INVESTIGATING THE EFFECTS OF ELECTROMAGNETIC FIELDS DUE TO HIGH VOLTAGE TRANSMISSION LINES ON DETONATOR FIRING CIRCUITS

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Degree of Master of Science

Department of Electrical Engineering

University of Moratuwa

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Declaration

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The above candidate has carried out research for the Masters under our supervision.

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(Eng. W.D.A.S. Wijayapala)

…… ……

Signature of the Supervisor **Date:**

(Dr. Asanka S. Rodrigo)

Abstract

High voltage A.C. transmission is the common mode adopted in transmitting bulk electrical power from one station to the other all over the world. Associated with these overhead transmission lines are the electric and magnetic fields emanating from these which could have a coupling influence on devices in its proximity. Detonator is one such electro explosive device (EED) that is susceptible to electromagnetic coupling when placed in proximity to the transmission lines which in turn could cause inadvertent misfires.

This report focuses on the computational modeling of electric and magnetic fields around overhead high voltage transmission lines at various voltage levels and line configurations starting from fundamental electromagnetic principles and the verification of those models by field measurements. MATLAB software was used in modeling the field profiles and the model is capable of accommodating any configuration with any number combination of conductors. The overhead transmission line parameters used in this report are from the present line configurations in practice in Sri Lanka. The measured values of electric and magnetic fields are compared with the modeled values for the verification of models. The possibility of shielding these extra low frequency electromagnetic fields are also discussed briefly.

Electrical detonator is one type of Electro Explosive Devices (EEDs) that is used to initiate blast sequences. the susceptibility of these devices to the electric and magnetic fields emanating from nearby high voltage transmission lines are comprehensively examined under scenarios of nominal rated loads, infrequent high loads, emergency short-time loads, faults, lightning and switching surges. Investigating the impacts of field couplings and possible unintentional misfires under different scenarios, safe distance levels for operation of detonators in the proximity of transmission lines are proposed for different voltages and line configurations.

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LIST OF ABBREVIATIONS

Abbreviation	Description
CEB	Ceylon Electricity Board
GSMB	Geological Survey and Mines Bureau
MATLAB	Matrix Laboratory software
EE	Electrical Engineer
IEEE	Institute of Electrical & Electronic Engineers
GSS	Grid Sub Station
DC	Direct Current
AC	Alternative Current
STC	Standard Test Conditions
RMS	Root Mean Square
EED	Electro Explosive Device
ICNIRP	International Commission on Non Ionizing Radiation Protection
IRPA	International Radiation Protection Association
WHO	World Health Organization

LIST OF SYMBOLS

Symbol	Description
E	Electric Field, V/m
V	Voltage, Volts
I	Current in Amperes
T	Tesla
μT	Micro Tesla
mG	Milli-Gauss
B	Magnetic Flux Density in T
H	Magnetic Field Intensity
Wb	Webers
Kg	Kilo-grams
C	Coulomb
Q, q	Charge in Coulomb
D	Bundle Diameter in m
d	conductor diameter in m
r	Sub conductor radius
N, n	Number of sub conductors
S	Sub conductor spacing
V_p	Potential at point P
μ_0	Permeability of free space
ε_0	Permittivity of free space

ANNEXES

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