External Hazard Reviews

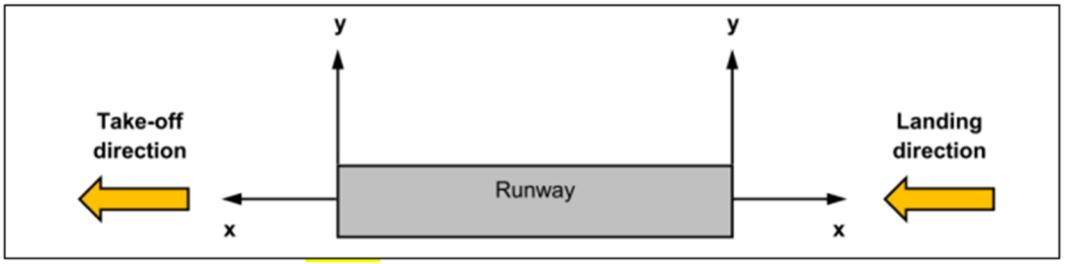
This section presents review of the external hazards that the proposed Project is subject to. The review is also applicable to other hazardous facilities as assessed in the QRA, since they are all in close proximity within Tai Po Industrial Estate.

Aircraft Crash

The Project site is located at 32 km northeast from the Hong Kong International Airport in approximate. The HSE [38] method has been used to estimate the frequency of aircraft crash per year as below.

The crash frequency model considers the parameters of the target area, including the longitudinal (x) and perpendicular (y) distances from the runway threshold.

Exhibit 8.5.1 Aircraft Crash Coordinate System



The crash frequency per unit ground area (per km²) is calculated as:

$$g(x,y) = NRF(x,y)$$

where N is the number of aircraft movements per year, R is the possibility of an aviation accident per movement, and F(x,y) is the spatial distribution of crashes. The distribution is divided into two scenarios: Landings and Take-off. The formulas are given by:

Landings

$$F_L(x,y) = \frac{(x+3.275)}{3.24} e^{\frac{-(x+3.275)}{1.8}} \left[\frac{56.25}{\sqrt{2\pi}} e^{-0.5(125y)^2} + 0.625e^{-\frac{|y|}{0.4}} + 0.005e^{-\frac{|y|}{5}}\right]$$

where $x > -3.275km$

Take-off

$$F_T(x,y) = \frac{(x+0.6)}{1.44} e^{\frac{-(x+0.65)}{12}} \left[\frac{46.25}{\sqrt{2\pi}} e^{-0.5(125y)^2} + 0.9635e^{-4.1|y|} + 0.08e^{-|y|}\right]$$

where $x > -0.6km$

The two equations for the spatial distribution are valid only under a specific range of x values. Otherwise, the possibility of the impact would be zero. The two equations can be applied to 25R, 25L runways for aircraft arrivals and 07R, 07L runways for aircraft departures.

The possibility of an aviation accident per movement R is obtained from the NTSB database for fatal accidents in U.S. involving scheduled airline flights during the period 1986 – 2010 (NTSB). Taking average of the 10-year period, it is suggested that the possibility of an aviation accident is at a rate of 2 x 10^{-7} per flight. There are 13.5% of accidents associated with landing, 15.8% associated with take-off [41]. Hence, it can be estimated that the possibility of aviation accident for the landing is 2.7x10^{-8} per flight and take-off is 4.0x10^{-8} per flight, in line with previous QRA [36].

The number of aircraft movements per year N is obtained from the Hong Kong International Airport (HKIA) database from 2010 to 2019 [42] (Table 8.5.1). The number of aircraft movements at year 2030 was estimated by linear regression respectively for landing and take-off cases. The movement number for both landing and take-off adopted in the calculation has been divided into 8, assuming that aircraft are using the runways equally.

Table 8.5.1 Hong Kong International Airport Civil International Air Transport Movements of Aircraft

Year	Landing	Take-ff	Total
2010	153 279	153 260	306 539
2011	166 919	166 887	333 806
2012	175 861	175 823	351 684
2013	186 048	186 032	372 080
2014	195 520	195 488	391 008
2015	203 043	203 005	406 048
2016	205 793	205 773	411 566
2017	210 339	210 320	420 659
2018	213 899	213 867	427 766
2019	209 904	209 891	419 795

For the aircrafts using runways 07R or 07L, are arriving from south-west. The longitudinal distance from the runway is hence around -14km, which is much smaller than the minimum value of -3.275km. For aircrafts using runways 25L or 25R for departures, they are taking-off toward south-west and have similar situation with runways 07R and 07L for landing. Hence, they have no potential impact to the proposed TPSTW area, or other sites in the vicinity,

Table 8.5.2 Calculation for Aircraft Crash Frequency

Year	Runway	x (km)	y (km)	F(x,y)	N (per year)	R (per flight)	Crash frequency (per unit area)	Target area (km2)	Crash Frequency (per year)
2030	25R Landing	9.6	16	6.3E-07	82587	2.7E-08	1.4E-09	7.73E-02	1.1E-10
2030	25L Landing	9.2	17.6	5.6E-07	82587	2.7E-08	1.2E-09	7.73E-02	9.6E-11
2030	07R Landing	-13.6	19.1	0.0E+00	82587	2.7E-08	0.0E+00	7.73E-02	0.0E+00
2030	07L Landing	-13.8	17.5	0.0E+00	82587	2.7E-08	0.0E+00	7.73E-02	0.0E+00
2030	07L Take-off	9.6	16	2.7E-08	82587	4.0E-08	9.0E-11	7.73E-02	6.9E-12
2030	07R Take-off	9.2	17.6	5.4E-09	82587	4.0E-08	1.8E-11	7.73E-02	1.4E-12
2030	25L Take-off	-13.6	19.1	0.0E+00	82587	4.0E-08	0.0E+00	7.73E-02	0.0E+00
2030	25R Take-off	-13.8	17.5	0.0E+00	82587	4.0E-08	0.0E+00	7.73E-02	0.0E+00

According to Table 8.5.2, the total crash frequency is 2.1×10^{-10} per year, which is much smaller than 1.0×10^{-9} per year. The risk of aircraft crash at the proposed site area could therefore not consider for further assessment.

Earthquake

Buildings and infrastructures in Hong Kong are designed to withstand earthquakes up to Modified Mercali Intensity (MMI) VII. Hong Kong is located in region of low seismicity [43][44] and considered similar to that of areas of Central Europe and the Eastern areas of the USA [45]. The probability of earthquake with intensity MMI VIII or higher happens in Hong Kong is very low and is estimated to be 1.0×10^{-5} per year [40] based on past QRA studies. In line with previous QRA, it is assumed that vessel rupture in such a major earthquake is possible with a probability of 0.01 [46]. The equipment rupture frequency is calculated to be 1.0×10^{-7} which is lower than the generic failure frequency by over an order of magnitude. As such, it can be concluded that the equipment of concern is generally not subject to any disproportionally higher risk of earthquake as compared to facilities elsewhere, and such earthquake failure risk is deemed to have covered by the use of generic failure rate. Nevertheless, the earthquake frequencies have been included in the analysis for completeness. In particular, earthquake scenario was considered for LPG leak scenarios, where the facility is vulnerable to earthquake impact and the generic leak frequency is comparable to that of earthquake [13][28].

Lightning

Lightning sparks have the possibility igniting combustible gas in air. The proposed TPSTW will be equipped with lightning protection system to protect the equipment from ignition. The same provision is expected to be in place for other facilities such as TPGPP. Lightning protection system should be installed with the following standards, including IEC62305, BS EN 62305, AS/NZS 1768, NFPA 780 or equivalent [41]. The installations will be protected with lightning conductors to safely earth direct lightning strikes. The double grounding system will be inspected regularly. Therefore, failures due to lightning strikes have been assumed to be covered by generic failure frequencies.

External Fire

External fire means the occurrence fire event which leads to the failure of equipment inside the facility. The proposed TPSTW faces Nine Eagles Golf Club in its East and surrounded by Tai Po Industrial Estate in the rest of the direction. Given this surrounding terrain and vegetation, the chance of hill fire is deemed to be negligible for facilities in Tai Po Industrial Estate.

In TPSTW, it will be equipped with fire alarms and fire suppression system. Stringent procedures will also be implemented to lower the probability of ignition inside the facility, such as prohibiting smoking or using naked flames.

Typhoon, Tsunami, and Subsidence

Loss of containments or failure of equipment due to severe environmental events such as typhoon or tsunami (large scale tidal wave) is not envisaged as the proposed TPSTW is designed to withstand wind load for local typhoon. TPSTW is located about 0.5km away from the waterfront of Tolo Harbour, as opposed to the sewage treatment works along the waterfront (e.g. Sai Kung STW) that have suffered damage (primarily due to flooding) during Super Typhoon Mangkhut in 2018. TPSTW did not

suffer any damage due to tidal waves during Super Typhoon Mangkhut in 2018. Historically, there is no known damage to biogas or other facilities at TPSTW or other sewage treatment works caused by wind loads during typhoons. Besides, Hong Kong is not threatened by Tsunami[55]. Tolo Harbour is a shallow, semi-estuarine inner protected harbour with depth varying from 5m to 20m with no known historical record on tsunami. Subsidence is usually slow in movement and such movement can be observed and remedial action can be taken in time. Thus, typhoon or tsunami causing a release is not considered further in this assessment.