

THE HONG KONG
INSTITUTION OF ENGINEERS
ELECTRICAL DIVISION



The Ninth Annual Symposium

Electrical Profession Development —

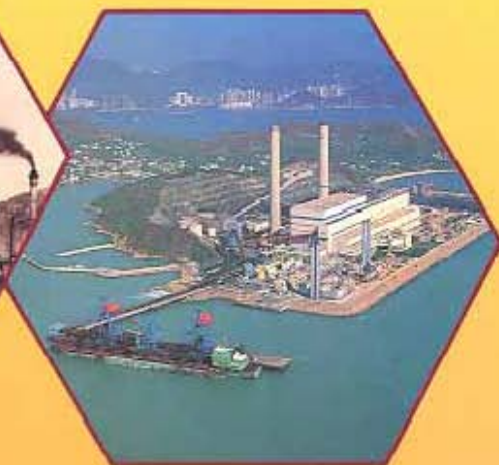
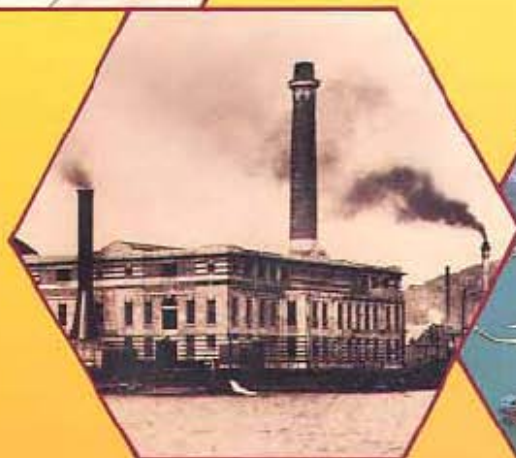


Review

and



Preview



Tuesday 22nd October, 1991



THE HONG KONG
INSTITUTION OF ENGINEERS
ELECTRICAL DIVISION

The Ninth Annual Symposium

Tuesday
22nd October 1991

*Electrical Profession
Development —
Review and Preview*

at

Silver Ballroom,
Sheraton Hotel,
Nathan Road,
Kowloon.

SYMPOSIUM PROGRAMME

- 08.30 Registration and Coffee
- 09.00 Introduction
— Symposium Chairman: Dr. C. C. Chan, FHKIE, CEng, FIEE

— Welcome by: Mr. P. H. Ho, MHKIE, CEng, MIEE, MIMechE
Chairman, Electrical Division, HKIE
- 09.05 Opening Address
— Mr. R. J. Blake, FHKIE, CEng, FICE, MIStructE
President, HKIE
- 09.10 Keynote Speech
The Impact of Information Technology on Electric Power System
— Professor Felix F. Wu
Department of Electrical Engineering and Computer Sciences, University of California, Berkeley,
U.S.A.

1. Education, Training and Management

- 09.40 Electrical Engineering Education in the 1990's
— Professor W. S. Leung, JP, Dean of Faculty of Engineering and Head of Department of Electrical
and Electronic Engineering, University of Hong Kong.
- 10.00 The Learning Engineer — Continuous Development to Maintain Competence and Competitiveness
in the 1990's
— Mr. Alfred S. P. Ho, Senior Advisor, Management Development Centre, Vocational Training Council
- 10.20 Discussion
- 10.45 Coffee Break
- 11.15 Human Resources Training for Matching the Technological Evolution — Power Transmission and
Distribution Environment
— Mr. Melvyn Mak, Training Engineer, The Hongkong Electric Co. Ltd.
- 11.35 Route from Engineering to Management
— Mr. F. K. Hu, CBE, JP, Chairman, Ryoden (Holdings) Ltd.
- 11.55 Discussion
- 12.10 Lunch

2. Technology Development

- 14.15 Disturbances from Electric Loads in Power System.
— Mr. C. K. Law, System Planning Engineer, China Light & Power Co. Ltd.
 Mr. C.C. Ngan, Planning Engineer, China Light & Power Co. Ltd.
- 14.35 Present Status and Future Plans in Electric Traction
— Mr. Ake Nilsson, Executive Vice President, ABB Transportation Management, Mannheim, Germany
- 14.55 Discussion
- 15.10 Coffee Break

3. Engineering Practice

- 15.30 Social Impact of Upgrading Local Supply Voltage
— Mr. K. M. Li, Deputy Chief Executive, Consumer Council
- 15.50 Conditions of Contract
— Mr. David Bateson, Partner, Jewkes and Partners
- 16.10 Discussion
- 16.30 Summing up:
— Symposium Chairman, Dr. C. C. Chan, Department of Electrical and Electronic Engineering,
 University of Hong Kong
- Closing Address
— Mr. P.K. Kwok, JP, Acting Director, Electrical & Mechanical Services Department

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Keynote Paper

**THE IMPACT OF INFORMATION TECHNOLOGY
ON
ELECTRIC POWER SYSTEMS**

Speaker: Professor Felix F. Wu
Department of Electrical Engineering & Computer Sciences
University of California, Berkeley, U.S.A.

THE IMPACT OF INFORMATION TECHNOLOGY ON ELECTRIC POWER SYSTEMS

The beginning of the second century of electric power system operation coincided with drastic changes in the environment in which it operates. The focus of this new era is on the improvement of economic efficiency through effective management of the integrated utility-customer system. At the same time information technology has advanced phenomenally and can be utilized to provide a comprehensive communication, computing, and control (3C) network operating in parallel with the power network for effective system management. Great challenges and opportunities in this merging of electric technology with information technology are outlined.

1. INTRODUCTION

The electric utility industry is undergoing an unprecedented transformation. The high price of oil, the safety problem of nuclear and the environmental problem of coal have turned around the economy of scale the industry has relied on for so many years to provide reliable service at declining costs. The resulting escalation of electricity costs has shattered consumer confidence in the way traditional electric utilities function. Some argue that the industry needs to be restructured through de-regulation or privatization to make it more competitive in order to foster economic efficiency. Competition from non-utility generation (co-generators, independent power producers, etc.) is introduced. Some argue that effective use of electricity through conservation and demand-side management is a better social solution than unchecked expansion. Direct customer load controls of air-conditioning and water heaters have been installed. Under pressure electric utilities are accelerating their automation effort to further improve operating efficiency and customer service.

Any of the above proposals to enhance the efficiency of supplying electricity to consumers would be unattainable if not for recent advances in information technology. In this paper such an integrated communication, computing, and control (3C) network covering from generation all the way to customers placed on top of the electric grid is envisioned. With the introduction of such a 3C network new functions that would enhance efficiency, conservation, and customer services may be inaugurated, some of which are speculated here. The merging of information technology with electric power system engineering will have enormous impact on engineering professional development.

The organization of the paper is as follows. Section 2 gives a brief historical account of power system developments. It is shown that we are entering a new era where improvements will come mainly from economic efficiency. Section 3 lists the components of this new power system paradigm. Section 4 reviews recent advances in information technology. Section 5 discusses what information technology as an enabling technology can contribute to future power systems. Some concluding remarks are included in Section 6.

2. HISTORICAL PERSPECTIVE

In 1882, Thomas Edison built the first electric power system in the United States on Pearl Street in New York¹. It was a triumphant result of his years of research in electric light bulbs. It was also the culmination of advancement in electric technology in previous years by many other inventors, including Joseph Swan in England, C. W. Siemens in Germany, etc. on dynamos, motors, switches, wiring methods, insulators, etc. Edison's power system was a DC system. In the ensuing years, Nikola Tesla made fundamental contributions to the development of AC system. George Westinghouse bought a patent on transformer design from Englishmen Garlud and Gibbs and had William Stanley improved upon it. The invention of transformer is a decisive event in the battle of currents. In 1891 Brown demonstrated in Germany that an efficiency of 77% can be achieved in a 110 mile long transmission system through a 30kV AC. Right after that, the decision of Niagara Fall generation system to go AC marked the beginning of the modern AC power systems. The period from 1880 to 1910 was characterized by innovation in apparatus and the development in power systems was strictly technology driven. It was an exciting time for inventors and entrepreneurs.



The next big event in electric power system perhaps was the one happened in 1920's when Sam Insull, who was Edison's business manager and by that time was the chief executive officer of a power company in Chicago, advanced the idea of regulated monopoly as a more efficient way of operating the power system. A monopoly derives its efficiency through economy of scales. For the next fifty years there was no fundamental change in technology, except that the generator size grew from kilowatts to gigawatts, the transmission voltage grew from ten kilovolts to a thousand kilovolts. As the result of interconnection, the role of system engineering became more prominent. This was actually a great time for power systems engineers — economic dispatch was invented, load frequency control was developed, and network analysis was advanced. In this period it was the business decision which led the technology development. The economic accomplishment in this period is phenomenal, the cost of electricity in 1970 was only one-sixth of that in 1882.

The energy crisis of 1973 and the subsequent events have changed all that, and the cost of electricity has more than doubled. The higher fuel costs, coupled with public opposition to new generation and transmission and government pressure for de-regulation, have made it impossible for electric utilities to do business as usual.

Although power system operation is extremely efficient as a result of years of engineering endeavors in the development of ways to improve dispatch, scheduling and control, some economists point out that the structure of the power industry including the pricing mechanism encourages inefficient production and consumption of electricity. The electric utility industry under traditional regulatory structure is one-sided, namely, supply-side oriented, and is ignorant or has ignored the potential contribution from the other side, i.e., the demand-side. Some believe that renewable energy sources are preferred than the large generators and should be encouraged. In 1978 the Congress passed the Public Utility Regulatory Policy Act (PURPA) mandating utilities to buy power from "qualifying facilities" at "avoided costs". PURPA opened the floodgate for non-utility generation. Ten years later FERC issued a Notice of Proposed Rulemaking (NOPR) in which generation bidding by independent power producers was promoted. Of course the privatization of Central Electricity Generating Board (CEGB) in UK around the same time shaken the electric utility industry throughout the world. With essential breakdown of monopoly by non-utility generation and bidding, transmission open access is seen as the next battleground by the advocates of de-regulation.

3. NEW PARADIGM

To meet the challenges of the new competitive environment, many power companies have adopted the strategy to move quickly to improve their operation in:

- overall operating effectiveness
- asset utilization
- customer service
- third party cooperation.

However, the public debate over the future of the power industry does not cease there. Many proposals, projections, and positions concerning utility industry structure, pricing mechanism, operating procedures, etc. advanced by various interest groups have been put forward. The very structure of the traditional vertically integrated generation, transmission, and distribution utility system is being challenged as a hinderance to competition². The privatization and reorganization of the industry in the U.K. have provided impetus to proponents of separate generation, transmission, and distribution entities. The believers of market economy suggest that power should be traded among suppliers and consumers with prices automatically adjusted to reflect the instantaneous costs. The so-called spot pricing would theoretically match the cost of supplying the electricity to its worth to the consumers, thus avoiding unnecessary waste³. Some proposals go even further suggesting that the pricing mechanism be used to match the consumer need of electricity in terms of quality. One such example is the priority pricing method in which the price of electricity is a function of the consumer's need for reliability⁴.

The debate is continuing. However, one thread common to all these proposals is the fact that, contrary to the last half century where the effort was in the improvement of engineering efficiency, in this new era the focus is on the improvement of economic efficiency of the complete chain of production, delivery and consumption of electricity. Both supply side and demand side are to be considered. Both the cost to the suppliers and the welfare to the consumers are to be addressed. The improvement of economic efficiency requires a new paradigm of power system operation. Central to this new paradigm will be the effective management of the integrated utility-customer system. To ensure both economic efficiency and engineering efficiency can be achieved, we need a new paradigm in which:



- There are many players in the production and delivery of electricity in the same service area.
- The decision-making for power generation and consumption is distributed throughout the system.
- These decision-makers are coordinated to ensure effective system operation.
- The system is operated to attain maximum engineering efficiency.
- The utility (suppliers) and the customers (consumers) cooperate in an integrated supply-side and demand-side management.

In this new paradigm, for effective operation of the system under distributed decision-making environment, it is required that there are:

- Timely collection of real-time data
- Comprehensive communication links to all customers
- Sufficient computing power throughout the system for real-time analysis
- Effective real-time control capability

This requires an integrated communication, computing and control (3C) system extending the whole power system and operating in parallel with the electrical power grid. This 3C system provides intelligence to the management of the complex power system of the future. In the next section we shall review the advances in information technology and discuss the feasibility of such 3C systems.

4. INFORMATION TECHNOLOGY

Recent revolution in information technology parallels the revolution in electric technology that took place at the beginning of this century. For example, in merely fifteen years following 1972 the capacity of memory chips rose 250-fold from a maximum of four kilobits to one megabits, while the price of the megabyte memory has fallen at least 1000 fold. A recent report by the Office of Technology Assessment predicts that changes in information technology will likely be as revolutionary in this decade as they have been over the previous one.

Computer chips with the capacity of performing several millions instructions per second (MIPS) have emerged in recent years. Tens of thousands of such processors are connected to form powerful parallel computers¹. Soon we will be talking about TIPS (trillion instructions per second). Equally impressive advances have been made in communication technology, fiber-optic communication systems running at gigabits per second (Gbps) rate, with the potential of going to terabits per second (Tbps), are replacing today's microwave radio at megabits per second (Mbps) speed.

Networking geographically distributed computers to work in a concerted way for control of large systems or other tasks is the trend in information technology to take advantage of the phenomenal success in computer and communication technologies. Today's communication networks make it possible for computers to share computational resources and to exchange data. Local area networks (LAN) connecting hundreds of personal computers and workstations within several kilometer range carrying data up to 10Mbps are commonplace in business, factories, and campuses. In these networks messages are blocked into smaller units called packets. Packets move like mail across a network. In a 10Mbps network, for instance, to transmit a one kilobyte packet takes 800 microseconds. For longer distance wide area networks have slower speed, thus, it will take 40 msec to transmit a 1 kbyte packet in a 256 kbps circuit. However, as mentioned above, communication technology is progressing rapidly. Over the horizon are the more powerful systems, such as the fiber distributed data interface (FDDI) and the distributed queue dual bus (DQDB), designed to cover more than 100 km with the capacity to carry data at 100 Mbps or higher. To take advantage of the distributed processing environment, in the future, a program may be decomposed into separate components, called procedures, which may be remotely executed in different computers and the system may balance the load of the computers by moving a process to an idling computer.

The de-regulated telecommunication companies, realizing the great opportunity in future information business, are aggressively pursuing the installation of the integrated services digital networks (ISDN). The basic ISDN connection provides a subscriber with three full-duplex (two-way) connections: two with a rate of 64 kbps and one with a rate of 16 kbps. The 64 kbps channels can transmit voice or computer data and the 16 kbps channel can transmit alarm, monitoring information, or control signals for lights and appliances. Research is being conducted on broadband integrated services digital networks (BISDN), which will provide subscribers with channels at 150 Mbps that are possible to carry high definition television (HDTV) signals. BISDN is viewed by many in the telecommunications industry as the network of the future.



The 3C network that is needed to operate in parallel with the electric network in the new paradigm of electric power system is thus entirely feasible with existing technology and is compatible with the trend in information technology. By the time the 3C system is deployed the information technology will be further advanced that there will be excess capacity in the 3C system to perform other tasks. Some electric power companies have realized the strategic advantage of having access to every household and the potential in future information services, and are pursuing research along this direction. For example, Southern California Edison Company has a demonstration project called NetComm with smart meters⁶ and Kyushu Electric Company has a demonstration project using fiber-optic links to the customers⁷.

5. IMPACT ON POWER SYSTEMS

Information is a valuable commodity⁸. With a 3C system operating alongside with the electric power system, the availability of real-time information will make power system operation more effective. The fact that the system extends to all customers makes it possible for electric utility to offer additional information services, in competition with or in cooperation with other information companies. Here we speculate some of the impact of this enabling technology will have on the electric power system.

The real-time information of the generation system will assist the operators of the plant to operate the system more efficiently. More and more information will be presented graphically, i.e. image-based rather than character-based that have been imposed on the operators by the engineers. Microsensors together with image processing techniques will be used for the detection of mechanical problems in generators such as metal fatigue or cracking in turbine blades.

The impact of the 3C system will be more pronounced in the operation of the transmission system under distributed decision making environment. Traditional economic dispatch adjusts the output of each generator to minimize the total fuel cost and the security of the system is maintained by having adequate reserve generation strategically distributed throughout the system. Power system security refers to its ability to withstand disturbance. It is still possible to minimize overall fuel costs and at the same time maximize overall welfare of the consumers in a distributed decision making environment using spot pricing of electricity³. The maintenance of system security is a more difficult problem. However, a scheme has been developed in which two types of information is provided to all generators and consumers: (i) the value of the generation reserve at the location, and (ii) the amount of generation reserve needed from the system at the location in case of a disturbance and it is shown that it is possible to maintain system security in an environment where each participant is only attempting to maximize its own expected profit if the above-mentioned information is provided and used⁹. In other words the information technology makes it possible to enhance economic efficiency (maximize individual profit or welfare) without losing engineering efficiency (economic dispatch/ security control). The 3C network with its distributed processing capability will fulfill the desire for on-line dynamic security assessment, thus greatly improving the capability for more power transfer and less stringent limit of transmission loading¹⁰. Utilities, independent power producers, and consumers can cooperate using timely data flowing through the 3C network to achieve better overall efficiency in the production, delivery and consumption of electricity. We have seen that energy management systems for transmission system control¹¹ are already moving toward distributed processing and open system architecture¹².

The distribution system can be fully automated using the 3C system. Integrated capacitor/voltage control¹³ and feeder reconfiguration¹⁴ can be employed in real-time to minimize losses and to balance the loading of transformers, i.e. to make the system operate more efficiently. With continuous monitoring, faults can be detected more quickly and their locations can be pinpointed more precisely. System restoration can proceed more effectively¹⁵. The nature of the distribution system dictates that the processors in the 3C network be geographically spread out throughout the service territory, distributed asynchronous computation algorithms need to be developed¹⁶.



The 3C system will drastically change the utility-customer (supplier-consumer) interaction. Utilities can provide such customer services as being discussed today: real-time pricing, direct load control, remote metering, customer load survey, theft detection, remote connect/disconnect, etc. Furthermore, utilities may market electricity differentiated by quality and consumers choose according to their need, for example, one measure of quality may be voltage fluctuation and a consumer may choose a lower quality electricity (more voltage fluctuation) at a lower price for his heater than another consumer who needs a higher quality electricity for his computer¹⁷. Consumers will have their own energy management and control systems (EMCS) to control their appliances for efficient usage¹⁸. Utilities may also provide such services as appliance efficiency monitoring, security alarm, etc. It is not inconceivable that load forecast information will be provided to both generators and consumers to assist them to plan their generation and consumption much like the weather forecast information is used today by the general public to determine what to wear and do.

6. CONCLUSION

The electric power system is going through a metamorphic transformation. Information technology is undergoing tremendous expansion. We are at a juncture where the two are converging and merging. We envision a communication, computing, and control (3C) network operating alongside with the power network to ensure the improvement of economic efficiency without sacrificing engineering efficiency. The orderly flow of information in the integrated 3C network assists effective management of the overall production, delivery, and consumption of electricity in the society.



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Paper No. 1

ELECTRICAL ENGINEERING EDUCATION IN THE 1990's

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ELECTRICAL ENGINEERING EDUCATION IN THE 1990's

Paper
No. 1

BACKGROUND

In the dictionary, electrical engineering is defined as the art of executing the practical application of the knowledge of electricity. While Luigi Galvani produced electricity accidentally in the form of a by-product in a chemical experiment as early as in 1772 and Michael Faraday produced electricity by moving a coil in a magnetic field back in 1831, electrical engineering as a profession and an academic discipline in education actually did not get off the ground until Thomas Edison in the early 1880's succeeded in commercially exploiting the electric incandescent lamp which subsequently became the standard light source in the world. Lighting was therefore the first major practical application of electricity, and it effectively gave birth to the electrical engineering as a profession. The next major practical application of electricity was the conversion of electricity into mechanical power by motors and into thermal energy by electric heaters. These are all energy-related applications of electricity which formed the basis of electrical engineering during the first phase of the development of the profession. In education, electrical engineering in the early years was primarily concerned with the conversion of electricity into light, heat, mechanical energy, chemical energy and vice versa where applicable.

SCOPE

During the first half of the twentieth century, techniques were developed to use electricity to transmit information over long distances in the form of sound, vision and printing. This is an information-related application of electricity which for some time was described as electronic engineering or light current engineering. At the same time the original energy-related application of electricity was re-named as power engineering or heavy-current engineering. Until a decade ago, the curriculum of a power engineering programme was rather limited in scope and contained only sufficient fundamentals of electronics to enable students to study control techniques in power systems. With the advent of computers and other Hi-Tech devices since the mid-1970's, the information-related application of electricity not only transmits but also processes and stores information. The area of information-related application of electricity has thus taken on an entirely new dimension and a number of new academic disciplines have been set up in universities all over the world. Electrical engineering, in its broad sense, embraces not only power engineering and electronic engineering but also computer engineering and information technology. In this paper the term, electrical engineering, is taken in its narrow sense to mean the energy-related application of electricity.

A BROADER PROGRAMME

As we move into the 1990's, the narrowly-based power engineering programme is replaced by the more broadly-based electrical engineering programme which covers five major types of energy-related systems, i.e. electro-electrical, electro-mechanical, electro-thermal, electro-optical and electro-chemical systems. An electro-electrical system is one which converts one form of electrical energy into another. Any one of the above five systems will contain electrical and non-electrical devices. The curriculum of such a programme should cover the system, which is usually of an electrical nature, the electrical devices and operating principles of the major non-electrical devices. The basic difference between the past power engineering programme and the present electrical engineering programme lies in the fact that information-related application of electricity which was practically absent in a power engineering programme now constitutes a substantial portion of an electrical engineering programme. This is the result of the wide-spread use of computers in energy-related systems. While information technology without the computer was mainly concerned with communication of information, computerised information technology has a much wider scope of application because information is being processed and manipulated in addition to being transmitted from one location to another. In a way, an electrical engineer of today is more of an all-rounder compared with the power engineer of yesterday. An electrical engineering programme should therefore begin with information technology which is commonly used in all the five major types of electrical energy-related systems mentioned earlier.



INFORMATION TECHNOLOGY

The function of a computer, which is now an integral part of most energy-related systems, is not only to monitor information but also to process and send it to various parts of the systems as command signals. A substantial portion of an electrical engineering programme has thus to be devoted to information technology. The information technology relevant to the electrical engineering profession are the subjects of Numerical Methods for Computer Applications, Computer Programming Techniques, Computer Graphics, and Computer Control. Since computerised control in a system is often of a remote nature, it is also necessary to include the subject of Computer Communications in the curriculum of an electrical engineering programme. This leads us on to the curriculum of the five major types of electrical energy-related systems.

ELECTRO-ELECTRICAL TECHNOLOGY

There are basically two sources of electrical power, namely low-frequency a.c. power from power stations and d.c. power from batteries. Today the application of electricity is so diverse that electric supplies of a wide range of frequencies, i.e. from d.c. to the frequency of light, are required. Moreover, electric voltages different waveforms are also needed in a variety of applications. This part of the electrical engineering programme, which covers transmission and conversion systems, will include such topics as high-voltage technology, voltage transformation, switching, rectification, inversion, frequency regulation, pulse technology, control engineering, etc.

ELECTRO-MECHANICAL TECHNOLOGY

The two basic electrical devices in electro-mechanical technology are the motor and generator (or alternator). These are traditional topics in the power engineering programme that are to be kept in the new electrical engineering programme. In the case of power generation, electrical engineering students should also learn about the principles of operation of steam and diesel turbines. In the case of the motor, there are now several new trends. Firstly, the increase of motorised electronic systems has precipitated the need for precision motors, such as stepping motors. There is therefore a need for students to learn about different types of micro motors. As the motion of micro motors has to be controlled with precision, it is necessary to bring the subject of Motion Control Systems into the curriculum. Secondly, in order to match a motor to its load, an electronic control or regulation system is now often incorporated into the motor as part of a drive system and the subject is known as Mechatronics. More and more motors appear now as parts of mechatronics systems which possess the combined characteristics of motors and their control systems. It is therefore necessary to include the subjects of Mechatronics, Automation and Robotics in the curriculum of an electrical engineering programme. For a number of years, the number of electric trams and trolley buses in use were on the decline with the result that Traction as a subject was dropped in the power engineering curriculum in many universities. Now that electric trains are replacing the steam-engine and diesel-engine trains, there is again a case for electrical engineering students to study some elements of traction. Finally, the characteristics of certain common motor loads, such as pumps, compressors, fans, machine tools, etc. should also be taught in an electrical engineering programme.

ELECTRO-THERMAL TECHNOLOGY

In a power station, thermal energy is indirectly converted into electricity via mechanical energy. Some knowledge of fossil and nuclear fuels, combustion and boilers will be useful to an electrical engineering student. With the rise in the use of air-conditioning in buildings, the operation of air-conditioners should be included in the curriculum of an electrical engineering programme. Superconduction of conductors and semiconductors is another area which holds great promise of development in the decade ahead. Following the breakthrough in 1986 by Bednorz and Miller who discovered that a La-Ba-Cu-O system of semiconductors could become superconductive at 30 K, the current state-of-the-art superconductive temperature has been raised to over 100 K. Superconduction should now be introduced into the curriculum of an electrical engineering programme. Finally, electrical engineering students should also learn about the thermal properties of dielectric and insulating materials as well as thermal sensors and transducers in the subject of Material Technology.

ELECTRO-OPTICAL TECHNOLOGY

In recent years, there are many more types of gaseous discharge lamps for different applications. Lighting has become a sufficiently complexed subject to warrant its inclusion in the curriculum of an electrical engineering programme. In some computerised control systems for electrical energy-related applications, there are optical cables for communications and optical sensors for detecting motion, etc. It will be useful for electrical engineers to have sufficient knowledge on properties of optical devices. The exploitation of solar energy is another potential development area in electrical engineering in the 1990's. Great strides have continually been made in the discovery of new semi-conductor materials for use in solar cells with higher and higher efficiencies. Properties of such semiconductors as silicon and gallium arsenide are suitable topics for inclusion in the subject of Material Technology for electrical engineering students.

ELECTRO-CHEMICAL TECHNOLOGY

There is now a large family of dry and storage batteries for use in various electronic equipment. The electrodes in these batteries are different and so are their chemical reactions. An understanding of the principles of operation and properties of the various types of batteries will be a big advantage to an electrical engineer. There is currently a school of thought that the electric car will be the car of the future pending a breakthrough in battery technology. Intensive efforts are being made at present in different countries in the world in research and development to produce a battery with a sufficiently high power-to-weight ratio and a sufficiently short charging time to make the electric car a viable substitute for the conventional motor car. Some time during the next decade, the curriculum of an electrical engineering programme will have include not only more battery technology but also battery management systems. Electro plating of different metals is another application of electro-chemical technology that can usefully be included in the curriculum of an electrical engineering programme.

ENVIRONMENTAL TECHNOLOGY

The continual increase in the population density in many parts of the world has dictated the protection of our living environment from being polluted by the electrical industry. Knowledge of air and thermal pollution from a conventional power station and that of radiation pollution from a nuclear power station will be necessary for a power station engineer. It is also important for an electrical engineering student to study pollutions created by noise and vibration in connection with driving systems and large transformers. There are also pollutions created by electromagnetic fields in connection with high-voltage transmission and switching surges. The discharge of waste materials from an electro-chemical plant constitutes a serious environmental problem and the waste materials have to be properly treated and disposed. The effects of these pollutions and the measures taken to reduce them are all relevant topics in the subject of Environmental Technology in an electrical engineering programme.

GENERAL STUDIES

Before commencing on an electrical engineering programme, students are expected to have learned sufficient physical fundamentals relevant to the programme. However they will require to learn more advanced mathematics as part of an electrical engineering programme. Mathematics for electrical engineers has to be adapted to meet the changing need of the profession. Some of the classical topics in mathematics have to be curtailed to make room for Computational Mathematics, Simulation Techniques, Statistical Methods, etc. Material Technology, which was mentioned in a number of energy application areas earlier, is another foundation subject to be taught in the first year of the programme. The subject of "Engineer in Society" in the old power engineering programme is rather vague. In the electrical engineering programme this subject should specifically include such topics as communication skill, human relations, organisation, management, contract laws, economics, etc.



FUTURE TRENDS

Looking ahead, a number of areas of development and research in electrical engineering appear on our horizon. There is no doubt that more and more computers will be incorporated into electrical energy-related systems. Research efforts will be intensified in search of new semiconductor materials that will lead to new breakthroughs in superconduction and solar energy. Improvements will be made on the dielectric properties of insulating materials and on the conducting properties of certain inert gases. There will be accelerated research programmes on batteries and in particular on storage batteries suitable for supplying electric vehicles on which research will also proceed in parallel. Research work will also be undertaken to reduce environmental and health hazards produced by devices and systems related to electrical engineering.

CONCLUSION

In the last couple of decades, the big majority of engineering students have been fascinated and attracted by Hi-Tech and almost all of them have chosen to study electronic and computer engineering. As a result, power engineering has become very unpopular with students in spite of the good job market in the profession. The unpopularity is partly due to the fact that the curriculum of the traditional power engineering programme was relatively narrow. One gets the impression that power engineering entails electrical power supply, electrical machinery and not much else. Educationists and industrialists all over the world have been concerned about the decline of student interest in power engineering resulting in an acute shortage of personnel in the profession. In order to remedy the situation, the programme of power engineering, preferably re-named as electrical energy systems engineering or simply as electrical engineering, should be substantially broadened to include all electrical energy-related systems. Since the curriculum is based on systems, computer technology and communications have to be brought into the programme which will then contain a large portion of Hi-Tech. It is hoped that with its Hi-Tech contents and diversity, the electrical engineering programme will gradually regain some of its lost popularity. I am certain that this is the way forward for electrical engineering education in meeting the challenges that lie ahead.



Paper No. 2

**THE LEARNING ENGINEER —
CONTINUOUS DEVELOPMENT TO MAINTAIN COMPETENCE
AND COMPETITIVENESS IN THE 1990's**

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THE LEARNING ENGINEER — CONTINUOUS DEVELOPMENT TO MAINTAIN COMPETENCE AND COMPETITIVENESS IN THE 1990's

Engineers and managers alike today are facing challenges posed by the increasingly turbulent operating environment. New business avenues are being opened up, and new orders are being established. To cope with this new situation one has to continuously develop oneself, both longitudinally within one's own profession and technical specialty, as well as laterally into related areas that previously were separate disciplines. Continuous development is the means to enable engineers and managers to maintain their competence and organisations to sustain their competitiveness. The concept of continuous development should be instilled into the mind of every individual and its value should be inculcated throughout the organisation to form an integral part of the organisation's culture. Some of the development tools and approaches available are discussed in this paper.

THE FUTURE SCENARIO

The 1990's will be the most challenging era for most nations. It will be marked by increasingly turbulent situations, both within the developed, developing and under-developed countries. Religious ideology has given way to secularism. Totalitarianism is being replaced by rationalism and humanism even in nations where the authorities have had deep-rooted traditions. Peaceful co-existence and collaboration are winning favour over political antagonism among most countries. New international order is now taking shape. On the international trade front, the future pattern will be characterised by greater international and regional specialisation and division of labour, increasing regional protectionism, higher uncertainty, and greater amplitude of fluctuations in exchange rates and interest rates.

As an international city pursuing free enterprise ideology and free port policy, Hong Kong will be exposed forefront to this new operating environment. Much of the above have been occurring a number of years ago. As the society develops the service industry has now become the leading economic sector in Hong Kong, and its labour force is growing at the expense of the manufacturing sector. Driven by escalating labour costs and land costs more and more manufacturing operations are now moving into China. Hong Kong manufacturers now employ directly and indirectly about 3 million labour forces in south China. The entrepot trade was once the key economic activity of Hong Kong (in the forties up to the early sixties). It diminished drastically in the late sixties as Hong Kong quickly became a low-cost manufacturer and exporter. Now it has again revived its full status. Alongside with these changes, the trade partner make-up of Hong Kong has also changed drastically. USA and Europe have long been Hong Kong's main customers. With the opening up of China, our future sovereign has overtaken USA and Europe as our leading trade partner. Foreign investment in Hong Kong is also changing. British and American investments in Hong Kong are now being quickly surpassed by Chinese and Japanese investments. The number of enterprises with foreign interests is quickly increasing. Coming along with this is the change in the management policies and practices. A new breed of Hong Kong-Chinese, Hong Kong-Japanese, Hong Kong-Singaporean, ... style of management is emerging.

Few managers these days can neglect what are going on elsewhere in the world, disregarding whether their markets are concentrated in Hong Kong or overseas. As Hong Kong companies grow big and have to diversify their businesses overseas, more foreign companies are coming here to exploit the local market and the market potential posed by the "Pacific Rim". So certain lines of business previously enjoying almost monopoly status are now facing threats of powerful new comers with international backing. Diversification overseas is not only confined to conglomerates. There are also a large number of medium-sized firms setting up operations in other countries. Some do this to spread out their political risks. Others do this to control their production costs. Yet others do this to take advantage of the export quota (or no quota restrictions) of the host countries. Even small manufacturers these days also move their operations into the Pearl River Delta area while keeping their Hong Kong offices and staff teams to look after the research, marketing, finance and other trade facilitation functions.

Open competition coupled with advances in information technology also make doing business in Hong Kong the most sophisticated game in the world. One can easily and economically employ tele-conferencing, electronic data interchange (EDI), and other forms of high-speed and high-density data links to keep in touch with the world. Business bosses who have emigrated (temporarily in most cases) can maintain almost full control of their businesses in Hong Kong through these telecommunication services. Hong Kong has the world's highest density of radio paging penetration (13%); it has the second highest density of fax machine installation (after Tokyo) in the world. One can, of course, go on further on this list.

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In a nutshell, in the 1990's we will be living and operating under an increasingly turbulent and uncertain new era characterised by increasing internationalisation, intra-regional co-operation, inter-regional competition, and technological sophistication. And, in Hong Kong we face an additional dimension: that is, the 1997 change of sovereignty factor.

THE MANAGEMENT IMPLICATIONS

Engineering managers, like any other professionals, are subject to the same challenges. They must keep their eyes open of developments external to their own areas of engineering specialisation, their profession, and their geographic areas of operation. Just take for example, as Hong Kong is moving ahead with its grand multi-billion dollar infrastructure construction project, local engineers will have to take into account of developments elsewhere to gauge the possible influences on materials, labour and project management expertise supply and costs.

Taking a micro look at the engineering profession, the advances in information technology and the ever-penetrating applications of micro-electronics and micro-processors are quickly changing every stream of engineering. The successful exploitation of these developments requires very close collaboration between science, technology and engineering. We are moving from an industrial society" to an "information society". Advances in these areas have not only eliminated time and the geographical barriers that used to limit information flow and management decisions, but have also changed the way in which many companies run their basic business operations. Engineering managers have to recognise what are happening and cope with it. Engineering managers' challenges lie in the successful introduction, implementation and the management of current technology and technological innovations.

From the above it becomes obvious that these new frontiers and challenges demand concepts, knowledge, and skills not previously taught in schools nor trained in businesses. Unprecedented changes and innovations are rendering concepts, knowledge, and skills learned before no longer relevant, valid, and useful. Disregarding level, seniority, areas of specialisation, and age, everyone has to continuously keep himself up-to-date, develop himself to maintain his effectiveness. Continuously facing new challenges will become a part of everyday life. One has to keep alert, flexible, mentally open and receptive of new ideas and practices. To be effective managers, they have to develop themselves fully, focus on their own personalities, maximise their strengths and minimise their weaknesses, and exploit their personal interests.

WHAT DO ENGINEERS NEED?

To determine engineers' development needs, let us first look at the work content of engineers. There is yet no published study on this particular aspect in Hong Kong. Research findings overseas on this topic may help throw some light on the picture. A study on a representative sample of professional engineers in New Zealand in 1989 found that 58% of their time was spent on management tasks. The average time spent on engineering tasks only accounted for 35% of their time. Budget, profit and cost were their major responsibility areas, and most of them were responsible for the management of engineering staff.¹ In another survey conducted in the United Kingdom, employers were asked what importance was given to certain qualities in promoting engineering graduates to a management position. It was found that 95% of them mentioned 'people management', 90% cited 'communication skills', and 87% suggested 'interpersonal skills'. The more 'technical' oriented qualities such as 'technical awareness', 'profit/efficiency', 'innovative skills' and 'training undergone' accounted for only 85%, 80%, 77% and 68% respectively.²

Being a qualified and experienced professional engineer does not automatically guarantee a competent manager. The management of human beings, be they subordinates, peers or superiors, demands concepts and skills quite different from the design, implementation and control of technical aspects of operation. The transition of an engineer to a managerial position is usually one of the most difficult to accomplish. Engineers promoted to management often encounter unique difficulties because of their particular level of training, background, personality traits, exposure and experience.



The more important problems associated with this transition have been summarised as follows:

- (1) People generally need more time and attention compared with problems relating to technical matters.
- (2) The manager has to deal with a broader set of uncertainties. And, further, the problems now deal with unfamiliar subjects such as finance, marketing, organisational structure, and politics.
- (3) Matters of budget, personnel and allocation of other resources may mean the difference between success and failure of a division or even the entire organisation.
- (4) The overall profitability of the organisation now requires immediate, decisive, and proper attention as they affect and involve the engineering function.³

Put it simply, the skills required of an engineer (as a specialist) and a manager (as a generalist) are significantly different.

In order to successfully undergo the managerial transition and succeed in the new management position, Koza and Richter suggest that an engineer must at least possess: (1) a broad organisational outlook, (2) an understanding of its operations, (3) people-relating skills, (4) communication skills, and (5) some knowledge of specific businesses areas such as marketing and finance.⁴

The New Zealand study mentioned above found that the six top ranking management subjects suggested by professional engineers are mostly people- or behaviour-oriented skills (personal and interpersonal). The balance was made up of finance and accounting, and project management.

The above findings are not unique to a single country. In fact these topics have been the subjects of many articles, papers and research reports in Australia, Canada, the United Kingdom and other European states.

These findings closely resemble the key management competence areas proposed by the Council for Management Education and Development of the United Kingdom under its Management Charter Initiative (MCI).⁵

THE DEVELOPMENT OPTIONS

By far the most common development path for one to pursue is to follow the traditional approaches. An ideal combination for an engineering manager designate is to possess a professional engineering qualification plus a post-graduate qualification in management, either acquired immediately upon graduation, or, even better, pursued through part-time study while working.

There are ample choices for young engineers in Hong Kong. The tertiary educational institutions in Hong Kong all offer part-time post-experience diploma in management studies (DMS) programmes and diploma and certificate programmes in specific fields of management. The City Polytechnic of Hong Kong also organises a post-graduate diploma in engineering management to cater for the particular development needs of local engineers. Higher up the award hierarchy there are numerous master in business administration (MBA) programmes, offered in full-time and part-time modes, in-campus or by distance learning. Some of these are organised by local tertiary institutions independently or in collaboration with overseas colleges; while others are administered and supported by private training operations.

For a shorter duration and concentrating on specific topics, there are hundreds of short management courses organised by the extra-mural studies departments of local tertiary institutions, professional training organisations, and independent training consultants.⁶ Of course, depending on the scale of development and organisational resources in-house management courses can also be organised.

No formal management training can replace systematic on-the-job training within the engineers' own organisations. Unfortunately the term 'on-the-job' has been too loosely used by many companies, sometimes just meaning that employees are simply left alone to learn from their day-to-day work.



Effective on-the-job development should begin with some form of selection and assessment process for identifying candidates and planning for their career paths. A senior manager who is experienced and familiar with the candidate's work should be assigned as the 'mentor' of this candidate extending personal guidance and advice on relevant issues over a period of time.

During this period in-company development opportunities should be arranged. Within any organisation, there are ample grounds for developing the management competence of individuals. In a study of the in-company management development practice of Hong Kong companies, the Management Development Centre of Hong Kong (MDC) has identified 11 related corporate activities that bear development values and 22 individual development activities (see Appendix)⁷. With proper planning and appropriate arrangement, most of these activities can in fact be implemented as part of everyday business operation. Of course, these 33 options may not exist in every company. However, any company, big or small, will be able to offer some of these opportunities to its employees if the management so desires.

There are also a number of newer approaches that are winning interests in Hong Kong. By using assessment centres, companies will be able to objectively measure the level of competence of individuals, their strengths, adequacies and limitations, as well as how they are perceived by others. Once the individuals and their employers have accurately identified their strengths and weaknesses, development can then be planned. Many people are aware that assessment centre techniques originate from western cultures and therefore question their relevance to the local context. Extensive studies and experiments have been undertaken by MDC over the last few years and a set of assessment tools measuring six basic management skills is now made available (free) to local businesses.

A field-proven management development approach that is particularly relevant to the development of engineering managers is through action learning. Learning is found to be most effective through acting and reflecting upon the consequences. Traditional learning is mostly achieved through assimilating programmed knowledge. In action learning the trainee develops through exploratory questioning and reflection. The action learning approach employs group interaction techniques to enable trainees learn from each other's experiences, be they successful or otherwise. Each of the participants within a small learning group (called 'set') has to bring along with him an issue to study and solve in the form of a project. This project should tackle a real issue, preferably be outside the normal scope of the trainee and of a high enough level (divisional or corporate, policy-related or strategic) to be of developmental value. Each participant should also be supported by a 'sponsor' with his organisation, who can be his superior or one that 'owns' the project (i.e., have direct interest in the project under study). In the group sessions, participants report their project findings and proposed solutions while other participants help critically assess the validity of the data and views and contribute ideas arising from their respective exposure and experiences. 'Set advisers' (the group tutor) will act as the facilitators in sessions, stimulating thoughts, guiding participants along in their discussions, and controlling (e.g., avoid too much side-tracking) where necessary. By exposing one in a foreign environment (e.g., engaging in a task different from one's day-to-day duties, and/or exploring within a strange organisational setting), this development method has proved to be highly effective in developing general management competence, broadening managers' perspectives, and promoting balanced and all-rounded deliberations. In view of the characteristics of engineering work, this development method is particularly useful.⁸

Planned self development activities such as selected readings and using self-paced learning packages can also be a low-cost and yet effective development approach. Large number of multi-media (e.g., workbooks with audio cassettes and/or video tapes) learning packages and computer based training (CBT) programmes are available in the market. (While most are designed and produced by overseas institutions, MDC has developed for Hong Kong companies a few sets of multi-media packages and CBT programmes in management, in both English and Chinese.) As these distance learning materials can be used by individuals alone at time and place that they feel convenient, and proceed at their own pace, they are particularly suitable for technically-oriented personnel. Management basically deals with people, so these distance learning materials are not substitutes for face-to-face classroom and group sessions. However, they can be cost-effective management primer for learning the basic concepts and skills to get better prepared for real-life human interaction in classrooms or in the work place. Furthermore they can also serve as readily available reference or revision materials after they have finished their classroom sessions.

The above few of course are by no means exhaustive of the development possibilities that companies may adopt. They are listed here more as thought-provoking ideas.



THE LEARNING ORGANISATION

The concept of "the learning organisation" is relatively new. It stems partially from the growing awareness of organisations, even very large multi-national corporations, that they have to face the environmental changes like anyone else these days. The emergence of "intrapreneurship" practices within these organisations are good evidence showing their recognition that they can learn and be benefited from the entrepreneurial nimbleness and creativity of their staff.

A concise definition of the learning organisation is 'an organisation that facilitates the learning of all its members and continuously transforms itself.'⁹ The learning organisation is not one that just provides a lot of training. Perhaps the words of Paul Marsh of Jaguar Motor Car can best illustrate what it is:

"it's about a company, as a priority objective, developing all its human resources, enhancing all their skills...but not being content with that...learning from those people how the company can be improved...so that it becomes a cycle of learning."¹⁰

Professor John Burgoyne has said: "An 'excellent' company is excellent; a 'learning company' stays excellent." To remain competitive and excellent, organisations have to move towards this direction now. As a prerequisite, organisations must show the will to develop their staff; and those in management, from first-line to those at the very top, must open themselves to continuous self development. Development is no longer the sort of things for the juniors and the new comers". Management has the responsibility to ensure that the corporate culture and management style are supportive to development, and that facilities are widely available.

While sponsoring staff to take up external training and establishing in-house training programmes are useful in helping staff to develop themselves, it is not the whole picture. The management of the company has the responsibility to cultivate and maintain a corporate environment that encourages continuous development. Opportunities must be provided for people to try out what they have learned. Nothing is more frustrating than raising people's expectations and then depriving them of the actual opportunities. A company investing in the development of staff but not utilising them effectively will only ensure one thing — high staff turnover.

CONCLUSION

Organisations can only achieve and maintain their competitive advantage through management development. The need to do this is ever pressing because the emergence of more dynamic and turbulent environments means that organisational performance is more heavily dependent on the quality of managers than it has ever been before. We have moved from the old order that was production oriented, efficiency based, operating under stable structures, and managed by functional based personnel, into a new order that is market oriented, entrepreneur based, functioning under changing structures managed by effective inter disciplinary work teams. Change is now the rule rather than exception; and the key to continued success lies in the most flexible organisational asset — people, people of quality. And, it is continuous development that maintains and heightens people's, and in turn, an organisation's quality.



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Appendix

Checklist of Management Development Activities

Related Corporate Activities

Determination of corporate business objectives and strategies
Major corporate issues and problems
Corporate development/reorganisation needs
Organisational development
Corporate manpower planning
Management succession planning
Special selection and recruitment procedure for managerial staff
Management by objective
Employee appraisal system
Management development and training policy
Resources for management development activities

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Development Activities

Structured management development system or programme
Employee career planning
In-house trainee programmes
In-house training courses
Sponsorship of external training courses
Sponsorship of external memberships and appointments
Acting appointments
Branch/site visits
Special projects
Committee or task force assignment
Presentations to senior management
Coaching or counselling employee
Mentoring



Management open door policy

Management or staff meeting

Job enrichment schemes

Management induction programme

Job rotations

Assistant or associate manager

Floater positions

Trainee positions

Secondment to other organisations



Paper No. 3

**HUMAN RESOURCES TRAINING FOR MATCHING
THE TECHNOLOGICAL EVOLUTION — POWER TRANSMISSION
AND DISTRIBUTION ENVIRONMENT**

Speaker: Mr Melvyn Mak
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HUMAN RESOURCES TRAINING FOR MATCHING THE TECHNOLOGICAL EVOLUTION — POWER TRANSMISSION AND DISTRIBUTION ENVIRONMENT

SYNOPSIS

Continuous growth of Hong Kong's economy in the past two decades has induced rapidly increasing demand for electricity in the region. At the same time, reliability of supply has become increasingly important to power system operators in line with the higher expectation of the society. The Hongkong Electric Co. Ltd. has posed to meet such demands by expanding its capacity and at the same time effectively upgrading its system equipment and apparatus. This has been achieved by introducing new technology and bringing in improved designs, new techniques and work methods for the purpose of enhancing efficiency and improving system security and reliability. With these rapid changes of system requirement and a very mobile work force, it is essential that effective training must be provided for all levels of engineering staff.

This paper is to present an overview of the major training undertakings geared to meet the evolution of technology and the introduction of new apparatus and techniques for power transmission and distribution activities in the recent years. Areas of coverage embrace the training philosophy/methodology for various grade/level of staff members, viz. engineers, assistant engineers, technicians and tradesmen, and the development of target-oriented training courses, training programmes and trade tests etc. for training employees for them to acquire new skills and knowledge in the installation, operations and maintenance of new low and high voltage system apparatus. Some interesting cases will be illustrated such as training of craft and technical employees for the new jointing technique of high voltage and low voltage cables, 132kV XLPE cable terminations, overhead lines, SF6 distribution gear, etc. The paper also includes a description of tailor-made authorisation courses for training of qualified competent and authorised persons for working in the high voltage systems in accordance with the Company's Safety Rules; and the technical seminars to enrich younger engineering staff in their knowledge and experience of system apparatus and design concepts for all voltage levels up to 275kV.

Paper
No. 3

1. INTRODUCTION

It is commonly accepted that technical institutes, polytechnics and universities should provide basic institutional training whilst industry accepts the responsibility for the provision of on-the-job practical training and specialized training. With no exception The Hongkong Electric Co. Ltd. has undertaken and operated formal training schemes for training of graduate engineers, technicians and craft apprentices during the past two decades and more.

These Company training schemes for new technical staff have been devised to recruit various grades of graduate students from the above-mentioned educational establishments and fit these persons into the present company staff structure after given required training. The objective is to maintain a source of supply of qualified personnel to account for expansion and movement of the workforce due to promotions, retirements, turn-over, etc.

Because of its specialised business nature, the Company has long since recognised the importance of staff training and development. The evolution of technological changes, the increasing demand from customers for electricity supply in the past years, and the quest for an ever more efficient and reliable supply system have become the continuous impetus for numerous system upgrading activities. These demands have also been instrumental in bringing about the constant need for continuous training and development of existing technical personnel to keep pace with the system growth and development. The ability of the Company to meet these dynamic changes can only be achieved by continually giving the employees systematic training and development.

The Company technical training functions come under the responsibility of two operational divisions, viz. the Generation Division which administrates the Company's power station in the Lamma Island, and the Transmission and Distribution Division which is responsible for the operation and maintenance aspects on the system network with voltage level up to 275kV.

This paper is aimed to present the major training undertakings organised in the past few years for various levels of staff members of Transmission and Distribution Division, with the objective of maintaining the required work standards within the organisation and upgrading staff to keep them abreast and up-to-date with technological developments and changes.



2. UNIFIED PHILOSOPHY

In every organisation the availability of well-trained and experienced staff is one of the absolute necessities to sustain efficient and effective operations of the organisation. This is even more pronounced with the power companies which have to provide 24 hour, round-the-clock services to the general public.

The Company is also well aware that the extent to which the Company can cope with continuing diversity of technological developments in a growing system efficiently and effectively depends greatly on the availability of trained technical manpower at all levels.

Although it is recognised that not every employee is capable of further development to higher positions, yet continual training or re-training with the prescribed objectives is still necessary for this group of employees to ensure these employees are in proper shape to undertake extra work in addition to their normal duties and to face up with technological changes. Furthermore, it is generally accepted that good management thinking is always forward looking and, by training and developing staff, the Company is investing in categorically the most important asset of the Company, namely, the human resources. The Company can only be as good as its employees. It is along these lines of thinking that we base our training philosophy which has resulted in the publication of an in-house training and development guide highlighting the training objectives and requirements for every level of staff within the organisation of the Division.

The purpose of staff training and development is therefore to improve and maintain standards of performance of our staff, to train them for new techniques and skills brought about by technological changes, while at the same time provides the machinery for ensuring an adequate supply of suitably trained personnel to meet the organisation's needs. In addition, the existing workforce will also be able to increase their working knowledge and skills, to gain recognition of their attainments and to open up ways for their future career advancement.

3. THE TECHNOLOGICAL DEVELOPMENTS

Apart from the normal operation and maintenance activities conducted on the system, there have been numerous project and development works undertaken in the past years for the improvement of system performance and reliability.

Below are some of the more significant system improvement works and/or new apparatus that are introduced in the system in recent years.

i. At 11kV Consumer Substation

- Installation of RTU's (remote termination units) to effect supervisory and automatic control on the operations of substation apparatus,
- Replacement of old Low Voltage endboxes with cutouts facilitating in-out looping of cables instead of service teed connections.

ii. Distribution Switchgear and Transformer

- Replacement of existing air and oil insulated switches with SF₆ gas insulated switches coupled with vacuum interruptors,
- Replacement of old oil insulated transformer with SF₆ insulated type.

iii. Transmission Switchgear

- Addition of 132kV Ring Main Units at zone-substations to upgrade operational flexibility.
- Replacement of zone-substation oil circuit breakers by vacuum circuit breakers for ease of maintenance and reduction of fire risk.



iv. Cable System

- Introduction of 132kV XLPE cables to the transmission network.
- Introduction of compression/mechanical ferrules for 11kV and low voltage cable joints and shear-head connectors for low voltage switchgear panels, to reduce the level of skill-dependency of jointing and termination.
- Joint development with supplier and subsequent application of mastic-filled straight joints for upgrading distribution cable reliability.
- Upgrading low voltage overhead line systems by pole replacement and utilisation of aerial-bundled cables.

In coping with these changes, the workforce must develop new skills. It is therefore necessary that well organised training must be provided for the existing employees before the introduction of the new type of apparatus and new work methods.

4. TRAINING STRATEGY

4.1 General Policy

Apart from the normal establishment of the training organisation, there exists a training committee acting as a supervisory and support body to the Training Section. It is chaired by the Head of the Division with key training staff as permanent members together with senior level representatives from the line Departments. The main objectives for the committee are:—

- To formulate and establish training policy for the Division.
- To identify and review training needs and training methods for every level of employee.
- To coordinate training programmes and maximise the utilisation of available training resources.

Because of the multiplicity of work disciplines involved within the organisation, it will be impracticable for just a single party to be responsible for the whole process of identifying specific training needs for various grades/levels of staff of different Departments. Concerted group effort should be summoned instead. It is essential to involve the line Sections/Departments in the identification process to make sure any training schemes devised will satisfy the specific needs of the line staff. The training committee would coordinate and prioritise all these needs and pass them to the Training Section who will prepare a final draft for approval and implementation.

In the process of analyzing and summarising all those training needs, careful and in-depth consideration is given to decide on their nature and relevancy, precise form of requirements, training contents, likely duration required, method of instruction, etc. At this stage the training needs will be categorised into groups for planning purpose, e.g. common areas of interests, operational needs that require short/long term training, needs that require certain degree of specialist training, requirement for external training resources, urgency or priority standing, etc. Last but not the least, availability of in-house training resources and financial implication for maximum cost-effectiveness should also be evaluated.

The involvement of the line Sections/Departments in the process will not only be time-effective. It will also be direct and effective in revealing genuine training needs of respective groups of staff members because of their mutual daily working relationship. Additionally the line Sections/Departments are fully aware of their current work requirements and have first-hand information on the work standard and knowledge as required from their subordinate staff.



4.2 Manpower Planning

The process of formulating present policy on training and development for employees has been evolved gradually through time and effort. It is a policy that is derived from long term manpower planning and staff succession projections.

Staff movements such as promotion and transfer, turn-over due to other employers, brain-drain and emigration, etc. have been one of the major consideration in the formulation of long term training strategy for staff.

Past records on staff movement has shown a consistent trend indicating that the biggest group of movers among the workforce are those ranked as assistant engineer. There were at times that movement of this level of staff had caused additional burden on the experienced and senior engineers that they had to spare some of their valuable time and effort to tend to routine works, which means extra working hours. And the peer group would have to share out the work of the movers, which means extra loading on the junior staff.

Dilution of experience has resulted from staff movement and is another factor of concern which could lead to lowering of work standards among the workforce. This could also in turn cause delay in the succession-plan in grooming potential staff to assume senior positions in the organisation. All these have a far-reaching impact on the healthy operation of the organisation in terms of both efficiency and effectiveness.

In order to provide continuous replenishment of competent staff, some form of well-structured and effective training for new staff is essential, such that the required technical standards can be maintained. It is only by the implementation of systematic and target-oriented training that this effective transfer of essential technical knowledge and know-how, practical skills of the required standard and up-to-date technical developments are passed on to the fresh staff.

4.3 Systematic Approach

It is most important that, if training aims and objectives are to be fully met, well planned and properly designed training is essential and that clearly defined training needs, targetted group of trainees, relevant training content and material, suitably chosen competent trainers, etc. are the main ingredients to successful training.

Equally important, the right conditions for learning to take place should be created and the approach for learning should be defined. Learning from information and learning from experience are the two general types of learning methods of which each has its own unique merit, with the academic learning representing the former type and practical on-the-job training as the latter.

Proven records have shown that training methods will be most effective if a combination of the two methods is adopted with the correct blend between the two in right proportion, depending on the nature of the training activity. For example, craft skill training will be very much of learning from practices, i.e. experiences with minimum amount of theory. Whereas to comprehend the fault level of a power system, for example, the trainee must commit to learn a fair amount of theory and calculation. Almost all of our training courses are organised on the combined basis of the two methods in varied proportion depending on the nature and the trainees, whenever possible.

4.4 Training of Target Groups

Training and development can be regarded as a continuous process with the ultimate aim of achieving efficient and effective performance from employees at all levels for all possible jobs within the organisation.

Training of target groups is often necessary to meet organizational needs. The purpose of training target groups can be (1) to accelerate growth of the target groups (2) to train them for specialist duty.

Some major examples of target group training that have been undertaken with effective results are shown below:

- Groups of selected tradesmen including ex-craft apprentices attained assistant technician/ technician grade for emergency and shift duties on cable work, LV overhead line work, fitting work and operational work in substations.
- Graduate trainees achieved "Authorised person status for working on the 11kV system through accelerated training programmes, immediately after two-year graduate training.
- Technicians and assistant engineers including ex-trainees and new staff achieved "Authorised person" status for high voltage works of different voltage levels, through the Safety Rules authorisation training process and periods of on-the-job training in designated areas and sections.
- Nominated engineering staff attended in-house seminars on selected topics of speciality, relating to the transmission and distribution systems, with lectures delivered by senior engineers.
- In-Section training organised by line Sections/ Department for selected groups of staff on aspects of job familiarisation and job enlargement.

Paper
No. 3

5. TRAINING COURSES

Formulation and implementation of training activities/ courses are normally coordinated by responsible training staff. However, expertise and effort from the line Sections/Departments are constantly called upon, particularly for seminars on topics of speciality and for work areas with peculiar requirement and skill.

Training and development for staff can only make headway and progress through the joint efforts between the line staff and training staff. Therefore a congenial environment has to be created through unified policies.

5.1 Induction Courses

These courses are originally organised for the purpose of introducing the structure and work organisation of the Company to new recruits, trainees and apprentices. With gradual growth in popularity, staff members also find these courses useful for job familiarisation. It has become a standard practice that all new staff and trainees are given these courses at the start of their job employment, and existing staff upon recommendation are also included.

In addition to the usual items on company structure and work organisation, special emphasis is placed on introducing topics related to work functions, operational systems, rules and regulations, manual and code of practice, etc. The objective is to equip the employees concerned with all the necessary information for them to work confidently as soon as possible in the complex system of the Company.

The main approach is through the extensive use of video films and well-prepared hand-outs of up-to-date information for the course of instruction to the participants. This is of vital importance in maintaining the standard of accuracy and consistency in terms of conveying system information. To arouse interactive responses and alertness from the audiences in these courses, frequent Q&A sessions and site visits are necessary.

5.2 Authorisation Courses

All works in our transmission & distribution system are governed by the Company's Electrical Safety Rules. Therefore, besides professional knowledge in high voltage engineering, all employees must be appropriately authorised in the context of the Safety Rules before they are allowed to carry out operational duties on the high voltage system.

Usually the entry level is authorisation for 11kV switching, isolation and earthing and the staff members will progressively seek for higher authorisation in line with their operational experience and academic background.



To prepare for authorisation at 11kV level, the employee must complete a pre-authorisation training course and must subsequently gain sufficient practical experience under supervision prior to attending interview by the authorisation panel.

The 11kV pre-authorisation training course is a 2-week course covering fundamentals of operational safety practices. The participants have to attend both theoretical and practical sessions which mainly consist of application of Safety Rules for working on the high voltage systems, switching operations at 11kV level, code of practice on cable identification & spiking, safety precautions in carry out 11kV phasing-out operation and high voltage pressure testing, etc.

Due to very practical nature of this course, live models for simulated operation are provided and every participant is required to go through every detailed operation through repeated hands-on practices on practical items, with great emphasis on safety awareness. At the end of the course all participants have to undertake a 3-hour written examination such that their performances can be assessed.

There is the built-in flexibility in running these authorisation courses in different independent modules to suit users' requirement. For authorisation up to transmission level, there are the following topics operating at the moment.

- 11kV capacitor bank maintenance
- 132kV/11kV zone transformer maintenance
- Oil works for 132kV/275kV oil-filled cables
- 132kV overhead line maintenance
- 11kV zone switchgear (V.C.B.'s) maintenance

5.3 Familiarisation Courses

It is of paramount importance that engineering staff should be kept well informed of the requirements of new technological changes that are to be brought into the system. They should be properly developed and prepared to handle new techniques and new type of apparatus of the system.

As factory training is usually exclusive to a few staff members, in-house familiarisation courses must be organised for the sake of the other staff before the introduction of a new technique or a new type of apparatus. In addition to cost-effectiveness, there is also the advantage that it provides a forum for staff members to discuss and exchange ideas on the new technique or equipment with reference to their past experiences. Positive feedbacks and valuable suggestions have often been generated.

Extensive use of video films and slide films are the best approach for the course of instruction by highlighting the required specialities of the new system. Well prepared course notes depicting the salient features and work procedures are most useful for participants' future reference. Demonstration sessions and facilities for hands-on practices are also arranged such that the staff concerned are fully equipped with all the necessary information and method of technique in coping with new situations.

The following are some of the major examples of familiarisation courses conducted.

- 11kV SF₆ insulated Ring Main Units
- 11kV zone substation V.C.B.'s
- Compression/Mechanical ferrules for 11kV and low voltage cable joints
- Low voltage overhead line using aerial bundled cables system



5.4 Craft Skill Training Courses

Craft skill training is as important as other aspects of training, as workmanship would affect the end quality of a job and reliability of the system. In fact, considerable time and effort are put into this aspect of training, because skilful work needs patience and care.

Whenever there is any technological changes to the apparatus or system which involve new skill, the Training School will be called upon and the responsible training staff would coordinate with the responsible engineering staff for the details of the practical requirements and techniques involved for which initial trial or practice would be arranged.

With all the necessary details finalised, i.e. work procedures, tool kits, material list, training video films, simulator model, etc. training sessions will be arranged. For engineering staff, lecture session supplemented by demonstration is the usual approach, whereas great emphasis is placed on hands-on practices for the tradesman group.

For some cases of special requirements, refresher training will be arranged or trade tests conducted for some specific groups of tradesmen such that the standard of workmanship can be maintained.

Cable jointing and switchgear fitting work have been the two big areas which require constant skill training, with examples as follows:

- 132kV XLPE terminations
- 11kV straight joints
- LV branch joints and cutouts
- Replacement of Gas-RMU's and vacuum circuit breakers

5.5 In-house Seminars

In-house seminars are an effective tool to update staff with system changes and new system developments. They are also a very cost effective medium for transferring experience and knowledge to the junior and young engineers.

Distribution seminars and transmission seminars are the two main types organised in this format consisting of theoretical sessions and practical sessions. About eight to ten topics are covered in each round of the seminar with spectrum ranging from system configuration & layout, system design and construction, to individual system apparatus i.e. switches, transformers, cables, etc. of the present transmission and distribution system.

Speakers are mainly from senior grade engineers who have in-depth working knowledge and wealth of experiences in these topics. Target groups of audiences are normally nominated by heads of line Sections/Departments who consider which staff concerned are in need of the development.

Very extensive use of all types of audio-visual aids are required and seminar notes are prepared both for the participants and future reference. Review and assessment are organised by means of group discussions, questionnaires and course work assignments to participants.



6. EXPERIENCES GAINED

Staff training and development has played a crucial role in the manpower planning of the Company. It is through the effort of training and development that the Company is able to face up with technological changes and the ever increasing demand for quality and efficient services. Experiences gained through the training process are noted as follows.

6.1 Unified Policy

The Company has placed particular emphasis and full support in the undertaking of training and development for staff members. This has created an organisational climate in fostering close working relationship between line Sections/Departments and training staff for the common goals. Senior engineers and supervisors become more involved in the roles of training their subordinate staff, which is rightfully a part of their normal duties. Line staff are becoming more cooperative to undertake assigned training and are aware of the likely benefits gained through the exercise.

6.2 Integrated Approach

Training is a process of programmed learning for performing a particular task and development is a similar process but usually taken as a sequential step after training for further advancement in jobs or positions.

The approach in integrating the two processes for targeted group of staff has produced expected results and has fulfilled the organisational needs.

6.3 Target-oriented Training

To meet specific training needs, in particular of a technical nature, target-oriented training proved to be the best approach in that particular emphasis is placed on clearly defined training objectives, relevant training content of the right amount, suitably chosen staff to receive the training and competent trainers.

6.4 Review and Assessment

Training reviews and assessments on trainees should be undertaken as a close loop requirement to any training process. Training review can take the form of group discussion, feedback through questionnaire, formal meeting, etc. Assessment on the performance of trainees can be by ways of interviews, participative discussion, course work assignments, feedbacks from supervisors, etc.

7. CONCLUSION

Load demand on the supply systems are increasing, along with technological changes which are evolving continuously. All these have imposed an ever increasing demand on the working knowledge and skills of technical staff and necessitate a competent workforce. Staff training and development is essential to meet the long term manpower needs of the organization in this dynamic environment.

Unified policy on staff development with full backing from Management has helped in allying supports from all levels. Also concerted group effort can be called upon from line Section/Departments in establishing training needs and implementing the required training activities/ courses effectively.

Integrating training and development as one continuous process coupled with target-oriented training approach has been effective in fulfilling the organisational need in terms of manpower planning and staff succession. It is also through this process that employees are upgraded to match with technological evolution.

A congenial environment has been successfully created in which line Sections/Departments work closely with training staff to meet the training needs of the organisation.

Useful training experience gained will further chart the course of direction for future training activities.



Paper No. 4

ROUTE FROM ENGINEERING TO MANAGEMENT

Speaker: Mr F.K. Hu, CBE, JP
Chairman
Ryoden (Holdings) Ltd.

ROUTE FROM ENGINEERING TO MANAGEMENT

HONOURABLE GUESTS, LADIES AND GENTLEMEN

It gives me much pleasure to be here today, to deliver a speech on "Route From Engineering to Management."

This is a subject close to my heart as my own journey started from engineering, ending up with managing various kinds of business.

Management has been widely analyzed and continues to be analyzed in universities and elsewhere in many parts of the world. It is the subject of intense research, widely written about and discussed wherever businesses flourish.

At one time the Americans led the world in management studies and practices. Then, very suddenly, the Japanese were thought to be in the lead. Many books were written and some of their "bottom up" practices were adopted, even in the United States.

In recent years the euphoria seems to have evaporated and there has been more talk of similarities between American and Japanese practices.

That, I believe, is because there are certain elements which are intrinsic to management anywhere and at any level. These are the basics that I would like to dwell on today.

But, let me start at the beginning of my own journey.

I graduated in 1944 in mechanical engineering and worked for an engineering firm before I was offered an opportunity for technical training in a manufacturing plant in Britain in 1949.

After serving the required two years there, I remained for a further year in the company's drawing office as a designer. In those early days of my career, I had a fairly broad training in both electrical and mechanical engineering. This was the requirement of those days when specialization in most disciplines was not as widespread as now.

In 1952, at the end of my three-year term in Britain, I found myself at a crossroad of my career. I had to decide what to follow and where to pursue it.

While still thinking over it, I was offered a job in Hong Kong. I accepted it to give myself more time to think about where I would finally settle down.

After a year at this new job, I joined another engineering company in Hong Kong. This new job required me to start up a new department. A one-man department to begin with.

I am proud to say that this department eventually earned as much as one-third of the entire company's earnings. In 1959 I was appointed a director of the company.

In 1966 I started my own company. My prime objective was to deliver higher levels of quality in engineering to achieve customer satisfaction. This commitment has remained unchanged through the years and I am happy to say that Ryoden has established its name in this respect in industry.

In engineering we have, most of the time, to deal with fitting various parts into a machine or system. Business is somewhat similar in that it is a consolidated structure of various functions or departments. Business components include sales and marketing, services, finance and administration.

You could call engineering a microcosm of business. The prime and fundamental responsibility of an engineer is to ensure the machine or the system functions properly and to the satisfaction of the user.

In business, the manager does the same. He has to manage the business in an efficient manner and to the satisfaction of owner or owners of the business. You might call it a macrocosm of engineering.



If I have led you into believing that engineering and management are alike, I must hasten to say that this is not entirely correct. For all their similarities, there are fundamental differences. In management you deal with people. There is no need for me to stress the differences between man and machine. You cannot be more wrong if you were to handle people as if they were pieces of equipment.

It also seems to me that in Hong Kong engineers take it as a matter of course that they should move into management as part of their career advance. This expectation is not quite correct.

In my company, a decision has to be made at some point to determine if an engineer should advance into management or to continue advancing along the technical field.

An engineer who goes on to management starts as an assistant manager. This happens when his superior is satisfied that the engineer is not just technically competent, but has also displayed an ability or a potential for management.

An engineer who has not shown such potential remains on the technical side, advancing to senior engineer and, eventually, to chief engineer.

Drawing from my past experience I would like to set out some of the basic requirements of an engineering graduate for the management level.

Firstly, diligence is an indication to top management of your desire, commitment and potential for the management level.

Secondly, an open mind makes you more receptive to new ideas, new things. You learn more and know more, with the result that new knowledge becomes part of practice.

Thirdly, logical and rational thinking are essential characteristics of a manager for they allow him or her to make appropriate decisions in circumstances which are new or unfamiliar.

Fourthly, be sensitive to the people around you, regardless of whether they are superior or subordinate to you. One very important aspect of management is to become a leader and manage a group of people.

This is also the one area where most engineers lack exposure to because they are not trained to deal with people. I do not believe in leadership by sheer authority. You become a true leader only by gaining the respect and trust of others.

When I first came to Hong Kong in 1952, the situation was vastly different from now, with few qualified engineers and some technicians. There was no formal training, either for technicians or engineers. In those days training was much more hands-on than now.

Nowadays, colleges or polytechnics and universities, local and overseas, provide engineering and management training and, with the opening of the University of Science and Technology, the numbers of trained graduates will increase significantly.

Perhaps, more qualified engineers will go beyond their discipline to engage in business.

Management is team work and delegation. Don't do everything yourself; delegate and give your subordinates all the opportunities to develop their full potential. Delegation is not getting somebody to handle a piece of work and forgetting all about it. You must delegate without losing control. It is still your responsibility even if you have delegated the work to your subordinate.

Integral to this philosophy is ambition. You must not be satisfied with just being able to handle the present job. You must aim for a higher standard of performance and achievement. So you must always be on the look out for new changes, preferably by actively seeking out and adapting to new situations. Ride on top of changes rather than be swamped by them.



Equally important, in my view, is honesty. Don't make promises you cannot keep. Be dependable and make your name synonymous with quality. Never cut corners. In the long run it simply does not pay.

As our economy grows and our standard of living rises, the efficiency of production and cost reduction become more and more important in coping with ever-increasing demand.

This not only pertains to manufacturing, but to all forms of systems enhancement. This will lead to a great demand for engineers of all kinds to strengthen the foundations of our economy.

To manage a large number of engineers, it may not be an ideal situation to use someone who only possesses management know-how but knows nothing about engineering. You will probably agree that it is much easier to train an engineer to become a manager rather than a manager to become an engineer.

By now you may be disappointed that there is nothing new to what I have said about management. As I said earlier, there are certain intrinsic elements of management which holds good wherever they are practised and at whatever level you practise them.

So there is really no secret to success. All of you know what it takes to become successful. It is the implementation and the determination which really makes for success. These are occasionally overlooked.

I would like to conclude by saying that Hong Kong has been and remains a very challenging place. It will remain challenging for a very long time to come. So the prospects of enterprising and industrious engineers are very good.

Make the transition and see for yourself.

Thank you.



Paper No. 5

**DISTURBANCES FROM ELECTRIC LOADS
IN POWER SYSTEM**

Speakers: Mr C.K. Law
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DISTURBANCES FROM ELECTRIC LOADS **IN POWER SYSTEM**

1. INTRODUCTION

The advance in modern technology and the continuing economic prosperity have led to widespread use of electric equipment in the public, manufacturing, commercial and residential sectors in Hong Kong. The increasing use of electricity has not only brought about comfort in life, but also improved productivity and efficiency in various areas. However, some modern electric equipment, if not properly designed, maintained, used or by its very nature while in operation, will inject a certain amount of unwanted 'energy' back into the electricity supply system. This unwanted 'energy' may then propagate to other supply points through the power networks and cause a wide spectrum of undesirable effects to the electricity consumers.

This paper describes the various types of disturbances generated by electric loads connected to the power system, their causes and the possible annoyances to electricity consumers. The precautionary measures that can be taken by the electricity consumers and power utilities to maintain the quality of electricity supply are presented. Practical examples on the mitigation of disturbances from major electric loads in the China Light & Power (CLP) system are also given as illustrations.

2. ELECTRIC LOAD DISTURBANCES IN DAILY LIFE

In our daily lives, electric load disturbances can cause certain unsatisfactory performance in electric appliances. Typical examples are:

- flickering of tungsten lamp
- picking up of noise signals by the radio receiver

Other incidents such as interruptions to computer operations, tripping of MCB, blowing of capacitor bank fuses, may also be related to the disturbances generated by electric loads.

3. TYPES OF ELECTRIC LOAD DISTURBANCES

Due to the difference in the generation, propagation and responses of the electric equipment, electric load disturbances can be broadly classified into Voltage Fluctuation, Harmonic Distortion and Unbalance Distortion. The generation of these disturbances and their subsequent annoyances are elaborated as follows:

3.1 Voltage Fluctuation

When the current drawn by an electric load changes rapidly and frequently, annoying voltage fluctuations will be produced at the supply point and experienced by all electric loads connected to the same supply point. Depending on the source impedances of the supply networks, voltage fluctuations of different degrees will also be transmitted to other supply points in the power system and affect the electric loads connected there. Typical electric loads that can produce voltage fluctuations are air-conditioners, refrigerators, arc furnaces, electric welding equipment, etc.

A common experience of voltage fluctuation is the lamp flickering effect which is very sensitive to the human eye. The increased demand for high quality and comfortable lighting systems in modern society has rendered the voltage fluctuation problem a major concern of both the electricity consumers and power utilities. Other disturbances due to voltage fluctuation include:

- a) distorted television display
- b) interruptions to computer operations
- c) mal-operation of voltage sensitive devices such as ripple control equipment



3.2 Harmonic Distortion

When voltages or currents at frequencies higher than the power frequency are injected into the electricity supply system, they will distort the sinusoidal power frequency voltage and current to produce harmonic distortion. Small levels of harmonic distortion are always present in the supply and has been tolerated for years, but this problem has been aggravated in recent years with the increasing use of various kinds of non-linear devices such as switching power supplies, rectifiers, cycloconvertors, fluorescent lamps and induction heaters. Furthermore, improperly designed or operated electric equipment such as operating a transformer above its rated voltage is likely to generate harmonic distortion.

Electricity supply distorted by these harmonics can circulate harmonic currents in the power networks and other electric loads, causing annoyances and adverse effects such as:

- a) interference on radio receivers, television sets and telephone communication
- b) overloading of power factor correction capacitors
- c) additional power losses
- d) mal-operation of computer equipment, ripple control device, thyristor controlled equipment and protection relays
- e) reduction in the accuracy of power system measuring devices

3.3 Unbalance Distortion

Balanced 3-phase voltages are produced at generator terminals. However, the connection of single-phase loads of different characteristics and power consumption to the 3-phase power system will result in unequal currents flowing in the 3-phase power circuits and unbalance phase voltages at the supply points, i.e. unbalance distortion. Strictly speaking, all single-phase loads are potential sources of unbalance distortion. Nevertheless, the random connection and operation of small rating single-phase loads will tend to cancel their unbalance distortions. Hence, large rating single-phase loads such as electric traction are the major sources of unbalance distortion in a power system.

The annoyances and adverse effects of unbalance distortion include:

- a) additional power losses
- b) reduced forward operating torque of induction machines
- c) overheating of synchronous machine rotors
- d) excessive electromagnetic interference
- e) additional errors in power system measurements

4. MITIGATION OF ELECTRIC LOAD DISTURBANCES

Electric load disturbances not only affect the electric loads that produce these disturbances but all other electric loads connected to the same electricity supply system. With a growing public consciousness of the quality of electricity supply, mitigation of electric load disturbances has assumed increasing importance in power supply industries.



4.1 Contribution by the Consumers

To avoid the disturbances from affecting their own electric equipment and that of the others, electricity consumers should plan their electric installations carefully and inform the power utilities in advance. In cases of uncertainty, advice from consultants, equipment manufacturers as well as power utilities should be sought. Based on the characteristics and operating conditions of their electric equipment, electricity consumers could prevent the generation of excessive disturbances from their electric loads by:

a) Using properly designed electric equipment

Properly designed electric equipment can help to minimize electric disturbances to the supply network. Typical examples are:

- installing fluorescent lamps equipped with choke and capacitor to avoid generation of excessive harmonic distortions;
- using 12 or 24-pulse bridge rectifier which inherently has low harmonic generation for a.c./d.c. conversion;
- limiting the starting current and thus voltage fluctuations from large electric motors with appropriate star-delta or auto-transformer starters.

b) Designing the private power networks properly

For consumers with their own power networks, it is possible to mitigate or control the spread of electric load disturbances through proper design of their power networks such as:

- connecting the single-phase loads evenly across the phases of a 3-phase supply so as to reduce the unbalance distortion;
- using dedicated supply terminals or sub-circuits for large electric machines, nonlinear electric loads, etc. to avoid the propagation of disturbances such as voltage fluctuations and harmonic distortions to other electric equipment.

c) Installing proper compensating equipment

For some electric loads that generate excessive disturbances to the supply network, installation of proper compensating equipment will be essential. Typical examples are:

- installing static flicker compensators to suppress the excessive voltage fluctuations from electric arc furnaces;
- installing L-C harmonic filters to absorb excessive harmonic currents and reduce harmonic distortions from large rating rectifiers

4.2 Contribution by the Power Utilities

As a responsible power utility, CLP realizes the need to maintain a high quality electricity supply to its consumers. At low voltage level, the possible disturbances from small rating electric equipment are usually mild and short in duration. Consequently, the spread of these disturbances can be rapidly attenuated in the power networks, especially via the distribution transformers. However, the disturbances from large rating electric loads in industries and public facilities will be more concentrated and frequent, thus requiring special mitigation efforts. Since the consumers may not have sufficient information on the arrangements and characteristics of the power networks, there could be difficulties for them to effectively mitigate the disturbances from their electric equipment. Therefore, CLP has employed its expertise, resources and various power system operation techniques to work closely with its consumers in the following aspects:



a) Establishment of Acceptable Limits

To ensure the quality of the electricity supply, common standards must be available as the guidelines for the electricity consumers, equipment manufacturers and power utilities as well. Basically, CLP has adopted limits based on widely accepted engineering practices such as the Engineering Recommendation from the U.K. and the IEC Standard. Nevertheless, consumers' feedback, engineering judgement and local conditions would be taken into consideration in order to apply these limits in a reasonable manner.

b) Planning the Supply Network

Past experience has shown that suitable supply arrangements not only can satisfy conventional requirements such as maximum demand, supply security, construction cost, etc. but also help to mitigate the possible disturbances from electric loads or reduce the rating of the compensator required. Hence, proper design of the supply network to electric loads with known disturbances to the supply system has always been considered by CLP as the best solution. This approach also enables the determination of the precautionary measures in the early design stages and avoids the difficulties such as the need to adopt temporary operational constraints, the interference to normal production, etc. encountered in taking the subsequent remedial actions. The success of this approach is enhanced by the increased understanding on the characteristics of modern electric loads and the availability of suitable computer software for various power system analyses.

For example, reducing the load current variation is the prime solution to limit voltage fluctuations. Yet lowering the source impedance can also be helpful. Hence, in a case of designing the supply network to a traction load, connection of this traction load to a number of CLP 11kV substations along the railway track was mooted initially. This arrangement had the advantage of low construction costs. However, studies on the source impedances of these 11kV substations indicated that installation of compensators at each 11kV infeed point would be necessary to limit the voltage fluctuations caused by the starting of the trains. Further analyses showed that the source impedance of the CLP 132kV network would be low enough to avoid the installation of compensators. Hence, bulk infeeds from the CLP 132 kV network were then designed for this traction load as shown in Fig. 1.

In another case, a local railway needed single-phase electricity supply to modernize its system and the power demand was anticipated to be high. Hence, connection of the whole traction load to any one phase of the CLP 3-phase system would produce unacceptable unbalance distortion. In order to provide adequate supply security and to minimize its possible unbalance distortion, a supply arrangement with 132/25kV single phase transformers connected across different phases of the CLP 132kV networks as shown in Fig. 2 was adopted.

c) Selection of Appropriate Compensator

When the disturbances generated by an electric load are highly concentrated or large in magnitude, altering the supply networks alone is not sufficient to solve the problem. In such cases, installation of suitable compensating equipment will be necessary. To ensure that consumers' compensators can perform satisfactorily, CLP has continuously offered support to its consumers in their selection of the most appropriate compensation. For example, in determining the rating of flicker compensator for a local arc furnace, with the full co-operation of the consumer who raised the request in good time and submitted the necessary information promptly, CLP was able to carry out analytical studies on the proposed plan. The results of the studies turned out to be valuable in evaluating the performance of the flicker compensator in the power system. Through the joint efforts of the consumer, the compensator manufacturer and CLP, a suitable rating was determined for the flicker compensator. This flicker compensator was confirmed adequate in suppressing the voltage fluctuations produced by the arc furnace after its commercial operation.



d) Operation and Monitoring

Proper design of the supply network and adequate compensation can mitigate the disturbances from electric loads. However, correct operation and maintenance of the compensating equipment are also essential. To maintain the quality of electricity in the CLP system and to assist its consumers in monitoring the integrity of their compensating equipment, site measurements on the electric load disturbances in the CLP system are performed regularly. With the help of modern power system measuring instruments such as the A.C. Harmonic Analyser, the disturbances from electric loads can now be measured directly. This improvement in the measuring techniques facilitates the early detection and rectification of any abnormal situation in the electricity supply system.

With the rapid development in Hong Kong, it is anticipated that the problems related to electric load disturbances will increase in line with electricity demand. Furthermore, the application of new technology may bring about new disturbances from modern electric loads. Nevertheless, CLP will continue its assistance to the consumers in tackling these problems with gained experience, updated knowledge and latest technology.

5. CONCLUSION

Application of modern technology in various electric equipment has increased the magnitude and frequency of voltage fluctuation, harmonic distortion and unbalance distortion in a power system. These disturbances bring about a wide spectrum of annoyances to the electricity consumers and adverse effects to the electric equipment. Fortunately, with properly designed supply networks, electric equipment and, in some unavoidable cases, compensating equipment, the generation of unacceptable disturbances from different electric loads can be prevented. Since the satisfactory performance of the electric equipment depends heavily on the quality of the electricity supply, maintaining the supply free of unacceptable electric load disturbances is thus the common goal of the electricity consumers, equipment manufacturers and power utilities. The full co-operation and active participation among the parties concerned, as in the past is the most effective way to come up with the optimal solution in the process of achieving this objectives.



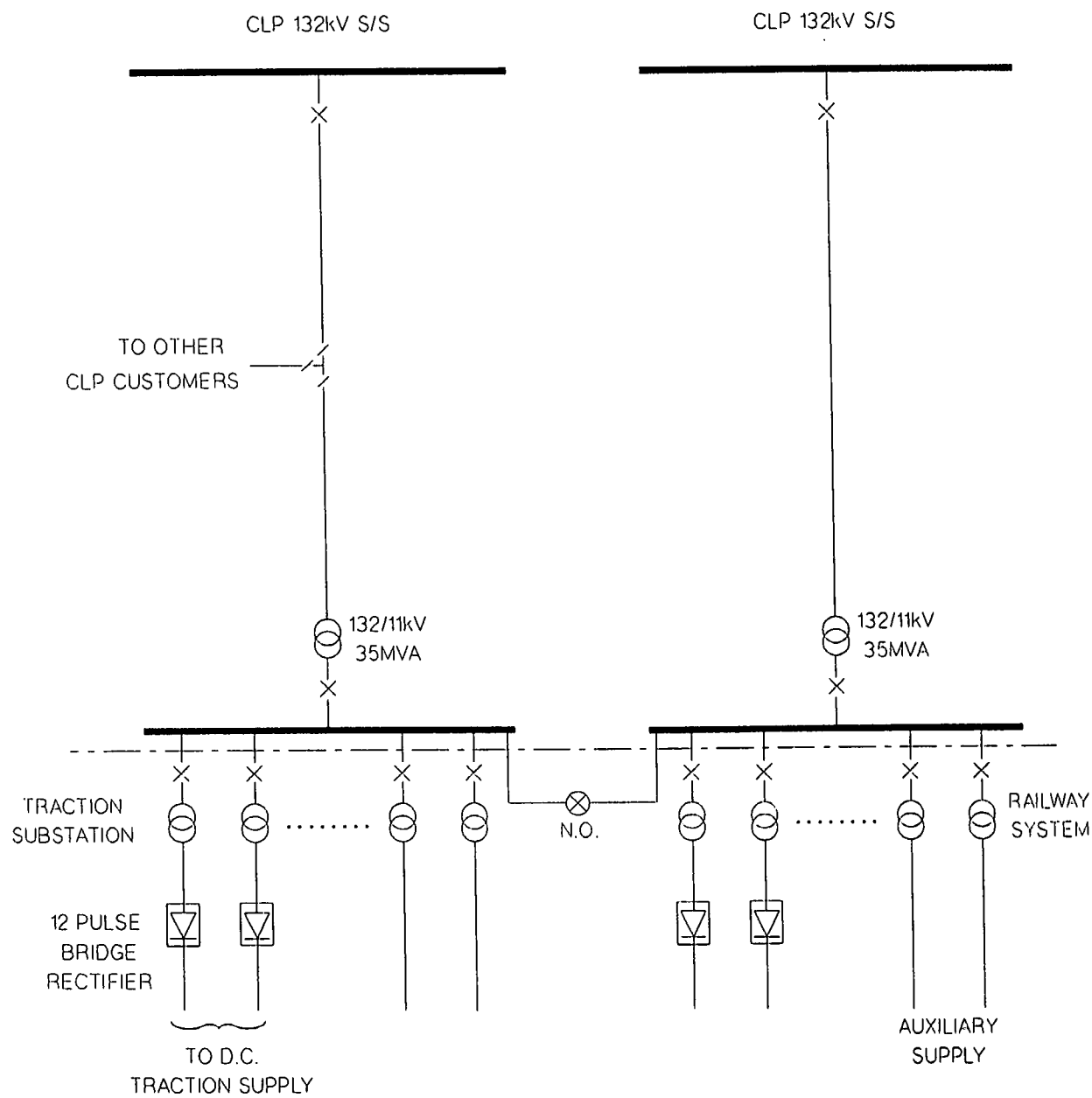


FIG. 1 SUPPLY ARRANGEMENT FOR A LOCAL D.C. TRACTION SYSTEM



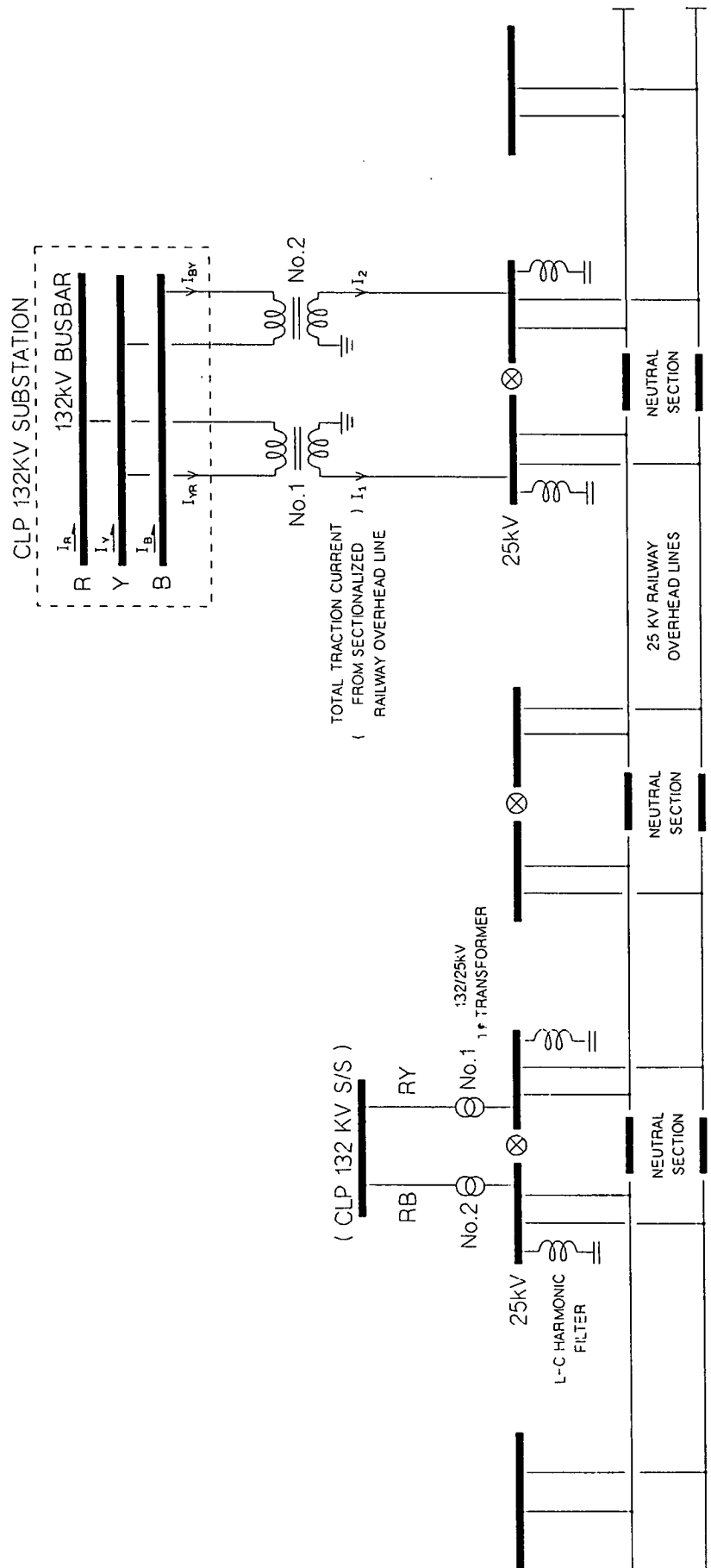


FIG. 2 SUPPLY ARRANGEMENT FOR A LOCAL SINGLE PHASE A.C. TRACTION SYSTEM



Paper No.6

**PRESENT STATUS AND FUTURE PLANS
IN ELECTRIC TRACTION**

Speaker: Mr Ake Nilsson
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PRESENT STATUS AND FUTURE PLANS **IN ELECTRIC TRACTION**

INTRODUCTION

Today we can soon celebrate the 200th anniversary of the birth of railways and 100th anniversary of the introduction of electrified urban railway transportation. After a period of stagnation of the railways we can now see a renaissance and rebirth of railways throughout the world. The reasons for this change are basically threefold:

- Congestion on roads.
- Environmental problems such as air pollution
- Road hazards; injuries and death toll

The purpose of this paper is to give an account of the present state of development in the railway sector on a global basis and to point at possible solutions to the problems that are building up in some parts of the world and becoming major threats to economic developments and, maybe even worse, to the health of the world population.

There is as a matter of fact not any major competition between the different modes of transport: air, roads, waterways and railways. All have their role to play in the building up of a modern society.

However, too much emphasis has been given for a long time to air and road transport investments, which has led to a situation of congestion and inefficiency. Along the main highways in the big cities and at the major airports we cannot cope with a continuing traffic increase. There is simply not sufficient space. To this must be added to impact on the environment of the engines of automobiles, large trucks and airplanes.

BENEFITS OF ELECTRIC TRACTION

It is against this background that an ever increasing interest is being shown around the world in railways and waterways, because these modes of transport are the most energy efficient and environmentally friendly. The basic reason for this is the benefits offered by the introduction of electric traction on rails. This offers:

- Lowest possible energy consumption, “ The steel wheel on steel rail”.
- The inherently lowest emission of polluting gases like carbon oxides, NOx, etc.
- Electrical power is generated in power stations having state-of-the-art flue gas cleaning systems, which give nearly zero emissions.
- The capacity of rail-borne freight and passenger service is very high in terms of the amount of land needed compared to road transport. Existing tracks can and should be used wherever possible

Hong Kong has shown great foresight in its traffic planning. Major investments were made in a metro system at a very early stage, links with People's Republic of China are being built and more is under way. Still more is needed.

Around the world there are hundreds of cities that have not even started planning mass transit systems. Addressing major public transport problems, as everybody well knows, calls for long-term planning. Experience shows that this is the biggest problem of all. The lead time for the building of a modern electrified transport system is about 10 years, and in some cases even 20 years. The key word here is 'infrastructure' and the big issues are then how to finance such projects, who is to finance them and who is to operate them.

CONGESTION

We shall encourage the development of all transportation modes in free competition. That ensures the best service for the society. However, this competition must take into account the negative impact of the three factors mentioned in the introduction and be evaluated when comparing the costs.



To quantify this statement, it can be mentioned that congestion on the roads in the 12 EG countries causes delays on the main roads that annually cost society US\$90 billion. This is what it would cost to build a new high-speed rail system, which could substantially contribute to the improvement of the transport system in these countries and which would consequently be part of the solution to these problems.

POLLUTION

The Second United Nations Conference on World Environmental Issues is to be held in June 1992. The first UN Conference took place in Stockholm 20 years ago. Scientists from all over the world will undoubtedly present reports showing that major efforts will have to be made to decrease the air pollution caused by the transportation sector. Despite the introduction of catalytic convertors on automobiles and of higher quality fuels, it is predicted that emissions in the transportation sector will increase dramatically due to increased traffic in the future. Electric Rail Traction is an effective way to come to grips with this problem.

ADDRESSING THE PROBLEMS

The view of the railway manufacturing industry on the ways and means to address the problems outlined above will now be presented.

Modern technology makes it possible to build electrified railway systems at a considerably lower cost. The heavy structures used in the past have now been replaced by preassembled lightweight designs.

ASYNCHRONOUS PROPULSION SYSTEMS

One of the simplest, most robust and most efficient of all electrical machines is the three phase asynchronous motor. It is reliable, powerful, small, light, economical and practically maintenance free.

Recent research and development work has made the asynchronous motor available for railway applications as well.

With the introduction of the GTO thyristor (Gate Turn Off) and the rapid development of microprocessors the prerequisites for controlling the frequency and torque of the three-phase motors were available for the demanding conditions placed on rail vehicles.

Even since the first prototypes in the early 1970's, ABB has been in the forefront of this important railway technology.

In fact, most of the many hundred rail vehicles that today utilize the benefits of three-phase asynchronous drives operate with ABB equipment.

Continuous development of technology will ensure that we take steps towards more reliable and more cost efficient drive systems. Development in our field of business often is done in cooperation with customers. ABB took an important step forward towards this when planning coordinated system in conjunction with the order for light rail vehicles for the city of Baltimore in the USA two years ago. Delivery has just started of the vehicles which represent the most recent and advanced development in this field as is shown and described in a separate catalogue. The drive system in a modularised system required for easy maintenance. It has been given the design name "MACS"—Modularised AC Drive System for railway vehicles, and is described in a separate pamphlet.

Existing today are the MACS750 products for a DC link voltage (power supply) of 750 or 600 VDC. MACS750 is today used on the Baltimore LRV's and the EMU's Arrow III (New Jersey transit).



SOLVING TRAFFIC PROBLEMS IN ISTANBUL

Istanbul is a good example of a city that has tackled the traffic problems. It is a city with almost 10 million inhabitants and has been faced by all the problems described earlier. Motor traffic at times is so intensive that the traffic comes to a complete standstill, not to talk with the quality of the air. Istanbul has a very ancient history with beautiful old quarters including the palace by the Bosphorus the narrow strait dividing Europe from Asia. In 1986 the city administration decided to start building an entirely new metro system. The first line starts from the Old City and extends in a bow over a distance of 23 km to the airport.

The city administration did not have any experience of planning or building up such a system and asked for tenders on a turnkey basis, including tunnels, tracks, stations, maintenance facility, signalling system and rolling stock. Even training of the drivers and maintenance personnel was part of the scope of delivery.

Above all the supplier had to arrange the total financing scheme and this was successfully done. The first section has been in full commercial operation since 1989. Work is now proceeding on further sections.

CONCLUSION

As demonstrated in the separate enclosures describing railway vehicles their control and drive of different types introduced over the last few years, the railway industry can supply rolling stock and fixed installation systems based on entirely new technology, which will contribute substantially to improve operating economy. Four specific areas should be mentioned in this context:

- Asynchronous drives using GTO thyristors
- Microcomputer control
- New structural design principles
- Bogies with radial steering

Based on this, the railway sector is in a position to play a major role in solving the environmental and congestion problems facing in the world today.

ISTANBUL LRT — A SUCCESSFUL TURNKEY PROJECT

Istanbul is located on the shores of the Bosphorus, bridging the Asian and the European continents. This ancient metropolis has the fastest growth of population in Europe, some 1,000 people every day. The current number of inhabitants is unofficially around 10 millions. The present public transport network is, however, barely able to cope with present demands, let alone those of the future.

1984, in coherence with other cities around the World, schemes involving the construction of a Light Rapid Transit System started to take place. LRT was soon realized to have much to commend it, being cheaper and more rapid to construct than conventional metro or heavy rail, yet providing a permanent alternative to road transport.

DESIGN AND BUILD, TURNKEY CONTRACT

By the end of 1984, the Municipality of the Greater City of Istanbul (GCI) had put together a performance specification based on a design and build, turnkey contract scheme. Tenders were called for, and in 1986, contracts were completed for the construction of an LRT system from Yenikapi to Atakoy on the European side of Istanbul, south of the Golden Horn. The winning ABB - Yapi Merkezi Consortium is comprising

- ABB Traction AB (former ASEA Traction), Sweden, as Consortium Leader
- and
- Yapi Merkezi Insaat ve Sanayii AS, Turnkey, as civil works partner



FINANCING CONTRACT

As a condition of the contract being awarded, the client required an attractive financing package. ABB was able to finance the total contract sum offered of approximately US\$ 400 millions. The package was made possible with the support of government of the countries involved in the project, by use of different export credit systems, and with assistance by an international bank syndicate, comprising some 16 banks.

ISTANBUL LRT SYSTEM

The initial contract, comprising 24.2 km of segregated double track, is divided in 2 stages

- Stage 1 of 8.9 km and
- Stage 2 of the remaining 15.3 km

The contract comprises the design and construction of civil works, the design, supply and installation of electromechanical works and 105 complete light rail vehicles, a comprehensive training program for the employees of the operation company, commissioning of the sub systems and a complete system test.

Originally only minor tunnels and a number of viaducts were planned in the routing, but before the effective date of contract, 2.5 km of cut and cover tunnel was added, including 3 underground passenger stations. This was due to a more extensive feasibility study during the last phase before the start of the works.

THE CLIENT

GCI is the main client and the head of the technical department is appointed project manager, the Engineer.

A separate contract was signed between GCI and the Istanbul Technical University (ITU) regarding technical consulting for the Engineer.

For the operation of the LRT system, GCI, in 1988, formed Istanbul Ulasim Sanyii ve Ticaret AS (Istanbul Transportation Company), ITC.

EXECUTION OF THE PROJECT

The short time available for completion of the first stage necessitated very close cooperation between the Client and the Consortium. It also required the design work, civil works and manufacturing of the hardware to be conducted in parallel. An agreement was reached at an early stage with the Client about fundamental design prerequisites, which then formed the basis for further work. When the project was started up, the principal guidelines had already been agreed upon, but detailed specifications still had to be worked out.

The execution involved a large number of qualified subcontractors and consultants.

A comprehensive time schedule covering the different phases of the first stage going down in details, was elaborated and agreed upon with Client.



SUCCESS IN RECORD TIME

In March, 1989, not more than 30 months from the effective date of the contract the first stage was inaugurated.

A trial operation was started up and an extensive training period for the ITC staff regarding driving the cars, dispatching the traffic, and maintenance and overhaul was carried through.

With the fully trained personnel, verification test were performed in July and August of 1989. The final test, which included operation at 2.5 minutes headway with trains at 80% over load for one hour. The test results were overwhelmingly good and showed that

- The performance of the different sub systems, when working as on LRT system, was excellent.
- The ITC staff was well qualified to participate in the test, both from a driving and a dispatching point of view.

STAGE 2

Some complications regarding the second stage became obvious by the start of commercial operations, and the political change in the Mayoralty, through the local elections in March 1989, and the introduction of a new Engineer on the Client's side, reduced the possibilities for a rapid solution, and has thus lead to a two years moratorium. However, a feasibility study for the second stage was finalized in the beginning of 1991, and a financing package covering US\$100 millions is due for signature in September 1991., which will restart the project.

The time frame for the 9 km second stage is set to 26 months.

Meanwhile, a temporary passenger station has been opened at the Ferhatpasa/Esenler depot, and the number of passengers has increased to some 45,000 - 50,000 per day for the operational 8.9 km system.

ACHIEVEMENTS

The design and build, turnkey method of contracting allows traditional design, manufacturing and construction timescales to be significantly reduced. In the Istanbul case it would also have been impossible to finance the local works unless a turnkey contract had been utilized. The reduced timescales also allow costs to be reduced.

As of today, the operation revenue covers the labour costs to run the present system, but no contribution can be given to the repay of the capital investment. If, however, the national economy is considered the LRT system contributes with

- lower travelling costs compared to cars, buses etc
- a higher average speed than other traffic modes
- a reduction in traffic congestion on highways
- no contribution of exhaust fumes to the heavily air polluted areas of Istanbul

As the second stage will bring more densely populated areas into the reach of the LRT, the future looks most positive.

The modern state-of-the-art system is today operated and maintained by the ITC, without any support from the Consortium, which is an achievement both for the city of Istanbul and for Turkey as a whole.

To this sustainable development, the increased competence achieved within the Istanbul Technical University and also within the civil works partner in the Consortium, Yapi Merkezi, should be added.



WHY TURNKEY?

The turnkey concept is most favorable when some of the following conditions are fulfilled

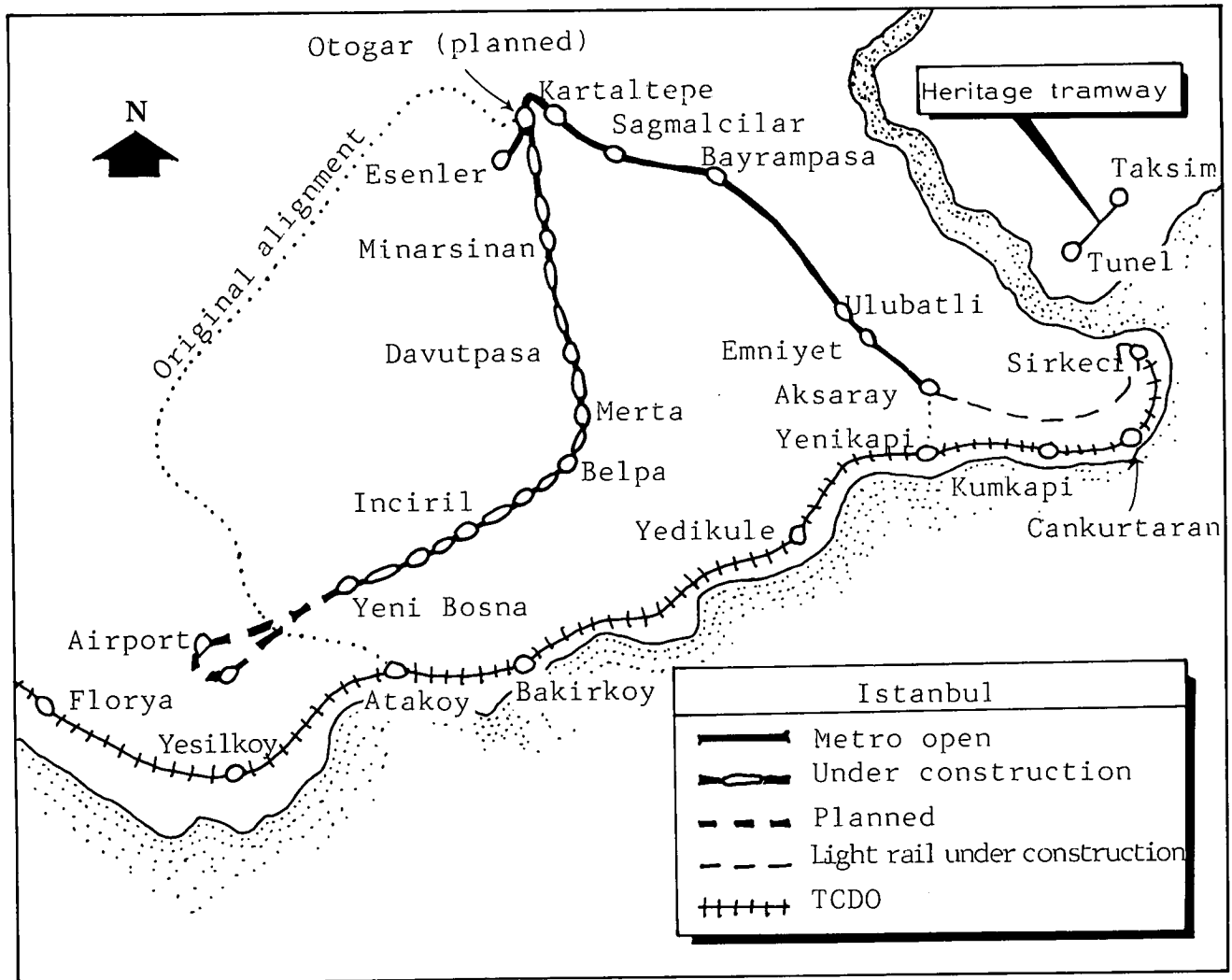
- The client lacks knowledge to perform the total project coordination within his own organization, and he does not consider it cost-effective to develop this knowledge himself.
- Financing arrangements are advantageous if a turnkey approach is used.
- The Client has an interest in minimizing his own risks.

In most cases the financing of public transportation will have to be performed in the traditional way through direct or indirect tax money. It must, however, be stated that projects of this type, with the aim to

- improve the infrastructure of an existing city
- reduce the traffic congestions caused by private cars, buses, etc, and
- reduce the effluent causing air pollution

are not only of local and/or domestic interest. Institutions like to IMF/World Bank, governmental development institutions, etc. should take an interest in the realization of these projects, as this is a global interest.





Paper No. 7

SOCIAL IMPACT OF UPGRADING LOCAL SUPPLY VOLTAGE

Speaker: Mr K.M. Li
Deputy Chief Executive
Consumer Council

SOCIAL IMPACT OF UPGRADING LOCAL SUPPLY VOLTAGE

Up to now, nobody can tell me why the standard electricity supply voltage in Hong Kong was rated at 200 volts single-phase and 346 Volts three-phase. These are quite different voltages from those in other parts of the world. The proposal to raise the standard supply voltages to more widely used ones was first raised in an adjournment debate in the Legislative Council in May 1976. In May, 1990, 14 years later, the Government decided that the supply voltages in Hong Kong should be raised to 220 / 380V through a phased programme.

The Consumer Council was first asked to give its views on the impacts of raising the supply voltage to domestic consumers in 1976, and I am going to address a similar question to-day.

The technical consultant engaged by the Government to study the effects and the implications of the voltage raising proposal gives a succinct list of the advantages to be reaped from switching to the 220 / 380V scheme. We are told that in the long run, the Hong Kong consumer will realize the benefits of upgrading from:

- (a) the availability of a larger selection of standardized appliances;
- (b) enhanced export potential for standardized electrical products;
- (c) enhanced capacity in existing low voltage electrical systems; and
- (d) improved performance of supply companies distribution facilities.

At the same time, the consultant also gave two examples of the near term negative impacts on residential consumers arising from raising the supply voltage. They are the somewhat shortened life span of 200V rated appliances and the 220V rated incandescent light bulb (as compared to its prolonged life under 200V).

The Consumer Council strongly believes that the net effect of raising the supply voltage from the least common to the most common system will be beneficial to the Hong Kong consumer. Therefore, it gives full support to such a proposal and takes an active role in the supply Voltage Advisory Committee for overseeing the implementation of the conversion. In spite of this, the Consumer Council also believes that the "minor, negative, near term impacts" of the conversion on residential consumers should not be treated lightly. The Council is concerned because it appears that other negative impacts of the conversion have not been clearly made known to the public by the consultant. The Council wishes to explore such impacts and to advise possible steps to minimize their effects.

SAFETY HAZARD

One of our main concerns is the additional safety hazard as the result of raising the voltage. We have been advised that if electrical appliances and wiring can operate safely at the existing voltage without overloading, then in general, they can be operated at the new voltage without any safety hazard. We have also been advised that the voltage rating of the wiring already in Hong Kong should be well above the impending upgraded voltage and therefore it will not be necessary for rewiring of existing premises in general.

We do not want to dispute this assurance as we are not fully informed of the measures taken by the consultant to ascertain the potential safety hazard re the existing wiring of domestic premises once the supply voltage is raised by 10%. However we are somewhat concerned about an overly optimistic general view and our worry is not unfounded.

In 1986, the Consumer Council ran a series of tests on nine makes of very popular PVC-insulated electric cables for fixed installation and the test results were quite alarming. Although for the insulation resistance, all nine cables passed the test, our laboratory measurements revealed that six out of the nine makes had smaller cross-sectional areas than those they claimed, and the discrepancies ranged from 13% to 32% difference. Our laboratory examination on "conductor resistance" and "thickness of insulation" of those electric cables further revealed that only two out of nine makes were able to satisfy all the requirements laid down in British standard 6004. Table 1 of this paper tabulates the test results for reference.

Judging from the wide availability of these substandard electric cables in the market, it is reasonable to assume that they are also commonly used in many existing installations.



The fact that all nine cables were found to comply with BS 6004 in insulation resistance might imply that the cables would operate satisfactorily at 300 / 500V, and thus apparently they should be able to bear the new supply voltage of 220 / 380V. However, the Consumer Council would like to caution that the reduced conductor size and the non-compliance of some cables with the requirement of conductor resistance might also imply that their current carrying capacity and the consequential temperature rise should be of concern. This is because excessive temperature rise above the design limit of the cable might lead to fire hazard. Subsequently, the Consumer Council does not feel comfortable in supporting that all the wiring installation which can operate safely in the existing voltage can be operated at the new voltage without any safety hazard. Further evaluation should be conducted before such advice could be given.

In 1990, there were over 1300 incidents of fire which originated from electrical overloading, short circuiting and faulty installations (but excluding electrical appliances). These incidents amounted to more than 21% of the fires that took place in premises. Therefore, the hazards of electrical fault origin should be of grave concern to all of us. The Consumer Council, knowing that sub-standard cables have been widely used, is naturally very anxious to know whether the situation would be aggravated by the increased voltage of 10%. It appears there is no ready answer to this except to carry out the necessary inspection.

In the 70s when the voltage in certain districts in the United Kingdom was changed from 200V & 220V to the standard 240V, the district's electricity boards had to bear the cost of checking the installations and adapting consumers' appliances for the new voltages. Further, if any piece of electrical apparatus failed within 6 months of the date when the increased voltage was introduced, the district boards concerned were held liable for such failure. Unfortunately, this is not the case in Hong Kong.

In Hong Kong it has been made clear that the power companies will not be responsible for adjusting consumer's installations for 220 / 380V operation. Under such circumstances, it is up to individual consumers to decide whether to employ qualified electricians to check their wiring installations prior to the voltage upgrade. Consumers should note that the Electricity Ordinance 1990, which will be fully operative in mid 1992 defines the responsibility among owners of electrical installation, power companies, registered electrical contractors and registered electrical workers.

Under the new legislation residential owners shall also employ registered electrical contractors to inspect the safety of their installations as and when required and this should be carried out irrespective of the voltage upgrade exercise. It is believed that many residential owners might find it onerous when required to carry out such inspection. Therefore the consumer must be advised adequately that it is in their interest to arrange this exercise so they feel justified in the demands it makes on their time and money. A more preferable way is to advise building managements to take up the job collectively in order to save the trouble to individual owners.

At the same time, we can see that there is always the possibility of unscrupulous traders cashing in on the situation to wrongly persuade consumers that all wiring must be automatically replaced or by charging inflated prices for their services, although the consumer shall be aware that any malpractices of the registered electrical workers and contractors are under the control of the Government. To prevent this from happening we would like to see the power companies set up a hotline and accessible advice centres to deal with consumer enquiries or complaints. The trade of electrical contractors, which is now more organized, can also help by publishing guides to costs for common electrical servicing, and informing consumers how best to check the integrity of an electrical contractor.

POWER CONSUMPTION

The second major concern with raising the supply voltage is whether the consumer will end up with a higher electricity bill. We have been assured that, even though the power companies will incur additional expenses in raising the supply voltage, the capital expenditure involved will not be of a magnitude sufficient to have a knock-on effect on tariffs. This means the consumer will not have to face higher electricity charges.

However, if we now look to the question of whether domestic consumers will have to pay a higher electricity bill, it might be a different matter. The consultant has concluded that "the conversion will not result in a significant increase or decrease in sales by the supply companies. Overall, the net effect of voltage upgrading on the revenue income of the supply companies should only be minimal one way or the other." The Consumer Council views such conclusions with reservation.



It is understood that the increased voltage will affect the power consumption of different types of electrical appliances in different ways. It is generally believed that the increase in power consumption by an appliance as the result of raising the supply voltage could be compensated for by a corresponding increase in efficiency and thus the running costs of such appliances could remain more or less the same. e.g. the increase in light output of an incandescent light bulb could provide an opportunity to use lower wattage bulbs; the greater cooling power produced by an air-conditioner with thermostatic control could lead to a shorter operating time for a certain cooling effect.

While recognising the enjoyment of better performance of the domestic appliances, we can see that in many cases, there is little that a domestic consumer can do to avoid paying a higher electricity bill after converting to higher supply voltage. (In fact no one has ever suggested that a consumer could pay less). Our view is made after studying the following real-life situations.

First, it is not easy to change the consumer's habit in using his appliances. e.g. he would still be inclined to take 30 minutes to clean his flat with a vacuum cleaner whether it is being operated under a supply voltage of 200V or 220V.

Second, no appropriate substitute items are available to enable a reduction in power consumption to be effected. e.g. there is only a limited range of wattages in incandescent light bulbs for consumers to choose from.

Third, due to the design and environmental factors, the thermostat of an appliance might not be able to function properly and to attain the expected corresponding reduction in operating time. e.g. a thermostat of an air-conditioner may not switch itself on and off in such a way that the additional power consumption at 220V is fully compensated for by reduced operating time.

Fourth, the consumer may not know how or is not able to adjust his appliances to avoid an unnecessary increase in power consumption. e.g. if an electric fan or heater is already customarily run at its lowest setting, it is impossible to turn it down further to allow for extra efficiency in operation at 220V.

Fifth, when complex alterations are required, which entail specific practical techniques, the consumer may decide against employing an electrician to make the changes. e.g. he does not think it worthwhile to install a dimmer system to reduce the power consumption of his lighting.

The short term impact of all these situations is that the consumer will end up paying a higher electricity bill after the supply voltage is raised. We are of the opinion that consumers should be advised of this fact accordingly. And at the same time, we consider that the Government, through its Supply Voltage Advisory Committee / Energy Efficiency Advisory Committee, together with the power companies, should step up their consumer education programme to educate the public on how they can best avoid increases in power consumption when the supply voltage is raised.

OLD INSTALLATIONS & APPLIANCES

A further issue of concern is the effect of the increased voltage on appliances or installations rated at 200 / 346 volts. It is recognized that domestic appliances designed for use on a 200V supply can operate on a 220V supply (and vice versa) but their life-span with a higher voltage will be shortened. However we consider that this negative impact is acceptable.

When the Consumer Council was first asked, in 1976, to comment on the proposal of raising the supply voltage, it concluded that the consumer stood to gain little or nothing in the conversion. This conclusion was made on the basis that the proportion of 200V rated appliances available was greater than the 220V rated ones. But when the number of 200V rated appliances available is compared to the number of 220V rated ones on the market in the last five years, an emerging trend in favour of 220V or 200/220 dual voltage models is apparent. This goes for samples of all popular appliances. According to market surveys conducted by the Consumer Council in 1987, it was found that 67% of the makes of window air-conditioners were designed for 200V. However in 1989, the corresponding figure fell to 21%. In 1991 only 10% of the makes of split-type air conditioners were rated at 200V and 100% of desk lamps and microwave ovens were rated at 220V or higher. This is a very clear indication that Hong Kong consumers will have less and less choice of 200V appliances. It also means that any new appliances bought are likely to be rated at 220V, and are thus ideally suited to the increased supply voltage so that we can today expect a natural gradual replacement of domestic 200V goods with 220V ones, which was not the case in 1976.



Having said this, we must also advise consumers that there is no urgent need to replace their 200V rated domestic appliances as there will be no significant adverse effects from using these appliances when the supply voltage increases. Complaints against unscrupulous electrical appliance shops always top the list of consumer complaints, and we are worried that these traders will also cash in on the situation to wrongly persuade the unwitting consumer to replace their domestic appliances before they actually need to do so. Thus this is an area which needs more consumer education when the conversion of voltage is implemented.

On the other hand, we are also worried that some traders, knowing that the supply voltage is soon to be raised, will pursue every means available to clear the 200V rated appliances from their stock during the transitional period. They might induce consumers to buy these now out-dated appliances through price reductions. Therefore, consumers should pay particular attention to the voltage rating of any new electrical appliances and devices they intend to buy from now on. They should look for the 220V rated or at least the 200/220V dual voltage appliances because the performance of these will be enhanced and their life-span extended with the new voltage. In this respect the consultant has recommended that manufacturers be required to collate and file information on the voltage ratings of their appliances with the Government or the Consumer Council before the supply voltage is raised. This will enable the Council to make relevant information available to the consumer. We endorse this recommendation and would be very pleased to help minimize the impact of the transition on consumers in this way.

While acknowledging that the negative impact of raising the voltage will be of an acceptable level for appliances used at home, we are more cautious when talking about any adverse effect on the operation and maintenance of lifts in high-rise buildings. The Consumer Council has received divergent views in respect of the effects of raising the supply voltage on the functioning of lifts in high rise buildings. While some consider that the raised voltage will probably lead to more frequent breakdowns if no substantial adjustments to the system are made, others consider that only minor adjustments, such as levelling, are required.

In connection with this concern, the Government carried out experiments and tests on the E & M equipment, including lifts and escalators in five Government buildings to ascertain the effect of an increased voltage of 220/380V. No adverse impact on lift operation or maintenance was reported. Subsequent phase I work on 77 Government installations has so far supported this finding. Further, no lift or escalator manufacturer has been able to substantiate that the proposed increased voltage will have any negative impact on lift and escalator motor. Therefore the minor adjustments to the system should be taken as monthly routine service by lift contractors.

We understand that all lifts in buildings are maintained by qualified contractors and while we are sure that the technical problems arising from the change can be dealt with easily, we are concerned with the social impacts which might arise. If as suggested above, the necessary adjustments to lift systems for voltage upgrading are included in the monthly routine service by lift contractors, then it will be of benefit to the public. We hope the trade will give open and definite confirmation to this effect as soon as possible.

However should it be found necessary to make substantial adjustments to the lift system as the result of raising the voltage, there might be a substantial charge to cover this or an increase in the cost of a maintenance package. Consequently unwanted disputes between the occupiers and the building management might arise. This is because the sum of money involved can be quite substantial. In some large housing estates, such incidents could easily become a complicated social issue as they affect a large number of people. The hardship faced by some building management organizations in meeting the cost of modification should not be under estimated.

The apparently restrictive practice provided by lift maintenance contractors has long been a common cause for complaint by consumers. Therefore it is now important for the trade concerned to tackle the problem directly and give candid and useful advice to their clients well in advance. The trade might be able to anticipate the hardship likely to be faced by building managements. Therefore it should examine collectively ways and means to reduce the implications of making the necessary adjustments. The trade could also improve the services to consumers in this voltage upgrade exercise by coordinating their service with the upgrade voltage programme in various areas.

CONCLUSION

I have just pointed out the three main negative impacts of raising the supply voltages, namely, safety, cost and effect on appliances. I could probably be criticised for painting a rather pessimistic picture of the outcome of changing the voltage. However the Consumer Council thinks that it has a duty to ensure that the consumer is fully aware of both sides of the coin. While not wishing to put a dampener on the situation, we felt it was necessary to expand on the 'minor, negative, near term impacts' to the consumers for their awareness and so they understand the possible solutions.

I reiterate here that the Consumer Council fully supports the proposed raising of the supply voltage and is convinced of the net benefits it will bring about. In forewarning the public of the potential drawbacks of the scheme before it is fully implemented, the Consumer Council hopes that consumers will be properly advised to offset by major hardships that may otherwise have arisen. It also hopes that power companies as well as electrical contractors can foresee those hardships and do their best to help alleviate the negative impacts on consumer. As a result, I can confidently predict a more enthusiastic reception for raising our supply voltage from consumers.



Comparative Test Results on PVC Electric Cable Published by the Consumer Council in "CHOICE" in March 1986

Code	Brand	Identification Marking	Country of Origin	Price per Reel	Length	Cross sectional Area of Conductor				Conductor Resistance	Sheath Thickness	Insulation Thickness	Insulation Resistance
						Marked Information	Value Calculated from marked Information (sq. mm)	Value Measured (sq. mm)	Discrepancy				
01	AEI	EX1488/53, 0192Y	U.K.	\$195	100m	2.5 sq. mm	2.50	2.50	0%	✓	✓	✓	✓
02	COMPANION	PVC INSULATED & SHEATHED CABLE TO BS 2004:1061	HONG KONG	\$105	100 Yard	7/0.29 in	2.08	2.59	-13%	✓	X	X	✓
03	FLYING EAGLE	PVC CABLE	HONG KONG	\$105	100 Yard	7/0.29	2.05	2.04	-31%	X	✓	X	✓
04	"L"	PVC ELECTRIC WIRE SPECIFICATION TO BRITISH STANDARD	HONG KONG	\$106	100 Yard	7/0.29	2.05	2.59	-13%	X	X	✓	✓
05	LIBERTY	PVC CABLE	HONG KONG	\$106	100 Yard	7/0.29 in	2.05	2.22	-26%	X	X	✓	✓
06	ROYAL HORSE	PVC/PVC ELECTRIC WIRE SPECIFICATION TO BRITISH STANDARD	HONG KONG	\$170	100 Yard	7/0.29 in	2.05	2.04	-31%	X	✓	X	✓
07	TIAN-TAN	ELECTRIC WIRE TYPE 6303	CHINA	\$230	100 Yard	7/0.29 in	2.05	2.05	0%	✓	✓	X	✓
08	"WINSTON"	TWIN CORE PVC/PVC WIRE	HONG KONG	\$118	118 Yard	7/0.29 in	2.95	2.40	-20%	X	X	X	✓
09	LIBERTY	PVC CABLE HKQ-MARK TO BS 6004	HONG KONG	\$185	100m	4.0 sq. mm	4.00	4.10	3%	✓	✓	✓	✓

A minus sign means that the measured area is smaller than the value claimed.
 Conducted with reference to BS6004:1054
 ✓ : Satisfactory in the particular test item
 X : Not in compliance with the BS6004:1054

TABLE 1



Paper No. 8

CONDITIONS OF CONTRACT

Speaker: Mr David Bateson
Partner
Jewkes and Partners

CONDITIONS OF CONTRACT

SUMMARY

A. REVIEW OF STANDARD SUB-CONTRACTS

(i) General

Sub-contracting is an important part of the Hong Kong construction industry. Contractual arrangements vary widely from simple verbal agreements to standard forms, and to complex forms specifically drafted for projects. Most sub-contracting is done on standard forms, which are either nominated or domestic, and the parties are usually familiar with these.

Whilst sub-contractors carry out the majority of construction work in Hong Kong, they do not have a strong bargaining position and consequently are discriminated against in conditions of contract, for example, the "pay when paid" provisions of the Private Green Form. In the event of disputes between the employers and main contractors, the sub-contractors often suffer from lack of cash flow, which adversely affects their ability to tender for new work, and in extreme cases, forces them out of business.

(ii) Private Form — Green Form

For use where the sub-contractor is nominated under the Standard Form of Building Contract sanctioned by the HKIA, RICS and Society of Builders, based upon its UK equivalent, but with variations.

Some of the important clauses in relation to claims are:

(a) Clause 1 — Notice of the Main Contractor to the Sub-Contractor

It places the onus on the sub-contractor to establish the main contract requirements.

(b) Clause 7 — Variations

Variations can only be ordered if they emanate from the architect. The contractor can give reasonable directions under Clause 2 but not variations.

(c) Clause 8 — Completion

- i. An architect's certificate on delay is required.
- ii. Reasonable notice of loss and expense to the sub-contractor is not a condition precedent to recovery.
- iii. Notice of delay at the appropriate time is probably a condition precedent to extension of time.

(d) Clause 11(b) — Pay when Paid

- i. This is very disadvantageous to the sub-contractor. As a result of the decision of the Hong Kong Court of Appeal in *Schindler Lifts (Hong Kong) Ltd v Shui On*. The Nominated Sub-Contractor ("NSC") will not obtain summary judgement in Court against the Main Contractor where the latter has not paid the relevant monies certified by the Employer's Architect. The pay when paid provision was primarily inserted to protect the Main Contractor against the risks of insolvency of the Employer.
- ii. According to *Hunter J* in the *Hong Kong Teakwood Works* case, the Main Contractor incurs no liability to pay the NSC until he receives payment from the Employer. Therefore, Clause 11(b) is to be construed literally.
- iii. The NSC is left with no option but to pursue his monies in Court or arbitration.
- iv. If an NSC is not at fault, it is unfair if he should be deprived of payment solely on the grounds the main contractor is in default and has not received payment from the employer.



(e) Clause 11(e)

This provides that the sub-contractor can suspend work when he has not been paid.

(f) Clause 13

- i. This clause entitles the main contractor to set off any sum for which the NSC is liable to pay to the main contractor under the sub-contract.
- ii. There is no set-off for liabilities under any other sub-contract between the parties.
- iii. Set off must be bona fide and in relation to monies already incurred.

(iii) Government Form

It is to be used in conjunction with 'Genral Conditions of Contract for Building Works' 1985 Edition.

This is similar to Green Form.

(a) Clause 13 — Commencement, Completion and Extensions of Time

There is a 30-day limit on notice of delay.

(b) Clause 14 — Variations

Architect's power to give variation orders is restricted to instructions necessary for the satisfactory completion and functioning of the sub-contract works.

(c) Clause 17 — Stringent Notice Requirements

Cut-off date of 120 days after completion has been certified for the whole of the works.

(d) Clause 21 — Application for Payment

There is a "pay when paid" provision. Interest is payable on sums the main contractor fails to pay.

(e) Clause 29 — Settlement of Disputes

- i. The Architect is required to give a decision on all disputes. The sub-contractor is obliged to proceed with the works once such a decision has been given, and gives effect to the decision unless the same is revised by an arbitrator.
- ii. These conditions make no provision for suspension of the works.

(iv) Domestic Form of Sub-Contract

There are many forms used in Hong Kong. I will deal with the proposed new Domestic Specialist Sub-Contract Form later.

B. ADVANTAGES OF NOMINATION

The advantages for adopting the nomination system may be summarised as follows:—

- (i) Owners Can Choose Specialists. As already noted, the owner can choose the sub-contractors for the specialist parts of the work.

(iv) NSC Design Errors

- (a) If delays and loss and expense are caused to a contractor by reason of design errors by an NSC or design changes, then the contractor is ordinarily entitled to extensions of time and loss and expense; the same as if it was a change by the consultant in his design. The employer has no remedy against the NSC in Hong Kong, unless he has a direct warranty.
- (b) Further, if there are design defects in NSC works, the consultant is under an obligation to issue a variation instruction to the contractor detailing changes required to overcome design defects. The consultant cannot therefore play his cat and mouse games by requesting proposals from the contractor but offering no solution himself.

Case of: Holland Hannen & Cubitts v Welsh Health Technical Services Organisation 1981

(v) Direct Warranties

- (a) Since the employer has no contractual relationship with an NSC, he ordinarily has no recourse against him in the event of NSC default. His remedy is against the contractor.
- (b) The employer can overcome this by insisting upon a direct warranty between him and the NSC - and this is common practice. Normally the NSC warrants that he has exercised and will exercise all reasonable care and skill in the design of the works in so far as they have been or will be designed by the sub-contractor and in the selection of materials or goods for the sub-contract works in so far as such materials or goods have been or will be selected by the sub-contractor.

D. ENTITLEMENT TO LOSS AND EXPENSE UNDER GOVERNMENT SUB-CONTRACT

- (i) Under the Government Standard Form of Nominated Sub-Contract (1978 Edition - Architectural Office), there is no written provision for payment of loss and expense where the NSC suffers delay and disruption as a consequence of instructions issued by the architect. The main contractor is, however, entitled to loss and expense under Clause 73(1)(b) and (c) or Clause 76.
- (ii) On many ASD projects, NSCs have submitted claims to the main contractors for loss and expense as a result of instructions issued by the architect. Such instructions constitute either direct variations to the sub-contract works, or variations issued to the main contractors or other NSCs, which cause indirect knock-on effects to the NSC works.
- (iii) The main contractors have passed these claims to the architect / surveyor for valuation but the general ASD policy, subject to the exception in (v), has been to refuse any payment because of any clause in the sub-contracts entitling the sub-contractors to loss and expense. Disputes have therefore arisen and the sub-contractors have requested arbitration under the sub-contracts. The main contractors in turn have then, on occasions, joined in the Government to such arbitrations.
- (iv) The sub-contractors have argued that the valuation of variation requirements of the sub-contracts are back to back with the main contracts. They have also argued that there is an implied term of the contracts that they are entitled to be compensated for all the consequences of a variation, whether it be prolongation or disruption costs.
- (v) ASD have agreed, on some contracts, that where a variation directly affects the sub-contractors' works, then they will pay for loss and expense reasonably incurred as a result of the variation. Where, however, a variation to the main contract or other sub-contracts has an indirect knock-on effect on an NSC works, then they have refused to pay for any loss and expense.
- (vi) due to ASD's rejections, Working Group of NSCs banded together to consider taking a 'test case' to the Court for a decision on this legal issue which would be binding on the industry. The Court was preferred because an arbitration award would only be binding on the parties and not others. Originally, this Working Group sought to obtain Government's consent to a test case but as this was not forthcoming, they are currently deciding whether or not to proceed to seek a Court ruling. If they decide not to proceed, then it appears the industry will not have binding decision guidance on this issue.



E. PROPOSED NEW GOVERNMENT DOMESTIC SPECIALIST SUB-CONTRACT

- (i) To cater for Government's General Conditions of Contract for Building Works, in conjunction with Architectural Services Department and the Electrical Mechanical Contractors Association, the HKCA has proposed a new Standard Form of Domestic Sub-Contract (the Domestic Form) for specialist contractors. It is yet to be finalised.
- (ii) The Domestic Form is modelled on the English Federation of Civil Engineering Contractors Blue Form, a form of sub-contract conditions for use with the ICE Conditions. As Government Main Conditions owe their genesis to the ICE Conditions, by adapting the Blue Form, the risk of inconsistency with the Main Conditions is minimised.
- (iii) Significant changes are made in the following areas:-
 - (a) In addition to the deeming provision that the sub-contractor has full knowledge of the provisions of the main contract, it is expressly provided that the sub-contractor shall assume and perform in respect of the sub-contract Works all the obligations and liabilities of the contractor under the main contract, except those to be undertaken by the contractor as expressly provided in the sub-contract.
 - (b) The sub-contractor is required to price for the possible effect of concurrent activities as shown in the contractor's programme of work.
 - (c) Express power is reserved for the contractor to serve written notice to the sub-contractor requiring the latter to take necessary measures to catch up with delay (except where extension of time is applicable or the delay was caused by the default of other trades) and on non-compliance by the sub-contractor, the contractor has the right to employ others to carry out the sub-contract Works and recover the costs of doing so from the sub-contractor.
 - (d) New provisions are also inserted to match with the latest changes in the Main Conditions relating to the optional dispute resolution by way of mediation, which is now strongly advocated by Government.
 - (e) The sub-contractor is also required to give a performance bond to the contractor within 14 days of execution of the sub-contract. It is expressly provided that payment due under the sub-contract shall not become payable unless and until the bond is provided. This provides an effective sanction to ensure that the sub-contractor will not neglect to comply with this requirement.
 - (f) The sub-contractor will also be required to give a direct warranty to the Government in the specified form. This warranty will afford some protection to the Government even though the Government will have no control over the choice of the sub-contractor.

