contingency berth is therefore incorporated at the interface between RTS and PFBP, where a single level access ramp will be provided towards the vehicular ferry. The second berth will only be operated under emergency only, access to the movable ramp via the proposed PFBP is considered acceptable. No additional queuing area will be provided for this emergency berth, with queuing area shared with the one for the permanent berth.

9.4.3.6 However, this option will have implication on the operation of the RTS and PFBP. Besides, should this option be employed, the RTS and PFBP will be shifted westward. This will reduce the size of typhoon shelter accordingly, unless the RTS/PFBP can be reduced in size.

9.4.4 *Current Provision*

9.4.4.1 Taking into account the potential constraints and impacts associated with the other options, the proposed location for the DGVFP in the current Outline Master Development Plan was selected as the optimum location within SEKD in recognition of a number of requirements such as:

- Vehicle queuing space;
- Constraints relating to existing land use;
- Landside and marine access; and
- The need to maintain continuous use by the public along the waterfront promenade.

9.4.4.2 The proposed location of the DGVFP will be separated into two portions, the landing and the queuing areas. This arrangement has the advantage that the landing area will occupy the least land intake at the waterfront at the Kwun Tong Area – hence the extent of reclamation can be kept at a minimum.

9.4.4.3 Under this provision, the queuing area of the DG vehicle ferry pier is located at the existing open space on northern side of Trunk Road T2/Western Coast Road (WCR). The DG vehicles will cross at the top of the underground road section towards the seafront at the time slot when loading and unloading will be made at the DG vehicle ferry.

9.4.4.4 The proposed DGVFP is located at the waterfront of Area 6C, and is separated from the existing Laguna City and the future residential development in Cha Kwo Ling by existing roads and a strip of open space planned in Area 6C. The schematic layout plan of the ferry pier is shown in **Drawing No. 22936/MS/121**. The ferry pier consists of a DG vehicle queuing area, a ground level crossing over a portal of Trunk Road T2 and a waterfront pier.

9.5 Risk Assessment for the Proposed DGVFP

9.5.1 *Introduction*

Background

9.5.1.1 This section is the Quantitative Risk Assessment (QRA) study for the proposed DGVFP at Cha Kwo Ling to replace the existing pier in Kwun Tong. The location of the proposed DG ferry pier and its internal layout are shown in **Drawing No. 22936/EN/361**. This Risk Assessment examines the potential risks associated with the relocation, identifies appropriate control measures and advises on any action that may be necessary.

9.5.1.2 Previously, the Government has commissioned two studies to obtain a better understanding of risks associated with DG transport. These are:

- The Risk Assessment of the Transport of LPG and Naphtha in Hong Kong (DNV Report, 1996).

- The Risk Assessment of the Transport of Non-Fuel Gas Dangerous Goods in Hong Kong (Chlorine, Explosives, Hydrocarbons, Industrial Gases and Chemicals) (DNV Report, 1997).

Objectives

9.5.1.3 The overall objective is to carry out risk assessment for the relocation of DGVFP using SAFETI Expert for assessing the transport of LPG, hydrocarbons and Chlorine Cylinders by road and sea for both the present conditions (2001) and for the year 2012.

9.5.1.4 The scope of work of the hazard assessment is outlined as follows:

1. To identify major hazards from LPG, hydrocarbons and chlorine transport, including individual and societal risks to residents, workers, road users and any other exposed people.
2. To carry out a QRA of Dangerous Goods risk associated with the relocation of the Kwun Tong DG Ferry Pier to Cha Kwo Ling (i.e. the risk from the activities within the boundaries of the DG Ferry Pier including transport).
3. To compare the existing and future levels of risk for the relocation of the DG ferry pier and the HK Risk Guidelines as defined in the EIA Ordinance.
4. To identify the main contributors to the risk, and hence suggest practical measures for risk reduction.

9.5.1.5 The frequencies used in this Risk Assessment are as per the previous QRA transport studies above.

Scope of the Risk Assessment

<u>Scenarios and Technical Scope</u>

9.5.1.6 Risk assessments have been undertaken for the current situation (2001) and a future scenario, based on developments to the year 2012.

9.5.1.7 The scope of the Risk Assessment is the deliveries of DGs to the relocated Dangerous Goods ferry pier and on via the DG ferry to North Point on Hong Kong Island. The Risk Assessment has evaluated the additional risk due to relocation of the DG Ferry Pier. This involves the risk from the waiting area and the transport route within the site boundary. The risks from the short section of additional route on the public road are not within the scope of this study.

9.5.1.8 The materials covered are LPG, hydrocarbons (petrol, diesel, etc.) and chlorine. The breakdown of the materials is as follows:

Table 9.5 Dangerous Goods Transport Using the Proposed Cha Kwo Ling DG Ferry Pier

Material	Category
LPG	Cat. 2
Leaded and unleaded petrol, aviation gasoline	Cat. 5 – Class 1
Diesel fuel, fuel oil	Cat. 5 – Class 3
Paint and chemicals, etc.	Cat. 5 (General)
Chlorine Cylinders	Cat. 2.3

1) LPG activities such as use of road tankers, etc. is strictly under the control of Gas Standard Office of EMSD.
2) Diesel and other chemicals are modelled as Cat.5 Class 3

<u>The Hazards</u>

9.5.1.9 The hazards covered by this Risk Assessment are those involving releases of LPG, hydrocarbon liquids and chlorine. Accidents involving purely mechanical impact and no DG release are excluded.

Persons at Risk

9.5.1.10 The people included in the societal risk calculations are residents, road users, harbour users, workers and other third-parties not directly involved in the DG operations. Workers at the ferry pier and waiting area sites are excluded, as are the drivers and assistants on DG vehicles. Crews on DG ships and ferries are excluded, as are drivers and assistants on other vehicles on the DG ferry. Emergency services personnel are included.

9.5.1.11 The scope of this Risk Assessment covers the risk of fatality to third parties. No injury risk results will be produced, but likely injury-to-death ratios will be reported. Other types of risk results that may arise due to accidental releases such as injury, property damage, environmental damage and business interruption will be accounted for in the cost-benefit analysis.

9.5.2 *Hazard Identification and Failure Case Selection*

Introduction

9.5.2.1 The aim of the hazard identification is to identify the type of accidents that could occur due to the transport of Dangerous Goods within the study area, as well as the potential consequences. The hazard identification provides input to the QRA as it is used in the:

- Frequency analysis which identifies base events and combinations of events which have the potential to result in hazardous releases.
- Consequence analysis and impact analysis where it provides input to the modelling to ensure it reflects mitigating factors and people’s responses to an accident.

9.5.2.2 This section also includes selecting representative failure cases for the QRA calculations.

Hazardous Properties of Dangerous Goods

LPG

9.5.2.3 LPG in Hong Kong is a 70/30 butane and propane mixture. At ambient temperature and pressure, LPG is a gas, but is readily liquefied by either pressure and/or refrigeration. For the purpose of this Risk Assessment, LPG was modelled as a saturated liquid at ambient temperature, which is typical for road & sea transport around Hong Kong.

9.5.2.4 The limits of flammability of LPG are approximately 2% to 10% volume of gas in air. An instantaneous release of LPG would result from the catastrophic rupture of a road tanker. If an instantaneous release is ignited immediately, a fireball will result, possibly with a residual pool fire. If ignition is delayed, a flash fire or vapour cloud explosion (VCE) may result, possibly with a residual pool fire. A continuous release of LPG may lead to a jet fire, flash fire or a VCE, possibly with a residual pool fire.

9.5.2.5 When a relatively minor incident causes a more significant event this is termed hazard escalation. Events that can lead to escalation are:

- Jet fires impinging on the road tanker.
- Missiles or overpressure impacting on the road tanker.
- Pool fires engulfing the road tanker.

9.5.2.6 If the initial accident causes catastrophic rupture and a fireball, this would represent a worst case scenario and no further hazard escalation is possible. Thus LPG jet fire impingement or engulfment of a tanker by pool fires are the only identified hazards which can lead to significant escalation, manifested in the form of a BLEVE (Boiling Liquid Expanding Vapour Explosion).

Hydrocarbons Hazards

9.5.2.7 Materials identified here are Category 5 materials, referred to substances that give off inflammable vapour. The most significant hazardous property of the liquid oil products and petrochemicals transported in Hong Kong is flammability. They are classified according to their flash point. The flash point of a flammable liquid is the lowest temperature at which the liquid produces sufficient vapours to make the vapour / air mixture flammable; i.e. the vapour in air concentration immediately above the liquid surface is above the material's lower flammability limit (LFL).

9.5.2.8 In Hong Kong, classification is based on the Dangerous Goods (Application and Exemption) Regulations, which classes liquids into three categories:
Class 1 – Substances having a flash point below 23^{o}C.
Class 2 – Substances having a flash point of or exceeding 23^{o}C but not exceeding 66^{o}C.
Class 3 – Substances having a flash point of or exceeding 66^{o}C.

9.5.2.9 Highly flammable products, Class 1, (eg. petrol) with a flash point below ambient temperature are readily ignited if spilled. Flammable products, Class 2, (eg. kerosene) and combustible products, Class 3, (eg. diesel and fuel oil) with flash points above ambient temperature can only ignite if the product is heated to above their flash point.

Chlorine Hazards

9.5.2.10 Chlorine is a greenish-yellow gas with a pungent, irritating odour. Inhalation of chlorine gas will lead to server burning of the respiratory tracts and lungs. On inhalation of the gas medical treatment must be carried out under all circumstances. The gas produces server burning of the eyes and irritation of the skin, possibly with blisters.

Dangerous Goods Transport Operations

9.5.2.11 The existing vehicular ferry pier at Kwun Tong Ferry Pier for DG vehicles will be replaced by a new ferry pier at Cha Kwo Ling Road at the south-eastern end of SEKD.

9.5.2.12 Under the current implementation program of SEKD, a temporary DG vehicle ferry pier will be established on the runway (see **Drawing No. 22936/IM/902** in **Appendix 9E**) and in operation in early 2006 before the permanent pier commence operation after the completion of Cha Kwo Ling reclamation, that is, end 2012.

9.5.2.13 Before relocation of the DG vehicle ferry pier from the temporary location to the permanent location, the land uses adjacent to the temporary pier are all temporary uses including public filling barging point (PFBP), public cargo working area (PCWA) etc. Part of the current transport route of the DG tankers to the existing vehicle ferry pier at Kwun Tong Ferry Pier through built up urban high rise will be replaced by a temporary route of similar length on the apron through an area with ongoing construction work and temporary uses with much less population than urban area. On this basis, the risk for the temporary DG vehicle ferry pier would be lower than the current pier and therefore considered acceptable.

9.5.2.14 The Dangerous Goods Ferry will be operated by the Hong Kong and Yaumatei Ferry Company Limited (HYF). They currently have four ferries that are licensed by the Marine Department to carry Category 2 and Category 5 Dangerous Goods. The ferry service from the relocated Cha Kwo Ling site to North Point ferry pier will be as tabulated in **Table 9.6**.

Table 9.6 Ferry Service for Dangerous Goods

Kowloon Bound	Cat.#	Hong Kong Bound	Cat.#
7.00am	5	7.25am	2
7.50am	2	8.15am	5
8.40am	5	9.05am	2

Kowloon Bound	Cat.#	Hong Kong Bound	Cat.#
9.30am	5	9.55am	5
10.20am	5	10.45am	5
11.10am	2	11.35am	5
12.00noon	5	12.35pm	5
12.50pm	2	1.15pm	2
1.40pm	5	2.05pm	5
2.30pm	2	2.55pm	5
3.20pm	2	3.45pm	5
4.30pm	5	4.35pm	5
4.50pm	2	-	-
5.30pm	2/5	-	-

* Courtesy of EMSD, Transport Department
# As defined in Table 9.5

9.5.2.15 HYF indicated that currently there are less than 90 vehicles (two-way) using the cross harbour services daily and therefore a queuing area capable of holding 60 heavy goods vehicles would be sufficient. Hence the 1.0ha queuing area, allowed for in the layout plan, would be more than adequate to accommodate the future demand.

9.5.2.16 The route from Cha Kwo Ling to North Point will be used by loaded vehicles from Tsing Yi oil terminals. According to HYF, the numbers of vehicles on each ferry / route vary from a single vehicle to a full ferry load of 10 vehicles.

9.5.2.17 Only the main deck of the ferry is used for carrying Dangerous Goods vehicles. Crew quota is usually around 8. No passengers other than the drivers and their assistants are allowed on the vehicles.

9.5.2.18 While waiting to board the ferry, the Dangerous Goods vehicles line up in single file at the dock side. An inspector checks each vehicle as it boards the ferry. This check is only to ascertain that the combinations of different Dangerous Goods do not breach regulations / guidelines specified by the Marine Department. No records of the Dangerous Goods being carried are kept. Vehicles board the ferry and drive into one of the two lanes on the ferry. Loading time is minimal; typically 10 minutes. The consultants were advised that vehicles are not secured other than by their own handbrakes.

9.5.2.19 Crews are trained at the Seaman Training Centre and also receive specific fire fighting training. Emergency procedures exist in case of fire. The ferry will not operate in typhoon number 3 or higher.

9.5.2.20 HYF also requires that LPG tankers are segregated from other vehicles by 1m or more (both onshore and on the ferry), engines to be switched off while ‘queuing’, and no naked flames in the vicinity.

9.5.2.21 In addition, the following Government safety requirements are necessary:

- Forward and reverse dedicated escape routes are to be provided.
- Dangerous Goods Vehicles carrying LPG should not be parked unattended if less than 15m from residential buildings and should not be parked unattended in a street.
- Dangerous Goods Vehicles should not carry both kerosene and LPG simultaneously as has been the practice for those with two separate compartments.

Dangerous Goods Transport Routes

9.5.2.22 There are no specific routes that the ferry or road tankers are required to use under any of the government regulations. However, under Road Tunnels (Government) Regulations, all DG vehicles are forbidden to use tunnels within Hong Kong. For transport by road tanker, each operating company advises the drivers to follow major routes and avoid heavy traffic and densely populated areas if possible. The typical road transport route from Tsing Yi to the

Kwun Tong DG Ferry Pier is Route 3, Ching Cheung Road, Lung Cheung Road, and Wai Yip Street.

Failure Case Selection

9.5.2.23 Screening of all failure cases for LPG, Hydrocarbons and Chlorine has been done from previous transport QRA studies (DNV, 1996, 1997). The selected failure cases that are considered to have potential off-site impact and modelled in this study are summarised in **Table 9.7**.

Table 9.7 Failure Case List

ID	Material	Vehicle	Description	Main Causes
T1	LPG	LPG Road Tanker	BLEVE	Fire + fire protection failure
T2			Cold Rupture	Road accident + tank rupture Overfilling + thermal expansion + PRV failure
T3			Large Liquid Leak	Tank shell leak Access hatch leak Un-isolated liquid pipework leak
T4			Large Vapour Leak	Spontaneous PRV leak Road accident + PRV leak
T5			Medium Liquid Leak	Tank shell leak Un-isolated liquid pipework leak
C1		LPG cylinder wagon	Multiple BLEVE	Fire + cylinder rupture
C2			Rupture	Road accident + cylinder rupture Spontaneous cylinder rupture
H1	Hydrocarbons	Hydrocarbon road tanker	Medium liquid leak	Tank shell leak Un-isolated liquid pipework leak
H2			Large liquid leak	Tank shell leak Access hatch leak Unisolated liquid pipework leak
H3			Fireball	Fire
H4			Rupture	Road accident + tank rupture Overfilling + thermal expansion + PRV failure
Cl1	Chlorine	Chlorine cylinder truck	Medium vapour leak	Truck fire Truck impact Truck impact
Cl2			Medium liquid leak	Truck fire Truck impact Truck impact
Cl3			Rupture	Road accident + cylinder rupture Spontaneous cylinder rupture

9.5.3 *Study Data*

Introduction

9.5.3.1 Data used in this Risk Assessment are based on previous transport studies conducted by DNV, supplemented by specific on-site surveys. The aim of the data analysis is to convert raw data obtained from data collection surveys and other sources into a form fit for risk results determination. The analysis can be broadly grouped in the following areas:

- Route Section Definition.
- Population Data.
- Ignition Sources.
- Meteorological Data.
- Frequency Analysis.

9.5.3.2 Data analysis is followed by Consequence and Impact modelling.

Route Sections

9.5.3.3 For the risk calculation, the transport network is divided into sections, and the risks calculated for each section separately. The risks can then be presented for individual sections, for routes (i.e. combinations of sections) or the complete network.

9.5.3.4 Each section must have broadly constant characteristics, i.e. it should be all urban or all rural, should not have major junctions except at the ends and should have a constant number of Dangerous Goods vehicles or vessels per year along their length.

9.5.3.5 For greater accuracy the sections should be as short as possible, but there is little gained by having sections shorter than the hazard range of the most common release types. The road section being considered is presented in **Drawing No. 22936/EN/361**.

9.5.3.6 The routes considered for the current case in this study cover the sections marked in **Drawing No.22936/EN/361** for the current and proposed ferry piers. There being no significant increase in the original marine route distance or change in marine population, it is not considered necessary to consider the marine risks further.

9.5.3.7 The current and future movements of LPG, Hydrocarbons and Chlorine are described below in detail.

Population Data

9.5.3.8 For road transport, the different types of population included in the analysis and identified as likely to be affected in the event of a Dangerous Goods accident are:

- People in vehicles on the road;
- People on the pavements next to the road; and
- People inside and outside buildings next to the road.

9.5.3.9 The population data was quoted from a previous study (DNV, 2000), supplemented by a site-specific survey conducted by DNV. The population is modelled as individual populated areas as shown in **Drawing No. 22936/EN/362** while the day and night time population modelled in each area are as listed in **Table 9.8**. Traffic flow figures used to estimate the nearby road population is as shown in **Table 9.9**. Data presented in **Table 9.8** has been provided by the Planning Department.

Table 9.8 Nearby Population of the Proposed Relocated DG Ferry Pier

Location Reference	Zoning on the current OZP	Predominant Land Use (2000)	Height / Storey	Estimated population (2000)		Proposed Land Use	Height / Storey	Estimated population upon full development	
			(2000)	Day	Night		(2012)	Day	Night
A(1+3)	O	Open Space	0	5	1	Open Space	0	5	1
B(1+3+4)	R(A)1	Residential	30	3373	13490	Residential	30	3030	12121
C(1+3+4)	R(A)2	Residential	30	1045	4180	Residential	30	925	3699
D(1+2+4)	R(A)4	Temporary shelters	1-2	470	1880	Residential	30	5845	23380
E(1+3+4)	R(A)	Residential	11	283	1130	Residential	11	194	777
F(2+5)	OU, O	Temp. Works Area, Sewage Treatment Plant (CIP)	1	50	5		0	50	5
G	OU, O	Sewage Treatment Plant	0	50	5	Sewage Treatment Plant	1	50	5
H		Commercial	30	8298	830	Commercial	30	8298	830
I		Bus Terminal	0	50	5	Bus Terminal	0	50	5
J	O	Open Space	0	45	5	Open Space	0	45	5
K		Commercial	30	5432	543	Commercial	30	5432	543

Assumptions

1) Figures as obtained from Planning Department.
2) Existing population figures are based on site survey.
3) Assume no significant change in population in future.
4) 25% of night-time population is assumed during the day-time for the residential buildings.
5) 10% of day-time population is assumed during the night-time for school/commercial premises in the study area.

Table 9.9 Road Population close to the Proposed Relocated DG Ferry Pier

Location	Daytime Traffic Flow (per hour)	Total population in area	
		Conti & Inst. Release	BLEVE
Cha Kwo Ling Road	888	7	2
Wai Yip Street	1824	22	5
Wai Fat Road	984	18	5
Western Coast Road	1824	21	5
Kwun Tong Bypass	3000	68	17

1. No dangerous goods movements are proposed for the night time period as the ferry is only run during day light hours.
2. In the event of a BLEVE it has been assumed that emergency services personnel have been able to reduce the street population to 25% of normal levels.

9.5.3.10 Road side populations have been calculated based on the estimated traffic flow rates generated by DNV via a series of site tours. The population is a function of the average vehicle population and the estimated time taken for the vehicle to travel the route length. Combining an average vehicle occupancy of 1.5 people, and speed of 50 km/hr along with the route length the following formula was applied:

Road Side Pop = 1.5 x (Route Length / 50 km/h) x Traffic Flow

Ignition Sources

Data Required

9.5.3.11 In order to calculate the risk from flammable materials, information is required on the ignition sources that are present in the area over which a flammable cloud may drift. For each ignition source considered, the following factors need to be specified:

- Presence Factor

  This is the probability that an ignition source is active at a particular location. For example, if a fire fighting training ground is only in use for 1 hour per week (during normal working hours, 8 hours x 5 days) this equates to a day-time presence factor of 0.025. Similarly, the presence factor could also be calculated for road vehicles based on the travelling speed and the number of vehicles per unit time.

- Ignition Factor

  This defines the "strength" of an ignition source. It is derived from the probability that a source will ignite a cloud if the cloud is present over the source for a particular length of time.

- Location

  The location of each ignition source must be specified. This allows the position of the source relative to the location of each release to be calculated. The results of the dispersion calculations for each flammable release are then used to determine the size and mass of the cloud when it reaches the source of ignition.

9.5.3.12 If these factors are known for each source of ignition considered, then the probability of a flammable cloud being ignited as it moves downwind over the sources can be calculated.

9.5.3.13 The data is entered into SAFETI Expert ignition input file for each source (as that used for population data). The risk calculation program (MPACT) calculates equivalent combined ignition factors and presence factors for all sources based on its location on the map.

9.5.3.14 Ignition sources in the SAFETI package may be of 3 types:

- Point sources: Known specific sources such as flares, workshops, etc.
- Line sources: Roads, railways, electrical transmission lines.
- Area sources: Population, industrial sites where location of specific sources is unknown.

Identification of Ignition Sources

9.5.3.15 The ignition sources identified are the road vehicles on Cha Kwo Ling Road, Wai Yip Street and Wai Fat Road, and the population in the study area. These are summarised below.

Point Sources
None.

Line Sources
Roads are line ignition sources in SAFETI Expert. The presence factor for a line source is determined based on traffic densities, average speed along the road and the length of the road element. This location of the line source is drawn onto the site map in SAFETI Expert.

The SAFETI Expert programme calculates the ignition probability based on the input data to the ignition file. Input values that are used are the number of vehicles per hour shown in **Table 9.10** and:

- 10% of day-time traffic densities are estimated for night-time.
- Probability of ignition for a vehicle is taken as 0.4 in 60 seconds.

Table 9.10 Line Ignition Sources

Ignition sources	Day-time traffic density (per hour)	Night-time traffic density (per hour)	Average traffic speed(km/hr)
Cha Kwo Ling Road	888	89	50
Wai Yip Street	1824	182	50
Wai Fat Road	984	98	50
Western Coast Road	1824	182	50
Kwun Tong Bypass	3600	360	50

Area Sources
No specific area ignition sources have been modelled in this study. SAFETI Expert however, will automatically allow for people acting as ignition sources. These are based on the population data. The presence of such sources (e.g. cooking, smoking, heating appliances, etc.) is derived directly from the population densities in the area of concern.

Meteorological Data

9.5.3.16 Meteorological data used in the risk assessment has been taken from a previous QRA study in Kwun Tong (DNV, 2000) which is applicable for this study.

Frequency Analysis

9.5.3.17 The movement data that are entered into the risk calculations for current and future cases are as tabulated in **Table 9.11** and **Table 9.12** respectively.

Table 9.11 Current Case – Ferry Deliveries of LPG and Hydrocarbons

Dangerous Goods	No. of Movements/day	No. of Movements/year
Hydrocarbon Tanker	30	16790
LPG Tanker	8	2920
LPG Cylinder Truck	11	4015
Compressed and Cryogenic Gases Cylinder Truck	5	1825
Other Chemicals	0	0
Petrol/ Diesel Tankers By Chartered Ferries	10	3650
Chlorine	-	24

* Data provided by EMSD

Table 9.12 Future Case – Ferry Deliveries of LPG and Hydrocarbons for 2006

Dangerous Goods	No. of Movements/ day	No. of Movements/ year #
Hydrocarbon Tanker	31	24820
LPG Tanker	21	7665
LPG Cylinder Truck	13	4745
Compressed and Cryogenic Gases Cylinder Truck	6	2190
Other Chemicals	6	2190
Chlorine	0.07	24

Assuming 365 days per year
* Data provided by EMSD

Failure Frequencies

9.5.3.18 The frequencies used for each of the failure cases were calculated based on event frequencies from the previous transport study report and the number of movements per year, provided by EMSD. The results for current and future scenarios are shown in **Table 9.13** to **Table 9.18**.

9.5.3.19 The changes in the road and marine routes are as follows:

- The additional distance by road from the existing DG ferry pier to the relocated one at Cha Kwo Ling is approximately 700m.
- The marine route has no significant increase compared to the present route.

Table 9.13 LPG Transport Failure Frequencies for Year 2001

ID	Vehicle	Hole Size (mm)	Failure Description	Likelihood per vehicle km+	No. of Movements per day (2001)	No. of Movements per year (2001)	Frequency per year km
T1	LPG Road Tanker	N/A	BLEVE	2.7E-12	8	2920	7.88E-09
T2		N/A	Cold Rupture	2.6E-09	8	2920	7.59E-06
T3		50	Large Liquid Leak	1.8E-08	8	2920	5.26E-05
T4		50	Large Vapour Leak	2.1E-09	8	2920	6.13E-06
T5		25	Medium Liquid Leak	6.8E-09	8	2920	1.99E-05
C1	LPG cylinder wagon	N/A	Multiple BLEVE	1.3E-09	11	4015	5.22E-06
C2		N/A	Rupture	2.8E-08	11	4015	1.12E-04

Assuming 365 days per year
+ As quoted from DNV Report, 1997

Table 9.14 LPG Transport Failure Frequencies for Year 2012

ID	Vehicle	Hole Size (mm)	Failure Description	Likelihood per vehicle km+	No. of Movements per day (2012)	No. of Movements per year (2012)	Frequency per year km
T1	LPG Road Tanker	N/A	BLEVE	2.7E-12	21	7665	2.1E-08
T2		N/A	Cold Rupture	2.6E-09	21	7665	2.0E-05
T3		50	Large Liquid Leak	1.8E-08	21	7665	1.4E-04
T4		50	Large Vapour Leak	2.1E-09	21	7665	1.6E-05
T5		25	Medium Liquid Leak	6.8E-09	21	7665	5.2E-05
C1	LPG cylinder wagon	N/A	Multiple BLEVE	1.3E-09	13	4745	6.2E-06
C2		N/A	Rupture	2.8E-08	13	4745	1.3E-04

Assuming 365 days per year.
+ As quoted from DNV Report, 1997.

Table 9.15 Hydrocarbons Transport Failure Frequencies for Year 2001

ID	Vehicle	Hole Size (mm)	Failure Description	Class Description	Likelihood per vehicle km+	No. of Movements per day (2001)	No. of Movements per year (2001)	Frequency per year km
H1P	Road tanker	25	Medium liquid leak	Petrol++	1.9E-10	15	5475	1.04E-06
H1D		25		Diesel++	4.8E-11	15	5475	2.63E-07

ID	Vehicle	Hole Size (mm)	Failure Description	Class Description	Likelihood per vehicle km+	No. of Movements per day (2001)	No. of Movements per year (2001)	Frequency per year km
H2P		100	Large liquid leak	Petrol	4.4E-11	15	5475	2.41E-07
H2D		100		Diesel	1.1E-11	15	5475	6.02E-08
H3P		N/A	Fireball	Petrol	9.6E-12	15	5475	5.26E-08
H3D		N/A		Diesel	1.9E-12	15	5475	1.04E-08
H4P		N/A	Rupture	Petrol	9.4E-10	15	5475	5.15E-06
H4D		N/A		Diesel	2.4E-10	15	5475	1.31E-06

\# Assuming 365 days per year
+ As quoted from DNV Report, 1996
++ Petrol and Diesel (including other chemicals) modelled as Octane in SAFETI.

Table 9.16 Hydrocarbons Transport Failure Frequencies for Year 2012

ID	Vehicle	Hole Size (mm)	Failure Description	Class Description	Likelihood per vehicle km+	No. of Movements per day (2012)	No. of Movements per year (2012)	Frequency per year km
H1P	Road tanker	25	Medium liquid leak	Petrol	1.9E-10	19	6935	1.32E-06
H1D		25		Diesel++	4.8E-11	12	4380	2.10E-07
H2P		100	Large liquid leak	Petrol	4.4E-11	19	6935	3.05E-07
H2D		100		Diesel	1.1E-11	12	4380	4.82E-07
H3P		N/A	Fireball	Petrol	9.6E-12	19	6935	6.66E-07
H3D		N/A		Diesel	1.9E-12	12	4380	8.32E-08
H4P		N/A	Rupture	Petrol	9.4E-10	19	6935	6.52E-05
H4D		N/A		Diesel	2.4E-10	12	4380	1.05E-06

\# Assuming 365 days per year.
+ As quoted from DNV Report, 1996.
++ Petrol and Diesel (including other chemicals) modelled as Octane in SAFETI.

Table 9.17 Chlorine Cylinder Transport Failure Frequencies for Year 2001

ID	Vehicle	Hole Size (mm)	Failure Description	Class Description	Likelihood per vehicle km+	No. of Movements per month (2001)	No. of Movements per year (2001)	Frequency per year km
Cl1	Chlorine Cylinder	7.5	Medium Vapour Leak	Cl2	8.20E-09	2	24	1.97E-07
Cl2		7.5	Medium Liquid Leak	Cl2	7.30E-08	2	24	1.75E-06
Cl3		N/A	Rupture	Cl2	5.10E-09	2	24	1.22E-07

Table 9.18 Chlorine Cylinder Transport Failure Frequencies for Year 2012

ID	Vehicle	Hole Size (mm)	Failure Description	Class Description	Likelihood per vehicle km+	No. of Movements per month (2012)	No. of Movements per year (2012)	Frequency per year km
Cl1	Chlorine Cylinder	7.5	Medium Vapour Leak	Cl2	8.20E-09	2	24	1.97E-07
Cl2		7.5	Medium Liquid Leak	Cl2	7.30E-08	2	24	1.75E-06
Cl3		N/A	Rupture	Cl2	5.10E-09	2	24	1.22E-07

Dangerous Goods Stand-by Failure Cases

9.5.3.20 Prior to loading the dangerous goods vehicles on to the Ferries the vehicles will queue in the designated area awaiting instruction to board the ferry. The risk presented to the by the waiting vehicles has been included in the risk assessment. The following assumptions have been applied:

- All vehicles on average spend half the time period between ferries in the designated waiting area. The time between ferries according to the schedule presented in **Table 9.7** is 50-minutes. Therefore it is assumed that each DG vehicle spends 25-minutes waiting for a ferry.
- Leak rates for the DG vehicles have been referenced from a previous DNV study of LPG Transport Risks in Hong Kong (DNV, 1996) for spontaneous leak and ruptures from cylinder and tankers.

9.5.3.21 The results for current and future scenarios are shown in **Tables 9.19 to 9.24**.

Table 9.19 LPG DG Ferry Pier Failure Frequencies for Year 2001

ID	Vehicle	Hole Size (mm)	Failure Description	Likelihood per vehicle or Cyl.	No. of Movements per day (2001)	No. of Movements per year (2001)	Estimated waiting period (yr)	Frequency per year
T1	LPG Road Tanker	N/A	BLEVE		8	2920	0.14	0.00E+00
T2		N/A	Cold Rupture	4.00E-08	8	2920	0.14	1.31E-04
T3		50	Large Liquid Leak	3.60E-08	8	2920	0.14	1.18E-04
T4		50	Large Vapour Leak	3.60E-08	8	2920	0.14	1.18E-04
T5		25	Medium Liquid Leak	3.60E-08	8	2920	0.14	1.18E-04
C1	LPG cylinder wagon	N/A	Multiple BLEVE		11	4015	0.19	0.00E+00
C2		N/A	Rupture	6.80E-06	11	4015	0.19	5.71E-02

Table 9.20 LPG DG Ferry Pier Failure Frequencies for Year 2012

ID	Vehicle	Hole Size (mm)	Failure Description	Likelihood per vehicle	No. of Movements per day (2012)	No. of Movements per year (2012)	Estimated waiting period (yr)	Frequency per year
T1	LPG Road Tanker	N/A	BLEVE		21	7665	0.36	0.00E+00
T2		N/A	Cold Rupture	4.00E-08	21	7665	0.36	1.46E-08
T3		50	Large Liquid Leak	3.60E-08	21	7665	0.36	1.31E-08
T4		50	Large Vapour Leak	3.60E-08	21	7665	0.36	1.31E-08
T5		25	Medium Liquid Leak	3.60E-08	21	7665	0.36	1.31E-08
C1	LPG cylinder wagon	N/A	Multiple BLEVE		13	4745	0.23	0.00E+00
C2		N/A	Rupture	6.80E-06	13	4745	0.23	1.53E-06

Table 9.21 Hydrocarbons DG Ferry Pier Failure Frequencies for Year 2001

ID	Vehicle	Hole Size (mm)	Failure Description	Class Description	Likelihood per vehicle	No. of Movements per day (2012)	No. of Movements per year (2012)	Estimated waiting period (yr)	Frequency per year
H1P	Road tanker	25	Medium liquid leak	Petrol++	3.60E-08	15	5475	0.31	1.97E-04
H1D		25		Diesel++	3.60E-08	15	5475	0.21	1.97E-04
H2P		100	Large liquid leak	Petrol	3.60E-08	15	5475	0.31	1.97E-04
H2D		100		Diesel	3.60E-08	15	5475	0.21	1.97E-04
H3P		N/A	Fireball	Petrol		15	5475	0.31	0.00E+00
H3D		N/A		Diesel		15	5475	0.21	0.00E+00
H4P		N/A	Rupture	Petrol	4.00E-08	15	5475	0.31	2.19E-04
H4D		N/A		Diesel	4.00E-08	15	5475	0.21	2.19E-04

Table 9.22 Hydrocarbons DG Ferry Pier Failure Frequencies for Year 2012

ID	Vehicle	Hole Size (mm)	Failure Description	Class Description	Likelihood per vehicle	No. of Movements per day (2012)	No. of Movements per year (2012)	Estimated waiting period (yr)	Frequency per year
H1P	Road tanker	25	Medium liquid leak	Petrol	3.60E-08	19	6935	0.33	1.19E-08
H1D		25		Diesel++	3.60E-08	12	4380	0.21	7.50E-09
H2P		100	Large liquid leak	Petrol	3.60E-08	19	6935	0.33	1.19E-08
H2D		100		Diesel	3.60E-08	12	4380	0.21	7.50E-09
H3P		N/A	Fireball	Petrol		19	6935	0.33	0.00E+00
H3D		N/A		Diesel		12	4380	0.21	0.00E+00
H4P		N/A	Rupture	Petrol	4.00E-08	19	6935	0.33	1.32E-08
H4D		N/A		Diesel	4.00E-08	12	4380	0.21	8.33E-09

Table 9.23 Chlorine Cylinder DG Ferry Pier Failure Frequencies for Year 2001

ID	Vehicle	Hole Size (mm)	Failure Description	Class Description	Likelihood per Cylinder	No. of Movements per month (2001)	No. of Movements per year (2001)	Estimated waiting period (yr)	Frequency per year
Cl1	Chlorine Cylinder	7.5	Medium Vapour Leak	Cl2	6.30E-06	2	24	0.001	7.19E-09
Cl2		7.5	Medium Liquid Leak	Cl2	5.70E-05	2	24	0.001	6.51E-08
Cl3		N/A	Rupture	Cl2	6.80E-06	2	24	0.001	7.76E-09

Table 9.24 Chlorine Cylinder DG Ferry Pier Failure Frequencies for Year 2012

ID	Vehicle	Hole Size (mm)	Failure Description	Class Description	Likelihood per Cylinder	No. of Movements per month (2012)	No. of Movements per year (2012)	Estimated waiting period (yr)	Frequency per year
Cl1	Chlorine Cylinder	7.5	Medium Vapour Leak	Cl2	6.30E-06	2	24	0.001	7.19E-09
Cl2		7.5	Medium Liquid Leak	Cl2	5.70E-05	2	24	0.001	6.51E-08
Cl3		N/A	Rupture	Cl2	6.80E-06	2	24	0.001	7.76E-09

9.5.4 *The Regulatory Situation*

Introduction

9.5.4.1 Risk assessment considers the level of societal and individual risk from a hazardous activity to members of the public against Government Risk Guidelines (RG). Hence determining the need to mitigate risks. The societal risk has been calculated for both existing and future population in the study area.

9.5.4.2 The risk criteria are defined in the EIA Ordinance.

The Hong Kong Risk Guidelines

9.5.4.3 The Government Risk Guidelines (RG) define acceptable risks as follows:

- *Individual Risk* (the risk to a single individual in a specific location): The maximum involuntary individual risk of death associated with accidents arising from a hazardous activity should not exceed 1 chance in 100,000 per year (10^{-5} / yr).
- *Societal Risk* (the risk to the population as a whole, independent of geographical location): The societal risk associated with a hazardous activity should comply with the FN diagram shown in **Drawing No. 22936/EN/037**. The figure is a graphical representation of the cumulative frequency, F, of a number, N, or more fatalities resulting from potential accidents at along a transport route plotted against N on a log-log scale. Three areas of risk are shown:
  - *Acceptable* where risks are so low that no action is necessary.
  - *ALARP (As Low As Reasonably Practical)* where the risks associated with the hazardous activity should be reduced to a level "as low as reasonably practical", under this principle the priority of measures is established on the basis of practicality and cost to implement versus risk reduction achieved.

  Risk mitigation measures may take the form of:
  - Radical measures (e.g. use of alternative materials and processes).
  - Alternative routes or site locations.
  - Engineered or procedural measures.
  - Development (i.e. population) controls in the vicinity of the hazardous activity.

9.5.4.4 The interpretation of ALARP has included consideration of both practicality and cost benefit. If a measure is practical and if the ratio of risk reduction which it achieves to cost incurred (or saved) falls below a limit of HK$480 million per life (for levels of risk more than an order of magnitude above the acceptable limit or resulting in over 1000 fatalities) and HK$24 million per life (for levels of risk near to the acceptable limit), then the measure should be applied. Otherwise it is not required to apply the measure.

9.5.5 *Consequence and Impact Analysis*

Consequence Modelling

9.5.5.1 The study carried out is based on previous transport QRA studies conducted by DNV. For this particular study, the consequences and risks of all release cases have been estimated with DNV's SAFETI Expert program. SAFETI Expert is considered to be a standard QRA software tool for use in Hong Kong. Its theory and application have not been discussed within this document.

Impact Modelling

9.5.5.2 Impact modelling in SAFETI involves a number of stages in which the impact in terms of the number of fatalities is calculated for each release scenario. The stages include:

- **Hazard analysis**: where the areas of impact from a particular hazardous outcome such as a fire or explosion are calculated.
- **Event tree analysis**: where the likelihood of each of the possible hazardous outcomes of a release scenario are calculated including an analysis of immediate and delayed ignition.
- **Impact Analysis**: where the hazard analysis and event tree analyses are combined with the potentially exposed population (as defined in the SAFETI population model) to calculate the number of fatalities per release scenario. To complete this calculation, probabilities of fatality to exposed individuals are defined in SAFETI for each hazard type for particular levels of exposure (i.e. heat radiation, explosion overpressure) for both indoor and outdoor populations.

9.5.5.3 The above approach to the impact analysis with in SAFETI results in a calculation of the number of fatalities per release scenario.

9.5.5.4 As the methodology is based on the *total potentially exposed population*, the population at each location within the SAFETI model has to be considered, with respect to the hazards to which the population may be exposed. This item is of particular importance in built-up areas such as Hong Kong, where high population densities may exist.

9.5.5.5 This point can be illustrated by the example of a continuous release, versus an instantaneous release as shown in **Drawing No. 22936/EN/363**.

9.5.5.6 With the continuous release resulting in a jet fire or flash fire, only people on the lower floor of a neighbouring high-rise building will be potentially effected. In comparison an instantaneous release, resulting in a fireball or large vapour cloud explosion would potentially impact on many levels of the neighbouring buildings. Therefore the following assumptions and modifications to the potentially exposed population as presented in **Table 9.8** have been applied.

- Flash fires and VCEs from late ignited instantaneous releases - SAFETI Expert predicts that the cloud depth tends to increase steadily after release. Based on the recent QRA (DNV, 1998), the cloud height to LFL for a 10 tonnes instantaneous rupture, is approximately 42m, which is equivalent to 14 floors. The horizontal depth into a building is limited to the first 10 meters for all 14 floors. Potentially exposed populations within a building have been calculated based on the density of people per square metre per building floor, for a 10-m deep area along the entire street front, times the estimated height of 14 floors.

- Fireballs (from immediately ignited instantaneous releases) and BLEVEs - these rise significantly while burning and are assumed to affect persons in the first 14 levels in a high rise building. This is conservative, as the likely overpressure associated with a BLEVE is low; windows have to break for a fireball to pose a significant indoor fatality risk. The same approach as described above has been applied.
- Jet fires, flash fires and VCEs from continuous releases - SAFETI predicts that the cloud depth will be only about 1m for smaller releases, rising to 10m for large releases. Thus it is appropriate to consider only the persons on the lowest 2 floors of each building to be exposed to the risk from these events. Potentially exposed populations within a building have been calculated based on the density of people per square metre per building floor, for a 10-m deep area along the entire street front, times the estimated height of 2 floors.
- For all continuous releases of chlorine the potentially exposed population has been estimated based on the entire building population up to the 15th floor.
- For instantaneous releases the impacted population has been limited to the ground floor as per previous analyses undertaken in Hong Kong. The impact from the rupture of chlorine cylinders on people located on elevated road ways is considered negligible as the road way is assumed to be located above the resulting chlorine vapour cloud.
- For releases (continuous and instantaneous) neighbouring low lying developments the entire building population is assumed to be exposed as there is considered to be minimal shielding effect from the dwelling at the street front to those behind.

9.5.5.7 In summary five (5) sets of population files have been applied in this study:

1. Continuous flammable releases.
2. Instantaneous releases –cold ruptures
3. Instantaneous releases –hot ruptures (BLEVE)
4. Continuous– toxic materials
5. Instantaneous releases – toxic materials

9.5.6 *Risk Assessment*

Introduction

9.5.6.1 The level of risk from relocating the Dangerous Goods ferry pier to the surrounding population has been assessed using SAFETI.

Transport Risk Results for the Existing DG Ferry Pier Location

<u>Individual Risk</u>

9.5.6.2 The Individual Risk (IR) contours for the existing DG ferry pier location is presented in **Drawing No. 22936/EN/393** in the form of location specific individual risk (LSIR). The inner risk contour is dominated by the instantaneous releases of LPG (cold and hot ruptures), whilst the outer contour is driven by toxic releases of Chlorine from the 50-kg cylinders. The individual risk levels are low with a maximum LSIR of less than 1 in a million per year (1×10^{-6}).

9.5.6.3 The individual risk results for each dangerous goods type are presented in **Drawing Nos. 22936/EN/394 to 396**.

Societal Risk Results

9.5.6.4 Societal risk results for the existing location of the DG Ferry Pier are presented in the form of Potential Loss of Life per year results and F-N Curves (see **Drawing Nos. 22936/EN/397 to 400**). The societal risk is dominated by the LPG risk with over 94-precent of the risk.

Table 9.25 Potential Loss of Life Results, Current Pier Location-2001 Trade

Dangerous Goods	Potential Loss of Life (per year)	Percentage Distribution of Total Risk
LPG	7.64×10^{-7}	94%
Chlorine Cylinders	4.68×10^{-8}	6%
Hydrocarbon	Neg.	-
Total Risk	8.11×10^{-7}	100%

Transport Risk Results for the Proposed DG Ferry Pier Location

Individual Risk Results

9.5.6.5 The Individual Risk (IR) contours for the transport risk at the relocated DG ferry pier are shown in **Drawing Nos. 22936/EN/401, 403, 405 and 407** and **Drawing Nos. 22936/EN/402, 404, 406 and 408** for the current trade and local development (2001) and for the future trade local area modelled as fully developed (2012) respectively.

9.5.6.6 For the current case (2001 – **Drawing No. 22936/EN/401**) the individual risk does not exceed 10^{-5} per year. From the centre of road the hazard distances to the 10^{-6}, 10^{-7} and the 10^{-8} per year are 60m, 75m and 85m respectively.

9.5.6.7 For the future (2012 – **Drawing No. 22936/EN/402**) case the 10^{-5} per year IR contour features along the whole transport route to the DG ferry pier. From the centre of road the hazard distances to the 10^{-6}, 10^{-7} and the 10^{-8} per year are 65m, 80m and 90m respectively.

9.5.6.8 The maximum level of individual risk in both the present and proposed cases is less than the "Acceptable Limit" of the HK Individual Risk Guideline (1×10^{-5} per year).

Societal Risk

F-N Curve

9.5.6.9 The FN curve for the relocated DG ferry pier is shown in **Drawing Nos. 22936/EN/409 to 412** for the years 2001 and 2012.

9.5.6.10 The combined results for the transport of LPG, Chlorine and hydrocarbons is presented in **Drawing No. 22936/EN/409**. Inspection of the individual F-N results for each of the products notes that the results are dominated by the transport of LPG in both the current and future case.

9.5.6.11 The FN curves for all materials and the combined trade lie in the acceptable region of the HKRG.

Potential Loss of Life (PLL)

9.5.6.12 The potential loss of life per year (PLL) results for the proposed DG Ferry Pier location are presented in **Table 9.26** for all dangerous goods.

9.5.6.13 The risk is dominated by LPG due to the dominance of the transport risks associated with LPG when compared to the chlorine and hydrocarbons.

9.5.6.14 Inspection of the results in **Table 9.25** and **Table 9.26** from the DG Ferry Pier at the existing DG Ferry Pier versus the proposed DG Ferry Pier (based on the year 2001 trade movements only) notes an increase in risk to people per year of around one order of magnitude. This is partly due to the longer route within the site boundary, but this increase is insignificant since levels of risk are acceptable.

Table 9.26 Potential Loss of Life Results – Proposed Pier Location

Dangerous Goods	Current Trade - 2001		Forecast Trade – 2012	
	Potential Loss of Life (per year)	Percentage Distribution of Total Risk	Potential Loss of Life (per year)	Percentage Distribution of Total Risk
LPG	7.15E-06	98%	7.71E-06	97%
Chlorine Cylinders	9.91E-08	2%	1.89E-07	3%
Hydrocarbons	6.37E-10	-	3.53E-09	-
Total	7.25E-06	100	7.90E-06	100

Risk Results for the Proposed Ferry Pier

9.5.6.15 The FN curve for the proposed DG Ferry Pier for the combined DG trade is in the acceptable region of the FN Curve. A comparison of the societal risk results for the existing DG Ferry Pier against the proposed DG Ferry Pier for the 2001 and the 2012 trade has been presented in **Drawing Nos. 22936/EN/413 to 416**. The results demonstrate the dominance of the LPG risks at the DG Ferry Pier ahead of the chlorine and Hydrocarbons trade.

9.5.6.16 The societal results for the combined trade shown in **Drawing No. 22936/EN/413** show the risk results for the proposed location to be higher than those for the existing DG Ferry Pier. However, this is not significant since the risk levels have been assessed to be below Acceptable Limit against the HK Risk Guidelines for all cases.

9.5.6.17 The proposed DG Ferry Pier, (2001 case and 2012 case) the maximum level of individual risk is less than the "Acceptable Limit of the HK Risk Guidelines for individual risk (1 x 10^{-5} per year).

Risk Mitigation and Cost Benefit

9.5.6.18 Since the societal risk for the proposed DG ferry pier lies in the acceptable region of the HK RG and the individual risk does not exceed the acceptable limit, no mitigation is necessary and the proposed relocation should be permitted to proceed.

9.5.7 *Conclusions and Recommendations*

9.5.7.1 The additional risk for the relocated DG ferry pier for LPG and hydrocarbons transport has been assessed using SAFETI Expert. Both individual and societal risks to residents, third party workers, road users and any other exposed people have been assessed for the present usage and location of the ferry pier (2001) and the proposed location and predicted usage for the year 2012.

9.5.7.2 The proposed location of the relocated DG ferry pier would be more than 100m from nearby high rise residential buildings. The route to the relocated DG ferry pier would follow the same road to the existing DG ferry pier and then an additional 0.7km on a new waterfront road through the Hoi Bun Road Extension, with limited population adjacent to this road. This route is consider optimal for the proposed location but has not been assessed in detail since it is beyond the scope of this study.

Individual Risk (IR)

9.5.7.3 For the current (2001) and future (2012)case, the maximum level of individual risk is less than the "Acceptable Limit of the HK Risk Guidelines for individual risk (1×10^{-5} per year).

9.5.7.4 The IR is less than 10^{-5} per year and so is considered acceptable.

F-N Results

9.5.7.5 The FN curves for all materials and the combined trade lie in the acceptable region of the HKRG. Therefore the societal risk is acceptable.

Potential Loss of Life

9.5.7.6 The PLL results show an increase from 8.1×10^{-7} for the existing location to 7.3×10^{-6} and 7.9×10^{-6} per year for the proposed location for the year 2001 and year 2012 cases respectively. Whilst this is roughly an order of magnitude increase in risk it is not significant since the level of societal risk is acceptable.

Risk Mitigation

9.5.7.7 Since the societal risk for the proposed DG ferry pier lies in the acceptable region of the HK RG and the individual risk does not exceed the acceptable limit, no mitigation is necessary and the proposed relocation should be permitted to proceed.

9.5.8 *References*

DNV, 1996. "*Quantitative Risk Assessment of the Transport of LPG in Hong Kong*" for EMSD.

DNV, 1997. "*Quantified Risk Assessment Report For The Risk Assessment Of The Transport Of Hydrocarbons In Hong Kong*" for EPD.

DNV, 2000. "*Quantitative Risk Assessment of Proposed LPG Filling Station at Kwun Tong*".

9.6 Chlorine Unloading Point

9.6.1 It was assumed that the chlorine unloading point will be permanently relocated outside SEKD as a consequence of the recommendations from previous SEKDFS EIA. Detailed information has been requested from Government Supplies Department (GSD). According to GSD, River Trade Terminal Co. Ltd. has planned to construct a commercial DG dock in its terminal in Tuen Mun. GSD is exploring the possibility of using the DG dock for loading and unloading of chlorine. According to the latest information from River Trade Terminal Co. Ltd., the proposed DG dock is expected to be available in the 2nd quarter of 2002.

9.6.2 Confirmation with GSD that permanent relocation of the chlorine loading / unloading point outside SEKD will be made prior to the population intake of SEKD, which is scheduled to be 2005. As such, risk associated with the co-existence of the interim chlorine unloading point and the SEKD population will no longer exist. On the other hand, if in any circumstances there is a need for co-existence of the chlorine dock and the future SEKD population, a detailed QRA would be required and the results are very likely to be unfavourable.