References List

[1]. Vladimir A. Rakov and Martin A. Uman, “Lightning Physics and Effects”, Cambridge: Cambridge University Press, 2003

[2]. A. Morched, B. Gustavsen, M. Tartibi, “A Universal Line Model for Accurate Calculation of Electromagnetic Transients on Overhead Lines and Cables”, Paper PE-112-PWRD-0-11-1997

[3]. J. Rohan Lucas, “High Voltage Engineering”, Revised edition 2001, Open University of Sri Lanka, Open University Press, 2001

[4]. K.S.S. Kumara, “Lightning Performance of Sri Lankan Transmission Lines: A Case Study”, M.Sc. thesis, University of Moratuwa, Katubedda, Sri Lanka, 2009

[5]. M. Kizilcay, C. Neumann, “Back Flashover Analysis for 110kV Lines at Multi-Circuit Overhead Line Towers”, International Conference on Power Systems Transients (IPST’07) in Lyon, France on June 4-7, 2007

[6]. Chisholm, W. A.; Chow, Y. L.; Srivastara, K.D: “Travel Time of Transmission Towers”, IEEE Trans. on Power App. And Systems, Vol. PAS-104, No. 10, S.2922-2928, October 1985

[7]. CIGRE WG 33-01: “Guide to Procedures for Estimating the Lightning Performance of Transmission Lines”, Technical Brochure, October 1991.

[8]. Manitoba HVDC Research Centre, “Applications of PSCAD/EMTDC”, Application Guide 2008, Manitoba HVDC Research Centre Inc., Canada

[9]. Modeling of power transmission lines for lightning back flashover analysis. A case study: 220kV Biyagama - Kotmale transmission line, M.Sc. thesis, University of Moratuwa, Katubedda, Sri Lanka, 2010.

[10]. Nor Hidayah Nor Hassan, Ab. Halim Abu Bakar, Hazlie Mokhlis1, Hazlee Azil Illias “Analysis of Arrester Energy for 132kV Overhead Transmission Line due to Back Flashover and Shielding Failure”, IEEE International

Conference on Power and Energy (PECon), 2-5 December 2012, Kota Kinabalu Sabah, Malysia

[11]. Toshiaki Ueda, Sadanori Neo, Toshihisa Funabashi, Toyohisa Hagiwara, Hideto Watanabe, "Flashover Model for Arcing Horns and Transmission Line Arresters", International Conference on Power Systems Transients (IPST'95) in Lisbon

[12]. Toshihisa Funabashi, Toyohisa Hagiwara, Nobutaka Takeuchi, Hideto Watanabe,Tatsunori Sato, Toshiaki Ueda, Laurent Dube"Flashover Modeling of Arcing Horns Using MODELS Simuation Language", International Conference on Power Systems Transients (IPST'97) in Seatle

[13]. Juan A. Martinez-Velasco, Ferley Castro-Aranda, "Modeling of Overhead Transmission Lines for Lightning Studies" International Conference on Power Systems Transients (IPST'05) in Montreal, Canada, Paper No. IPST05 – 047

[14]. A.H.A. Bakar, D.N.A. Talib, H. Mokhlis, H.A. Illias, "Lightning back flashover double circuit tripping pattern of 132 kV lines in Malaysia"

[15]. Nur Zawani, Junainah, Imran, Mohd Faizuhar, "Modelling of 132kV Overhead Transmission Lines by Using ATP/ EMTP for Shielding Failure Pattern Recognition", Malaysian Technical Universities Conference on Engineering & Technology 2012, MUCET 2012, Part 1- Electronic and Electrical Engineering

[16]. B. Marungsri, S. Boonpoke, A. Rawangpai, A. Oonsivilai, and C. Kritayakornupong, "Study of Tower Grounding Resistance Effected Back Flashover to 500 kV Transmission Line in Thailand by using ATP/EMTP", World Academy of Science, Engineering and Technology nternational Journal of Electrical, Computer, Energetic, Electronic and Communication Engineering Vol:2, No:6, 2008

[17]. Igor Gutman, Georgij Porporkin, "Comparative performance of conventional 220 kV insulator strings and multi-chamber insulator-arresters strings under specific ice conditions of Russia", The 14th International Workshop on Atmospheric Icing of Structures, Chongqing, China, May 8 - May 13, 2011

[18]. G. V. Podporkin, E. Yu. Enkin, E. S. Kalakutsky, V. E. Pilshikov and A. D. Sivaev "Lightning Protection of Overhead Lines Rated At 3-35 kV And Above With the Help of Multi-Chamber Arresters and Insulator-Arresters", X International Symposium on Lightning Protection 9th-13th November, 2009 – Curitiba, Brazil

[19]. Podporkin G. V, "Development of Long Flashover and Multi-Chamber Arresters and Insulator-Arresters for Lightning Protection of Overhead Distribution and Transmission Lines", Plasma Physics and Technology 2015, 2, 3, 241-250

[20]. G. V. Podporkin, E. Yu. Enkin, E. S. Kalakutsky, V. E. Pilshikov and A. D. Sivaev, "Development of Multi-Chamber Insulator-Arresters for Lightning Protection of 220 kV Overhead Transmission Lines", 2011 International Symposium on Lightning Protection (XI SIPDA), Fortaleza, Brazil, October 3-7, 2011

[21]. G. V. Podporkin, E. Yu. Enkin, V. E. Pilshikov, "Lightning Protection Overhead Distribution and Transmission lines by Multi Chamber Arrester and Multi Chamber Insulators Arresters of a Novel Design", INMR World Congress, September 9-12, Vancouver, Canada

[22]. Multi-Chamber Arresters And Insulator-Arresters for lightning protection of overhead distribution and transmission lines Power Point Presentation of the Streamer Company Website (www.streamer-electric.com)

[23]. Georgij V. Podporkin, Evgeniy Yu Enkin, Evgeniy S. Kalakutsky, Vladimir E. Pilshikov, and Alexander D. Sivaev "Overhead Lines Lightning Protection by Multi-Chamber Arresters and Insulator-Arresters" IEEE TRANSACTIONS ON POWER DELIVERY, VOL. 26, NO. 1, JANUARY 2011

[24]. Gi-ichi Ikeda, "Report on Lightning Conditions in Ceylon, and Measures to Reduce Damage to Electrical Equipment", Asian Productivity Project TES/68, 1969

[25]. Operating Manual, SiG.110.Z, Streamer International AG, (www.streamer-electric.com)

[26]. Georgij V. Podporkin, Alexander D. Sivaev, “Lightning Protection Overhead Distribution Lines by Long Flashover Arresters”, IEEE Transaction on Power Delivery, Vol 13, No.03, pp 814-823, (July 1998)

[27]. Technical Data of 115kV & 150kV strings of Smart Insulators

[28]. Matthieu ZINCK, “Multi-Chamber Arrester Field Test Experience in Asia High Lightning Density Area”, 2015 Asia-Pacific International Conference on Lightning (APL), Nagoya, Japan

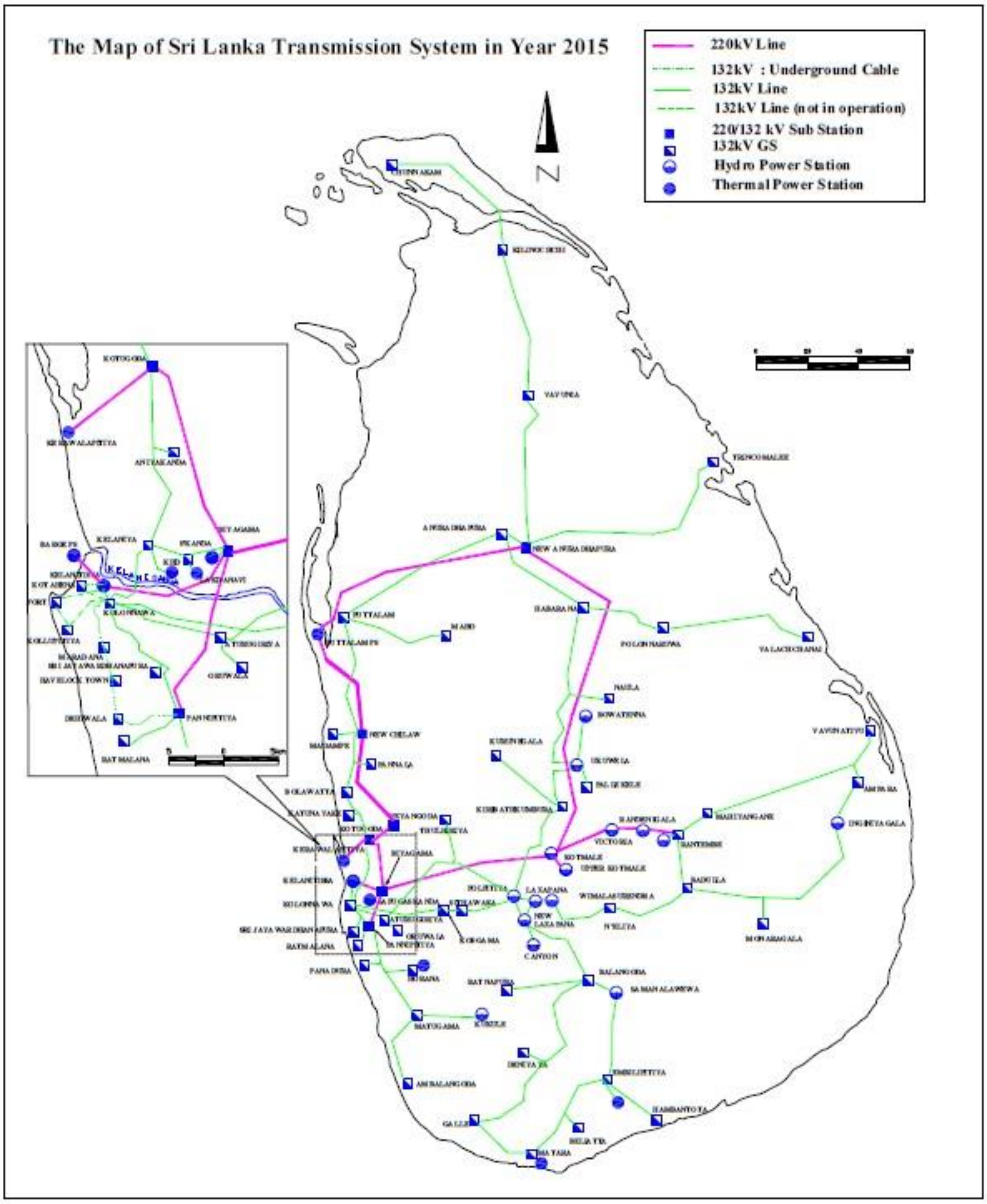
[29]. EPRI, “Handbook for Improving Overhead Transmission Line Lightning Performance”, EPRI, Palo Alto, CA: 2004. 1002019

[30]. External Evaluator Report from the Hajime Sonoda (Global Group 21 Japan) done on year 2007 for Kukule Ganga Hydroelectric Power Project

[31]. Statistical Digest 2014, Ceylon Electricity Board of Sri Lanka

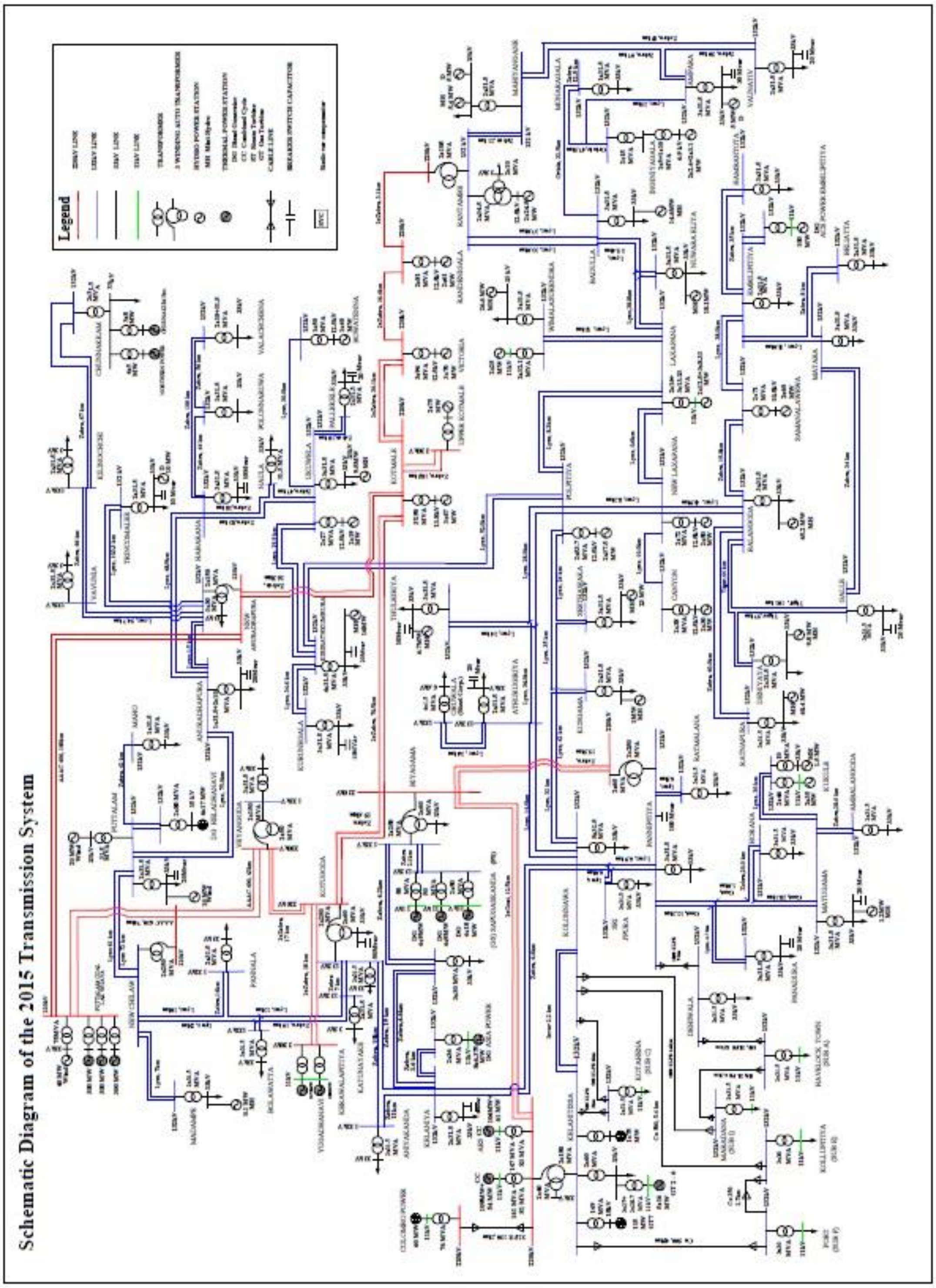
Appendix-01

Present Transmission System of Sri Lanka



Appendix-02

Transmission System of Sri Lanka (Single Line Diagram)



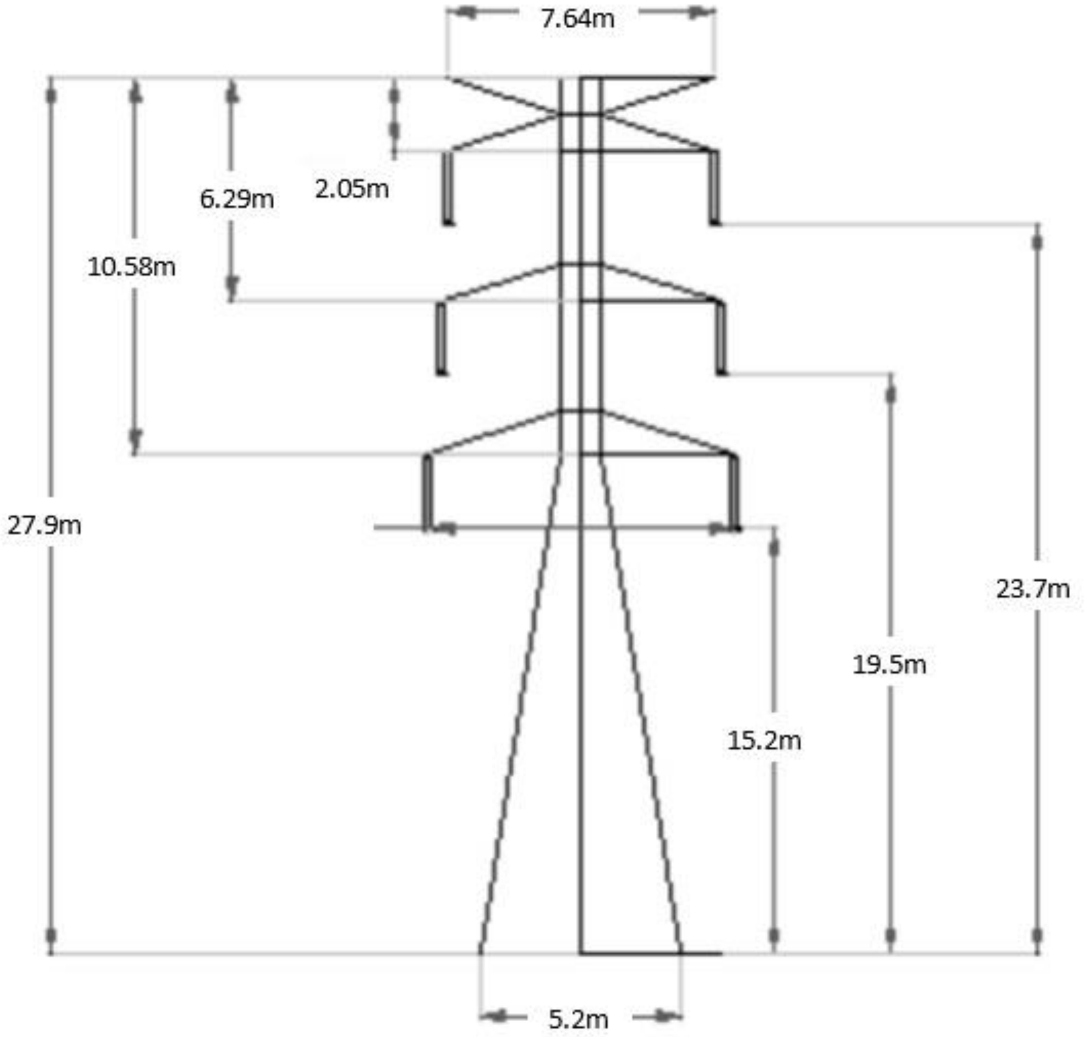
Appendix-03

Mathugama-Kukule, 132kV Transmission Line Parameters

No.	**Line parameters' description**	**Value**	**Unit**
1	Voltage	132	kV
2	Steady state Frequency	50	Hz
3	Line/Span length	As per the tower schedule (Appendix 5)	Km
4	Line shunt conductance	1x10-11	mΩ/m
5	No. of circuits	02	Nos.
6	Conductor Type/Name	ACSR "LYNX"	
7	Conductor size	226.2	mm^2
8	Conductor radius	0.009765	m
9	Conductor DC resistance	0.1576	Ω/km
10	Sag of all phase conductors	5.59	m
11	No. of sub conductors per phase	01	Nos.
12	No. of Earth wires	02	Nos.
13	Earth wire-1 Type/Name	GSW 7/3.25	
14	Earth wire-1 size	58.07	mm2
15	Earth wire-1 radius	0.004875	m
16	Earth wire-1 DC resistance	3.297	Ω/km
17	Earth wire-2 Type/Name	OPGW	
18	Earth wire-2 size	81.1	mm2
19	Earth wire-2 radius	0.006	m
20	Earth wire-2 DC resistance	0.519	Ω/km
21	Sag of Earth wire	4.09	m
22	Ground resistivity	1000	Ωm
23	Relative ground permeability	1.0	
24	Ideally Transposed Line	No.	

Appendix-04

Typical Transmission Tower



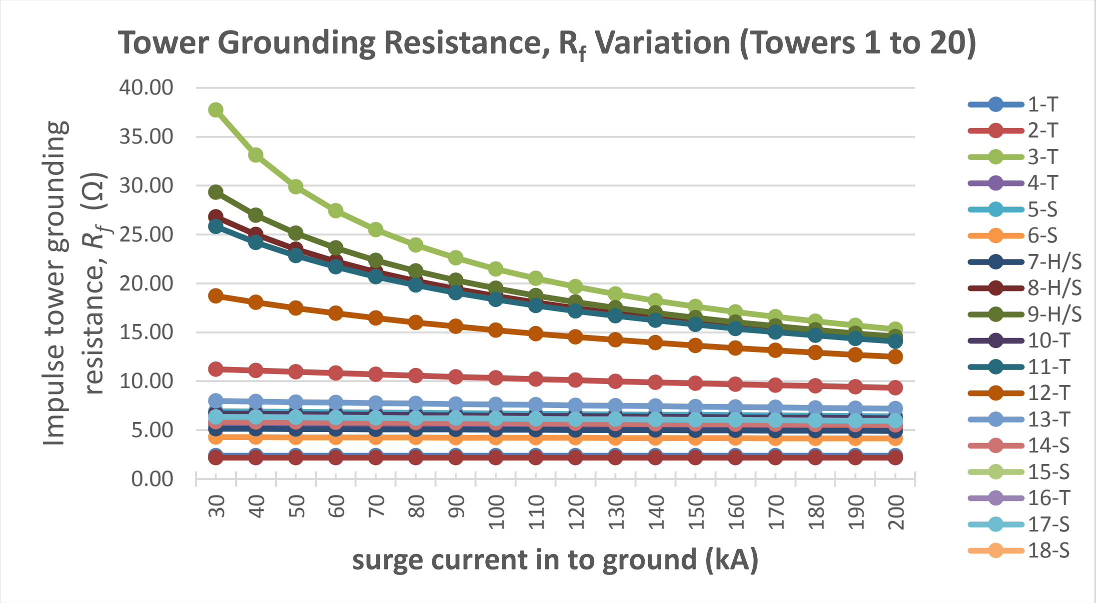
Appendix-05

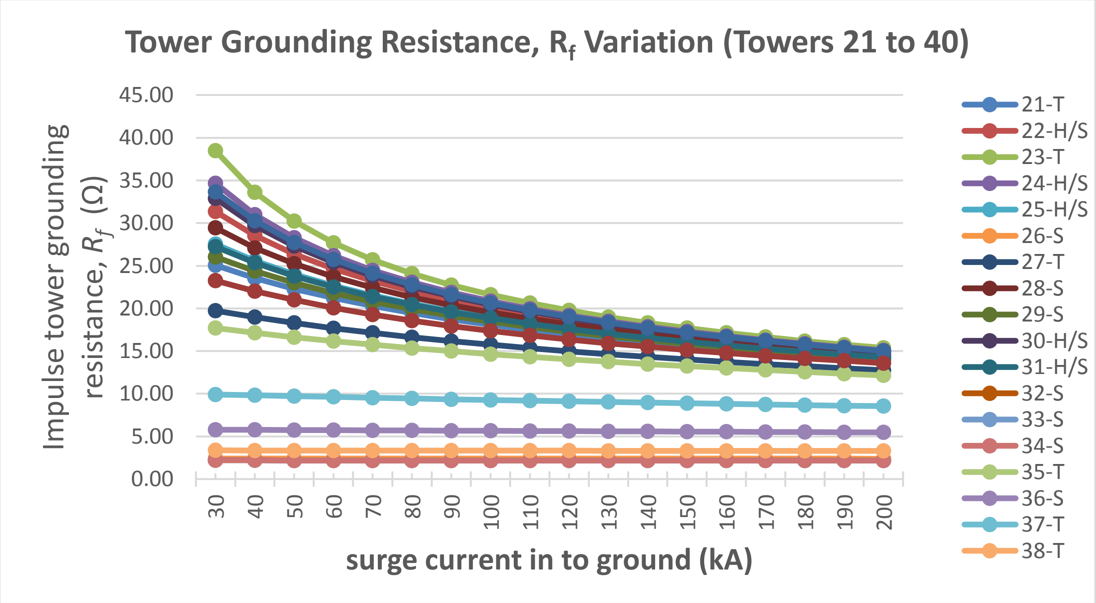
Tower Schedule

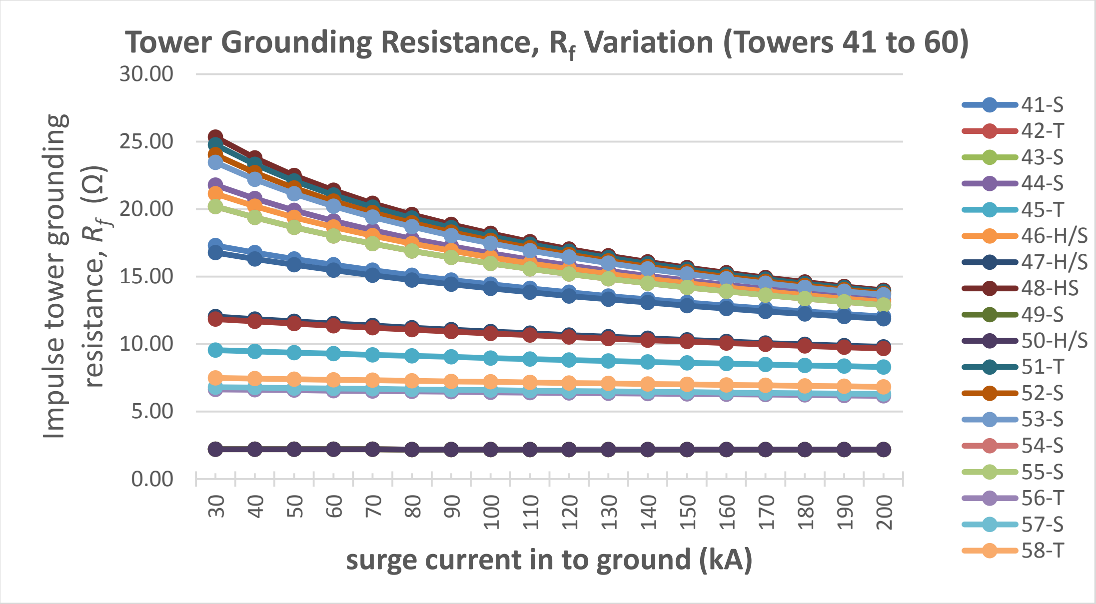
Tower Number	Span (m)	Tower	
		Type	Body Ext
Gantry	103.16		
1	164.47	KMDT	0
2	152.45	KMD1	12
3	449.63	KMD3	12
4	439.39	KMD1	12
5	283.51	KMDL	0
6	392.42	KMDL	3
7	513.07	KMD1	12
8	610.77	KMD1	12
9	506.71	KMD1	12
10	244.24	KMD1	0
11	259.78	KMD3	0
12	334.60	KMD3	12
13	194.59	KMD1	12
14	306.09	KMDL	12
15	233.31	KMDL	12
16	284.89	KMD3	12
17	241.51	KMDL	9
18	256.72	KMDL	3
19	306.51	KMDL	9
20	563.00	KMD3	6
21	543.29	KMD1	0
22	468.59	KMD1	12
23	496.04	KMD3	0
24	642.45	KMD1	12
25	322.96	KMD1	0
26	372.77	KMDL	12
27	278.81	KMD3	9
28	199.77	KMDL	6
29	428.02	KMDL	0
30	368.73	KMD1	6
31	376.98	KMD1	6
32	212.93	KMDL	6
33	278.95	KMDL	0
34	268.50	KMDL	6
35	230.99	KMD3	3
36	309.44	KMDL	9
37	354.23	KMDL	12
38	244.67	KMD3	9
39	348.39	KMD1	0
40	381.17	KMDL	0
41	395.26	KMD1	9
42	289.47	KMD3	9
43	216.95	KMDL	0
44	169.36	KMDL	0
45	455.21	KMD1	12
46	420.26	KMD1	0
47	568.47	KMD1	0
48	620.54	KMD1	0
49	525.74	KMD1	0
50	507.65	KMD1	12
51	200.18	KMD1	6
52	265.07	KMDL	6
53	158.30	KMDL	6
54	172.01	KMDL	0
55	418.90	KMD1	6
56	267.00	KMD1	6
57	391.51	KMDL	3
58	366.21	KMD1	6
59	207.96	KMDL	6
60	469.12	KMD1	6
61	431.79	KMD1	12
62	291.02	KMDL	0
63	403.26	KMD1	0
64	427.34	KMD1	12
65	413.93	KMD1	12
66	864.50	KMD1	3
67	166.69	KMD1	3
68	380.50	KMDL	0
69	250.49	KMD3	0
70	166.24	KMDL	0
71	305.26	KMD1	9
72	417.09	KMDL	12
73	255.06	KMDL	6
74	250.88	KMDL	6
75	530.40	KMD1	0
76	218.93	KMD1	0
77	221.72	KMD1	6
78	428.83	KMD1	3
79	50.00	KMDT	0
Gantry			

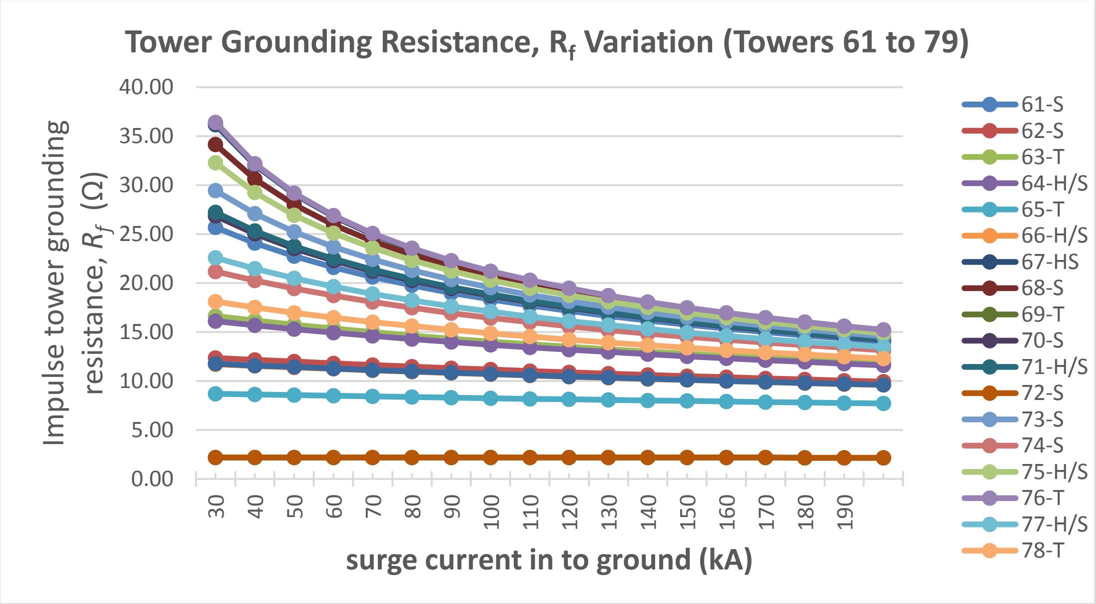
Appendix-06

Grounding Resistance Variation of Towers due to soil ionization effect






Tower Grounding Resistance, R_f Variation (Towers 41 to 60)
Impulse tower grounding resistance, R_f (Ω)
surge current in to ground (kA)
0.00
5.00
10.00
15.00
20.00
25.00
30.00
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
41-S
42-T
43-S
44-S
45-T
46-H/S
47-H/S
48-HS
49-S
50-H/S
51-T
52-S
53-S
54-S
55-S
56-T
57-S
58-T

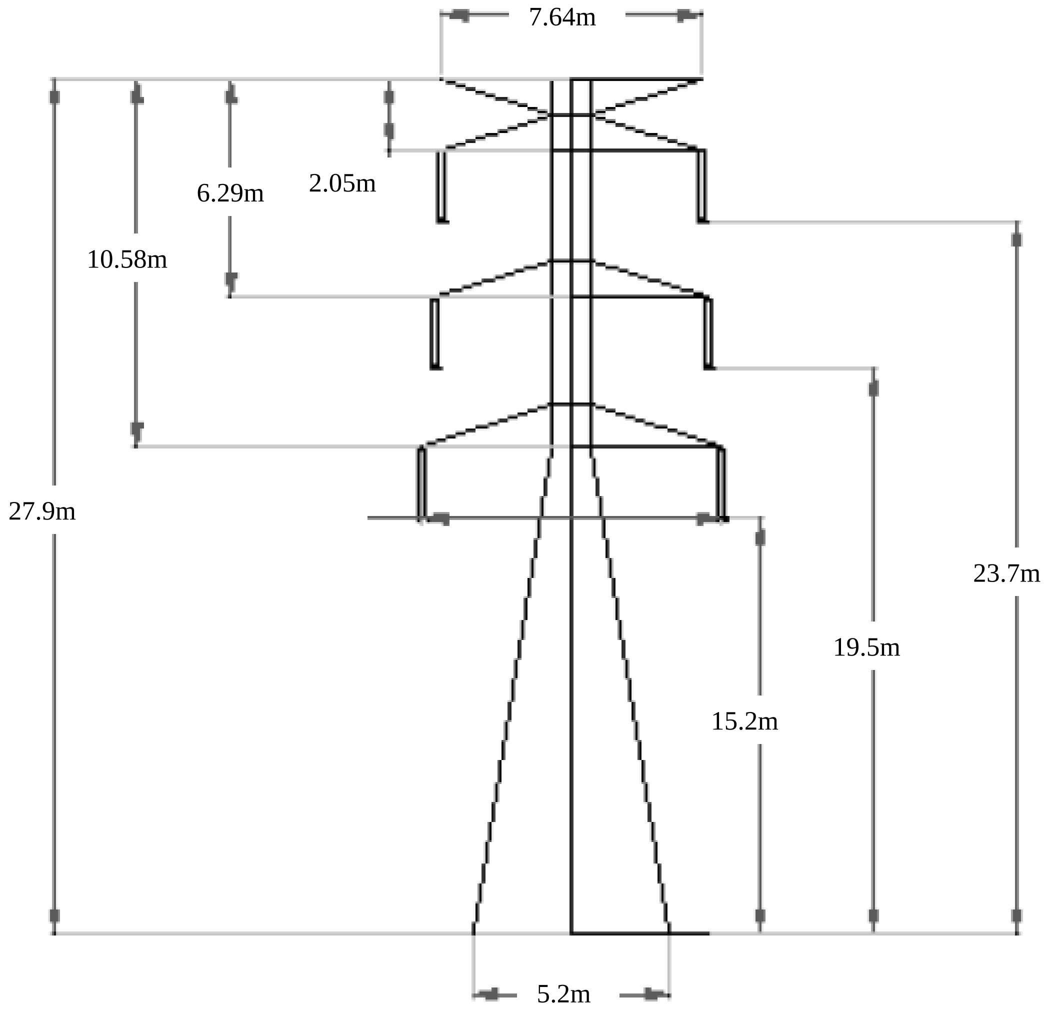

Tower Grounding Resistance, R_f Variation (Towers 61 to 79)
Impulse tower grounding resistance, R_f (Ω)
surge current in to ground (kA)
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
61-S
62-S
63-T
64-H/S
65-T
66-H/S
67-HS
68-S
69-T
70-S
71-H/S
72-S
73-S
74-S
75-H/S
76-T
77-H/S
78-T

Appendix-07

Calculations of Tower Surge Impedance [4]

1. **Steps and Equations used for finding effective self-surge impedance of the conductor**

Step 1: Drawing of the tower



Step 2: Establishing the isokeraunic level

Isokeraunic level of the transmission line is selected for the calculations from below map.

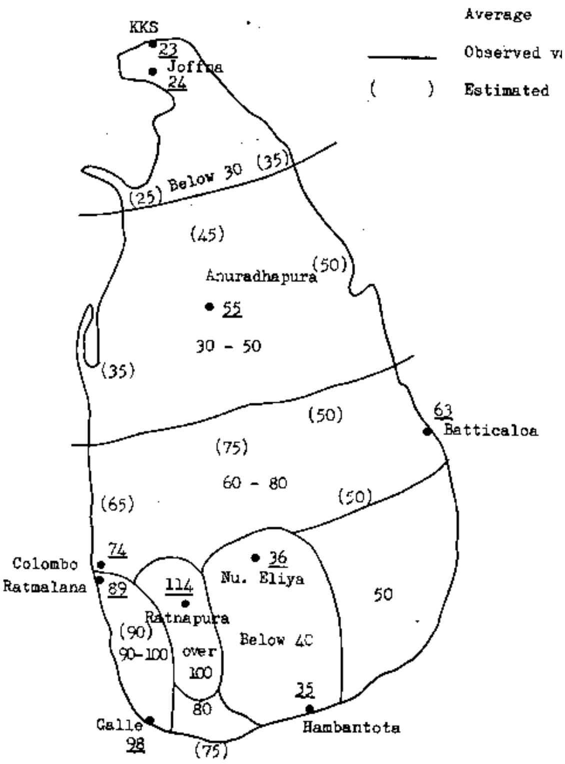


Figure A7.1 - IKL map of Sri Lanka

Mathugama-Kukule, 132kV transmission line is traversed through the Rathnapura and Colombo districts and when considering these two areas, the lowest isokauranic level is selected for the calculations.

Therefore, IKL = 89

Step 3: Computation of strokes to earth per square kilometer per year

$$N = 0.12T \tag{A7-1}$$

where

N	Number of flashes to earth per square kilometer per year
T	Thunder days or IKL

$$N = 0.12\ x\ 89 = \mathbf{10.68}$$

Step 4: Computation of mean shield wire height

Since the conductor sags at the middle, a mean value is calculated

$$\hat{h} = h_s - sag \times \frac{2}{3} \tag{A7-2}$$

where

ĥ	Mean shield wire height
h_s	Height of the shield wire
sag	Sag of the shield wire

$$\hat{h} = 27.9 - 5.59 \times \frac{2}{3} = \mathbf{23.63\ m}$$

Step 5: Calculation of total number of flashes to the line

The following equation is from Whitehead,

$$N_1 = 0.012T\left(b + 4\hat{h}^{1.09}\right) \tag{A7-3}$$

where

N_1	Number of flashes to the line per 100km per year
T	Thunder days or IKL
b	Distance between parallel shield wires
ĥ	Average height of the Shield wire from Step 4

T = 89

b = 7.64 m

ĥ = 23.63 m

$$N_1 = 0.012\ x\ 89(7.64 + 4x23.63^{1.09})$$
$$= \mathbf{142.35}\ (Flashes\ per\ year\ per\ 100km)$$

Step 6: Flashover voltage of the most exposed insulator string at 6μs

From Darveniza, Popolansky and Whitehead,

$$V = K_1 + \frac{K_2}{t^{0.75}} \tag{A7-4}$$

where

V	Flashover voltage of the most exposed insulator string at 6μs. Since the air gaps of all the insulators are the same, the same voltage applies.
h_s	Height of the shield wire,
A_g	arching horn air gap
K_1 = 0.4 x Ag	Constant
K_2 = 0.71 x Ag	Constant
t = tt = 6μs	Duration

A_g = 1.5 m

K_1 = 0.4 x 1,5 = 0.6

K_2 = 0.71 x 1.5 = 1.065

$$\boldsymbol{V = 878kV}$$

Step 7: Computation of mean height of the top phase conductors

$$\hat{h}_{\Phi} = h_{\Phi} - sag \times \frac{2}{3} \tag{A7-5}$$

where

$\hat{h}_\varphi$	Mean of phase conductor height
h_φ	Height of the top phase wire,
Sag	Sag of the phase wire

h_φ = 23.74 m

Sag = 7.09 m

$$\boldsymbol{\hat{h}_{\Phi} = 19.01\ m}$$

Step 8: Single conductor corona radius

$$R\ln\frac{2\hat{h}_{\Phi}}{R} = \frac{V}{E_o} \tag{A7-6}$$

where

R	Single conductor corona radius using iterative techniques
$\hat{h}_{\varphi}$	Average height of the top phase conductor from step 7
E_o = 1500kV/m	Corona inception voltage gradient
V	Flashover voltage of the most exposed insulator string at 6μs from step 6

$\hat{h}_{\Phi} = 19.01$ m

V = 878kV

R = 0.098m

Step 9: Equivalent single conductor radius of the phase conductor

$$\boldsymbol{R_{eq} = 0.009765m}$$

Step 10: Approximate corona radius of the phase conductor

$$R_c = R_{eq} + R \tag{A7-7}$$

where

R_c	Approximate Corona radius of the phase conductor
R	Single conductor corona radius from step 8
R_{eq}	Equivalent single conductor radius of the phase conductor from step 9

$$\boldsymbol{R_c = 0.108m}$$

Step 11: Effective self surge impedance of the conductors Z_o

$$Z_{\phi} = 60\sqrt{\ln\frac{2\hat{h}_{\Phi}}{R_{eq}} \times \ln\frac{2\hat{h}_{\Phi}}{R_c}} \tag{A7-8}$$

where

Z_{φ}	Effective self surge impedance of the conductor
R_c	Approximate corona radius of the phase conductor step 10

$\hat{h}_{\varphi}$	Average height of the top phase conductor from step 7
R_{eq}	Equivalent single conductor radius of the phase conductor from step 9

$\hat{h}_{\varphi} = 19.01$ m

$R_{eq} = 0.009765\mathrm{m}$

$R_c = 0.108\mathrm{m}$

$\underline{\underline{\boldsymbol{Z_{\phi} = 417.7\ \Omega}}}$

2. Steps and Equations used for finding effective self-surge impedance of the earth wire

Step 1: Flashover voltage of the insulator string at 2μs

From Darveniza, Popolansky and Whitehead,

$$V_2 = K_1 + \frac{K_2}{t^{0.75}} \qquad \text{(A7-9)}$$

where

V_2	Flashover voltage of the insulator string at 2μs
h_s	Height of the shield wire
Ag	Insulator string air gap
$K_1 = 0.4 \times Ag$	Constant
$K_2 = 0.71 \times Ag$	Constant
t = tt = 2μs	Rise time of wave front

$h_s = 27.90$ m

Ag = 1.5 m

$K_1 = 0.4 \times 1.5 = 0.6$

$K_2 = 0.71 \times 1.5 = 1.065$

$V_2 = 1233.3$ kV

Step 2: Flashover voltage of the most exposed insulator string at 6μs

From Darveniza, Popolansky and Whitehead,

$$V_6 = K_1 + \frac{K_2}{t^{0.75}} \qquad \text{(A7-10)}$$

where

V_6	Flashover voltage of the insulator string at 6μs Since the air gaps of all the insulators are the same, the same voltage applies.
h_s	Height of the shield wire,
A_g	Insulator string air gap
$K_1 = 0.4 \times Ag$	Constant
$K_2 = 0.71 \times Ag$	Constant
t = tt = 6μs	Insulator string air gap

$K_1 = 0.6$

$K_2 = 1.065$

$h_s = 27.90$ m

V_6 = 877.8 Kv

Step 3: Estimate of tower top voltage and average for all phases (kV)

Tower Top voltage = V_2 x 1.8 = **2219.9 kV**

From Transmission Line Reference Book,

Step 4: Shield wire corona diameter at tower height

$$R \ln\frac{2h_s}{R} = \frac{V}{E_o} \qquad \text{(A7-11)}$$

where

R Single conductor corona radius using iterative techniques

h_s Height of the top shield wire

E_o = 1500kV/m Corona inception voltage Gradient

V Estimated tower top voltage from step 3

Rc = 0.279m

Step 5: Self surge impedance of each shield wire at tower

$$Z_{sh} = 60\sqrt{\ln\frac{2h_s}{R_s} \times \ln\frac{2h_s}{R_c}} \qquad \text{(A7-12)}$$

where

Z_{sh} Effective self surge impedance of each shield wire at tower

R_c Approximate corona radius of the shield wire, step 4

h_s Height of the top shield wire

R_s Conductor radius of the shield wire

$h_s = 27.90$ m

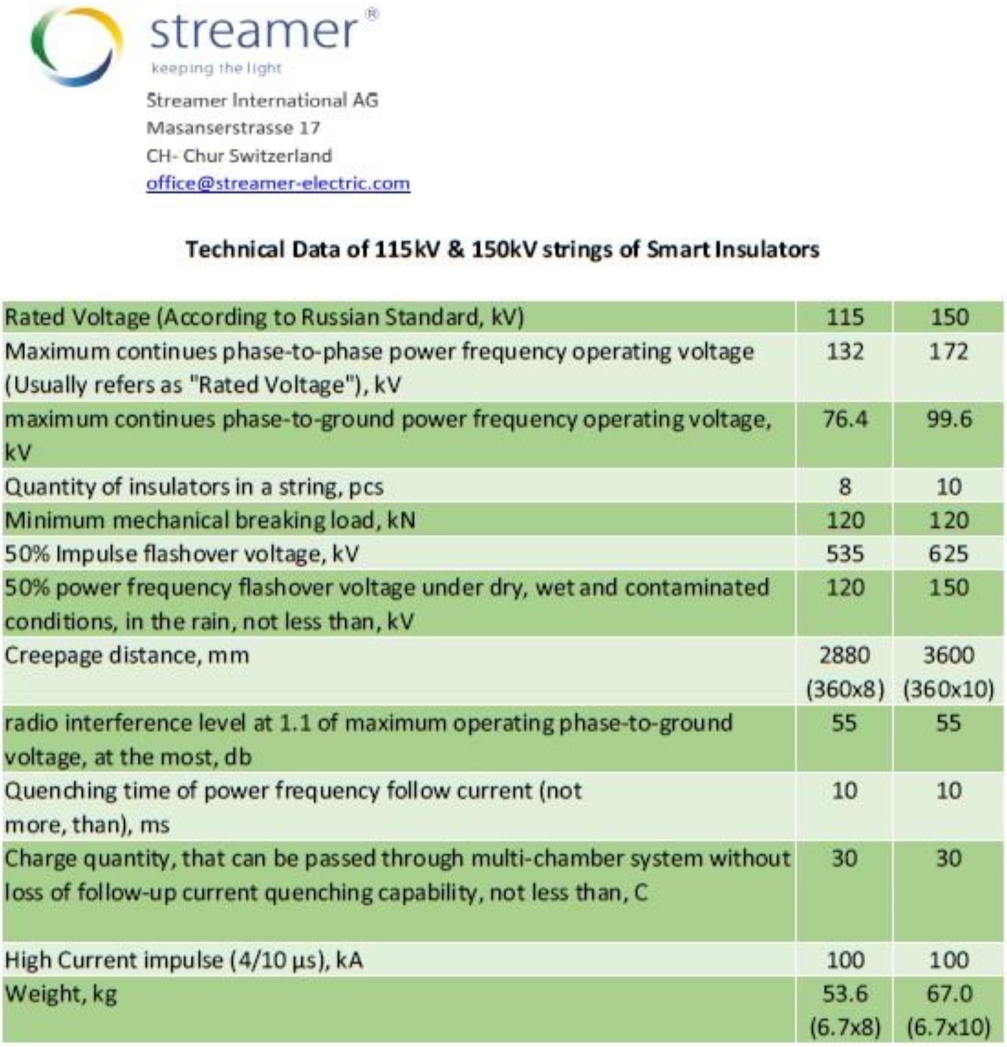
Rs = 0.004875 m

Rc = 0.279m

$\underline{\underline{\boldsymbol{Z_{sh} = 422.2\Omega}}}$

Appendix - 08

Technical Data for MCIA String



streamer®
keeping the light

Streamer International AG
Masanserstrasse 17
CH- Chur Switzerland
office@streamer-electric.com

Technical Data of 115kV & 150kV strings of Smart Insulators

Rated Voltage (According to Russian Standard, kV)	115	150
Maximum continues phase-to-phase power frequency operating voltage (Usually refers as "Rated Voltage"), kV	132	172
maximum continues phase-to-ground power frequency operating voltage, kV	76.4	99.6
Quantity of insulators in a string, pcs	8	10
Minimum mechanical breaking load, kN	120	120
50% Impulse flashover voltage, kV	535	625
50% power frequency flashover voltage under dry, wet and contaminated conditions, in the rain, not less than, kV	120	150
Creepage distance, mm	2880 (360x8)	3600 (360x10)
radio interference level at 1.1 of maximum operating phase-to-ground voltage, at the most, db	55	55
Quenching time of power frequency follow current (not more, than), ms	10	10
Charge quantity, that can be passed through multi-chamber system without loss of follow-up current quenching capability, not less than, C	30	30
High Current impulse (4/10 µs), kA	100	100
Weight, kg	53.6 (6.7x8)	67.0 (6.7x10)

Appendix - 09

Simulation Results

Step-1, Simulation No. 02

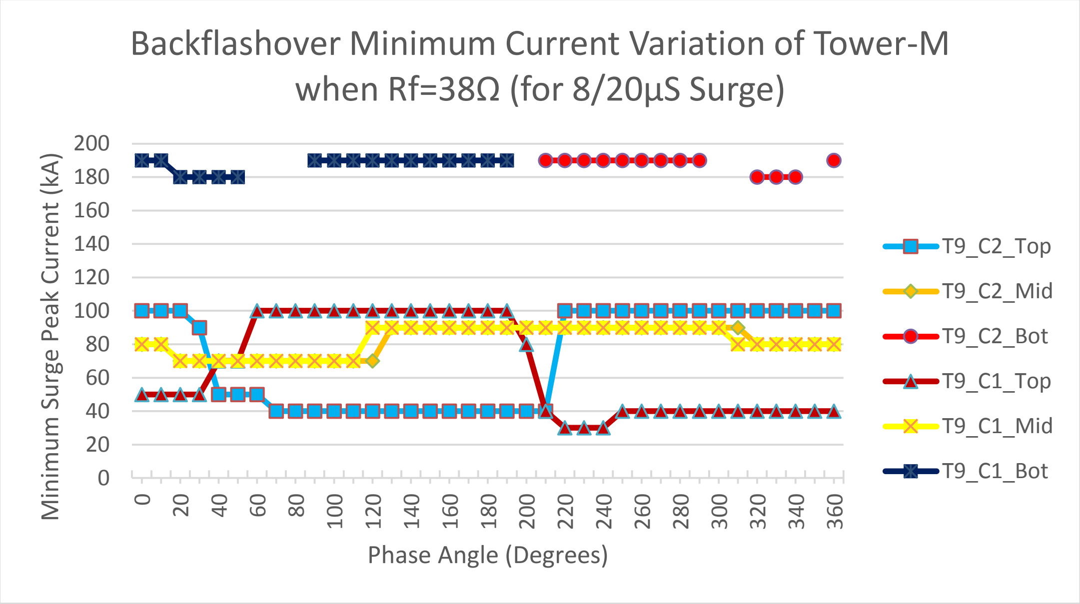


Figure A9.1 – Simulation results with no MCIA protection for 8/20µS Surge for the ground resistance of 38Ω

Step-1, Simulation No. 03

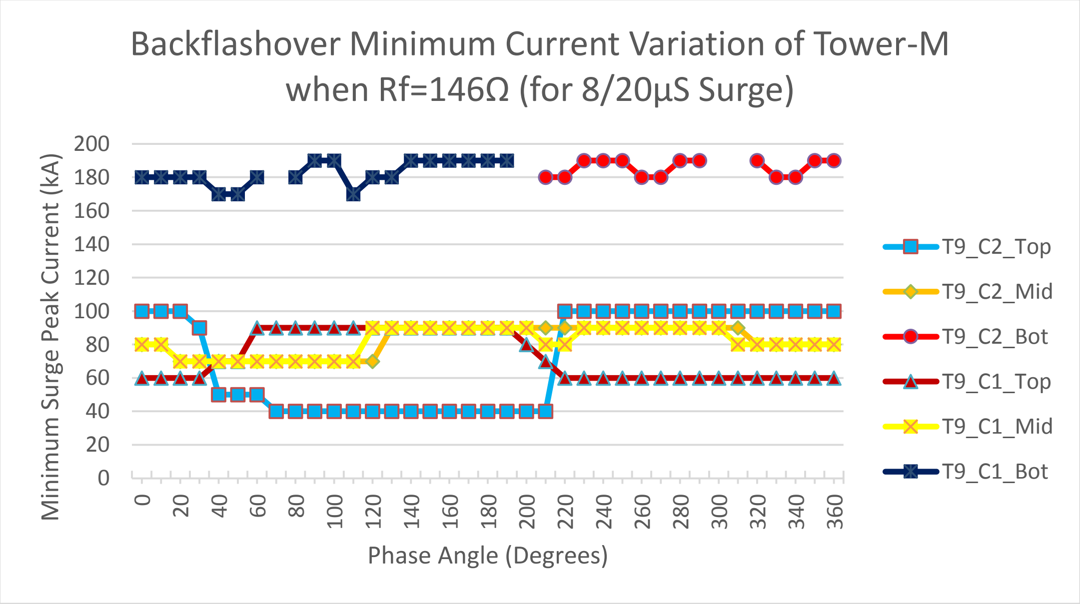


Figure A9.2 – Simulation results with no MCIA protection for 8/20µS Surge for the ground resistance of 146Ω

Step-1, Simulation No. 05

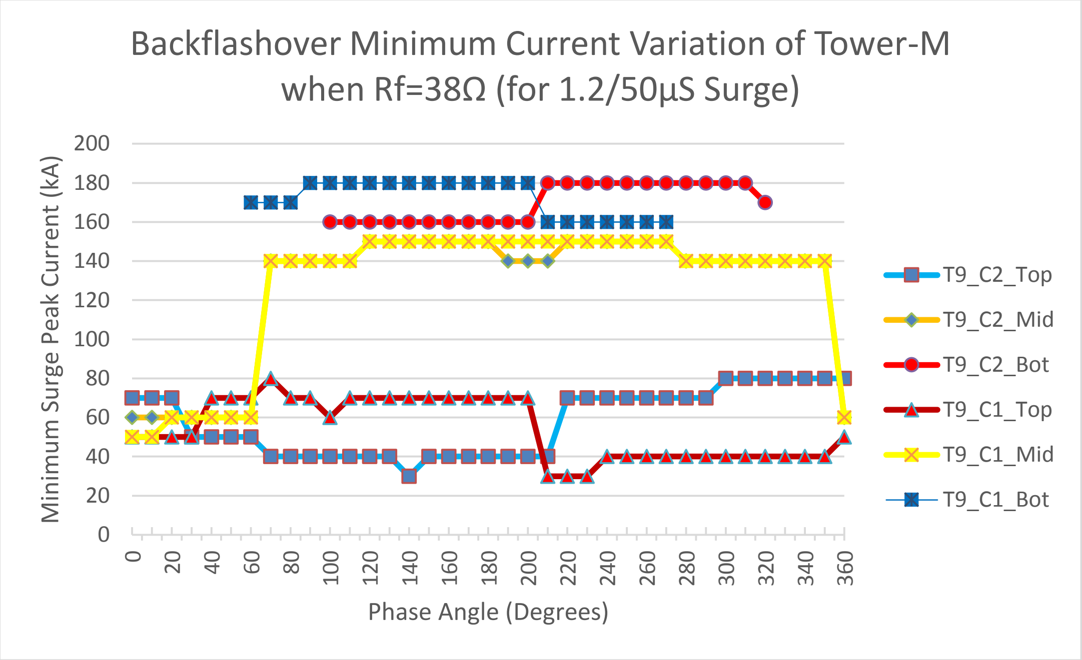


Figure A9.3 – Simulation results with no MCIA protection for 1.2/50µS Surge for the ground resistance of 38Ω

Step-1, Simulation No. 06

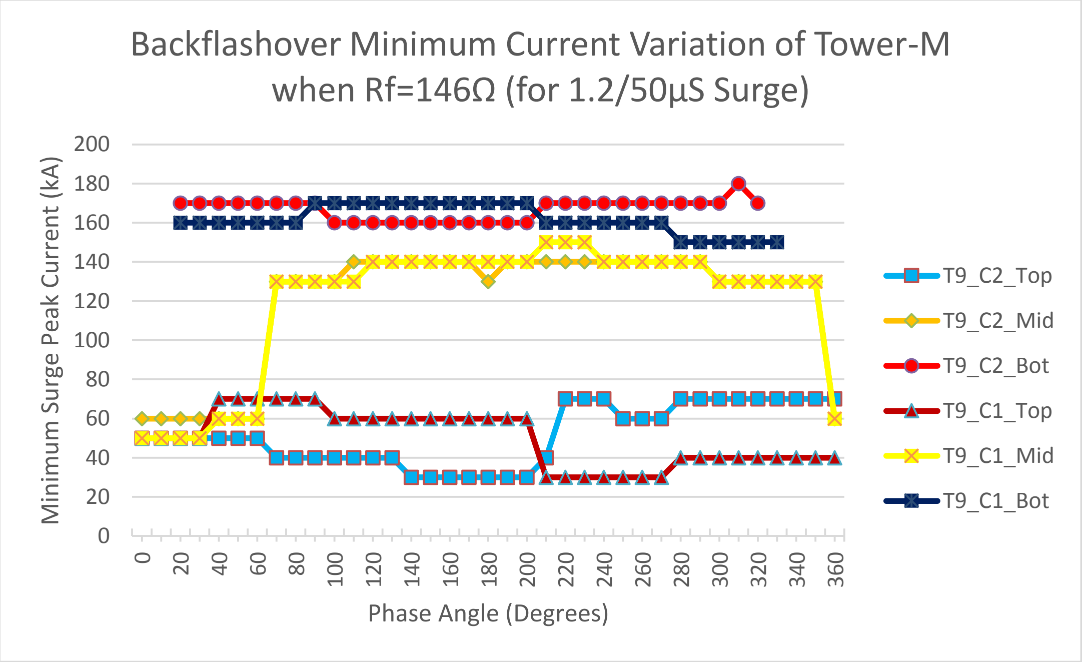


Figure A9.4 – Simulation results with no MCIA protection for 1.2/50µS Surge for the ground resistance of 146Ω

Step-2, Simulation No. 08

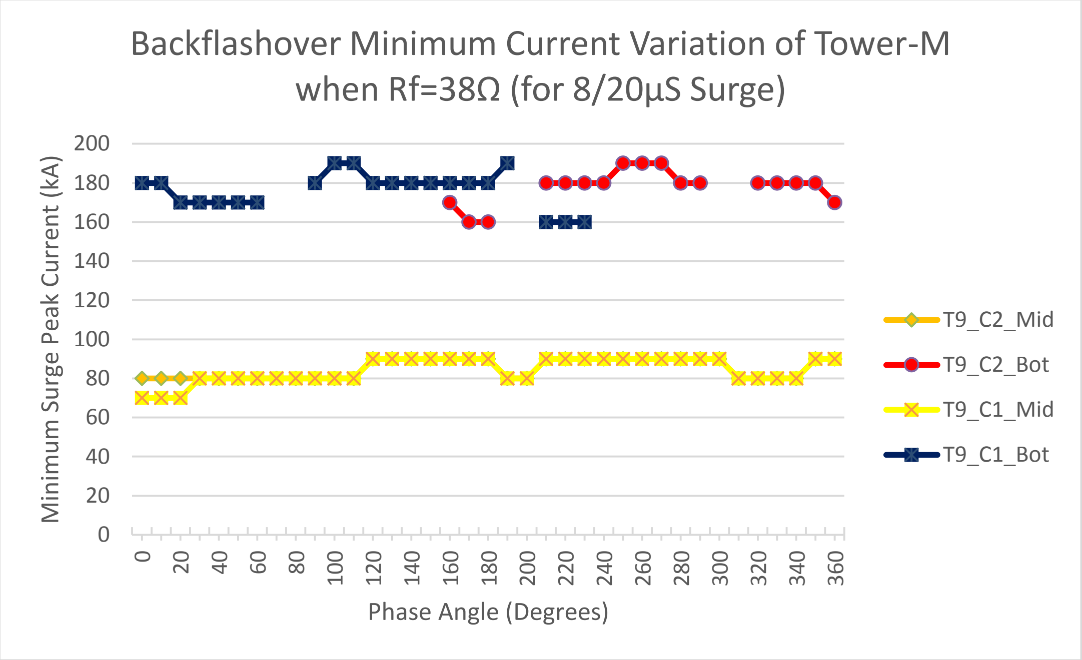


Figure A9.5– Simulation results with Two MCIA protection on TOP phases for 8/20µS Surge for the ground resistance of 38Ω

Step-2, Simulation No. 09

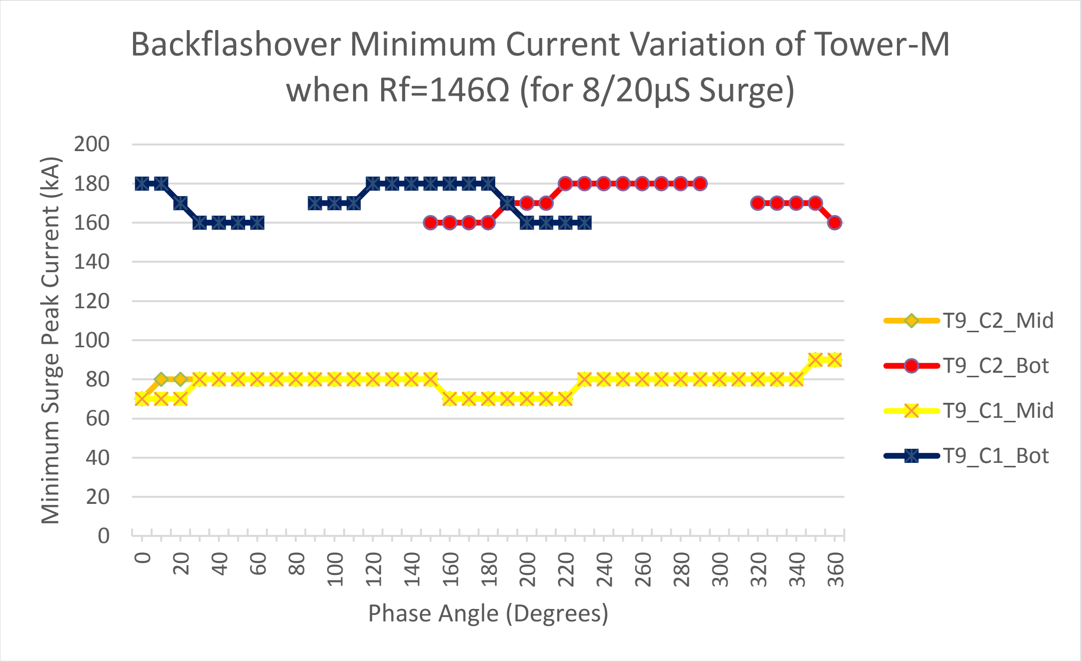


Figure A9.6– Simulation results with Two MCIA protection on TOP phases for 8/20µS Surge for the ground resistance of 146Ω

Step-2, Simulation No. 11

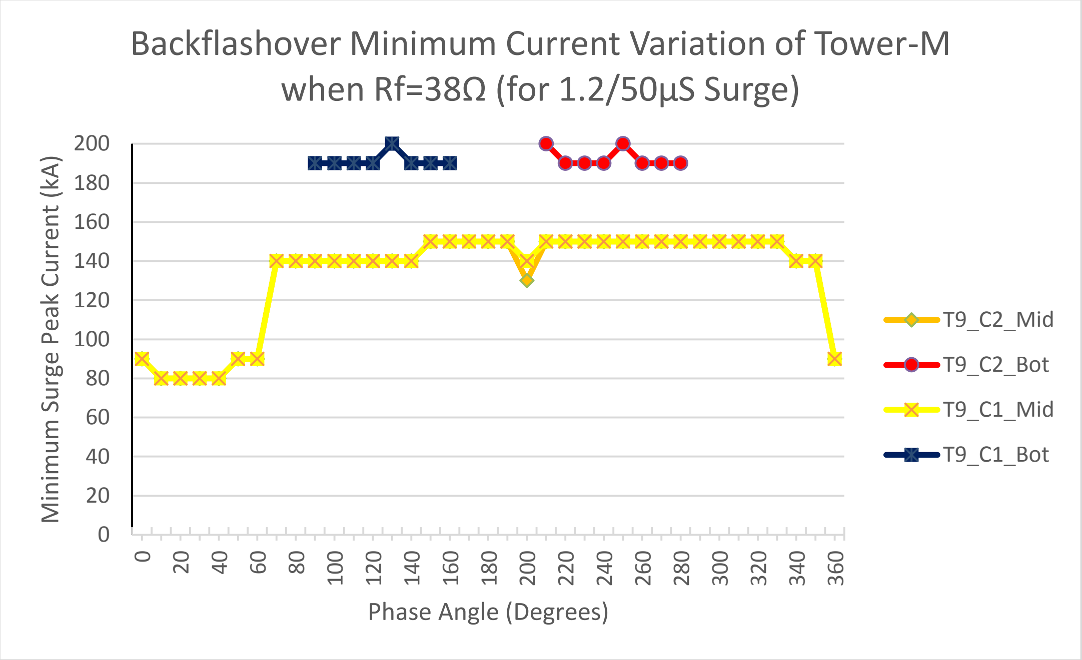


Figure A9.7– Simulation results with Two MCIA protection on TOP phases for 1.2/50µS Surge for the ground resistance of 38Ω

Step-2, Simulation No. 12

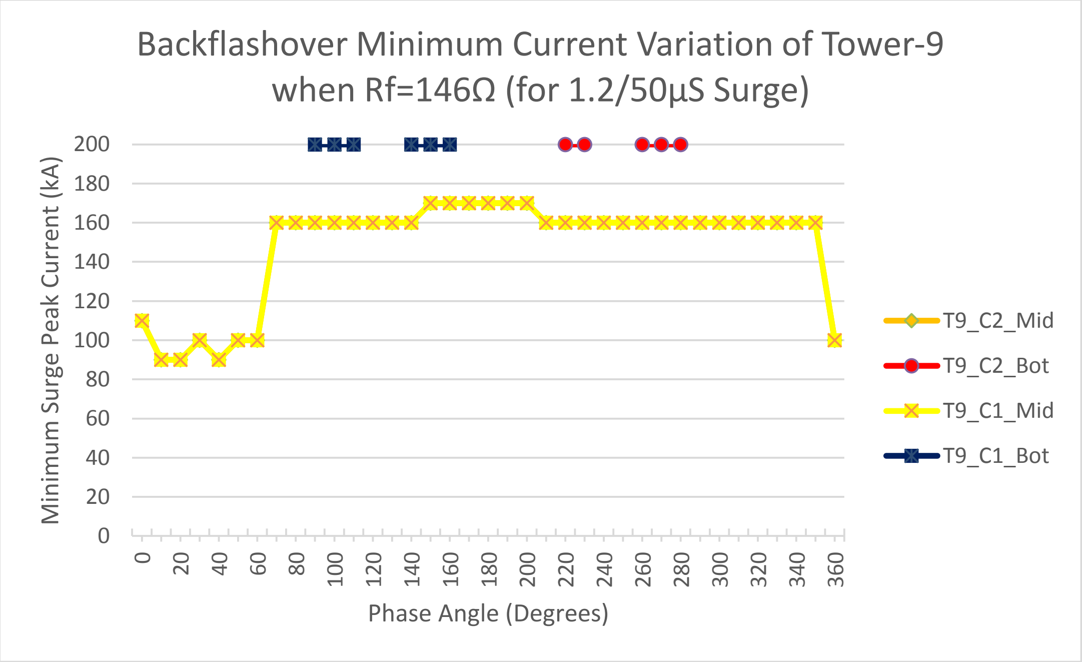


Figure A9.8– Simulation results with Two MCIA protection on TOP phases for 1.2/50µS Surge for the ground resistance of 146Ω

Step-2, Simulation No. 14

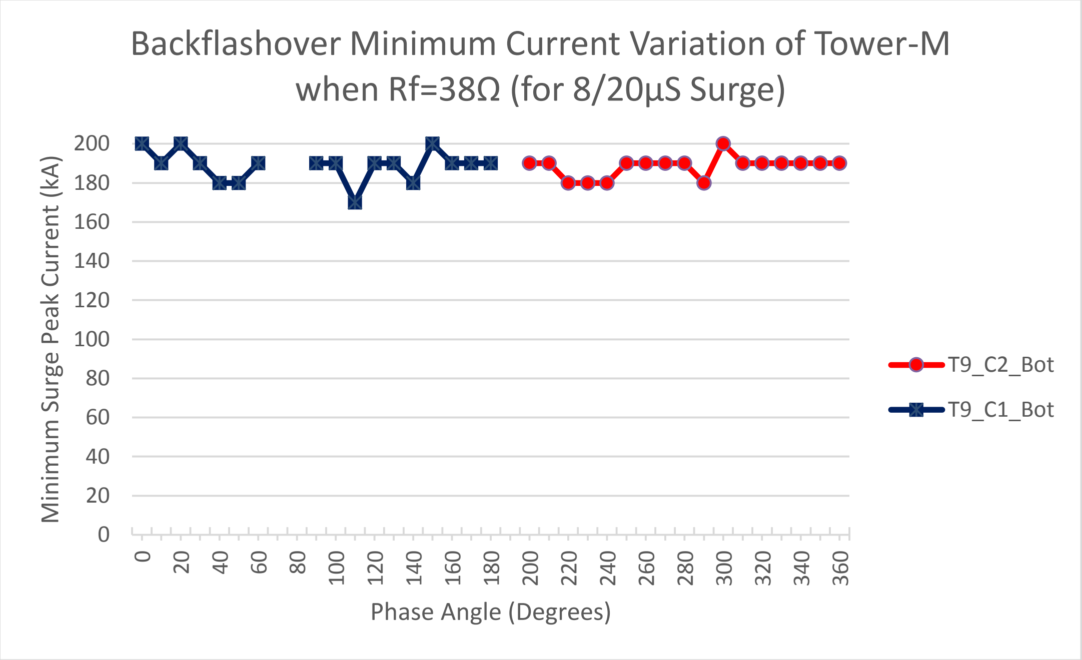


Figure-A9.9 - Simulation results with Four MCIA protection on TOP and MIDDLE phases for 8/20µS Surge for the ground resistance of 38Ω

Step-2, Simulation No. 16

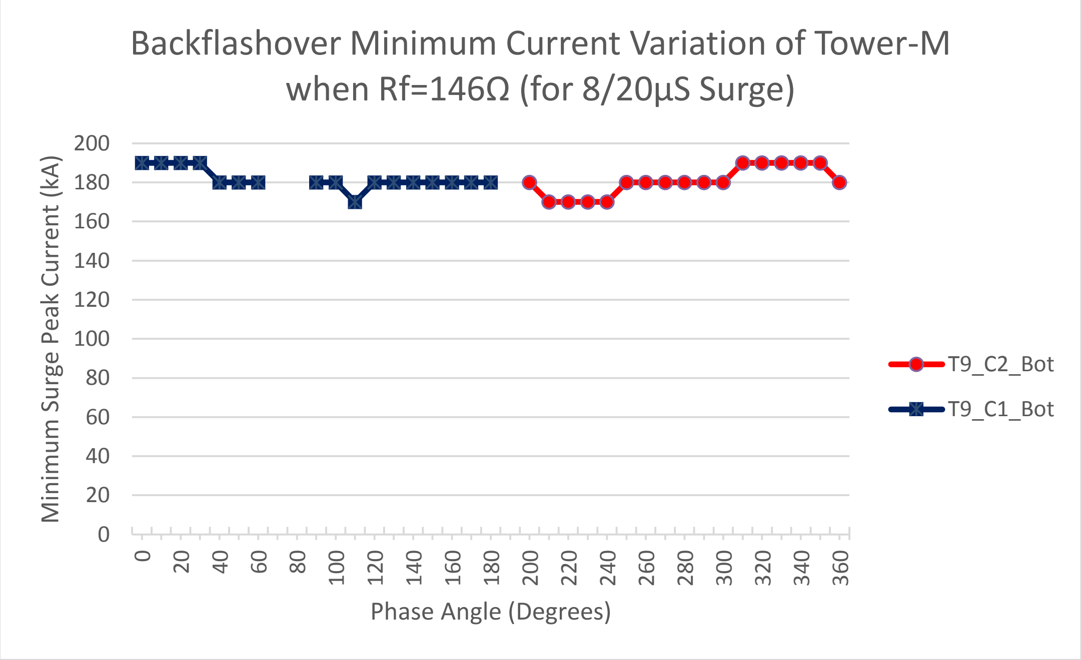


Figure-A9.10 - Simulation results with Four MCIA protection on TOP and MIDDLE phases for 8/20µS Surge for the ground resistance of 146Ω

Step-2, Simulation No. 17

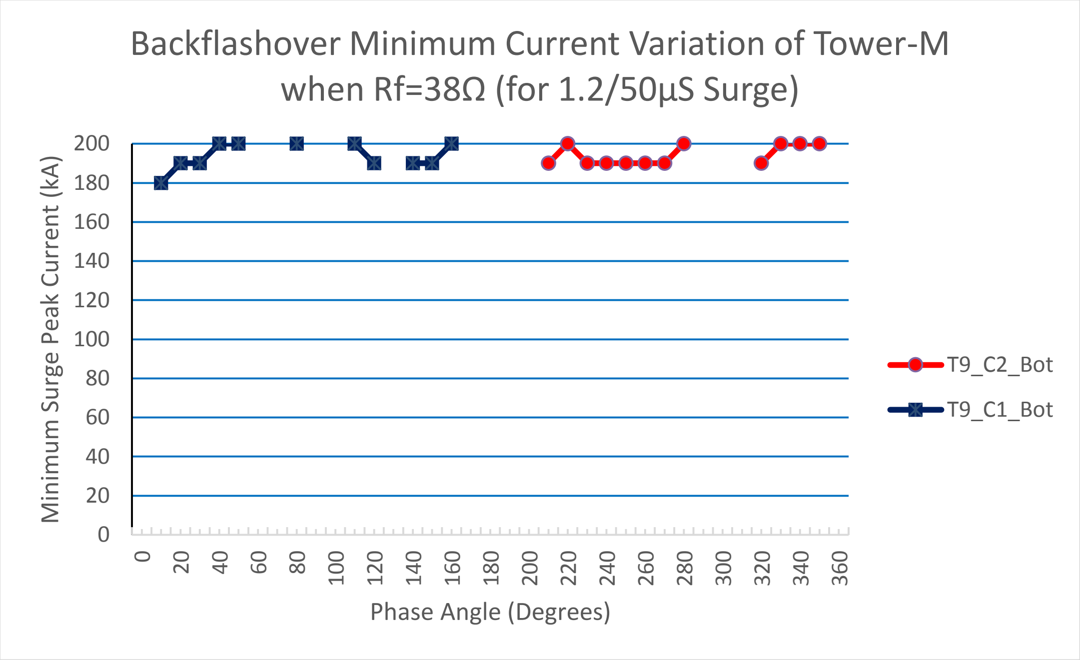


Figure-A9.11 – Simulation results with Four MCIA protection on TOP and MIDDLE phases for 1.2/50µS Surge for the ground resistance of 38Ω

Step-2, Simulation No. 18

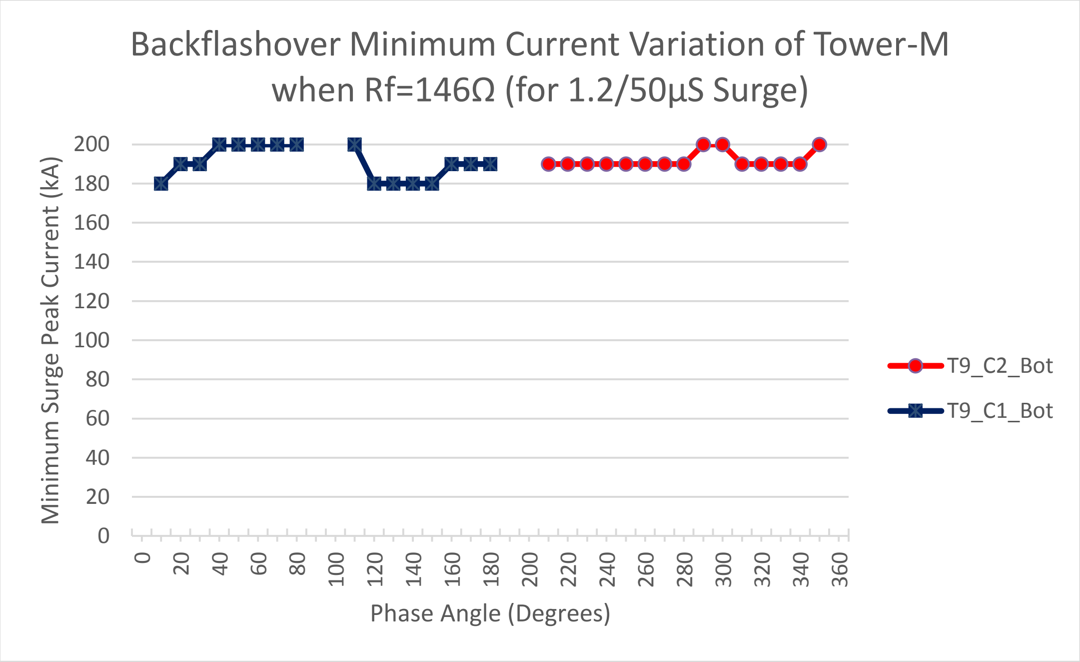
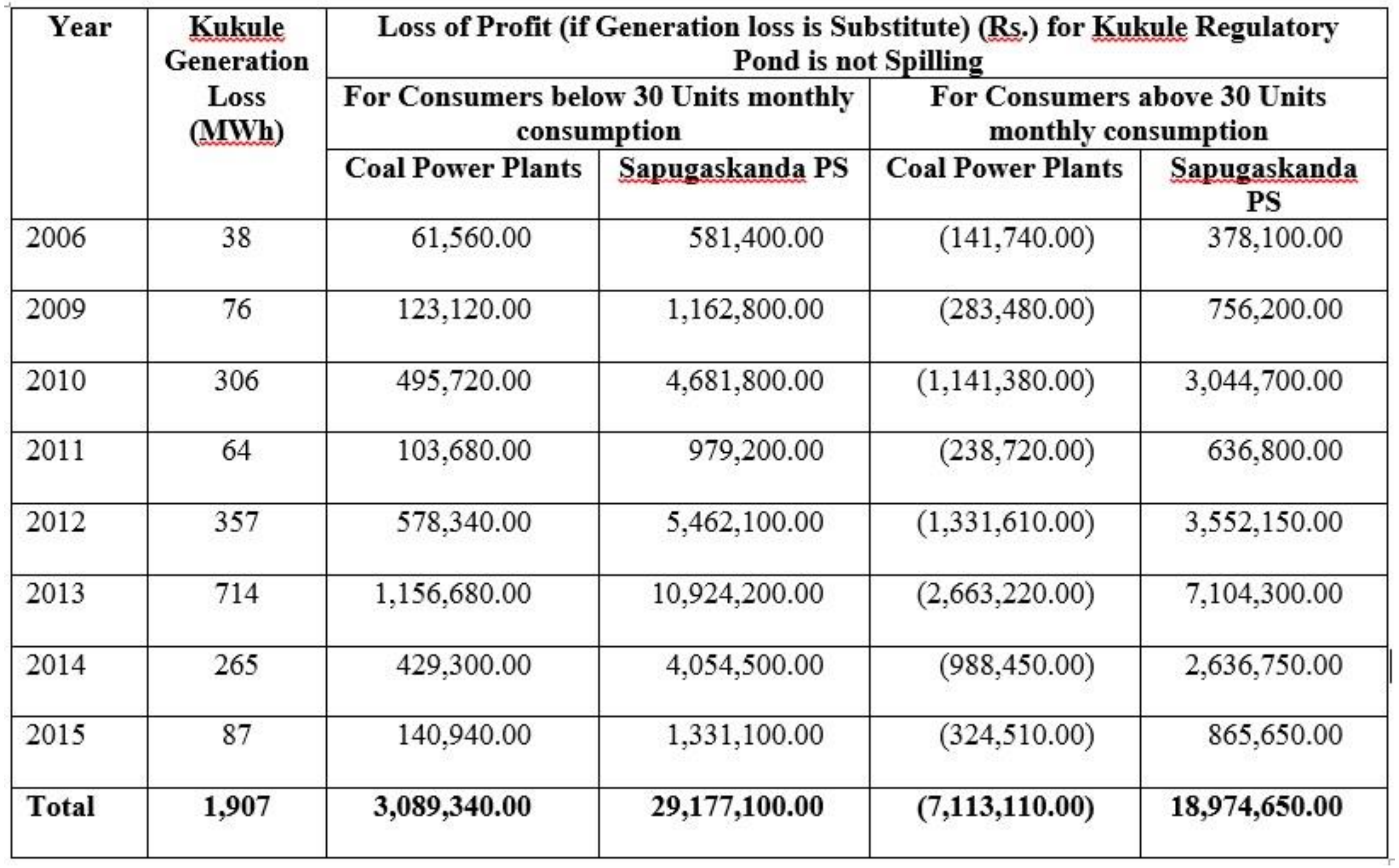


Figure-A9.12 – Simulation results with Four MCIA protection on TOP and MIDDLE phases for 1.2/50µS Surge for the ground resistance of 146Ω

Appendix - 10

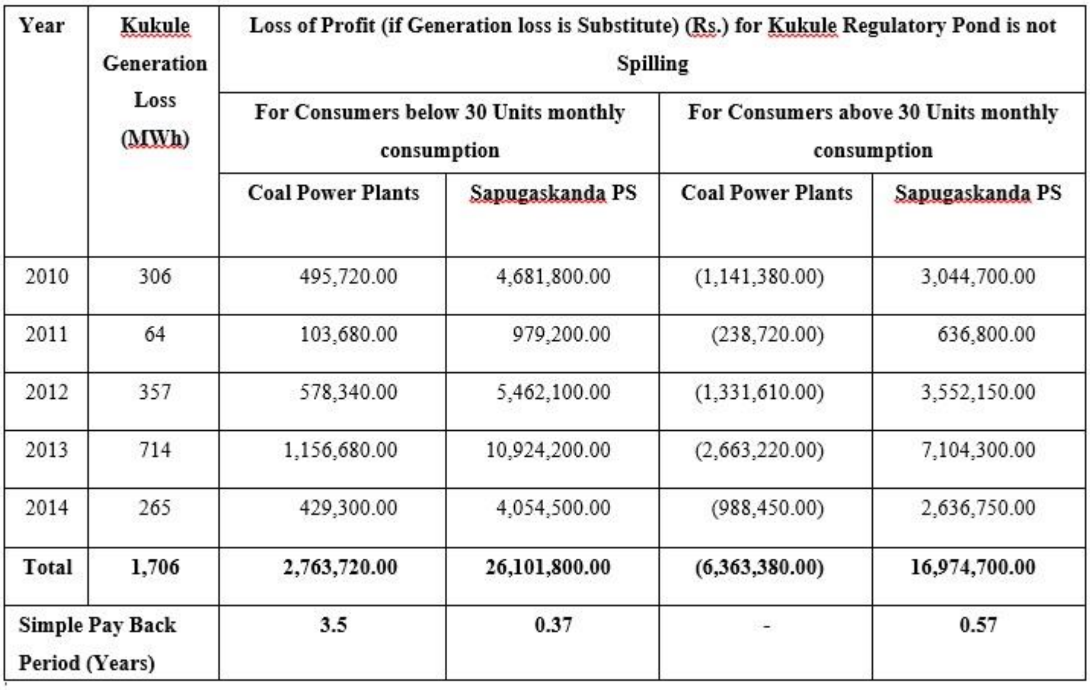
Loss of Profit Calculation

Table A10.1- Loss of Profit Calculation (if Generation loss is Substitute) for Kukule Regulatory Pond is Spilling



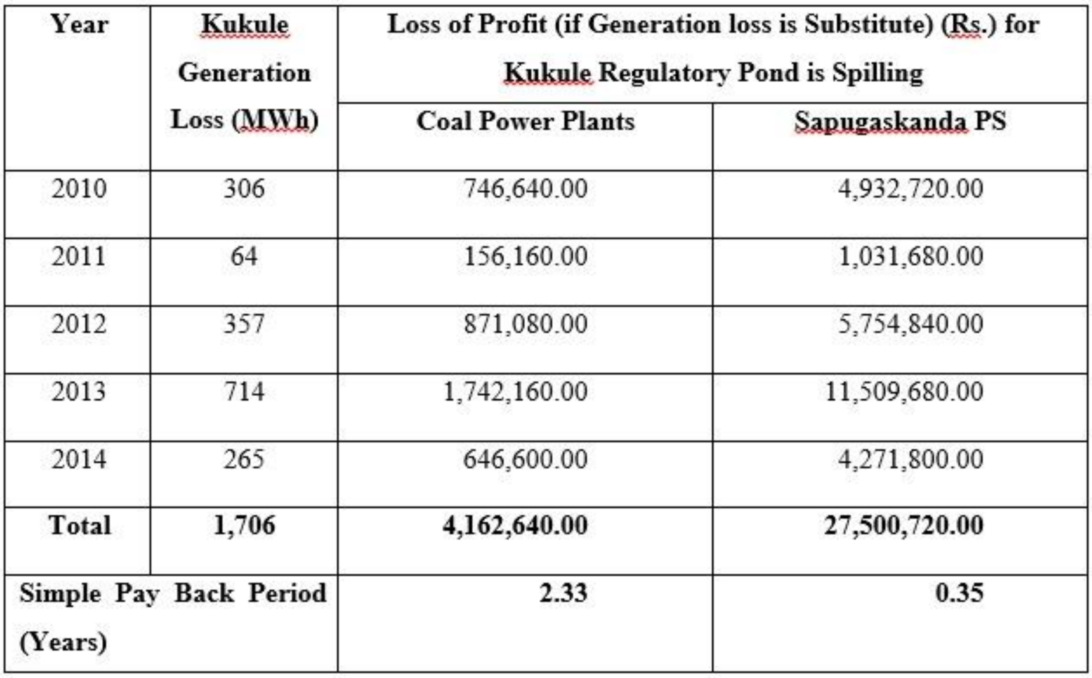
Year	Kukule Generation Loss (MWh)	Loss of Profit (if Generation loss is Substitute) (Rs.) for Kukule Regulatory Pond is not Spilling			
		For Consumers below 30 Units monthly consumption		For Consumers above 30 Units monthly consumption	
		Coal Power Plants	Sapugaskanda PS	Coal Power Plants	Sapugaskanda PS
2006	38	61,560.00	581,400.00	(141,740.00)	378,100.00
2009	76	123,120.00	1,162,800.00	(283,480.00)	756,200.00
2010	306	495,720.00	4,681,800.00	(1,141,380.00)	3,044,700.00
2011	64	103,680.00	979,200.00	(238,720.00)	636,800.00
2012	357	578,340.00	5,462,100.00	(1,331,610.00)	3,552,150.00
2013	714	1,156,680.00	10,924,200.00	(2,663,220.00)	7,104,300.00
2014	265	429,300.00	4,054,500.00	(988,450.00)	2,636,750.00
2015	87	140,940.00	1,331,100.00	(324,510.00)	865,650.00
Total	**1,907**	**3,089,340.00**	**29,177,100.00**	**(7,113,110.00)**	**18,974,650.00**

Table A10.2- Calculation Results of Simple Payback Period when Kukule Regulatory Pond is not Spilling



Year	Kukule Generation Loss (MWh)	Loss of Profit (if Generation loss is Substitute) (Rs.) for Kukule Regulatory Pond is not Spilling			
		For Consumers below 30 Units monthly consumption		For Consumers above 30 Units monthly consumption	
		Coal Power Plants	Sapugaskanda PS	Coal Power Plants	Sapugaskanda PS
2010	306	495,720.00	4,681,800.00	(1,141,380.00)	3,044,700.00
2011	64	103,680.00	979,200.00	(238,720.00)	636,800.00
2012	357	578,340.00	5,462,100.00	(1,331,610.00)	3,552,150.00
2013	714	1,156,680.00	10,924,200.00	(2,663,220.00)	7,104,300.00
2014	265	429,300.00	4,054,500.00	(988,450.00)	2,636,750.00
Total	**1,706**	**2,763,720.00**	**26,101,800.00**	**(6,363,380.00)**	**16,974,700.00**
Simple Pay Back Period (Years)		**3.5**	**0.37**	-	**0.57**

Table A10.3 - Calculation Results of Simple Payback Period when Kukule Regulatory Pond is Spilling



Year	Kukule Generation Loss (MWh)	Loss of Profit (if Generation loss is Substitute) (Rs.) for Kukule Regulatory Pond is Spilling	
		Coal Power Plants	Sapugaskanda PS
2010	306	746,640.00	4,932,720.00
2011	64	156,160.00	1,031,680.00
2012	357	871,080.00	5,754,840.00
2013	714	1,742,160.00	11,509,680.00
2014	265	646,600.00	4,271,800.00
Total	**1,706**	**4,162,640.00**	**27,500,720.00**
Simple Pay Back Period (Years)		**2.33**	**0.35**