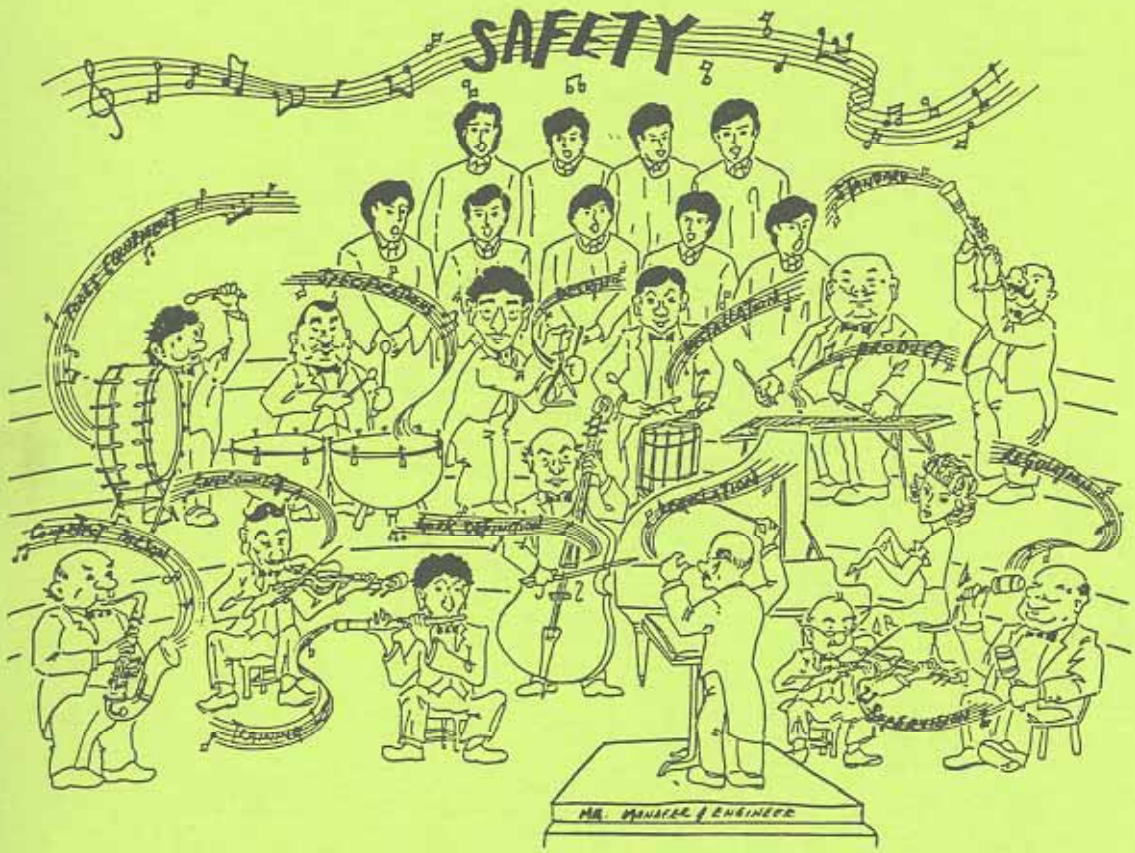

MANAGEMENT AND IMPLEMENTATION of ELECTRICAL SAFETY in HONG KONG

THE HONG KONG INSTITUTION OF ENGINEERS
ELECTRICAL DIVISION
ONE DAY SYMPOSIUM
11th OCTOBER, 1984

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Symposium Programme

08.30 Registration and Coffee

09.00 Welcome and Introduction
- Chairman: Mr. C. MIAO, MHKIE, C. Eng., MIEE, MI Mech. E.

09.05 Opening Address
- President: Mr. G. J. Osborne JP, FHKIE, C. Eng. FI Mech. HKIE E. FBIM.

1. Management of Safety and the role of Legislation

09.10 'The Management and Implementation of Electrical Safety'
- Speaker: Mr. A. D. Longmore, FHKIE, C. Eng. FIEE, MBIM, Electrical Division, The Hong Kong Institution of Engineers.

09.30 'The New Electricity Bill'
- Speaker: Mr. K. W. Tong, MHKIE, C. Eng. MIEE, MI Mech. E. Chief Engineer (Legislation Enforcement), Elect. & Mech. Services Dept.

09.50 'Fires with Electrical Origin'
- Speaker: Mr. T. D. C. Gardiner, Chief Fire Officer, Fire Services Department.

10.10 'Profile of Electrical Safety Regulations for Industrial Undertakings in Hong Kong'
- Speaker: Mr. Peter K. L. Yam, Cert. in OHS, MIOSH, Divisional Factory Inspector, Labour Dept

10.30 Discussion

10.45 Coffee

2. Safety of Electrical Appliances and Accessories

11.00 'Safety of Electrical Equipment in Hong Kong'
- Speakers: Dr. Cecil S. O. Chan, Ph.D. FHKIE, C. Eng. FIEE, FBIM.
  Mr. Harry C. W. Yeung, AP (HK), MIEEE
  Mr. C. W. Li, B.Sc. (Eng.)
  Hong Kong Standards & Testing Centre

11.20 'Consumer Product Safety'
- Speaker: Mr. K. M. Li, Chief Research Officer, Consumer Council.

11.40 'The Safety Aspect of Electrical Installations for Domestic Premises'
- Speaker: Mr. H. D. Beck, Marketing & Sales Director, Crabtree Electrical Industries Ltd.

12.00 Discussion

12.20 Lunch

TAI Tak-him

3. Safety of Electrical Installations – Supply Rules and 15th Edition IEE Wiring Regulations

14.10 'The Power Company's role in ensuring Safety of Electrical Installations'

– Speaker: Mr. J. H. Henderson, MHKIE, C.Eng. MIEE, Senior Consumer Installation Engineer The Hongkong Electric Co. Ltd.

14.30 'Electrical Safety for High Rise Building'

– Speaker: Mr. Samuel P. W. Wong, FHKIE C. Eng. FIMMech.E FCIBS, FIEE, Principal Partner . Associated Consulting Engineers,

14.50 'Miniature Circuit Breakers & Residual Current Devices in relation to Safety in Electrical Installation'

– Speaker: Mr. V. C. Sweet, Technical Manager, Domestic Switchgear, Delta Accessories and Domestic Switchgear.

15.10 Coffee

15.25 'Installing Switchgear in compliance with 15th Edition IEE Wiring Regulations'

– Speaker: Mr. N.C.J. Badley, Export Regional Manager, Simplex-GE Ltd.

15.45 'Safety in our hands'

– Speakers: Mr S. Tam, MHKIE, C. Eng. MIEE; Mr. K. C. Wong Senior MIIE, MBIM, MIEEE Hong Kong and Kowloon Electrical Contractors Association Ltd.

16.05 Discussion;

16.30 Closing;

– Professional W. S. Leung, Ph.D., FHKIE, C. Eng. FIEE, Head of Electrical Engineering Department, University of Hong Kong.

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Mr. Peter K. L. Yam
Dr. Cecil S. O. Chan
Mr. Harry C. W. Yeung
Mr. C. W. Li
Mr. K. M. Li
Mr. H. D. Beck
Mr. J. H. Henderson
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1. Management of Safety and the role of Legislation

Paper No. 1

The Management and Implementation of Electrical Safety

Speaker: Mr A. D. Longmore
B. Sc. (Eng.) Dip. MS
C. Eng., FIEE, FHKIE, MBIM
Committee member, Electrical Division 84/85 HKIE
Chief Engineer, Transmission & Distribution, CLP.

THE MANAGEMENT AND IMPLEMENTATION OF ELECTRICAL SAFETY

Summary

Safety in its varied forms or disciplines tends to be regarded as someone else's responsibility, although Legislation does exist, and equipment can be purchased in accordance with specification and national standards, and competent people employed, accidents still happen which are often explained by employee's attitude or lack of concern, and often excused by cultural and/or philosophical arguments.

This paper reviews the broad spectrum of electrical safety and makes reference to the various sources of information available to engineers and managers. It accepts that people are fallible, that people are conditioned to accept risk and supports the premise that safety will not happen by itself, but that safety can and must be created and maintained.

Membership of the Hong Kong Institution of Engineers is drawn from the multi-facets of the electrical industry and these members carry a professional responsibility in the maintenance of electrical safety standards. At all times they must strive for improvements in the education, training and discussion of electrical safety, since all are necessary to achieve an improved attitude towards personal responsibility and to create a continued safety awareness.

It should be the objective of everyone involved in the regulation of, the design, the manufacture, the installation, the operation of electrical equipment and the education of electrical personnel to be actively concerned in the management and implementation of safety.

Present Reality

'Accidents only happen to others – it was so unexpected – it was his first accident – he was a trained operator – it is in accordance with BSS – if everything goes okay who will say spend more money or more time on safety'.

Most engineers and managers will have heart, read, thought or said similar sentiments. They will certainly have asked WHY? but have they asked themselves and others the WHAT, WHERE and WHEN of safety? The statement that – 'each manager is responsible for his decisions; each employee is responsible for his actions' is an over-simplication when reviewing electrical safety, as equally is the statement – 'the manager creates the environment; the employee provides the attitude'.

An accident can be a time-consuming and expensive experience, damage to productive plant can result in reduced or nil production, injury to one or more workers in a reduction of worker efficiency, especially fatalities which have a demoralising effect on the workforce. All can and do seriously affect the whole enterprise.

However, the fact that the world is a complex and dangerous place is freely accepted. People are conditioned to accept risk; thousands fly daily on international and domestic airlines though aircrafts are known to crash, thousands travel each day by rail through trains collide or are derailed, people travel each day by car where the fantasy of some drivers is that they are Formula One drivers irrespective of the road conditions, pollution is known to cause severe health problems but the pollution can be tolerated as a by-product of modern day life; the list is endless; hence in modern day life people accept a degree of risk.

There are minority groups who protest or demonstrate against such things as damage to the environment, pollution and especially nuclear weapons because they fear the ultimate catastrosphe of a nuclear holocaust.

In this complex world, what does a member of the general public do? He cannot be part Scientist, Engineer, Nuclear Physicist, Chemist, Doctor, Economist, etc. Although it could be classed as an abdication of one's personal responsibility, the general public turns to those who claim to be more knowledgeable, more expert in a particular field, to those either in Government or in Industry in whom he has been conditioned to place his trust under the assumption that these experts will safeguard his interests.

It is not argued that such attitudes are unreasonable, but it does stress the responsibility that is carried by these experts/specialists. It does highlight the trend or conditioning which continues in the realms where personal responsibility and accountability should exist – i.e. personal safety. As commented in a recent U.S. journal – 'such is mankind's optimism that people expect accidetns to happen to others, never to themselves'. In the U.K. it is estimated that in any year, 39,000 will die from lung cancer, 5,000 people will be killed in the home and 700 will die in industrial accidents. In all such fatalities there is an element of personal responsibility, but more pertinent to this paper, a large number of accidents in the home and at work here in Hong Kong are due to either an electrical defect or to the way in which electrical equipment is used.

Electricity is an established necessity of modern life – whether at home or the workplace. Its use is widespread and varied, and its acceptance generally unquestioned. Unfortunately, many people forget or are not even aware that electricity is a quantity of energy which in unknowledgeable, unskilled and incompetent hands can become dangerous, or that the human body can be an efficient conductor of electricity so that the 'dangerous' becomes 'lethal'.

Rules, Regulations, Good Practice

Since electricity has to be produced and supplied before it is used, it is not surprising to find in the Laws of Hong Kong.

"Electricity Supply Ordinance, Chapter 103 – to regulate the supply of electricity for lighting and other purposes'

that the first provisions is

'The security of the safety of the public in respect of electricity, electric line and works.'

Similarly, in the Factories and Industrial Undertakings Ordinance, the paramount issue is the health and safety of the workers.

Hence, it could be claimed that the Hong Kong Government is playing a positive role in publishing Ordinances and Regulations to establish a standard of acceptable performance. The Electricity Supply Ordinance is being revised and updated to suit modern practices.

It could be argued that the Ordinance and associated Regulations only provide a point of reference because the monitoring aspect of control is extremely difficult to achieve. It is questionable how much 'control' should be exercised by the Hong Kong Government, and how much control should be implemented by the industry itself. The electrical industry has many representative bodies, contractors associations, manufacturers associations, the two power companies, the HKIE itself, etc.

There is no question of the validity of the Ordinances and Regulations – they set out to protect the health and safety of the less knowledgeable. The original documents and the subsequent amendments and revisions are soundly based, they have stood the test of time and are a credit to all involved in their writing.

Reference to the Hong Kong Government Publications Directory published by the Government Information Services indicates the breadth and scope of legislation. The Reference manual for Factory Reports published by the Labour Department covers most of the main requirements of Factory Legislation 'to provide a safe and good working environment'. Its foreword states – 'use it as a guide to safety'. Again two excellent publications, readily available if you know they exist!

Such statutory legislation is not just for certain engineers, managers, employers, it also provides the basis for the designer, the consultant, the manufacturer, and the contractor. To assist them in their quest for satisfactory yet economic products and installations, there is an extensive list of Standards, such as IEC, EEC Directives, British Standards, IEE Wiring Regulations, etc., etc. – setting out the norms for the industry. Again, all credit must be given to those who have devoted time, energy and experience totheir publication. However it is a fact of life that Standards are the acceptable compromise between the ideal and the economic practical and product. Though excellent points of reference, they must be used with judgement, e.g. does the BSS really cover the Hong Kong environment?

Hence, there is an extensive list of Ordinances, Regulations, Standards, Codes of Practice, etc., which are available to support the concepts of electrical safety. It is argued that they are restrictive, that argument prompts the reply – 'only to those who wish to cut corners and take risks at someone else's peril!' It is submitted that availability of information is not the total answer. Fundamentally such Rules and Regulations can only be followed if they are understood. Statutory legislation and even certain standards are written in a legal style because either they are Law or could be used in legal cases. The choice of words is very precise to accurately define the intention yet the style and wording combined tends to make difficult reading for the unwary. If it is difficult to the U.K.-born reader, it must be doubly so in Hong Kong where English is the second language. Many experienced people will confirm that it is only their continued exposure and/or involvement in such documentation that ensure their proficiency in understanding.

Therefore, it is contended that there is a lack of appreciation of the role of legislation and standards, and it is a serious gap in the education of every engineer, manager, tradesman, apprentice in the electrical industry. Perhaps it is a task which should be initiated by the HKIE with its wide membership drawn from Government, academic bodies, supply companies, the consultants and the contractor associations, in order to further the means of formal and self-education in this basic component of electrical safety.

Management of Electrical Safety

The management of electrical safety includes the prerequisites of –

(i) appreciation of legislation, specifications, standards.
(ii) correct design
(iii) correct purchasing
(iv) correct installation,

but it will not be complete until the correct use and maintenance procedures are covered. This applies either in the home or at the workplace. It must be accepted that the 'home' category is extensive and outwith any control technique, hence electrical safety can only be achieved by stringent standards of electrical installations done and modified only by competent people and by the use of fully tested and approved appliances. However the workplace is under someones control and the problem then exists of translating the good intentions of Electrical Safety into practice. A most persistent barrier to overcome is that of 'employee attitude and lack of concern'. It has already been commented that there is a general abdication of personal responsibility in technical and complex matters, but because the problem is universal, it does not mean that it is an insoluble problem. It is necessary to start with the concept that "People do not set out to have an accident, it is the accident that is allowed to happen". It is possible to identify specific items in the work organization which assists the maintenance of safety standards, e.g.: –

1. Work to be correctly and clearly defined.

2. A safe environment to be established.

3. Correct tools, etc., to be provided.

4. Work to be given to a competent person.

5. That competent person to be trained in tasks to be undertaken.

Safety standards are easier to maintain with informed personnel – but 'informed' requires communication and training. Unfortunately the majority of electrical staff and workers acquire their habits (good or bad) during the course of their work. The point has been made in previous papers published by the HKIE, that industrial safety training and electrical safety training requires the backing of positive professional bodies. Some training is available in the Labour Department, the E & M schools and the power companies, but it is minimal in relation to the total Hong Kong requirement. Again, it needs the support and inovlvement of the Universities, Polytechnic, technical colleges and the electrical contractors associations.

It is postulated that with engineers, technicians and ex-apprentices who have been formally educated in the basic principles of safety and trained in practical Electrical Safety and with the assistance and backing of management, these people would create the conditions whereby other employees would respond with an improvement attitude and concern towards electrical safety.

Conclusion

This paper has dealt with electrical safety in a broad sense. Reference has been made to legislation and standards and the need to be aware of and to understand their contents. Though Cicero said 'The health and safety of the people is the highest law', legislation by itself cannot create safety. Ordinances, Regulations, Standards, Specifications, Codes of Practice, etc., are devised, administered and implemented by the same people who must strive for improvements in the education, training and discussion of electrical safety.

Reference to the dictionary definition of "ACCIDENT' states – '(legal) – an unforeseen event that occurs without anyone's fault or negligence'. In that case, it is necessary to stop using the word accident and use 'incident' or 'event'. Apart from a bolt of lightning, electrical incidents can be foreseen, they can be anticipated and unfortunately many have happened before.

It is worth repeating that – Safety will not just happen, safety must be created, implemented and maintained! It is necessary to progress beyond the finger pointing stage after an event to a concerted effort by everyone involved in the legislation, design, construction, installation and operation of electrical equipment and in the education of electrical personnel.

Everyone who wishes to be identified as a responsible member of the electrical industry has his part to play in the management and implementation of electrical safety.

Paper No. 2

The New Electricity Bill

Speaker: Mr. K. W. Tong
Chief Engineer (Legislation Enforcement)
Electrical and Mechanical Services Department

THE NEW ELECTRICITY BILL

1. Structure

1.1 The new Electricity Bill will follow closely the normal structure of the laws of Hong Kong in that there will be a main enabling Ordinance to be enacted by the Legislative Council, subsidiary legislation in the form of Regulations to be made by the Executive Council and a series of Codes of Practice to be introduced by the administrative Authority. The main Ordinance will, of course, set out the legal frame work encompassing all the areas within which the new law shall apply. It will clearly define the duties and obligations of each and every one of the concerned parties, that is to say the Supply Companies, the consumer, the electrical contractors and electrical workers; and, of course, it will also define the duties and prerogatives of the Authority administering the Ordinance. Besides, in save guarding the interest of the general public, provisions will also be built into the Ordinance to limit the power of the executive branch of the Government making it not only accountable for each and every one of its actions but also actually subjecting its decisions to public appeal hearings. Final judgement will, of course, rest with the judiciary.

1.2 For the new Electricity Bill, a number of Regulations will be required, notably the Registration of Electrical Contractors and Workers Regulations which sets out in details the procedures and requirements for registration and de-registration of the electrical contractors and workers and forms the basis and reference on which they shall operate. This Regulation will have to be enacted simultaneously with the Main Bill for the latter to have any real meanings.

1.3 Other Regulations specifying the nominal voltage and frequency of the supply or specifying the safety standards of electrical appliances and accessoreis, or stipulating conditions and requirements for the securing of a safe, regular and efficient supply of electricity, or those generally for the control and regulation of such a supply, all will also be introduced at later stages in order to make the Ordinance complete.

1.4 Codes of Practice detailing technical specifications and requirements will have to be published to prescribe the safety standards of electrical products and also to prescribe the standards and criteria which the electrical contractors and workers are to follow. Notably, a Code of Practice on wiring installations which shall be prepared basing basically on the technical requirements of the existing Supply Rules of the Supply Companies and of the latest edition of the U.K. Institution of Electrical Engineers Wiring Regulations, will have to be published when the Main Bill is enacted to make it effective.

2. Principles

2.1 Common law requires that apart form their contractual obligations, electrical contractors and workers have a duty to carry out their work properly and consumers a duty to keep their installations safe irrespective of any legal obligation of the Supply Companies. Therefore one of the main principles of the proposed new Electricity Bill is to place the responsibility of ensuring safe installations onto those directly involved, i.e. the electrical contractors and workers; and to relief the Supply Companies from the outdates and impractical obligation of undiscriminated periodical testing of consumer installations. In order to do this without derogating public safety, Government would establish a system of compulsory registration of electrical contractors and workers so that consumers are required by law to employ only qualified contractors to do their work to ensure that their installations do not constitute a danger to others.

2.2 Another main principle is to ensure that installations in place of public entertainment and other premises frequented by large numbers of the public as well as those in a hazardous environment, are periodically tested and maintained in good safe working order. Other principles are to include accident reporting, the control of illegal tapping and interference of the Supply Company's mains, the control of unsafe electrical appliances and accessories, and the up-grading of the supply voltage to a more commonly used voltage in the world etc. In fact, a broad general principle is to include all other issues relating to the security of a safe and efficient supply of electricity and generally for the control and regulation of such supply.

3. Responsibilities and Duties

3.1 Common to all legislation, the New Electricity Bill has to be developed from within a frame work of accepted duties and responsibiliteis of all those concerned. For this New Electricity Bill, it is envisaged that the following responsibilities and duties would have to be delineated:

3.2 The responsibilities and duties of the Government would be:

(a) to delegate the Director of Electrical & Mechanical Services (DEMS) as the named Authority on the safe use of electricity, and to define his prerogative in respect to entry, inspection, investigation, testing and finally power to discounnect supply;

(b) to empower the Governor-in-Council to issue a series of Codes of Practice setting out the minimum safety standards for electrical products and fixed wiring installations;

(c) to establish and empower an independent Appeal Board (or Board of Inquiry) to hear any appeals against the actions and decisions of the administrative Authority, i.e. the Director of Electrical and Mechanical Services;

(d) to empower the Director of Electrical and Mechanical Services to establish a system of registration of electrical contractors and workers;

(e) to empower the Director of Electrical and Mechanical Services to monitor and control the performance of registered contractors and workers;

(f) to empower the Governor-in-Council to make other Regulations pertaining to the security of a safe and efficient supply of electricity and generally for the control and regulation of such supply.

3.3 The responsibilities and duties of the Supply Companeis would be:

(a) to inspect and test or check all installations to their satisfaction before initial connections of supply, and also on applications for additional load to existing wiring installations;

(b) to provide a safe and reliable supply to consumers if their installations meet all the safety standards as set down in the Code of Practice or in specific regulations for special areas (e.g. supply to hawker stalls and squatter areas);

(c) to notify the Director of Electrical and Mechanical Services of any fatal or serious (i.e. requiring hospitalisation) accidents involving their installations, and to assist the Director of Electrical and Mechanical Services in investigations when called upon to do so.

(d) to coordinate with the Director of Electrical and Mechanical Services in the monitoring and control of the performance of registered electrical contractors and workers by providing feedback information on their performance.

3.4 The responsibilities and duties of consumers would be:

(a) to employ registered electrical contractors to carry out all electrical work including new installations, modifications, extensions and repairs;

(b) to cause their installations to be tested and inspected periodically by registered electrical contractors/workers as required by the law;

(c) to display certificates and submit certificates to the Director of Electrical and Mechanical Services in respect to their legal obligations as required in (b) above;

(d) to repair any obvious damage and defects in their installations (e.g. broken socket outlsets and obvious damaged wirings etc.);

(e) to notify and obtain approval from the Supply Companies if additional capacity is required. (The registered electrical contractor is to advise the consumers in this respect.)

(f) to be accountable for any illegal extensions from their installations.

3.5 The responsibilities and duties of registered electrical contractors would be:

(a) to employ appropriate registered electrical workers to carry out the work, if they themserlves are not registered workers;

(b) to be responsible for the work of their employees as required under common law;

(c) to exercise reasonable control over the performance of their empolyees and standards of their work;

(d) to issue a dated certificate of completion of work together with test results to the Supply Company, and the same to the client for periodical tests performed. (This certificate is also to be signed by a registered electrical worker with declaration that the installation comply fully with the Code of Practice and is in safe and good working order.)

(e) to investigate and submit report on electrical accidents involved in installations certified and tested by them when asked by the Director of Electrical and Mechanical Services;

(f) to inform the Director of Electrical and Mechanical Services of any changes of conditions for registration.

3.6 The responsibilities and duties of registered electrical workers would be:

(a) to carry out only those category of work as permitted under the registration; (Different category of work requiring different level of competency which will be defined in the new Regulations.)

(b) to ensure work undertaken or supervised by them complying fully with requirements of the Code of Practice;

(c) to certify installations in safe and good working order after testing and inspection;

(d) to notify his client of any defective and/or illegal installations which may come to his knowledge;

(e) to exercise due care and take all reasonable precautions to ensure that both property and human life are adequately protected from electrical hazards;

(f) to advise the Director of Electrical and Mechanical Services of any change of conditions for registration.

Implementation

4.1 The principles, responsibilites and duties mentioned earlier form the bases of the contents in the New Electricity Bill and its relevant Regulations. The Government has produced a number of detailed discussion papers on which extensive discussions and consultations with various concerned parties have been or will continue to be conducted. It is worth recording that many useful inputs and advice have so far been offered by the parties concerned; these advice would be considered before the law draftsman prepares the draft

Bill and relevant Regulations. Further consultation and discussion would take place when the draft Bill and Regulations are available. The new Electricity Bill is therefore not a sole product of the Government, but rather the result of a collective effort.

4.2 It is apparent that a lot of hard work is still required before the full scope of the New Bill can be completely covered. However, at the first stage, the Regulations on the registration of electrical contractors and workers shall be enacted with the new Electricity Bill simultaneously. Also, a Code of Practice on wiring installations would be published at the same time. Other Regulations and Codes of Practice will follow at a later date.

4.3 At it is Government's decalred policy to permit all existing electrical contractors and workers to continue practising their trade; in the first instance, it can be expected that all electrical contractors who have business licences issued by the Companies Registry of the Registrar General's Department and who can provide evidence being in the wiring installation trade will be registered. A performance monitoring system will have to be developed by the Government in conjunction with the Supply Comapnies to ensure good workmanship and high safety standards are observed and maintained by these registered contractors for them to remain so registered.

4.4 It is intended only to registre skilled workers who are currently employed in the fixed wiring installation work. They would have to be qualified to perform all statutory functions, i.e. certifying tests and signing of completion certificates and supervising work carried out by unregistered workers.

4.5 Initially special training courses on basic building wiring principles, regulations and related tests will have to be organised by the Vocational Training Council to enable exiting workers to have up-to-date knowledge of electrical installation standards and safety requireemnts. It has been arranged that such courses will be made avilable in September 1985 at the Kwai Chung Training Centre.

4.6 It is envisaged that generally the legislation will be introduced gradually without any drastic changes which will affect the public or those who are engaged in the electrical trade significantly; and that sufficient time will be allowed for the electrical trade to respond and adequate publicity will be introduced to inform the general public of their obligations.

Paper No. 3

Fires with Electrical Origin

Speaker: Mr. T. D. C. Gardiner
Chief Fire Officer
Fire Services Department

FIRES WITH ELECTRICAL ORIGIN

At about this time every year the Fire Services Department, in conjunction with Government Information Services, launches a fire prevention publicity campaign and one year ago the theme chosen was fires with an electrical origin. The reason was simple. As is the case in recent years in many other countries, Hong Kong has been experiencing a large number of fires resulting from an electrical cause. Ten years ago the HK total averaged just over 1000; for several years recently it has been around 2000 but in 1983, this figure was surpassed in the first nine months and at that year's end totalled 2522. It would be nice to think that this publicity campaign has done some good because the figures show a slight decrease for 1984. (893) for first 6 months. Be that as it may, I do not think this will become the new trend unless something is done to provide legislating control. The proposed new Electricity Bill should do a fair amount to achieve this end.

The main problems in Hong Kong, as I see them, are threefold:

(i) The consumers' ignorance of basic safety requirements in the use of electricity, which leads to abuse and sometimes deliberate flouting of the law.

(ii) Sub-standard and even dangerous electrical accessories on sale to an unsuspecting public.

(iii) Deteriorating wiring in older buildings and the rewirable fuse.

I will elaborate on these statements but first fo all on the figures quoted earlier. The annual incidence of fires with electrical origin at around 2000 show this to be our second biggest cause. This disturbing feature is reflected in statistics from elsewhere, so Hong Kong is not alone. An analysis of large fires in UK (resulting in £200,000 or more loss) for the whole year of 1983 has electrical causes producing the second highest number of fires but the greatest monetary loss.

USA large loss fires for 1982 (i.e US$0.5 M or more) have electrical origin at the top of the list for stores and offices (33.5%) and manufacturing properties (26%) and ranked second for goods storage premises (17.8%). In both the UK and USA figures quoted, it is electrical equipment which is stated to have caused the fires.

In HK, as elsewhere,, fire officers try to determine the cause of fire and if the causes is not capable of being determined, it is recorded as unknown. Fire with unusual features or where death or injury is involved or which are very big are investigated by a team which includes officers from other Government Depts. such as Government Chemist and E & MSD. However, even this thorough investigation often results in cause "unknown". I will not be so silly as to say that every cause that is recorded is 100% accurate but officers are instructed to be as sure as they possibly can be before stating a particular "supposed" cause for a fire. As a matter of fact, back in the '70s, for a period all electrical fires were double-checked by experts as to cause and the fire officers "supposed causes" were found to be 90% accurate. It is, therefore, likely that a few of the 2000 or so fires with electrical cause recorded are due to something else. The other side of the coin is – how many of the unknown (819) last year) were due, really, to electrical causes?

There is now way that people can be prevented from doing things for themselves around their home, such as changing a plug, connecting an appliance, etc., – not am I advocating such control. What I would like to see is easy to read leaflets made available which explain how these simple tasks are properly done. We have a public which is happy to make use of the whole range of electrical devices but does not properly understand the limitations and dangers involved. Education is necessary and perhaps the Electrical Division of the Institution could give this some thought.

Going a stage further, when something is beyond the capabilities of the householder, it is fairly natural that he will look for a supposedly competent person to do the job for him and the one chosen will very likely be the person who will do the cheapest job. There are plenty of Mr. Fix Its in Hong Kong who may or may not do an adequate job. We all know that there are people who are competent in the illegal tapping of supply. Look around some of the squatter areas for examples of their work, we in the Fire Services are on the receiving end when it comes to extinguishing squatter fires. If it isn't exploding LPG cylinders to contend with it is live wiring sprouting from huts all over the place.

Previously there has been a lack of control on people setting themselves up as electricians. There has been no legal definition for this nor is there any form of registration, examination or testing. Anyone can say that he is a qualified electrician and it is questionable, in some cases, what standards of workmanship result. The new Electricity Bill proposes registration of skilled and experienced workers, (so I understand) together with registration of electrical contracting companies. The Code of Practice for electrical wiring installation and the apprentice training programme also proposed will, in conjunction with the registration procedure, fill this void which has existed for years. I support it wholeheartedly.

Next I would like to spend a few minutes on the subject of electrical accessories. Once again, through lack of control, we have supermarkets and shops all over the Territory selling sub-standard and even dangerous accessories to a public which is unaware of quality. Let me show some examples.

On the subject of wiring in buildings again we have problems but these are not so obvious. Pre 1960 buildings still exist and there is a good chance that these were and still are wired with VIR insulated cables. By now some of that rubber could be becoming brittle and breaking away, exposing the conductor. Hong Kong also suffers from rodents and it was established some eyars ago that rodents can chew away at PVC insulated cables and produce fire hazards. The situation is both unsatisfactory and dangerous. Repairs often do no more than remove the immediate problem and these are frequantly done by the so-called "staircase electricians" on the cheap.

When the more modern buildings were constructed the electricity company provided the building supply and the contract provided internal wiring to the units in the building. Everything sound and verified by the supply company before connection of supply. In so many cases however, at a later stage, it was found necessary to increase the supply to individual units and this has sometimes been without authorization from the supply company and without control. The result – a proliferation of wiring in common areas. While this may be electrically safe the exposed wiring is open to mechanical damage which, in turn, can lead ot fire hazards. Conduit or ducting is the answer.

Building owners (especially of older property) are unlikely to involve themselves in the expense of rewiring if they can avoid doing so. The older property can be in a dilapidate state – could be declared dangerous or maybe expected to be demolished in the foreseeable future. So, with no legal requirement to do so, rewiring will only rarely be carried out and with no inspection made of the condition of the existing installation, the danger will continue until something happens – power failure or fire or electrocution. In UK, local council grants are possible to help defray the costs of rewiring but I do not foresee the same bounty being made available in Hong Kong.

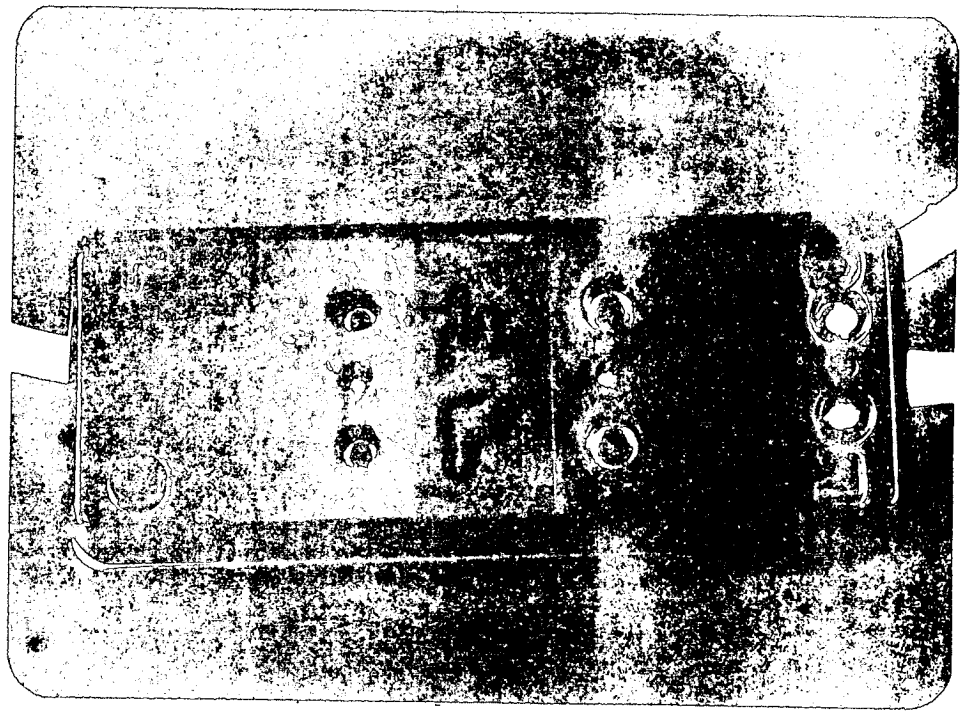
Regarding rats the question must be raised of sealing off small openings in floors and walls to prevent them from moving around. These openings, which are breaks in compartmentation, raise yet another issue. Whether they were made with the object of providing electircal services or something else, openings in walls and floors destroy the approved compartmentation of the building which is a basic fire prevention principle. Please remember this when you are doing this type of work. The holes must be fire-stopped around the conduit that passes through the wall or floor.

At one incident involving a prestige high-rise property in Central leaking cooling water travelled a considerable distance laterally, entered eventually into a switch-room, and then trickled down from 25th to 17th floor through floor openings in each floor's switch-room. The openings had been cut to provide, at a later date, emergency generator cables. The water infiltrated a busbar rising main on 17th floor, soaked the asbestos insulated spacers and brought about a breakdown of insulation resistance. Some local heating then generated smoke which actuated the smoke detection system and fortunately no fire occured.

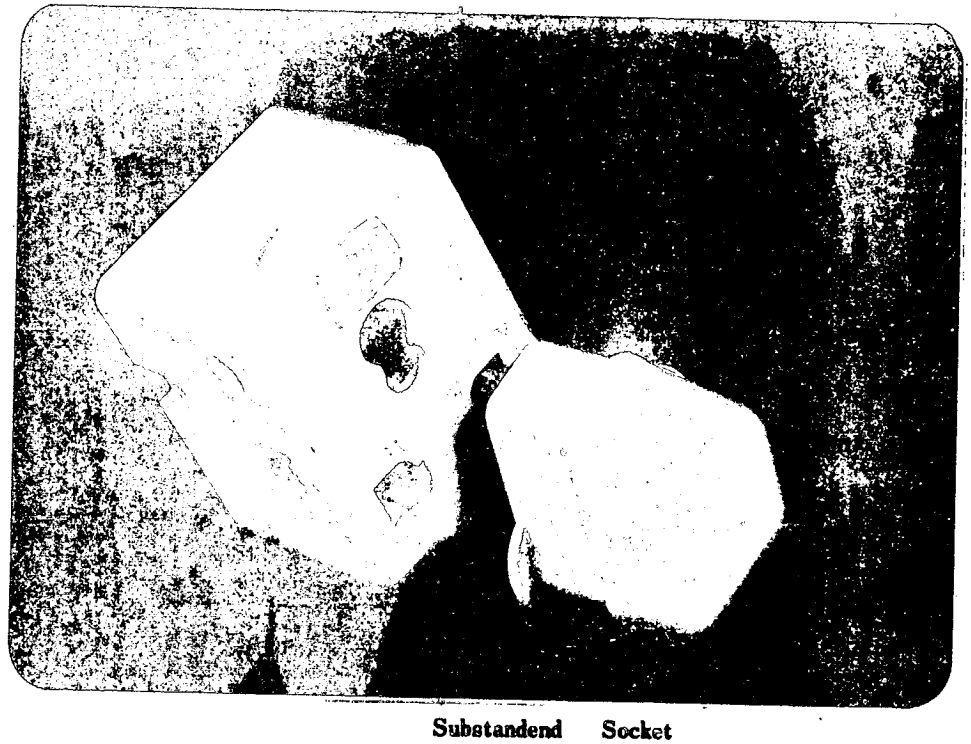
Finally, the rewirable fuse, surely it is high time that HK caught up with other countries and rid itself of devices which are so open to abuse. The big problem with this fuse is that it can be rewired by anyone and by using any conducting material. How tempting it can be for the consumer who finds his fuse blowing regularly to replace it with something that will not blow. MCBs and ELSBs should be the norm in any building if we are to provide safety. Not a very high pride to pay, considering the protection they provide.

To conclude, I consider this Bill, moderate as it is, to be long overdue and very welcome. The public needs to be protected as much as is practicable and not least from themselves. They are going to continue to make mistakes and to take risks until the ability to do so is taken from them. Legislation with retrospective effect is not in favour – most certainly not in HK – but people will continue to be electrocuted and cause electrical fires unless something is done to protect them and their property.

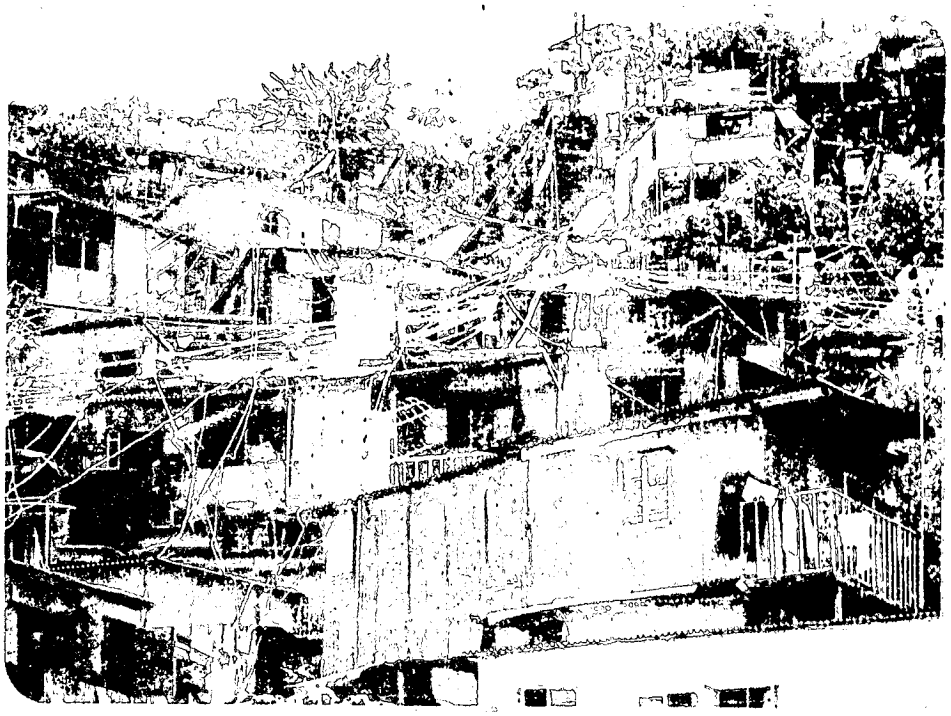
Retrospective legislation was introduced in part of USA in 1981 for the provision of fire and life safety standards. It has been provided in HK with regard to car seat belts. I would like to see it here to provide for a greater degree of public safety from electrical hazards.



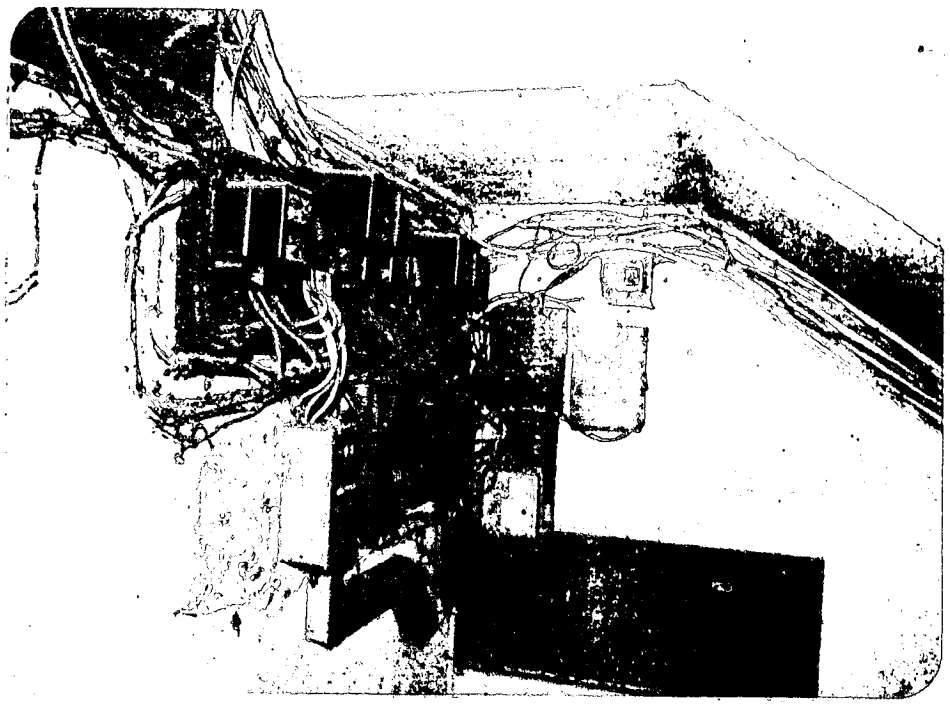
Danger live part exposed electrical equipment



Substandend Socket



Illegal Electricity Connection



Deteriorating wiring Installation

Paper No. 4

Profile of Electrical Safety Regulations for Industrial Undertakings in Hong Kong

Speaker: Mr. Peter K. L. Yam
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Factory Inspectorate Division
Labour Department

PROFILE OF ELECTRICAL SAFETY REGULATIONS FOR INDUSTRIAL UNDERTAKINGS IN HONG KONG

Introduction

Electricity is nature's most versatile form of energy, yet, behind the power that lights up a bulb or drives a motor is a force capable of causing catastrophic damages. Safety depends upon harnessing this force under proper control. Protection of persons from the dangers of electricity is a major engineering consideration in the design & construction of electrical installations and equipment. Such considerations should also be foremost in the maintenance of electrical equipment – not only for the protection from electric shock, but also from fires which electricity could cause.

Accident statistics

The standard of electrical installation and maintenance in industrial undertakings is often low. Statistics of electrical accidents to employed persons reflect these standards. In the past 10 years, 98 persons were killed by electrocution and 1342 non-fatal industrial accidents were reported. Please refer to Appendix 1. However these figures understate the size of the problem for a number of reasons.

Year	Fatal	Non-Fatal	Total
1974	3	88	91
1975	4	75	79
1976	3	84	87
1977	6	111	117
1978	18	127	145
1979	15	199	214
1980	17	199	216
1981	12	156	168
1982	11	174	185
1983	9	129	138
Grand Total	98	1342	1440

Appendix I. Reported Industrial Electrical Accidents

Reliable statistics on electrical accidents are difficult to obtain as many accidents are not reported because of their minor in nature – just tingling effects – and some of which could be fatal if the accident circumstances or conditions were only slightly altered. Electrical accident different from most industrial accidents in that the victim is normally either dead or very seriously injured or is fortunate and does not require three days absence from work in which case the accident is unreported. There are few half measures with electrical accidents.

Furthermore, injuries or deaths resulting from fires or other cause believed to have been originated from electrical faults, sparking or faulty equipment are not always classified as electrical accidents. For example, a man working on a scanffold receives an electric shock and falls to his death or an electrical short circuit causes an explosion of inflammable vapours; such cases would be classified as "falling from height" and "explosion" but in both cases the underlying cause is electrical.

Electrical safety legislations

Up to 1982, there has not been a single, comprehensive set of regulations governing the safe use of electricity in industrial undertakings. Some measures for the prevention of hazards arising from the use of electricity in industrial undertakings have been contained in different items of safety legislation and have been restricted to certain areas or intended for specific purposes only. For example, Regulations 47 of the Construction Sites (Safety) Regulations deals with the danger from contacting live overhead wires and underground cables and Regulation 6 of the Factories and Industrial Undertakings (Cargo Handling) Regulations deals with the protection of electrical equipment used in docks, quays or wharfs. Appendix 2 contains a summary of all such regulations.

The Factories and Industrial Undertakings (Electricity) Regulations which came into operation on the 1st of December 1982 lay down basic safety requirements to safeguard persons against hazards associated with the generation, transmission, distribution and use of electricity in industries. These regulations are general in form requiring the best practical means to be used to secure safety. Specific guidance to achieve such standards is set out in international standards or reputable national , in power companies' supply rules and in the recommendations of the Institution of Electrical Engineers and other professional bodies.

Factories and Industrial Undertakings (Electricity) Regulations, 1982

These regulations place general responsibility on the proprietor of an industrial undertaking for the safety and safe working of his installation. These regulations also deal with insulation and safeguarding of conductors, construction of switch and switchboards, switch-fuse, circuit-breaker and isolating link, means of isolating voltage and means to ensure freedom from shock and fire. There are also requirements for proper connection of flexible wires to portable apparatus and provision of personal protective equipment for use by employees. Unauthorised persons are prohibited from entering into specified areas such as substations or places where live bare conductors are present.

Part I of the regulations contains definitions and states which industrial undertakings the regulations apply to. This part also empowers the Commissioner for Labour to modify requiremenets if he is satisfied that reasonable freedom from electrical hazard can be otherwise secured or that no increase in electrical hazard will result.

Part II deals with general safety requirements such as the construction and use of apparatus, and the insulation and protection of conductors.

Part III provides that every switch, switch-fuse, circuit-breaker and isolating link shall be properly constructed, placed, protected and installed. This part also required that every circuit shall be protected against excessive current by means of a suitable fuse or circuit breaker and contains detailed provisions for cutting off and isolating all voltage in a system to prevent electrical hazard.

Part IV deals with switchboards and switchboard apparatus and includes provisions dealing with the location of switchboard apparatus, precautions against metal becoming live and precautions to be taken when persons are working on electrical apparatus.

Part V covers protective equipment lighting and special rishs. This part requires the provision of protective stands, screens, insulating boots and gloves. It also deals with access to and working space for apparatus, the lighting of apparatus and precautions to be taken in special conditions.

Part VI contains detailed provisions on the construction of substations, and the control of entry to substations, including those built underground.

Part VII contains penalty clauses which may be involved in the event of any failure on the part of the proprietor of an industrial undertaking, an electrical contractor or any person, to comply with the regulation.

Conclusion

Legislations alone cannot prevent any electrical accident; the cooperation of relevant parties is essential if workers' safety are to be safetuarded. Manufacturers or importers must ensure that apparatus they manufactured or imported conformed with international or reputable national standards. Electrical contractors should carry out electrical installations in accordance with laid down wiring rules, code of practice etc. and with good workmanship. Supply companies should see that installations are up to requirements before electricity is supplied. Employers should observe and implement safety requirements, statutory and non-statutory alike. Employees should follow safety instructions and use safety equipment provided by their employers. And finally, the Government should carry out effective enforcement to ensure that the laws are not breached by way of inspection, education and if necessary, prosecution. Only through their mutual cooperations can electrical accidents be reduced to a minimum, if not totally be eliminated.

Reference

1. Annual Departmental Reports of the Labour Deapartment.
2. Construction Sites (Safety) Regulations.
3. Factories and Industrial Undertakings (Cargo Handling) Regulations.
4. Factories and Industrial Undertakings (Work in Compressed Air) Regulations.
5. Factories and Industrial Undertakings (Spraying of Flammable Liquids) Regulations.
6. Factories and Industrial Undertakings (Electricity) Regulations.

Appendix 2
Special Regulations which incorporate statutory control on electrical equipment used in a particular situation or for specific purposes

CONSTRUCTION SITES (SAFETY) REGULATIONS

Regulation 47

Use of Electricity

Where workmen employed at a construction site are liable to come into contact with any life electric cable or apparatus, the contractor shall, before the commencement of work and during its progress, take steps to prevent them from being endangered by the cable or apparatus.

Where there is any electrically charged overhead cable or apparatus, the contractor shall ensure that the cable or apparatus will not be dangerous to the workmen. This may be done by the provision of adequate and suitably placed barriers or other methods.

FACTORIES AND INDUSTRIAL UNDERTAKINGS (CARGO HANDLING) REGULATIONS

Regulations 6

Electrical equipment

Electrical equipment and circuits shall be properly designed, constructed, installed, protected and maintained to prevent danger from contact and fire. Switching arrangements for electrical installations shall be so arranged that the power supply can be easily and quickly cut-off in the event of an accident or in the presence of potential danger. This means that switches, isolators, etc. shall be efficient and within easy reach from the corresponding electrical equipment, easily identifiable and easily operated.

Electrical equipment shall be suitable both for the purpose to which it is being applied and for the circumstances in which it is being used. For instance, flame-proof electrical equipment shall be used in places where there is an explosion risk; electrical equipment exposed to wet or corrosive conditions shall be either specially designed for the purpose or suitably protected and so on. Care should be taken when using portable electrical equipment. In particular, portable or flexible electrical conductors shall be kept away from areas where there is constant movement or persons, machines, vehicles or cargo.

Portable lamps shall only be used when it is impracticable to provide permanent lighting. In hazardous situations, such as wet conditions, the voltage of portable lamps shall be kept as low as possible in order to avoid the danger of electric shock to the users.

Portable electrical equipment shall be inspected at least once in every day of use. This inspection may be a visual examination to detect, for example, the condition of conditors, joints, connecting plugs and switches. This inspection shall be carried out by a competent person appointed to do so by the proprietor responsible for the compliance of these regulations. Competent person means a person who, by reason of his training and practical experience, is competent ot perform the inspection.

FACTORIES AND INDUSTRIAL UNDERTAKINGS (Work in Compressed Air) REGULATIONS

Regulatiosn 8(7) and 21(5)

FACTORIES AND INDUSTRIAL UNDERTAKINGS (SPRAYING OF FLAMMABLE LIQUIDS) REGULATIONS

Regulation 8

Man Lock and Medical Lock

The wirings of the lighting and heating systems of a man lock and a medical lock shall be of mineral insulated copper cable (M.I.C.C.) to British Standard 6207 or equivalent and the system shall be such that there is no fire hazard.

Electrical Equipment

All electrical equipment likely to be exposed to flammable vapour arising from spraying process should be so constructed, designed, installed and maintained as to prevent, as far as reasonably possible, the ignition of such vapour. The following precautionary measures are recommended:

(a) Inside spraying rooms:–

All electrical equipment, lighting fittings and installations should be of:

(i) a flameproof type; or

(ii) an intrinsically safe type; or

(iii) positive pressurisation design (i.e. the equipment is subject to positive air pressure so that any ingress of flammable vapours is impossible. As an additional safety measure when this design is adopted, the air supply must be interlocked with the electrical equipment so taht in the event of a failure in the air pressure, the electrical equipment is automatically switched off).

2. Safety of Electrical Appliances and Accessories

Paper No. 5
Safety of Electrical Equipment
in Hong Kong

Speakers: Dr. Cecil S. O. Chan Ph.D.
FHKIE, CEng, FIEE, FBIM, FRSH, SMIEEE
Mr. Harry C. W. Yeung AP (HK) MIEEE
Mr. C. W. Li B.Sc. (Eng)
Hongkong Standards & Testing Centre

SAFETY OF ELECTRICAL EQUIPMENT IN HONG KONG

INTRODUCTION

When this paper was being drafted, the Hong Kong Government was in the process of drafting legislation on the safety of electrical installations and equipment in the form of a major revision of the Electricity Supply Ordinance and Regulations. It is not known therefore at the time of the writing of this paper what the final revision of the said Ordinance would be when this paper is presented at the Symposium. However, irrespective of what the final revisions would be, there are still several basic issues which need to be addressed to bring all interested parties into the right perspectives.

One of the very first and foremost questions that should be addressed to are "Why electrical equipment should be safe?" and "Why government control is needed to ensure that electrical equipment for sale in the marketplace does not create hazards that would affect the safety of the users and of the buildings in which the equipment is used?".

ELECTRICAL EQUIPMENT IN THE HONG KONG MARKETPLACE

Although Hong Kong produces a very wide range of elctrical and electronic products operated from mains voltage, most of these products are exported to the world. Therefore Hong Kong relies heavily on imported products to satisfy the needs of the domestic consumers. These imported goods which are manufactured to varying standards come from different parts of the world; some of them are manufactured for use on 115V 60Hz electicity supply system; some of them are manufactured to operate on a 240V 50Hz system; some are designed for use on a 220 to 240V 50Hz system while some, to a lesser extent, are deisgned for use in the Hong Kong system of 220V 50Hz.

This diversity of products having differnt rated voltages and frequencies has created a need for another diversity of accessories such as stepdown transformers, plug and socket adaptors, cable couplers, and so on. The result is confusion not only to the general public but also to the professional electrical engineer.

There are many situations where the connecting plug fitted at the end of the appliance does not fit properly into the wall socket or even the adaptor. It is not uncommon to see a situation where an American two-pin plug is required to fit into a Hong Kong-made adaptor which in turn is requried to plug into a British-made socket, all of them having differnt sizes of and spacings between the pins. This chain of plug-adaptor-socket is highly unsatisfactory due to poor contacts and we as electrical engineers all know very well the consequences of improper electrical contacts.

Added. to this confusion is the danger that there are many Class O equipment in the market which are highly unsuitable for our electrical supply system. As the protection in a Class O equipment relies upon basic insulation, this means that there are no means for connection of accessible conductive parts to the protective (earthing) conductor in the fixed wiring of the installation, the accessible conductive parts to the protective (earthing) conductor in the fixed wiring of the installation, the accessible conductive parts, e.g. metal housing may become live in the event of a failure of the basic insulation.

Another dangerous situation concerns, for example, a European product of Class I design fitted with a 2-pin plug with an earth-contact on the side of the plug enclosure. When this appliance is plugged into the socket outlet in Hong Kong, the earth-contact on the plug does not make contact with the earth-hole in the socket outlet, therefore, the earth continuity path is incomplete. In the event of a failure of the basic insulation, on which a Class I appliance solely relies for electric shock protection, the metal housing or other accessible conductive parts would become live.

We go on and on giving examples of potential dangers that exsit in electrical equipment being used in Hong Kong, because there are as yet no safety standards in Hong Kong prescribing what are considered appropriate and safe for use here.

Hong Kong has two official languages, namely English and Chinese. But, unfortunately these two official languages to do not seem to apply to electrical safety. One can easily find an electrical product in the market with all its markings, instruction manuals and, worst of all, warning labels written in languages other than our two official languages.

Ladies and gentlemen, enough has been said about the present confusion and dangerous situation. It should be stressed here that we are dealing with a subject which is of vital importance because accidents caused by electricity could result in the loss of human lives or properties. We have in Hong Kong, government legislation government the sale of food and drugs, we also have regulations pertaining to the use of safety helmets and safety belts in motor cycles and private motor cars respectively. Since the safety of electrical equipment is of equal importance, parallel legislation is usually not capacble of differentiating between a safe electrical appliance from one which is unsafe until after an accident has occurred, ans therefore the most effective way of ensuring that no unsafe electrical equipment is used by the consumer is to prohibit the sale of such equipment in the marketplace, hence the need for government legislation.

HOW IS SAFETY DEFINED

Before we consider what measure should be taken in Hong Kong to ensure the safety of electrical equipment, we need ot consider the question of "How safe is safe?". In other words, we need to predefine Safety in respect of electrical equipment. This is not an easy matter because safety has a direct relationship with cost. For example, one could design an electrical product with an excessive number of layers of insulation in order to make the product outstandingly safe, but the cost for doing so would be very high and consumers may not be able to afford. Another consideration which should be given when defining Safety is to consider whether it is necessary to pre-assume that the goods would be properly used only or whether the goods are to be designed so as to cater for foreseeable misuse where this is reasonably practicable.

In the UK Consumer Safety Act 1978, the definition of "Safe" includes the pre-supposition that the product might be subject to foreseeable misuse where this is reasonably practicable. When this Bill was in Committee in the House of Lords, this point was explained in the following way:

"Unfortunately people, and particularly young children, are not always reasonable in the use to which they put the goods. It may not be considered reasonable to open the dryer of a spin dryer while it is revolving at several hundred revolutions per minute, but a number of accidents have occured in that way and it has been accepted that, on that account, an inter-locking device is needed which prevents the cover of a spin dryer from being opened while it is revolving . . . . Another example is that it is not reasonable for children to insert their fingers or metal implements into electric wall sockets, but before safety shutters were incorporated they did so, with sometiems fatal results. To prevent the Government from imposing safety requirements such as these would seriously limit the effective, of the safety regulations."

Therefore the word safe has been defined in the UK Consumer Safety Act 1978 as follows:

"Safe" means such as to prevent or adequately to reduce any risk of death and any risk of personaly injury from the goods in question all from circumstances in which the act might be used or kept, and for the purposes of Section I of this Act the Secretary of State shall be entitled to consider that goods containing radio active substances are safe or not safe by reference to the radiation from the goods and from other sources and to the consequences of the radiation for users of the goods and other persons.

SAFETY OF INSTALLATION ALONE IS NOT ENOUGH

We are aware that at the present time in Hong Kong we have an ordinance called Electricity Supply Ordinance which is in the process of being revised. It should be pointed out that this Ordinance is not only outdated but also incomplete from the point of view of ensuring safety protection to the consumers form electrical hazards. This Ordinance in its present form deals mainly with the fixed electrical installation leaving out the equally important area of safety of electrical equipment.

As consumers ourselves, we all know that we are in daily contact with a host of electrical appliances and accessories such as refrigerators, rice cookers, hair dryers, electric kettles, battery chargers, electric shavers and massage equipment. Out contact time with these appliacnes often far exceed our contact time with fixed electrical installation. In most cases out contact time with fixed installation, as consumers, can only be measured in terms of seconds when we switch a light on or off or plug an appliance into or out of a wall socket.

Hence our Electricity Supply Ordinance cannot be complete without making provisions for the safety of electrical equipment which is connected to the fixed installation and forms an important part of the electrical circuit. In other words, safety of installation alone is not enough.

WHAT SHOULD BE DONE IN HONG KONG

As there have not been effective measures taken in Hong Kong to ensure the safety of electrical equipment, Hong Kong people have become potential victims of electrical hazards brought about by potentially unsafe products. Indeed accidents involving unsafe electrical equipment have been reported from time to time. In order to rectify this unsatisfactory situation, the following measures are suggested:

1) Legislative Measure

Since the question of electrical safety is a matter concerning the protection of human lives and properties it is clearly a government responsibility. It is therefore encouraging to note that the outdated Electricity Supply Ordinance and Regulations are being revised, and it is hoped that this revision will take into account of the safety of electrical equipment apart form fixed electrical installations. Therefore effective provision should be made to prohibit the sale of electrical equipment, applicances and accessories in Hong Kong unless they are considered safe, and the definition suggested earlier on safe electrical equipment would be appropriate.

2) Standards must be Established

It should be recognised that safety begins with compliance with Standards. In the case of electrical equipment the international organisation responsible for the establishement of electrical standards is the International Electrotechnical Commission (IEC). Most of the countries around the world are making an effort to harmonise their national standards with those of the IEC. These countries include the United Kingdom, West Germany, Japan and many other Western European countries. Without a standard it is not possible for a legislative framework to operate, therefore it is a standard practice for an electrical safety legislation to make reference to recognised standards. For example, in the United Kingdom the Electrical Equipment (Safety) Regulations 1975 of the Consumer Proetection Act makes reference to British Standards in specifying safety requirements of the full range of the electrical equipment and accessoreis.

As we all know that there are no existing standards in Hong Kong for electrical equipment and accessories, one should consider the possibility of adopting overseas or IEC standards if they are found to be acceptable. In case where they are found not completely acceptable, modifications should be introduced.

It should be noted also that as standards affect producers, users, testing organisations and governmental control authorities, the principle of consensus must be strictly applied in the drafting or adoption of standards. In other words, a democratic machinery is needed to be established to deal with this aspect of the establishment or adoption of standards for use in Hong Kong.

) Effective Policing Measures to be Introduced

The whole exercise of establishing legislation and standards will become futile if there is no effective policing in the marketplace. Such policing measures should include obtaining samples in the market, checking and testing samples in accordance with standards, prosecuting offenders, and so on.

4) Product and Materials Testing Facilities

To provide the technical back-up necessary for the effective policing activities in the enforcement of legislative regulations it is important that there be adequate and competent testing facilities in Hong Kong. Indeed there exist already a number of international known testing organisations in Hong Kong whose facilities should be made available to the enforcement authority.

5) Consumer Education

Though many people are already aware of the potential danger of electricity, they are still taking for the granted that all the electrical equipment they purchase are already safe and pay little attention to the using of them. In view of these, education should be arranged through perhaps the mass media concerning the safety of electrical equipment.

Examples are as follows:

(a) To teach the consumers to recognise the meaning and significance of the approval markings and warning statements, and to install and maintain the equipment according to instructions provided with the equipment.

(b) To teach the consumer of the meaning of "class I" and class II" in the general sense. The consumers should be educated to realise the importance of "double insulation" and "earthing". They should choose those equipment that are proved to be "double-insulated" or have "all-insulated" enclosure when purchasing. Otherwise, they should prefer those equipment that are having 3-core mains flexible lead or 3-terminal connection block, and to connect the "earthing" according to the safety instructions associated with the equipment.

(c) To teach the general public not to open the enclosure of the electrical equipment for investigation and/or repair unless qualified to do so.

(d) To teach the general public of the fact that to remove the mains plug from the wall socket is the only way to ensure that the equipment is completely "off".

(e) To introduce to the public of the advantages of using "up-to-standard" products. A product that complies with safety standards may be more expensive than the one that is not, but it may be worthwhile as it may have additional protection devices inside, like fuses, safety relistors, isolating transformers, etc. and may have more robust construction. It may turn out to be more reliable in normal use and abuse. In fact, paying more for a safe product is worthwhile as it is always better to be sure than to be sorry later, especially if there are children in the house.

6) Voluntary Safety Certification Mark Schemes

In order to assist the consumer to identify products which have been found to comply with safety standards and are manufactured under a system of quality control and surveillance, certification mark schemes have been developed around the world. Some of those well-known schemes include those operated by the British Standards Institution, British Electrotechnical Approvals Board, the Underwriters Laboratories of the USA, the Canadian Standards Association of Australia, etc. In Hong Kong, the HKQ-mark is gradually gaining popularity and recognition in the local market.

In or to be granted the HKQ-mark a product must first of all be tested and found to comply with a recognised international or overseas standard. This is then followed by a thorough assessment of the quality assurance capabilities of the manufacturer. In addition, a system of regular and continuing surveillance of the quality assurance activities of the factory will be instituted. Such a scheme will not only enable the consumer to have a means of identifying up-to-standard products but will also help the manufacturer to maintain or upgrade its quality assurance functions in the factories. It is hoped, therefore, that more and more manufactuers will participate in this Scheme.

7 The Role of Insurance Companies

The role that could be played by insurance companeis in helping to ensure the safety of electrical equipment is often neglected. In fact, they can play an important role if they were to specify in their insurance policies that damages incurred as a result of sub-standard electrical equipment will be excluded. This would have the effect that when consumers are purchasing electrical equipment in the market they would look for those which have been found safe such as those carrying a safety certification mark.

CONCLUSIONS

It cannot be disputed that we do have a safety problem with regard to electrical equipment currently being offered for sale in the market or in use by consumers in Hong Kong. Indeed corrective measures such as those suggested in this paper are long overdue. As mentioned earlier we are now dealing with a matter which concerns the lives of human beings and the protection of the buildings in which we live. This matter certianly needs urgent attention. We are grateful to the Hong Kong Institution of Engineers for this opportunity to express our views on this important matter of safety of electrical equipment and we hope that our contributions are useful and constructive, and would result in some positive action by relevant parties in the not-too-distant future.

LIST OF REFERNECES

1. U.K. Statutory Instruments 1975 No. 1366 Consumer Protection – The Electrical Equipment (Safety) Regulations 1975.

2. U.K. Statutory Instruments 1976 No. 1208 Consumer Protection – The Electrical Equipment (Safety)(Amendment) Regulations 1976.

3. BS 2754: 1976 "Memorandum of construction of electrical equipment for protection against electric shock".

4. BS 3456 Part 1: 1969 "Specification for the testing and approval of household electrical appliances Part 1: General requirements".

5. IEC Publication 335-1: 1976 "Safety of household and similar electrical appliances. Part 1: General requirements".

6. IEC Publication 65: "Safety requirements for mains operated electronic and related apparatus for household and similar general use".

7. "A look at Electrical Safety" by P. Emery, extracted from ELECTRONICS, Australia, June 1973.

Paper No. 6

Consumer Product Safety

Speaker: Mr. K. M. Li
Chief Research Officer
Consumer Council

CONSUMER PRODUCT SAFETY

Safety First

1. I am quite sure no one will disagree that a consumer product should be safe. 'Safety First' seems to be a widely accepted philosophy by all disciplines. Ask an exponent of the view why safety comes first, he will probably come out with something like 'because it is good' or 'for the benefit of mankind'. Most manufacturers or suppliers of consumer products will also tell you that 'safety is an overriding consideration' or 'safety is of paramount importance' in the policies of their organizations.

2. However from my experience in dealing with dangerous consumer products, I have come across many cases which indicate that product safety is in a very low order on the priority list of many suppliers as the ethic of product safety has been overridden by many higher order objectives of their organizations. Furthermore they all have some reasons to put forward when confronted with queries on risks found in their products.

Is the Product Risk Avoidable?

3. One of the common reasons put forward by producers is that the risk associated with a product is unavoidable. The philosophy is that safety is seldom absolute, and so it may be deemed to include an acceptable degree of risk. For examples, the uses of knives, axes, chainsaws, explosives etc, all include very obvious hazards. They may go on to say that it is unrealistic to expect that all risks incurred through the use of a consumer product can be eliminated, as a significant increase in safety might deteriorate the effectiveness of the performance or the quality of the product considerably.

4. It is admitted that a product which can meet the estalished safety standards but is unable to do the work for which it has been designed for is of little value to the consumer; it is like the aircraft described as 'safest on earth'. However what is an avoidable risk and what is not has to be judged. To make such judgement often requires the dedication fo a producer to product safety. The Con-Sumer Council did find that some suppliers of consumer products had taken very little effort in making a candid judgement. I am quoting here a real case as an illustration of a manufacturer who had the capability to design a safe product but had failed to do so: "One morning in February, 1980, a fire broke out in the bedroom of a 17-month-old baby in a falt in Kowloon, and the baby was burned to death. At the death inquiry held by the coroners' court, it was revealtd that fire was caused by an electric fan heater which the maid had left switched on a chair near the baby's cot. The heater was somehow overturned and dropped on the carpeted floor of the room causing the carpet to burn. In fact such model of electric fan heater had been found to be able to comply with the safety standards in respect of temperature rise, protection against electric shock and scorching test."

5. At first glance, one may think that it was an accident caused by the stupidity of the maid as she should not have left a switched on heater unattended. One may also easily jump to the conclusion that there was nothing the manufacturer of the fan heater could have done to prevent such accident. Nevertheless, if one cares to take a closer examination, one will also find that the manufacturer of the heater was also at fault. Had the heater been fitted with an automatic cut-out device which would operate when the heater was overturned, then the fire would not have taken place and the baby would have been saved.

Carelessness, Misuse, Abuse

6. Suppliers of consumer products will also claim that much of the product injury is attributable to user causes such as carelessness or misuse on the part of consumers, or inadequate supervision on children. Therefore it is unreasonable to expect the manufacturer to do anything to safeguard the consumer against the risks associated with the product through carelessness or misuse. Generally speaking, legally recognized consumer vulnerability does not extend to misuse or careless use. Yet I must say that it is not unreasonable to expect a responsible supplier to include safety devices in his product for preventing a preventable risk. One must realize that people and particularly young children, are not always reasonable in the use of the goods they bought. For example, it may not be considered reasonable to open the door of a spin drier while it is revolving at several hundred revolutions per minute, but a number of accidents did occur in that way, and now there is, in most washing machines, a built-in interlocking device which prevents the cover of a spin drier from being opened while it is revolving. Another example is that it is not reasonable for children to insert their fingers or metal implements into electric wall socket, but fatal incidents did take place in that way, and therefore safety shutter is now incorporated in every wall socket.

7. The causes of product hazards may be man-related, environmental or product-related. But irrespective of root causes, it can always be rightly said that manufacturers have the greatest potential and, therefore, the largest responsibility for reducing hazards. In May, 1980, the Consumer Policy Committee of the International Standard Organization (ISO) recommended that safety measures of consumer products "must cover intended use as well as predictable misuse or abuse". Therefore, even though it is unrealistic to expect that all risks incurred through the use of consumer products can be eliminated, yet a responsible manufacturer should be able to eliminate or reduce all preventable risks.

Is Product Safety Costly and Unprofitable?

8. Among other factors, cost may be the major one which deters manufacturers from making their products more safe. They have, rightly or wrongly, a concept that safety can be obtained at the cost of an increase in product price, and that a lower price can easily be achieved at the expense of safety. Some suppliers consider it more prodfitable to spend money in sales promotion that in upgrading their facilities for improving safety standards of their products. Others are worrying that they will lose out if they institute to improve the safety and gain an unfair competitive advantage over responsible manufacturers.

9. However if one examines this factor more closely, one will find that such consideration is very short-sighted. In fact dedication to consumer product safety has been proved to be a strong selling point for business. A safe product contributes to consumer satisfaction and encourages repeat sales. A good safety scorecard for a company can mean lower insurance rates. Evidence of compliance with the steps safety standards is valuable in case of government inquiry or a defence against liability claims. A wise manufacturer should take all these costs, and not just the production cost, into consideration when implementing product safety measures.

Consumer Product Safety a Growing Concern

10. On the other hand, the penalties for neglecting product safety are often far more costly than is the institution of sound business practices to make products as safe as reasonable. This is because consumer product safety has become a concern to more and more governmental as well as voluntary consumer protection agencies. Regulatory, actions including development of product safety standards, inspection and testing of consumer products,prohibition, recall and seizure of hazardous goods are growing in many countries in the recent years. Furthermore, it is important to note that the supplies of hazardous products are being watched diligently at international level. e.g. the International Organization of Consumers Union (IOCU) has launched an international warning system called the Consumer Interpol to facilitate quick exchange of information of information on hazardous products found by consumer organizations around the world. 120 members of IOCU in more than 50 countries are receiving such information. The Bureau European des Unions de Consummateurs (BEUC) of EEC is also issuing similar hazardous product notification regularly. These systems established to promote efforts to control the international trade of hazardous products. Therefore an unsafe consumer product stands a very good chance to be discovered, banned, and recalled. A major recall from the marketplace of an unsafe product can easily strain the resources of even the most successful companies. Moreover consumer injuries resulting from unsafe products may bring about lawsuits for compensatory damages and punitive damages. That would amount to thousands or millions of dollars.

Be on the Lookout for Product Hazards

11. An ethical and responsible suppleir of consumer product should not let himself jump to the conclusion that the hazard associated with the product is unavoidable. He also should not put the blame on the consumer for being careless or abusive in using the product when hazards are discovered. Furthermore he should not consider the production cost only when he has found it necessary to institute safety measures to improve his product. Then what should he look out for in acertaining product related risks? There are many mandatory requirements, in product safety. However, such requirements often provide the very basic safety standards only. Therefore apart from referring to those requirements, a responsible supplier should also ask himself the following questions:

1) Are the hazardous properties for functioning of the product necessary?

2) Could the normal user anticipate and guard against the risk associated with the product?

3) Will the risk threaten established consumer expectations with respect to a contemplated use?

4) Are there areas in which the user should be protected even though no definable pattern of expectation with respect to either the product or the particular hazard has been developed?

5) Will there be any product related risks too new to be anticipated by the user?

6) Could safety practices be designed for new product to minimize the consequences of accidents which have not yet taken place actually?

7) If a product needs adjustment before use, are there possible measures to prevent risks caused by wrong adjustment?

8) Are there foreseeable misuse by a particular, group such as small children, elderly, handicapped?

12. The list of questions can be endless. Yet one thing is clear: be on the lookout for product hazards. Product hazards vary in their gravity and visibility. However if a manufacturer does always put product safety in this priority list, I am sure he will never miss the necessary steps by far.

Product Safety Checkpoints

13. How best can a manufacturer or supplier of consumer goods assume his responsibility for product safety? A lot of studies have been carried out to answer this question. I would like to draw your attention to list of Product Safety Checkpoints issued by the Office of Consumer Affairs of the U.S. Department of Commerce (Please see the annex of this paper). The list, I think, can serve as a good reference for implementing actions on product safety. The lit is especially useful to small and medium-size manufacturers and suppleirs who do not have adequate facilities for supervising all phases of manufacture, marketing and servicing.

User Instruction, Warnings, Labelling

14. On those checkpoints, I would like to elaborate a bit on the following two issues. The first is on the point of warning and information to user. It is important to note that a product may become unsafe simply because the product supplier has failed to provide adequate warnings or instructions for use. Such point is often very much neglected by suppliers of consumer goods. In a study carried out by the Cosumer Council on thermal storage electric water heaters in 1983, it was found that the samples choosen had passed almost every safety test required by British Standards. However it was also found seven out of ten samples included in the study did not have adequate warning labels and/or instructions to users: e.g. the markings or warning labels of some samples could easily be rubbed off or could easily become illegible. More important, some water heaters did not bear any indication to denote which is the inlet for cold water and which is the outlet for hot water. The lack of such indication could lead to very serious consequence: a wrong connection of water supply to the outlet instead of the inlet of a water heater of non-pressure or open type would render it very unsafe as it would then become a water heater of 'closed' type without expansion pipe for venting the steam when the heater is not functioning normally. In fact there were several reported incidents of explosion of electric water heaters in the recent years, and the main cause could be atrributed to wrong connection of water supply to the water heaters concerned, due to the lack of markings of 'inlet' and 'outlet' on the heaters.

15. It is difficult to specify the user needs for safety related information. However the following two categories of information should be needed by users of most products: The are

(1) Identification of the product. This means that the product should be properly labelled and that the labelling should include any precautions necessary to prevent hazardous misuse or abuse of the product.

(2) Guidance for assembling, installing, using and maintaining the product.

Distributor & Retailer Assist in Product Safety

16. The next point I would like to discuss is how a distributor or retailer can contribute in consumer product safety. Firstly, distributors and retailers, especially, are very convenient channels for reporting safety-related deficiencies to manufacturers. They can also provide refund, replacement or repair on behalf of manufacturers. If a product has been found hazardous, distributors and retailers should take an active part in assisting the manufacturer with the recall. For example they should remove the hazardous product from warehouses and retail shelves; they should also post signs to inform the public and explain that the product may be returned for refund or repair.

17. Secondly, a distributor or retailer can actually help make a consumer product safe before ti is sold to the user. In a study on electric space heaters carried out by the Consumer Council, it was found that many space heaters could be taken as potentially dangerous simply because they had been fitted with plugs which could not match the electric supply system in Hong Kong. It has been pointed out that there are particular dangers associated with the unsuitable plugs such as those come usually moulded on the cord with some domestic appliances imported from Europe. The plugs came with the electric space heaters mentioned above are very safe when used in combination with sockets designed for us in some European Countries. However, in Hong Kong, the pin spacing and diameter of those plugs cannot match sockets installed in homes in Hong Kong, and thus the earthing connections cannot function. Moreover, the earth connections of the European plugs are in gooves on the outside of the plugs which could be gripped by hands during plugging in and out. Then a user has two chances of being electrocuted if his appliance has developed a fualt.

18. The Consumer Council has found that many electric appliances fitted with this type of unsuitable plugs are sold and delivered to consumers. We consider that importers have an obligation to advise their manufacturers to fit in the factory the correct plugs to meet Hong Kong conditions. If not, the importer or retailer should have them changed before the appliances are sold to the consumer.

Conclusion

19. The right to safety is one of the four basic rights of the consumer. It can briefly be expressed as his right to be assured that goods and services offered to him must be such that, under normal or foreseeable conditions of use, they present no risk to his health and safety. With the advance of science and technology, many consumer products have become highly complex and therefore an ordinary cosumer should not be expected to be able to safeguard himself against risks associated with thsoe products. Irrespective of the root causes for product injuries, manufacturers in fact have the greatest potential and the largest responsibility for reducing product hazards.

20. The basic cause of product safety problem in many cases is the lack of integrity judgement on the part of production management. If the problem is faced maturely, it can always get itself handled. With the growing concern over consumer product safety around the world, the penalties of neglecting product safety are often far more costly than is the institution of sound business practices to make products as safe as reasonable. In that respect, the manufacturer, the distributor as well as the retailer all have a role to play.

PRODUCT SAFETY CHECKPOINTS* Annex

Following are suggested steps for managment to follow when establishing policies and procedures for the product safety program.

Product Manufacture

- Establish company policies and procedures
- Set up safety Review Committee
- Assign responsibility and lines of authority
- Begin product design
  - Open product development file
  - Establish performance requirements consistent with intended use
  - Select raw materials and components
  - Prepare written specifications and design drawings
  - Document all changes in design
  - Sign-off by responsible authority

- Conduct prototype testing
  - Hire independent lab
  - Check for mandatory or voluntary standards
  - Obtain lab reports, certification, or "listing"
  - Document all changes made as a result of testing
  - Sign-off by responsible authority
- Prepare for production
  - Procure raw materials and components
  - Develop purchasing specifications and contracts
  - Inspect materials and components
  - Document all changes or repairs
  - Establish procedures for handling and storage
  - Sign-off by responsible authority
- Production quality control
  - Open quality control file
  - Train personnel
  - Put instructions and procedures in writing
  - Periodically inspect equipment
  - Inspect and test products from production line
  - Segregate faulty or non-conforming products
  - Preserve worker safety
- Product distribution
  - Identify products by lot, batch, serial number, or date of production
  - Prepare packaging that protects the product and handlers during shipping and storage
  - Prepare labels and instructions with adequate warnings, list of antidotes, recommended use
  - Prepare operating instructions covering proper use, anticipated misuse, installation, maintenance, storage, and disposal
  - Include instructions for repairs consumers can safety make, and warnings about unsafe repairs
  - Market test labels and instructions and change if necessary
  - Sign-off by responsible authority
  - Prepare advertising and promotions with safety in mind
  - Demonstrate safe use in advertisements
  - Emphasize instructions and warnings
  - Avoid exaggerating safety features and giving user a false sense of security

Product Distribution and Sale

- Contracts between Manufacturers, Distributors and Retailers
  - Include product description, expected performance, and function
  - Include guarantees and warranties and certifications
  - State extent of repairs possible and circumstances in which products must be returned to manufacturer for repair
  - Include all identification necessary to trace product
- Retailers' responsibilities
  - Train buyers to select products carefully and to be knowledgeable about mandatory and voluntary safety standards
  - Understand manufacturers' warranties and the circumstances in which retailers can become bound by warranty obligations
  - Train sales personnel not to remove tags and other safety disclosures from display merchandise, or to discount or contracdict manufacturers' safety information. Sales personnel should encourage consumers to read and understand these disclosures
- Product servicing
  - Follow manufacturers' instructions, diagrams, and charts showing correct methods of repair
  - Return products to manufacturer for major repairs, if manufacturer requests
  - Train and consider certifying personnel
  - Promptly report safety problems and potential defects to manufacturer

- Customer Service and Complaints
  - Establish a system for reporting complaints, injuries, product defects, inadequacies in product literature, and design problems to the manufacturer
- Product recall
  - Agree on procedures in advance with manufacturers, distributors, and retailers
  - Anticipate the costs of a recall, including repurchase, handling shipping, and publicity
  - Keep records by product lot, manufacturer, dates, and purchaser's name, if possible
  - Help manufacturer keep track of product returns
  - Make plans for returning products to service centers and for distributing replacement parts
  - Consider a trial run of recall procedures so response can be prompt and effective
- Audit procedures
  - Conduct audits to evaluate procedures and evaluate how well they are carried out
  - Maintain the integrity of the recordkeeping system

* Extract from Consumer Safety: Responsive Business Approaches to Consumer Needs of Office of Consumer Affairs, U.S. Department of Commerce.

Paper No. 7

The Safety Aspect of Electrical Installations for Domestic Premises

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THE SAFETY ASPECTS OF ELECTRICAL INSTALLATIONS FOR DOMESTIC PREMISES

Electricity is often described as the perfect servant. It is willing, always present, clean and, providing it is well controlled, safe. However, if it is ill treated or abused it can become dangerous and uncontrollable to the extent of causing fatalities.

Needless to say, all reputable manufacturers of electrical equipment for domestic premises are fully conscious of their responsibilities and over the years have followed a continuous policy of product improvement and development with safety uppermost in mind.

This paper is concerned with the fixed part of the electrical installation in domestic premises and I would like to look in particular at two areas; firstly the devices by which electricity is supplied to our appliances namely switches, sockets plugs etc., and secondly the aspect of protection and the steps that have been taken to ensure that if anything does go wrong the user is still protected.

The first accessory that a householder normally comes across is the switch on the wall controlling the light. Most early designs used ceramic materials for the base, on to which were built fairly substantial contacts with metal operating levers and protected by a brass cover. When compared with modern designs it will be seen that the electrical properties were substantially over engineered and the easy removal of the brass cover could not possibly meet todays standards of safety.

However, although it was so easy to unscrew the cover and touch live contacts, I do not believe that there were many instances of people electrocuting themselves in this manner. Perhaps the modern age has brought with it more inquisitive or destructive minds, but certainly the current regulations that live parts should not be accessible without the use of tools makes the modern switch far less prone to tampering fingers. In fact, the latest design of switch goes even further with a labyrinth face plate which makes it impossible to push anything through the small gap between the rocker and the face plate and touch live metal. A further benefit of this design is that the arc flash which occurs when a switch is operated cannot be seen through the rocker face plate gap and although the arc in itself if not dangerous it does give added confidence to the user.

Little use is made of ceramic materials today as modern moulding techniques have taken over with the use of thermo-setting materials and whilst the larger contact systems with a quick make and break action were required for D.C. distribution systems standardisation A.C. for domestic use has resulted in much lighter and more economic contact arrangements.

Of course, flush mounting switches themselves are not a new or recent invention. Some of the earlier types of flush switches also used brass cover plates which were seldom earthed and which could be easily removed by unscrewing the retaining ring. Todays legislation demands that adequate provision is made for earthing all metal parts and that front plates cannot be removed without the use of tools.

Another potentially dangerous situation can arise when a householder is re-decorating a room since painting or wallpapering is made much easier if the switch is eased away from the wall by slackening or removing the fixing screws, thereby exposing live connections. One modern design of switch overcomes this hazard by having a removable front plate which can be removed for decorating with live parts remaining inaccessible behind the main body of the switch. When the room has been re-decorated the front plate is easily replaced. Other safety features incorporated in the latest designs of switches include a positive drive mechanism so that the switch cannot be moved to the off position if the contacts should weld and a 3 mm contact gap to comply with the latest requirements.

The use of a neon seek light on switches which enables them to be easily located in the dark is another useful safety feature.

There are particular rules concerning the use of electrical equipment in bathrooms and lights and other appliances are often controlled by cord operated pull switches. A requirement of the relevant standard is that if the cord is worn or broken it can be renewed without dissembling the switch. Cord operated switches used as isolators for instantaneous showers should be provided with mechanical indicator to show whether the switch is "on" or "off". The only type of socket outlet permitted in a bathroom is a shaver socket with a double wound transformer rated at 20VA maximum. The latest wiring regulations also require that all metal parts should be bonded and connected to the main earth terminal.

The subject of plug and socket outlets covers a multitude of designs and in England, as in Hong Kong, we have a mixture of round and flat pin types. Even though the ring main concept and the 13A plug was introduced more than 30 years ago round pin plugs are still being used, albeit in rapidly diminishing numbers. Our wiring regulations insistance on three pin plugs and sockets has done much to ensure safety and the 13A system has been adopted in many parts of the world.

As with switches the early design of plugs and sockets were quite large, a single 15A switch socket for example occupying more wall space than a modern 13A twin socket. The 13A socket outlet incorporates several safety features, one of the most important being the shutter arrangement which is an almost uniquely British concept, designed to prevent the insertion of little childrens fingers or metal objects held by little childrens fingers!

British Standards for both round and square pin plugs and sockets are such that when properly used the pins do not become live until the plug is inserted far enough to prevent fingers touching the pins. Thus an average person cannot touch live pins while inserting or withdrawing the plug. However, it has been known for people to try to lever plugs out of a socket using for example a screw-driver or a knife which could lead to contact with live metal. This has led to the development of sleeved or insulated pins where part of the pin nearest to the plug body is shrounded in insulation. This does not detract from the part of the pin making contact in the socket and there is still adequate current carrying surfare available. It has been recognised that this feature adds even further to what is already a very safe system and BS1363 is currently being revised to incorporate sleeved pins as standard.

There have unfortunately been many reports of overheated plugs which have tended to give the 13A fused plug system a bad name. All such cases can inevitably be traced to some form of abuse, the most common of which are centred on the fuse cartridge itslef. Extensive heat run tests are carried out on plugs and fuses to BS1363 on leads of over 13A and all reputable manufacturers products complying with the relevant standards will carry the load safety without overheating.

Problems usually arise through the use of non-standard fuses and cases have been known of a blown fuse either rewired or even wrapped in metallic foil before being replaced in the fuse holder. This in turn forces or weakens the spring clip and again leads to trouble.

Years of experience and use has shown that there is nothing inherently wrong with the concept of a fused plug and providing he fuse is to BS1362 and preferably ASTA certified no problems will be experienced.

Whilst on this subject it is perhaps worth mentioning that the so called International Plug and Socket which, despite the name, will never be accepted internationally, could be extremely dangerous is adopted in its present form.

The dangers arise due to the interchangeability between the proposed new plug and both the British flat pin and round pin domestic systems. The new plug could be inserted between live and earth which would leave appliances without earthing and, in the case of the 13A system, without individual fuse protection. A most unsatisfactory and potentially dangerous situation.

There are various other types of control switches used on domestic installations and one of particular interest is the cooker control unit which combines the switch with socket. Such a combination is in itself open to question. A cooker control unit must of needs be placed close to the cooker and there is always a temptation for kettles or other appliances plugged into the unit to have flexes trailing across the top of a hot cooker. For this reason the cooker unit is also available without a socket outlet. However, popular demand often insists that a socket be provided adjacent to the cooker and we must, therefore, ensure that the combination is as safe for the user as possible. It is important that the two switches on a combined unit are as unlike as possible, conssitent with good aesthetic appeal so that they do not get mistaken for one another or other means taken to associate the switch with the socket outlet. This can be done by markings on the front plate or by differnces in the style of switches themselves. Similarly any indicator lights incorporated in the unit should show clearly which switch is on or off.

Before leaving accessories I should just like to mention lampholders which provide another problem. Live terminals are bound to be exposed when the lamp is taken out particularly in table and standard lamps. If brass lampholders are used these must be efficiently earthed as required by the wiring regulations. This will prevent the lampholder from becoming 'live' if a stray whisker of wire such as is sometimes found on some of the cheaper bulb caps touches the side of the holder. Suitable heat resisting materials must also be used for moulded lamp holders and care must always be taken in any lamp fitting where there is restricted ventilation that the rating of the bulb does not exceed that recommended by the manufacturers.

So much then for the accessories and the parts of the installation that the householder handles regularly. Let us now look at the various types of protective devices used in domestic premises bearing in mind that our Wiring Regulations require protection to be given against the hazards of both shock and over current.

You may recall me mentioning earlier that electricity is often described as a willing servant and as such there is always a danger that the lord and master of the house will attempt to get as much work out of him as possible. Consequently unless suitable preventative measures are taken there is a danger that the householder will overwork the servant and overload the installation. In fact a householder is often encouraged to do so by the use of multi-way adaptors in socket outlets leading to what is often described as the "Christmas tree." Reputable makes of adaptors will of course have fuses fitted to ensure that they cannot be loaded beyond 13A but unfortunately there are many there are not.

Three types of device are used to protect deomstic circuits from over current, namely rewireable fuses, hrc fuses or miniature circuit breakers. Rewireable fuses are still used in England and several other countries, but are increasingly giving way to other forms of protective devices. The are cheap to install and cheap to maintain since replacement fuse wire is quite inexpenseive – assuming of course that the householder goes to the bother of buying fusewire! Only too often the most convenient piece of wire, paperclip, hair clip etc., is used to restore the supply as quickly as possible irrespective of the danvers this may cause Rewireable fuses are subject to abuse and if they are used the householder must be instructed in the correct method of rewiring a fuse. Easily said of course, but how one really goes about it I'm not quite sure. None of these problems arise from the use of hrc fuselinks, but these can be expensive in use and there is a need to maintain a stock of spares. Both of these points have encouraged householders to repair blown hrc fuses which is far from safe and can give rise to a potentially dangerous situation.

Recent years have seen an increase in the use of miniature circuit breakers for the protection of domestic circuits. Whilst their initial cost may be higher than that of fuses there are no further costs to be met since the breaker, having operated on a fault, can be re-closed simply, quickly and safely. Mcbs are sealed, tamper proof devices and will continue to give the protection they are designed to give through the life of the installation. The handle of a breaker quickly identifies whether the contacts are open or closed and a breaker which has operated can be easily recognised.

Developments in circuit breaker technology have led to higher breaking capacities and a reduction in I^2t let through providing a unit with a similar characteristic to that of an HRC fuse combined with the mechanical advantage of a miniature circuit breaker.

The latest amendment to the British Standard for mcbs BS3871 Part 1 facilitates the selection of the most suitable breaker for a given application by classifying mcbs according to the current at which the breaker becomes instantaneous which, for this purpose, is taken as operation in less than 100 ms.

The result of this classification is two-fold. Ideally we would like the instantaneous trip current to be as low as possible as by this means you get the maximum amount of protection against both over current and shock risk. However, the trip current could be too low and cause the breaker to operate on inrush or transient surges making it difficult if not impossible to use breakers on circuits containing motors, capacitors or other devices with high inrush currents.

Thus, by virtue of this classification it is now possible to balance these conflicting requirements and to choose the most suitable breaker for a given application. The Type 1 mcb which has an instantaneous trip between 2.7 and 4 times its rated current and provides protection against both overload and indirect contact with relatively high values of earth loop impedance is used widely in the UK for domestic installations, but the circumstances may differ here in Hong Kong due to the fairly widespread use of air conditioners.

The introduction of the 15th Edition of the Wiring Regulations has led to an increas in the use of current operated earth leakage circuit breakers as they are now known. These devices come in all shapes, sizes and ratings and are designed to provide fire and shock risk protection.

Our wiring regulations have for many years insisted that all exposed metal work be bonded together and connected to earth so that should a fault occur on to such metal work enough current will flow to oeprate the fuse or circuit breaker protection that circuit. If however earthing of the installation is inadequate to cause that operation an earth leakage circuit breakre will then be required.

The earliest types of earth leakage circuit breakers were voltage responsive and were ideally suited for rural installations where the problems normally arose. These are still used quite extensively in countries with overhead distribution lines to rural districts. They are not suitable for use in congested urban areas where faults can be imported from one installation to another and where several paths to earth could exist from a given installation.

The modern approach therefore is to use a current operated or residual current device which operates as soon as it detects a current flowing to earth. Our wiring regulations prefer the use of the residual current breaker and indeed insist on its application under certain circumstances.

On a convention TN system where the supply authority provides an earth connection back to their transformer sufficiently low impedances will usually be obtained to permit the over current device protecting a final circuit to provide earth leakage protection as well by operating within the necessary time.

If this is not the case then a residual current breaker must be used. These are available in a wide range of sensitivities and the regulations lay down that the sensitivity of the breaker to be used when multiplied by the loop impedance shall not exceed 50. This is to keep the voltage rise under fault conditions to 50 volts and to meet this regulation breakers having sensitivities of the order of 300mA could be used. Even if the loop impedance is low enough to give the necessary protection it may be felt advisable to use high sensitivity breakers to give better protection still. It is available so why not use it?

The wiring regulations define an equipotential zone which is an area wherein all metal work is solidly bonded together and connected to a common earth point. If a socket outlet within the zone is intended to supply equipment that will be physically used outside it, the regulations now require that socket outlets intended to supply such appliances or any fixed appliances so installed shall be protected by an RCD having a sensitivity of 30mA or better. In addition if a domestic installation is earthed locally, in other words a TT system as you have here in Hong Kong, then all socket outlets on that installation shall be protected by a 30mA RCD. Whilst devices with a sensitivity of 30mA or better must be used in these circumstances 300mA units are more than adequate for the purposes mentioned earlier.

There are several ways of achieving the protection required by the latest edition of the wiring regulations.

Consumer units are now available incorporating residual current circuit breakers. These may be with the rccb used as the main incomer thereby providing protection for the whole installation. Care should be given to the choice of sensitivy use however and for all general puposes 300mA would be adequate on a TN installation. Where 30mA protection is required for socket outlets on a TN or a TT system it is preferable to use a "split load" consumer unit where the rccb controls only that section of the unit supplying socket outlets and other circuits requiring shock risk protection. Fixed equipment such as lighting, water heating etc would be fed directly from the main isolator.

There any also be substances where a 300mA or 100mA rccb is required if the earth loop impedance exceeds the value required for shock risk protection and a 30mA rccb to protect socket outlet circuits only. In this case the consumer unit would probably incorporate a main switch a lower sensitivity roob and 30mA roob each controlling different outgoing circuits.

Other methods of achieving compliance with the regulations include combined mcb/rccbs and protected socket outlets.

The combined mcb/rooc has an advantage in as much as it can easily be fitted to existing installations and isolates the fault without affecting other circuits controlled by the consumer unit. It provides over current and earth fault protection in one unit, provides visual indication of the type of fault and is available in a wide range of current ratings and tripping sensitivities.

The switch socket with rccb protection also has the advantage that it can easily be fitted to any existing installation, can be provide in moulded and metal plate versions with sensitivities of 10 and 30mA.

When looking into the future one thing is certian and one big question mark remains.

The certainty is that we shall see an increase in the use of rccbs. We are already finding that the additional protection they can give is being specified on installations where they are not necessarily essential for compliance with the wiring regulations. As they say in one well known television programme "we have the technology" and we shall use it.

The question mark rest over the future of developments in socket outlets. The need for an international plug and socket has been long recognised and international debate has continued for many years as to how best this can be achieved. There has been no shortage of "solutions" to the problem for each nation with its own system felt that its own system should be adopted as the international standard. Such a move would give that nation an immediate commercial advantage and for this reason it was originally agreed by the IEC that any international standard should be independent of any existing standard.

A design was produced but found wanting and there is a strong movement from Europe to adopt a system which would be compatible with present Continental European standards. This would introduce problems and dangers as mentioned earlier in this paper. The debate continues but unfortunately it is likely to seek a political solution rather than a technical one.

3. Safety of Electrical Installation – Supply Rules and 15th edition IEE Wiring Regulations

Paper No. 8

The Power Company's Role in Ensuring Safety in Electrical Installations

Speakers: Mr. J. H. Henderson.
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THE POWER COMPANY'S ROLE IN ENSURING SAFETY IN ELECTRICAL INSTALLATIONS

SAFETY FROM THE UTILITY'S VIEW POINT

The power supply undertakings in Hong Kong are very much concerned with electrical safety for the following obvious reasons:

a) They wish the use of their product by the public, their consumers, to be as safe as possible so that the expected growth in use of electricity would never be affected for safety reasons.

b) Use of proper engineering standards incorporating strict safety features ensures for both consumer and the power company, stability and continuity in use, rapid clearance of faults by the removal of the faulty section only ensuring efficient use of the supply and no interference to the supplies given to other consumers.

c) Electrical accidents very ofetn cause electrical faults, disrupting supply not only to the user but possibly adjacent consumers.

All this is apart from any statutory requirement laid down by the existing Government Electricity Supply Ordinance that the Power Supply Company should not give supply when the consumers installation does not comply with certain minimum safety standards.

In other words, an unsafe installation is trouble or potential trouble, not only for the consumer, but for the supply utility and it makes good commercial sense to ensure that safety standards exist. Faults cost money, since during loss of supply no units are sold to the consumer, or possibly other adjacent consumers who have been affected. Also at this time of loss of supply there is a loss of good relations with our customers.

All these things are apart from our sense of responsibility, as professional engineers serving society that engineering progress should bring a minimum of detrimental factors to public life.

PRACTICAL CONSIDERATIONS

How can we, then, practically ensure safety in the use of electricity.

We can begin within our own network, by paying attention to safety in the methods of providing supply by cable or overhead line, by the safe state of our own plant and its operation with provision of adequate means of protection which will operate not only to faults in our own plant but after hte necessary discrimination time, operate for any uncleared faults, due to failure of protection, in the consumers plant.

We have also to ensure that the fault level once stated to a consumer at a specific point is not exceeded so that after purchasing a piece of switchgear, for example, to suit that fault level, the consumer can be assured that it will always be adequate.

We ensure also that the length of the Company's supply cable or line will not add excessively to the earth loop impedance path so that adequate earth fault current will flow. We also ensure that voltage and frequency are in accordance with declared values.

Since we are required under Government Ordinance to ensure that an installation has certain minimum safety standards, when supply is given, it is worthwhile considering which standards these should be.

Hong Kong has inherited a system of electricity supply, similar to some other places round the world, for example, in the Far East, Singapore and Malaysia, based on U.K. practice and it is therefore necessary to apply to this method of supply the appropriate rules i.e. the U.K. Institution of Electrical Engineerings Regulations for Electrical Installations. It is also correct that having decided this, we should not be using items of plant or accessories which where designed to suit other methods of supply for example Continental, American or Japanese plugs and sockets or 110V appliances etc. etc. Some items of plant of course, to internal standards, are suitable after due consideration.

MINIMUM STANDARDS

It may therefore be worth considering what the minimum standards required for an installation should be.

They are basically:

a) Adequate insulation resistance.

b) A value of earth loop impedance which will ensure that earth faults will be cleared by the operation of fuses, miniature circuit breakers, etc.

c) Conductors rated for the declared loading of the circuits.

d) Protective devices suitably rated for the conductors.

e) Proper materials rated for the work to be done and to the British or other acceptable standard, and correctly installed.

EFFECT OF NEW REGULATIONS

In the new 15th Edition of the I.E.E. Regulations, the inter-relation of earth loop impedance, conductors, protective conductors and fuses or circuit breakers are explained in a scientific, but not necessarily easy to understand way. It will however, repay a little applied study.

Time does not permit here a detailed evaluation of all these aspects so I shall single out two.

Firstly, insulation resistance, or the lack of it, is still a very important requirement. In the early days it was the leakage from initially poor or rapidly deteriorating insulation which set premises on fire. There was also the problems of rubber insulated wires which in Hong Kong's heat and humidity deteriorated or perished in a short time and often become brittle, falling off the conductor, leaving bare wires which could spark together. We are now almost clear of the perished rubber covered wires era, and luckily wood PVC insulation is capable of longer life. This does not mean we can ignore the insulation resistance values. It shows for example poor values when conductors have been scraped bare on the edges of conduits which have not been "de-burred" or smoothed after cutting and screwing. It shows up wires pulled into conduits or boxes which have become wet or full of water due to lack of protection from weather or other excesses of water used by other building operations. It shows up the poor quality PVC coating of wires bought from cheap sources to no known standard. It shows up the poor insulating qualities of cheap sub-standard ballast coils and capacitors in fluorescent fittings, all of which may become potential fire risks. Despite this a high percentage of craftsmen on site never test insulation; many installation contractors do not possess an insulation tester.

The second item deserving special mention is the new requirement of the 15th Edition which calls for the provision of earth leakage protection by means of a residual current device covering every socket outlet, designed to trip on an earth leakage current 30 milli-amps.

This regulation, a small step in the changed regulations, represents a great leap forward in electrical safety. It means, for example, that even if many others things go wrong, for example, failure to earth an appliance or unexpected breakage of an earth wire or protective conductor, then the actual earth fault current flowing through the body of the person involved to earth will operate the residual current device and trip off the supply if the current approaches 30mA. The RCD will trip in a time between 40 milliseconds and 200 milliseconds dependent on current and will in nearly all cases prevent: the timeand current factors which cause fatal electric shock by fibrillation of the heart. This is of special value to workers in building sites, markets etc. where a combination of wet surroundings and lack of proper footwear has caused

We appeal to all persons knowledgeable of these devices to convince all users that all operations of RCDs, so called false trippings be heeded and properly investigated. We will have, hopefully only reliable RCD's in use which conform to proper standards and when they operate are doing so because there is leakage which can be measured and investigated.

When we have this extra protection in use, we should not of course abandon all other safety measures. We hope that RCDs will become a valuable life saver on building sites where one can see every day, extension cords without earth wires going to hand held tools which need earthing. There is still reluctance of local contractors on building sites to use 110 volt tools via safety transformers and of course we have no legislation to enforce it.

Unfortunately, anything that plugs into a socket whether it be on the building site or in the home cannot be controlled by any regulation since the consumer does not have to display it on test and the more unhealthy state it is in, the less likely it will be shown.

In these matters where only the education of the public is going to help, we the power companies cooperate with such other authorities as Fire Services Dept., Labour Dept., Urban Services, Consumer Council etc. to help them with technical advice and support.

We also carry out tests on installations when requested for the issue of Stability Certificates required by Urban Services etc. to show that the installation involved meets the relevant standards.

Although it is not our responsibility we remind our consumers on the rules of the authorities concerning neon signs, swimming pool lights, high voltage electrostatic equipment when we find it.

SAFETY BENEFITS OF 13 AMP. SOCKETS & RING CIRCUITS

We welcome the use of 13-amp. ring circuits for socket outlets for the extra safety and convenience they provide and often wonder why it is taking so long to have this excellent method adopted generally in Hong Kong.

It confers the following advantages:

a) Generous concessions from the I.E.E. Regulations regarding the numbers of socket outlets, the size of wiring conductors and the use of common MCB and RCD in the distribution box, all of which correctly applied may save money for the client.

b) The use of an adequate number of socket outlets, including the use of double outlets on one plate means ample outlets for all purposes, avoiding the use of multi-way adaptors.

c) The fact that all appliances have one common plug type which can be used on every socket outlet; again avoiding multi-way adaptors.

d) The more rapid clearance of faults on appliances or appliance leads due to the fuse in the plug which can be down rated to suit.

In Hong Kong, where table lamps and similar are often fitted with inadequately size conductors, this alone can prevent faults being cleared by burning of the leads before the circuit fuse or MCB trips.

In this field we hear also with regret, stories of 13-amp. socket installations being replaced by 15 amp. sockets to avoid the consumer changing the plugs on appliances. Without the benefits of the fuse in the plug this cannot of course be done with safety.

INDIRECT INFLUENCE OF UTILITY ON SAFETY

Having dealt with the practical aspects of our influence we can make mention of some of the indirect ways in which we can and do influence electrical safety.

Our Public Relations staff are being constantly contacted by the press, radio and television on the subject of electrical safety and we are always pleased to be able to give them access to the correct information on the Hong Kong system. Many writers try to adapt articles written on electrical safety in other countries, very often from the USA, and are surprised to find that considerable changes may be necessary to adapt the articles for Hong Kong conditions. We have supplied speakers on electrical safety for womens radio and T.V. programmes and in conjunction with others helped to produce booklets on general safety in the home and the correct application of electrical appliances.

We have provided speakers to talk to many organisations and societies on electrical matters, particularly safety, to groups as diverse as School Science teachers and building caretakers. In this last year in particular, the talks on unravelling the hidden mysteries of the 15th Edition of the I.E.E. Regulations has been apparently a sought after service.

We and others in this field, many of whom are talking to you today, can do their best in their own field to impress the public and industry with the methods of achieving electrical safety but we have to reach the hearts and the consciences of every one involved to realise that safety depends on each persons individual effort. The craftsman must be made to realise that the joint he makes badly or the sharp edge on the conduit he fails to file, may save him time but at the cost of someones life in a fire. The contractor must ensure his design staff know what they are proposing meets all the rules and that the foreman and supervisors on site really check and test the work which they have done and not leave it for others to find. We must install a sense of professional pride in this industry and the starting of their own voluntary inspection council may not be a bad way of showing they have pride in their standards.

CONCLUSIONS

The Supply Industry plays an important role in ensuring by means of a few practical tests that an installation is safe to supply but in future we will be expecting the contractor who has done the work of installation to declare his responsibility by written certification that it conforms to the necessary standards. In this way the responsible contractor will be given a fuller share in guaranteeing the integrity of his work. If he proves that these standards are consistently good, testing will be minimal.

The pursuit of safety in electrical installations should be a joint effort of all parties concerned, i.e. the consumer of tenant who should insist on safe installations from contractor or developer, the Contractor, either as a small one man business or in cooperative Associations, intaking full responsibility for their work, by Government in drawing up more comprehensive regulations and really enforcing them.

By the good cooperation we see from all the interested parties at this Symposium it leads us to hope that our combined efforts will enable us to continue to claim Electricity as the safest, as well as the most convenient and versatile fuel that the public can use.

Paper No. 9

Electrical Safety For High Rise Building

Speaker: Mr. Samuel P. W. Wong
FHKIE C. Eng. FIEE,
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ELECTRICAL SAFETY FOR HIGH RISE BUILDING

I. Introduction

For high rise buildings, the reliability of electrical supply must be assured to the greatest extent possible since, in most cases, windows of the buildings could not be open and artificial lighting is employed.

The incoming supply from the power companies should be provided via at least two sources originating from different sub-stations and routed to the buildings from separate directions, or by a network affording double contingency providing for simultaneous loss of one feeder and one transformer.

Continuity of the incoming supply is no longer the only criterion for judging a power source. We are now introducing into office buildings more & more computers and sophisticated communication systems that required power that is stable as well as dependable. So it is necessary to introduce a buffer between the power company and the sensitive equipment in order to maintain voltage and frequency within operating parameter, regardless of fluctuations of the incoming service.

The design of the wiring distribution system complements the highly reliable incoming service. It should be planned in such a way that a fault at any location in the system will be isolated before other uninvolved circuits were disconnected unnecessarily. Building services installations, such as air-condition, mechanical ventilation, lighting, communication, lifts etc. should be designed in such a way so that the failure of a feeder or protective device of the incoming service connection will not deprive the entire building of these essential services and nessitate the building's evacuation.

We shall now discuss some of the basic requirements in achieving a safe & reliable power distribution system for high rise buildings, these are:–

a) A systematic design approach
b) use of proper materisls
c) installation work by competent persons only
d) Routine preventive maintenance.

2. A Systematic Design Approach

2.1 Building Load Estimates

The design engineer should base his estimates on loadings of similar buildings, i.e. buildings of similar sizes, shapes and of course similar activities and tenants mix. A good design engineer should keep an up-to-date record of his previous design jobs amending it as necessary by actually measuring the existing loading etc. The power companies on both side of the harbour have monitored the power requirements of all different types of buildings and their statistical information should be a good check for your loading estimation.

2.2 H. V. Network & Transformer Arrangement

To minimise the problem of voltage drop in high rise buildings and for other special reason, it is quite common to install some of the transformers on upper floors of the buildings. This is specially so when the big loading centre, the air-conditioning plant was not in the lower portion of the building. For buildings of 30 storey high and above, it is nearly impossible to use normal size cables or busbar to provide 346/380 supply and limit the voltage drop to 2.5%, as required by the I.E.E. regulations; unless transformers are installed at higher level. For such installation, care must be taken to ensure adequate hoisting facilities and easy access for future maintenance or replacement of transformers & switch-gears. It is good practice to provide two H.V. feeder cables each sized for the total transformer loading. Do not run the H.V. cable feeders in cable ducts where L.V. cables or other building services are already there. Adequate ventilation is essential to help heat dissipation of the transformers. Currently, the following types of transformers have been accepted by the Fire Services Department for installation at high level: -

a) Dry-type transformer
b) Cast-resin dry type transformer
c) SF6 gas insulated transformer
d) Silicon fluid-filled transformer
e) Formel NF Transformers

All requirements of the transformer manufacturers and those of the F.S.D. must be strictly adhered to.

2.3 L. V. Distribution Networks

If thesupply isfrommore than one transformer, inter-connection facility between main incoming circuit breakers to reinforce the L. V. supply reliability is recommended.

All cable and switchgears should be properly sized with suitable current-carrying capacity.

Imported busbar ducts are now frequently use as feeders or risers. For industrial building and commercial building; provision of dual busbar ducts service each floor or at least provision of spare T-off on each floor is recommended. Provision of concrete kerbs in cable ducts to prevent seepage of water, and proper selection of routing of the busbar are necessary to avoid dripping of warer from other services pipings to the busbar duct.

2.4 Emergency Power System

An emergency power system consisting on single or multiple generating sets to provide standby power to fire services installation, emergency lighting, alarm and communication system, emergency lightings and pressurization system for staircase is essential. This should also be capable to return all lifts to the ground floor to evacuate passengers by operating each group of lifts on one-at-a-time basis as an emergency measure. In sizing the capacity of the generating set, particular attention should be given to motor that draw much higher starting current than the full-load running current.

2.5 Protection Against Electric Shock

According to the I.E.E. Wiring Regulations, more specific requirements have been imposed on overload protection, short circuit protection and earthing arrangements. These requirements would improve the safety standards, such as the use of RCCB (previously known as current operated ELCB) for socket-outlets and bonding to extraneous conductive parts, could reduce the risk associated with electric shock and fire hazard due to leakage currents. In deed, we have used the ELCBs for many years now and have found them very effective, especially for installations in construction sites, squarters and rural areas where supply is usually provided via overhead lines. However, careful consideration must be given when using RCCBs for protection of socket-outlets. As the use of individaual RCCB to protect each outgoing circuit is too expensive, then for larger area, it is advisable to have a group of socket-outlet circuits protected by an independent RCCB instead of using a single RCCB to protect all socket-outlet circuits because the latter may lead to nuisance tripping. Particular attention should be given to socket-outlets which may be used to provide supply to electric kettle and heating appliance of high leakage current.

3. Use of Proper Materials

The type of equipment and materials for the electrical installation should be carefully selected to suit the environment, specified duty and site conditions. The equipment/material selected should comply with requirements of the appropriate international reputable testing authority, on its rating and performance etc. to ensure satisfactory performance during operation. There were occasions when installations with poor quality equipment/materials, causing power failure, sometimes fire hazard and explosion.

4. **Installation Work by Competent Persons Only**

Needless to say, electrical installation with poor workmanship is one of the main sources of frequent breakdown, power interruption and fire hazard. It is essential that the complete electrical installation be carried out by competent & exprienced persons in order to achieve satisfactory result. The registration of electrical contractors and workers as currently proposed by the Government is in the right direction.

A thorough final inspection and testing on the installation by competent engineers or technicians could minimise possible human error, wrong connections, defects etc.

5. **Routine Preventive Maintenance**

Apart from keeping the transformer rooms, the switch rooms etc. absolutely free from unauthorized storage of goods, usage by others and penetration by other building services, it is important that the whole electrical system is checked, maintained and serviced at regular intervals.

Continuous state of changing occupancy requirements would mean additional wiring work or additional power requirements. A competent person should be engaged to plan and implement a preventive maintenance schedule, recording any change of power demands, failures of supply etc. When busbar ducts are used, the regular servicing requirement is most important in order to prevent deteriortation of the bar etc.

The stanby generators should be test-run on regular basis. Battery installation should be both visually checked and check by meters. Temperature rise of transformers, busbar etc. should be proper recorded for the future reference.

To conclude, to secure a reliable and safe electrical system for high rise buildings depend not only on good systematic system design, good workmanship in installation but also rely heavily on the operation and maintenance staff of the buildings to service and manage the system, since, without electricity supply, the building is but a useless concrete shell.

Paper No. 10

Miniature Circuit Breakers & Residual Current Devices in relation to safety in Electrical Installation

Speaker: Mr. V. C. Sweet
Technical Manager, Domestic Switchgear,
Delta Accessories and Domestic Switchgear

COMPARISON OF SHORT CIRCUIT PERFORMANCE IN ACCORDANCE WITH SELECTED NATIONAL AND INTERNATIONAL STANDARDS

STANDARDS CONSIDERED IN THIS REPORT

1) BS 3871:Pt1:1965 + AMD 3594

British Standards Institution; specification for miniature and moulded case circuit breakers : Part 1 : miniature air-break circuit breakers for a.c. circuits.

2) IEC 157-1 : 1973

International Electrotechnical Commission low-voltage switchgear Part 1 : Circuit breakers

3) UL 489

Underwriters Laboratories Inc.
Standard for moulded case circuit breakers and circuit breaker enclosures.

4) AS 3111 : 1983

Australian Standard

Approval and test specification for miniature overcurrent circuit-breakers.

5) AS 2184 : 1980

Australian Standard

Moulded-case circuit-breakers (up to and including 600V .a.c. and 250V d.c.) (Interrupting rating 10kA and more)

6) VDE 0641/6.78

West German Standard

Miniature circuit-breakers up to 63A rated current, 415V a.c. (VDE - specification)

This report compiled by V. C. Sweet M.S.c., Technical Manager (Domestic Switchgear).

INTRODUCTION

A key area of MCB performance is that of short circuit or breaking capacity. It represents the ability of the MCB to safely interrupt short circuit fault currents.

Although by no means the sole criteria for assessing performance, it is often this characteristic of MCB operation that is used to compare one MCB against another.

Invariably the breaking capacity is assigned in accordance with set test methods defined in national or international standards. These test methods can vary to the extent that comparison of MCB's tested to different standards can be meaningless. In fact, even comparison of MCB's tested to the same standard can be difficult, due to differences in MCB performance not covered by the test requirements.

Short circuit ratings fall into two categories:

a) Unconditional

b) Conditional

Unconditional Short Circuit Rating

This is the short circuit rating obtained in a test where the MCB or MCB's interrupt the prospective fault current unaided. That is; no back up protection is provided.

This short paper deals exclusively with considerations related to unconditional ratings.

Conditional Short Circuit Rating

This is the short circuit rating obtained in a test where the MCB or MCB's interupt the prospective fault current in association with an additional protective device. This additional device will generally be an HRC fuse or MCCB and will typically have a short circuit rating above the unconditional rating of the MCB.

Under such conditions the additional device is said to provide 'back up protection' for the MCB and the combination said to provide 'co-ordinated protection'.

Such conditional ratings are not covered by this paper and are subject to additional and different considerations.

½ CYCLE 'V' CURRENT LIMITING MCB's

The mechanism by which MCB's achieve circuit interruption under short circuit conditions provides a convenient means of separating MCB devices into two generic groups (see Fig 1.):

a) ½ cycle or zero point extinguishing

b) Fault current limiting

2.1 ½ Cycle MCB

Under short circuit conditions, the current in bimetal A is sufficient to attract armature C towards magnetic pole piece D, thereby releasing latch E.

The high energy arc formed as the contacts open will not be extinguished until the next current zero, hence the MCB may have to carry the fault current for ½ cycle. The fault current will be nearly equal to the prospective value limited only by the volt drop across the single arc and internal impedance of the MCB.

The de - ion plate F is added to minimise the risk of a re-strike across the open contact gap during the next ½ cycle due to ionised gas.

The energy (I^2t) let through by the MCB during the breaking operation is high and nearly equal to that of ½ cycle of the prospective fault current.

2.2 Fault Current Limiting MCB

Under short circuit conditions the rising fault current energises the solenoid G attracting the plunger H.

The plunger H pushes pin J out of the rear of the solenoid, to de-latch the MCB mechanism; the knob K, striking the moving contact with considerable kinetic energy, thus forcing the contacts apart. By this action, inertia of the latch mechanism is effectively eliminated and the time from initiation of fault to contact separation is minimised.

The resulting high energy arc is moved rapidly, under the influence of electromagnetic force, along arc runners L into the arc splitter pack. Due to the large number of plates a very high arc voltage is generated.

This high arc voltage produces current decay, rapidly reducing fault current to zero.

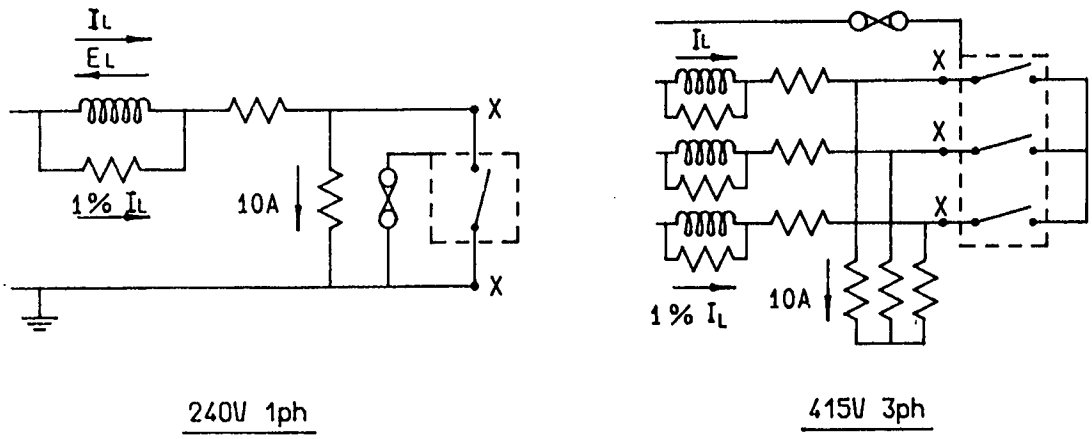
The peak value of fault current and energy (I^2t) let through by the MCB during the breaking operation is thus restricted to a fraction of the prospective value.

3. COMPARISON OF PERFORMANCE ½ CYCLE 'V' CURRENT LIMITING MCB.

The key to any considerations is the substantial difference in the value of the energy let through or I^2t.

Because of its high I^2t let through, the ½ cycle MCB has historically been limited to breaking capacity - say in accordance with BS3871:Pt 1 of M3 (3,000A) although recent developments have extended this figure to M6 (6,000 A). This latter figure relates generally to 415V three phase applications and is not directly comparable with the M3 (3,000 A) rating which relates specifically to 240V single phase applications.

FIG.2



Conversely, because of its ability to limit I^2t, prinicipally due to the limitation of peak current, the fault current limiting MCB can easily achieve a BS 3871:Pt 1 breaking capacity of M6 (6,000A) or M9 (9,000A) for 240V single phase applications.

Single pole MCB's may be installed in single phase or three phase installations. These two areas of application are provided for in BS 3871 by two separate tests.

Cl 31a or b for single phase.
Cl 31c for three phase.

Fig. 2 illustrates the separate test circuit arrangements for each duty.

It is important to note that in the test circuit for 240V 1 phase duty, each MCB must open the fault current unaided.
In the test circuit for 415 V 3 phase duty, since at least 2 MCB's must open on test , there is inevitably some sharing of duty, hence slightly higher breaking capacities can sometimes be achieved.

This is particularly true for ½ cycle MCB's where the following pattern is common:

	240 1Ph Isc	415 3Ph Isc
a)	M 3.0	M 4.5
b)	M 4.5	M 6.0

At a prospective fault current of 9,000A the fault current limiting MCB shows a typical I^2t let through of only $50X\ 10^3\ A^2s$ compared with almost 10^5 A^2s for a ½ cycle MCB at 3,000A.

Although in theory ½ cycle and current limiting MCB's can have the same breaking capacity, they will never have the same I^2t let through. Hence in practice the current limiting MCB will always achieve higher breaking capacity.

4. CLASSIFICATION OF MCB's ACCORDING TO SHORT CIRCUIT RATING - SOME GENERAL COMMENTS

Fig. 3 sets out the principle requirements for determination of the breaking capacity for MCB units in respect of five commonly quoted standards. Although not exhaustive in respect of detail technical considerations the chart together with the following comments serves to indicate the main differences between these standards, and the effect these differences can have on achieved breaking capacity.

Note that in respect of VDE 0641, which by national practice relates typically to current limiting MCB's, no specific provision is made for a single phase test.

Note also that in respect of UL489 the 120/240 V test does not give a true 240V 1Ph rating due principally to the test arrangement of 2 MCB's in series.

4.1 No of Units to be submitted to Test

Typically three or four MCB's of Minimum and maximum current ratings are tested. This general rule is based on the assumption

MPARISON OF S/C TESTS. S.P UNITS ONLY.~ REFER TO SPEC'S FOR TEST WORK.

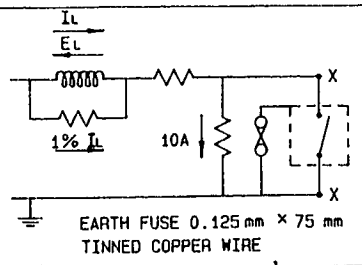
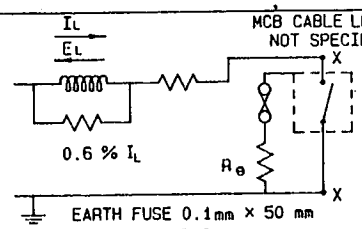
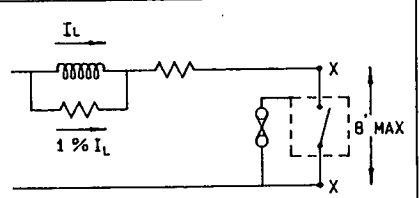
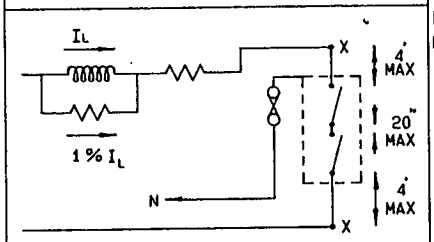
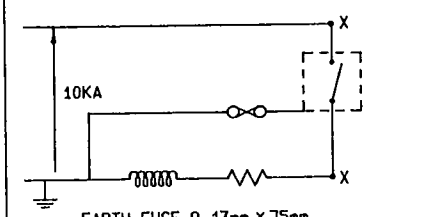
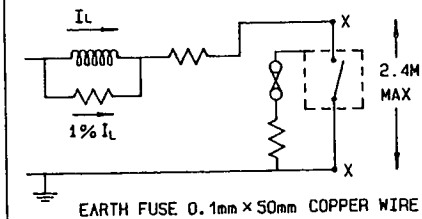
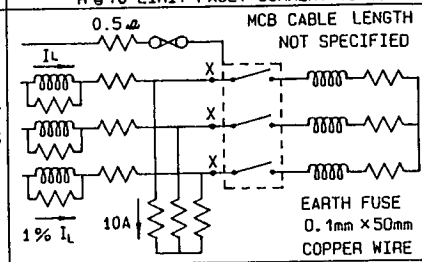
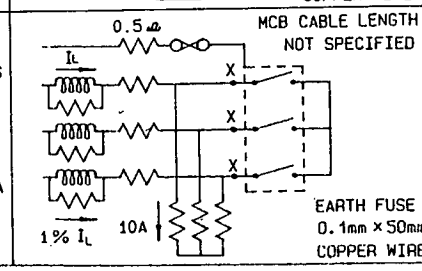
	UNITS TO BE SUBMITTED TO TEST	PRE-TEST REQUIREMENTS	CIRCUIT P.F. Cos ϕ	TEST SEQUENCE	TEST CIRCUIT [X=POINT OF CURRENT CALIBRATION]	POST TEST REQUIREMENTS	NOTES
971 1 85 1594	3 OFF I_n max 3 OFF I_n min	a] I_n-NT 2 HRS 40°C b] 1.35/1.5 I_n-T 1 HR 40°C	3KA 0.75-0.8 6KA 0.75-0.8 9KA 0.55-0.6	TEST SEQUENCE-S B-2-MB-2-MB at 60° DISTRIBUTED p.o.w S at 100 % S/C S at 30 % S/C SAME SAMPLES		a] 500V WITHIN 3MIN OF TEST : LINE EARTH 0.5M Ω MIN ACROSS OPEN CONTACTS 0.25M Ω MIN LINE TO EXPOSED METAL 0.5M Ω MIN b] 2 × I_n-T<3MIN	TESTS AT 50Hz USUALLY AT 240V
157.1 3 752 1977 660 101 82	1 OFF I_n max		3KA -0.9 6KA -0.7 10KA -0.5 20KA -0.3	P1 B-3-MB P2 B-3-MB-3-MB	 R_e TO LIMIT FAULT CURRENT TO 100A	a] WITHSTAND 2 × U_t b] M & B 2 Ith at U_n c] 2.5 × Ith-T≤T FOR 2.0 × Ith IN NEW STATE d] TEMP RISE AT Ith OR I FOR NO TRIP SHOULD NOT CAUSE DAMAGE a] WITHSTAND 2 × U_t b] 2.5 × Ith TO AGREE WITH PUBLISHED INFORMATION c] TEMP RISE AT Ith SHOULD CAUSE NO DAMAGE	TYPICALLY TESTS AT 50 Hz VDE-USUALLY 220V BS-USUALLY 240V THESE SPEC'S NORMALLY USED FOR TESTING MCC'BS ASTA WOULD EXPECT TOTAL MCB CABLE TO BE APPROX 2.5M ASTA WOULD REQUIRE TESTS ON I_n MIN MCB'S
489 8	120V 3 OFF I_n MAX 3 OFF I_n MIN 120/240V 4 OFF I_n MAX 4 OFF I_n MIN	a] 2 × I_n-T 0-30A≤2 MIN 31-50A≤4 MIN 51-100A≤6 MIN b] 1.25/1.35 × I_n-T ≤1 HR c] 6 × I_n (150A MIN) U_n 35 OPS O/C 15 OPS C/T d] TUNGSTEN LAMP TEST e] I_n AT T_{ref} NT 1HR f] T RISE AT I_n g] 6 OPS/MIN 4k MECHANICAL 6k ON LOAD U_n, I_n h] 2 × I_n etc as a] i] 1.25/1.35 × I_n as b]	I_{sc}≤10KA 0.45-0.5 10KA< I_n <20KA 0.25-0.3 I_{sc} >20KA 0.15-0.2	B-2-MB	 	a] 900V AC 60 Hz [2 × U_n OR 900V MIN] (i) ACROSS OPEN CONTACTS (ii) LINE TO EARTH FOR 1 MIN [MIN 500VA CAP SUPPLY] b] 2.5 × I_n- T 0-30A≤2 MIN 31-50A≤4 MIN 51-100A≤6 MIN	TYPICALLY TESTS AT 60 Hz 120V OR 120/240V
111 80 S/C KA	1 OFF EACH CURRENT RATING	a] 500V DC (i) LINE TO EXPOSED METAL (ii) ACROSS OPEN CONTACTS 10M Ω MIN b] 2KV AS IN a] c] 500 OPERATIONS d] 1.5 × I_n 0.9pf 250V: 100ops e] T RISE AT I_n f] I_n- N.T CONT. 1.25 I_n T≤2 HRS 2 I_n T≤6 MIN 6 I_n T≤5 SEC	0.75-0.8	FOR S/C>1.5KA B AT 1KA MB AT 1KA B AT 2KA MB AT 2KA B AT 3KA MB AT 3KA 2 MIN INTERVALS		a] 2,000V FOR 1 MIN (i) LINE TO EXPOSED METAL C.B OPEN & CLOSED (ii) ACROSS OPEN CONTACTS b] 500V DC AS ABOVE 10 M Ω MIN c] TEMP RISE AT I_n d] I_n N.T CONT 1.25 I_n-T≤2 HRS e] 2 × I_n-T≤6 MIN f] 6 × I_n-T≤5 SEC	TYPICALLY TESTS AT 50 Hz 250V AC
184 FOR >3KA TIONAL 3111 S ON SET MPLES	1 OFF I_n MAX 1 OFF I_n MIN		>3KA 0.65-0.75 6KA 0.5-0.65 9KA 0.4-0.5 10KA 0.4-0.5	B-3-MB	 R_e TO LIMIT FAULT CURRENT TO 100A	a] 2 × U_n (i) LINE TO EARTH C.B. OPEN & CLOSED (ii) ACROSS OPEN CONTACTS b] 2.5 × I_n-T 0-30A≤2 MIN 31-50A≤4 MIN 51-100A≤6 MIN	
E 6.78 LES ITTED .5KA SERIES RATED ERIES RATE OFF LES	(1.5KA TEST) 3 OFF I_n MAX 3 OFF I_n MIN	a] VARIOUS THERMAL TRIP TESTS DEPENDANT ON I_n b] MAGNETIC TRIP CHECK c] VARIOUS THERMAL TRIP TESTS IN CONTROLLED T_{amb} d] MECHANICAL SHOCK TESTS	0.9-0.95	9 OPERATIONS 6-B 3-MB 3 MIN INTERVALS 6-B's EVENLY DISTRIBUTED P.O.W.		a] 2,000V AC 50 Hz (i) ACROSS OPEN CONTACTS (ii) LINE TO EARTH [CAPACITY 200mA MIN] b] CARRY I_{th} - NT 1 HR c] VOLT DROP ACROSS MCB d] CASE IMPACT TEST	TYPICALLY TESTS AT 220/380V 50 Hz
	(RATED S/C TEST) 3 OFF I_n MAX 3 OFF I_n MIN		3KA 0.8-0.9 6KA 0.6-0.7 10KA 0.5-0.6 [4.5KA 0.7-0.8]	TEST SEQUENCE-S B-3-MB-3-MB 3KA-S AT 3KA 6KA-S AT 3KA S AT6KA 10KA-S AT 4.5KA S AT 10KA		a] CARRY I_{th} -NT 1 HR	

Fig. 3.

KEY TO SYMBOLS

I_n - Nominal rated current

I_{th} - Rated Thermal current

U_n - Nominal rated operating voltage

U_i - Rated insulation voltage

A>B - A greater than B

A≥B - A greater than or equal to B

A<B - A less than B

A≤B - A less than or equal to B

'B' - A break operation of MCB

'MB' - A make-break operation of MCB

'T' - Trip

'NT' - No trip

that in a homogenious series the top and bottom of the range represents the ultimate variation in design change.

Significant departures from the rule are:

IEC 157-1 - only one sample of I_n max

AS 3111 - one sample of each I_n

AS 2184 - only one sample of I_n min and I_n max.

.2 Pre- Test Requirements

Generally establish that MCB performance in respect of time- current characteristics are in accordance with the requirements of the relevant standard.

Significant departures from this general rule are:

IEC 157-1 - No pre test requirements

UL 489 - 185 operations at 6 X I_n
6000 operations at I_n

AS 3111 - 100 operations at 1.5 X I_n

The on-load operations of UL 489 and AS 3111 essentially submit a 'used' MCB to short circuit test.

3 Power factor of test circuit (cos ø)

An important consideration in respect of the ease with which arcs formed between opening contacts can be extinguished.

It also influences the energy contained within the arc.

Generally a lower power factor is more onerous. This is particularly true for ½ cycle (zero point or 'American) type MCB's.

Note the inference of preferred values of breaking capacity.

4 Test Sequence

Generally a series of 'break' and 'make break' operations.

The time interval between tests is an important consideration.

Standards where 'point on wave' is controlled in respect of 'break' operations are generally more onerous.

.5 Test circuit

The most important considerations are:

a) Point of prospective current calibration.

b) Specified lengths of cable to connect MCB to test circuit. (This cable will generally serve to further limit fault current.)

c) Test arrangemnt for MCB's.

4.6 Post test requirements

Generally establishes suitability of MCB for further duty. Typically includes checks on insulation resistance thermal calibration, and sometimes temperature rise test.

4.7 General

Three significant factors are listed:

4.7.1 Test Voltage

Usually related to national system voltage. Small changes in voltage can significantly affect achieved breaking capacity, this is particularly evident with current limiting MCB's. Generally increased voltage means reduced breaking capacity.

Typical Values:

BS 3871		240V
IEC 157-1	(VDE)	220V
	(BS)	240V
UL489		120V
	or	120/240V
AS3111/2184		250V
VDE 0641/6.78		220/380V

4.7.2. Test frequency

Particularly important for ½ cycle types, 60Hz a significant advantage over 50Hz.

5. SPECIFIC COMMENTS RELATING TO VARIOUS STANDARDS.

5.1 BS 3871 : Pt 1:1965 + AMD 3594

A standard specifically related to MCB's and used on an international basis both for certification of performance and as the basis for many other national standards.
Widely recognised as providing a reliable measure of MCB performance, and generally accepted as imposing onerous test conditions.

NOTE: a) Three samples of I_n max and I_n min submitted to test.

b) Tests required at 100% and 30% of breaking capacity on the same samples.

c) Point on wave control on 'break' operations.

d) Length of MCB connecting cable to prospective calibration point specified - 1.2m total.

e) Specific thermal calibration performance check after short circuit test.

Ratings typically achieved for 240V 1 Phase application:

½ cycle MCB's	3 - 5kA
Current limiting MCB's	6 - 9kA

IEC 157-1 : 1973
(BS 4752, VDE 0660 : Pt 101)

principally a standard for MCCB's but recently popular with MCB manufacturers; since P1 rating allows a high breaking capacity to be claimed.

NOTE :

a) Only one sample of I_n max each to P1 and P2 test series.

b) No stated pre-test requirements.

c) P1 tests only 1-B, 1-MB.

d) Test interval is 3 min

e) Deterioration of thermal calibration characteristics are permitted after short circuit test - P1 rating.

f) MCB does not have to be capable of carrying I_n after short circuit test P1 rating.

g) No point on wave control on 'break' operation.

h) No specified MCB connecting cable length.

Typically used for current limiting MCB's.

P2 duty is similar to rating obtained by BS 3871 test, P1 must be regarded as an 'absolute' breaking capacity i.e. : the MCB will safely clear the fault but is not suitable for further normal duty.

.3 UL 489 : 1978

Probably gives rise to the most controversy. This specification relates directly to the American 120/240V distribution system.

American terminology classes MCB's as moulded case circuit breakers (MCCB's) The typical 'MCB' product being the 1" module 'QP' type ½ cycle MCB.

Such MCB's typically have a breaking capacity to UL 489 of 10,000A rms at '240V'.

This is not a true 240V 1 Phase rating and is achieved by use of the test circuit for 120/240V duty

NOTE :

a) 120/240 test circuit does not give a true 240V 1 Phase rating.

b) Two MCB's are in series for the test.

c) Although pre-test sequence appears onerous, only 1B, 1-MB required; on two sets of samples.

d) No specified time interval between tests.

e) Length of MCB connecting cable specified - 9'8" (appx. 3.0m)

f) Tests typically at 60Hz

g) No point on wave control on 'break' operations.

Typically ½ cycle 'QP' type 1" module MCB's with UL 489 breaking capacity of 120/240V - 10,000A rms will achieve only M 3.0 (3,000A) to BS 3871.

5.4 AS 3111, AS 2184 (1980)

For MCB's of Isc > 3kA tests are made to AS 3111 and part of AS 2184.

The tests of AS 3111, in respect of MCB's with Isc > 3kA, essentially confirm adequate performance at low fault currents. Such tests could be a problem with some current limiting MCB designs where low fault currents will not generate good arc running characteristics.

The tests of AS 2184 confirm performance at rated breaking capacity where I_{sc} > 3kA.

NOTE: AS 3111

a) Only one sample of each I_n submitted to short circuit test.

b) Pre-test includes 100 ops at 1.5 X I_n , U_n

c) 3-B, 3-MB on each sample.

AS 2184

a) Only one sample each I_n max, I_n min to short circuit test.

b) No pre-test requirements

c) 1-B, 1-MB on each sample.

d) Test interval 3 min.

e) Length of MCB connecting cable specified - 2.4 m

f) No point on wave control on 'break' operations.

Although somewhat different in format to BS 3871 achieved breaking capacities will generally be similar to BS 3871 ratings.

5.5 VDE 0641/6.78

The test method reflects W. German practice of supplying almost all loads three phase, including domestic.

Tests are split into two sequences:

1.5 kA test

As in AS 3111, used to confirm adequate performance at low fault levels.

Rated s/c test

Proves rated breaking capacity.

NOTE: 1.5 kA test

a) 6-B, 3-MB operations required

b) Test interval 3 min.

c) No post-test thermal calibration check other than I_n N.T., 1 hr.

Rated s/c Test

a) For I_{sc} of 6 and 10kA two test sequences required on some samples.

b) Test interval 3 min.

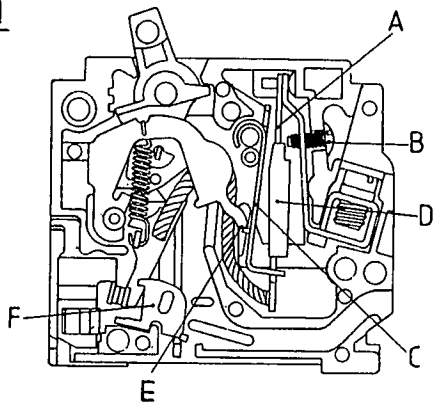
c) No point on wave control on break shots.

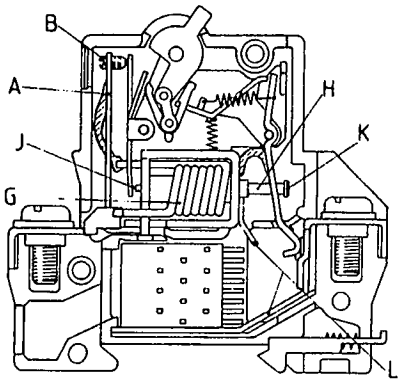
d) No specified MCB connecting cable length.

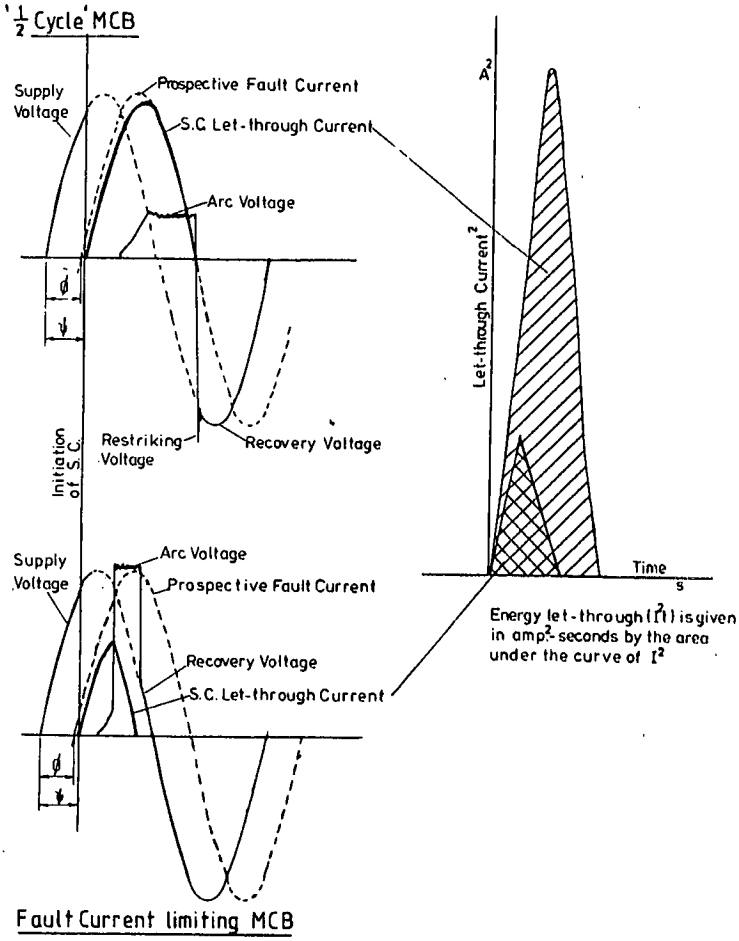
e) Only one post s/c check: I_n - N.T. 1 hr.

A common feature of both test circuits is the three phase connection. Under test conditions at least 2 of the 3 MCB's must operate. This inevitably leads to some sharing of duty. Typically MCB's with VDE 0641 breaking capacity of 10kA will achieve M9 (9,000A) to BS 3871.

Fig.1







Fault Current limiting MCB

Paper No. 11

Installing Switchgear in Compliance with 15th Edition IEE Wiring Regulation

Speaker: Mr. N. C. J. Badley
Export Regional Manager
Simplex–GE Ltd.

INSTALLING SWITCHGEAR IN COMPLIANCE WITH 15TH EDITION IEE WIRING REGULATIONS

The First Edition of the Wiring Regulations entitled "Rules and Regulations for the Prevention of Fire Risks Arising From Electrical Lighting" was published in 1882 and now we have progressed to "The 15th Edition IEE Wiring Regulations". Originally the emphasis was on preventing fires occurring from wiring for electrical lighting, but now the main concern is to protect people.

The following 3 extracts are from "A Guide to the 15th Edition Wiring Regulations" by J. K. Whitefield.

Para 2.2.2. Legal Status

"The Regulations are intended to provide safety against Fire, Shock and Burns in installations complying with their requirements".

Para 3.1 Introduction

"Every installation must be protected against short circuits and overloads. The people using the installation and the building containing it, must be protected from electrical shock, fire and other hazards arising from faults and misuse".

Para 2.2.1 Scope of Regulations

". . . . . , neigher do they apply to the construction of equipment but only its selection and application".

Construction of equipment is governed by recognised international standards and here we are considering switch fuses and fuse switches both complying with–

BS5419 Category of duty AC22 and AC23.
BS5420 Category IP41 for enclosures.
BS88 Part 2 for HRC fuses.

All reputable manufacturers issue independant test certificates to confirm their performance claims, in this case these would be ASTA Test Certificates for switch fuse and fuse switch performance and also for the HRC fuses. Other independant international testing stations such as KEMA, issue valid test certificates.

Switch fuses are normally available up to 100 amps 415V AC and comprise a switch mechanism and separate HRC fuse mounted in shrouded fuse units.

Fuse switches are normally available for 63 amps up to 1200 amps 415V AC. The HRC fuses are mounted on the moving carriage of the double break moving contact mechanism. Above 100 amps they have the advantage of strong mechanisms and lesser volume than an equivalent switch fuse.

The Regulations cover the application of these equipments in all types of installations Industrial, Commercial and Domestic – indoor and outside.

The design of equipments must comply with the requirements for:–

Regulation 412, Protection against Direct Contact.

i) Protection by insulation of live parts.
ii) Protection by barriers or enclosures.
iii) Protection by obstacles.
iv) Protection by placing out of reach.

(iii) and (iv) are more intended for installations such as sub-stations or overhead lines, switchgear must be approached by the operator who must be protected from contact with normally live parts whether the switch is closed in the on position or open in the off position, switchgear requires a combination of (i) and (ii).

412.2 Protection by insulation of live parts.

Live parts shall be completely covered with insulation which can only be removed by destruction and which is capable of durably withstanding the mechanical, electrical, thermal and chemical stresses to which it may be subjected in service.

NOTES: 1. Where insulation is applied during the erection of the installation, the quality of the insulation should be confirmed by tests similar to those which ensure the quality of insulation of similar factory-built equipment.

2. Paints, varnishes, lacquers and similar products without additional insulation do not generally provide adequate insulation for protection against direct contact.

412.3 Protection by barriers or enclosures

Live parts shall be inside enclosures or behind barriers providing at least the degree of protection IP2X (see BS 5490) except that, where an opening larger than that admitted for IP2X** is necessary to allow the replacement of parts or to avoid interference with the proper functioning of electrical equipment both the following requirements apply:

i) Suitable precautions shall be taken to prevent persons or livestock from unintentionally touching live parts.
ii) It shall be established as far as practicable, that persons will be aware that live parts can be touched through the opening and should not be touched.

NOTE: In consumer's installations required to comply with the Electricity (Factories Act) Special Regulations, 1908 and 1944, more stringent requirements may be applicable.

**IP2X from BS5490:1977 protect against entry by fingers or similar objects not exceeding 80mm in length. Solid objects exceeding 2.5 mm in diameter.

413. Protection against Indirect Contact

i) Earth equipotential bonding and automatic disconnection of supply.

The equipotential bonding applies in an indoor zone where earth bonding is intended to create a zone in which voltages between exposed conductive parts and extraneous conductive parts are minimised.

The characteristics of the protective devices for automatic disconnection, the earthing arrangements for the installation and the relevant impedances of the circuits shall be co-ordinated so that during any earth fault the voltages between simultaneously accessible exposed and extraneous conductive parts anywhere in the installation shall be of such magnitude and duration as not to cause danger.

This is known as the 'touch voltage' requirement and no doubt will be referred to in the second paper as final sub-circuits are normally protected by miniature circuit breakers which protect 'against excessive touch voltage' with or without residual circuit breakers operating in series, however where BS88 Part 2 HRC fuses are protecting sockets the maximum earth loop impedance is as Table 41A1.

Maximum earth fault loop impedance (Zs) for socket outlet circuits

Rating (Amperes)	6	10	16	20	25	32	40	50
Zs (OHMS)	8.7	5.3	2.8	1.8	1.5	1.1	0.8	0.6

This requires measurig the earth loop impedance with disconnection occurring within 0.4 second. This also applies only to tools/portable appliances etc. used within the equipotential zone. Therefore a socket incorporating a residual circuit breaker with 30mA trip sensitivity is to be strongly recommended.

Maximum earth fault loop impedance (Zs) for circuit supplying fixed equipment.

a) Fuses to BS88 Part 2.

Rating (Amperes)	6	10	16	20	25	32	40	50
Zs (OHMS)	13	7.7	4.4	3.0	2.4	1.8	1.4	1.1
Rating (Amperes)	63	80	100	125	160	200	250	
Zs (OHMS)	0.86	0.6	0.45	0.34	0.27	0.19	0.16	
Rating (Amperes)	315	400	500	603	800			
Zs (OHMS)	0.11	0.096	0.065	0.054	0.034			

Table for other fuses BS3036 (Semi enclosed) BS1362 (Plug Tops) BS3036 (Domestic) are listed for sockets and fixed equipments but only BS88 Part 2 are used with BS5419 Switchgear.

A combination of thermal magnetic MCB's and current operated 30mA RCD's give ideal protection for people using fixed appliances or equipments plugged into the mains (except in some industrial applications).

However all live conductors must be protected and the MCB protected against short circuits of such a high value that many damage the MCB.

613-15 Earth Loop Impedance

Where protective measures are used which require a knowledge of earth fault loop impedance, the relevant impedance shall be measured or determined by an equally effective method.

In some instances the enclosure may be part of the earth continuity and manufacturers would be required to produce resistance figures but these may differ between manufacturers due to differences in materials used or interconnections between sections, this is more appropriate to rising main busbar systems or conduit installations. Switchfuse and Fuse Switches do not normally contribute to the earth loop impedance and the concern would be the earth termination.

4.3.2-4

The breaking capacity rating shall be not less than the prospective short circuit current at the point at which the device is installed except where the following paragraph applies.

A lower breaking capacity is permitted if another protective device having the necessary breaking capacity is installed on the supply side. In that case the characteristics of the devices shall be co-ordinated so that the energy let-through the these two devices does not exceed that which can be withstood without damage by the device on the load side and the conductors protected by these devices.

A typical distribution system might be supplied by a 1000 KVA transformer with a potential short circuit of 29KA at 415V AC. In Hong Kong the supply may be fed to upper floors of multi-storey buildings by cooper Rising Main Busbars with little resistance to lower the short circuit potential. Cable runs from the busbars to the consumers MCB may be comparatively short and the fault potential at the consumers MCB board may be in excess of the 3 or 4.5 or 6 or 9 KA rating of the MCB's installed.

The MCB's would then be dependant on the protective device at the busbar tap off point, where the supply is taken from the busbars to the MCB boards, a cable connection would be used of lower rating than the busbars and a protective device must be installed within the first 3 metres. Most tap off devices are rated at 60 amp or 100 amps and could be either –

a) Moulded Case Circuit Breaker BS4752-P1 which would have three problems.

i) Breaking capacities are often only 16KA 415V AC and this may be too low for this point in the system.

ii) The over load would be the same type in principal as the MCB and the magnetic element would not operate fast enough to prevent the MCB having to withstand the full short circuit potential.

iii) A100 amp MCCB might trip instantaneously a 1000 amps and a 60 amp MCCB as low as 600 amps and they would trip out with the MCB on short circuits well within their capability.

b) Fuse switches or Switch fuses complying with BS5419 and fitted with HRC fuse complying with BS88 can be selected to give adequate back-up protection to MCB's and let them cope unaided with short circuits .nearly up to the maximum capacbility fo the MCB. This is supported by the guide to the Regulations 3.7.5 Back-up Protection.

There are various occasions when the overload protection has insufficient capacity to break the prospective short-circuit current for the point of the installation at which it is connected, an instance is when a large number of low rated miniature circuit breakers is connected at the end of a feeder or large corss-sectional area. In a case such as this, the circuit breakers, as well as the circuits they protect against overload, must be protected by 'back-up' protection. HBC fuses at the supply end of the feeder would provide satisfactory back-up protection.

3.8.5 Discrimination

A normal circuit has a number of protective devices in series and it is advisable for them to operate in the correct order if healthy circuits are not to be disconnected.

CONCLUSION

Switch fuses or Fuse Switches may be used to feed individual sockets or individual equipments or motors but more often they are required to provide the following functions.

a) Circuit isolation.
b) Overload protection.
c) Short circuit protection.
d) Back-up protection MCB's
e) Discrimination with MCB's to ensure that healthy circuits are not unnecessarily interrupted.

All these functions can be achieved by correct selection and installation and would comply with the recommendations of the 15th Edition IEE Wiring Regulations.

PAPER 12

SAFETY IN OUR HANDS

SPEAKERS: Mr. S. T. Tam, MHKIE, CEng, MIEE
Mr. K. C. Wong Senior MIIE, MBIM, MIEEE,
Hong Kong and Kowloon Electrical
Contractors Association Ltd.

Introduction

In Hong Kong, as in all modern societies, Electricity as a source of energy plays an important role in our daily lives. It would be difficult to think of any person, no matter young or old, to pass a day without using Electricity. However, how many of these people do realise that a full grown human being subjected to a voltage of 220V 50Hz found hand to hand or hand to foot for only 0.05 sec. would normally be the limit he can withstand without sustaining bodily injury. In terms of current flow, the limit is about 10mA. These figures demonstrates the exacting requirements of a safe electrical installation for protection of human being against shock alone. Other electrical hazards, as fire and explosion, can cost many more human lives and heavy financial losses. The responsibility of reducing all these electrical hazards rests squarely on those who set the standards, research and develop the equipment and system, manufacture the electrical products, carry out and test the installations and service and maintain the systems. Each group is an important link in ensuring that electricity can be used safely. Thus the Electrical Contractor has their part to play in the carrying out and testing of the installations and sometimes in the servicing and maintenance of the equipment and system.

Equipment for an Installation

The Electrical Contractor is guided by the Supply Rules of the Electricity Supply Companies. These Supply Rules in turn, are more or less formulated based on the IEE Regulations and British Standards. We in Hong Kong are fortunate to have access to a wide range of equipment and materials from many countries. Although different countries may not have identical standards, they are more or less similar owing to the excellent international communication and technical co-operation of the engineering professional. Obviously the ideal case would be the eventual enforcement of regulations set up by the International Organisation for Standisation (ISO) which is beyond the scope of this paper.

As most of the major electrical installation in Hong Kong can be considered as "Fully Designed" projects, the system safety aspects are normally taken care of by the Designers. The Electrical Contractor has only to spend very little time to grasp the concept of the system design. Then he matches the equipment to be offered against the design specification bearing in mind the local climatic conditions and the environmental condition of the place of installation.

For example, a diesel generating set will be quoted by the manufacturer with a continuous rating based on ambient conditions as 1000kN/m^2 barometric pressure, 27°C air temperature and 60% relative humidity. The Electrical Contractor carrying out the installation in Hong Kong should consider derating the unit for operation at say 35°C and 100% relative humidity if the plant room is well shaded and ventilated. At the same time if the generator set is to be used as standby duty in Hong Kong, then consideration can be given to the overload capacity above the engine constraints rating. Should the generator set be installed outside Hong Kong, an entirely different set of ambient conditions may have to be considered. Other factors as transient load, thyristor load, regenerative load may have to be looked into apart from the mechanical aspects as structural dynamic loading and vibration transmission etc.

One of the difficult problems in selecting suitable equipment for projects in Hong Kong is the pace of construction and likely changes in the usages of space under construction. The load constrains and environmental conditions for a garment factory is very different from that for an electronic factory. That for an office building is also very different from that for a hotel. It is not uncommon in Hong Kong for a factory to be built without knowing whether it would eventually house a garment factory or an electric factory. Also, an office building under construction could within a few months be revised to building for a hotel. Another problem is the space limitations available for installations. This will obviously affect the ambient conditions under which the equipment will have to be operated.

Workmenship and Use of Tools

An electrical installation involves work scattered throughout the entire area of the project. As has been illustrated earlier, every single point if not properly installed can lead to creation of an electrical hazard. This reversal of connection between the line and neutral wires to an edison screw lamp holder may subject an unwary person changing a lamp bulb to an electric shock. A loose connection may cause a high resistance joint and subsequent overheating leading to fire. A broken or damaged protective conductor may result in loss of protection from indirect contact. All these may not be easily detected during a normal testing of the electrical system. Thus it is imperative that workmen are trained to acquire an acceptable standard of workmanship. They should be made awared of the importance of each procedure of operation in ensuring a safe installation.

Workmanship relies very much on the use of proper tools. Using an undersized conduit bender will crush the conduit and reduce the cross-section area of the conduit path at a critical point of the system. A cut edge of the conduit without proper rimming is likely to damage the insulation of the cable to be pulled through. Using just fingers to lock a conduit box to the conduit may result in poor earth continuity. Using a pair of cutters to strip the insulation of a cable may damage the core of the cable and reduce the current carrying capacity of the conductor. All these seem obvious to most of us and are to be of minor consequence now. However, the earness application of proper tools avoids such defects. This saves time in making good afterwards and reduces electrical hazards.

There are numerous labour-saving tools being widely used. These not only improve the efficiency of the workforce but also help in the improvement of the standard of workmanship. A striking example which is now taken for granted as common usage, is the precussion type drill in place of the raw plug chisel and hammer. In the case of installations involving identical repetitive units, there is great advantages in the prefabricated method of construction. The equipment and materials are tailored and constructed in factories and workshops either off-site or on-site. Owing to the repetitive nature of these components, they can be made more accurately and quickly. There could be more frequent inspection and better quality control. This sensible application of suitable tools and methods of installation not only save time and money but also contribute towards better installation.

Construction Site Safety has been much in the lime light. However the working environment on site have often not been given sufficient attention. Yet it has a direct bearing on workmanship which result in safe installations. It is common that at many spaces in a site where electrical installations have to be carried out, these are not adequately lit; these is insufficient ventilation; mosquitoes abound and in some cases these have been used as toilets. Under such circumstances, it would be extremely difficult for the workers to concentrate on carrying out their work properly. It would be advisible to provide hand-lamps for task lishting which can be plugged into convenient socket-outlets at the places of work. similarly portable ventilation; fans should be provided for work spaces, in particular, where operations involve the generation of fumes as in soldering or sweating. The sites should also be kept clean and tidy to avoid breeding of mosquitoes and other insects. Suitable toilet facilities should be provided at convenient locations in the site and workers should be educated and warned warned that they should keep the site in a sanitary condition.

Site Administration

A well-organised administration is essential to enhance a proper installation. For large projects, the number of technical staff and workers warrant the administration to be based on site. This will give more direct and more frequent communication and supervision.

Equipment and materials delivered to site should be checked against the specification of the order as well as contract specifications. It should be examined for damages or defects before being stored or installed. Where there is special requirement for installation or connection these should be specifically pointed out to the technicians in-charge or electricians doing the installation. This may also necessitate the co-ordination with other trades. It will also be necessary to supervise, inspect and check that instructions are followed. This is one of the most important stage during which most of the installation can readily be checked and controlled for quality to ensure a safe installation. It is at this stage that a more realistic comparison can be made between the design criteria and the actual installation conditions.

As the work progresses, if the workmanship is carefully monitored, any deficiencies can be immediately pointed out and rectified. This avoids having to dismental installation after completion for inspection and reduces chances of hidden defects and waste of materials and manpower for rectification for sections yet to be installed.

Apart from co-ordination and quality control, and important function of the site administration is to keep proper records of the installation. Records of tests on the installation as the work is being carried out often provide useful information for the commissioning of the system. Record drawings are essential for the future servicing and maintenance of the installation. Records of progress are vital in the overall programming of the project. This is necessary to prevent a final mad rush for completion which often affects the quality of the work and thus the safety of the installation.

Testing and Commissioning

As a final reconfirmation fo the work carried out before handover a period of testing and commissioning of the system is necessary. Individual parts of the installation will have to be checked and compared with previous test records. This ensures that during the period after installation to the time of actual operation, equipment installed have not be affected by the environment or by other trades. Also the installation, as a system, should be checked for proper functioning. Here again, the tests should be properly analysed and recorded for future reference.

A point to note for these testing which is often overlooked is the accuracy of the test instruments. Very often a test instrument is purchased and used until it is physically damaged and not operational. Very seldom is a piece of test instrument checked or re-calibrated. This is usually due to the lack of regulation governing this requirement and the existence of only a limited number of such calibration laboratories in Hong Kong. Even these few calibration laboratories rarely publicise their services to encourage these procedures.

Servicing and Maintenance

After the system has been tested, commissioned and put to use, the present trend for most consumers is to take it for granted that nothing is going to go wrong. There is the requirement under the Supply Ordinance that the installation should be tested once every five years. Owing to the large number of installations, this has not been dutifully enforced. The installation is left to its natural deterioration. This is a dangerous state of affair although during the past two decades or so many of the installations out-lived the building itself, owing to the continual re-development in Hong Kong and th increased life span of the electrical materials and equipment. It is thus up to Electrical Contractors who have been called upon to do modification or repair works to take the initiative of advising the customers of the necessary improvements and re-instatements during the intervening years. Of course, for places of public entertainment, the Supply Companies, before their issuance of yearly Certificates of Stability, carry out tests and requires rectification work to be carried out. This greatly reduces the risks of faulty installation and electrical hazards whch could effect large numbers of people and expensive properties.

CONCLUSION

The Electrical Contractor, in carrying out their work properly and conscienciously, form one of the important links in the process of creating a safe installation. Unless this link is carefully and reliably forged, the efforts of detailed design before the installation as well as the stringent testing after the installation may come to waste. With this responsibility fully in our mind we together with manufacturers, designers and supply authorities have taken the challenge in providing a safe environment for the public. There have been electrical related accidents in the past, resulting in loss of lives and damages in properties but our records, we believe, are better than many neighbouring countries. However, let us not be complacent of our achievement and strive for better results through positive educationand increased responsible action.

APPENDIX I

LIMIT OF CONTACT VOLTAGE

AS A FUNCTION OF TIME

CONTACT VOLTAGE (V)	LIMIT OF BREAKTIME (S)
50	5
75	1
90	0.5
100	0.3
150	0.1
220	0.05
280	0.03

APPENDIX II

EXTENT OF DANGER TO THE HUMAN BODY BY DIFFERENT LEVELS OF EXPOSURE TO ALTERNATING CURRENT (I.E.C. PUBLICATION 479)