**University of Western Sydney**

In Conjunction with

**The Hong Kong Polytechnic University**

# The Selection and Use of Electrical Insulating Gloves of Electricians in HKSAR

By

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## Declaration of Originality

The following work has been completed by the author as coursework research project report in the Master of Applied Science (Safety Management) at the University of Western Sydney in conjunction with the Hong Kong Polytechnic University under the supervision of Mr. Gary Ma.

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material that has been previously published or written by another person nor material which to a substantial extent has been accepted for the award of any other degree or diploma of a University or other institute of higher learning, except where due acknowledge has been made in the text.

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Lai Man Fai

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# Abstract

There are over 50000 Registered Electrical Workers (REW) in Hong Kong Special Administrative Region (HKSAR). The average number of electrical accidents is 56 cases per annum over the past eight years. Electrocution has been one of the highest fatal accident rate amongst all industrial mishaps. Uses of insulating gloves are often prescribed after an electrical accident. In searching the documentation on 402 electrocution cases of the National Institute for Occupational Safety and Health of USA (NIOSH), concluded that 95 cases could have been prevented with uses of insulating gloves and other personal protective equipment (PPE).

In Hong Kong SAR, the application of insulating gloves has neither been popular in the workplaces or nor been appropriately placed in the hierarchy of hazard control. Instead of being applied as the last line of defence, the apparent simplicity of insulating gloves was used in common sense for live working without due electrical risk assessment. Further review on international standards of insulation gloves for live working indicated that the standards were mainly specification on manufacturing and testing of gloves under laboratory conditions. There is no official guideline on the selection and use of insulating gloves in work environments.

Given the aforementioned, a study consisted of literature review, pilot interview and questionnaire survey was conducted on a group of random sampled REW amongst the contracting branch, servicing branch, power supply companies and trade unions. Salient findings were:

- 90% of the electricians of the surveyed 216 samples had encountered live work and 21% did not isolate the power in their daily work.
- Inadequate risk assessment and electrical shock hazard elimination procedures in their routine jobs.
- 81% of the electricians did not wear insulating gloves, with mostly the perception of lost of dexterity and lack of grip.
- Incomprehensive knowledge in selection of suitable insulating gloves.
- Inadequate training and skill in the use and maintenance of insulating gloves.

The findings conclusively confirmed the need of guidelines on selection, and care of insulating gloves. Technical guides on the selection, use and maintenance were prepared and recommended for the REW in HKSAR, based on the survey results. For easy reference of electrical workers in the trade, a draft “Guidance Notes” on the issues was also prepared, as an attachment of the project report.

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## Content of the Study

In Chapter One, electrical accident statistics in HKSAR and the apparent safety problems associated with the use of insulating gloves, alone with the background of the study are presented. The importance of the study to the industry is highlighted and the aim is established. Delimitations of the research are explained.

Chapter Two is a review of the literature surveyed for the study. General perception of safety and potential electrical hazards are briefly addressed. Protective Strategies in terms of safe system of work and risk assessment are explained. Hierarchy of control on electrical hazards, legal requirement on live work and codes of practices on isolation are studied. National Standard and specification of electrical protective gloves are reviewed. What is known and what is apparently not known are summarized at the end of this Chapter.

Based on established study aim and the summary of reviewed literature, Chapter Three sets out the objectives of the study. The methodology of the survey, including pilot study, scope of work, sampling strategy and questionnaire design are explained in details.

Results of the study are discussed in Chapter Four. Graphical presentations of the finding are included to assist the interpretation, elucidation and elaboration of the findings.

In Chapter Five, the survey results are summarized, and the conclusions reached are presented. Recommendations based on the study and findings of the survey are presented at the end of report.

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## List Abbreviations

| | |
|---|---|
| **ac** | Alternating current |
| **AS/NZS** | Australian/New Zealand Standard |
| **ASTM** | American Society for Testing and Materials |
| **BS** | British Standard |
| **dc** | Direct current |
| **EAWR** | The Electricity at Work Regulations |
| **EMSD** | Electrical and Mechanical Services Department o HKSAR |
| **EN** | European Standard |
| **F&IUR** | Factories and Industrial Undertakings Regulations |
| **GB** | The National Standard of PRC |
| **HKIE** | Hong Kong Institution of Engineers |
| **HKSAR** | Hong Kong Special Administrative Region |
| **IEC** | International Electro technical Commission |
| **IEE** | The Institution of Electrical Engineers |
| **JIS** | Japanese Industrial Standard |
| **JSA** | Job Safety Analysis |
| **NASD** | The National Ag Safety Database |
| **NIOSH** | National Institute for Occupational Safety and Health |
| **NOHSC** | National Occupational Health and Safety Commission |
| **OSHA** | Occupational Safety & Health Administration of US |
| **OSHR** | Occupation Safety and Health Regulations |
| **PHR** | Process Hazard Review |
| **PPE** | Personal protective equipment |
| **PRC** | The People's Republic of China |

| | |
|---|---|
| **RCDs** | Residual Current Devises |
| **REW** | Registered Electrical Worker |
| **r.m.s.** | root mean square |
| **RTS** | Return to sender |
| **v** | Voltage |
| **VTC** | Vocational Training Council |

# 1. Introduction

This project focuses on the selection and care of insulating gloves used by electrical workers in Hong Kong Special Administrative Region (HKSAR) and recommends improvements based on the research findings.

In the study of safe isolation of electricity at work (Occupational Safety and Health Branch, 2002), it was revealed that live work practices were common in Hong Kong and there were various reasons for failing to isolate power source at work. Insulating gloves, as well as other types of personal protective equipment, are effective; provided that their applications are correctly placed in the context of the hazard control hierarchy. The apparent simplicity of insulation gloves often being wrongly applied by electricians as the first choice to reduce injuries or damages in live working. Factors in effective selection and care of insulating gloves are grossly underestimated.

Background and contextual information of this project is explained in the following sections. The purpose of this study and it delimitations are elucidated at end of the chapter.

## 1.1 Background

In the manpower survey of Vocational Training Council (VTC, 1997), there were 51431 workers in the electrical industry and their distributions in the trade are as shown in Figure 1.

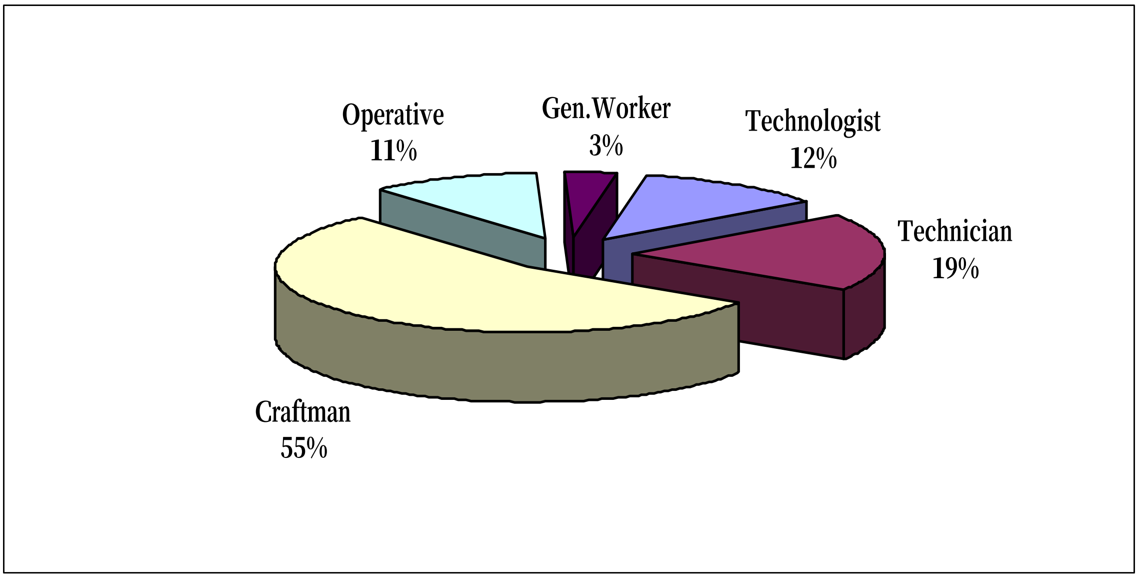



Figure 1. Distribution of Electrical Workers in Trade (Source: VTC, 1997 Manpower Surveyor Report – Electrical Industry)

According to the VTC (1997), 35% of the workers in trade, did not receive formal craft skill training and with education level below Form 5. As commented by the Training Board of Electrical and Mechanical Services (VTC, 1997), there is a concern on the quality and safety standard of work carried out by those tradesmen without completing the craft courses and employed in the industry. The operative job nature, lack of formal structure training and comparatively low education, expose craftman of the trade at higher risk of electrical shock.

Electrical incidents have been one of highest fatal accident rate amongst all industrial mishaps in HKSAR. The average number of electrical incidents, which involves contact with electricity or electric discharge, is over 56 cases per annum over the past eight years. Recent statistics on electrical accidents are as shown in Figure 2.

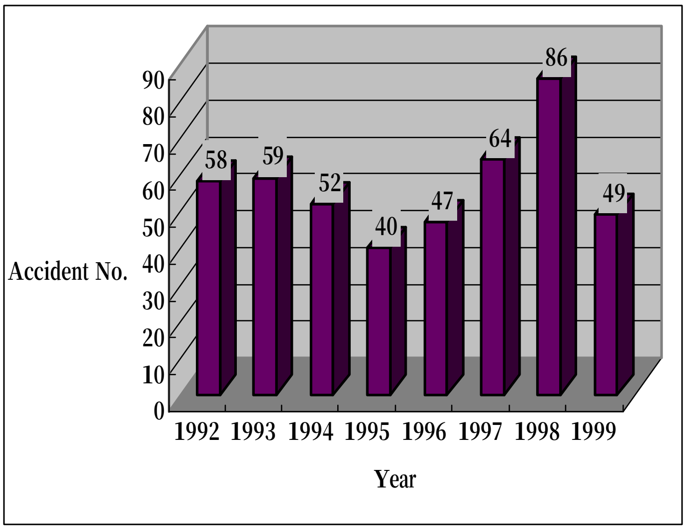



Figure 2. Number of Electrical Accidents from 1992 to 1999 (Source: Annual Report of Labour Department, 1993 – 2000)

Personal protective equipment (PPE) is commonly prescribed after an accident, as a measure to prevent reoccurrence (Nill, 1999). Detailed electrical accident reports have not been published by the local Labour Department. In searching the in-house documentation on 402 cases of electrocution studies conducted by The National Institute for Occupational Safety and Health (NIOSH) of US, recommendations on uses of insulating gloves and PPE to control or to prevent future electrical accidents are identified in 95 documents (FACEWeb, 2000). The importance on proper uses of protective gloves for electricians on accident prevention is emphasized.

## 1.2 Legal Requirements and Codes of Practices on Insulating Gloves

Local regulations on electrical safety, Factories and Industrial Undertakings (Electricity) Regulations, demands the employer on provision and upkeep of insulating gloves and other protective equipment, while the employee shall make proper use of the provided protective equipment. There is, however, no official guideline on selection and use of gloves for electricians in HKSAR.

The apparent simplicity of electrical protective gloves may result in a gross underestimation of the amount of effort and expense required to effectively use of this equipment to electrical workers. At the operation level, common sense estimations often overruled the consensus standard. The study is focused on the following areas to ensure effective protection of electrical gloves on electricians:

- Hazard Evaluation
- Selection
- Fitting
- Training and Education
- Maintenance and Repair

### 1.3 Statement of the Problem

The purpose of this study is to seek an overview and improvement on the selection and use of insulating gloves of electricians in the Hong Kong Special Administrative Region.

This study aim could be met by answering the following questions:

- What are the current safety practices of electricians in execution of their daily jobs?
- How do the application of appropriate gloves reduce the chance of electric shock?
- What are the considerations of suitable insulating gloves for electricians in HKSAR?
- How to use insulating gloves correctly at work?
- What to be done to upkeep and maintain insulating gloves?

The listed questions had been transformed into the main objectives of this study in Chapter 3, subsequent to the review of related literatures.

### 1.4 Delimitation of the Problem

This study will consider electricians as Registered Electrical Workers (REW) under the Electricity (Registration) Regulation (Chapter 406, 1990) in either one of the following categories.

- Grade A – electrical work on low voltage fixed electrical installation of maximum demand not exceeding 400A, single or three phase.
- Grade B – electrical work on low voltage fixed electrical installation of maximum demand not exceeding 2500A, single or three phase.
- Grade C – electrical work on low voltage fixed electrical installation of any capacity.
- Grade H – electrical work on high voltage fixed electrical installation.
- Grade R – electrical work on neon sign installation, air conditioning, or generating facility.

Similarly, study samples will only be drawn from the potential pool of REW in power supply companies, trade unions, contracting branch and servicing branch as discussed in Chapter 3.

# 2 The Study of Related Literature

## 2.1 Literature Review on Electrical Safety

### 2.1.1 General Perception of Safety

Safety has been defined almost unlimitedly. In the Occupational Safety and Health Convention (1981) of the International Labour Organisation, the term safety, in relation to work, is considered as without risk to health, where health not merely means the absence of disease or infirmity, it also includes the physical and mental elements affecting health which are directly related industrial hygiene (Occupational Safety and Health Convention, 1981)

Recent safety professions in Mainland China opt the view that safety shall mean free from danger, unthreatened and accident free (Yeung, 1999). Safety in production processes is focused on save guard of workers from injuries and occupational diseases; protection of plant equipment from losses. Mathematically, safety can be expressed as Equation 1(Yeung 1999):

$$\mathbf{S = 1 - D}, \qquad (1)$$

where S is the degree of safe and D is the degree of danger.

Safety studies are practically the study of risk and harm. In the Tenth Annual Symposium of the Hong Kong Institution of Engineers (Electrical Division), safety was regarded as “a morally acceptable degree of risk”, which implied the assumption that safety was a relative concept and assessment had to be conducted prior to work (Powell, 1992)

### 2.1.2 Understanding Risks

In general, we tend to be overoptimistic about the risk that we face (Mohanna and Chambers, 2000). Very often misperception on risks exists; towards the illusion of invulnerability and complacency. Correct perception of risk is a prerequisite in all safety activities, misplaced optimism may result in a barrier to hazard analysis and subsequent control actions. In simple terms, risk can be defined as the probability that a hazard will give rise to harm.

#### 2.1.2.1 Cultural Theory

Cultural theorist opts the view that "personality" affect individuals on the understanding of risk and subsequent risk-taking behavior. According to the cultural theory model, there are 4 main types of "personality" (Mohanna and Chamber 2000):

- Individualists – They emphasize the individual responsibility to minimize personal risk. Individualists have a strong sense of personal autonomy and may resent suggestion of safety professions.
- Hierarchists – This group of people adopts the epidemiological base to evidence which is opposite to individualists.
- Egalitarians – They have a tendency to distrust experts and the context within which risks are viewed is a social construct. Understanding and therefore avoiding risk can be improved by public participation.
- Fatalist – They diminish the importance of the group experience as a provider of evidence about outcomes and tend not to recognize the role of society as a force or a source of support. They perceive risks as part of the increasing complexity of modern

life, against which they have no defense.

The fundamental of culture theory is based on how we look at the world and the experience, which we have learnt from our live. In workplace, we do experience worker adopts opposite “personality” when confronted with different work situations.

#### 2.1.2.2 Risk Compensation Theory

Adam (1995) suggested that we all, to some extent, build an element of uncertainty into our life to increase reward. He further proposed that there is a “risk thermostat” to balance risk taking and the value we placed on the reward. The basic assumption of this theory is summarized as follows (Mohanna and Chamber 2000)

- Everyone has propensity to take risk
- This propensity depends on the potential reward of risk taking
- Individual risk-taking decisions are a balanced act on perceptions of risk against potential rewards.

The risk compensation theory develops along the same lines of thinking on the acceptability of risk. The thinking comes from a legal case, Edwards v NCB [1949] (cited in McGuinness and Smith, 1999), in which it was judged that a computation must be made where the quantum of risk is placed on one scale and the sacrifice involved in the measure for averting the risk is placed on the other. One of the shortcomings of this risk compensation theory would seem to define accidents as consequence of risk taking and individual decisions which is a result of a balancing act between the effects those accidents have on us and the value we place on the rewards. This may contradict with safety professionals on elimination of hazards and move towards total abolition of accidents.

The perceptions of safety vary dramatically among individuals. Safety behaviors and attitudes at work are being driven by appropriate risk perception. It would be necessary to appreciate the general safety concepts of the electrical workers in the study by formulating structure questions in the interviews and questionnaires.

### 2.1.3 Electrical Hazards

Electrical safety involves a thorough understanding on the electrical hazards so that we will have the correct perception in development of protective strategies. The National Institute for Occupational Safety and Health has prepared a student manual of Safety and Health for Electrical Trade (NIOSH Publication No. 2002-123), in which electrical hazards are broadly classified as follows.

#### 2.1.3.1 Shock

Electric Shock is the physical stimulation that occurs when electric current passes through the body (Cadick, 2000). The degree of danger from electrical shock depends on the amount, duration, path of the shocking current and the general physical condition of the person receiving shock. The damages of electric shocks arising from varying amount of current passing through the body are summarized in Table1.

| Current | Reaction |
|---|---|
| 1 milliamp | Just a faint tingle |
| 5 milliamps | Slight shock felt. Disturbing, but not painful. Most people “let go”. However, strong involuntary movement can cause injury. |
| 6-25 milliamps (women)<br>9-30 milliamps (men) | Painful shock. Muscular control is lost. This is the range where “freezing currents” start. It may not be possible to “let go”. |
| 50-150 milliamps | Extremely painful shock, respiratory arrest (breathing stops), severe muscle contractions. Flexor muscles may cause holding on; extensor muscles may cause intense pushing away. Death is possible. |
| 1-4.3 amps | Ventricular fibrillation (heart pumping action not rhythmic) occurs. Muscles contract; nerve damage occurs. Death is likely. |
| 10 amps | Cardiac arrest and severe burns occur. Death is probable. |

Table 1 Effects of current passing through human body (Source : Safety and Health for Electrical Trade (NIOSH Publication No. 2002-123))

#### 2.1.3.2 Burns

Burns caused by electricity are frequently third degree burns as a result of burning from the inside. It could be further categorized into 3 main groups (Cadick, 2000):

- Electrical Burns.
- Arc burns
- Thermal contact burns

#### 2.1.3.3 Falls

Even low voltages at 80 a-c volts (Cooper, 1993) can cause violent muscular contraction. One may lose the balance and fall at height. Serious injuries, like bone fractures or even death may be resulted from the fall arising from electrical incident.

#### 2.1.3.4 Explosion

Blasts may follow when an electric arc occurs. As the surrounding air is being superheated, a rapid expansion of air with a wavefront could reach a pressure of 100 to 200 pounds per square foot (Cadick, 2000). Such pressure is sufficient to explode enclosed electrical appliances.

### 2.1.4 Systemic Approach in Electrical Safety

In the symposium titled "Quest for Quality and Quantity in Electrical Engineering, Hong Kong (1988)", the representatives of Electrical and Mechanical Services Department (EMSD) proposed a systems approach on the promotion of electrical safety in Hong Kong. It had been emphasized that many personnel and workers engaged in the electrical industry had not received any proper training and they had only gained their knowledge from their daily work (EMSD, 1988). Legislation on electricity safety could only be directive. To assist the industry, it was suggested that Government should publish some technical guidelines in form of code of practice and guidance notes so that the industry can adapt to the safety principles laid down in the legislation more easily. The focus on practical guidelines to be issued is as shown in the block diagrams of Figure 5.

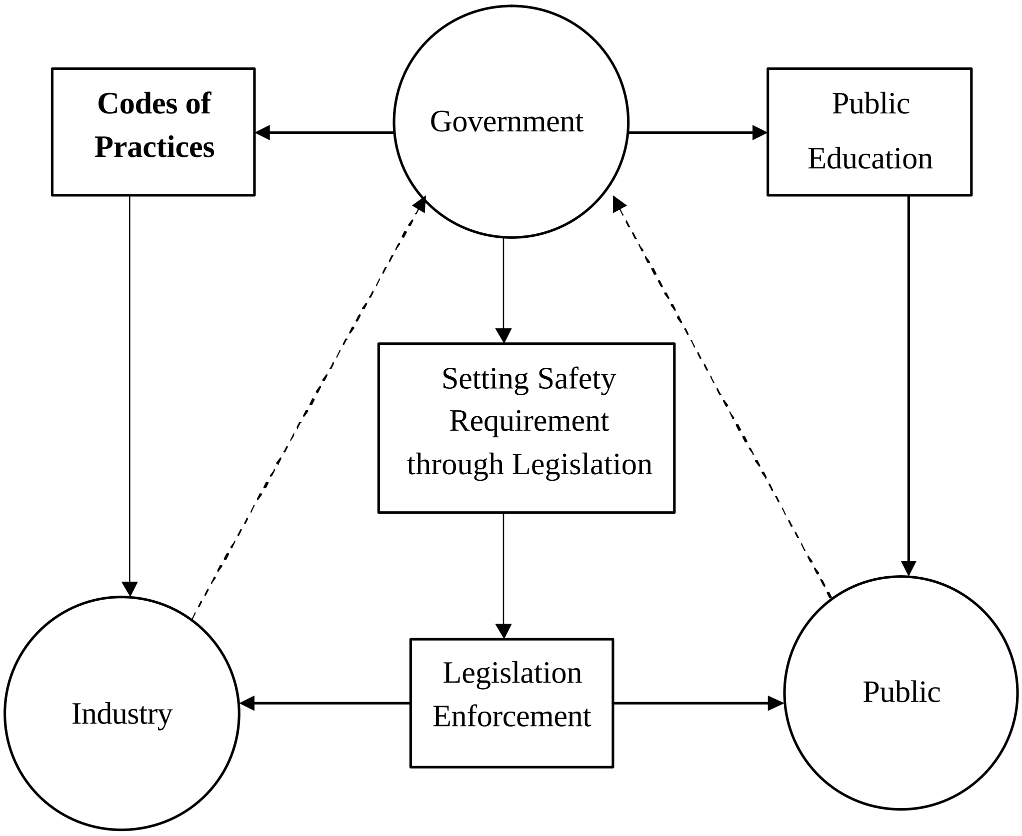



Figure 3 Proposed System Approach in Electrical Safety by EMSD (Source: EMSD, 1988, Quality & Safety – A Systems Approach)

Based on the systemic approach of EMSD, it would seem most beneficial in preparation of a guidebook on the issue to improve electrical safety subsequent to a survey on the selection and use of insulating gloves used by electricians in HKSAR.

## 2.2 Protective Strategies

The occupation and health legislation of HKSAR, among other safety provisions, follows similar protective strategies as established in the Health and Safety At Work of the UK. Under Section 6A of the Factories and Industrial Undertakings Ordinance, Chapter 59, employers are legally obliged to provide and to maintain "systems of work", as far as reasonable practical, safe and without risks to health.

### 2.2.1 Safe System of Work

In the Health and Safety Briefings of The Institution of Electrical Engineers (IEE, 2002), systems of work have a broad meaning which includes:

- Physical layout of the job.
- Sequence in which the work is to be carried out
- Provision of warnings and notices
- Issue of instructions.
- Any subsequent modification and improvements of the established system.

In simple terms, the protection of workers relies on the duty of care of employer under the provision of safe system of work (Labour Department, 1990). The obligation on the employer is threefold :

- Provision of a competent person
- Adequate material and plant
- Effective supervision

### 2.2.2 Key Elements of a Safe System of Work

The process to develop a modern safe system of work (IEE, 2002) is to identify the hazards, with reasonable care and precautions, and then to:

- make a risk assessment

- determine what can be done to remove the identified hazards.
- formalize the hazard control steps into procedures.
- include in the procedure the use of permit to work coupled with physical lockout systems.
- monitor the observance
- feed-back failures in system
- rectify defects and modify system
- keep monitoring and continuous improvement.

The safe system of work can be considered as a formal procedure which results from systematic examination of a task in order to identify all the hazards. It defines safe methods to ensure that hazards are eliminated (Labour Department, 1990)

### 2.2.3 Risk Assessment

The Management of Health and Safety at Work Regulations (1999) of UK defines risk assessment as identifying the hazards present in any undertaking and then evaluate the extent of the risks involved, taking into account whatever precautions are already being taken. It further defines hazard as potential harm and risk as the likelihood of the harm from a particular hazard being realized.

In Hong Kong, the Factories and Industrial Undertakings Regulations and the Occupational Safety and Health Regulations require common risks to be assessed. It is the legal duty of employers to assess certain risks to identify what has to be done to protect workers from harm. The Safety Management Regulation (2000) of HKSAR further sets out the requirement in establishment of a program to identify hazardous exposure or the risk of such exposure to the workers. Proposed engineering controls and provision of suitable personal protective equipment are one of the key elements stipulated in the Safety Management System to be adopted. It is important to note that very specialized risks, such as electrical hazards, has not been set out in the Factory and Industrial Undertakings (Electricity) Regulations or the Electricity Ordinance.

The Factories and Industrial Undertakings (Electricity) Regulations was established in 1982 on a prescriptive basis. The clauses on electrical safety requirements are focused on the construction and usage of circuit breakers, switchboards, electrical motors; insulation and protection of conducts. There is neither requirement on assessment of electrical hazard at work nor implementation of controls on identified electrical hazards. The Electricity Ordinance has come into operation since 1990. It consists of sets of regulations on safety requirement of electricity supply, registration of electrical workers, installation of wiring and safety provisions on electrical products. There is, however, no provision on risk assessment of electrical shock hazards at work places.

### 2.2.4 Personal Protection Devices

The protection of worker in Mainland China follows similar protective strategies. The Labour Law of The People's Republic of China (PRC) was adopted at the Eight Meeting of the Standing Committee of the Eighth National People' s Congress on July 5, 1994 and came into effective in January 1, 1995. In Article 52, employing units are required to establish and perfect the system of occupational safety and health through the follows.

- Provision of safety education among labour.
- Prevention of accidents in the process of work, and
- Elimination occupational hazard in workplaces.

It should be noted that these fundamentals of worker protection is stated unequivocally in the National Standard of PRC, GB 11651 – 89, Selection rules of articles for labour protection use. The Labour Department of PRC has categorized 38 hazardous work classes, according to the potential harms of the energy or material associated with the work characteristic or the specific work conditions, as shown in Table 2.

Table 2 Classification of Work Category (Source : GB11651-89, Schedule 1)

| 編<br>(Ref. No) | 作 別名稱<br>(Work Categories) | Remark |
|---|---|---|
| A01 | 易燃易爆場所作<br>(Works at flammable and explosive workplaces) | Workplaces containing self-igniting materials. |
| A02 | 可燃性粉塵場所作<br>(Works at flammable dust workplaces) | Workplaces containing flammable solid dust particles. |
| A03<br><br><br>A04 | 高 作<br>(High temperature works)<br><br>低 作<br>(Cryogenic works) | Works as defined in GB 4200-84, Works at High Temperature<br>Workers require insulating clothing to keep warm |
| A05 | 低壓帶 作<br>(Low voltage live works) | Live work at rated voltage of less than 1200V |
| A06 | 高壓帶 作<br>(High voltage live works) | Live work at rated voltage higher than1200V |
| A07 | 吸入性气相毒物作<br>(Inhaling toxic gaseous works) | Works involves toxic gaseous or vapour at room temperature |
| A08 | 吸入性气溶 毒物作<br>(Respiratory toxic fumes works) | Works involves toxic fumes or dust |
| A09 | 沾染性毒物作<br>(Toxic contamination works) | Toxin absorption through contaminated clothing |
| A10 | 生物性毒物作<br>(Biological toxin works) | Possible infection arising from biological toxin |
| A11<br><br>A12 | 腐蝕性作<br>(Corrosive works)<br>易 作<br>(Contamination works) | Production of application of corrosive material<br>Dirt contaminating skin or clothing |
| A13 | 惡味作<br>(Objectionable odour works) | Nontoxic, however strong objectionable odour or smell |
| A14 | 密閉場所作<br>(Confined space works) | Vessel entry, or non-ventilated space of oxygen content below 18% |
| A15 | 噪音作<br>(Noisy works) | Noise level higher than 90dB |
| A16 | 光作<br>(Glaring works) | Glaring light source, IR or UV works |

Table 2 Classification of Work Category (Source : GB11651-89, Schedule 1)

| 編<br>(Ref. No) | 作 別名稱<br>(Work Categories) | Remark |
|---|---|---|
| A17 | **激光作**<br>(Laser works) | Laser generating or processing works |
| A18 | **熒光屏作**<br>(VDU works) | Extended hours work at VDU |
| A19 | **微波作**<br>(Microwave works) | Microwave generating or processing works |
| A20 | **射 作**<br>(Ionizing radiation works) | Radiation dosage higher than limits. |
| A21 | **高 作**<br>(High level works) | Works at height >2m with falling hazard |
| A22 | **存在物體墜落、撞擊的作**<br>(Potential fall object/impact works) | Construction, mining, shipbuilding, hoisting works |
| A23 | **有碎屑 濺的作**<br>(Splashing works) | Milling, grinding works |
| A24 | **操縱轉 機械**<br>(Operating revolving machines) | Lathe, conveyor belts |
| A25 | **人工搬 `**<br>(Manual handling) | Manual lifting, push, pull and transportation |
| A26 | **接觸使用鋒利器具**<br>(In contact with sharp objects) | Glazier |
| A27 | **地面存在尖利器物的作**<br>(Sharp objects hidden in ground) | Frost and construction work |
| A28 | **手持振 機械作**<br>(hand held vibrating machine works) | Pneumatic drill, chisel |
| A29 | **人承受全身震 的作**<br>(Body subject to vibration works) | Work under vibrating environment |
| A30 | **野外作**<br>(Outdoor works) | Long term exposure in outdoor |
| A31 | **水上作**<br>(Water works) | Working at water platforms |
| A32 | **涉水作**<br>(Wetting works) | Work in mining wells, tunnels |
| A33 | **潛水作**<br>(Diving works) | Work under water surface |

Table 2 Classification of Work Category (Source : GB11651-89, Schedule 1)

| 編 (Ref. No) | 作 別名稱 (Work Categories) | Remark |
|---|---|---|
| A34 | **地下挖掘建築作** (Underground construction works) | |
| A35 | **車輛駕駛** (Vehicle driving) | |
| A36 | **、吊、推机械操縱** (Hoisting works) | Machinery lifting |
| A37 | **一般性作** (General works) | |
| A38 | **其他作** (Other works) | Works no included in above |

The National Standard further grouped common personal protective equipment into 51 types, based on the application conditions and protective functions, as shown in Table 3

Table 3 Grouping of Personal Protective Equipment (Source : GB11651-89, Schedule 2)

| 編 (Ref. No) | 品品 W (Types of Protective Equipment) |
|---|---|
| B | Prohibited Types |
| B01 | Nylon clothing |
| B02 | PVC shoes |
| B03 | Shoes with steel insoles |
| B04 | Gloves |
| C<br>C01 | Mandatory Types<br>White cotton outfits to protect against heat |
| C02 | Synthetic reflective outfit to protect against heat |
| C03 | Cotton overall |
| C04 | Foundry boots |
| C05 | Caps to protect against cold |
| C06 | Outfits to protect against cold |
| C07 | Gloves to protect against cold |
| C08 | Shoes to protect against cold |
| C09 | Antistatic clothing |

Table 3 Grouping of Personal Protective Equipment (Source : GB11651-89, Schedule 2)

| 編<br>(Ref. No) | 品品 W<br>(Types of Protective Equipment) |
|---|---|
| C10 | Equal-potential clothing |
| C11 | Insulating gloves |
| C12 | Insulating shoes |
| C13 | Antistatic shoes |
| C14 | Safety goggles |
| C15 | Face masks |
| C16 | Canister respirators |
| C17 | Self-contained breathing apparatus |
| C18 | General purpose dust respirators |
| C19 | Non-permeable clothing |
| C20 | Non-permeable gloves |
| C21 | Anti acid(alkaline) clothing |
| C22 | Anti acid(alkaline) gloves |
| C23 | Anti acid(alkaline) shoes |
| C24 | Barrier cream |
| C25 | Ear plugs |
| C26 | Ear muffs |
| C27 | Safety spectacles to protect against welding arcs, UV lights |
| C28 | Safety spectacles to protect against laser |
| C29 | Safety spectacles to protect against microwave |
| C30 | Safety spectacles for VDU works |
| C31 | Safety spectacles to protect against ionizing radiation |
| C32 | Shielding Clothing |
| C33 | Coverall to protect against ionizing radiation |
| C34 | Hairnets |
| C35 | Helmets |
| C36 | Safety belts |
| C37 | Face shields |
| C38 | Anti-vibration gloves |
| C39 | Anti-vibration shoes |
| C40 | Anti-slip shoes |
| C41 | Gloves to protect against cut and sharp objects |
| C42 | Impact resistant helmet |

Table 3 Grouping of Personal Protective Equipment (Source : GB11651-89, Schedule 2)

| 編 (Ref. No) | 品品 W (Types of Protective Equipment) |
|---|---|
| C43 | Anti-slip gloves |
| C44 | Footwears to protect against twist |
| C45 | Shoes with steel insoles |
| C46 | Waterproofing outfits |
| C47 | Clothing for wet processing |
| C48 | Diving suits |
| C50 | General work clothing |
| C51 | Other protective accessories, sleeves, gaiters, aprons |

Section 5 of GB 11651 – 89 matches the possible harms of the categorized works and the protective functions of the classified PPE and formed a schedule of selection specification. For each of the 39 hazardous work classes, associated mandatory protective equipment, recommended protective equipment and prohibited non-compatible equipment types are listed for immediate references as shown in Table 4.

Table 4 Selection Specification (Source: GB11651-89, Schedule 3)

| 編 (Ref. No) | 不可使用的品 W (Prohibited Types) | 必須使用的 品 (Mandatory Types) | 可考慮使用的 品 (Recommended Types) |
|---|---|---|---|
| A01 | B01, B02, B03 | C03, C09, C13 | |
| A02 | B01, B03 | C03, C15 | C09, C13 |
| A03 | B01, B02 | C01, C04, C27, C35 | C02, C51 |
| A04 | B03 | C06, C07, C08 | C08, C40 |
| A05 | | C11, C12 | C35, C37 |
| A06 | | C11, C12, C36 | C10, C37 |
| A07 | | C15 | C16, C17 |
| A08 | | C15,C34 | C14, C16, C17, C19, C20 |
| A09 | | C14, C15, C19, C20, C34 | C16, C17, C24 |
| A10 | | C15, C19, C20, C34, C37 | C16, C24 |

Table 4 Selection Specification (Source: GB11651-89, Schedule 3)

| 編 (Ref. No) | 不可使用的品 W (Prohibited Types) | 必須使用的 品 (Mandatory Types) | 可考慮使用的 品 (Recommended Types) |
|---|---|---|---|
| A11 | | C14, C15, C21, C22, C23, C34 | C17 |
| A12 | | C18, C34, C50, C51 | C24 |
| A13 | | C50 | C17, C24, C34 |
| A14 | | C17 | |
| A15 | | | C25, C26 |
| A16 | | C27 | |
| A17 | | C28 | |
| A18 | | | C30 |
| A19 | | | C29, C32 |
| A20 | | C31, C33 | |
| A21 | B03 | C35, C36 | C40 |
| A22 | | C35, C44 | |
| A23 | | C37, C50 | |
| A24 | B04 | C34, C37, C50 | |
| A25 | B03 | C43 | C35, C40, C44 |
| A26 | | C50 | C41, C44, C45 |
| A27 | | C45 | |
| A28 | | C38 | |
| A29 | | C39 | |
| A30 | | C46 | C05, C06, C07, C08, C37, C40 |
| A31 | | C40, C48 | C36, C47 |
| A32 | | C46 | |
| A33 | | C49 | |
| A34 | | C35 | C18, C25, C38, C44, C46 |
| A35 | | C50 | C27, C37, C42 |
| A36 | | C50 | C18, C27, C37, C46 |
| A37 | | | C50 |
| A38 | | | C50 |

The apparently oversimplified guideline may be of limited uses. While it is true that some jobs are inherently more dangerous than others, modern accident researchers opt the view that incidents are multiple causation and root causes often relate to the management system (Heinrich, Petersen and Roos, 1980). Chmiel (2000) further suggested that workplace could involve various environmental and social conditions, such as noise, heat, illumination, long hours and production targets. It is important to investigate and conduct assessment on individual job process to identify effective protective equipment.

### 2.2.5 Selection and Use of PPE

The Department of Employment of Queensland Government has prepared an industrial guideline, Workplace Health and Safety Management Advisory Standard 2000 Supplement 1 – Personal Protective Equipment, to guide the selection of PPE. Key selection factors are:

- Risk assessment of the work process.
- Matching the acceptable risk level and the performance requirement of PPE.
- Ensure the selected PPE is compatible with other types of PPE being adopted in the same process.
- Comfort and fitness
- Effect of heat

Stull (1998) further suggested a checklist approach in the selection and use of PPE as shown in Table 5

Table 5 Selection protocol of PPE (Source : Stull, 1998, pp xxxi)

| Procedure | Selection Steps |
|---|---|
| Conduct a risk assessment to: | 1. identify the hazards present.<br>2. determine the affected body areas or body areas by the identified hazards.<br>3. assess the risks associated with each hazard. |
| Use information from risk assessment to: | 4. determine which hazards must be protected against.<br>5. decide which general types of PPE must be used<br>6. set minimum performance levels for relevant properties. |
| For the general types of PPE items determined to be necessary: | 7. choose a specific design type.<br>8. choose appropriate design features.<br>9. set minimum performance levels for relevant properties. |
| Prepare the PPE specification | 10. select an existing standard.<br>11. Modify or supplement an existing standard<br>12. prepare a minimum design and performance specification. |
| Evaluate candidate PPE to supply against the minimum acceptance criteria: | 13. require manufacturers to supply product information and technical data.<br>14. use PPE evaluated by independent test laboratories or certified to specific standards<br>15. conduct field trials. |
| Establish a PPE program | 16. set responsibilities within the organization to oversee the PPE program.<br>17. train workers in the selection, use, care and maintenance of PPE.<br>18. provide a system for care and maintenance of PPE. |
| Periodically conduct a new risk assessment | 19. evaluate how selected PPE is working to provide adequate levels of protection. |

AS/NZS 2161.1:2000, Occupational protective gloves – Part 1: Selection, Use and Maintenance, was prepared by the Joint Australia/New Zealand Standards Committee. The Standard sets out recommended practices to allow users to choose and maintain occupational protective gloves with adequate levels of protection. Hazard identification and risk assessment are specified as prerequisites in selection of protective gloves, in order to identify the critical aspects of use and the type of glove likely to suit the type of work and the anticipated environmental conditions.

To summarize, mapping and checklist, are the two main approaches in the selection of personnel protective equipment. In either selection approaches, hazard identification and risk assessment are essential procedures. The use of PPE is to minimize exposure to specific hazards or to reduce the severity of injury (Graham, 1999). PPE, itself, can neither reduce the hazard nor guarantee total protection.

## 2.3 Overview of Personal Protection

The scope of personal protection includes all control measures in preventing occupational injuries and diseases (Herrick, 1998). In the year 2000 survey on ' Usage of Personal Protective Equipment in Hong Kong' conducted by Occupational Safety and Health Council (OSHC, 2000), it was revealed that employers and workers rely on the protective equipment as the key means of preventing exposure. The result also indicated that many employers and employees had selected the protective device without knowing the hidden hazards. Effective implementation of personal protection schemes depends on the proper placing of personal protection program in the hazard control hierarchy. Personal protective equipment is never a substitute for good engineering control, administrative measures or good work practices (Ohasis, 2002).

### 2.3.1 Hierarchy of Control on Electrical Hazards

In a broad sense, the hierarchy of engineering control being: firstly elimination, then isolation and lastly minimization (Pringle, 2001). The hierarchy of hazard control can be summarised in the inverted pyramid as shown in Figure 4.

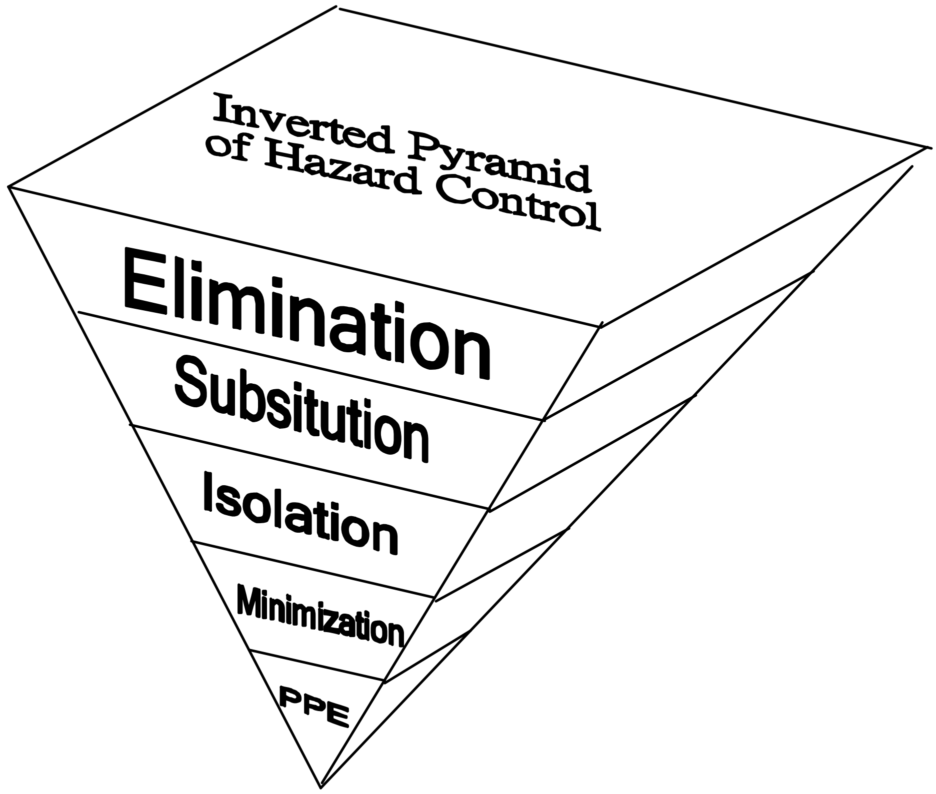



Figure 4 Inverted Pyramid of Hazard Control (source: Pringle, 2001)

Following a similar hierarchy of control, WorkCover Corporation of South Australia (2002) suggests a sequence of action to deal with anticipated electrical hazard.

- Elimination
  - Remove hazardous electrical plant from the workplace.
  - Cease in-house operations of hazardous work.

- Substitution
  - Use low voltage electrical appliances
  - Substitute movable electrical plant with fixed equipment
- Isolation
  - Place hazardous electrical plant in enclosures with restricted access
  - Apply tagout and lockout procedure
- Minimization
  - Use engineering controls. The application of RCDs to protect socket outlet could be an effective means to protect workers from harmful electrical shock.
  - Use administrative controls. Scheduled inspections and checks on electrical installation and implementation of safe work practices, instruction and training would help to identify electrical faults and rectify the defeats in a systemic way.
- Use Personal Protective Equipment (PPE)
  - The use of insulated gloves, rubber mats and other personal protective equipment is the last resort. Protective barrier on person is the lowest level of the control hierarchy. "All practicable steps" in each control level shall be applied, before dropping to the next level.

There is always a temptation to resort to the use of PPE as a cheap immediate solution, without proper evaluation of the effective control measures as listed in the hierarchy.

### 2.3.2 Live Work and Isolation

The Electricity at Work Regulations 1989 (EAWR) of UK have wide implication to all electrical systems and require precautions to be taken against the risk of death or injury from electricity in work activities. Regulation 14 of EAWR specifies that no person shall be engaged in any work activity on live work that danger may arise unless:

- It is unreasonable for it to be dead.
- It is reasonable for him to be at work on it live.
- Suitable precautions (including where necessary the provision of suitable protective equipment) are taken to prevent injury.

In Hong Kong, there are no similar safety clauses in our Electricity Ordinance. Isolation of electrical equipment is encouraged in the Code of Practice for the Electricity Regulations (1997). It is, however, remarked that where serious inconvenience would arise from isolating circuits, adequate precautions should be taken to avoid danger for work involving the handling of energized parts or working within touchable distance, direct or indirect, of energized parts at low voltage. The Code allows live works with the following precautions:

- Live works should be done only by Registered Electrical Workers (REW), or under his supervision.
- Screen or other means to avoid danger from inadvertent contact with energized conductors should be provided.
- Fixing of warning notices for repair, barriers and screens.

It is, however, according to the Occupational Safety and Health Branch of Labour Department (2002), comparatively high percentage of live work were executed without proper isolation of electricity source at work, mainly due to the following reasons.

- Deliberately not isolating power supply source
  - Under-estimate the hazards and the consequence of accidents.

- Over estimate one's competency and carefulness at work.
- Cut comers to save time and for convenience.

- No Lock Out Procedure
  - The isolate power source has not been locked out so that it could be connected back accidentally.
  - No warning notice, signs or tags posted at the isolated power source to alert others not to disturb it.

- Deficiency in the working system
  - Inadequate house rules and working system to govern the isolation of power supply for electrical work.
  - Lack of supervision such that workers committed danger acts instead of following safety procedures.
  - Lack of management control on the access of power supply source/electrical switch room.

It would seem "worker behaviour" and "system of work" are the two key issues to be included in the survey to help the understanding of the live work practices of REW in execution of their routine jobs.

In Mainland China, 6kV-10kV distribution networks are the most common supply infrastructure for industries and households. To ensure supply securities and avoidance of regional power interruption, the repairs and upkeep of which are frequently executed in live (Wu, 2001). Special trainings are provided to workers by provincial power supply units. According to Wu (2001), the specified conditions for live works are:

- Maximum allowable current to pass through human body shall be less than 1 mA
- Maximum allowable field strength shall be less than 240kV/m.
- Maintain a safety distance with live conductors as listed in Table 6.

| Rated Voltage of Equipment | <10kV | 20-35kV | 44kV | 60kV | 110kV | 220kV | 330kV |
|---|---|---|---|---|---|---|---|
| Safety distance of between energized conductor and human body during live works | 400mm | 600mm | 600mm | 700mm | 1000mm | 1800mm | 2600mm |

Table 6 Safety Distance between Workers and Lived Equipment (Source: On, 1998 Practical Handbook of Safe Electrical Operation, pp26)

In summary, live works are not prohibited in national and international standards. Isolation of live system prior to electrical works is not absolute duty, however, energized system shall render dead as far as reasonable practical. The requirement is of “reasonable practicability” where the risk considered on one hand is assessed against the cost and physical difficulty of reducing the risk to an acceptable level on the other (IEE-Health and Safety Briefing 34a, 2002). It would be interested to study the live work practices of REW and their associated risk assessment of electrical works in the survey.

## 2.4 National Standard and Specification of Electrical Protective Gloves

### 2.4.1 BS EN60903: 1993 Specification for Gloves and Mitts of Insulating Material for Live Working

This is one of the most commonly used standard of protective gloves for electricians in HKSAR. The standard specifies the physical requirements and testing procedures of insulating gloves for live electrical works. Six classes of gloves, differing in electrical characteristics, are provided. Gloves are further classified into six categories according to their resistance properties against acid, oil, ozone, mechanical strength, a combination of all and for extreme low temperature. This specification only provides simple guidelines for the selection of the class of glove in relation to nominal voltage of a system. The maximum use voltage recommended for each class of glove is designated in the following table.

| Class | a.c. r.m.s (V) | d.c. (V) |
|---|---|---|
| 00 | 500 | 750 |
| 0 | 1000 | 1500 |
| 1 | 7500 | 11250 |
| 2 | 17000 | 25500 |
| 3 | 26500 | 39750 |
| 4 | 36000 | 54000 |

Table 7 Maximum use voltage for the 6 classes of glove (Source: BS EN60903: 1993, Table A I)

The shapes of the gloves, including the curve of the finger and the contour are clearly specified. For each size of insulating gloves (8 to 11) detailed dimensions of the follows are given.

- Circumference of palm

- Circumference of wrist
- Circumference of cuff
- Circumference of each fingers
- Width of palm
- Wrist to end of second finger
- Base of thumb to end of second finger
- Mid-point of curve of second finger
- Lengths of each finger.

Contrasting with the two measurement on hand circumference and length requirement of general protective gloves (EN 420: 1994), the given details do emphasis the fit of users' hands on glove contours are essential elements for proper protection. It suggests a survey on this widely accepted European standard on physical fit on local tradesman would be interesting, to ensure safe application.

In-Service recommendations are provided as guidance in Appendix G of the document. Notes on the follows are given for maintenance, inspection, retest and use of gloves after purchase.

- Storage
- Examination before use
- Precaution in use
- Periodic inspection and electrical retesting

The guidance notes provides helpful information on safety use of the gloves in daily operation. However, the in-service recommendations are not designated as 'normative' as part of the body of the specification and demands manufacturers in provision of the relevant information.

### 2.4.2 Designation : D120-95 of ASTM Standard 1996

This standard specifies the testing of rubber insulating gloves for electricians. The specification defines 2 types of gloves, resistant/non-resistant to ozone. Similar to BS EN60903, six classes of gloves are specified according to different electrical characteristic and protection against different voltages. The use and maintenance of gloves are given to be beyond the scope of the specification. General selection guide is based on the relationship between the maximum voltage on which they are used and the proof test voltage at which they are tested. To summarise, the concept of “safety margin” is being applied as the major criteria of selection. The calculation equations and proof-test/use voltage relationship are as shown in Table 7.

Equations for calculation of maximum use voltage (classes 1, 2, 3, and 4)

Maximum A-C use voltage = 0.95 a-c proof-test voltage – 2000 V (2)

Maximum A-C use voltage = 0.95 d-c proof-test voltage – 30500V (3)

Equation for calculation of maximum use voltage (classes 0)

Maximum A-C use voltage = 0.95 d-c proof-test voltage – 18000 V (4)

where Maximum Use Voltage is the a-c voltage (rms) classification of the protective equipment that designates the maximum nominal design voltage of the energized system that may be safely worked. The nominal design voltage is equal to the phase-to-phase voltage on multiphase circuits;

and

Proof Test Voltage is either the a-c rms or dc average voltage that used protective equipment must be capable of withstanding for a specified test period without breakdown.

| Class of Glove | Maximum Use Voltage (a-c rms, V) | A-C Proof Test Voltage (a-c rms, V) | D-C Proof Test Voltage (average V) |
|---|---|---|---|
| 00 | 500 | 2500 | 10000 |
| 0 | 1000 | 5000 | 20000 |
| 1 | 7500 | 10000 | 40000 |
| 2 | 17000 | 20000 | 50000 |
| 3 | 26500 | 30000 | 60000 |
| 4 | 36000 | 40000 | 70000 |

Table 8 Proof-Test/Use Voltage Relationship (source : D120-95 of ASTM Standard 1996, pp 16)

It has been highlighted in Section 4 of D120-95, Significance and Use, that gloves are for personal protection and work practises vary from user to user. Selection of gloves should not based on operation system voltages alone; other criteria such as construction design, work procedure techniques, weather conditions are crucial selection factors. It is further recommended in the specification that complete instructions and regulations to govern the correct and safe use of gloves are to be prepared by users.

### 2.4.3 Designation : F496-95a Standard Specification for In-Service Care of Insulating Gloves and Sleeve

The Standard covers the in-service care, inspection, testing and use voltage of insulating gloves and sleeves for protection from electric shock. Guidelines on field care, inspection and storage are given, which include :

- Visual checks
- Air test
- Cleaning methods
- Repair of minor cuts by patching
- Record keeping and markings

It is specially remarked that gloves with any of the following defects shall not be used and shall be returned to an electrical testing facility for inspection and electrical retest:

- Holes, tears, punctures or cuts.
- Ozone cutting or ozone checking
- Imbedded foreign objects
- Texture changes
- Other defects that damage the insulating properties.

It would be important to make workers aware of the compliance of this specification to ensure sound protective equipment being in use after initial acceptance in accordance with D120.

### 2.4.4 BS 697 : 1986, Specification for Rubber gloves for electrical purposes.

This British Standard specifies the requirement of rubber gloves for electrician according to 4 rated voltages.

- 650V
- 1000V
- 3300V
- 4000V

The Standard recognizes the need for gloves of up to 650V, in certain circumstances, to have a high degree of flexibility. A maximum thickness of no more than 1.5mm is, therefore, specified of gloves of rating at 650V. While for high rating of gloves, minimum thickness is indicated to control the ability of gloves to meet the electrical resistance test.

| Rated Potential of Gloves | Minimum Average Thickness |
|---|---|
| 650V | Not more than 1.25mm (minimum thickness is not specified and is determined only by the requirement of electrical resistance. |
| 1000V | 1.25mm |
| 3300V | 1.75mm |
| 4000V | 2.00mm |

Table 9 Thickness of gloves (Source : BS 697 : 1986, Table 1 and 2)

Guidance concerning the maintenance, inspection, re-testing and use of rubber gloves after purchase is given in Appendix C of the standard. A simple stretching test is recommended for that of surface defects which may develop with use. Each finger of the glove should be stretched by hand to ascertain that is mechanical strength is adequate. Gloves showing any defects should be destroyed or rendered unusable. It is further remarked that gloves must not be turned inside out for mating.

It has been emphasised in the Standard that rubber gloves is the not the only means of protection for those working on electrical circuits. Every other practicable precautions should be take against the risk of shock and, whenever possible, the circuit should be isolated.

### 2.4.5 AS 2225 – 1994, Insulating gloves for electrical purposes

This Australian Standard is similar to BS 697, in which 4 classes of gloves, viz., 650V, 1000V, 3300V and 4000V are specified. No minimum thickness is specified for 650V gloves, in order to be more comfortable to wear and have more feel whilst still affording adequate protection against electric shock. One the major difference of this specification is the mandatory requirement for instructions for storage and cleaning to be provided with each pair of gloves. Recommendations concerning uses and storage precautions are detailed in Appendix C of the specification.

- Storage – detailed storage method and limits of storage temperature are specified.
- Issue – gloves for electrical line workers and other outdoor workers should be issued in a protective container, like, canvas or leather bags, fibre boxes or water proof containers.
- Examination before use – visual inspection and air inflated leak tests are suggested.
- Precautions in use – avoid mechanical damages and exposure to excessive heat, light and chemical agents.

### 2.4.6 JIS T 8112, Rubber gloves for electrical insulation

This Japanese Industrial Standard classifies electrical gloves into 3 categories. It should be noted that a low limit of working voltage is specified for each class, other than maximum allowable voltage.

| Classification | Working Voltage |
|---|---|
| Class A | >300V up to 600V |
| Class B | >600V up to 3500V |
| Class C | >3500V up to 7000V |

Table 10 Classification of Insulating Gloves in JIS T 8112

Brief guidelines on handling and checking of rubber gloves are given as informative reference. It is recommended that protective gloves are to be worn in using gloves of class B and C and inspection records on insulation performance are to be kept for three years.

### 2.4.7 GB 17622 – 1998 Insulating gloves for live working, 帶 作 絕緣手套.

This Chinese specification was established in accordance with the requirements of IEC 903:1998 with adjustment on product types with respect to the industrial specification of PRC. Insulating gloves are grouped into 3 types according to voltage rating of electrical installation being applied.

| 型 (Type) | 標稱 壓 (Rate Voltage) rms kV |
|---|---|
| 1 | 3 kV |
| 2 | 6 kV |
| 3 | 10 kV |

Table 11 Maximum Usage Voltage of Insulating Gloves (Source : GB 17622 –1998, Table2)

### 2.4.8 BS EN420 : 1994, General Requirements for Gloves

This British Standard describes the general requirements for ergonomy, glove construction, high visibility, innocuousness, cleaning, comfort and efficiency applicable to all protective gloves. It is, however, not applicable to electrician's gloves. The innocuousness requirement specified, though no mandatory for electrician's glove, would be an interesting area on study of allergies, where electrician's gloves are in close contact with the user for a long working hours. The defined test procedure for finger dexterity is another interesting area of study. Trained operator wearing the protective gloves shall pick up pins of various diameters. The smallest diameter of pin that can be picked up will be charted for performance level. The identified performance level would affect workers' attitude towards the acceptance and proper uses of protective equipment.

In summary, studies of national standards of insulating gloves revealed that most of the standards are specifications on manufacturing requirements and inspection procedures for compliance in laboratory tests. There are no selection guidelines for electricians to pick up the appropriate types of insulating gloves according to the corresponding tasks in the workplaces. In some of the national Standards, field care and storage notes are provided as "informative" appendix, however, without illustrative and procedural information for electricians to follow at work.

## 2.5 Summary: What is Known and What is Not Know

Electrical safety has been well documented in trade journals and electrical handbooks. Potential electrical hazards and associated risk assessment procedures are under regular revisions by various governmental organisations and professional institutions. Insulating gloves, as well as other PPE, are recommended as viable protective means to reduce the possible damages and minimise the risks of injuries, provided that they are applied effectively in the hazard control hierarchy. The accident statistics, associated with electric discharge and electrical shock, indicate that electricians may often neglected to isolate power system and reluctant to wear insulating gloves. Safety behaviors and attitudes at work are often described by safety professions as “being driven by appropriate risk perception”. It would be necessary to appreciate the general safety concepts of local electrical workers in the study.

Studies of international standards of insulating gloves revealed that most of the standards are specifications on manufacturing requirements and inspection procedures for compliance in laboratory tests. There are no selection guidelines for electricians to pick up the appropriate types of insulating gloves according to the corresponding tasks in the workplaces. In some of the national Standards, field care and storage notes are provided as “informative” appendix, however, without illustrative and procedural information for electricians to follow at work. In the review of the Standards on selection and care of occupational protective gloves, only guides on hand protection against general and chemical hazards have been established. Codes of practices or technical guidance notes has not been set out for selection, use and maintenance of insulating gloves for electrical workers at workplaces. Based on the reviewed Standards, helpful information on basic elements of insulating gloves selection were identified as follows:

- Protection performance
- Size, shape and style
- Fit, dexterity and comfort
- Wear resistance
- Marking and packing

The identified criteria could be set in the survey questionnaire to collect information about the knowledge of REW in gloves selection.

In the review of legislative documents on electrical safety and PPE, the provisions of insulating gloves, are implied legitimate duty of employers under the General Duty of F&IU regulations. There is, however, no legal requirement for electricians to wear insulating gloves during live work. As discussed in the electrical engineering symposium of IEE (1988), legislation on electricity safety could only be directive. To help the industry, it would be advisable to publish some technical guidelines in form of code of practice and guidance notes so that craftsman of the trade can adapt to the safety principles more easily.

# 3 Survey on the Selection and Use of Insulating Gloves

## 3.1 Objectives of the Study

The purpose of this study is to examine the use, or, not use of insulating gloves by electricians in HKSAR. The apparent simplicity of insulating gloves may result in a gross underestimation of the amount of effort and expense required to effectively use of this equipment to electrical workers. At the operation level, common sense estimations often overruled the consensus standard, which lead to misuses of gloves or lack of proper maintenance. Even more often, well experience electricians ignore PPE is the last resort and do not wear insulating gloves (Labour Department, 2002). The study focuses on the following areas.

Objective 1. To understand the risk assessment and live work practices of electrician in their routine works.

Objective 2. To understand the motives and interests, or the otherwise, on their application of insulating gloves in their routine jobs.

Objective 3. To understand the beliefs, perceptions and knowledge of electricians in selection of insulating gloves.

Objective 4. To understand the use and maintenance of insulating gloves by electricians.

Objective 5. To identify the areas for improvement in selection and use of insulation gloves.

## 3.2 Methodology

To meet the study objectives, ethnographic survey allows the uncovering of culture and normative work patterns of electricians in their daily works (Burns 1994). Given the limited project time, it would be unlikely to collect data by participant observation. Questionnaires are designed to conduct the observation.

### 3.2.1 Pilot Study

A pilot study was conducted in early July, 2002, in which structured interviews were conducted to two groups of electricians, one group consisted of four electricians who worked in a workshop of catering factory and one group consisted of two electricians in a renovation site, in order to have a preliminary understanding on the follows.

- Their perception on electrical shock hazards.
- Is it possible to isolate electricity source in all of their daily work?
- How is PPE assessed for suitability?
- How is insulating gloves used in their daily work?
- Suggestion for improvement on encouraging for use of insulating gloves

A common view expressed by the electricians of the pilot study was that the use of insulating gloves was not popular and they have limited knowledge in the selection and maintenance. All of them appreciated that the consequence of an electrical shock could be very serious, including electrocutions, burns and fall from height. Isolation of electricity source was agreed as the most effective mean to prevent electric shock during the interview.

The electricians in the pilot study, however, indicated that live works were inevitably unavoidable, in some incidents, to avoid interruptions to processing system which might otherwise cause higher risk. In some of the equipment testing and commissioning, live voltage was reported essential to conduct the required functional checks. Their attitudes toward PPE were rather passive. All six interviewed electricians indicated that they only use PPE provided by the employer. They were instructed to wear safety shoes/helmets and were not sure whether an assessment on suitability had been conducted. Suggestions on improvement in encouraging the use of insulating gloves were diversified, including promotion by Government, provision of user guidelines, training and inclusion in existing Code of Practice (Wiring).

### 3.2.2 Scope of Study

All electrical workers in HKSAR are required to register with permitted classes of works under the Electricity (Registration) Regulation, according to their qualification and electrical work experiences. The targeted population for study is the registered electrical workers (REW) in the trade. From the registration list of the Electrical and Mechanical Services Department (EMSD), the total number of electricians in various permitted class of works, as at March 2002, are as follows.

| Grade | Permitted Class of Work | No. of REW |
|---|---|---|
| A | Below 400 Ampere, Low Voltage | 38022 |
| B | Below 2500 Ampere, Low Voltage | 6924 |
| C | Unlimited Amperage, Low Voltage | 930 |
| H | Unlimited Amperage, High Voltage | 2177 |
| R | Neon sign, air conditioning and generator | 3471 |
| Total number of registered electrical workers | | 51524 |

Table 12 REW in HKSAR as at February 2002 (Source: Registration List of EMSD)

### 3.2.3 Sampling Strategy

There is no detailed analysis of insulating gloves used in HKSAR. Sample size estimation is based on standard error calculation of simple random sampling and level of confidence. For the purpose of this study, we target to have the sampling accuracy to be within 10%, with 95% confidence.

Mathematically,

$$\pm 10 = \pm 1.96 \sqrt{[P\% \, (100\text{-}P\%)/n]} \qquad (5)$$

where n is the sample size

P is the % of electrician who has used insulating gloves.

Since we have no previous survey data on the population, we put P = 50%, which will give $\sqrt{[P\% \, (100\text{-}P\%)/n]}$ a maximum value to meet our accuracy requirement.

$$\Rightarrow n = (1.96/10)^2(50)(50) \qquad (6)$$

$$n = 96 \qquad (7)$$

It was decided that at least 100 samples should be taken in random to ensure the established accuracy.

### 3.2.4 Questionnaire Design

The questionnaire was intended to serve a comprehensive source of data to study the safety attitude and work behavior of electricians in the daily uses of insulating gloves. Questions were evolved around consensus codes of practices on selection and use of PPE and international standards of electrical insulating gloves. The formed questions were grouped into 4 main categories:

- Background information of the surveyed samples
- Questions about their daily work and safety behavior
- Their opinions on the selection of insulating gloves
- Their users' experience on insulating gloves

A flowchart was prepared to help the design of the questionnaire, which serves to guide the respondent to provide answers in a logical sequence (Youngman, 1982)

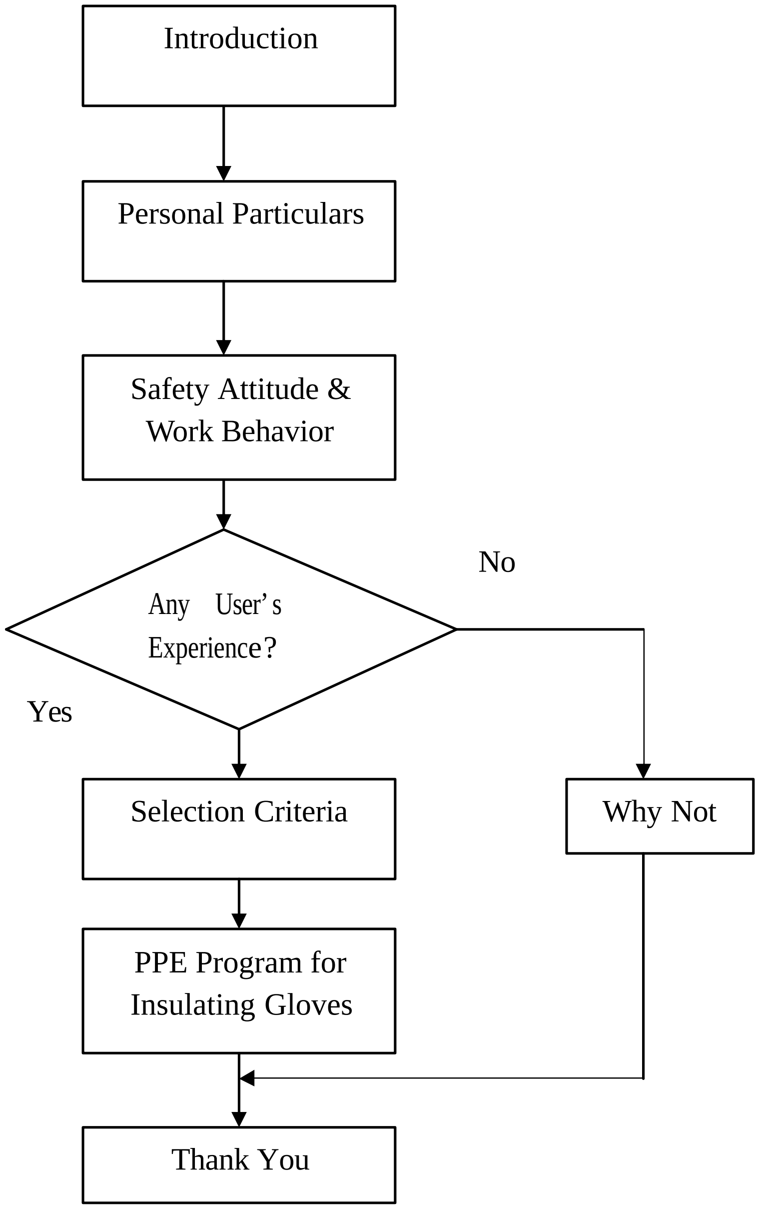



Figure 5 Flowchart to assist questionnaire design

A draft questionnaire was prepared and tested. It was found that the rating of importance on the selection criteria from 1 to 5 was arbitrary. The questionnaire was modified with mostly YES/NO/DON'T KNOW questions to help electricians in answering. It also helped the subsequent statistical analysis easier. Copies of the questionnaire in Chinese and English are as shown in Appendix B and Appendix C respectively.

# 4. Results of the Study

## 4.1 Profile of the Collected Information

The primary data used in this study is acquired from observations by using questionnaires. A total of 550 questionnaires were dispatched to trade union, power supply companies, contracting firms and servicing branches to collect information of Registered Electrical Workers (REW) in August, 2002.

| **Institutions** | **Nos. Dispatched** |
|---|---|
| HK & Kowloon Electrical Engineering & Appliances Trade Workers Union | 200 |
| Power Supply Companies | 50 |
| Contracting Branch | 100 |
| Servicing Branch | 200 |
| Total Numbers of Questionnaire Dispatched | 550 |

Table 13 Dispatches of Questionnaires

Of the 550 questionnaires sent out :

- 7 were returned to the sender intact (RTS)
- 12 were scrapped due to incompleteness, or filled by non-REW (Scrapped).
- 216 were processed, which constitutes 39.2% of the total dispatched questionnaires.

| Sent | RTS | Scrapped | Processed |
|---|---|---|---|
| 550 | 7 | 12 | 216 |

Table 14 Summary of Survey Reply

Amongst the 216 processed samples, the distribution of permitted classes of electrical works was summarized as follows.

- 184 REW were engaged in Grade A electrical work of low voltage fixed electrical installation of maximum demand not exceeding 400A single or three phases.
- 28 REW were engaged in Grade B electrical work of low voltage fixed electrical installation of maximum demand not exceeding 2500A single or three phases.
- 0 REW were engaged in Grade C electrical work of low voltage fixed electrical installation of any capacity.
- 0 REW were engaged in Grade H electrical work of high voltage fixed electrical installation.
- 4 REW were engaged in Grade R electrical work on neon sign installation/air conditioning installation/generating facility installation.

In comparing with the REW registration list of Electrical and Mechanical Services Department (EMSD) of February 2002, the distributions were found similar.

| **Grade** | **REW in Population** | **%** | **Surveyed Sample** | **%** |
|---|---|---|---|---|
| A | 38022 | 74% | 184 | 85% |
| B | 6924 | 13% | 28 | 13% |
| C | 930 | 2% | 0 | 0% |
| H | 2177 | 4% | 0 | 0% |
| R | 3417 | 7% | 4 | 2% |
| Total | 51524 | 100% | 216 | 100% |

Table 15 Comparisons of Sample and Population Distribution

It can be concluded that the distribution of the sample and the target population are similar.

## 4.2 Profile of the Electricians under study

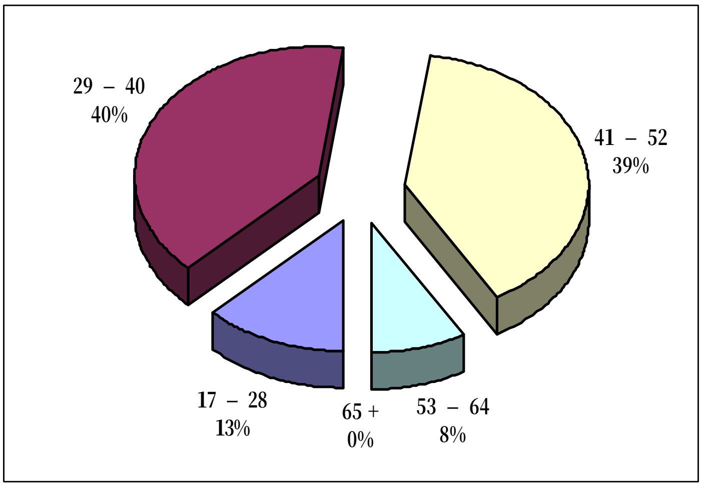
### 4.2.1 Age Distribution

The predominated age groups are 29-40 and 41-52, which amongst 79% of the surveyed sample. The finding was in line with the population census conducted in Hong Kong in March 2001 (Key Statistics, 2001). The article concluded that the population continued to dejuvenate and grow old in the past 10 years. Widened of the median age in the population pyramids was noted.

| Age Group | Count |
|---|---|
| 17 – 28 | 27 |
| 29 – 40 | 86 |
| 41 – 52 | 85 |
| 53 – 64 | 18 |
| 65 + | 0 |

Table 16 Age Group of Surveyed Samples

Figure 6
Age Distribution
of REW in Study



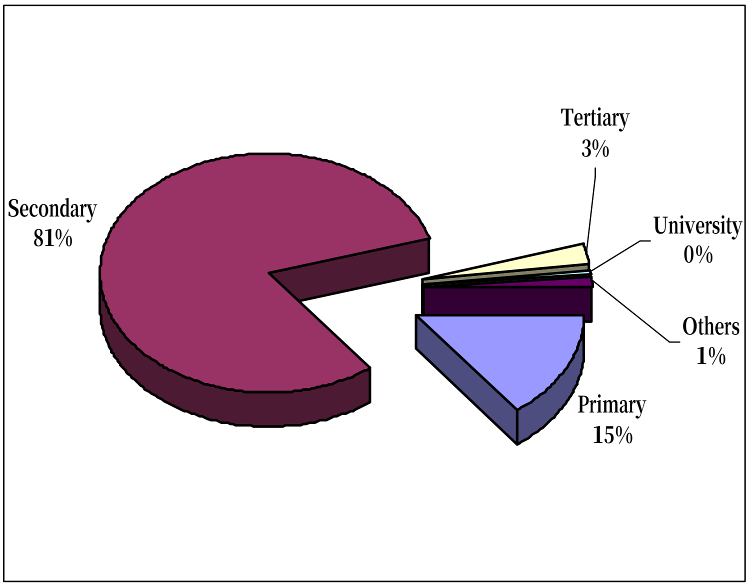
### 4.2.2 Education Level

81% of the surveyed REW were of secondary education. As commented in the Key Statistics of Population Census (2001), there was improvement in the education attainment of the population. The proportion of the population aged 15 and over having attended secondary or higher education increased from 62.1% in 1991 to 71.1% in 2001 (Key Statistics, 2001).

| Education | Count |
|---|---|
| Primary | 32 |
| Secondary | 174 |
| Tertiary | 6 |
| University | 1 |
| Others | 3 |

Table 17 Education Level of Surveyed Sample

Figure 7
Education Level attained by Surveyed REW



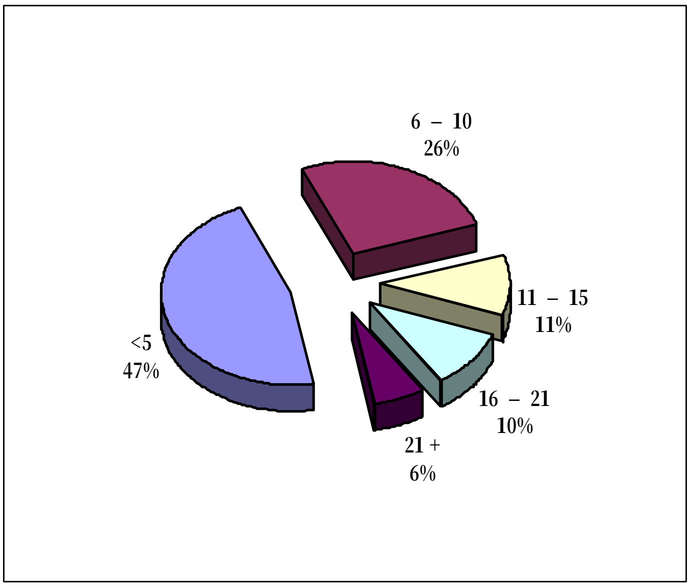
### 4.2.3 Years of Electrical Work Experience

The survey indicated that about half (47%) the electricians had electrical work experience equal to 5 years or less.

| Years | Counts |
|---|---|
| <5 | 100 |
| 6 – 10 | 57 |
| 11 – 15 | 23 |
| 16 – 21 | 22 |
| 21 + | 14 |

Table 18 Electrical Work Experience of Surveyed Sample

Figure 8
Electrical Work
Experience of
Surveyed REW



The demographic and education characteristics of the surveyed samples were summarized in the Table 19

| | | | | | |
|---|---|---|---|---|---|
| Age Distribution | 17-28 | 29-40 | 41-52 | 53-64 | 65+ |
| | 13% | 40% | 39% | 8% | 0% |
| Education | Primary | Secondary | Tertiary | University | Others |
| | 15% | 81% | 3% | 0% | 1% |
| Experience | <5 | 6-10 | 11-15 | 16-21 | 21+ |
| | 47% | 26% | 11% | 10% | 6% |

Table 19 Demographic Characteristics of the Surveyed Sample.

### 4.2.4 Risk Assessment and Safety Activities

Table 20 indicates the job safety activities of the surveyed REW encountered in their routine works.

| Job Safety Activities | Response % | | |
|---|---|---|---|
| | Yes | No | Don't Know |
| Risk Assessment | 56% | 15% | 29% |
| Accident Analysis | 63% | 8% | 30% |
| Job Safety Analysis | 45% | 12% | 44% |
| Process Hazard Review | 31% | 13% | 56% |
| Lock Out Procedure | 49% | 17% | 34% |

Table 20 Response of REW on Job Safety Activities

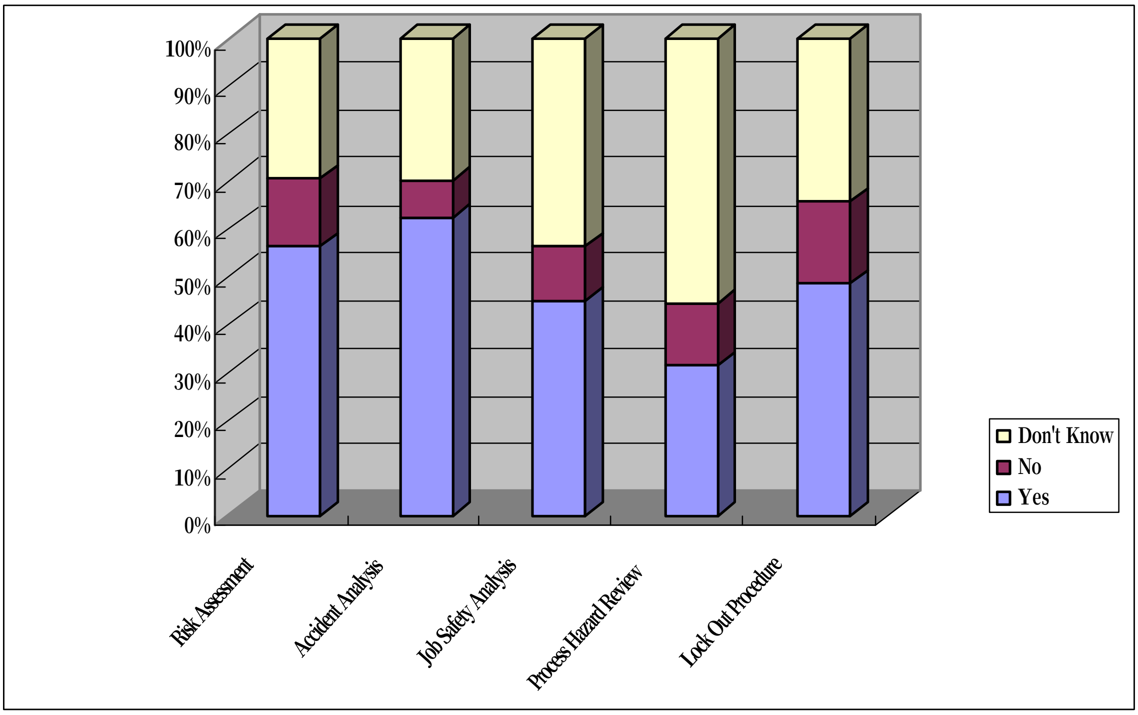



Figure 9 Risk Assessment and Safety Activities of Surveyed REW

It was noted that 44% of the surveyed sampled had not conducted risk assessment and 55% did not carried out Job Safety Analysis (JSA) in their routine jobs. About half (51%) did not lock out the supply source in their daily electrical works. More than half (56%) did not know about Process Hazard Review. Based on the response of the surveyed REW, it was apparent that the safety management control on electrical works of REW was inadequate.

### 4.2.5 Live Electrical Working

Table 21 indicates the frequency, which surveyed REW had encountered live work in execution of their routine jobs.

| Live Work Frequency | Respondent Count |
|---|---|
| daily | 45 |
| weekly | 68 |
| monthly | 54 |
| yearly | 27 |
| never | 22 |

Table 21 Response of REW on Live Work Frequency

Majority of the REW (90%) responded that they have encountered live work. Over half (52%) executed live electrical works on a regularly monthly basis. 21% of the surveyed sample involves live work in their routine jobs almost daily. The surveyed results on frequency of live work were summarized in Figure 10.

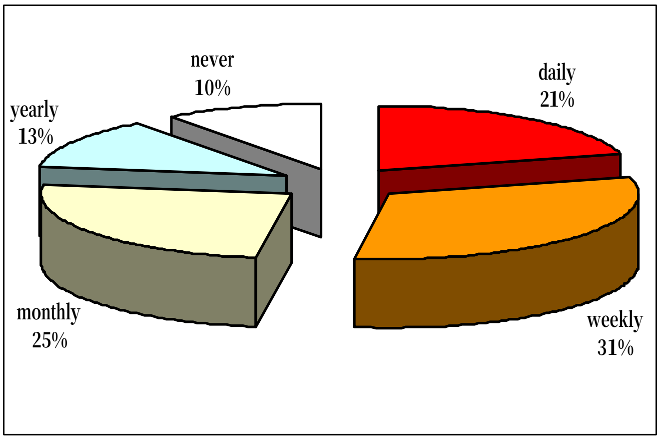



Figure 10
Frequency of Live Work

Table 22 tabulates the response of REW on the job natures of their executed live work.

| Job Nature of Live Work | Respondent Count |
|---|---|
| Installation | 60 |
| Repair | 114 |
| Inspection | 73 |
| Testing | 31 |
| Commissioning | 28 |

Table 22 Job Nature of Live Work

From the survey study, repair works are the most frequent (37%) job nature which electricians encountered live work. Details of the other work live types are summarized in Figure 11.

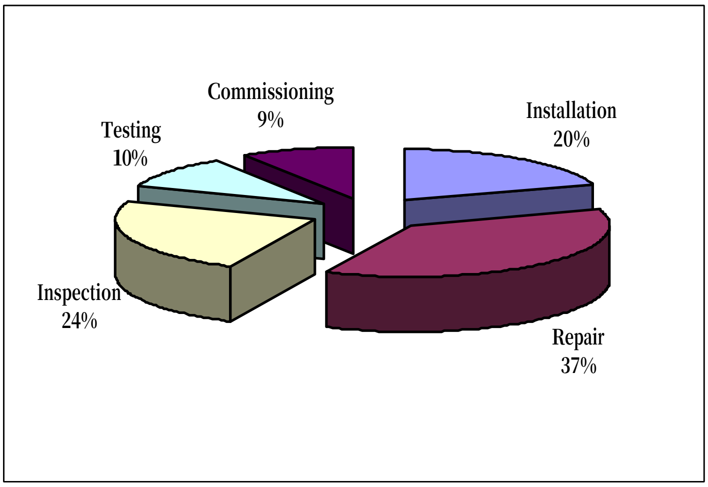



Figure 11
Nature of Live Work which electricians encountered.

### 4.2.6 Experience of Insulating Gloves

Table 23 indicates the responses of REW to the question "Have you used electrical protective gloves before?"

| Use of Electrical Gloves | Respondent count |
|---|---|
| Yes | 40 |
| No | 176 |

Table 23 Reply of REW on use of electrical gloves

Majority of the surveyed REW (81%) replied that they had not used any insulating gloves. Findings were indicated in Figure 12

Figure 12
Experience of Using
Insulating Gloves

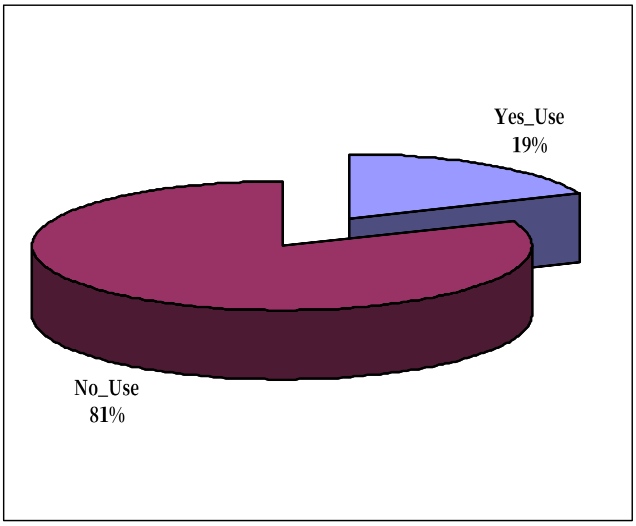


Table 24 indicates the ranking of reasons of surveyed REW not wearing insulating gloves.

| Reasons of not using gloves | Count | Percentage |
|---|---|---|
| Inappropriate length of protection | 2 | 1% |
| Not durable | 3 | 1% |
| Allergies | 3 | 1% |
| Ineffective protection | 6 | 2% |
| Others | 7 | 2% |
| Incompatible to task | 14 | 5% |
| Size don't fit | 16 | 5% |
| Uncomfortable | 21 | 7% |
| Cost | 29 | 10% |
| No knowledge | 35 | 12% |
| No particular reasons | 40 | 13% |
| Lack of grip | 41 | 13% |
| Lost of dexterity | 87 | 12% |

Table 24 Ranking of Reasons on NOT wearing insulating gloves.

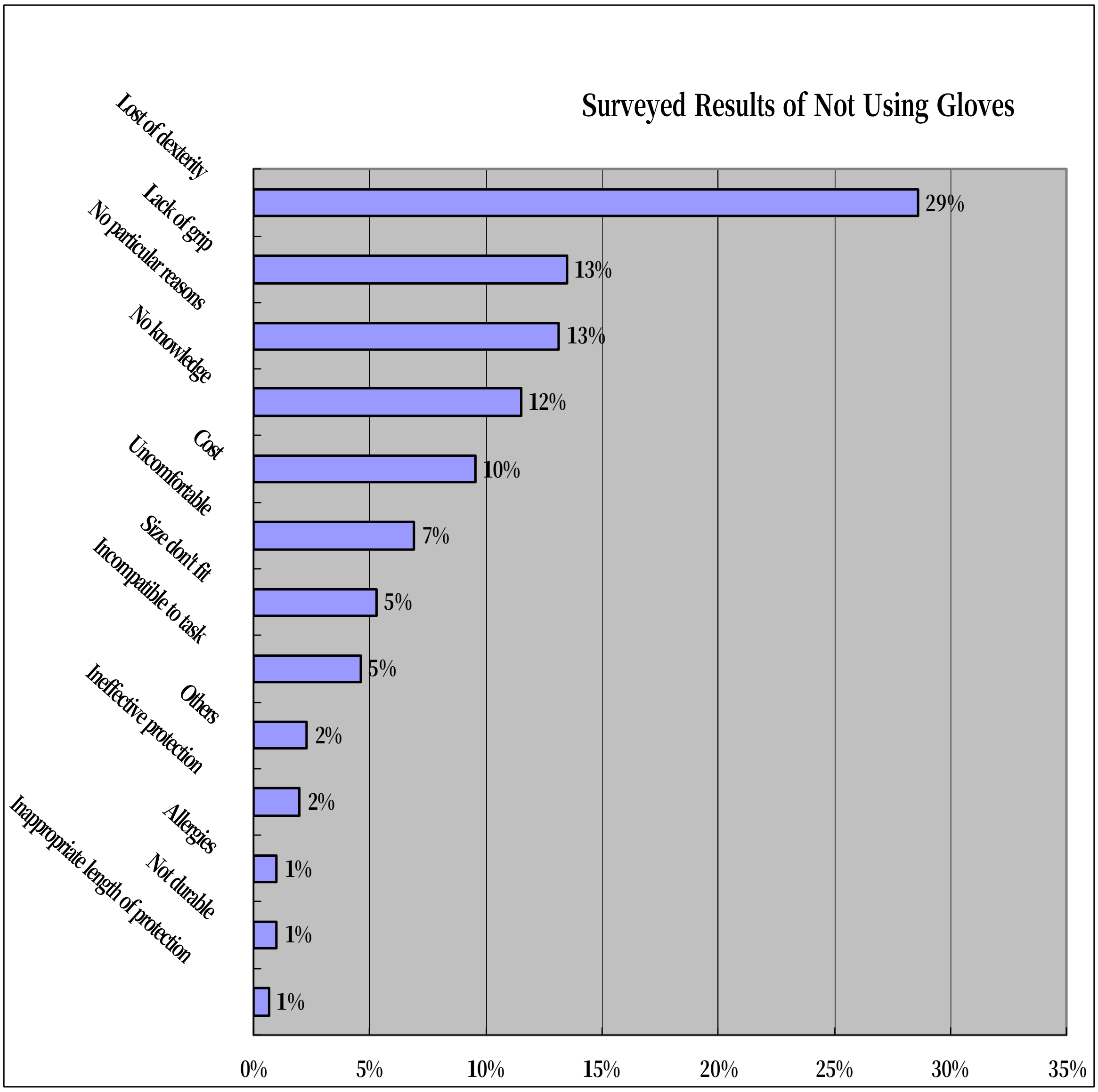



Figure 13 Responses to the question “Why NOT use?”

In reply to the question of “Why NOT use?”; lost of dexterity (29%) and lack of grip (13%) were ranked the first and second major reasons. It should be noted that a significant portion (13%)of surveyed REW did not wear insulating gloves without particular reasons.

### 4.2.7 Where Were Insulating Gloves Obtained

The reply of REW on "Where do you obtain your obtain your insulating gloves?" are shown in Table 25

| Where to Obtain? | Respondent count |
|---|---|
| Employer | 28 |
| Hardware Store | 7 |
| PPE Store | 3 |
| Trade Union | 0 |
| Internet | 2 |

Table 25 Reply of REW on "Where to obtain insulating gloves.

Most electricians (69%) replied that their insulating gloves were provided by their employers. Others brought their own insulating gloves through hardware store (18%), PPE store (8%), or through mail or Internet ordering (5%). Local major trade unions did not seem to have insulating gloves available for purchase.

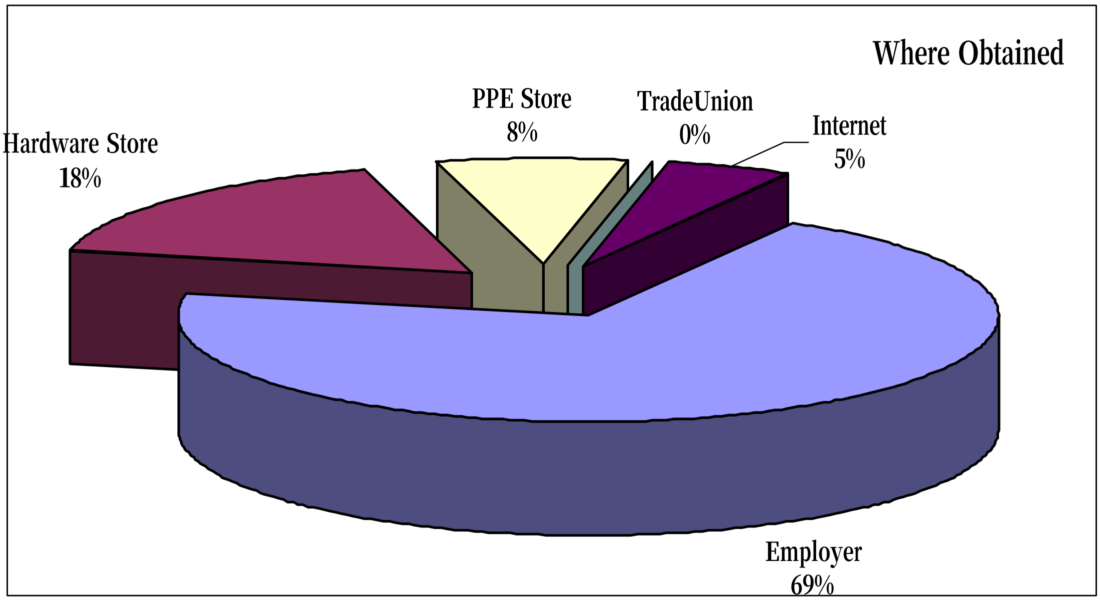



Figure 14 Sources of Insulating Gloves

### 4.2.8 Selection Criteria

When asked on the question of “Have your consider the following factors in selection?”. The replies of REW are as shown in Table 26.

| Consideration Factors | Yes | No | Don't Know |
|---|---|---|---|
| Protective capability | 39 | 0 | 1 |
| Size | 37 | 2 | 1 |
| Dexterity | 35 | 3 | 2 |
| Task compatibility | 35 | 2 | 3 |
| Comfort | 35 | 2 | 3 |
| Workmanship and product quality | 33 | 1 | 6 |
| Length to be protected | 31 | 6 | 3 |
| Durability | 31 | 5 | 4 |
| Puncture, snag, tear and cut resistance | 31 | 2 | 7 |
| Grip | 30 | 5 | 5 |
| Cuff style | 25 | 8 | 7 |
| Cost | 22 | 10 | 8 |
| Marking | 18 | 15 | 7 |
| Packing | 15 | 20 | 5 |

Table 26 Consideration Factors of REW on selection of insulating gloves

Majority of the relies focused on protective capacity and size, while neglecting label markings and packing which bears important information like, manufacturing standard, color codes or designation for each voltage class, glove size, month and year of manufacture. All these are essential data for field application and subsequent periodical testing.

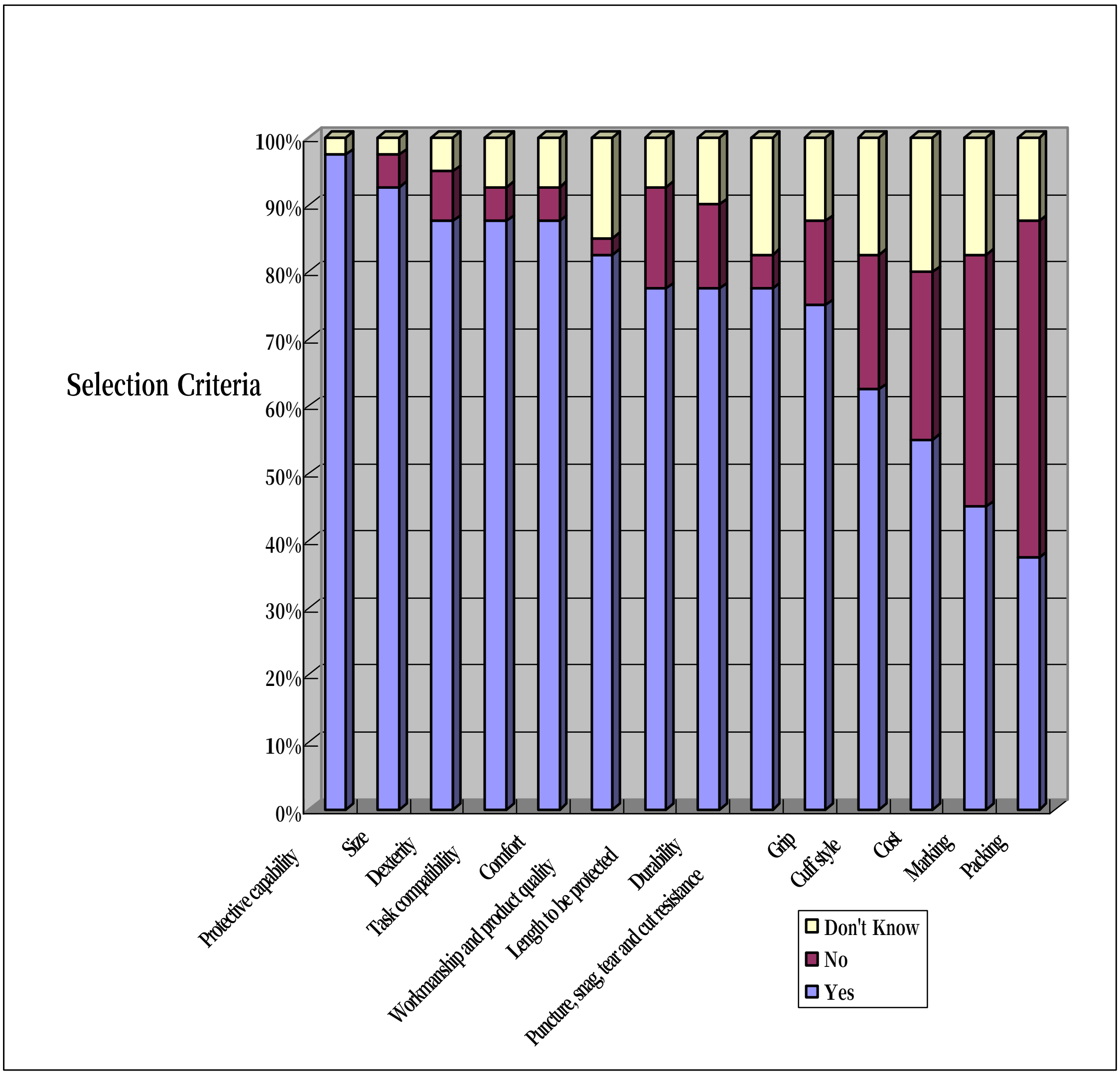



Figure 15 Selection criteria rated by electricians

#### 4.2.9 Use of Insulating Gloves

Those REW who had used insulating gloves were asked on their daily application practices and field cares of their gloves.

Figure 16 indicates that only half of the REW had read manufacture's instruction on the uses and cares of their insulating gloves.

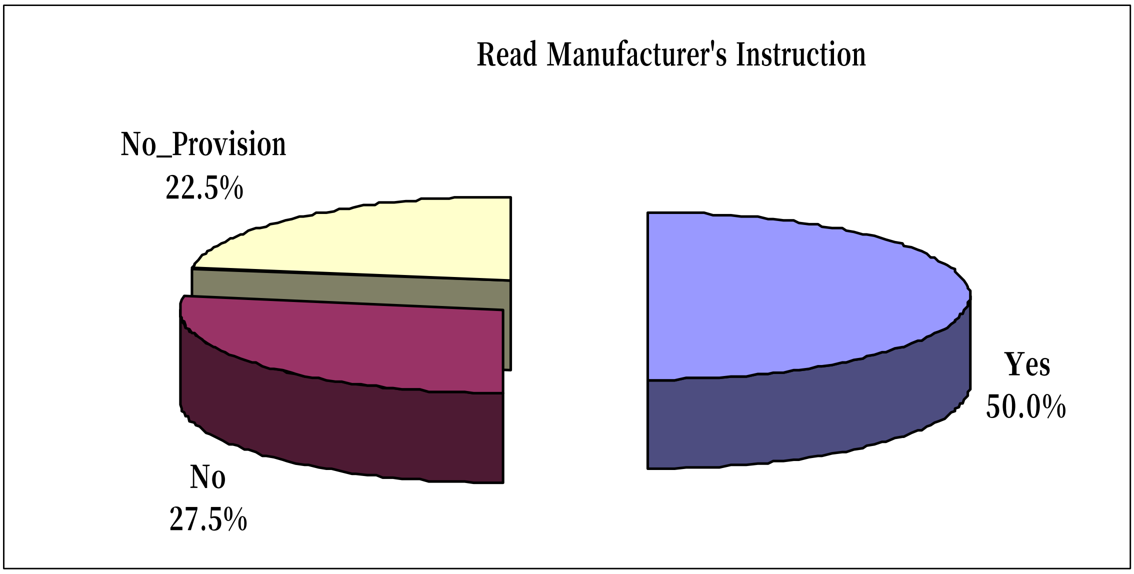



Figure 16 REW who had read manufacturer's instruction

Figure 17 shows that 55% of the REW did not have a PPE program on the use of insulating gloves. Further analysis of the returned questionnaires found that 40% of the electrician using gloves had neither read the instructions of manufacturers nor an established PPE program of insulating gloves.

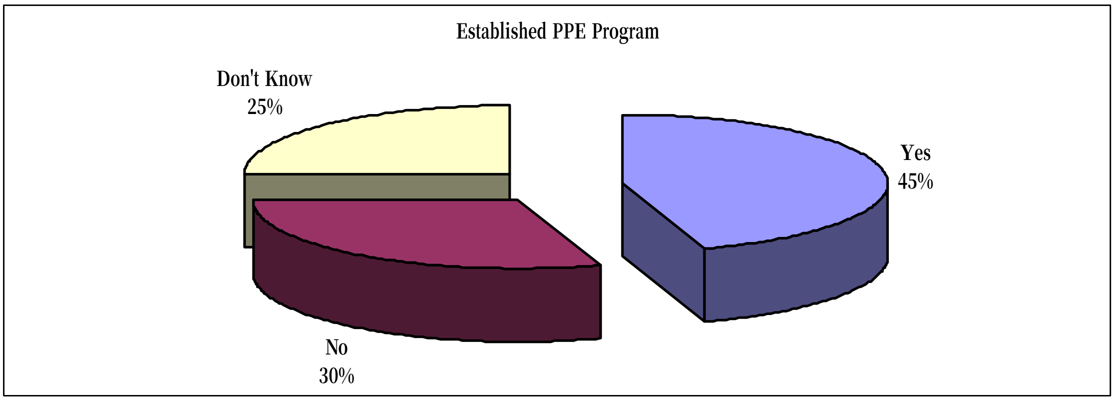



Figure 17 REW who had an established PPE program of insulating gloves

While the proper storage method of insulating gloves should be in locations free from heat, sunlight, ozone and the use of the supplied package of manufacturers, 60% of the surveyed sample did not store their insulating gloves correctly. Response on their storage practice is as shown in Figure 18.

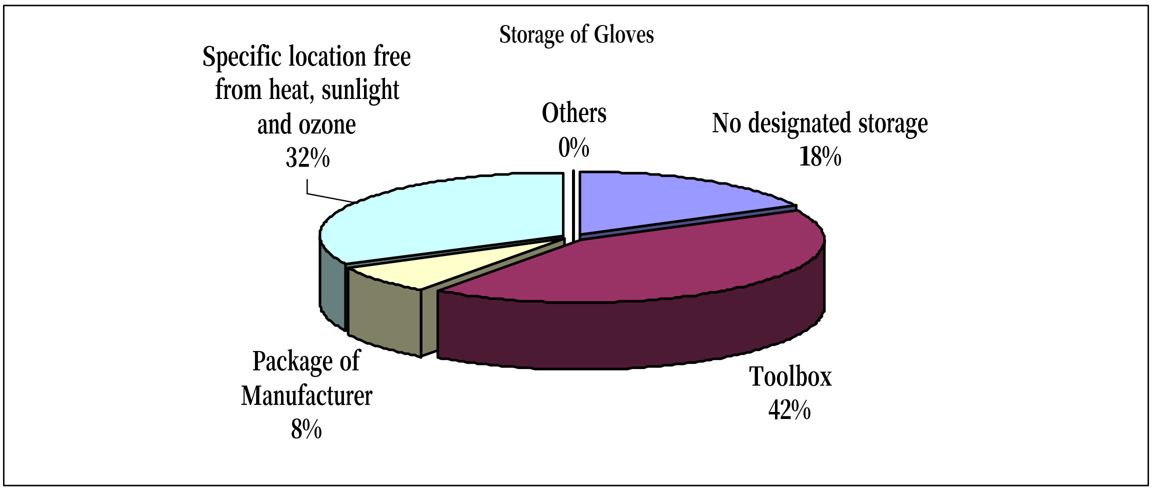



Figure 18 Response of REW on storage practice

### 4.2.10 Inspection and Tests of Gloves

The respond of REW on inspection and tests carried out prior to their uses of insulating gloves are tabulated in Table 27

| Inspection and Tests | Yes | No | Others |
|---|---|---|---|
| Visual inspection | 30 | 9 | 1 |
| Rolling test | 21 | 18 | 1 |
| Periodic test | 21 | 18 | 2 |
| Inflated leak test | 18 | 22 | 0 |

Table 27 Response of REW on inspection and tests on insulation gloves prior to use

Other than visual inspection, majority of the electricians did not carry out rolling tests, periodic dielectric tests and inflated leak tests.

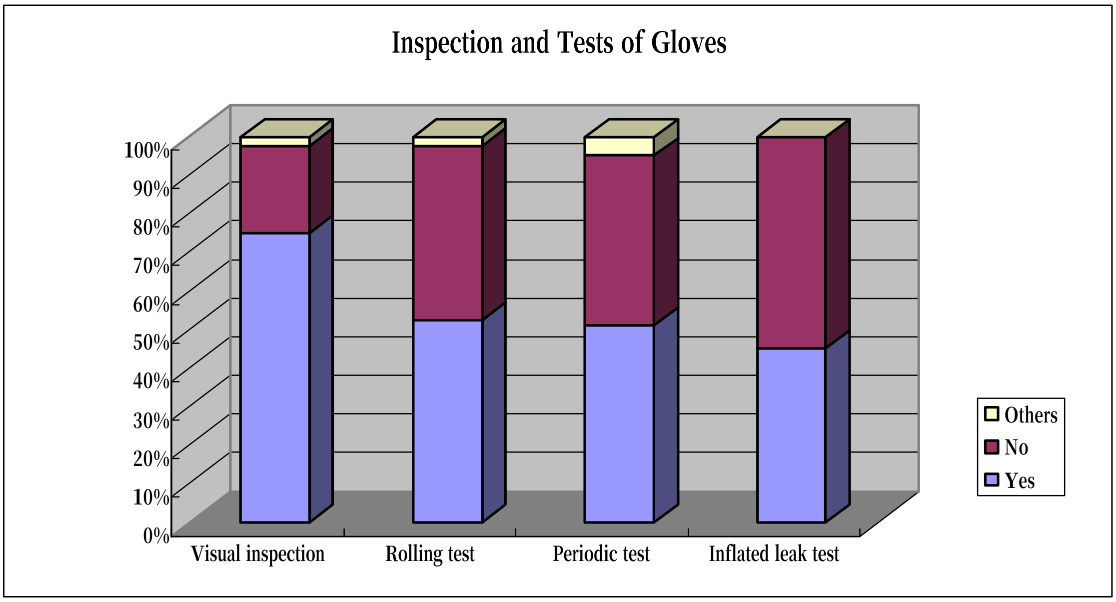



Figure 19 Response of REW in reply to the testing and inspection on their insulating gloves.

### 4.2.11 Allergy

In response to the inquiry on allergic contact dermatitis on use of insulating gloves, the result data are indicated in Table 28.

| Dermatitis/Irritants | Response Count |
|---|---|
| Yes | 7 |
| No | 32 |
| Others | 1 |

Table 28 Response of REW on dermatitis and irritants

18% replied that they had experienced allergy and 3% in other types of irritants reactions.

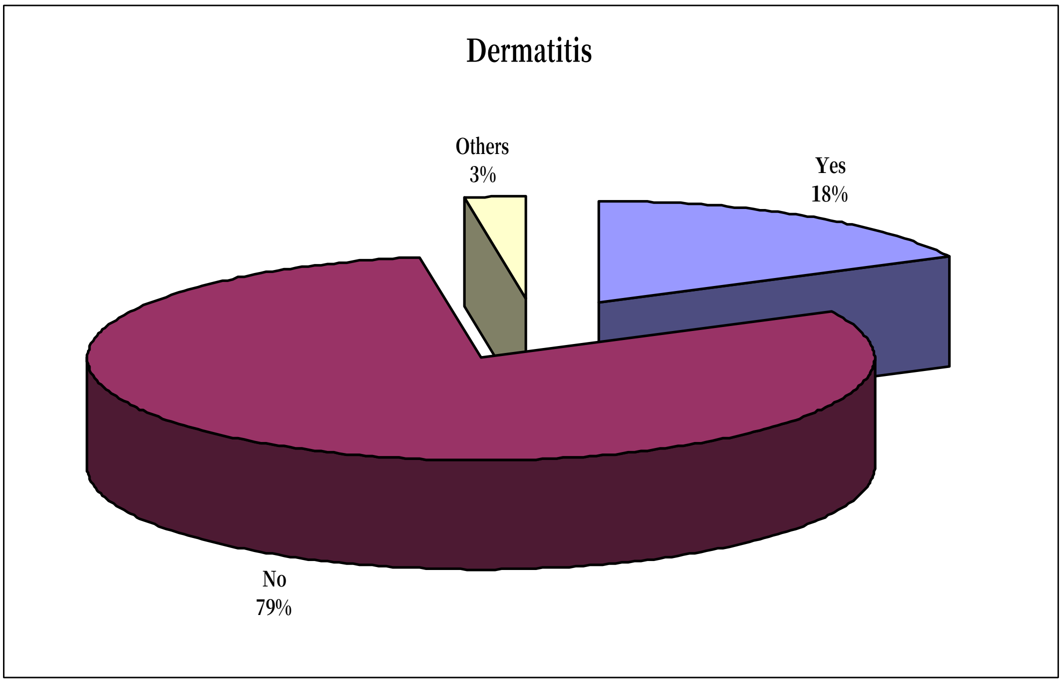



Figure 20 REW who had experienced dermatitis and irritants

# 5. Summary, Conclusions and Recommendations

## 5.1 Summary of Salient Findings

Relative to the objectives of the survey, salient findings of the study are summarized as follows.

- Sample distribution has a similar pattern to the targeted population of Registered Electrical Workers in HKSAR in terms of demographic characteristics and permitted classes of electrical work distribution.
- 90% of the electricians had encountered live work and 21% did not isolate the power correctly in their daily routine jobs. Repair works were the most frequent job type, which electricians had executed in live. (Objective 1)
- Inadequate risk assessment and electrical shock hazard elimination procedures in their routine jobs. 44% of the electricians did not conduct risk assessment and 55% did not carried out Job Safety Analysis (JSA) in their routine jobs. About half (51%) did not lock out the supply source in their daily electrical works. More than half (56%) did not know about Process Hazard Review. (Objective 1)
- A large majority, 81% of the electricians, did not wear insulating gloves; with the mostly the perception of lost of dexterity and lack of grip. (Objective 2)
- Incomprehensive knowledge in selection of suitable insulating gloves. While most of the insulating gloves (69%) were provisions of employers, electricians mainly focused their selection considerations on protective capacity and size; neglecting the label markings and packing which bears important information like, manufacturing standard, color codes or designation for each voltage class, glove size, month and year of manufacture. All these are essential data for field

applications and subsequent date reference for periodical testing. “No knowledge” was ranked the forth-highest reasons of electricians who were reluctant to wear insulating gloves. (Objective 3)

- Inadequate training and skill in the use and maintenance of insulating gloves. Half of the REW had not read manufacture’s instruction and 55% of the REW did not have a PPE program for insulating gloves. 60% of the surveyed sample did not store their insulating gloves correctly. Other than visual inspection, about half of the electricians did not carry out rolling tests (45%), periodic dielectric tests (43.9) and inflated leak tests (55%). (Objective 4)
- 21% of the electricians experienced allergy or other types of irritants reactions on wearing insulating gloves.

### 5.2 Conclusions

Given the scope of the study, which entailed an investigation of the safety behaviors and work practices of electricians in HKSAR, and the salient finding listed above; two major conclusions are drawn.

- Safety perception of REW in HKSAR is comparatively weak. This conclusion is made relative to:
  - the high frequency of live work exposure and poor safety management system.
  - incomprehensive risk assessment
  - lack of hazard elimination procedure

- REW are incompetence in the selection and use of insulating gloves, due to:
  - inadequate knowledge
  - lack of training

## 5.3 Recommendations

Based on the findings of literature review, pilot study, the surveyed results and the general conclusions deduced, a technical guide on the scope of selection, field care and general applications of insulating gloves are recommended in the following sections (Objective 5). To assist REW, a copy of Guidance Notes on Selection, Use and Maintenance is prepared in Appendix A

### 5.3.1 Selection Guides

The selection of proper insulating glove begins with an accurate evaluation of job applications. Factors that influence the selection are as listed in the following sections.

### 5.3.1.1 Maximum Usage Voltage

Voltages of electrical installations to be handled are of prime importance in selection of insulating gloves. Typical types and their specified voltages are listed for information.

| BS EN60903: 1993; D120-95 of ASTM 1996 | | BS 697: 1986; AS 2225 – 1994 | | GB 17622 – 1998 | | JIS T 8112: 1997 | |
|---|---|---|---|---|---|---|---|
| Glove Type | Rated Voltage | Glove Type | Rated Voltage | Glove Type | Rated Voltage | Glove Type | Rated Voltage |
| 00 | 500V | | | | | | |
| | | | | | | A | 600V |
| | | a | 650V | | | | |
| 0 | 1000V | b | 1000V | | | | |
| | | | | 1 | 3000V | | |
| | | c | 3300V | | | | |
| | | | | | | B | 3500V |
| | | d | 4000V | | | | |
| | | | | 2 | 6000V | | |
| | | | | | | C | 7000V |
| 1 | 7500V | | | | | | |
| | | | | 3 | 10000V | | |
| 2 | 17000V | | | | | | |
| 3 | 26500V | | | | | | |
| 4 | 36000V | | | | | | |

Table 29 Maximum use voltage for various classes of insulating gloves (Source: BS EN60903: 1993, Table A I; D120-95 of ASTM Standard 1996, pp 16; JIS 8112: 1997, Table 1; GB17622 –1998, Table2; BS697: 1986, Clause 1 and AS 2225 – 1994, Table 3)

#### 5.3.1.2 Special contact requirements

Insulating gloves may need special resistance properties, in addition to insulation performance, to meet actual job requirement at workplaces. Typical resistance properties are listed

BS EN60903 : 1993

| Category | Resistant to |
|---|---|
| A | Acid |
| H | Oil |
| Z | Ozone |
| M | Mechanical (higher level) |
| R | Acid, oil, ozone, mechanical (higher level) |
| C | Extreme low temperature |

Table 30 Special properties of insulating gloves of BS EN60903.1993 (Source: BS EN60903: 1993, Table I)

Designation: D120-95 of ASTM Standard 1996

| Category | Resistant to |
|---|---|
| Type I | Non-resistant to ozone |
| Type II | Resistant to ozone |

**Table 31 Special properties of insulating gloves of** D120-95 of ASTM (Source: D120-95 of ASTM Standard 1996, pp 16-17)

#### 5.3.1.3 Dexterity requirements

Lost of dexterity was the prime reason that the surveyed REW were not willingly to wear insulating gloves in their daily work. For a given rubber polymer, an increase in thickness will result in a higher level of protection. But thick gloves can impair dexterity. Both BS 697:1986 and AS 2225-1994 recognize the need to have a high flexibility and dexterity in certain jobs. No minimum thickness is specified for 650V gloves under these Specifications. Electrical performances of which are determined by tests.

#### 5.3.1.4 Grip requirements

Lack of grip was ranked the second highest reason for reluctance in use of insulating gloves. Sensitivity and the ability to grip are important factors. Select an insulating glove with working area (all fingers, thumb crotches and palm) of suitable finish to provide the necessary grip needed for your job.

#### 5.3.1.5 Size and fit

Proper size and fit contribute to comfort, productivity and safety. Gloves which are undersize may cause undue hand fatigue. Oversized gloves are uncomfortable, lack of sensitivity and may get caught in between revolving parts. Hand circumference method is the most common measurement in glove sizing. Circumference of the hand around the palm area, with fingers together and hand relaxed. The measured length in inches is closest to the actual glove size. Illustration 1 shows the measurement to determine proper gloves size.

Illustration 1. To determine glove size by hand circumference measurement (8 inches equals to size 8)


For easy comparison, glove sizes and corresponding general sizes are shown in Table 32.

| | | | | | |
|---|---|---|---|---|---|
| Numerical Glove Size | 6-7 | 7-8 | 8-9 | 9-10 | 11 |
| General Glove Size | XS | S | M | L | XL |

Table 32 Corresponding glove sizes (Source: Cole Parmer, Safety Glove Sizing Guide)

Dimensions of gloves may be different amongst manufacturers. Detailed measurements should be with specifications of manufactures. Typical glove dimensions are as shown in Table 33

| Details | Glove Size | | | |
|---|---|---|---|---|
| | 8 | 9 | 10 | 11 |
| Circumference of palm | 210 | 235 | 255 | 280 |
| Circumference of wrist | 220 | 230 | 240 | 255 |
| Circumference of cuff | 330 | 340 | 350 | 360 |
| Circumference of thumb | 70 | 80 | 90 | 95 |
| Circumference of index finger | 60 | 70 | 80 | 85 |
| Circumference of middle finger | 60 | 70 | 80 | 85 |
| Circumference of forefinger | 60 | 70 | 80 | 85 |
| Circumference of little finger | 55 | 60 | 70 | 75 |
| Width of palm | 95 | 100 | 110 | 125 |
| Wrist to end of index finger | 170 | 175 | 185 | 195 |
| Base line of thumbs to end of index finger | 110 | 110 | 115 | 120 |
| Mid point of curve of index finger | 6 | 6 | 6 | 8 |
| Length of index finger | 60 | 65 | 70 | 70 |
| Length of middle finger | 75 | 80 | 85 | 85 |
| Length of forefinger | 70 | 75 | 80 | 80 |
| Length of little finger | 55 | 60 | 65 | 65 |
| Length of thumb | 55 | 60 | 65 | 65 |
| Length between end of index and middle finger | 15 | 17 | 17 | 17 |

Table 33 Typical gloves dimensions (Source: EN 60903: 1992, Table B1)

#### 5.3.1.6 Puncture, snag, tear and cut resistant

Other than electrical insulation performance, gloves selected should comply with specified strength requirement to provide protection against possible damages by puncture, snag, tear and cut during working process. Typical strength requirements are as shown in Table 34.

| Physical Strength Property | Typical Requirement |
|---|---|
| Tensile Strength | 17.2 Mpa |
| Ultimate elongation | 600% |
| Tear Resistance | 21 kN/m |
| Puncture Resistance | 18 kN/m |
| Hardness | 47 shore A |

Table 34 Typical strength requirement of insulating gloves (Source: D120-95 of ASTM Standard 1996, Table 4)

#### 5.3.1.7 Allergic reaction

Gloves of natural latex or rubber may cause an allergic sensitivity to some of the wearers. The allergic reaction most commonly appears as a reddening or itching at the site of glove contact. Stop further wearing insulating gloves on suspect of allergic reaction and check with manufacturers for availability of non-latex alternative types.

### 5.3.2 Application Guide

Insulating gloves should be worn when there is a danger in contact between the hands and live parts of the electrical system. Typical working conditions which demand the uses of insulating gloves are shown in Table 35.

| |
|---|
| • Working close to exposed, overhead energized lines |
| • Working in switchgear, close to exposed energized conductors |
| • Anytime that a flash suit is recommended |

Table 35 Typical applications of insulating gloves (Source: Cadick, Capelli-Schellpfeffer, and Neitzel, 2000, pp 2.11, Table 2.5)

Always inspect your insulating gloves before wearing them. The prime concern of field inspections are cuts, tears, punctures, discoloration, stiffness and non-uniformities in the rubber materials. Field inspection and periodic tests are summarized as follows.

#### 5.3.2.1 Air Test

Air test should be conducted before each use. Inflate the glove with air and held close to the face to feel for air leaks through pinholes or cracks. The procedures are illustrated in Illustration 2 and 3.

Illustration 2 Inflate the glove with air


Illustration 3 Held the inflated glove close to the ear to detect for leaks

### 5.3.2.2 Hand Rolling and Pinch Rolling

Squeeze the inside surface of the gloves so as to bend the outside surface by rolling between the hands. The stress developed will highlight cracks, cuts, scratches and irregularities, if any. Pinching rolling is a more precise inspection by rolling gloves between the thumb and fingers. It is used to inspect suspicious areas. Inspection by hand and pinch rolling are shown in Illustration 4 and 5

Illustration 4 Rolling between the hand to inspect cracks, cuts, scratches and irregularities



Illustration 5 Pinching is to squeeze the gloves by fingers to pinpoint the irregularities of a small area.

#### 5.3.2.3 Stretching

Stretch the thumb and finger crotches by pulling apart adjacent thumb and fingers to look for irregularities as shown in Illustration 6.

Illustration 6 To stretch the crotches area to check for irregularities

#### 5.3.2.4 Electrical Retesting

It is recommended that insulating gloves are to be electrically tested at an interval of every 6 months. Electrical testing of insulating gloves is a specialized procedure and should be conducted by accredited testing center with recognized Standards.

#### 5.3.2.5 Precautions in Use

- Gloves should not be exposed to undue heat or light
- Gloves should not be allowed to come into contact with oil, grease, turpentine, whit spirit or strong acid. Gloves should be wiped clean as soon as possible, if being contaminated.

- Soiled gloves should be cleaned with soap and water.
- Protector gloves should be worn over insulating gloves to protect against anticipated mechanical damages.
- Gloves may be dusted with talcum powder to absorb perspiration.

#### 5.3.2.6 Damaged Gloves.

Gloves with the following defects shall not be used.

- Holes, tears, punctures, or cuts.
- Ozone cutting
- Imbedded foreign objects
- Texture changes and sticky

### 5.3.3 Maintenance Guide

#### 5.3.3.1 Storage

Gloves should be stored in their container or package. It should not be compressed, folded, or stored in proximity to heat sources, direct sunlight or ozone sources. Gloves may be kept inside of a protector or a box used exclusively for its storage.

#### 5.3.3.2 Repair

Minor cuts, abrasion, tears or punctures may be repaired by compatible patches. Repair shall be limited to the gauntlet area. Subsequent to any repair, gloves shall be re-inspected and retested in accordance with the field tests and electrical tests prior put back to service.

#### 5.3.3.3Record Keeping

A record shall be kept of the testing/retesting details of the gloves. Date of test and voltage applied shall be recorded. Gloves that failed the tests shall be rejected and disposed by cut, defaced, or marked for its unsuitable for electrical services.

## 5.4Recommendations for Further Studies

Given the findings of the survey, the following topics will be of interest to help the REW on promotion of insulating gloves in the trade.

- Lost of dexterity had been ranked the highest score which REW were reluctant to wear insulating gloves in their daily jobs. It will be interested to conduct systematic tests to measure dexterity performances and analysis the lost of performance, if any, of REW in job execution with insulating gloves at work.

- There were over one-fifth (21%) of REW using insulating gloves reported allergy or irritant reactions. It may wealth a comprehensive hygienic study on the issue, to ensure on extended applications of insulating gloves would not lead to adverse occupational health hazard.

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## Appendix A

# Guidance Notes

# on

# The Selection, Use and Maintenance

# of

# Insulating Gloves

# Guidance Notes

# on

# The Selection, Use and Maintenance

# of

# Insulating Gloves


Prepared By : M. F. Lai


Date : December 2002

## 1. Background

There are no official guidelines for electricians in HKSAR to select and use insulating gloves. Most of the present national standards address the testing and manufacturing specification of gloves under laboratory conditions, not the selection and uses of insulating gloves at workplaces. In a survey of 216 Registered Electrical Workers (REW) in mid 2002, 90% of the electricians had encountered live electrical working. Over half of the surveyed sample (52%) worked on live system or equipment on a weekly basis. The survey further indicated that 81% of the REW has no experience in the use of insulating gloves.

To reduce electrical shock hazards, isolation and safe work system are effective approaches. Tag out/lock out procedure and restricted access to hazardous electrical areas are common isolation practices. Insulating gloves, as well as other personal protective devices, are the last line of defense. To achieve the intended protection, the selection of insulating gloves should satisfy the set out performance criteria and the use of gloves shall follow established safety program.

## 2. Scope

This Guidance Notes set out recommendations based on a review of literature on electrical safety and findings of questionnaire survey on Registered Electrical Workers (REW) of mid 2002. It gives guidance on the three main areas.

2.1 Selection – Criteria in the determination on the classes of gloves appropriate to the particular application and the envisaged hazards.

2.2 Use – Safety precautions to be followed in daily applications at workplaces.

2.3 Maintenance – Safe and hygienic practices to be followed in cleaning, repair, periodic testing and storage

## 3. Objectives

The objective of this Guidance Notes is to allow REW to correctly select insulating gloves appropriate for their applications and to upkeep them to ensure proper protective functions are maintained.

## 4. Electrical Hazards

Electrical safety involves a thorough understanding on the electrical hazards so that we will have the correct perception in development of protective strategies. The National Institute for Occupational Safety and Health has prepared a student manual of Safety and Health for Electrical Trade (NIOSH Publication No. 2002-123), in which electrical hazards are broadly classified as follows.

### 4.1 Shock

Electric Shock is the physical stimulation that occurs when electric current passes through the body (Cadick, 2000). The degree of danger from electrical shock depends on the amount, duration, path of the shocking current and the general physical condition of the person receiving shock.

### 1.3.2 Burns

Burns caused by electricity are frequently third degree burns as a result of burning from the inside. It could be further categorized into 3 main groups :

- Electrical Burns.
- Arc burns
- Thermal contact burns

### 1.3.3 Falls

Even low voltages at 80 a-c volts (Cooper, 1993) can cause violent muscular contraction. One may lose the balance and fall at height. Serious injuries, like bone fractures or even death may be resulted from the fall arising from electrical incident.

The damages of electric shocks arising from varying amount of current passing through the body are summarized in Figure 1.

Figure 1 Effects of current passing through human body

| Current | Reaction |
|---|---|
| 1 milliamp | Just a faint tingle. |
| 5 milliamps | Slight shock felt. Disturbing, but not painful. Most people can "let go." However, strong involuntary movements can cause injuries. |
| 6-25 milliamps (women)† 9-30 milliamps (men) | Painful shock. Muscular control is lost. This is the range where "freezing currents" start. It may not be possible to "let go." |
| 50-150 milliamps | Extremely painful shock, respiratory arrest (breathing stops), severe muscle contractions. Flexor muscles may cause holding on; extensor muscles may cause intense pushing away. Death is possible. |
| 1,000-4,300 milliamps (1-4.3 amps) | Ventricular fibrillation (heart pumping action not rhythmic) occurs. Muscles contract; nerve damage occurs. Death is likely. |
| 10,000 milliamps (10 amps) | Cardiac arrest and severe burns occur. Death is probable. |

(Source : Safety and Health for Electrical Trade (NIOSH Publication No. 2002-123))

## 5. Protective Strategies

Under Section 6A of the Factories and Industrial Undertakings Ordinance, Chapter 59, employers are legally obliged to provide and to maintain “systems of work”, as far as reasonable practical, safe and without risks to health.

### 5.1 Safe System of Work

In the Health and Safety Briefings of The Institution of Electrical Engineers (IEE, 2001), systems of work have a broad meaning which includes :

- Physical layout of the job.
- Sequence in which the work is to be carried out
- Provision of warnings and notices
- Issue of instructions.
- Any subsequent modification and improvements of the established system.

In simple terms, the protection of workers relies on the duty of care of employer under the provision of safe system of work (Labour Department, 1990). The obligation on the employer is threefold :

- Provision of a competent person
- Adequate material and plant
- Effective supervision

### 5.2 Key Elements of a Safe System of Work

The process to develop a modern safe system of work (IEE, 2001) is to first, identify the hazards, followed by:

- Make a risk assessment
- Determine what can be done to remove the identified hazards.
- Formalize the hazard control steps into procedures.
- Include in the procedure the use of permit to work coupled with physical lockout systems.
- Monitor the observance
- Feed-back failures in system
- Rectify defects and modify system
- Keep monitoring and continuous improvement.

The safe system of work can be considered as a formal procedure which results from systematic examination of a task in order to identify all the hazards and subsequent effective elimination of hazards (Labour Department, 1990)

**5.3 Risk Assessment**

The Management of Health and Safety at Work Regulations (1999) of UK defines risk assessment as identifying the hazards present in any undertaking and then evaluate the extent of the risks involved, taking into account whatever precautions are already being taken. It further defines hazard as potential harm and risk as the likelihood of the harm from a particular hazard being realized.

In Hong Kong, the Factories and Industrial Undertakings Regulations and the Occupation Safety and Health Regulations require common risks to be assessed. It is the legal duty of employers to assess certain risks to identify what has to be done to protect workers from harm. The Safety Management Regulation (2000) further sets out the requirement in establishment of a program to identify hazardous exposure or the risk of such exposure to the workers. Proposed engineering controls and provision of suitable personal protective equipment are one of the key elements stipulated in the Safety Management System to be adopted. It is important to note that very specialized risks, such as electrical hazards, has not been set out in the Factory and Industrial Undertakings (Electricity) Regulations or the Electricity Ordinance.

### 5.4 Hierarchy of Control on Electrical Hazards

In a broad sense, the hierarchy of engineering control being: firstly elimination, then isolation and lastly minimization (Pringle, 2001). The hierarchy of hazard control can be summarised in the inverted pyramid as shown in Figure 2.

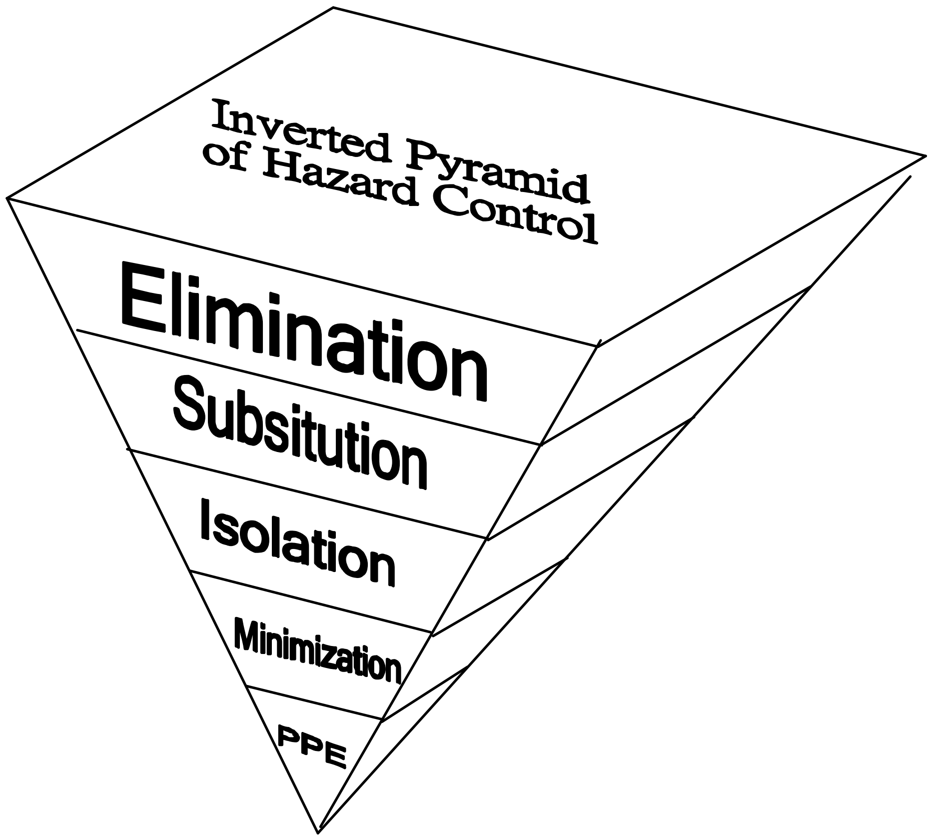


Figure 2 Inverted Pyramid of Hazard Control (source: Pringle, 2001)

Following a similar hierarchy of control, WorkCover Corporation of South Australia (2002) suggests a sequence of action to deal with anticipated electrical hazard.

- Elimination
  - Remove hazardous electrical plant from the workplace.
  - Cease in-house operations of hazardous work.

- Substitution
  - Use low voltage electrical appliances
  - Substitute movable electrical plant with fixed equipment

- Isolation
  - Place hazardous electrical plant in enclosures with restricted access
  - Apply tagout and lockout procedure

- Minimization
  - Use engineering controls. The application of RCDs to protect socket outlet could be an effective means to protect workers from harmful electrical shock.
  - Use administrative controls. Scheduled inspections and checks on electrical installation and implementation of safe work practices, instruction and training would help to identify electrical faults and rectify the defeats in a systemic way.

- Use Personal Protective Equipment (PPE)
  - The use of insulated gloves, rubber mats and other personal protective equipment is the last resort. Protective barrier on person is the lowest level of the control hierarchy. “All practicable steps” in each control level shall be applied, before dropping to the next level.

## 6. Selection of Insulating Gloves

The selection of proper insulating glove begins with an accurate evaluation of job applications. Factors that influence the selection are:

6.1 Maximum Usage Voltage

Voltages of electrical installations to be handled are of prime importance in selection of insulating gloves. Typical types and their specified voltages are listed below for information.

| BS EN60903: 1993; D120-95 of ASTM 1996 | | **BS 697: 1986; AS 2225 – 1994** | | GB 17622 – 1998 | | JIS T 8112: 1997 | |
|---|---|---|---|---|---|---|---|
| Glove Type | Rated Voltage | Glove Type | Rated Voltage | Glove Type | Rated Voltage | Glove Type | Rated Voltage |
| 00 | 500V | | | | | | |
| | | | | | | A | 600V |
| | | a | 650V | | | | |
| 0 | 1000V | b | 1000V | | | | |
| | | | | 1 | 3000V | | |
| | | c | 3300V | | | | |
| | | | | | | B | 3500V |
| | | d | 4000V | | | | |
| | | | | 2 | 6000V | | |
| | | | | | | C | 7000V |
| 1 | 7500V | | | | | | |
| | | | | 3 | 10000V | | |
| 2 | 17000V | | | | | | |
| 3 | 26500V | | | | | | |
| 4 | 36000V | | | | | | |

Table 1 Maximum use voltage for various classes of insulating gloves (Source: BS EN60903: 1993, Table A I; D120-95 of ASTM Standard 1996, pp 16; JIS 8112: 1997, Table 1; GB17622 –1998, Table2; BS697: 1986, Clause 1 and AS 2225 – 1994, Table 3)

## 6.2 Special contact requirements

Insulating gloves may need special resistance properties, in addition to insulation performance, to meet actual job requirement at workplaces. Typical resistance properties are listed

6.2.1 BS EN60903 : 1993

| Category | Resistant to |
|---|---|
| A | Acid |
| H | Oil |
| Z | Ozone |
| M | Mechanical (higher level) |
| R | Acid, oil, ozone, mechanical (higher level) |
| C | Extreme low temperature |

Table 2 Special properties of insulating gloves of BS EN60903.1993 (Source: BS EN60903 : 1993, Table I)

6.2.2 Designation : D120-95 of ASTM Standard 1996

| Category | Resistant to |
|---|---|
| Type I | Non-resistant to ozone |
| Type II | Resistant to ozone |

**Table 3 Special properties of insulating gloves of** D120-95 of ASTM (Source: D120-95 of ASTM Standard 1996, pp 16-17)

## 6.3 Dexterity requirements

Lost of dexterity was the prime reason that the surveyed REW were not willingly to wear insulating gloves in their daily work. For a given rubber polymer, an increase in thickness will result in a higher level of protection. But thick gloves can impair dexterity. Both BS 697:1986 and AS 2225-1994 recognizes the need to have a high flexibility and dexterity in certain jobs. No minimum thickness is specified for 650V gloves under these Specifications. Electrical performances of which are determined by tests.

## 6.4 Grip requirements

Lack of grip was ranked the second highest reason for reluctance in use of insulating gloves. Sensitivity and the ability to grip are important factors. Select an insulating glove with working area (all fingers, thumb crotches and palm) of suitable finish to provide the necessary grip needed for your job.

### 6.5 Size and fit

Proper size and fit contribute to comfort, productivity and safety. Gloves which are undersize may cause undue hand fatigue. Oversized gloves are uncomfortable, lack of sensitivity and may get caught in between revolving parts. Hand circumference method is the most common measurement in glove sizing. Circumference of the hand around the palm area, with fingers together and hand relaxed. The measured length in inches is closest to the actual glove size. Figure 3 shows the measurement to determine proper gloves size.

Figure 3. To determine glove size by hand circumference measurement (8 inches equals to size 8)


For easy comparison, glove sizes and corresponding general sizes are shown in Table 4.

| | | | | | |
|---|---|---|---|---|---|
| Numerical Glove Size | 6-7 | 7-8 | 8-9 | 9-10 | 11 |
| General Glove Size | XS | S | M | L | XL |

Table 4 Corresponding glove sizes (Source: Cole Parmer, Safety Glove Sizing Guide)

Dimensions of gloves may be different amongst manufacturers. Detailed measurements should be with specifications of manufactures. Typical glove dimensions are as shown in Table 5

| Details | Glove Size | | | |
|---|---|---|---|---|
| | 8 | 9 | 10 | 11 |
| Circumference of palm | 210 | 235 | 255 | 280 |
| Circumference of wrist | 220 | 230 | 240 | 255 |
| Circumference of cuff | 330 | 340 | 350 | 360 |
| Circumference of thumb | 70 | 80 | 90 | 95 |
| Circumference of index finger | 60 | 70 | 80 | 85 |
| Circumference of middle finger | 60 | 70 | 80 | 85 |
| Circumference of forefinger | 60 | 70 | 80 | 85 |
| Circumference of little finger | 55 | 60 | 70 | 75 |
| Width of palm | 95 | 100 | 110 | 125 |
| Wrist to end of index finger | 170 | 175 | 185 | 195 |
| Base line of thumbs to end of index finger | 110 | 110 | 115 | 120 |
| Mid point of curve of index finger | 6 | 6 | 6 | 8 |
| Length of index finger | 60 | 65 | 70 | 70 |
| Length of middle finger | 75 | 80 | 85 | 85 |
| Length of forefinger | 70 | 75 | 80 | 80 |
| Length of little finger | 55 | 60 | 65 | 65 |
| Length of thumb | 55 | 60 | 65 | 65 |
| Length between end of index and middle finger | 15 | 17 | 17 | 17 |

Table 5 Typical gloves dimensions (Source: EN 60903 : 1992, Table B1)

### 6.6 Puncture, snag, tear and cut resistant

Other than electrical insulation performance, gloves selected should comply with specified strength requirement to provide protection against possible damages by puncture, snag, tear and cut during working process. Typical strength requirements are as shown in Table 6.

| Physical Strength Property | Typical Requirement |
|---|---|
| Tensile Strength | 17.2 Mpa |
| Ultimate elongation | 600% |
| Tear Resistance | 21 kN/m |
| Puncture Resistance | 18 kN/m |
| Hardness | 47 shore A |

**Table 6 Typical strength requirement of insulating gloves (Source :** D120-95 of ASTM Standard 1996, Table 4)

### 6.7 Allergic reaction

Gloves of natural latex or rubber may cause an allergic sensitivity to some of the wearers. The allergic reaction most commonly appears as a reddening or itching at the site of glove contact. Stop further wearing insulating gloves on suspect of allergic reaction and check with manufacturers for availability of non-latex alternative types.

## 7. Use of Insulating Gloves

Insulating gloves should be worn when there is a danger in contact between the hands and live parts of the electrical system. Typical working conditions which demand the uses of insulating gloves are shown in Table 7.

| |
|---|
| ● Working close to exposed, overhead energized lines |
| ● Working in switchgear, close to exposed energized conductors |
| ● Anytime that a flash suit is recommended |

Table 7 Typical working conditions which demand the uses of insulating gloves (Source : Cadick, Capelli-Schellpfeffer, and Neitzel, 2000, pp 2.11, Table 2.5)

Always inspect your insulating gloves before them. The prime concern of field inspections are cuts, tears, punctures, discoloration, stiffness and non-uniformities in the rubber materials. Field inspection and periodic tests are summarized as follows.

**7.1 Air Test**

Air test should be conducted before each use. Inflate the glove with air and held close to the face to feel for air leaks through pinholes or cracks. The procedures are illustrated in Figure 4 and 5.

Figure 4 Inflate the glove with air


Figure 5 Held the inflated glove close to the ear to detect for leaks

**7.2 Hand Rolling and Pinch Rolling**

Squeeze the inside surface of the gloves so as to bend the outside surface by rolling between the hands. The stress developed will highlight cracks, cuts, scratches and irregularities, if any. Pinching rolling is a more precise inspection by rolling gloves between the thumb and fingers. It is used to inspect suspicious areas. Inspection by hand and pinch rolling are illustrated in Figure 6 and 7


Figure 6 Rolling between the hand to inspect cracks, cuts, scratches and irregularities


Figure 7 Pinching is to squeeze the gloves by fingers to pinpoint the irregularities of a small area.

**7.3 Stretching**

Stretch the thumb and finger crotches by pulling apart adjacent thumb and fingers to look for irregularities as shown in Figure 8.

Figure 8 To stretch the crotches area to check for irregularities


**7.4 Electrical Retesting**

It is recommended that insulating gloves are to be electrically tested at an interval of every 6 months. Electrical testing of insulating gloves is a specialized procedure and should be conducted by accredited testing center with recognized Standards.

**7.5 Precautions in Use**

- Gloves should not be exposed to undue heat or light
- Gloves should not be allowed to come into contact with oil, grease, turpentine, whit spirit or strong acid. Gloves should be wiped clean as soon as possible, if being contaminated.
- Soiled gloves should be cleaned with soap and water.
- Protector gloves should be worn over insulating gloves to protect against anticipated mechanical damages.
- Gloves may be dusted with talcum powder to absorb perspiration.

**7.6 Damaged Gloves.**

Gloves with the following defects shall not be used.

- Holes, tears, punctures, or cuts.
- Ozone cutting
- Imbedded foreign objects
- Texture changes and sticky

## 8. Care and Maintenance of Insulating Gloves

### 8.1 Storage

Gloves should be stored in their container or package. It should not be compressed, folded, or stored in proximity to heat sources, direct sunlight or ozone sources. Gloves may be kept inside of a protector or a box used exclusively for its storage.

### 8.2 Repair

Minor cuts, abrasion, tears or punctures may be repaired by compatible patches. Repair shall be limited to the gauntlet area. Subsequent to any repair, gloves shall be re-inspected and retested in accordance with the field tests and electrical tests prior put back to service.

### 8.3 **Record Keeping**

A record shall be kept of the testing/retesting details of the gloves. Date of test and voltage applied shall be recorded. Gloves that failed the tests shall be rejected and disposed by cut, defaced, or marked for its unsuitable for electrical services.

## 9. **Summary**

Electricians need to exercise special care in the selection, use and maintenance of insulating gloves. Understanding selection criteria, types limitation, proper care and adhere to precautions at use can enhance safety against electrical shock. One should always remember that insulating gloves, as well as other personal protection equipment, are essential parts of a hazard control strategy. They are effective, provided their position, as the last line of defense, is properly recognized in the control hierarchy.

# Appendix B

## Questionnaire (English) of the Survey

Contact Code ☐☐☐☐

## Electrical Protective Gloves Survey

I am a POSH student of the University of Western Sydney and the Hong Kong Polytechnic University. This is a questionnaire to find out how electricians in HKSAR select and use electrical protective gloves in their daily jobs. It will take you about 15 minutes to complete this questionnaire. Kindly return your completed questionnaire to me by the attached envelop before August 30, 2002.

FIRST SOME FACTS ABOUT YOU

1. Age Group 17 – 28 ☐ 29 – 40 ☐ 41 – 52 ☐ 53 – 64 ☐ 65 + ☐

2. Education Primary ☐ Secondary ☐ Tertiary ☐ University ☐
   Others ☐, please specific ___________________________

3. Permitted Class of Electrical Work A ☐ B ☐ C ☐ H ☐ R ☐

4. Electrical Work Experience
   <5 years ☐ 6 – 10 years ☐ 11 – 15 years ☐ 16 – 20 years ☐ 21 + years ☐

**NOW SOME QUESTIONS ABOUT YOUR WORK**

5. Do you or your employer conduct risk assessment prior to electrical work?
   Yes ☐ No ☐ Don' t Know ☐

6. Have you or your employer carried out accident/incident investigation after an accident?
   Yes ☐ No ☐ Don' t Know ☐

7. Does your company have Job Safety Analysis (JSA)
   Yes ☐ No ☐ Don' t Know ☐

8. Does your company conduct Process Hazard Review?
   Yes ☐ No ☐ Don' t Know ☐

9. Does your company have a lock out procedure?
   Yes ☐ No ☐ Don' t Know ☐

10. How often do you encounter live electrical work?
daily ☐ weekly ☐ monthly ☐ yearly ☐ never ☐ (**Skip to Q13**)

11. Which type of electrical work do you encounter live work most?
Installation ☐ Repair ☐ Inspection ☐ Testing ☐ Commissioning ☐

**NOW SOME OPINIONS ABOUT YOUR SELECTION ON ELECTRICAL GLOVES**

12. Have you used electrical protective gloves before?
Yes ☐ **(Skip to Q 14)** No ☐

13. With regard to not using electrical protective gloves, which of the following factors influenced you? (You may tick more than one)

Cost ☐
No knowledge ☐
Ineffective protection ☐
Incompatible to task ☐
Not durable ☐
Lack of grip ☐
Lost of dexterity ☐
Allergies ☐
Uncomfortable ☐
Size don' t fit ☐
Inappropriate length of protection ☐
No particular reasons ☐
Others ☐, please specify ________________________

**YOU HAVE COMPLETED THIS QUESTIONNAIRE, THANK YOU FOR YOUR TIME. YOU CAN LEAVE THE FOLLOWING QUESTIONS BLANK.**

14. Where do you obtain your electrical protective gloves?
Provided by employer ☐ Bought from hardware store ☐ Bought from PPE store ☐
Bought through trade union ☐ Bought through mail or internet ordering ☐

HAVE YOU CONSIDERED THE FOLLOWING FACTORS IN YOUR SELECTION?

| | YES | NO | DON' T KNOW |
|---|---|---|---|
| 15. Protective capability | ☐ | ☐ | ☐ |
| 16. Workmanship and product quality | ☐ | ☐ | ☐ |
| 17. Task compatibility | ☐ | ☐ | ☐ |
| 18. Dexterity | ☐ | ☐ | ☐ |
| 19. Grip | ☐ | ☐ | ☐ |
| 20. Comfort | ☐ | ☐ | ☐ |
| 21. Size | ☐ | ☐ | ☐ |
| 22. Cuff style | ☐ | ☐ | ☐ |
| 23. Length to be protected | ☐ | ☐ | ☐ |
| 24. Puncture, snag, tear and cut resistance | ☐ | ☐ | ☐ |
| 25. Durability | ☐ | ☐ | ☐ |
| 26. Marking | ☐ | ☐ | ☐ |
| 27. Packing | ☐ | ☐ | ☐ |
| 28. Cost | ☐ | ☐ | ☐ |

**NOW SOME USER EXPERIENCE OF YOURSELVE ON ELECTRICAL GLOVES**

29. Have you read the in-service recommendations and instructions of gloves manufacturers prior to first use?
    Yes ☐ No ☐ Not provided ☐

30. Where do you store your electrical gloves?
No designated storage ☐ Toolbox ☐ Package of manufacturer ☐ Specific location free from heat, sunlight and ozone. ☐ Others ☐ , please specify ____________________

31. Do you inflate gloves and check for air leaks before each use?
Yes ☐ No ☐ Other leak tests ☐ , please specify ____________________________

32. Do you carry out visual inspection before each use
Yes ☐ No ☐ Other tests ☐ , please specify ____________________________

33. Do you carry out rolling test to check surface defects and imbedded materials
Yes ☐ No ☐ Other tests ☐ , please specify ____________________________

34. Do you or your employer carry out periodic inspection and dielectric test every six months?
Yes ☐ No ☐ Other leak tests ☐ , please specify ____________________________

35. Do you or your employer establish instructions and regulations to govern the correct use of gloves
Yes ☐ No ☐ Don't Know ☐

36. Have you experienced allergic contact dermatitis on use of electrical protective gloves?
Yes ☐ No ☐ Other irritant reactions ☐

**THANK YOU FOR YOUR TIME TO COMPLETE THIS QUESTIONNAIRE**

# Appendix C

## Questionnaire (Chinese) of the Survey

參考編號: □□□□

**有關電工使用電器安全手套之調查**

**本人是由澳洲 UWS 大學及香港理工大學所舉辦職業安全及健康課程的研究生. 現在正進行一項有關香港在職的電工如何選購及使用絕緣手套的調查. 是次問卷只需閣下約十五分鐘完成, 完成後請把問卷在 2002 年 8 月 30 日前放入附上的信封寄回.**

**謝謝閣下合作!**

**第一部分: 基本統計資料**

**在適當的方格加上 ▤號**

1. **年齡組別:** 17-28 □ 29-40 □ 41-52 □ 53-64 □ 65 以上 □

2. **學歷:** 小學 □ 中學 □ 大學 □ 其他 □, 請註明 _______________

3. **註冊之電工准許工程級別:** A □ B □ C □ H □ R□

4. **電力作業之經驗:** 少於 5 年 □ 5-10 年 □ 11-15 年 □ 16-21 年□ 21 年或以上 □

**第二部分: 有關閣下日常工作的題問**

5. **你或你的顧主在開始有關電力工作之前有否進行風險評估?**

   有 □ 否 □ 不清楚 □

6. **一旦有事故發生, 你的顧主有否進行意外/事故調查研究?**

   有 □ 否 □ 不清楚 □

7. **你的顧主有否採用工作安全分析 (Job Safety Analysis)?**

   有 □ 否 □ 不清楚 □

8. **你的公司有否進行工序危害覆核(Process Hazard Review)?**

   有 □ 否 □ 不清楚 □

9. **你的公司有否採用斷電上鎖/掛牌程序** (Lockout/Tagout Procedure)?

**有** ☐ **否** ☐ **不清楚** ☐

10. **你有多經常帶電作業**?

**每天** ☐ **每週** ☐ **每月** ☐ **每年** ☐
**從未** ☐ **(跳至第 13 題)**

11. **以下那種工作令你最經常帶電作業**?

**安裝** ☐ **修理** ☐ **檢查** ☐ **測試** ☐ **啟動**☐

**第三部分: 有關你選擇電器安全手套的意見**

12. **你曾否使用電絕緣手套**?

**有** ☐ **(跳至第 15 題)** **否** ☐ **(請到第 14 題及完成問卷)**

13. **以下那些因素影響你在工作時不使用電絕緣手套**? **(可選多於一項)**

**價錢** ☐ **影響靈活性** ☐
**缺乏有關知識** ☐ **皮膚過敏** ☐
**保護不足** ☐ **不舒適** ☐
**不能與工作相容** ☐ **尺碼不合** ☐
**不耐用** ☐ **保護長度不合** ☐
**不能緊握物件** ☐ **沒特別原因** ☐
**其他** ☐, **請註明** ____________

**閣下已完成此問卷, 謝謝閣下抽空完成! (以下部分請留空**)

14. **你從那種途徑獲得電絕緣手套**?

**由顧主提供** ☐ **五金器具店** ☐ **職安健專門店** ☐
**經工會購買** ☐ **經電郵或網上商店購買** ☐

**選擇絕緣手套前，你會否考慮以下因素?**

| | 有 | 否 | 不清楚 |
|---|---|---|---|
| 15. **保護能力** | ☐ | ☐ | ☐ |
| 16. **產品質量** | ☐ | ☐ | ☐ |
| 17. **電氣絕緣性能** | ☐ | ☐ | ☐ |
| 18. **靈活性** | ☐ | ☐ | ☐ |
| 19. **緊握度** | ☐ | ☐ | ☐ |
| 20. **舒適度** | ☐ | ☐ | ☐ |
| 21. **尺碼** | ☐ | ☐ | ☐ |
| 22. **袖口設計** | ☐ | ☐ | ☐ |
| 23. **雙手受保護部份** | ☐ | ☐ | ☐ |
| 24. **抗刺穿/劃破/撕破/剪斷的耐力** | ☐ | ☐ | ☐ |
| 25. **耐用性** | ☐ | ☐ | ☐ |
| 26. **標記** | ☐ | ☐ | ☐ |
| 27. **包裝** | ☐ | ☐ | ☐ |
| 28. **價格** | ☐ | ☐ | ☐ |

**第四部份:有關使用電絕緣手套的經驗**

29. **.在使用電絕緣手套之前，你有否先閱讀過製造商的使用指示或建議?**

**有** ☐ **否** ☐ **沒有提供** ☐

30. **你如何儲藏你的電絕緣手套**?

**沒有指定地方** □ **工具箱** □ **製造商的包裝合** □
**放在避免與陽光, 高溫及臭氧接觸的地方** □
**其他, 請註明** ____________________

31. **你有否在每次使用絕緣手套前使手套進行洩氣測試**?

**有** □ **否** □ **使用其他測試** □, **請註明** ________________

32. **每次使用前有否使用目測法檢查手套？**

**有** □ **否** □ **使用其他測試** □, **請註明** ________________

33. **每次使用前有否用拇指展開壓痕以便檢查表面瑕疵及是否藏有雜質**?

**有** □ **否** □ **使用其他測試** □, **請註明** ________________

34. **你或你的顧主有否每六個月進行定期檢查及驗証電壓試驗**?

**有** □ **否** □ **使用其他漏電測試** □, **請註明** ____________

35. **你或你的顧主有否定立正確使用電絕緣手套的指示及規則**?

**有** □ **否** □ **不清楚** □

36. **你曾否因穿戴電絕緣手套而引起皮膚過敏症狀?**

**有** □ **否** □ **其他過敏反應** □

**完**

**謝謝閣下抽空完成問卷!**