Appendix VII

Quantitative Risk Assessment

Prepared by

Ramboll Hong Kong Limited

S16 PLANNING APPLICATION OF PROPOSED COMPREHENSIVE DEVELOPMENT AT 8 LAM CHAK STREET, KOWLOON – N.K.I.L. 6215

QUANTITATIVE RISK ASSESSMENT

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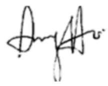
Signed	
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1.0 Introduction

1.1 Project Background

A site at 8 Lam Chak Street, Kowloon – N.K.I.L. 6215 is proposed for redevelopment as comprehensive use involving 2 residential towers on a podium of commercial use (hereafter referred as the "Proposed Development"). The Site covers an area of about 6,541m^2, which is currently zoned as "Commercial". The location of the Site is shown in **Figure 1**.

The Site falls within 150m of a dedicated Liquefied Petroleum Gas (LPG) Filling Station (hereafter referred as the "the Station") at Cheung Yip Street, Kowloon Bay, which is classified as Notifiable Gas Installations (NGIs) under the Gas Safety Ordinance (Cap. 51). A Quantitative Risk Assessment (QRA) is hence prepared to address the potential risk impact posed by the Station on the population in the vicinity including the future population brought by the Proposed Development.

1.2 Scope of Work

The objective of this study is to re-assess the potential risks to the public in the vicinity of the Station in year 2033, with operation of the Proposed Development.

The scope of the study is limited by the following criteria:

1. The risks associated with the transport of LPG by road tankers have been restricted to the consideration of their final approach to the LPG storage installation within the Station;

2. The risk assessment has been limited to those events which have the potential for off-site fatalities.

1.3 Hong Kong Planning Standards and Guidelines (HKPSG)

1.3.1 Special Requirement Relevant to LPG Filling Stations

LPG filling station is classified as NGIs under the Gas Safety Ordinance Cap. 51. A QRA is required to ascertain that the off-site risk levels posed by the LPG filling station is acceptable in accordance with the HKRG outlined in the HKPSG [1]. As general rule, the following separation distance of the LPG filling facilities from different land uses should apply:

- High-rise residential / education / hospital: 55m
- Commercial / recreational / industrial: 15m
- Low density residential / incidental dwelling: 15m

1.3.2 Hong Kong Risk Guidelines (HKRG)

Chapter 12.4 of the HKPSG [1] stipulates the risk guidelines to determine the acceptability of Potentially Hazardous Installation (PHI) in terms of individual and societal risks. These risk guidelines are also adopted to ascertain whether the risk levels posed by the Notifiable Gas Installations (NGIs) are acceptable.

The individual and societal risk criteria for the risk assessment are described below:

i. Individual Risk (IR): a measure of the frequency at which an individual at a specified distance from the hazardous installations is expected to sustain a specified level of harm from the realization of hazardous incident(s). The maximum level of off-site individual risk causing fatality of a person located 24 hours a day outside the facility of concern should not exceed 1×10^{-5} / year, i.e. 1 in 100,000 per year.

ii. Societal Risk: a measure of the relationship between the frequency of an incident and the number of fatalities that will result. It is typically expressed graphically by an F-N curve showing the cumulative frequency (F) of incidents causing N or more fatalities. The societal risk criteria are presented graphically as in **Figure 2**. There are three regions as described below:

   - **Acceptable** where the risk is so low that no action is necessary;
   - **Unacceptable** where the risk is so high that they should be reduced regardless of the cost or else the hazardous activity should not be proceeded; and
   - **ALARP** where the risk associated with the hazardous activities should be reduced to a level of "As Low As Reasonably Practicable", in which the mitigation measures should be prioritised on the basis of practicality and implementation cost versus the risk reduction achieved.

1.4 Methodology

1.4.1 Overall QRA Approach

The methodology of this study follows the QRA Methodology for LPG Installations in Hong Kong [2] and previous QRA studies of hazardous installations with LPG facilities [3][4][5].

1.4.2 Case to be Considered

The Proposed Development is anticipated to commence operation in year 2033. This study will consider the following scenarios to demonstrate the increase in the risk levels of the Station due to the operation of the Proposed Development. The cases to be considered include:

- ***Case 1 – Base Case in Year 2033***: evaluating the risk level in year 2033 without redevelopment of the Proposed Development (i.e. as existing commercial building);
- ***Case 2 – Operation Case in Year 2033***: evaluating the risk level in year 2033 with the redevelopment of the Proposed Development.

2.0 Hazardous Storage and Operation

2.1 LPG Filling Station (the Station)

The Station is located at junction of Cheung Yip Street and Hoi Bun Road in Kowloon Bay, as indicated in **Figure 1**. It is adjacent to an industrial building in the east, that is 15m away from the LPG facilities separated by the convenient store in the Station.

The operational data of the Station was collected through a site survey dated on 16 July 2025. For information that is not able to be obtained through visual inspection, such as quantity and volume of underground vessel, assumptions are made based on the best available information and from similar studies.

The collected information and assumptions of the Station are summarised in **Table 1**.

Table 1 Summary of the LPG Installation and Operation Information

Item	Data Collected / Assumptions
LPG vessel	2 × 14 tonnes vessels (1); Under normal operation, the LPG vessel is assumed to be filled approximately to 85% of its maximum capacity, which is equivalent to 11.9 tonnes of LPG per vessel.
LPG dispensers	5 LPG dispensers with 10 nozzles
LPG tanker	9 tonnes (1)
LPG road tanker delivery	6 tankers per day(2). About 2,190 road tankers deliveries per year, both day time and night time delivery
LPG unloading time	90 minutes
Vehicles refuelling	Assume 839,500 LPG vehicles per year (2)

Note:

(1) Reference to NAH EIA[4]
(2) Advised by EMSD.

The design of Station shall comply with the requirements of EMSD. Safety design features and fire service systems shall be provided to prevent LPG release and protect against fire. The storage vessels are assumed covered with corrosion protecting coating, stress relieved and 100% radiographed.

3.0 Project Information and Assumption

3.1 The Proposed Development

The Application Site is located at 8 Lam Chak Street, Kowloon, which is approximately 15m from the LPG installations in the LPG filling station on Cheung Yip Street, as indicated in **Figure 1**. The site area is approximate 6,541m^2 and is currently zoned as "Commercial" (C(2)) under the approved Kai Tak Outline Zoning Plan (OZP) No. S/K22/8. The existing site consists of a commercial building, namely Harbourside HQ, which comprises of a 2-storey carpark in the northern portion and a 30-storeys commercial building in the southern portion.

The Application Site is proposed to be redeveloped as comprehensive residential development. The preliminary design of the Proposed Development comprises of 2 residential towers on top of a podium with retail facilities and club house, providing a total of 1,140 (±5%) flats for approximately 2,850 (±5%) residents (conservatively taken as 3,000 residents in this study). The Proposed Development is anticipated to be completed for population in-take in year 2033.

The proposed high rise residential towers will be separated at least 49m from the LPG facilities in the Station in the north. The layout plan of the Proposed Development is given in **Annex A**.

3.2 Study Area

A study area of 200 m radius from the Station is adopted in the study, which is consistent with approved QRA study of similar LPG filling station [5], as shown in **Figure 1**.

3.3 Population

The population considered includes surrounding population lies within the 200m study area. Staff operating the Station or drivers of vehicles using the Station are regarded to be voluntary takers of risk and are not considered in this study.

3.3.1 Population in the Vicinity

Population information was collected from desktop research and site survey. Planned developments in the vicinity of the Station were identified. The Planning Department was consulted and advices were received in Jan-2026. Details refer correspondence with the Planning Department in **Annex F**.

The study area mainly comprises industrial and commercial buildings, planned residential development and also the New Acute Hospital which will be completed in 2026 tentatively.

Future population within the study area is estimated based on:

- Average residential household size of 2.5 in Kwun Tong Central District Council Constituency Area as per 2021 Population Census [6]; and
- Conservative assumption of worker density of 25m^2/worker for business use, 25m^2/worker for industrial use and 700m^2/worker for warehouse.

The population groups considered within the study area are illustrated in **Figure 3**. The population data are summarised in **Table 3**.

3.3.2 Transient Population

Transient population includes traffic population as well as pedestrians along the road sections within the study area. Traffic population can be calculated using the equation below:

$$\text{Traffic Population (ppl)} = \frac{\frac{\text{No. of ppl}}{\text{vehicle}} \times \frac{\text{No. of vehicle}}{\text{hr}}}{\text{Traffic Speed } ({}^{\text{km}}/_{\text{hr}})} \times \text{Road Section Length (km)}$$

The transient population adopted for this study is summarised in **Table 3** with the detailed calculations provided in **Annex B**.

3.3.3 Temporal Change in Population

To reflect the temporal changes in population within a week, the corresponding population proportion of the time periods are assumed based on observation from site survey and with reference to the approved Environmental Impact Assessment (EIA) reports [3][7].

Day time is defined as 07:00 to 19:00 and night time from 19:00 to 07:00 next day. The temporal changes of different population category are provided in **Table 2**.

Table 2 Temporal Change of Population within A Week

Category	Population Variation in Time Period			
	Weekday Day (WDD)	Weekday Night (WDN)	Weekend Day (WED)	Weekend Night (WEN)
Car Park (1)	100%	10%	100%	10%
Club House (1)	50%	20%	100%	20%
Commercial (2)	100%	10%	40%	5%
Community (1)	100%	5%	100%	5%
Fire Station (1)	100%	100%	100%	100%
Hospital (3)	100%	80%	85%	80%
Hotel (3)	30%	90%	65%	90%
Industrial (2)	100%	10%	40%	5%
Residential (2)	25%	100%	70%	100%
Retail (3)	50%	25%	100%	25%
Road (4)	100%	63%	100%	63%
Warehouse (1)	100%	0%	50%	0%

Note:

(1) Conservative assumption based on survey and judgement.
(2) Reference to HATS Stage 2A EIA [7]
(3) Reference to South Island Line EIA [3]
*(4) Estimated from Annual Traffic Census 2024. Refer **Annex B**.*

3.3.4 Indoor and Outdoor Ratio

Building structures can offer some protection from fires for the occupants inside. An indoor ratio of 95% is applied to the population in residential development, industrial buildings and commercial buildings while the remaining 5% of population is assumed to be outdoor, accounting for outdoor activities and walking pathways.

Patients and employee in hospital are mostly indoor, an outdoor ratio of 3% is conservatively assumed to account for population in potential landscape area and rehabilitation gardens.

Passengers in vehicles are considered as 100% outdoors population although vehicles may provide certain protection.

Table 3 Population Data Within Study Area

ID	Population Name	Population Category	Population in 2033		Indoor Ratio	Base Level (mPD)	Building Height (mPD)	Remarks
			Base Case	Operation Case				
01	Kai Tai Fire Station	Fire Station	50	50	80%	4.4	36.7	Conservative assumption.
02	New Acute Hospital (Acute Block)	Hospital	11843	11843	97%	4.7	132.8	Reference to NAH Rooftop Helipad EIA (EIA-266/2020).
03	Planned Residential Development	Residential	4820	4820	95%	4.4	115.0	1928 flats as per Planning Application No. A/K22/43. Assume average household size of 2.5.
04	Planned Residential Development	Residential	3625	3625	95%	4.3	100.0	1450 flats as per Planning Application No. A/K22/31-2. Assume Domestic Household Size of 2.5.
05	Kerry DG Warehouse	Warehouse	30	30	90%	3.1	20.4	GFA of 16,910m^2. Estimated by worker density of 700m^2/worker for warehouse.
06a	Pacific Trade Centre (G/F – 3/F)	Industrial	184	184	95%	4.2	17.8	15-storey industrial buildings with site area of 5,343m^2. Assume usable floor area as 80% of total floor area. Assume 60% of area as warehouse use and 40% of area as industrial use as observed in site survey. Estimated by worker density of 25m^2/worker for industrial and 700m^2/worker for warehouse.
06b	Pacific Trade Centre (5/F – 17/F)	Industrial	506	506	95%	17.8	51.1	
07a	The Quayside (Upper)	Commercial	2370	2370	95%	16.0	76.3	Total office area of 74,000m^2 as advised by the Planning Department. Assume usable floor area as 80% of total floor area and worker density of 25m^2/worker for business.
07b	The Quayside (Lower)	Retail	300	300	95%	4.3	16.0	Conservative assumption from site survey.
08a	WSD Kowloon East Regional Building (Lower)	Car Park	20	20	90%	4.6	49.9	10-storey building comprises office area and a 7-storey car park, occupying a site area of 2,834m^2. Assume usable floor area as

ID	Population Name	Population Category	Population in 2033		Indoor Ratio	Base Level (mPD)	Building Height (mPD)	Remarks
			Base Case	Operation Case				
08b	WSD Kowloon East Regional Building (Upper)	Commercial	340	340	95%	49.9	58.9	80% of total floor area and worker density of 25m²/worker for business. Conservatively assume 20 people in car park.
09	Planned Commercial Development (Office)	Commercial	4180	4180	95%	30.0	135.0	Reference to MPC Paper No. 10/21, total office area of 130,510m². Assume usable floor area as 80% of total floor area and worker density of 25 m²/worker for business.
10	Planned Commercial Development (Retail)	Retail	1800	1800	95%	5.4	25.0	Conservative assumption based on the proportion of site area to that of Site ID07b.
11	Planned Commercial Development (Hotel)	Hotel	800	800	95%	96.0	120.0	Conservative assumption of 400 rooms and 2 guests per room, with reference to the Dorsett Kai Tak Hotel in nearby area with similar floor area.
12a	Planned Commercial Development (Office)	Commercial	4620	4620	95%	35.0	115.0	Reference to MPC Paper No. 10/21, total office area of 144,470 m². Assume usable floor area as 80% of total floor area and worker density of 25 m²/worker for business.
12b	Planned Commercial Development (Retail)	Retail	1500	1500	95%	5.0	35.0	Conservative assumption based on the proportion of site area to that of Site ID07b.
13	Capital Building	Commercial	1460	1460	95%	4.3	120.2	Total floor area of 45,768m² as per Planning Application No. A/K13/308. Assume usable floor area as 80% of total floor area and worker density of 25m²/worker for business.
14a	Harbourside (Lower)	Car Park	20	-	90%	4.3	22.3	Conservative assumption from site survey.
14b	Harbourside (Upper)	Commercial	2020	-	95%	22.3	136.5	GFA of approx. 678,990 ft². Assume usable floor area as 80% of total floor area and worker density of 25m²/worker for business.

ID	Population Name	Population Category	Population in 2033		Indoor Ratio	Base Level (mPD)	Building Height (mPD)	Remarks
			Base Case	Operation Case				
PD	Proposed Development:							Project information
	▪ Residential	Residential	-	3000	95%	23.0	136.5	
	▪ Clubhouse	Club House	-	63	95%	14.5	19.35	
	▪ Retail and Food & Beverage	Retail	-	150	95%	4.5	14.5	
	▪ G/IC	Community	-	16	95%	4.5	14.5	
RD01	Chueng Yip Street	Road	39	39	0%	3.9	-	Refer to **Annex B**
RD02	Lam Chak Street	Road	11	11	0%	4.1	-	Refer to **Annex B**
RD03	Kai Hing Road	Road	22	22	0%	4.3	-	Refer to **Annex B**
RD04	Hoi Bun Road	Road	38	38	0%	4.0	-	Refer to **Annex B**
RD05	Wai Yip Street	Road	45	45	0%	4.2	-	Refer to **Annex B**
RD06	Kwun Tong Bypass	Road	90	90	0%	14.0	-	Refer to **Annex B**
RD07	Kai Fuk Road Flyover	Road	41	41	0%	12.0	-	Refer to **Annex B**

3.4 Source of Ignition

Flammable gas cloud from an accidental release can be ignited and led to fire or explosion if there are ignition sources present in the close proximity or along the dispersion path of the cloud. If the gas cloud is diluted outside the flammable concentration range (i.e. below Lower Flammable Limit), or in the absent of ignition sources, no fire hazards will be expected. The energy level, timing, location and ignition effectiveness of ignition sources in the vicinity of the hazardous installations affect the extent of gas cloud dispersion and its potential impacts.

Two types of ignition sources are defined in the model, including:

- *Population source*: accounting for human activities such as smoking, cooking, and using electrical appliances and are assigned implicitly to all population group by SAFETI.

- *Line source – transportation route segments:* account for the moving vehicles on roads. The ignition probabilities are calculated from the traffic density, average vehicle speed, vehicle ignition efficiency and total length of the roads. Vehicle ignition efficiency is taken as 0.4 per 60 seconds [8]. Traffic flow and average vehicle speed are included in **Annex B**.

3.5 Meteorological Information

Meteorological conditions affect the consequences of gas release, in particular wind direction, speed and stability which influences the direction and degree of turbulence of gas dispersion. Meteorological data from Kai Tak Weather Station (Year 2024) was collected from the Hong Kong Observatory and adopted in the consequence model to determine the various gas dispersion, fire and explosion effects. The data are rationalised into a set of weather classes in accordance with TNO Purple Book [8]. The meteorological data can be expressed in combination of wind speed and Pasquill stability classes. Pasquill classes (A to F) represent the atmospheric turbulence with class A being the most turbulent class while class F being the least turbulent class.

The six most dominant sets of wind speed-stability class combination for both day-time and night-time are listed in **Table 4** and **Table 5** below respectively. The average ambient temperature adopted in the analysis is 23.5°C and relative humidity is 80%.

Table 4 Day Time Wind Direction Frequency of Kai Tak Weather Station

Direction	Weather Class						Total
	3.5B	2.0D	4.0D	7.5D	3.0E	2.0F	
0 – 30	1.49	0.33	0.44	0.00	0.09	0.51	2.87
30 – 60	1.78	0.42	0.75	0.00	0.63	0.42	3.99
60 – 90	1.92	0.33	0.61	0.00	0.54	0.58	3.97
90 – 120	3.90	0.19	1.14	0.42	0.28	0.33	6.26
120 – 150	13.81	0.72	7.66	0.68	1.45	0.58	24.90

Direction	Weather Class						Total
	3.5B	2.0D	4.0D	7.5D	3.0E	2.0F	
150 – 180	16.54	2.17	3.36	0.12	1.14	2.06	25.39
180 – 210	2.45	0.63	0.09	0.00	0.19	0.70	4.06
210 – 240	2.03	0.54	0.07	0.00	0.16	0.28	3.08
240 – 270	5.40	0.79	0.54	0.00	0.23	0.58	7.54
270 – 300	4.39	0.68	0.77	0.02	0.28	0.68	6.82
300 – 330	2.34	0.63	0.56	0.00	0.49	0.79	4.81
330 – 360	3.39	0.28	1.45	0.14	0.56	0.47	6.28
All	59.43	7.71	17.45	1.38	6.05	7.99	100.00

Table 5 Night Time Wind Direction Frequency of Kai Tak Weather Station

Direction	Weather Class						Total
	3.5B	2.0D	4.0D	7.5D	3.0E	2.0F	
0 – 30	0.00	0.05	0.95	0.00	0.71	2.71	4.42
30 – 60	0.00	0.12	0.62	0.00	2.05	2.85	5.64
60 – 90	0.00	0.07	0.36	0.00	1.31	1.71	3.45
90 – 120	0.00	0.05	2.59	0.50	1.36	1.40	5.90
120 – 150	0.00	0.12	13.70	1.05	8.92	4.80	28.59
150 – 180	0.00	0.38	3.31	0.00	6.28	11.61	21.57
180 – 210	0.00	0.12	0.05	0.00	0.45	4.38	4.99
210 – 240	0.00	0.02	0.14	0.00	0.43	2.57	3.16
240 – 270	0.00	0.05	0.21	0.00	0.69	2.57	3.52
270 – 300	0.00	0.00	0.76	0.12	1.33	3.59	5.80
300 – 330	0.00	0.14	1.36	0.02	1.38	3.54	6.44
330 – 360	0.00	0.02	2.26	0.02	1.76	2.45	6.52
All	0.00	1.14	26.30	1.71	26.66	44.19	100.00

4.0 Hazard Identification

4.1 Properties of LPG

LPG supplied in Hong Kong is a pressurised mixture of propane and butane (3:7 in mole ratio). Upon release to the ambient environment, it vaporises and mixes with air, forming a dense flammable gas cloud which tends to flow and disperse closed to the ground. The gas cloud may extend over a long distance until it becomes too diluted or encounters ignition sources.

4.2 Event Leading to an Accidental LPG Release

The main hazard associated with the LPG facilities is an accidental uncontrolled release of LPG resulting in a fire or explosion upon ignition. The initial events leading to an LPG release could be one of the following:

- Spontaneous failure of pressurised LPG equipment due to material / design / construction defect, fatigue, corrosion, erosion, etc;
- Loading operation failure, i.e. an LPG release occurs as a direct result of the road tanker unloading operation or vehicle refuelling operation; and
- External events.

4.2.1 LPG Storage vessel failure

Failure of the storage vessel includes cold catastrophic failure and partial failure (25 mm hole), which may be resulted from:

- Spontaneous failure;
- Loading failure due to overfilling / over-pressurisation of storage vessel; and
- External events, such as earthquake.

Considering the content in vessel varies in time due to consumption and refilling, the vessel is assumed nominally at full load inventory (i.e. 85% of maximum capacity) for 20% of the time and at low inventory level with 60% of maximum capacity for the rest of the time. In case of failure of storage vessel due to overfilling, the release inventory is assumed to be 100% of maximum capacity.

4.2.2 LPG Road tanker failure

Failure of the road tanker includes cold catastrophic failure and partial failure (25 mm hole), which may be resulted from:

- Spontaneous failure; and
- Accidents during unloading caused by collision by another vehicle in the station.

Similar to the case of storage vessel that the content of a LPG road tanker varies with time, road tanker is modelled to have full inventory for 20% of the time and 50% of maximum capacity for 80% of time.

4.2.3 Pipework failure

LPG pipework failure in the Station includes guillotine failure and partial failure (hole size of 10% of diameter) of the follows:

- Liquid inlet pipework for LPG unloading to the LPG storage vessel;
- Liquid supply lines from LPG storage vessel to dispensers; and
- Vapour return lines from the dispensers to the storage vessel.

In light of that most of the LPG pipework runs underground, the major cause of pipework failure is spontaneous failure. As part of the liquid inlet pipework for LPG unloading to the LPG storage vessel is aboveground at road tanker unloading bay, such pipework may be subjected to failure due to impact of the LPG road tanker.

According to consequence modelling, LPG vapour release from the rupture of underground vapour return line can only impact 1 metre maximum from the point of release. This does not impose risk to the off-site population and thus failure of vapour return line is not further considered in the study.

4.2.4 Dispenser failure

Failure of the dispenser may be caused by spontaneous failure and vehicle impact to dispenser. This will result in a liquid leak from a nominal 20 mm hole, equivalent to the diameter of the dispenser pipework. The rate of release will however be limited by the discharge rate of submersible pump.

4.2.5 Flexible hose failure

An accidental release from the flexible hose may be caused by:

- Spontaneous failure; and
- Loading failures, including:
- Hose misconnection error – an error where the driver / operator fails to properly connect the loading hose and the hose comes adrift during unloading;
- Hose disconnection error – an error where the driver / operator inadvertently disconnects the hose while the valve is still open or has failed open;
- Road tanker / vehicle drive-away error, an error where the driver inadvertently drives the tanker away during unloading / refuelling; and
- Impact to the refuelling vehicle by another vehicle in the station, which causes movement of the refuelling vehicle leading hose disconnection and hose damage.

4.2.6 Submersible pump failure

Leak from the submersible pump itself will result in a release of LPG back to the storage vessel and therefore no hazard is expected. A release is only possible from the flange associated with the fitting of the pump on the top of the storage vessel. This may result in a liquid leak from a 25 mm hole, equivalent to the space between 2 bolt holes on a flanged joint.

4.2.7 LPG vehicle (taxi, minibus) failure

Failure of the LPG vehicle (taxi, minibus) may result from:

- Spontaneous failure; and
- Accidents during refuelling caused by collision by another vehicle in the station.

The small inventory in LPG vehicle only sustains a short duration of the LPG release, resulting in insignificant impacts compared with releases from the pipework / hose connected to the LPG storage vessel / road tankers. Based on consequence modelling, the rupture of minibus LPG tank could affect 23 metres maximum. With the radiation wall installed in the Station, the hazards from LPG vehicle are unlikely to reach off-site population. The risk of LPG vehicle failure is considered negligible and is not further assessed in this study.

4.2.8 External events

An LPG release may occur due to external events and the consequence could be catastrophic failure or leak. The related external events are listed as follows:

- Earthquake;
- Aircraft crash;
- Helicopter crash;
- Car crash;
- Landslide;
- Subsidence;
- Severe environmental events;
- Dropped object; and
- External fire.

4.2.9 Safety Provisions

Various safety provisions are installed in the Station upon the requirements of the Gas Authorities of EMSD, the Code of Practice of Hong Kong LPG Industry, and operator's company guideline. These safety provisions act in different combinations to prevent or mitigate the hazards due to an accidental LPG release.

4.2.10 Isolation System

The following safety provisions are provided on LPG road tanker and in the Station to prevent uncontrolled release of LPG:

- **Non-return valve** installed on the LPG inlet pipework prevents back flow from the LPG storage vessel;
- **Excess flow valves** installed at the tanker, storage vessel and the dispenser stop the liquid flow when a large release occurs (e.g. guillotine failure of the pipe / hose);
- **Breakaway coupling** prevents LPG spillage due to road tanker/vehicle drive-away while the hose is still connected during unloading / refuelling;
- **Double-check filler valve** installed at the LPG filling point prevents the release from the storage vessel. The design of the valve is essentially two non-return valves in series;
- **Pressure relief valve** installed on the LPG road tanker and LPG storage vessel protects against excessive pressure build-up due to overfilling or over-heating by fire;
- **Manual isolation valves** are installed on the LPG road tanker, storage vessel, dispensers and pipework for the operators / drivers to isolate the LPG installations in case of failure or for maintenance operation; and
- **Emergency shutdown (ESD) system** on the LPG storage vessel and LPG road tanker isolates the vessel / tanker and stops unloading operation or LPG supply to dispensers when activated.

4.2.11 Firefighting / Fire Protection

The follow detection and firefighting systems are implemented on LPG road tanker and in the station to mitigate the hazards of accidental LPG release:

- **Leak detection system with alarm** is installed near the LPG filling point, LPG storage vessel, LPG dispensers and the office. Alarm will be raised upon detection of a flammable vapour cloud;
- **Chartek coating** on the LPG road tanker gives a protection and prevents formation of hot spots for at least 30 minutes in case of jet fire impingement [2]
- **Fire service protection system** includes fire extinguishers, sand buckets and fire hydrant provided for general firefighting uses and also a water spray system which is automatically activated by leak alarm detection system as well as the manual push handle. Fire brigade will be available within a few minutes upon an emergency call in case of fire.

4.3 Escalation

Escalation refers to knock-on effect from a fire event. Hazard in the Station that can lead escalation include jet fire impinging on the road tanker.

When jet fire impinges on the LPG road tanker over a period of time, it may cause the formation of hot spots on the LPG road tanker wall and subsequent structural failure leading to fire escalation to a Boiling Liquid Expanding Vapor Explosion (BLEVE) event. Road tanker BLEVE due to jet fire impingement is considered credible when:

- LPG release is failed to be isolated;
- Jet fire impinges in the direction of LPG road tanker; and
- Fire-fighting system are ineffective.

4.4 Outcome of an Accident LPG Release

The following outcomes could result from an accidental LPG release:

- Jet fire;
- Flash fire;
- Vapour cloud explosion (VCE);
- Fireball; and
- BLEVE.

The LPG storage vessel in the Station is buried underground in a concrete compartment filled with washed sand. Fireball is considered unlikely for the underground LPG storage vessel.

If there is no ignition source in the LPG vapour cloud or along the migration path of the cloud with the wind, the LPG vapour cloud will dissipate and cause no hazardous impact.

4.5 LPG Release Scenarios Considered

Representative LPG accidental release scenarios considered in this study are summarised in **Table 6**.

Table 6 Representative LPG accidental release scenarios considered

Equipment	Failure type	Release type	Potential hazardous outcomes
LPG storage vessel	Catastrophic failure Partial failure	Instantaneous Continuous	Flash fire, VCE Jet fire, flash fire, VCE
LPG road tanker	Catastrophic failure Partial failure	Instantaneous Continuous	Fireball, flash fire, VCE Flash fire, VCE, jet fire
Aboveground liquid inlet pipework	Catastrophic failure Leak	Continuous Continuous	Jet fire, flash fire, VCE, BLEVE Jet fire, flash fire
Underground liquid supply line to dispenser	Catastrophic failure Leak	Continuous Continuous	Jet fire, flash fire, VCE Jet fire, flash fire

Equipment	Failure type	Release type	Potential hazardous outcomes
Dispenser	Guillotine failure	Continuous	Jet fire, flash fire, BLEVE
Flexible hose to LPG vessel	Catastrophic failure Leak	Continuous Continuous	Jet fire, flash fire, VCE, BLEVE Jet fire, flash fire
Flexible hose to LPG Vehicle	Guillotine failure	Continuous	Jet fire, flash fire, BLEVE
Submersible Pump Flange	Leak	Continuous	Jet fire, flash fire, VCE

5.0 Frequency Assessment

A frequency assessment involves analysis of likelihood of LPG containment failure leading to an accidental LPG release and subsequent outcome probabilities. The initiating failure probabilities are estimated from the historical accident statistics, published failure data report, industrial testing results and expert judgment. Base failure frequencies of LPG facilities (vessels, pipework, etc.) are derived from the initiating failure events by applying failure analysis techniques such as fault tree analysis. Occurrences of subsequent hazardous outcomes in an accident are estimated by event tree analysis, taking into account severity of the release event and surrounding environment. Frequency assessment in this study takes into account of previous risk assessment studies [3][4][5][7].

5.1 Spontaneous Failure

5.1.1 LPG storage vessel failure

Storage vessel failure refers to cold catastrophic failure leading to instantaneous release of the whole inventory or cold partial failure causing a continuous leakage. Failure rates of 1.8×10^{-7} per vessel year and 5.0×10^{-6} per vessel year [2] are adopted for cold catastrophic and partial failures, respectively. The vessel is assumed to be stress-relieved and 100% radiograph tested.

5.1.2 LPG road tanker failure

LPG road tanker can be regarded as a mobile LPG storage vessel. The cold spontaneous failure rate for LPG road tankers could be higher than for a fixed storage vessel. This is because of stresses experienced by the road tanker due to vibration during transportation, and cyclic loading associated with filling/unloading of the road tanker. The catastrophic and partial failure probabilities of an LPG road tanker are taken as 2.0×10^{-6} and 5.0×10^{-6} per year [2], respectively.

5.1.3 Pipework failure

Failure of LPG pipework can be guillotine failure (full bore rupture) and partial failure (leak from pipe cracks). The generic guillotine failure rate of LPG pipework is taken as 1.0×10^{-6} per meter per year [2]. The rate of partial failure (equivalent to 10% pipe diameter) is taken as 2.7 times of the guillotine failure rate [8], i.e. 2.7×10^{-6} per meter per year. The failure of pipework may result in uncontrolled continuous release of LPG, if and only if, isolation fails, i.e. simultaneous failure of safety equipment (non-return valve, excess flow valve and ESD valve) and manual shut-off valves.

5.1.4 Dispenser failure

LPG from the storage vessel is pumped to the dispenser for vehicle refuelling. Typical dispenser is a metering device consisting a hose with self-sealing connector, 4 ball valves (with 2 flanges for each valve) and a certain length of rigid pipework.

As the LPG dispenser in the Station has 2 nozzles instead, it is assumed to have an additional metering device and 2 ball valves for the connection of additional nozzle. Failure of the dispenser is estimated to be 1.2×10^{-4} per year by 'Parts Count' method as illustrated in **Table 7**. The pipework in the dispenser is assumed to have a diameter of 20 mm. Only significant leak is considered in the assessment.

Table 7 Determination of Dispenser Failure Frequency

Item	Quantity, no. or m	Base failure rate, per year or per m.year	Fraction of significant leak (>0.2 D)	Failure rate, per year
Pipe (1)	2m	2.5×10^{-5}	15%	7.5×10^{-6}
Ball valve (2)	6 no.	8.8×10^{-5}	6%	3.2×10^{-5}
Flange (1)	16 no.	5.0×10^{-6}	100%	8.0×10^{-5}
Total				1.2×10^{-4}

Note：

(1) Reference to HSE onshore [9]
(2) Reference to Lees [10] and E&P forum [11]

5.1.5 Flexible hose failure

Cold spontaneous failure of flexible hose may occur during the road tanker unloading or vehicle refuelling operations. Likelihood of a guillotine failure is taken as 9.0×10^{-8} per hour [2]. With average times of 2 hours for road tanker unloading operation and 5 minutes for LPG vehicle refuelling operation, the guillotine failure rates of the flexible hose are estimated as 1.8×10^{-7} per road tanker unloading operation and 7.5×10^{-9} per vehicle refuelling operation.

Similar to pipework failure, the frequency of partial failure of flexible hose is assumed to be 2.7 times the guillotine failure rate.

5.1.6 Release from Submersible Pump Flange

The submersible pump flange may leak due to fitting arrangement. Failure frequency of 5.0×10^{-6} per year is applied to the study [9].

5.2 Loading Operation Failure

5.2.1 Hose misconnection error

A misconnection error may occur if the hose is improperly connected to the filling point, including failure to open manual isolation valve. A failure rate of 3×10^{-5} per operation [2] is adopted. It is assumed that such error results in hose coming completely apart, leading to a full-bore release. Small leaks will be rectified instantaneously by the tanker driver or his assistant.

5.2.2 Hose disconnection error (during tanker unloading)

Hose disconnection error refers to inadvertently disconnecting the filling hose during the unloading operation, which requires a complete disregard of normal operating procedures, as well as the failure to re-tightening the coupling immediately upon loosening it. A gross human error of 2×10^{-6} per operation [2] is adopted in the analysis.

5.2.3 Road tanker drive-away error

A drive-away error may occur due to repositioning of the truck during delivery or inadvertent drive-away before completion of replenishment. The outcome of this failure matches those of hose misconnection, i.e. full-bore release. Repositioning during delivery is deemed remote because there is a dedicated unloading bay in the LPG Filling Station. The driver and his assistant are responsible for monitoring the unloading process during replenishment. Thus, the probability of drive-away error before operation completion is deemed very low and a failure rate of 4×10^{-6} per operation [2] is adopted.

5.2.4 Road tanker impact onto LPG facilities

The road tanker may strike the LPG installation during manoeuvring, causing damage to the LPG installation or the road tanker. A likelihood of 1.5×10^{-4} per operation [2] is adopted for this human error. In view of the slow speed of road tanker during manoeuvring to its unloading bay and the side and rear end protection of LPG road tanker, a release from the road tanker due to slight impact is considered remote.

The probability of damaging the filling pipework is considered very low as it is protected by a steel framework to minimize the chance and energy of direct tanker impact on the pipework. A release from the damaged pipework may ensue only if the driver neglects his duty to check the pipework integrity and possible leakage before unloading starts.

5.2.5 Road tanker collision during unloading

The LPG road tanker is parked in a designated unloading bay of the LPG Filling Station. Warning traffic cones should be placed around the LPG road tanker, forming an area with limited access during unloading operation. The collision by other vehicles to an unloading road tanker is considered very unlikely. Nevertheless, a frequency of 1.0×10^{-8} per operation is adopted [2].

5.2.6 Damage due to tanker / vehicle impact

Road traffic accident statistics (**Table 8**) from the Transport Department [12] reported 12% (take 20% in the after-mentioned calculation) was serious collision and 1% was fatal collision. Most of the road accidents are related to speeding, crossing the road, drunk / drug driving, poor road surface conditions, bad weather, etc.

Compared with normal road accidents, inadvertent impact by tanker / vehicle to the LPG facilities is deemed to be a low speed / momentum collision due to provision of speed limit, sufficient lighting, well-maintained concrete floor, warning signage, and supervision of working staff, etc. at the Station. Mostly it will cause slight damage, which is not potential to result in an uncontrolled LPG release.

It is assumed fatal accidents have the potential to cause catastrophic rupture of the tanker or guillotine failure of the LPG pipework / dispenser, and serious accidents have the potential to cause leakage of the tanker / pipework. A reduction factor of 0.5 is conservatively applied to the probabilities in damaging dispenser / hose at vehicle fuelling area to account for the low vehicle speed and safety provisions at the Station. In addition, to account for the extra protection of side / rear protection and steel framework, a modification factor of 0.1 is considered to probabilities of damaging tanker / inlet pipework in an impact accident.

As mentioned in **Section 5.2.4**, road tanker and inlet pipework are equipped with side / rear protection and steel framework, preventing impact to the LPG facilities from vehicle collision. Thus, vehicle collision to cause tanker / inlet pipework failure are unlikely. To account for the extra protection of side / rear protection and steel framework, a modification factor of 0.1 is considered and the probability of catastrophic failure and partial failure of tanker / inlet pipework in an impact accident is taken as 0.1% and 2%.

Table 8 Road Traffic Accidents by Severity (2017 - 2023)

	2017	2018	2019	2020	2021	2022	2023	Sum	% Total
Fatal	104	107	107	96	94	89	96	693	1%
Serious	2070	1682	1831	1912	1824	1046	1000	11365	12%
Slight	13551	14146	14164	13290	15913	13972	16093	101129	87%
Total	15725	15935	16102	15298	17831	15107	17189	113187	100%

Table 9 Probabilities of Vehicle Impact to Cause Loss of Containment

Events Related to Vehicle Impact	Base Frequency Assumed	Reduction Factor	Probability Adopted
Probability of sufficient vehicle impact energy to cause tanker catastrophic failure	0.01	0.1	0.001
Probability of sufficient vehicle impact energy to cause tanker partial failure	0.2	0.1	0.02
Probability of sufficient tanker impact energy to cause guillotine failure of the inlet pipework	0.01	0.1	0.001
Probability of sufficient tanker impact energy to cause partial failure of the inlet pipework	0.2	0.1	0.02
Probability of sufficient vehicle impact energy to cause dispenser damage	0.01	0.5	0.005
Probability of sufficient vehicle impact energy to cause hose damage	0.01	0.5	0.005

5.2.7 Storage vessel overfilling / over-pressurization

As usual on-site practice of unloading LPG operation, the vessel will only be filled up to 85% of the total capacity. The filling in progress should be monitored by the tanker driver and his assistant through the ullage gauge at all time. The possibility of overfilling is deemed low and is taken to be 2×10^{-2} per operation [2]. Even if an overfilling occurs, an LPG release due to over-pressurisation will only happen if the following human error or failure of safety provisions take place:

- Driver and his assistant fail to activate ESD system and close manual shut-off valve;
- Failure of truck pump over-pressurisation protection system; and
- Failure of pressure relief valve on the storage vessel

Considering the design pressure of the LPG storage vessel is 17.5 barg (almost 3 times of the operating pressure of 5.3 barg), the outcome of storage vessel overfilling / over pressurization is most probably leakages from vessel connections. Nevertheless, catastrophic rupture of the vessel may not be ruled out. An accident review of historical records (1950 – 2006) in the MHIDAS database on vessel overfilling was performed. It was identified that 3 in 123 incidents led to rupture of the storage vessel (records bolded), which accounted for about 2.4% of all incidents. In this assessment, probability of catastrophic rupture is assumed as 2.5%, i.e. 0.025.

5.2.8 Loading pipework over-pressurization

In an unloading operation, the operator may make an error that fails to open all valves on the filling line to the storage vessel, which would potentially result in over-pressurization of the loading pipework. This potential scenario is considered under "Misconnection error".

5.2.9 Human Error

In case of accidental failure, it is highly possible that the onsite staff cannot rectify the problem before and after any hazard event occurs. Two competent persons (the driver and the assistant) are engaged in the unloading process and stayed in close vicinity to the road tanker and the filling point during the unloading. They are suitably trained in unloading operation, first aid, firefighting and emergency response, and equipped with necessary personal protection equipment (PPE). Nevertheless, they might make errors in a series of operations. The probability is taken as 0.01 for error in a routine operation where care is required from "A Guide to Practical Human Reliability Assessment" [13].

Upon an accidental LPG release, alarm will be raised by the leak detection system, the onsite working staff should activate the ESD system to isolate the LPG installations. The human error to start the ESD system under an emergency situation is taken as 0.1 for failure to act correctly at a stressful emergency situation [13]. In case for isolation of LPG vessel and LPG dispensers that can be activated by all ESD buttons by all staffs at the Station, the probability of multiple human error involving two or more staffs to activate the ESD system is considered as 0.01 (= 0.1×0.1).

Probability of human error becomes much higher under emergency situations when a hazard event occurs. The chance of failure to rectify the problem under extreme stresses is 0.3 for general rate of errors involving very high stress level [13].

5.2.10 Failure of Safety Provision

Hazards from an accidental LPG release can be prevented or mitigated by the safety provisions at the Station. Fire protection / firefighting systems are provided in the Station and on road tanker. The failure probabilities of safety provisions and fire protection system adopted are listed in **Table 10**.

Table 10 Failure of Safety Provisions

Item	Failure Probability	Remark
Excess Flow Valve (LPG vessel)	0.13 per demand	
Excess Flow Valve (LPG road tanker)	0.013 per demand	
Excess Flow Valve (LPG dispenser)	0.013 per demand	Same one-year test interval as the LPG road tanker
Non-Return Valve	0.013 per demand	
ESD Trip System Fails	1×10^{-4} per demand	
Pressure Relief Valve	0.01 per demand	Reference to Lees [10]
Truck Pump Over-pressure Protection System (LPG Road Tanker)	1×10^{-4} per demand	Emergency protection. Assume same as ESD trip system fails
Breakaway Coupling	0.013 per demand	
Double-Check Filler Valve	2.6×10^{-3} per demand	
Water Spray System	0.015 per demand	
Chartek Coating under Jet Fire Attack	0.1 per demand	
Fire Service to Prevent BLEVE (Jet Fire Impingement on Road Tanker)	0.5 per demand	

Note:

(1) Unless other specified, the failure probabilities are adopted from QRA Methodology for LPG Installations [2].

5.3 External Events

5.3.1 Earthquake

Hong Kong is not located within the seismic belt. According to Hong Kong Observatory, earthquakes occurring in the circum-Pacific seismic belt which passes through Taiwan and Philippines are too far away to affect Hong Kong significantly. Moreover, buildings and infrastructures in Hong Kong are designed to withstand earthquakes up to Modified Mercalli Intensity (MMI) VII. Therefore, it is assumed that MMI VIII is of sufficient intensity to cause damage to specially designed structures. The chance of earthquake occurring at MMI VIII and higher in Hong Kong is very low in comparison with other regions and is estimated to be 1.0×10^{-5} per year [2]. It is assumed that such earthquake may result in storage vessel leakage and pipework rupture at a probability of 0.01 [14].

5.3.2 Aircraft crash

The Station is located over 28km from the Hong Kong International Airport. The frequency of aircraft crash is estimated using the HSE methodology and the estimated number of flights predicted from air traffic statistics between year 2014 and 2024 [15].

The calculated rate of aircraft crash to the Station is 2.48×10^{-11} per year, which is smaller than 1.0×10^{-9} per year. It is therefore not further considered in the analysis.

5.3.3 Helicopter crash

Helicopter accidents during take-off and landings are confined to a small area around the helipad, extending up to 200m only from the centre of the helipad. 93% of accidents occur within 100m of the helipad. The remaining 7% occur between 100 and 200m of the helipad [16].

A helicopter landing pad will be provided at the New Acute Hospital. According to NAH EIA [4], the Station is about 211m away from the helicopter flight path. The helicopter crash rate to the Station is 5.05×10^{-8} per year. It is assumed that helicopter crash may result in catastrophic failure of aboveground LPG facilities, including rupture of LPG road tank or guillotine failure of dispenser.

5.3.4 Car crash

The Station is fenced by a 2.5-m concrete wall at southbound to protect facilities at LPG road tanker unloading bay and also crash barriers at northbound and westbound to prevent car crash from public access roads. It is considered car crash on the public road impacts negligible threat to the Station.

5.3.5 Landslide

Risk due to landslide on the Station is not considered in the analysis because there is no slope nearby.

5.3.6 Subsidence

Excessive subsidence may lead to failure of the structure and ultimately loss of containment scenario. However, subsidence is usually slow in movement. Such movement can be observed and remedial action can be taken in time. Risk from subsidence is therefore deemed remote and not further considered.

5.3.7 Severe environmental events

Loss of containment due to severe environmental events such as typhoon or tidal wave is considered unlikely since the LPG installation is designed safe to withstand the wind load for typhoon and the Station is situated away from seashore. Therefore, the risk is deemed remote and not further considered.

5.3.8 Dropped object

The Station is sheltered by the roof. Thus, it is considered the threat from dropped objects to the Station is insignificant and not further assessed in the analysis.

5.3.9 External fire

External fire refers to the occurrence of a fire event outside the Station, which may lead to the failure of the LPG facilities. This might occur from minor vehicle accidents on the public road. The resulting fire is usually small, only affecting a few meters around the car, and could be quickly extinguished using fire extinguishers or by the fire brigade. The key facilities inside are further protected by concrete building structures (e.g. the LPG vessel compartment). The risk of escalation of external fire to the LPG facilities is deemed negligible and not further considered.

5.4 Failure Frequencies

Base failure frequencies of hazardous events are derived by fault tree analysis from the initiating failures. The details are presented in **Annex C**. The failure frequencies are factorised by assuming 80% of time in a year with 60% inventory of LPG within the Station. 100% of inventory of LPG is assumed for the rest of time within the Station. The results are summarised in **Table 11** below.

Table 11 Resultant frequencies after Fault Tree Analysis

Hazardous Event		Original Frequency (per year)	Inventory	Time Fraction	Factored Frequency (per year)
Cold Catastrophic Failure of LPG Vessel	Spontaneous and External Event	3.60E-07	100%	0.2	7.20E-08
			60%	0.8	2.88E-07
	Loading Failure	1.11E-08	Max	1.0	1.11E-08
Cold Partial Failure of LPG Vessel	Spontaneous and External Event	1.01E-05	100%	0.2	2.02E-06
			60%	0.8	8.08E-06
	Loading Failure	4.31E-07	Max	1.0	4.31E-07
Cold Catastrophic Failure of Road Tanker		7.92E-07	100%	0.2	1.58E-07
			50%	0.8	6.33E-07
Cold Partial Failure of Road Tanker		2.31E-06	100%	0.2	4.63E-07
			50%	0.8	1.85E-06
Guillotine Failure of Liquid Inlet Pipework		4.30E-08	100%	0.2	8.60E-09
			50%	0.8	3.44E-08
Leak of Liquid Inlet Pipework		3.80E-06	100%	0.2	7.61E-07
			50%	0.8	3.04E-06
Guillotine Failure of Flexible Hose during Unloading to LPG Vessel		1.40E-05	100%	0.2	2.79E-06
			50%	0.8	1.12E-05
Leak of Flexible Hose during Unloading to LPG Vessel		3.98E-05	100%	0.2	7.97E-06
			50%	0.8	3.19E-05
Guillotine Failure of Liquid Supply Line to the Dispenser		1.59E-07	100%	0.2	3.18E-08
			60%	0.8	1.27E-07

Hazardous Event	Original Frequency (per year)	Inventory	Time Fraction	Factored Frequency (per year)
Leak of Liquid Supply Line to the Dispenser	1.22E-06	100%	0.2	2.45E-07
		60%	0.8	9.79E-07
Failure of Dispenser	8.97E-06	100%	0.2	1.79E-06
		60%	0.8	7.17E-06
Guillotine Failure of Flexible Hose during Refuelling to LPG Vehicle	1.12E-04	100%	0.2	2.24E-05
		60%	0.8	8.98E-05
Failure of Submersible Pump Flange (leak)	1.00E-05	100%	0.2	2.00E-06
		60%	0.8	8.00E-06

5.5 Event Tree Analysis

Event tree analysis is used to develop the evolution of a failure event from its initial release to the final outcome scenarios, namely, jet fire, flash fire, fireball, etc. It depends on various factors such as release type (instantaneous or continuous), ignition sources and probabilities, and degree of congestion to cause a vapour cloud explosion. The event tree analysis adopted in the study is provided in **Annex D**.

SAFETI's built-in event trees are used to calculate the frequencies of hazardous outcome scenarios.

5.5.1 Catastrophic Failure of LPG Storage Vessel

Immediate ignition is assumed a probability of 0.3 for large releases following Cox, Lees and Ang [10], as shown in **Table 12**. The immediate ignition of instantaneous LPG release from LPG storage vessel / road tanker will result in a fireball. Regarding to LPG storage vessel installed underground in a sand-filled concrete compartment, the probability of a fireball is negligible and therefore its effect is not evaluated, flash fire is considered under this circumstance instead.

Table 12 Ignition Probabilities from Cox, Lees and Ang

Release Rate	Ignition Probability Rate	
	Gas Release	Liquid Release
Minor (<1 kg/s)	0.01	0.01
Major (1-50 kg/s)	0.07	0.03
Massive (>50 kg/s)	0.3	0.08

A probability of 0.5 [5] is assigned to delayed ignition, which may produce a flash fire or vapour cloud explosion (VCE). A VCE is caused by ignition of a dispersed gas cloud present in a confined or congested space. Given the relatively open nature of the surroundings of the Station, an explosion probability of 0.2 is assumed.

5.5.2 Leak from LPG Storage Vessel / Road Tanker

A lower probability of 0.07 is adopted from **Table 12** for immediate ignition of partial failure (leak) of LPG storage vessel and road tankers. Immediate ignition of a continuous pressurised release results in a jet fire. Similar probabilities are assumed for the delayed ignition, which can also lead to a flash fire or VCE.

5.5.3 Failure of Aboveground Pipe / Hose / Dispenser

A jet flame from aboveground pipe / hose / dispenser failure may impinge on road tanker leading to tank failure over a period of time. The chance of flame impingement is assumed as 1/6 for liquid inlet pipework and flexible hose of the road tanker [3]. A direction probability of 1/12 is assumed to the dispenser and the flexible filling hose to vehicle based on the layout. The residence time of LPG road tanker is also considered for fire impingement.

LPG road tankers are protected by a layer of Chartek coating, preventing the formation of hot spots. Credit is given to the passive Chartek coating protection on road tanker and water spray system and fire-fighting services in the Station. The probability of coating failure is assigned as 0.1 [2]. The failure rate of water spray system is taken as 0.015 [2]. Fire services system is assumed to have a chance of 0.5 [2] being ineffective in preventing a BLEVE.

The underground LPG storage vessel is free from flame impingement.

5.5.4 Leak from Underground Pipe / Submersible Pump Flange

Vertical jet release is considered for underground release. BLEVE due to jet fire impingement on the LPG road tanker wall is not considered as the vehicle chassis protects the LPG tank.

6.0 Consequence Analysis

The consequence assessment estimates impact of each outcome in the area of concern. The consequence assessment consists of two major parts, namely:

- Source term modelling – to determine the appropriate discharge models to be used for calculation of the release rate, duration and quantity of the release; and

- Physical effect modelling – to determine the gas dispersion, fire and explosion effects zone based on the output of source term modelling.

The simulation software SAFETI 8.9 developed by Det Norske Veritas (DNV) was employed to calculate the hazardous release and the effects zones.

6.1 Source Term Modelling

LPG is modelled as a mixture of 30% propane and 70% butane. LPG stored in a tank is pressurised to medium pressure to reach an equilibrium state between the liquid and vapour phases, depending on the ambient temperature.

The maximum capacity of the LPG storage vessel is about 14 tonnes. The vessels are assumed nominally at full load inventory (i.e. 85% of maximum capacity, equivalent to 11.9 tonnes) for 20% of the time and at low inventory level with 60% of full load inventory (equivalent to 7.14 tonnes) for the rest of the time. Road tankers are assumed to have a maximum capacity of 9 tonnes. The road tanker is modelled to have full inventory for 20% of the time and 50% of inventory for the remaining 80% of time.

Instantaneous release of the whole inventory is assumed for the cases of catastrophic failure / rupture. Partial failure / leak will lead to a continuous release, in which, discharge rate is calculated by SAFETI based on the leak size, release temperature, release pressure, and fluid phase. Duration of continuous discharge is determined by discharge rate and total inventory.

6.2 Physical Effect Modelling

6.2.1 Gas Dispersion

LPG vaporises rapidly and forms a vapour cloud upon release. Fire scenarios of different kinds may be developed in the presence of ignition sources in the proximity of an LPG release. If no ignition source exists, the vapour cloud will disperse downwind and will then be diluted to a concentration below its Lower Flammable Limit (LFL). In this case, the vapour cloud will become too lean to be ignited and will have no harmful effect.

The dispersion characteristics of the vapour cloud are influenced by meteorological conditions and material properties, such as density. The built-in UDM model in SAFETI is used for modelling the dispersion of unignited vapour cloud following an LPG release. The model takes into account various transition phases, from dense cloud dispersion to buoyant passive gas dispersion, in both instantaneous and continuous releases.

6.2.2 Jet Fire

When flammable fluid stored under pressure releases from an orifice, it will lead to a flame jet (i.e. jet fire) if it is ignited immediately. The flame length is determined from the momentum of the release. If a jet fire impinges on another pressurised LPG storage container, thermal intrusion and heat radiation could boil liquid and induce over-pressurisation and subsequent rupture of the container, causing a BLEVE.

6.2.3 Fireball and BLEVE

Immediate ignition of an instantaneous release of massive inventory inside a pressurised vessel will result in a fireball. A fireball is characterised by its high thermal radiation intensity and short duration time. The principal hazard of fireball arises from thermal radiation, which is not significantly influenced by weather, wind direction or source of ignition.

A BLEVE occurs as fire escalation event upon integrity failure from fire impingement. It has similar characteristics to a fireball and its physical effects are calculated as a fireball.

6.2.4 Thermal Radiation of Fires

The major hazard of a jet fire, pool fire or fireball is the flame and the thermal radiation. Persons caught in the flame zone are considered be fatally injured. Persons outside the flame zone are determined by lethal probability using the following Probit equation [8]:

$Pr = -36.38 + 2.56 \ln Q^{4/3t}$

where Q is the thermal radiation intensity in W/m^2 and t is the exposure time in seconds.

6.2.5 Flash Fire

An LPG release will vaporise and form a vapour cloud. This cloud, if not ignited immediately, will move in the downwind direction, entraining air as it disperses and becomes diluted. A flash fire will occur if the vapour cloud is ignited at a concentration above its LFL.

Major hazards from flash fire are thermal radiation and direct flame contact. Because of the short duration of the flash combustion, the thermal radiation effect on persons is limited. Humans who are encompassed outdoor by the flash fire is considered be fatally injured. A fatality rate of unity is assumed for outdoor population, and 90% protection factor is assumed for indoor occupants [2].

6.2.6 Vapour Cloud Explosion

If the vapour cloud passes through a congested area (e.g. cluster of pipe racks, a confined space) and be ignited, the confinement will limit the expansion of the burning cloud, causing an explosion and damage to the surroundings by the resulting overpressure. In SAFETI, the hazardous effects are modelled by two concentric circular areas corresponding to heavy and light building damage, respectively. Fatality rates for persons outdoors and indoors are determined from the TNO Purple Book [8].

6.3 Hazardous Impacts on Offsite Population

6.3.1 Worst Consequence Distances

Population in the vicinity of the Station can be potentially affected by the hazardous events depending on the consequence distances. The affected distances of different hazardous events are simulated in SAFETI and the worst impact distances are summarised in **Table 13** below. The worst consequence distance is 164m, which is resulted from the flashfire of cold catastrophic failure of LPG vessel.

Table 13 Summary of Worst Consequence Distances

Hazardous Event	Failure Event	Parameter	Distance (m)
Fireball	Cold Catastrophic Failure of Road Tanker	Fireball radius Lift off height	56.6 113.1
Jet fire	Guillotine Failure of Liquid Inlet Pipework	Flame length	25.6
Flashfire	Cold Catastrophic Failure of LPG Vessel	Flash fire envelop at 100% LFL	164

6.3.2 Shielding Factor for Fireball

Shielding factors are assumed to account for protection by the front part of the building or by other buildings from fireball effects [2]. A shielding factor of 0.5 is assigned to those buildings wholly within the fireball diameter and partly inside the fireball diameter, i.e. 56.6m to the Station. Buildings that are outside the fireball and are not in the direct line of sight of the Station are considered being protected by the buildings in the front.

6.3.3 Height Protection Factor

Population above the cloud height is not exposed to flash fire events. In another term, these population are "protected". The height protection factors to the "protected" population are corresponding to the proportion of building above the top of the cloud [2]. The Station is situated at +4.5mPD. According to the SAFETI modelling, the maximum height of vapour cloud is 32m resulted from the cold catastrophic failure of LPG vessel.

The population factors applied to various population groups within flash fire envelope for flash fire events are shown in **Table 14**. The height protection factor is used as a discount factor to the population of the area to address those who are not affected by the flashfire. It also applies to the jet fire scenario since the flame length of the jet fire is similar and does not exceed the cloud height of flash fire.

Table 14 Height Protection Factor Considered

ID	Description	Shielding Factor	Distance from the Station (m)	Cloud height (m)	Height Protection Factor
01	Kai Tai Fire Station	0.5	38	10	0.68
02	New Acute Hospital (Acute Block)	1	73	10	0.92
03	Planned Residential Development	1	116	10	0.91

ID	Description	Shielding Factor	Distance from the Station (m)	Cloud height (m)	Height Protection Factor
04	Planned Residential Development	1	115	10	0.89
05	Kerry DG Warehouse	1	173	5	0.61
06a	Pacific Trade Centre (G/F – 3/F)	0.5	19	22	0
06b	Pacific Trade Centre (5/F – 17/F)	0.5	19	22	0.73
07a	The Quayside (Upper)	1	150	10	1
07b	The Quayside (Lower)	1	150	10	0.10
08a	WSD Kowloon East Regional Building (Lower)	1	208	5	1
08b	WSD Kowloon East Regional Building (Upper)	1	208	5	0.89
13	Capital Building	1	198	5	0.95
14a	Harbourside (Lower)	0.5	25	16	0.08
14b	Harbourside (Upper)	0.5	55	10	1
PD	Proposed Development:				
	▪ Residential	0.5	49	10	1
	▪ Clubhouse	0.5	45	10	1
	▪ Retail and Food & Beverage	0.5	45	10	0
	▪ G/IC	0.5	45	10	0
RD06	Kwun Tong Bypass	0	35	10	1
RD07	Kai Fuk Road Flyover	0	172	5	1

7.0 Risk Assessment

7.1 Risk Summation

Risk summation combines the likelihood and consequence of hazardous event, as well as meteorological data and population in the hazard effect zones, to give a numerical measure of risks around the Station. The risk analysis is conducted by the simulation software – SAFETI 8.9 developed by DNV and the outcome results are presented in terms of IR contours and Societal Risk (as F-N curves or Potential Loss of Life (PLL)). The risk outcomes are compared to the criteria set out in the risk guidelines, as specified in **Section 1.3**.

7.2 Results of Individual Risk

The IR contours of the Station are presented in **Figure 4**. The offsite risk of the Station is less than 1×10^{-5} per year and decreases at distances further away from the Station. The individual risk at the Application Site is below 1×10^{-6} per year and thus, the criteria set in the Hong Kong Risk Guidelines is satisfied.

7.3 Results of Societal Risk

The societal risk results of the Station are presented in the form of F-N curve **Figure 5** with detailed data presented in **Table 15**. As recaptured from **Section 1.4.2**, Case 1 - Base Case represents the risk level in year 2033 without redevelopment of the Proposed Development (i.e. as existing commercial building) while Case 2 - Operation Case represents the risk level in year 2033 with the redevelopment of the Proposed Development.

The population brought by the Proposed Development cause slight increase to the overall risk level of the Station. The F-N curve of the operation case increases slightly. Although, the separation distance of the high-rise residential towers in the Proposed Development from the LPG facilities in the Station is less than 55m, and the societal risk level after redevelopment of the Proposed Development remains within "ACCEPTABLE" region of the HKRG societal risk criteria and complies with the criterion stipulated in the Hong Kong Risk Guidelines.

Table 15 F-N Data

No. of fatality	Frequency (per year)	
	Case 1 – Base Case	Case 2 – Operation Case
1	2.02E-06	2.02E-06
2	8.89E-07	8.90E-07
3	5.74E-07	5.75E-07
4	4.84E-07	4.85E-07
5	4.57E-07	4.58E-07
6	4.45E-07	4.47E-07
8	4.31E-07	4.33E-07

No. of fatality	Frequency (per year)	
	Case 1 – Base Case	Case 2 – Operation Case
10	4.22E-07	4.24E-07
12	3.87E-07	3.88E-07
15	3.09E-07	3.11E-07
20	2.91E-07	2.93E-07
25	2.67E-07	2.75E-07
30	2.41E-07	2.66E-07
40	1.92E-07	2.18E-07
50	1.70E-07	1.85E-07
60	8.03E-08	8.89E-08
80	5.63E-08	5.90E-08
90	4.87E-08	5.01E-08
100	2.79E-08	4.21E-08
120	2.08E-08	2.25E-08
150	1.37E-08	1.49E-08
200	8.23E-09	9.03E-09
250	5.02E-09	5.90E-09
300	3.01E-09	3.74E-09
400	1.05E-09	1.48E-09
500	1.80E-10	3.87E-10

Note: Values less than 1E-9 per year are not shown in the figure of F-N curve

Societal risk can also be represented in the form of Potential Loss of Life (PLL). It expresses the risk to the population as a whole and for each scenario and its location. The PLL is an integrated measure of societal risk obtained by summing the product of each F-N pair:

$$\mathrm{PLL} = f_1 N_1 + f_2 N_2 + \cdots + f_n N_n$$

The PLL values of the major contributors are shown in **Table 16**. With the additional population brought by the Proposed Development, the total PLL is increased by 5.2%, from 2.24×10^{-5} no. of fatality per year to 2.35×10^{-5} no. of fatality per year. The major risk contributing event at the Proposed Development is fireball arising from LPG Road Tanker.

Table 16 Breakdown of PLL

Hazardous Event	Hazard Outcome	Case 1 – Base Case		Case 2 – Operation Case	
		PLL (no. of fatality per year)	% of total PLL	PLL (no. of fatality per year)	% of total PLL
Cold Catastrophic Failure of Road Tanker	Fireball	8.60E-06	38.44%	9.30E-06	39.51%
	Flash Fire	2.44E-06	10.92%	2.47E-06	10.48%
	VCE	1.50E-06	6.70%	1.55E-06	6.60%
Cold Catastrophic Failure of LPG Vessel	Flash Fire	4.26E-06	19.04%	4.42E-06	18.75%
	VCE	3.09E-06	13.82%	3.33E-06	14.13%
Guillotine Failure of Flexible Hose during Unloading to LPG Vessel	Jet Fire	7.91E-07	3.53%	7.91E-07	3.36%
	VCE	2.20E-07	0.98%	2.20E-07	0.93%
	Flash Fire	1.96E-07	0.88%	1.96E-07	0.83%
Cold Partial Failure of Road Tanker	Jet Fire	4.93E-07	2.20%	4.93E-07	2.09%
	VCE	2.85E-07	1.27%	2.85E-07	1.21%
	Flash Fire	2.03E-07	0.91%	2.03E-07	0.86%
Others		2.90E-07	1.29%	2.91E-07	1.23%
Total		**2.24E-05**	**100.00%**	**2.35E-05**	**100.00%**

8.0 Conclusion

An Application Site at 8 Lam Chak Street, Kowloon – N.K.I.L. 6215 is proposed to convert from existing commercial use to comprehensive residential development. A Quantitative Risk Assessment (QRA) has studied the risk impact of a dedicated LPG filling station on Cheung Yip Street, Kowloon Bay to the surrounding population, including the additional population brought by the redevelopment of the Application Site.

The result revealed that the offsite individual risk of the LPG filling station is below 1×10^{-5} per year, in which the individual risk at the Application Site is below 1×10^{-6} per year.

Although, the minimum separation distance of the high-rise residential towers in the redevelopment of the Application Site from the LPG facilities in the Station is less than 55m, the societal risk of the LPG filling station, with the redevelopment of the Application Site, remains within "Acceptable" region of the criteria in the Hong Kong Risk Guidelines. No mitigation measure is required.

9.0 References

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Figures

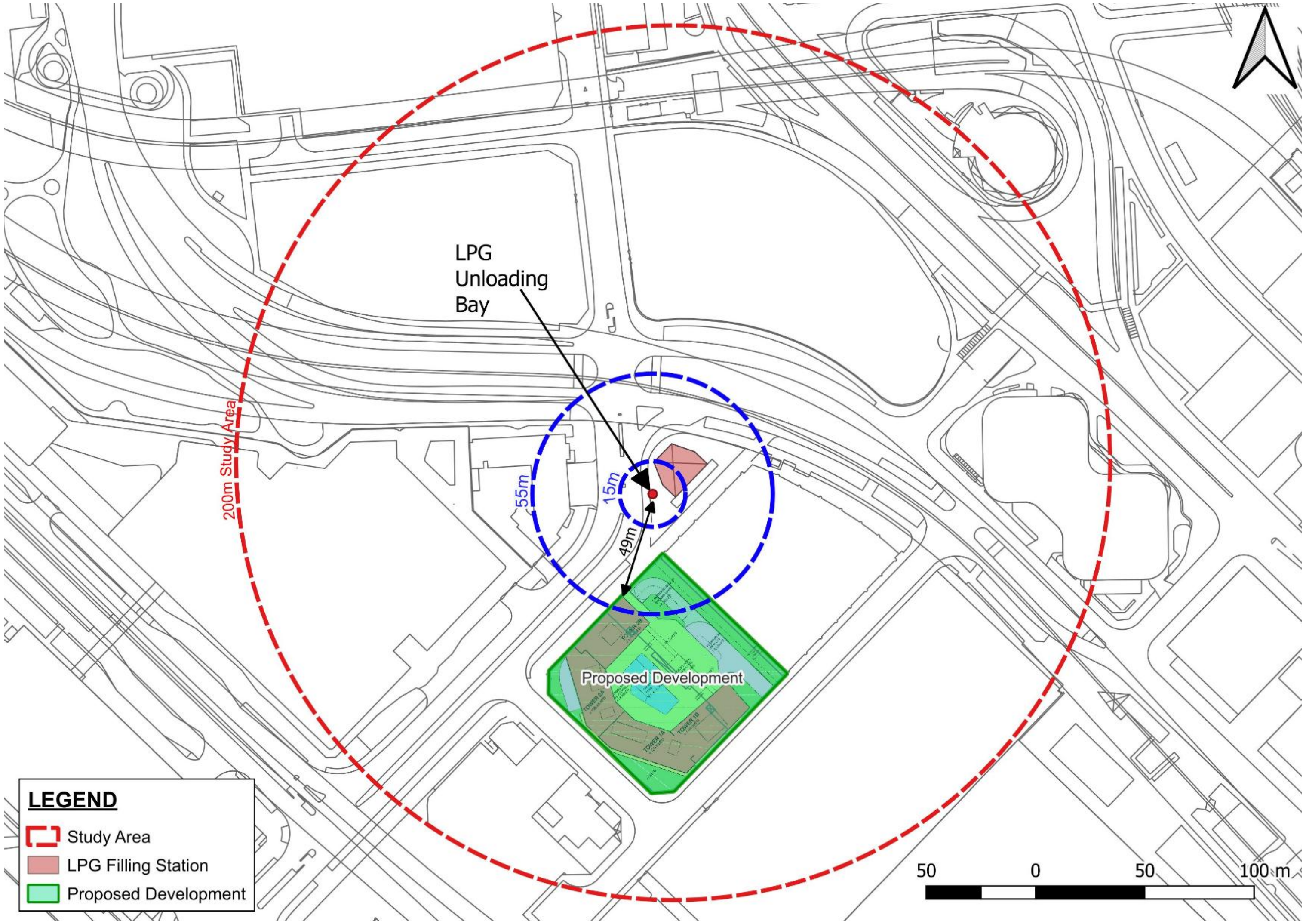


Figure 1 Location of Proposed Development and Study Area

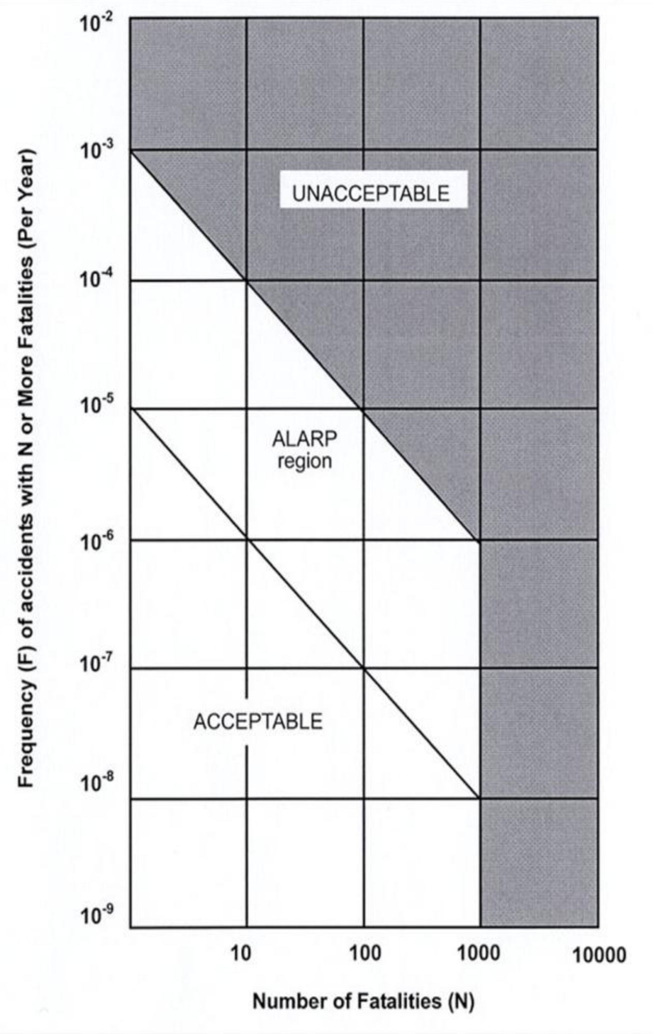


Figure 2 Societal Risk Guideline

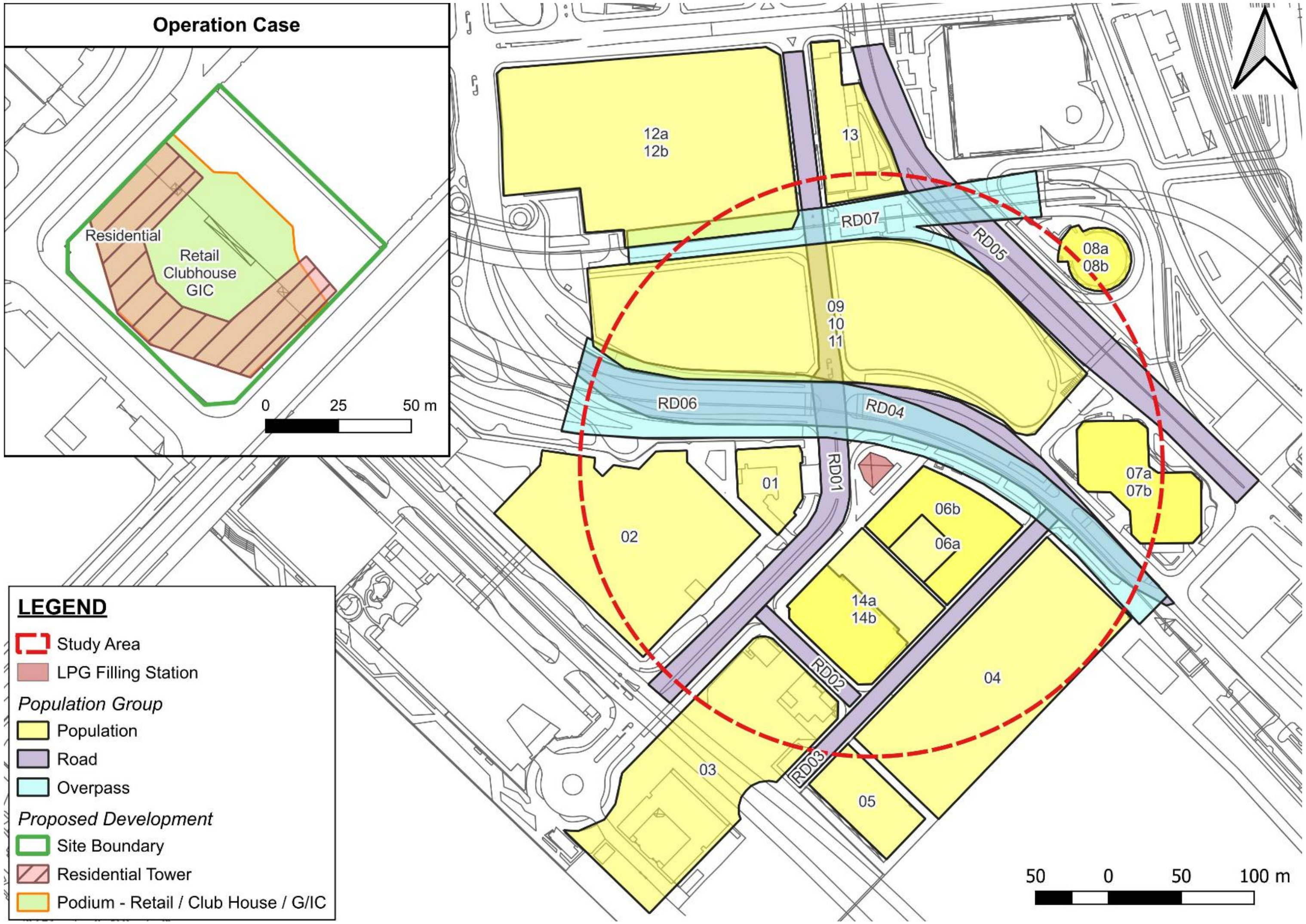


Figure 3 Population Considered in this Study

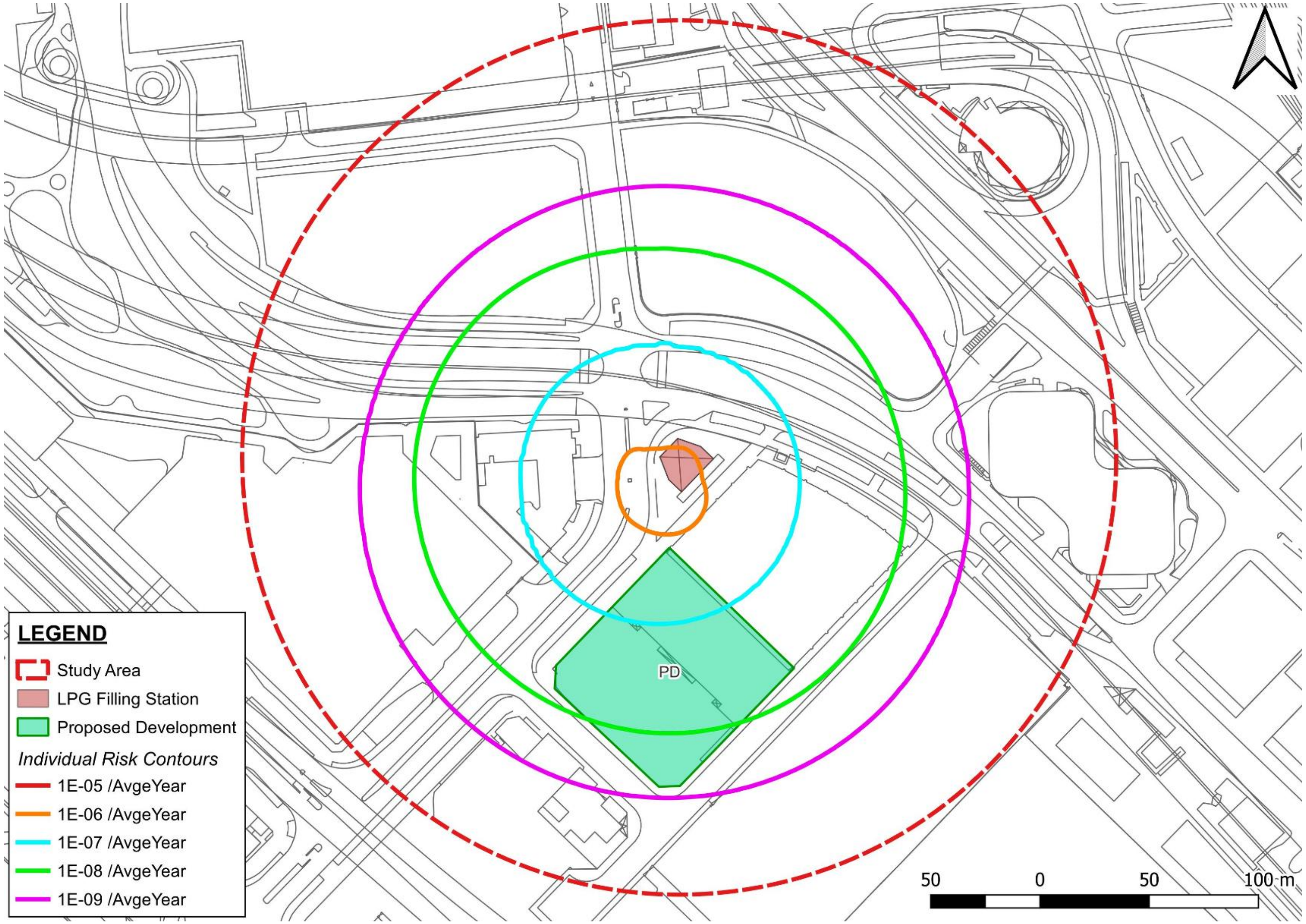


Figure 4 Individual Risk of the LPG Filling Station

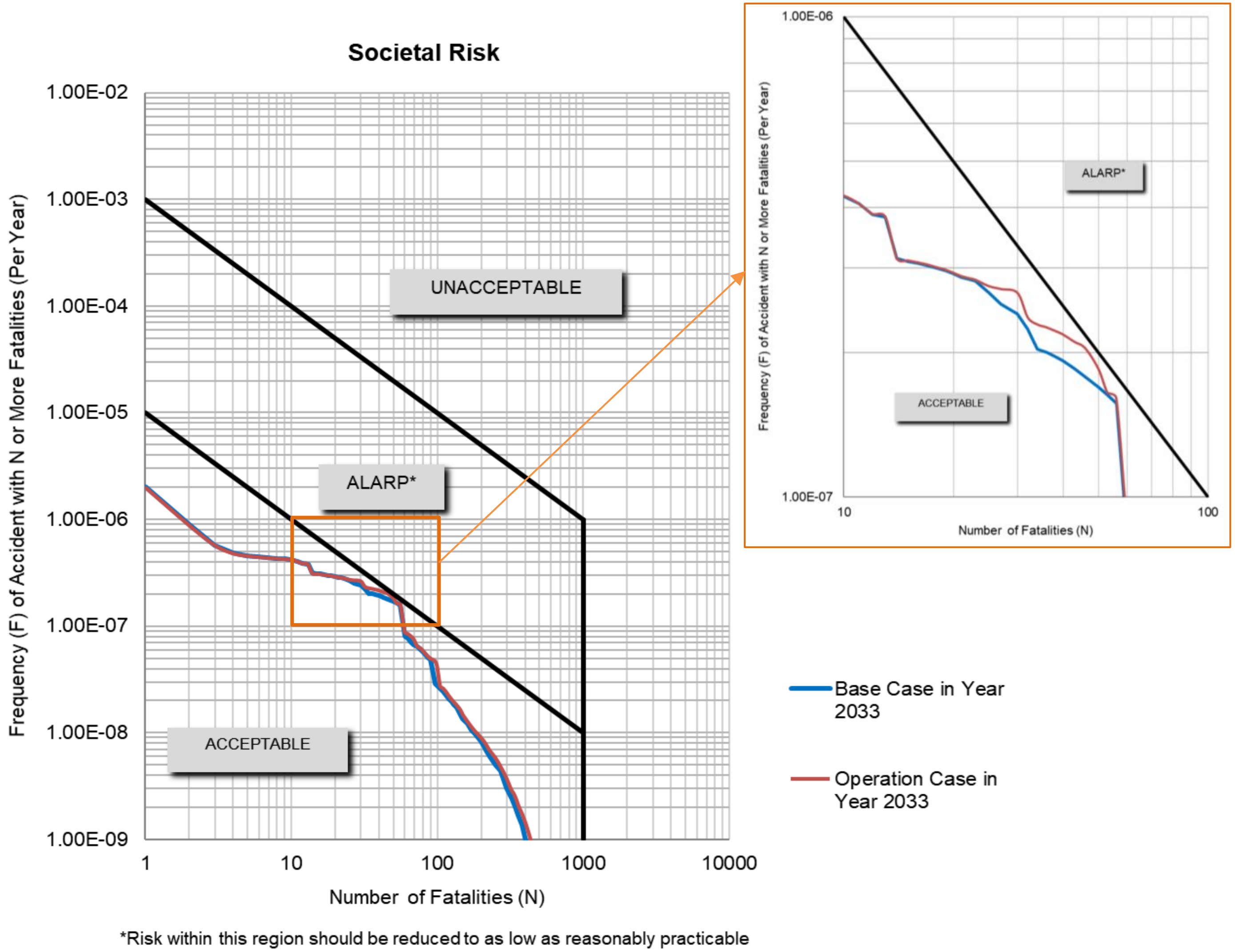
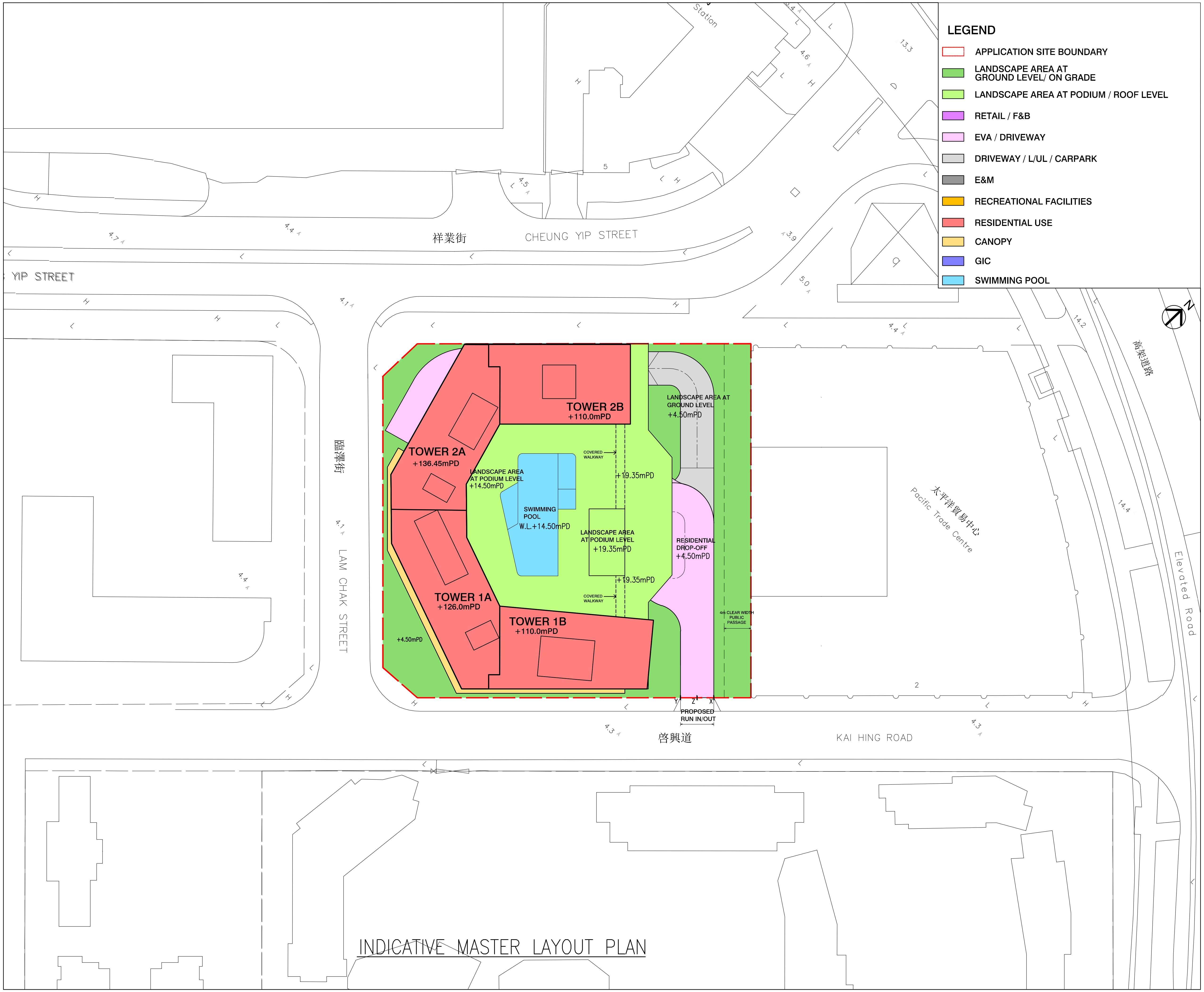


Figure 5 Societal Risk Results

Annex A:
Layout Plan of the Proposed Development



INDICATIVE MASTER LAYOUT PLAN

LEGEND

- APPLICATION SITE BOUNDARY
- LANDSCAPE AREA AT GROUND LEVEL/ ON GRADE
- LANDSCAPE AREA AT PODIUM / ROOF LEVEL
- RETAIL / F&B
- EVA / DRIVEWAY
- DRIVEWAY / L/UL / CARPARK
- E&M
- RECREATIONAL FACILITIES
- RESIDENTIAL USE
- CANOPY
- GIC
- SWIMMING POOL

B.D. REFERENCE 屋宇署檔案

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CAD FILE NAME 檔案編號

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PROJECT 項目名稱

PROPOSED COMPOSITE DEVELOPMENT AT 8 LAM CHAK STREET, KOWLOON – N.K.I.L. 6215

TITLE 標題

INDICATIVE MASTER LAYOUT PLAN

SCALE 比例 1:800(A3)	DATE 日期 MAY 2026
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JOB NO. 工程項目 N3591–H	DRAWING NO. 圖號 –

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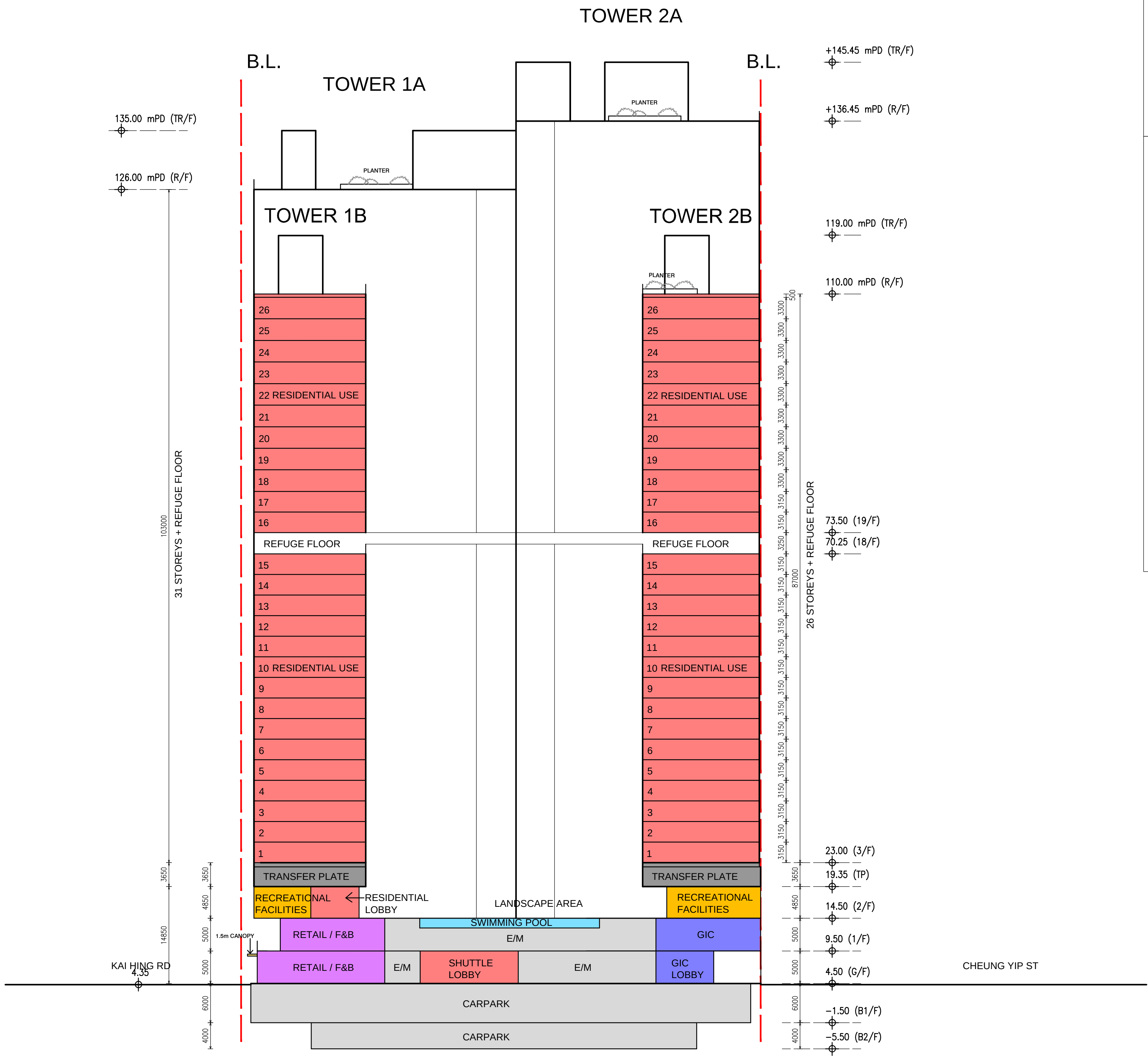

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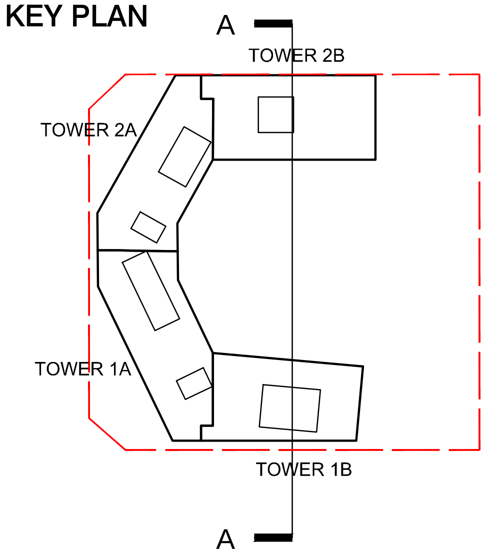

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PROJECT 項目名稱
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INDICATIVE SECTION A-A

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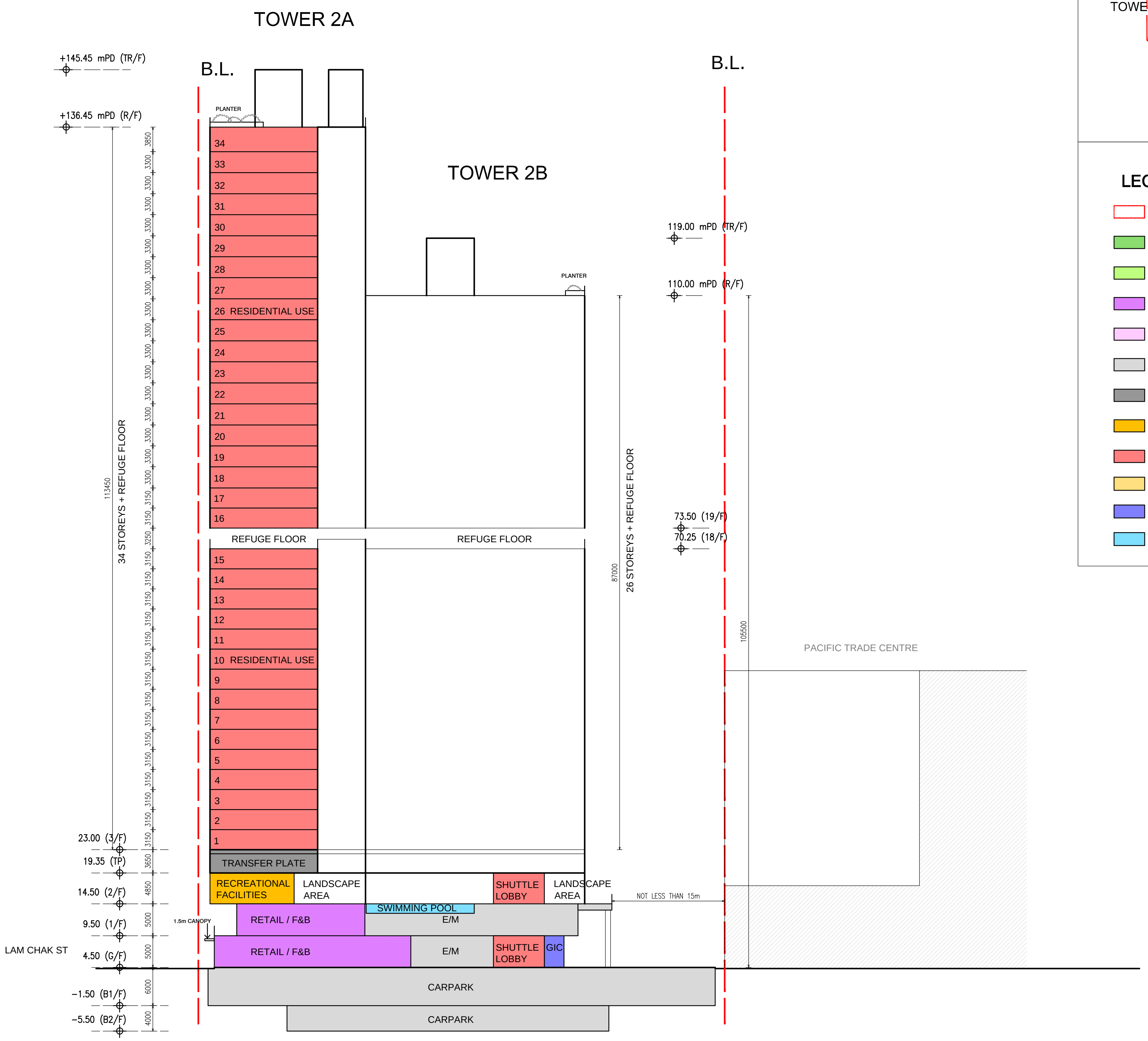

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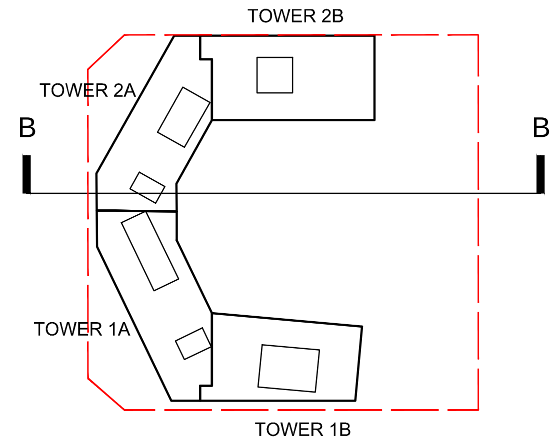

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PROPOSED COMPOSITE DEVELOPMENT AT 8 LAM CHAK STREET, KOWLOON – N.K.I.L. 6215

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INDICATIVE SECTION B-B

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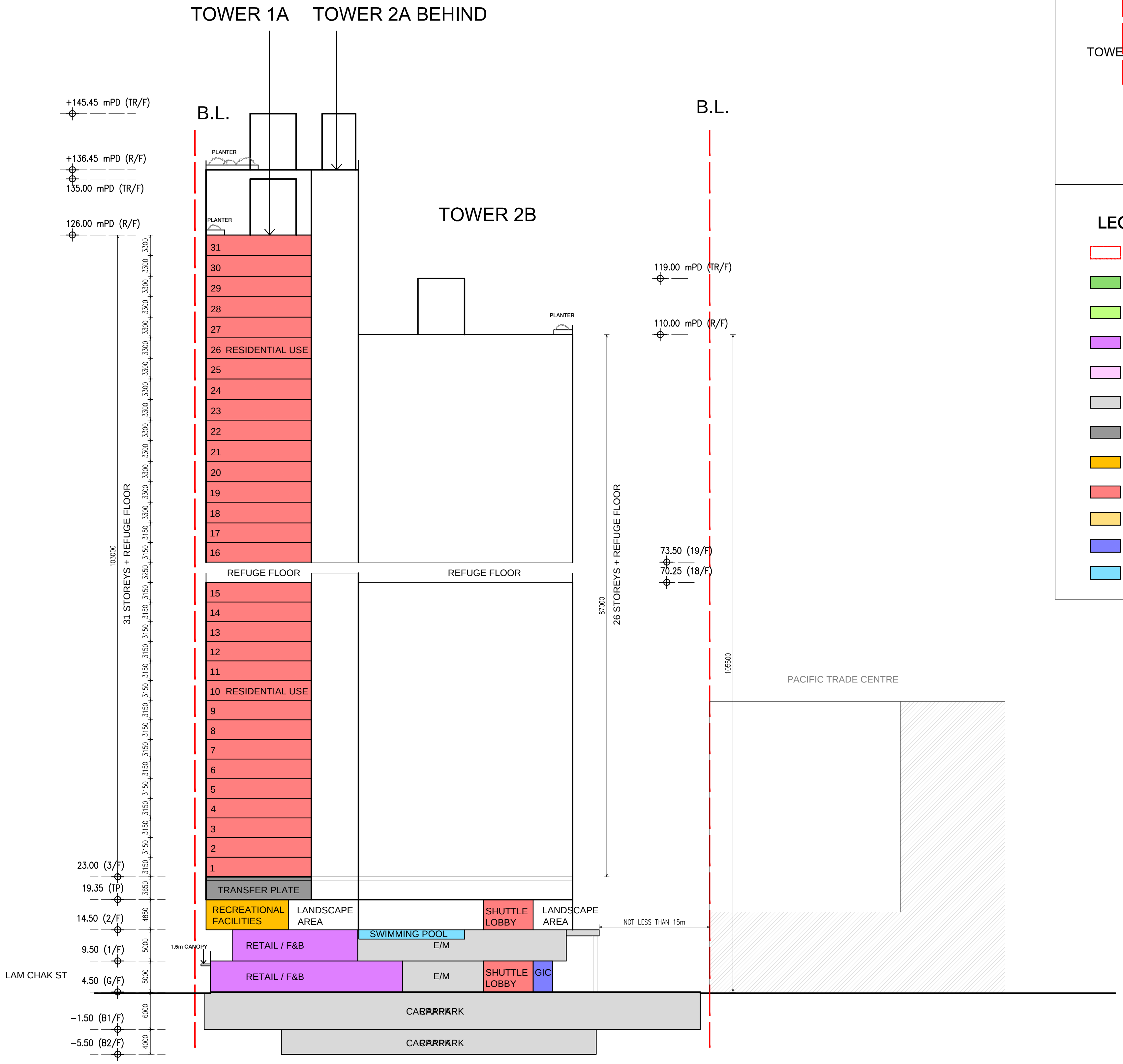

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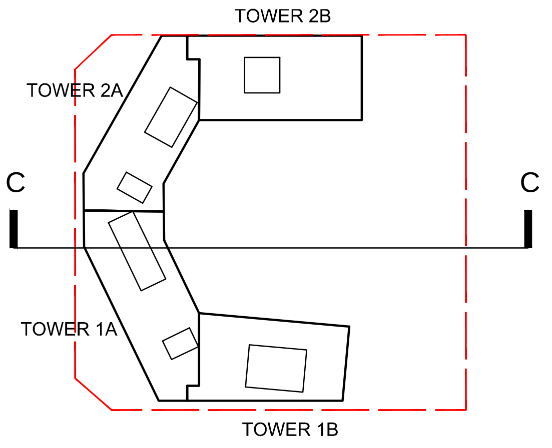

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TITLE 標題

INDICATIVE SECTION C-C

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Annex B: Calculation of Transient Population

B1. Calculation of Average Occupancy

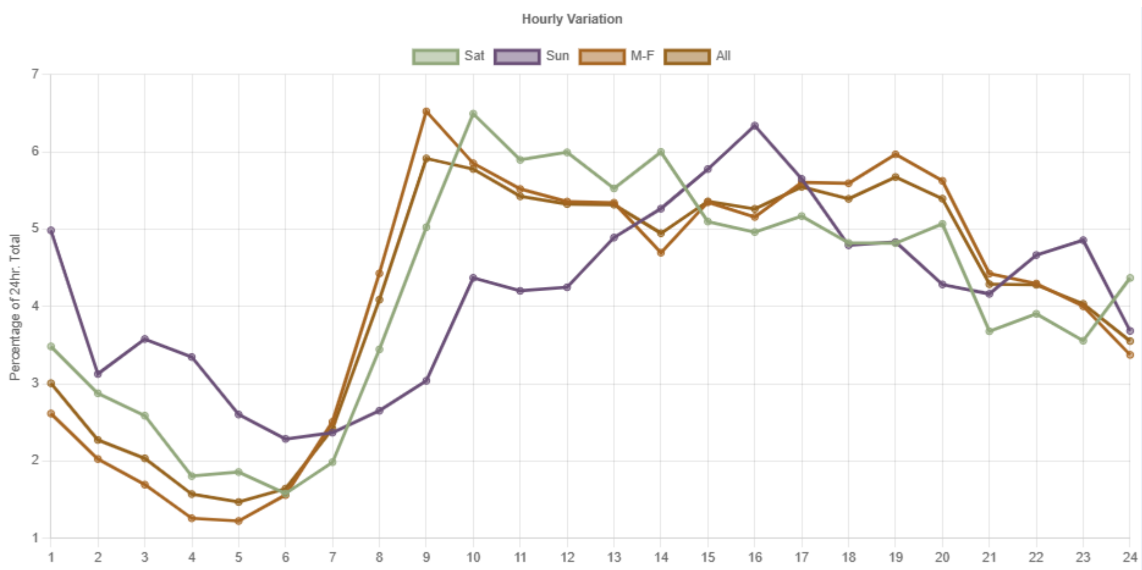
The average occupancies of vehicles on roads concerned are estimated from statistics of nearby traffic stations in Annual Traffic Census 2024.

Station No.	3004		4219	
Link	Kai Tak Tunnel		Kwun Tong Bypass	
Vehicle Type	**Pro**	**Ocp**	**Pro**	**Ocp**
Motor Cycle	3.6	1.1	3.1	1.1
Private Car	48.7	1.4	57	1.3
Taxi	23.2	1.9	12.3	2.1
Private Light Bus	0.7	2.7	0.8	4.2
Public Light Bus	0.1	8.2	1	11.7
Light Goods Vehicle	14.1	1.4	15.2	1.3
M&H Goods Vehicle	4.6	1.2	7	1.1
Non Fr. Bus	1.8	8.3	1.3	15.4
SD Fr. Bus	0.1	1	0.1	0.7
DD Fr. Bus	3.2	27.2	2.3	49.9
Average Occupancy	2.46		2.81	

Note:
(1) *Average occupancy* $= \sum(Probability_i \times Occupancy_i)/\sum Probability_i$

B2. Calculation of Traffic Variation within the Day

The traffic flow variation on roads within the study area is assumed as same as the that at Kai Tak Tunnel which is the major road link to the area.



Station No.	Road	Ratio of Day-time and Night-time Traffic Flow		Ratio to WDD Traffic Flow	
		Day	Night	Day	Night
3004	Kai Tak Tunnel	61%	39%	100%	63%

B3. Estimation of Traffic Flow

Traffic flow on concerned roads are projected from annual traffic statistics of nearest traffic stations in the past 8 years.

Traffic Station	Annual Average Daily Traffic (AADT)							
	2017	2018	2019	2020	2021	2022	2023	2024
Cheung Yip Street (Station No. 4606)	7,610	5,450	5,820	5,920	7,320	7,350	15,890	15,240
Wai Yip Street (Station No. 3686)	24,690	24,580	24,080	23,900	24,800	23,620	25,000	23,460
Kwun Tong Bypass (Station No. 3023)	97,360	95,620	97,380	90,600	90,430	95,920	112,420	102,550
Kai Fuk Road Flyover (Station No. 3206)	63,940	68,240	71,780	67,370	68,320	64,710	67,930	69,740

ID	Road	AADT in 2024	Ave. Annual Traffic Growth	Predicted AADT in 2033	Day Hourly Traffic (veh/hr)	Night Hourly Traffic (veh/hr)
RD01	Chueng Yip Street	15,240	13.5%	15,240 (1)	781	489
RD02	Lam Chak Street	-	-	3,048 (2)	156	98
RD03	Kai Hing Road	-	-	3,048 (2)	156	98
RD04	Hoi Bun Road	-	-	15,240(3)	781	489
RD05	Wai Yip Street	23,460	0% (4)	23,460	1,201	753
RD06	Kwun Tong Bypass	102,550	1.0%	112,217	5,743	3,602
RD07	Kai Fuk Road Flyover	69,740	1.2%	77,333	3,958	2,482

Note:

(1) The vast increase of traffic on Cheung Yip Street in 2023 and 2024 was caused by construction traffic to/from NAH construction site. Such construction traffic is considered as temporary situation until completion of NAH in 2026. Nevertheless, the AADT in 2024 is conservatively adopted as future traffic flow in 2033.

(2) Assume as 20% of that of Chueng Yip Street.

(3) Assume as 100% of that of Chueng Yip Street.

(4) As the Average of annual growth of Traffic Station 3686 were observed to be negative. Therefore, it is conservatively assumed to be 0%.

B4. Calculation of Transient Population

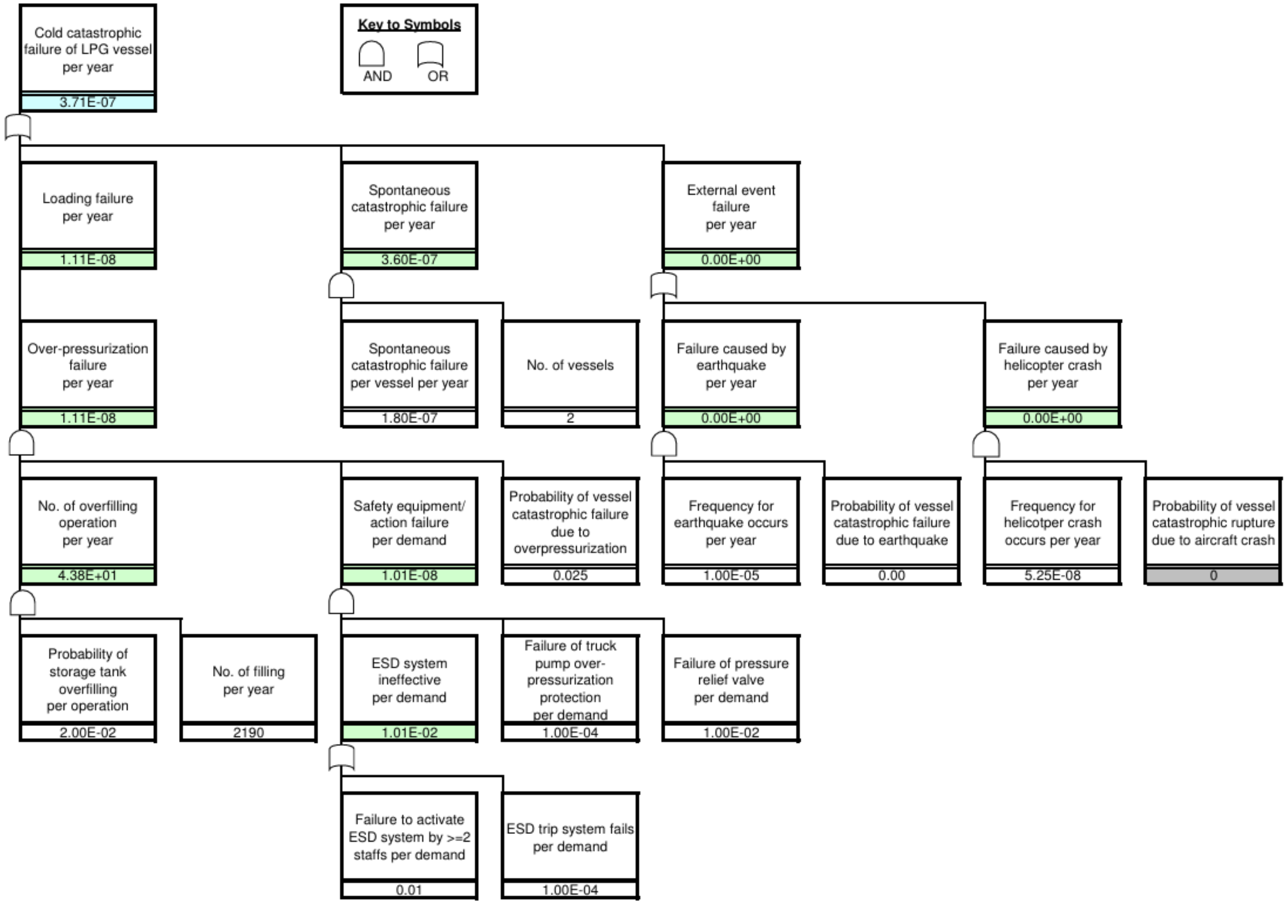
ID	Road	Average Occu-pancy	Speed (km/hr)	Road Length (m)	Daytime Traffic Popula-tion	Pedes-trian	Daytime Popula-tion
RD01	Chueng Yip Street	2.46	50	490	19	20	39
RD02	Lam Chak Street	2.46	50	80	1	10	11
RD03	Kai Hing Road	2.46	50	260	2	20	22
RD04	Hoi Bun Road	2.46	50	475	18	20	38
RD05	Wai Yip Street	2.46	50	410	25	20	45
RD06	Kwun Tong Bypass	2.81	80	444	90	0	90
RD07	Kai Fuk Road Flyover	2.46	70	290	41	0	41

Note:

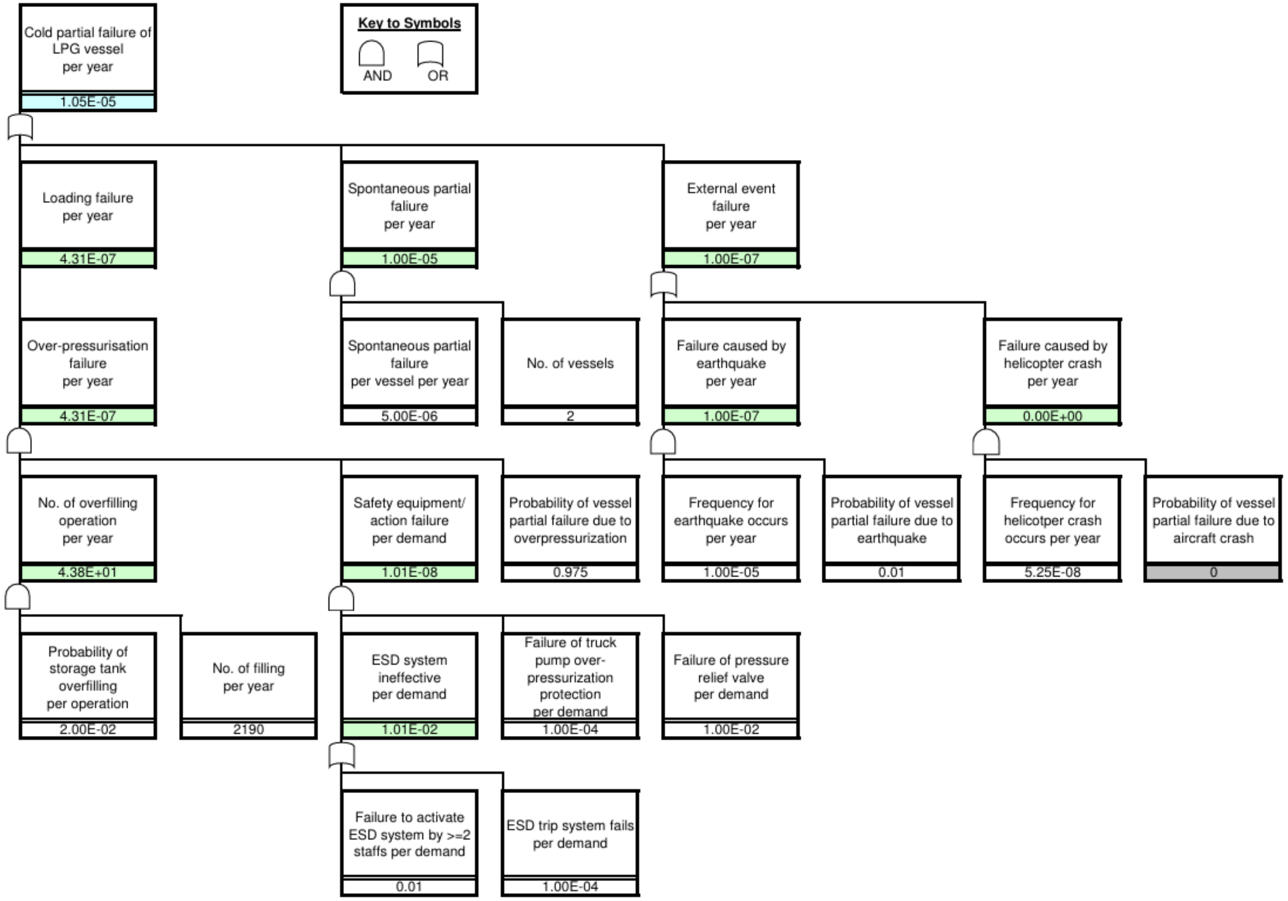
(1) Daytime Traffic Population = Morning Peak Hour Traffic × Average Occupancy × Road Length / Speed

Annex C:
Fault Tree Analysis

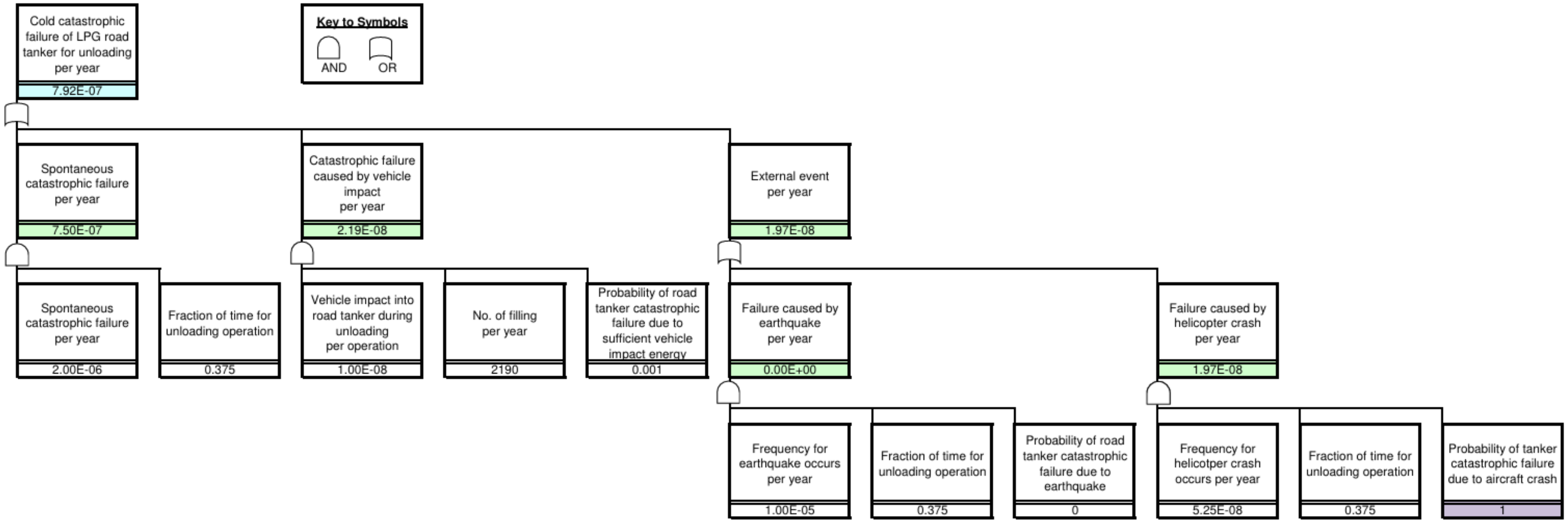
Fault Tree 1 - Cold Catastrophic Failure of LPG Vessel



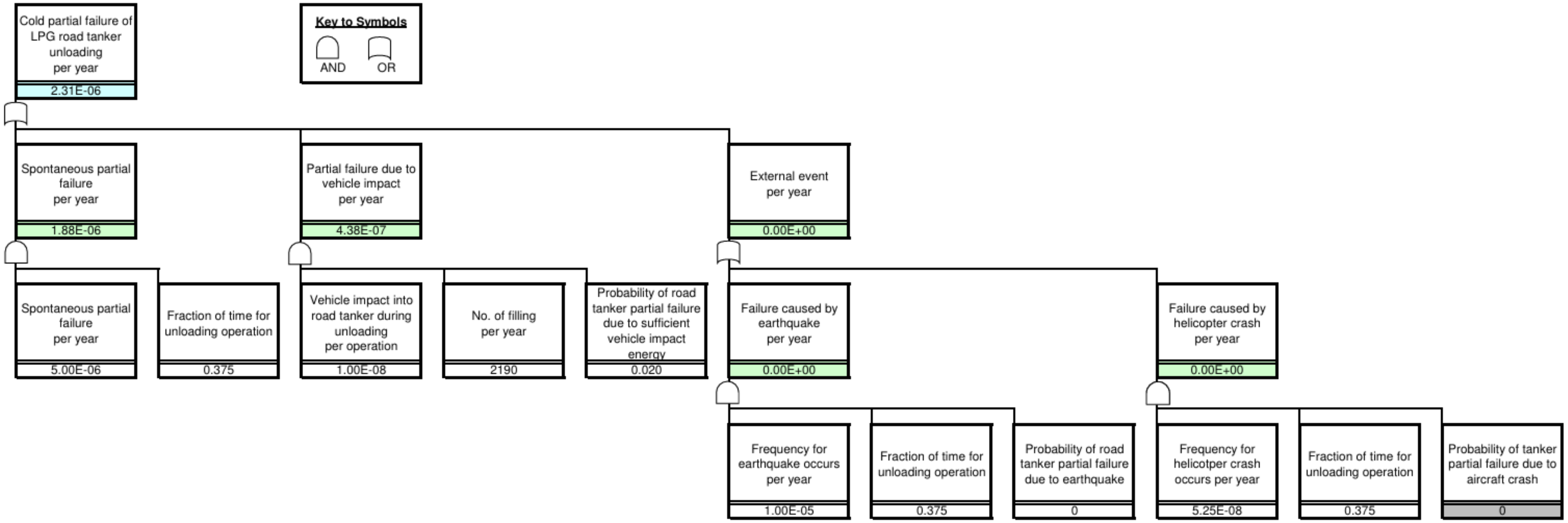
Fault Tree 2 - Cold Partial Failure of LPG Vessel



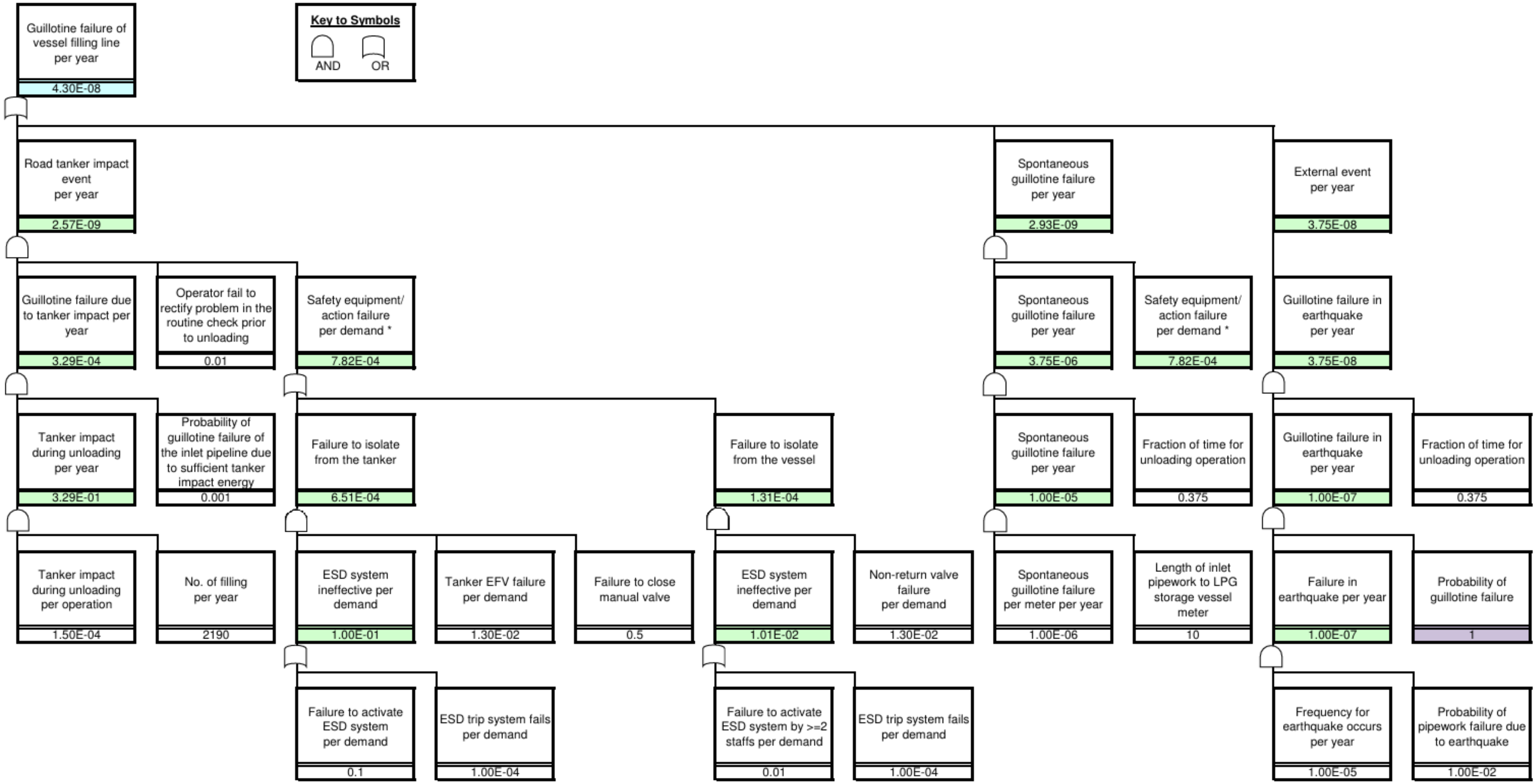
Fault Tree 3 - Cold Catastrophic failure of Road Tanker



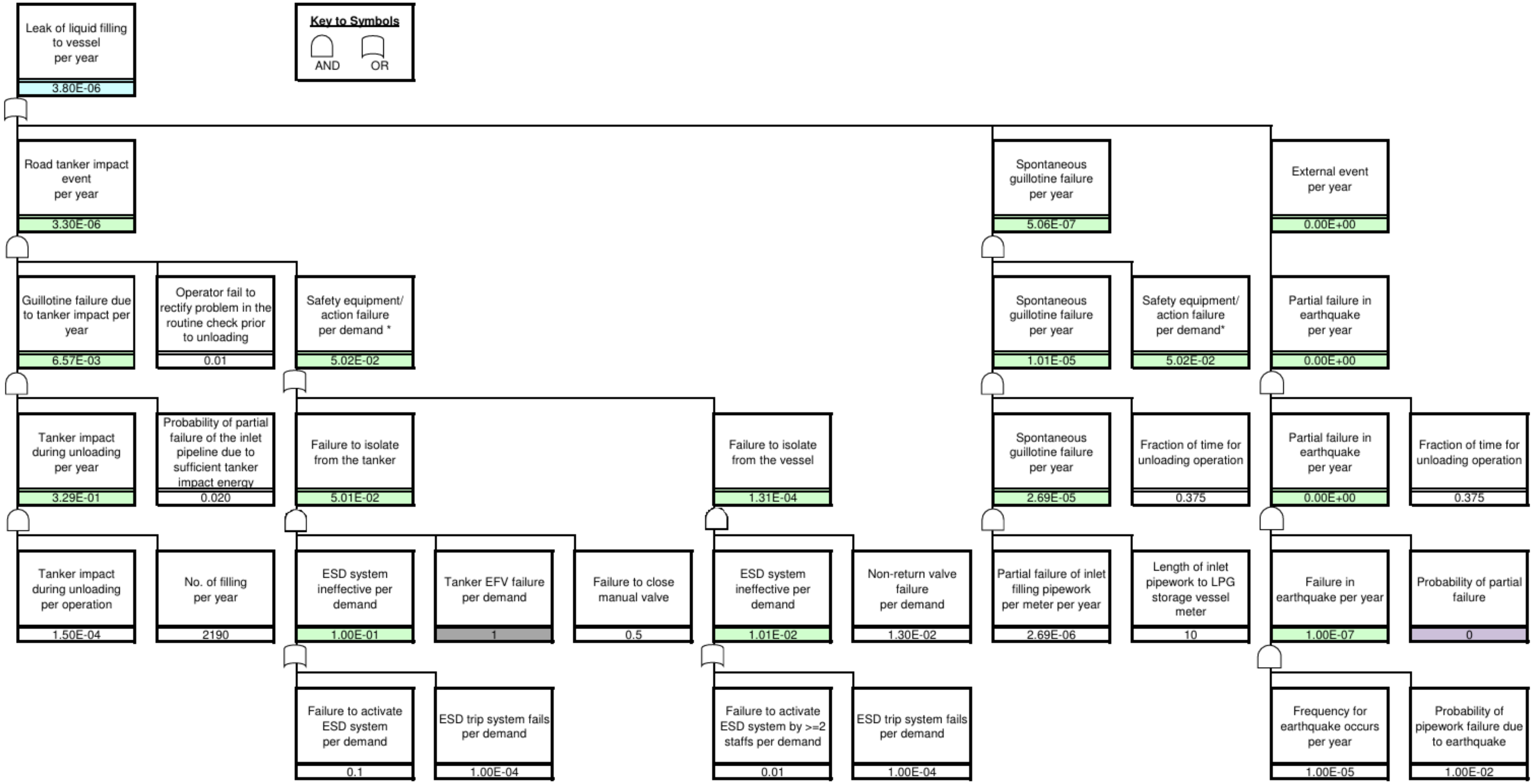
Fault Tree 4 - Cold Partial failure of Road Tanker



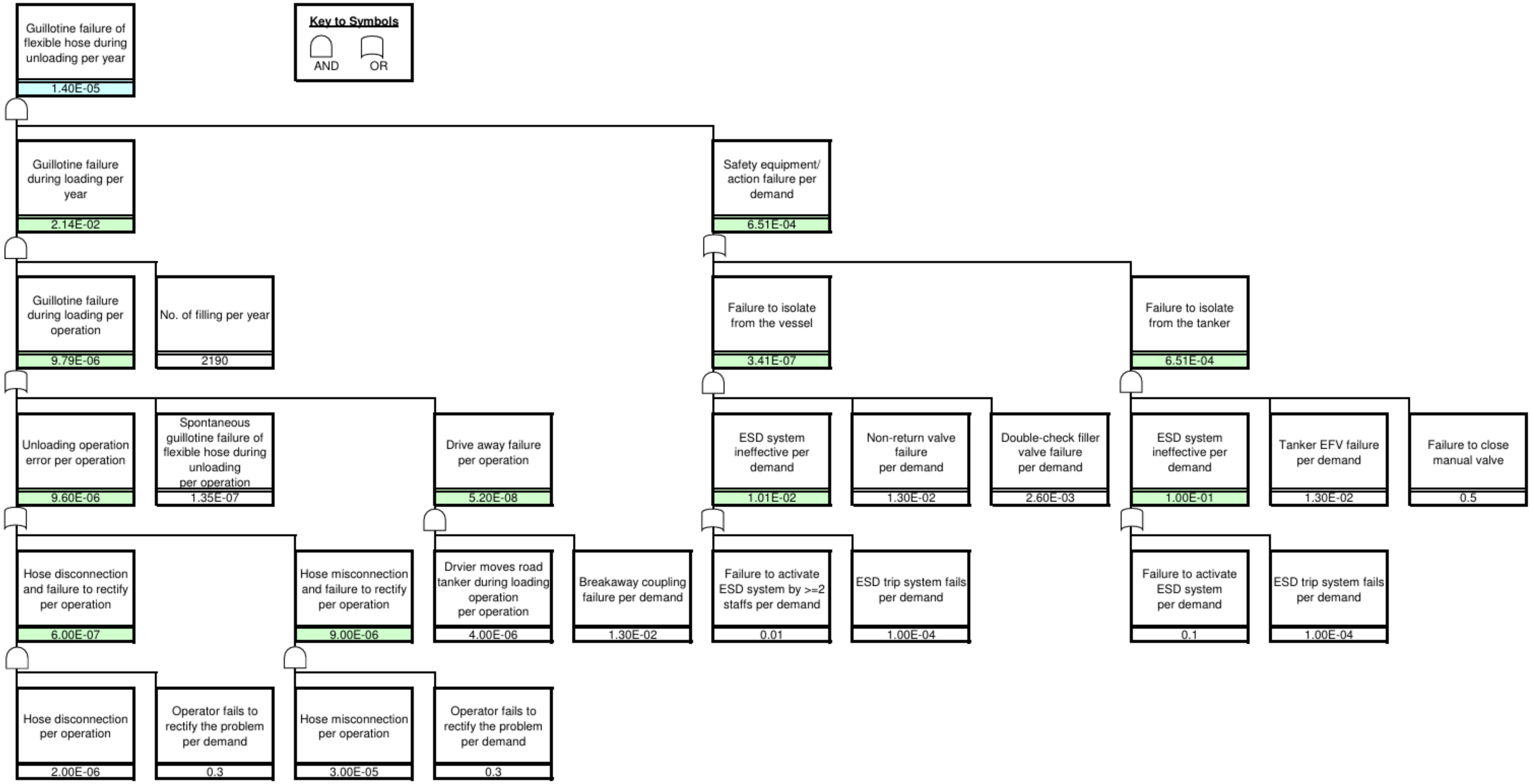
Fault Tree 5 - Guillotine failure of Liquid Inlet Pipework



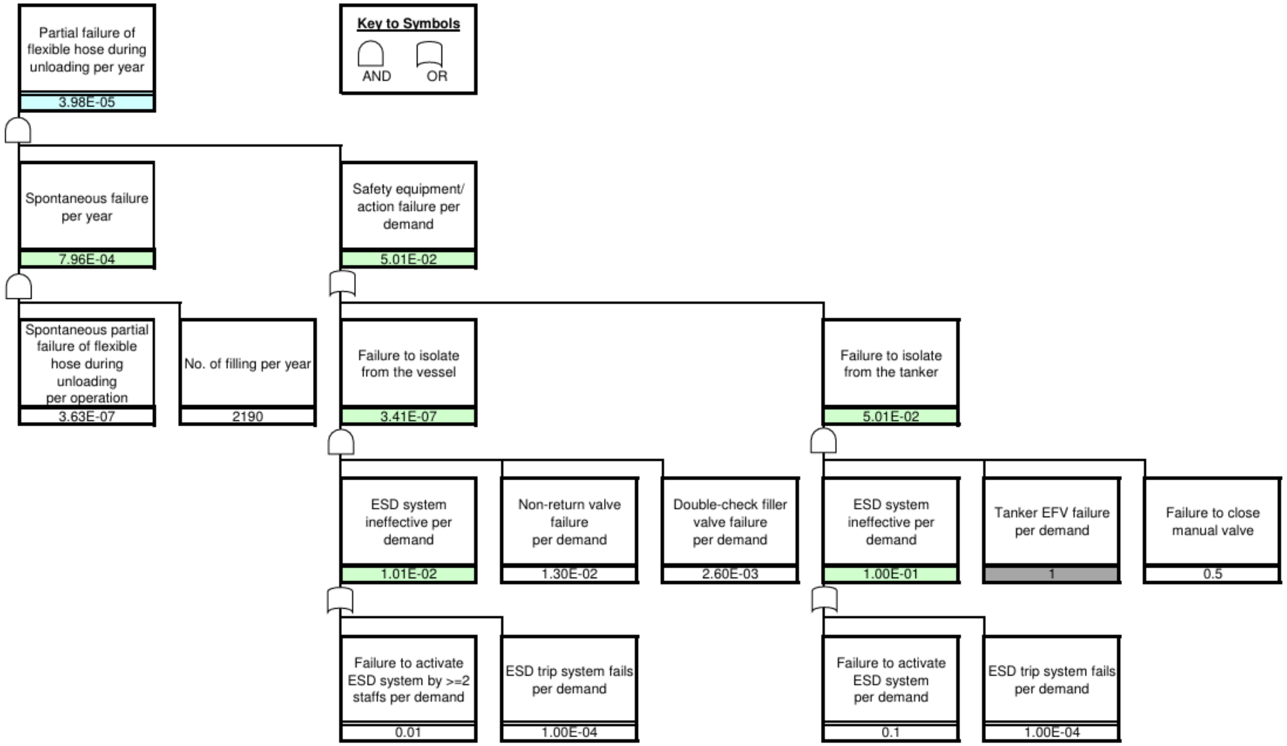
Fault Tree 6 - Leak of Liquid Inlet Pipework



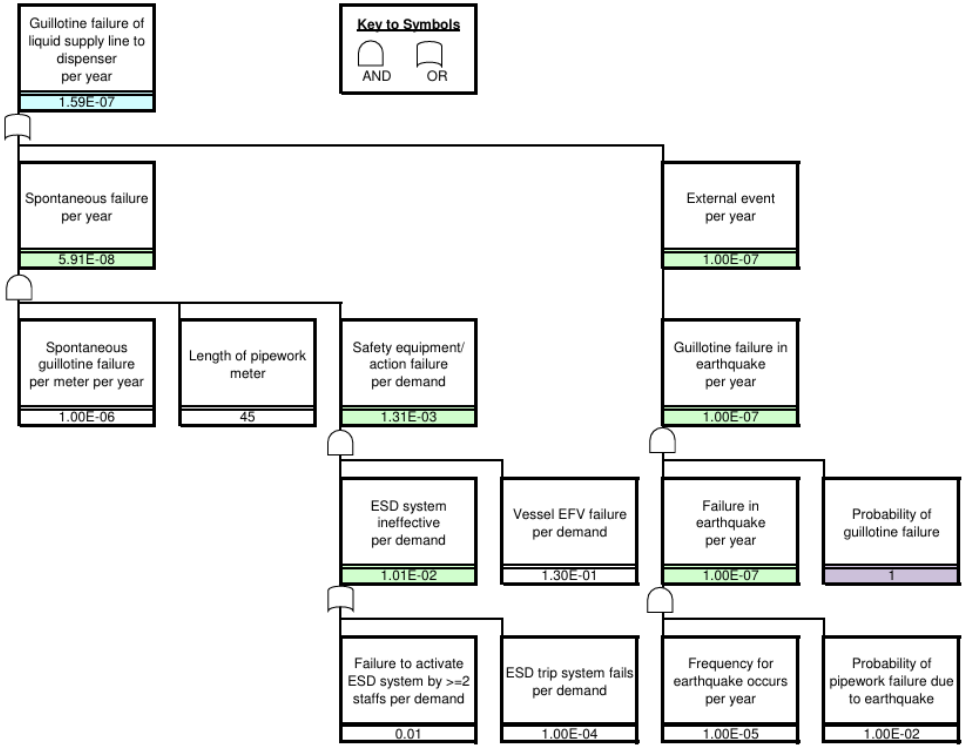
Fault Tree 7 - Guillotine Failure of Flexible Hose during Unloading to LPG Vessel



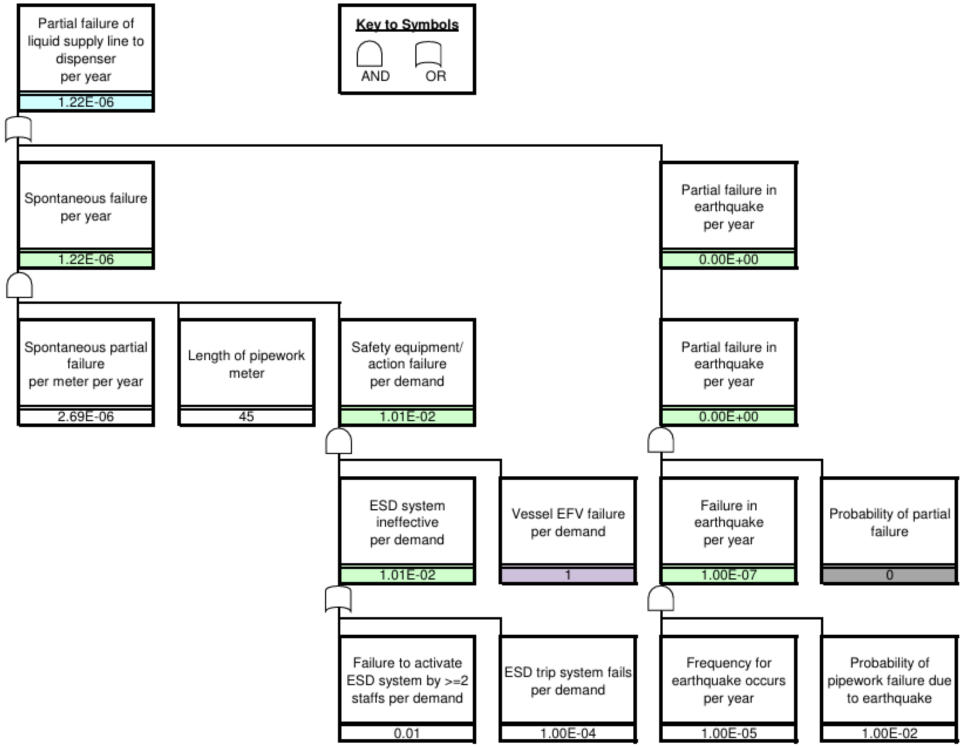
Fault Tree 8 - Leak of Flexible Hose during Unloading to LPG Vessel



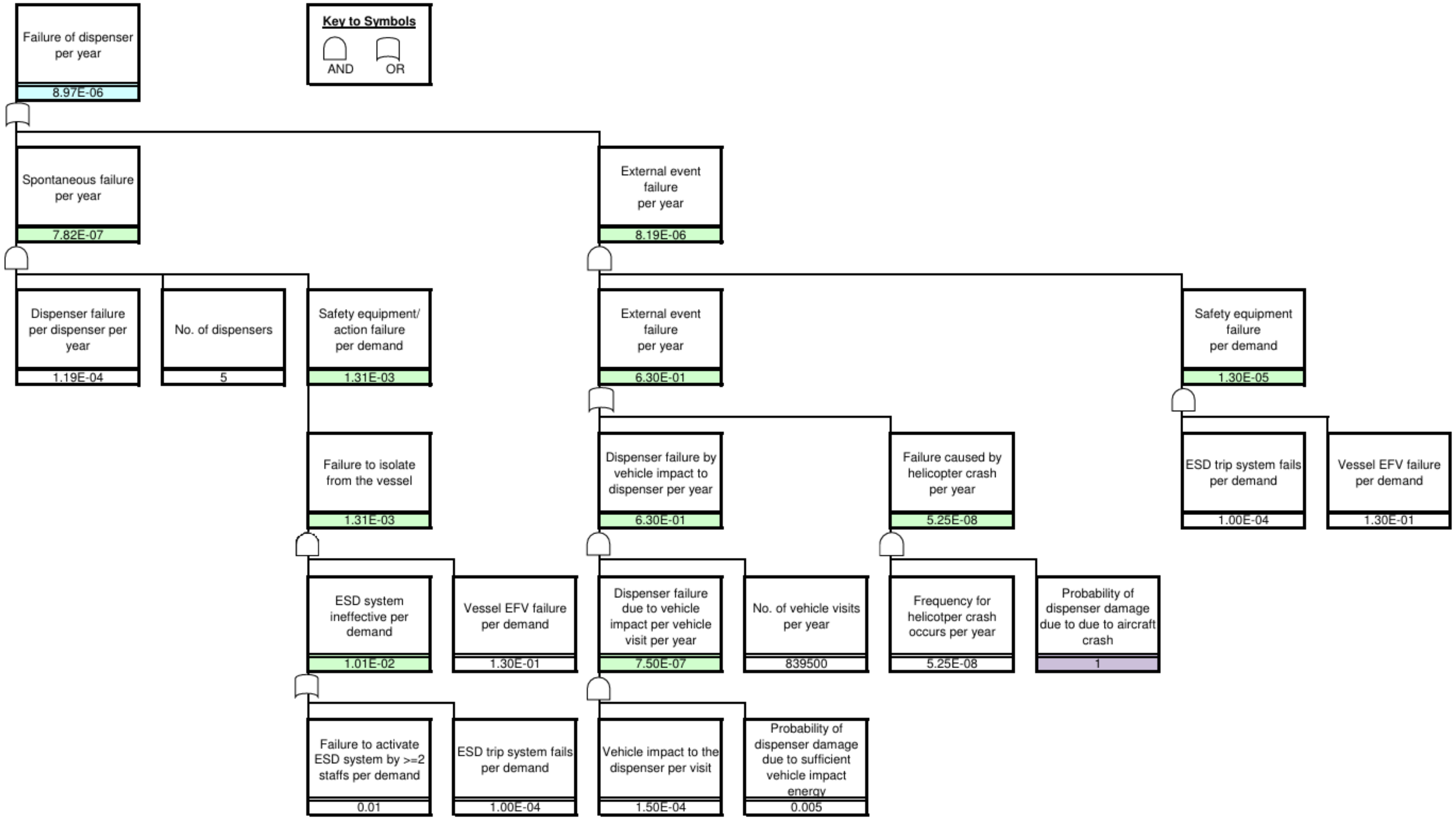
Fault Tree 9 - Guillotine failure of Liquid Supply Line to Dispenser



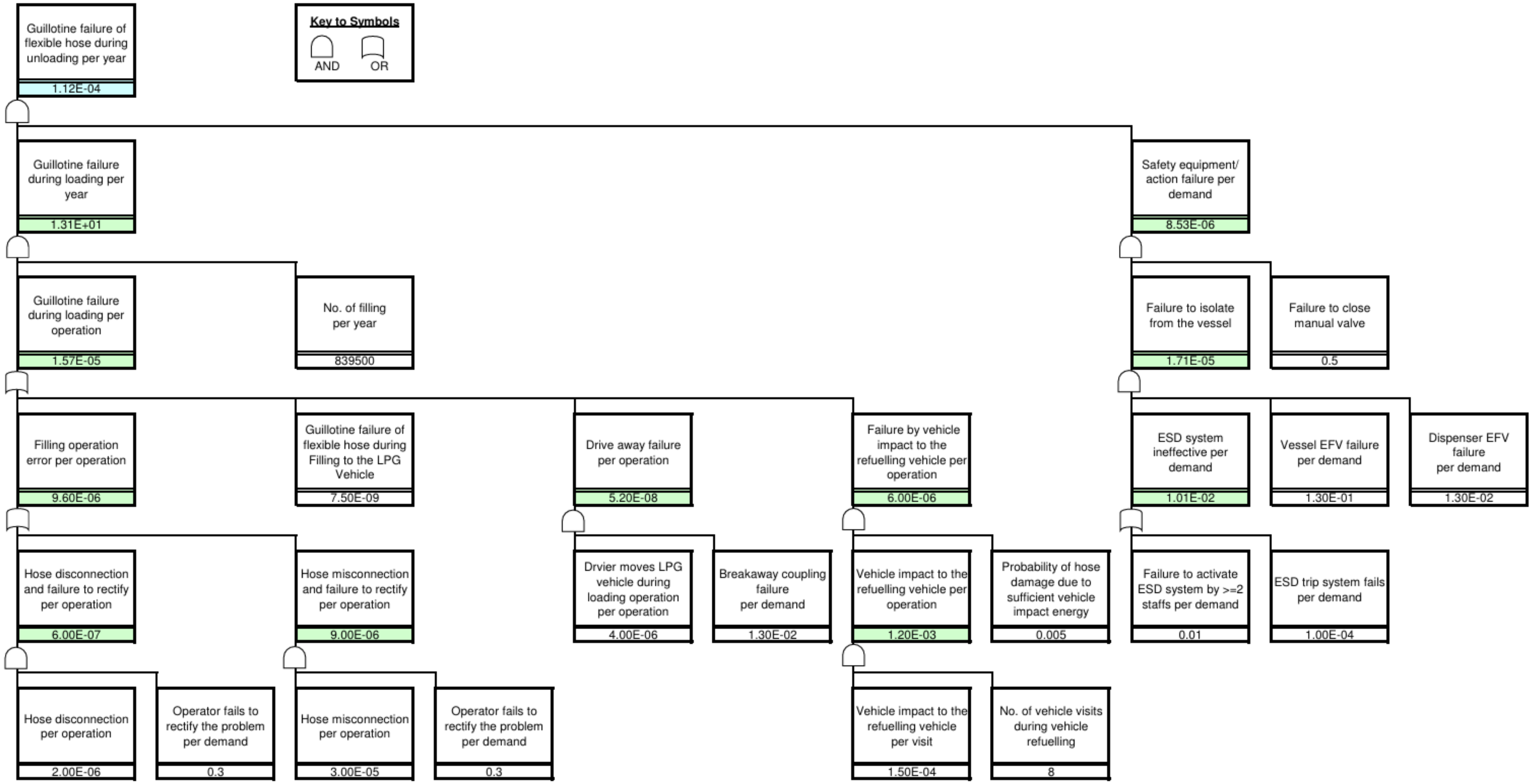
Fault Tree 10 - Leak of Liquid Supply Line to Dispenser



Fault Tree 11 - Failure of the Dispenser

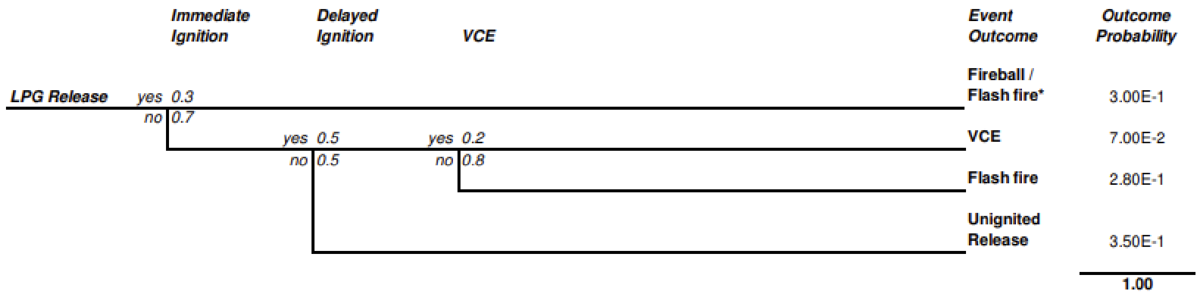


Fault Tree 12 - Guillotine Failure of Flexible Hose during Refuelling to LPG Vehicle



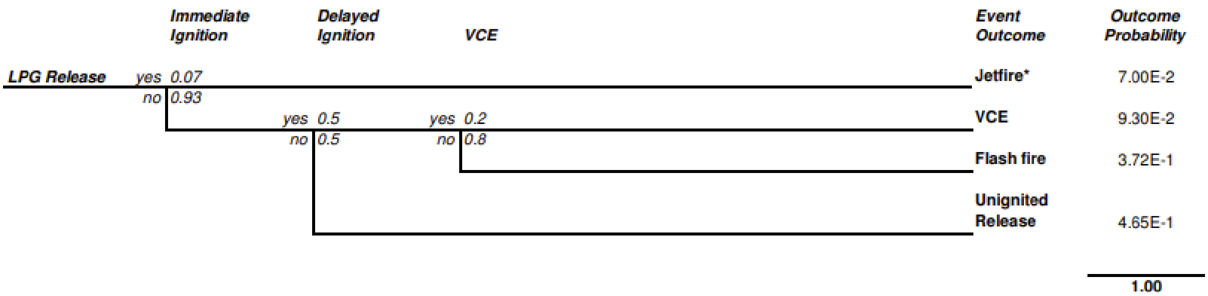
Annex D:
Event Tree Analysis

ETA 1 - Catastrophic Failure of LPG Vessel



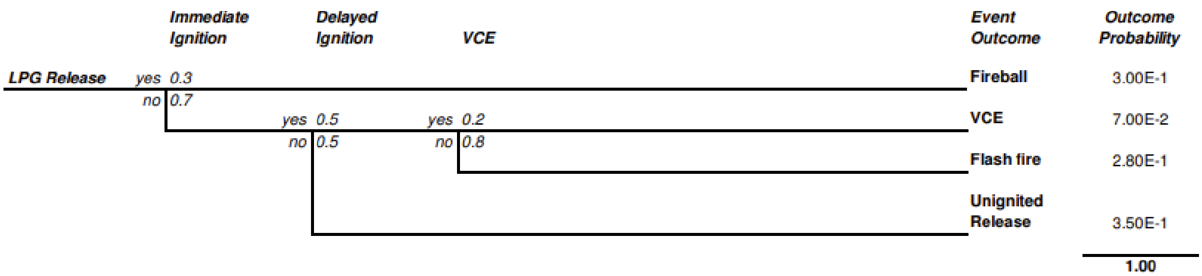
*Fireball effects are negligible for the underground storage tank. Instead Flash Fire is considered.

ETA 2 - Partial Failure of LPG Vessel

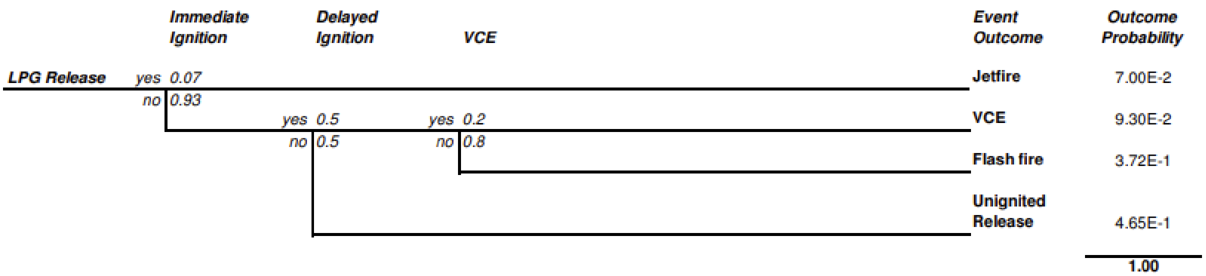


* Vertical Jetfire is considered for partial failure of the underground storage tank.

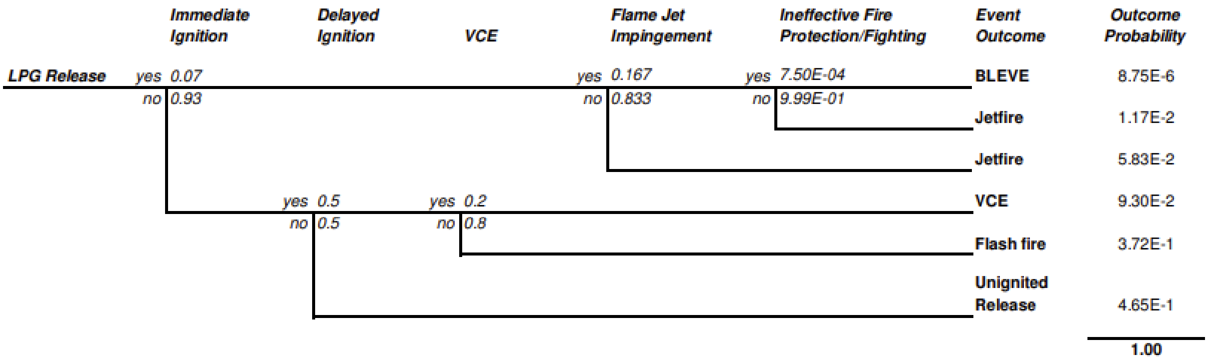
ETA 3 - Catastrophic Failure of LPG Tanker



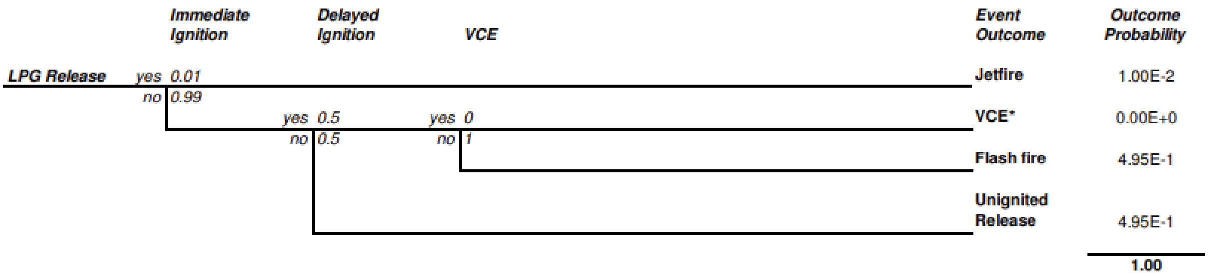
ETA 4 - Partial Failure of LPG Tanker



ETA 5 - Guillotine Failure of Aboveground Pipe (Liquid-Inlet Pipework, Flexible Hose to Vessel)

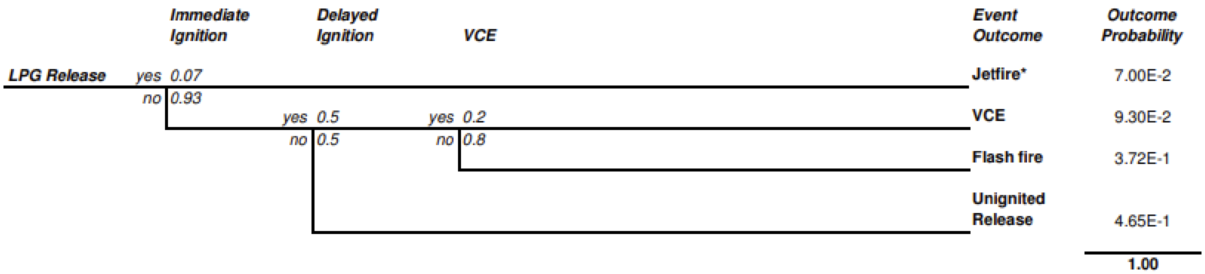


ETA 6 - Leak of Aboveground Pipe (Liquid-Inlet Pipework, Flexible Hose to Vessel)



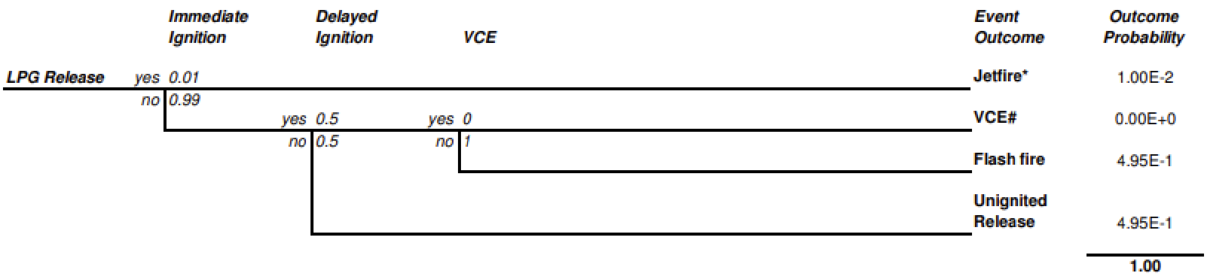
* VCE is not considered for a small release.

ETA 7 - Guillotine Failure of Underground Liquid Supply Line to Dispenser, Failure of Submersible Pump Flange



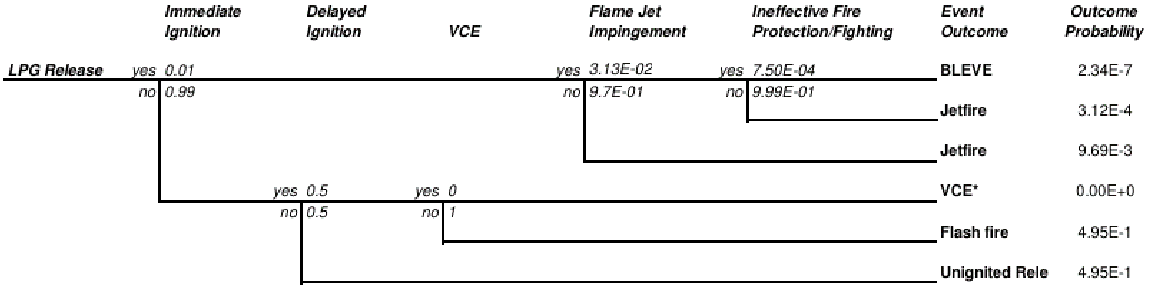
* Vertical Jetfire is considered for failure of the underground pipe / equipment.

ETA 8 - Leak of Underground Liquid Supply Line to Dispenser



* Vertical Jetfire is considered for failure of the underground pipe.
\# VCE is not considered for a small release.

ETA 9 - Failure of Dispenser, Flexible Filling Hose to Vehicle



* VCE is not considered for a small release.

1.00

Annex E:
Atmospheric Stability Class-Wind Speed Frequencies

Day Time Atmospheric Stability Class-Wind Speed Frequencies at Kai Tak Weather Station (Year 2024)

Wind Speed	Stability Class						Total
	A	B	C	D	E	F	
0-2	6.4%	4.7%	0.0%	5.6%	0.0%	7.5%	24.2%
2-4	4.5%	20.2%	9.2%	12.7%	5.8%	0.8%	53.1%
4-6	0.0%	7.9%	5.6%	6.7%	0.3%	0.0%	20.5%
6-8	0.0%	0.0%	0.6%	1.4%	0.0%	0.0%	2.0%
>8	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.2%
Total	10.9%	32.7%	15.5%	26.5%	6.1%	8.3%	100.0%

Night Time Atmospheric Stability Class-Wind Speed Frequencies at Kai Tak Weather Station (Year 2024)

Wind Speed	Stability Class						Total
	A	B	C	D	E	F	
0-2	0.0%	0.0%	0.0%	1.0%	0.0%	40.9%	41.9%
2-4	0.0%	0.0%	0.0%	14.9%	25.2%	5.1%	45.2%
4-6	0.0%	0.0%	0.0%	10.6%	0.5%	0.0%	11.2%
6-8	0.0%	0.0%	0.0%	1.5%	0.0%	0.0%	1.5%
>8	0.0%	0.0%	0.0%	0.2%	0.0%	0.0%	0.2%
Total	0.0%	0.0%	0.0%	28.2%	25.8%	46.0%	100.0%

Annex F: Correspondence with the Planning Department

From: Helen Ka Wing IP/PLAND <hkwip@pland.gov.hk>
Sent: Monday, 26 January 2026 10:18 am
To: Chloe Kung, Wing Chun
Cc: Ernest CM FUNG/PLAND; Amy Ho, Yee Kei
Subject: Re: Enquiry of Advices on Population Data for QRA, 8 Lam Chak Street, Kowloon Bay
Attachments: RtC_PlanD.pdf

Follow Up Flag: Follow up
Flag Status: Completed

Dear Chloe,

Noted for IDs 06a and 06b, reference has been made to the existing industrial building.
Please revise the remark as following as the PR restriction on OZP is referring to the new commercial developments on site.

	15-storey industrial buildings with site area of 5,343m² ~~and maximum plot ratio of 9.5~~. Assume usable floor area as 80% of total floor area. Assume 60% of area as warehouse use and 40% of area as industrial use as observed in site survey. Estimated by worker density of 25m²/worker for industrial and 700m²/worker for warehouse.

No further comments on the remaining items please.

Thanks and regards,
Helen
TP/K12, K DPO, PlanD
Tel: 2231 4971

<u>Internal</u>
K-22/34
Site Record

From: Chloe Kung, Wing Chun <chloewckung@meinhardt.com.hk>
Sent: Friday, January 23, 2026 6:24 PM
To: Helen Ka Wing IP/PLAND <hkwip@pland.gov.hk>
Cc: Ernest CM FUNG/PLAND <ecmfung@pland.gov.hk>; Amy Ho, Yee Kei <amyykho@meinhardt.com.hk>
Subject: RE: Enquiry of Advices on Population Data Near Lam Chak Street, Kowloon Bay

Ref 92071

Dear Helen,

Thank you for your advises on the estimated population data for the QRA study. Attached please find our detailed responses to your comments, along with the revised population estimation.

Should you have any questions, please feel free to contact me at the undersigned or our Ms Amy Ho at 2859 5478.

Your assistance is greatly appreciated.

Best Regards,

Chloe Kung
Engineer

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From: Helen Ka Wing IP/PLAND <hkwip@pland.gov.hk>
Sent: Monday, 12 January 2026 5:12 pm
To: Chloe Kung, Wing Chun <chloewckung@meinhardt.com.hk>
Cc: Amy Ho, Yee Kei <amyykho@meinhardt.com.hk>; Ernest CM FUNG/PLAND <ecmfung@pland.gov.hk>
Subject: Re: Enquiry of Advices on Population Data Near Lam Chak Street, Kowloon Bay

Dear Chloe,

Regarding the population figures shown in the QRA reports for the pre-application submission at 8 Lam Chak Street's, please find our comments below:

- For IDs 03 and 04, please advise the source of the assumed domestic household size of 2.5.
- For ID04, please note the latest planning permission for the site (No. A/K22/31-2). The updated number of flat unit is 1,450.
- For IDs 06a and 06b, the site falls within the "Commercial(2)" zone on the Kai Tak OZP (No. S/K22/8). Please review and confirm if the assumptions in population figures are based on the existing industrial building or the planned commercial developments. If it is pertaining to the planned commercial developments, it is not necessary to differentiate the lower and upper potions of the building, conversely, please elaborate in the "Remark" column that the presented figures are for the future proposed commercial development. The quoted site area and PR are correct.
- For IDs 07a and 07b, the whole development is called the Quayside, it is not necessary to differentiate the developments into upper and lower portions. The development parameters are not accurate, the total office area is about 74,000 m^2, and the retail floor area is about 7,900 m^2.
- For IDs 08, 09 and 10, the sites fall within the "Commercial(2)" zone on the Ngau Tau Kok and Kowloon Bay OZP (No. S/K13/34). As shown on the MPC Paper No. 10/21 on 10.12.2021, the total office area for the Proposed Commercial Development is 130,510 m^2, the total area for retails is 55,610 m^2 and total area for hotel is 14,880 m^2. Please adjust the assumptions accordingly.
- For IDs 11a and 11b, please note the subject proposed development falls within this area. Please review if the figures should be replaced by the proposed development parameters in this pre-application submission.

- For ID 14, the site falls within the "Commercial(1)" zone on the Ngau Tau Kok and Kowloon Bay OZP (No. S/K13/34). As shown on the MPC Paper No. 10/21 on 10.12.2021, the total office area for the Proposed Commercial Development is 144,470 m^2, the total area for retails is 55,130 m^2 and total area for transport facility is 5,000 m^2. Please adjust the assumptions accordingly.

Happy to discuss if you have any further questions.

Thanks and regards,
Helen
TP/K12, K DPO, PlanD
Tel: 2231 4971

Internal
K-22/34
Site Record

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From: Chloe Kung, Wing Chun <chloewckung@meinhardt.com.hk>
Sent: Monday, January 12, 2026 11:10 AM
To: Helen Ka Wing IP/PLAND <hkwip@pland.gov.hk>
Cc: Amy Ho, Yee Kei <amyykho@meinhardt.com.hk>
Subject: FW: Enquiry of Advices on Population Data Near Lam Chak Street, Kowloon Bay

Dear Helen,

As per our tele-conversation, attached please find the mentioned document for your action.
I have also included the email previously sent to Patrick below for your reference.

Many thanks!

Best Regards,

Chloe Kung
Engineer

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From: Chloe Kung, Wing Chun
Sent: Monday, 29 December 2025 5:46 pm
To: 'pwywong@pland.gov.hk' <pwywong@pland.gov.hk>
Cc: Amy Ho, Yee Kei <amyykho@meinhardt.com.hk>
Subject: Enquiry of Advices on Population Data Near Lam Chak Street, Kowloon Bay

Dear Patrick,

We just spoke, we are the risk consultants undertaking a Quantitative Risk Assessment (QRA) for a S16 planning application of proposed comprehensive development in Kowloon Bay, near a dedicated LPG filling station and a Dangerous Goods (DG) Godown operated by Kerry Logistics Network Limited.
Pre-submission of QRA reports regarding the risks related to the LPG Filling Station and the DG Godown have been prepared and submitted to the Electrical and Mechanical Services Department (EMSD). Comments were received and we were requested to seek Planning Department's advices on our estimated population data within the study area (See attached file - Population Estimation.pdf).

In this connection, we will appreciate for your assistance to:

1. Review and comment on our estimated surrounding population within the study area; and
2. Advise if there will be any future approved development within the study area.

It will be much appreciated if you can advise on the above matter before *12th Jan 2026*.

Thank you for your kind attention. Should you have any questions, please feel free to contact me at the undersigned or our Ms Amy Ho at 2859 5478.

Looking forward to your reply. Many thanks.

Chloe Kung
Engineer

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