REFOCUSING OF ELECTRICAL SAFETY PRACTICES IN MALAYSIA, CONSIDERING UNCONTROLLED AND CONTROLLED PARAMETERS

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To my beloved husband, mother and family

for their encouragement, blessing and inspiration…

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ABSTRACT

This project examines the issue of electrical safety and the regulatory inspection system currently practiced in Malaysia. There are controlled parameters should be considered in this electrical safety such as people, equipment and managing system itself. This project is concerned on three types of industry which are large (Panasonic, Pasir Gudang), medium (TNB, Johor Bahru) and small (Kedai Letrik Mohamad Lotfi, Kuala Pilah). Electrical safety is more than just the Arc Flash Hazard. Therefore, electrical safety needs to be a holistic approach that includes all aspects of electrical safety. This study attempts to identify the loopholes in electrical safety by surveying and visit those industries and then to focus attention on the items that need to be addressed to create on holistic approach to electrical safety. For uncontrolled parameter such as lightning we need to considered also in this project. Unfortunately the study of this lightning phenomenon is very difficult due to the fact that it doesn't occur so frequently and cannot be controlled. Therefore, for the uncontrolled parameters the simulation with ATP-EMTP will be used to show how the effects of current/lightning to human being by using AC and impulse sources. This project concludes with analysis by accident reporting and identified the new technology methods to prevent them from injury.

ABSTRAK

Projek ini adalah untuk mengkaji isu-isu mengenai keselamatan elektrik dan sistem peraturan yang diamalkan di Malaysia. Terdapat parameter-parameter yang boleh dikawal dalam mengkaji keselamatan elektrik ini seperti pekerja, peralatan dan sistem pengurusan di industri itu sendiri. Kajian projek ini melibatkan tiga kategori industri iaitu industri besar (Panasonic, Pasir Gudang), industri sederhana (TNB Johor Bahru) dan industri kecil (Kedai Letrik Mohamad Lotfi, Kuala Pilah). Keselamatan elektrik bukan sekadar bahaya percikan arka. Oleh yang demikian, keselamatan elektrik perlu pendekatan yang lebih holistik yang merangkumi semua aspek keselamatan elektrik. Projek ini juga dapat mengenalpasti kelemahan dalam keselamatan elektrik yang diamalkan dengan menggunakan kaedah lawatan ke industri-industri yang terlibat dalam kajian ini dan perlu diberikan penekanan yang mendalam serta pendekatan yang sebaik mungkin bagi menangani kemalangan daripada berlaku. Bagi parameter yang tidak dapat dikawal seperti kilat, ianya juga perlu dikaji. Walau bagaimanapun, fenomena ini amat sukar untuk dikaji. Oleh yang demikian, simulasi komputer dengan menggunakan perisisan ATP-EMTP telah digunakan bagi tujuan ini untuk menunjukkan bagaimana kesan arus/kilat terhadap manusia melalui sumber bekalan arus ulangalik dan dedenyut. Projek ini diakhiri dengan analisis yang didapati dari laporan kemalangan serta menyarankan teknologi baru bagi melindungi pekerja-pekerja di industri dari terjebak dengan sebarang kemalangan elektrik.

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LIST OF SYMBOLS

SYMBOL	DESCRIPTION
Hz	Unit for frequency (hertz)
I_{AC}	Injected current with AC source
I_{imp}	Injected current with impulse source
I_{1F}	Current flow with one finger touching
I_{2F}	Current flow with two fingers touching
I_{3F}	Current flow with three fingers touching
I_{4F}	Current flow with four fingers touching
I_{5F}	Current flow with five fingers touching
m	$1x10^{-3}$ (milli)
R_{1F}	Resistance for one finger touching
R_{2F}	Resistance for two fingers touching
R_{3F}	Resistance for three fingers touching
R_{4F}	Resistance for four fingers touching
R_{5F}	Resistance for five fingers touching
R_L	Leg resistance

GREEK SYMBOL	DESCRIPTION
μ	$1x10^{-6}$ (micro)
Ω	Unit for resistance (ohm)

LIST OF ABBREVIATIONS

AP	Authorized Person
ATP – EMTP	Alternative Transient Program – Electromagnetic Transients Program
CIDB	Construction Industry Development Board
CP	Competent Person
CPR	Cardiopulmonary Resuscitation
DOE	Department of Engineering
DSM	Department of Standards Malaysia
EPPE	Electrical Personal Protective Equipment
ESD	Electrostatic Discharge
HV	High Voltage
IEC	International Electro-Technical Committee
ISO	International Standard Organization
LV	Low Voltage
NEC	National Electrical Code
NFPA	National Fire Protection Association
NIOSH	National Institute of Occupational Safety and Health
OSH	Occupation Safety and Health
OSHA	Occupational Safety and Health Administration
PAVCJM	Panasonic Audio Video Networks Johor Malaysia
PPE	Personal Protective Equipment
PTW	Permit to Work
SIRIM	Standard Industrial Research Institute Malaysia
TNB	Tenaga Nasional Berhad

CHAPTER 1

INTRODUCTION

1.1 Introduction

From the earliest introduction of electricity to the States of Malaya, electrical safety has been a concern for the regulator and increasingly for the public (Ir. H. P. Looi, 2003). As is the practice in most countries, regulatory measures to ensure electrical safety is embedded in the historical development of the electrical industry and plays a major role in the regulation of electrical safety. Principles of safety in electrical systems encompass two major issues:

a) Protection of persons; and
b) Protection of property (principally fire hazard).

Accordingly regulations in Malaysia take cognizant of the above by:

a) prescribing safe practice;
b) instituting a system of inspection and accident reporting; and
c) maintaining prescribed list of electrical equipment, contractors and installations.

This traditional approach where the regulator plays a dominant role in ensuring safety with rigid application of regulatory standards and procedures and punitive measures is increasingly being challenged. Current principles of 'Occupational Safety and Health' (OSH) where the public and purveyor of electrical systems and equipment are also being made responsible for electrical safety are being 'worked' into new model for electrical safety and regulation.

An electrical safety program is a plan designed so that neither workplace conditions, nor the action of people, expose personnel unnecessarily to electrical hazards. Employers should develop and implement an electrical safety program to give overall safety directions for facility activities related to electrical work. Effective electrical safety programs are a major key in preventing electrical incidents (Kim Eastwood, Danny Liggett, and Erling Hesla, 2002).

An electrical safety program are integrated with an overall safety and occupational health program. Good reasons for practicing electrical safety are:

1) Personal reasons – desire to return home healthy to family at the end of workday.
2) Business reasons – safety makes good business sense.
3) Regulatory and legal reasons – violations can result in fines and/or imprisonment.

There are five key objectives of an electrical safety program:

1) to instruct personnel concerning rules, responsibilities and procedures for working safely in an electrical environment;

2) to demonstrate the employer's intention to fully comply with all applicable laws;

3) to document general requirements and guidelines for providing workplace facilities that are free from unauthorized exposure to electrical hazards;

4) to document general requirements and guidelines that direct the activities of personnel who could be exposed to electrical hazards;

5) to encourage, and make it easier for, each employee to be responsible for his/her own electrical safety self-discipline.

The scope of the electrical safety program should address the needs of all employees, as well as contractors and visitors, at a facility. All parties shall be orientated with the program, and be very familiar with the parts that pertain to his/her own particular job assignments. The written program should include policy, requirements, responsibilities, and general guidelines. Specific, detailed procedures can be written in subdocuments and referred to in the program.

A complete electrical safety program should contain the following elements:

1) management commitment;
2) organizational support;
3) electrical safety policy;
    a) electrically safe facilities;
    b) documented safe electrical work practices;
4) training and qualification of all personnel;
5) use of protective equipment, testers, tools, and protective methods;
6) use of electrical equipment;
7) documentation;
8) oversight and auditing;
9) technical support;
10) emergency preparedness.

1.2 Objective

The objectives of this project are:

i) To focus of electrical safety on current practices in industries and refocus by defining on improvement by analyzing fault related issues and management dynamics.

ii) To model human being when they are touch in current/lightning by using ATP-EMTP software.

iii) To produce a electrical safety training aid to facilitate in training of personnel to be more awareness about safety.

1.3 Scope of Project

The scope of work for this project includes:

i) Study the currently practices of electrical safety for three types of industries which are large (Panasonic), medium (TNB) and small (Kedai Letrik Mohamad Lotfi).
ii) Analyzed data from the industries.
iii) Determined the advantages and the weakness of the practices.
iv) Compare the practices with the standard and regulation.
v) Simulation study by using human body model when they are touch in current/lightning with ATP-EMTP software.
vi) Produce a training aid to facilitate in training of personnel to be more awareness about safety.

1.4 Research Methodology

The research work is undertaken in the following stages:

i) Survey the practices in the industries by:
   a) Interview the person or officer in charged of the electrical safety.
   b) Questionnaire for the officers and workers.

ii) Site visit to focus of the electrical safety and what is currently being practices in the industries.

iii) Looking at the accident reported.

iv) Simulation study to show the effect to the human being.

1.5 Literature Review

This project is new. Therefore not much reference in Malaysia is related to this project. However there is some literature review is carried out on the current practice in maintenance and safety inspection to help me in completing this thesis.

1.5.1 Occupation Safety and Health (OSH)

The establishment and maintenance of a system of inspection and maintenance of safety standards for the electricity industry is a complex issue involving regulatory instruments, voluntary efforts and common practice. Traditionally, (before the term OSH became fashionable) public safety was

maintained by strict application of punitive measures enforced by the law. This approach was one-sided and it was not found to be not effective. OSH recognizes that punitive actions and prescriptive regulations alone are not the answer to public safety and health,

a) The responsibilities for OSH lie also on the private sector and industry instead of just the regulator;

b) OSH legislation and regulations are therefore less prescriptive but more performance oriented;

c) The active involvement of industry and the private sector in OSH is encouraged both on voluntary and punitive programmed. The privatization of inspection officers (as oppose to the employment of fully government inspectors) can perhaps be listed as part of this procedure.

1.5.2 Active Measures

In Malaysia maintenance and safety inspection for the electrical industry include a mixture of punitive legislative measures and encouragement of voluntary efforts from industry. In line with the latest OSH trend, the involvement of private industry is expected to play an increasingly important part in OSH for the electrical industry. In Malaysia, maintenance and safety inspection can be categorized under the following broad categories:

a) **Maintenance Inspection** under “The Electricity Act” is mandatory for certain categories of industries where regular visits are made by independent licensed inspectors. Accident reporting as a mandatory statutory requirement under the responsibility of the inspector.

b) **Operation.** The safe operation of electrical installation are also covered under “The Electricity Act” which provides for the mandatory employment of competent persons qualified under the relevant grade of restriction. Accident reporting as a mandatory statutory requirement is also a function of the competent person responsible for maintaining the installation.

c) **Installation of new electrical installation** are covered by multiple laws which promote installation safety and standards:

i) “The Street, Drainage and Building Act” – all new structures or installation require submission of plans by competent persons, cross reference to the Engineers Act is also made. Under this Act registered engineers are also responsible for the maintenance of minimum safety standards (and in the near future energy efficient standards);

ii) “The Engineers Act” – registered engineers are name as qualified person eligible to submit plans;

iii) “The Electricity Act” – only registered wiring and/or electrical contractors are eligible to work on wiring/electrical installation;

iv) “The Electricity Act” – only qualified commissioning engineer and/or chargeman or wireman are eligible to test and endorse commissioning reports at their relevant competency level.

d) **Product Certification** supports the approval process listed above. Relevant agencies and laws are as follows:

i) The Electrical Department (Jabatan Elektrik) of the Energy Commission maintains a list of prescribed and approved items;

ii) In support of the prescribed list, SIRIM certifies electrical integrity and safety standards for approval. External or other foreign testing laboratories are also recognized by the Electrical Department;

iii) Apart from prescribed items, other items not on the prescribed list are subjected to certification standards demanded as a matter of procedure (especially in the construction industry);

iv) "The Standards of Malaysia Act" by its enactment confers certain legal status to standards adopted and published as Malaysian Standards. ISO/IEC standards by proxy therefore has legal status over other standards (if MS are not available).

1.5.3 Industry Participation

In line with current trends, the participation of the private sector in OSH legislation and procedures are increasingly becoming important. Concurrent with and reinforcing this trend include new paradigms shifts such energy efficiency, sustainable development and liberalization of the public sector. Some efforts in this include:

a) Standards Development

Despite and in spite of SIRIM and the DSM standard development and writing is a private sector driven initiative with DSM and SIRIM purely taking on the role of facilitator and record keeping.

b) Energy Efficiency

New legislative efforts in promoting energy efficiency are partly being driven by the private sector with the recognition that prescriptive and punitive regulations are not effective. Active consultation between industry and the regulators is an ongoing process.

c) Paradigm Shift in OSH for the Electrical Sector

Public consultation on a multitude of issues relating to OSH for the electrical sector is an ongoing process with perhaps a revision to “The Electricity Act’ and associated regulations, and the drafting of grid codes (for regulating the generation sector). This trend in public consultation has in recent times gained such momentum that government planners and legislator even co-opting the private sector participation in a multitude of issues including globalization, construction industry issues and sustainable development.

1.5.4 Industry Statistics

A quick preview of the electrical industry in Malaysia is shown in the following charts 1.1 to 1.2 (Ir. H. P. Looi, 2003) that shows statistics on accident reporting. The charts would seem to infer statistical rate (against total number of electrical consumers) as follows:

a) Electrical accident reports of about 1 to 100,000 per year; and
b) Rate of fire accident conclusively attributed to electrical fault of about 1 to 500,000 per year.

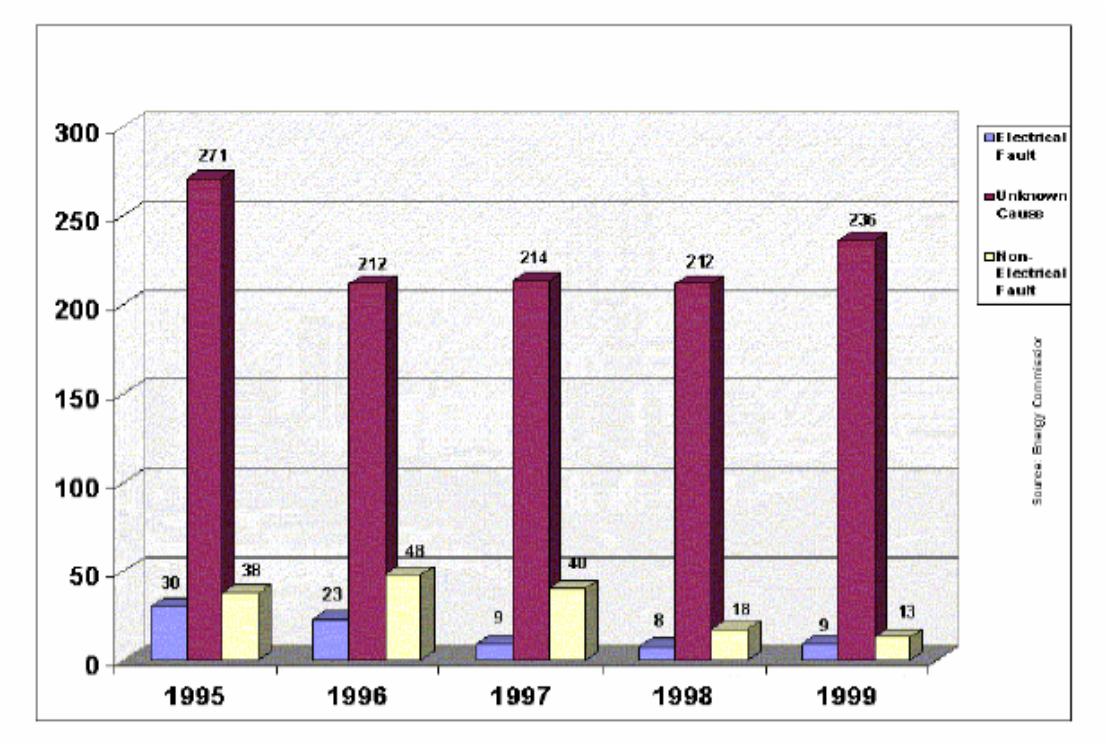

Chart 1.1: Number of Fire Accident Reported.

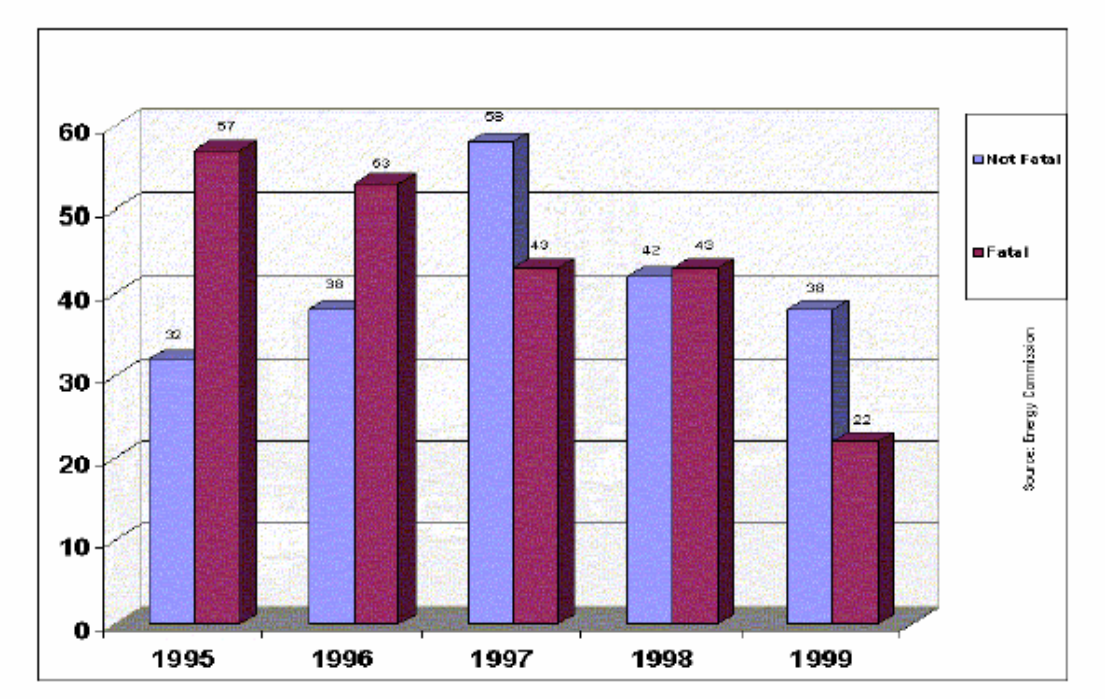

Chart 1.2: Number of Electrical Accidents Reported.

1.6 Structure and Layout of Thesis

This thesis is organized into five chapters. Chapter 1 gives the introduction to the project, stating its objective, scope of work, research methodology and overview. Chapter 2 mentioned the electrical safety must be addressed in a holistic manner to see the significant step change in improvement.

Chapter 3 discusses the result obtained from the surveying in the large, medium and small industry and continues with an analysis. Whilst in Chapter 4 the simulation is done by modeling the human being and to show the effect when they are touch in current/lightning. This is to facilitate in training of personnel to be more awareness about safety by using ATP-EMTP software. The thesis ends with Chapter 5, where the summary of this project is described. Recommendations for future work are also presented in this final chapter. Case study and training aid are also included in the appendix for employers and employees to be awareness about electrical safety.

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