RE-EVALUATION OF LIGHTNING PROTECTION SYSTEM TO GOVERNMENT BUILDING IN SARAWAK USING SIMPLIFIED RISK ANALYSIS AND ROLLING SPHERE METHOD

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DEDICATION

This project is dedicated to my family who have been the source of inspiration and give me strength when I thought of giving up, who continually provide their moral, spiritual and emotional support.

To my friends and classmates who shared their words of advice and encouragement to finish this study.

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ABSTRACT

The lightning strike can be intimidating to living being and can cause of property damage and economic loss. Inadequate assessment of risk management will lead to poor design of lightning protection and risk mitigation which cause life hazard, structures damage and services interruption. Likewise, insufficient installation and placement of the external lightning protection system (LPS) are the possible reason of inefficient protection due to lightning strike. Lightning Risk Assessment (LRA) study is conducted to determine risk and probability of damage for lightning risk management (LRM). Rolling Sphere Method (RSM) among the approaches used to meet optimum placement of external LPS. However, studies the use of RSM method in determining the location for protection due to lightning strikes and it consequences to compliment LRM specifically in Sarawak, Malaysia is still inadequate. In this work, existing LPS installation for selected government buildings in Sarawak is re-evaluated by using simplified LRA tools as in IEC62305:2, where critical parameters are carefully identified in order to reduce the hazardous impact and decrease risk level to a tolerable limit. Suitable protection measure using RSM approached for external lightning rod placement was integrated with LRM to achieve the optimum LPS design. The simulation was carried out using 3D Lightning for AutoCAD to identify the ideal position of air termination component comparatively with the LRA and LRM measurement. It was found that the improvement of calculating total risk component, R_X to be less than the risk tolerable limit, R_T; ($R_X > R_T$) can be achieved with appropriate LRM and right positioning of external LPS. Hence, with the establishment of the simplified LRA, better protection scheme can be designed with the optimal cost scheme and the effective protection system. Therefore, it is anticipated that the integration of LPS placement in LRM shall enhance safety and economical value for the protection lightning system design of the selected building.

ABSTRAK

Fenomena panahan kilat merupakan kejadian yang menakutkan dan boleh mengakibatkan kerosakan harta benda dan kerugian ekonomi. Penilaian pengurusan risiko yang lemah, membawa kepada ketidakberkesanan rekabentuk system perlindungan kilat yang boeleh mendatangkan bahaya kepada makhluk hidup, kerosakan struktur dan gangguan perkhidmatan. Begitu juga pemasangan dan penempatan sistem perlindungan kilat luaran (LPS) yang tidak mencukupi meyebabkan kemungkinan fungsi perlindungan penahan kilat yang kurang cekap. Kajian Penilaian Risiko Kilat (LRA) dijalankan untuk menentukan risiko serta kebarangkalian kerosakan bagi membolehkan pengurusan risiko kilat (LRM) dilakukan. Kaedah *Rolling Sphere* (RSM) adalah diantara kaedah yang digunakan bagi menempatkan LPS luaran secara optimum. Walau bagaimanapun, kajian yang menggabungkan LRM dan penggunaan kaedah RSM dalam menentukan posisi perlindungan panahan kilat khususnya di Sarawak, Malaysia masih tidak mencukupi. Dalam kajian ini, pemasangan LPS sedia ada untuk bangunan kerajaan terpilih di Sarawak akan dinilai semula dengan menggunakan LRA yang dipermudahkan berdasarkan IEC62305: 2, di mana parameter kritikal dikenal pasti dengan teliti untuk mengurangkan kesan bahaya dan menurunkan tahap risiko kepada had yang boleh diterima. Langkah perlindungan yang sesuai menggunakan RSM untuk penempatan rod kilat telah diintegrasikan dengan LRM untuk mencapai reka bentuk LPS optimum. Simulasi ini dijalankan menggunakan program Lightning 3D untuk AutoCAD bagi mengenal pasti kedudukan ideal komponen rod kilat serta pengiraan LRA dan pelaksanaan LRM. Adalah didapati bahawa pengiraan jumlah komponen risiko, R_X tidak melebihi had risiko yang boleh diterima, R_T; (R_X> R_T) boleh dicapai dengan LRM yang sesuai dan kedudukan LPS luaran yang betul. Oleh itu, penggunaan LRA yang telah dipermudahkan dapat menghasilkan rekabentuk skim perlindungan kilat yang lebih baik serta kos yang optimum dan sistem perlindungan yang berkesan.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

CSM	-	Collection Surface method
DEGM	-	Dynamic Electro- Geometrical Model
EGM	-	Electro- Geometrical Model
IE	-	Interception Efficiency
LEMP	-	Lightning Electro- Magnetic Pulse
LIS	-	Lightning Imaging Sensor
LPL	-	Lightning Protection Level
LPS	-	Lightning Protection System
LPZ	-	Lightning Protection Zone
LRA	-	Lightning Risk Analysis
LRM	-	Lightning Risk Management
PB	-	Damaged Probability
RSM	-	Rolling Sphere Method
SE	-	Selection Efficiency

LIST OF SYMBOLS

R_X	-	Risk Component
N_X	-	Number of annual lighting risk
P_X	-	Probability of structure damage
L_X	-	Rate of lightning stroke loss
R_T	-	Tolerable Risk
D, d	-	Diameter
r	-	Radius

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Background of the Problem

Statistic shows that Kuching, Sarawak and nearby area received 285 flashes of lightning strikes in the period of March 2017 to February 2018 as per shown in Figure 1.1 [1]. There are difficulties to have extensive data for fatality incident and human injuries due to the lightning strike specifically in Kuching. However, according to study by Ab Kadir [2], death to injury ratio in Malaysia is about 1 in 10 lightning-strike victims. The numbers of fatalities and injury have been increased over the year as per data collected from 2008 to 2015 [2].

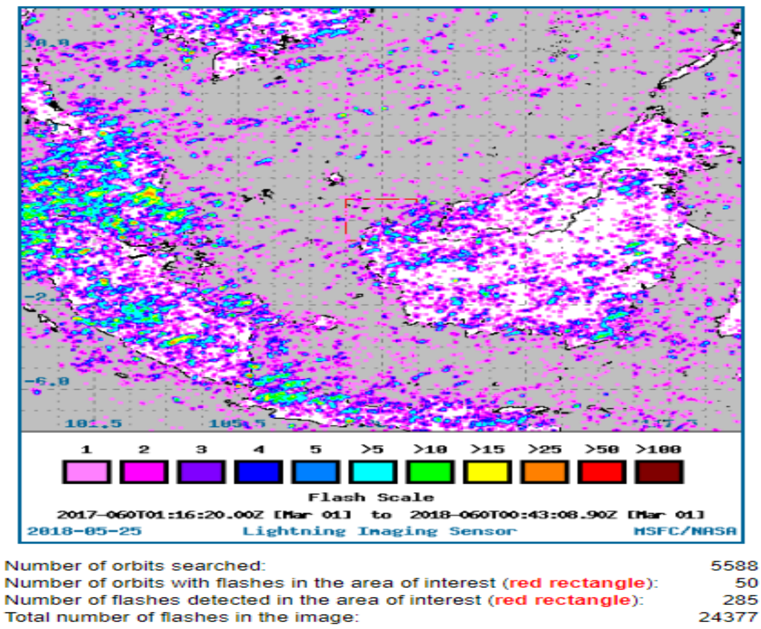

Figure 1.1 Flashes detected from LIS space time domain data

Impact of lightning strikes to structures and services are also significant. Losses over RM 250 million were estimated [2] in our country due to properties damaged, systems malfunction, equipment fault, services downtime and etc. Major hazard cause by lightning strikes are damages due to fire when structure flammable material exposed to high temperature of lightning strike; power surge damages happened as lightning strike to power line system, then used electrical line as a path to discharge and destructive shock wave produced by lightning can fractures concrete and brick

Property damages and life losses caused by direct lightning strike have become one of major attention for most study. An efficient lightning protection system design shall be incorporate to minimize impact cause by direct lightning strikes.

Unfortunately, awareness of doing the risk assessment analysis and appropriate placement of external lightning protection system (air rod of air termination system) is still lacking among designer and developers especially in Sarawak.

1.2 Statement of Problem

Risk assessment is important element to determine the requirement of building lightning protection measure. Failure to carry out risk analysis may lead to inadequate or over rated of protection to the building. In general, the awareness of Risk Assessment requirement is still lacking where some designer and developer have made no attempt to carryout risk analysis prior to designing lightning protection system.

Inadequate provision protection of lightning strike may lead to life hazard, physical damage to structures and failure of services. It put the building and life at risk due to direct and indirect lightning strike. Lightning protection system shall be properly functioned to allow lightning energy dissipated safely onto the earth by providing low path impedance without causing damage to properties or causing life loss.

Allocating right position of air termination system is essential for optimum protection against lightning strike. According to IEC 62305 there are 3 conventional method can be used to determine position and arrangement of air termination system; rolling sphere method, protection angle method and mesh method. Unfortunately, in most design, designers are simply positioned the air rod at edge of four corner of the building without further investigate the risk assessment nor applying the placement of air termination method prior to design the LPS.

1.3 Objective of the Study

The need of lightning protection is becoming an imperative requisite for the protection of structures and its contents. Followings are the objectives for this study:

(a) To evaluate risk assessment of selected building using simplified risk assessment analysis method and do selection of building protection measure to reduce the risk to tolerable limit
(b) To re-evaluate LPS air terminal placement on the selected building in order to improve optimum protection of lightning strike and facilitate economical design

1.4 Scope of the Study

The works for this paper will focus on :

(a) Selection of existing building as a case study
(b) Identification of type of relevant loss
(c) Risk assessment analysis – Simplified method and protection measure
(d) Simulation of LPS placement using RSM method

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