EVALUATION

OF

DISASTER MANAGEMENT AND PREPAREDNESS

OF

A PETROCHEMICAL COMPLEX IN MALAYSIA

BY

CHEW SOONG KONG

Project Paper submitted in partial fulfillment of the requirements for the
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Abstract of Research Project submitted to the Faculty of Engineering, University Putra Malaysia in partial fulfillment of the requirement for the Degree of Master of Science (Emergency Response and Planning)

EVALUATION OF DISASTER MANAGEMENT AND PREPAREDNESS OF A PETROCHEMICAL COMPLEX IN MALAYSIA

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CHEW SOONG KONG

OCTOBER 2000

Supervisor : Dr. Fakhru'l Razi Ahmadun

Faculty : Faculty of Engineering
University Putra Malaysia

In tandem with the intensification of the country's industrialization programs, the petrochemical industry was identified as one of the sectors that have tremendous potential for growth. Malaysia is now entering into a new era in the development of its Petrochemical Industry where the path forward is to plan and implement petrochemical projects on an integrated basis to maximize on the synergy.

As Integrated Petrochemical Complexes (IPCs) is one of the most hazardous operation to be undertaken in the country, there is a need to effectively mitigate against a whole range of incidents from emergency to crisis. This is to prevent loss of life, damage to the environment and minimize losses to property.

Since prevention is always the first defense against any incident, the operators at the IPCs should at all times be equipped and prepared to response professionally to all incidents. Thus the purpose of this project is to evaluate the status of compliance by the operators in accordance to the mandated guidelines, the level of emergency preparedness of the plant's emergency response team in handling incipient stage incident, and the capability of the Complex Fire Brigade to mitigate them when it is beyond the ability of the mentioned team.

The findings showed that the emergency management system is in place at both the operator and complex fire brigade level whereby it met the requirements with an overall scores of 3.19 and 3.36 respectively. Nevertheless, additional commitment is needed to enhance the level of emergency preparedness of the

plant's emergency response team in handling incipient stage incident since the overall score achieved was 2.36.

These finding will be highlighted to the operator for their continuous improvement, used as a benchmark for other similar plants and acts as indicators of the industry's health.

Abstrak Project Penyelidikan yang dikemukakan kepada Fakulti Kejuruteraan, Universiti Putra Malaysia sebagai memenuhi sebahagian daripada keperluan untuk mendapat Ijazah Master Sains (Perancangan dan Respon Kecemasan)

PENILAIAN PERSEDIAAN DAN PENGURUSAN BENCANA DI SEBUAH KOMPLEK PETROKIMIA BERSEPADU

Oleh

CHEW SOONG KONG

Oktober 2000

Penyelia : Dr. Fakhru'l Razi Ahmadun

Fakulti : Fakulti Kejuruteraan
Universiti Putra Malaysia

Seiringan dengan perkembangan program industri negara, industri petrokimia telah dikenalpasti sebagai salah satu industry yang mempunyai potensi untuk membangun. Malaysia kini memasuki era baru dalam perusahaan petrokimia di mana projek sepadu tengah dirancang dan dijalankan untuk memaksimumkan sinergi negara.

Tindakan untuk mencegah segala jenis kemalangan, biarpun dari kecemasan ke keadaan yang krisis di Komplek Petrokimia Bersepadu (KPB) adalah langkah yang munasabah kerana KPB boleh dianggap salah satu industri yang paling merbahaya. Ini dilakukan supaya kehilangan nyawa dihindarkan, alam sekitar dipemelihara dan kerosakan hartabenda dapat dikurangkan kepada tahap yang minimum.

Memandangkan pencegahan adalah langkah utama menyekat berlakunya sebarang insiden, operator KPB haruslah sentiasa melengkapkan diri untuk menghadapi sebarang kecemasan. Matlamat projek ini adalah untuk menganalisa sejauh mana operator di KPB mengikut peraturan yang telah ditetapkan, tahap persediaan pasukan kecemasan mereka terhadap sebarang kecemasan yang mungkin berlaku di luar dugaan, dan juga keupayaan pasukan bomba dalaman KPB menangani sebarangan kecemasan jika ia berada di luar kawalan pasukan kecemasan tersebut.

Hasil kajian telah menunjukkan bahawa pengurusan sistem kecemasan berfungsi dengan baik di peringkat operator dan pasukan bomba dalaman KPB di mana markah keseluruhan adalah memenuhi keperluan iaitu 3.19 dan 3.36 masing-masing. Tetapi, kommitmen yang lebih tinggi diperlukan untuk

meningkatkan tahap persediaan kecemasan di kalangan pasukan kecemasan loji dalam menghadapi insiden-insiden peringkat awal di mana markah keseluruhan yang dicapai adalah 2.36 iaitu di bawah paras keperluan. Hasil dari kajian ini akan ditujukan kepada operator untuk memastikan peningkatan yang berterusan, sebagai rujukan untuk loji-loji yang seakan, dan selanjutnya sebagai tanda tahap keadaan industri sekarang.

CHAPTER ONE

INTRODUCTION

1.1 Background

Malaysia is now entering a new era in the development of its petrochemical industry. Given Malaysia's substantial natural gas resources, the Industrial Master Plan (IMP) aims to maximize value from the indigenous gas resources through improved linkages with the manufacturing sector. This will be achieved by broadening and deepening the range of petrochemical products to be produced from our large natural gas reserve of 85 trillion cubic feet. The availability of basic and intermediate petrochemical is essential to support the manufacturing sector, which is poised to play a key role in the Malaysia economy, particularly in value-added export-oriented industries.

The manufacturing sector's contribution to the GDP is expected to increase significantly from 23.9% under the IMP 1 (1986 – 1995) to 38.4% in the IMP 2. The Seventh Malaysia Plan had also set a 34.7% target for the manufacturing sector's contribution to the GDP. Petrochemical products are both critical feedstock and raw material for these manufacturing industries.

Oil and natural gas are the basic building blocks for the petrochemical industry. A key strategy for Malaysia is to maximize benefits from these natural resources. The aim is develop the petrochemical industry as a vehicle to attract foreign investment and technology. Beside profitability, there is economic benefits to be derived from the development of this industry, particularly its' linkage to the other sectors of the economy. It is also envisaged that the petrochemical industry will create employment opportunities as well as broaden the skill-base of our people.

The development of Malaysia's petrochemical industry follows an orderly phased approach in line with the development of feedstock supply and markets growth. Before 1970s, there was really no petrochemical industry in Malaysia. In the early 1990's, PETRONAS (a wholly owned National Oil Corporation) embarked on the construction of a world scale ethylene and polyethylene plant at Kerteh to support the domestic monomer and polymer industry, particularly the plastics industry. These plants were established to serve as a nuclei of growth for further downstream and intermediate petrochemical products in the country. The foundation for establishing the petrochemical industry on a large scale was made possible with the completion of the Peninsular Gas Utilization scheme where gas-processing facilities were increased significantly. Facilities were installed to extract gas components to provide the feedstocks required by the petrochemical industry. This made PETRONAS a key player in the regional petrochemical industry.

Key players in the global petrochemical industry were attracted to Malaysia's potential, both as an investment site as well as its strategic position in the Asia Pacific market. In tandem with the intensification of the country's industrialization programs, Malaysia is envisaged to become a producer of a full range of petrochemical products with integrated petrochemical complexes being established in other parts of the country besides Kerteh, i.e. Gebeng, Kuantan, Bintulu and Pasir Gudang by the year 2020.

Future petrochemical projects will provide investment opportunities to investors, as PETRONAS will continue to pursue such projects on a joint venture basis. PETRONAS' involvement will be mainly in strategic raw materials, such as primary feedstock. Where advanced technology and experience is needed, the project will be undertaken on a joint venture basis. Such strategic alliances with foreign multinational players are important in providing us with the resilience to adapt and survive the volatility and cyclical nature of the petrochemical industry (Bakar, 1999).

1.2 Problem Statement

Disasters in oil, gas and petrochemical industry are as diverse and dramatic as the industry in which they occur. Mahoney (1997) carried out a review and analyses on 100 property damage losses that occurred in the hydrocarbon-chemical industries over the last 30 years which represented

approximately US$7.52 billion. The loss amounts were trended using an inflation index for petroleum equipment published by Industrial Risk Insurers, thus allowing a comparison of events on a constant dollar basis over the 30-year period. The loss amounts include property damage, debris removal, and cleanup costs while the costs of business interruption, extra expense, employee injuries and fatalities, and liability claims are excluded.

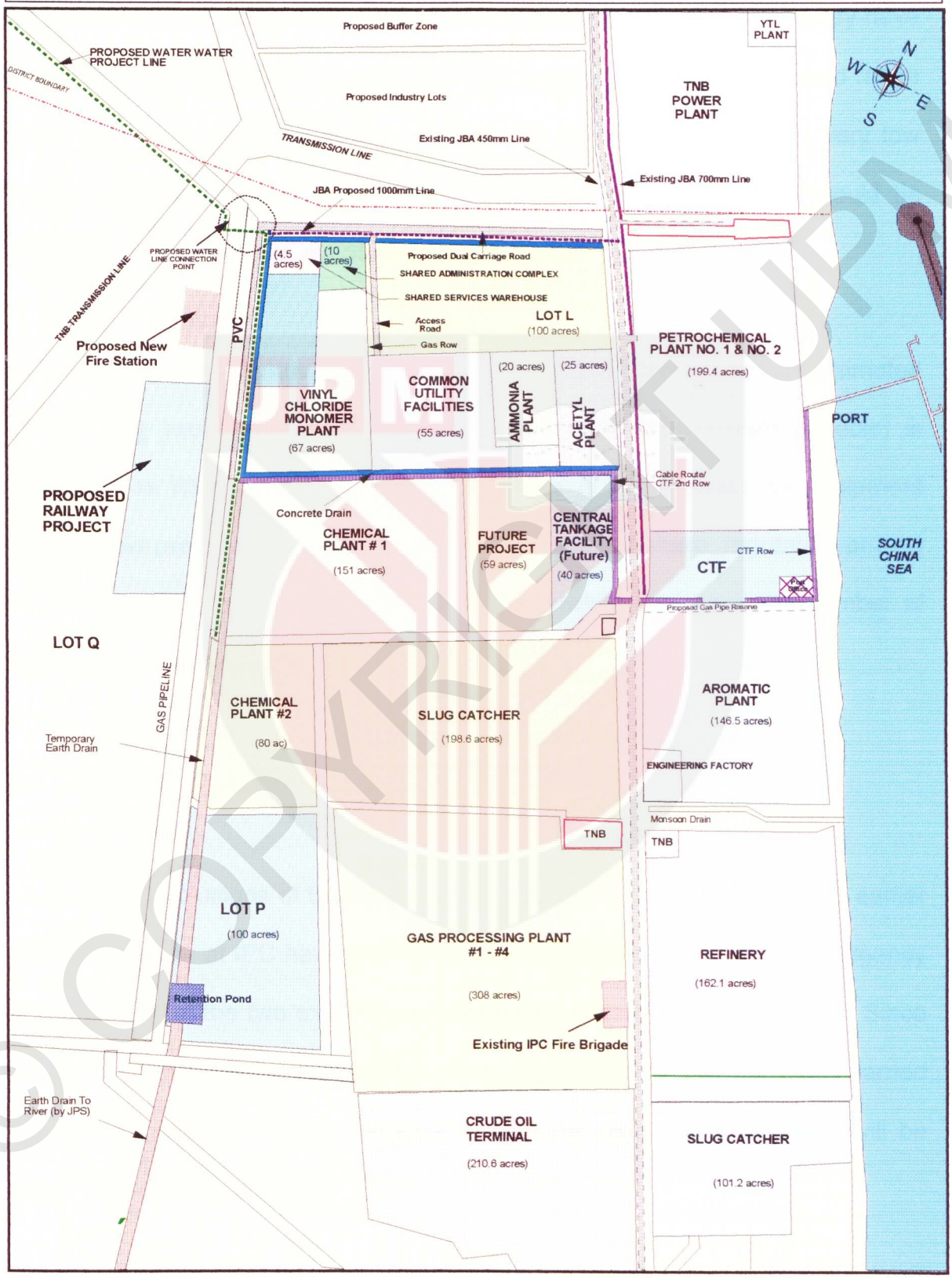
The magnitude of losses has increased significantly over the 30-year period analyzed. The five-year period from 1992 through 1996 contains three times more losses than the period from 1967 through 1971. In addition, the period from 1987 through 1991 contains the highest total dollar loss and the largest number of losses with 31, which is approximately five times more losses than the period from 1967 through 1971. The overall increase in the magnitude of losses over the 30-year period may be the results of attempts to achieve greater economies of scale and efficiency in the hydrocarbon-chemical industries with larger capacity plants. Another factor affecting the increase in magnitude is large single train operations, which result in a greater concentration of assets in a smaller area and consequently a larger total dollar exposure for a single loss event.

The most devastating losses involving losses from the study carried out by Mahoney (1997) showed that delayed ignition of vapor clouds accounted for the greatest percent of large losses (36%) and highest average loss (US$110.9 m).

However had this study included additional losses of lesser magnitude, the percent of losses involving fires would have exceeded that of vapor cloud explosion. The study also showed that the losses contributed by petrochemical plants was 35% of the total losses accounted with an average loss of US$80.8m. (Refer to Appendix I)

In Malaysia, there is an Integrated Petrochemical Complex (IPC) undergoing rapid development. Todate, there are a total of four (4) gas processing plants, two (2) petrochemical plants, two (2) power generation plants, a port and few other facilities (Refer to Figure I). Several projects are currently ongoing and are expected to be in operation between end of 2000 to the year 2003. Those new installations will be using materials like ethanol, ethane, ethylene, ethylene dichloride, ethylene oxide, heavy naphtha, methanol, natural gas, and propane as their feedstocks. All these materials are either flammable and toxic gases or liquid. Thus an integrated approach in terms of managing risk not only to safeguard each individual's billion-dollar installation but also to protect personnel, general public and the environment. With a systematic approach undertaken in terms of managing risk, billion-dollar installations can be safeguarded, and life of those personnel and the general public can be protected.

FIGURE I : THE INTEGRATED PETROCHEMICAL COMPLEX LAYOUT



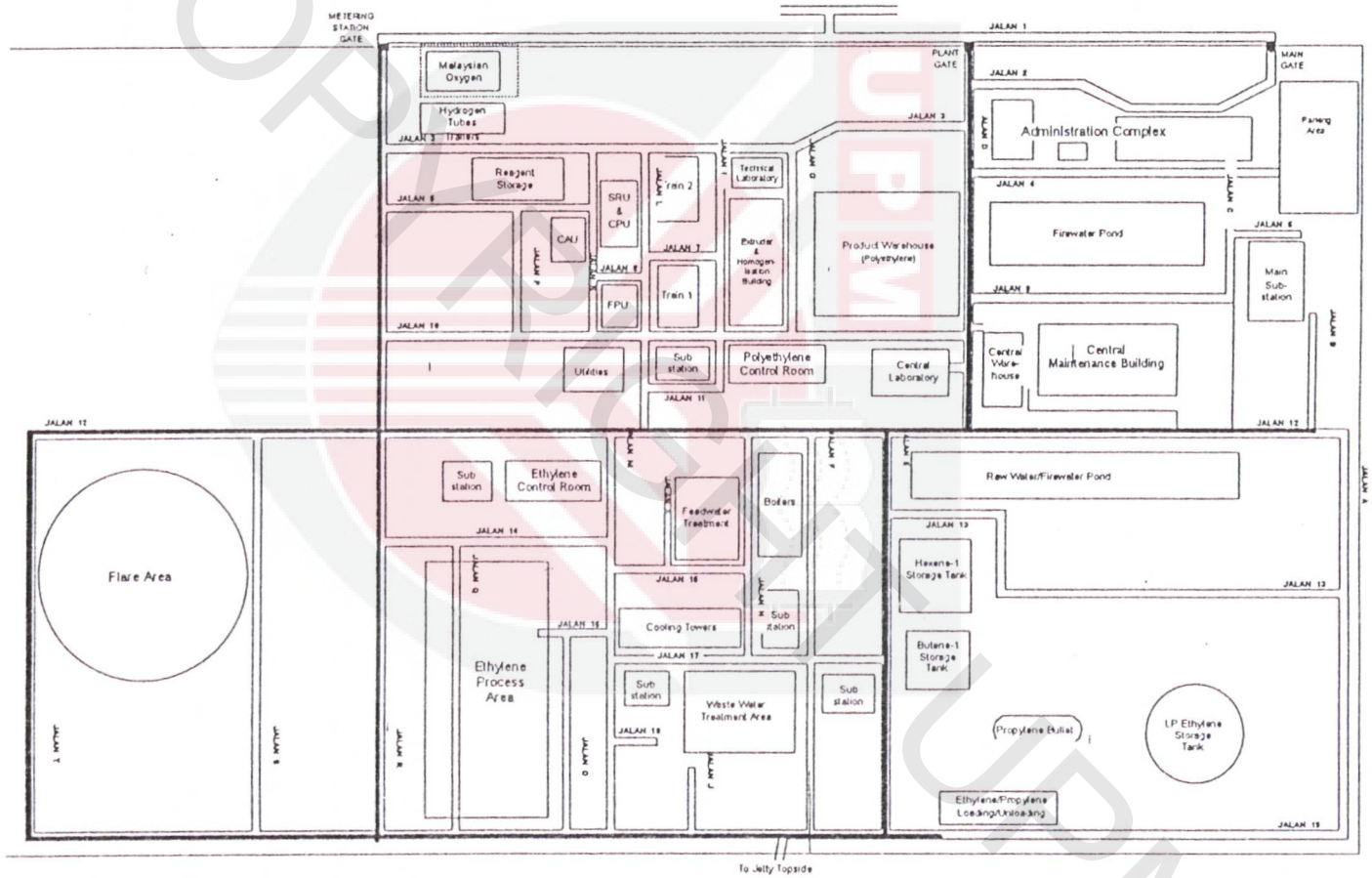
An integrated risk assessment study was carried out by DNV (1999) on the present two petrochemical plants in that region. The results of the study have given rise to some concern on an event with a large consequence hazard range which may cause fatalities in the range of 100 to 1,000 (though with very low incident frequency), or a worst case consequence asset loss which would be around RM400 million per event. (Refer to Appendix II).

In another separate study carried out by DNV, the maximum estimated loss for any event at the IPC (on completion of all the present projects) is calculated to RM4 billion. However, this value is only related to equipment damage. No cost related to business disruption, market share, reputation or cost due to loss of life is included in the figure. Meanwhile, the maximum number of fatalities from any event is 500.

1.3 Objectives of Study

The conclusions of the draft report prepared by DNV (1999) for the earlier mentioned study at IPC have given ground to conduct a study on the emergency preparedness of the two existing petrochemical plants (Refer to Figure II). Since the same operator manages both the petrochemical plants, the study was carried out on an integrated basis. Hereinafter both the petrochemical plants will be called "Petrochemical Plant".

FIGURE II : PETROCHEMICAL PLANT LAYOUT



Presently, the insitu emergency response management of the Petrochemical Plant is coordinated by a Health, Safety and Environment Department (HSED) which is manned by eight (8) full time staffs (Refer to Figure III). During any incipient stage incident, the HSED Staff will coordinate the mitigating process with the aid of the Petrochemical Plant's Emergency Response Team. Simultaneously, assistance will be requested from the nearby IPC Fire Brigade's team (Refer to Figure IV). The primary objective of the IPC Fire Brigade is to provide centralized emergency response services needs by the various operators within this IPC.

The Petrochemical Plant's Emergency Response Team which is make up of the operation staff are provided with basic industrial fire training and information to mitigate any incipient stage incident. Prior to the arrival of the IPC Fire Brigade's team, they will be the first line fire fighters. For each shift, there will be six (6) emergency responders for the two Petrochemical Plants respectively. According to White (1999) for most routine emergency response, four (4) or five (5) emergency personnel per shift is quite sufficient. Subsequently, the Petrochemical Plant's staff will continue to assist the IPC Fire Brigade's team upon their arrival in mitigating the incident.

FIGURE III : PETROCHEMICAL HSE ORGANIZATION CHART

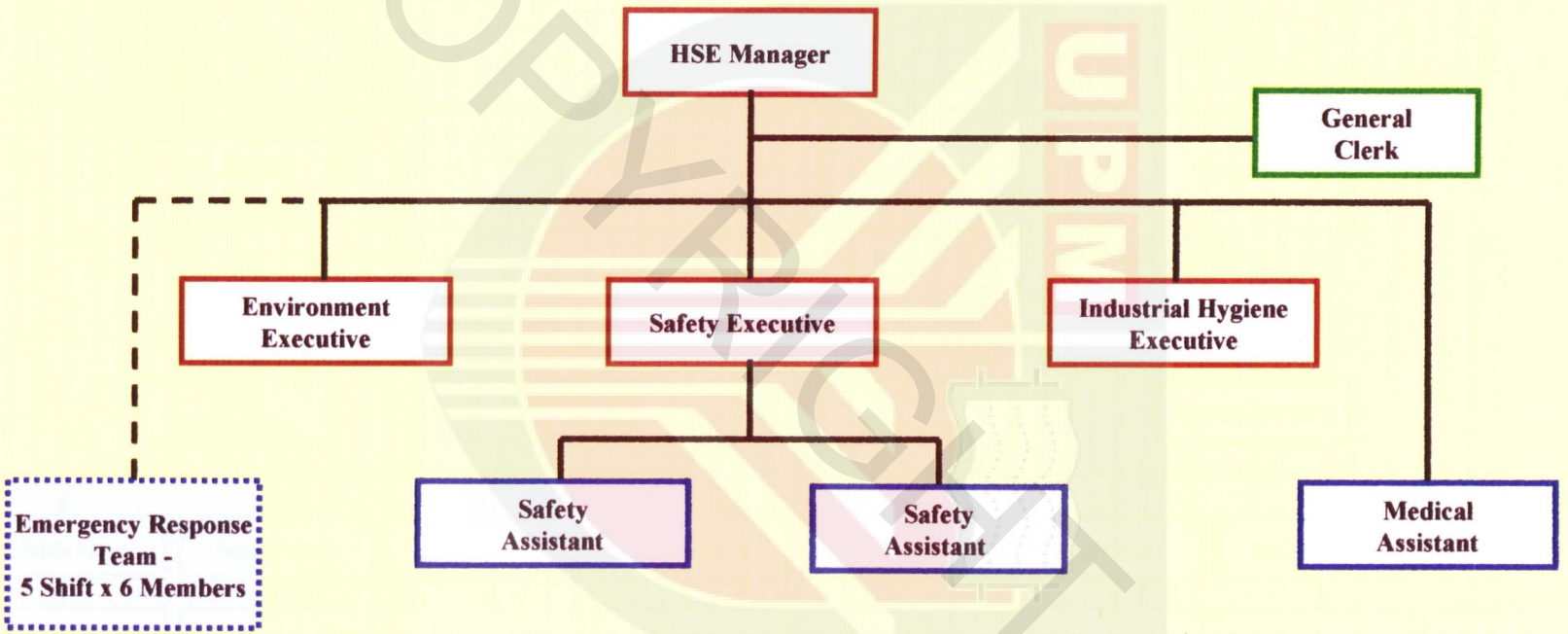
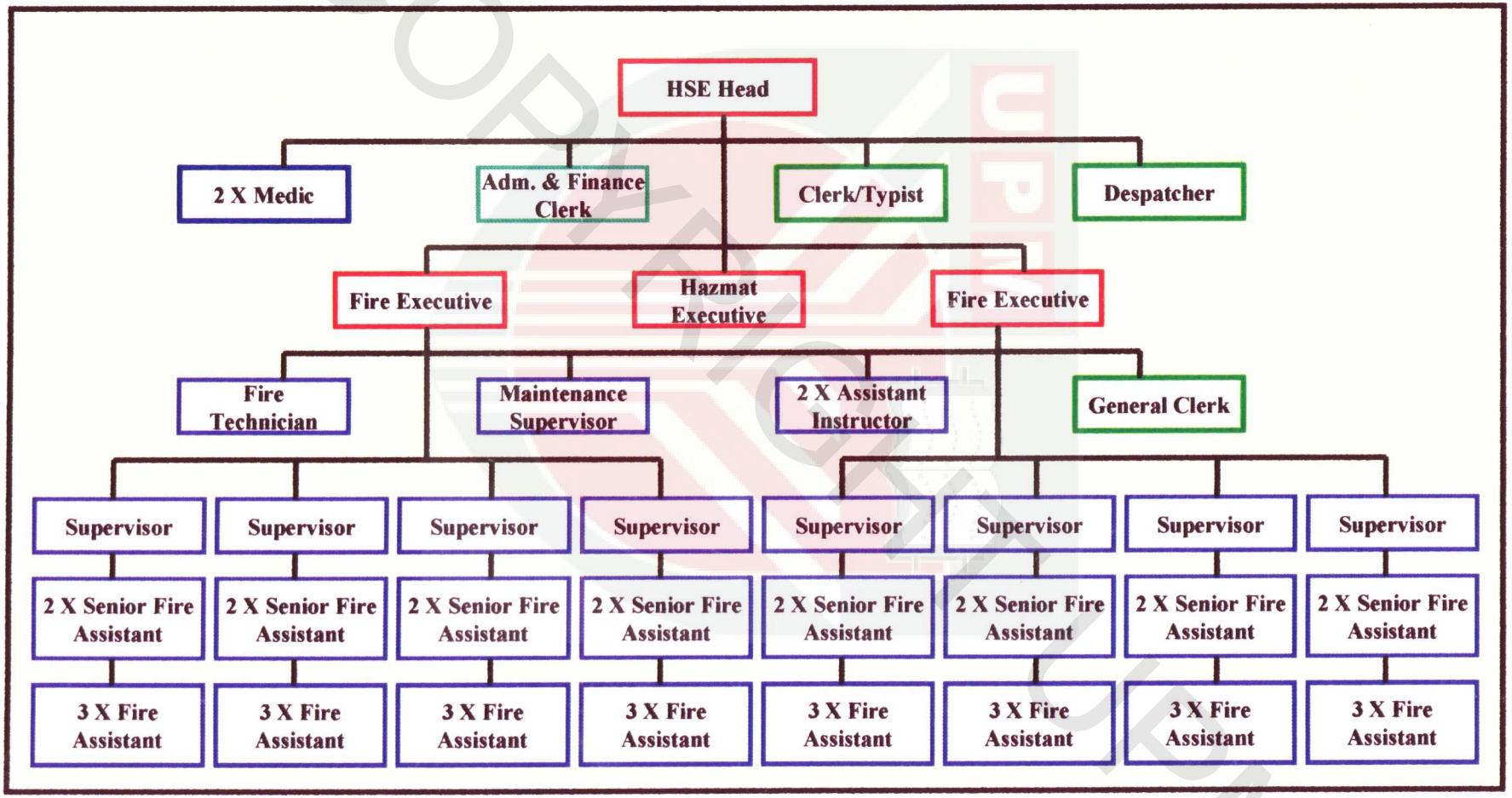


FIGURE IV : INTEGRATED PETROCHEMICAL COMPLEX FIRE BRIGADE ORGANIZATION CHART



Thus, the objective of this study is to find out :-

i. The Petrochemical plant's level of compliance to the guidelines issued by the Department of Occupational Safety and Health (DOSH) for Emergency Response Planning;

ii. The Petrochemical plant's level of protection and preparedness in facing a likely exposure, and in the event if it leads to a disaster; and

iii. The IPC Fire Brigade's capability to mitigate the incident, if it is, beyond the capability of the petrochemical plant personnel.

1.4 Significance of Study

The results from this study can be used to :-

i. Alert the Petrochemical Plant's management to strengthen areas for improvement;

ii. Establish a benchmark for new petrochemical plant within the IPC; and

iii. Enhance the training program tailored to improve the capability of the IPC Fire Brigade emergency responder.

As emphasized earlier, the results from this study can be used as an indicator on the overall petrochemical industry's emergency preparedness. Beside those projects in this East Coast IPC, there are other new petrochemical plants that will also come onstream in the next few years in other parts of the country. These findings can then be used as a benchmark to alert the industry on its current health.

1.5 Limitations of Study

In carrying out this study, we have to accept the facts that there are certain limitations that are beyond our control.

i) The study only limits itself to the evaluation of only this Petrochemical Plant and the East Coast Integrated Petrochemical Complex. In other word, we are assuming that it is the standard practice throughout all the Petrochemical Plant and Integrated Petrochemical Complex in this country.

ii) The emergency response system practiced in each individual Petrochemical Plant may be different. Since there is no standardized emergency response system in this country, it is dependent on the interpretation of those operators who come from different parts of the world.

iii) The petrochemical industry is very diversifying. Hence the hazards and risk related to this industry is equally dramatic. A generalization of an ideal emergency response system in handling any disaster may be too far fetch. Certain adjustment or modification needs to be made.

iv) There is no major incident happened in the Petrochemical Plant. Hence we are only evaluating its capability basing on prescribed guidelines without the opportunity to assess them on real scenarios.

v) Cross border incidents were not considered. But with new petrochemical plants being set-up and expected to be operational within the next few years, additional emergency response hardwares have to be procured and specialized training needs to be provided. The present emergency response system also needs to be reviewed to include new requirements.

vi) Emergency responders' capabilities were evaluated based on their theoretical and practical part of emergency response training where efforts are placed on the physical aspects in these training programs. Psychological or mental training elements had not been included.

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