

## ***Appendix 11.2.5***

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### ***Sample Calculation for Aircraft Accident Rate***

## Appendix 11-2-5 – Sample Calculation for Aircraft Accident Rate

The model considers specific factors such as target area of the proposed hazard site and its longitudinal (x) and perpendicular (y) distances from the runway threshold for landing and take-off movement respectively. The aircraft crash frequency per unit ground area (per km<sup>2</sup>) is calculated as:

$$g(x, y) = NRF(x, y) \quad (1)$$

Where  $N$  is the number of runway movements per year  $R$  is the probability of an accident per movement (landing or take-off).  $F(x, y)$  gives the spatial distribution of crashes and is given by:

For aircraft landing,

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

for  $x > -3.275$  km

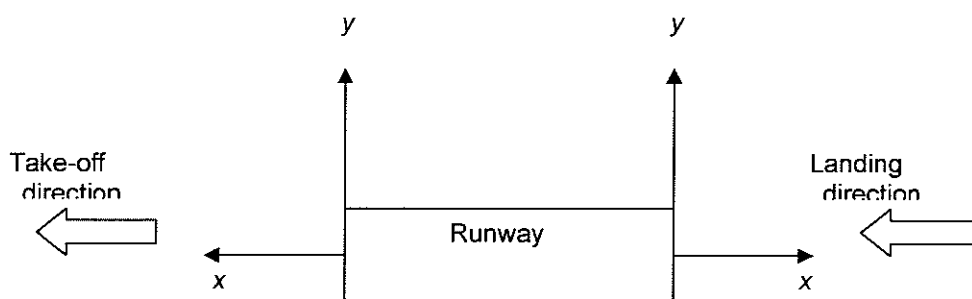
For aircraft take-off

$$F_T(x, y) = \frac{(x + 0.6)}{1.44} e^{\frac{-(x+0.65)}{1.2}} \left[ \frac{46.25}{\sqrt{2\pi}} e^{-0.5(125y)^2} + 0.9635e^{-4.1|y|} + 0.08e^{-|y|} \right] \quad (3)$$

for  $x > -0.6$  km

Equations 2 and 3 are valid only for the specified range of  $x$  values. If  $x$  lies outside this range, the impact probability is zero. This case applies for 07L and 07R runways for arrival flight path and 25L and 25R runways for departure flight path.

Distance is measured between the two sites and the four runway exits. These distances are then transformed into longitudinal (x) and perpendicular (y) distances in the Aircraft Crash Coordinate System according to the following figure. For example, the values of  $x$  and  $y$  are 22.0 km and 23.8 km respectively for landing case on runway 25R. The sign of  $y$  is neglected in the equations.



The probability of an accident per movement  $R$  is interpreted from NTSB data [25] for fatal accidents in the U.S. involving scheduled airline flights during the period 1986-2005. The 10-year moving average suggests a downward trend with recent years showing a rate of about  $2 \times 10^{-7}$  per flight. From other data [26], there are only 13.5% of accidents associated with the approach to landing, 15.8% associated with take-off and 4.2% are related to the climb phase of the flight. Thus it is assumed that the accident frequency for the approach to landings is taken  $2.7 \times 10^{-8}$  per flight and for take-off/climb  $4.0 \times 10^{-8}$  per flight.

The number of runway movements of aircraft  $N$  is provided by yearly statistics of the Hong Kong International Airport in 1998-2006. Number of Movements between years 2009 and 2014 is estimated by linear regression respectively for landing and take-off cases. The movement number adopted in the calculation has been divided by 4 to take into account that only a quarter of landing or take-off use a specific one of runways.

The crash frequency is finally obtained by multiplying  $g(x,y)$  to target area which is estimated to be  $1.2 \times 10^{-2} \text{ km}^2$  for the MTKGWNP.

The calculations are presented in Table 1 for MTKGWNP. Table 2 summarizes the total crash frequency per year including all runways for landing or take-off in each year.

**Table 1 Calculation for Aircraft Crash Frequency**

Year	Runway	$x$ (km)	$y$ (km)	$F(x,y)$	$N$ (per year)	$R$ (per flight)	$g(x,y)$ (per unit area)	Target area ( $\text{km}^2$ )	Crash Frequency (per year)
2021	25R Landing	22.0	23.8	$1.1\text{E-}9$	60167	$2.7\text{E-}8$	$1.8\text{E-}12$	$1.2\text{E-}2$	$2.2\text{E-}14$
2021	25L Landing	21.8	23.1	$1.1\text{E-}9$	60167	$2.7\text{E-}8$	$1.8\text{E-}12$	$1.2\text{E-}2$	$2.2\text{E-}14$
2021	07L Take-off	22.0	23.8	$9.1\text{E-}14$	60167	$4.0\text{E-}8$	$2.2\text{E-}16$	$1.2\text{E-}2$	$2.7\text{E-}18$
2021	07R Take-off	21.8	23.1	$9.1\text{E-}14$	60167	$4.0\text{E-}8$	$2.2\text{E-}16$	$1.2\text{E-}2$	$2.7\text{E-}18$

**Table 2 Total Aircraft Crash Frequency**

Year 2021	Total crash frequency (per year)
Landing	$4.3\text{E-}14$
Take-off	$5.4\text{E-}18$
<b>Total</b>	<b><math>4.3\text{E-}14</math></b>