Stansted Airport Generation 1 Inquiry

PROOF OF EVIDENCE BY
Malcolm Pratt
BSc, EurChem, CChem, CEnv, FRSC, FIEMA

April 2007
Report for

BAA Stansted

Proof of Evidence

Air Quality – Volume 3 Tables, Figures and Appendices

April 2007

Entec UK Limited

Main Contributors

Issued by

Entec UK Limited

Approved by

Entec UK Limited

Windsor House
Gadbrook Business Centre
Gadbrook Road
Northwich
Cheshire
CW9 7TN
England
Tel: +44 (0) 1606 354800
Fax: +44 (0) 1606 354810

Certificate No. EMS 69090
Certificate No. FS 13881

In accordance with an environmentally responsible approach,
this document is printed on recycled paper produced from 100% post-consumer waste or on ECF (elemental chlorine free) paper.
Copyright and Non-Disclosure Notice

The contents and layout of this report are subject to copyright owned by Entec (© Entec UK Limited 2007) save to the extent that copyright has been legally assigned by us to another party or is used by Entec under licence. To the extent that we own the copyright in this report, it may not be copied or used without our prior written agreement for any purpose other than the purpose indicated in this report.

The methodology (if any) contained in this report is provided to you in confidence and must not be disclosed or copied to third parties without the prior written agreement of Entec. Disclosure of that information may constitute an actionable breach of confidence or may otherwise prejudice our commercial interests. Any third party who obtains access to this report by any means will, in any event, be subject to the Third Party Disclaimer set out below.

Third Party Disclaimer

Any disclosure of this report to a third party is subject to this disclaimer. The report was prepared by Entec at the instruction of, and for use by, our client named on the front of the report. It does not in any way constitute advice to any third party who is able to access it by any means. Entec excludes to the fullest extent lawfully permitted all liability whatsoever for any loss or damage howsoever arising from reliance on the contents of this report. We do not however exclude our liability (if any) for personal injury or death resulting from our negligence, for fraud or any other matter in relation to which we cannot legally exclude liability.

Document Revisions

<table>
<thead>
<tr>
<th>No.</th>
<th>Details</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Final Report</td>
<td>25.04.07</td>
</tr>
</tbody>
</table>
Contents

Table 3.1 Modelled Annual Mean Pollutant Concentrations (µg/m³) in the 25 mppa and 35 mppa Cases in 2014 (using 2003 meteorological data) 1
Table 4.1 Reference Deposition Rates (APIS) 3
Table 4.2 NOx and NO2 Concentrations from the G1 Air Quality Assessment (kgN/ha/y) 3
Table 4.3 Calculated Deposition Rate - ES Assessment 4
Table 5.1 Carbon Dioxide Emissions (kt) in a National and International Context (2000 and 2004) 5
Table 5.2 Carbon Dioxide Emissions (kt) in a National and European Context (2004) 6
Table 5.3 Emissions of CO2 from Stansted at 25mppa and 35mppa (kt(a)) in 2014 7
Table 5.4 Comparison of CO2 emissions from Stansted at 25mppa and 35mppa with forecast transport and UK emissions (kt(a)) in 2014 8

Figure 4.1 Nitrogen Deposition to Forests 1991 – 2001 (printed from the APIS website) 9
Figure II.2 Scatter plot of calculated vs measured annual-mean NOx concentrations at the continuous monitoring stations 25
Figure II.3 Scatter plot of calculated vs measured annual-mean NO2 concentrations at the continuous monitoring stations 25

Appendix I Data Issues 11
Appendix II Modelling and Monitoring Issues 13
Appendix III Application of Objectives and Limit Values 26
Appendix IV Greenhouse Gases and non Carbon Dioxide Effects 35
Appendix VII Highways Agency (2005) Guidance for undertaking environmental assessment of air quality for sensitive ecosystems in internationally designated nature conservation sites and SSSIs (Supplement to DMRB 11.3.1) Interim Advice Note 61/05. March 50
Appendix VIII CD/188 NEGTAP (2001) Transboundary air pollution: acidification, eutrophication and ground-level ozone in the UK 54
Appendix XIV Earthtrends (2005). Climate and Atmosphere 2005 91
Appendix XV Laxen D and Marner B (2004) Further assessment (Stage 4) of Air Quality within Two Air Quality Management Areas in Reigate & Bansted. Prepared for Reigate and Bansted Borough Council April 98
Appendix XVIII AQLR Regulations 2003 SI 2003 No. 2121 124
Appendix XX English Nature The Ecological Effects of Diffuse Air Pollution from Road Transport (Report Number 580) 134
Appendix XXI  USA 2006 Uttlesford District Council  137
Appendix XXII  USA 2006 East Hertfordshire District Council  141
Appendix XXIII  HM Treasury (2003) Aviation and the Environment using Economic Instruments  144
### Table 3.1 Modelled Annual Mean Pollutant Concentrations (µg/m³) in the 25 mppa and 35 mppa Cases in 2014 (using 2003 meteorological data)

<table>
<thead>
<tr>
<th>Site name</th>
<th>X</th>
<th>Y</th>
<th>NO₂</th>
<th>PM₁₀</th>
<th>benzene</th>
<th>1,3-butadiene</th>
<th>PM₁₅</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>25 mppa</td>
<td>35 mppa</td>
<td>25 mppa</td>
<td>35 mppa</td>
<td>25 mppa</td>
<td>35 mppa</td>
<td>25 mppa</td>
</tr>
<tr>
<td>High House</td>
<td>555925</td>
<td>223345</td>
<td>19.0</td>
<td>20.2</td>
<td>20.4</td>
<td>20.6</td>
<td>0.55</td>
</tr>
<tr>
<td>Takeley</td>
<td>556226</td>
<td>221490</td>
<td>15.1</td>
<td>15.4</td>
<td>19.6</td>
<td>19.6</td>
<td>0.43</td>
</tr>
<tr>
<td>Landing Lights²</td>
<td>555518</td>
<td>224934</td>
<td>18.3</td>
<td>19.7</td>
<td>20.1</td>
<td>20.3</td>
<td>0.52</td>
</tr>
<tr>
<td>Balancing Pond</td>
<td>552310</td>
<td>221561</td>
<td>24.8</td>
<td>25.6</td>
<td>22.5</td>
<td>22.8</td>
<td>0.55</td>
</tr>
<tr>
<td>Highfield Lodge</td>
<td>553967</td>
<td>223745</td>
<td>19.5</td>
<td>20.4</td>
<td>20.1</td>
<td>20.2</td>
<td>0.50</td>
</tr>
<tr>
<td>Molehill Green</td>
<td>556250</td>
<td>224735</td>
<td>16.9</td>
<td>18.3</td>
<td>19.7</td>
<td>19.9</td>
<td>0.48</td>
</tr>
<tr>
<td>Bamber Green</td>
<td>557300</td>
<td>223000</td>
<td>16.7</td>
<td>15.0</td>
<td>19.5</td>
<td>19.5</td>
<td>0.42</td>
</tr>
<tr>
<td>Old House Farm</td>
<td>555540</td>
<td>222885</td>
<td>18.6</td>
<td>19.5</td>
<td>20.3</td>
<td>20.5</td>
<td>0.53</td>
</tr>
<tr>
<td>Thremhall Farm</td>
<td>553310</td>
<td>221450</td>
<td>19.9</td>
<td>20.8</td>
<td>20.5</td>
<td>20.6</td>
<td>0.49</td>
</tr>
<tr>
<td>Tilekiln Green</td>
<td>552180</td>
<td>221390</td>
<td>19.5</td>
<td>19.9</td>
<td>20.6</td>
<td>20.7</td>
<td>0.50</td>
</tr>
<tr>
<td>Bury Lodge</td>
<td>552500</td>
<td>222800</td>
<td>18.9</td>
<td>19.3</td>
<td>20.4</td>
<td>20.5</td>
<td>0.53</td>
</tr>
<tr>
<td>Burton End</td>
<td>553225</td>
<td>223770</td>
<td>17.4</td>
<td>17.8</td>
<td>19.8</td>
<td>19.9</td>
<td>0.48</td>
</tr>
<tr>
<td>Tye Green</td>
<td>554190</td>
<td>224430</td>
<td>18.6</td>
<td>19.5</td>
<td>19.8</td>
<td>19.9</td>
<td>0.48</td>
</tr>
<tr>
<td>Mott's Hall</td>
<td>555225</td>
<td>225020</td>
<td>18.0</td>
<td>19.2</td>
<td>20.0</td>
<td>20.2</td>
<td>0.50</td>
</tr>
</tbody>
</table>

#### Statutory (non-statutory) Standards/Objectives

<table>
<thead>
<tr>
<th>Site name</th>
<th>% of AOO¹</th>
<th>increment a % of AOO²</th>
<th>% of AOO</th>
<th>increment a % of AOO³</th>
<th>% of AOO</th>
<th>increment a % of AOO</th>
<th>% of AOO</th>
<th>increment a % of AOO</th>
<th>% of AOO</th>
<th>increment a % of AOO</th>
<th>% of AOO</th>
</tr>
</thead>
<tbody>
<tr>
<td>High House</td>
<td>48%</td>
<td>3%</td>
<td>51%</td>
<td>1%</td>
<td>11%</td>
<td>0%</td>
<td>8%</td>
<td>1%</td>
<td>54%</td>
<td>1%</td>
<td></td>
</tr>
<tr>
<td>Takeley</td>
<td>38%</td>
<td>1%</td>
<td>49%</td>
<td>0%</td>
<td>9%</td>
<td>0%</td>
<td>3%</td>
<td>0%</td>
<td>52%</td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td>Landing Lights²</td>
<td>46%</td>
<td>4%</td>
<td>50%</td>
<td>1%</td>
<td>10%</td>
<td>1%</td>
<td>6%</td>
<td>1%</td>
<td>53%</td>
<td>1%</td>
<td></td>
</tr>
<tr>
<td>Balancing Pond</td>
<td>62%</td>
<td>2%</td>
<td>56%</td>
<td>1%</td>
<td>11%</td>
<td>0%</td>
<td>7%</td>
<td>0%</td>
<td>59%</td>
<td>1%</td>
<td></td>
</tr>
<tr>
<td>Highfield Lodge</td>
<td>49%</td>
<td>2%</td>
<td>50%</td>
<td>0%</td>
<td>10%</td>
<td>0%</td>
<td>6%</td>
<td>0%</td>
<td>53%</td>
<td>0%</td>
<td></td>
</tr>
</tbody>
</table>

¹ Statutory (non-statutory) Standards/Objectives
² % of AOO: % of Air Quality Objective
³ increment a % of AOO: Increment above % of Air Quality Objective

© Entec UK Limited
April 2007
<table>
<thead>
<tr>
<th>Site name</th>
<th>X</th>
<th>Y</th>
<th>NO₂</th>
<th>PM₁₀</th>
<th>benzene</th>
<th>1,3-butadiene</th>
<th>PM₁₅</th>
</tr>
</thead>
<tbody>
<tr>
<td>Molehill Green</td>
<td>556250</td>
<td>224735</td>
<td>42%</td>
<td>4%</td>
<td>49%</td>
<td>1%</td>
<td>1%</td>
</tr>
<tr>
<td>Bamber Green</td>
<td>557300</td>
<td>223000</td>
<td>37%</td>
<td>1%</td>
<td>49%</td>
<td>0%</td>
<td>8%</td>
</tr>
<tr>
<td>Old House Farm</td>
<td>555540</td>
<td>222885</td>
<td>47%</td>
<td>2%</td>
<td>51%</td>
<td>0%</td>
<td>11%</td>
</tr>
<tr>
<td>Thremhall Farm</td>
<td>553310</td>
<td>221450</td>
<td>50%</td>
<td>2%</td>
<td>51%</td>
<td>0%</td>
<td>10%</td>
</tr>
<tr>
<td>Tilekiln Green</td>
<td>552180</td>
<td>221390</td>
<td>49%</td>
<td>1%</td>
<td>51%</td>
<td>0%</td>
<td>10%</td>
</tr>
<tr>
<td>Bury Lodge</td>
<td>552500</td>
<td>222800</td>
<td>47%</td>
<td>1%</td>
<td>51%</td>
<td>0%</td>
<td>11%</td>
</tr>
<tr>
<td>Burton End</td>
<td>553225</td>
<td>223770</td>
<td>44%</td>
<td>1%</td>
<td>50%</td>
<td>0%</td>
<td>10%</td>
</tr>
<tr>
<td>Tye Green</td>
<td>554190</td>
<td>224430</td>
<td>46%</td>
<td>2%</td>
<td>50%</td>
<td>0%</td>
<td>10%</td>
</tr>
<tr>
<td>Mott's Hall</td>
<td>555225</td>
<td>225020</td>
<td>45%</td>
<td>3%</td>
<td>50%</td>
<td>0%</td>
<td>10%</td>
</tr>
</tbody>
</table>

Notes:
1. All statutory and non-statutory relate to protection of human health. Non-statutory standards are shown in brackets.
2. Receptors shown in italics are potentially occupational locations where the standard may not apply.
3. This value is a concentration cap in a proposed EU directive. It is not an adopted standard.
4. 25 mppa concentration divided by the air quality objective (AQO).
5. Increment (35 mppa – 25 mppa concentration) divided by the AQO.
### Table 4.1  Reference Deposition Rates (APIS)

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Critical load range (kgN/ha/y)</th>
<th>Total N deposition (1999-2001) (kgN/ha/y)</th>
<th>Percentage exceedance of critical load in 2000</th>
<th>Forecast Total N deposition (2014) (kgN/ha/y)</th>
<th>Percentage exceedance of critical load in 2014</th>
<th>Reduction in N deposition (kgN/ha)</th>
<th>Average reduction in N deposition per year (kgN/ha/y)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hatfield Forest</td>
<td>10 – 15</td>
<td>36.5</td>
<td>204%</td>
<td>26.3</td>
<td>119%</td>
<td>10.2</td>
<td>0.7</td>
</tr>
<tr>
<td>(553200,221300)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eastend Wood</td>
<td>10 - 15</td>
<td>38.8</td>
<td>223%</td>
<td>27.9</td>
<td>133%</td>
<td>10.9</td>
<td>0.8</td>
</tr>
<tr>
<td>(55800,225000)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes:

(a) the selected receptors are just outside Hatfield Forest and Eastend Wood (See Figure 4.2 Volume 3)

(b) Calculation based on a representative critical load value of 12kgN/ha/y as adopted by CEH (2007) UK National Focus Centre for critical loads modelling and mapping¹

### Table 4.2  NOx and NO₂ Concentrations from the G1 Air Quality Assessment (kgN/ha/y)

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Case</th>
<th>NOx concentration (μg/m³)</th>
<th>Ratio airport/total</th>
<th>Total NO₂ concentration (μg/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hatfield Forest</td>
<td>25 mppa</td>
<td>28.8</td>
<td>8.9</td>
<td>0.31</td>
</tr>
<tr>
<td>(553200,221300)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eastend Wood</td>
<td>25 mppa</td>
<td>30.6</td>
<td>10.8</td>
<td>0.35</td>
</tr>
<tr>
<td>(55800,225000)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes:

(a) the selected receptors are just outside Hatfield Forest and Eastend Wood (See Figure 4.2 Volume 3)

¹ Extracts from CEH (2007) UK National Focus Centre are provided in Appendix XIII
### Table 4.3  Calculated Deposition Rate - ES Assessment

<table>
<thead>
<tr>
<th>Receptor (a)</th>
<th>Case</th>
<th>ES Assessment</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>N deposition rate from total NOx (kgN/ha/y)</td>
<td>N deposition rate from airport NOx (kgN/ha/y)</td>
<td>Airport % of total N deposition 2014</td>
</tr>
<tr>
<td>Hatfield Forest</td>
<td>25 mppa</td>
<td>3.6</td>
<td>1.1</td>
<td>4.3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>35 mppa</td>
<td>3.8</td>
<td>1.3</td>
<td>5.1</td>
<td></td>
</tr>
<tr>
<td>Difference</td>
<td></td>
<td>0.2</td>
<td>0.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eastend Wood</td>
<td>25 mppa</td>
<td>3.3</td>
<td>1.2</td>
<td>4.3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>35 mppa</td>
<td>3.6</td>
<td>1.5</td>
<td>5.5</td>
<td></td>
</tr>
<tr>
<td>Difference</td>
<td></td>
<td>0.3</td>
<td>1.2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes:

(a) the selected receptors are just outside Hatfield Forest and East end Wood (See Figure 4.2 Volume 3)

### Table 4.4  Calculated Deposition Rates - Regulation 19 sensitivity test

<table>
<thead>
<tr>
<th>Receptor (a)</th>
<th>Case</th>
<th>Regulation 19 Sensitivity test</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>N deposition rate from total NOx (kgN/ha/y)</td>
<td>N deposition from airport NOx (kgN/ha/y)</td>
<td>Airport % of total N deposition 2014</td>
</tr>
<tr>
<td>Hatfield Forest</td>
<td>25 mppa</td>
<td>4.3</td>
<td>1.3</td>
<td>5.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>35 mppa</td>
<td>4.5</td>
<td>1.6</td>
<td>6.1</td>
<td></td>
</tr>
<tr>
<td>Difference</td>
<td></td>
<td>0.3</td>
<td>1.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eastend Wood</td>
<td>25 mppa</td>
<td>4.0</td>
<td>1.4</td>
<td>5.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>35 mppa</td>
<td>4.3</td>
<td>1.8</td>
<td>6.5</td>
<td></td>
</tr>
<tr>
<td>Difference</td>
<td></td>
<td>0.4</td>
<td>1.4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes:

(a) the selected receptors are just outside Hatfield Forest and East end Wood (See Figure 4.2 Volume 3)
Table 5.1  Carbon Dioxide Emissions (kt) in a National and International Context (2000 and 2004)

<table>
<thead>
<tr>
<th></th>
<th>2000</th>
<th>UK as a percentage of</th>
<th>2004(^2)</th>
<th>UK as a percentage of</th>
<th>UK Domestic Aviation as a percentage of</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Emissions(^1,2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Worldwide</td>
<td>23,895,700 (2.3%)</td>
<td>N/A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EU25</td>
<td>3,960,000</td>
<td>4,116,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EU15</td>
<td>3,355,000 (16.3%)</td>
<td>3,506,000 (16.0%)</td>
<td></td>
<td></td>
<td>(0.38%)</td>
</tr>
<tr>
<td>UK</td>
<td>548,000</td>
<td>562,000</td>
<td></td>
<td></td>
<td>(0.38%)</td>
</tr>
<tr>
<td>Energy Emissions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EU15</td>
<td>1,190,270 (17.4%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UK</td>
<td>207,101</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transport Emissions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EU15</td>
<td>859,866 (14.6%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UK</td>
<td>128,487</td>
<td></td>
<td></td>
<td></td>
<td>(1.65%)</td>
</tr>
<tr>
<td>Aviation Emissions (Domestic)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EU15</td>
<td>23,342 (9.9%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UK</td>
<td>2,303</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Excluding land use change and international bunker (shipping and aircraft)

\(^2\) Extracts from Earth Trends (2005) are provided in Appendix XIV
Table 5.2 Carbon Dioxide Emissions (kt) in a National and European Context (2004)

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2004</td>
<td>UK as a percentage of</td>
<td>UK Aviation as a percentage of</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EU15</td>
<td></td>
</tr>
<tr>
<td>All Emissions¹</td>
<td></td>
<td>3,506,000</td>
<td>(16.0%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>562,000</td>
<td></td>
</tr>
<tr>
<td>International Bunkers (one way international flights)</td>
<td></td>
<td>114,311</td>
<td>(29.0%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>33,123</td>
<td></td>
</tr>
<tr>
<td>All Emissions (including bunkers)</td>
<td></td>
<td>3,620,311</td>
<td>(16.4%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>595,123</td>
<td></td>
</tr>
<tr>
<td>All Aviation (domestic and one way international)</td>
<td></td>
<td>137,653</td>
<td>(25.7%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>35,426</td>
<td></td>
</tr>
</tbody>
</table>

Notes

### Table 5.3  Emissions of CO₂ from Stansted at 25mppa and 35mppa (kt\(^{(a)}\)) in 2014

<table>
<thead>
<tr>
<th></th>
<th>25mppa</th>
<th>35mppa</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic LTO (Landing and Take Off)</td>
<td>34.1</td>
<td>36.4</td>
<td>2.3</td>
</tr>
<tr>
<td>Domestic Cruise (two way)</td>
<td>68.1</td>
<td>74.5</td>
<td>6.4</td>
</tr>
<tr>
<td>(Sub total Domestic)</td>
<td>(102.2)</td>
<td>(110.9)</td>
<td>(8.7)</td>
</tr>
<tr>
<td>Engine testing</td>
<td>2.4</td>
<td>3.0</td>
<td>0.6</td>
</tr>
<tr>
<td>Airside vehicles</td>
<td>4.1</td>
<td>5.7</td>
<td>1.6</td>
</tr>
<tr>
<td>Car parks</td>
<td>0.8</td>
<td>1.3</td>
<td>0.5</td>
</tr>
<tr>
<td>Fire training</td>
<td>0.1</td>
<td>0.1</td>
<td>0.0</td>
</tr>
<tr>
<td>Heating plant</td>
<td>6.9</td>
<td>7.7</td>
<td>0.8</td>
</tr>
<tr>
<td>Airport total</td>
<td>116.5</td>
<td>128.7</td>
<td>12.2</td>
</tr>
<tr>
<td>Airside related landside roads(^{(b)})</td>
<td>100.3</td>
<td>114.1</td>
<td>13.8</td>
</tr>
<tr>
<td>Airport and airport related roads</td>
<td>216.8</td>
<td>242.8</td>
<td>26.0</td>
</tr>
<tr>
<td>International LTO (Landing and Take Off)</td>
<td>266.5</td>
<td>351.3</td>
<td>84.8</td>
</tr>
<tr>
<td>International Cruise (one way)</td>
<td>2,490.8</td>
<td>3,442.2</td>
<td>951.4</td>
</tr>
<tr>
<td>(Sub total International)</td>
<td>(2,757.3)</td>
<td>(3,793.5)</td>
<td>(1,036.2)</td>
</tr>
<tr>
<td>Stansted Total</td>
<td>2,974.1</td>
<td>4,036.3</td>
<td>1,062.2</td>
</tr>
</tbody>
</table>

**Notes:**

(a) All emission data rounded to the nearest kilotonne (kt)

(b) Based on a traffic model area of 43km by 45km
Table 5.4  Comparison of CO₂ emissions from Stansted at 25mpa and 35mpa with forecast transport and UK emissions (kt\(^{(a)}\)) in 2014

<table>
<thead>
<tr>
<th></th>
<th>25mpa</th>
<th>35mpa</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic aviation (and including airport related activity and airport related road traffic) – Table 5.3</td>
<td>217</td>
<td>243</td>
<td>26</td>
</tr>
<tr>
<td>International (one way) – Table 5.3</td>
<td>2,757</td>
<td>3,794</td>
<td>1,036</td>
</tr>
<tr>
<td>Total Stansted emissions</td>
<td>2,974</td>
<td>4,037</td>
<td>1,062</td>
</tr>
<tr>
<td>All UK transport (2014) (^{(b)})</td>
<td>142,487</td>
<td>142,487</td>
<td></td>
</tr>
<tr>
<td>Total UK Emissions (2014) (^{(b)})</td>
<td>522,000</td>
<td>522,000</td>
<td></td>
</tr>
<tr>
<td>Total Stansted as % of transport</td>
<td>2.09</td>
<td>2.83</td>
<td>0.74</td>
</tr>
<tr>
<td>Total Stansted as % of total UK emissions</td>
<td>0.57</td>
<td>0.77</td>
<td>0.20</td>
</tr>
</tbody>
</table>

Notes:

(a) All emission data rounded to the nearest kilotonne (kt)

(b) Defra (2004) Review of the UK Climate Change Programme Consultation Paper December
The Simple Site-Based Assessment should be used only to assist the user in obtaining a broad indication of the likely pollutant impact at a specific location.
Figure 4.2 (previously Figure 8) Annual mean concentration of NOx for the 35 mppa case in 2014 modelled using 2003 meteorological data

Vegetation Protection Limit Value is 30 µg/m³ (Table 2). The 5 km restrictions applied to this limit value are illustrated in Figure 1. Concentrations below the limit value have no statutory significance but are shown to illustrate the fall in concentration with distance from the Airport and major roads. Background concentrations of NOx are in the region of 15 µg/m³.
Appendix I
Data Issues
2 Pages

In this Appendix I will address a number of data issues that could affect the interpretation of the modelling results in the Volume 3 of the ES (CD/6) or the robustness of the forecast concentrations.

Meteorological data
1.1 In the SSE representations to UDC (CD/202, section 3) there is a misunderstanding over the way the modelling concentrations have been reported that effects the conclusions reached in that text. To avoid any further misunderstanding I would like to explain the use of meteorological data in the ES.

1.2 The modelled concentrations in 2014 were calculated using emissions from that year and historical meteorological data. After examining the effect on concentrations of using meteorological data from 2001, 2002 and 2003, it was concluded (CD/6 page 32) that 2003 gave the highest concentrations and this meteorological year was adopted for the assessment.

1.3 In SSE’s representations (CD/202 - Box A) it is suggested that the modelled concentrations are under-estimating measured concentrations in 2003. This is not correct because there are no modelled concentrations in 2003. Modelling for 2003 concentrations would have required an emission inventory for that year which is not available. This misunderstanding in the SSE work was also pointed out in the Bureau Veritas report (CD/144 page 22).

1.4 The model test (Underwood 2005 – CD/190) work produced nitrogen dioxide concentrations for the period 23rd October 2003 to 18th May 2004 at the five locations (4 diffusion tube sites and High House). In this work it was reported that measured concentrations using diffusion tubes were on average 23% higher than the modelling concentrations. It was noted in the model test report that this level of difference was comparable to the accuracy of the diffusion tube measurements. (See also Appendix II para 1.2.11).

Forecast data used in the model
1.5 SSE has made a number of assertions (e.g. CD/201 paras 6.2.9 and 6.2.18) that the forecast data are not reliable and that material referred to in the ES was not made available.

1.6 As far as reference material is concerned, I understand that BAA has made available to UDC all reference material from the ES that has been requested.

1.7 Forecasting air quality is subject to constraints and uncertainty. This was recognised in the ES (CD/6 page 11) in the limitation, constraints and assumptions section. This section notes the reliance placed on forecast data by BAA, Halcrow and QinetiQ. These sources were used because, in my opinion, they were the best available. In the ES
(CD/6) we tested the sensitivity of the assessment to changes in forecast data and assumptions. I am satisfied that the ES assessment is robust and provides a good basis for consideration of the likely effects from the proposed G1 development.

Airport activity data

I.8 The airport activity data were compiled by BAA and others from operational information. It was cross-checked by the modelling team to ensure the data were reasonable and consistent with those used in previous studies at Stansted and elsewhere. Any inconsistencies identified were discussed and rationalised in discussion with BAA or the originators of the data.

I.9 I am satisfied that the assessment is robust and provides our best estimate of future concentrations. Variations in forecasts, operational data or assumptions will inevitably increase or decrease future concentrations but not to an extent that would cause the health based objectives to be breached.
Appendix II
Modelling and Monitoring Issues
13 Pages

In this appendix, I will address the issues of monitoring, model verification together with some other matters (business as usual forecast for the 25mppa case, the credentials of the ADMS model, roadside modelling and the reduction of emissions since the 15+ assessment) which I have grouped under a “general modelling” heading.

Monitoring

II.1 This section provides a summary of why I believe there is sufficient monitoring information available to assess baseline (2005) air quality around the airport. I will also set the requirements for monitoring in the s. 106 agreement and demonstrate how these requirements have been achieved.

II.2 The adequacy, or otherwise, of any monitoring survey is a matter of judgement in the context of the reasons why a survey needs to be undertaken. Most monitoring in the UK is undertaken to:

1. investigate whether air quality objectives are likely to be exceeded. (This monitoring is focused on areas where possible exceedances are most likely usually close to roads or in urban centres);
2. meet national reporting requirements (e.g. Automatic Urban Network);
3. establish an air quality baseline against which development proposals can be assessed; and
4. investigate specific issues around a larger emitter (e.g. the recent Heathrow study).

II.3 For each of these surveys the number of sites used in the study will vary as will the equipment and the duration of the measurements. The costs of monitoring surveys can be substantial when continuous monitors, that deliver hour by hour concentrations, are employed.

II.4 Both UDC and EHDC have been investigating air quality in their districts to determine whether the objectives are likely to be exceeded. In some areas, the potential to exceed objectives was identified and further detailed investigations were undertaken. I have referred to this work in the ES (CD/6 – page 20). To date no air quality management areas have been declared in either district.

II.5 UDC, quite rightly, recognised the potential for emissions at Stansted Airport to have an impact on air quality and a monitoring programme was agreed in the s.106 agreement (May 2003) attached to the grant of the 2003 planning permission.

II.6 Under this agreement it is provided that:
“STAL shall until 2010 monitor air quality in the vicinity of the airport in the following terms:

a) Continuous monitoring of oxides of nitrogen and fine particulate matter \( (PM_{10}) \) at a fixed site to be agreed with the UDC such monitoring to be conducted for a period of three months agreed with in each year until 2005, and throughout each year thereafter.

b) diffusion tube monitoring of nitrogen dioxide levels at not less than 4 sites to be agreed with the UDC.”

II.7 There have been a number of diffusion tube surveys involving up to seven sites. This number was revised to the current four sites (plus the co-location site at High House).

II.8 BAA agreed the siting of the monitoring equipment with UDC. The data from this, and other monitoring undertaken by BAA, is shared with UDC on a regular basis. The data reported in the ES (Table 10) demonstrates that BAA has met its air quality monitoring obligations under the s.106 agreement.

II.9 One of the reasons I listed above for undertaking monitoring is for the collection of baseline data which is commonly undertaken when a new development is planned in an area where there is little or no existing data. Baseline surveys are commonly undertaken using diffusion tubes over periods of up to one year. Surveys as short as one to three months have sometimes been employed.

II.10 Before embarking on a monitoring survey BAA, like any developer, is entitled to examine air quality data produced by others (e.g. UDC/EHDC) to understand the air quality in the area. In the Stansted area, in addition to the sites operated by BAA, there is a site in Takeley operated by UDC\(^4\). In addition there are some 16 diffusion tube sites operated by UDC. EHDC has two continuous monitoring sites and 16 diffusion sites. BAA is not required to undertake monitoring without a clear purpose. In the light of the above, it concluded that there was sufficient monitoring data to assess the baseline conditions around the airport and the road transport routes to the airport. I concur with this view. Air quality scientists will always want more data, but in the present context, whilst additional monitoring might be “nice to have”, I do not think it would have changed the overall assessment of the current air quality in the Stansted area.

II.11 The use of diffusion tubes was required by, and agreed with, UDC. Both parties recognise that reported \( NO_2 \) concentrations\(^5\) using diffusion tubes are subject to uncertainty. BAA has co-located diffusion tubes with the continuous monitors and, over a 3 month period at High House and Thremhall Farm, showed the diffusion tubes were over estimating \( NO_2 \) concentrations by 69% and 30% respectively (giving a bias adjustment figure of 0.59 and 0.76, if data were representative of a full year). Over 12 month periods in 2005 and 2006 at High House the diffusion tube concentrations were over estimating by 31% and 9% respectively (giving a bias adjustment figure of 0.76

\(^{4}\) A mobile site was also commissioned (2005) in Plegdon Green

\(^{5}\) There has been some inconsistency in reporting diffusion tube data, some have been bias corrected while others have not. BAA data are not normally bias corrected.
and 0.91). At the National level the bias adjustment figures for 2004 and 2005 are 0.89 and 0.91 respectively, for the pertinent tube type and exposure condition. The National bias adjustment factors for 2006 are not yet available. The location of these monitoring sites is identified in Figure II.1.

II.12 It is important to understand that diffusion tubes are useful to indicate the spatial distribution of NO₂ concentrations for review and assessment work and baseline studies as they give an indication of likely concentrations. However, these concentration data cannot be used to show compliance or otherwise with the objective/limit values as concentrations are not recorded using the reference method (chemiluminescence). If diffusion tube concentration data suggests a breach of an objective that could result in the declaration of an air quality management area (AQMA) further, more detailed studies are normally carried out to ascertain whether a breach is likely to occur before the AQAM is declared.

II.13 Monitoring is undertaken where objective concentrations might be exceeded and the regulations apply. As distance from major roads, urban centres and airports increase there is a decreasing likelihood that objectives will be breached and therefore there is no reason to undertake monitoring. If the objectives do not apply in a given location monitoring will not usually be carried out. Health and Safety regulations, rather than air quality objectives and limit values, apply to occupational exposure to air pollutants. I will explain the application of objectives in Appendix III of this evidence.

II.14 When I look at all the monitoring data around the airport I am satisfied there is sufficient information to make a judgement on the air quality in the Stansted area. Some diffusion tube concentrations do suggest that objective values might be approached or exceeded and this is addressed through the review and assessment process undertaken by, in this case, UDC. Monitoring has been undertaken where the objectives might apply but not elsewhere which is common practice. The location of monitoring sites required by the s.106 agreement has been agreed with UDC and the measured concentrations are made available to UDC routinely.

Model Verification

II.15 This section provides a summary of why the ADMS model we have used in the ES assessment is fit for purpose. The model code has been validated and this is not in question. The performance of the ADMS model, as used at Stansted, has been tested against monitoring data at three airports as described below.

Background

II.16 A number of parties have criticised the extent of site-specific model verification that was undertaken for the air quality work reported in the ES.

II.17 It is important to understand what is meant by the term verification. I have assumed it does not mean here the checking of computer coding to ensure that it correctly interprets the requirements of a particular model, which has been a common usage of the term in the past. Here I use the term in the sense that has been defined in the context of Local Air Quality Management and its associated “Review and Assessment” procedures, where it has come to mean the comparison of model results against measured values in the study area of interest, usually followed by adjustment of the
model to give better agreement with the modelled values before it is used to predict concentration in future cases.

II.18 I have some reservations about this type of model adjustment, on the grounds that it makes the tacit assumption that whatever (unknown) influence is causing the discrepancy between measurement and model in the current case will affect future concentrations in exactly the same way, which may give misleading estimates of future concentrations. I use the term ‘unknown’ because if the cause of the discrepancy can be clearly identified then the model can be amended accordingly. If it cannot, then the discrepancy is best viewed as a measure of the precision with which the model can simulate reality. I accept that there may be circumstances when it is expedient to make ad hoc adjustments to a model to give agreement with data, but this requires justification on a case-by-case basis rather than being considered as the default way to handle model-measurement discrepancies.

II.19 Nevertheless, I acknowledge the benefit to be obtained in comparing model results with monitoring data for a current/recent situation – whatever term one uses for the process - in that it adds confidence that the model is performing as expected, within the recognised uncertainties of the type of modelling carried out and the type of measurement made.

II.20 The model-monitoring comparison at Stansted discussed below (para II.32) was undertaken to check the performance of the overall model in the Stansted context. The duration of the test (7 months) was long enough to reflect the range of meteorological conditions that are likely to occur within any year. While I accept that the benefit of model-monitoring comparisons increases with the number of sites for which comparisons can be made (provided they are in appropriate locations), I do not accept that comparison at a single site is ‘inadequate’ for the purpose intended.

II.21 I wish to distinguish the model-measurement comparisons discussed below from dispersion model ‘validation’, which tests the representation of physical (and sometimes chemical) processes within the model against real-world data for a range of well-characterised conditions and with known source strength. The atmospheric dispersion model used for the G1 assessment (ADMS) has been validated by the developers of the code, Cambridge Environmental Research Consultants, and as noted in the ES these details can be found on their website www.cerc.co.uk (ADMS validation summary). This validation work is not at issue.

II.22 However, in the current context the ‘model’ must be taken to include the quantification of the emissions as well as the representation of the dispersion (transport and dilution) in the atmosphere, which together lead to the predicted concentrations at relevant receptor locations. It is difficult to check emissions estimates independently other than through their impact on concentrations. In addition, the modelled concentrations include a sizeable contribution from ‘background’, which is estimated by a separate methodology. In this light, the purpose of model-monitoring comparisons is to provide a check on the overall modelling system, encompassing all of the components discussed above.

II.23 Although the airport air quality modelling methodology used for the G1 assessment has been continuously refined over a number of years, the approach is similar to that used in a number of previous air quality assessments at Heathrow, Gatwick and Stansted
airports, so model-measurement comparisons carried out for those studies provide additional information on the performance of the overall model. A number of key conclusions that emerge from those comparisons.

Gatwick

II.24 The air quality study reported as part of the Local Authority Review and Assessment (LARA) process for Reigate and Banstead (the local authority to the north of Gatwick airport - Laxen et al 2004)\(^6\) made use of annual-mean NO\(_x\), NO\(_2\) and PM\(_{10}\) concentrations for 2002/3 calculated by AE A using a methodology for Gatwick airport that was essentially the same as that used for the Stansted G1 assessment. Comparisons were made with monitoring data collected at two continuous monitoring sites and 26 diffusion tubes sites located within an air quality management area (AQMA) and an additional continuous monitoring site outside the AQMA, located on the airport.

II.25 Although diffusion tubes measurements have lower precision than those from continuous analysers, it is commonly understood that the absolute accuracy of a network of tubes can be improved by ‘bias-correction’, using data from a continuous analyser co-located with one of the tubes. In fact, for the 2002/3 period of the Gatwick study there were two co-location sites for most of the period, and the diffusion tube measurements were corrected using information derived from both sites. Although the ratio of modelled to measured annual-mean NO\(_2\) concentrations showed considerable scatter (as would be expected from the precision of the measurement systems), various tests were devised to search for systematic trends in the ratio that would indicate deficiencies in one or other aspect of the model. To this end, the aforementioned ratio was plotted against the distance of the monitoring site from the airport, and the distance from the nearest main road. It was also plotted as a function of the modelled NO\(_x\) contribution from aircraft, the modelled contribution from non-airport sources and the modelled road-traffic contribution. No significant trends were observed in these plots, from which it was concluded by Laxen et al (2004) that:

- emissions from road vehicles are adequately represented in the model;
- NO\(_x\) emissions from aircraft are not under-represented by the model;
- NO\(_x\) emissions from non-airport sources are not under-represented by the model;
- NO\(_x\) emissions from road vehicles are not under-represented by the model; and
- as the model does not systematically produce higher total concentrations than measured values, it can also be inferred that the background contribution is not overestimated.

Heathrow

II.26 For Heathrow the model-measurement comparison exercise carried out for the Project for the Sustainable Development of Heathrow (PSDH) was part of the process of selecting an air quality modelling approach that used the best available data and

\(^6\) Extracts from Laxen et al (2004) Further Assessment (Stage 4) of Air Quality within two AQMA are provided in Appendix XV
techniques whilst at the same time minimising any tendency to over- or underestimate NO$_2$ concentrations, particularly in locations significantly affected by aircraft sources. It was considered likely that ignoring the “plume rise” (i.e. the tendency of hot exhaust plumes to rise bodily as they disperse under the action of atmospheric turbulence) from the aircraft engines was responsible for a significant fraction of the model overestimation seen close to aircraft sources in previous airport studies (e.g. Underwood 2002)$^7$, and the model eventually chosen (ADMS-Airport) included a prototype sub-model for taking into account the plume rise from a moving jet source.

II.27 In the PSDH work a number of different models were used to examine model performance using a Heathrow airport emission inventory for 2002. For the comparison, eight$^8$ continuous monitoring sites were employed. Although the model-measurement comparisons benefited from having this number of monitoring sites, it is worth noting that none of the sites was installed specifically for the PSDH study; three sites were installed for monitoring construction activities from T5, two were pre-existing near motorway sites, one was a long-standing on-airport site and the other two were local-authority sites set up for monitoring compliance with air quality objectives.

II.28 Without going through all the PSDH work, it is evident from the report that, while the AEA modelling approach (which was used for Stansted G1) was not selected, its performance was similar to that of the other models that were tested. For example, the model/monitoring comparisons for NOx and NO$_2$ (Figures 4.4 and 4.5 (Dft 2006)$^9$ based on the AEA results show a similar level of scatter about the 1:1 line as the other models.

II.29 Figures 4.4 and 4.5 from the PSDH report are reproduced in Figure II.2 and Figure II.3 with the addition of the identity of each monitoring site. What this reveals is the model tends to overestimate concentrations close to major roads and close to airport sources. On the other hand, at sites where the model underestimates, concentrations tend to be dominated by the background contribution, although the degree of underestimation at these sites is well within the precision of the modelling component used to generate the background contribution.

II.30 At this point I wish to correct a statement made in the Bureau Veritas Comments on Regulation 19 Response (CD/145 - pages 5 and 6). There the AEA scatter plots from the PSDH report (Figures 4.4 and 4.5) are reproduced as Figures 1 and 2. Paragraph 2.21 (CD/145) correctly indicates that the AEA model shows some tendency to over-predict NOx (even if the M25 site is excluded). The subsequent comment to the effect that there is no evidence of overestimation for NO$_2$ is not however correct, as inspection of the figure shows that only two values fall below the 1:1 correlation line and the remaining 5 (or 6 if the M25 site is included) are either on the line or above it. This is my opinion suggests the AEA model shows some tendency to over-predict NO$_2$ as well as NOx.

$^7$ Extracts from Underwood (2002) Air Quality Modelling for Heathrow are provided in Appendix XVI

$^8$ Some model comparisons considered nine monitoring sites, although the ninth site was distant from the airport and would have negligible contribution from airport sources.

$^9$ Extracts from Dft (2006) PSDH are provided in Appendix XVII
II.31 A sensitivity test carried out as part of the AEA contribution to the PSDH work showed that adding a plume rise of only a few tens of metres to aircraft exhaust plumes significantly reduced the aircraft contribution to concentrations at near-airport receptors and resulted in a level of model-measurement agreement for total NOx and NO2 concentrations equivalent to that from the selected version of ADMS (ADMS-Airport).

Stansted

II.32 As part of the AEA air quality assessment for the Stansted 15+ development (CD/28), the modelling results for 1999 were compared with concentrations measured at a number of on-airport diffusion tubes; on average the modelled annual-mean NO2 concentrations were 13% lower than the measured values. It was noted that the diffusion tubes were more likely to overestimate than underestimate concentrations compared to those recorded by continuous analysers and that diffusion tube measurements have an accuracy of about ±20%. Given that the modelled results were within 3% to 19% of the measured concentration, the comparison was considered not to provide strong evidence for model underestimation or overestimation, so the model was used without modification for the 15+ assessment.

II.33 There was, however, concern that the model results suggested exceedance of the annual-mean NO2 limit value outside the airport boundary and this prompted the additional monitoring work reported in the Addendum to the ES, in which continuous analysers were co-located with diffusion tubes at two sites within the predicted exceedence area. That work, based on a three-month continuous-monitoring programme, suggested that the diffusion tubes were overestimating concentrations significantly (≥30%), and that the 3-month average measured concentrations in the High House (and Thremhall Farm) areas in 2002 were significantly lower than the calculated concentrations for 1999. Measurements have continued at High House and concentrations have remained below 30µg/m3 in every year. The most recent concentration (2006 - with 22mppa) at this location was 28µg/m3. With hindsight, these data show that the 15+ modelled concentrations were overestimates.

II.34 A subsequent model-monitoring comparison was carried out prior to the G1 air quality assessment. In the interim, the methodology (both for emissions estimation and for dispersion modelling) had been refined, so the approach used was much closer to that used in the Gatwick and Heathrow studies referred to above. The changes included

(a) better quantification of airport emissions (particularly aircraft NOx emissions);
(b) refinement of the spatial representation of the aircraft sources; and
(c) better choice of parameter values used in the dispersion modelling.

II.35 The model-monitoring comparison focused principally on the continuous-analyser site at the High House. The modelled mean NOx concentration (47.3µg/m3) was within 5% of the measured value (49.9µg/m3), which is well within uncertainties in air quality modelling and the precision of the measurements. Similarly the modelled NO2 concentration (27.3µg/m3) was within 5% of the measured value (28.8µg/m3). Thus this comparison showed the model to be performing as expected (i.e. the agreement is within the recognised level of uncertainty). The site is not close enough to a major road nor does it have a large enough aircraft contribution for this comparison to provide any additional evidence that the model overestimates concentrations close to major roads or...
overestimates the aircraft NOx contribution. Nevertheless, the comparison is not necessarily inconsistent with overestimation of the aircraft contribution, given the uncertainty in the modelled background contribution.

II.36 Modelled concentrations were also compared with measured concentrations at the diffusion tube sites and the latter were on average 23% higher. As this level of difference is comparable to the accuracy of diffusion tube measurements, the comparison provided little additional information on overall model bias. The uncertainty in diffusion tube concentrations is considered in para I.2.11 above.

II.37 As noted in the Regulation 19 Response there is considerable uncertainty in the bias adjustment factors for a single type of tube and analyst. While the guidance for review and assessment work (Defra 2003) suggests using a bias adjustment factor derived from other studies (p6-6)\textsuperscript{10}, the advice goes on to say (pA1-40) that the bias correction needs to have regard to the particular exposure period and site location. The general bias correction factors publicly available, such as those referred to by Bureau Veritas (CD/144 - p10), are for annual periods. In selecting the 2004 value (0.89) Bureau Veritas did not have regard to either the measurement period or the site type. In view of this I believe that bias correction in this way would simply add to the uncertainty in the values derived from the diffusion-tube measurement.

II.38 As part of the model test work the methodology to calculate the background contribution (i.e. the concentrations arising from emission sources that were not explicitly modelled) was compared with measurements at more distant monitoring sites (within 30km). There were only two sites (East Herts 2 and Braintree) within the study area with high enough data capture (>90%) within the relevant period that could be used. At these sites the fractional difference between modelled compared to measured concentration was +23% and -15%. These differences are within the range of model – measurement differences found for the data set used to verify the background model (Stedman et al 2003) and illustrate that the model underestimation at High House could readily derive from the background contribution.

Conclusion

II.39 The various studies summarised above provide confidence that the model performs as expected (i.e. the agreement with monitoring data is within the recognised level of uncertainty). There is some evidence to show that the model overestimates concentrations close to major roads and close to aircraft sources.

II.40 What is important here is to understand whether there is any reason to believe the model as described in the ES and its associated reports will systematically underestimate future concentrations either with or without the proposed development. Using the supporting information, which I have briefly summarised in this evidence I believe the model performs well and the predicted concentrations provide a robust assessment of the likely effects arising from the proposed G1 development.

II.41 Bureau Veritas suggest that:

“there is some evidence that the model is under predicting” (CD/144 p10).

\textsuperscript{10} See Appendix IX
In their conclusions to the Regulation 19 Response (CD/145), however Bureau Veritas say

“Despite the concerns regarding model verification, based on the predictions presented by BAAS, and our experience at other major UK airports it is not considered likely that the G1 expansion would cause any exceedance of health based air quality objectives”.

II.42 While we can debate whether or not the model under or over estimates future concentrations, I agree with the view that Bureau Veritas express which says it is unlikely that any of the health based objectives would be exceeded as a result of the G1 development.

**General Modelling**

II.43 Under this heading I will address a number of concerns about the 25mppa case assessed, the credentials of the model, roadside modelling and emission reductions. I will deal with each subject in turn.

**Business as Usual**

II.44 Under the EIA regulations the developer (in this case BAA) is required to show the likely significant effects of the development on the environment. This is normally achieved by modelling the potential effects with and without the proposed development. Defining how the airport might grow in the absence of the proposed G1 development is a matter for BAA. The ‘without development’ case is based on the permitted passenger throughput of 25mppa and 216,000 movements.

**Modelling methodology**

II.45 The dispersion model ADMS3.2 was used in the ES assessment. There are three ADMS models namely ADMS3, ADMS Roads and ADMS Urban. ADMS3 was designed to handle a number of point, line and area sources. ADMS Road was designed to handle a larger number of line sources. ADMS Urban was designed to handle large numbers of point, line and area sources as well as a large number of receptors. The choice of model is determined by the size of the model study area, the number of receptors and the number and type of sources. The code within the models is essentially the same. ADMS3.2 provided the flexibility in source type and number and enough receptor points to provide spatial resolution that was consistent with that of the emission sources under consideration and was selected for the ES assessment.

II.46 As a result of the PSDH work, this model (ADMS Urban) is being modified to include a new term to handle specifically the dispersion of the hot emissions from the aircraft engine. This modified version of ADMS Urban, referred to as ADMS Airport was not available when the ES was produced and is still not commercially available.

II.47 The introduction of the new term in the dispersion model effectively reduces the concentration contribution from aircraft at receptors close to the airport; this effect diminishes with increasing distance from the runway. It follows from this that had ADMS Airport been used for this assessment then the total concentrations would be slightly lower than those reported in the ES (CD/6). Apart from this, there is little
II.48 I am satisfied that the ES assessment was undertaken using the best model available.

Road Traffic Model Verification

II.49 As set out in the Regulation 19 Response (CD/22) there was no specific verification of the model for near-road receptors. This work was not done because sufficient information on the model used by AEA had been gathered in other studies (notably the work at Heathrow carried out for the PSDH) to enable the model to be used as a screening tool to check for potential exceedences of objectives close to roads in the G1 assessment. The evidence suggests that the AEA model underestimates the impact of vehicle-induced turbulence in reducing concentrations close to roads thereby overestimating near-road concentrations. The intention was that if the model indicated any potential exceedences at properties close to roads a more detailed study would be carried out using a specialised near-road dispersion model, namely ADMS Roads, which is widely accepted as a validated code for near-road air quality assessment. It is worth noting that in this context the only essential difference between ADMS 3.2 (the code at the heart of the netcen methodology) and ADMS Roads is the inclusion in the latter of an additional turbulence term that reduces concentrations close to the road.

II.50 This screening approach to the assessment did not identify any properties at risk of exceeding the objective so more detailed modelling using ADMS Roads was not required.

Emission reductions

II.51 The reasons for the reduction in emissions between the 15+ (CD/28) and G1 (CD/6) studies are fully explained in the model test report (Underwood 2005 – CD/189 - paragraphs 2.10.8 – 2.10.17 (NOx) and 2.10.25 – 2.10.32 (PM10)). NOx emissions, for example, were significantly lower in the model test report. For aircraft the reduction was about 30% but the differences were not uniform across aircraft operations but can be summarised by:

- take off roll emissions lower by 44% (reduced thrust and change in take off roll times);
- taxiing emissions higher by 21% (increased taxiing times);
- number of movements decrease 7%;
- differences in aircraft mix (number and type);
- times in mode were based on analysis of noise and track keeping radar;
- APU times reduced based on movement cycles; and
- landing roll emissions reduced as reverse thrust was used for a shorter periods and lower power on advice from the operators.

Vehicles emissions were also significantly lower;
- airside vehicle emissions lower by 44% (due to use of red diesel and removal of some double counting); and
• car parking emissions lower by 44% (as the G1 emissions were based on recorded transactions rather than estimates).

II.52 The improved quantification of emissions results from the additional studies that were undertaken since the 15+ study was commissioned.

Conclusions
II.53 The EIA regulations require the examination of a without development case and this was defined by BAA based on the permitted passenger throughput 25mppa and 216,000 movements. I am satisfied that the assessment of this and the with development case (35mppa) was undertaken using the best model that was available. No specific verification of the model was undertaken for near road receptors as there was evidence to suggest that the modelling approach misses out some processes (vehicle induced turbulence) that would tend to lower near roads concentrations. The emission reductions between the 15+ assessment (CD/28) and the G1 assessment was explained in some detail (Underwood 2006 (CD/190)) and reflects the evolution of the methodology. None of these matters impact on the robustness of the assessment presented in the air quality assessment (CD/6).
Figure II.2  Scatter plot of calculated vs measured annual-mean NOx concentrations at the continuous monitoring stations

Figure II.3  Scatter plot of calculated vs measured annual-mean NO2 concentrations at the continuous monitoring stations
Appendix III

Application of Objectives and Limit Values

In this appendix, I will address the application of objectives and limit values to demonstrate that I have not misrepresented their use in Volume 3 (CD/6) of the ES.

Applicability of Air Quality Standards

III.1 The location at which objectives and limit values apply is slightly different and complicated. Firstly neither objectives nor limit values apply to occupational or indoor exposure. Objectives have a relevant exposure criterion whereas the limit values do not.

III.2 Relevant exposure relates to where members of the public are regularly present and likely to be exposed over the averaging period (e.g. 1-hour, 24-hour, 1-year) of the objective. Guidance on where objectives should apply is given (Defra 2003) and this further qualifies “the public” as not to imply it must be the same people regularly present. For a longer term objective say 1 year, it suggests a cumulative period of 6 months. To avoid any doubt on the applicability of the objectives an extract of the relevant guidance is provided in Box III.1 in this Appendix.

III.3 The numerical values of the objectives and limit values were set out in the ES (CD/6) in Table 3. For convenience I have reproduced this information as Table III.1 in this Appendix.

III.4 Concerns have been expressed that my interpretation of these air quality criteria is not correct with respect to the indicative PM$_{10}$ limit value that was to be achieved by 2010 and the vegetation objective (limit value) for NOx.

PM$_{10}$ indicative limit value

III.5 The Directive 1999/30/EC makes it clear in Annex III that the Stage 2 limit value of 20µg/m$^3$ to be achieved by 1 January 2010 is an indicative value which is to be reviewed$^{11}$. The Air Quality Limit Value Regulations (SI 2121:2003)$^{12}$, which implement the Directive 1999/30/EC, Schedule 1 part III do not include the Stage 2 limit values. The addendum to the air quality strategy (2003) does introduce an objective of 20µg/m$^3$ for the annual mean to be achieved by 2010 (as stated in Table 3 of the ES) which is consistent with the non-binding EU indicative limit value.

III.6 The draft air quality strategy (Defra 2006 – CD/186)$^{13}$ provides no clear direction on the Government’s position on the 2010 PM$_{10}$ objective but it seems to favour reviewing the objective once the position in Europe is clear.

---

$^{11}$ See Appendix X

$^{12}$ Extracts from Air Quality Limit Value Regulations are provided in Appendix XVIII

$^{13}$ See Appendix VI
III.7 The proposal for a new directive on ambient air quality COM (2005) 447\(^{14}\) considers a number of alternatives to replace Stage 2 limit value of 20µg/m\(^3\) but none to retain it. The proposal for the new directive favours the introduction of a PM\(_{2.5}\) concentration cap 25µg/m\(^3\) in place of the Stage 2 PM\(_{10}\) limit. This concentration cap is referred to in the ES (CD/6) page 13).

Vegetation limit value

III.8 My interpretation on where the limit value applies is based on the criteria set out in Annex VI of the Directive (1999/30)\(^{15}\). This annex was translated in the limit value regulations (SI 2121:3004 Schedule 4 part I)\(^{16}\). While the term “exclusion zone” is not used in the Directive or regulations it has been used by for example by Bignal (2004)\(^{17}\) and it also appears in the draft air quality strategy (Defra 2006 CD/186 – page 112).

III.9 I did draw a distinction in the ES (CD/6) between compliance with the Directive and the effect on vegetation. The NO\(_x\) contours for example Figure 4.2 (Volume 3) of this evidence shows the extent of the 30µg/m\(^3\) concentration. This contour does not extend into either Hatfield Forest or Eastend Wood.

III.10 In the draft Air Quality Strategy (2006 – CD/186) paragraph 73 states:

“For oxides of nitrogen, the UK Government and the devolved administrations propose that the current objective remains unchanged for all areas outside the exclusion areas. In addition, it is proposed to adopt a long-term aspiration that the critical level will be achieved at all SSSI, ASSI and Natura 2000 sites (including Ramsar sites), both inside and outside the exclusion areas. The UK Government and the devolved administrations propose that the medium term objective towards our long-term aspiration is to achieve the nitrogen oxides objectives at 99% of all sites, by area, by 2010. This objective would be achieved by already agreed measures included in the baseline assessment in Chapter 2. Therefore the proposed new objective would generate no additional costs.”

III.11 The NO\(_x\) emissions and resulting concentrations from the 35 mppa case do not, in my opinion, compromise this aspiration.

Monitoring for Compliance

III.12 To demonstrate compliance (or a breach) of a limit value it is necessary to measure the concentration in accordance with the prescriptions within the Directive (1999/30/EC\(^{11}\) Annex IX). The monitoring requirements to comply with the objectives would appear less prescriptive as the technical guidance (Defra 2003) does allow some discretion. For Updating and Screening Assessment (part of the Review and Assessment process I referred to earlier) diffusion tubes and portable monitors can be used. For detailed

---

14 Extracts from COM (2005) 447 are provided in Appendix XIX
15 See Appendix X
16 See Appendix XVIII
17 Extracts from Bignal (2004) Ecological Effects of Diffuse Air Pollution are provided in Appendix XX
assessments automatic analysers (chemiluminescence) are recommended (para A1.19)\textsuperscript{18}
coupled with a documented and traceable quality assurance/control system.

III.13 In my judgement, based on the above, if a limit value or objective was under threat of exceedance I would expect those responsible for monitoring to use continuous analysers to ensure that the measured concentration was reliable. It follows from this that diffusion tubes should not be used for compliance purposes.

**Roadside locations exceed limit value**

III.14 Any concentration that suggests there might be a breach of the objective needs to be investigated by the relevant local authority to determine whether an AQMA should be declared. To date UDC has not declared an AQMA but EHDC has. UDC is currently investigating an area in Saffron Waldren (USA 2006 p40) and needs to

"Complete a Detailed Assessment of NO\textsubscript{2} in areas identified at risk of exceeding the annual mean objective, to determine with reasonable certainty whether or not there is a likelihood of the objective not being achieved."

III.15 UDC is also investigating the possible exceedance of the objective at Burton End but this may have been due to

"considerable disruption in recent years due to the traffic flow on the M11 due to the construction of new slip roads to the Airport and resurfacing work. Following previous discussions with DEFRA the Council will continue to monitor the site under 'normal' traffic flows and then reassess the position."

(USA 2006 page 27)\textsuperscript{19}

The USA report indicates that UDC will continue to monitor at this location.

III.16 An AQMA was declared by EHDC at Stage 3 of the review and assessment process, for PM\textsubscript{10} in Sawbridgeworth but this was revoked (2004) on the basis of the more detailed Stage 4 study. In August 2005 EHDC was undertaking additional monitoring to establish if AQMAs needed to be declared in Ware (Viaduct Road) and Bishop Stortford (Hockerill Street/London Road junction). Following further assessment (USA 2006 page 26)\textsuperscript{20} it was judged that exceedances of the NO\textsubscript{2} objective were likely at the Hockerill Junction in Bishops Stortford (EHDC12, 16, 17 and 18). EHDC has been advised by DEFRA to declare this as an AQMA. This declaration was made in January 2007.

III.17 Against this background, it is incorrect of SSE to say (CD/201 para 6.3.1) that limit values have been exceeded simply by inspection of the data in Tables 7 and 9 of the ES (CD/6) alone. The process to determine exceedance of a limit (or objective) is more complex.

\textsuperscript{18} See Appendix IX
\textsuperscript{19} Extracts from USA (2006) UDC are provided in Appendix XXI
\textsuperscript{20} Extracts from USA (2006) EHDC are provided in Appendix XXII
Conclusions

III.18 The various air quality objectives and limit values are set out in Appendix IV. There is no dispute that the correct standards are identified but there are suggestions that my interpretation on their applicability is not correct. The applicability of the objective is given in the Defra Guidance (TG/03) the salient points of which are set out in Appendix III (Box III.1). I believe the comments I have made are consistent with that advice. The indicative PM$_{10}$ limit value is correctly described (Appendix III) and while the UK Government’s position remains unclear on the status of its objective; the EU in a proposed directive favours its replacement by a concentration cap for PM$_{2.5}$. Similarly the applicability of the vegetation protection limit value is subject to some interpretation and became clear from the monitoring criteria (Annex VI of the Directive 1999/30) for compliance with the limit value. My interpretation is also consistent with that given by others (e.g. Defra 2006). Against this background I have not misrepresented the applicability of the air quality standards. The methodology to demonstrating compliance with air quality objectives and limit values is based on a prescriptive measurement method and/or relevant exposure criteria. It is not simply a matter of exceeding a measured concentration of a pollutant, at any location, using any measurement technique.

Box III.1 Extract from Local Air Quality Management, Technical Guidance TG03 DEFINA 2003

1.20 Several factors have been taken into account when developing the guidance on locations considered relevant:

- The Regulations refer to locations where members of the public are regularly present. This does not imply that it must be the same persons regularly present at that location. This is important for an understanding of relevant exposure where a short-term objective allows a number of exceedences of the standard. The standard is the basis for a potential risk to health, thus a single exposure of an individual above the standard is to be avoided. The objective allows a number of exceedences of the standard because of considerations of feasibility and practicability. Thus for sulphur dioxide, where there is a 15-minute standard, a relevant location would be anywhere where a member of the public might be exposed for a single 15-minute period, as long as members of the public are regularly present at that location. The allowance of up to 35 exceedences before the objective is breached determines the need to control concentrations at that location, not whether that location is relevant in terms of exposure.

- The long-term objectives apply where members of the public are likely to be exposed over the averaging period of the objective. As with the discussion of short term objectives, this does not require the same individual to be present for a full year at a particular location, but the location must be one where people are likely to be regularly present for long periods. For instance, in the case of the 24-hour objectives, a relevant location would be one where members of the public may be exposed for 8 hours or more in a day, while for the annual mean objectives this might be where people are exposed for a cumulative period of 6 months in a year.

- There is a link between pollutant concentrations measured both inside and outside of a building. For this reason it is considered appropriate to measure at the building façade to represent relevant exposure. Thus, for exposure alongside a busy road, it is considered reasonable to select the façade of residential properties closest to the road as a representative location to assess exposure for pollutants with a 24-hour or annual mean.
1.21 For the purpose of assisting local authorities, some examples of where the objectives should, and should not apply, are summarised in **Box 1.4**. However it should be borne in mind that it is not possible to be prescriptive in this matter, and authorities should bear local circumstances in mind when considering the application of the objectives. The examples given in the table are not intended to be a comprehensive list, and it is expected that local judgement will often be required. In the case of doubt, further guidance may be obtained from the Review and Assessment Helpdesk.

**Box 1.4: Examples of where the Air Quality Objectives should/should not apply**

<table>
<thead>
<tr>
<th>Averaging period</th>
<th>Objectives should apply at:</th>
<th>Objectives should generally not apply at:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Annual mean</strong></td>
<td>All locations where members of the public might be regularly exposed. Building facades of residential properties, schools, hospitals, libraries etc.</td>
<td>Building facades of offices or other places of work where members of the public do not have regular access. Gardens of residential properties. Kerbside sites (as opposed to locations at the building facade), or any other location where public exposure is expected to be short term.</td>
</tr>
<tr>
<td><strong>24-hour mean and 8-hour mean</strong></td>
<td>All locations where the annual mean objective would apply. Gardens of residential properties²¹</td>
<td>Kerbside sites (as opposed to locations at the building facade), or any other location where public exposure is expected to be short term.</td>
</tr>
<tr>
<td><strong>1-hour mean</strong></td>
<td>All locations where the annual mean and 24 and 8-hour mean objectives apply. Kerbside sites (e.g. pavements of busy shopping streets) Those parts of car parks, bus stations and railway stations etc. which are not fully enclosed, where the public might reasonably be expected to spend 1-hour or more. Any outdoor locations to which the</td>
<td>Kerbside sites where the public would not be expected to have regular access.</td>
</tr>
</tbody>
</table>

²¹ Such locations should represent parts of the garden where relevant public exposure is likely, for example where there are seating or play areas. It is unlikely that relevant public exposure would occur at the extremities of the garden boundary, or in front gardens, although local judgement should always be applied.
<table>
<thead>
<tr>
<th><strong>15-min mean</strong></th>
<th>All locations where members of the public might reasonably be exposed for a period of 15 minutes or longer</th>
</tr>
</thead>
</table>
### Table III.1: Air Quality Objectives and European Union Limit Values

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Criteria</th>
<th>Protection</th>
<th>Objective Concentration or Limit Value</th>
<th>Measured as</th>
<th>Date to be achieved by</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen dioxide (NO₂)</td>
<td>AQR 2000</td>
<td></td>
<td>200 μg/m³ (not to be exceeded more than 18 times a year)</td>
<td>1-hour mean</td>
<td>31/12/2005</td>
</tr>
<tr>
<td></td>
<td>AQR 2000</td>
<td></td>
<td>40 μg/m³</td>
<td>Annual mean</td>
<td>31/12/2005</td>
</tr>
<tr>
<td></td>
<td>AQLVR 2003³</td>
<td>Hourly limit value for the protection of human health</td>
<td>200 μg/m³ (not to be exceeded more than 18 times a year)</td>
<td>1-hour mean</td>
<td>01/01/2010</td>
</tr>
<tr>
<td></td>
<td>AQLVR 2003</td>
<td>Annual limit value for the protection of human health</td>
<td>40 μg/m³</td>
<td>Annual mean (Calendar)</td>
<td>01/01/2010</td>
</tr>
<tr>
<td>Nitrogen oxides (NOx)</td>
<td>AQLVR 2003</td>
<td>Annual limit value for the protection of vegetation</td>
<td>30 μg/m³</td>
<td>Annual mean (Calendar)</td>
<td>19/07/2001</td>
</tr>
<tr>
<td>Particulate matter (PM₁₀)</td>
<td>AQR 2000</td>
<td></td>
<td>50 μg/m³ (not to be exceeded more than 35 times a year)</td>
<td>24-hour mean</td>
<td>31/12/2004</td>
</tr>
<tr>
<td></td>
<td>AQR 2000</td>
<td></td>
<td>40 μg/m³</td>
<td>Annual mean</td>
<td>31/12/2004</td>
</tr>
<tr>
<td></td>
<td>AQS³⁴</td>
<td></td>
<td>50 μg/m³ (not to be exceeded more than 7 times a year)</td>
<td>24-hour mean</td>
<td>31/12/2010</td>
</tr>
<tr>
<td></td>
<td>AQS³⁴</td>
<td></td>
<td>20 μg/m³</td>
<td>Annual mean</td>
<td>31/12/2010</td>
</tr>
<tr>
<td></td>
<td>AQLVR 2003</td>
<td>24-hour limit value for the protection of human health</td>
<td>50 μg/m³ (not to be exceeded more than 35 times a year)</td>
<td>24-hour mean</td>
<td>01/01/2005</td>
</tr>
<tr>
<td></td>
<td>AQLVR 2003</td>
<td>Annual limit value for the protection of human health</td>
<td>40 μg/m³</td>
<td>Annual mean</td>
<td>01/01/2005</td>
</tr>
<tr>
<td></td>
<td>EU Limit Value ³</td>
<td></td>
<td>50 μg/m³ (not to be exceeded more than 7 times a year)</td>
<td>24-hour mean</td>
<td>01/01/2010</td>
</tr>
<tr>
<td></td>
<td>EU Limit Value²</td>
<td></td>
<td>20 μg/m³</td>
<td>Annual mean</td>
<td>01/01/2010</td>
</tr>
<tr>
<td>Benzene</td>
<td>AQR 2000</td>
<td></td>
<td>16.25 μg/m³</td>
<td>Running annual mean²</td>
<td>31/12/2003</td>
</tr>
<tr>
<td></td>
<td>AQAR 2002⁸</td>
<td></td>
<td>5.0 μg/m³</td>
<td>Annual mean</td>
<td>31/12/2010</td>
</tr>
<tr>
<td>Pollutant</td>
<td>Criteria</td>
<td>Protection</td>
<td>Objective Concentration or Limit Value</td>
<td>Measured as</td>
<td>Date to be achieved by</td>
</tr>
<tr>
<td>---------------------------</td>
<td>----------</td>
<td>-------------------------------------------------</td>
<td>----------------------------------------</td>
<td>---------------------------------------</td>
<td>------------------------</td>
</tr>
<tr>
<td></td>
<td>AQLVR 2003</td>
<td>Limit value for the protection of human health</td>
<td>5.0 μg/m³</td>
<td>Annual mean</td>
<td>01/01/2010</td>
</tr>
<tr>
<td></td>
<td>AQR 2000</td>
<td>2.25 μg/m³</td>
<td></td>
<td>Running annual mean</td>
<td>31/12/2003</td>
</tr>
<tr>
<td>1,3 Butadiene</td>
<td>AQAR 2002</td>
<td>10.0 mg/m³</td>
<td></td>
<td>Maximum daily running 8-hour mean</td>
<td>31/12/2003</td>
</tr>
<tr>
<td></td>
<td>AQLVR 2003</td>
<td>Limit value for the protection of human health</td>
<td>10.0 mg/m³</td>
<td>Maximum daily 8-hour mean</td>
<td>01/01/2005</td>
</tr>
<tr>
<td>Carbon monoxide (CO)</td>
<td>AQR 2000</td>
<td>0.5 μg/m³</td>
<td></td>
<td>Annual mean</td>
<td>31/12/2004</td>
</tr>
<tr>
<td></td>
<td>AQR 2000</td>
<td>0.25 μg/m³</td>
<td></td>
<td>Annual mean</td>
<td>31/12/2008</td>
</tr>
<tr>
<td></td>
<td>AQLVR 2003</td>
<td>Annual limit value for the protection of human health</td>
<td>0.5 μg/m³</td>
<td>Annual mean (calendar)</td>
<td>01/01/2005</td>
</tr>
<tr>
<td>Lead (Pb)</td>
<td>AQR 2000</td>
<td>125 μg/m³ (not to be exceeded more than 3 times a year)</td>
<td>24-hour mean</td>
<td>31/12/2004</td>
<td></td>
</tr>
<tr>
<td></td>
<td>AQR 2000</td>
<td>350 μg/m³ (not to be exceeded more than 24 times a year)</td>
<td>1-hour mean</td>
<td>31/12/2004</td>
<td></td>
</tr>
<tr>
<td></td>
<td>AQR 2000</td>
<td>266 μg/m³ (not to be exceeded more than 35 times a year)</td>
<td>15-minute mean</td>
<td>31/12/2004</td>
<td></td>
</tr>
<tr>
<td></td>
<td>AQLVR 2003</td>
<td>Limit value for the protection of ecosystems</td>
<td>20 μg/m³</td>
<td>Annual mean (calendar) and 1st October to 31st March</td>
<td>19/07/2001</td>
</tr>
<tr>
<td>Sulphur dioxide (SO₂)</td>
<td>AQR 2000</td>
<td>20 μg/m³</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Notes:

µg/m³ micrograms per cubic metre

1. AQR 2000 The Air Quality (England) Regulations 2000 SI No 0928
2. AQLVR 2003 The Air Quality Limit Value Regulations 2003 SI no 2121
4. Objectives not currently set in the Regulations
5. Stage 2 Indicative limit values to be reviewed in the light of further information on health and environmental effects, technical feasibility and experience in the application of Stage 1 limit values in member states 1999/30/EC Council Directive of 22 April 1999 relating to limit values for sulphur dioxide nitrogen dioxide and oxides of nitrogen, particulate matter and lead in ambient air OJ L163 29.6.1999 p41

The running annual mean may be assumed to be equivalent to the predicted annual mean⁰³⁷
Appendix IV
Greenhouse Gases and non Carbon Dioxide Effects

2 Pages

In this appendix, I address some of the terminology and different “carbon dioxide units” that can be encountered in this subject. If these units are applied incorrectly it can cause much confusion.

Greenhouse Gases

IV.1 The methodology (Watterson et al 2004) adopted for the calculation of carbon dioxide emissions from aviation set out in this evidence also quantifies emissions of other greenhouse gases namely methane, nitrous oxide, nitrogen oxides (nitric oxide and nitrogen dioxide), carbon monoxide, non-methane volatile organic compounds and sulphuric dioxide. Carbon dioxide, methane and nitrous oxide are direct greenhouse gases which are subject to the Kyoto Protocol. These gases contribute directly to climate change due to their positive radiative forcing effect. The other four pollutants (nitrogen oxides, carbon monoxide, non-methane, volatile organic compounds and sulphur dioxides) are indirect greenhouse gases as they can increase the tropospheric ozone concentrations which increase the radiative forcing.

IV.2 The combined radiative forcing effect of the direct greenhouse gases (carbon dioxide, nitrous oxide and methane) is calculated by multiplying the emissions of each of the three pollutants by the appropriate global warming potential factor and summing the resulting emissions. These emissions are then reported in “mass CO₂ equivalent” typically kt CO₂ equivalent (sometimes abbreviated to kt CO₂e).

IV.3 This unit is therefore different, and should not be confused with, “kt CO₂” which the mass of carbon dioxide as a single gas. This unit has been used throughout Volume 1.

Non-Carbon Dioxide effects

IV.4 It is recognised that the impact of aircraft emissions in the upper atmosphere may be greater than might be expected from the carbon dioxide emissions alone. As reported in The Future of Air Transport (CD/87 - page 39) aviation contributes to climate change through the emission of carbon dioxide, water vapour (which leads to the formation of contrails and cirrus clouds at altitude), nitrogen oxides (leading to the formation of the greenhouse gas ozone at altitude), particulates (soot and sulphate particles) and other compounds including sulphur oxides, carbon monoxides, hydrocarbons and radicals such as hydroxyl). The environmental impact of these non-carbon dioxide effects have been assessed by the Intergovernmental Panel on Climate Change (IPPC 1999) and the

22 Radiative forcing is the change in the balance between radiation coming into the atmosphere and radiation going out. A positive radiative forcing tends on average to warm the surface of the Earth, and negative forcing tends on average to cool the surface
Royal Commission on Environmental Pollution (2002) who both reported that these effects were between two to four times greater than the effect of carbon dioxide alone.

IV.5 In the Treasury Paper (2003)\textsuperscript{23} multipliers of between 2.4 and 2.7 were applied. The emission data shown in Tables 5.1, 5.2 and 5.3 do not include this multiplier. If this multiplier is applied then the units should be changed from “kt CO\textsubscript{2}” to “equivalent kt CO\textsubscript{2}” to reflect this uplift. In the response on behalf of Stop Stansted Expansion (SSE3 - Volume 3 paragraph 3.2.5) it is made clear that this uplift has been applied to their figures.

IV.6 I am not aware of any accepted convention for reporting carbon dioxide emission that have been uplifted by this radiative forcing index (RFI) but we need to be very careful not to confuse these emissions with those of carbon dioxide as the gas (kt CO\textsubscript{2}) or greenhouse gas emissions combined together through their global warming potential factors and expressed in terms of kt CO\textsubscript{2} equivalent.

\textsuperscript{23} Extract from HM Treasury (2004) Aviation and the Environment are provided in Appendix XXIII
Appendix V


3 Pages
Appendix VI
Appendix VII
Highways Agency (2005) Guidance for undertaking environmental assessment of air quality for sensitive ecosystems in internationally designated nature conservation sites and SSSIs (Supplement to DMRB 11.3.1) Interim Advice Note 61/05. March
3 Pages
Appendix VIII

CD/188  NEGTAP (2001) Transboundary air pollution: acidification, eutrophication and ground-level ozone in the UK

7 Pages
Appendix IX
8 Pages
Appendix X

Appendix XI


6 Pages
Appendix XII

Consultation Paper December
2 Pages
Appendix XIII


3 Pages
Appendix XIV
Earthtrends (2005). Climate and Atmosphere 2005
6 Pages
Appendix XV
Laxen D and Marner B (2004) Further assessment (Stage 4) of Air Quality within Two Air Quality Management Areas in Reigate & Bansted. Prepared for Reigate and Bansted Borough Council April
14 Pages
Appendix XVI
5 Pages
Appendix XVII
Dft (2006) Project for the Sustainable Development of Heathrow
3 Pages
Appendix XVIII
AQLR Regulations 2003  SI 2003 No. 2121
5 Pages
Appendix XX

English Nature The Ecological Effects of Diffuse Air Pollution from Road Transport (Report Number 580)

2 Pages
Appendix XXI
USA 2006 Uttlesford District Council
3 Pages
Appendix XXII
USA 2006 East Hertfordshire District Council
2 Pages
Appendix XXIII
3 Pages