1 APPLICATION OF DISPERSION MODELLING RESULTS IN QRA

This annex presents the details of how the chlorine dispersion modelling results from the CFD modelling and PHAST flat terrain dispersion modelling have been applied in the QRA. It complements the discussion in Section 13.2.8 of the main text of this report.

In the CFD modelling results for proposed Desalination Plant (Annex B1 of the report), 44 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 direction and atmospheric stability. This annex describes how the results of the CFD modelling and PHAST modelling have been used to generate all cloud shapes required for the QRA.

The aspects covered are as follows:

- Scaling of the CFD results for different chlorine release rate / quantity;
- Scaling of the CFD results for different wind speeds;
- Simulation of release at different locations along the site access road; and
- Interpolation of the CFD results for different wind directions (i.e. the method of 'wind smoothing').

Table 1.1 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 1.1 Application of Dispersion Modelling Results in QRA

Parameter	Details of Application of Dispersion Modelling Results
1. Chlorine release rate	The CFD considered only a limited range of continuous chlorine release, i.e. one continuous release case (1.4 kg/s) for the proposed Desalination Plant. However in the PHAST flat terrain modelling a much greater range of chlorine release rates were considered (Annex A of report). From the PHAST results it is possible to derive a relationship between the chlorine release rate and the hazard range. These relationships are used to scale the LD contours generated by the CFD according to the release rate of interest. A method of uniform scaling is used, which is undertaken mathematically within the Risk Summation Software. This method of scaling is sufficiently accurate provided that the range of extrapolation is not too great and that the topography surrounding the Desalination Plant is reasonably flat. The scale factors used in continuous release scenarios in the QRA for Desalination Plant are as follows: 1. Continuous releases ('Base case': 1.4 kg/s continuous release) a. Event RU1TMML (4.2 kg/s continuous release) – Scale factor = 1265/636 = 2.0 (From Table 1.1 of Annex A, the results of the 1.4 kg/s and 4.2 kg/s have been compared to determine the scaling factor. The maximum scale factor is chosen which belongs to weather class of F1.5.) b. Event HCltoNaOCl (1.95 kg/s continuous release) – Scale factor = 1.2 (from Figure 1.1 of Annex A of report). c. Event NaOCltoHCl (1.37 kg/s continuous release) – Scale factor = 1.0, same release rate as 'Base case': 1.4 kg/s continuous release d. Event $FeCl_3$toNaOCl (1.33 kg/s continuous release) – Scale factor = 1.0, same release rate as 'Base case': 1.4 kg/s continuous release. e. Event NaOClto$FeCl_3$ (1.37 kg/s continuous release) – Scale factor = 1.0, same release rate as 'Base case': 1.4 kg/s continuous release f. Event H_2SO_4toNaOCl (13.04 kg/s continuous release) – Scale factor = 2.7 (from Figure 1.1 of Annex A of report). g. Event NaOCltoH_2SO_4 (0.69 kg/s continuous release) – Scale factor = 0.7 (from Figure 1.1 of Annex A of report)
2. Wind speed	In the CFD modelling for Desalination Plant, most simulations were undertaken at a 2 m/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 4.5 m/s, usually for critical wind directions such as towards the nearest population. In the previous 8 WTWs Reassessment Study, the scale factors for different wind speeds are derived from wind tunnel test results. In this study, PHAST and CFD modelling results have been used to derive the scale factors. The results of the 2 m/s and 4.5 m/s from PHAST and CFD modelling have been compared to determine a simple scaling factor. This scaling factor is then applied to all the 2 m/s LD contours to generate the corresponding 4.5 m/s contours. The calculated scaling factor is conservatively assumed as 1 for both continuous and instantaneous releases.

Parameter	Details of Application of Dispersion Modelling Results
3. Release locations	Accidents associated with the transport of chlorine along the site access road may occur at any location along the access road (Figure 2.4 of the main report) and it is important to take this into account in the QRA. In the CFD modelling for Desalination Plant, releases were modelled at one location – at the end of the access road close to the Chlorination Store. In the QRA, however releases are considered to occur at several points along the access road (approximately one release point every 50 m). The cloud contours for each location are generated by simply translating the clouds generated from the nearer of the location modelled in the CFD modelling.
4. Wind direction	In the CFD modelling for Desalination Plant, up to eight (8) wind directions (N, NE, E, SE, S, SW, W, NW) were simulated for the most important release scenarios (i.e. 1.4 kg/s continuous, 1 tonne instantaneous release, 57 kg instantaneous release and 4.2 tonnes 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 (as is the case for Desalination Plant), wind smoothing can be achieved with sufficient accuracy by the simple method of cloud 'rotation', i.e. rotating adjacent clouds to fill the directional 'gaps' left by the CFD modelling (Technical Note 1 of 8 WTWs Reassessment Study). The cloud rotation is achieved mathematically within the GIS*Risk* software. 36 directions are considered for each release scenario/location.
5. Atmospheric stability	The CFD modelling for the Desalination Plant shows that atmospheric stability is not a significant factor influencing the chlorine hazard range, when comparing B, D and F 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 B or F conditions is simply combined with that for D conditions. Whilst the CFD modelling shows no significant influence of atmospheric stability on the chlorine hazard range, the shape of the cloud (i.e. impacted area) may be affected. D (neutral conditions) impacts relatively larger area than B (unstable conditions) and F (stable conditions) for LD03, LD50 and LD90 contours, i.e. a factor of 1.0 ~ 2.7 for 1.4kg/s continuous release and 1.0 ~ 1.2 for 1 tonne instantaneous release. The factors were obtained by comparing the impacted area ratio of chlorine dispersion at different lethal concentrations under stability class of 2D respective to various stability classes (i.e. D/B and D/F). This aspect is considered further in the uncertainty analysis (Section 13.8 of Main Report).