

APPLICATION OF DISPERSION MODELLING RESULTS IN QRA

This annex presents the details of how the chlorine dispersion modelling results from the wind tunnel testing, CFD modelling and DRIFT flat terrain dispersion modelling have been applied in the QRA. It complements the discussion in *Section 4.2* of the main text of this report.

In the wind tunnel testing for Yau Kom Tau WTW (*Annex B*) 14 separate simulations of chlorine releases were undertaken. However in the QRA it is necessary to consider a much large number of possible release scenarios corresponding to various combinations of chlorine release rate/quantity, release location, wind speed, wind direction and atmospheric stability. This annex describes how the results of the wind tunnel testing, in combination with those from the CFD modelling and DRIFT modelling have been used to generate all the cloud shapes required for the QRA.

The aspects covered are as follows:

- scaling of the wind tunnel results for different chlorine release rates/quantities;
- scaling of the wind tunnel results for different wind speeds;
- simulation of releases at different locations along the site access road;
- interpolation of the wind tunnel results for different wind directions (ie the method of 'wind smoothing'); and
- the influence of atmospheric stability on the chlorine hazard range.

Table D1 below lists each of the key parameters of interest and details how the results of the various strands of the dispersion modelling work have been applied in the QRA.

Table D1 Application of Dispersion Modelling Results in QRA

| Parameter | Details of Application of Dispersion Modelling Results |
|-----------------------------------|---|
| 1. Chlorine release rate/quantity | <p>The wind tunnel testing considered only a limited range of chlorine release rates/quantities, ie typically one instantaneous release case and one or two continuous release cases per site. However in the DRIFT flat terrain modelling a much greater range of chlorine release rates/quantities was considered (<i>Annex A</i>). From the DRIFT results it is possible to derive a relationship between the chlorine release rate/quantity and the hazard range. These relationships are used to scale the LD contours generated by the wind tunnel according to the release rate/quantity of interest. A method of uniform scaling is used, which is undertaken mathematically within the GISRisk software.</p> <p>The scale factors used in the QRA for Yau Kom Tau WTW are as follows:</p> <p>1. Continuous releases (‘Base case’ continuous release: 1.4 kg/s)</p> <p>Event RUI1TMMML (4.2 kg/s continuous release) Scale factor = 1.8 (from <i>Figure A1</i>)</p> <p>2. Instantaneous Releases (‘Base case’ instantaneous release: 1 tonne)</p> <p>Event RUI1TMRU (3 tonne instantaneous release) Scale factor = 1.7 (from <i>Figure A2</i>) Event EU1TMRU (7.7 tonne instantaneous release) Scale factor = 2.7 (from <i>Figure A2</i>)</p> |
| 2. Wind speed | <p>In the wind tunnel testing for each WTW, most simulations were undertaken at a 2m/s wind speed, which is typical of the weather conditions in Hong Kong. However a small number of tests were undertaken at the higher wind speed of 5 m/s, usually for critical wind directions such as towards the nearest population. The results of the 2 m/s and 5 m/s wind tunnel tests have been compared for all sites to determine a simple scaling factor. This scaling factor is then applied to all the 2 m/s LD contours to generate the corresponding 5 m/s contours. The calculated scaling factor is 0.7.</p> |
| 3. Release locations | <p>Accidents associated with the transport of chlorine along the site access road may occur at any location along the access road and it is important to take this into account in the QRA. In the wind tunnel testing for each WTW, releases were typically modelled at two locations - the store and one location on the access road. In the QRA however releases are considered to occur at several points along the access road (typically one release location every 50m). The cloud contours for each location are generated by simply translating the clouds generated from the nearer of the two locations modelled in the wind tunnel.</p> <p>For Yau Kom Tau WTW the number of release locations considered for the access road is four (for continuous releases) and two (for instantaneous releases). It is not necessary to consider as many release locations for the instantaneous releases, because the clouds are large and the spatial resolution need not be as great.</p> |

| Parameter | Details of Application of Dispersion Modelling Results |
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| 4. Wind direction | <p>In the wind tunnel testing for each WTW, up to eight wind directions were simulated for the most important release scenarios (eg a 1 tonne instantaneous release). However in the QRA it is necessary to consider a much larger number of possible wind directions, in order to avoid any numerical error in the risk results. The means interpolating between modelled wind directions is called 'wind smoothing'. For the case of flat terrain, wind smoothing can be achieved with sufficient accuracy by the simple method of cloud 'rotation', ie rotating adjacent clouds to fill the directional 'gaps' left by the wind tunnel testing (see <i>Technical Note 1</i>). The cloud rotation is achieved mathematically within the GISRisk software.</p> <p>For the case of complex terrain, however, it is necessary to ensure that, within the raw wind tunnel data, the effects of nearby topography (including any high rise buildings) are adequately represented, such that further wind smoothing is either not necessary or can be achieved easily using the method of cloud rotation. For Yau Kom Tau WTW sufficient directions were considered in the original wind tunnel testing (8), such that wind smoothing to fill the remaining directional 'gaps' could be achieved with minimal error.</p> <p>The above discussion applies to the instantaneous chlorine releases at Yau Kom Tau WTW. For the continuous releases on the access road the results from the CFD modelling for Sha Tin WTW (1.4 kg/s continuous release case) have been used in the QRA in preference to the wind tunnel results, as explained in <i>Section 4.2</i> of the main text of the report. For this release case wind smoothing has been achieved by simple rotation of the cloud shape from the CFD study for a total of 36 wind directions at each release location on the access road.</p> |
| 5. Atmospheric stability | <p>The CFD modelling for Sha Tin WTW and Tai Po Tau WTW shows that atmospheric stability is not a significant factor influencing the chlorine hazard range, when comparing D (neutral) and F (stable) atmospheric conditions, which are the most important in Hong Kong. Therefore atmospheric stability is not a parameter which is considered in the QRA and the probability of unstable (B) or stable (F) conditions is simply combined with that for D (neutral) conditions.</p> <p>Whilst the CFD modelling shows no significant influence of atmospheric stability on the chlorine hazard range, it does reveal a significant influence on the direction of travel of the cloud. This aspect is considered further in the uncertainty analysis (<i>Annex K</i>).</p> |