A15.1 Air Quality Model Evaluation

1 Model Evaluation

1.1.1 As described in Chapter 15, Section 15.2, model verification was carried out by comparing the model results of annual mean NO2 concentrations at receptor locations equivalent to existing monitoring locations within the study area. Verification was undertaken using diffusion tubes and continuous monitoring results from Fife Council, diffusion tube results from West Lothian Council and diffusion tube results from the Jacobs Arup survey. Since base year traffic data have been provided for 2005, it was considered appropriate to use 2005 background data and 2005 meteorological data for model evaluation for comparison with 2005 monitoring data. However, in the case of the Fife continuous monitoring sites and Jacobs Arup diffusion tube sites, no data are available for 2005, only for 2008. Initially consideration was given to applying background and meteorological data from 2008 for the evaluation with the 2008 survey and continuous monitoring data but investigations identified that annual average NOx and NO_2 background concentrations at St Leonards for 2008 are unusually high when compared with years prior to 2008 and for 2009 (up until end of July). It was therefore considered unsuitable to use the 2008 background data for this model evaluation exercise and hence 2005 background data have been used throughout.

Table 1.1: Observed and Modelled Annual Mean NO_2 Concentrations ($\mu g/m^3$)

Site	Location details	Grid ref.	NO_2		Comment
			Observed	Modelled	
FC 1	Rumblingwell (RS), Dunfermline	307865, 688231	21.0	28.6	n/a
FC 2	Barrie Street (B), Dunfermline	308381, 688251	12.0	27.6	The observed NO_2 concentration at this background site is lower than the annual average background concentration that was used for this study (taken from Edinburgh St. Leonards). To take account of the higher backgrounds, for the purpose of this model evaluation only, the modelled NO_2 concentration was reduced by 14$\mu g/m^3$, which represents the difference in mapped[1] and observed backgrounds.
FC 3	Aytoun Grove (B), Dunfermline	308327, 688428	12.0	27.4	The observed NO_2 concentration at this background site is lower than the annual average background concentration that was used for this study (taken from Edinburgh St Leonards). To take account of the higher backgrounds, for the purpose of this model evaluation only, the modelled NO_2 concentration was reduced by 14$\mu g/m^3$, which represents the difference in mapped and observed backgrounds.
FC 4	Carnegie Drive (F), Dunfermline	309019, 687632	32.0	31.5	n/a
FC C1	Appin Crescent, Dunfermline (C)	309912, 687738	30.0	30.8	n/a
FC 5	Appin Crescent (RS), Dunfermline	309882, 687713	29.0	37.3	This monitoring location is closest to the road compared to other Appin Crescent sites, therefore the highest observed result would be expected. However, the observed level at FC5 is slightly lower than at FC7, suggesting that observed concentrations at FC5 are under-predicted. This is likely to be a cause

[1] Maps of UK background concentrations are provided on the UK air quality archive website for each 1km grid square. These annual mean background concentration data have been estimated using UK scale modelling techniques and provide a good indication of pollutant background concentrations where there are no continuous monitors present.

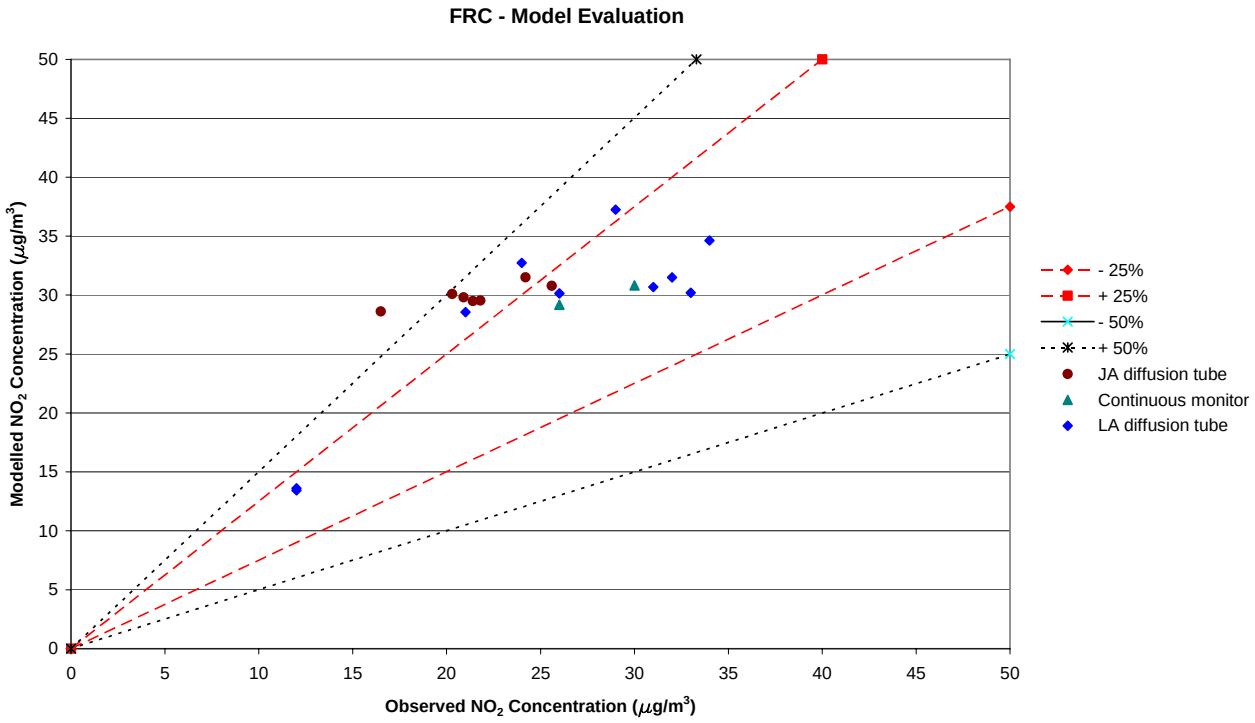
Site	Location details	Grid ref.	NO_2		Comment
			Observed	Modelled	
					of uncertainties associated with using diffusion tubes.
FC 6	Appin Crescent (F) 1	309882, 687720	24.0	32.7	n/a
FC 7	Appin Crescent (F) 2	309885, 687716	34.0	34.6	n/a
FC C2	Admiralty Road, Rosyth (C)	311752, 683515	26.0	29.2	n/a
FC 9	Admiralty Rd (K), Rosyth	312103, 683439	31.0	30.7	n/a
FC 10	Admiralty Rd (F), Rosyth	312140, 683439	26.0	30.1	n/a
WLC	East Main Street (RS), Broxburn	308306, 672217	33.0	30.2	n/a
AQ 1 (N)	Selvage Street (R), Rosyth	312247, 683184	20.3	30.1	n/a
AQ 2 (N)	Ferry Barns Crescent (B), North Queensferry	312645, 680603	14.6	28.7	The monitoring location is relatively close to the coast. Meteorological data used for this study do not take account of coastal effects and hence more windy conditions along the coast. It can be assumed that actual concentrations are significantly lower than those predicted by the model due to higher dispersion. The observed NO_2 levels from this monitoring point were therefore not used for model verification purposes.
AQ 1 (S)	Society Road (B), Linn Mill	311357, 678749	11.8	27.3	The monitoring location is relatively close to the coast. Meteorological data used for this study do not take account of coastal effects and hence more windy conditions along the coast. It can be assumed that actual concentrations are significantly lower than those predicted by the model due to higher dispersion. The observed NO_2 levels from this monitoring point were therefore not used for model verification purposes.
AQ 2 (S)	Hopetoun Road (RS), S. Queensferry	312439, 678388	16.5	28.6	n/a
AQ 3 (S)	Hopetoun Road (RS), S. Queensferry	312516, 678346	21.8	29.5	n/a
AQ 4 (S)	Stoneyflatts Ct. (RS), S. Queensferry	312381, 678005	20.9	29.8	n/a
AQ 5 (S)	Ferrymuir Gate (RS), S. Queensferry	312532, 677923	24.2	31.5	n/a
AQ 6 (S)	Buie Rigg (RS), Kirkliston	311656, 674623	25.6	30.8	n/a
AQ 7 (S)	Newton Main Street, Newton	309270,677730	21.4	29.5	n/a

Note: RS – Road Site; B – Background Site, F – Façade; K – Kerbside, C – Continuous Monitor

1.1.2 Graph 1 shows the correlation between observed and modelled NO_2 concentrations.

1.1.3 It should be noted that the modelled NO_2 concentrations shown in the graph include adjustments made as described in the comments in Table 1.1 above.

Graph 1: Scatter Plot for Model Evaluation



1.1.4 Comparing modelled and observed NO_2 concentrations indicates that the model is performing reasonably well. Ten out of 19 receptors are within ±25% of the observed value while eight are outside of ±25% but within ±50%. This is very close to the margin of error for the accuracy of diffusion tube monitoring results (±20%) against which the majority of model results are compared. The modelled NO_2 concentrations at the continuous monitoring sites are very close to the monitored concentrations (< ± 3% Dunfermline monitoring station and < ± 13% Rosyth monitoring station). In addition, Graph 1 indicates that the majority of modelled concentrations are overpredicted when comparing them to the observed concentrations. The model can therefore be described as giving pessimistic results and providing a worst case scenario. In addition, 2008 background data have been used to factor up background concentrations for future years. As described above, the annual average NO_x and NO_2 background concentration at St Leonards continuous monitoring station in 2008 was unusually high, thus using 2008 data to factor future years also provides a worst case scenario. In line with the Technical Guidance LAQM.TG(09) no model adjustment has therefore been undertaken.

1.1.5 The possibility of undertaking model evaluation for PM_{10} was investigated, however, there were no continuous monitoring sites that recorded PM_{10} data for twelve consecutive months. Model evaluation was therefore carried out for NO_2 only.

1.1.6 The air quality assessment reported in this chapter is a comparative study, i.e. model results of different scenarios (Do-Minimum, Do-Something) are compared to establish impacts on local air quality resulting from the proposed scheme. Whilst modelled pollutant concentrations are being

assessed with regards to whether or not they are predicted to meet the relevant air quality objectives and limit values, the emphasis lies on the comparative component. The reliance on absolute concentrations for the purpose of this study is therefore not of primary importance, particularly as local monitoring indicates that air quality objectives and limit values are not being approached or breached.

Model Uncertainty

1.1.7 Dispersion models are simplifications of the actual atmospheric processes that occur, inevitably these simplifications will result in differences between observed and measured values and there are no reasons to suggest why these errors should be systematic and constant throughout the modelling domain.

1.1.8 According to Technical Guidance TG(09) (Defra, 2009), the total uncertainty associated with dispersion models is a combination of model uncertainty (due to model formulations), data uncertainty (due to errors in input data, including emission estimates, background estimates and meteorology) and variability (randomness of measurements).

1.1.9 The TG(09) model adjustment methodology assumes that there is a linear relationship between measured and modelled values, i.e. it forces a straight line relationship between the two sets of data. There is no reason why this should be the case, the reasons why there are differences between the measured and monitored values may well be different depending on the concentration observed. Table 1.1 above identifies possible reasons for differences in observed and modelled concentrations for different monitoring locations.

1.1.10 Another point to bear in mind is that the majority of monitoring points used for model evaluation in this study were diffusion tubes. Diffusion tubes can only be expected to have an accuracy of ±20% and therefore evaluating the model based on diffusion tube results might introduce a level of uncertainty in itself.

2 References

Defra (2009). Local Air Quality Management. Technical Guidance LAQM.TG (09), February 2009. Department for Environment, Food and Rural Affairs.