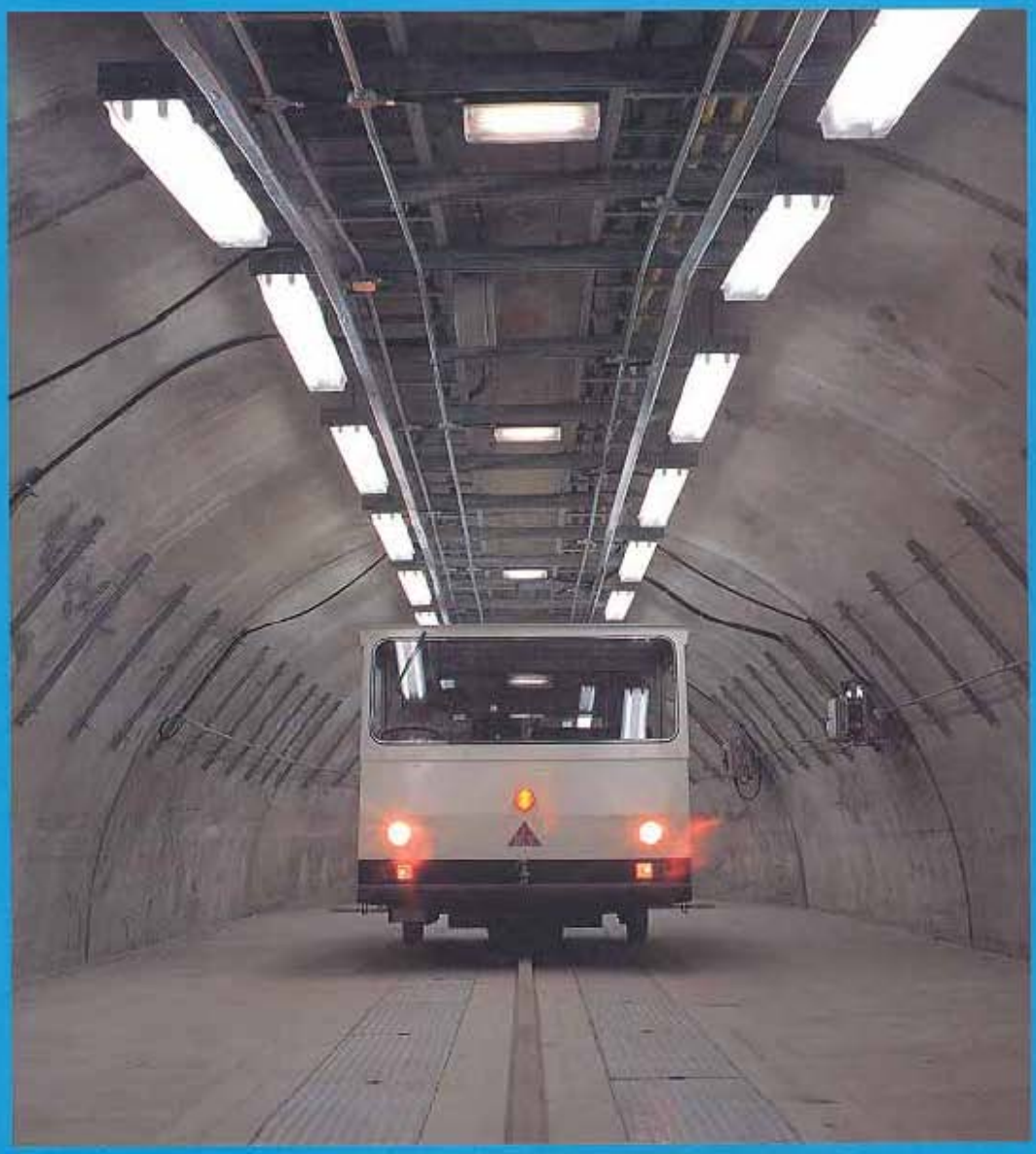
THE HONG KONG
INSTITUTION OF ENGINEERS

ELECTRICAL DIVISION

Symposium

For Better or For Worse
— An Electrical Engineering Perspective



Tuesday 13th November 1990

THE HONG KONG INSTITUTION OF ENGINEERS ELECTRICAL DIVISION

Symposium

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For Better or For Worse — An Electrical Engineering Perspective

at

Silver Ballroom,
Sheraton Hotel,
Nathan Road,
Kowloon.

SYMPOSIUM PROGRAMME

08.30 Registration and Coffee

09.00 Introduction
- Symposium Chairman: Mr. L.Y. Cheung, MHKIE, CEng, MIEE
- Welcome by: Dr. C.C. Chan, FHKIE, CEng, FIEE
  Chairman, Electrical Division, HKIE

09.05 Opening Address
- Mr. James Chiu, BSc. (Eng), FHKIE, CEng, FIEE
  President, HKIE

1. Supply

09.10 Development of Worldwide Power Station Capacity and the Carbon Dioxide Problem
- Speaker: Dr.-Ing. Holger Ann, Deputy Director, Siemens AG, Power Generation Group KWU, West Germany

09.30 Future Generation Development
- Speaker: Dr. Y.B. Lee, Divisional Manager-Planning & Systems, China Light & Power Co. Ltd.

09.50 Discussion

10.10 Coffee

2. System

10.40 Newly Developed Digital Protection Relays
- Speaker: Mr. Youichi Sasaya, Manager, Power Systems Department Mitsubishi Electric Corporation, Japan

11.00 Railway Transportation — From Steam, Diesel to Electric Traction
- Speaker: Mr. Y.H. Chang, Senior Research & Development Manager, Kowloon Canton Railway Corporation

11.20 Airport E&M Systems: Today and Tomorrow
- Speaker: Mr. S.K. She, Senior E&M Engineer, Electrical & Mechanical Services Department

11.40 Discussion

12.15 Lunch

3. Practice

14.15 Contracting in the 90's
— Speaker: Mr. C.K. Lau, Vice President, H.K. Electrical Constractors' Association Ltd.

14.35 Quality Assurance in Consulting Engineering Practices
— Speakers: Mr. Patrick Yip and Mr. S.K. Au Yeung Partners, J. Roger Preston & Partners

14.55 Discussion

15.10 Coffee

4. Management

15.30 Implications of the Control of Exemption Clauses Ordinance for the Hong Kong Construction Industry
— Speaker: Mr. Philip Nunn, Partner, Simmons & Simmons

15.50 Current Personnel Management Problems and their Impact on Electrical Engineers
— Speaker: Mr. Patrick Maule, Personnel Director, Mass Transit Railway Corporation

16.10 Discussion

16.30 Summing Up:
— Symposium Chairman: Mr. L.Y. Cheung, Chief Engineer (T&D), The Hongkong Electric Co. Ltd.

Closing Address
— The Hon. H.K. Cheng, OBE, JP, Member of the Executive and Legislative Councils

Acknowledgement

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Speakers/Authors

James Chiu
Dr.-Ing. Holger Ann
Y.B. Lee
Youichi Sasaya
Y.H. Chang
S.K. She
C.K. Lau
Patrick Yip
S.K. Au Yeung
Philip Nunn
Patrick Maule
H.K. Cheng, OBE, JP.

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SYMPOSIUM ORGANIZING COMMITTEE

Symposium Chairman: Mr. L.Y. Cheung

Organizing Chairman: Mr. L.Y. Cheung

Members: Dr. C.C. Chan

Mr. S.T. Tam

Mr. C.K. Tsang

Mr. T.H. Tai

Mr. Simon Kum

Mr. Y.K. Chu

Mr. C.L. Wong

Hon Secretary and Treasurer: Mr. S.K. Ho

Paper No. 1

DEVELOPMENT OF WORLDWIDE POWER STATION CAPACITY AND THE CARBON DIOXIDE PROBLEM

Speaker: Dr.-Ing. Holger Ann
Deputy Director
Siemens AG, Power Generation
Group KWU, West Germany

DEVELOPMENT OF WORLDWIDE POWER STATION CAPACITY AND THE CARBON DIOXIDE PROBLEM

Governments and the utility industry, international financing institutions as well as energy related industries like oil-, gas- or mining-companies have a strong interest in the future development of the electrical power industry. The same applies to manufacturers, as the utility business is a long term business with high investment costs. The manufacturing facilities, the engineering workforce and the sales organisation must meet the requirements at least of the next one or two decades. Moreover the monopoly of the power equipment industry in the industralized countries is fading away. It is essential to build up local industries and to transfer technology to the developing countries. The success of local manufacturing, however, depends among other things on adequate investment. "Adequate" means according to the local needs and a certain share for export later on.

Both reasons require a substantial knowledge what's going on in the utility industry both private and governmental in industrialized and developing countries.

In the sixties and seventies the targets for the development of the electric power industries in different countries were defined by long-term projections of electricity demand or political and economic aims of state-owned institutions. In most cases plenty of capital was available. In the eighties things have changed considerably. The targets are related to the overall economic situation, i.e. to the domestic and foreign financial resources.

It is necessary to create planning criteria which make it possible to forecast the development of the electric power industry in the next 15 to 20 years. Therefore the economic trends have to be taken into account, especially the development of the gross domestic product (GDP), the gross domestic investment and the share for the electric power industry. In developing countries the gross domestic investment is in the range of 25% of the GDP (1).

The share of the investment in the electric utility industry comprising power stations and transmission and distribution facilities is about 6 to 12% of this, that means about 1.5 — 3% of the GDP.

As the projections of the growth of the GDP by the international financing institutes (1) seem to be relatively substantial and reasonable, they are a guideline for the future financial potential of a country with respect to its electric power investment. So the available amount of money and also the specific investment costs for 1 kW of installed generating capacity plus the respective share for transmission and distribution are known. From this follow the megawatts of power stations and the circuit-kilometers of high voltage and low voltage lines including metering in the houses, which can be installed in that country.

The share of the GDP for the utilities in industrialized countries is lower. Their share is in the range of 0.5 to 1.5% of GDP (for the time being 0.6% in the Federal Republic of Germany).

The method of comparing the investment in the electric power industry with the abovementioned share of the GDP is a simple means to check whether a published plan is in accordance with the future financial resources of that country, or to get an idea which investment can be performed at a predicted rate of rise of the GDP.

To find out what the capital demand in the next two decades will be projections of the electricity generation worldwide, of the development of the generating capacity and of the capital demand for the utilities and private or independent power producers may be useful.

Before discussing these figures we will see the capital requirements of all kinds of energy and the share of electricity.

At the World Energy Conference 1986 in Cannes a paper was presented (2) showing the investment requirements for the energy supply of the world between 1980 and 2000 (Table 1). It is interesting to see that 65% of the accumulated capital requirement is needed for electricity, 21% for oil, 10% for natural gas and 4% for coal.

Fig. 1 shows the projections of the generation of electric energy up to the year 2020. The generation will double between 1980 and 2010, and by the way, the value of 1980 was already eightfold that of 1950, but the rate of rise is expected to slow down to less than 2% p.a. worldwide, to then 1% in the industrialized countries of today and 3.3% in 2010 in the developing countries of today, except in those being industrialized in about 20 years, thus coming into a state of saturation. According to papers prepared for the World Energy Conferences in 1986 and 1989 the figures were broken up into the three groups: Industrialized Countries (OECD including Western

Europe, USA, Canada, Japan, Australia, NZ) exclucluding Greece, Portugal and Turkey; Centrally Planned Economies (Eastern Europe) and the Developing Countries, comprising all other countries including China. The World Bank uses another classification — high, medium and low income countries, but we don't have the corresponding figures up to now.

Fig. 2 shows the installed generating capacity by regions and by their primary energy sources. It will be slightly less than 4000 GW in the year 2010. By far the largest growth will happen in the developing countries, mainly in East- and Southeast-Asia and Latin America. The actual demand for new generating capacity will be much higher but limited by financial restrictions. A considerable growth is also being predicted in the centrally planned countries. These figures are not as reliable as they were one year ago because a general switch-over to market economies and financial restrictions may change the picture. The growth in the industrialized countries is relatively small as the efficiency of the power stations is higher and financing of energy saving measures is easier.

Fig. 2 also shows the development of the installed generating capacity by their primary energy sources gas, oil, coal, nuclear and hydro. Other renewable energies will not exceed 5%.

Oil consumption for oil fired steam power plants, gas turbines and diesel power stations will still increase because of the modest price level expected to remain at least until the end of the century. Even a limited Gulf crisis should not be able to change the trend. Oil consumption will increase only slightly in the next century as prices will increase because of shrinking resources.

The importance of gas will grow. There is already a boom in gas-turbines and gas-fired combined cycle power stations worldwide because of lower investment costs and special qualities of gas as a fuel source. With regard to the resources there will be similar limitations as with oil.

Coal fired power stations will be added at a considerable amount (e.g. China) as coal is the only primary energy available in many countries and without limitation for the next two or three centuries.

Nuclear fuel has reached a very significant share in electricity production starting just in the late 60ies. A further growth can be expected.

Hydro power will extend its share as the only large-scale renewable energy present in the next decades. The hydropower capacity forecast for 2000 and 2010 seems reasonable as in 1990 a capacity of 836 GW is in service or under construction and further 785 GW are in the planning stage (3).

Fig. 3 gives the estimations of the capital demand for the electric power industry in billions of US$ per year. The capital requirements in the industrialized countries will remain on the same level for the next twenty years. The actual capital demand in developing countries will grow fast and will be as high as in industrialized countries in 2010.

The problems and restrictions in industrialized countries are in the first place ecological and administrative and second financial. In developing countries the problems are mainly financial.

Here we could and with a view to the next 20 years of utility development, but there is still another aspect which is getting much attention in public just now — the Carbon dioxide problem. For many years ecological considerations have had an impact on the siting and construction of electrical power plants, mainly large hydro power stations, nuclear power stations and the installation of desulphurization and denoxing equipment of conventional thermal power stations. But in recent years the tremendous problems arising from the global warming of the earth are more and more getting into focus, not so much as a result of the waste heat of power stations which is a special problem, but the warming up of the earth by the so-called Greenhouse Effect.

In this respect Carbon dioxide is of great importance as it makes up about one half of the Greenhouse Effect. The other 50% come from various trace-gases. Fig. 4 shows the split-up of the CO_2 emissions. The share of the power stations burning fossil fuel is about 11% of the total emissions.

The environment-conference "The Changing Atmosphere" in Toronto in June 1988, the so-called "Toronto Conference" gave guidelines to reduce the CO_2-emissions by 20% of the emissions of today for the year 2005 and by 50% for the year 2050. In our opinion these requirements are justified to protect our environment but the target can only be met with new technologies still to be developed.

As different types of fossil fuel produce different amounts of CO_2 new strategies for the generation of electrical energy are necessary. The ratio of CO_2-emissions produced per unit of energy from coal, as compared to oil and gas, is 10:8.6:5.6. From this it might seem obvious to switch over from coal to gas or oil. Unfortunately the known reserves of gas and oil are much smaller than the coal reserves and must not be wasted in the next 20 years. Therefore the conservation of energy should in any case be given the first priority. That can happen with more efficient household appliances, fridges and freezers, air conditioning plants, lighting in the domestic and industrial sector and load-controlled industrial motors. Better thermal insulation may result in lower losses in heated as well as in airconditioned buildings.

On the generation side more efficient equipment or even processes have been introduced or are in the state of being developed. Heavy duty gas turbines for high operating temperatures have been developed in the last two decades and are still being improved. They are a very important alternative to steam power plants, especially because of their relatively low investment costs, short erection times and the favourable equalities of natural gas.

The combination of gas and steam turbines in a combined cycle system has an even better efficiency — about 50% compared with nearly 40% at best of modern coal power stations — and thus an even higher reduction of CO_2-emission

Another innovation is the gasification of coal. Various processes have already been successfully developed and others are still being tested. If the process of the gasification of coal and of the cleaning of the gas is linked to a combined cycle, resulting in the so-called "integrated gasification combined cycle (IGCC) power plant", the large reserves of coal can be utilized with much better efficiency.

As already mentioned, the Toronto Conference 1988 demanded a reduction of today's CO_2-emissions by 20% in the year 2005. This raises a major problem, as the consumption of electrical energy will grow by more than 50% worldwide in the next 20 years even under the assumption, that all conservation efforts mentioned above will be made. A technical solution like filtering the CO_2 out of the flue gas is not to be expected for the near future, but research is going on in that field.

As already shown in Fig. 2 an installed capacity of slightly less than 4000 GW worldiwde is to be expected even under the assumption of a modest growth of consumption. To meet the target of Toronto in 2010 the capacity of power stations burning fossil fuel has to be limited to 50% of the world's capacity, but the mix of primary energy will then be different. Fig. 5 shows a possible result of this demand. Natural gas with its lower specific CO_2-emissions has to replace a considerable amount of coal. The share of oil can only slightly be raised because of limited resources. However the amount of coal has to be reduced considerably. Hydro power will amount to 50% of the exploitable resources (3), a figure which may be reduced because of ecological limitations. Other renewable sources included in hydro power cannot be expected to get a share of more than 5% of the world's capaicty. From today's point of view the remaining gap can only be covered by nuclear power.

This prognosis will raise a number of questions about the future acceptance of nuclear power stations, social problems in connection with reduced coal mining, siting problems for all types of power stations and ecological constraints for the construction of large dams and hydro power stations.

As already pointed out the main targets are to generate electrical energy as efficiently as possible and to save energy by using low energy consuming processes and appliances. The financial constraints of today underline the need of research and development in the field of new or more efficient sources of energy for tomorrow.

Sources

(1) World Development Report 1988
Oxford University Press, Washington

(2) Investment requirements of the world energy industries
1980-2000
World Energy Conference 1986, WG 7

(3) Water Power and Dam Construction Handbook
Alison Bartle, 1988
Sutton/Survey

	Oil		Natural Gas		Coal		Electricity		
	production	transmission +refineries	production	transmission	production	transmission	generation	transmission	total
IC´s	691	225	405	222	109	9	1529	2441	5631
DC´s	354	166	10	79	152	88	732	509	2090
CP´s	474	194	40	220	92	7	702	729	2458
prod. +transm	1519	585	455	521	353	104	2963	3679	
total	2104		976		457		6642		10 179

IC´s = Industrialized Countries, DC´s = Developing Countries, CP´s = Centrally Planned Countries

Table 1: Global Investment Requirements 1980-2000 in Bio.US $ (1988)
(low scenario acc.to WEC 1986, WG 7 - paper)

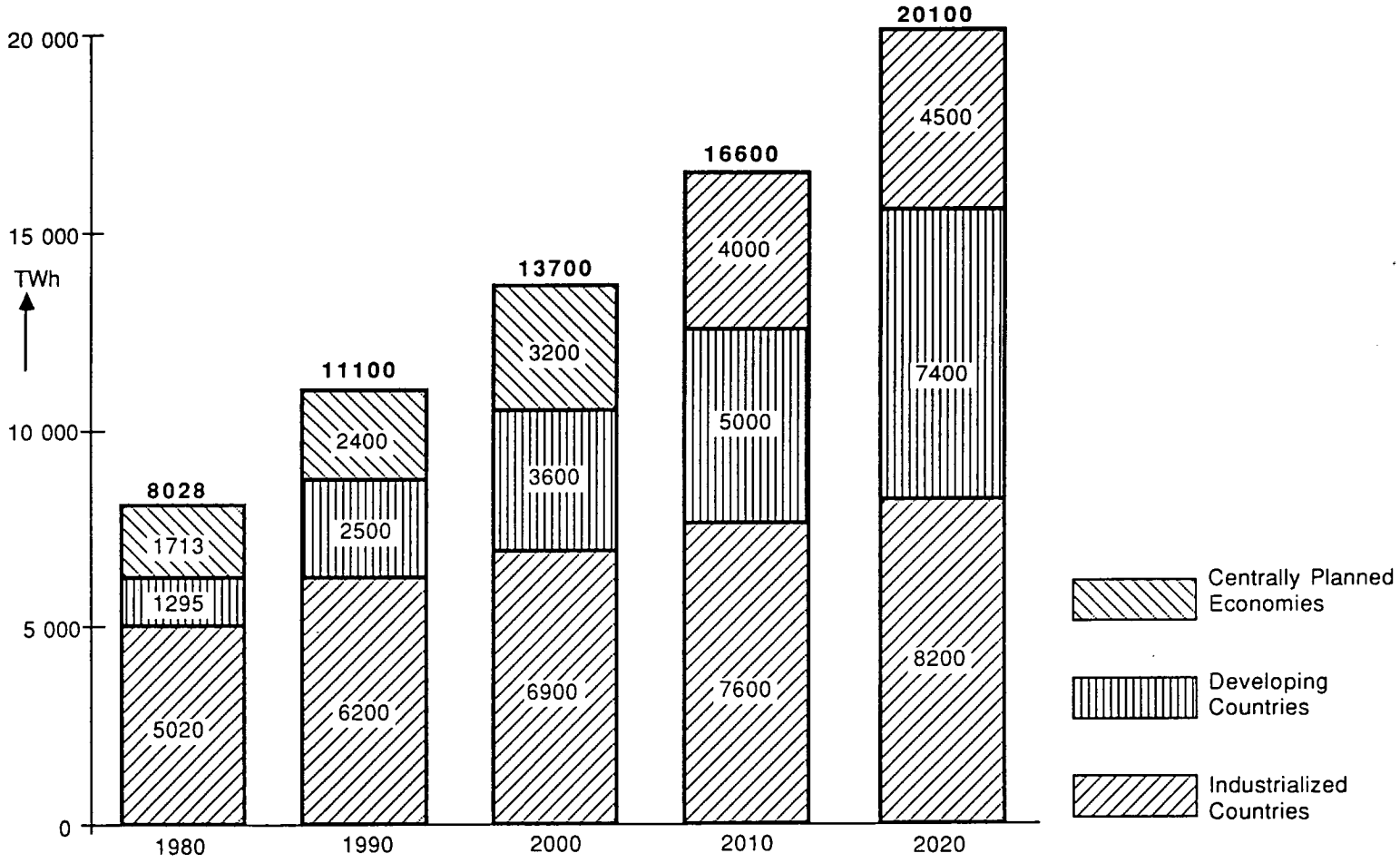

Fig 1 : Regional development of the generation of electric energy

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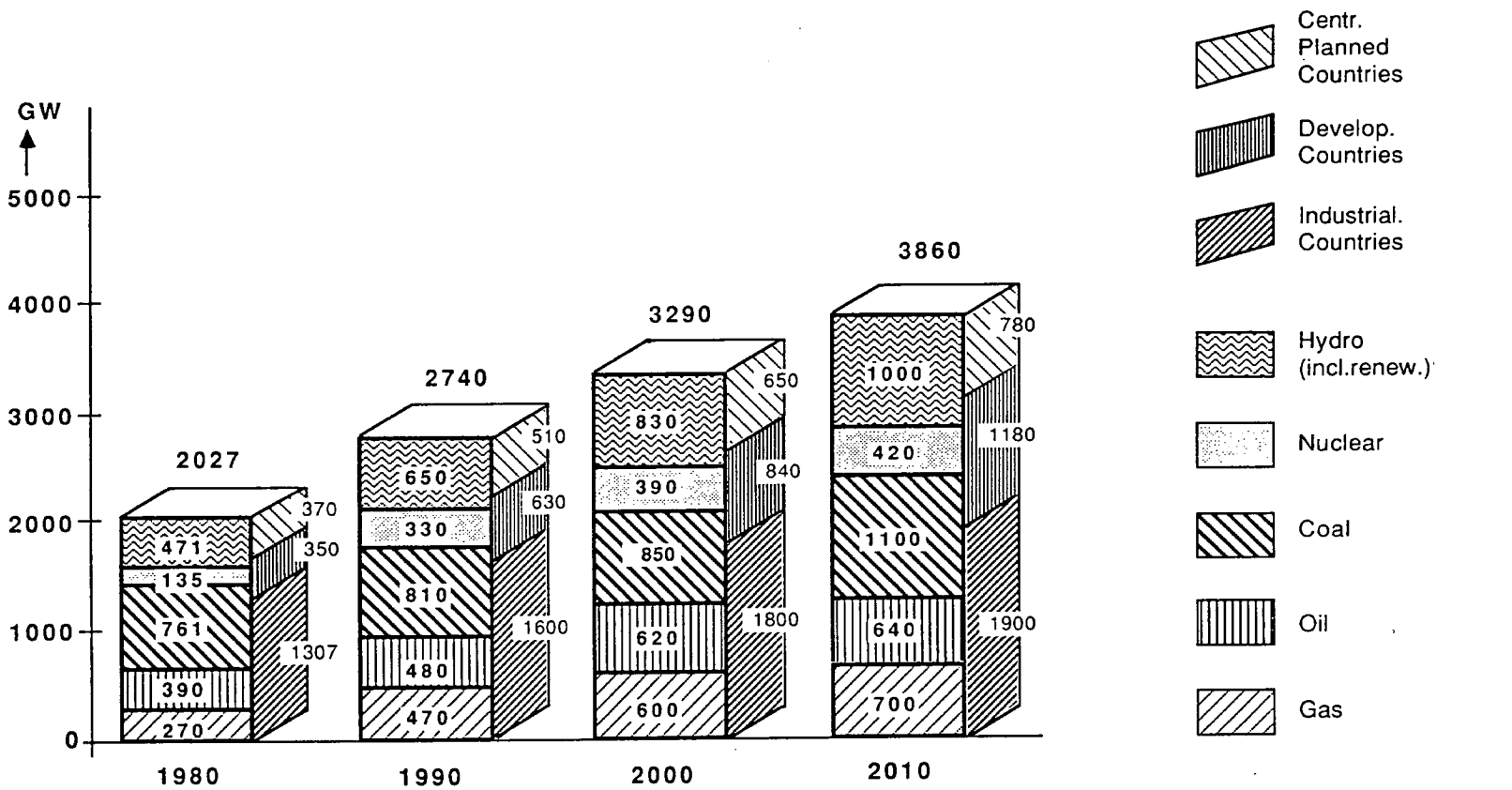

Fig.2 : Development of the installed generating capacity worldwide

KWU G 121
09/90 - 14-Mr

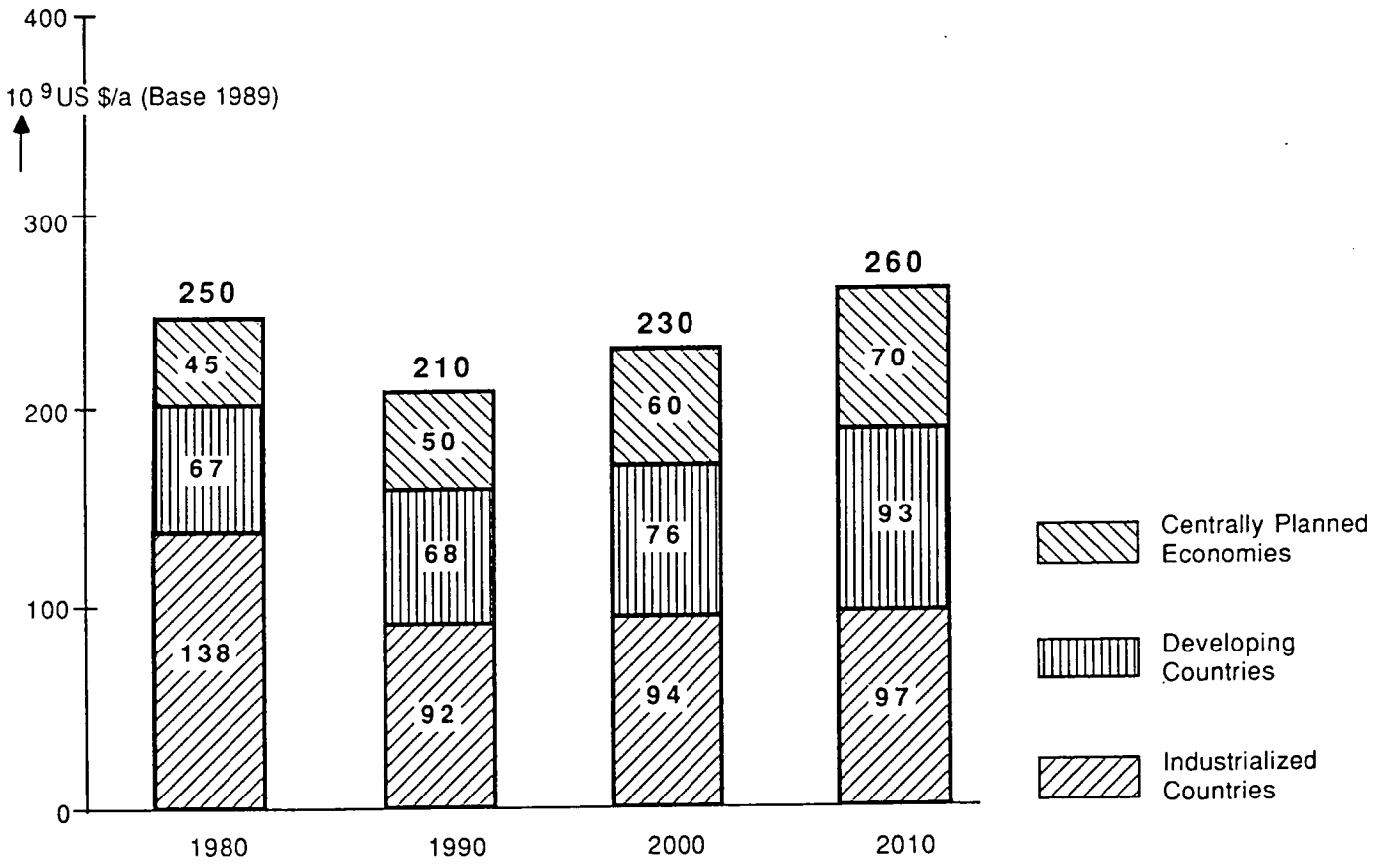

Fig 3 : Regional development of investment in the electric utility industry (US$)

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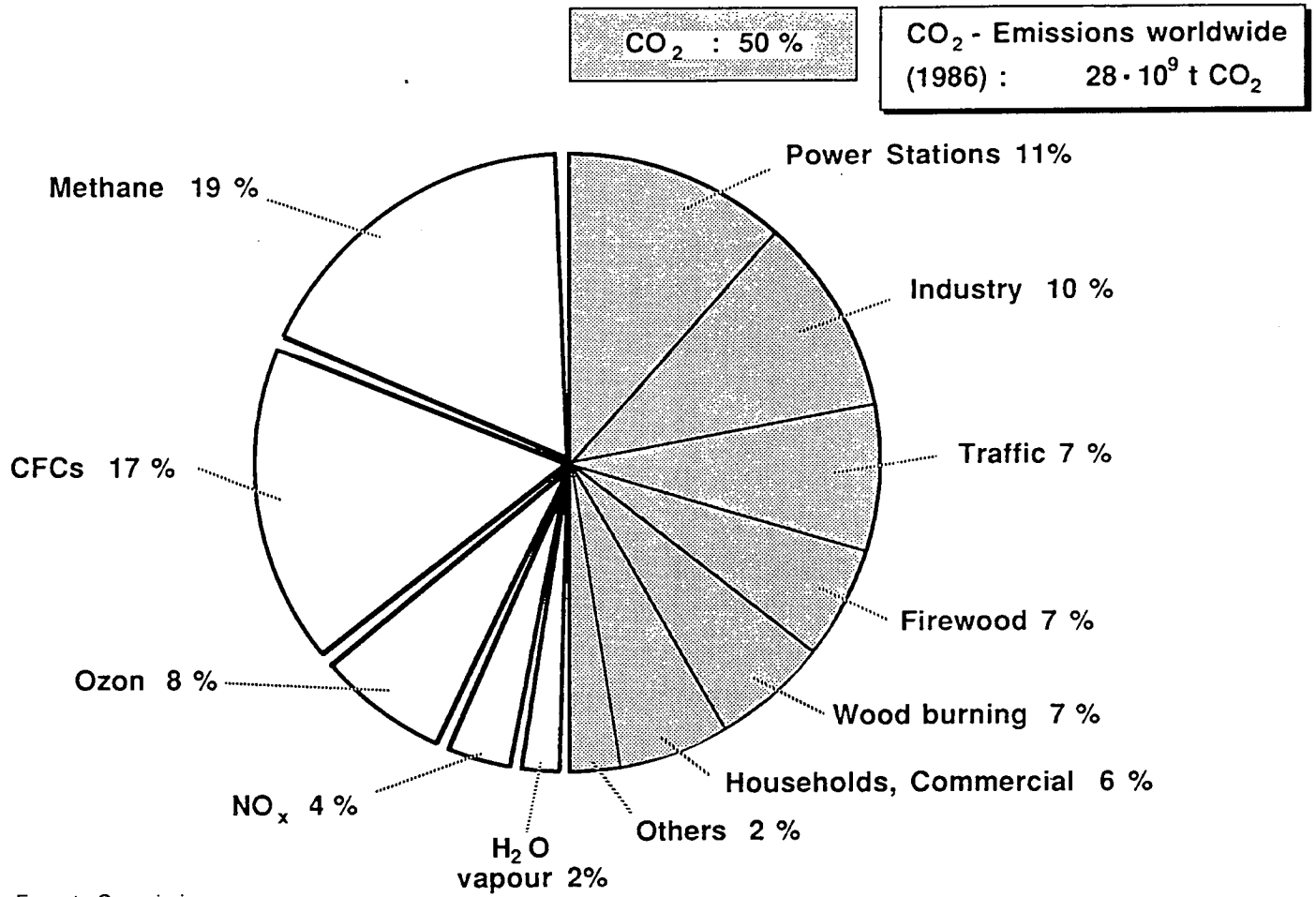

Source: German Enquete-Commission
Siemens Calculation 1988

Fig.4: Trace Gases of the Greenhouse Effect

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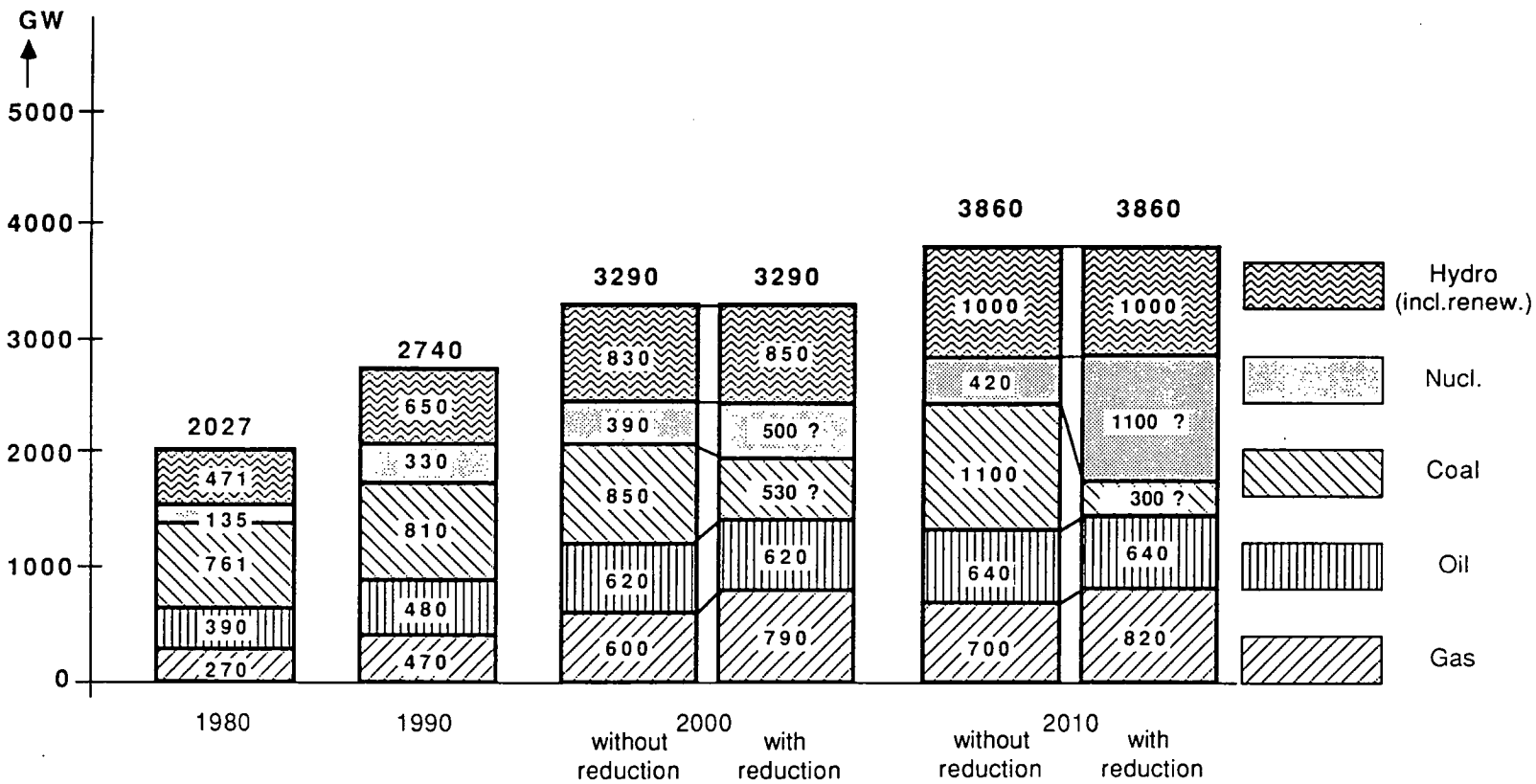

Fig 5 : Development of the installed generating capacity worldwide without and with reduced CO_2-emissions by 20% in 2005 (Toronto 1988)

G 121/Ce
09/90 -10-Mr

Paper No. 2

FUTURE GENERATION DEVELOPMENT

Speaker: Dr. Y.B. Lee
Divisional Manager — Planning & Systems
China Light & Power Co. Ltd

FUTURE GENERATION DEVELOPMENT

1. INTRODUCTION

Electricity consumption in the China Light & Power (CLP) supply area, viz. Kowloon and the New Territories, grew at an average rate of 9.9% p.a. in the 1970's and 8.6% p.a. in the 1980's. The consumption reached 16 billion units in 1989 and the system maximum demand so far is 4,407MW. The electricity consumption per capita in Hong Kong is 3,600 units, which is significantly lower than that of other developed countries, e.g. 5,500 units in Japan, 5,000 units in UK and 10,000 units in U.S.A. It is expected that electricity consumption in Hong Kong will continue to grow in the future, albeit at a rate lower than that in the past.

The CLP system is presently supplied by three power stations, viz. Castle Peak Power Station, Tsing Yi Power Station and Hok Un Power Station with a total installed capacity of 6,132MW. As the economy of Hong Kong grows and electricity consumption increases, more generating facilities will be required in order to meet the expected demand.

This paper reviews the economic growth and electricity consumption in Hong Kong and describes the guiding principles based on which the future generation development of CLP is formulated.

2. ELECTRICITY DEMAND FORECAST

2.1 Economic Growth and Electricity Consumption

Electricity supply is an essential service and there is a direct correlation between economic growth and electricity consumption. Fig. 1 shows the growth in Gross Domestic product (GDP) and that in electricity consumption in Hong Kong for the period 1961-1989. It is noted that during this period, GDP and electricity consumption increased by an average rate of 8.5% p.a. and 10.6% p.a. respectively.

Fig. 2 shows the growth in domestic exports and electricity consumption in Hong Kong by the industrial sector during the period 1970-89. This graph indicates that electricity consumption increased in step with growth in export. The average growth rates of domestic export and electricity consumption during the period are 9.1% and 7.7% respectively. Fig. 3 shows the electricity consumption per capita in Hong Kong in the domestic sector during the period 1970-89. It is noted that, as the standard of living improved, electricity consumption per capita in the domestic sector increased at an average rate of 6.8% during the period.

2.2 Forecast Models

In CLP, electricity demand forecast is done by two independent models, viz. the micro and macro forecast models. The purpose of using two separate models for forecasting is to cross check the results to ensure that they are consistent. In the micro model, regression analysis using economic or demographic variables suitable for explaining the consumption trend of individual classes is performed. The results obtained are combined with information derived from industry surveys conducted by government and major associations as well as from direct contacts by CLP with large consumers. The analysis generates electricity consumption forecasts, year by year, for a total of over 20 individual classes of consumers separately. These forecasts are aggregated to give the overall system demand forecast.

The macro analysis employs a multiple regression statistical model which examines the electricity consumption growth as a function of growth in GDP and price of electricity. To take account of the lagged effects of GDP growth and electricity price changes, the lagged dependent variable (i.e. electricity consumption of the previous year) is also included as an explanatory variable. A typical macro forecast model used is as follows:

$$\text{Log } S_t = -1.388 + 0.5117 \log S_{t-1} + 0.5064 \log X_t - 0.1412 \log (P_t/P_{t-1})$$

Where S is the electricity consumption in GWh,
X is real GDP in 1980 H.K. dollar,
P is the real price of electricity in 1980 H.K. dollar,
The subscripts t, t-1 denote the respective years.

Based on the above functional relationship, an increased of 10% in real GDP will result in an increase of about 10.4% in electricity sales in the long run if price is kept constant, and a 10% reduction in the real price of electricity will boost electricity consumption by about 3% in the long term, if GDP remains unchanged.

2.3 Demand Forecast

By adopting the methodology described above, it is estimated that the electricity demand will increase at an average rate of about 6% p.a. for the next 10 years. This forecast forms the basis for planning CLP's future generation development. As there is a degree of uncertainty in any forecast, it is considered important that flexibility be built into the development plan to cope with varying situations.

3. GENERATION DEVELOPMENT PLANNING

According to the current electricity demand forecast, the existing generating capacity and generation developments planned for the next few years will be able to meet the system demand up to the mid 1990's. After that, new generating facilities will have to be installed in order to maintain a secure supply to consumers. As all the existing power stations are fully developed, a new power station will have to be constructed. A new power station will take about 5 years to build and a generation development plan for the second half of the 1990's is therefore necessary.

In formulating the generation development plan, the major issues to be considered are reliability of supply, environment, choice of generation technology and cost to consumers. Each of these issues are discussed in detail in the following sections.

4. SUPPLY RELIABILITY

4.1 Reliability of Supply

One of the unique features of a power system is that electricity cannot be stored in any significant amount and therefore must be generated exactly as and when consumers demand it. For continuity of supply, a power system needs reserve capacity in excess of the maximum demand. Spinning reserve is required to cater for the sudden failure of a generating unit operating on the system. In such an event, the spinning reserve capacity will replace the lost capacity, resulting in consumers being unaffected. In order to cater for the loss of any generating unit operating on a power system, the spinning reserve kept is usually equal to the capacity of the largest generating unit on the system. In addition to the requirement for spinning reserve, standby capacity is also required to cater for machine outages for annual overhaul, maintenance and repairs.

In general, the greater the reserve capacity, the more reliable will be the supply. However, high reserve margins require large capital investment which increases the cost of electricity. It is necessary to strike a balance between reserve capacity, hence service reliability, and the cost of electricity in formulating the generation development plan.

4.2 Supply Reliability Criterion

Outages of generating units and fluctuations in consumers' demand occur in a random manner. CLP uses the Loss-of-load Probability (LOLP) method in assessing these random occurrences. The LOLP method has been widely used by the electricity supply industry in the last 20 years.

To utilize the LOLP method for generation planning, a computer programme is used to determine the reserve capacity required for reliable supply. This LOLP programme takes full account of the support available through the interconnection with the neighbouring Hongkong Electric power system.

In CLP, the reliability planning criterion is that the LOLP should not exceed 0.5 day/year. The criterion says that on average, there should not be more than one day in 2 years during which the generating capacity available is insufficient to meet consumers' demand.

Burns & Roe, the U.S. consultant employed by the Government a few years ago to study the technical aspects of system planning in CLP, concluded in their finding that CLP's reliability planning criterion and methodology used for system generation planning are reasonable and conform to power industry practices in other industrialized countries. The generation expansion plan developed by the application of the criterion and methodology is expected to provide a reliable and adequate system, without overbuilding, that will meet the projected demands of its consumers.

5. ENVIRONMENTAL CONSIDERATIONS

5.1 Environmental Protection

Electricity is a clean form of energy. In the process of electricity generation, transmission and utilization, the effects on the environment are controlled to acceptable levels. Measures to limit environmental impact of electricity generation are determined by detailed environmental impact analyses and by reference to applicable standards. Environmental standards in Hong Kong have tightened considerably over the last 10 years and CLP has continued to improve the environmental performance of its generation, transmission and distribution facilities.

It is CLP's objective to minimize environmental effects of its generation, transmission and distribution facilities whenever it is feasible to do so and to comply with any future standards set by the Government. The effects on the environment due to power generation and the initiatives taken by CLP to control them are described in the following sections.

5.2 Sulphur Dioxide Emission

At the planning stage of Castle Peak Power Station, CLP recognized the need to minimize sulphur dioxide emission. At that time the most effective way was by burning low sulphur coal. In the submission of Castle Peak power Station Environmental Impact Statement, it was stated that the power station would burn coal of no higher than 1% sulphur. This compares favourably with the coal burnt in other parts of the world. In the eight years' of operation of Castle Peak Power Station, CLP has strictly followed the practice and the sulphur content of coal burnt averaged only 0.6%.

To disperse the sulphur dioxide and other gaseous emissions, tall chimneys have been built at Castle Peak. Castle Peak 'A' Power Station has a chimney height of 215 metres and Castle Peak 'B' Power Station 250 metres. These chimney heights were determined by wind tunnel modelling to ensure that the gaseous emissions would not affect neighbouring populated areas such as Tuen Mun New Town.

Sulphur dioxide concentration has been monitored in various locations in the areas around Castle Peak Power Station. Results show that sulphur dioxide concentrations due to the power station emissions are within the levels predicted and that all standards adopted for the environmental impact assessment have been met.

5.3 Nitrogen Oxides Emission

At the time of planning Castle Peak Power Station, environmental standards for nitrogen oxides emission were not widely established. Hence, Castle Peak Power Station was not equipped with facilities to limit nitrogen oxides emission. Over the last few years, advanced technologies have been developed to reduce the production of nitrogen oxides and related environmental standards have been established. In response, CLP has placed an order to retrofit low NOx burners on one of the 680MW units at Castle Peak 'B' Power Station. If proved to be effective, the other units will also be fitted with similar burners.

For the gas turbine units planned for commissioning in 1992, nitrogen oxides emission will be limited to 75ppm which is line with the Government's latest standards. This will be achieved by injecting water into the combustion chamber to lower the combustion temperature.

5.4 Dust Emission

At Castle Peak power Station, dust is removed from the flue gas by electrostatic precipitators which achieve a high efficiency of dust removal in excess of 99%. The technique of injecting small traces of sulphur trioxide (SO_3) into the flue gas was recently introduced to further reduce dust emission. By injecting SO_3 upstream of electrostatic precipitators, dust resistivity is reduced, resulting in a higher precipitator collection efficiency.

All units of Castle Peak 'A' Power Station are now operating with SO_3 injection systems. Installation of similar equipment has just been completed on all 4 units of Castle Peak 'B' Power Station. Dust emission levels are thereby controlled well below the limit set by Government.

5.5 Coal Ash

About 840,000 tonnes of ash is currently being produced annually by Castle Peak Power Station. Bottom ash is supplied to the block making industry. The pulverised fly ash (PFA) is supplied to China Cement for cement making and to the Government for reclamation and road building. A small quantity is used as building materials. The excess quantity of PFA is pumped to an ash lagoon at Tsang Tsui for storage. In order to protect the marine environment, the ash lagoon is sealed such that there is no leaching of trace metals into the sea.

5.6 Water Quality

At Castle Peak Power Station, some 10 million tonnes of sea water per day is required for cooling. Sea water is chlorinated and circulated through the condenser and discharged back to the sea. When the sea water is discharged, its temperature is about 10°C above the inlet temperature. Ecological studies indicate that the temperature rise is rapidly dispersed and does not affect marine life. There is a visible scum formed due to the effects of chlorination but this is organic and is harmless to health. Improvements have been made by chemical treatment.

5.7 Energy Conservation

CLP recognises that energy conservation is important not only to preserve resources for future generations but also because it reduces the adverse environmental effects caused by the combustion of fossil fuels. The company supports the cause of energy conservation and over the years has taken various initiatives to achieve energy saving. For instance, during the ten-year period 1980-1989, the overall thermal efficiency of the power stations in CLP increased from 32.5% to 36.1%. This has brought about a total saving equivalent to 3.4 million tonnes of coal during the period.

5.8 Visual Impact

Some people find power stations and overhead transmission lines visually obtrusive. CLP has tried to use power station designs which are visually pleasing and blend well with the environment. Special attention is paid to landscaping and tree planting to minimize visual impact and a total of 130,000 trees and shrubs were planted on the backslope of Castle Peak Power Station to improve the appearance.

After construction of overhead transmission lines, CLP reinstate indigenous plants under the towers to restore the original state of site. It is estimated that on average 3,000 trees were planted per tower site, and in some cases up to 15,000 trees totalling 40 species were planted.

Over the past several years, CLP has planted some 650,000 trees and shrubs in the New Territories where the Company's projects are located. To support the future programme of tree planting (at least 600,000 for the next four years) and the high demand for seedlings, CLP operates its own nursery which is located at Castle Peak Power Station. This nursery will provide the necessary back-up for the ambitious tree planting programme to match the Company's development plan.

5.9 Future Initiatives for Environmental Protection

CLP is considering effective measures to protect the environment in its future generation development. These measures include:

(a) *Siting of New Power Station*

The new power station will be located at an environmentally acceptable site to minimize the impact on the population and environment. In addition, chimneys to a height of not less than 250 metres would be constructed to ensure that gaseous emissions do not cause local pollution above applicable standards.

(b) *Enegy Conservation*

Modern and efficient generating plants will be selected for the new power station. In particular, gas turbine combined cycle plants which can achieve efficiencies of about 45-50% will be considered. Old and inefficient plant will be retired or redeveloped into modern and efficient generating equipment to achieve more effective use of fuels.

(c) *Reduction of Sulphur Dioxide Emission*

At the new power station, low sulphur coal will be used as at Castle Peak power Station. If necessary, flue gas desulphurisation (FGD) equipment will be installed on the coal-fired units to further reduce sulphur dioxide emission.

(d) *Reduction of Nitrogen Oxides Emission*

For the control of nitrogen oxides (NOx) emission at the new power station, low-NOx burners will be installed for the coal-fired units. Post-combustion De-NOx facilities may also be installed to reduce nitrogen oxides emission.

(e) *Dust Suppression*

Similar to Castle Peak Power Station, high efficiency dust removal facilities will be installed for the coal-fired units in the new power station to minimize particulate emission.

(f) *Use of Natural Gas for Electricity Generation*

Natural gas is a clean fuel compared with other fossil fuels. It produces no sulphur dioxide nor dust and substantially less carbon dioxide and nitrogen oxides. Provision will be made to use natural gas for electricity generation in the future generation system.

(g) *Removal of Plant from Urban Area*

Consideration will be given to relocating generating plant currently installed in urban areas to more remote areas. This includes relocating the gas turbines at Hok Un Power Station. The purpose is to avoid environmental problems in populated areas.

(h) *Visual Impact*

CLP will pay special attention to the design of the new power station to ensure that it will be visually pleasing and blend well with the environment. Measures such as landscaping and tree planting will be adopted to minimize the visual impact of the new power station and transmission lines.

6. CHOICE OF GENERATION TECHNOLOGY

6.1 Coal-fired Plant

The use of coal in conventional coal-fired boilers for electricity generation is a well-developed and proven technology throughout the world. Since the early 1980's, coal has been burnt in Hong Kong, progressively substituting more expensive fuel oil for power generation.

Apart from conventional boilers, there are also a number of other coal-burning technologies being developed:

(a) Coal Gasification

(b) Fluidised Bed Combustion

(c) Coal/Oil Mixture

(d) Coal/Water Mixture

Whilst development of the above coal-burning technologies is promising, they are not sufficiently proven at this moment to be adopted for large scale electricity generation in Hong Kong.

6.2 Conventional Oil-fired Plant

CLP has been using generating plant burning residual fuel oil for a long time. The ease of transport and storage, together with ash-free burning characteristics, make fuel oil a technically desirable fuel. However, sulphur content tends to be high and this gives considerable environmental problems. Furthermore, drastic increases in price since the early 1970's have progressively reduced the use of oil-fired plant for base-load generation in many utilities.

6.3 Conventional Gas-fired Plant

The technology of burning natural gas in conventional boilers for electricity generation is straightforward. Where available in suitable quantities, natural gas is a technically desirable alternative fuel for power generation. In terms of thermal efficiency, conventional gas-fired plant is inferior to gas-fired combined cycle plant.

6.4 Gas Turbines

Gas turbine generating units have been used in the CLP system for a long time, mainly for supplying peak demand and as emergency standby plant. Gas turbine units are characterized by low capital cost, high running costs, short installation time and short start-up time. This makes them well suited for peak lopping, emergency and standby use but not for base-load generation.

Gas turbines usually burn gas or industrial diesel oil (IDO). Burning residual fuel oil is also possible, but fuel treatment is required the maintenance requirements are increased. This increases the capital and operation & maintenance costs and reduces plant availability.

6.5 Gas Turbine Combined-Cycle Plant

In recent years, the use of natural gas for power generation has been promoted by the development of large gas turbine combined-cycle plant. This type of plant achieves high thermal efficiency by combining gas turbines with steam turbines arranged in a combined cycle mode. Heat energy in the high temperature exhaust gas is recovered in a heat recovery boiler which generates steam for the steam turbine. Efficiencies in the range of 45-50% are currently achievable and will probably increase in the foreseeable future. Apart from high efficiency, combined-cycle plant also has the advantages of quick start capability, high partial load efficiency and low operation and maintenance costs.

Apart from being gas-fired, combined-cycle plant can also burn IDO. Combined-cycle plant is often used as intermediate-load plant, but in some utilities it is also used as base-load plant for environmental reasons.

6.6 Economic Assessment

As the various candidate generation technologies have different capital and operating costs, the relative economics among the options depend on the amount of energy the plant is expected to generate during its life (i.e., the expected capacity factor of the plant). More capital intensive plant, such as coal-fired plant, can only be justified by long running hours at high load, i.e. operating at a high capacity factor. On the other hand, less expensive plant such as gas turbines usually burn premium fuel (e.g. IDO) and therefore have high running costs. They are economical only if required to run for short periods. A simple approach to the economic comparison of different plant types is to compare their "annualized costs", which take into account both capital charges and running costs of the respective plant type over the expected plant life of 20 years.

Figure 4 shows in graphical form the annualized cost per kW sent-out of various base-load plant options, at capacity factors in the range of 30-90%. It is noted that in this range of capacity factors, coal-fired steam plant is the most economical option. All the other plant options, including oil-fired plant, gas-fired (using liquified natural gas) conventional plant and combined cycle plant, are considerably more expensive. Figure 5 shows the annualized cost curves for peaking and intermediate-load plants, in the capacity factor range of 0-30%. It is observed that for capacity factors in the range of 8% to 22%, the IDO-fired combined-cycle plant is the most economical. When the capacity factor drops below 8%, gas turbine plant is more economical.

It is noted that the above economic assessment is based on the current prices of fuel. Should there be significant changes in these prices, the economic assessment will have to be repeated before any choice is made.

7. COMPARISON OF ALTERNATIVE DEVELOPMENT PROGRAMMES

Based on the results of the "screening" exercise described above, alternative generation development programmes are identified. The economics of these alternative programmes is compared in order to determine the optimum plan. As far as consumers are concerned, the economics of each expansion pattern is reflected ultimately in the cost of electricity. The expansion patterns are therefore compared in terms of the total cost over the comparison period and the present worth sum of annual costs to consumers, including depreciation, fuel cost, operation and maintenance costs, operating interest, taxation, and permitted return as defined in the Scheme of Control.

The various generation development programmes call for different capital expenditure schedules and incur different operating costs. Capital cost streams are developed for each expansion scheme, including loan financing so that yearly financing charges and operating interest are estimated. The capital cost for transmission development is also included in the economic comparison among the scheme. A probabilistic computer simulation model is used to simulate the operation of the generation system to calculate, on an annual basis, the fuel requirements of different expansion schemes to supply the forecast demand. Operation and maintenance costs of different expansion patterns are estimated and incorporated into the annual operating cost streams. The expansion programme which would incur the minimum total cost to consumers is selected.

8. CONCLUSION

With the continued economic growth in Hong Kong, it is expected that the electricity demand will increase. Based on the current electricity demand forecast, it is expected that the existing generating facilities in the CLP system together with the planned developments will be able to meet the demand until the mid 1990's. New generating facilities will be required thereafter to maintain an adequate and reliable supply to consumers. The generation development plan for the second half of the decade and beyond is being formulated.

In developing the geneation development plan, CLP takes into account the growth rate of electricity consumption, environmental protection, security of supply and cost to consumers. Economic models, both at the macro and micro levels, are used to estimate future electricity demand. CLP has paid much attention to environmental protection in its generation development and implemented various effective measures to achieves the same. The Company will continue its efforts and initiatives to protect the environment in its future generation development. Subject to meeting all environmental and security of supply requirements, the objective is to meet consumers' demand at the lowest possible cost. This is achieved by selecting the development programme which would incur the lowest total cost to consumers.

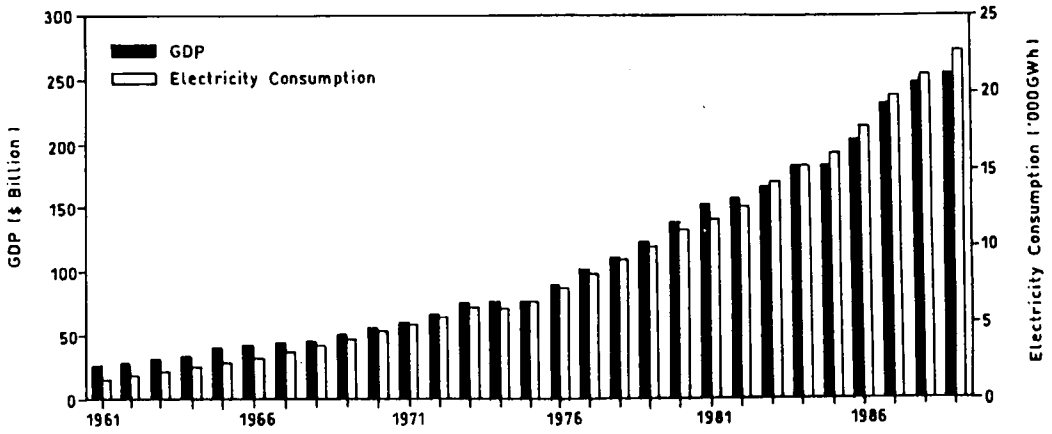

Fig. 1 Growth in GDP and Electricity Consumption

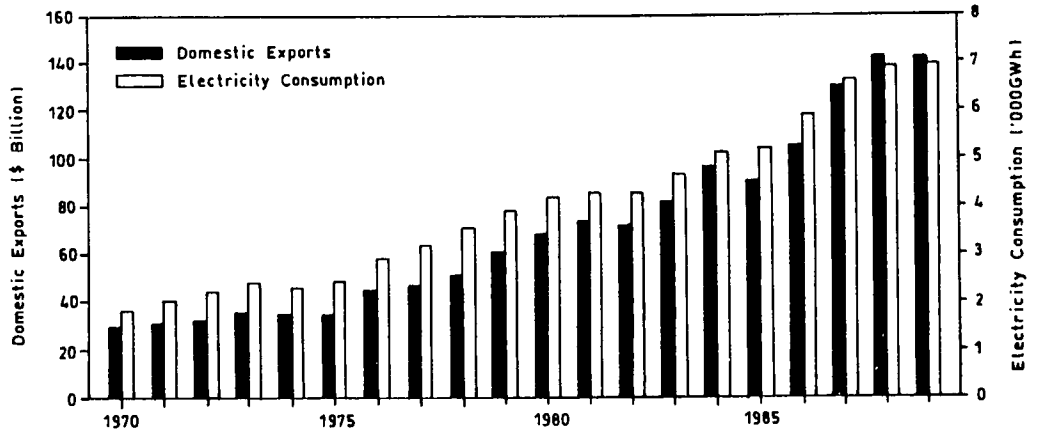

Fig. 2 Domestic Exports and Industrial Electricity Consumption

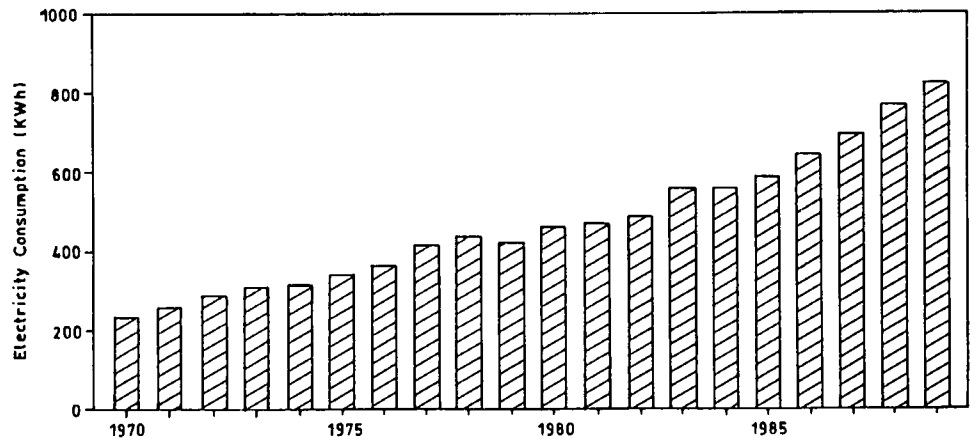

Fig. 3 Electricity Consumption Per Capita in Domestic Sector

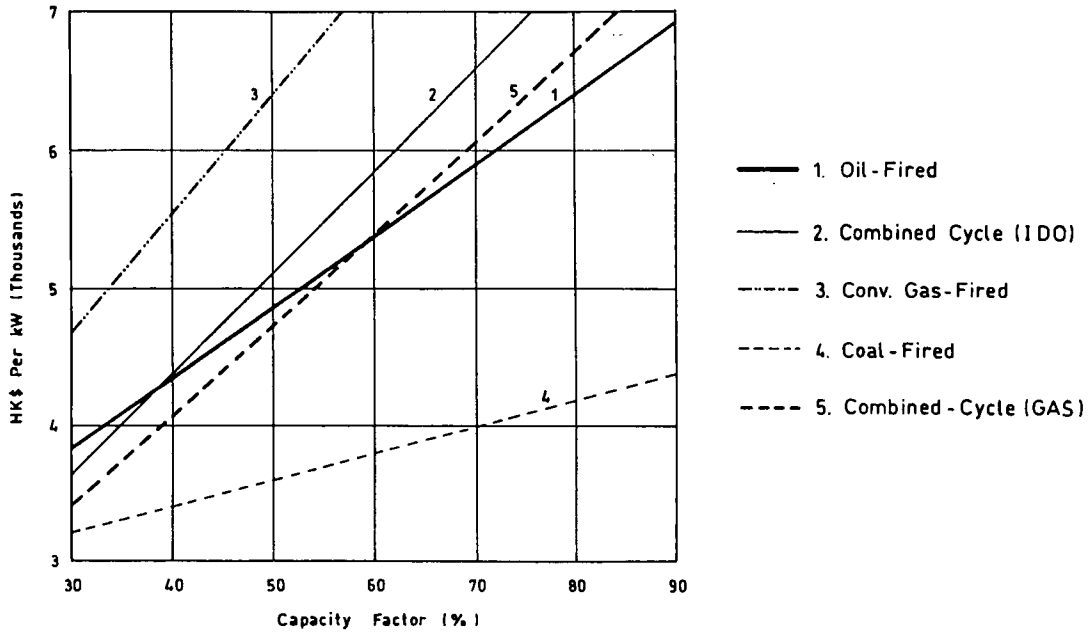

Fig. 4 Annualised Costs of Base Load Plants

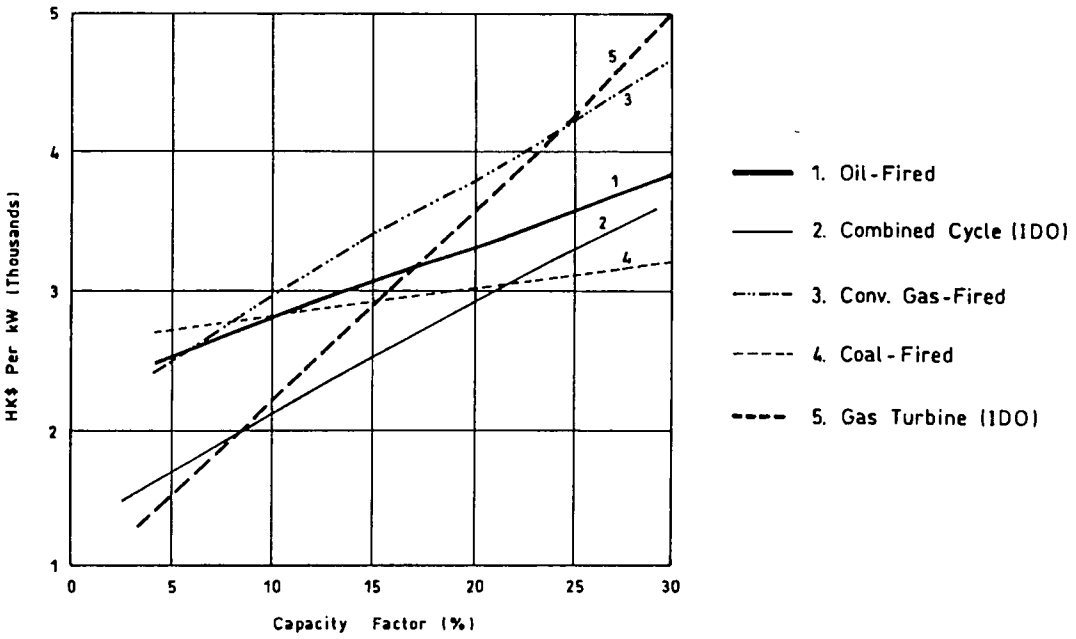

Fig. 5 Annualised Costs of Peaking & Intermediate Plants

Paper No. 3

NEWLY DEVELOPED DIGITAL PROTECTION RELAY

Speaker: Mr. Youichi Sasaya
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NEWLY DEVELOPED DIGITAL PROTECTION RELAY

1. APPLICATION OF DIGITAL RELAY IN JAPAN AND OTHER COUNTRIES

Since 1976, field test of digital relays had been started based on the assistance of power supply companies in Japan, and then commercial use was appeared within two years. Those relays were full-digital type so that the advantage of "digital" could be mostly obtained, and the severe problems on the circumstance of electrical net-work could be mostly solved by the digital technics.

In Japanese relay market in this moment 1990, product ratio of digital relay is over 70 percent in the all kinds of protection relay under the class of more than 154 kV net-work.

On the other hand American and European power supply companies also required such technics in these five or six years. Accordingly semi or full digital relays became to be appeared in those markets. Because digital relays also can be easily incorporated with digital communication link, it is considerable that digital relay become to be popular and have main product equipment in the relay manufacturer in the world in future.

Paper No. 3

2. TECHNICAL REASON FOR THE APPEARANCE OF DIGITAL RELAY

The power supply net-work and distribution systems have been expanded in scale year by year with the following conditions;

— Voltage class increased.
— Long transmission and distribution line.
— Many underground cables instead of over-head line at the area of cities and its suburbs.
— Heavy-loaded line.

These circumstance caused various unprecedented phenomena and problems that the conventional protective relays were unstable.

As a solution of those problem digital relay was developed, which could posses the adequate countermeasure such as the accurate low frequency harmonics characteristics, d.c. component characteristics, high speed operation, new calculation principle, etc.

3. GENERAL CONSTRUCTIONOF DIGITAL RELAY

Fig. 1 shows the general construction and principle of digital relay containing from the input current/voltage circuit to the output tripping signal circuit. After the analog input data are sampled and held, and the data are re-arranged by a multiplexer, the data are digitized by an A/D converter. Latter the microprocessor performs data storage and call, and calculations under the software program to finally obtain the output signals. It is a great feature that this principle is common to almost all digital relays.

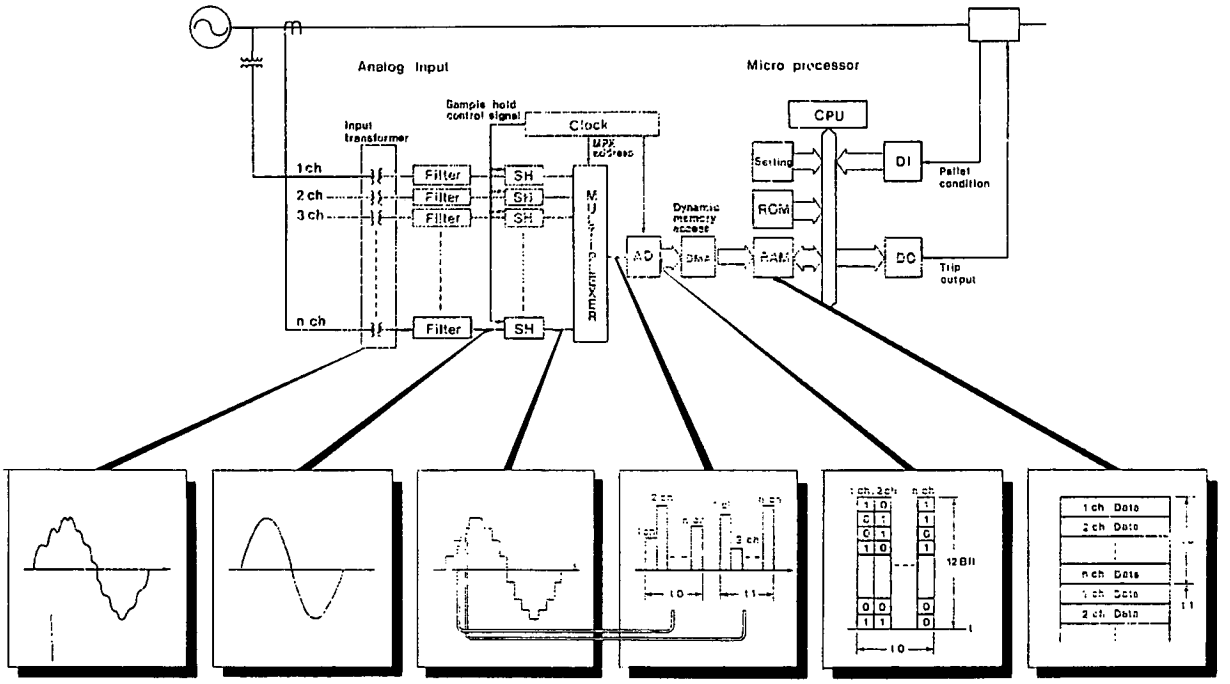


Fig. 1 General construction of digital relay

4. (OVER) CURRENT AND (OVER) VOLTAGE RELAY IN DIGITAL TYPE

Conventional analog relay detects the level of fault current or voltage. The method is the judgment which is only whether the fault current (voltage) level is over the setting level of relay or not.

Digital type relay calculates the actual degree of the fault current (voltage) and also of the normal load current (voltage). Therefore digital relay can display the current (voltage) value of normal and fault condition for each feeder in the power circuit at the front fact of its relay, similar function as ammeter and voltmeter. Fig. 2 shows a typical overcurrent relay. Three elements are contained in this one unit though this size can contain only one element in case of analog relay.

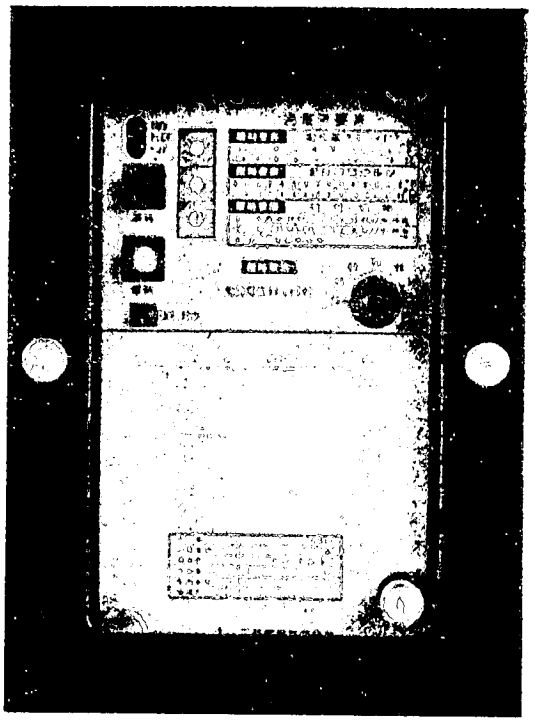


Fig. 2 Three pole overcurrent relay

5. TRANSFORMER PROTECTION RELAY IN DIGITAL TYPE

The most interested and useful point for any user is that digital type can display the normal current flowing in the different circuit. As well known fact the transformer differential relay must minimize the mismatch current which is resulted from the CT's unbalance error, CT's ratio the difference of voltage between high and low voltage side of main transformer. For the checking of this unbalance current in the different circuit the display is very important.

6. DISTANCE RELAY IN DIGITAL TYPE

The distance protection relay is well used for almost transmission and distribution line for the high voltage power circuit. Recently as the construction of those line, it is increased that the underground cable is used instead of over-head line at the urban areas such as Hong Kong, Singapore, Tokyo, London, etc. The following description is concerned about the phenomena of those cable line, the subsequent problem, and the method of countermeasure.

6.1 As increasing the underground cable length, the harmonic content ratio of low harmonic orders, such as 2nd and 3rd harmonics, in the transient current/voltage on the fault occurrence, have been remarkable.

Table 1 shows an example of the result of the computer calculation for 275 kV cable line.

Table 1 Distorted wave of cable (example)

%: content ratio

Frequency / Total cable length(approx.)	2f	2.5f	3f	3.5f	4f
40 km	7	7	8	9	11
80 km	26	82	96	33	20
100 km	45	57	148	121	39

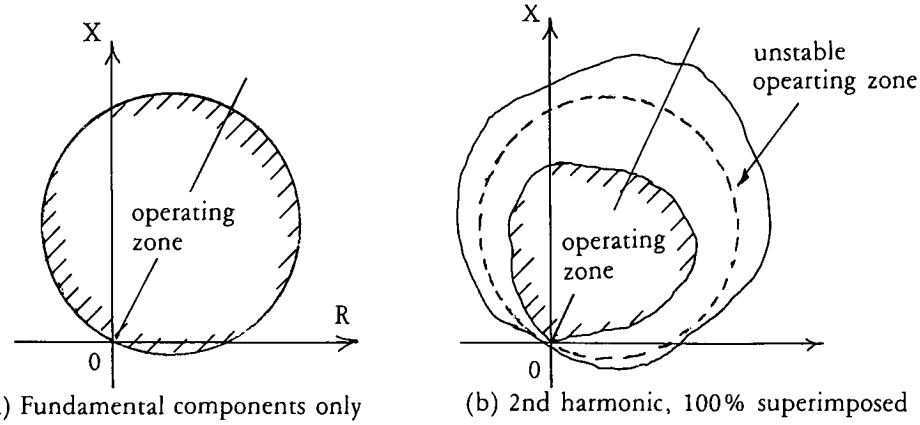
f: base frequency

Fig. 3 shows a test example of phase characteristic under distorted wave (2nd harmonic, 100% superimposed) of an existing analog type distance relay. This shows that the distance relay may have a large unstable operating zone and it may be difficult to apply the relay on such a large low order harmonic distortion condition.

Although existing relay has a filtering circuit to eliminate a high harmonic wave, it is difficult to design an analog filter which can remove low orders of harmonic but at the same time maintain sufficient short transient time.

Accordingly, new distance relay which has high immunity for low order harmonic distortion wave is required.

Fig. 3 Phase characteristic under distorted wave of an existing type



(a) Fundamental components only (b) 2nd harmonic, 100% superimposed

6.2 To cope with above, new distance protection relay using digital micro-processor technique has been developed.

The necessary specifications for low order harmonic are
(1) correct reach measurement
(2) high operation speed
(3) stable against external fault.

If a countermeasure against the distorted wave of 2nd harmonic order is designed by the well-known input analog filtering circuit only, the operating speed would be slower than the expected value. Therefore, the following method designed by digital hardware was adopted.

(1) Combined analog/digital filter to suppress 3rd and higher harmonic order.
(2) Digital direct measurement calculation to suppress 2nd and lower harmonic order.

1) Combined Analog/Digital Filter

Fig. 4 shows the gain-frequency characteristic of analog and digital filter used. This shows the gain suppress to small level for 3rd and higher harmonic components.

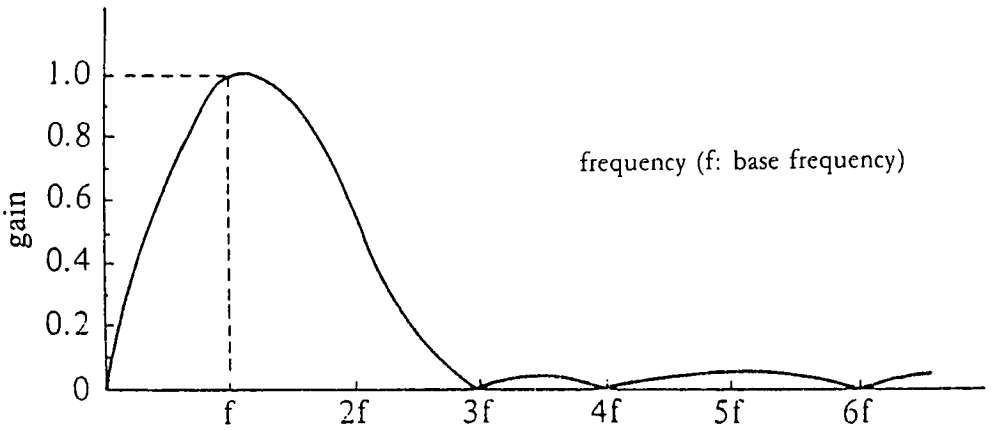
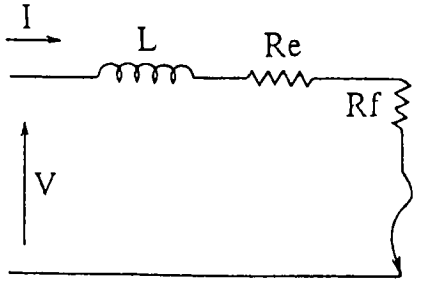


Fig. 4 Total frequency characteristic of analog and digital filter

2. Digital Measurement Calculation

The simplified model of line fault is described in Fig. 5



L: Line inductance to the fault point
Re: Line resistance to the fault point
Rf: Arc resistance
V: Voltage at relay point
I: Current at relay point

Fig. 5 Equivalent circuit of line fault

In the digital relay, the voltage and current values are input by sampling to the microprocessor as discrete values. From Fig. 5, the circuit equation at time 't' is as follows.

$$V(t) = (Re + Rf)\, i(t) + L\frac{di(t)}{dt}$$
$$= R \cdot i(t) + L\frac{di(t)}{dt} \qquad \cdots\cdots (1)$$

where, $R = Re + Rf$
$v(t)$: voltage at time 't'
$i(t)$: current at time 't'

and the circuit equation at time 't-T'.

$$v(t-T) = R \cdot i(t-T) + L\frac{di(t-T)}{dt} \qquad \cdots\cdots (2)$$

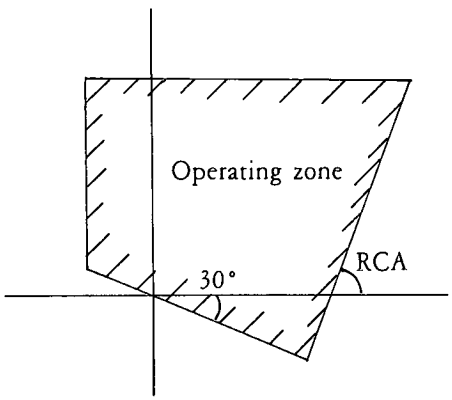
From equation (1) and (2), R and L are derived as shown in equation (3) and (4).

$$R = \frac{v(t-T)\frac{di(t)}{dt} - v(t) \cdot \frac{di(t-T)}{dt}}{i(t-T)\frac{di(t)}{dt} - i(t) \cdot \frac{di(t-T)}{dt}} \qquad \cdots\cdots (3)$$

$$L = \frac{v(t) \cdot i(t-T) - V(t-T) \cdot i(t)}{i(t-T) \cdot \frac{di(t)}{dt} - i(t) \cdot \frac{di(t-T)}{dt}} \qquad \cdots\cdots (4)$$

Equations (1) and (2) are valid for transmission frequency even if fault current and voltage have large distorted wave. This principle will improve the characteristic against distorted wave in case values of voltage, current and differential part of current can be used. V(t), i(t) v(t-T) and i(t—t) are input data and di(t)/dt and di(t-T)/dt are calculated from the sampled data around that time. To reduce the error of differential part calculation, the time interval was selected to 15 electrical degree.

The phase characteristic was selected to quadrilateral shape as shown in Fig. 6. The operation of each zone was derived from the calculation result of R (resistance) and L (reactance).



RCA: Relay characteristic angle

Fig. 6 Phase characteristic

6.3 To confirm the operation of newly developed digital relay, same test was performed.

Fig. 7 shows the phase characteristic under the 2nd and 3rd harmonics distorted wave (100% superimposed).

The operating time was measured and found 23 ms — 33 ms at SIR (system impedance ratio) = 2-30 and fault point is 80% of relay setting.

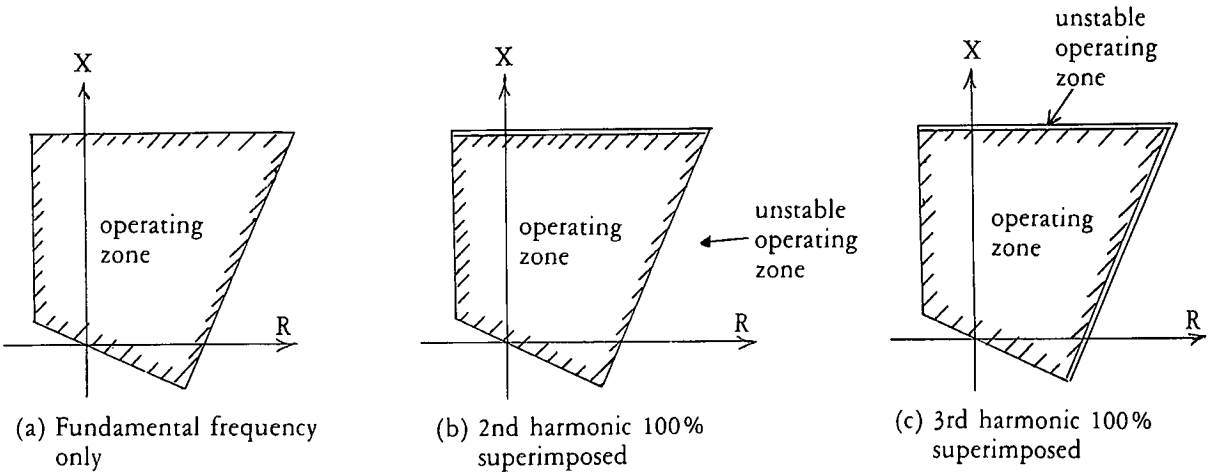


Fig. 7 Phase characteristic under distorted wave of new digital distance relay

Fig. 8 shows the newly developed digital distance relay construction.

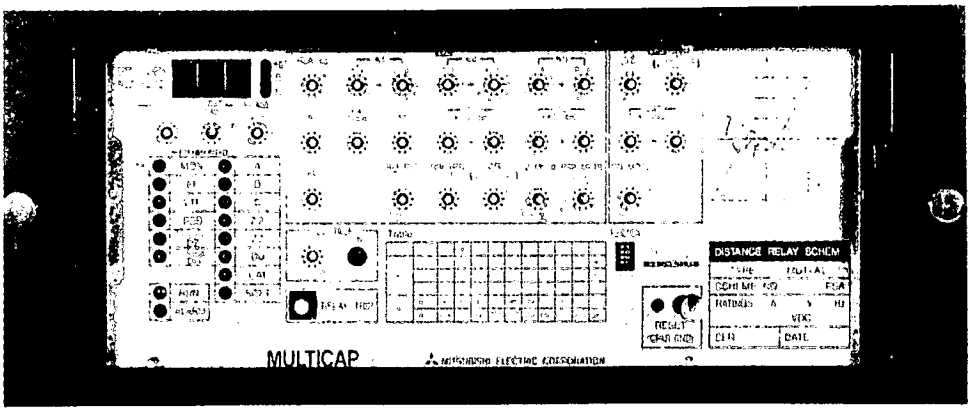


Fig. 8 Distance relay

7. SUMMARY FOR THE FEATURE OF DIGITAL RELAY

(1) High reliability and stability
(2) Multi-function
(3) Self-monitor
(4) Maintenance free

Reference

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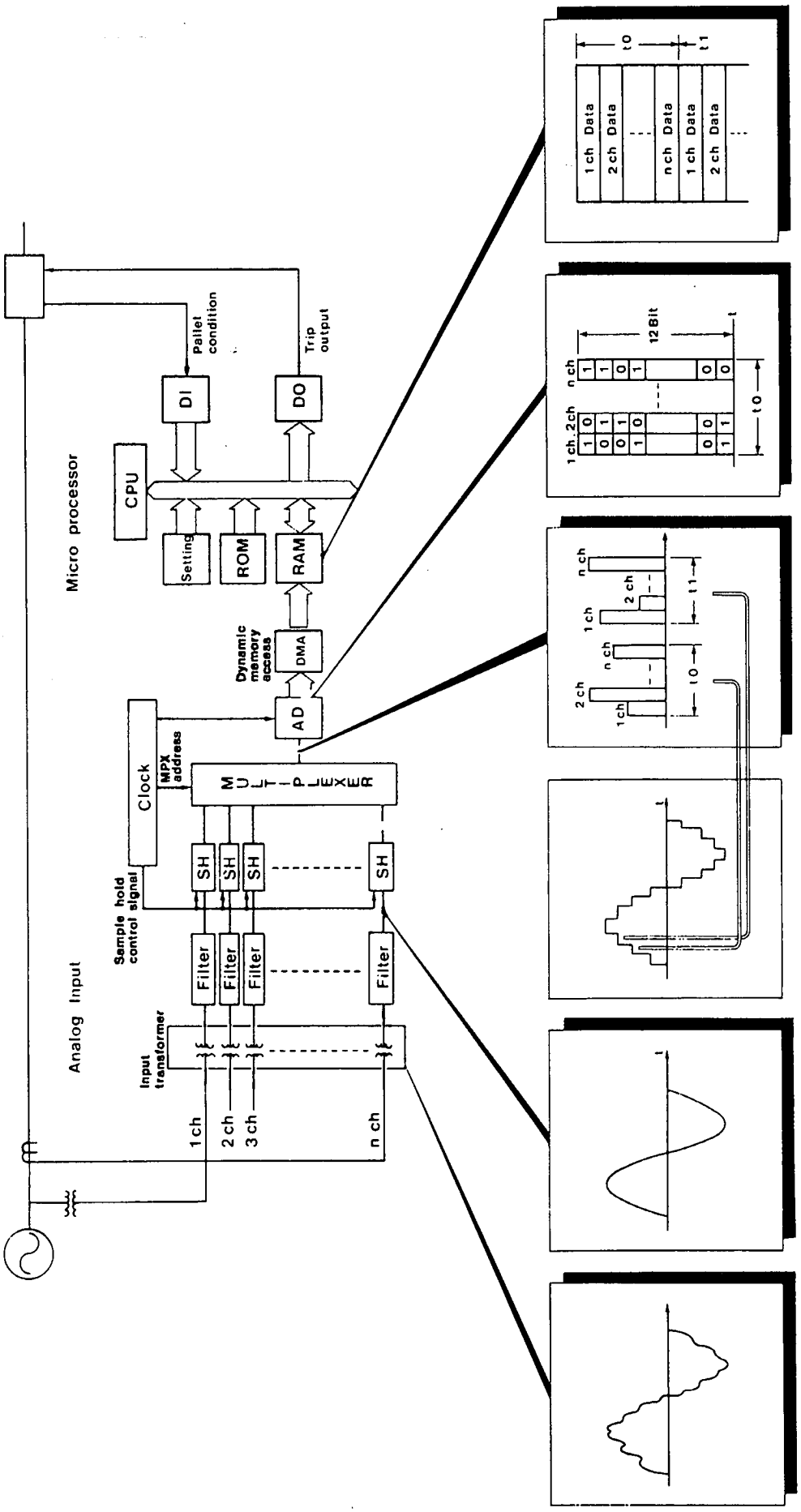


Fig. 1 General construction of digital relay

Paper No. 4

RAILWAY TRANSPORTATION FROM STEAM, DIESEL TO ELECTRIC TRACTION

Speaker: Mr. Y.H. Chang
Senior Research & Development
Manager, Kowloon Canton Railway Corporation

RAILWAY TRANSPORTATION
FROM STEAM, DIESEL TO ELECTRIC TRACTION

1. KCRC — THE EARLY DAYS

When the New Territories was leased to the British in 1898, communication and transportation between Mainland China and Kowloon was difficult. The terrain was rugged and roads are inadequate. The opening of the KCRC mainland between Shumchun and Kowloon in October, 1910 was a major break through in connecting the two places.

The trains at that time were worked by steam locomotives on a single track with primitive semaphore signals. The motive power remained unchanged until the introduction of diesel locomotives 45 years after the opening.

The first two diesel locomotives began service as early as 1955. Since then the steam locomotives were gradually phased out. However, complete dieselization was not completed until 1962 when the last steam locomotive retired from service. Between 1955 and 1976, KCRC acquired a total of 12 diesel locomotives. They are still serving the Railway up to this very moment. However, their roles have now switched from passenger services to freight traffic and shunting duties.

The power of the locomotives ranges from 840 to 1640 kw, making up to a total motive power of 14.4 MW. The basic design are all essentially identical. Similar improved versions of the vehicles are still produced by the original manufacturer in the USA.

2. MODERNIZATION AND ELECTRIFICATION

Since 1910, the KCRC was run by the Hong Kong Government as a department for 73 years. In 1978, the Government decided to modernize the Railway to tie in with new town development in the New Territories along the Railway.

Between the 5 years from 1978 to 1983, the KCRC was transformed into a modern railway in a HK$3.5 billion redevelopment programme. The mainline was double-tracked and electrified throughout. The number of station is increased from 9 to 13. Maximum line speed is stepped up from 80 to 120 kph and journey time is reduced from 75 to 40 minutes.

The new electric trains came in self-powered 3-car electrical multiple units (EMUs). The fully air conditioned saloons provide a quiet, fast and comfortable ride to the passenger when compared to the noisy and sometimes smoky old days.

In line with these changes, the Kowloon-Canton Railway Corporation was established in December 1982 and took over the KCRC in 1983. Since then the KCRC become an independent corporation which operates on commercial principles.

3. YEARS OF GROWTH

Under the management of KCRC, the Railway experience an unprecedented high rate of growth.

Patronage increases from 79 million passengers per year in 1984 to 171 million in 1989. EMU fleet size grows from 55 to 87. During the same period freight tonnage rises from 2.8 million to 4.5 million. Even the availability of EMUs shows a slight increase from 86% to 92%.

Furthermore, the KCRC also operates the Light Rail Transit System which has 70 light rail vehicles carrying 227,000 passengers daily. The Bus Division of the Corporation supports both railways and provides feeder services to 85,000 passengers per day with a fleet of 71 buses.

4. INTRODUCTION OF THYRISTOR TECHNOLOGY TO TRACTION

Currently KCRC is running 60 tap-changer controlled EMU (3 cars set). The schematic power circuit is as shown in Drawing No. 1.

The variable voltage supplied to the recitifier is controlled by on-load tap changing the two secondary windings of the main transformer. The arc generated during on loading switching cause severe wear and tear at the tap changer contact surface. Special maintenance effort has to be put on to inspect and replace them regulary.

The stepwise changing of voltage also introduces jerking of train movement.

In order to shift away of using mechanical wear parts and provide a smooth transition between Notches i.e. a better ride, thyristor controlled units are introduced. Up to June 1990, KCRC is running 35 (3-cars set) thyristor units. By early 1992, the fleet size of thyristor unit will progressively increase to 57 nos.

The schematic power control circuit diagram is as shown in Drawing 2.

The principal method of controlling the variation of voltage supplied to the traction motors is by varying the firing angle of the thyristors of the two serial connected half-controlled asymmetrical rectifier bridges.

The smooth variation of voltage lead to smooth ride. No particular maintenance effort has to put on the thyristors as compared with the tap changes. Thus maintenance cost is saved. These are the main advantages of using thyristor control unit.

5. INTRODUCTION OF THYRISTOR TECHNOLOGY TO AUXILIARY 3-PHASE SUPPLY

The voltage supplied by the tertiary winding of the main transformer is 1580V single phase 50Hz. In order to change it to 3-phase 440Y and 60Hz supply, a Motor Alternator Set is employed for each of the EMU.

The 1580V supply is first rectified and fed to a D.C. motor which is coupled to an alternator that generate the required voltage. A very sophisticated electronic control system is used to control the output frequency and voltage.

This sort of traditional mechanical drive involve a lot of mechanical maintenance such as inspecting and changing of carbon brushes regularly, overhaul of machines parts, etc. The cost of maintenance is high.

In order to reduce the maintenance cost of the rotary machines, and improve the reliability of the 3-phase supply system, KCRC has put forwarded a trail of Inverter System for over 1 year in a unit.

The tertiary voltage 1580V is first rectified and fed to the Invertor. By sequential switching of the internal thyristors, 3 phase sine wave output is produced to supply the 6 air conditioning units in an EMU.

Up to present, the trial is up to satisfaction.

6. ON CONDITIONING MONITORING

In order to further improve the reliability of the EMU's and the performance of the equipment, the feasibility of employing the On-Condition Monitoring by Micro Processors is being studied.

All the essential areas such as the supsension system, traction system etc, will be monitored. All the faults of the systems will be recorded by the computer. The fault data will be printed out for maintenance staff to act accordingly. Based on this system, the unit can be called to Depot for maintenance when the AI (Artifical Intelligence) computer advise that it is necessary.

This helps in reducing unnecessary regular preventive maintenance and facilities, KCRC to shift to Predictive Maintenance which is the current new maintenance philosophy of the industry.

7. SEAT CONVERSIONS

The initial EMU fleet was made up of 61 units, 19 of which were inner suburban units and the rest were outer suburban units. The former consists of ordinary class saloons with 2 + 3 seats throughout. These were intended to serve shorter journeys from Kowloon to Tai Po. The latter incorporates a small first class compartment and 2 toilets meant for longer journeys between Kowloon and Lo Wu.

With the increasing population in the developing new towns along the Railway, the number of passengers rises at an average rate of 14% per year. To meet this challenge, several programmes were carried out to boost up carrying capacity.

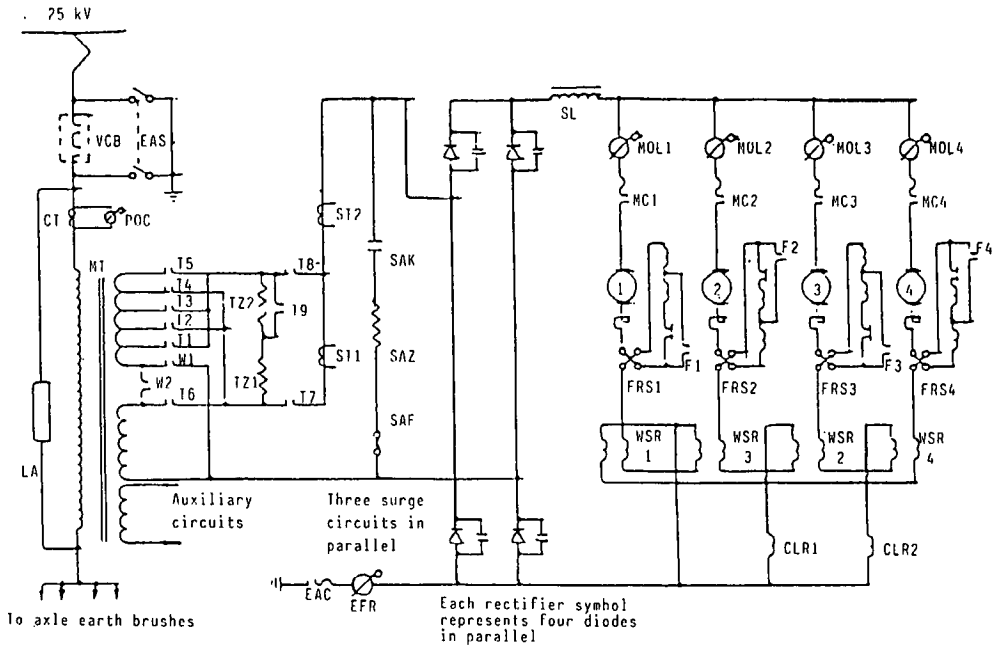
Firstly, a large scale conversion programme was conducted on the initial EMUs, Handrails and Straphargers were installed in the saloons. To create more standing space, 1 seat is removed from the 2 + 3 seat arrangement in the ordinary class saloons. Toilets adjacent to the First Class Compartment were dismantled and handrails were provided in the luggage compartment. In an attempt to rationalize stock deployment in operation, 27 of the original first class compartments were enlarged. The remaining 13 are converted into full length ordinary class. After this project, the carrying capacity of the initial 60 EMUs were increased by 14%.

Secondly, additional EMUs of larger carrying capacity were procured. The new 25 sets of thyristor controlled units delivered between 1987 and 1988 are all furnished with 2 × 2 ordinary class saloons. With these additional stocks, trains were made longer to carry more passengers. The fleet carrying capacity after this exercise was thus further increased by 43%.

Thirdly, a further batch of 16 sets of 6 car EMUs are now being delivered. To create additional standing space, 2 intermediate driving cabs are removed. Seats and draft screens adjacent to the doorways are deleted. The carrying capacity of these latest units is a factor of 28% over their earliest fore-runners.

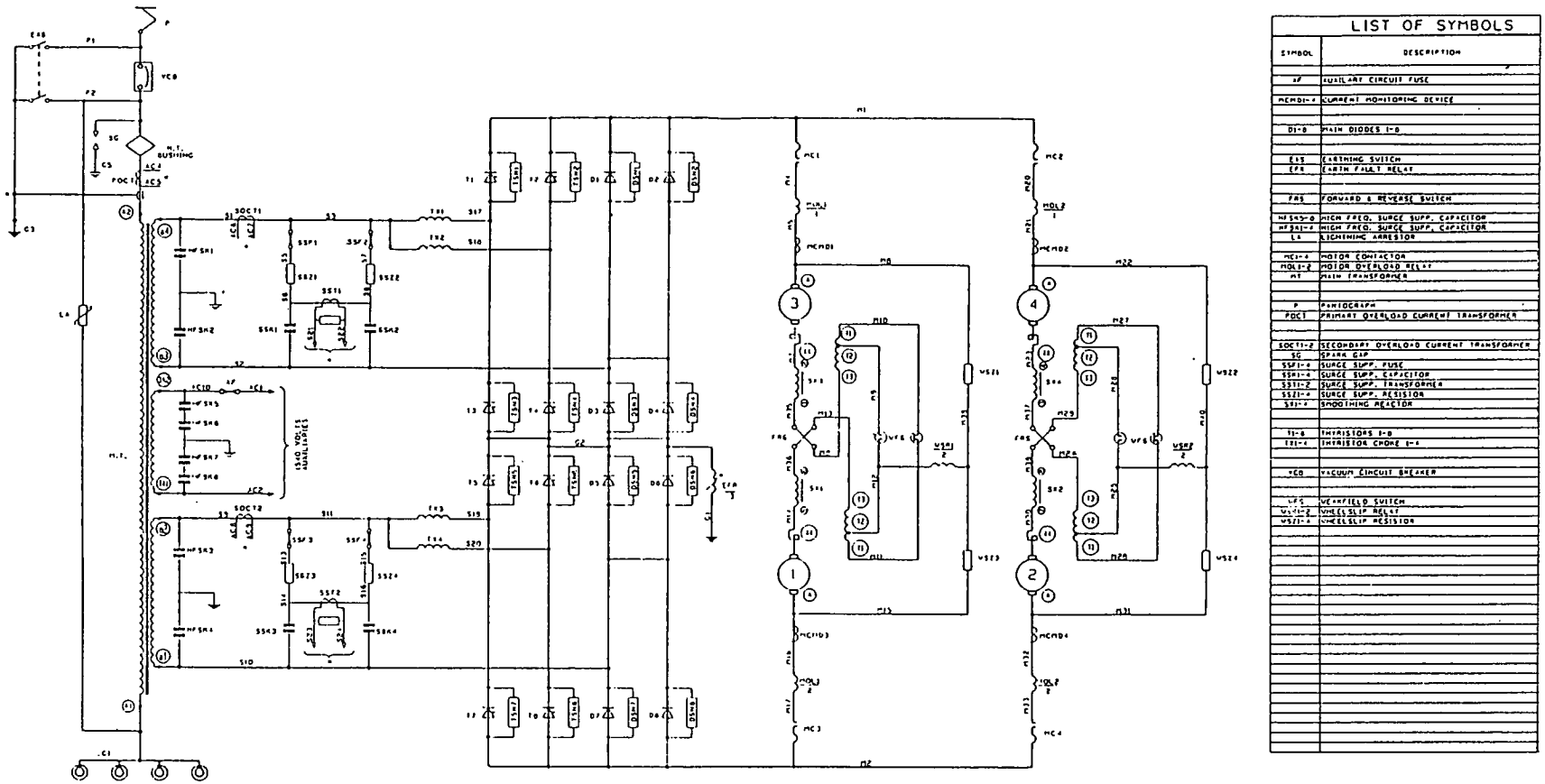
Finally, a project is now underway to convert a total of 85 EMUs to the latest version. The project costs over $200 million and will be completed by May 1993. Before the seats are removed the structure of the underframe must be strengthend by adding extra load bearing elements. The bogies frames are modified, brake machanisms are changed and the wheel axles are enlarged.

After all these efforts, the total carrying capacity of the final 117 EMUs will eventually be stepped up to 2.5 times of the figure in 1985.



①②③④	Traction Motors	LA	Lightning Arrestor	SL	Smoothing Inductor
CLR	Current Limit Relay	MC	Motor Contactor	TS1-2	Secondary Overload CT
CT	Current Transformer	MOL	Motor Overload Relay	T1-9	Tapping Contactor
EAC	Earth Contactor	MT	Main Transformer	TZ1-2	Tapping Resistor
EAS	Earthing Switch	POL	Primary Overhoad Relay	W1-2	Secondary Group Contactor
EFR	Earth Fault Relay	SAX	Surge Suppression Capacitor	WSR	Wheelsho Relay
F1-4	Field Tap Switch	SAZ	Surge Supporession Resistor	VCB	Vacuum Circuit Breaker
FRS	Field Reversing Switch	SAF	Surge Suppression Fuse		

Drawing 1. Tap-changer Controlled Unit Power Circuit Diagram



LIST OF SYMBOLS

SYMBOL	DESCRIPTION
AF	AUXILIARY CIRCUIT FUSE
MCMD1-4	CURRENT MONITORING DEVICE
D1-8	MAIN DIODES 1-8
EAS	EARTHING SWITCH
EFR	EARTH FAULT RELAY
FRS	FORWARD & REVERSE SWITCH
MFSH5-8	HIGH FREQ. SURGE SUPP. CAPACITOR
MFSH1-4	HIGH FREQ. SURGE SUPP. CAPACITOR
LA	LIGHTNING ARRESTOR
MC1-4	MOTOR CONTACTOR
MOL1-2	MOTOR OVERLOAD RELAY
MT	MAIN TRANSFORMER
P	PANTOGRAPH
PCT	PRIMARY OVERLOAD CURRENT TRANSFORMER
SOCT1-2	SECONDARY OVERLOAD CURRENT TRANSFORMER
SG	SPARK GAP
SSF1-4	SURGE SUPP. FUSE
SSH1-4	SURGE SUPP. CAPACITOR
SST1-2	SURGE SUPP. TRANSFORMER
SSR1-4	SURGE SUPP. RESISTOR
SR1-4	SMOOTHING REACTOR
T1-8	THYRISTORS 1-8
TR1-4	THYRISTOR CHOKE 1-4
VCB	VACUUM CIRCUIT BREAKER
WFS	WEAKFIELD SWITCH
WSR1-2	WHEELSLIP RELAY
WSR1-4	WHEELSLIP RESISTOR

Drawing 2. Thyristor Controlled Unit Power Circuit Diagram

Paper No. 5

AIRPORT E&M SYSTEMS: YESTERDAY, TODAY AND TOMORROW

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Electrical & Mechanical Services Department

AIRPORT E&M SYSTEMS: YESTERDAY, TODAY AND TOMORROW

1. INTRODUCTION

An aircraft landing area was initially referred to an airfield and in fact a field it was with grass upon it and bounded by hedges. The area could be as small as one fifth of an acre (approximately 100 sq yards) and fitted with only one piece of equipment known as a windsock or to use the International Civil Aviation Organisation (ICAO) definition — wind direction indicators.

What is amazing is this piece of simple equipment still in use nearly 70 years after the first aircraft developed by the Wright Brothers. In fact the wind direction indicator will become mandatory by November 1990.

Of course the word airfield has been replaced by the term Airport, of which there are around 6000 in the world. Fully international airports in today's world refer to a public flying ground for commercial use by airliners, usually with offices for customs and immigration. In order to function in today's world, airports require a number of specially developed engineering systems such as Baggage handling, airfield lighting, aircraft docking, aerobridge and 400Hz power supply in addition to the normal E&M systems for a commercial building.

This paper will only cover a few of these systems that we (Electrical and Mechanical Services Department) have direct design, operation and maintenance responsibility involvement. I shall also describe the possible systems, which may be incorporated into the new airport for tomorrow. I trust that the audience can then make up their own mind whether an electrical engineering perspective in an airport is for Better or for Worse.

Paper No. 5

2. BAGGAGE HANDLING

Baggage handling systems cover all types of baggage variously known as interline, outside, group, arrival and departure. Of all these systems, the departure system is by far the most complex. this will be the system primarily dealt with in our paper.

If passenger baggage could be standardised, the system would not need to be so complex. However in truth there is no standard bag consequently more expense design parameters are needed to cope with an astionishingly wide variety of items.

In fact, the existing baggage system has undergone several major changes in the Hong Kong International Airport. Briefly the early departure systems consisted of a simple check-in desk with a weighscale. A handwritten label was attached to a bag which was normally loaded onto a trolley until the trolley was full. The trolley would then be towed to the aircraft. Bags would be manually loaded into an aircraft.

This labour intensive and slow system quite obviously had a very low capacity of only a few hundred bags an hour. It also occupied a large area of the passenger processing space in the airport. To cope with the increasing numbers of passengers, it was necessary to devise other system of baggage handling that could handle large quantities of bags quickly using less space and labour.

Today in Hong Kong we have baggage system of six islands, fitted with computers to ensure that all baggage conveyor processes are co-ordinated and synchronised so that bags checked will eventually be sent to the correct spurs within the specified time. I should mention here that the spur is the point in the system where a bag is manually removed from the baggage handling system and stacked into the aircraft container. The computer also collects operating data of the system for managerial decision and control and deals with flight information.

The computer is aided by the programmable logic controllers for physical control of conveyors, priority bag merging at check-in belts, and sortation functions at the coding station.

Two islands out of six are of the newer version. They incorporate very efficient tippers for tipping bags. The air gaps of the conveyor system are minimised by using pulley drives with smaller diameters. This reduces bag trapping. A cascading "water fall" is installed whereby the head conveyor pulley is placed at least 50mm lower than the preceding tail pulley. No positive slope in the conveyor train is allowed in order to eliminate bag jam due to untoppled bags on wheels.

To enhance the system reliability, additional fall back facilities are used. These include the dual drive arrangement, emergency supply from diesel generators for all the motors, manual transfer facilities in the event of motor drive failure, dual computers and a standby programmable logic controller.

With these facilities, the designed capacity of 1440 bags per island can be easily achieved. To bring the other four islands up to these standards, a major refurbishment project is well under way. This includes provision of efficient tippers and water fall effect as previously mentioned for the newer version.

Tomorrow, we are looking at check-in counters fitted with computers and automatic bag tag printing. At the touch of a single button, the bag can proceed to an automatic (unmanned) code reader that directs the bag to a preselected spur.

At this point of time, the bar-code system seems most promising. Its capacity can be up to 2000 bags per reader. The major consideration is however the poor no-read percentage which can be up to 25%. Incorrect read resulting in despatch to incorrect destination is normally very much lower and being well below 1%.

When the bags are delivered to the spur, the bags are then loaded manually into a special container or dolly which is then towed to the parking bag. The container is then moved onto a hydraulic platform that delivers it to the aircraft.

The weak point of this system is that it still involves manual loading. This can introduce human errors and constitute some measure of security hazard.

As a step further, there is a system under feasibility study that can convey bags from the check-in desk directly to the belly of the aircraft without being touched by human being. The concept is to convey the bags through automatic sorters such as bar code readers and via conveyors in aerobridges to the belly of aircraft. Apart from the problem of the reliability of readers, the interface between aerobridge needs to be carefully looked at.

The very latest concept is still in its infancy although the technology already exists is bags being fitted with microchips that can be 'read' inrrespective of position or shielding.

3. AIRCRAFT DOCKING SYSTEMS

Once an aircraft is on the ground, the airline quite correctly considers that the aircraft is no longer earning revenue. Therefore it is essential to expedite the deplanning and emplanning of passengers and subsequent return to the air.

Early systems consisted of a few strategicaly located signs and ground markings to give general guidance to the aircraft to stop in an open area near the terminal building. Passengers were deplanned via opensteps to the tarmac and then proceeded on foot to the terminal building whilst being exposed to the environment.

The increasing need to return the aircraft to the revenue earning mode and provision of comfort to the passengers created the atmosphere to develop protected means of deplanning the passengers from the aircraft direct into the terminal building. This protected environment was provided by aerobridges which led to the need for more accurate docking systems than a human marshaller with two bats.

Today we use aerodrome lighting control computer to guide the aircraft to the designed parking bay. The computer stores the possible routes of taxiways that the air traffic controller can choose from the keyboard. Due to the great increase in numbers of flights, the controller finds difficult to spare time to fully use the computer to direct aircraft taxiing.

For inner bays, there are optical lens docking systems installed. The system uses high intensity light bars to show the correct alignment both for the centre line and for the stop distance from the building. Whilst the optical system is very reliable, its accuracy is subject to the eye level of the pilot. This is in turn affected by the physical height of the pilot and the loading of the aircraft. Poor docking can delay the deplanning of passengers.

Tomorrow, the computer is more user-friendly. For aerodrome lighting control, the replacement computer is being tendered for use in 1991. A light pen will be used by the air traffic controllers sitting in the tower to select and activate various command poke point on the computer video display unit which incorporates the mimic diagram of the entire airfield lighting system. As such, it is much easier to choose the taxiway route. It is possible that when the aircraft reaches taxiing speed after touch down, the aircraft can be automatically guided off the runway, along the taxiway and stops against the aerobridge with an accuracy of a matter of centimetres.

Such accuracy of docking can be achieved by some docking systems. One system uses induction sensors embedded in the apron slabs. As the nosewheel of the aircraft pass over the sensors, they transmit signals through a scanning unit to a microcomputer. The microcomputer will determine the correct stop position after checking the type of aircraft. As such the stop position will not be affected by the eye level of the pilot.

4. AEROBRIDGE

The functions of the areobridges have been described above. Today, we have twin aerobridges per parking bay. The outer bridge is mobile and is apron-driven. The inner bridge is fixed. For smaller aircraft, only the outer bridge is used. For wide-body aircraft, both bridges are used for fast processing of departure and arrival passengers.

To prevent exerting excessive pressure on the fuelage of an aircraft by the bridge, the existing bridges are equipped with various protective limit switches to stop the bridge when in contact with the aircraft and to reduce its docking speed in the proximity of the aircraft. Some bridges installed in 1989 are equipped with dual switches to allow for redundancy.

For newer generation of bridges, mini-movers may be installed in the fixed bridges as well. This can cater for the slow response of the pilot to the electronic docking system. To save time and manpower in tying down the bridges in typhoon, an integral tie-in facility will be equipped in the bridge.

Also, for quick disengagement of bridge in case of malfunction or misoperation, an integral hand-wind facility may be provided to release the bridge from the aircraft so that the aircraft can depart in time. A protection override device may be provided so that the operation of the bridge can still be carefully manoeuvred in case of malfunction of the protection system.

An fully automatic bridge docking system is being developed in Europe which will eliminate the need for a bridge operator.

5. AIRFIELD LIGHTS

Lighting of yesterday consisted of a few dozen hand positioned kerozene flares to delineate the runway. Today, airfield lights are numbered in the thousands and cover the runway, taxiway and apron. As described before, remote control from the air traffic control tower is the norm and in many cases is automatically controlled by appropriate sensing devices and computing devices that not only control on/off functions but the light intensities as well.

Some taxiway centre lights installed in 1959 are normally designed for narrowed body aircraft. When they are subject to the present wide body aircraft, frequent failures on the seals, filters, glass, lamps are experienced. These indicate that these lights cannot sufficiently bear the weight and vibrations of the wide body aircraft.

For new generation of airfield lights, they are of more robust construction and fewer use of glass. The use of dichroic lens can eliminate the filters and give higher light intensity output. Together with pre-focused lamp bulbs of better design, lower wattage bulbs can be used whilst giving the required output.

A computerised monitoring system is also developed to monitor the lights, provide historical statistical data, diagnostic information, real time status of the lighting systems and the power equipment supporting these lights. This will keep the maintenance and operation personnel constantly advised of any malfunctions, deterioration or other conditions in the systems so that appropriate steps may be taken to correct problems.

Airfield lights are supplied from constant current regulators (CCRs) to ensure their uniform brilliancy level. By the introduction of automatice power sensing techniques in CCRs, they can efficiently control and cost effectively handle lighting loads. The energy saving are obtained by the careful choice of internal parameters. Taking into account load variations and the ability to switch off non required lights, the total power consumption cost saving can be about 50%.

6. 400 HZ SUPPLY

An aircraft utilise 400Hz instead of 50Hz supply for its equipment on board thus minimising motor frame sizes, saving weight and space.

Initially this supply was obtained from its own auxiliary power unit (APU) which is both noisy and expensive to run (about $100 per hour) plus the fact that it contributes to air pollution.

One method to reduce the usage time of APU is to use mobile diesel generators. These mobile units still polluate but not so much as the APU but are cheaper to run being around $30 per hour.

To eliminate the pollution of exhaust gas and noise from these mobile units, the fixed ground power concept was developed. Costs become even lower than $3 per hour. It has been calculated at the Hong Kong International Airport that when the system is installed at the inner passenger bays, pay back on capital investment will be around 2 to 3 years making the system very attractive to the airport operators. As such, 400Hz fixed ground power units are being procured and will be installed in late 1990 in the Airport.

There has been a detailed investigation and feasibility study on deciding where static units or conventional rotary units are to be used. The rotary units are of proven design, giving higher output and more robust. The static units are however quieter, smaller and lighter. The most important finding is that the new aircraft such as Boeing 747-400 requires very high quality of electricity supply which rotary units cannot normally guarantee under all conditions of usage. Consequently, tripping has resulted. Based on the above, static units, for both centralised and decentralised systems, are to be used. The rapid development in power electronics has made the static units much more robust and reliable.

7. RAMP SERVICES

Ramp services are the push-out tugs, baggage handling, fueling, waste disposal and ground power, some of which have been described above. These services constitute part of the air and noise pollution in the airport.

To effectively minimise the pollution, a new terminal is being constructed in Stockholm / Arlanda which will open in late 1990. It will attempt to do what no other airport has yet tried — almost completely remove ramp vehicles from the apron.

Push-out tugs, baggage vehicles, fuel tankers, waste-disposal equipment and ground power units will all be replaced with underground services which rise to apron-level when the aircraft is parked. An automatic push-back system which slides the aircraft out of its parked position is also featured. Besides lowering level of pollution at the airport, the new system should cut down turn-round times.

These services are housed in support and maintenance tunnels below every aircraft stand. Each tunnel is covered by lids. In the tunnel there are a number of cables and pipe-lines to elevators on the ground level. The different elevators can be raised to about one meter above the ground level for providing services to the aircraft.

8. CONCLUSION

The above briefs a few of the E&M system in the Hong Kong International Airport for yesterday, today and probably for tomorrow. It is shown that continuous improvements have been incorporated into these systems. These systems all depend upon electricity for their subsequent and continued developments.

It is impossible to conceive of an international airport handling thousands of aircraft and millions of passengers each year without the aid of electricity. No doubt, the above mentioned developments aim for better in an electrical engineering perspective.

Paper No. 6

CONTRACTING IN THE 90'S

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Vice President
H.K. Electrical Contractors Asso. Ltd.

CONTRACTING IN THE 90'S

1. FOREWORD

For better or worse, contracting in the 90's is setting out to be a different concept than that of the 80's and before. The name of the game has changed. The word "contracting" had been defined by the dictionary to mean "a business agreement for the supply of goods or performance of work at a specified price". It is definitely a little more than that.

The evolution of the concept of contracting is not much the result of technological progress, which does play a part, but of the result of various interacting factors that are part of the development of our society — such as increased complications of contracts, the use of integrated approach to contracts, the advent of the multinational contractor, the increased affluence and aspirations of the labour force, the changing of engineering standards, and of course, a quest for quality.

2. THE QUEST FOR QUALITY

As the business of contracting gets more complicated, so does the business of maintaining quality. Doing a job well now means the achievement of quality in each and every respect that matters. These include design, management, and workmanship.

2.2 Quality of Design

A good design is the most important prerequisite for a good job. Here the work is much easier to define in engineering than in architecture — the end result does not need to look different — it just have to work. That may sound easier than it could be, but to deliver a professional engineering design is no easy feat. Consulting engineers not only have to cater to the more basic engineering requirements, but they also have to cope with the complications of changing standards, increasing demands of safety requirements, energy conservation consideration, and environmental constraints. These factors will interplay with design work in a much more elaborate way as we move into the 90's. And on top of that the requirements of owners, developers, and customers will become more sophiscated and demanding.

2.2 Quality of Standards

The purpose of standards should be to forestall quality. The questions often are what standards are to be used and to what extent they are being adhered to. The situation is complicated by the large number of standards that are promulgated by different countries. While consulting engineers may find the study of standards another part of their work, and may even find the exercise stimulating, the subject may prove to be the ultimate nightmare of the average Mr. Contractor.

In the forefront of the electrical installation field there are standards of wiring practices. The expansiveness and complexity of the whole business was epitomed a few years ago by the publication of the 15th edition of wiring regulations by the IEE in the UK. It created instant chaos and confusion, and took the industry months to understand what it was all about. Now that engineers are acquainted with the new standards, they could be ready again for the next shock, whatever that may be. Europe 1992 could be the next one. The harmonization of standards inevitably brings out disharmony, without which the differences cannot be ironed out. We know that eventually every thing will be fine. The question is when.

We can probably consider ourselves lucky that inspite of the lack of a strong arm from the government on the choice of standards in the electrical industry, we have more or less settled on one main stream of standards. This is not because the British Standards are better standards — they probably are, — but because we work on one commonly agreed set of standards and not a combination of several set of standards. Some of our neighbours, like China and Thailand, have a more liberal philosophy on standards. The result is a collection of quite different and sometimes conflicting engineering practices. For better or worse, engineering is still more of a science than an art, and compatability still takes precedence over nonconformance and eccentricity.

Are some standards actually better than others? I do not think so. Some standards may be more comprehensive, some may be more precise, while others are more understandable, but all major standards are just adequate and workable in their respective countries. The difference, it appears, lie in the implementation of the standards. So long as the industry practices with discipline in adhering to the standards, safety and quality can be achieved. In Hong Kong thanks are due to the government, the utility companies, and private consulting engineering firms, who act as the watchdogs. As for contractors, they do not have much room to maneuver, because their charge of getting caught cutting corners is very high, thanks to the watchdogs.

2.3. Quality of Management

Management is what tells between a good and a mediocre job, and whether a contractor is successful or not.

Success from a contractor's point of view would necessarily mean the completion of a contract, and getting paid, and making a profit. This simple set of goals have not changed over the years, though the rules of the game have. Contract management now encompasses tasks and skills so diverse that it seems can only be handled by superhumans rather than mere professionals.

Of all the various aspects of contract management nothing is more demanding as the management of human resources. From the top level of general management to project management, site management, and supervision of work, the problems are diverse and the management skills required are different. The situation has been futher complicated by the problem of brain drain on the one hand, and of labour shortage on the other.

As most contracts are actually done by subcontractors the problem is partially pushed onto the subcontractors, who are usually left with the unenviable task of finding the bodies to do the work. Unfortunately it also means that the contractor has less control over what goes on at the site and when something goes wrong it might take longer to find out and remedy.

Automation has helped to alleviate some of the labour problems. Computer aided design has freed drafting and design personnel for other necessary tasks, while general computerisation has generally reduced the amount of work for estimation and contract monitoring. But again, a balance has to be struck on the extent of computerisation, which adds rigidity, and maintaining the human factor, which maintain the flexibility of the operation.

And the aspect of cost control, which determines at the end of the day the contract is profitable or not, is probably most important and hardest to achieve. The task is not made easier by the rapid increase of labour costs, and the ever fluctuating costs of materials and currency exchange rates. During the past 2 years labour costs in the electrical installation industry have more than doubled. And the combined effects of wild fluctuations of raw materials like PVC, copper, and steel, together with the roller-coaster relationship between the Hong Kong dollar and currencies like the British Pound Sterling, the Japanese Yen and the German Mark, has resulted in equipment cost gyrations of up to 50% or more in just a matter of months.

The problem is not so much the fluctuations themselves as foretelling how much the fluctuations are going to be. In the absence of protection against labour and material costs in most cases, the exercise of cost control has been a contractor's nightmare. The art of keeping costs down takes more than quality of management — luck has to be on one's side. On the other hand, if too many contingency safety factors are built in, the tender prices would go up accordingly, and one might not get the contract to begin with.

2.4 Quality of Work

Quality of work is an area that need to receive more attention. The contractors who invest their efforts in this area should be able to reap the benefits — a trouble-free track record, a good reputation, and getting the job next time.

In simple terms, quality of work makes the difference between a good job and a bad job. All things being equal, it is how one contractor is chosen over another for a piece of work — it might be for a better team of engineers, or a better team of technicians and workers, or more attentive and responsive service, or completing jobs promptly, or better workmanship and finish, or better choice of equipment, or just a better name.

3. THE WAY AHEAD

If contracting is already a complex business, it is heading towards more unfamiliar ground in the 90's. Let's look at some of the issues at hand, and see where they are bringing us in the decade ahead.

3.1 Integration

Buildings are getting more sophisticated and the divers building services and facilities that are being put into a building require better co-ordination among the various trades and disciplines.

Modern buildings include electrical installations, air conditioning, plumbing, gas supplies, fire systems, security systems, lifts and escalators, waste management, telecommunication, telephone, building automation and energy management systems, etc. Invariably someone at some point takes up the function of overall co-ordination of these services, whether it be the developer's in-house co-ordination team, a separate project management contractor, or the general contractor, or the consulting engineer, or a mixture of the above. In the 90's we shall probably see more combined — services contractors who will take up several or all of the building services functions. There is also a tendency for owners and developers to consider incorporating the buiding services contracts into the main contract, thereby transferring the task of coordination and overall responsibility onto the main contractor. Another probable step from there would be design build, a concept not uncommon overseas but would need time to take root in Hong Kong. While the practice simplifies things for the owner it does require a new discipline and skill that is still lacking in main contractors in Hong Kong at present. Furthermore most building service contractors, in particular electrical contractors, do not like to work as a domestic subcontractors to the main contractor. There has been very strong opposition against the introduction of domestic subcontracting in Hong Kong. How quickly the 90's will see the change from nominated subcontract to domestic subcontract form of contracts will define how the electrical subcontractor will have to cope — whether it will continue to be an owner/consulting engineer relationship, or whether to learn to live more intimately with the general contractor.

3.2 Computerization

The computer will play a bigger role in the contractor's office. More CAD drawings will come out of laser-plotters. Three dimensional graphics will sort out the space problem and avoid services such as electrical cables, conduits, air conditioning ducts and piping, plumbing fixtures, gas pipes, and telephone lines from crossing one another. More information will be retrieved from the screen than from files, project tendering, material control, and work scheduling will rely more on the computer than the human hand. But we shall wait to see if we shall get robots replacing electrical fitters!

3.3 Substitution of Manpower

The current labour shortage will continue at least into the early 90's. As wages go further up and skilled labour is still not sufficient, there will be increasing pressures from the industry to import foreign workers.

The problem will not be any less serious at the technicians and engineers level, given the current rate of loss of people through emigration. There will be similar demands on the government to relax rules on the issue of work permits for foreign brains as for foreign hands.

In the longer term vocational training will play a larger role in the grooming of skilled workers. It would be a race against time, to get a sufficient number of workers trained to meet with demand, and its chance of winning depends largely on whether the industry can lure sufficient young people to join the profession, in light of apparently faster returns in easier jobs in other industries.

Meanwhile the trend would be for consultants and contractors to turn to more extensive application of prefabricated materials and foreassembled equipments, all to minimise the usage of manpower on site.

3.4 The Labour Factor

In the past two years we have seen the re-emergence of collective bargaining in a number of labour sectors, some with political overtones.

With the continued shortage of labour, increasing take-home pay and growing affluence of workers, the escalating political awareness of the average citizen, and the possibility of representation through election, the participation of workers in union type activities will be on the rise. There will be demands for higher wages, more employment benefits and better working conditions. All these will result in a higher overall labour costs, as well as more attention from management on labour relations.

There will also be resistance to the importation of labour, probably on a more united front. We shall see more cases of employers succumbing to pressures from labour. But in return employers will hope to receive more loyalty from workers, and there could be a reduction in the turnover rate of employment which is troubling the industry at present.

3.5 The Government's Role

The government will play a larger role in relation to electrical contracting in the 90's. It has started in a very positive note this year by introducting the Electricity Bill 1990, putting in the hands of the Director of Electrical and Mechanical Services some real power for the enforcement of safety in all aspects of electrical installation.

In less than two years we shall see that most electrical workers and contractors will be registered a their appropriate grading or class with the government, a long awaited step towards upholding the standard in electrical contracting.

We shall also expect to see an electrical products safety code, which will serve to put out of circulation substandard products that could be safety hazards.

As in other developed countries, upgrading and enforcement of safety standards result in higher contract costs. But it will be a price worth paying.

One area that will need more government involvement is site safety standards. Without tougher legislation of site safety, work site conditions will remain in its present hapless state for some time to come.

3.6 Legal Aspects

Hong Kong contractors in the early years seldom had to deal with lawyers. In the 80's they have found the situation a little different. A few general contractors went into receivership and subcontractors found themselves scrambling for legal assistance to get paid and protect their own interests. An arguement between one general contractor and the government over project delay and related claims and counterclaims resulted in a legal wrangle that had to resort to arbitration. In a large prestigeous development the developer sues the architect for professional liability. In another luxurious residential development on an outlying island the electrical installation turned some houses into live electric cage which resulted in tenants suing developer, developer suing consultant, and almost everyone suing the electrical contractor. The list goes on.

In the 90's the legal aspects of contracting will certainly receive more attention, if only as a precautionary measure. Arbitration, which is gaining popularity overseas, could find its place in Hong Kong. May be contractors will learn soon enough to settle rather than to sue. In the legal business there is always one winner — the lawyer.

3.7 Risk Management

Contractors will have to face up to the task of minimizing their risks in order to survive the unexpected that can come their way, from any direction, at any time.

First and foremost is the risk of materials and labour cost fluctuations. Contractor will try to negotiate longer term contracts with suppliers, which in fact shuffles the risk onto the suppliers. They might also get more involved in the hedging of currencies and metal prices against material supplies for their longer term contracts.

Contractors will also have to break new ground if they want protection against cost escalations and price fluctuations. Although common in quite a number of countries, there is little or no provision for escalation clauses or indexed price adjustments in Hong Kong. So far contractors are making their bets everytime they sign a contract, but the exercise could prove expensive in today's volatile markets. Another area is the loss of materials on site due to theft, fire, or other means. Losses due to site theft alone accounts for nearly 2% of contract values. The provision of insurance against such losses is still inadequate, so is the demarcation of responsibilities between the main contractors and subcontractors. We should see the development of more proper coverage for site losses.

Coverage provisions for loss of life or disability on site are still minimal by international standards. Here is another growth area for the insurance business, especially with the probable increase of pressure from workers for better coverage.

Another area that will receive more attention would be professional liability. It has started with architects and consultants. When they are all covered, it would be the turn for contractors to take a serious look.

3.8 The Multinational Perspective

Quite a number of foreign contractors have come to Hong Kong and obtained work. The reverse is not so true as local contractors tend to shy away from overseas work. However China has provided a good training ground for quite a number of local contractors, most of whom have probably paid their "training fee' in kind of doing contracting away from home. There are also cross country activities on an institutional level. The Hong Kong Electrical Contractors Association (HKECA) is already part of the Federation of Asian and Pacific Contractors' Associations, which includes countries such as S. Korea, Taiwan, Australia, and all the ASEAN countries.

It is an open question whether we shall actually see more Hong Kong Contractors operating in foreign shores in the next decade. But with a lot of our industry's talents already resident in the likes of Toronto or Sydney, the possibility is not that remote.

3.9 Standards and Codes of Practice

Questions have been raised as to whether Hong Kong needs its own standards. My opinion is that it does not, as the current standards are totally adequate and appropriate. With the advent of the Electricity Bill 1990 and its accompanying wiring regulations, the current British Standard based codes of practice in the electric installations industry gets a defacto endorsement from the government. It is also the first time that such regulations are written out in great detail, providing a framework for the industry for the 90's.

One other development that could be interesting is the adoption in Europe of ISO 9000 and its UK equivalent, BS5750, in other areas than the manufacturing industries. Some contractors are trying to incorporate this standard into their contract quality control systems. This is a welcomed development that could give the quality control aspect of contracting new dimensions.

I have tried to speculate. From what I have speculated I would certainly not come to any conclusion as to where contracting is heading in the 90's. But it looks like that it is not going to be easier. The 90's Mr. contractor not only knows how to put the nuts and bolts (or is it plugs and sockets) together, he also has to be a competent overall manager, a good labour relations man, a legal expert, a financial expert, knows his internal systems and computers, knows how to hedge against risks, multinational in outlook, and above all, can make a profit.

All the indications point to one thing, that contracting is going to be a better quality business, a safer business and better care for its people. But all these will not come free. For better or worse, we are going to have to pay for it.

Paper No. 7

QUALITY ASSURANCE IN CONSULTING ENGINEERING PRACTICES

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QUALITY ASSURANCE
IN
CONSULTING ENGINEERING PRACTICES

1. WHAT IS "QUALITY ASSURANCE"?

The term "Quality Assurance" is actually defined in British Standards BS 4778: Part 1: 1987 (ISO 8402-1986) as "All those planned and systematic actions necessary to provide adequate confidence that a product or service will satisfy given requirements for quality". In simple terms, Quality Assurance does not necessarily relate to engineering superiority or excellence, but rather to fitness for purpose in meeting the client's brief. Quality Assurance is all the activities necessary to the attainment of Quality including the management to ensure that things happen in the way they are intended to.

There is a growing trend, especially in the United Kingdom in the engineering consulting industry for implementing Quality Assurance procedure and programmes in one form or another. "To make a mistake once may be tolerable, but to make the same mistake again is inexcusable" is many consultants' motto.

As many of the Quality vocabulary are given in BS 4778: Part 1: 1987, we do not intend to dwell upon them in this paper. Let us now look at an example of how it may affect the structure and management of an engineering consulting firm, say a building services consulting firm.

First of all, let us understand the business nature and activities of a typical engineering consulting firm. A typical project flow chart is shown on Figure 1 and a typical consulting firm structure is given on Figure 2.

How does a consulting firm market itself? It sells and promotes its engineering service (which is its end-product). What are the assets of the consulting firm? The assets of the firm are its people and the firm is only as good as its people's performance. To capitalise a firm's assets, i.e. its people, it should impact its end-products by its technical know-how and its past years of experience and track record (very important so as not to repeat the same past mistakes twice). With the firm's structure and project flow chart as shown on Figures 1 and 2, the quality of its end-product depends very much upon the individuals who are looking after the project. One design team or its engineer may repeat the same mistakes of another design team or another engineer unknowingly. This is why there is a need to introduce Quality Assurance into the firm.

Figure 3 shows an example of how the firm is restructured after the introduction of quality assurance. Partner A or a senior member of the practice on the diagram takes charge of Quality Assurance and he himself may also be the Quality Assurance Manager. He reduces his project responsibilities by transferring some of these to say, Partner B or another design team. The Quality Assurance Group under him looks after quality control by means of standardisation, specialisation and exchange of information among all project teams. It ensures not only that the work of each project team is carried out efficiently, but that the firm as a whole (and not just that of teams or individuals) is reflected in the quality of the design and other services which the firm offers to their clients. The project flow chart after the introduction of Quality Assurance is indicated on Figure 4. This chart indicates the two main functions of the Quality Assurance Group — design critiques and project management reviews. Design critiques are achieved by inviting senior members of the firm not associated with the design of the particular project to carry out design checks. Design critiques are carried out at various critical stages of the project as indicated on the chart. Having ensured the quality of the design, the Quality Assurance Group also reviews the management aspects of each project team to ensure that each group operates at maximum efficiency. It ensures that all project team operations are carried out in conformity with approved procedures and technical standards. These monitoring functions are terms Project Management Reviews.

All Quality Assurance activities and functions are carried out under the direction of the Quality Assurance Manager assisted by his deputies. To make the scheme work, it is important that:

a) the Quality Assurance Manager is a very senior member of the firm (preferably a Partner or Director). He must have the authority and respect from his colleagues and staff members in exercising his duties required of the Quality Assurance Manager.

b) All Quality Assurance procedures have to be well documented. A Quality Manual should be developed which gives in detail the firm's organisation, guidance procedures, standard design, standard specification and Quality Assurance procedures. This Manual should be available to all project team members. All project management reviews and design critique decisions should be documented and kept in the project file for future reference and hopefully refinement.

c) A constant and good communication link has to be maintained among the Quality Assurance Manager and the heads of the project teams.

2. WHAT IS THE COST OF QUALITY ASSURANCE?

Same as a production plant in a factory, Quality Assurance incurs both capital and recurrent expenses. The capital cost is the engineering time of senior member(s) in reviewing the firm's procedures and developing the Quality Manual. In one case in UK, it has taken a firm 18 months to develop the Quality Manual which cost them around HK$850,000. The recurrent cost involves divorcing some (if not all) of the Quality Assurance Manager and his team members' time from actual project works to execute Quality Assurance tasks. It is said that the annual cost to that firm in implementing Quality Assurance can be in excess of HK$1,000,000.

3. DOES QUALITY ASSURANCE PAY BACK?

The answer is yes, but it is difficult to quantify the payback period. It pays back in terms of improving the firm's efficiency and reputation. More importantly, it improves the quality of the firm's work which reduces the firm's exposure to claims by other parties resulting from professional negligence — an item which is surely difficult to put a dollar value against.

To conclude, we see the trend for professional firms to lean more heavily towards Quality Assurance. In implementing Quality Assurance, it provides the motivation for a total review and updating the firm's procedures and organisation. It is by no means cheap, but it improves the efficiency and quality of a firm's work, and thus raises the standard of our profession. In the present claim conscious society, it will greatly minimise the firm's exposure to claims arising from professional negligence.

Acknowledgement

The writers experess their thanks to Mr Bernard T. Rose for providing information about the trend of Quality Assurance in UK. Mr Rose is the Past President of the Institute of Hospital Engineering and is a Partner in J. Roger Preston & Partners. He is responsible for the Quality Assurance organisation of the UK practice.

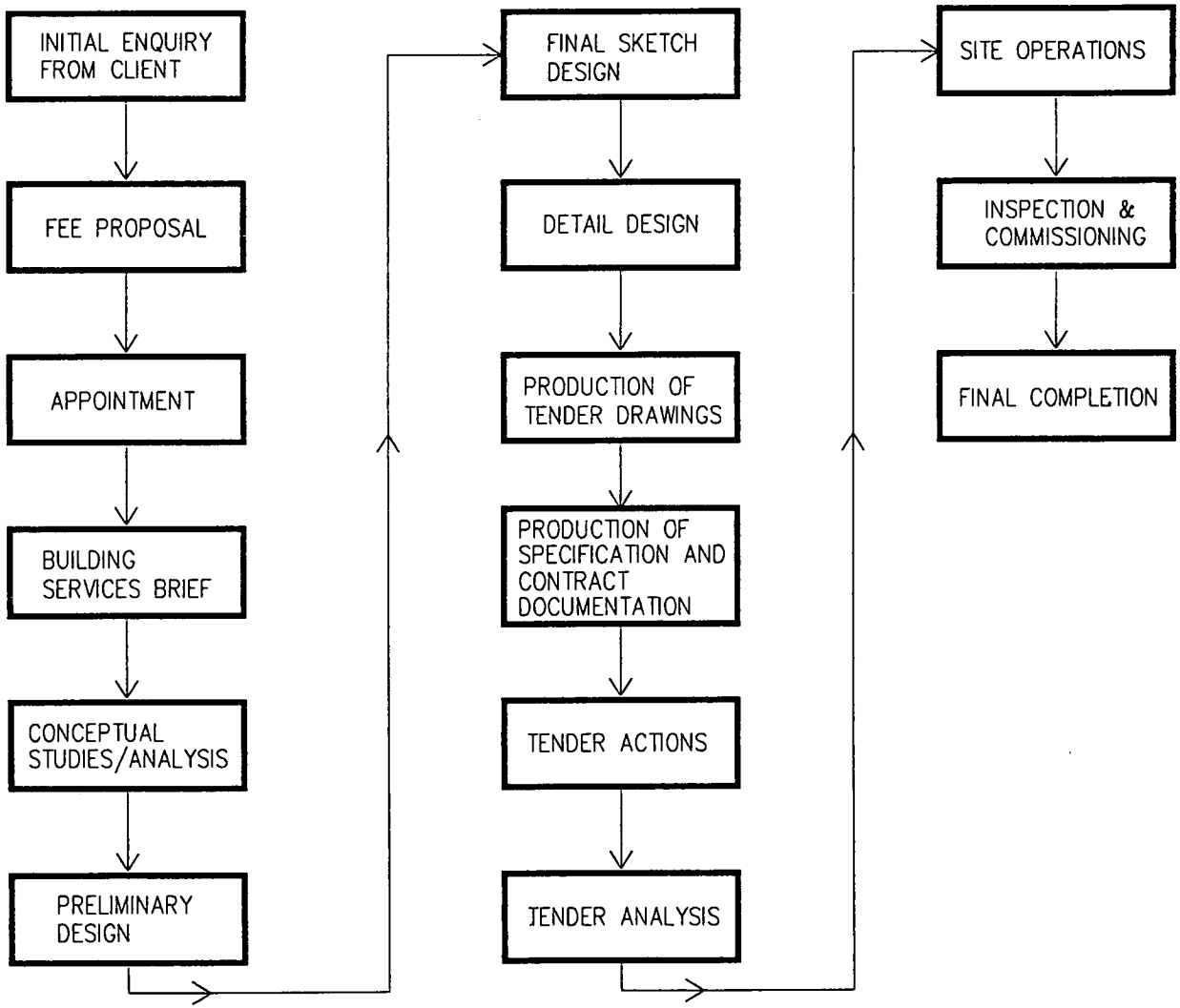

FIGURE 1 : A TYPICAL PROJECT FLOW CHART PRIOR TO INTRODUCTION OF QUALITY ASSURANCE

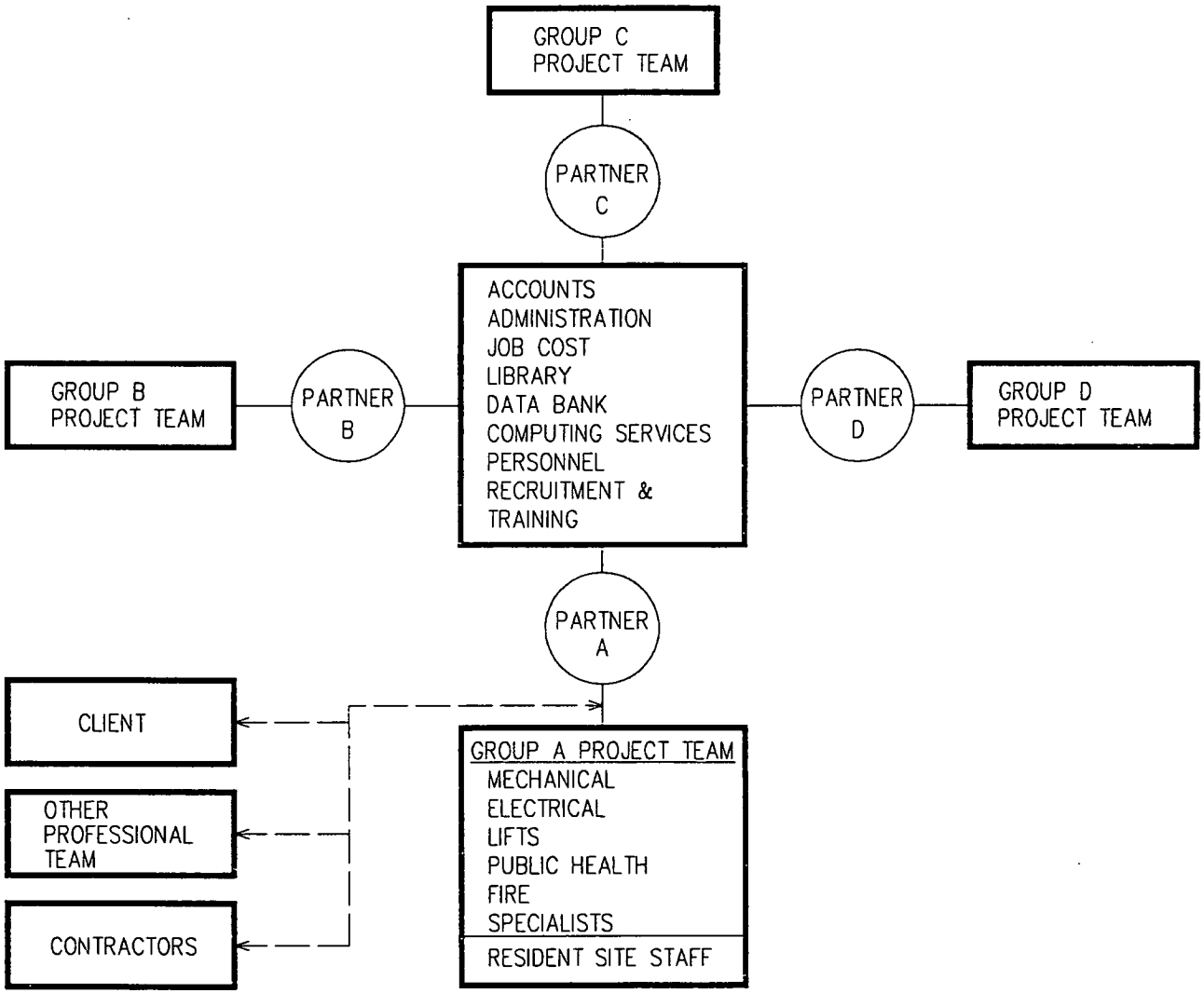

FIGURE 2 : A TYPICAL ENGINEERING CONSULTING FIRM PRIOR TO THE INTRODUCTION OF QUALITY ASSURANCE

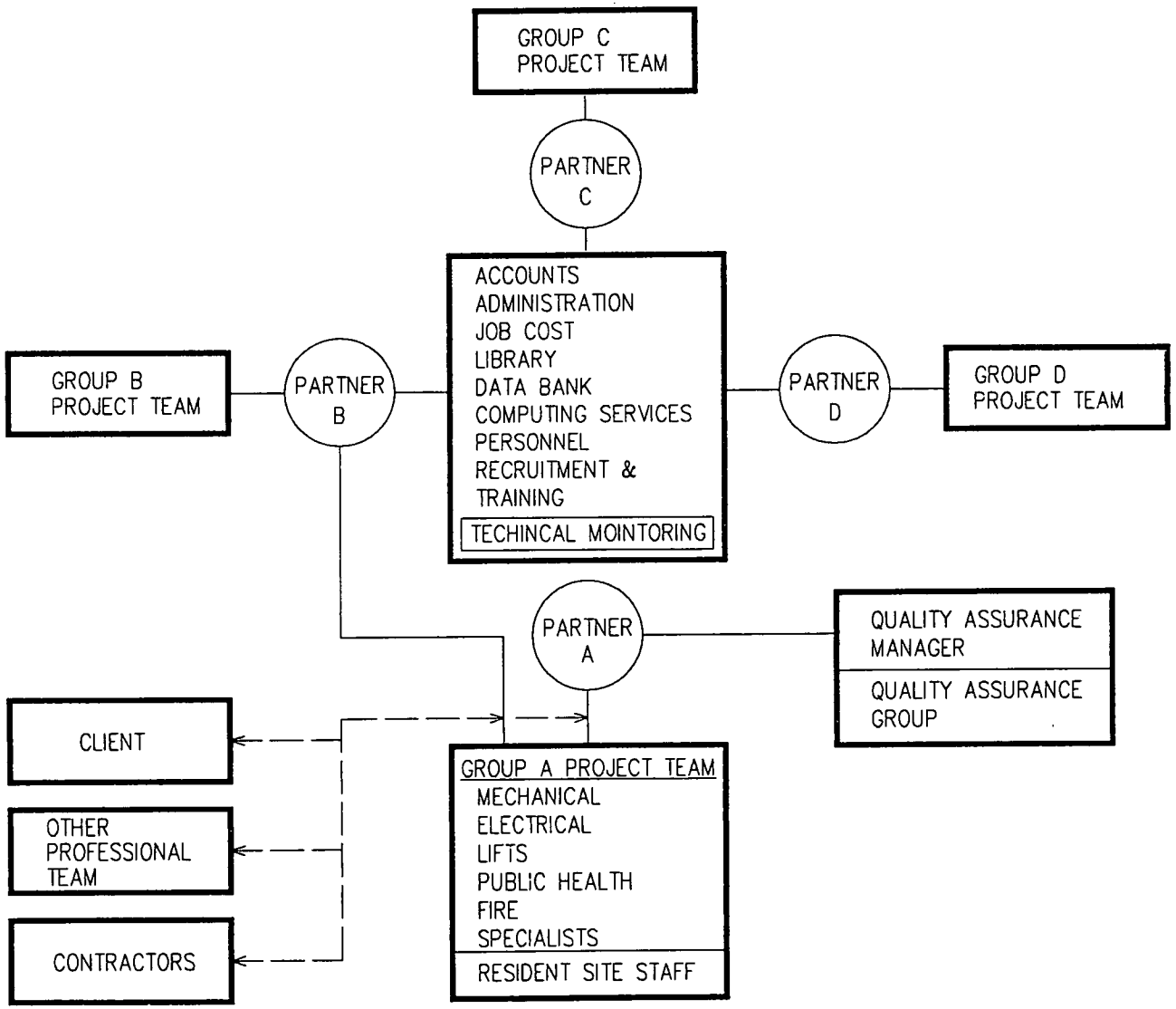

FIGURE 3 : A TYPICAL ENGINEERING CONSULTING FIRM AFTER THE INTRODUCTION OF QUALITY ASSURANCE

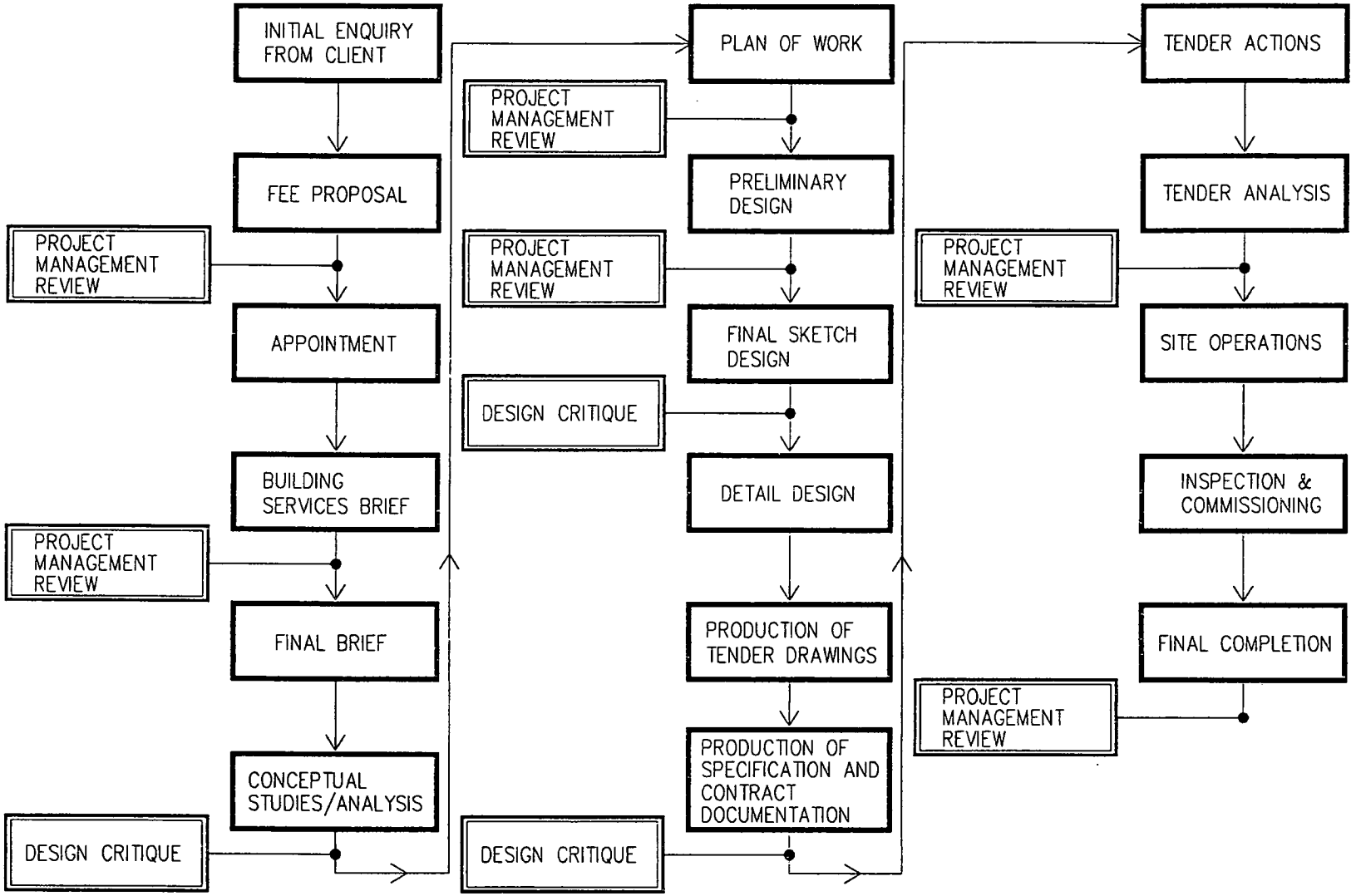

FIGURE 4 : A TYPICAL FLOW CHART AFTER THE INTRODUCTION OF QUALITY ASSURANCE

Paper No. 8

IMPLICATIONS OF THE CONTROL OF EXEMPTION CLAUSES ORDINANCE FOR THE HONG KONG CONSTRUCTION INDUSTRY

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"THE IMPLICATIONS OF THE CONTROL OF EXEMPTION CLAUSES ORDINANCE FOR THE HONG KONG CONSTRUCTION INDUSTRY"

1. THE BACKGROUND OF THE LEGISLATION

(1) What are exemption clauses 2

Meaning and effects

An exemption clause is a term in a contract which seeks to exclude or limite one of the parties' obligations, liabilities, rights or remedies. Whilst an exemption clause may be a perfectly legitimate device in contracts between parties of equal bargaining power, where the parties are of unequal standing, exemption clauses may be used to deny a party's legitimate rights and normal expectations. Very often the party seeking to impose the exemption clause may have the economic bargaining strength to insist on its acceptance and allow no room for negotiation.

Examples

Examples of exemption clauses are those which exclude liability for a party's negligence; enable a party to supply goods or services that are different from those reasonably expected; or deny a party from resolving a dispute in court by providing a mandatory arbitration clause.

In Hong Kong, a good illustration of how an exemption clause can operate is the notice posted up in a public carpark stating a term along the lines that the carpark does not accept any responsibility for the loss or damage to any vehicles, its accessories or contents, or for the death or injury to any person.

(2) Control of Exemption Clauses in the U.K.

Common Law

In theory, the basis of the law of contract under any Common Law jurisdiction is "agreement" i.e. a consensual meeting of intentions of both offeror and offeree. In reality, very often it is not the meeting of actual intentions which prevails when determining the legal duties of the parties concerned but rather the meeting of the "intentions" as stated in the contract. Hence, whenever a term, including an exemption clause, has been properly incorporated into a contract, in the absence of fraud, misrepresentation, frustration etc., it is enforceable at Common Law. The courts will not normally look beyond the intent of the parties as manifested in the terms of the contract itself.[1]

Although the Common Law cannot alter the effect of an exemption clause or ignore it, except in limited circumstances, the courts have generally looked on exemption clauses with disfavour. This judicial attitude stems from a realisation that exemption clauses are frequently used where there is a monopoly or near-monopoly, or where there is a strong trade assocation resulting that the weaker party to a contract is seriously disadvantaged. Hence, the Common Law devised a series of tests which, though not aimed at controlling exemption clauses, have the effect of rendering such clauses ineffective.

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These tests include whether the clause has been properly incorporated into the contract, whether on a true construction the clause is clear and the main purpose rule.

In short, these tests require that an exemption clause can only be incorporated into a contract and become enforceable if the contract document has been signed by the party being bound or if the party being bound has been given sufficient notice of its existence. If there is any ambiguity in an exemption clause, it must be resolved against the person who is seeking to rely on it. In construing an exemption clause there is a presumption that it was not intended to defeat the main purpose of the contract.

Statutory Intervention: Unfair Contract Terms Act 1977

Although the courts had tried to mitigate the unfair use of exemption clauses, the limitation of the Common Law is that it must generally give effect to the intention of the parties as manifested in the terms of the contract itself. Hence, if an exemption clause can pass the tests mentioned above, the courts are generally powerless to ignore it even if it gives rise to an unfair and unjust result. In 1975, the U.K. Law Commission in its Report on Exemption Clauses therefore recommended statutory intervention into the law relating to exemption clauses. As a result of their recommendation, the Unfair Contract Terms Act 1977 was promulgated. It came into effect on 1st February 1978.

The 1977 Act does not seek to prohibit all exemption clauses. Rather it aims at achieving a balance by recognizing the reality of an agreed apportionment of risk between two parties of equal bargaining strengths but also recognising that there are cases where one party uses its economic strength at the expense of the other party.

The main provisions of the 1977 Act which are relevant to this topic are as follows:—

(a) The Act only applies to business liability i.e. liability arising from things done by a person in the course of a business.

(b) Liability for death or personal injury resulting from negligence cannot be excluded or restricted by any contract term or notice.

(c) In the case of other loss or damage, any exemption from liability for negligence is subject to the requirement of reasonableness i.e. the exemption clause must have been a fair and reasonable one to be included having regard to the circumstances. Guidelines for the application of the reasonableness test are laid down in the Act.

(d) When one party deals as consumer or on the other party's written standard terms of business, that other party cannot
   i) when himself in breach of contract, excluse or restrict has liability in respect of the breach;
   ii) claim to be entitled to render a contractual performance substantially different from that which was reasonably expected of him;
   iii) claim to be entitled to render no performance at all except subject to the requirement of reasonableness.

(e) A person "deals as consumer" if he does not make or hold himself out as making the contract in the course of a business and the other party does make the contract in the course of a business. Further if the contract is for the supply of goods it is also necessary that the goods are of a type ordinarily supplied for private use or consumption. The effect of this definition is that where a non-business person contracts with another non-business person neither party "deals as consumer".

(f) In contracts for the sale and hire-purchase of goods, implied terms as to title cannot be excluded at all; implied terms as to conformity of goods with description or sample or as to their quality or fitness for a particular purpose cannot be excluded as against a person dealing as consumer, and, as against non-consumers, can only be excluded subject to the requirement of reasonableness.

(3) Control of Exemption Clauses in Hong Kong

General

In Hong Kong, the common Law principles relating to the incorporation, interpretation and construction of exemption clauses are closely followed. Further, Hong Kong currently has legislation dealing with exemption clauses in specific types of contracts. For example, the Motor Vehicles Insurance (Third Party Risks) Ordinance and the Employees' Compensation Ordinance. These ordinances deal mainly with personal injuries cases. Exemption clauses in sale of goods contracts are subject to controls in the Sale of Goods Ordinance. As far as general contracts are concerned, Hong Kong has the Misrepresentation Ordinance. However, compared with the U.K. legislation, consumer protection and control of exemption clauses in Hong Kong has been far from adequate.

Report on the Control of Exemption Clauses by the Law Reform Comission

In December 1986, the Law Reform Commission published a Report on the Control of Exemption Clauses. Having considered the local situation and the measures of control taken in other countries, the Commission concluded that the use of exemption clauses leads to abuse, especially where the parties are not in positions of equal bargaining strength. The Commission believed that the benefits of some measure of control would outweigh any economic disadvantages which might be caused by this limited interference with the freedom of contract. They therefore recommended that legislation equivalent to the U.K. Unfair Contract Terms Act 1977 should be enacted in Hong Kong.

2. CONTROL OF EXEMPTION CLAUSES ORDINANCE

An Examination of the Main Provisions

As recommended by the Law Reform Commission, the Control of the Exemption Clauses Ordinance was passed on 16th November 1989 but will only come into operation on 1st December 1990. The purpose of this delayed commencement is to allow interested parties to make necessary adaptations to comply with the provisions of the Ordinance. The Ordinance is largely modelled on the U.K. Unfair Contract Terms Act 1977.

Part I — Preliminary

This part of the Ordinance defines the important terms used in other provisions. They include "negligence", "business" and "dealing as consumer". Section 3 together with the guidelines stated in Schedule 2 to the Ordinance provide a formula for applying the "reasonableness" test. The basic principles and definitions of the various terms in the Ordinance are substantially the same as those embodied in the U.K. Act mentioned above. One exception which is worth noting is that under Section 3(4), in determining whether a contract term or notice satisfies the requirements of reasonableness, the court shall have regard to whether the language in which the term or notice is expressed is one understood by the person as against whom another person seeks to rely upon the term or notice. In future, it is advisable therefore to express all "consumer" contract exemption clauses in both the English and Chinese languages in order to pass the reasonableness test.

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Part II — Control of Exemption Clauses

This is the main part of the Ordinance. It contains the provisions governing the control of exemption clauses.

The following table sets out the extent and categories of control of exemption clauses:—

1	2	3	4	5
Section Number	Liability which an exemption clause purports to exclude or restrict	All contracts not specifically excluded by the Ordinance	Contracts in which one party is dealing on the other party's written standard terms of business	Contracts in which one party is "dealing as consumer"
7(1)	Negligence — liability for death or personal injury	automatically ineffective	same	same
7(2)	Negligence — liability for loss or damage (other than death or personal injury)	effective only if it satisfies the requirement of reasonableness	same	same
8	Breach of Contract — any liability when a party himself is in breach; or to render a contractual performance substantially different from reasonable expectations or no performance at all	Not applicable	Effective only if it satisfies the requirement of reasonableness	same
9	Negligence or breach of contract — to indemnify another person in respect of that other person's liability	Not applicable	Not applicable	Effective only if it satisfies the requirement of reasonableness
10	Negligence — liability under a guarantee for loss or damage resulting from defective consumer goods	Not applicable	Not applicable	Automatically ineffective
11(1)	Breach of Contract — seller's implied undertaking as to title of goods supplied	Automatically ineffective	same	same
11(2) & (3) and 12(3) & (4)	Breach of Contract — seller's implied undertaking as to conformity of goods with description or sample or quality or fitness	Effective only if it satisfies the requirement of reasonableness	same	Automatically ineffective
15	Agreement to submit future difference to arbitration	Not applicable	Not applicable	Enforceable only with consumer's written consent or he has himself had recourse to arbitration
Schedule 3	Misrepresentation — liability and remedy by reason of misrepresentation	Effective only if it satisfies the requirement of reasonableness	same	same

Part III — Circumstance Whether Control Does Not Apply

This part together with Schedule 1 to the Ordinance determines the scope of the legislation.

The following matters are outside the scope of the Ordinance:—

(a) International supply contracts

(b) Contracts of insurance

(c) Contracts relating to the creation or transfer of an interest in land or intellectual property e.g. patent, trade mark, copyright, registered design etc.

(d) Contracts relating to the formation, dissolution constitution etc. of a company or partnership.

(e) Contracts of marine salvage or towage; charter party of a ship or hovercraft and contracts for carriage of goods by ship or hovercraft (except in respect of death or personal injuries or loss or damage when one party is dealing as consumer).

3. THE IMPLICATIONS OF THE ORDINANCE FOR THE HONG KONG CONSTRUCTION INDUSTRY

(1) General

The main area where the Ordinance will have effect is probably in relation to specialist suppliers and installers (e.g. of electrical and mechanical goods) who sometimes contract on the basis of widely drawn exemption clauses.

Since the Ordinance is modelled on the U.K. 1977 Act, it is expected that the application of the Ordinance and case law development in this area of the law will follow the trend in the U.K. In fact, since the passage of the U.K. 1977 Act, many U.K. standard form building contracts have been amended to take the Act into account. Since many Hong Kong Standard Form Contracts are based on U.K. Standard Forms my general view is that the Ordinance should not create a major problem for the building industry in Hong Kong. However, there are specific points that need to be considered.

As can be seen from the above summary of the main provisions of Ordinance, building contracts are not excluded by the Ordinance. Those controls as outlined in the above table will be applicable to building and related contracts.

(2) Standard Form Contracts — "the other's written standard terms of business"

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As mentioned above, certain controls imposed by the Ordinance only apply where one of the contracting parties deals on the other's written standard terms of business. It should be noted that neither the Ordinance nor the U.K. 1977 Act defines the term "Standard Terms of Business". In fact, the English Law Commission recommended that no definition be given to this terms. This gives rise to various interesting questions.

First of all, since many building contracts are prepared by various professional bodies, if both contracting parties agree to adopt one of these contracts, it is difficult to argue that the contract is "the other's written standard terms of business" as referred to in the Ordinance. Perhaps, the position is different if the contract uses the General Conditions of Contract issued by the Government of Hong Kong where the Government is one of the contracting parties.

A difficulty may arise where amendments have been made to a standard form building contract or where amendments have been made after negotiations between the contracting parties. The question is whether an amended standard contract is still a standard form contract.

It is difficult to generalies about the effect of amendments to standard form contracts. The English Law Reform Commission has stated in its report:

"It does not seem to us that the lack of negotiation, or of an opportunity for negotiation, can itself be regarded as the distinguishing feature of standard form contracts. In many contracts there may be negotiation as to some terms, such as the quantity or price, with no opportunity to negotiate the exempting terms with which we are concerned."

Obviously, there must come a point where the number of amendments to a standard form contract makes it impossible for the transaction to be considered as being done on written standard terms of business. However, generally speaking, written amendments to a standard form contract will not prevent it from being regarded as one by the Ordinance.

(3) An Examination of various provisions in the Ordinance which may affect various Standard Form Contracts commonly used in the construction industry.

i) Section 2(2) — "Business Liability"

Building Contractors will generally fall within the definition of "business liability" as stated in Section 2(2) of the Ordinance. Therefore, they will generally be unable to exclude or restrict their liability as described below.

ii) Section 4 — "Dealing as Consumer"

Depending on the circumstances, a purchaser under an M & E contract may deal as a consumer and therefore be entitled to all the protection under the Ordinance as stated in the above table. However, this will probably be save. In most model forms of mechanical or electrical engineering contracts, it is not envisaged that the reference to "Purchaser" will be considered as "dealing as consumer" since in most cases the contract is made in the course of a business. It is also worth noting that under Section 4(3) if a private buyer e.g. in a Supply Contract, organises a competitive tender for a sale to him, he will not be regarded as dealing as a consumer.

iii) Section 7 — "Negligence Liability"

Under the Ordinance, contractors will generally be unable to exclude or restrict their liability for death or personal injury resulting from their negligence. In most standard form contracts now commonly used, this principle has been reflected in the relevant clauses.

In the 1972 edition of the Government Standard Conditions for Maintenance Works in Civil Engineering, Highways and Waterworks Offices, Clause 26 states that "the Employer shall not be liable for or in respect of any damages or compensation payable at law in respect of or in consequence of any accident or injury to any workman or other person in the employment of the Contractor or sub-contractor save and except an accident or injury resulting solely from any act or default of Government..."

This clause would now be unlawful since Government was trying to limit their liability to accidents which resulted solely from their default. In the 1985 Edition of the Government Standard Conditions for Civil Engineering Works, Clause 26 omits the word "solely".

In the case of other loss or damage, contractors will only be able to exclude or restrict their liability for negligence in so far as the relevant contract term or notice satisfies the requirement of "reasonableness".

One example to consider is in the Standard Government Conditions for Civil Engineering Works Clause 13(1) which states that "The Contractor shall be deemed to have examined and inspected the Site..." and Clause 13(2) "No claim by the Contractor for additional payment shall be allowed on the ground of any misunderstanding in respect of the matters referred to in sub-clause (1)... or the fact that incorrect or insufficient information was given to him..."

This clause is effectively an exclusion clause and is therefore subject to the test of reasonableness. In cases where Government is clearly negligent in supplying incorrect or insufficient information to the Contractor, it is possible that the courts or an arbitrator will hold this exclusion clause unreasonable both under Section 7 and Schedule 3 to the Ordinance and therefore ineffective.

Another example is a common condition in hire contracts which attempts to pass much of the risk of damage to the hirer, including the risk of negligence on the part of a competent operator provided by the owner. In Phillips Products Limited v, Hyland (1984), it was held that this sort of condition was not fair and reasonable and therefore ineffective as an exclusion clause.

iv) Section 8 — "Performance of Contract"

This section will probably affect a lot of written standard terms of business. The following clause which is found in some standard form supply contracts seeks to restrict one party's liability when he is in breach of contract:

> "...the Contractor shall not be liable to the Purchaser by way of indemnity or by reason of any breach of the Contract for loss of use (whether complete or partial) of the Works or of the project..."

This clause limits the Contractor's liability for any breach of the Contract, not just delay in completion. In view of the wording in Section 8, this limitation may be attacked by the Ordinance.

v) Section 11 — "Seller's Liability"

This section deals with the liability for breach of the obligation arising from the Sale of Goods Ordinance. It will affect for example contracts for the supply of plant and machinery.

4. CONCLUSION

(1) Standard Form Contracts should be Examined

As mentioned above, there has been some speculation as to whether the various Standard Forms of Contracts might be the "written standard terms of business" of one or both parties within the meaning of the Ordinance. If the courts in Hong Kong were ever to bring the various Standard Form Contracts within the scope of the Ordinance, it would seem likely that many of the clauses in these Contracts would be affected. Contractors should examine those clauses which exclude or limit their liability to ensure that they can satisfy the test of reasonableness.

(2) Enforceability of Existing Contracts

Section 19 of the Ordinance states that "Nothing in this Ordinance applies to contracts made before the date on which it comes into force but subject to this, it applies to liability for any loss or damage which is suffered on or after that date".

The effect of this section is that so far as contractual liabilities are concerned, the Ordinance only applies if the contract was made after the commencement of the Ordinance i.e. 1st December 1990. It is therefore anticipated that the various provisions of the Ordinance should not have any direct impact on existing contracts.

However, in view of the second limb of Section 19, non-contractual liabilities will still be governed by the Ordinance if the loss or damage is suffered after its commencement. For example, if an examption notice was first displayed before the commencement of the Ordinance, it will still be subject to the control of the Ordinance if someone suffers loss or damage after its commencement date. Alternatively, where a clause in a contract executed before the commencement date of the Ordinance seeks to exclude one party's liability for negligence, if the other party suffers loss or damage after that date and sues under the law of tort, the exclusion clause will not be effective.

Paper No. 9

CURRENT PERSONNEL MANAGEMENT PROBLEMS AND THEIR IMPACT ON ELECTRICAL ENGINEERS

Speaker: Mr. Patrick Maule
Personnel Director
Mass Transit Tailway Corporation

CURRENT PERSONNEL MANAGEMENT PROBLEMS AND THEIR IMPACT ON ELECTRICAL ENGINEERS

We enter the last decade of the century with many uncertainties facing us;
- World unrest caused by the Middle East Crisis
- Prospects of a new Europe
- Upheaval in Europe
- The rapid approach of 1997
- The state of "the rose garden"

Locally, Hong Kong has entered the decade with a heavy burden of problems to carry on it's back;
- High inflation and interest rates
- The lowest GDP growth rates for many years
- Salary inflation several percent higher than CPI
- High labour turnover
- Labour unrest among the civil service associations
- High loss of professionals to other countries
- Continuing influx of unwanted immigrants
- Lowest birth rate in the region
- Low growth rate of workforce

Each of the above problems poses major difficulties for employers in Hong Kong who now face a major constraints in their future strategic development caused by people related problems. In a recent major survey conducted by the Census and Statistics department amongst Hong Kong's Owner/manager companies the proprietor cited Human Resource problems as their most pressing and difficult challenges. This contrasts starkly from the seventies and early eighties when Hong Kong enjoyed great abundance of labour and as a result, rapid expansion.

In consequence, a growing number of companies are beginning to take seriously what used to be an often quoted platitude namely, that "our people are our most precious asset."

REMEDIES

None of the problems have simple solutions but many can be mitigated in part by a comprehensive personnel management or human resource management strategy. This needs to be in four parts and starts with the acceptance of the fact that a larger portion of the companies overhead must be devoted to people management;

1. Basic terms and conditions of employment must be competitive in order to attract and retain staff. This covers;
   - * Salaries
   - * Benefits
   - * Work environment

   and the many "hygiene" factors affecting work motivation

2. Employee relations must be taken seriously. This involves;
   - * Keeping staff well informed on matters of interest and concern
   - * Finding out what they really think and want by such means as attitude surveys,
   - * Allowing staff some involvement in the decision making process on issues directly or indirectly affecting them e.g. by joint consultation or by less formal mechanisms,
   - * Building team spirit and developing a "Corporate Culture" which clarifies what your company's principal purpose and values are,
   - * Providing and organizing sports and recreational activities

3. Training and developing your staff so that they are;
   - * using their capabilities to the full in their present job
   - * being groomed for more rapid future promotion than used to apply are "brain drain" days
   - * being skilfully selected so that the best people are being promoted fastest and to appropriate jobs

4. Providing staff support and assistance to help them with their work or domestic difficulties. For example,
    * welfare services
    * counselling services
    * self help programmes such as Credit Unions
    * discount purchase schemes

The talk will be illustrated with the help of a number of slides of data dealing with,
Labour Turnover from 1985-1990
Brain drain statistics 1987-1989
Emigration intentions and experience statistics
Salary movement statistics

and also examples of how the Mass Transit Railway Corporation is tackling some of these issues.