RISK ASSESSMENT OF GROUNDING SYSTEM IN ELECTRICAL SUBSTATION
CASE STUDY: ABO ZAABLE SUBSTATION 66 kV

By

Hoda Saber Hafez

A Thesis Submitted to the

Faculty of Engineering at Cairo University

In Partial Achievement of the

Requirements for the Degree of

Master of Science

in

Risk Engineering

FACULTY OF ENGINEERING, CAIRO UNIVERSITY

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Key Words

Risk assessment, Risk Modeling, PRA model; Grounding System in Electrical Substation.

Summary: Grounding system in electrical substation is a main protection in power plant system that protects workers and equipment against lightning, overvoltage, switching and safe the operation continuity. So the design of the grounding system must be according to standard code IEEE 80 and it must be maintenance, test periodically.
This research introduces risk assessment on the hazard that causes failure of grounding system. Preliminary risk assessment model (PRA) is used to identify, determine and show risks in grounding system to indicate the suitable control case. The 5-Step Process of Risk Management is also used to identify system hazards, before conducting the analysis of probabilities, severities and rank risk. So PHA gives preventive and protective values for unacceptable risks.

Disclaimer

I hereby declare that this thesis is my own original work and that no part of it has been submitted for a degree qualification at any other university or institute.

I further declare that I have appropriately acknowledged all sources used and have cited them in the references section.

Name: Hoda Saber Hafez Elsakhawy Date:

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DEDICATION

To my family, for their support and devotion

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ABBREVIATIONS

α_0	=	Thermal Coefficient of Resistivity at 0 °C
α_r	=	Thermal Coefficient for Resistivity at Reference Temperature
ρ_r	=	The Resistivity of Ground Conductor at Reference Temperature
A	=	Conductor Cross Section in mm2
A.Z.SS	=	Abo Zaable Substation
AIChE	=	American Institute of Chemical Engineers
BS	=	British Standard
C.T	=	Current Transformer
CB	=	Circuit Breaker
CCPS	=	Center for Chemical Process Safety
C_s	=	Reduction Factor Considering Reflection and Thickness of Surface Layer (gravel layer)
D_f	=	The Decrement Factor for the Entire Duration of fault $t_f$given in sec
EETC	=	Egyptian Electricity Transmission Company
EHV SS	=	Extra-High Voltage Substation; Voltages Between 132 kV and 400 kV
EPA's	=	Environmental Protection Agency
EPG	=	Electric Power Grid
EPR	=	Earth Potential Rise
EUS	=	Egyptian Utility Standard
FMEA	=	Failure Mode and Effects Analysis
GIS	=	GAS Insulation System
GPR	=	Ground Potential Rise
HAZID	=	Hazard Identification Analysis
HAZOP	=	Hazard and Operability Study
HSW	=	Health and Safety at Work
HV SS	=	High Voltage Substation ; Voltages Between 33 kV and 66 kV
IEC	=	International Electro-Technical Commission
IEEE	=	Institute of Electrical and Electronics Engineers
I_f	=	The RMS Value of Symmetrical Ground Fault Current in

		Amperes
I_G	=	Maximum Grid Current in Amperes
I_g	=	The RMS Symmetrical Grid Current in Amperes
NG	=	National Grid
O.H.T.L	=	Overhead Transmission Lines
OHSAS 18001	=	According to Occupational Health and Safety Assessment Series
OSHA	=	The Occupational Safety and Health Administration
PDF	=	Probability Density Function
PHA	=	The Process Hazard Analysis
PHA	=	Preliminarily Hazard Analysis
PP	=	Power Plant
PPHA	=	The Preliminary Process Hazard Analysis
PRA	=	Probabilistic Risk Analysis
PSA	=	Probabilistic Safety Analysis
PSM	=	Process Safety Management
PSM	=	Process Safety Management
QRA	=	Quantitative Risk Analysis
RMP	=	Risk Management Program
RMP	=	Risk Management Program
RR	=	Risk Ranking
S_f	=	The Fault Current Division Factor
Std.	=	Standard
T_a	=	Ambient Temperature in °C
t_c	=	Time of Current Flow in s
TCAP	=	Thermal Capacity Factor from Table 1, in J/cm3/°C
T_m	=	Maximum Allowable Temperature in °C
TR	=	Power Transformer
T_r	=	Reference Temperature for Material Constants in °C
t_s	=	Fault Clearing Time (1 s)
U.G.P.C	=	Underground Power Cables
UHV SS	=	Ultra-High Voltage Substation ; Operating on Voltage Above 400 kV