

6 Hazard Assessment For the Dock at Tsing Yi

6.1 Introduction

Background

- 6.1.1 In accordance with Section 3.5.3 of the EIA Study Brief (ESB-124/2005), an assessment/review of risk incidence associated with Potentially Hazardous Installations (PHI) near the Tsing Yi site, namely the Caltex Terminal (CT) and the ExxonMobil West Terminal (EMWT) should be carried out and necessary mitigation measures proposed.
- 6.1.2 This section presents details of the assessment and the identified mitigation measures, including an evacuation plan for the Dock at Tsing Yi.

Objectives and Scope

- 6.1.3 The objective of the hazard assessment is to identify mitigation measures, including an evacuation plan, for the proposed Dock at Tsing Yi with regard to the risk incidences associated with the Caltex terminal and the ExxonMobil West terminals at south-west Tsing Yi.
- 6.1.4 The assessment has been limited to risk incidents associated with the Caltex terminal and the ExxonMobil West terminals, that have potential impacts on offsite personnel.
- 6.1.5 The study covers a review of relocation and operational activities of the Dock to be undertaken within the consultation zone of the two oil terminals during both the relocation and operational stage of the Yiu Lian Floating Dock No.3 in order to develop an evacuation plan for the staff of the Dock.

Study Approach

- 6.1.6 A structured assessment has been developed to identify mitigation measures for the proposed Dock at Tsing Yi. The key elements of the study include:
- (i) Identification of potential risk incidents that may associate with the two oil terminals;
 - (ii) Review of construction activities of the relocation works and operation activities of the Dock;
 - (iii) Assessment of the impact on the workforce of the Dock during construction and operational stage;
 - (iv) Devising mitigation measures based on the identified hazardous scenarios;
 - (v) Develop an evacuation plan for the Dock; and

- (vi) Propose any other recommendations.

6.2 Description of Relocation Project

General

6.2.1 The relocation of the Yiu Lian No.3 Floating Dock currently located at Yam O Wan, North East of Lantau Island to South Tsing Yi includes the following major works:

- (i) Trench Dredging and Pre-Anchoring;
- (ii) Moving of Dock to Tsing Yi Site;
- (iii) Post anchorage of the Dock after relocation; and
- (iv) Retrieval of redundant anchors from seabed at Yam O.

6.2.2 The prime activities during each stage of the relocation works are indicated in Figure 6-1.

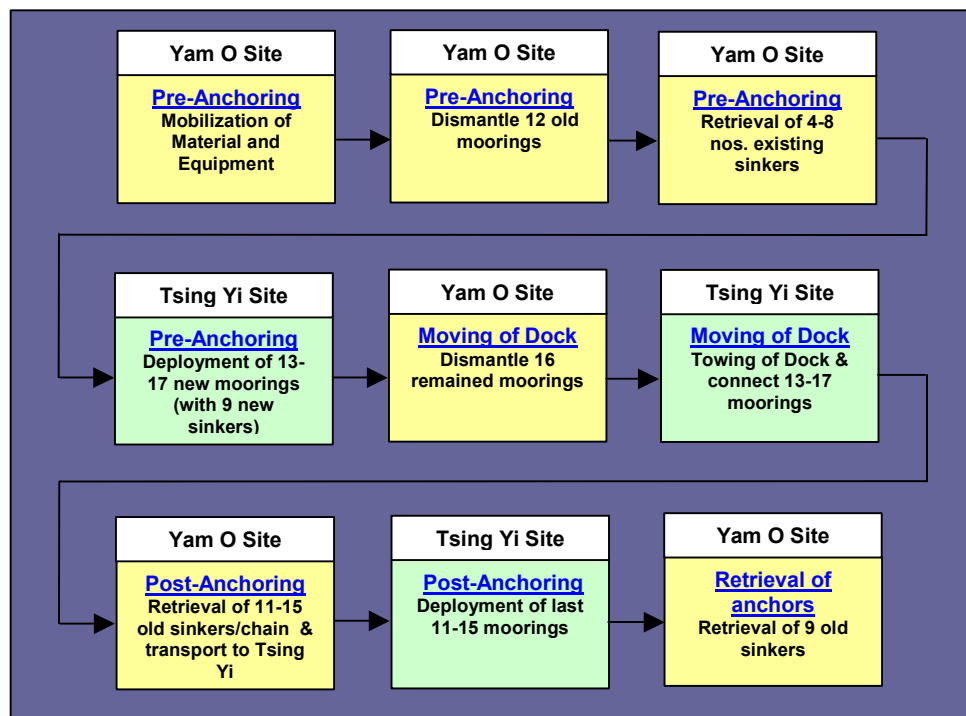


Figure 6-1 Relocation Process Flow Diagrams

6.2.3 It is estimated that the relocation requires 14 weeks of work. Details of these activities and key safety issues identified are discussed in Sections 6.2.6 to 6.2.14 of this report.

- 6.2.4 Future operation activities of the Dock have been reviewed systematically and key issues have been identified in Sections 6.2.15 to 6.2.29 of this report.
- 6.2.5 Figure 6-2 illustrates the new location of the Yiu Lian Floating Dock No.3 at south-west Tsing Yi. The figure also indicates the positions of the CT and the EMWT and their respective Consultation Zones within 1km.

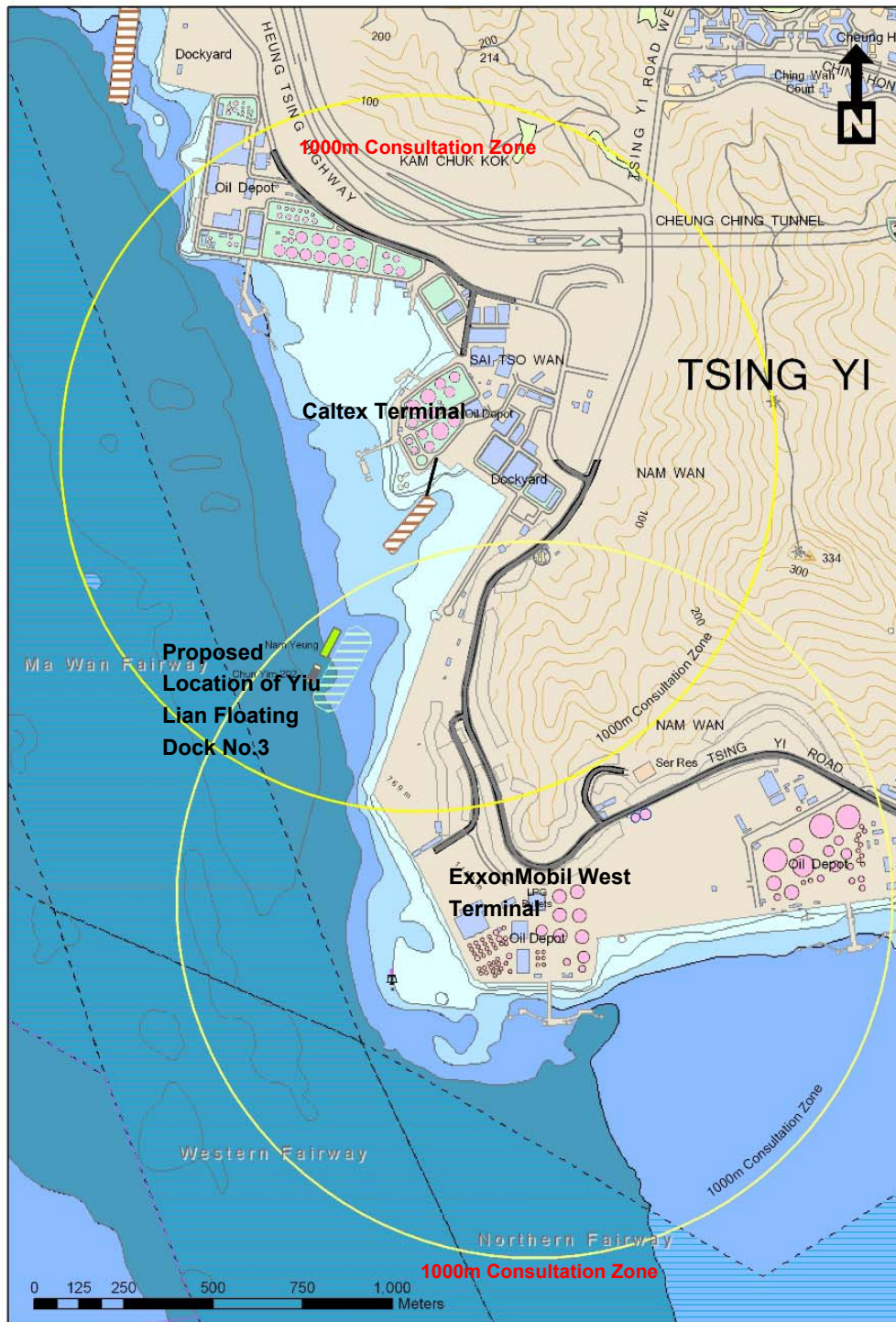


Figure 6-2 Location of Yiu Lian Floating Dock No.3 at Tsing Yi

Review of Relocation Activities within the Consultation Zone

General

- 6.2.6 The relocation activities, which will be undertaken within the intersection of the consultation zones of the two PHIs, have been reviewed. Details of the activities are summarised in subsequent subsections.
- 6.2.7 For the relocation activities to be undertaken outside the consultation zones of the oil terminals, such as salvage of the existing anchor block and disconnection of anchor chains in Yam O Wan of Lantau Island, it is anticipated that potential hazards to workers should be insignificant. Therefore, the work to be undertaken at Yam O Wan has not been further assessed in this study.

Stage 1 - Retrieval and Pre-anchoring

- 6.2.8 Dismantling of 12 old moorings at Yam O and deployment of 13 to 17 new moorings at Tsing Yi will require 5.5 weeks to complete. Table 6-1 below shows the resources allocation for the work.

Resources	Details	No. of Vessel	No. of Staff
Working Vessels	200t Work Barge	1	12
	70t Work Barge	1	
	Derrick Barge	1	
	Working Boat	1	
	650 HP Motor Tug	1	
	800 HP Motor Tug	1	
Supporting Team	Supervisor	-	2
	Diver	-	3

Table 6-1 Details of Anchoring Work before Relocation

Stage 2 - Moving of Dock to New Location and Mooring of the Dock

- 6.2.9 Upon completion of disconnecting the anchorage of the Dock at Yam O Wan, the Dock will be towed to the Tsing Yi site. It is estimated to require 1.5 weeks to transport the Dock to site and to moor it in position. Table 6-2 below shows the resources allocation for the work.

Resources	Details	No. of Vessel	No. of Staff
Working Vessels	70t Work Barge	1	20
	Derrick Barge	1	
	Working Boat	1	
	650 HP Motor Tug	1	
	800 HP Motor Tug	1	
	4,000 HP Tug	4	
Supporting Team	Supervisor	-	2
	Diver	-	3

Table 6-2 Details of Moving of Dock, Positioning and Mooring Work

Stage 3 - Retrieval and Post-Anchoring

6.2.10 After relocation of the Dock at Tsing Yi Site, the remaining moorings will be deployed. These works will require 5.5 weeks to complete. Table 6-3 below shows the resources allocation for the work.

Resources	Details	No. of Vessel	No. of Staff
Working Vessels	200t Work Barge	1	12
	70t Work Barge	1	
	Derrick Barge	1	
	Working Boat	1	
	650 HP Motor Tug	1	
	800HP Motor Tug	1	
Supporting Team	Supervisor	-	2
	Diver	-	5

Table 6-3 Details of Retrieval & Post-anchoring

Stage 4 - Retrieval of Redundant Anchor Blocks at Yam O

6.2.11 This is the final stage of work in Yam O, which is outside the consultation zones under consideration.

Key Issues of Concern

- 6.2.12 During each stage of work, different working vessels and staff will be deployed. It is understood that a Contractor will be commissioned for the relocation of the Dock. Therefore, most of the staff involved in the relocation work will not be Yiu Lian's workforce and thus may not be familiar with the Yiu Lian's safety management practice. In addition, the workers may not be familiar with the working environment close to the oil terminals.
- 6.2.13 In order not to affect the normal operation of the floating dock, vessel repair shall continue upon relocation of the floating dock. Therefore, during the construction stage, the workforce in the Tsing Yi area should include both the crew from the construction teams and the operational teams.
- 6.2.14 Diving works are required at each stage of work as indicated above. The means of evacuation for the divers from the sea and boarding the work craft/boat during emergency should be considered.

Review of Floating Dock Operational activities

General

- 6.2.15 The Floating Dock No. 3 is Yiu Lian's largest floating dock that can accommodate various types of vessels for damage repairs and conducting surveys. Typical operational tasks in the floating dock includes:
- (i) Preparation for vessel docking.
 - (ii) Vessel towing into floating dock.
 - (iii) Vessel repairing at floating dock. Typical activities include:
 - Steel renewal for hull structures;
 - Sand blasting of exterior hull surface;
 - Painting of exterior hull surface;
 - Drydocking survey of vessels including but not limited to the keel, stem, stern frame, rudder, propeller, anchor chain and outside of side and bottom plating, together with bilge keels, thrusters, exposed parts of stern bearing and seal assembly, sea chests, rudder pintles and gudgeons and their security arrangement.
 - (iv) Vessel leaving the floating dock.
 - (v) Other tasks, such as floating dock idling for maintenance, etc.
- 6.2.16 In order to assess the risk associated with the oil terminals to staff at the Dock during the operation stage, the activities of the Dock with respect to the following three aspects are reviewed.

- (i) Preparation for vessels docking and other activities with no vessel in the Dock;
- (ii) Towing of vessel into the Dock and vessel leaving the Dock;
- (iii) Vessel under repair at the Dock.

Preparation for Vessel Docking and Other Activities with No Vessel in the Dock

- 6.2.17 Before the vessel can enter, the Dock is required to prepare for its docking. A minimum workforce will be maintained at the Dock.

Vessel Docking and Leaving Dock

- 6.2.18 Vessels to be repaired should be towed into the Dock with the assistance of tugboats, one ahead and one astern. Normally, the tug will tow the vessel into the Dock from the southwest end of the Dock. The tugs will align the vessel in position and the vessel will be moored at the floating Dock. Then the Dock can be floated to allow repair work to be carried out.
- 6.2.19 Upon completion of the repair work, the Dock will be sunk. Tugs will be used to tow the vessel out of the Dock from the southwest end of the dock.
- 6.2.20 It takes about 20 minutes to fix the vessel onto the Dock. For releasing the vessel from the Dock, 10 minutes will be required.

Vessel Under Repair at the Dock

- 6.2.21 During normal operation, approximately 80 workers will work on the floating Dock for approximately 90% of working days. It is estimated that a maximum of 110 workers may be required in certain circumstances.
- 6.2.22 Normally, Dock operations continue from Monday to Saturday and will cease on Sunday. For special occasions that require Sunday operations, the number of workers is estimated to be 40.
- 6.2.23 Furthermore, there will be a maximum of 30 staff expected inside the vessel under repair.
- 6.2.24 The distribution of workforce for a normal working day is shown in Table 6-4, below.

Time Period	No. of Workers at Floating Dock	Mode
8am-5pm	80 (Maximum 110)	Normal Working Hours
5pm-7pm	72	Overtime
7pm-9pm	16	Overtime
9pm-11pm	4	Overtime
11pm – 2am	4	Overtime
2am onward	4	Overtime

Table 6-4 Temporal Distributions of Floating Dock Staff in Normal Working Days

Key Issues of Concern

- 6.2.25 The maximum number of workers will be present during normal working hours.
- 6.2.26 Although there are only 4 workers on the Dock during nighttime and non-working hours, consideration should be given to safe evacuation and mobilisation of resources during this period.
- 6.2.27 For safety reasons, the entering and leaving of vessel to the Dock cannot be stopped until the vessel is moored securely or completely released from the Dock. Therefore, in case of incident in the oil terminal, Dock staff should ensure vessel stability before evacuation.
- 6.2.28 At present, Yiu Lian makes use of one passenger craft with a capacity of more than 80 to transport workers from Yiu Lian Floating Dock No.3 to shore. After the Dock is relocated to the Tsing Yi site, it is anticipated that only 3-5 minutes are required to bring all workers from the Dock ashore.
- 6.2.29 There are totally two passenger crafts in Yiu Lian's fleet. Therefore, if the number of workers at the Dock is more than 80, both craft can be mobilised to transport them to land at the same time.

6.3 Assessment of Risk Incidents

General

- 6.3.1 The review of risk incidents associated with the CT and the EMWT has been conducted and summarised in this section.
- 6.3.2 The products stored and operations of each terminal have been reviewed in order to identify any hazardous events that may impact on staff at the Dock. The consequences of these events were then evaluated.

6.3.3 The prime operation of two terminals involve Dangerous Goods (DG) vessels unloading, bulk storage, bulk tankers or cylinders and drums filling and delivery of products by land or sea transportations.

6.3.4 A review of previous Quantitative Risk Assessment (QRA) ^[1] for the Route 9 project in southwest Tsing Yi has indicated that the largest risks to offsite personnel at a distance will only be associated with the Liquefied Petroleum Gas (LPG) storage and tanker unloading facilities in the event of major releases. On this basis, the review of the risk incidents associated with the Terminals at Tsing Yi Island has been limited to release of LPG that could have the potential impact on the Dock

Review of Dangerous Goods Storage and Operations in Terminals

6.3.5 EMWT and CT, handle and store various petroleum products, such as LPG, Heavy Fuel Oil, Jet A1 fuel, Gasoline, Mogas, Lubrication Oil, and Solvents. Operations such as lubrication oil filtering and blending and solvent filling are undertaken in the terminals. Tables 6-5 and 6-6 summarised the LPG storage and handling facilities.

	EMWT	CT
Storage Type	Mounded Bullets	Spheres
No. of Storage Tank	4	3
Tank Capacity (te)	1000 (11.3 kbbl)	1000

Table 6-5 LPG Storage in EMWT and CT

Operations	Facilities
Ship Unloading	Jetty, unloading arms, associated pipework with emergency shutdown valves
LPG Storage	Moulded bullet tank (EMWT) / spherical tank (CT)
	Associated pipework with isolating valves and relief valves
	Fire protection systems / leak detection systems
LPG Cylinder Filling	LPG cylinder filling station, cylinder storage area
Road Tanker Loading	Road Tanker loading rack

Table 6-6 LPG Handling Facilities in EMWT and CT

Review of Potential Risk Incidents

Potential Hazardous Scenario

6.3.6 LPG is colourless liquefied gas of extremely flammable nature. The gas is heavy with a density about twice that of air. The Lower Flammability Limit

(LFL) is about 1.9% by volume and the Upper Flammability Limit (UFL) is about 9.5%.

6.3.7 A release of flammable LPG has the potential to cause fire or explosion if ignited. The nature of the combustion will depend on the timing of ignition and the scale of release. The potential hazardous outcomes of LPG releases in the terminals are identified and summarised in Table 6-7.

Location	Components	Causes	Consequences
Jetty	LPG Tanker	Catastrophic failure of LPG tank	Pool fire, flash fire, BLEVE, fireball
		Gas leakage (LPG tank, pipework etc.)	Pool fire, flash fire, jet fire, explosion
	LPG Unloading System	Catastrophic failure of LPG pipe	
		Gas leakage (connections, pipework etc.)	
Tank Farm	LPG Storage Tank	Catastrophic failure of LPG tank	Pool fire, flash fire, BLEVE, fireball
		Gas leakage (LPG tank, pipework etc.)	Pool fire, flash fire, jet fire, explosion
Road Tanker Loading Bay	Road Tanker	Catastrophic failure of LPG tank	Pool fire, flash fire, BLEVE, fireball
		Gas leakage (LPG tank, pipework etc.)	Pool fire, flash fire, jet fire, explosion
Cylinder Filling Station	Cylinder Filling System	Gas leakage (LPG pipework etc.)	

Table 6-7 Identified LPG Risk Incidents

Effect on People at Floating Dock

6.3.8 From the assessment of the product storage and operations of the terminals, it is considered that majority of hazardous events may not be capable of impacting seriously on staff on the Dock. It is anticipated that only a few unlikely catastrophic events or escalation of incidents due to knock-on effects may impact on staff working on the Dock.

- 6.3.9 Three possible outcomes due to the massive release of LPG have been considered in the previous study ¹, i.e. flammable vapour cloud dispersion, Boiling Liquid Expanding Vapour Explosion (BLEVE)/fireball from vessel rupture and ignition and explosion effects.
- 6.3.10 Particular concerns have been given to CT, as three above-ground LPG spheres installed at the seashore of the terminal that are more vulnerable to fire impingement leading to BLEVE and fireball events. Well-protected sand moulded bullets in the EMWT are less vulnerable. In addition, the distance of the moulded bullets at EMWT is further from the shore than that of the spheres at CT.
- 6.3.11 The following table summarises the closest distance from the storage tank and unloading jetty of EMWT and CT to the Dock.

Facilities	Closest Distance from Floating Dock to Terminal Facilities	
	EMWT	CT
LPG Unloading Jetty	1100m	400m
LPG Storage Tanks	770m	500m
LPG Road Tanker Loading Bay	720m	700m

Table 6-8 The Closest Distance between the Terminal Facilities and the Dock

- 6.3.12 With regard to the flammable vapour cloud dispersion due to catastrophic rupture of the LPG storage tank, it is likely that given other ignition sources on the road and elsewhere, the cloud should have been ignited and leading to a fireball before it can reach the Yiu Lian Floating Dock No.3.
- 6.3.13 The CT LPG facility has above ground storage spheres, which contribute to the risk of BLEVE/fireball. It is anticipated that the Dock may be located within the heat radiation effect zones of the fireballs due to cold rupture/BLEVE of the LPG spheres and rupture of LPG tankers. Therefore, an evacuation plan to cater for such incident is necessary.
- 6.3.14 LPG may be explosive in the area of congestion and/or confinement into which a gas cloud is introduced and ignited. Among the facilities at the terminal, it is considered that the semi-confined LPG cylinder filling shed may be such a confinement where an explosion may occur. Given a limited mass of the potential LPG release, the stringent control of ignition sources on-site, and the separation distance of the Dock from the Terminal, the blasting effect should be insignificant. For other facilities installed in open areas of the Terminals, with a low degree of confinement or congestion, risk of explosion should be low.

¹ Route 9 between Tsing Yi and Cheung Sha Wan, Environmental Impact Assessment Report, Atkins China Ltd, Oct 1999.

6.4 Identification of Mitigation Measures

General

6.4.1 In Section 6.3, risk incidents at the Terminals have been assessed. Given that the Dock may be located within the heat radiation zone due to cold rupture/BLEVE incident, mitigation measures, such as an evacuation plan to cater for incidents in oil terminals, is necessary.

6.4.2 In this section, a review of existing safety management of Yiu Lian has been conducted. Based on the findings presented in Sections 6.2 and 6.3 of this report, mitigation measures have been identified. The following subsections provide measures recommended and the development of the Evacuation Plan for the Dock which is attached in Appendix 6A of this report.

Review of Existing Safety Management

6.4.3 Yiu Lian has developed a Safety Management System. A series of safety documentation, such as Safety Management Manual, Emergency Preparedness and Response Plan, etc, have been prepared.

6.4.4 A Safety Plan, which meets all evacuation/contingency requirements stipulated by the Marine Department, has been prepared for the Dock with a workforce of over 100. An Emergency Preparedness and Response Plan, provided with detailed procedures, has been documented in Section 8 of the Yiu Lian's Safety Management Handbook.

6.4.5 This Emergency Preparedness and Response Plan specifies the scope of the plan which includes fire and explosion (on-board), serious industrial accidents, oil spillage, typhoon, poisonous material/gas release, ship collision, etc. In addition, the organisation and the duty of the Emergency Management Team, Emergency Control Procedures, training and drill requirements have been stipulated.

Proposed Mitigation Measures

6.4.6 Mitigation measures have been identified for the Dock based on the review of activities at the Dock and the potential hazardous events at the CT and the EMWT.

General Measures

6.4.7 An evacuation plan for the Yiu Lian Floating Dock No.3 has been developed for evacuating staff on the Dock to a safe place in an effective and efficient manner. This plan will integrate with the existing Emergency Preparedness and Emergency Plan.

- 6.4.8 The contents of the evacuation plan has been given in Section 6.4.17 and the proposed evacuation plan is attached in Appendix 6A of this report.
- 6.4.9 In case of a major incident at one of the oil terminals, the Yiu Lian's Emergency System should come into operation. The Emergency Command Centre (ECC) should establish a communication channel amongst the Authorities, such as the Fire Services Department and the oil terminals. When it is considered that an evacuation is required, the Chief Commander of Emergency Management Team should initiate the Dock evacuation in according with the evacuation procedures.
- 6.4.10 Should an emergency incident occur at CT, it is proposed to use the rear section (southwest end) of the Dock for boarding the passenger craft. If the incident occurs at EMWT, it is recommended to use the front section (northeast end) for boarding. This can keep Dock personnel further away from the scene.
- 6.4.11 Training and drill for implementation of the Evacuation Plan should be arranged annually or when it is necessary.

Specific Measures during Construction Stage

- 6.4.12 An induction course should be given by Safety Personnel to each staff before commencing works. The contents should include general safety procedures, fire evacuation procedures, escape route, etc. The evacuation arrangement in case of the terminal emergencies should also be included in the course.
- 6.4.13 Direct communication links between Emergency Command Centre and each working vessels should be established for emergency communications. Considering that the crewmembers may only understand Cantonese, announcement should be broadcast in Cantonese via the public address (PA) system.

Specific Measures during Operation Stage

- 6.4.14 Critical activities of towing ships to the Dock and release of the ships to the sea are identified. In the event that the terminal incidents occur during performance of these activities, the Dock Master should ensure the vessel stability and instruct all outdoor personnel in floating dock to find shelter at once to prevent injury from heat radiation of fire in the oil terminal before evacuation.
- 6.4.15 Due to the variation of the number of workers on the Dock at different times, the Dock Master should assess whether the resources are sufficient for emergency evacuation.
- 6.4.16 Resources should be available for evacuation during the period from 5pm to 8am.

Evacuation Plan Development

- 6.4.17 An Evacuation Plan is necessary to ensure adequate preparation for effective evacuation management of personnel on the Dock. Personnel at all levels should be familiar with the plan to ensure effective implementation of a prepared and concerted response.
- 6.4.18 An evacuation plan has been developed for the Yiu Lian Floating Dock No.3. The following areas have been considered in the formulation of the plan:
- (i) Emergency Organisations;
 - (ii) Pre-arrangement;
 - (iii) Communications; and
 - (iv) Evacuation Procedures (including evacuation routes).
- 6.4.19 The Evacuation Plan for the Floating Dock No.3 is attached in Appendix 6A of this report.

6.5 Conclusions and Recommendations

Recommendations

- 6.5.1 To allow prompt action to be taken and preparedness in case of emergency at the terminals, it is recommended that the Yiu Lian Security Guard and Operation Team should be alerted for any incidences that may occur at the terminals.
- 6.5.2 Yiu Lian and the oil terminals shall establish a dedicated communication channel and periodic testing of the communication channel to ensure its functionality. The threshold of the scale of incidents should also be established between both parties and should be agreed with FSD on necessary actions.
- 6.5.3 The evacuation plan should be reviewed periodically to ensure that it caters for latest operations of the Dock and of the terminals.
- 6.5.4 Periodic drills involving all parties, including related Authorities, oil terminals and the dockyard staff, should be conducted. Effective communication and co-ordination is the most important aspect in case of a terminal emergency.
- 6.5.5 Upon completion of the drills, a review on every step taken should be conducted to seek for further improvement of the plan.

Conclusions

- 6.5.6 A risk incident assessment/review has been conducted. Risk incidents associated with CT and EMWT have been identified and assessed.
- 6.5.7 A review on operations related to the relocation work of the Yiu Lian Floating Dock No.3 and on future operation at the Tsing Yi site has been undertaken.
- 6.5.8 Based on the findings of the assessment, mitigation measures have been recommended, including the development of an evacuation plan for the Dock. This plan should be integrated as a part of the existing Emergency Preparedness and Emergency Plan.
- 6.5.9 Provided that the recommended measures are implemented properly, the risk to workers/personnel working on the Dock at the Tsing Yi site could be minimised to an acceptable level.