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潘孝維
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By Email and Hand

Date : 20 January 2025
Your Ref.: TPB/A/YL/321
Our Ref. : LDS/PLAN/7073

Secretary
Town Planning Board
15/F, North Point Government Offices
333 Java Road
North Point, Hong Kong

Dear Sir/Madam,

Application for Planning Permission for
Proposed Social Welfare Facility (excluding those involving Residential Care) at
3/F and 7/F, Tower 1, One North, No. 8 Hong Yip Street, Yuen Long, N.T.
(Application No. A/YL/321)

We refer to the comments from Transport Department (TD) and Electrical and Mechanical Services Department (EMSD) on the captioned application and submit herewith 4 copies of the following further information for your consideration:

(1) Our response to the comments from TD and the revised Traffic Report (see **Annex 1**); and
(2) Our response to the comments from EMSD and the revised Quantitative Risk Assessment Report (see **Annex 2**).

Should there be any queries, please contact our Ms. Cannis Lee at [redacted]

Yours faithfully,
For and on behalf of
Lawson David & Sung Surveyors Limited

Lawson David & Sung

Encl.

c.c. DPO/TM & YLW (Attn.: Ms. Carmen Cheung) – By Email
Client

香港中環雲咸街1-3號南華大廈1601室
Room 1601, South China Building, 1-3 Wyndham Street, Central, Hong Kong. Tel: (852) 2877 1636 Fax: (852) 2524 0355
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Annex 1

Response to the Comments from Transport Department and
the Revised Traffic Report

Comments	Responses
Ms. Sarita CHAN, Commissioner for Transport **Ref : By Email** **Dated : 6th January 2024**	
• **Table 2.3** & **Para. 2.3.3** & **Para. 2.3.6**: For the proposed conversion of office to social welfare facilities, GFA of office use will be reduced. Therefore, the required parking provision for office will be changed. Please review.	As mentioned in **Para. 2.3.3**, with reference to the lease requirement, private car parking space shall be provided in regardless of the development component. Since the proposed conversion of office to social welfare facilities will not induce any change in GFA, there is no change on private car parking space (i.e. fulfil the lease requirement). Please refer to **Table 2.3** of the revised traffic report demonstrated the required parking provision for office under the proposed conversion.
• **Para. 2.3.4** & **2.3.5**: The parking provision for social welfare facilities should suit the operational need. Please provide confirmation from the operator.	Please note that currently there is no operator dedicated to the proposed social welfare facilities. As shown in **Table 2.3**, a parking space is reserved for the proposed social welfare facilities. In fact, the parking spaces within the Subject Site are opened for the visitors and tenants of the Subject Site, it is sufficient to cater for the demand of parking provision for social welfare facilities.
• **Table 2.3** & **Para. 2.3.5** & **Para. 2.3.7**: For parking spaces to be provided as ancillary parking facilities for other uses of the premises, please show the net change of parking facilities (i.e. existing vs required parking spaces) of each use in **Table 2.3** and proposed parking spaces for reference.	Under the lease requirement, there is no change on the required for private car parking space. Nevertheless, it is expected that the actual demand for social welfare facilities will be less than the usage for commercial (i.e. office and retail) and there will be a surplus in supply on the provision of car parking spaces under the proposed conversion, and such spaces will be provided as ancillary parking facilities for other uses of the premises. Please refer to **Table 2.3** of the revised traffic report for the net change of parking facilities of each use and the proposed provision of transport facilities.

Comments	Responses
• **Tables 3.2** & **4.2**: Please specify the exact period of AM and PM peaks adopted for the surveys.	The vehicular and pedestrian traffic generation surveys, as demonstrated in **Tables 3.2** and **4.2**, were conducted on a typical weekday between 09:00-11:30 and 16:00-18:00, aligning with the opening hours of each selected ICYSCs. Since nil vehicular traffic was observed during survey period for the selected ICYSCs, only peak 15-min pedestrian traffic for the selected ICYSCs is identified. The observed peak period adopted for pedestrian traffic generation surveys for the selected ICYSCs is listed in **Table 3.2** of the revised traffic note.
• Although the number of pedestrian is assumed to be lower due to the conversion, the target consumers of the social welfare services are mostly children and those of special needs, enhanced pedestrian connectivity and universal accessibility to the nearby public transport facilities, e.g. GMB, bus stops and MTR station. Please review the adequacy of pedestrian connectivity accordingly.	The existing pedestrian connectivity between the Subject Site and the nearby public transport facilities have been reviewed and presented in **Chapter 6** of the revised traffic note. Under the current situation as shown in **Figure 6.1**, Wang Yip Street West and Po Yip Street serve as the primary pedestrian routes between the Subject Site and public transport facilities, with proper pedestrian crossing facilities available along Po Yip Street, which is deemed universally accessible for pedestrians with special needs. On the other hand, pedestrians may consider to cross Wang Yip Street West at their own discretion. As there are no restrictions on crossing zones and visibility is adequate along Wang Yip Street West, pedestrian can access the Subject Site cross Wang Yip Street West depending on traffic conditions. In view of the above, pedestrian generated/attracted by the proposed social welfare facilities can utilise the existing footpath and at-grade/grade separated crossing to access the nearby public transport facilities from the Subject Site. Therefore, it is considered that there is sufficient pedestrian connectivity and universal accessibility between the Subject Site and the nearby public transport facilities, and no further improvements are necessary.

20/01/2025

Reference number CHK50844710

SECTION 16 PLANNING APPLICATION FOR THE PROPOSED SOCIAL WELFARE FACILITIES AT 3/F AND 7/F, TOWER 1, ONE NORTH, NO. 8 HONG YIP STREET, YUEN LONG, NEW TERRITORIES

REVISED TRAFFIC REPORT

SYSTRA MVA

IDENTIFICATION TABLE	
Client/Project owner	Regal Crown Development Limited
Project	Section 16 Planning Application for the Proposed Social welfare facilities at 3/F and 7/F, Tower 1, One North, No. 8 Hong Yip Street, Yuen Long, New Territories
Study	Revised Traffic Report
Date	20/01/2025
File name	Revised Traffic Report (20250120).docx
Reference number	CHK50844710

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1. INTRODUCTION

1.1. Background

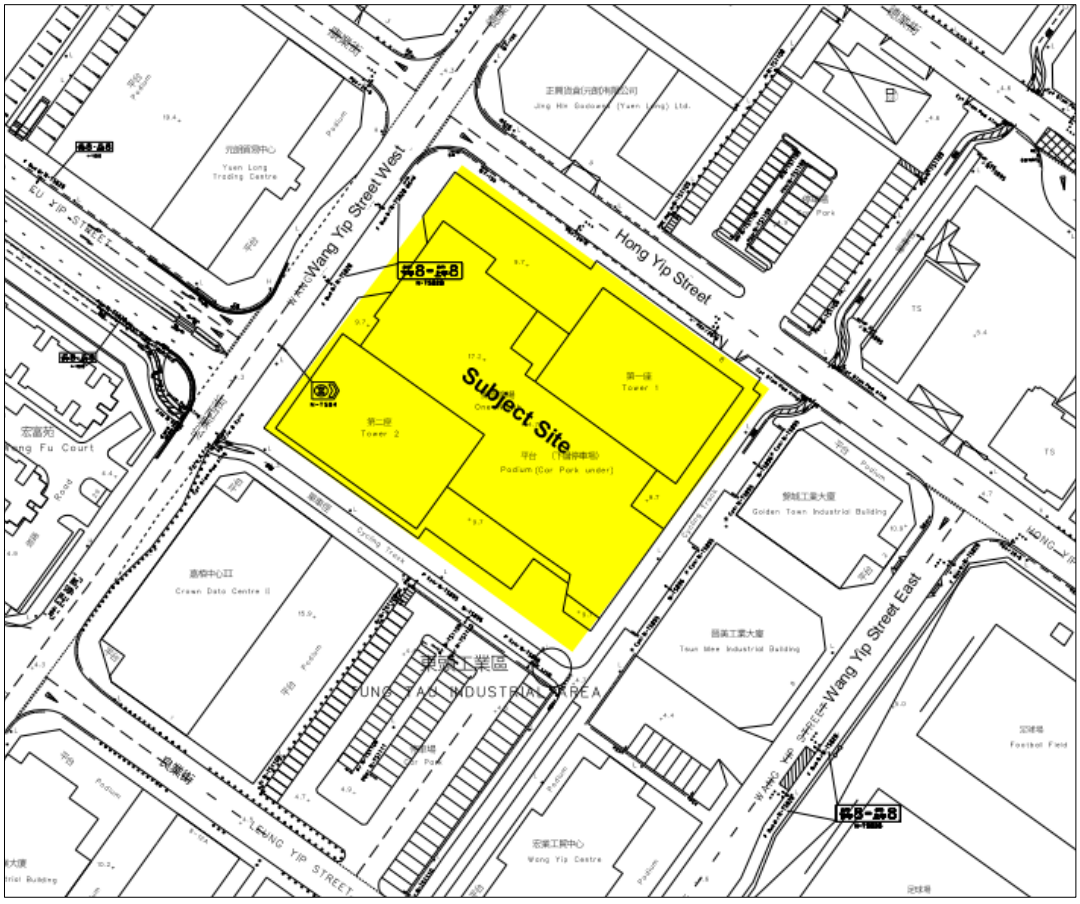
1.1.1. The Subject Site is located at One North, 8 Hong Yip Street, Yuen Long, where is zoned as "Other Specified Uses" annotated "Business" under the approved Yuen Long Outline Zoning Plan (OZP) No. S/YL/27. The Client acquired the site in Yuen Long for commercial development from a government tender in December 2015.

1.1.2. The Client intends to change the use of 3/F and 7/F, Tower 1 of One North, from “Office” to “Social welfare facilities” as specified under column 2 in the OZP.

1.1.3. A Section 16 Planning Application A/YL/321 has been submitted in September 2024 and comments from government departments were received as per Planning Department’s (PlanD’s) email on 6th November 2024.

1.1.4. MVA Hong Kong Ltd. has been commissioned as the traffic consultant, to conduct the Traffic Report to review on the traffic impact inducted by the change of development parameters of the Subject Site. The location of the Subject Site is shown in **Figure 1.1**.

Figure 1.1 Location of the Subject Site



1.2. Study Objective

1.2.1. The scopes of this Traffic Report are as follows:

a) Summarize the provision of parking and loading/unloading facilities for the Subject Site;
b) Review the vehicular and pedestrian traffic generation and attraction by the existing office purpose based on the vehicular and pedestrian trip rates adopted in Transport Planning and Design Manual (TPDM);
c) Estimate the vehicular and pedestrian traffic generation and attraction by the proposed social welfare facilities with reference to the vehicular and pedestrian trip rates obtained by traffic surveys on some existing similar social welfare facilities;
d) Carry out comparison of the two set of traffic generation and attraction as described above; and
e) Review the adequacy of nearby public transport and pedestrian facilities.

2. THE SUBJECT SITE

2.1. The Proposed Conversion

2.1.1. The proposed conversion is designated to convert the office floor space on the 3/F and 7/F of Tower 1 into social welfare facilities which are designed to provide support and service to children, youth and families particularly those from different ethnic and income backgrounds.

2.1.2. The proposed services will be provided on a service-by-appointment basis, and the proposed social welfare facilities include:

- Pre-school Rehabilitation Services (for children who are aged 2 or above)
- Children and youth services (aged 6-24 on neighbourhood basis)
- Integrated education and rehabilitation service
- Family education and counselling services
- Community development services
- Specialized services
- Support services for ethnic minorities/new immigrants
- Physical/Speech/Occupational Therapy

2.1.3. The development parameter for the whole premises (i.e. Tower 1 and Tower 2 for One North, Yuen Long) is summarized in **Table 2.1** below.

Table 2.1 Development Parameter for the Whole Premises

Development Type	Floor		GFA (m^2) (1)
Retail	G/F to 2/F		10,569.650
Office	Tower 1	1/F	712.736
		2/F	1,139.287
		3/F (the Proposed Conversion)	1,302.186
		7/F (the Proposed Conversion)	1,325.685
		5/F to 6/F and 8/F to 17/F	13,256.85
	Tower 2	1/F	962.615
		2/F	977.899
		3/F	1,313.653
		5/F to 17/F	15,896.925
	Sub-total for office		35,574.183
Total			**46,143.833**

Note:
(1) Based on the latest General Building approved in September 2022.

2.2. Existing Provision of Internal Transport Facilities

2.2.1. With reference to the latest General Building Plan (GBP) approved in September 2022, the existing provision of Internal Transport Facilities under lease requirement is summarized in **Table 2.2** below.

Table 2.2 Requirement on the Provision of Internal Transport Facilities under Lease Requirement and Existing Provision

Transport Facilities	Development Component	Development Parameters (m^2)	Lease Requirement		Existing Provision [3]	
Private Car Parking Space	Retail	10,569.650	• 1 space for every 600m^2 GFA • Accessible car park space shall be reserved as the Building Authority may require and approved		18	
	Office	35,574.183			59	
Accessible Car Parking Space		-	• Space shall be reserved as the building authority may require and approved		3	
Total for Car Parking Space					**80 [1]**	
Container Parking Space		-	• 1 space shall be provided		1	
Taxi / Private Car Layby		-	• 1 space shall be provided		1	
Motorcycle Parking Space	Retail	10,569.650	• 10% of the total number of private car parking spaces		2	
	Office	35,574.183			6	
	Total for Motorcycle Parking Space				**8 [1]**	
					HGV	**LGV**
Goods Vehicle Parking Space; Loading/ unloading (L/UL) Bay [2]	Retail	10,569.650	• 1 space for every 1,000m^2 GFA • 50% shall be used for parking and the remaining 50% for L/UL	Parking	2	3
				L/UL	2	4
				Sub-total	4	7
	Office	35,574.183	• 1 space for every 1,530m^2 GFA • 50% shall be used for parking and the remaining 50% for L/UL	Parking	5	7
				L/UL	4	9
				Sub-total	9	16
	Total for Goods Vehicle Parking Space; Loading/unloading Bay			**Parking**	**7**	**10**
				L/UL	**6**	**13**
				Sub-total	**13 [1]**	**23 [1]**

Note:

(1) Flexibility of 5% in car parking space, goods vehicle parking space, loading/unloading bay is allowed

(2) 35% for HGV and 65% for LGV

(3) Based on the latest General Building Plan (GBP) approved in September 2022

2.2.2. As shown in the above **Table 2.2**, a total of 80 nos. of car parking spaces (3 nos. of accessible car park space has been included), 1 no. of container parking space, 1 no. of taxi/private car layby, 8 nos. of motor parking space, 13 nos. for heavy goods vehicles (7 nos. for goods vehicle parking space and 6 nos. for loading/unloading bay) and 23 nos. of light goods vehicles (10 nos. for goods vehicle parking space and 13 nos. for loading/unloading bay) are provided.

2.3. Proposed Provision of Internal Transport Facilities

2.3.1. Under the proposed conversion, it is proposed that no change in the provision of internal transport facilities for the whole premises. The proposed provision of internal transport facilities under the proposed conversion is summarised in **Table 2.3** below.

Table 2.3 Proposed Provision of Internal Transport Facilities under the Proposed Conversion

Transport Facilities			Existing Provision under the Lease Requirement [1] (A)		Required Provision under the Proposed Conversion		Proposed Provision (B)		Net Change ((B) – (A))	
Private Car Parking Space	Retail		18		18		18		-	
	Office		59		55		55		-4	
	Social Welfare Facilities		-		4		4		+4	
Accessible Car Parking Space			3		3		3		-	
Total for Car Parking Space			**80**		**80**		**80**		-	
Container Parking Space			1		1		1		-	
Taxi / Private Car Layby			1		1		1		-	
Motorcycle Parking Space	Retail		2		2		2		-	
	Office		6		6		6		-	
	Social Welfare Facilities		-		-		-		-	
	Total		**8**		**8**		**8**		-	
			HGV	**LGV**	**HGV**	**LGV**	**HGV**	**LGV**	**HGV**	**LGV**
Goods Vehicle Parking Space; Loading/ unloading (L/UL) Bay	Retail	Parking	2	3	2	3	2	3	-	-
		L/UL	2	4	2	4	2	4	-	-
		Sub-total	4	7	4	7	4	7	-	-
	Office	Parking	5	7	4	7	4	7	-1	-
		L/UL	4	9	4	8	4	8	-	-1
		Sub-total	9	16	8	15	8	15	-1	-1
	Social Welfare Facilities	Parking	-	-	-	-	1	-	+1	-
		L/UL	-	-	-	-	-	1	-	+1
		Sub-total	-	-	-	-	1	1	+1	+1
	Total	**Parking**	**7**	**10**	**6**	**10**	**7**	**10**	-	-
		L/UL	**6**	**13**	**6**	**12**	**6**	**13**	-	-
		Sub-total	**13**	**23**	**12**	**22**	**13**	**23**	-	-

Note:
(1) Based on the latest General Building Plan (GBP) approved in September 2022

Private Car Parking Space

2.3.2. With reference to the lease requirement as mentioned in **Table 2.2**, 1 no. of private car parking space for every 600m^2 GFA shall be provided in regardless of the development component.

2.3.3. Since the proposed conversion of office to social welfare facilities will not induce any change in GFA, there is no change on private car parking space (i.e. fulfil the lease requirement).

2.3.4. In addition, according to Hong Kong Planning Standards and Guideline (HKPSG), there is no specific requirements on the provision of internal transport facilities for social welfare facilities.

2.3.5. Nevertheless, it is expected that the actual demand for social welfare facilities will be less than the usage for commercial (i.e. office and retail) and there will be a surplus in supply on

the provision of car parking spaces under the proposed conversion, and such spaces will be provided as ancillary parking facilities for other uses of the premises.

Goods Vehicle Parking Space/Loading/unloading Bay

2.3.6. Under the lease requirement as mentioned in **Table 2.2**, goods vehicle parking space/loading/unloading bay will be provided in accordance with the office and retail GFA. Since there is a decrease in office GFA under the proposed conversion, it is anticipated that there is a decrease in the required provision for goods vehicle parking space/loading/unloading bay.

2.3.7. Similar to private car parking space, there will be a surplus on the provision of goods vehicle parking space/loading/unloading bay under the proposed conversion, and such spaces/bays will be provided as parking facilities for the proposed social welfare facilities.

3. COMPARISON OF VEHICULAR TRAFFIC GENERATION FOR THE PROPOSED CONVERSION

3.1. Adopted Vehicular Trip Rates

Vehicular Trip Rates for Office

3.1.1. In order to estimate the traffic generation and attraction of office use, reference has been made to the Transport Planning and Design Manual (TPDM) published by Transport Department. The adopted vehicular trip rates for office is listed in **Table 3.1** below.

Table 3.1 Adopted Vehicular Trip Rates for Office

Development Type	Vehicular Trip Rates (pcu/hr/100 m^2 GFA)			
	AM Peak		PM Peak	
	Generation	Attraction	Generation	Attraction
Office (pcu/hr/100 m^2) (1)	0.1703	0.2452	0.1573	0.1175

Note:
(1) The mean trip rates is adopted for the Subject Site.

Vehicular Trip Rates for Social Welfare Facilities

3.1.2. There is nil information regarding the traffic generation and attraction of social welfare facilities in TPDM, since they normally serve local needs and insignificant traffic generation is anticipated. Nevertheless, traffic generation surveys are conducted to obtain the vehicular trip rates for social welfare facilities, if any.

3.1.3. Traffic trip generation surveys for social welfare facilities were conducted at some Integrated Children and Youth Services Centres (ICYSCs) which are providing educational programs, counseling, health services, and recreational activities for children and youth. These ICYSCs are opened to the public and equipped with community-based facilities, and they are designed to provide a holistic range of services for children and youth and to organizes a wide variety of indoor and outdoor activities.

3.1.4. Having considered that the traffic demand for services at ICYSCs will be relatively higher when comparing among the social welfare facilities for different sectors of the community among children and youth, rehabilitation services and family services, etc., trip rates for ICYSCs have been taken into consideration in this study for conservative approach.

3.1.5. In addition, the proposed services will be provided on a service-by-appointment basis as mentioned in **Chapter 2**. It is anticipated that the traffic trip generation and attraction for the proposed services will be less than the obtained traffic trip generation rate for ICYSCs.

3.1.6. Manual classified count surveys for vehicles were conducted to obtain the most up-to-date vehicular trip generations and attractions for two selected ICYSCs in Tuen Mun and one selected ICYSCs in Tin Shui Wai in November 2024 during the AM and PM peak periods. These selected ICYSCs includes:

- The Boys' & Girls' Clubs Association of Hong Kong - Jockey Club Tuen Mun Children & Youth Integrated Services Centre
  (香港小童群益會 - 賽馬會屯門青少年綜合服務中心)
- Chinese YMCA of Hong Kong Tuen Mun Centre
  (香港中華基督教青年會屯門會所)
- H.K.S.K.H. St. Matthias' Integrated Services - Jockey Club Youth Express
  (香港聖公會聖馬提亞綜合服務 – 賽馬會青年幹線)

3.1.7. The vehicular and pedestrian traffic generation surveys were conducted on a typical weekday between 09:00-11:30 and 16:00-18:00, aligning with the opening hours of each selected ICYSCs. Since nil vehicular traffic was observed during survey period for the selected ICYSCs, only peak 15-min pedestrian traffic for the selected ICYSCs is identified. The observed peak period adopted for pedestrian traffic generation surveys for the selected ICYSCs are summarized in **Table 3.2**.

Table 3.2 Peak Period Adopted for Vehicular Traffic Generation Surveys for the Selected ICYSCs

Facilities	Opening Hours on Typical Weekday	Peak Period adopted for Survey		Observed Peak Period for Traffic Generation Survey	
				Vehicular (1)	Pedestrian (2)
The Boys' & Girls' Clubs Association of Hong Kong - Jockey Club Tuen Mun Children & Youth Integrated Services Centre (香港小童群益會 - 賽馬會屯門青少年綜合服務中心)	• Monday-Friday (except Tuesday): 14:00-18:00 • Tuesday: 10:00-18:00	AM Peak	09:30-11:30	-	09:45-10:00
		PM Peak	16:00-18:00	-	-
Chinese YMCA of Hong Kong Tuen Mun Centre (香港中華基督教青年會屯門會所)	• Monday-Friday (except Thursday): 14:00-20:30 • Thursday: 09:30-13:00 & 14:00-17:15	AM Peak	09:00-11:00	-	09:00-09:15
		PM Peak	16:00-17:30	-	16:20-16:35
H.K.S.K.H. St. Matthias' Integrated Services - Jockey Club Youth Express (香港聖公會聖馬提亞綜合服務 – 賽馬會青年幹線)	• Monday-Friday (except Wednesday): 14:00-18:00 & 19:00-22:00 • Wednesday: Closed	PM Peak	16:00-18:00	-	16:05-16:20

Note: (1) Nil vehicular traffic was observed during survey period for the selected ICYSCs
(2) Nil pedestrian traffic was observed during survey period during PM peak period for the Boys' & Girls' Clubs Association of Hong Kong - Jockey Club Tuen Mun Children & Youth Integrated Services Centre

3.1.8. As there is no designated car parking spaces nor loading/unloading facilities for these ICYSCs, surveyors were assigned to record if there is pick-up/drop-off and loading/unloading activities on the adjacent roads to access these ICYSCs.

3.1.9. The locations of the surveyed ICYSCs in Tuen Mun and Tin Shi Wai are shown in **Figures 3.1** to **3.3,** and the surveyed trip rates are illustrated in **Table 3.3.**

Figure 3.1 **Location of The Boys' & Girl's Clubs Association of Hong Kong - Jockey Club Tuen Mun Children & Youth Integrated Services Centre**

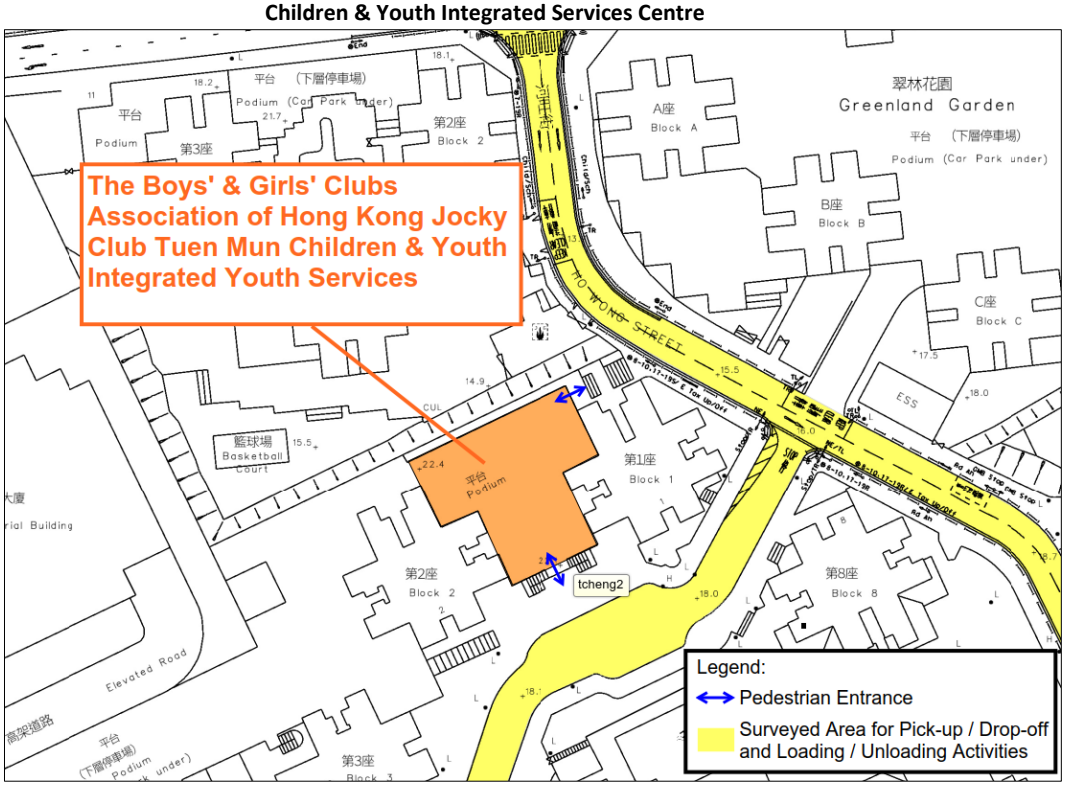


Figure 3.2 **Location of Chinese YMCA of Hong Kong Tuen Mun Centre**

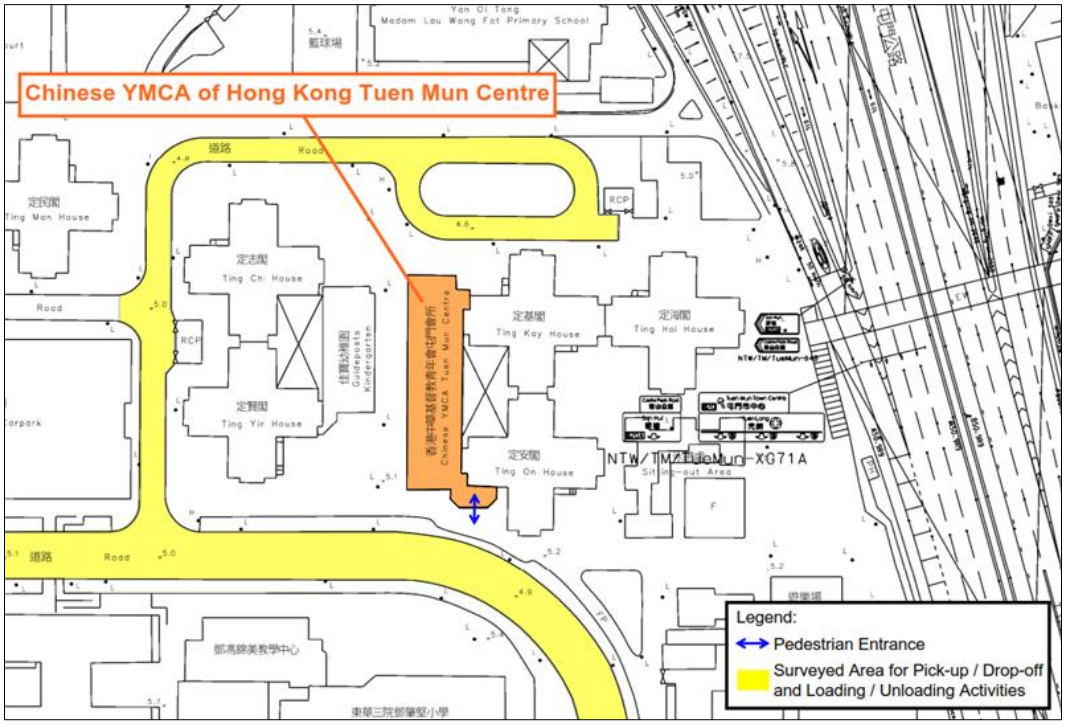


Figure 3.3 Location of H.K.S.K.H. St. Matthias' Integrated Services - Jockey Club Youth Express

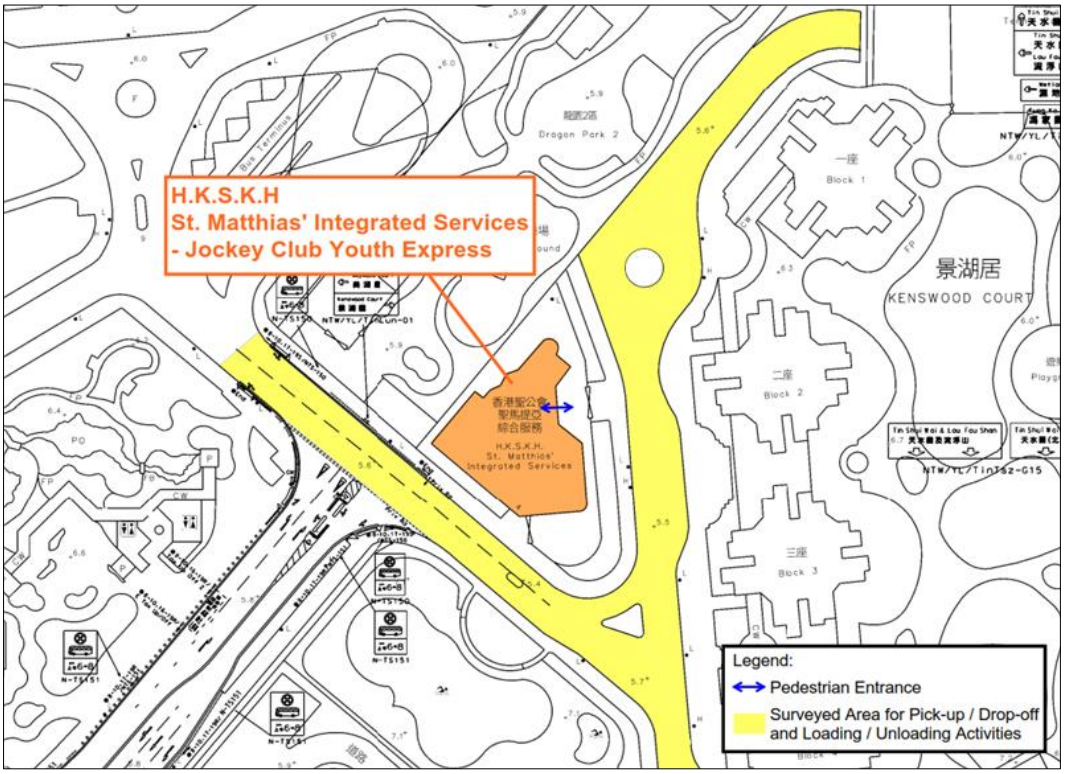


Table 3.3 Vehicular Trip Rates for the Selected ICYSCs in Tuen Mun and Tin Shui Wai

Facilities	GFA (m^2) (1)(2)	Vehicular Trip Rates (pcu/hr/100 m^2 GFA)			
		AM Peak		PM Peak	
		GEN	ATT	GEN	ATT
The Boys' & Girls' Clubs Association of Hong Kong - Jockey Club Tuen Mun Children & Youth Integrated Services Centre (香港小童群益會 - 賽馬會屯門青少年綜合服務中心)	Approx. 700m^2	0.000	0.000	0.000	0.000
Chinese YMCA of Hong Kong Tuen Mun Centre (香港中華基督教青年會屯門會所)	Approx. 600m^2	0.000	0.000	0.000	0.000
H.K.S.K.H. St. Matthias' Integrated Services - Jockey Club Youth Express (香港聖公會聖馬提亞綜合服務 – 賽馬會青年幹線)	Approx. 700m^2	N/A	N/A	0.000	0.000
Adopted Trip Rate for Social Welfare Facilities		**0.000**	**0.000**	**0.000**	**0.000**

Note:
(1) The above GFA is indicative only.
(2) GFA is estimated based on the site area of the existing premises with only 1 storey of social welfare facilities

3.1.10. Based on on-site observations, no vehicular trip was observed for the three surveyed ICYSCs during the survey period (i.e. ICYSCs serves the local residents from the local area).

3.2. Comparison of Vehicular Traffic Generation and Attraction under Office and Social Welfare Facilities

3.2.1. Based on the development parameter of the Subject Site given in **Table 2.1** and the adopted rates as shown in **Tables 3.1** and **3.2**, the net difference of vehicular traffic generation and attraction between office and social welfare facilities are presented in **Table 3.4**.

Table 3.4 Net Difference of Vehicular Trip Generation and Attraction due to the Proposed Conversion

Development Type	GFA (1)	Vehicular Trip (pcu/hr)			
		AM Peak		PM Peak	
		GEN	ATT	GEN	ATT
Office (pcu/hr/100m^2) [a]	2,627.871m^2	5	7	5	4
Social Welfare Facilities (pcu/hr/100m^2) [b]		0	0	0	0
Net Difference [b] – [a]		**-5**	**-7**	**-5**	**-4**

Note:
(1) Refer to **Table 2.1**, the total GFA for the Subject Site (i.e. 3/F & 7/F)
= 1,302.186m^2 + 1,325.685m^2 = 2,627.871m^2

3.2.2. As shown in **Table 3.3**, it is revealed that the overall vehicular traffic generation for social welfare facilities will be lower than office (i.e. **less vehicular traffic will be generated**).

4. COMPARISON OF PEDESTRIAN TRAFFIC GENERATION FOR THE PROPOSED CONVERSION

4.1. Adopted Pedestrian Trip Rates

Pedestrian Trip Rates for Office

4.1.1. To estimate the demand of pedestrian for office, reference is also made from MVA's in-house database for trip rates for office developments is listed in **Table 4.1**.

Table 4.1 MVA's in-house Database for Pedestrian Trip Rates for Office

Development Type	Pedestrian Trip Rates (ped/15mins/100m^2 GFA)			
	AM Peak		PM Peak	
	Generation	Attraction	Generation	Attraction
Office (ped/15mins/100m^2 GFA) (1)	0.530	2.170	1.320	0.190

Note:
(1) Based on MVA's in-house database for pedestrian trip rates for Millennium City 6 at Kwun Tong Road

Pedestrian Trip Rates for Social Welfare Facilities

4.1.2. Similar to vehicular trip generation survey as mentioned in **Chapter 3,** the proposed social welfare facilities will be operated on a service-by-appointment basis, it is anticipated that the pedestrian trip generated and attracted under the proposed conversion shall be less than expected.

4.1.3. For conservative purpose, manual pedestrian count surveys were also conducted to obtain the most up-to-date pedestrian trip generations and attractions at the selected ICYSCs as mentioned in **Chapter 3** in November 2024 during the AM and PM peak periods.

4.1.4. The surveyed trip rates for the three surveyed ICYSCs are illustrated in **Table 4.2.**

Table 4.2 Pedestrian Trip Rates for the Selected ICYSCs in Tuen Mun and Tin Shui Wai

Facilities	GFA (m^2) (1)(2)	Pedestrian Trip Rates (ped/15mins/100 m^2 GFA)			
		AM Peak		PM Peak	
		GEN	ATT	GEN	ATT
The Boys' & Girls' Clubs Association of Hong Kong - Jockey Club Tuen Mun Children & Youth Integrated Services Centre (香港小童群益會 - 賽馬會屯門青少年綜合服務中心)	Approx. 700m^2	0.143	0.000	0.000	0.000
Chinese YMCA of Hong Kong Tuen Mun Centre (香港中華基督教青年會屯門會所)	Approx. 600m^2	**0.333**	**0.167**	**1.167**	**0.167**
H.K.S.K.H. St. Matthias' Integrated Services - Jockey Club Youth Express (香港聖公會聖馬提亞綜合服務 – 賽馬會青年幹線)	Approx. 700m^2	N/A	N/A	1.000	0.143
Adopted Trip Rate for Social Welfare Facilities		**0.333**	**0.167**	**1.167**	**0.167**

Note:
(1) The above GFA is indicative only.
(2) GFA is estimated based on the site area of the existing premises with only 1 storey of social welfare facilities

4.2. Comparison of Pedestrian Traffic Generation and Attraction under Office and Social Welfare Facilities

4.2.1. Based on the development parameter of the Subject Site given in **Table 2.1** and the adopted rates as shown in **Tables 4.1** and **4.2**, the net difference of pedestrian traffic generation and attraction between office and social welfare facilities are presented in **Table 4.3**.

Table 4.3 Net Difference of Pedestrian Trip Generation and Attraction due to the Proposed Conversion

Development Type	GFA (1)	Pedestrian Trip (ped/15mins)			
		AM Peak		PM Peak	
		GEN	ATT	GEN	ATT
Office (ped/15mins/100m^2) [a]	2,627.871m^2	14	58	35	5
Social Welfare Facilities (ped/15mins/100m^2) [b]		9	5	31	5
Net Difference [b] – [a]		**-5**	**-53**	**-4**	**0**

Note:
(1) Refer to **Table 2.1**, the total GFA for the Subject Site (i.e. 3/F & 7/F)
= 1,302.186m^2 + 1,325.685m^2 = 2,627.871m^2

4.2.2. As shown in **Table 4.3**, it is revealed that the overall pedestrian traffic generation for social welfare facilities will be lower than office (i.e. **less pedestrian traffic will be generated**).

4.2.3. Alternatively, it is anticipated that less pedestrian traffic demand will be induced for nearby pedestrian facilities, including pedestrian routing between the Subject Site and public transport facilities.

5. EXISTING PUBLIC TRANSPORT SERVICES

5.1. Public Transport Services in the Vicinity

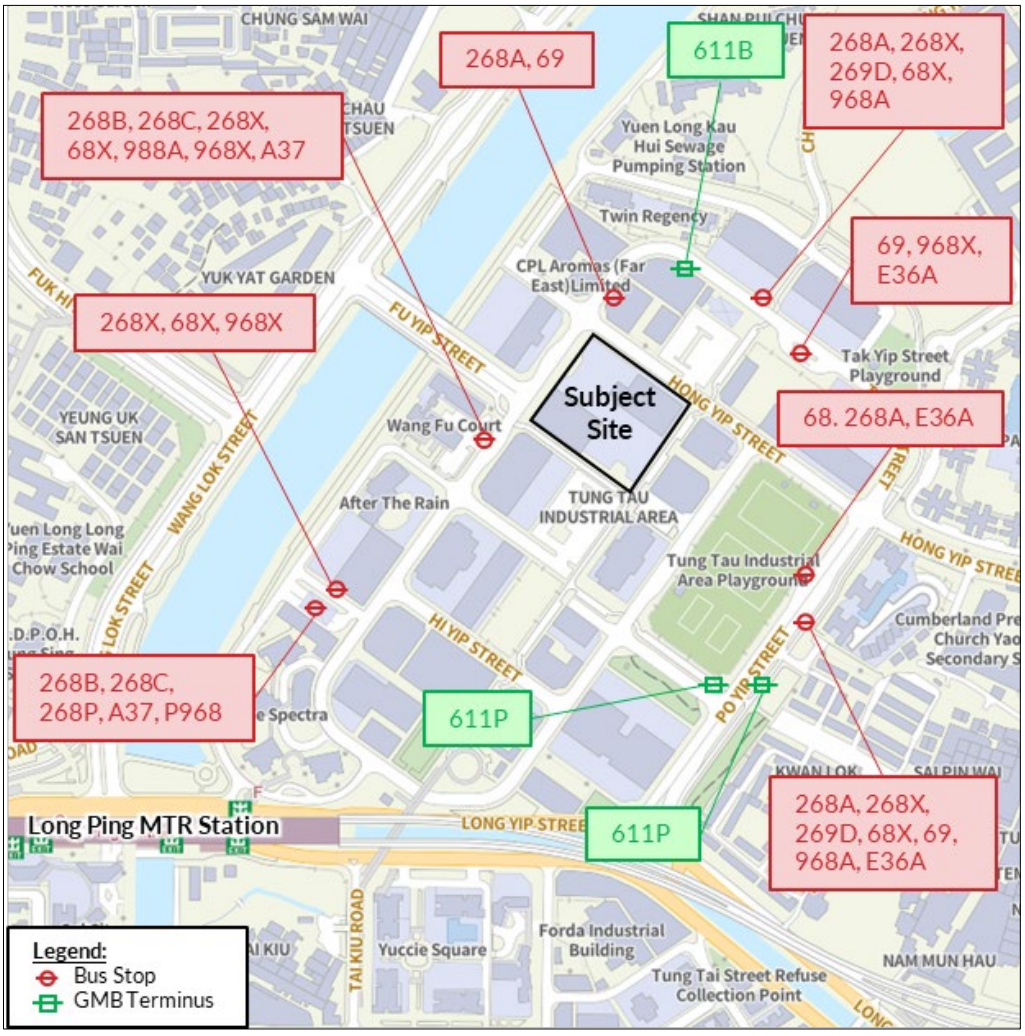
5.1.1. Ten franchised bus routes and two GMB routes are operating in the vicinity of the Subject Site to/from Yuen Long City Centre. Details of these franchised bus and GMB services are listed in **Table 5.1** and **Figure 5.1** below.

Table 5.1 Existing Public Transport Services

Route	Destination – Origin	Peak Frequency (minutes)
Franchised Bus		
68X	Yuet Ping House Long Ping Estate → Mong Kok (Park Avenue)	07:50 (1)
69	Yuen Long (Tak Yip Street) – Tin Shui Wai Town Centre	15-25
E36A	Yuen Long (Tak Yip Street) – Tung Chung (Yat Tung)	15-30
268A	Long Ping Estate → Kwun Tong Ferry	07:05 & 07:20 (1)
268B	Long Ping Station – Hung Hom (Hung Luen Road)	20-30
268C	Long Ping Station – Kwun Tong Ferry	5-30
268X	Yuet Ping House Long Ping Estate → Jordan (West Kowloon Station)	08:00 (1)
269D	Tin Shui Wai Station → Lek Yuen	07:20 (1)
968A	Yuen Long (West) → Causeway Bay (Tin Hau)	07:30 & 07:45 (1)
968X	Yuen Long (Tak Yip Street) → Quarry Bay (King's Road)	07:00, 07:10, 07:20, 07:30, 07:40, 07:50 & 08:00 (1)
Green Mini-bus		
611B	Tak Yip Street – Fau Tsoi Street (Circular)	30
611P	Shan Pui Road – On Shun Street (Circular)	20-30

Note:
(1) Monday to Friday, except public holidays

Figure 5.1 Public Transport Services in the Vicinity



5.2. Public Transport Utilisation

5.2.1. A traffic survey was conducted on a typical weekday in November 2024 to identify the peak hour public transport utilization at the existing bus and GMB stops near the Subject Site at Wang Yip Street West, Tak Yip Street and Po Yip Street. The survey results are summarized in **Table 5.2**.

Table 5.2 Observed Peak Hour Public Transport Utilisation

Location/ Bound	Mode	Route No.	Observed No. of Vehicle	Total Service Capacity (pax) (1)	Observed Utilisation (pax)	Utilisation Rate (%)
AM Peak (07:30-10:00)						
Wang Yip Street Northbound	Bus	268B	2	180	0	0%
		268C	15	1,350	21	2%
		268X	1	90	2	2%
		968A	2	180	28	16%
		A37	6	540	1	0%
	GMB	611B	10	160	80	50%
		69	6	540	20	4%
		E36A	4	360	5	1%
Po Yip Street Southbound	Bus	68X	1	90	27	30%
		69	5	450	123	27%
		268X	1	90	33	37%
		269D	1	90	40	44%
		968A	2	180	114	63%
		E36A	5	450	40	9%
Keung Yip Street Eastbound	GMB	611P	10	112	11	10%
PM Peak (17:30-19:30)						
Wang Yip Street Northbound	Bus	268C	7	630	34	5%
		968X	3	270	17	6%
		A37	4	360	2	1%
	GMB	611B	10	160	80	50%
Po Yip Street Northbound	Bus	268A	1	90	9	10%
		69	5	450	27	6%
		E36A	5	450	9	2%
Po Yip Street Southbound	Bus	69	5	450	94	21%
		968A	4	360	41	11%
Keung Yip Street Eastbound	GMB	611P	7	112	11	10%

Note:
(1) In estimating the public transport trips provided by each bus, 120 pax/bus with 75% utilisation rate should be adopted as the calculation basis, which equals to 90 pax/bus.

5.2.2. From **Table 5.2**, all the utilisation rate of existing public transport near the Subject Site are far below 100%, indicating that the demand for existing public transport service is within capacity during AM and PM peak periods for the existing situation and the proposed conversion.

5.2.3. Alternatively, as mentioned in **Table 4.3**, the overall pedestrian traffic generation for social welfare facilities will be lower than office (i.e. less pedestrian traffic will be generated), anticipated that there is no adverse impact on the demand for existing public transport service.

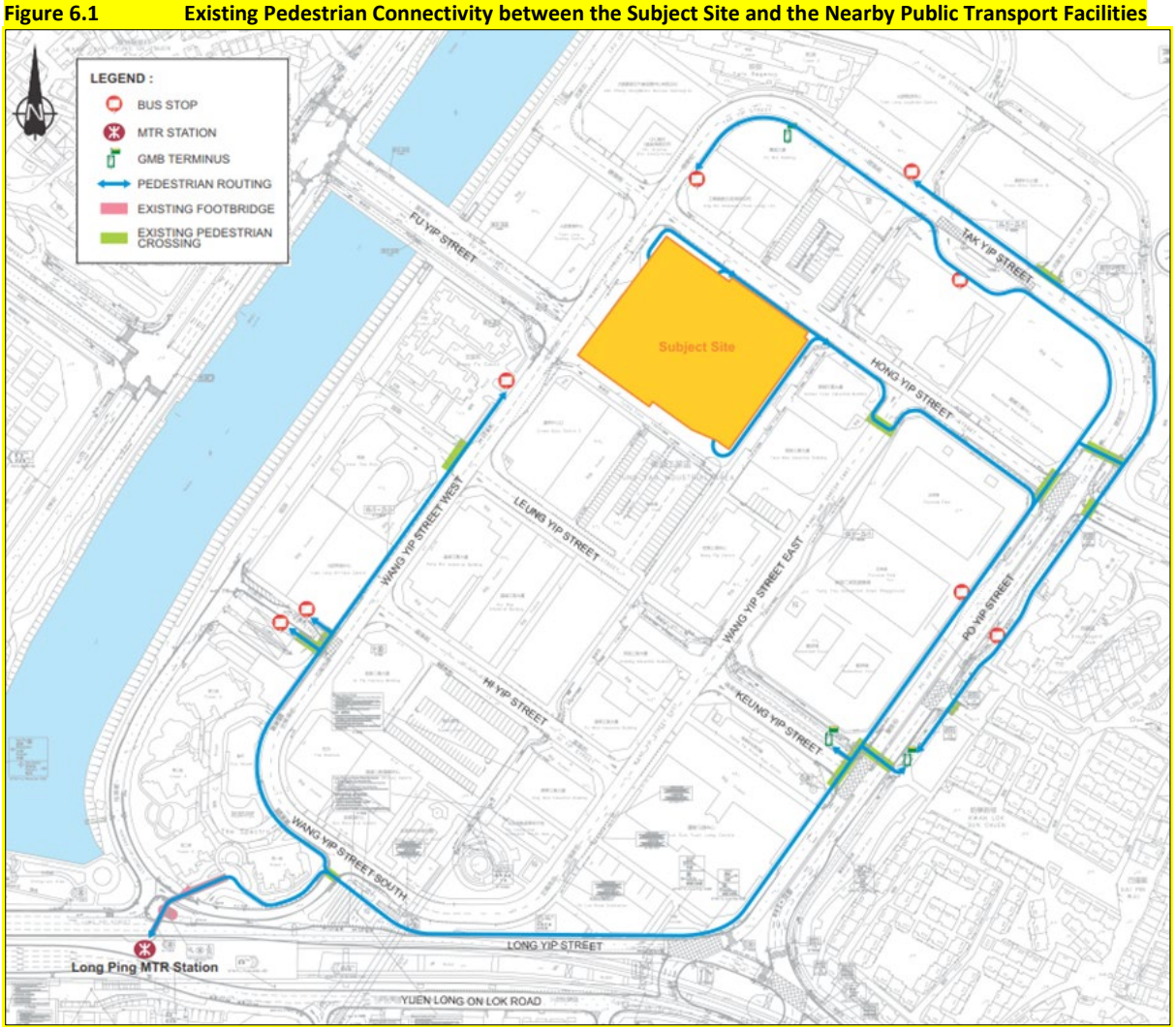
6. PEDESTRAIN CONNECTIVITY

6.1. Existing Pedestrian Facilities

6.1.1. As mentioned in **Chapter 4.2**, less pedestrian traffic will be generated/attracted due to the proposed conversion. Hence, it is anticipated that there is less pedestrian traffic demand on nearby pedestrian facilities along pedestrian routing between the Subject Site and public transport facilities, and the nearby pedestrian facilities are adequate to entertain the anticipated demand.

6.1.2. Since the target visitors of the proposed social welfare services are mostly children and those of special needs, considering there will be more children visiting the proposed social welfare facilities, the existing pedestrian connectivity and universal accessibility between the Subject Site and the nearby public transport facilities have been reviewed and illustrated in **Figure 6.1** below.

Figure 6.1 Existing Pedestrian Connectivity between the Subject Site and the Nearby Public Transport Facilities



6.1.3. Under the current situation, Wang Yip Street West and Po Yip Street serve as the primary pedestrian routes between the Subject Site and public transport facilities, with proper pedestrian crossing facilities available along Po Yip Street, which is deemed universally accessible for pedestrians with special needs.

6.1.4. On the other hand, pedestrians may consider to cross Wang Yip Street West at their own discretion. As there are no restrictions on crossing zones and visibility is adequate along Wang Yip Street West, pedestrian can access the Subject Site across Wang Yip Street West depending on traffic conditions.

6.1.5. In view of the above, pedestrian generated/attracted by the proposed social welfare facilities can utilise the existing footpath/footbridge and at-grade/grade separated crossing to access the nearby public transport facilities from the Subject Site. Therefore, it is considered that there is sufficient pedestrian connectivity and universal accessibility between the Subject Site and the nearby public transport facilities.

7. CONCLUSION

7.1.1. The overall vehicular and pedestrian traffic generation and attraction of social welfare facilities and public transport utilisation will be lower than office under the proposed conversion (i.e. less traffic will be generated).

7.1.2. Therefore, the proposed conversion of office to social welfare facilities is considered acceptable from traffic engineering point of view.

Annex 2

Response to the Comments from Electrical and Mechanical Services Department and the Revised Quantitative Risk Assessment Report

S16 Planning Application of Proposed Social Welfare Facility (Excluding Those Involving Residential Care) At 3/F And 7/F, Tower 1, One North, No. 8 Hong Yip Street, Yuen Long, N.T. – Submission of Quantitative Risk Assessment (Ref: R5151_V3.0)

	Comments from Ivy Chan /EMSD via email on 06/01/2024	Proposed Response
1	The LPG inventory of each LPG storage vessel should be 12 tonnes, instead of 10.2 tonnes	Model is revised accordingly. The consequence analysis result and risk summation results have been updated. Please refer Section 5.3 and Section 6 for details.

Prepared by

Ramboll Hong Kong Limited

S16 PLANNING APPLICATION OF PROPOSED SOCIAL WELFARE FACILITY (EXCLUDING THOSE INVOLVING RESIDENTIAL CARE) AT 3/F AND 7/F, TOWER 1, ONE NORTH, NO. 8 HONG YIP STREET, YUEN LONG, N.T.

QUANTITATIVE RISK ASSESSMENT

Date	**January 2025**
Prepared by	**Amy Ho *et. al***
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Signed	
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Signed	
Project Reference	**SNOYL532EI00**
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1.0 Introduction

1.1 Project Background

A quantitative risk assessment (QRA) was conducted for the newly completed office and retail complex – One North at No. 8 Hong Yip Street, Yuen Long, N.T. (hereafter referred as the "Application Site") in 2021. The QRA report (Report Ref.: R5151_V2.0) (the "Previous Report") was approved by Director of Electrical and Mechanical Services (DEMS) in January 2022 [2].

A S16 Application (A/YL/321) has been submitted for proposed change of use from office to social welfare facility (except for those involving residential care) at 3/F and 7/F of Tower 1 of One North (hereafter referred as the "Proposed Social Welfare Development"). The venue is tentatively ready for operation in 2025. Referring to recent comment from EMSD, the proposed change of use would introduce increase of population so that the applicant should submit a QRA to ascertain that the risk level posed by the station is still acceptable. This QRA is therefore conducted to re-assess the risk level by the LPG Filling Station (hereafter referred as the "the Station") to the surrounding, including the additional population brought by the Proposed Social Welfare Development in response to the comment.

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 LPG Filling Station in year 2025, with operation of the Proposed Social Welfare Development. Site survey was conducted to understand the current situation and update the Previous Report [2] where necessary.

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

(a) 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 LPG Filling Station;

(b) 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 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: 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 prioritized on the basis of practicality and implementation cost versus the risk reduction achieved.

1.4 Methodology

1.4.1 Overall QRA Approach

A QRA on the concerned LPG Filling Station was completed for this Project and approved by DEMS in 2022. The QRA methodology of this study follows the approved Previous Report, which complies with the HKRG stipulated in Section 4 of Chapter 12 of the HKPSG[1] and the QRA Methodology for LPG Installations in Hong Kong [3].

The major phases in QRA include:

i. **Hazard Identification**: Identify hazard scenarios associated with the operation of the LPG Compound, and then determine a set of relevant scenarios to be included in a QRA.

ii. **Frequency Assessment**: Assess the likelihood of occurrence of the identified hazard scenarios.

iii. **Consequence Assessment**: Assess the consequences and impact to the surrounding population.

iv. **Risk Summation and Assessment**: Evaluate the risk level, in terms of individual risk and societal risk. The risks will be compared with the criteria outlined in HKRG to determine their acceptability.

v. **Identification of Mitigation Measures**: Identify and assess practicable and cost-effective risk mitigation measures if necessary. The risks of mitigated cases will then be reassessed to determine the level of risk reduction.

1.4.2 Case to be Considered

The Proposed Social Welfare Development is targeted to commence operation in year 2025. This study will consider the following scenarios to demonstrate the increase in the

risk levels of the LPG Filling Station due to the operation of the Proposed Social Welfare Development. The cases to be considered include:

- ***Case 1*** – ***Base Case in Year 2025***: evaluating the risk level in year 2025 without the Proposed Social Welfare Development;
- ***Case 2*** – ***Operation Case in Year 2025***: evaluating the risk level in year 2025 with the operation of the Proposed Social Welfare Development.

2.0 Project Data

2.1 The Proposed Development

One North is located at 8 Hong Yip Street in the junction of Wang Yip Street West and Hong Yip Street of Tung Tau Industrial Area, Yuen Long, falling within an area zoned "Other Specific Uses" annotated "Business" ("OU(B)") under the approved Yuen Long Outline Zoning Plan (OZP) No. S/YL/27.

The 3/F and 7/F of Office Tower 1 of One North at the Application Site are planned to be converted from office use to social welfare facility, where are expected to accommodate no more than 200 visitors and staffs on each floor. The population of remaining areas of the Application Site is assumed the same as before.

The uses on different floors of the Application Site are detailed in **Table 1**.

Table 1 Uses in Application Site

Uses	Floors
Office	Tower 1 (3/F – 17/F) (except for 3/F and 7/F)
	Tower 2 (3/F – 17/F)
	G/F – 2/F
Proposed Social Welfare	3/F (GFA 1302.186m^2)
	7/F (GFA 1325.685m^2)
Retail	G/F – 2/F
Outdoor reactional space	2/F

The layout plan of the Proposed Development is given in **Annex A**.

2.2 Hazardous Storage and Operation

2.2.1 Location and Surrounding Land Use

The LPG Filling Station is approximate 70m northeast to the site boundary of the Application Site as indicated in **Figure 1**. It is surrounded by industrial buildings and open car park space. The nearest industrial building is adjacent to the LPG Filling Station and is about 15m away from the LPG facilities separated by the convenient store in the LPG Filling Station. The nearest high rise residential building locates 55m away from the LPG Filling Station.

2.2.2 LPG Filling Station Operation

The LPG Filling Station consists of two 14 tonnes underground LPG storage vessels (equivalent to 12 tonnes LPG inventory, taking into account the ullage requirement of not filling more than 85% of the vessel volume), each installed in an individual concrete chamber filled with washed sand. The vessel shall be designed, manufactured and tested in accordance with the requirements of the Electrical and Mechanical Services Department (EMSD) and is covered with corrosion protection coating, 100% radiography tested and fully stress relieved.

Six LPG dispensers with two nozzles for each dispenser are located in a canopied island for LPG vehicle refuelling.

2.2.3 LPG Delivery and Transfer

LPG vessel is replenishment by LPG road tanker with a maximum capacity of the road tanker of about 9 tonnes at dedicated LPG road tanker unloading bay.

A site survey was conducted on 26th November 2024. The filling operation of LPG vehicle was observed over a one-hour period from 15:30 to 16:30, which is assumed to be the peak hour of LPG vehicle refuelling. 169 taxis and 4 minibuses were counted. A LPG road tanker was engaged in unloading operation during the site survey with an unloading time of approximately 50 minutes recorded. The observation aligned with the information collected and assumptions presented in the Previous Report [2]. Hence this study will adopt the same assumptions as reported on the Previous Report [2].

A summary of the LPG Filling Station facilities and operations is presented in **Table 2**.

Table 2 Summary information on the LPG installation

Item	Data Collected / Assumptions
LPG vessel	2 × 14 tonnes (maximum capacity) Filled up to 85% of its maximum capacity under normal operation
LPG dispensers	6 LPG dispensers with 12 nozzles
LPG tanker	9 tonnes
LPG road tanker delivery	6 tankers per day. About 2,190 road tankers deliveries per year, both day time and night time delivery Average residence time at the station is about 50 min[1]
Vehicles refuelling	1108 LPG vehicles per day, including LPG taxi and LPG minibus [2]
Fire & gas safety provision	Dry powder fire extinguishers, sand buckets and fire hydrant. Manually / remotely operated isolation valves. Leak detection system with alarm. ESD system. Water spray system. Emergency plans.
Further development	No further development/ modification planned for the existing LPG Filling Station.

Note
1. Conservative assumption based on Previous Report [2]
2. Conservative assumption based on Site Survey

2.3 Study Area

Following the Previous Report [2], a study area of 200m radius from the LPG Filling Station is adopted in this study, as shown in **Figure 1**.

2.4 Population

2.4.1 Population in the Vicinity

Population close to the hazardous installations may be impacted by hazardous events arising from the accidental LPG release from the LPG facilities. As the QRA is aimed to assess the off-site risk to life, staff present at the LPG Fillings Station are regarded as voluntary takers of risk and are not considered in this study.

Population in the vicinity of the LPG Filling Station is illustrated in **Figure 1**, and summarized in **Table 3**. The future population within the study areas is estimated following the approach in the Previous Report [2] but using the up-to-date data published by the Government Departments and site observation dated 26th November 2024.

The following information and assumptions are adopted in the estimation:

- Average residential household size of 2.5 in Town Planning Unit (TPU) 524 as per 2021 Population Census [5];
- Conservative assumption of annual population growth of 1% as per population statistics in TPU 524 in 2021 Population Census [5] and the Projections of Population Distribution 2023 – 2031 [6]; and
- Maximum plot ratio of 5 for industrial building in "New Industrial Areas" according to the Outline Zoning Plan;
- Conservative assumption of worker density of 35m^2/worker for office and industrial buildings in "New Industrial Areas" and 700m^2/worker for warehouse.

The population data are summarized in **Table 3**.

2.4.2 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**.

Table 3 Population Data Within Study Area

ID	Population Name	Population Category	Population in 2025		Temporal Population Change					Indoor Ratio	Base Level (mPD)	No. of Storey	Building Height (m)	Remarks
			Base Case	Opn Case	RUSH	PEAK	WDD	WED	NIGHT					
1	Goodman Yuen Long Logistics Centre	Industrial	22		100%	25%	100%	40%	10%	95%	4.7	16	88	Warehouse use according to site survey observation. Estimate from max. plot ratio and site area.
2	Crown Data Centre III	Industrial	25		100%	25%	100%	40%	10%	95%	4.7	14	73	Warehouse use according to site survey observation. Estimate from max. plot ratio and site area.
3	Tak Yip Street Playground	Recreational	10		25%	50%	50%	100%	5%	0%	4.7	-	0	Conservative assumption based on site survey
4	Mansfield Industrial Centre	Industrial	130		100%	25%	100%	40%	10%	95%	4.8	7	34	According to site survey observation, the building is a mix of 50% workshop use and 50% warehouse use. Estimate from max. plot ratio and site area.
5	Project Site Office	Industrial	60		100%	25%	100%	40%	10%	95%	5.4	2	6	Conservative assumption with reference to the Previous Report [2].
6	Tung Tau Industrial Area Playground (Future Underground Public Vehicle Park (excluding Container Vehicle) and Re-provisioning of Permitted Sports Facilities)	Recreational	42		25%	50%	50%	100%	5%	0%	5.1	-	0	Conservative assumption with reference to the Previous Report [2].
7	Golden Town Industrial Building	Industrial	42		100%	25%	100%	40%	10%	95%	4.7	3	18	Ground floor is used as workshop and the rest are used as warehouse according to site survey observation. Estimate from max. plot ratio and site area.
8	Tsun Mee Industrial Building	Industrial	10		100%	25%	100%	40%	10%	95%	4.7	3	17	Warehouse use according to site survey observation. Estimate from max. plot ratio and site area.
9	Yuen Long Trading Centre	Commercial	392		100%	25%	100%	40%	10%	95%	4.3	18	66	Warehouse use according to site survey observation. Estimate from max. plot ratio and site area.
10	Car Park	Car park	5		100%	100%	100%	50%	10%	0%	4.9	-	0	Conservative assumption with reference to the Previous Report [2].
11	Jing Hin Godowns (Yuen Long) Limited	Industrial	14		100%	25%	100%	40%	10%	95%	4.7	6	24	Warehouse use according to site survey observation. Estimate from max. plot ratio and site area.
12	Po Wai Building	Industrial	107		100%	25%	100%	40%	10%	95%	4.7	4	19	According to a site survey, the building is a mix of 50% warehouse and 50% industrial use. Population estimated from max. plot ratio and site area.
13	CPL Aromas (Far East) Limited	Industrial	78		100%	25%	100%	40%	10%	95%	4.3	7	31	Industrial use according to site survey observation. Estimate from max. plot ratio and site area.
14	Mercedes-Benz Trucks & Buses Service Centre	Industrial	20		100%	25%	100%	40%	10%	95%	4.4	2	10	Conservative assumption based on site survey observation.
15	Dry Weather Flow Pumping Station	Industrial	0		100%	25%	100%	40%	10%	95%	4.7	1	3	Pumping station is assumed to be an unmanned area.
16	Yuen Long Kau Hui Sewage Pumping Station	Industrial	0		100%	25%	100%	40%	10%	95%	5.2	1	3	Pumping station is unmanned

ID	Population Name	Population Category	Population in 2025		Temporal Population Change					Indoor Ratio	Base Level (mPD)	No. of Storey	Building Height (m)	Remarks
			Base Case	Opn Case	RUSH	PEAK	WDD	WED	NIGHT					
17	Shan Pui Chung Hau Tsuen	Residential	70		50%	25%	25%	70%	100%	95%	3	2	6	28 no. of 2-storey houses counted based on desktop study. Average household size of 2.5 from 2021 Population Census.
18	Vacant	Vacant	0		0%	0%	0%	0%	0%	0%	4.1	-	0	Vacant site use according to site survey observation.
19	Car Park	Car park	5		100%	100%	100%	50%	10%	0%	4.5	-	0	Conservative assumption with reference to the Previous Report [2].
20	Wang Yip Centre	Commercial	348		100%	25%	100%	40%	10%	95%	4.6	8	37	Office use according to site survey observation. Estimate from max. plot ratio and site area.
21	Car Park	Car park	5		100%	100%	100%	50%	10%	0%	4.5	-	0	Conservative assumption with reference to the Previous Report [2].
22	Crown Data Centre II	Industrial	25		100%	25%	100%	40%	10%	95%	4.3	14	70	Warehouse use according to site survey observation. Estimate from max. plot ratio and site area.
23	Future Residential Development	Residential	280		50%	25%	25%	70%	100%	95%	4.2	3	9.9	112 units from Town Planning Board document. Average household size of 2.5 from 2021 Population Census.
24	Twin Regency	Residential	1403		50%	25%	25%	70%	100%	95%	4.4	23	80	526 units . Average household size of 2.5 from 2021 Population Census.
PD1	One North Tower 1	Commercial	708	609	100%	25%	100%	40%	10%	95%	14.65	17	70	Project info: The GFA each tower is 17700.021 sq.m. Estimate the population using a density of 25 sq.m/person. 2 floors are proposed to convert into social welfare use which has a total GFA of 2627.871 sq.m. GFA of 15072.15 sq.m will remain as office use.
	One North Tower 1 (3/F Social Welfare Facilities)	Social Welfare	0	200	100%	25%	100%	100%	0%	95%	19.65	1	5	Project Info: 3/F and 7/F of Tower 1 will be used as social welfare facilities with an estimated population of 200 persons per floor.
	One North Tower 1 (7/F Social Welfare Facilities)	Social Welfare	0	200	100%	25%	100%	100%	0%	95%	33.65	1	4.5	
PD2	One North Tower 2	Commercial	710		100%	25%	100%	40%	10%	95%	14.65	17	70	Project info: The GFA each tower is 17689.881 sq.m. Estimate the population using a density of 25 sq.m/person
PD3	One North Retail	Retail	600		48%	100%	26%	13%	5%	95%	4.55	3	15	Project info: UFA of approx. 9,043 sq.m. Estimated from population density of 16.7m2/person with reference to the Previous Report. Rounded up to nearest 100.
PD4	One North Outdoor Space	Recreational	50		25%	50%	50%	100%	5%	0%	4.55	2	10	Conservative assumption with reference to the Previous Report [2].
R01	Tak Yip Street	Road	36		100%	100%	74%	64%	29%	0%	4.5	-	0	Includes passage in vehicles and pedestrian. Refer **Annex B**.

ID	Population Name	Population Category	Population in 2025		Temporal Population Change					Indoor Ratio	Base Level (mPD)	No. of Storey	Building Height (m)	Remarks
			Base Case	Opn Case	RUSH	PEAK	WDD	WED	NIGHT					
R02	Hong Yip Street	Road	35		100%	100%	74%	64%	29%	0%	4.5	-	0	Includes passage in vehicles and pedestrian. Refer **Annex B**.
R03	Wang Yip Street West	Road	27		100%	100%	74%	64%	29%	0%	4.3	-	0	Includes passage in vehicles and pedestrian. Refer **Annex B**.
R04	Wang Yip Street East	Road	27		100%	100%	74%	64%	29%	0%	4.6	-	0	Includes passage in vehicles and pedestrian. Refer **Annex B**.
R05	Po Yip Street	Road	27		100%	100%	74%	64%	29%	0%	4.6	-	0	Includes passage in vehicles and pedestrian. Refer **Annex B**.
R06	Lau Yip Street	Road	37		100%	100%	74%	64%	29%	0%	4.5	-	0	Includes passage in vehicles and pedestrian. Refer **Annex B**.

2.4.3 Temporal Change in Population

In order to reflect the temporal changes in population within a week, the following time periods, and corresponding proportion of population adopted in the analysis, with reference to the Previous Report [2].

Day time is defined as 07:00 to 19:00 and night time from 19:00 to 07:00 next day. Rush hour is defined as 07:00 to 09:00 and 18:00 to 20:00 on Monday to Saturday to cater for the workers' movement before and after business hours. Peak hour is defined as 12:00 to 14:00 on Monday to Saturday as the lunch time peak of retails.

The temporal changes of different population category are provided in **Table 4**. The detailed temporal changes of population for each population site considered are provided in **Table 3**.

Table 4 Temporal Change of Population within A Week

Time Period	Time Portion	Population Variation by Category						
		Commercial	Industrial	Residential	Recreational	Social Welfare	Retail (1)	Car park
Rush hour (RUSH)	14.28%	100%	100%	50%	25%	100%	48%	100%
Peak hour (PEAK)	7.14%	25%	25%	25%	50%	100%	100%	100%
Weekday day (WDD)	20.83%	100%	100%	25%	50%	100%	26%	100%
Weekend day (WED)	11.31%	40%	40%	70%	100%	100%	13%	50%
Night (NIGHT)	46.43%	10%	10%	100%	5%	0%	5%	10%

Note

1. Conservative assumption based on Previous Report [2] According to site survey observations, the population variation on retail floors of the Application Site is low in non-peak time periods.

2.5 Indoor/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 commercial, industrial, social welfare, retail and residential buildings while the remaining 5% of population is assumed to be outdoor, accounting for outdoor activities and walking on pathways.

Passengers in vehicles are considered as 100% outdoors although vehicles may provide certain protection. Population in the car park and the open recreational space is considered as 100% outdoors.

2.6 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 SAFETI model, including:

- *Population source* which are assigned implicitly to all population groups by SAEFTI to account for human activities such as smoking, cooking and using electrical appliances.
- *Transportation route segments* which are defined for the moving vehicles on roads. The ignition probability of a transportation route segment is calculated form the traffic density, average vehicle speed, vehicle ignition efficiency and total length of the road. The vehicle ignition efficiency for moving vehicles is adopted to be 0.4 per 60 second [7]. Traffic flow and average vehicle speed are included in **Annex B**.

2.7 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 Wetland Park Weather Station (Year 2023) 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 [7]. 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 5** and **Table 6** below respectively. The average ambient temperature adopted in the analysis is 23°C and relative humidity is 80%.

Table 5 Day Time Wind Direction Frequency of Wetland Park Weather Station

Direction	Weather Class						Total
	2.0B	1.5D	4.0D	7.5D	2.5E	1.5F	
0 – 30	6.25	1.92	0.00	0.00	0.18	3.26	11.61
30 – 60	9.59	2.58	0.33	0.00	0.35	2.20	15.05
60 – 90	12.47	3.39	0.13	0.00	0.30	2.93	19.22
90 – 120	4.70	2.33	0.61	0.03	0.33	1.82	9.81
120 – 150	3.29	1.19	0.30	0.00	0.13	1.39	6.30
150 – 180	6.60	1.87	0.78	0.00	0.53	1.69	11.48
180 – 210	5.39	0.91	0.61	0.03	0.23	1.06	8.22
210 – 240	2.15	0.15	0.15	0.00	0.00	0.13	2.58
240 – 270	1.80	0.33	0.00	0.00	0.00	0.18	2.30
270 – 300	1.75	0.46	0.00	0.00	0.03	0.23	2.45
300 – 330	3.34	0.48	0.03	0.00	0.00	0.18	4.02
330 – 360	4.81	1.09	0.05	0.00	0.08	0.94	6.95
All	62.11	16.69	2.98	0.05	2.15	16.01	100.00

Table 6 Night Time Wind Direction Frequency of Wetland Park Weather Station

Direction	Weather Class						Total
	2.0B	1.5D	4.0D	7.5D	2.5E	1.5F	
0 – 30	0.00	0.31	0.08	0.00	0.64	18.63	19.66
30 – 60	0.00	0.42	0.28	0.03	1.36	9.20	11.29
60 – 90	0.00	0.78	0.17	0.08	0.67	9.59	11.29
90 – 120	0.00	0.31	0.33	0.00	0.83	12.04	13.52
120 – 150	0.00	0.08	0.28	0.00	0.56	8.06	8.98
150 – 180	0.00	0.17	0.17	0.00	2.25	15.49	18.08
180 – 210	0.00	0.11	0.14	0.00	1.33	8.12	9.71
210 – 240	0.00	0.00	0.00	0.00	0.06	0.78	0.83
240 – 270	0.00	0.08	0.00	0.00	0.03	0.22	0.33
270 – 300	0.00	0.03	0.03	0.00	0.00	0.36	0.42
300 – 330	0.00	0.03	0.00	0.00	0.00	1.14	1.17
330 – 360	0.00	0.33	0.03	0.00	0.03	4.34	4.73
All	0.00	2.64	1.50	0.11	7.76	87.99	100.00

3.0 Hazard Identification

3.1 Properties of LPG

LPG supplied in Hong Kong is a pressurized 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.

3.2 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. A schematic diagram of LPG filling facilities [8] is shown in **Figure 3**. 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.

3.2.1 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.

3.2.2 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.

3.2.3 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.

3.2.4 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.

3.2.5 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.

3.2.6 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.

3.2.7 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.

3.2.8 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;
- Car crash;
- Landslide;
- Severe environmental events;
- Lightning strike;
- Dropped object;
- Subsidence; and
- External fire.

3.3 Safety Provisions

Various safety provisions are installed in the LPG Filling 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.

3.3.1 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.

3.3.2 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 [3]
- **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.

3.4 Escalation

Escalation refers to knock-on effect from a fire event. Hazard in the LPG silling station concerned 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.

3.5 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.

3.6 LPG Release Scenarios Considered

Representative LPG accidental release scenarios considered in this study are summarized in **Table 7**.

Table 7 Representative LPG accidental release scenarios considered

Equipment	Failure type	Release type	Potential hazardous outcomes
LPG storage vessel	Catastrophic failure Partial failure (leak)	Instantaneous Continuous	Flash fire, VCE Jet fire, flash fire, VCE
LPG road tanker	Catastrophic failure Partial failure (leak)	Instantaneous Continuous	Fireball, flash fire, VCE Flash fire, VCE, jet fire
Liquid-inlet pipework	Guillotine failure Leak	Continuous Continuous	Jet fire, flash fire, VCE, BLEVE Jet fire, flash fire, VCE
Liquid supply line to dispenser	Guillotine failure Leak	Continuous Continuous	Jet fire, flash fire, VCE Jet fire, flash fire
Dispenser	Guillotine failure	Continuous	Jet fire, flash fire, BLEVE
Flexible hose to vessel	Guillotine failure Leak	Continuous Continuous	Jet fire, flash fire, VCE, BLEVE Jet fire, flash fire
Flexible hose to vehicle	Guillotine failure	Continuous	Jet fire, flash fire, BLEVE
Submersible Pump Flange	Leak	Continuous	Jet fire, flash fire, VCE

4.0 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 follows the Previous Report [2].

4.1 Spontaneous Failure

4.1.1 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 [3] are adopted for cold catastrophic and partial failures, respectively. The vessel is assumed to be stress-relieved and 100% radiograph tested.

4.1.2 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 [3], respectively.

4.1.3 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 [3]. The rate of partial failure (equivalent to 10% pipe diameter) is taken as 3.3 times of the guillotine failure rate [7], i.e. 3.3×10^{-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.

4.1.4 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 [2]. A schematic diagram of a typical LPG dispenser is illustrated in **Figure 4**.

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 8**. The pipework in the dispenser is assumed to have a diameter of 20 mm. Only significant leak is considered in the assessment.

Table 8 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]

4.1.5 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 [3]. With average times of 50 minutes for road tanker unloading operation and 5 minutes for LPG vehicle refuelling operation, the guillotine failure rates of the flexible hose are estimated as 7.5×10^{-8} 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 3.3 times the guillotine failure rate.

4.1.6 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].

4.2 Loading Operation Failure

4.2.1 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 [3] 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.

4.2.2 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 [3] is adopted in the analysis.

4.2.3 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 [3] is adopted.

4.2.4 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 [3] 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 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.

4.2.5 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 [3].

4.2.6 Damage due to tanker / vehicle impact

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 LPG Filling Station. Mostly it will cause slight damage, which is not potential to result in an uncontrolled LPG release.

As mentioned in **Section 4.2.4**, road tanker and inlet pipework are equipped with side / rear protection and steel framework, preventing impact to the LPG installation from vehicle collision. Thus, vehicle collision to cause tanker / inlet pipework failure are unlikely. The probabilities of vehicle impact to cause LPG facilities failure are estimated from Road Traffic Accident Statistics from the Transport Department [12], as tabulated in **Table 9**.

The statistics reported 13% (take 20% in the after-mentioned calculation) was serious collision and 1% was fatal collision. Assuming fatal accidents would have the potential to cause catastrophic rupture of the tanker or guillotine failure of the LPG pipework, and serious accidents would have the potential to cause leakage of the tanker / pipework, a modification factor of 0.5 is conservatively applied account for the safety provisions at the LPG Filling Station. The probability of catastrophic failure and partial failure in an

impact accident is taken as 1% × 0.5 = 0.5% and 20% × 0.5 = 10%, respectively. In considering the steel frame protection of the liquid-inlet pipework at the LPG filling point, a modification factor of 0.1 is applied and the probability of catastrophic failure and partial failure of pipework in an impact accident is taken as 0.1% and 2%.

Table 9 Road Traffic Accidents by Severity (2010 - 2020)

	2016	2017	2018	2019	2020	Sum	% Total
Fatal	129	104	107	107	96	543	1%
Serious	2 379	2 070	1 682	1 831	1 912	9 874	12%
Slight	13 591	13 551	14 146	14 164	13 290	68 742	87%
Total	16 099	15 725	15 935	16 102	15 298	79 159	100%

Table 10 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	0.5	0.005
Probability of sufficient vehicle impact energy to cause tanker partial failure	0.2	0.5	0.1
Probability of sufficient tanker impact energy to cause guillotine failure of the inlet pipeline	0.01	0.1	0.001
Probability of sufficient tanker impact energy to cause partial failure of the inlet pipeline	0.2	0.1	0.02
Probability of sufficient vehicle impact energy to cause dispenser damage	0.2	0.5	0.1
Probability of sufficient vehicle impact energy to cause hose damage	0.2	0.5	0.1

4.2.7 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 [3]. 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.

4.2.8 Loading pipework over-pressurization

In an unloading operation it is possible that the driver forgets to open all valves on the filling line to the storage vessel, which would potentially result in over-pressurization of the loading pipework. However, such result would require the malfunction of the over-pressurization protection system of the road tanker, as well as isolation fails such as excess flow valve, emergency stop system and closure of manual valve(s). The potential scenario is of much lower probability than the "misconnection" error event (which will lead to a similar outcome) and the misconnection error is considered already accounted for this factor.

4.2.9 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].

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]. Nevertheless, a more conservative probability of 0.5 [3] is adopted in this analysis considering the operators are facing the dangers from an LPG release.

4.2.10 Failure of Safety Provision

Hazards from an accidental LPG release can be prevented or mitigated by the safety provisions at the LPG Filling 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 11**.

Table 11 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 the Road Tanker)	0.5 per demand	

Note:
(1)Unless other specified, the failure probabilities are adopted from QRA Methodology for LPG Installations [3].

4.3 External Events

4.3.1 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 [3]. It is assumed that such earthquake may result in storage vessel leakage and pipework rupture at a probability of 0.01 [14].

4.3.2 Aircraft crash

The LPG Filling Station is located from the Hong Kong International Airport with a distance of about 18 km. The frequency of aircraft crash is estimated using the HSE methodology [15], which was adopted in Previous Report [2]. The number of flights from 2014 to 2022 is extracted from the Civil Aviation Department [16], and extrapolated to year 2023 by linear regression. The calculated impact frequency due to aircraft crash is 7.37×10^{-11} per year, which is smaller than 1.0×10^{-9} per year. It is therefore not further considered in the analysis.

4.3.3 Car crash

The LPG Filling Station is fenced by a 2.5-m concrete wall on three sides. A buffer area with crash barriers is implemented to the public access roads. Speed restriction and warning signage are imposed within the LPG Filling Station. It is considered car crash on the public road impacts negligible threat to the LPG Filling Station.

4.3.4 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 [15].

Since the distance to nearest helicopter landing pad (the Lut Chau North Helicopter Landing Pad in Mai Po Nature Reserve Area) is about 3.51 km away from the Project site, risk due to helicopter crash is not further considered in the assessment.

4.3.5 Landslide

Risk due to landslide on this LPG Filling Station is not considered in the analysis because there is no slope near the LPG Filling Station.

4.3.6 Severe environmental events

Loss of containment due to severe environmental events such as typhoon is considered unlikely since the LPG installation is designed safe to withstand the wind load for typhoon. Therefore, the risk is deemed remote and not further considered in the analysis.

4.3.7 Lightning strike

The frequency of lightning strike on a properly protected building structure is extremely low in Hong Kong. Risk resulting from lightning strike on facilities in the filling station is extremely low as the filling station is fitted with lightning rod and surrounded by a number of high-rise buildings. It is deemed lighting strike is remote, therefore not further considered in this assessment.

4.3.8 Dropped object

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

4.3.9 Subsidence

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

4.3.10 External fire

External fire refers to the occurrence of a fire event outside the LPG filling 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.

4.4 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 results are summarized in **Table 12** below.

Table 12 Resultant frequencies after Fault Tree Analysis

Hazardous Event	Inventory	Time Fraction	Original Frequency (per year)	Factored Frequency (per year)
Cold Catastrophic Failure of LPG Vessel (Spontaneous and External Event)	100%	0.2	3.60E-07	7.20E-08
	60%	0.8	3.60E-07	2.88E-07
Cold Catastrophic Failure of LPG Vessel (Loading Failure)	100%	1.0	1.10E-07	1.10E-07
Cold Partial Failure of LPG Vessel (Spontaneous and External Event)	100%	0.2	1.01E-05	2.02E-06
	60%	0.8	1.01E-05	8.08E-06
Cold Partial Failure of LPG Vessel (Loading Failure)	100%	1.0	4.27E-06	4.27E-06
Cold Catastrophic Failure of LPG Road Tanker	100%	0.2	5.26E-07	1.05E-07
	50%	0.8	5.26E-07	4.21E-07
Cold Partial Failure of LPG Road Tanker	100%	0.2	3.23E-06	6.46E-07
	50%	0.8	3.23E-06	2.59E-06
Failure of Liquid-Inlet Pipework (rupture)	100%	0.2	3.21E-08	6.42E-09
	50%	0.8	3.21E-08	2.57E-08
Failure of Liquid-Inlet Pipework (leak)	100%	0.2	7.01E-06	1.40E-06
	50%	0.8	7.01E-06	5.61E-06

Hazardous Event	Inventory	Time Fraction	Original Frequency (per year)	Factored Frequency (per year)
Failure of Liquid Supply Line to Dispenser (rupture)	100%	0.2	3.60E-07	7.21E-08
	60%	0.8	3.60E-07	2.88E-07
Failure of Liquid Supply Line to Dispenser (leak)	100%	0.2	6.61E-06	1.32E-06
	60%	0.8	6.61E-06	5.29E-06
Failure of Dispenser	100%	0.2	8.81E-05	1.76E-05
	60%	0.8	8.81E-05	7.05E-05
Failure of Flexible Hose to Vessel (rupture)	100%	0.2	4.61E-05	9.22E-06
	50%	0.8	4.61E-05	3.69E-05
Failure of Flexible Hose to Vessel (leak)	100%	0.2	5.43E-05	1.09E-05
	50%	0.8	5.43E-05	4.34E-05
Failure of Flexible Hose to Vehicle (rupture)	100%	0.2	4.99E-03	9.99E-04
	60%	0.8	4.99E-03	4.00E-03
Failure of Submersible Pump Flange (leak)	100%	0.2	1.00E-05	2.00E-06
	60%	0.8	1.00E-05	8.00E-06

4.5 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.

4.5.1 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 13**. 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 13 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 [2] 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.

4.5.2 Leak from LPG Storage Vessel / Road Tanker

A lower probability of 0.07 is adopted from **Table 13**. 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.

4.5.3 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 [4]. 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 [3]. The failure rate of water spray system is taken as 0.015 [3]. Fire services system is assumed to have a chance of 0.5 [3] being ineffective in preventing a BLEVE.

The underground LPG storage vessel is free from flame impingement.

4.5.4 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.

5.0 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.

5.1 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 14.1 tonnes. the vessel is assumed nominally at full load inventory (i.e. 85% of maximum capacity, equivalent to 12 tonnes) for 20% of the time and at low inventory level with 60% of full load inventory (equivalent to 7.2 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.

5.2 Physical Effect Modelling

5.2.1 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 a 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. SAFETI is used for the dispersion of unignited vapour cloud following an accidental 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.

5.2.2 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.

5.2.3 Fireball and BLEVE

Immediate ignition of an instantaneous release of massive inventory inside a pressurised vessel would result in a fireball. A fireball is characterized 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.

5.2.4 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 [7]:

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

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

5.2.5 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 [3].

5.2.6 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 [7].

5.3 Hazardous Impacts on Offsite Population

Population in the vicinity of the LPG Filling 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 summarized in **Table 14** below. The worst consequence distance is 141.7 m, which is

resulted from the flashfire of cold catastrophic failure of LPG vessel during unloading operation.

Table 14 Summary of Worst Consequence Distances

Hazardous Event	Failure Event	Parameter	Distance (m)
Fireball / BLEVE	BLEVE of LPG Road Tanker	Fireball radius Lift off height	60.3 181.0
Jet fire	Failure of Liquid-Inlet Pipework (rupture)	Flame length	20.4
Flashfire	Cold Catastrophic Failure of LPG Vessel (unloading)	Flash fire envelop at 100% LFL	141.7

5.3.1 Height Protection Factor

Population above the cloud height is not exposed to flash fire events. In another term, these populations are "protected". The height protection factors to the "protected" population are corresponding to the proportion of building above the top of the cloud [3]. According to the SAFETI modelling, the maximum height of vapour cloud is 24m resulted from the rupture of LPG vessel.

The population factors applied to various population groups within flash fire envelope for flash fire events are shown in **Table 15**.

Table 15 Height Protection Factor Considered

ID	Description	Base Level (mPD)	Building height (m)	Distance from LPG filling station (m)	Cloud height (m)	Height Protection Factor
1	Goodman Yuen Long Logistics Centre	4.7	88	27.3	24	0.73
2	Crown Data Centre III	4.7	73	50.1	24	0.67
4	Mansfield Industrial Centre	4.8	34	113.8	24	0.30
9	Yuen Long Trading Centre	4.3	66	129.0	24	0.64
13	CPL Aromas (Far East) Limited	4.3	31	99.9	24	0.23
24	Twin Regency	4.4	80	43.6	24	0.70

ID	Description	Base Level (mPD)	Building height (m)	Distance from LPG filling station (m)	Cloud height (m)	Height Protection Factor
PD1	One North Tower 1	14.65	70	83	24	0.80
	One North Tower 1 (7/F Social Welfare Facilities)	33.65	4.5	83	24	1.00
PD2	One North Tower 2	14.65	70	83	24	0.80

5.3.2 Shielding Factor

Shielding factors are assumed to account for protection by the front part of the building or by other buildings from fireball effects [3]. A shielding factor of 0.5 is assigned to those buildings within the fireball diameter, outside the fireball and partly inside and partly outside the fireball.

Table 16 Buildings with Fireball Shielding Factor Applied

ID	Description
1	Goodman Yuen Long Logistics Centre
2	Crown Data Centre III
4	Mansfield Industrial Centre
7	Golden Town Industrial Building
8	Tsun Mee Industrial Building
9	Yuen Long Trading Centre
11	Jing Hin Godowns (Yuen Long) Limited
12	Po Wai Building
13	CPL Aromas (Far East) Limited
14	Mercedes-Benz Trucks & Buses Service Centre
17	Shan Pui Chung Hau Tsuen
20	Wang Yip Center
22	Crown Data Centre II
23	Future Residential Development
24	Twin Regency
PD1	One North Tower 1
	One North Tower 1 (3/F Social Welfare Facilities)

ID	Description
	One North Tower 1 (7/F Social Welfare Facilities)
PD2	One North Tower 2
PD3	One North Retail

6.0 Risk Assessment

6.1 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**.

6.2 Results of Individual Risk

The individual risk contours of the LPG Filling Station are presented in **Figure 5**. Risk to the offsite population is lower than 1×10^{-5} per year, and decreases at distances further away from the LPG Filling Station.

The individual risk at the Application Site is below 1×10^{-7} per year and thus, the criteria set in the Hong Kong Risk Guidelines is satisfied.

6.3 Results of Societal Risk

The societal risk results are presented in **Table 17** and **Figure 6**. As recaptured from **Section 1.4.2**, Case 1 - Base Case represents the risk level in year 2025 without the Proposed Social Welfare Development while Case 2 - Operation Case represents the risk level in year 2025 with the operation of the Proposed Social Welfare Development.

As illustrated in the F-N curves, the F-N curve of the operation case lies within the Acceptable region. The societal risk result complies with the criterion stipulated in the Hong Kong Risk Guidelines.

Table 17 F-N Data

No. of fatality	Frequency (per year)	
	Case 1 – Base Case	Case 2 – Operation Case
1	4.24E-07	4.25E-07
2	3.79E-07	3.80E-07
3	3.78E-07	3.79E-07
4	3.77E-07	3.77E-07
5	3.73E-07	3.74E-07
6	3.15E-07	3.16E-07
8	3.13E-07	3.14E-07
10	3.10E-07	3.11E-07
12	3.02E-07	3.03E-07
15	2.65E-07	2.66E-07

No. of fatality	Frequency (per year)	
	Case 1 – Base Case	Case 2 – Operation Case
20	2.45E-07	2.45E-07
25	1.99E-07	2.01E-07
30	1.53E-07	1.55E-07
40	1.18E-07	1.23E-07
50	8.72E-08	9.33E-08
60	5.67E-08	6.44E-08
80	2.38E-08	3.12E-08
100	8.61E-09	1.57E-08
120	3.73E-09	7.73E-09
150	1.44E-09	1.96E-09
200	1.12E-10	2.26E-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 contributors are shown in **Table 18**. With the additional population brought by the Proposed Development, the total PLL is increased by 5.4%, from 1.23×10^{-5} no. of fatality per year to 1.30×10^{-5} no. of fatality per year.

Table 18 Breakdown of PLL

Equipment	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
LPG Tanker	6.23E-06	50.52%	6.61E-06	50.85%
LPG Vessels	6.07E-06	59.17%	6.35E-06	48.86%
Aboveground Pipework (Liquid-Inlet Pipework, Flexible Hose, Dispenser)	3.76E-08	0.31%	3.76E-08	0.29%
Underground Pipework (Liquid Supply Line to Dispenser)	7.70E-16	0.00%	7.70E-16	0.0%
Total	1.23E-05	100%	1.30E-05	100%

7.0 Conclusion

A Quantitative Risk Assessment (QRA) for an LPG Filling Station was carried out to study the population increase due to the Propose Social Welfare Development in Yuen Long Town Lot No. 532, which is at the junction of Wang Yip Street West and Hong Yip Street of Tung Tau Industrial Area.

The result revealed that the offsite individual risk of the filling station was lower than $1x10^{-5}$ per year. While the societal risk F-N curve for the Operation Case with the operation of the Proposed Social Welfare Development lied within the "Acceptable" region. The risk posed by the LPG Filling Station to the surrounding, including the additional population brought by the Proposed Social Welfare Development, complies with criterion in the Hong Kong Risk Guidelines.

8.0 References

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Figures

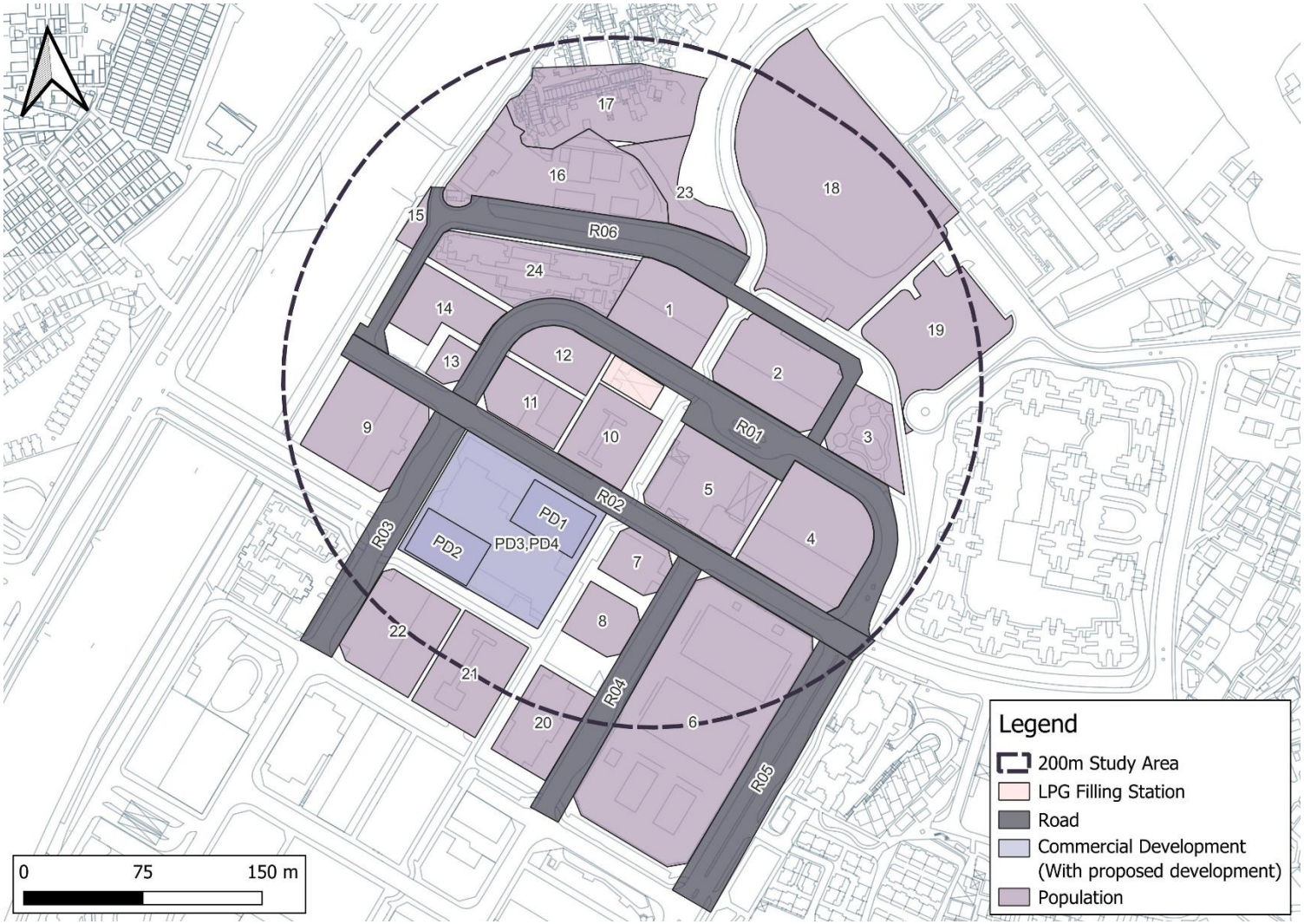


Figure 1 Location of Proposed Development and Study Area

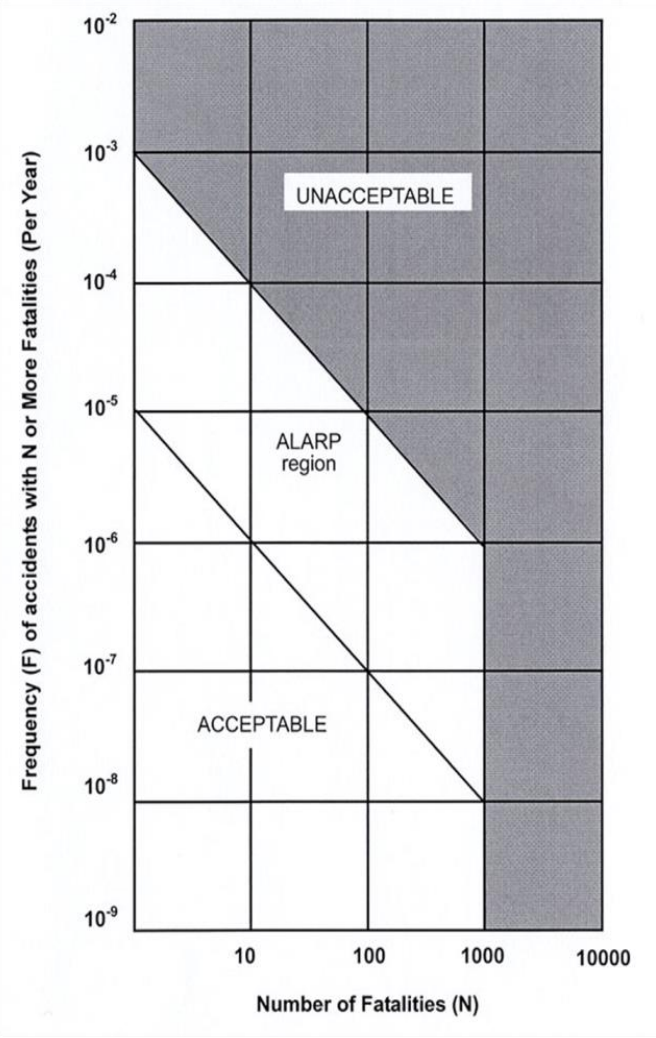


Figure 2 Societal Risk Guideline

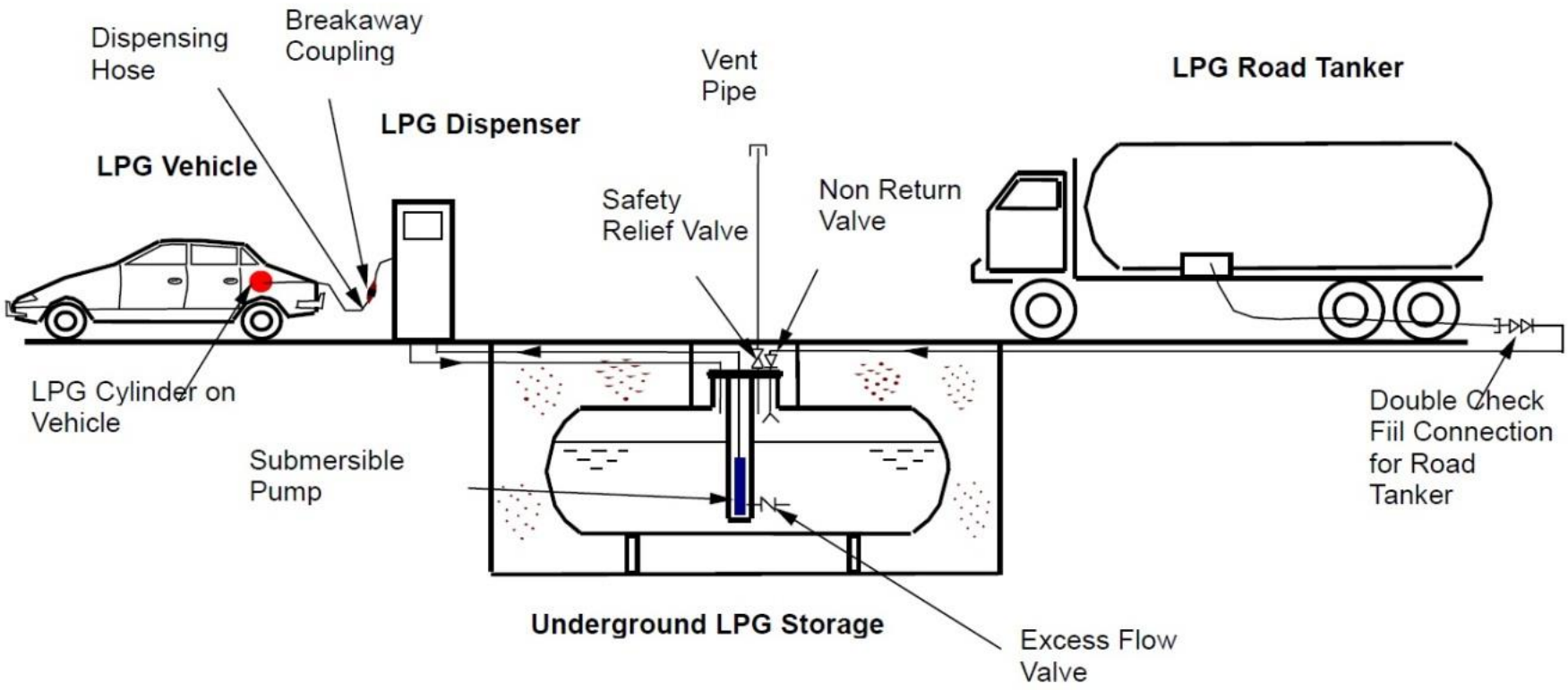


Figure 3 Schematic Diagram of LPG filling station

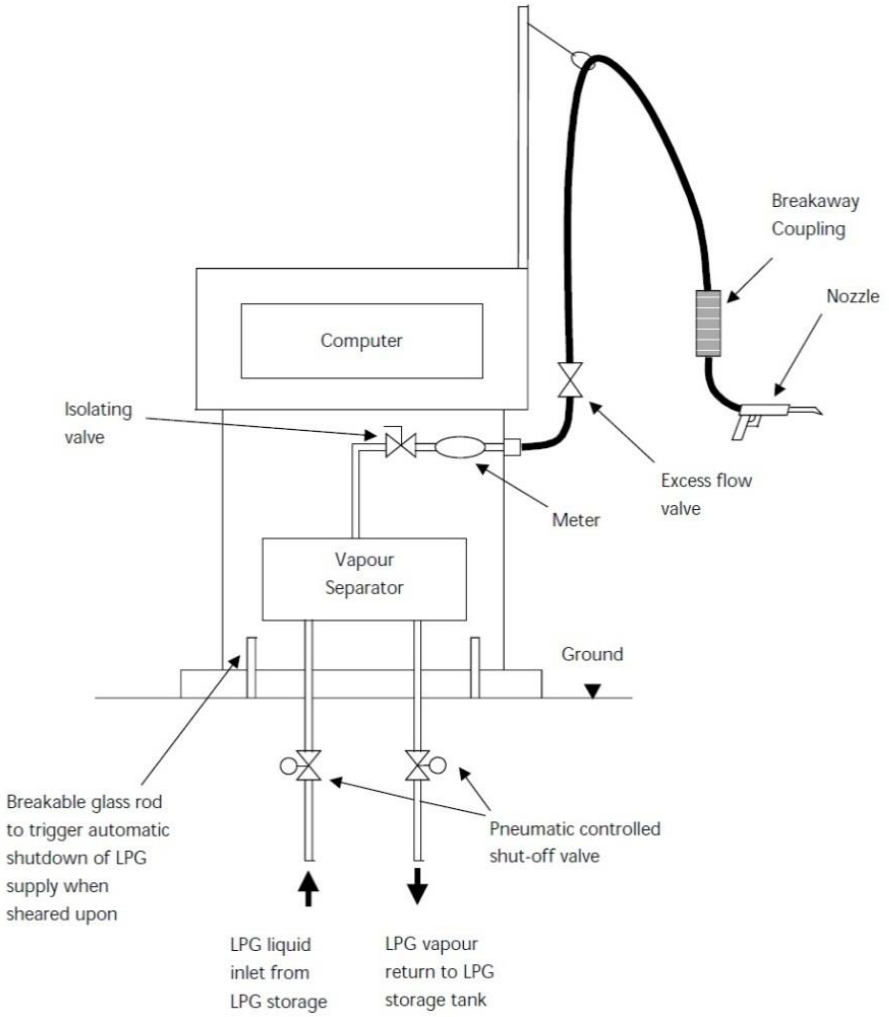


Figure 4 Schematic Diagram of a Typical LPG Dispenser

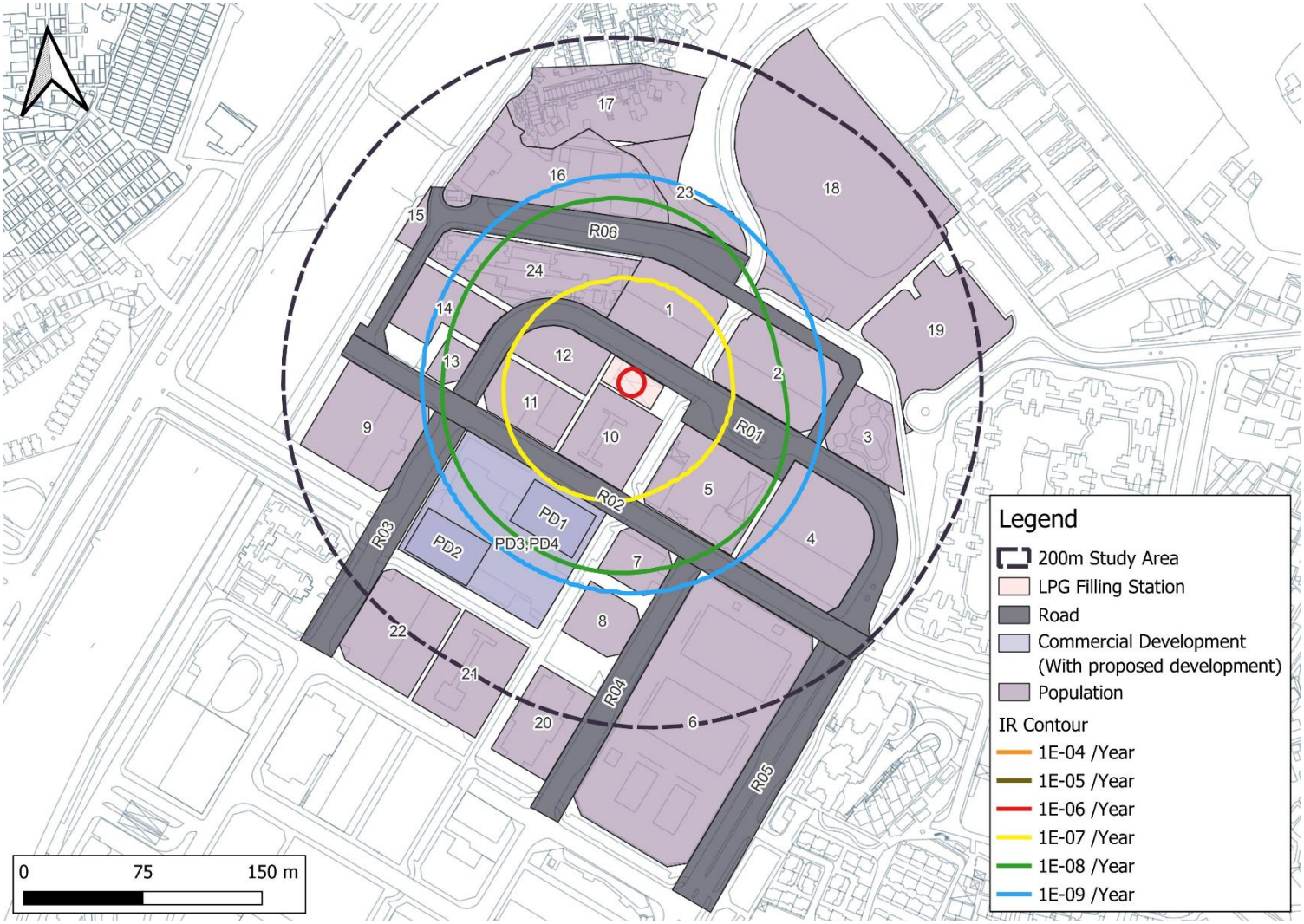


Figure 5 Individual Risk of the LPG Filling Station

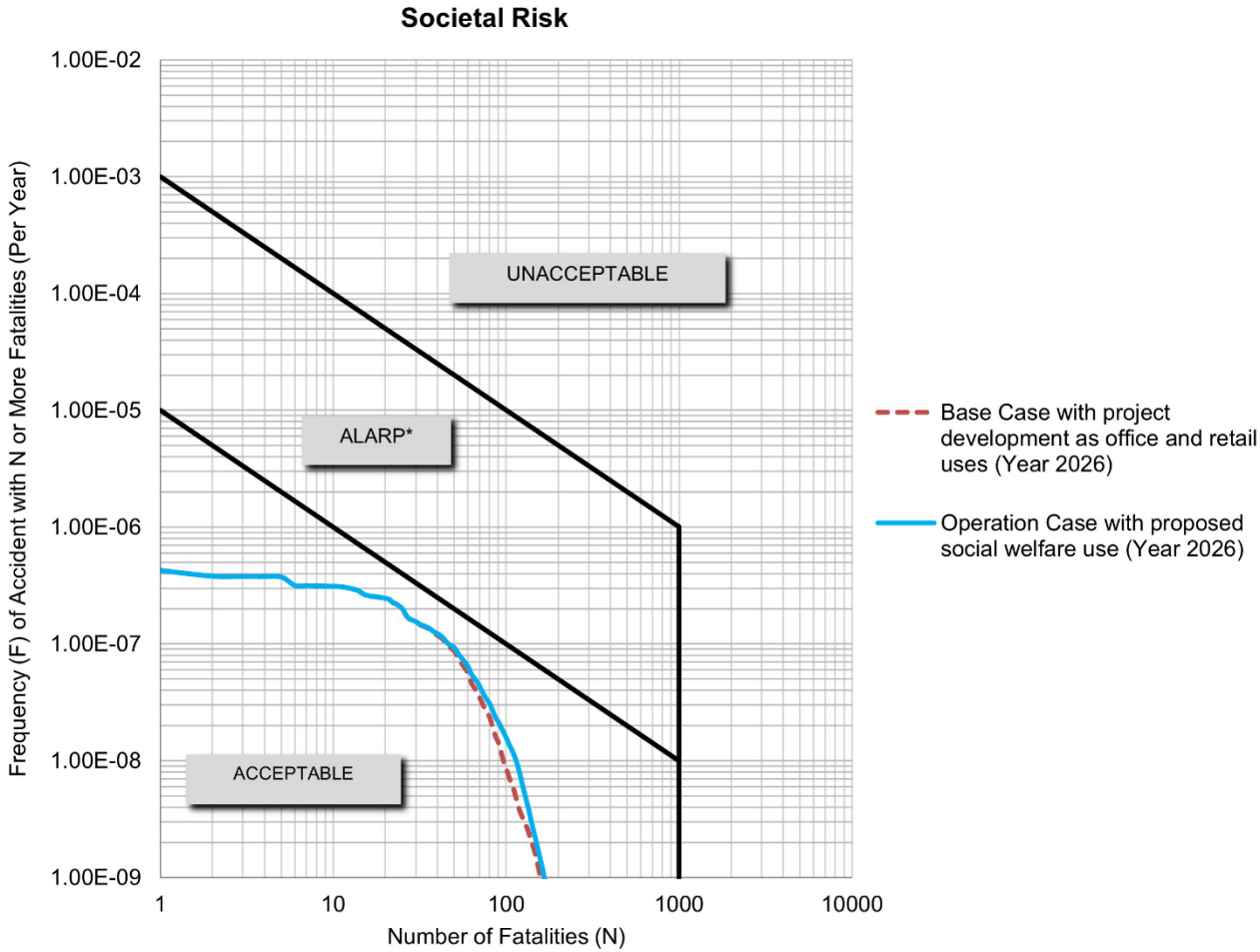
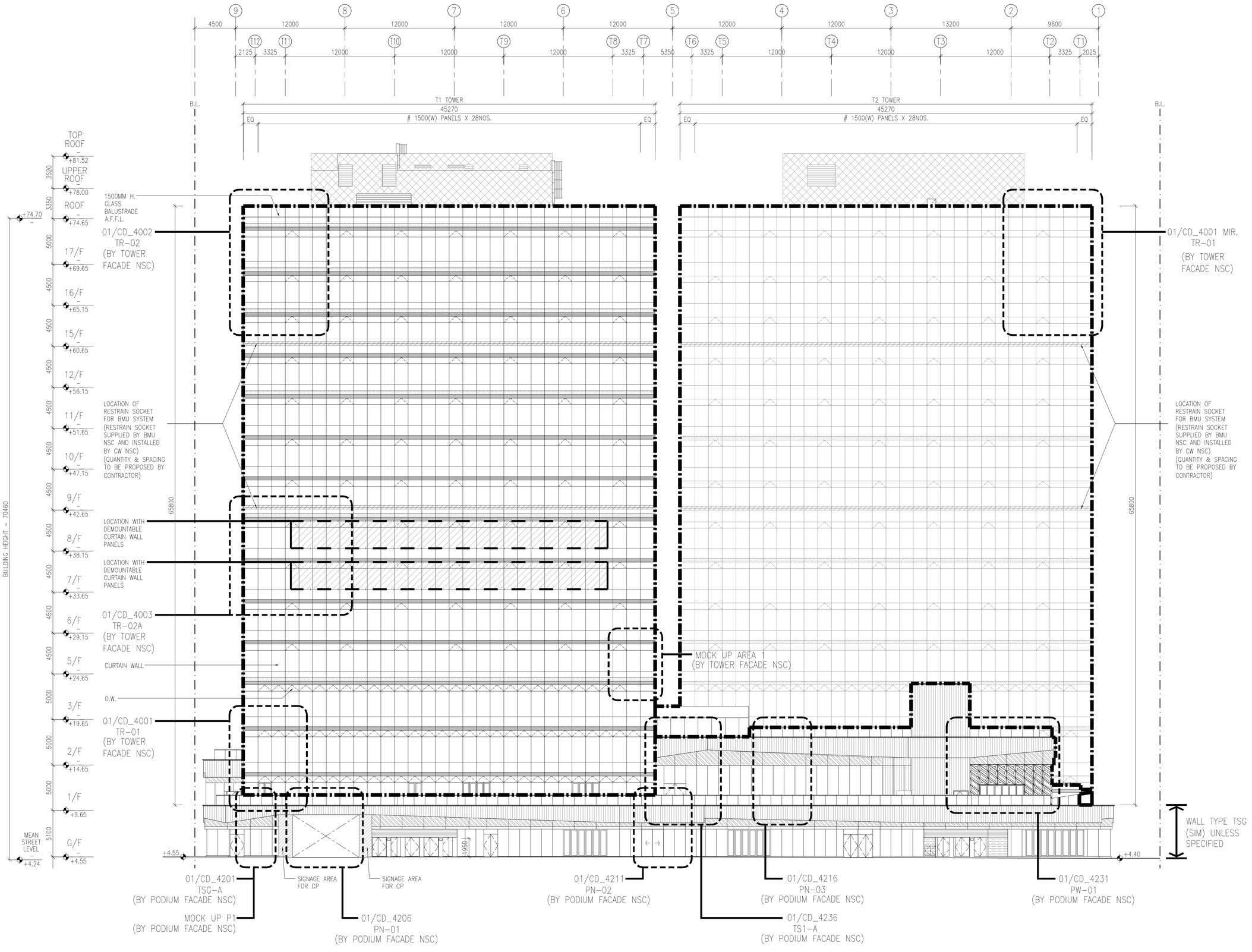


Figure 6 Societal Risk Results

Annex A: Layout Plan of the Proposed Development



Drawing Type **CONSTRUCTION DRAWING**

DEMARCATION TO THE EXTENT OF TOWER FACADE WORKS AND BMU SYSTEM

- 05:AL04 (PF)
- 05:AL20A (PF/CW)
- 09:P02
- 05:AL21A (PF)
- AL20A (VERTICAL) (PF) / AL21A (VERTICAL) (PF)

Rev.	Description	Issue Date	Initial
B	REVISED	01.2021	YKC
A	FIRST ISSUANCE	06.2020	YKC

Original by	Date	Draw	Check	App
IVY	**06.2020**	**YKC**	**IVY**	**CL**

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Project **Y.L.T.L.532, Junction of Wang Yip Street West and Hong Yip Street, Tung Tau Industrial Area, Yuen Long, N.T**

Drawing **NORTH ELEVATION**

Computer file **Q:\160024-00\CADD\Drawing\Sheet\Construction Drawing**

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Drawing Number	Rev.	Issue status
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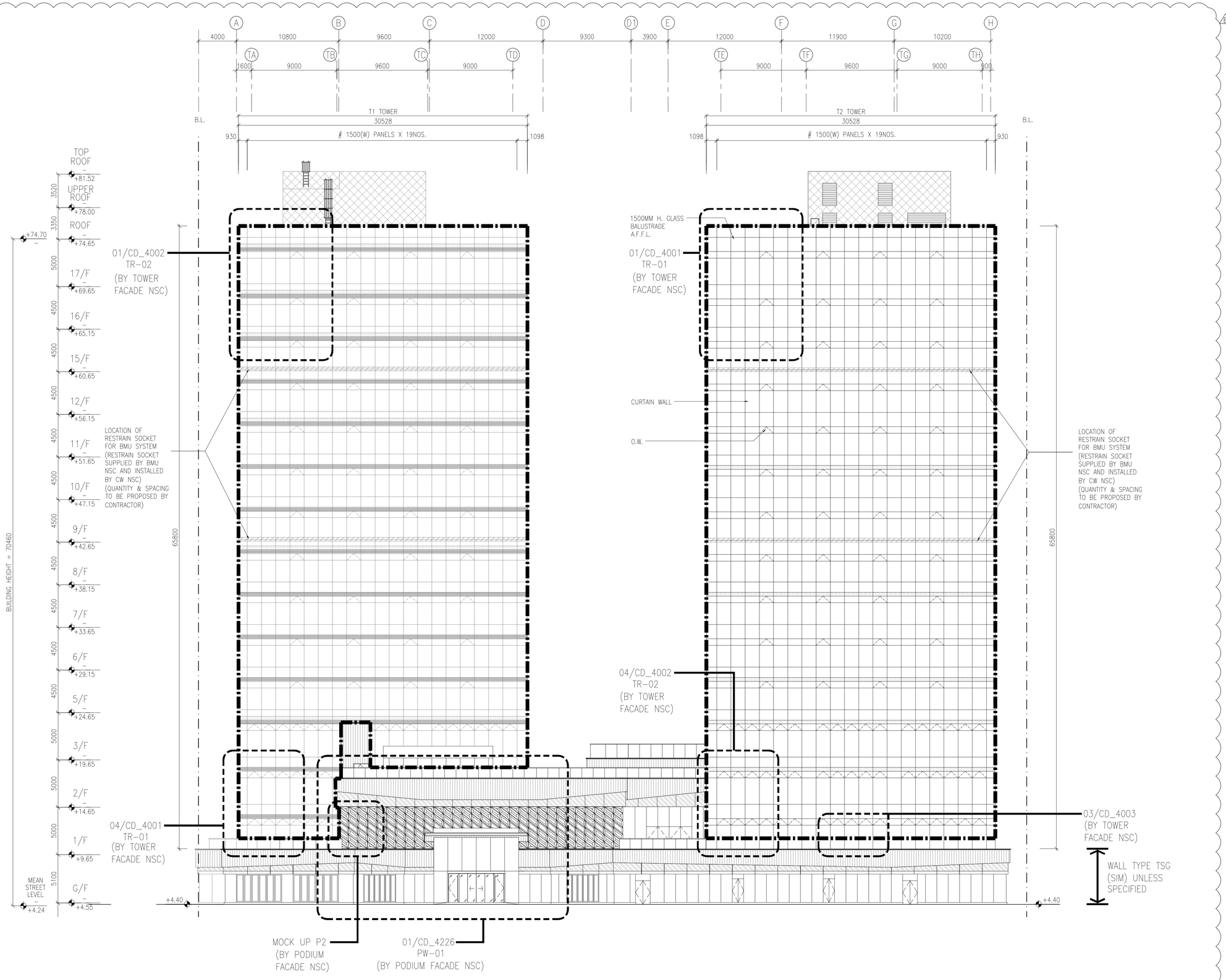

Drawing Type **CONSTRUCTION DRAWING**

DEMARCATION TO THE EXTENT OF TOWER FACADE WORKS AND BMU SYSTEM

05:AL04 (PF)

05:AL20A (PF/CW)

09:P02

05:AL21A (PF)

AL20A (VERTICAL) (PF) / AL21A (VERTICAL) (PF)

Rev.	Description	Issue Date	Initial
B	REVISED	01.2021	YKC
A	FIRST ISSUANCE	06.2020	YKC

Original by	Date	Draw	Check	App
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Drawing **WEST ELEVATION**

Computer file **Q:\160024-00\CADD\Drawing\Sheet\Construction Drawing**

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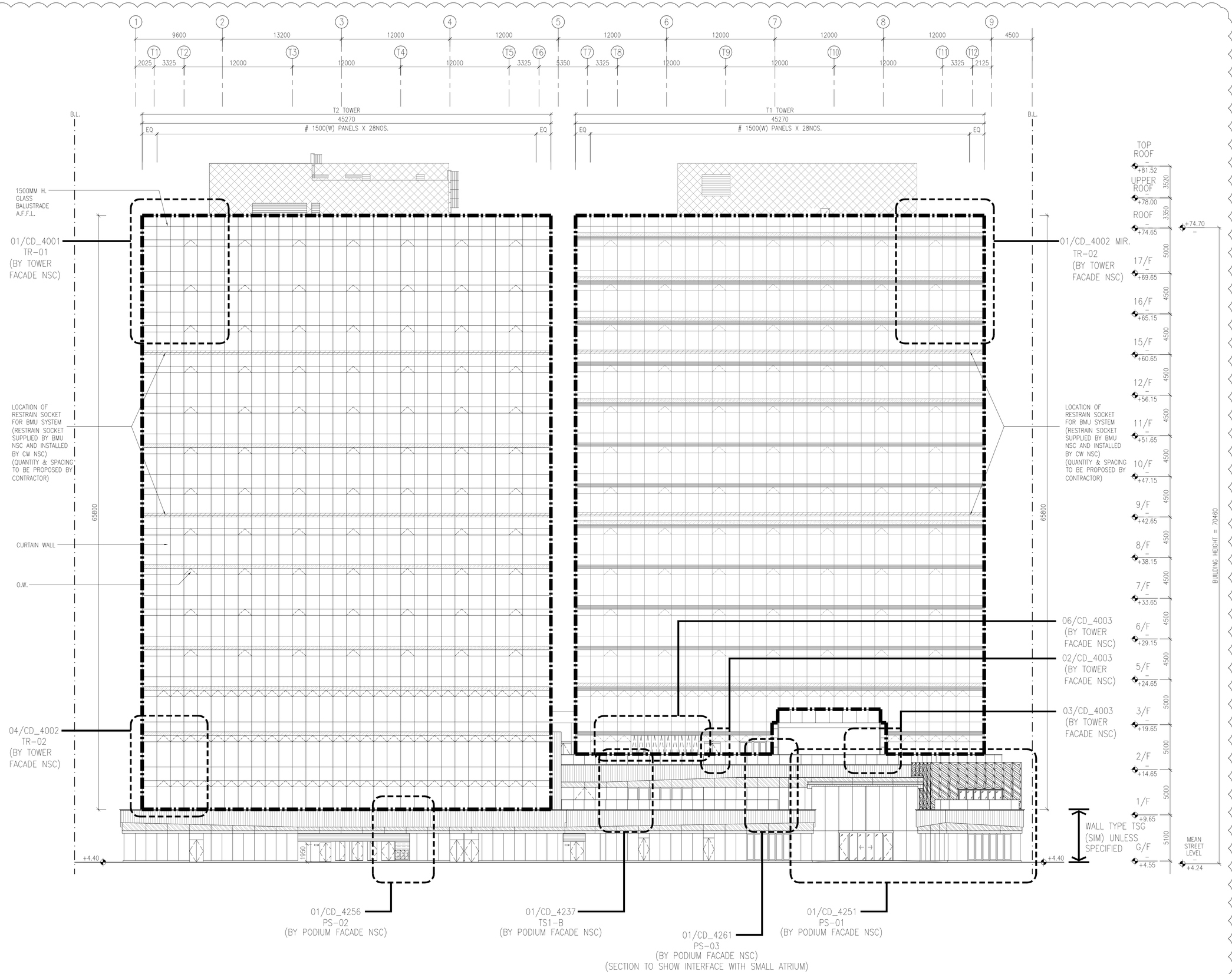

Drawing Type **CONSTRUCTION DRAWING**

DEMARCATION TO THE EXTENT OF TOWER FACADE WORKS AND BMU SYSTEM

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09:P02

05:AL21A (PF)

AL20A (VERTICAL) (PF) / AL21A (VERTICAL) (PF)

Rev.	Description	Issue Date	Initial
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A	FIRST ISSUANCE	06.2020	YKC

Original by	Date	Draw	Check	App
IVY	**06.2020**	**YKC**	**IVY**	**CL**

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Drawing **SOUTH ELEVATION**

Computer file
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Drawing Number	Rev.	Issue status
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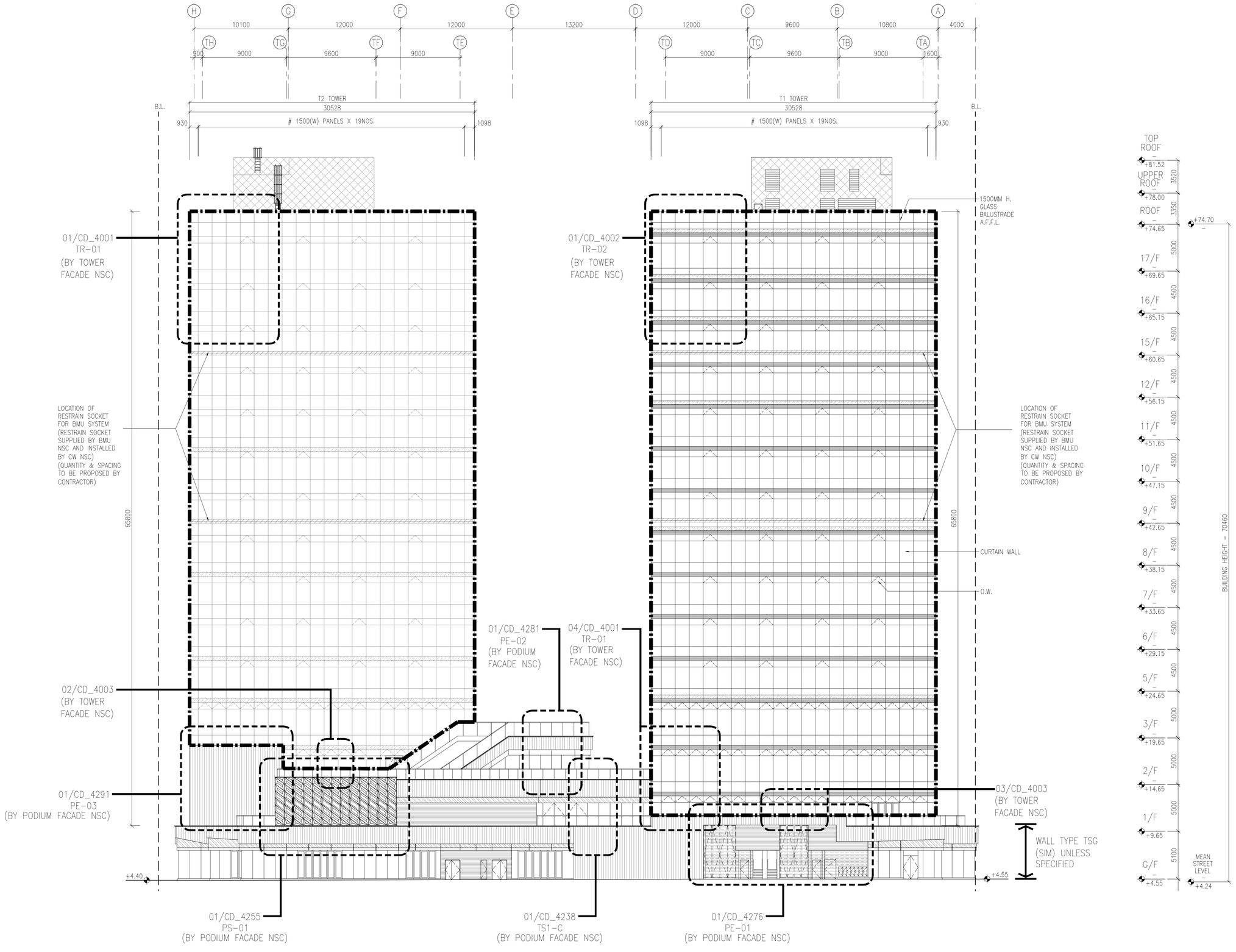

Drawing Type **CONSTRUCTION DRAWING**

DEMARCATION TO THE EXTENT OF TOWER FACADE WORKS AND BMU SYSTEM

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- 05:AL20A (PF/CW)
- 09:P02
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- AL20A (VERTICAL) (PF) / AL21A (VERTICAL) (PF)

Rev.	Description	Issue Date	Initial
B	REVISED	01.2021	YKC
A	FIRST ISSUANCE	06.2020	YKC

Original by	Date	Draw	Check	App
IVY	06.2020	YKC	IVY	CL

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Project **Y.L.T.L.532, Junction of Wang Yip Street West and Hong Yip Street, Tung Tau Industrial Area, Yuen Long, N.T**

Drawing **EAST ELEVATION**

Computer file
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Annex B: Calculation of Transient Population

B1 Calculation of Average Occupancy

Source: Hong Kong Annual Traffic Census 2022

The average occupancy adopted in this study is taken from Traffic Station No. 5016, which is the nearest traffic station in the vicinity with vehicle occupancy data.

Time		Motor cycle	Private car	Taxi	Private light bus	Public light bus	Light goods veh.	M & H goods veh.	Non Fr. Bus	SD Fr. bus	DD Fr. bus
16 hrs	Pro	1.7	49.5	5.7	0.6	2.6	20.2	16.9	1.5	0.1	1.3
	Ocp	1.1	1.3	1.7	3.5	12.6	1.3	1.1	12.9	2.4	38.5
		0.012	0.626	0.146	0.018	0.447	0.238	0.236	0.472	0.001	0.864

Average occupancy = (0.019+0.643+0.097+0.021+0.327+0.262+0.186+0.193+0.002+0.500) = 2.3 persons per vehicle

B2. Calculation of Traffic Variation within the Day

Source: Hong Kong Annual Traffic Census 2022

The traffic flow variation adopted is taken from Traffic Station No. 5016, which is the nearest traffic station in the vicinity with traffic flow variation data.

Time	% of 24 Hours Total (All-day)	Time	%of 24 Hours Total (All-day)
0000-0100	1.4%	1200-1300	6.0%
0100-0200	0.9%	1300-1400	5.9%
0200-0300	0.6%	1400-1500	6.0%
0300-0400	0.6%	1500-1600	6.2%
0400-0500	0.6%	1600-1700	6.5%
0500-0600	1.3%	1700-1800	6.9%
0600-0700	3.3%	1800-1900	6.1%
0700-0800	5.8%	1900-2000	4.9%
0800-0900	6.6%	2000-2100	3.7%
0900-1000	6.2%	2100-2200	3.5%
1000-1100	6.2%	2200-2300	2.9%
1100-1200	6.1%	2300-2400	2.0%

Parameter	
Average all-day AADT	41410
% day traffic flow (0700 – 1900) to all-day	74.5%
% night traffic flow (1900 – 0700) to all-day	25.5%
Average weekday AADT	43895
Weekday to average all-day traffic flow ratio	106%
Average weekend AADT	37017.5
Weekend to average all-day traffic flow ratio	89%
Temporal Change of Road Population Within a Week	
Rush hour	100.0%
Peak hour	100.0%
Weekday day	74.5%×106% = 79.0%
Weekend day	74.5%×89% = 66.6%
Night	25.5%

B3. Estimation of Traffic Flow

Source: Hong Kong Annual Traffic Census 2022

Traffic station is not available within the Tung Tau Industrial Area. The traffic flows on the roads within the study area are estimated from Traffic Station No. 5812 (Long Yip St & Yuen Long On Lok Road) which is the nearest traffic station in conjunction with the Tung Tau Industrial Area.

The traffic flows are projected to 2025 from the most recent six years Annual Average Daily Traffic (AADT) data of Traffic Station No. 5812.

Station	AADT (Veh / day)						Average Annual Growth (%)	Annual AADT (Veh / day)
	2017	2018	2019	2020	2021	2022		2025
5812	23050	23790	24730	23540	25330	25340	2%	26684

Traffic Station No. 5812 represents a primary distributor, its traffic flow would be much higher than that of a local distributor (Tak Yip Street and Hong Yip Street etc.) within the study area. It is therefore further assumed that the traffic flows on local distributors is about 50% of that of the primary distributor.

Road	Day Time Hourly Traffic Flow	Night Time Hourly Traffic Flow
	veh/hr	veh/hr
Tak Yip Street	828	284

Road	Day Time Hourly Traffic Flow	Night Time Hourly Traffic Flow
	veh/hr	veh/hr
Hong Yip Street	828	284
Wang Yip Street West	828	284
Wang Yip Street East	828	284
Po Yip Street	828	284
Lau Yip Street	828	284

B4 Calculation of Road Population

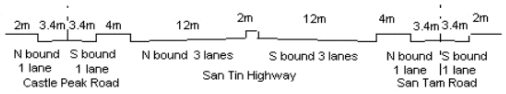
Road	Average Occu-pancy	Speed	Road Length	Daytime Traffic Popula-tion	Pedes-trian	Daytime Popula-tion
	ppl/veh	km/hr	m	ppl	ppl	ppl
Tak Yip Street	2.3	50	405	16	20	36
Hong Yip Street	2.3	50	380	15	20	35
Wang Yip Street West	2.3	50	170	7	20	27
Wang Yip Street East	2.3	50	183	7	20	27
Po Yip Street	2.3	50	183	7	20	27
Lau Yip Street	2.3	50	433	17	20	37

Note:

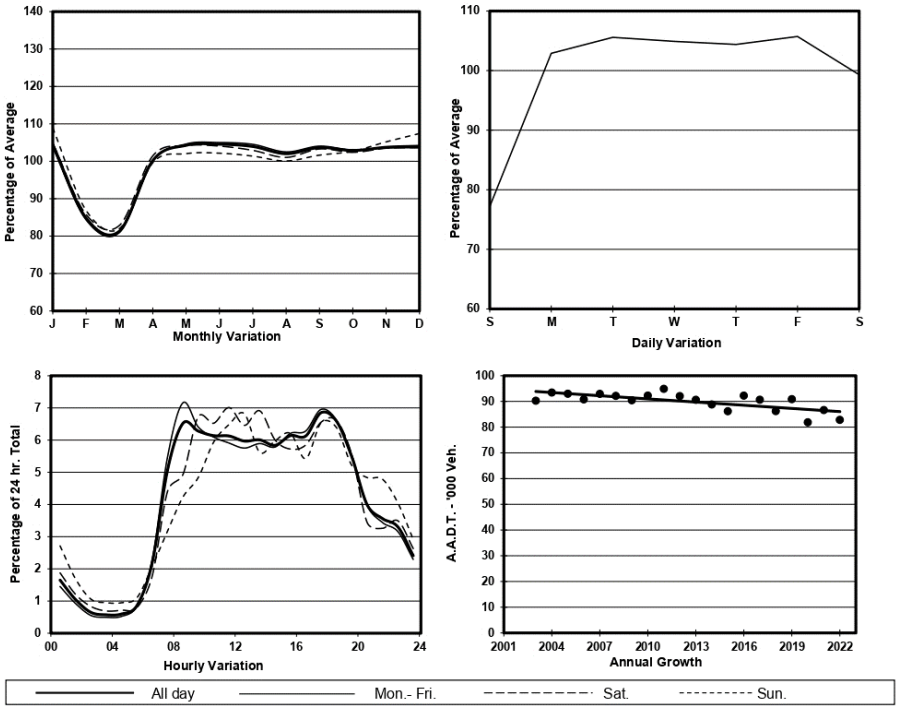
(1) Daytime Traffic Population = Day Time Hourly Traffic Flow × Average Occupancy × Road Length / Speed

YEAR 2022 **LINK** SAN TIN HIGHWAY, CASTLE PEAK RD & SAN TAM RD (from KAM TIN RD to FAIRVIEW PARK BOULEVARD)

CORE STATION 5016
ROAD NETWORK MAJOR
ROAD TYPE PRIMARY DISTRIBUTOR



1. TRAFFIC FLOW VARIATION AND GROWTH



2. TRAFFIC CHARACTERISTICS (BY DIRECTION)

Parameter	All - Day	Mon. - Fri.	Sat.	Sun.
SOUTH BOUND				
A.A.D.T.	41740	44090	41730	33650
R 12 / 24 - %	72.9	73.8	72.7	67.2
R 16 / 24 - %	89.2	89.9	88.3	86.1
AM Peak Hour	0800-0900	0800-0900	0900-1000	0900-1000
One-way flow at AM peak hour	2650	3070	2460	1620
T - % (AM)	-	21.1	-	-
PM Peak Hour	1800-1900	1800-1900	1700-1800	1800-1900
One-way flow at PM peak hour	2850	2960	2860	2550
T - % (PM)	-	10.5	-	-
Prop.of commercial vehicles - 16 hr.	-	19.4	-	-
NORTH BOUND				
A.A.D.T.	41080	43700	41570	31120
R 12 / 24 - %	74.5	75.3	74.7	68.2
R 16 / 24 - %	90.8	91.4	90.6	87
AM Peak Hour	0800-0900	0800-0900	0900-1000	0900-1000
One-way flow at AM peak hour	2750	3220	3140	1510
T - % (AM)	-	15.2	-	-
PM Peak Hour	1700-1800	1700-1800	1800-1900	1700-1800
One-way flow at PM peak hour	2950	3270	2650	1990
T - % (PM)	-	17.9	-	-
Prop.of commercial vehicles - 16 hr.	-	20	-	-

3. OTHER INFORMATION AND COMMENT

Core Station 5016
Year 2022

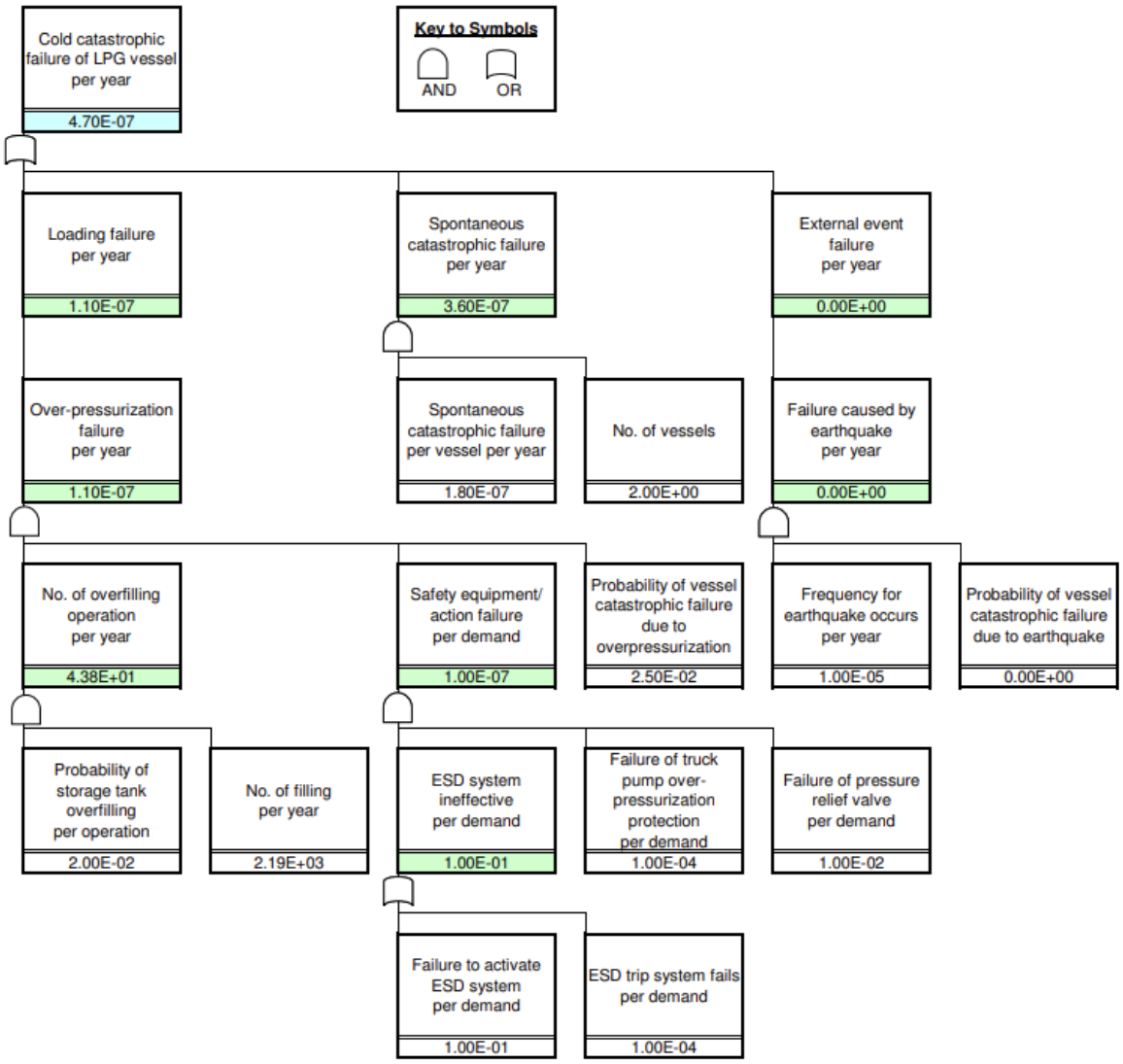
4. Vehicle classification and occupancy - Monday to Friday

Time		Class of vehicle									
		Motor Cycle	Private Car	Taxi	Private LB	PLB	Goods veh.		Non Fr. Bus	Fr. Bus	
							Light	M & H		SD	DD
0700-0800	Pro	1.9	52.7	6.8	0.6	3.3	16.5	14.8	1.9	0.1	1.5
	Ocp	1.1	1.2	1.9	5.1	16.1	1.3	1.1	16.8	1.0	63.7
0800-0900	Pro	1.3	52.4	6.7	1.0	2.8	17.7	14.8	2.2	0.0	1.1
Peak hour	Ocp	1.1	1.2	1.6	3.9	14.4	1.2	1.1	17.1	0.0	56.8
0900-1000	Pro	1.3	47.7	4.4	0.4	1.9	19.7	22.4	1.0	0.0	1.1
	Ocp	1.1	1.3	1.6	4.5	11.3	1.2	1.2	9.1	0.0	31.8
1000-1100	Pro	0.9	35.6	5.2	0.2	2.4	29.9	23.7	1.1	0.0	1.1
	Ocp	1.0	1.3	2.0	1.5	9.3	1.2	1.1	5.5	0.0	27.3
1100-1200	Pro	0.7	40.7	4.8	0.6	2.4	27.3	20.7	1.3	0.0	1.3
	Ocp	1.1	1.3	1.9	2.3	10.5	1.2	1.1	4.5	0.0	26.8
1200-1300	Pro	1.5	42.4	5.2	0.8	2.6	22.5	22.2	1.5	0.0	1.3
	Ocp	1.2	1.4	1.8	3.3	11.5	1.2	1.1	7.1	0.0	27.3
1300-1400	Pro	1.4	44.2	5.5	0.8	1.8	23.1	21.2	1.0	0.0	1.2
	Ocp	1.0	1.4	1.6	6.7	11.1	1.2	1.1	11.5	0.0	30.2
1400-1500	Pro	1.3	39.0	4.9	1.2	2.2	24.8	23.8	1.5	0.0	1.2
	Ocp	1.0	1.4	1.8	2.7	12.8	1.2	1.1	9.2	0.0	25.0
1500-1600	Pro	0.7	38.5	3.7	0.5	1.8	26.0	26.6	1.0	0.0	1.2
	Ocp	1.1	1.2	1.8	3.9	11.0	1.2	1.2	12.2	0.0	24.2
1600-1700	Pro	1.3	42.1	4.5	0.9	2.3	24.6	22.1	1.1	0.0	1.2
	Ocp	1.2	1.4	1.7	3.3	11.6	1.3	1.1	15.3	0.0	38.7
1700-1800	Pro	2.7	49.7	4.3	0.5	2.8	23.5	13.6	1.7	0.0	1.2
	Ocp	1.1	1.4	1.8	1.9	15.4	1.3	1.1	11.4	0.0	55.1
1800-1900	Pro	2.9	63.6	5.1	0.4	2.7	14.4	7.1	2.6	0.1	1.2
	Ocp	1.1	1.2	1.7	2.3	15.0	1.4	1.1	16.6	1.0	68.1
1900-2000	Pro	3.0	65.6	5.1	0.1	3.1	11.6	8.0	1.9	0.0	1.6
	Ocp	1.1	1.3	1.8	2.0	15.0	1.1	1.1	14.0	0.0	34.2
2000-2100	Pro	1.9	62.6	8.4	0.6	3.7	12.8	7.5	0.8	0.0	1.6
	Ocp	1.1	1.4	1.6	2.2	9.0	1.2	1.1	13.4	0.0	28.9
2100-2200	Pro	2.0	63.7	10.1	0.3	3.0	10.4	6.8	1.8	0.0	1.9
	Ocp	1.1	1.1	1.8	1.0	9.8	1.2	1.1	12.0	0.0	22.9
2200-2300	Pro	1.8	62.2	10.7	0.3	3.1	12.6	6.1	1.3	0.1	1.9
	Ocp	1.1	1.4	1.6	4.0	9.7	1.2	1.0	14.3	11.0	19.6
16 hours	Pro	1.7	49.5	5.7	0.6	2.6	20.2	16.9	1.5	0.1	1.3
	Ocp	1.1	1.3	1.7	3.5	12.6	1.3	1.1	12.9	2.4	38.5

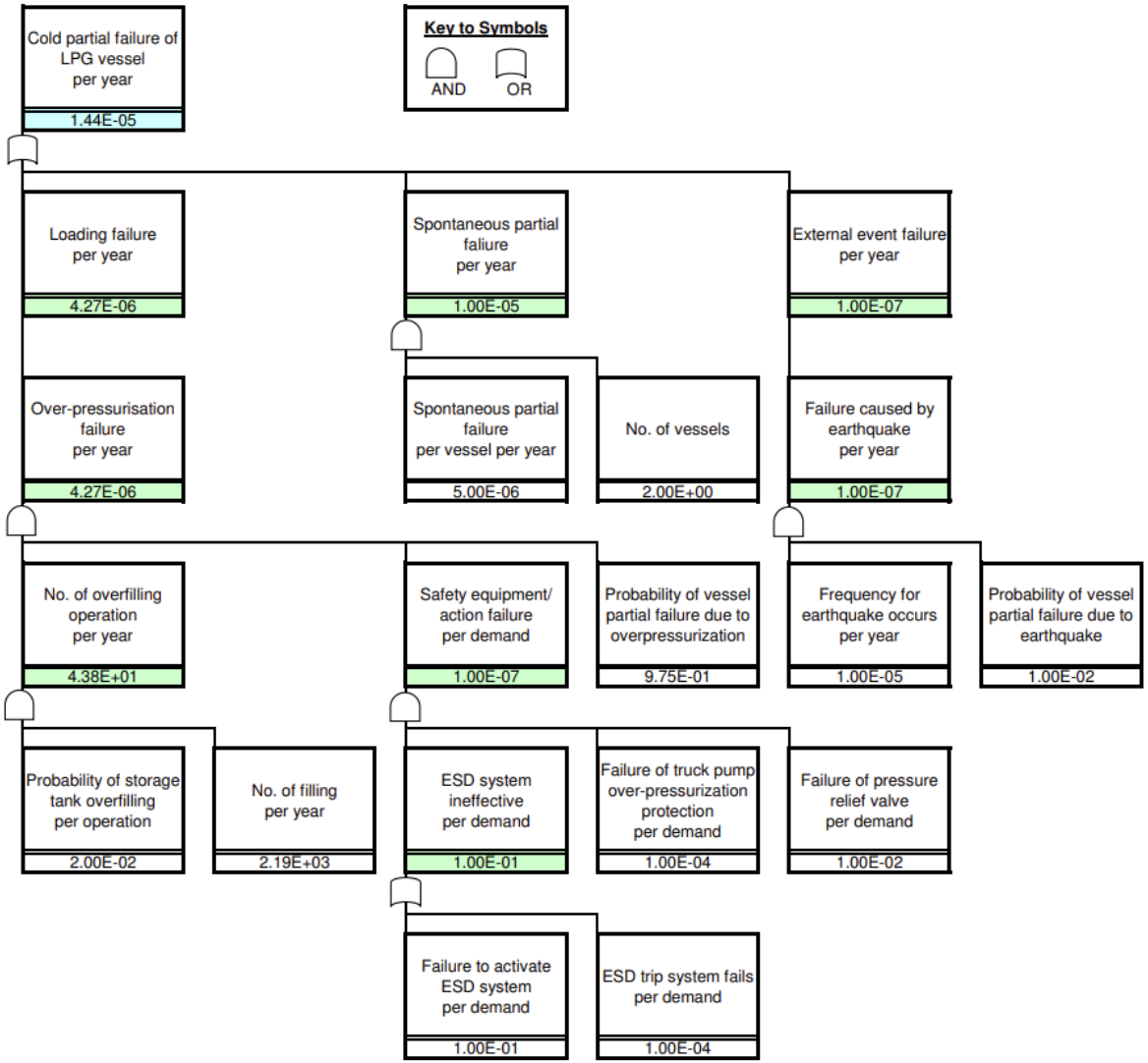
Legend: Pro. Proportion of vehicles in % (Sum may not add up to 100% due to figure rounding)*
Ocp. Average occupancy of vehicles including both driver and passengers*
M&H Medium and Heavy
* All traffic data are collected from combined bounds

Annex C:
Fault Tree Analysis

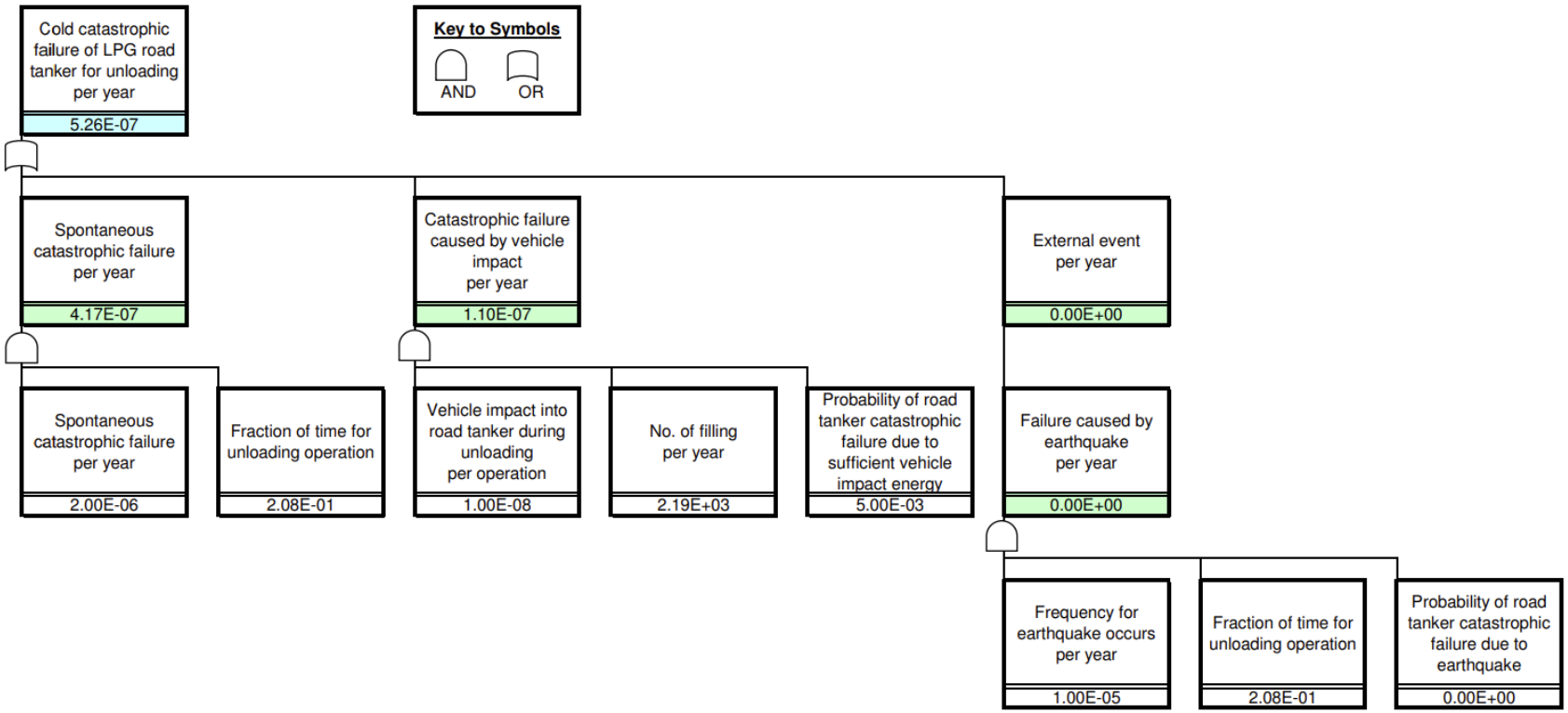
Fault Tree 1 - Cold Catastrophic Failure of LPG Vessel (LPG Filling Station)



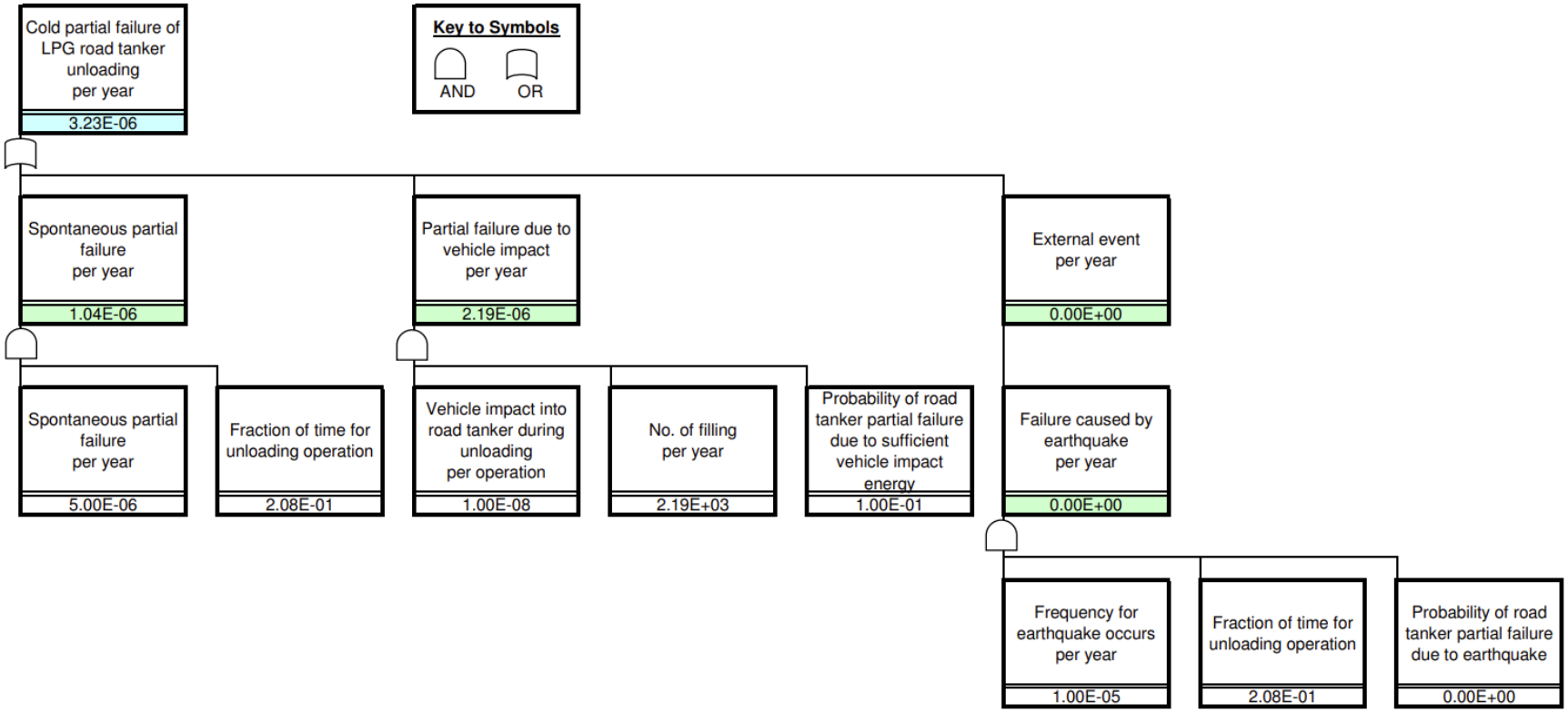
Fault Tree 2 - Partial Failure of LPG Vessel (LPG Filling Station)



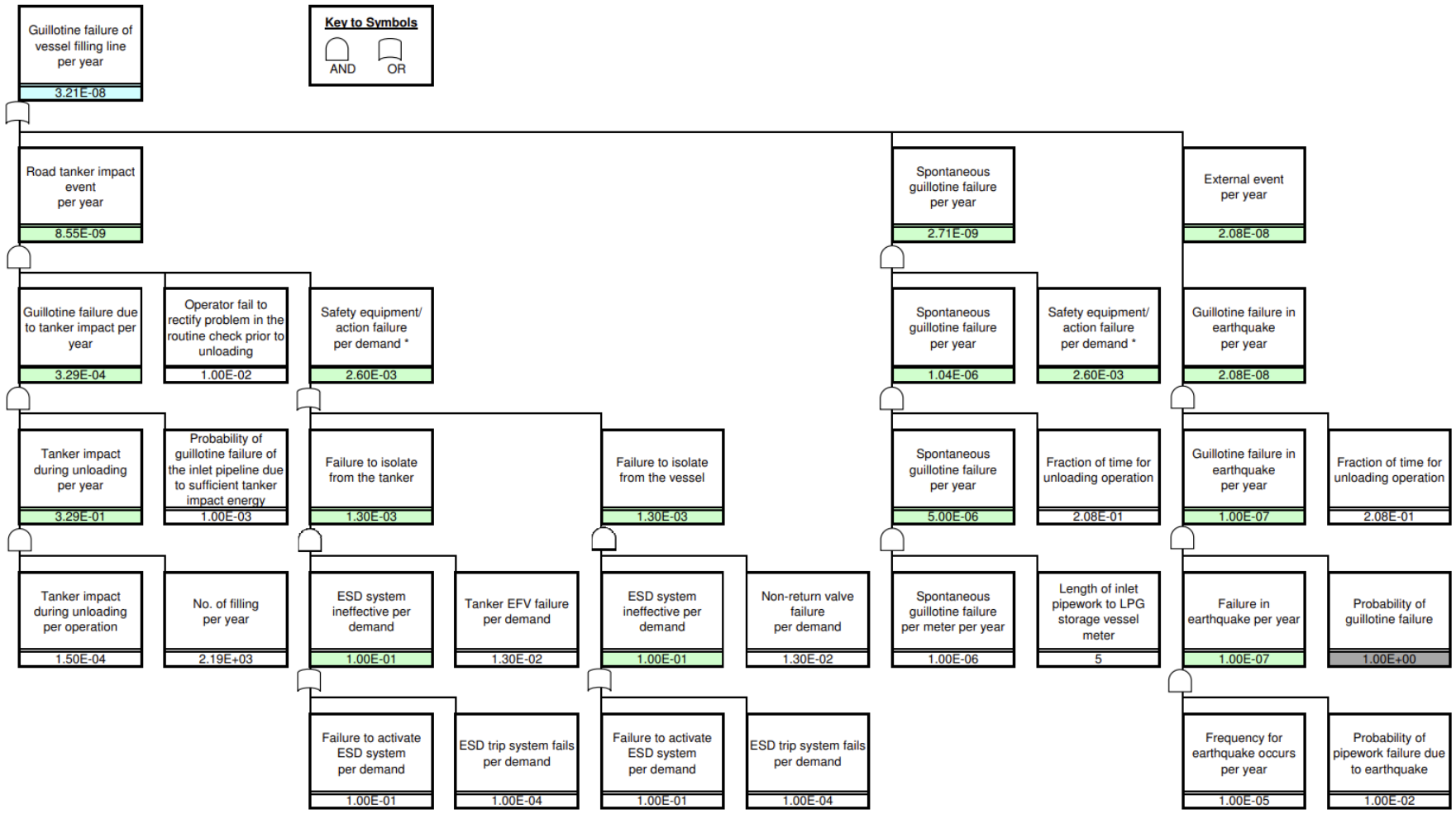
Fault Tree 3 - Cold Catastrophic failure of Road Tanker (LPG Filling Station)



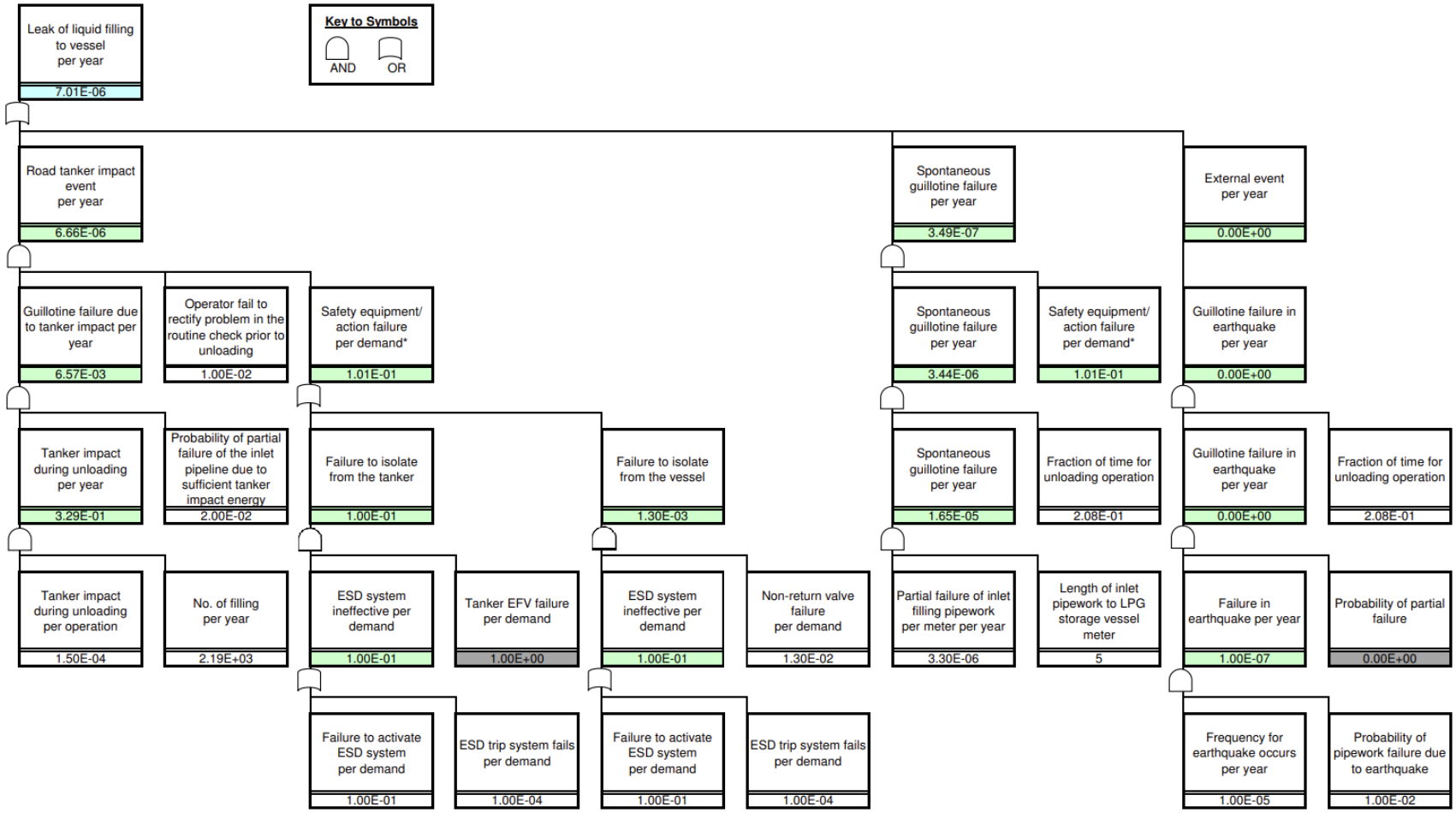
Fault Tree 4 - Partial failure of Road Tanker (LPG Filling Station)



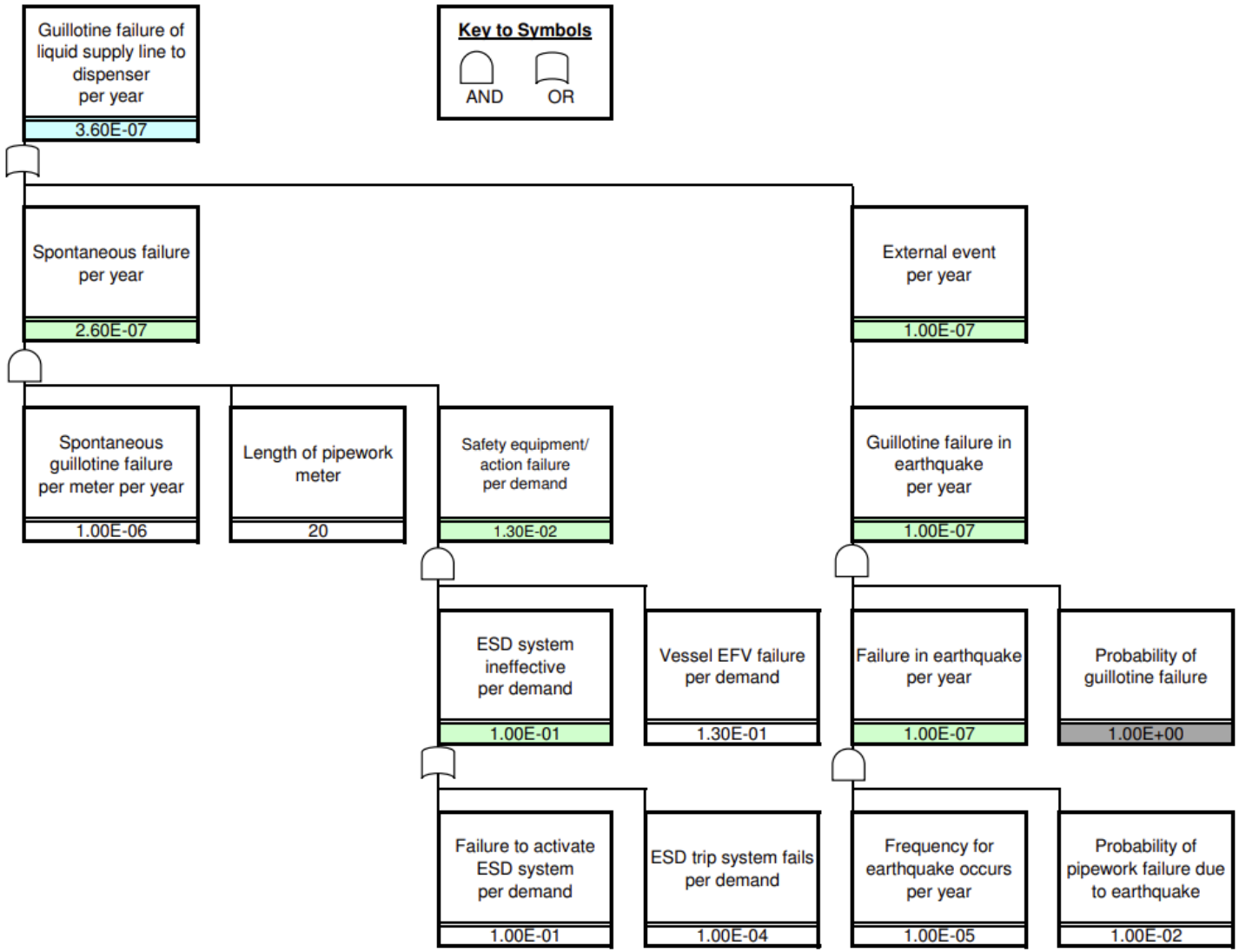
Fault Tree 5 - Guillotine failure of Liquid Inlet Pipeline



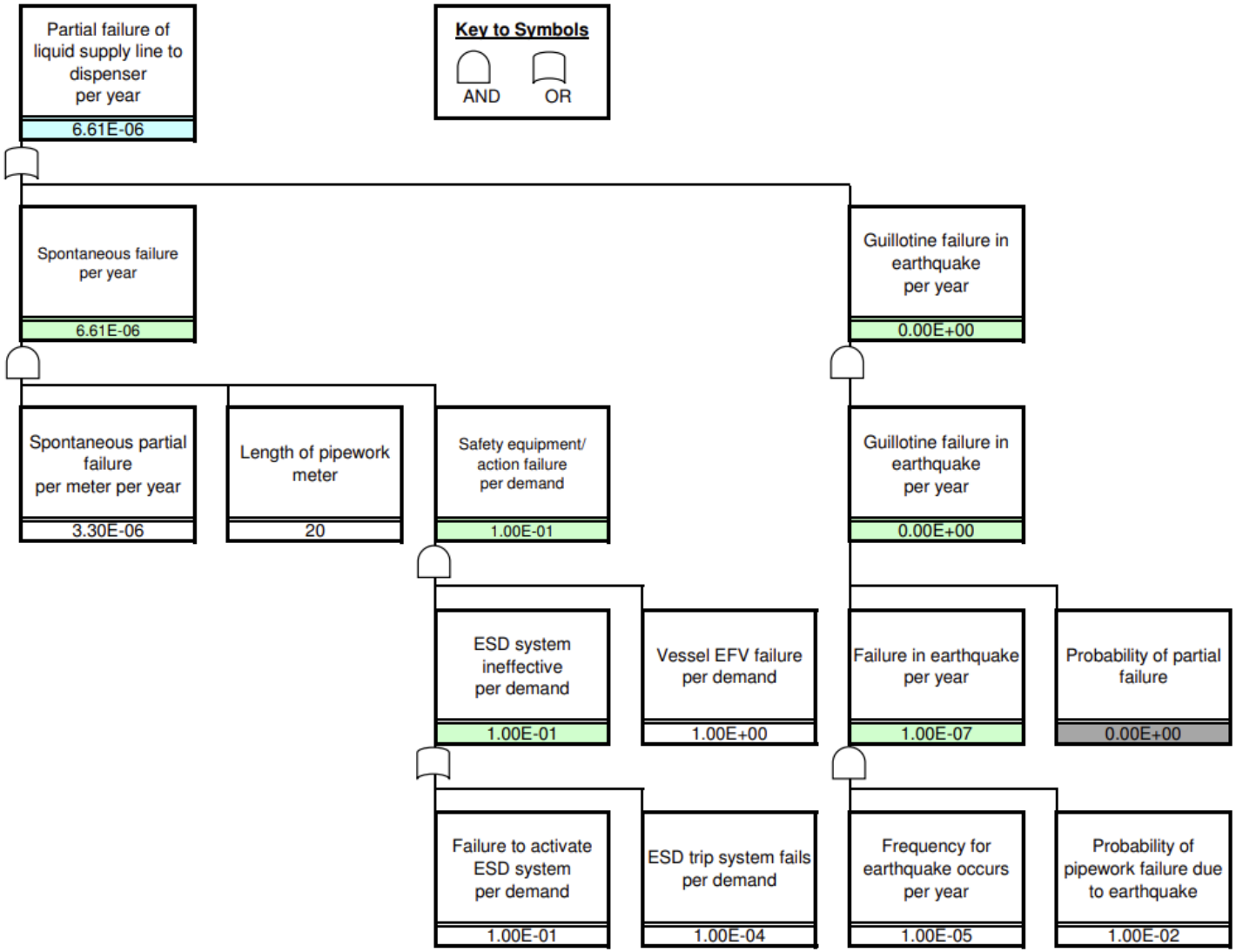
Fault Tree 6 - Partial failure of Inlet Pipeline (LPG Filling Station)



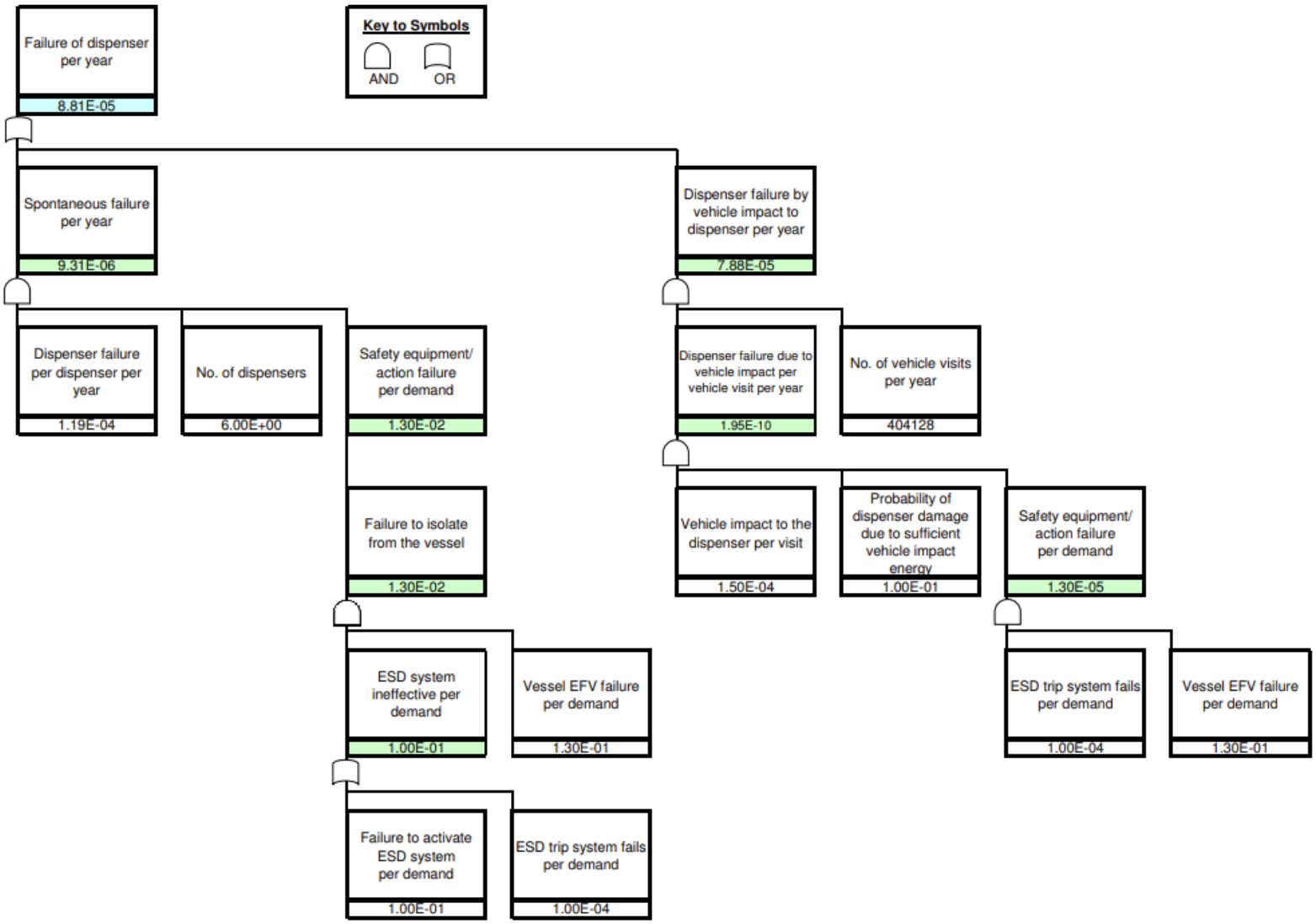
Fault Tree 7 - Guillotine failure of the Liquid Supply Pipeline to the Dispenser (LPG Filling Station)



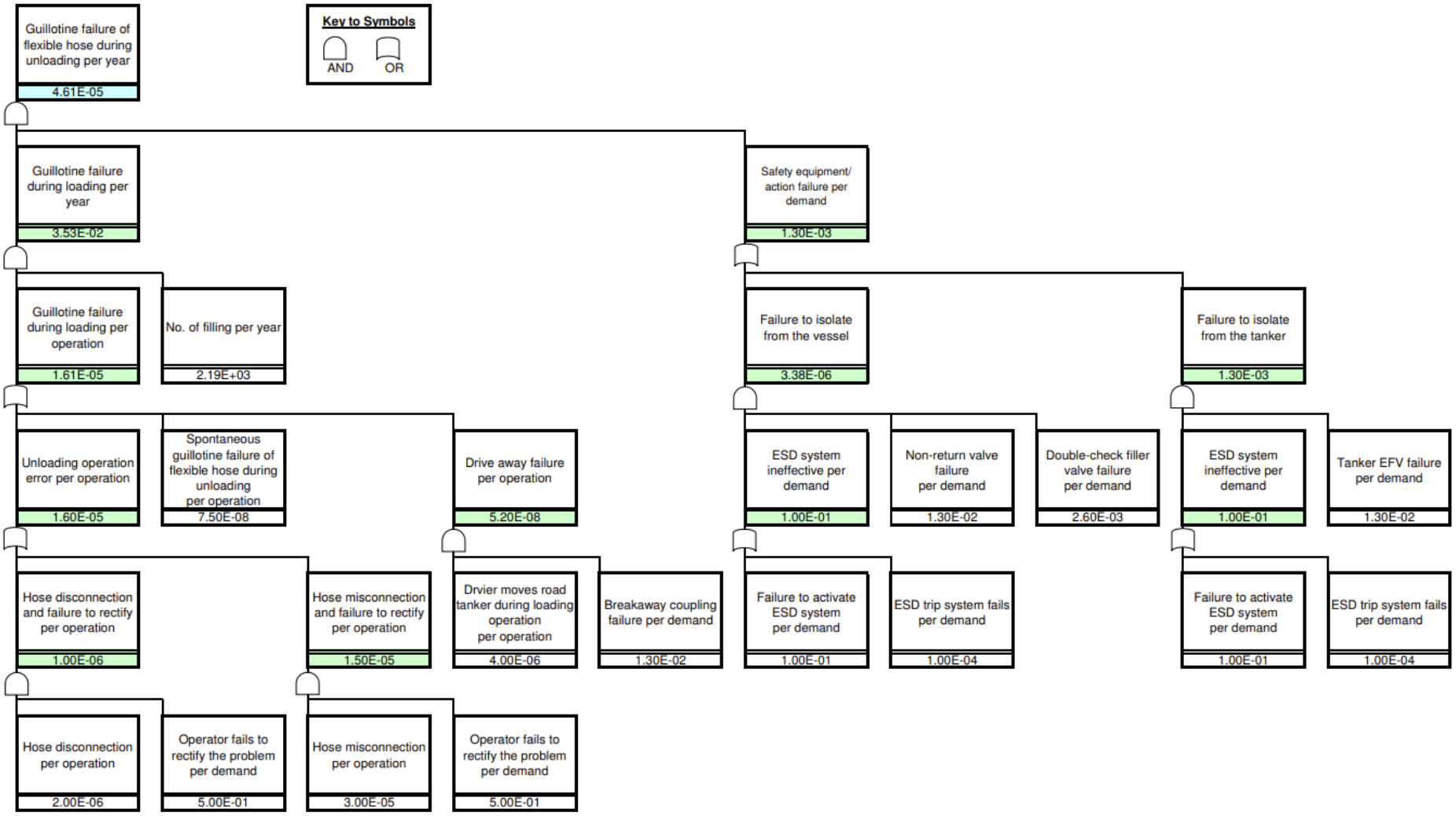
Fault Tree 8 - Partial failure of the Liquid Supply Pipeline to the Dispenser (LPG Filling Station)



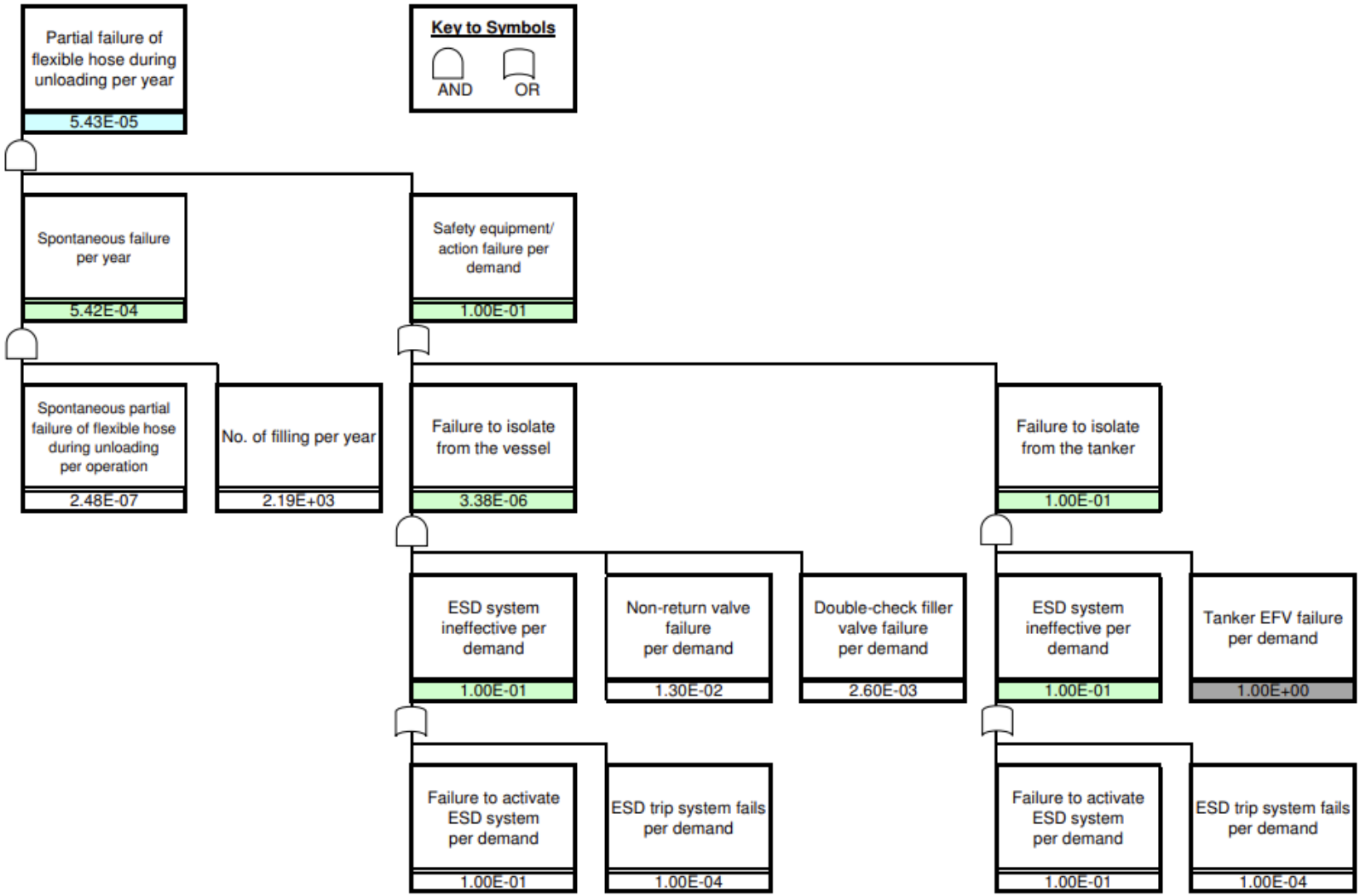
Fault Tree 9 - Failure of the Dispenser (LPG Filling Station)



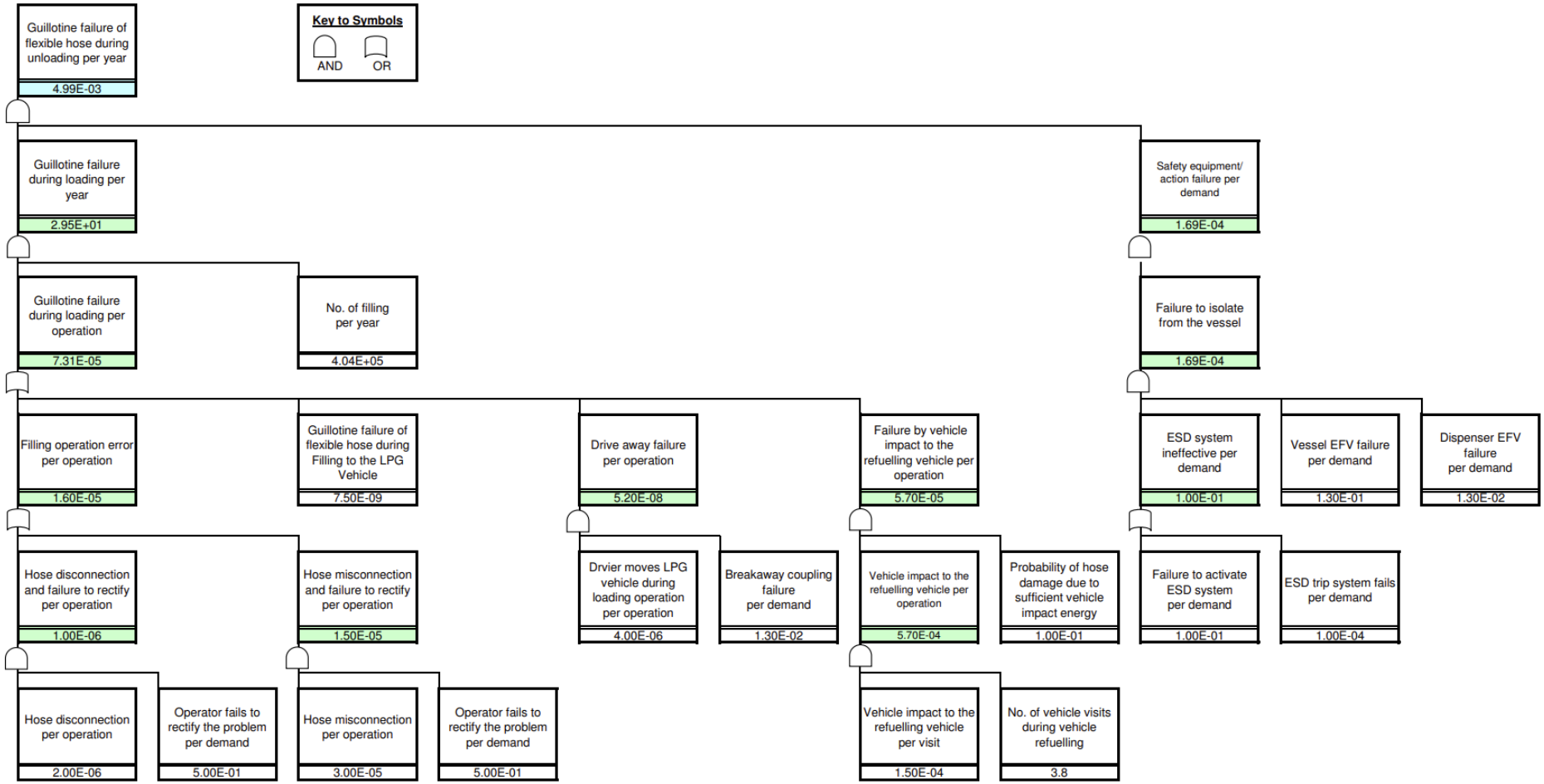
Fault Tree 10 - Guillotine failure of Flexible Hose during Unloading to the LPG vessel (LPG Filling Station)



Fault Tree 11 - Partial failure of Flexible Hose during Unloading to the LPG vessel (LPG Filling Station)

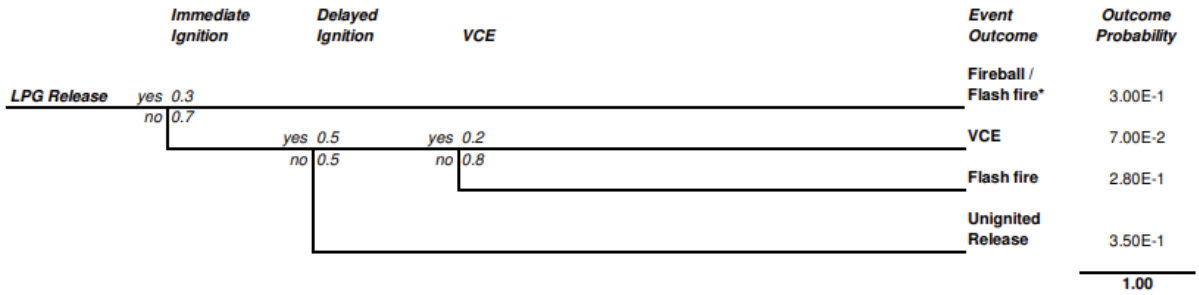


Fault Tree 12 - Guillotine failure of Flexible Hose during Filling to the LPG Vehicle (LPG Filling Station)



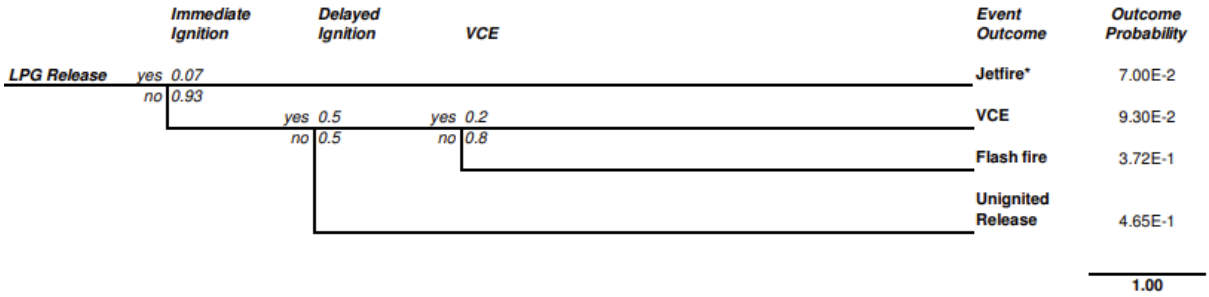
Annex D:
Event Tree Analysis

ETA 1 - Catastrophic Failure of LPG Vessel



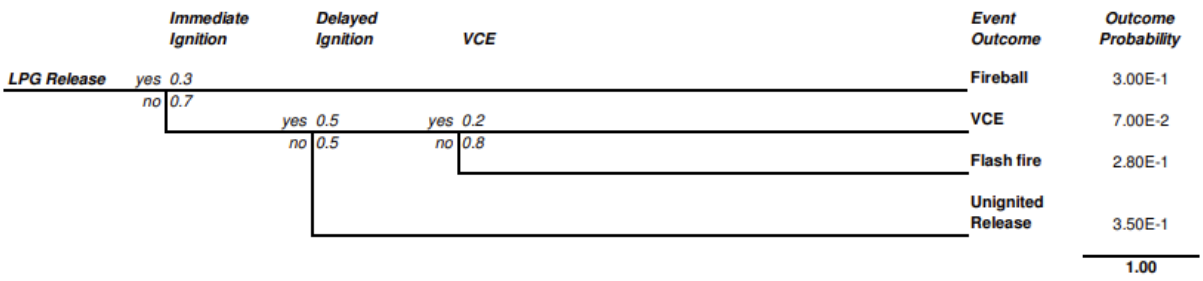
*Fireball effects are negligible for the underground storage tank. Instead Flash Fire is considered.

ETA 2 - Partial Failure of LPG Vessel

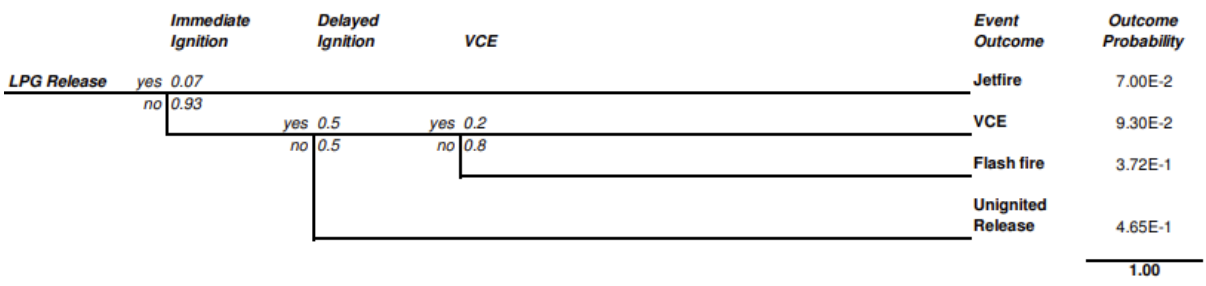


* Vertical Jetfire is considered for partial failure of the underground storage tank.

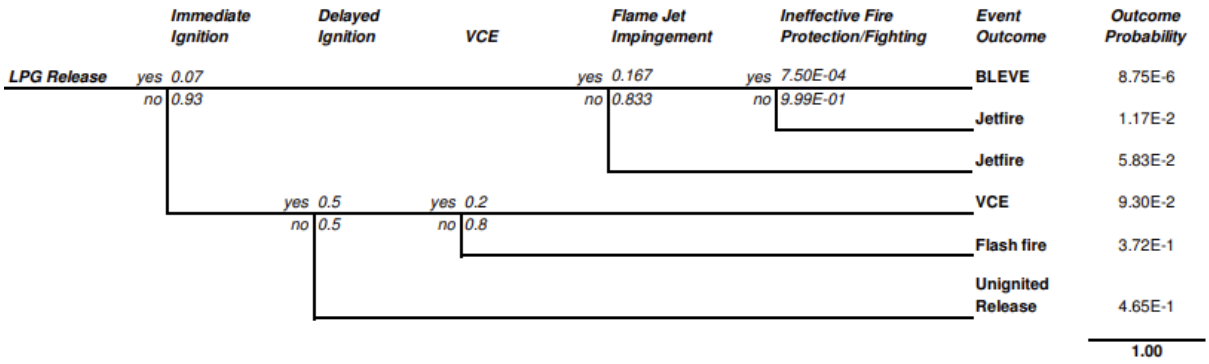
ETA 3 - Catastrophic Failure of LPG Tanker



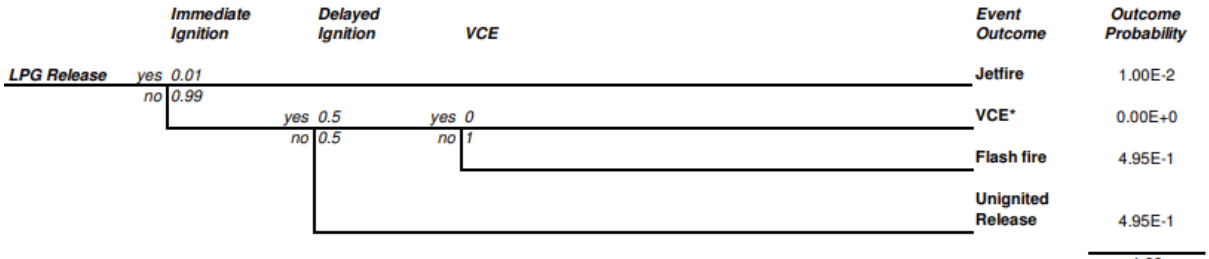
ETA 4 - Partial Failure of LPG Tanker



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

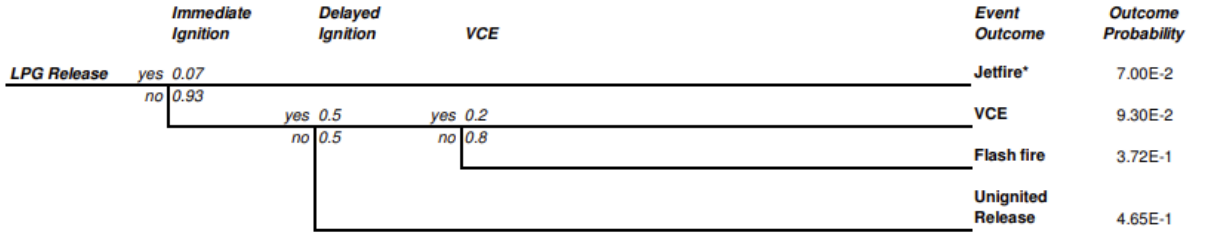


ETA 6 - Leak of Aboveground Pipe (Liquid-Inlet Pipework, Flexible Hose to Vessel)



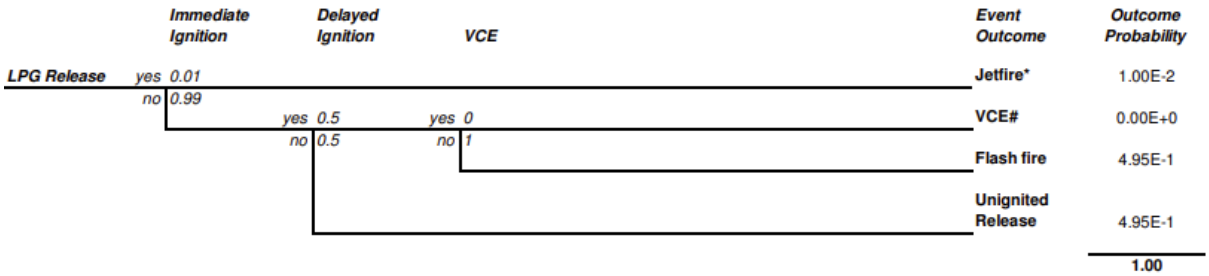
*** VCE is not considered for a small release.**

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



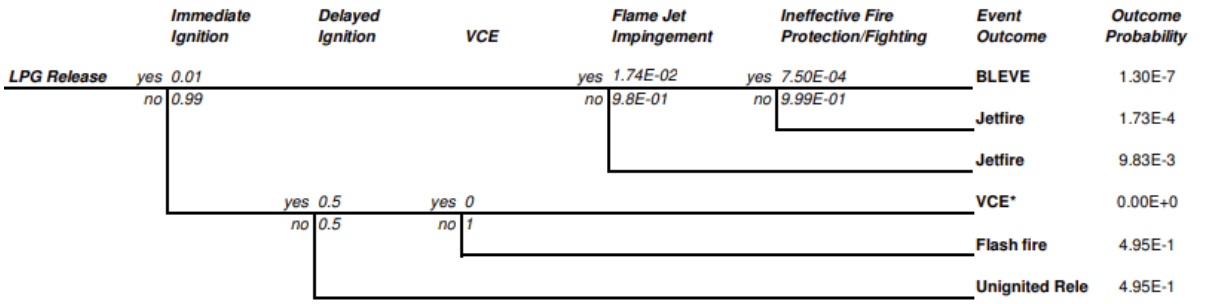
*** Vertical Jetfire is considered for failure of the underground pipe / equipment.**

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 Wetland Park Weather Station (Year 2023)

Wind Speed	STABILITY CLASS						Total
	A	B	C	D	E	F	
0-2	27.4%	12.7%	0.0%	14.8%	0.0%	17.5%	72.4%
2-4	5.0%	9.7%	5.2%	4.3%	1.9%	0.3%	26.5%
4-6	0.0%	0.5%	0.3%	0.3%	0.0%	0.0%	1.1%
6-8	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.1%
>8	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Total	32.4%	22.9%	5.6%	19.4%	1.9%	17.9%	100.0%

Night Time Atmospheric Stability Class-Wind Speed Frequencies at Wetland Park Weather Station (Year 2023)

Wind Speed	STABILITY CLASS						Total
	A	B	C	D	E	F	
0-2	0.0%	0.0%	0.0%	2.2%	0.0%	88.4%	90.7%
2-4	0.0%	0.0%	0.0%	1.1%	6.4%	1.4%	8.9%
4-6	0.0%	0.0%	0.0%	0.4%	0.0%	0.0%	0.4%
6-8	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.1%
>8	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Total	0.0%	0.0%	0.0%	3.8%	6.4%	89.8%	100.0%