

Challenges to Enhancing the Electrical Safety in a Densely Populated City

Ir Y.H. LEUNG

Electrical and Mechanical Services Department
Hong Kong SAR Government, Hong Kong

Abstract : Hong Kong is a densely populated city among the world. Safe supply, delivery and use of electricity are vital to our daily life and commercial activity. The Electricity Ordinance in Hong Kong aims at safeguarding the general public at large in the use of electricity, which is supplied through transmission and distribution. The Electrical and Mechanical Services Department [EMSD] is the authority in Hong Kong responsible for the enforcement of the Electricity Ordinance and its subsidiary regulations. This paper briefly explains how EMSD is enforcing the current regulatory framework to meet the challenges in preventing electricity cables from damage, ensuring electrical installation safety and assuring electrical product safety. It will then elaborate the public education and publicity activities carried out by EMSD in recent years to promote to the public and the trade about electrical safety and to educate them the potential danger of electricity. To give a broader picture on worldwide regulatory control of electrical safety, benchmarking with Singapore and the United Kingdom on regulatory regime of electricity legislation will also be discussed. The paper will finally give an account of the challenges ahead facing EMSD to upkeep the high standards of safety in Hong Kong.

1. INTRODUCTION

Although Hong Kong is a small place in a total area of 1,098 km², its population is now growing to almost 7 millions. When compared with Singapore and London (see Table 1), the population and household densities of Hong Kong are relatively high. In such a densely populated city, safe supply, delivery and use of electricity are vital to our daily life and commercial activity. Because of effective legislative measures and high standards of safety, electricity has significantly improved our lifestyle, working environment, communication efficiency and information technology in past years. In Hong Kong today, safe and reliable electricity supply, electrical installations and electrical products continue to improve our quality of life and maintain our city as a world-class international metropolis.

Although most of us understand that improper use of electricity can be lethal, not many members of the public are fully aware that the risks associated with the underground electricity cables on streets, electrical installations in buildings, electrical products of household have been greatly reduced and mitigated through effective enforcement of the current regulatory framework under the Electricity Ordinance.

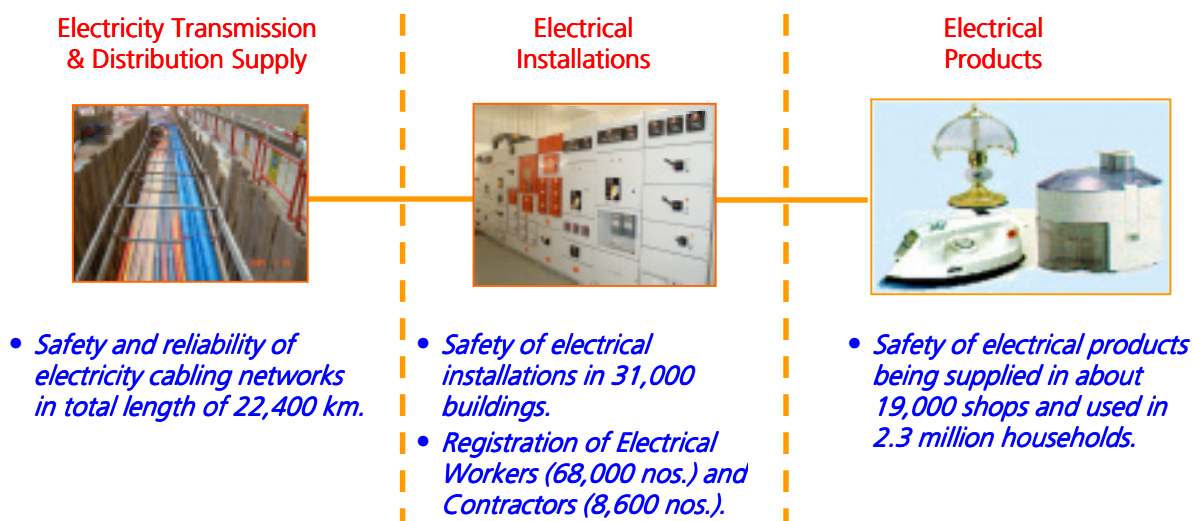
Place	Hong Kong	Singapore	London
Area	1,098 km ²	697 km ²	1,572 km ²
Population (Population Density)	6.99 million (6,366 people / km ²)	4.35 million (6,241 people / km ²)	7.52 million (4,784 people / km ²)
Household (Household Density)	2.32 million (2,113 household / km ²)	0.92 million (1,320 household / km ²)	3.11 million (1,978 household / km ²)

Table 1 - Comparison of Population and Household between Hong Kong, Singapore and London

2. REGULATORY FRAMEWORK IN HONG KONG

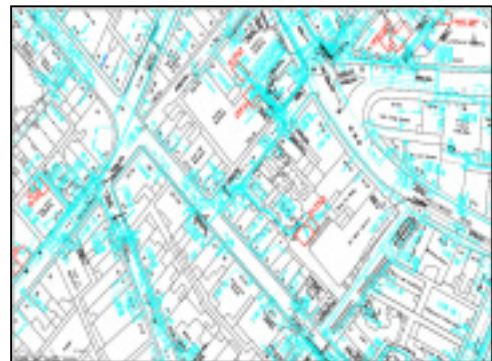
The Electricity Ordinance (Cap. 406) establishes an embracing and systematic regulatory framework to ensure electrical safety in Hong Kong. It is supported by a number of subsidiary regulations including the Electricity Supply Lines (Protection) Regulation, Electricity (Wiring) Regulations, Electricity (Registration) Regulations, Electrical Products (Safety) Regulation, and others to govern the transmission, distribution and utilization of electricity.

EMSD is the authority in Hong Kong responsible for the enforcement of the Electricity Ordinance and its subsidiary regulations. Fast growing cabling networks for electricity supply, rising expectations of community for reliable power supply in buildings and increasing public awareness of household safety have brought up to us three major areas of concern, namely prevention of damage to electricity cables, quality and workmanship of electrical installations and safety of household electrical products. In such demanding situations, EMSD is facing the challenges in ensuring the safe supply, delivery and use of electricity in Hong Kong through enforcing the current regulatory framework.

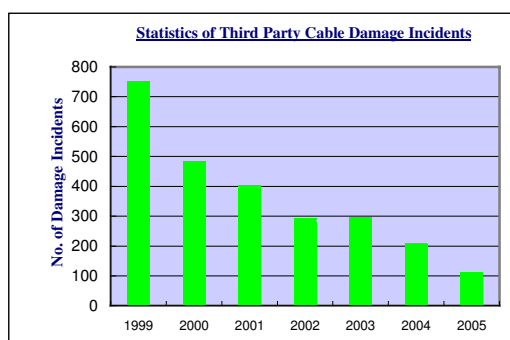
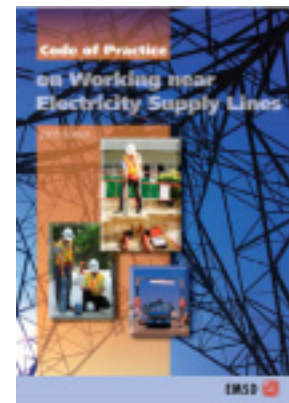


3. PREVENTION OF DAMAGE TO ELECTIRICTY CABLES

The transmission and distribution power cables laid underground in Hong Kong are more than 22,400 km in total length, over half circumference of the earth which is 40,225 km. In most urban areas, the pavements are crowded with power cables and also other utility facilities. During work particularly in the course of excavation, damage to a live electricity cable may lead to an explosion, and the site workers as well as other persons in the vicinity, may be electrocuted or burnt. In addition, the damage will also cause a power interruption and serious inconvenience to the general public. The Electricity Supply Lines (Protection) Regulation [ESLPR] requires the adoption of precautionary steps before the commencement of works and implementation of safety measures during the course of construction works for proper protection of electricity cables with a view to preventing power interruptions and electrical accidents arising from damages by third parties.



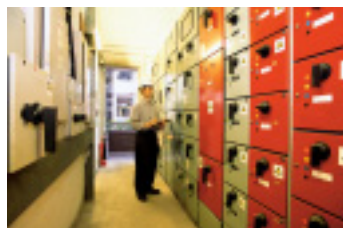
The main objective of the ESLPR is to regulate construction site activities including the use of heavy machinery to prevent damaging the underground power cables. EMSD published a “Code of Practice on Working near Electricity Supply Lines” to outline the “Safe System of Work”, which requires site contractors and workers to obtain cable plans from power companies, engage a qualified competent person to locate underground cables, and take measures to avoid damaging the cables by adopting safe working practices when carrying out works in the vicinity of underground power cables. In addition, power companies are also obligated to provide information relevant to power cables in the vicinity of works upon request. As regards the competent persons, EMSD also maintains and administers a list of approved competent persons for locating underground power cables. More than 1,000 competent persons have been approved under the registered list to ensure adequate qualified persons available in the trade to meet the demand for cable detection work in the construction industry.



The ESLPR has been in force for over 5 years. With our sustained effort in recent years in promoting the technical requirements, conducting surveillance checks to works sites, monitoring the performance of competent persons for locating underground cables, investigating electricity cable damage incidents, and bringing offenders to courts, the outcomes are very encouraging, with a sharp 85% drop in cases concerning damages to underground power cables (from 753 cases in 1999 to 113 in 2005). The improvement trend can best be illustrated by the chart.

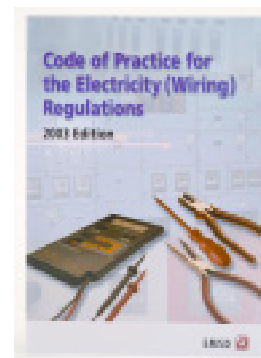
4. ENSURING ELECTRICAL INSTALLATION SAFETY

Residential, commercial and industrial buildings are diversely located in different districts of Hong Kong. Development areas are usually highly packed with numerous high-rise residential buildings and town centers are covered with sky-high commercial buildings and mega-sized shopping malls. It is not exaggerated to say that we are very difficult to find a place in Hong Kong without seeing any tall building, of which the electricity supply is of paramount importance. Water supply, lift service, lighting, air-conditioning, etc will be no longer available if the electrical installation for the building is failed. To keep in good conditions of the electrical installation and ensure electrical safety of the public and building owners, the Electricity (Wiring) Regulations [EWR] require that communal electrical installations in a building shall be periodically inspected, tested and certified safe. The test certificate shall then be submitted to EMSD for endorsement. To perform the watch-dog function,



EMSD checks and endorses the test certificates and conducts on-site sample checks to inspect the electrical installations every year. With our continuous effort in the past years, the safety awareness of building owners has become higher, particularly on the periodic inspection of their electrical installations.

The EWR also stipulates the safety requirements for the design, installation, testing and certification of electrical installations. In order to facilitate the trade and industry to comply with the statutory requirements of the EWR, EMSD published a Code of Practice for the Electricity (Wiring) Regulations [CoP]. The CoP provides comprehensive practical guidelines to help the trade to properly design, install, test and certify electrical installations.



To ensure the quality and workmanship of the electrical work being carried out, the Electricity (Registration) Regulations [ERR] specifies the qualifications and experience of registered electrical contractors and registered electrical workers [REC/REW]. Since electrical works in Hong Kong must be carried out by REWs, the quality and workmanship of these workers are the key elements in ensuring electrical safety. EMSD administers the registration of REC/REWs and constantly monitors the standard, performance and quality of work of REC/REWs through routine inspections, complaint and accident investigations. For the purpose of enhancing the performance of REWs, EMSD also sets up a Performance Monitoring Point System to provide fair and transparent administrative guidelines to take appropriate action against them.

5. ASSURING ELECTRICAL PRODUCT SAFETY

Long times ago, an electric lamp might be the only electrical product in a household and an electric fan or a radio was considered as a luxury possession. Today, it will be difficult to find a family in Hong Kong which has less than 10 items of electrical products. Electrical product has become an essential necessity in our daily life. According to the latest statistics, the number of households in Hong Kong has risen to 2.3 millions, in which wide varieties of electrical products (more than 60 types) such as electric fan, refrigerator, television, washing machine, room heater, air-conditioner, etc. are commonly used. It is foreseen that the variety and quantity of electrical products supplied in the market will continue to be on an upward trend. The Electrical Products (Safety) Regulation [EPSR] will be increasingly essential to assure public safety in the use of household electrical products.



For any household electrical product supplied in Hong Kong, it has to comply with the relevant international safety standards and has been issued with a certificate of safety compliance for every model. This is to ensure that the electrical product in the market shall meet all the safety requirements of the standards e.g. temperature rise, insulation clearance, electrical and mechanical strength, resistance to heat and fire, etc. In addition, an electrical product shall comply with essential safety requirements under the EPSR. Its main purpose is to ensure that under normal circumstances, users are protected from electric shock due to direct contact, the risk of fire or explosion due to over-heating, and personal injury due to any electrical or non-electrical danger which may arise.

EMSD has introduced Guidance Notes [GN] for the EPSR to help the trade and industry understand the requirements of the EPSR. The GN also sets out lists of standards that are deemed to satisfy the applicable safety requirements. In general, electrical products that are designed to meet the International Electrotechnical Commission (IEC) standards or compatible standards satisfy the safety requirements of the Regulation.



There are about 19,000 retail shops to sell the electrical products in different districts of Hong Kong. To deter the supply of non-compliant electrical products in these shops, EMSD carries out routine inspections and special



operations (either product-type or location-oriented inspections) to check any shops supplying sub-standard or unsafe products on regular basis. In 2005, we achieved the target of 3,800 shop inspections to check more than 10,000 models of electrical products. To further monitor the safety of electrical products being sold in the market, we employ independent laboratory to conduct full-scale safety surveillance tests on selected electrical products in accordance with corresponding safety standards to dig out any inherent design defect or manufacturing

quality problem. If problematic products are identified, we will follow up with the relevant suppliers/manufacturers and take necessary action as appropriate according to the EPSR.

For each reported incident related to electrical product, EMSD conducts on-site investigation to identify the root causes leading to the incident. Electrical products related to incidents are seized for post-mortem analysis. We also follow up with product suppliers and/or manufacturers on unsafe products and, if necessary, conduct product recall on such products.

EMSD has launched a voluntary scheme for registration of safety compliance certificates issued for household electrical products and posted the relevant product information onto EMSD's website. This voluntary scheme aims to facilitate consumers in selecting household electrical products that should satisfy the safety requirements of the Regulation. At present, 22 types of common electrical products have been registered under the scheme such as refrigerator, television, fan, room cooler, washer, microwave oven, rice cooker, induction cooker, etc. and its overall penetration rate is nearly 70% of the current market models.

6. PROMOTION AND PUBLIC EDUCATION



EMSD always believes that public education is the most effective way to enhance electrical safety. Thus, we arrange promotion and public education activities through various channels, whilst we consider prosecution action as the last resort. In recent years, we underscore our strategy of broadening our reach, by reaching out to the different strata of the community, from the kindergarten pre-schoolers to students and from the minority to the average citizen. In 2006, we have completed nearly 200 publicity events.



Attracting the attention of the public on our educational materials to promote electrical safety, we have adopted popular and world-famous cartoon characters, Snoopy and Doraemon, to enliven the design of posters, newsletters, booklets, leaflets, calendars, etc. and also invited celebrities to appear in our Electricity News for disseminating electrical safety messages to the public via these impressive materials. This approach has proven to be extremely effective, as high public demand for these promotion materials readily speaks for themselves.



Moreover, EMSD produces television and radio commercials focusing on the importance of safe use and proper maintenance of household electrical products and building electrical installations and broadcasts these on television and radio in different time slots to capture the attention of various audience groups. Safety messages are posted on buses, in MTRC/KCRC stations and on billboards in various



districts, etc. focusing on simple and clear messages. To better bring our electrical safety messages to the public in all walks of life, EMSD has also been publishing articles in a popular local newspaper every week to answer public enquiry on safety matters.



EMSD also publishes the "E&M Safety Newsletter" as leisure magazine for the general public with tips on electrical safety and distributes over 120,000 copies to schools, property management companies, public and private housing estates. Special household electrical safety booklets have been prepared for new immigrants and domestic helpers with languages in Pilipino and Indonesian taking care of the minority groups and large number of foreign domestic helpers.

Our volunteer team visits households of the needy and elderly to perform electrical safety check-ups, repair defective electrical installations/appliances and also convey electrical safety messages to them. Moreover, our safety ambassadors conduct outreach visits to kindergartens and nurseries throughout Hong Kong to teach students about basic household electrical safety through storytelling, games and drama. Similar programme to elderly and youth centres was also organized. Moreover, EMSD organises regular activities such as talks and carnivals to educate the general public on electrical safety.



In addition to educating the public, EMSD maintains close communications with the trade to help raise the standards of electrical work carried out in Hong Kong. On one hand, we collaborate with the electrical trade in conducting a large-scale technical seminar for 1,000 electrical contractors and workers to ensure that they all are familiar with the EWR, its CoP and other relevant safety requirements. On the other hand, we organize a series of safety talks for more than 800 property management companies.

7. BENCHMARKING WITH SINGAPORE AND THE UNITED KINGDOM

7.1 General

The Electricity Ordinance and its subsidiary regulations set out a legal framework in Hong Kong to regulate electrical safety encompassing three major areas of concern, namely electricity supply, electrical installations and electrical products. EMSD is the enforcement authority of the Electricity Ordinance. In Singapore and the United Kingdom (UK), electricity safety legislation is also put in place to protect the public over the supply, delivery and use of electricity. The following block diagrams simply show the relevant regulations in Hong Kong, Singapore and UK in respect of electricity supply, electrical installations and electrical products.

	Hong Kong	Singapore	UK
Electricity Supply	Electricity Supply Lines (Protection) Regulation	Electricity Act, Electricity (Cable Detection Workers) Regulations	Electricity at Work Regulations
Electrical Installations	Electricity Wiring Regulations, Electricity Registration Regulations	Electricity (Electrical Installations) Regulations, Electricity (Electrical Workers) Regulations	Electricity at Work Regulations, Building Regulations
Electrical Products	Electrical Products (Safety) Regulation	Consumer Protection (Safety Requirements) Regulations	Electrical Equipment (Safety) Regulation, Plugs and Sockets (Safety) Regulations

7.2 Prevention of Damage to Electricity Cables

For protection of underground electricity cables, Hong Kong is not alone in putting a set of precautionary safety practices under regulatory control. Efforts have been made by many developed countries to prevent electrical accidents or power interruptions arising from damage to electricity cables. Singapore's electricity network is unique in the world in that both transmission and distribution of electricity are carried out via the fully underground cabling system. In Singapore, damage to those underground cables will affect electricity consumers particularly in high-technology industries (e.g. high-technology electronics and process plants) that use voltage-sensitive equipment. For them, a momentary voltage drop can cause voltage-sensitive equipment to malfunction, resulting in downtime for affected production and process lines. In view of this, under the Singapore's Electricity Act, it is mandatory for the contractor carrying out excavation works in the vicinity of underground electricity cables to obtain cable plan, engage Licensed Cable Detection Worker and notify power company for commencement of excavation works. In UK, there is no such similar legislation to prevent the electricity cable from third party damage, but the Electricity at Work Regulations require that every work activity on or near an electrical system shall be carried out in such a manner as not to give rise to danger. It implies that excavation works should not be carried out unless all suitable and sufficient steps have been taken to identify and, as far as is reasonably practicable, prevent any risk of injury arising from any underground cables. Therefore, the legal requirements in UK deal only with risks to the safety of people and are not concerned with damage which has no direct risk associated with it.

To provide practical technical guidance for the construction industry to follow, the regulatory authorities of Hong Kong, Singapore and UK have respectively issued codes of practice to outline the safe system of work for excavation. They have three key elements in common : obtaining cable plan from power company during planning stage, locating cable position on site before the commencement of work and following safe digging practice in the course of excavation.

It is noted that there is marked reduction in the number of damage incidents since the implementation of the legislation in Hong Kong and Singapore. The relevant data on cable damage prevention are summarized in Table 2 to show the noticeable effectiveness of the legislation in both Hong Kong and Singapore.

Place	Hong Kong	Singapore
Length of underground electricity cables	22,400 km	15,255 km
Number of cable damage incidents before enactment of legislation	753 (in year 1999)	467 (in year 1989)
Number of cable damage incidents in 2005	113	about 50
Percentage drop	85%	89%

Table 2 - Relevant Data on Cable Damage Prevention in Hong Kong and Singapore

7.3 Electrical Installation Safety

To ensure electrical safety of the public and building owners in Hong Kong, communal electrical installations in a building shall be periodically inspected, tested and certified safe every five years. In UK, there is no legal requirement on statutory periodic inspection of electrical installations. According to BS 7671, periodic inspection and testing interval depends on a number of considerations e.g. age of the installation, type of premise, the extent of wear and tear, etc. As a guidance, the recommended maximum intervals are 10, 5 and 3 years for domestic, commercial and industrial premises respectively. Similar to UK, periodic inspection and testing of existing electrical installations is not specifically required by law in Singapore, but requirement of carrying out proper maintenance on electrical installations is stipulated in the Singapore's Electricity (Electrical Installations) Regulations.

The code of practices for electrical installations in Hong Kong and Singapore are both derived from British Standard 7671 (i.e. IEE Wiring Regulations) which is the national standard for the safety of electrical installations in UK. But, there are some modifications in technical requirements to suit local situations and trade practices in both Hong Kong and Singapore.

For the sake of enhancing the quality and workmanship, electrical works in Hong Kong shall be carried out by RECs and REWs. In Singapore, electrical works shall be carried out by licensed electrical workers (LEWs) registered with the Energy Market Authority. Unlike Hong Kong, electrical contractors in Singapore need not be registered since 2002. There is no registration scheme for electrical workers in UK. However, many electrical contractors in UK are registered with trade or professional organizations such as National Inspection Council for Electrical Installation Contracting (NICEIC) of Electrical Safety Council (ESC).

Although the legislative requirements are quite different in Hong Kong, Singapore and UK because of their distinct trade practices, the statistics in Table 3 indicate that, in these 3 places, the electrical accidents caused by exposure to electrical current are at a low fatality rate.

Place	Hong Kong	Singapore	UK
Average fatalities per year	About 1 to 4	About 2 to 6	About 12 to 20
Fatalities per million people per year	About 0.14 to 0.57	About 0.46 to 1.40	About 0.20 to 0.33

Table 3 – Fatality Rate of Electrical Accident Caused by Exposure to Electrical Current

7.4 Electrical Product Safety

In general, both Hong Kong and UK adopt post-market regime to regulate the safety of household electrical products. In this regard, electrical products do not require prior approval by the regulatory authority for sale in the market. This regulatory regime on safety of electrical products relies on the self-declaration by the products manufacturer and conformity assessment by accredited certification bodies or testing laboratories. On the contrary, Singapore strictly controls the safety of household electrical products through pre-market registration scheme. Mandatory registration of 41 types of controlled electrical products by the regulatory authority must be required before supplying to the market. In addition, a mandatory “Safety Mark” must be affixed to the registered electrical products for identification.

Hong Kong does not establish our own domestic standards for the safety of household electrical products. Currently, IEC safety standards, which are commonly adopted in the market for household electrical products, are deemed to comply with the safety requirements of the Regulation. As regards the safety of household electrical products in UK, the European harmonized standards basically making reference to the IEC safety standards are adhered to. Unlike Hong Kong, Singapore develops its own national standards i.e. the Singapore standards to regulate the safety of household electrical products, but the relevant safety requirements are also mainly aligned with the IEC standards.

The electrical faults of electrical products or overheating of its internal components commonly result in accidental fire. Table 4 shows the average number of reported fire incident caused by electrical products in Hong Kong and UK.

Place	Hong Kong	UK
Average number of reported fires caused by electrical products	About 70	About 3,000
Number of reported fires per 100,000 household per year	About 3	About 12

Table 4 – Number of Reported Fire Incident Caused by Electrical Product

From a broad perspective, the technical requirements on electrical safety between Hong Kong, Singapore and UK are quite similar, but the respective legislative requirements are indeed different in some aspects to suit the local situations and trade practices. With effective enforcement of the electricity legislation, these three places all enjoy a comparatively good electrical safety record in international terms.

8. CHALLENGES AHEAD

EMSD is currently working together with power companies to monitor statistics on incidents involving damage to underground cables. Although there has been a consistent reduction of these incidents in the past years, we are not complacent and it is our target to continue achieving a steady decreasing trend in the years ahead. As such, EMSD has critically examined the contents of the Code of Practice on Working near Electricity Supply Lines in light of the experience gained in the past few years. In collaboration with trade organisations and other government departments, this Code has been revised to provide a practical and up-to-date guideline for the construction industry. We have stepped up the publicity activities to promote to the trade about the new requirements of the revised Code and are now closely monitoring its implementation by the trade.

To further improve the overall safety requirements of household electrical products, EMSD has been consulting and liaising with the trade since 2005 with a view to establishing a mutually agreed time frame for supplying electrical products in compliance with the latest IEC safety standards. The latest standards will further enhance the performance on “resistance to heat and fire” to greatly reduce the risks of fire due to electrical faults or overheating. The trade and product suppliers in Hong Kong have given their substantial supports on adoption of the latest safety standards and we are now finalizing the implementation time frame with them.

Enhancing electrical safety of our community is one of the key missions of EMSD. We will keep abreast of the latest developments in international safety standards and electrical technology and take a leading role in establishing and updating safety codes and guidelines. We will continue to work proactively in the preparation and enforcement of safety legislation in all matters relating to the use of electricity to ensure public safety. We will also keep in close contact with the trade and industry to maintain partnership collaboration.

While we enjoy the benefits arising from the use of electricity, it is very often easy for us to forget its potential dangers. We aspire to upkeep the awareness of electrical safety in the electrical trade and to foster a safety culture in the community through adopting proactive approach in promotion and public education and maintaining close collaboration with trade organizations.