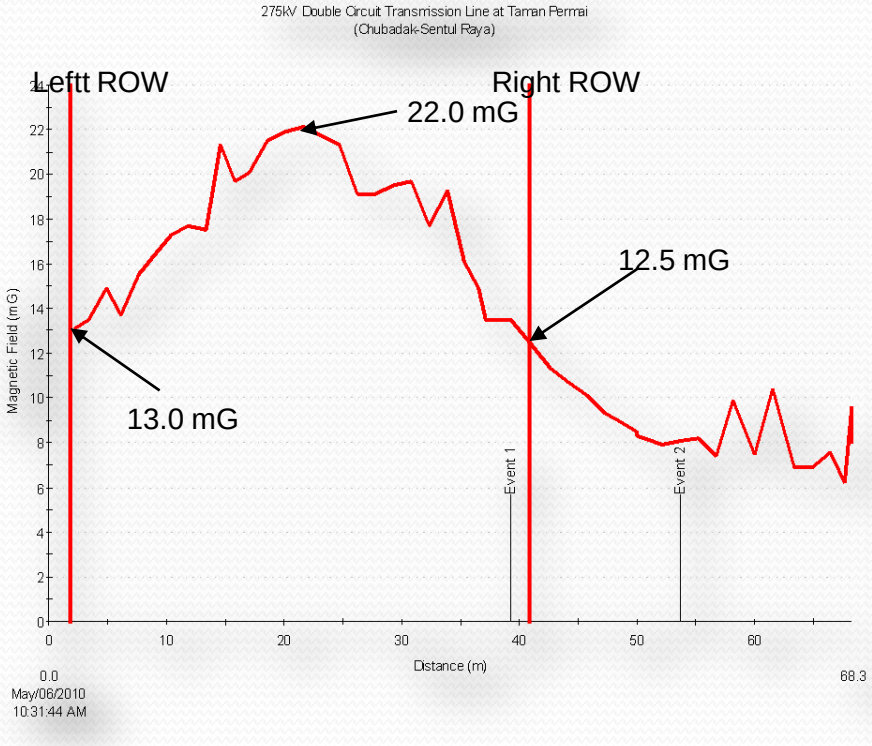
Measurement Results (cont.)

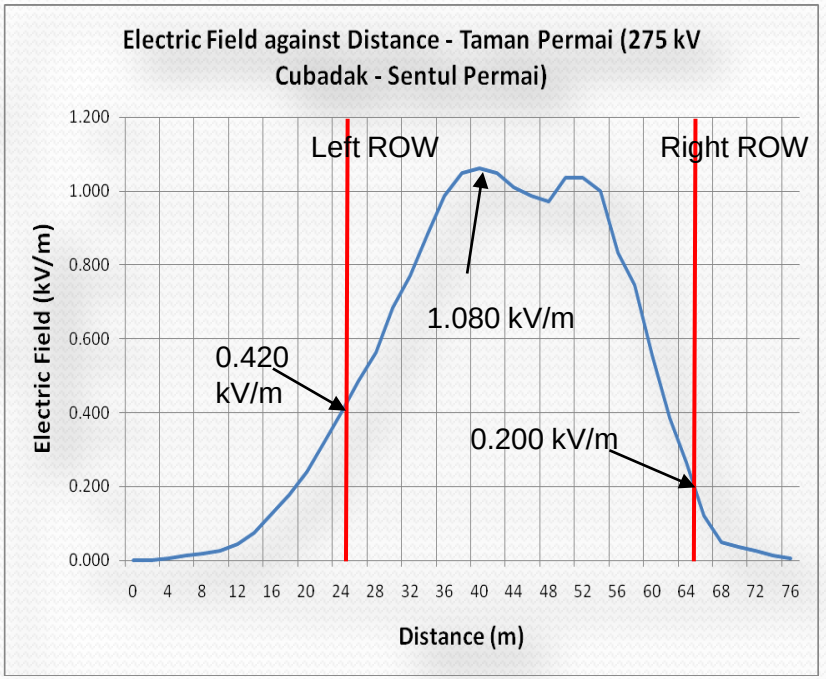
Site 14: Under 275kV Double Circuit Transmission Lines at Taman Permai (CBDK – SRYA)



Measurement Results (cont.)

Measurement Results (cont.)

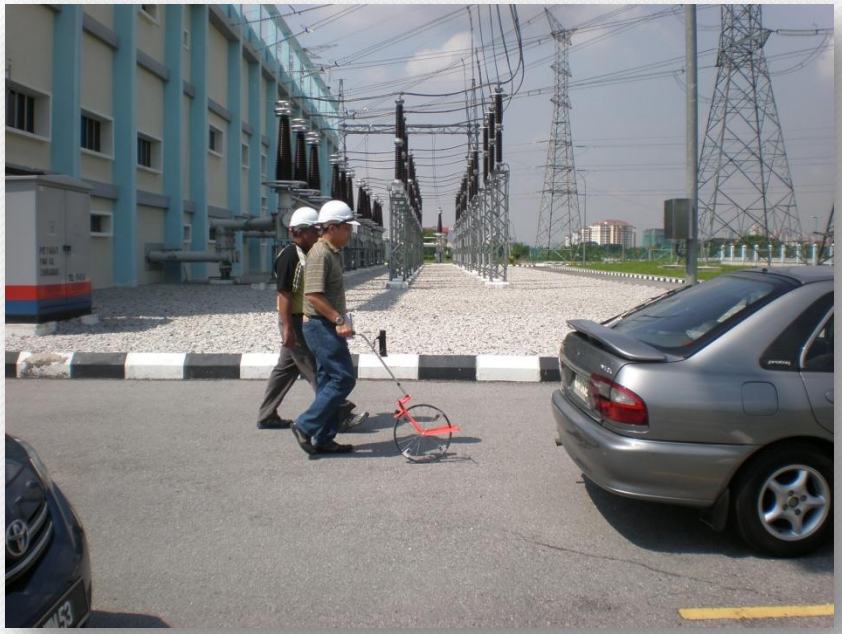




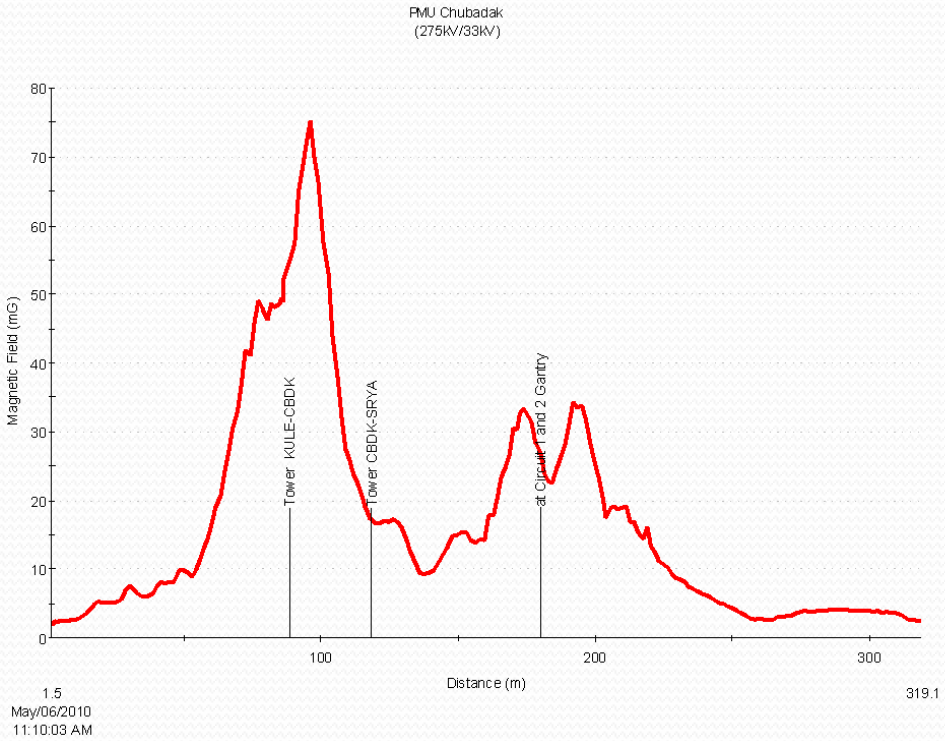
Measurement Results (cont.)

Site 15: PMU Chubadak, Sentul, Kuala Lumpur

Measurement Results (cont.)



Measurement Results (cont.)



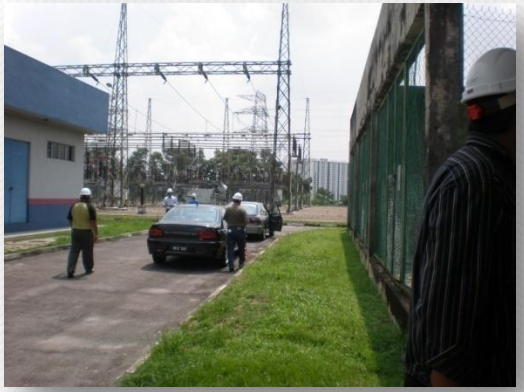
Descriptive	Minimum	Maximum	Mean	Standard Deviation	Median
Broadband Resultant (mG)	2.01	75.30	16.91	16.13	11.23

Measurement Results (cont.)

Descriptive	Minimum	Maximum	Mean	Standard Deviation	Median
Broadband Resultant (kV/m)	0.018	1.454	0.532	0.544	0.60

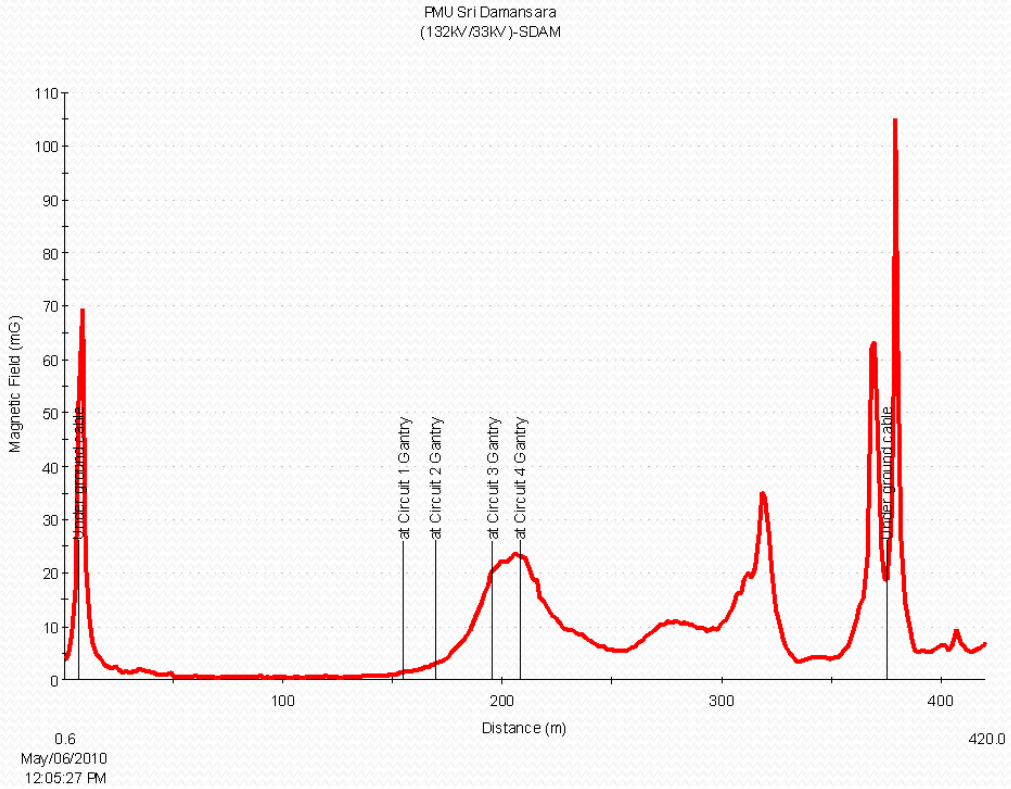
Measurement Results (cont.)

Site 16: PMU Sri Damansara



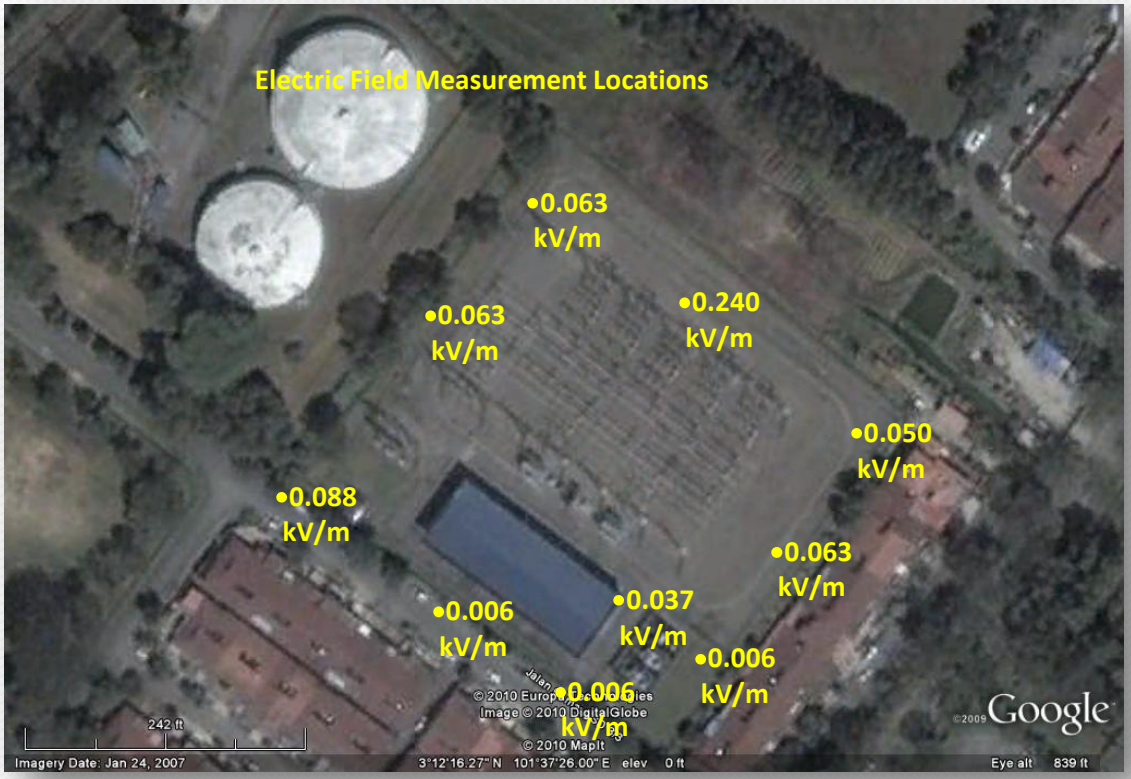
Measurement Results (cont.)

Measurement Results (cont.)



Descriptive	Minimum	Maximum	Mean	Standard Deviation	Median
Broadband Resultant (mG)	0.36	105.30	8.82	1.30	5.44

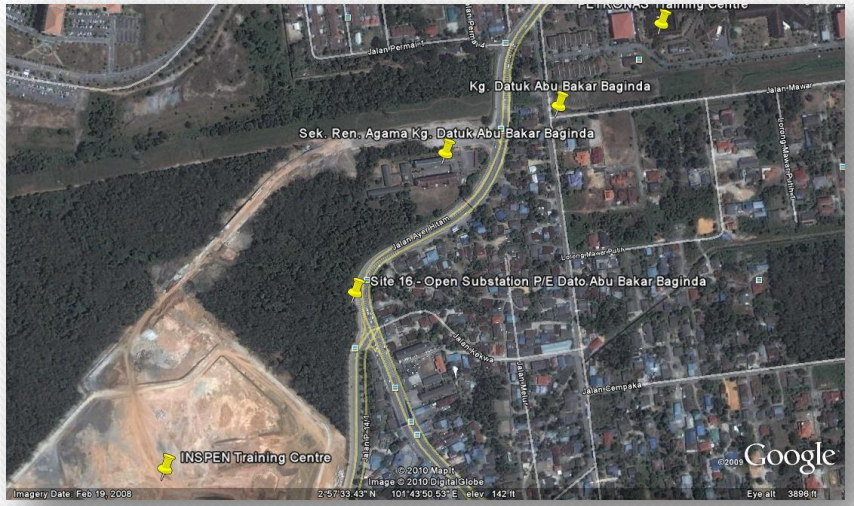
Measurement Results (cont.)



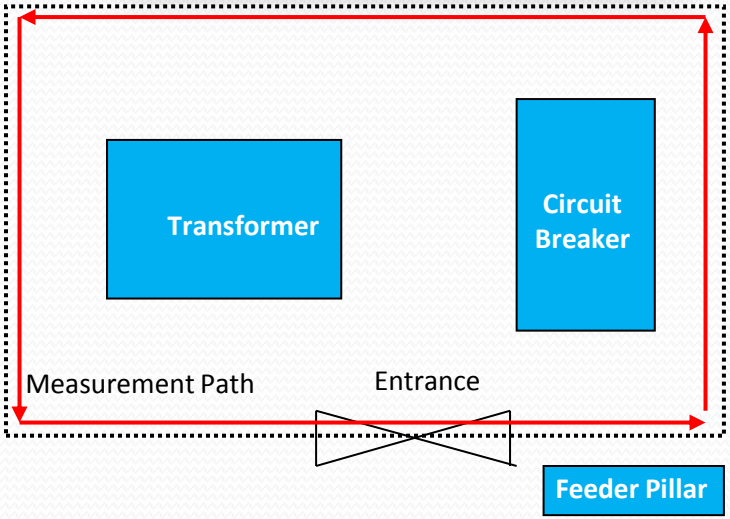
Descriptive	Minimum	Maximum	Mean	Standard Deviation	Median
Broadband Resultant (kV/m)	0.006	0.240	0.062	0.069	0.057

Measurement Results (cont.)

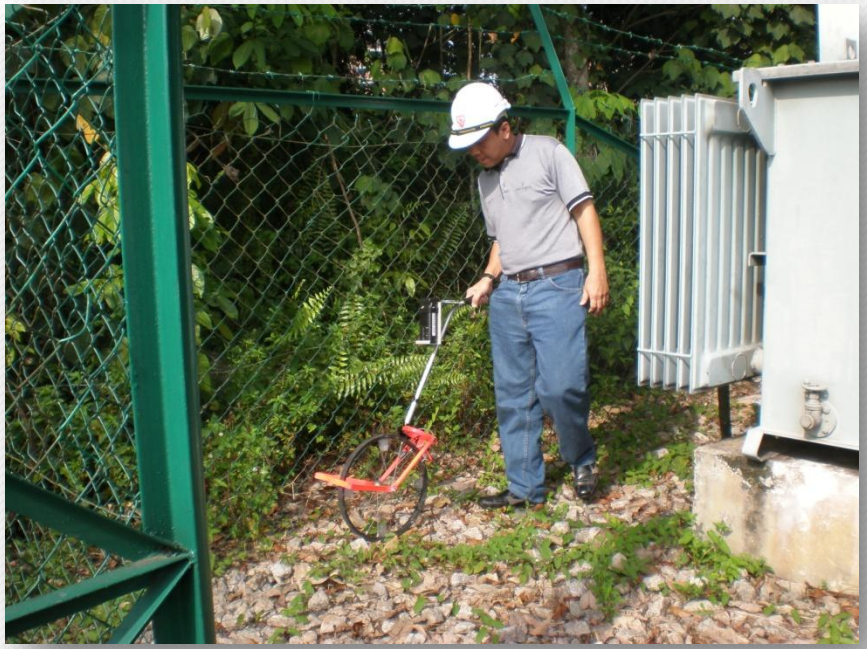
Site 17 Open Substation P/E Dato Abu Bakar Baginda



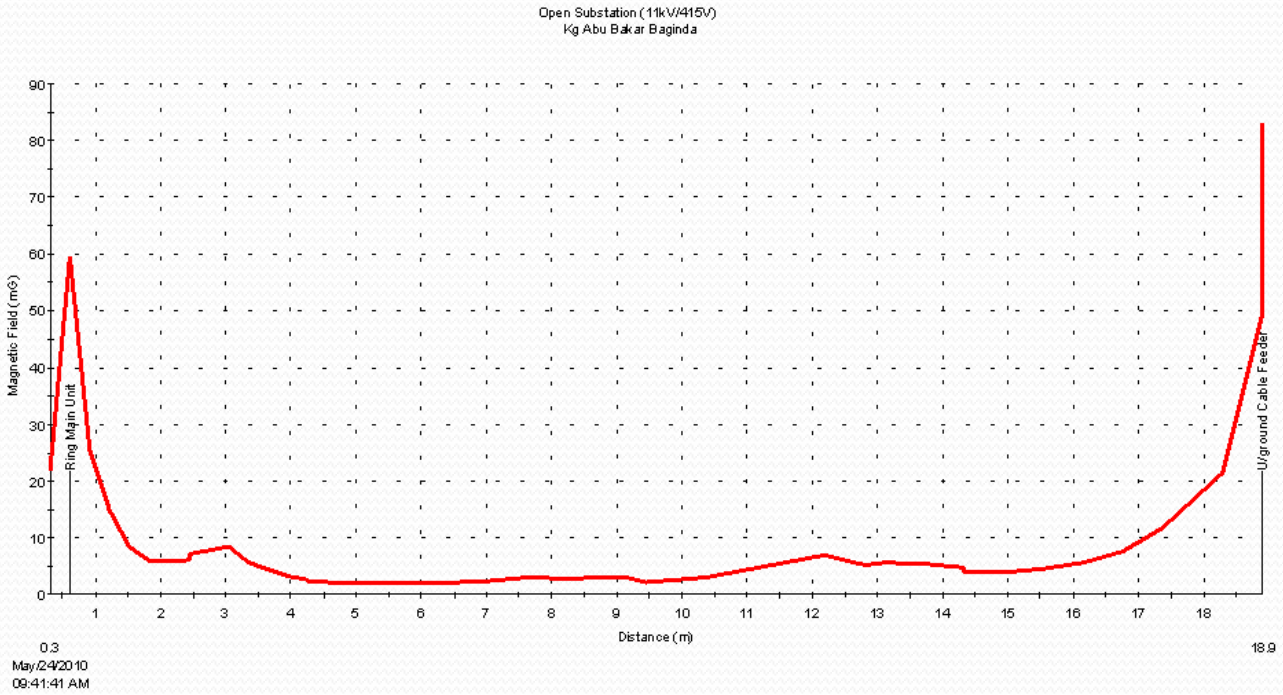
Substation Fence



Measurement Results (cont.)



Measurement Results (cont.)



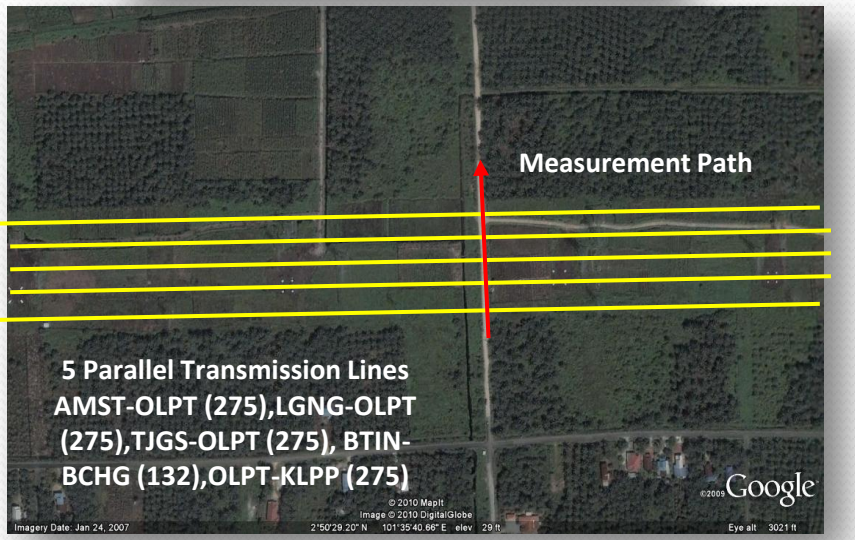
Descriptive	Minimum	Maximum	Mean	Standard Deviation	Median
Broadband Resultant (mG)	2.06	83.10	10.52	16.64	5.14

Measurement Results (cont.)

Electric field measurement conducted for the substation and was found to be zers for all locations.

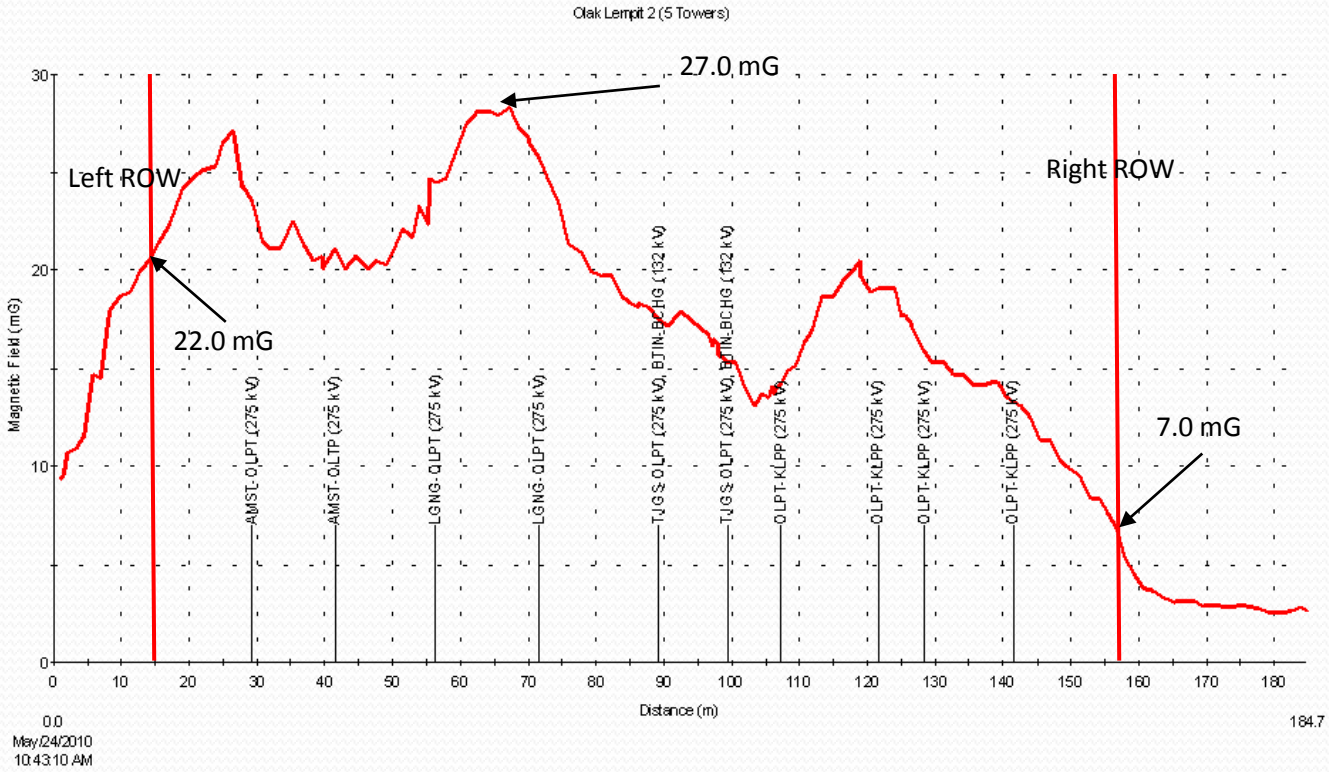
Measurement Results (cont.)

Site 18: Multiple Double Circuit and Quadruple Lines, Olak Lempit, Selangor

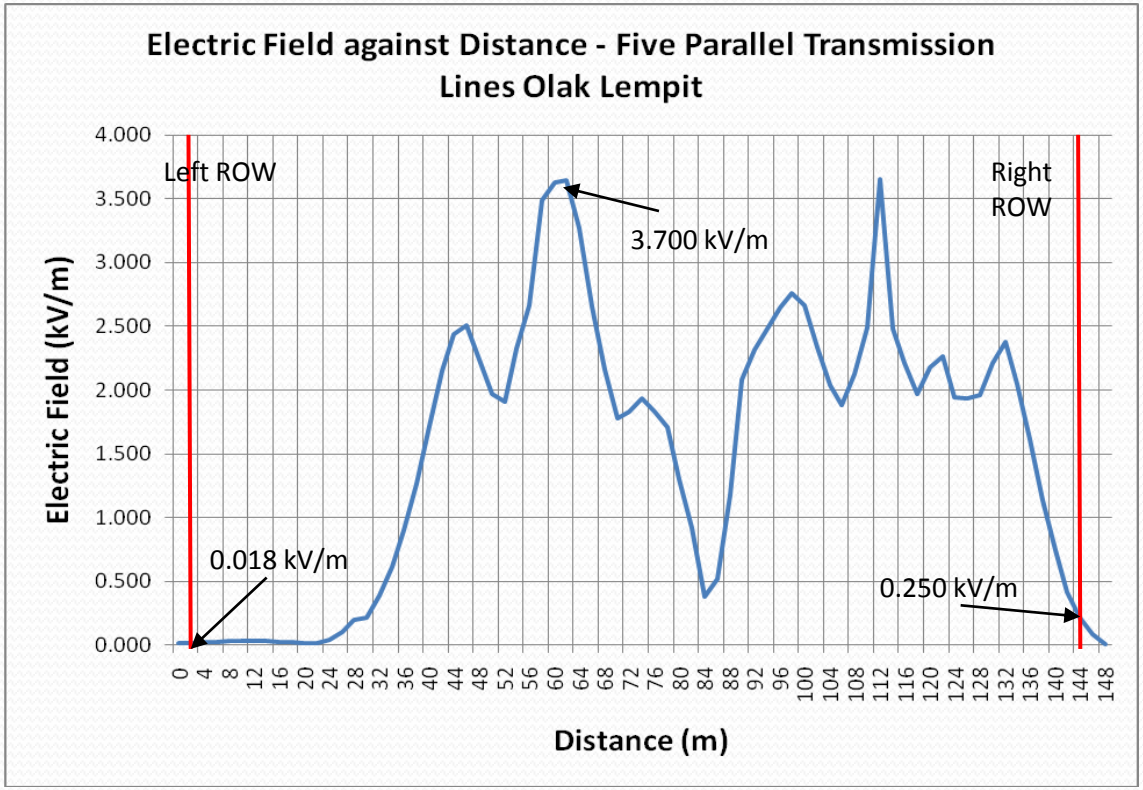


Measurement Results (cont.)

Measurement Results (cont.)



Measurement Results (cont.)



Summary Transmission Lines Magnetic Field Measurement Results

No	Site	Type	Location	Lines	Magnetic Field (mG)		
					LROW	Peak	RROW
1	2	132 kV Double Circuit Lines	Kpg. Abu Bakar Baginda	ABBA-NUNI (132)	6.4	9.9	3.2
2	11	132 kV Double Circuit Monopole Tower Lines	Pantai Height, Bangsar	TNHQ-SGBT (132), TNHQ-DMHT (132)	3.0	17.0	6.0
3	4	275 kV Double Circuit Lines	Kpg. Abu Bakar Baginda	SLTI-SRDG (275)	28.0	49.0	16.0
4	14	275 kV Double Circuit Lines	Taman Permai	CBDK-SRYA (275)	13.0	22.0	12.5
5	6	500 kV Circuit Lines	Kota Puteri, Ijok	KPAR-BTRK (500)	11.0	19.0	10.0
6	3	275 kV/132 kV Quadruple Circuit Lines	Jalan Reko, Kajang	LGNG-NUNI (275), SMYH-KJNG (132)	3.8	8.0	4.6
7	10	275 kV/132 kV Quadruple Circuit Lines	In-front of TNB Jalan Timur	KULN-PTAI (275), NSPK-PTAI (132)	15.0	21.0	6.2
8	1	275 kV Double Circuit Lines Parallel with 132 kV/132 kV Quadruple Circuit Lines	Presint 14 Putra Jaya	SLTI-SRDG (275) , ABBA-SRDG (132), ABBA-NUNI (132)	28.0	45.0	3.0
9	18	132 kV and 275 kV Double and Quaduple Circuit Lines	Olak Lempik, Banting	AMST-OLPT (275) LGNG-OLPT (275) TJGS-OLPT (275) BTIN-BCHG (132) OLPT-KLPP (275)	22.0	27.0	7.0
10	5	500 kV Substation (Incoming Lines)	500 kV Substation, Kapar	KPAR-BTRK (500)	7.0	12.0	9.0

Summary Transmission Lines Electric Field Measurement Results

No	Site	Type	Location	Lines	Electric Field (kV/m)		
					LROW	Peak	RROW
1	2	132 kV Double Circuit Lines	Kpg. Abu Bakar Baginda	ABBA-NUNI (132)	0.300	0.600	0.150
2	11	132 kV Double Circuit Monopole Tower Lines	Pantai Height, Bangsar	TNHQ-SGBT (132), TNHQ-DMHT (132)	0.050	1.200	0.010
3	4	275 kV Double Circuit Lines	Kpg. Abu Bakar Baginda	SLTI-SRDG (275)	1.400	2.200	1.400
4	14	275 kV Double Circuit Lines	Taman Permai	CBDK-SRYA (275)	0.420	1.080	0.200
5	6	500 kV Circuit Lines	Kota Puteri, Ijok	KPAR-BTRK (500)	0.002	4.300	0.002
6	3	275 kV/132 kV Quadruple Circuit Lines	Jalan Reko, Kajang	LGNG-NUNI (275), SMYH-KJNG (132)	0.060	0.700	0.230
7	10	275 kV/132 kV Quadruple Circuit Lines	In-front of TNB Jalan Timur	KULN-PTAI (275), NSPK-PTAI (132)	0.160	0.550	X
8	1	275 kV Double Circuit Lines Parallel with 132 kV/132 kV Quadruple Circuit Lines	Presint 14 Putra Jaya	SLTI-SRDG (275) , ABBA-SRDG (132), ABBA-NUNI (132)	0.080	1.800	0.590
9	18	132 kV and 275 kV Double and Quaduple Circuit Lines	Olak Lempik, Banting	AMST-OLPT (275) LGNG-OLPT (275) TJGS-OLPT (275) BTIN-BCHG (132) OLPT-KLPP (275)	0.018	3.700	0.250
10	5	500 kV Substation (Incoming Lines)	500 kV Substation, Kapar	KPAR-BTRK (500)	4.500	5.100	3.200

Summary Substation Magnetic Field Measurement Results

No	Site	TYPE	Location	Magnetic Field (mG)				
				Min	Max	Mean	Std Dev	Median
1	17	Outdoor P/E Abu Bakar Baginda	Kpg. Abu Bakar Baginda	0.006	0.24	0.062	0.069	0.057
2	7	P/E Low Cost Housing Seksyen 51A	Seksyen 51A, Petaling Jaya	1.76	26.10	7.70	6.11	5.33
3	8	PPU 33/11kV Kelana Jaya	Kelana Jaya	0.59	63.7	4.72	7.13	3.12
4	9	PPU 33/11kV SEA Housing	Seksyen 23, Petaling Jaya	0.87	26.9	6.52	7.04	3.22
5	12	PMU Pantai	Bangsar, KL	0.38	128.3	23.31	28.64	11.45
6	15	PMU Chubadak	Kg. Chubadak, Sentul, KL	2.01	75.3	16.91	16.13	11.23
7	16	PMU Sri Damansara	Damansara Height, KL	0.36	105.3	8.82	1.3	5.44
8	5	PMU 500KV Kapar	Kapar, Klang	1.46	66.3	10.09	10.16	7.66
9	6	500 kV Circuit Lines (Longitudinal Profile)	Kota Puteri, Ijok	3.19	6.91	5.64	0.97	5.86
10	13	Many Transmission Line Towers (Longitudinal Profile)	Taman Sejahtera, Segambut along Jalan 8/42A	1.08	2.61	1.83	0.43	1.78
11	5	275 kV Substation (Horizontal Configuration Line))	500 kV Substation, Kapar	2.96	47.3	16.54	10.44	17.1

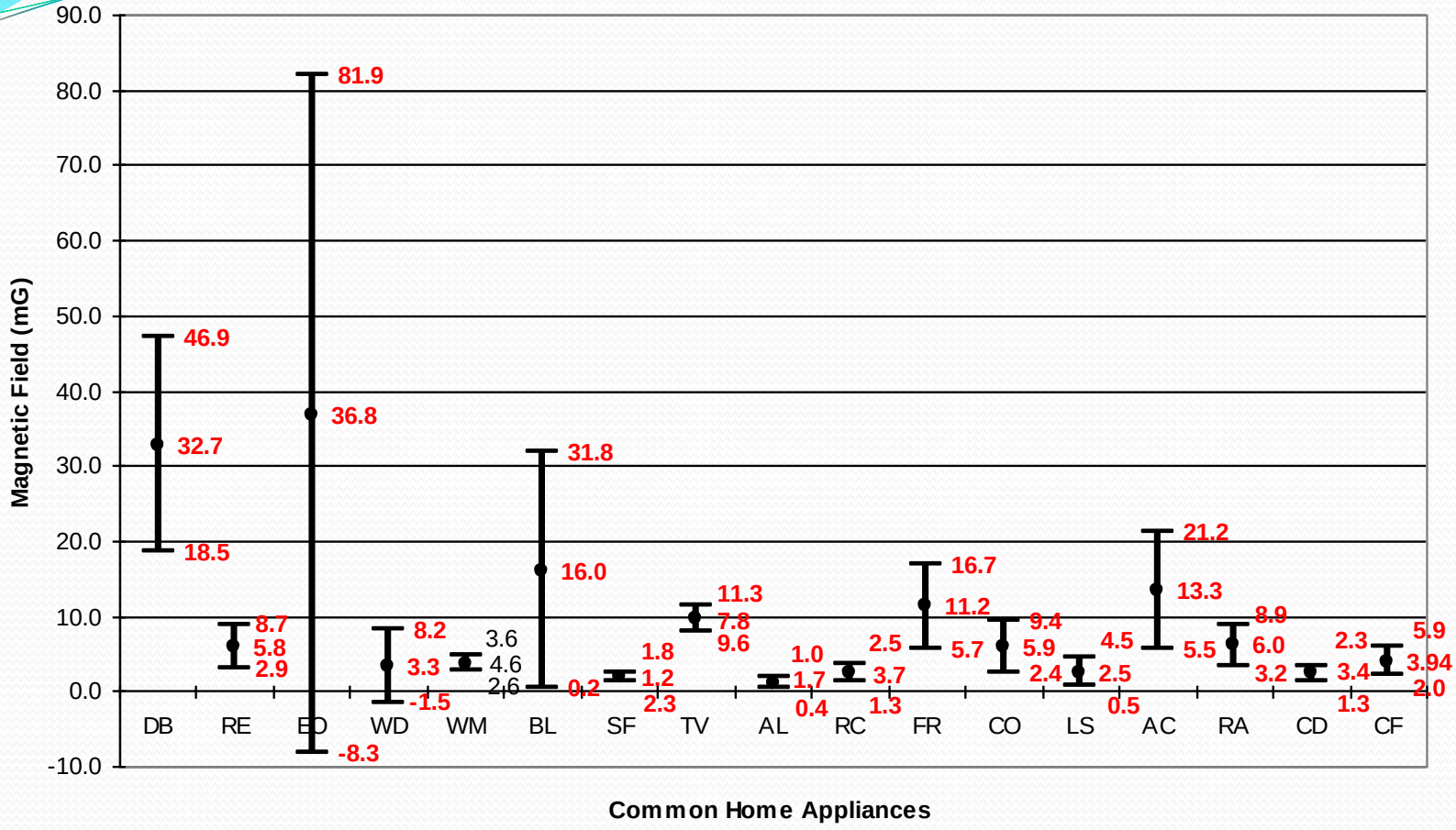
Summary Substation Electric Field Measurement Results

No	Site	TYPE	Location	Electric Field (kV/m)				
				Min	Max	Mean	Std Dev	Median
1	17	Outdoor P/E Abu Bakar Baginda	Kpg. Abu Bakar Baginda	0.000	0.000	0.000	0.000	0.000
2	7	P/E Low Cost Housing Seksyen 51A	Seksyen 51A, Petaling Jaya	0.000	0.000	0.000	0.000	0.000
3	8	PPU 33/11kV Kelana Jaya	Kelana Jaya	0.000	0.050	0.021	0.021	0.017
4	9	PPU 33/11kV SEA Housing	Seksyen 23, Petaling Jaya	0.000	0.000	0.000	0.000	0.000
5	12	PMU Pantai	Bangsar, KL	0.006	0.044	0.025	0.027	0.025
6	15	PMU Chubadak	Kg. Chubadak, Sentul, KL	0.018	1.454	0.532	0.544	0.600
7	16	PMU Sri Damansara	Damansara Height, KL	0.006	0.240	0.062	0.069	0.057
8	5	PMU 500KV Kapar	Kapar, Klang	0.037	5.109	1.159	1.184	0.758
9	6	500 kV Circuit Lines (Longitudinal Profile)	Kota Puteri, Ijok	0.000	0.000	0.000	0.000	0.000
10	13	Many Transmission Line Towers (Longitudinal Profile)	Taman Sejahtera, Segambut along Jalan 8/42A	0.006	0.177	0.061	0.064	0.028
11	5	275 kV Substation (Horizontal Configuration Line))	500 kV Substation, Kapar	0.040	1.240	0.640	0.340	0.620

Residential Magnetic Field Exposure Study

- The study was conducted by EMF Research Group, UNITEN for Engineering Division, Ministry of Health Malaysia in 2007
- Objectives:
  - To obtain average magnetic field in homes in Klang Valley
  - To obtain average magnetic field from common home appliances measured directly in front, 1 foot and 2 feet from appliances
- 44 homes were randomly selected
- 438 home appliances were measured consisting of 17 different types.

Mean Magnetic Field Immediately In Front of Common Home Appliances Shown Also Their Upper Upper and Lower Limit for 95% CI



Abbreviation:

DB: Dist. Board

RE: Refrigerator

EO: Electric Oven

WD: Water Dispenser

WM: Washing Machine

BL: Blander

SF: Stand Fan

TV: Television

AL: Alarm Clock

RC: Rice Cooker

FR: Fan Regulator

CO: Computer

LS: Lamp Switch

AC: Air Condition

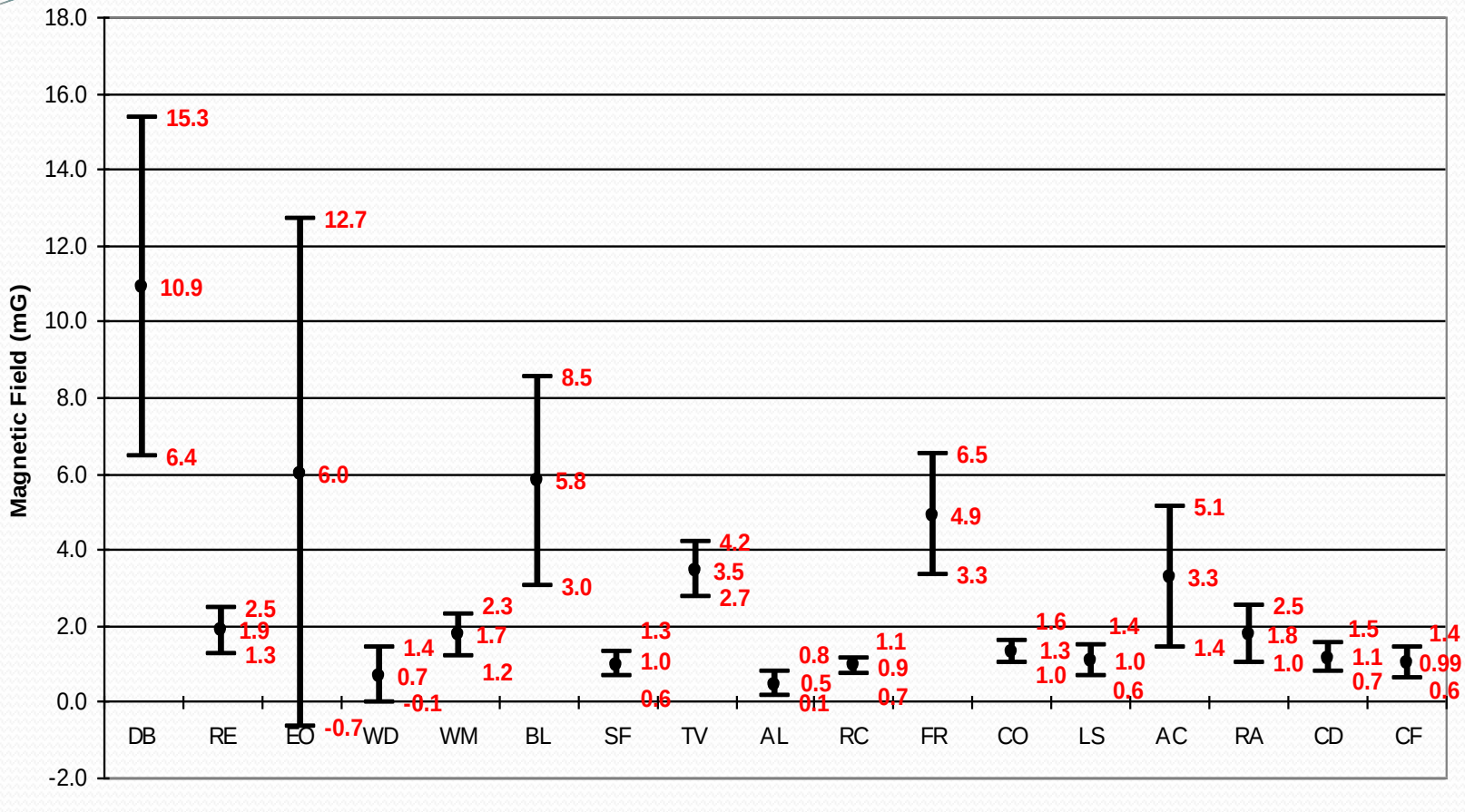
RA: Radio

CD: CD/DVD Player

CF: Ceiling Fan

Descriptive Statistics	DB	RE	EO	WD	WM	BL	SF	TV	AL	RC	FR	CO	LS	AC	RA	CD	CF
Count	41.0	41.0	14.0	4.0	32.0	14.0	31.0	54.0	13.0	33.0	26.0	31.0	34.0	19.0	16.0	18.0	17.00
Mean (mG)	32.7	5.8	36.8	3.3	3.6	16.0	1.8	9.6	1.0	2.5	11.2	5.9	2.5	13.3	6.0	2.3	3.94
Median (mG)	12.0	3.2	7.8	3.4	3.8	9.0	1.3	8.7	0.4	1.5	8.3	2.5	0.9	3.5	3.4	1.7	2.30
Standard Deviation (mG)	45.1	9.2	78.1	3.1	2.8	27.4	1.5	4.6	1.1	3.4	13.6	9.6	5.7	16.3	5.3	2.0	3.81
Minimum (mG)	1.2	0.2	0.2	0.3	0.3	3.7	0.2	2.1	0.3	0.4	0.6	1.0	0.3	0.3	1.2	1.1	1.40
Maximum (mG)	227.0	53.0	299.0	6.2	8.1	110.0	6.5	33.7	3.8	20.1	64.0	35.0	33.2	40.9	14.6	8.2	13.00
Confidence Interval (95.0%)	14.2	2.9	45.1	4.9	1.0	15.8	0.6	1.7	0.7	1.2	5.5	3.5	2.0	7.9	2.8	1.0	1.96

Mean Magnetic Field 1 feet from Common Home Appliances Shown Also Their Upper Upper and Lower Limit for 95% CI



Common Home Appliances

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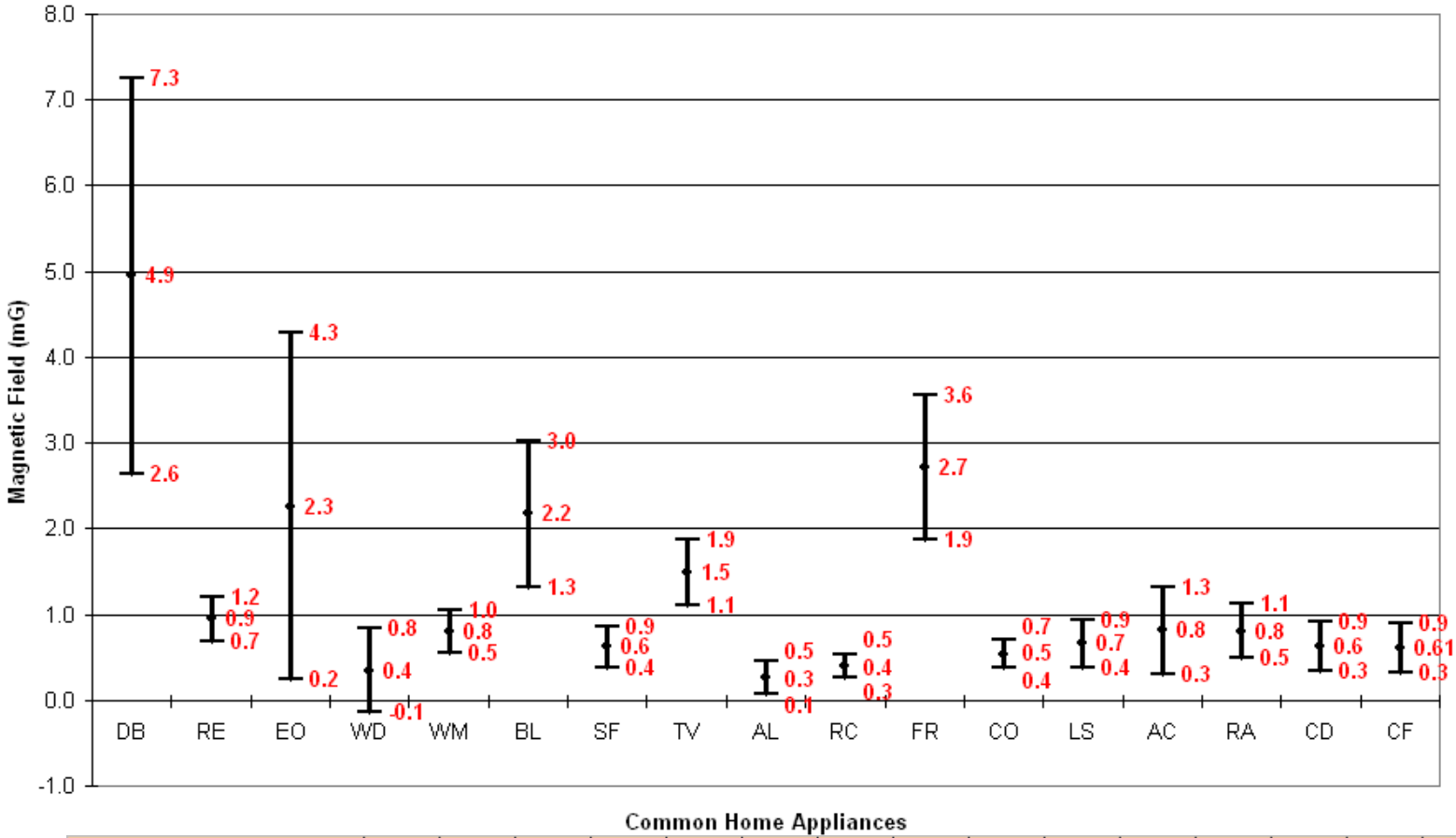
RA: Radio

CD: CD/DVD Player

CF: Ceiling Fan

Descriptive Statistics	DB	RE	EO	WD	WM	BL	SF	TV	AL	RC	FR	CO	LS	AC	RA	CD	CF
Count	41.0	41.0	14.0	4.0	32.0	14.0	31.0	54.0	13.0	33.0	26.0	31.0	34.0	19.0	16.0	18.0	17.00
Mean (mG)	10.9	1.9	6.0	0.7	1.7	5.8	1.0	3.5	0.5	0.9	4.9	1.3	1.0	3.3	1.8	1.1	0.99
Median (mG)	4.3	1.5	3.0	0.7	1.2	4.9	0.7	2.9	0.2	0.7	4.7	1.1	0.6	0.9	1.1	0.9	0.60
Standard Deviation (mG)	14.1	1.9	11.6	0.5	1.5	4.8	0.9	2.7	0.5	0.6	3.9	0.8	1.2	3.9	1.4	0.8	0.79
Minimum (mG)	0.5	0.2	0.2	0.2	0.2	1.0	0.2	0.5	0.1	0.2	0.3	0.2	0.1	0.3	0.2	0.2	0.10
Maximum (mG)	59.7	9.1	45.0	1.2	5.4	20.6	3.1	10.2	2.0	3.2	14.5	2.9	4.1	11.7	5.3	3.3	2.70
Confidence Interval (95.0%)	4.4	0.6	6.7	0.7	0.5	2.8	0.3	0.7	0.3	0.2	1.6	0.3	0.4	1.9	0.7	0.4	0.41

Mean Magnetic Field 2 feet from Common Home Appliances Shown Also Their Upper Upper and Lower Limit for 95% CI



Common Home Appliances

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RA: Radio

CD: CD/DVD Player

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Descriptive Statistics	DB	RE	EO	WD	WM	BL	SF	TV	AL	RC	FR	CO	LS	AC	RA	CD	CF
Count	41.0	41.0	14.0	4.0	32.0	14.0	31.0	54.0	13.0	33.0	26.0	31.0	34.0	19.0	16.0	18.0	17.00
Mean (mG)	4.9	0.9	2.3	0.4	0.8	2.2	0.6	1.5	0.3	0.4	2.7	0.5	0.7	0.8	0.8	0.6	0.61
Median (mG)	1.3	0.6	1.2	0.3	0.6	2.1	0.3	1.0	0.1	0.3	3.2	0.4	0.3	0.4	0.9	0.5	0.30
Standard Deviation (mG)	7.3	0.8	3.5	0.3	0.7	1.5	0.7	1.5	0.3	0.4	2.1	0.4	0.8	1.0	0.6	0.6	0.56
Minimum (mG)	0.2	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.10
Maximum (mG)	33.2	3.2	13.8	0.8	3.2	6.3	2.5	5.5	1.2	1.4	7.8	1.5	2.9	3.4	2.3	2.3	1.90
Confidence Interval (95.0%)	2.3	0.3	2.0	0.5	0.3	0.9	0.2	0.4	0.2	0.1	0.8	0.2	0.3	0.5	0.3	0.3	0.29

EMF Exposure Standard

- Most countries adopt electric and magnetic field exposure limits as advised by the International Commission on Non-Ionizing Radiation Protection (ICNIRP).
- The World Health Organization (WHO) recommend the exposure limit set by ICNIRP (1998).
- For power frequency electric and magnetic fields, exposure limits for the general public are 5.0 kV/m and 1000 mG respectively and for occupational exposure the limits are 10 kV/m and 5000 mG.

EMF Exposure Standard (cont.)

- For overhead transmission lines it was found that
  - highest magnetic field was at 49.0 mG within the ROW and 28.0 mG at the edge of the ROW.
  - Highest electric field was 4.3 kV/m for 500 kV line and 2.2 kV/m for 275 kV line, while at the edge of ROW was 1.4 kV/m.
- For substations, highest magnetic field was at 128.0 mG, while for electric field it was at 5.1 kV/m.
- For general public EMF exposure these values were lower than the limits recommended by WHO.
- The 5.1 kV/m reading was measured inside the 500 kV substation. This value will decrease further when it goes beyond the substation compound.

Conclusions

- The concern of EMF adverse health effects not only people in Malaysia but worldwide.
- The World Health Organization (WHO) looks after the well-being of human-kind.
- For public exposure, WHO recommends the exposure limit of 5 kV/m for electric field and 1000mG for magnetic.
- From measurement results, the ground level electric and magnetic field from transmission lines and substations in Malaysia are below this limit.

Thank You