Appendix 14.3 Sensitivity of AERMOD Dispersion Model

AERMOD DISPERSION MODEL SENSITIVITY FOR EfW EMISSIONS

A.1.1 The Environment Agency policy number EAS/2007/1/1 Choice of air dispersion models, published in 2000, and its guidance “Air dispersion modelling requirements (for detailed dispersion modelling)” lists the elements of a report that are expected to be present in an air dispersion modelling report. Also of relevance are the ADMLC/2004/3 Guidelines for the Preparation of Dispersion Modelling Assessments for Compliance with Regulatory Requirements – an Update to the 1995 Royal Meteorological Society Guidance, published by the UK Atmospheric Dispersion Modelling Liaison Committee.

A.1.2 That guidance generally requires an appraisal of sensitivity, uncertainty and variability of the output from a dispersion model, as that appraisal adds to the understanding of the output. Sensitivity is the change in model output. The ADMLC guidance defines sensitivity as “the differential of model output by model input”; uncertainty as “the change of model output for a plausible change in model input”; and variability as “that which cannot be reduced by further experiment”. That guidance also identifies the following key input variables to which dispersion model may be sensitive to:

- Emission characteristics (including rate, height and velocity).
- Meteorology, both annual and spatial variability.
- Atmospheric chemistry.
- Terrain.
- Building effects.
- Coastal effects, if applicable.
- Receptor spacing.

A.1.3 As a concern is the emissions from the EfW, the following provides a sensitivity and variability analysis of the dispersion model input to model output in relation to the EfW.

A.1.4 A stack height appraisal was carried out as part of the design and consultation process and the following graphs show the reduction in the maximum predicted ground level concentration as a function of the stack height (60-120m) for the site specific situation. For the site situation due to the topography, the model predicts the maximums ground level concentrations to occur to the south east localised on the north east facing summit slope of Squires Hill, rather than downwind of the prevailing south westerly wind direction as is the case for the ADMS predictions.

Figure 0.1 – Effect of Stack Height on Long Term NO_2

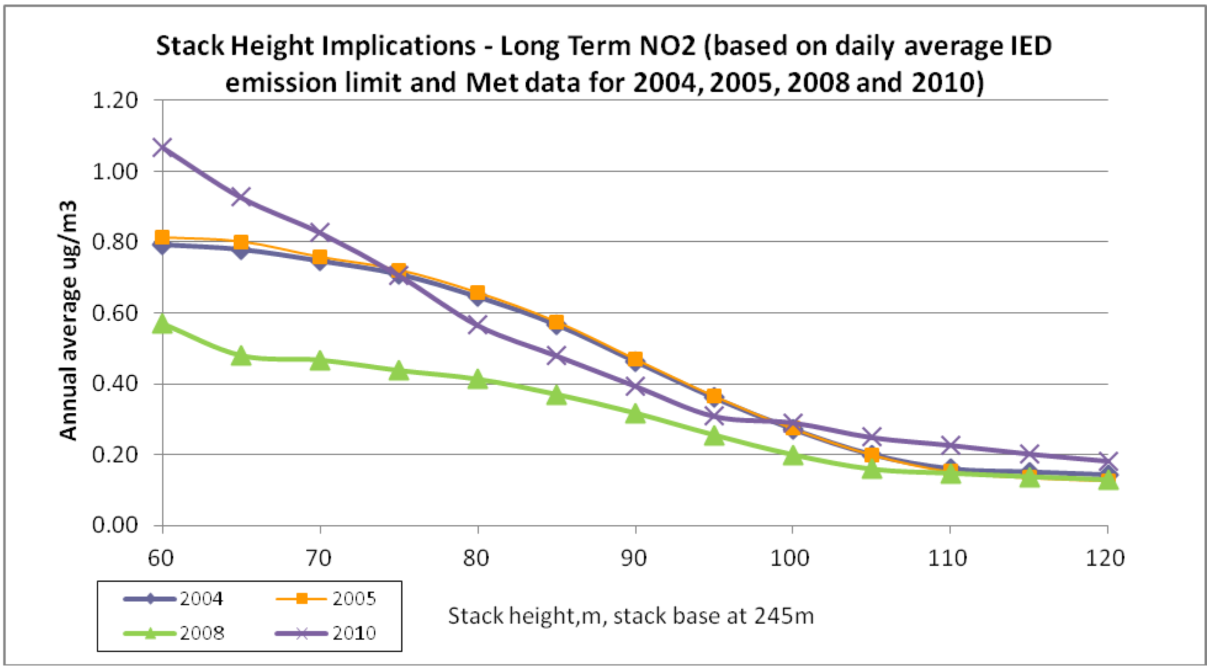
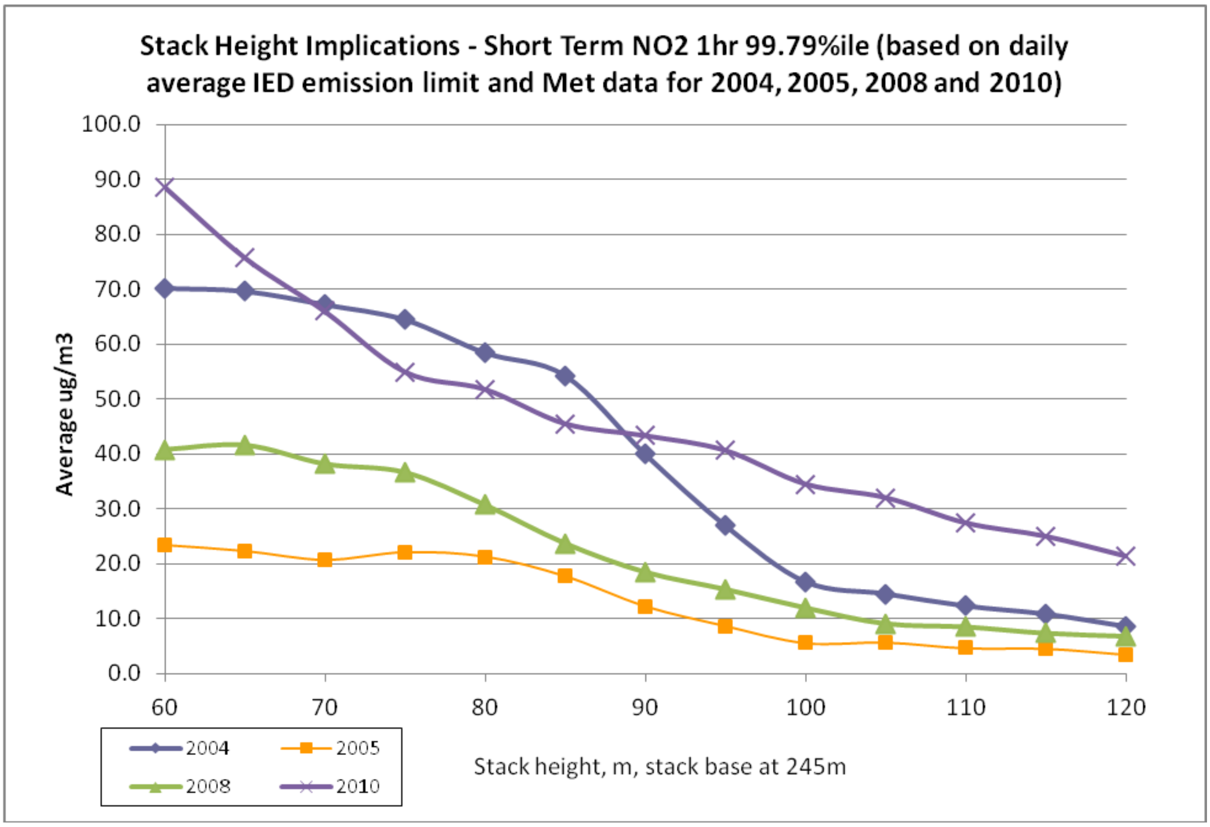


Figure 0.2 – Effect of Stack Height on Short Term NO_2



A.1.5 The rate of reduction in the maximum predicted long term ground level concentrations provides a small incremental benefit from 60-65m to 100m stack height, whereas above a 75m stack height the maximum predicted short term ground level concentrations continues to reduce for stack heights up to 100m.

A.1.6 In combination with the results from dispersion modelling using ADMS, it was evaluated that an EfW stack height of 95m i.e. an emission height of 340m derived from a modelled ground level of 245m, would provide environmental improvement in terms of reducing maximum process contributions to attain or be very close to screening criteria, and that would further align the design requirement of the EfW to apply best available techniques (BAT) to prevent pollution. While it is not normally considered necessary to achieve those screening criteria for every substance to ensure no significant pollution, harm or environmental impact, that provides a more conservative and precautionary approach, taking into account the context of the local topography and nature of the surrounding area, leading to a more robust BAT appraisal for the EfW.

A.1.7 Note with regard to emission of nitrous oxide, the Environment Agency AQMAU provides guidance on the conversion ratio for NO_x to NO_2, and for this assessment the 'worst case scenario' has been applied which assumes 70% conversion to NO_2 in the long term and 35% conversion to NO_2 in the short term. As that is the 'worst case scenario' approach no further sensitivity assessment is required regarding nitrous oxide conversion.

A.1.8 For emissions from the EfW, this assessment has applied a conservative approach by assuming emission rates at the IED emission limit values, and the implications of possible variation in emission rates, for example ranging from the half hourly average 100 or 97 percentile emission limits to the daily average emission limit, or due potential abnormal operations has been appraised within the report text. As the plant will apply BAT and must operate with emission rates well below the IED emission limits to ensure compliance with those limits, no further sensitivity assessment of emission rates has been carried out.

A.1.9 However sensitivity analysis has been carried out to check the model predictions as a consequence of changes to various input parameters (other than stack height), with the results of the various model runs indicated the following table. The baseline was the model setup used for the assessment, and for the sensitivity analysis only the parameter(s) referred to were altered, the other input parameters remain as per the baseline model.

Table 0.1 – Results of AERMOD Dispersion Model Sensitivity Analysis for EfW

Model Parameter Adjusted	Max NO_2 Annual Average µg/m^3	Percent change from Baseline	Max NO_2 99.79%ile of 1hr average µg/m^3	Percent change from Baseline
Met data for 2004	0.36	16.7%	13.5	-33.7%
Met data for 2005	0.37	18.2%	13.7	-32.7%
Met data for 2006	0.23	-24.6%	13.8	-32.0%
Met data for 2007	0.27	-12.8%	11.0	-45.7%
Met data for 2008	0.26	-17.3%	7.7	-62.1%
Met data for 2009	0.22	-30.2%	8.1	-60.2%
Met data for 2010 as baseline	0.31	0.0%	20.3	0.0%
Met data for 2011	0.23	-25.6%	10.7	-47.5%
Met data for 2012	0.26	-15.9%	12.1	-40.3%
Met data for Gatwick 2004 (land use processing as per the baseline)	0.34	10.1%	15.3	-24.8%
Receptor height 1.5m above ground level (as opposed to ground level)	0.33	7.2%	40.4	98.9%

Model Parameter Adjusted	Max NO_2 Annual Average µg/m^3	Percent change from Baseline	Max NO_2 99.79%ile of 1hr average µg/m^3	Percent change from Baseline
Surrounding land all as grassland	0.41	32.4%	54.0	165.7%
Surrounding land all as cultivated	0.35	12.8%	46.2	127.2%
Surrounding land all as heathland	0.28	-9.8%	37.3	83.4%
Flat terrain	0.23	-24.5%	5.3	-73.9%
No buildings	0.31	0.1%	40.7	100.0%
Maximum EfW capability, design point LPA volumetric flow rate 144,000m3/hr, moisture 22.6%, oxygen 6.8%, exit velocity 17.099m/s, giving an emission rate of 8.0g/s, i.e. a short term increase of approximately 3%.	0.31	0.1%	40.2	98.0%
Exit temperature increased by 20deg C (emission limit, moisture and oxygen kept the same, resulting in lower flow volume, 133,381Nm3/hr, and lower emission rate 7.41g/s)	0.28	-9.7%	35.7	75.8%
Exit temperature decreased by 20deg C (emission limit, moisture and oxygen kept the same, resulting in higher flow volume, 147,311Nm3/hr, and higher emission rate 8.184g/s)	0.37	18.6%	46.2	127.2%
Exit velocity increased by 15% from 16.185m/s to 18.613m/s(emission limit, moisture and oxygen kept the same, resulting in higher flow volume, 161,000Nm3/hr, and higher emission rate 8.945g/s)	0.33	6.9%	41.4	103.9%
Exit velocity reduced by 15% from 16.185m/s to 13.757m/s (emission limit, moisture and oxygen kept the same, resulting in lower flow volume, 119,000Nm3/hr, and lower emission rate 6.611g/s)	0.30	-1.5%	37.6	84.9%

A.1.10 The model is sensitive to site specific related parameters such as the surrounding land use and terrain, but for this assessment the surrounding land use has been appraised and the terrain is not flat, hence reliance needs to be placed on the site specific parameters.

A.1.11 The model predictions are also sensitive to operational parameters such as the flue gas exit temperature and velocity, and also due to the meteorological conditions. Using the meteorological data for 2005 gives the highest annual average, with the range due to the meteorological data year being 1.3 to 40.9% less than that maximum value. Using the meteorological data for 2010 gives the maximum short term process contribution with the range for meteorological data for other years being 24.8-62.1% less than the maximum process contribution predicted using the meteorological data for 2010.

A.1.12 The predicted process contributions are less than the air quality objective (the assessment criterion) for nitrogen oxides, and the process environmental contributions would also be less than 70% of the long term assessment criteria. Based on the sensitivity analysis appraisal it is concluded use of meteorological data for the years 2004 to 2012 from Belfast (Aldergrove) International Airport provides a good overall basis for the interpretation carried out in this air quality assessment, as the conclusions are effectively drawn from evaluation of 78,922 predictions (excluding 160 missing hours from the period).