THE IMPLICATIONS OF THE VARIABILITY OF NATIONAL AND REGIONAL AIR QUALITY REGULATIONS ON THE MODELLING OF AIRPORT AIR QUALITY WITHIN GLOBAL AVIATION AND ENVIRONMENT

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AVIATION INTEGRATED MODELLING PROJECT

WWW.AIMPROJECT.AERO
Aviation Integrated Modelling General Architecture

Sample policy: ATC evolution
Sample policy: Regulation
Sample policy: Economic instruments

Aircraft Movement Module

Airport Activity Module

Air Transport Demand Module

Global Climate Module

Local Air Quality & Noise Module

Regional Economics Module

Global environment impacts
Local environment impacts
Local/national economic impacts
## UK AND EU LIMIT VALUES

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Monitored</th>
<th>Concentration</th>
<th>Enforced by End of</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO₂</td>
<td>Annual Mean</td>
<td>40 µg/m³</td>
<td>2005/2010?</td>
</tr>
<tr>
<td></td>
<td>1 Hour Mean</td>
<td>200 µg/m³ (18 times)</td>
<td>2005/2010?</td>
</tr>
<tr>
<td>PM₁₀</td>
<td>Annual Mean</td>
<td>40 µg/m³</td>
<td>2004/2005</td>
</tr>
<tr>
<td></td>
<td>24 Hour Mean</td>
<td>50 µg/m³ (35 times)</td>
<td>2004/2005</td>
</tr>
<tr>
<td>Ozone</td>
<td>Daily max 8 Hour Mean</td>
<td>100 µg/m³ (10 times)</td>
<td>2005</td>
</tr>
</tbody>
</table>
Figure 4. Time Series of Hourly Averaged Concentrations at LHR2 – 2003

Table 5. Monthly Average Air Pollutant Concentrations at LHR2 and Harlington, 2003

<table>
<thead>
<tr>
<th></th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
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</thead>
<tbody>
<tr>
<td>NO µg m⁻³</td>
<td>59</td>
<td>68</td>
<td>54</td>
<td>43</td>
<td>21</td>
<td>23</td>
<td>26</td>
<td>29</td>
<td>53</td>
<td>59</td>
<td>59</td>
<td>87</td>
</tr>
<tr>
<td>NO₂ µg m⁻³</td>
<td>57</td>
<td>67</td>
<td>65</td>
<td>63</td>
<td>47</td>
<td>47</td>
<td>49</td>
<td>57</td>
<td>64</td>
<td>63</td>
<td>63</td>
<td>64</td>
</tr>
<tr>
<td>NOₓ µg m⁻³</td>
<td>147</td>
<td>171</td>
<td>148</td>
<td>128</td>
<td>79</td>
<td>82</td>
<td>89</td>
<td>102</td>
<td>146</td>
<td>153</td>
<td>154</td>
<td>197</td>
</tr>
<tr>
<td>CO mgm⁻³</td>
<td>0.5</td>
<td>0.5</td>
<td>0.4</td>
<td>0.4</td>
<td>0.3</td>
<td>0.4</td>
<td>0.5</td>
<td>0.8</td>
<td>0.5</td>
<td>0.4</td>
<td>0.4</td>
<td>0.6</td>
</tr>
<tr>
<td>PM₁₀ µg m⁻³ (TEOM)</td>
<td>21</td>
<td>31</td>
<td>30</td>
<td>29</td>
<td>17</td>
<td>18</td>
<td>21</td>
<td>31</td>
<td>27</td>
<td>23</td>
<td>21</td>
<td>21</td>
</tr>
</tbody>
</table>
GOVERNMENT SUPPORT FOR THIRD RUNWAY AT HEATHROW IF COMPLIANCE WITH AIR QUALITY LIMITS CAN BE MET

TIMING 2015-2020

ACTION MUST BE TAKEN TO TACKLE NO₂ PROBLEM

GOVERNMENT WOULD INSTITUTE A PROGRAMME OF ACTION TO CONSIDER HOW THESE CONDITIONS CAN BE MET

THIS COMMITMENT CARRIED FORWARD THROUGH PROJECT FOR THE SUSTAINABLE DEVELOPMENT OF HEATHROW (PSDH)
PROJECT FOR THE SUSTAINABLE DEVELOPMENT OF HEATHROW (PSDH)

THREE PANELS OF AIR QUALITY-RELATED EXPERTS:

– DISPERSION MODELLING
– MONITORING OF AIR POLLUTION
– EMISSION SOURCE DATA

• EACH PANEL …. BALANCED MEMBERSHIP

• HUMAN HEALTH RELATED AIR QUALITY STANDARDS

• PRIMARY FOCUS ON ANNUAL AVERAGE CONCENTRATIONS OF NITROGEN DIOXIDE $\text{NO}_2$ AND SECONDLY BY PARTICULATE MATTER $\text{PM}_{10}$

• PSDH REPORT FROM DfT JULY 2006, SUBMITTED TO PARLIAMENT JULY 19 2006; OPENLY AVAILABLE
COST - BENEFITS

The White Paper: Heathrow Airport is of vital importance to the UK economy, .... Supporting 100,000 jobs (direct and indirect). A short third runway would yield net economic benefits of £ 6 billion (net present value).

BA says two extra runways for the South East could generate £ 65 billion of economic benefits. BBC News 24; 2 December 2003

However of possibly greater concern is the cost of not expanding and becoming less competitive with other airports in other countries. The cost of delayed or stunted economic growth can be estimated but I was unable to find estimates for this cost.
<table>
<thead>
<tr>
<th></th>
<th>NO$_x$ as NO$_2$ (µg/m$^3$)</th>
<th>NO$_2$ (µg/m$^3$)</th>
<th>PM$_{10}$ (µg/m$^3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NO$_x$ as NO$_2$ (µg/m$^3$)</strong></td>
<td>Annual average</td>
<td>31</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>Maximum hourly average</td>
<td>592</td>
<td>130</td>
</tr>
<tr>
<td></td>
<td>99.79$^{th}$ percentile</td>
<td>348</td>
<td>54</td>
</tr>
<tr>
<td><strong>NO$_2$ (µg/m$^3$)</strong></td>
<td>Annual average</td>
<td>19</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>Maximum hourly average</td>
<td>134</td>
<td>130</td>
</tr>
<tr>
<td></td>
<td>99.79$^{th}$ percentile</td>
<td>103</td>
<td>54</td>
</tr>
<tr>
<td><strong>PM$_{10}$ (µg/m$^3$)</strong></td>
<td>Annual average</td>
<td>26</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>Maximum hourly average</td>
<td>130</td>
<td>130</td>
</tr>
<tr>
<td></td>
<td>90.41$^{st}$ percentile of 24 hour averages</td>
<td>54</td>
<td>54</td>
</tr>
<tr>
<td></td>
<td>98.08$^{th}$ percentile of 24 hour averages</td>
<td>80</td>
<td>80</td>
</tr>
</tbody>
</table>
OVERVIEW

Activity

**Emissions** control based on NOx

Dispersion/Reaction/Deposition

**Concentrations** control based on NO₂

Exposure

Health Effects

Observation: Many/most engineering colleagues working on NOx emissions were unaware that there were no air quality regulations on NOx
Note that annual mean regulatory standard is 40 μg/ m3. Heathrow airport in particular and parts of London have great difficulty in meeting this limit value. This is less than half the annual mean federal regulatory standard in the US of 100 μg/ m3.

WHY?

Move London to the US solves the problem.
EMISSIONS AND DISPERSION MODELLING SYSTEM (EDMS)

• FROM US FEDERAL AVIATION ADMINISTRATION

• COMPREHENSIVE MODEL – INTEGRATED EMISSION DATABASE FOR LARGE VARIETY OF AIRCRAFTS + AERMOD DISPERSION MODEL

• \( \text{NO}_2 \) IS NOT PREDICTED BY THIS MODEL

• A POST-PROCESSING \( \text{NO}_2 \) CORRELATION WAS USED

• ANNUAL AVERAGE CONCENTRATION FOR \( \text{NO}_2 \) WAS WELL PREDICTED AND THIS IS THE CRITICAL REGULATORY PARAMETER

Observation: Little interest in the US regarding \( \text{NO}_2 \)
ASK STEVE HANNA: HARVARD SCHOOL OF PUBLIC HEALTH

“Yesterday I listened to a lecture by Doug Dockery (HSPH Department Head) on how health standards are set. Alan Eschenroeder is leading the class. Doug talked about the WHO standards (40 μg/m³ annual average for NO2) and said that most countries do not enforce the WHO standards. After I asked about the discrepancy between US and Europe standards for NO2 annual average. They were surprised. They said that NO2 has largely dropped off the radar screen in the US and it is thought to be important only as a precursor to ozone and PM. He said that he was wondering why the Europeans do so many NO2 health studies in comparison to few by the US. I mentioned about the concerns at airports and in cities in Europe and he said he was wondering why Europe was doing so many airport and urban traffic studies, too.

This seems like a peculiar situation.

Steve”

AN INTERESTING COMMENT!
WHERE HAS THIS REGULATORY VALUE FOR ANNUAL AVERAGE NO2 COME FROM?

Source is the WHO air quality guidelines of 1996.
EU CAFÉ did ask a WHO working group to review the most recent scientific evidence on the adverse health effects of PM, O3 and NO2 and this led to a report WHO, 2003. For NO2 “new evidence does not provide sufficient information to justify a change in the guideline value”. It was also noted that because of a lack of evidence the former group WHO, 1996 selected a value from a prior review.
Also ..” given the role of NO2 as a precursor of other pollutants and as a marker of traffic related pollution …..
EU CAFÉ later provided some follow up questions WHO, 2004 including “what was the basis for maintaining the WHO NO2 annual specific guideline”, essentially asking for evidence. It was concluded that “NO2, as a marker of a complex mixture of traffic-related pollution is consistently associated with adverse effects on health at relatively low levels of long-term average exposure.
OBSERVATIONS

The regulatory limit values for annual average nitrogen dioxide concentrations vary considerably on a global scale, up to a factor of 2.5 between Europe and the USA.
FROM BOB MAYNARD (CHAIR OF THE WHO WORKING GROUPS) PERSONAL COMMUNICATION

You rightly point out that the US standard is 100. This is, I think, based on a less recent examination of the evidence base. Whether the US EPA will recommend a lower figure on their next review of NO2 can only be conjectured.
The relevant limit value has been difficult to meet in Europe in urban areas and near to many airports, but not within the USA.
Consequently there is a marked difference in the efforts in the US and Europe regarding NO2 as a pollutant, in research funding and, consequently, in national commitment of scientific expertise.
NO2 appears to be being interpreted in Europe as a marker for a complex mixture of traffic related pollutants
It is not at all clear that mitigation efforts to reduce NO2 concentrations will be transferred to reductions in the health effects on the population.

(Also recent evidence indicates that it is not at all clear that reducing NOx emissions will reduce NO2. It doesn’t proportionately. Near Heathrow between 1993 and 2004 NOx reduced by 6 µg/m³ per year whereas NO2 reduced by 0.5 µg/m³.)
The large national or regional variability in some regulated pollutants and the implied health effects on the population may lead to difficulties in developing equitable monetisation within global aviation/environment models, such as those being developed in the US for ICAO/CAEP that will probably be used globally.