

AIN SHAMS UNIVERSITY  
FACULTY OF ENGINEERING  
ELECTRICAL POWER AND MACHINES DEPT.

CALCULATION OF ELECTRIC FIELD BY  
CHARGE SIMULATION METHOD

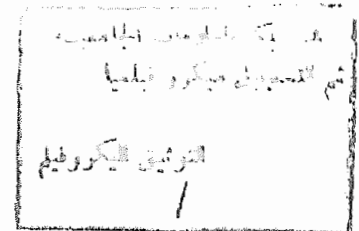
A Thesis

Submitted in Partial Fulfillment for  
the Requirement of the Degree of Master  
of Science in Electrical Engineering

By

Samah Mohamed Taha El Safty

B.Sc. Electrical Engineering, Ain Shams University, 1988



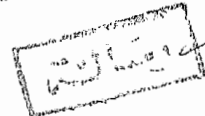
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CAIRO - 1993

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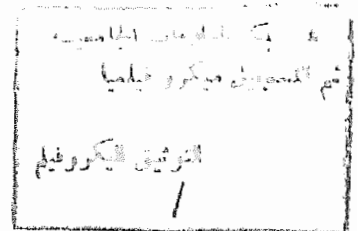
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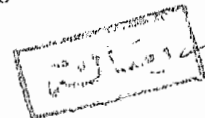
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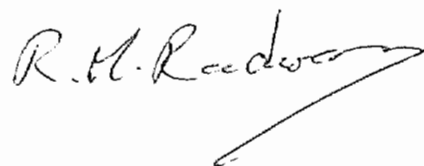
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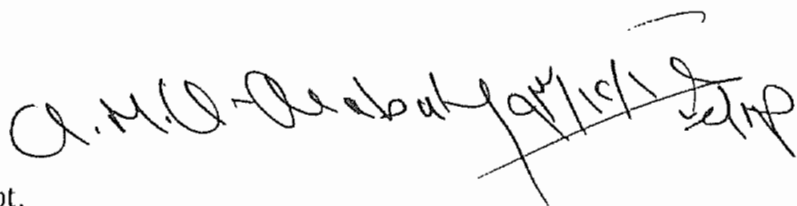
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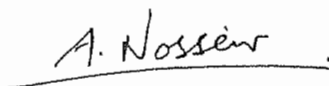
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## STATEMENT

This dissertation is submitted to Ain Shams University for the degree of Master in Electrical Engineering.

The work included in this thesis was carried out by the author. No part of this thesis has been submitted for a degree or a qualification.

Samah EL Safty

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## ABSTRACT

Gas insulated substations (GIS) have been developed with the view of utilizing the high reliability, compactness and economization achieved by gas insulation. The basic insulation components in GIS are SF<sub>6</sub> gas and solid spacers which are necessary for the physical support of conductors.

The working performance of compressed gas insulated system (GIS) to a great extent depends on the electric performance of spacers. Therefore the knowledge of the potential and electric field distributions in the vicinity of the spacer and on its surface is of great significance for the optimum design of spacers.

In the present work a computer program has been developed for the calculation of the potential and electric field distributions in the vicinity of the spacer and on its surface by using the charge simulation technique (CST). Lotus spread sheet and Harvard Graphics have been used for plotting the results.

The effects of using metal insert at one or both ends have been studied. Also the dependence of the electric field on the depth and width of the metal insert has been investigated. The effect of varying the spacer length and material on the electric field has also been studied. Moreover, the optimal design of a spacer having metal inserts is discussed. A significant reduction in the electric field has been achieved by using suitable metal inserts at both ends.

The effect of accumulation of surface charges on the potential and electric field distributions at the interfacial boundary between the solid insulator and  $\text{SF}_6$  has been studied in two cases ; namely with and without metal inserts.

Also in this work analytical study has been carried out in order to calculate the electric field at measured values of the flashover voltages and for different values of gas pressure.

The development and relevant sizes of the discharge electron avalanches have been calculated. Hence, the criteria of electric breakdown are investigated.



# TABLE OF CONTENTS

LIST OF ABBREVIATIONS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION ..... 1

CHAPTER I: GAS INSULATED SYSTEMS REVIEW OF RELATED LITERATURE  
AND PREVIOUS INVESTIGATIONS

1.1.	GENERAL. ....	5
1.2.	GIS. ....	5
1.2.1.	SF <sub>6</sub> ....	6
1.2.2.	Spacers. ....	7
1.2.2.1.	Insulator/electrode surface. ....	7
1.2.2.2.	Material of spacer. ....	8
1.2.2.3.	Spacer design. ....	8
1.3.	ELECTRIC FIELD FOR SPACERS' DESIGN. ..	9
1.4.	OBJECTIVES. ....	10

CHAPTER II: METHOD OF COMPUTATION.

2.1.	GENERAL. ....	12
2.2.	NUMERICAL METHODS. ....	13
2.2.1.	Finite Difference Method. ....	13
2.2.2.	Finite Element Method. ....	16

2.2.3.	Monte Carlo Method. ....	19
2.2.4.	Charge Simulation Method. ....	20
2.2.4.1.	Basic principle. ....	21
2.2.4.2.	Application of CSM to two dielectric media. ....	24
2.2.4.3.	Computer program. ....	31
2.2.4.4.	Accuracy principle. ....	34
2.2.4.5.	Application of CSM with accumulated surface charge. ....	36

### CHAPTER III: POTENTIAL AND ELECTRIC FIELD DISTRIBUTIONS OF GIS' SPACERS.

3.1.	GENERAL. ....	39
3.2.	SPACER CONFIGURATION. ....	39
3.3.	POTENTIAL AND ELECTRIC FIELD DISTRIBUTION. ....	42
3.3.1.	Effect of Dimensions of Metal Inserts. ....	44
3.3.2.	Effect of Varying Dimensions of One Metal Insert. ....	58
3.3.3.	Effect of Presence of Metal Insert at One Conductor. ....	63
3.3.4.	Effect of Spacer Length. ....	70
3.3.5.	Effect of Dielectric Material. ....	74

CHAPTER IV: ELECTRIC FIELD MODIFICATION DUE TO ACCUMULATED  
SURFACE CHARGE.

4.1.	GENERAL. ....	76
4.2.	MODIFICATION IN METHOD OF COMPUTATION. ....	76
4.3.	SURFACE CHARGE DISTRIBUTION. ....	77
4.3.1.	Electrostatic Probe Technique. ....	78
4.3.2.	Dust Figure Technique. ....	80
4.4.	RESULTS FOR CYLINDRICAL INSULATOR. ...	80
4.5.	EFFECT OF METAL INSERT. ....	86

CHAPTER V: ANALYSIS OF DISCHARGE GROWTH IN GIS.

5.1.	GENERAL. ....	93
5.2.	BREAKDOWN MECHANISM IN COMPRESSED GASES	93
5.2.1.	Townsend Mechanism. ....	94
5.2.2.	Streamer Mechanism. ....	96
5.3.	PRESENT INVESTIGATION OF DISCHARGE GROWTH CRITERIA. ....	97
5.3.1.	Steps of Analysis. ....	97
5.3.2.	Application of Analysis to SF <sub>6</sub> . ....	99
5.3.3.	Application of Analysis to N <sub>2</sub> . ....	107

CHAPTER VI: GENERAL CONCLUSIONS AND SUGGESTIONS FOR FURTHER  
INVESTIGATIONS.

6.1.	GENERAL. ....	113
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6.2.	CONCLUSIONS. ....	114
6.3.	SUGGESTIONS FOR FURTHER INVESTIGATIONS .....	117
REFERENCES	.....	118
APPENDIX	.....	125

## LIST OF ABBREVIATIONS

GIS	: Gas Insulated Switchgear.
SF <sub>6</sub>	: Sulphur Hexaflouride.
CSM	: Charge Simulation Method.
FDM	: Finite Difference Method.
FEM	: Finite Element Method.
E <sub>n</sub>	: Normalized normal field component.
E <sub>t</sub>	: Normalized tangential field component.
E <sub>T</sub>	: Normalized total field component.
E <sub>nc</sub>	: Normalized normal field component at the cathode junction.
E <sub>tc</sub>	: Normalized tangential field component at the cathode junction.
E <sub>Tc</sub>	: Normalized total field component at the cathode junction.
E <sub>nm</sub>	: Normalized maximum normal field component.
E <sub>tm</sub>	: Normalized maximum tangential field component.
E <sub>Tm</sub>	: Normalized maximum total field component.
E <sub>a</sub>	: Applied electric field.
E <sub>s</sub>	: Space charge field.

## LIST OF TABLES

Table (3.1):	Field components at triple junction and their maximum values for different spacer length ...	50
Table (3.2):	Total field at the triple junction .....	58
Table (3.3):	Field components at triple junction and their maximum values for different spacer materials .	75
Table (4.1):	The values of the field components at constant depth = 5 mm and variable width with presence of surface charge .....	91
Table (5.1):	Computed electric field and discharge parameters values at applied voltage = 87 kV at 1 atm over the whole spacer surface for SF <sub>6</sub> .....	101
Table (5.2):	Computed applied and space charge fields in the critical location for SF <sub>6</sub> at 1 atm where E <sub>a</sub> E <sub>s</sub> .....	104
Table (5.3):	Computed electric field, space charge field and discharge parameters values at an applied voltage = 95 kV at 4 atm over the whole spacer surface	

## LIST OF FIGURES

Figure (2.1) :	Regular grid for Finite Difference technique indicating the node numbers .....	14
Figure (2.2) :	A section of area A subdivided into triangular elements, notation of nodes $i, j, m$ for element $e$ .....	18
Figure (2.3) :	Three point charges in free space .....	23
Figure (2.4) :	Spacer configuration with contour points and charge locations .....	26
Figure (2.5) :	Configuration of spacer with cylindrical symmetry .....	30
Figure (2.6) :	Flow chart for computer program .....	32
Figure (3.1) :	Elevation and plan of electrode configuration	40
Figure (3.2) :	Spacer configuration .....	41
Figure (3.3) :	Equipotential lines of the system .....	43
Figure (3.4) :	Potential distribution along the surface of the solid insulator - gas interface for $x/r=0.25$ .....	45
Figure (3.5) :	Normalized tangential field $E_t$ along the surface of the solid insulator - gas interface for $x/r = 0.25$ .....	46