Heathrow Air Quality
Together towards sustainability

# Heathrow Air Quality Strategy

2011–2020

Heathrow
Making every journey better

# Contents

# Foreword

The UK faces many challenges in terms of meeting EU air quality limits and it is not alone. Many parts of Europe experience similar issues, in particular in meeting limit values for the main pollutant of concern, nitrogen dioxide ($NO_2$).

Within the UK, it is not surprising that central London records the highest levels of $NO_2$ nationally. Around Heathrow, concentrations are substantially lower than in the capital but are still above recommended levels.

Our sustainability policy for Heathrow commits us to enhance the economic and social benefits that the UK's only hub airport brings, while at the same time reducing our environmental impacts and meeting agreed environmental limits. The sources of emissions in the Heathrow area are a complex mix – from major motorways such as the M25 and M4, to the Great Western rail line, industrial outlets and residential properties. The presence of a major international airport adds to the emissions in the area. And while Heathrow's operations make up a relatively small proportion of the pollution in air around the airport – up to 20% at the airport boundary – BAA is committed to playing its role in achieving compliance with EU air quality limits.

We have worked closely with stakeholders to align our strategy to those of others in this arena including local authorities around the airport, the Mayor of London, and central Government departments. We will only achieve our goals by close collaboration with other partners that have a stake in reducing the UK's emissions.

This Air Quality Strategy builds on the progress that has been made at the airport to reduce emissions from its operations. Through it we have set out actions to further cut emissions from the airport over the next 10 years. We will keep these actions under review and regularly assess their emissions impact.

We have seen some encouraging results at Heathrow over the past three years. For example, as airlines are replacing older aircraft with newer, low emitting models, this has brought about significant emissions reductions. To support this, we have re-balanced airport landing charges to encourage airlines to use cleaner, quieter aircraft which have local noise benefits too.

Another example is our commitment to reduce aircraft emissions on the ground. We provide power and increasing numbers of pre-conditioned air units for aircraft, which enables airlines to reduce their use of APUs (auxiliary power units); small jet engines which provide electrical power when aircraft are parked and main engines are switched off. We will continue to work with airlines to reduce APU use.

We recognise Heathrow is a small but significant source of pollution in the local area and we are committed to playing our part to help meet AQ limits.

Colin Matthews,
Chief Executive Officer
BAA

# Executive Summary

## Introduction

As the world's busiest international airport and the UK's only major hub airport, Heathrow performs the important economic role of maintaining a frequent and profitable network of direct long haul air routes that help the economic vitality of London and the UK.

Located to the west of London, the airport is within an area of high emissions; with significant contributions from London itself as well as from two nearby motorways, major roads, local industry and local housing as well as the airport. Tackling local air quality issues will require action and collaboration from a range of industries, organisations and individuals. Where airport operations significantly add to these emissions Heathrow Airport Ltd (HAL) will play its role in achieving compliance with the EU limit values at sites around Heathrow. We will do this by tackling our own emissions (those we control), and working in partnership with airlines and other companies that use our airport to address the emissions they create (those we guide and influence).

We take a logical, systematic approach and this Strategy sets out the actions we will take to reduce air pollution emissions. The actions taken will be balanced against the other operational environmental needs of the airport – i.e. seeking reductions in noise and $CO_2$ emissions. This Strategy builds on the success of previous Air Quality Action Plans as well as incorporating new initiatives and technological advances. It has three primary objectives:

1. To accurately quantify the contribution from airport related sources to local air quality concentrations at all relevant local receptors to ensure we focus our management activity in areas with the most significant impacts;
2. To reduce $NO_x$ emissions we control, guide and influence to help achieve compliance with the EU air quality limit values;
3. To demonstrate we are using the best practicable measures to reduce Heathrow's contribution to air quality to ensure our contribution is understood by key stakeholders.

## Pollutants of concern

Large areas of London exceed the health-based air quality limit values due primarily to emissions from road traffic and from buildings, and every London borough has declared at least one Air Quality Management Area (AQMA). This pattern is repeated locally, where the activities that take place at Heathrow Airport are just one of the many sources of air pollutant emissions in the local area.

Air quality management is a key priority for HAL and local air quality is one of the issues of concern to local residents and national stakeholders. The main pollutants of concern in the Heathrow area are nitrogen dioxide ($NO_2$) and particles (measured as $PM_{10}$ and $PM_{2.5}$). The EU has specified concentration limits for these pollutants due to their impact on human health. Only $NO_2$ exceeds the EU limit value in some local areas which requires HAL and other stakeholders to reduce emissions of its precursor – oxides of nitrogen ($NO_x$).

Local air quality monitoring shows measured concentrations of particles have declined over recent years and that the UK and EU health-based air quality objectives have not been breached at locations inside or outside the airport boundary since 2003. Even so, HAL is committed to reduce these emissions and many of the actions within this Strategy, focussed on reducing emissions of $NO_x$, will also reduce emissions of particles.

We use two methods to determine air quality levels;

1. Continuous air quality measurements are undertaken to national standards at a number of fixed sites – providing comparison with legal limit values, as well as historical trends and a basis to enable computer models to be verified.

2. Dispersion modelling gives a much clearer picture of concentrations over a large area, and 'fills the gaps' between monitoring stations. Because the modelling is based on an estimate of emissions in and around the airport, the impact of changing these emissions and carrying out future projections is also possible.

## Areas of focus

HAL recently completed a new emissions inventory for Heathrow Airport[1]. It updates the last inventory completed for 2002, which was used as a basis for the Project for the Sustainable Development of Heathrow (PSDH) and takes account of the new airport layout – including Terminal 5.

Direct airport $NO_x$ (oxides of nitrogen) emissions for 2008/09 were estimated to be in the region of 5,800 tonnes. Ground level emissions, which make the most impact to local air quality, were less than half of these – approximately 2,600 tonnes.

The main improvements to on-airport emissions were brought about from the opening of Terminal 5 enabling more efficient aircraft movements on the airport and changes to the aircraft fleet. Total $NO_x$ emissions from ground-level aircraft sources were approximately 1,637 tonnes; a fall since 2002 of around 24 tonnes even though there were 3,500 more aircraft movements in 2008/09.

In 2010, we calculated emissions fell by approximately 80 tonnes compared with 2008/09 which indicates two of our key policies are working well:

1. More aircraft with lower $NO_x$ emissions are using the airport, partly in a response to our landing charges. Ground emissions from aircraft main engines fell by approximately 45 tonnes

2. Limit the use of auxiliary power unit (APU) use on the airport and assess how long they run for. This data indicates APU emissions fell by approximately 35 tonnes, based on manual surveys.

Elevated aircraft $NO_x$ emissions – those produced after take-off – have a much lower impact on local air quality. These emissions increased between 2002 and 2008/09, and although part of this increase was due to increase number of aircraft movements, methodological changes have also had an impact – see section 4 for details.

Emissions for airside vehicles and stationary sources increased between 2002 and 2008/09, which may partly be due to better data collection methods for the 2008/09 inventory.

Although HAL is committed to reducing airport-related emissions, we also expect other organisations to play their part to reduce emissions from other sources over which HAL has no influence or control; non-airport related road traffic for example. We will work in partnership with relevant organisations to influence emissions reduction from these non-airport sources.

This Strategy focuses on reducing emissions from the four main airport sources:

- Aircraft emissions – both airborne and whilst on the ground
- Airport-related road traffic
- Airside vehicles and plant
- Fixed energy plant

[1] AEA, 2010: *Heathrow Airport Emission Inventory 2008/9* Warrington, UK.

## Key actions

We encourage the cleanest possible aircraft fleet to use Heathrow by levying a $NO_x$-based landing charge; minimise the use of auxiliary power units by enforcing mandatory time limits and encourage the efficient movement of aircraft whilst taxiing.

Over the next 10 years, the development of low and zero emission vehicle fuels and technologies is likely to provide a range of choices to reduce $NO_x$ (and $CO_2$). It is not clear at this stage which will be most appropriate for use in airside vehicles. It is likely that a mix of technologies and fuels will be needed due to the niche applications that exist on a major airport such as Heathrow, and we are committed to supporting the trials of new vehicle fuels and technologies to assess their cost-benefits for deployment. These trials could include further investigations of electric vehicles, biofuels and hydrogen.

Actions to reduce emissions from landside airport-related vehicles will be investigated and where appropriate incorporated into the Sustainable Transport Plan in 2012.

For further information on our wider corporate responsibility programme, please visit our website www.heathrow.com.

## Key Performance Indicators

The following table summarises the Key Performance Indicators we will use to track the effectiveness of key policies in the Strategy.

| Objective | KPI | Current position |
|---|---|---|
| 1. Accurately quantify contribution from airport related sources to local air quality | Maintain agreement between monitored and modelled $NO_x$ concentrations of ±15% | met in 2008/09 inventory |
| | Minimum of 90% data capture at our monitoring sites | 9 monitors out of 13 above 90% data capture in 2010, 2 above 80% and 2 above 75% |
| 2. Reduce $NO_x$ emissions we control, guide and influence | Number of relevant air quality monitoring sites within the Heathrow Study Area which are not compliant with the EU limit value for $NO_2$ | 3 sites out of 8 exceeded in 2010 |
| -Control | PPC permit emissions limits exceedance for boiler plant resulting in EA taking enforcement action | zero in 2010 |
| | Total $NO_x$ emissions from HAL vehicle fleet | Emissions baseline of 4.2 tonnes established for 2010 |
| -Guide | Proportion of ATMs by CAEP standard | 91% ATMs CAEP 4 or better |
| | Compliance with maximum APU run time allowances on arrival and departure | 2010 compliance target was 85%<br><br>Actual compliance was 91% |
| -Influence | Total $NO_x$ emissions from airport related traffic. | Calculated as 929 tonnes in 2002. Updated contribution to be determined in 2011 |
| 3. Demonstrate we are using best practicable measures to reduce emissions and ensure our strategy is understood by key stakeholders | Heathrow's performance benchmarked against other airports | To be determined in 2011 |
| | Survey of stakeholder opinion | To be determined in 2011 |

# 1. Introduction

## Heathrow Airport

Heathrow is the world's busiest international airport. In 2010 it handled some 66 million passengers on approximately 460,000 flights. It has two runways and four terminals[2] and approximately 90 scheduled airlines fly from Heathrow to 176 destinations around the world.

Heathrow is the UK's only major hub airport and is vital to the health of the UK economy. Hub airports perform an important economic role because their high proportion of transfer passengers enables them to maintain a frequent and profitable network of direct long haul air routes that could not be supported by a point-to-point airport.

Heathrow Airport is located on the western edge of London. Close to two motorways and the main line rail route from Paddington to the southwest, it is in an area of high emissions. Airport operations add to them and aircraft emissions are significant at locations directly adjacent to the airport. Heathrow Airport Ltd (HAL), as the airport operator, will play its role in achieving compliance with the EU limit values at sites around Heathrow. This Strategy represents HAL's commitment to manage air quality emissions from the airport.

## Local air quality

The EU has set legally binding limit values for nine air pollutants. Two of these are of concern around Heathrow – nitrogen dioxide ($NO_2$) and particles (measured as $PM_{10}$ and $PM_{2.5}$). Based on health studies, some pollutants have both a short-term and long-term limit value. $NO_2$ is one example; it has both an hourly and annual average objective.

The main pollutant of concern is $NO_2$, and large areas of London, the rest of the UK and Europe, exceed the annual average EU limit value, due mainly to emissions from road traffic and from buildings. This pattern is repeated locally, where the activities that take place at Heathrow Airport are just one of the major sources of air pollutant emissions in the local area.

Air quality management is a key priority for HAL and we use two methods to determine air quality levels;

1. Continuous air quality measurements are undertaken to national standards at a number of fixed sites – providing comparison with legal limit values, as well as historical trends and a basis to enable computer models to be verified.

2. Dispersion modelling gives a much clearer picture of concentrations over a large area, and 'fills the gaps' between monitoring stations. Because the modelling is based on an estimate of emissions in and around the airport, the impact of changing these emissions and carrying out future projections is also possible.

## Our approach to air quality management

This Strategy builds on the achievements of the second *Heathrow Air Quality Action Plan,* which covered the five year period to 2011. It aligns with the current UK Air Quality Strategy, London Air Quality Strategy and neighbouring local authorities' air quality action plans and introduces additional measures that focus on reducing $NO_x$ emissions up to the end of 2020. A review of the *2007-11 Heathrow Air Quality Action Plan* is included in Appendix 3.

[2] Terminal 2 was being rebuilt at the time of publication.

We envisage this Strategy will evolve over its implementation period as new data and emission reduction technologies become available. Progress updates will be produced annually via our sustainability website[3] and, where appropriate, the associated Action Plan may be revised and updated to reflect developments in government policy and regulation, scientific knowledge, stakeholder feedback, company policy and airport air quality management.

Although HAL will focus on reducing emissions of oxides of nitrogen ($NO_x$) the majority of actions will also reduce other local air pollutants, such as particles. Where practicable, actions in this Strategy will also help reduce emissions of carbon dioxide ($CO_2$) and other greenhouse gases. Further explanation of the relationship between greenhouse gases and local air pollutants is given in Chapter 2.

## Recent airport development

In March 2008 Terminal 5 became operational. One major aspect of its design was to improve the efficiency of aircraft movements at the airport. Looking at aircraft movements since it opened shows that the time taken for aircraft to taxi to the runways, and from the runways to terminals, has decreased by about 30% on average, significantly reducing aircraft emissions on the ground. We will work with NATS, the UK air navigation service provider, to investigate how these more efficient movements can be maintained and improved.

A similarly designed new terminal is currently being built on the eastern end of the airport; replacing Terminal 2. The new design should also help in reducing taxiing times as well as giving HAL the opportunity to make the terminal itself more sustainable in terms of energy and water use.

[3] www.heathrowairport.com, click on 'our business and community', then click on 'sustainability'.

# 2. Purpose of Strategy

## Objective

Heathrow Airport Ltd will play its role in helping to achieve compliance with the EU limit values at sites around Heathrow.

Action taken by HAL will only have a limited impact to local air quality. Dispersion modelling has shown that direct airport emissions (i.e. aircraft, airside vehicles and fixed plant) account for between approximately 4 and 25% of concentrations within 2km of Heathrow. Consequently we also expect other organisations to play their part to reduce emissions from other sources over which HAL has no influence or control; non-airport related road traffic for example. We will work with key stakeholders to facilitate further emission reductions.

We carried out a full emissions inventory and dispersion modelling for the 12 month period from April 2008 to March 2009 to determine the emissions from the airport and from indirect airport-related traffic (see Table 5 in Appendix 2). Since then, we have updated the aircraft component of the Emissions Inventory twice – for 2009 and 2010, using actual aircraft movement data for each year. We estimate ground level emissions have fallen by approximately 80 tonnes between 2008/09 and 2010 suggesting our policies are working well; particularly by encouraging airlines to use cleaner aircraft, and by also encouraging the use of auxiliary power units to be cut.

## Scope

## Timescale

This Strategy outlines our approach to managing local air quality impacts associated with the operation of a five-terminal, two-runway airport up to the end of 2020, capped at 480,000 flights. This includes the opening of a new Terminal 2 and any other developments which have been granted planning permission at the time of publication. It is primarily focused on reducing emissions of $NO_x$.

We are still developing our transport policies and taking into account new data sources. We will publish further transport related policies in a *Heathrow Vehicle Emission Action Plan* in 2012

## Assessing air quality

The basic methodology recommended by the panel of experts who participated in the Project for the Sustainable Development of Heathrow (PSDH) is still used to assess air quality; from the production of emission inventories to subsequent dispersion modelling using ADMS-Airport. HAL will continue to use the agreed methodology for future assessments, but will take into account any relevant developments in emissions assessment methodologies or improvements to modelling.

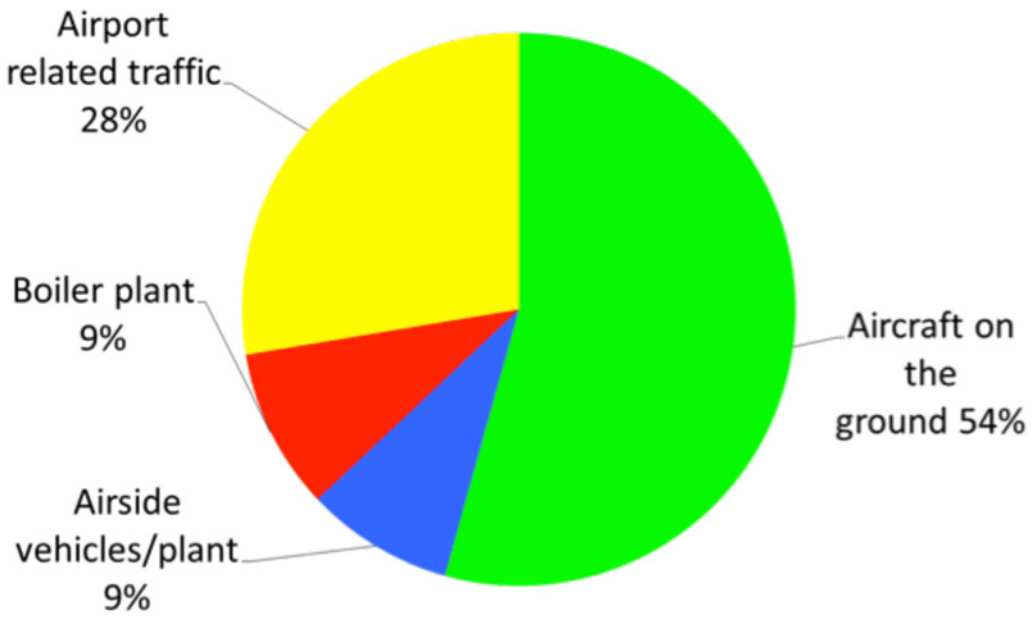
## Air pollution and emissions

As mentioned previously, only two air pollutants are of concern in the local area – nitrogen dioxide ($NO_2$) and particles – and only $NO_2$ exceeds the EU limit value around Heathrow. HAL is committed to play its role in reducing emissions of its precursor $NO_x$ (oxides of nitrogen) from the four main airport-related sources:

- Aircraft emissions – both airborne and whilst on the ground
- Airport-related road traffic
- Airside vehicles and plant
- Emissions from fixed plant

The percentage of $NO_x$ emissions estimated to come from activities relating to Heathrow are shown Table 5 (Appendix 2) and in Figs. 1 and 2.

**Fig. 1 – Estimated ground level airport-related emissions from Heathrow Airport in 2008/09**

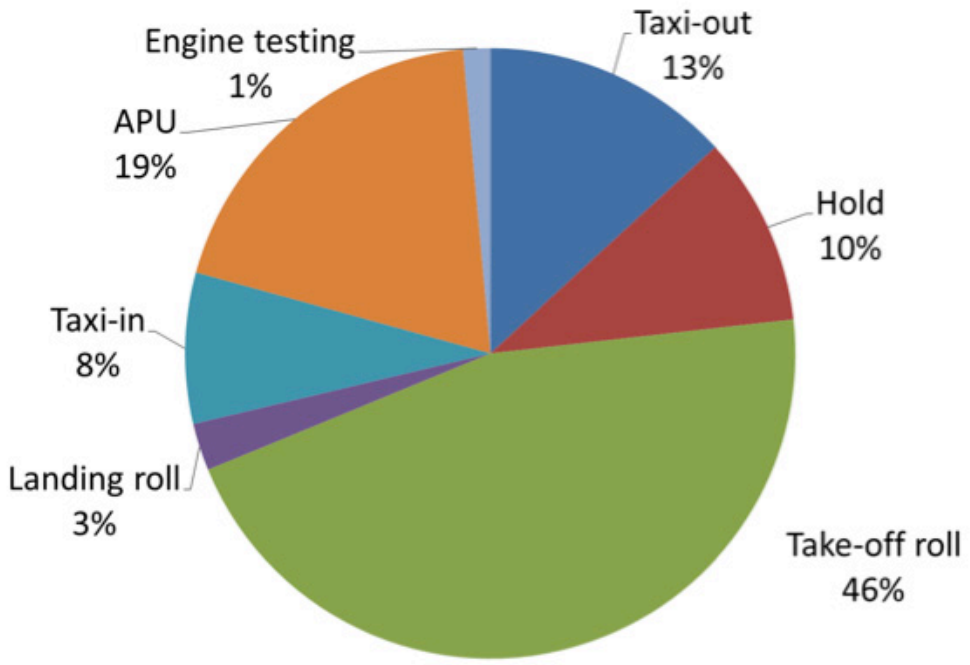



Note: Emissions from airport-related traffic is estimated using 2002 breakdown

Ground-level emissions associated with the airport have the biggest impact on local air quality whereas elevated aircraft emissions have less impact because they take place at increasing height. Fig. 1 shows aircraft make up approximately 54% of ground level emissions, whereas airport related traffic is estimated to make up a further 28%. Of any airport-related emissions, these two sources have the most significant impact to local air quality. The remainder of emissions are from boiler plant and airside vehicles (approximately 9% each). These two sources have a lower impact on local air quality.

Aircraft $NO_x$ emissions are broken down further into a number of 'activities' in Fig. 2. Take-off roll is the biggest emissions source (46%); though taxiing and use of auxiliary power units (APUs) are almost as large when considered together. These areas all impact on local air quality and we have developed actions to reduce their local impacts – see section 4.

**Fig. 2 – Estimated ground level emissions from aircraft at Heathrow Airport in 2010 (% by flight phase)**




Although HAL will focus on reducing emissions of $NO_x$ the majority of actions will also reduce other local air pollutants, such as particles. Where practicable, actions in this Strategy will also help reduce emissions of carbon dioxide ($CO_2$) and other greenhouse gases. Further explanation of the relationship between greenhouse gases and local air pollutants is given below.

## Interdependencies between air quality and other topics

HAL has long been aware of the trade-offs between air quality and other topics such as noise and $CO_2$ emissions and has undertaken a number of studies to help quantify the balance that needs to be struck for specific joint actions (e.g. in relation to reduced engine taxiing). Additional studies will be undertaken to provide HAL with the information it needs to make informed decisions when operational changes are planned.

## Local air quality and climate change

Emissions of carbon dioxide ($CO_2$) and other greenhouse gases produced by operations at Heathrow Airport are not addressed directly by this Strategy. However, the implementation of some of the actions will result in a reduction in $CO_2$ emissions from certain activities.

Some measures designed to tackle climate change have a beneficial effect on local air pollution, whereas others can be detrimental. For example, improvements in aircraft engine technology designed to improve fuel efficiency (and so reduce emissions of $CO_2$) tend to result in fuel being burned at higher temperatures, which increases emissions of $NO_x$.

More research needs to be carried out to ensure that by trying to fix one problem, we do not inadvertently exacerbate another. Where trade-offs are needed between climate change and local air quality at Heathrow, we will take careful account of them and make an informed decision on what action to take based on our current understanding of impacts at the airport. Work being undertaken includes investigating the use of reduced engine taxiing and assessing the implications of reducing APU use.

Heathrow's carbon emissions are managed through our Climate Change Strategy which uses the model of control, guide and influence. See website for more information; www.heathrow.com.

## Local air quality and aircraft noise

The management of air quality is further complicated by the trade-offs that exist with aircraft noise management. Most of the technological advances in aircraft design in the last twenty years have led to a reduction in emissions of both noise and $CO_2$. Emissions of local air pollutants such as $NO_x$, have been reduced through the introduction of increasingly stricter emissions standards defined by the Committee on Aviation Environmental Protection (CAEP).

A balanced approach also needs to be taken during operations. For example, in some cases the adoption of a reduced thrust setting for an aircraft during take-off can lower $NO_x$ emissions by up to 30% when compared to a full-thrust setting. While many airlines already employ "reduced thrust" as their standard operating procedure and this may decrease noise in the immediate vicinity of the airport, there can be a small increase in noise experienced further away from the airport under the departure flight path as the aircraft takes a gentler ascent

Another example is the use of continuous descent approach (CDA), where aircraft maintain a constant rate of descent with very limited or no periods of level flight during landing as opposed to using a number of short descents followed by periods of prolonged level flight. The use of CDA reduces noise as well as $CO_2$ and $NO_x$ emissions.

## Local Air Quality and Surface Access

Airport-related traffic can make a significant contribution to local air quality concentrations because these vehicles are driven along roads where people live. Heathrow's *Surface Access Strategy* 2007 – 2012 (ASAS) seeks to balance the provision and use of transport modes in relation to airport operations. It deals with the airport's strategic placement to act as an interchange and 'hub' for bus, coach and rail routes and the quality of these modes.

The ASAS sets targets to minimise the impact arising from transport activities; such as numbers of passengers using public transport and staff travelling in single car journeys.

HAL's Consolidation Centre was set up in 2001 to increase the efficiency of deliveries into the airport by reducing the number of vehicles needing to enter airside. This measure reduces congestion, emissions of $NO_x$ and $CO_2$ as well as ensuring timely deliveries.

To focus action on surface access issues, we will seek to develop a number of complementary actions in the forthcoming *Heathrow Vehicle Emission Action Plan* aimed at reducing $NO_x$ and $CO_2$ emissions from traffic HAL can influence.

More information is available in our brochures Towards a Sustainable Heathrow from www.heathrowairport.com.

# 3. Overview of regulations

This section summarises the principle legislation and regulations for the management of air quality in the UK. Table 1 (Appendix 2) provides a brief summary.

## Air quality regulation

## Global

### International Civil Aviation Organisation (ICAO)

The ICAO is an inter-governmental organisation and develops the principles and techniques of international civil air navigation as well as planning the development of international air transport. One of ICAO's chief activities is the establishment of International Standards, Recommended Practices and Procedures regarding the technical fields of aviation, including aircraft emissions.

Through its Committee on Aviation Environmental Protection (CAEP), ICAO has set progressively tighter certification standards for air pollutant emissions from new and future civil aircraft, which are known as CAEP standards. The latest standard is CAEP/6, with CAEP/8 coming into force in 2012.

## Europe

### European Union

EU directives define the policy direction to be taken by Member States' governments by providing a framework for emissions reduction, ranging from; setting targets for tighter vehicle emission standards to setting national emissions ceilings for each Member State.

To address the health impacts of poor air quality, the EU placed a requirement on Member States to achieve prescribed health-based air quality limits through the Air Quality Framework Directive on Ambient Air Quality (see Table 2). These limits are legally binding and must be met by the UK Government (see Table 3). The EU Directive recognised member states may need more time to meet the EU limit values for $NO_2$ and enables them to apply for a time extension. More detail can be found on the Defra website, www.defra.gov.uk.

## UK

### DfT

DfT is responsible for transposing EU legislation into UK law with respect of tighter vehicle emissions limits and road pricing. It is also responsible for providing fiscal support for alternative technologies (e.g. electric vehicles) either directly, or through grant bodies, such as the Office for Low Emission Vehicles and CENEX. Under the Civil Aviation Acts, DfT also has direct control over many aspects of aviation at Heathrow Airport. Operational procedures and operating restrictions relate largely to noise. Some measures help reduce air pollution emissions, such as continuous descent approach and banning noisier Chapter 2 aircraft.

### Defra

Defra is the lead Government department in terms of air quality and has published its UK Air Quality Strategy as required by the Environment Act 1995 (which also outlines measures to be taken by the Mayor of London and local authorities to improve air quality under the local air quality management (LAQM) regime). The UK Air Quality Strategy provides a framework to identify air quality

improvement measures and sets out a co-ordinated approach to achieve them. It implements the requirements of the EU Air Quality Directive which defines the EU air quality limit values for specific pollutants. Defra is also able to specify tighter national air quality objectives if it chooses. At the time of going to press, Defra is expected to apply to the EU for a five year time extension to enable the EU limit values for $NO_2$ to be achieved within 40 of the 43 UK regions which still exceeded in 2010.

## Regional regulation

Established by the Greater London Authority Act 1999, the Mayor of London is required to produce an Air Quality Strategy as one of several strategies for Greater London. The Mayor's Air Quality Strategy is required to include proposals and policies to implement measures in the UK Air Quality Strategy as well as any other proposals and policies which may act to improve air quality. In addition, the Mayor of London has a duty to assess the air quality action plans of London local authorities and ensure actions are commensurate with both the London and UK Air Quality Strategies.

## Local regulation

As required under the Environment Act 1995, local authorities have a statutory duty to review and assess air quality in their area and to identify areas of poor air quality where national targets will not be met. If after carrying out a review and assessment, a local authority finds that one or more of the EU limit values or national air quality objectives is likely to be breached, it is obliged by law to declare an Air Quality Management Area (AQMA). Once an authority has declared an AQMA, it must then develop an action plan which sets out how it will use its powers to help meet the EU limit values or national objectives. This duty is described as Local Air Quality Management (LAQM).

Nationally, more than 200 local authorities have identified locations within their boundaries where the EU limit values have been, or are likely to be breached. This equates to 40 out of 43 UK regions having areas of exceedence within them.

The four local authorities closest to Heathrow (LB Hillingdon, LB Hounslow and Spelthorne and Slough Borough Councils) have all declared air quality management areas (AQMAs) for $NO_2$. HAL is working especially closely with these local authorities to implement measures to improve air quality in the Heathrow area and this Strategy is a key element of this work.

## Heathrow's role and the regulation of air pollutant emissions at source

As explained earlier in this section, many organisations are involved in regulating emissions of air pollutants from many sources and HAL encourages action to reduce $NO_x$ emissions from these sources. Local authorities can include actions related to these organisations, as appropriate, within their air quality action plans. HAL seeks to reduce emissions from the sources outlined below.

## Emissions from aircraft

Aircraft emissions are regulated in the UK by the European Aviation Safety Agency and the UK Civil Aviation Authority (CAA). As outlined above, the International Civil Aviation Organisation (ICAO) publishes internationally agreed standards and recommended practices on aircraft engine emissions through its Committee on Aviation Environmental Protection (CAEP).

Emissions standards for new aircraft were agreed at the CAEP/6 meeting in 2004 and were applicable from 2008. At the CAEP/8 meeting in 2010, these standards were further modified for new engine

types certified after 31 December 2012. The ICAO standards are 'technology following' and many aircraft engines manufactured before the CAEP/8 meeting already met the CAEP/8 standards.

Current operational fleets contain aircraft with a mix of CAEP emission standards, which are a function of the time these aircraft were bought or leased. This has an important impact on $NO_x$ emissions because there is a time lag between new technology being introduced and then being taken up in large enough volumes to start having a positive impact on emissions. The lifetimes of aircraft are generally between 30 and 40 years, so the introduction of cleaner aircraft is a long-term solution.

In order to encourage a quicker take-up of cleaner aircraft, HAL introduced a $NO_x$ charge as part of its landing charges in 2004 to incentivise airlines to operate planes with lower emissions. The $NO_x$ fee was increased at twice the rate of the underlying increase in landing charges to provide a more robust financial incentive for airlines to reduce emissions.

In 2010 we reviewed the landing charging structure and following consultation with partner airlines we introduced a new landing fee structure in April 2011. The new landing fee charges reflect the changing priorities of air travel and will strengthen the incentives for airlines to use Heathrow in the most efficient way, with the quietest and cleanest aircraft. The charge for $NO_x$ was increased from £2.73 per kg to £5.18.

## Emissions from other airport operations

### Emissions from transport

We use the Euro and Stage emission standards to encourage the use of cleaner vehicles on the airport.

HAL's current Airport *Surface Access Strategy* has targets to increase the proportion of passengers who travel to the airport by public transport, and as a consequence reduce emissions by reducing the number of private cars driven on local roads. We will seek to incorporate into our *Surface Access Strategy* air quality objectives to develop the transport provision relevant to Heathrow.

### Emissions from boilers

At Heathrow Airport our network of fixed boilers, which produce heating and hot water for the terminals and associated buildings, is regulated by the Environment Agency through a Pollution Prevention and Control Permit. The main aim is to reduce emissions of $NO_x$, but it also controls other environmental impacts from their operation. When we install new equipment our aim is to use the most energy efficient plant with the lowest $CO_2$, $NO_x$ and particle emissions.

## Planning conditions

Where further development of Heathrow Airport may result in an increase of air pollutant emissions, the local planning authority can choose to impose planning conditions on HAL to mitigate the local impact.

For example, the planning permission for Terminal 5 set a number of conditions which relate to air quality:

- A limit of 480,000 air transport movements per year which restricts the total number of aircraft that can use Heathrow.
- A limit on the number of car parking spaces for both passengers and staff to 42,000
- The production of a five-year air quality strategy to show how HAL intends to minimise the emissions of pollutants attributable to Heathrow Airport.

## Roles of others

Other organisations have a big role to play in reducing emissions relating to the airport, or to control emissions in the local area over which HAL has no influence. HAL will continue to reduce emissions we are directly responsible for and seek to reduce emissions from sources we guide and influence. We also seek to work in partnership with other organisations to reduce emissions from sources that are beyond our control, for example;

- lobbying aircraft manufacturers (via ICAO and UK Government) to increase focus on landing and take-off cycle $NO_x$ emissions and CAEP standards;
- working with NATS (which provides air traffic control services) and the CAA (Civil Aviation Authority) to reduce emissions from ground operations at Heathrow;
- working with aircraft manufacturers, airlines and research bodies for improved emissions-related data, and;
- supporting the work of DfT, the Highways Agency, Mayor of London, Network Rail and rail operators to reduce the emissions from sources under their remits.

# 4. Local air quality and Heathrow – the current picture

## Pollutants of concern

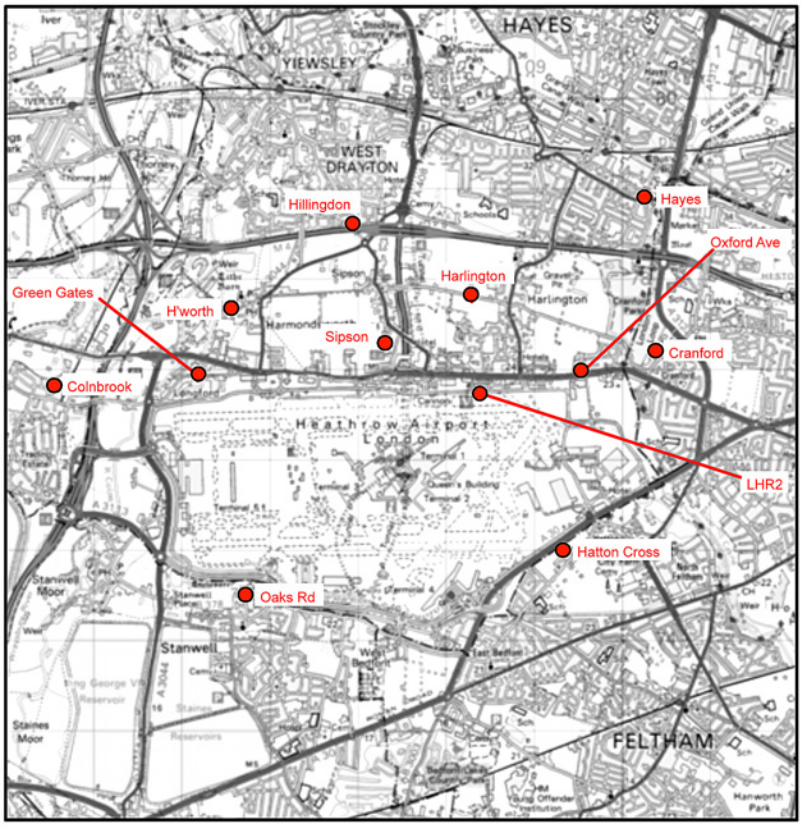
This Strategy addresses the air pollutants of most concern in the local area –nitrogen dioxide and particles – due to their impact on health and the local environment. Only the annual average $NO_2$ EU limit value is exceeded in the local area.

**Nitrogen dioxide** ($NO_2$) is formed during combustion. Operation of vehicles, aircraft and boilers, for example, produces oxides of nitrogen ($NO_x$), which is a mixture of gases made up primarily from nitrogen dioxide ($NO_2$) and nitric oxide (NO). NO reacts with ozone in the air to form more $NO_2$ over time, so the proportion of $NO_2$ within a concentration of $NO_x$ can increase with increasing distance from the source.

**Particles** ($PM_{10}$ and $PM_{2.5}$) are categorised in terms of their size. $PM_{10}$ refers to particles with an aerodynamic diameter of less than 10 microns (µm) and $PM_{2.5}$ is a sub-set of this, referring to particles of less than 2.5µm. $PM_{10}$ and $PM_{2.5}$ are produced from a wide range of materials and from many sources including vehicles, aircraft and boilers, brake and tyre wear, fires and construction. Natural sources can also be significant, e.g. sea salt blown inland.

## Air quality monitoring locations and trends

**Fig. 3 – Principal automatic air pollution monitoring sites near Heathrow Airport**



The Heathrow Airwatch website[4] provides information on air quality monitoring carried out by HAL, local authorities and Government around Heathrow Airport. Measurements are undertaken by both automatic monitoring equipment and passive methods, such as $NO_2$ diffusion tubes. Fig. 3 indicates the location of the key automatic monitoring sites and the boundary of the Heathrow Study Area[5] used for our dispersion modelling exercises. More information of the range of air pollutants measured at each site is in Table 4 in Appendix 2.

**Fig. 4 – Annual average $NO_2$ concentrations measured at a selection of sites around Heathrow Airport from 1995**

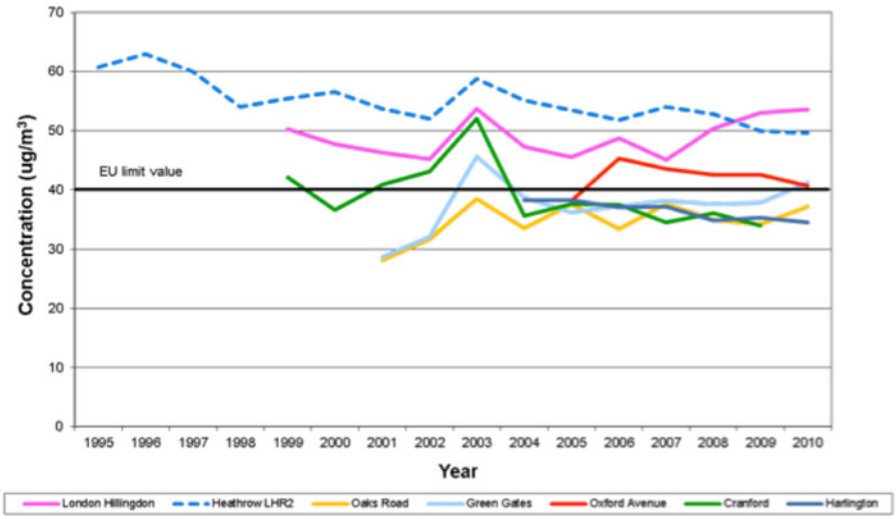


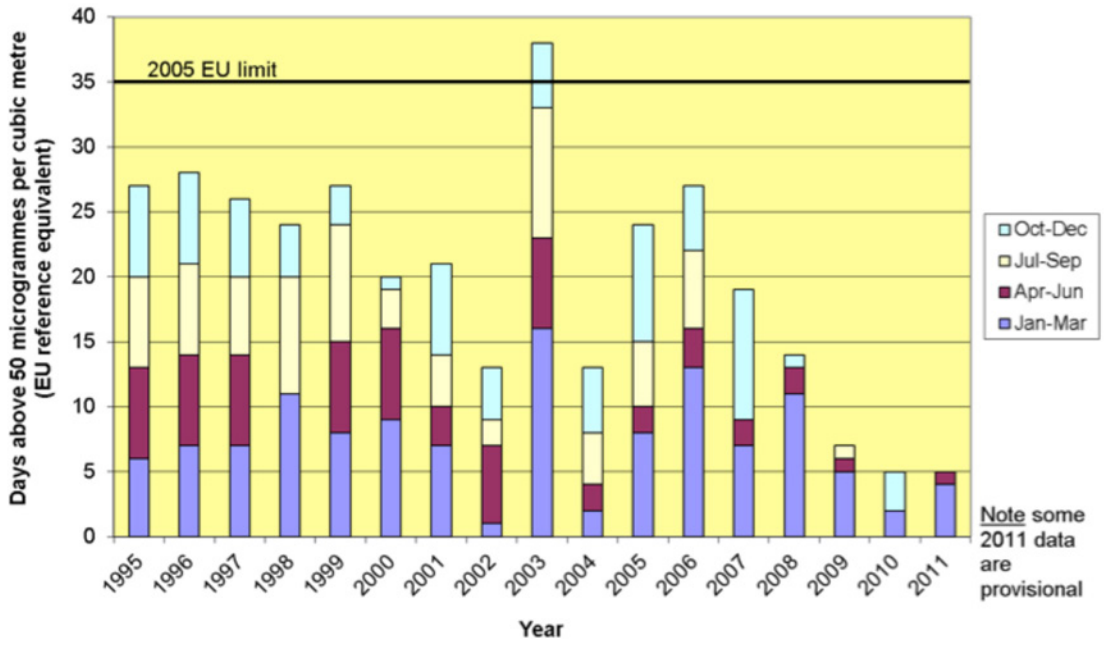

Fig. 4 shows the annual trends in $NO_2$ concentrations measured at a selection of key sites. Over the last decade, concentrations have fallen at most monitoring sites, though these reductions are not as fast as predicted; mainly because the benefits of replacing older road vehicles in the UK fleet with new models with tighter exhaust emissions standards have not been as great as forecasts suggested. A number of pollution incidents occurred in 2003 due to prolonged hot, sunny conditions producing higher than average $NO_2$ concentrations. The peak in annual average concentrations can be clearly seen, and was mirrored at monitoring sites across the UK.

The $PM_{10}$ EU limit value has been met at all monitoring sites in the Heathrow Study Area for a number of years. In general, concentrations are highest at LHR2, where the EU limit value for $PM_{10}$ has been met since 2003, when unfavourable weather conditions produced 38 breaches of the EU limit value and also affected sites throughout the UK. See Fig. 5.

It is not unusual for daily mean $PM_{10}$ levels to exceed 50µg/m$^3$, though the EU limit value allows 35 exceedances (equal to 35 days) per year before the limit value is breached.

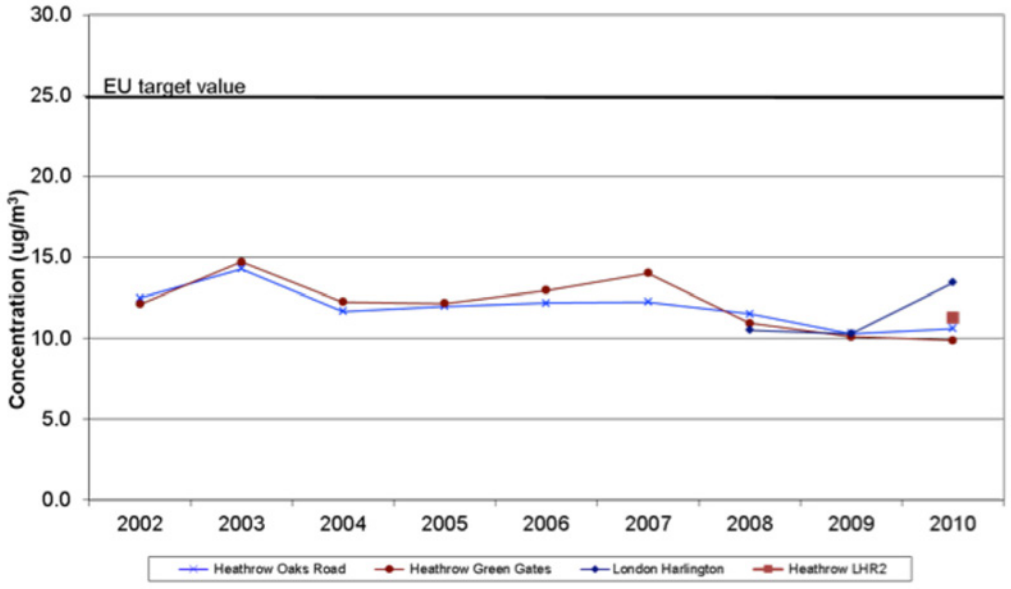
[4] www.heathrowairwatch.org.uk
[5] Heathrow Study Area is a 81km$^2$ zone around the airport

**Fig. 5 – Comparison of daily average $PM_{10}$ concentrations with the EU limit value on Heathrow Airport from 1995**




As well as $PM_{10}$, HAL also monitors the finer fraction $PM_{2.5}$ at all four of its monitoring sites. Fig. 6 shows annual mean concentrations of $PM_{2.5}$ measured at Green Gates, Oaks Road, Harlington and LHR2 in 2010 were less than half of the EU target of 25 µg/m³.

**Fig. 6 – Annual average gravimetric $PM_{2.5}$ measurements at HAL's monitoring sites from 2002**



## 2008/9 Emissions Inventory and subsequent work

HAL recently completed a new emissions inventory for Heathrow Airport[6]. It updates the previous inventory for 2002 and took into account the new 5-terminal airport layout.

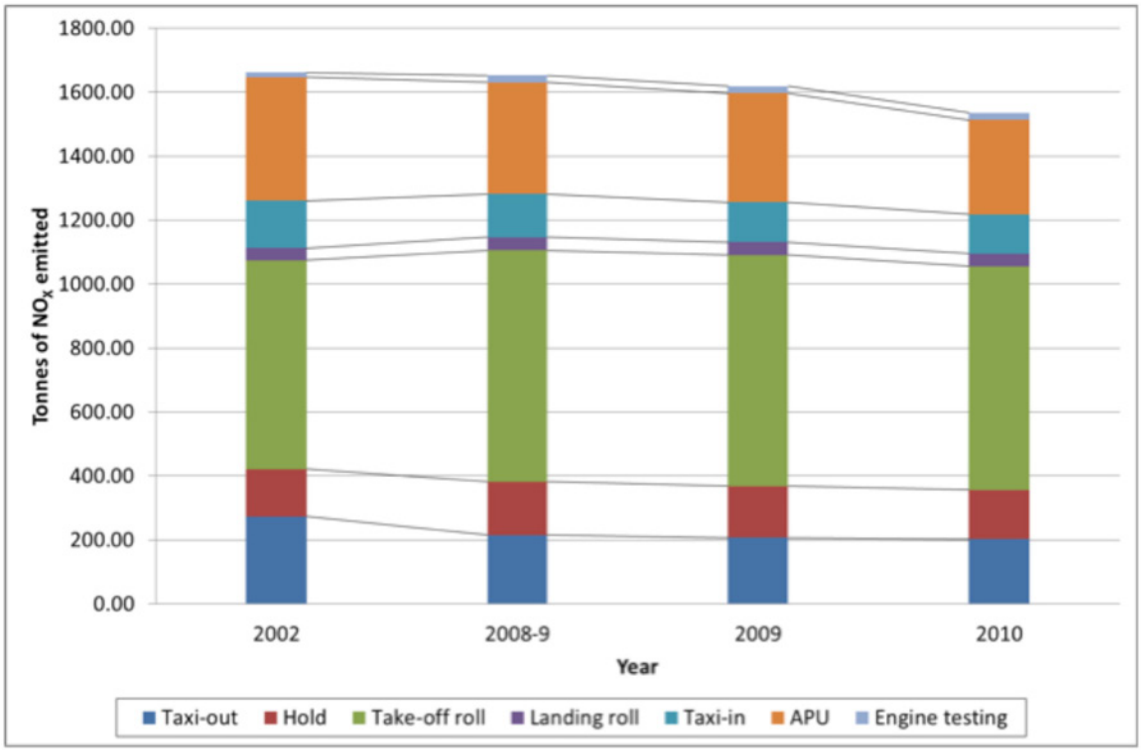
Because Terminal 5 opened in March 2008 a convenient 12 month period needed to be chosen so that dispersion modelling could be carried out, enabling air pollution concentrations to be calculated. The inventory runs for the 12-month period April 2008 – March 2009. Emissions were assessed for the pollutants $NO_x$, $PM_{10}$ and $PM_{2.5}$.

The Inventory covers an area approximately 81 $km^2$ around the airport, as shown in Fig. 3 and Table 6 (Appendix 2) summarises estimated emissions from four major airport sources and road traffic within it. The proportion of $NO_x$ emissions from ground-level airport activities are summarised in Figs. 1 and 2 on pages 11 and 12.

The main improvement to on-airport emissions is brought about from the opening of Terminal 5 enabling more efficient aircraft movements on the airport – cutting $NO_x$ emissions by approximately 75 tonnes. Since 2002, APU emissions were cut by approximately 40 tonnes, helping to bring about a total fall from all ground-level aircraft activities of 24 tonnes even though there were 3,500 more aircraft movements in 2008/09. Total ground level aircraft emissions were approximately 1,637 tonnes.

Since 2009 we have produced an annual mini-update of the inventory to assess aircraft emissions and the $NO_x$ results are shown in Fig. 7.

**Fig. 7 – Comparison of total annual ground level aircraft $NO_x$ emissions at Heathrow Airport**




[6] AEA (2010) *Heathrow Airport Emission Inventory 2008/9* Warrington, UK

In 2010, emissions of $NO_x$ fell for three main reasons:

– $NO_x$ landing charges have encouraged the use of cleaner aircraft, and main engine emissions fell by approximately 45 tonnes

– Limit the use of auxiliary power unit (APU) use on the airport and assess how long they run for. This data indicates APU emissions fell by approximately 35 tonnes, based on manual surveys.

– Fewer aircraft movements resulted in a further reduction of 25 tonnes

Due to increased dilution and dispersion and because they take place at increasing height, elevated aircraft emissions – from take-off to 1,000m – have a less significant impact on air quality than aircraft emissions on the ground. These emissions were approximately 2,806 tonnes in 2008/9.

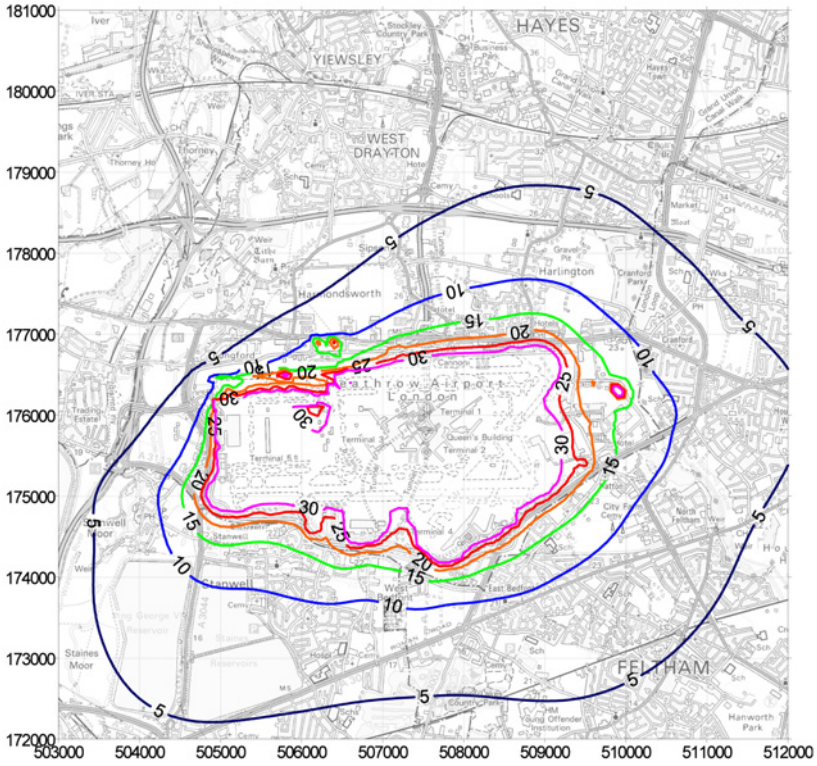
Emissions for airside vehicles and stationary sources increased, due to increased fuel sales. This increase may partly be due to an artefact of better data collection methods for the 2008/09 inventory. Airside vehicles may be the focus of further emissions reduction policies in the *Heathrow Vehicle Emission Action Plan.*

Emissions from airport car parks and surrounding roads decreased since 2002. This was due to increased numbers of newer vehicles with lower exhaust emissions replacing older models. Airport-related landside vehicles will be a focus of the *Heathrow Vehicle Emission Action Plan.*

At the time when the inventory was being developed no new data was available on the proportion of airport-related vehicles which use landside roads. The split estimated in 2002 is used as the best available data and estimated emissions were approximately 880T. HAL has commissioned work in 2011 to update this data set and produce an improved emissions estimate.

**Source apportionment at air quality monitoring sites around Heathrow**

**Fig. 8 – Airport contribution to 2008/9 period-mean $NO_x$ concentrations (contours shown for 5µg/m³ to 30µg/m³)**



Direct emissions from Heathrow Airport have a lower impact at monitoring sites outside of the airport boundary, compared to emissions from road traffic[7] which predominates at them. Background concentrations, comprising local emissions from housing, minor roads and from London and the southeast, are also higher than emissions from the airport itself.

Fig. 8 was produced as part of HAL's 2008/9 Emission Inventory modelling evaluation. It shows only the calculated $NO_x$ contribution from direct airport emissions (i.e aircraft, airside vehicles and fixed plant). Relatively high (approximately 30%) airport-related concentrations are present on the campus and close to the boundary, but concentrations directly attributable to airport-related emissions fall quickly with distance from the airport. The impact of the prevailing wind can be seen, which blows emissions to the north and east of the airport. Direct airport emissions make a very small contribution to concentrations at the monitoring station adjacent to the M4 where traffic is the most significant source. It is approximately 1.8km from the airport boundary.

**Fig. 9 – $NO_2$ monitoring sites and 2008/9 $NO_x$ source apportionment estimates**

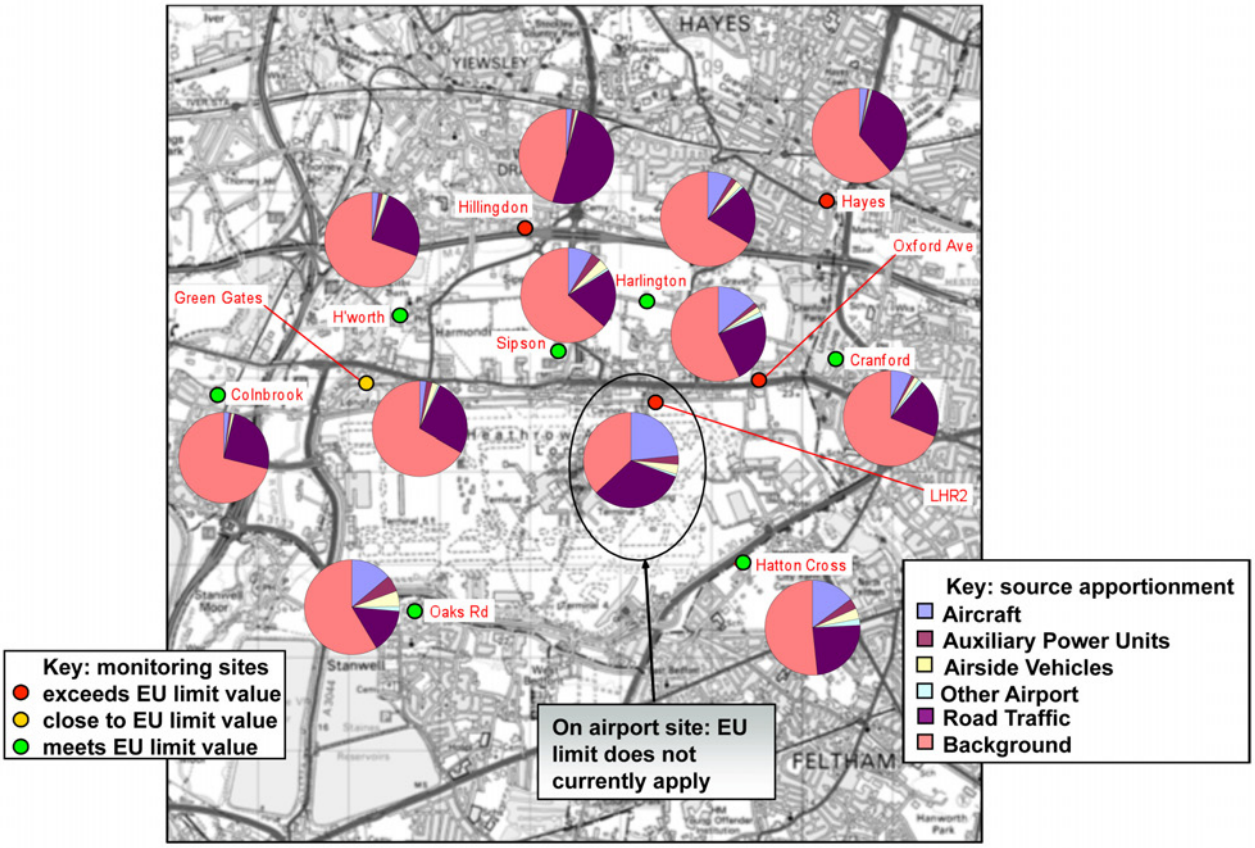



Fig. 9 shows the estimated $NO_x$ emissions that contribute to measurements at each of the monitoring sites on and around Heathrow. Comparing these estimates with Fig. 8, direct emissions from the airport are significant at the three monitoring sites closest to the airport to the northeast, east and southwest (Oxford Avenue, Hatton Cross and Oaks Road respectively), though background emissions (local housing, minor roads and emissions from London and the southeast) predominate at them all. Direct airport emissions make up approximately 14%, 19% and 17% respectively of concentrations at these three sites.

[7] Airport-related traffic will have an impact to local air quality. HAL will make an assessment of this impact as part of its on-going air quality assessment in 2011.

The influence of Heathrow's direct emissions can be seen by looking at the proportion of the different emission sources at three monitoring stations which are roughly in line going north from the northern runway:

1. LHR2 where 33% of emissions are directly from airport operations
2. Sipson 0.5km away, where 11% of emissions are directly from airport operations
3. M4 1.8km away, where 4% of emissions are directly from airport operations

## Particulates

None of the EU limit values are exceeded for particles on and around Heathrow Airport. Even so, HAL is committed to reducing these emissions. Many of the actions within this Strategy, focussed on reducing emissions of $NO_x$, will also reduce emissions of particles.

Table 6 (Appendix 2) gives estimates of $PM_{10}$ emissions, and comparison with emissions in the 2002 inventory.

# 5. Managing Local Air Quality – Our Strategic Approach

Heathrow Airport Ltd will play its role in helping to achieve compliance with the EU limit values at sites around Heathrow.

The Strategy has the following three objectives:

## 1. To accurately quantify the contribution from airport sources to local air quality concentrations to ensure we focus our management activity in areas with the most significant impacts

Our primary aim is to understand the quantity of emissions coming directly from the airport, the quantity and source of other airport-related emissions and the impact these all have to local air quality. We use two methods – air quality monitoring and dispersion modelling based on a specific emissions inventory.

Access to a good quality, robust database is critical to our ability to assess airport-related emissions on a year-on-year basis and their impact on local air quality. The availability of new sources of data may require a subsequent change to our emission inventory methodology and we will seek to develop these two separate, but mutually dependent work streams in a coordinated way.

Key actions include:

- Improving our sources of airport activity data for more robust emission assessments
- Testing the $NO_x$ emission impact of potential new airport policies (e.g. reduced engine taxiing)
- Annual assessment of key policies and their impact to $NO_x$ emissions

Key performance indicators:

- Maintain agreement between monitored and modelled $NO_x$ concentrations of ±15%
- Minimum of 90% data capture at our monitoring sites

## 2. To reduce $NO_x$ emissions we control, guide and influence to help achieve compliance with the EU air quality limit values

Our action plan addresses our air quality management responsibilities. It focuses on the four main sources identified in the *2008/09 Heathrow Emissions Inventory* namely:

- Aircraft in the air and whilst on the ground
- Airport-related road traffic
- Airside vehicles and plant
- Fixed boiler plant.

The level of control HAL has can be divided into three areas. These are:

- Control – airport fixed energy plant and vehicles we own or lease (approximately 10% of airport-related emissions)
- Guide – aircraft ground movements, airside vehicles and staff travel to and from the airport (approximately 30% of airport-related emissions)
- Influence – aircraft fleet mix and passenger travel to and from the airport (approximately 60% of airport-related emissions)

As well as continuing with existing actions to reduce emissions, the action plan defines a number of new areas to be developed to either trial or roll-out new emissions reduction measures. Where appropriate, estimated impact to $NO_x$ emissions is included for each action in the action table in Appendix 1.

Key actions to reduce aircraft emissions include:

- Regular review of landing charges in order to encourage the greater use of cleaner, quieter aircraft
- Minimising emissions from APUs (auxiliary power units) by maximising the use of FEGP (fixed electrical ground power) and, where fitted, PCA (pre-conditioned air)
- Encouraging airlines to sign up to the Departures and Ground Operations Code of Practice
- Working with NATS to further reduce $NO_x$ emissions during aircraft operations (e.g. taxiing and hold and use of reduced engine taxiing)

Key actions to reduce airside vehicle emissions include:

- We expect all companies to comply with the current vehicle OSIs (operational safety instruction)
- Working with our Clean Vehicle Programme and Sustainability Partnership members to help implement actions to reduce emissions from the airside fleets (e.g. electric, hybrids, biofuels and hydrogen).
- Carrying out exhaust emissions checks to VOSA (Vehicle and Operator Services Agency) standards
- Revising training materials to include reference to eco driving for all drivers who require an airside driving permit.
- Reviewing the relevant vehicle OSI with the aim of introducing minimum exhaust emission standards
- Seeking to provide adequate infrastructure to encourage the use of low and zero emission vehicles on the airport, including safeguarding land for future use.

Key actions to reduce airport-related landside vehicle emissions include:

- Working with our Clean Vehicle Programme and Sustainability Partnership members to reduce emissions from the airport-related landside fleets.
- Seek to incorporate into our Sustainable Transport Plan air quality objectives to develop the transport provision relevant to Heathrow.
- Supporting the Hytec Project for 15 hydrogen taxis in London by 2012.

Key Performance indicators:

- Number of relevant air quality monitoring sites within the Heathrow Study area which are not compliant with the EU limit value for $NO_2$
- PPC Permit compliance for boiler plant
- Total $NO_x$ emissions from HAL vehicle fleet
- Proportion of ATMs by CAEP standard
- Compliance with maximum APU run time allowances on arrival and departure
- Total $NO_x$ emissions from airport related traffic.

## 3. To demonstrate we are using the best practicable measures to reduce Heathrow's contribution to air quality, balanced against the other operational needs, and to ensure our strategy is understood by key stakeholders

Having a full understanding of current emissions sources and the impact of emission reduction measures is crucial to our work on the airport. We have identified a number of key areas where improved information could help our management of air quality. New actions which the action plan seeks to develop include:

- Investigating new methods of air quality monitoring on the airport
- Investigating improvements to our research methods
- Trialling new vehicle fuels and technologies to assess their cost-benefit for deployment, such as electric vehicles, biofuels and hydrogen
- Benchmarking HAL with other suitably sized airports.
- Regular emission assessment of $NO_x$, noise and for other pollutants (e.g. particles and $CO_2$).
- Undertake occupational exposure monitoring at least once a year in undercrofts and other high risk areas.

Key performance indicators:

- Heathrow's performance benchmarked against other airports
- Survey of stakeholder opinion

The support of stakeholders is key to our success and is an area we seek to continuously improve. We already report on air quality regularly to local groups; the Heathrow Airport Consultative Committee (HACC), Local Focus Forum (LFF) and the Heathrow Air Quality Working Group (HAQWG). We will continue to liaise with the Mayor of London and UK Government to ensure regional and national policy with regards to air quality development is fully informed and is both realistic and possible. Finally, research into the environmental impacts of aviation is the main way for technological changes to happen and HAL will continue to support organisations such as CAEP and the OMEGA Partnership in the work they do in this area.

Some potential action HAL could take to reduce emissions need agreement at an international level to enable them to take place. For example, it is not legally possible for HAL to ban from landing aircraft with very high $NO_x$ emissions. We will seek to influence the work of the EU and international aviation bodies to develop measures that can be taken on a national basis or by individual airports.

## Key Performance Indicators (KPIs)

A small number of KPIs have been developed to track the delivery of this Strategy and to assess its impact. The chosen KPIs are outlined below.

| | | Goal | | | | Impact on local air quality |
|---|---|---|---|---|---|---|
| **Objective** | **KPI** | **2011** | **2015** | **2020** | **Key activities (see action plan, below)** | |
| To accurately quantify the contribution from airport related sources to local air quality concentrations at all relevant local receptors to ensure we focus our management **activity in areas with the most significant** impacts | • Maintain good agreement between monitored and modelled $NO_X$ concentrations from airport sources as measured by average fractional difference at local monitoring sites in the direction of the prevailing wind[8]. | • ±15% | • ±15% | • ±15% | • 2015 Emission Inventory and dispersion modelling (Action 1.7)<br>• 2020 Emission Inventory and dispersion modelling (Action 1.8) | N/A |
| | • Minimum of 90% data capture at our monitoring sites | • 90%. | • 90%. | • 90%. | • Air quality monitoring at our four fixed monitoring sites (Action 1.1) | N/A |
| To manage and where practicable reduce $NO_X$ emissions we control, guide and influence in order to help drive compliance with the EU limit values | • Number of relevant air quality monitoring sites within the Heathrow Study Area which are not compliant with the EU limit value for $NO_2$ | • 0 breaches. | • 0 breaches | • 0 breaches | • See below for actions to reduce emissions | N/A |
| To reduce $NO_X$ emissions we | • Total $NO_X$ emissions from fixed boiler plant | • Not to exceed agreed PPC permit emissions | • Not to exceed agreed PPC permit | • Not to exceed agreed PPC permit | • Replacement programme for boiler plant assets (Action | Low |

[8] NOTE: value was +13.7% for 2002 HEI, and – 5.6% for 2008/9 – This is a measure of the inherent variability in pollution measurement, dispersion modelling and our accuracy in assessing airport emissions – so is not necessarily an area where we can drive improvement, but is an area where we can show the level of confidence we place in the results of our full airport inventories.

| | | | | | | |
|---|---|---|---|---|---|---|
| control | | limits | emissions limits (new T2 Energy Centre to be added to permit in 2011/2) | emissions limits | 2.23) | |
| | • Total $NO_X$ emissions from HAL's vehicle fleet | • Reduce $NO_X$ emissions by 15% from 2010 levels | • To be determined by12/2011 | • To be determined | • Develop new guidance to lease or buy low emission vehicles (Action 2.16)<br>• Developing long-term fleet technology plan by end 2011 (Action 3.5) | Low |
| To reduce $NO_X$ emissions we guide | • Percentage compliance with maximum APU run time allowances on arrival and departure | • 72% compliance in 2011 | • 85% compliance in 2015 | • To be determined | • Maintaining good availability of FEGP and PCA (Actions 2.6 and 2.7)<br>• Installation of PCA on new stands (Action 2.8)<br>• Carry our audits and promote compliance with APU standards (Action 2.5) | Medium |
| To reduce $NO_X$ emissions we influence | • Percentage of CAEP/6 equivalent aircraft or better ATMs in the Heathrow fleet<br>• Percentage of pre-CAEP equivalent aircraft ATMs | • 45%<br>• 8% | • 50%<br>• 4% | • 55%<br>• 0% | • Encourage $NO_X$ emission reductions through landing charges (Action 2.1)<br>• Liaison with airlines and forecasting team to determine fleet replacement programme | High |

| | | | | | | |
|---|---|---|---|---|---|---|
| | • Total $NO_X$ emissions from airport related traffic. KPI to be developed through the Sustainable Transport Plan | • N/A | • To be determined in 2012 as part of the Sustainable Transport Plan | • To be determined in 2012 as part of the Sustainable Transport Plan | • Ensure actions developed for the Sustainable Transport Plan complement emissions reductions (Action 2.18) | High |
| To demonstrate we are using the best practicable measures to reduce Heathrow's contribution to air quality, balanced against the other operational needs, and to ensure our strategy is understood by key stakeholders | • Benchmark Heathrow's position with regards to air quality management with other comparable airports.<br>• Benchmark stakeholders' opinion of Heathrow's approach to local air quality | • Establish baseline in 2011<br>• Establish baseline in 2011 | • To be determined by end 2011<br>• To be determined by end 2011 | • To be determined by end 2011<br>• To be determined by end 2011 | • Conduct a benchmarking exercise (Action 3.7)<br>• Opinion survey (Action 3.8) | N/A |

# Appendix 1 – Air Quality Action Plan

Air quality is one of the key environmental topics for Heathrow. In particular, emissions of $NO_X$ from the airport impact significantly on local concentrations of $NO_2$, which exceed the health-based EU air quality limit values (due to be met in 2010). This Action Plan details what HAL will do to manage and reduce emissions from aircraft, vehicles and fixed plant to help local sensitive areas meet the EU limit values.

Key to emission reduction estimates:

- high >50 T/yr
- medium = 20 – 50 T/yr
- low <20 T/yr

| Objective | Action | Expected $NO_X$ emission reduction | Timescale | PIs | Interactions and trade-offs | Targets |
|---|---|---|---|---|---|---|
| **1. To accurately quantify the contribution from airport sources to local air quality concentrations to ensure we focus our management activity in areas with the most significant impacts[9]** | | | | | | |
| Monitoring air quality. | 1.1. We will continue to fund automatic air quality monitoring to national standards for nitrogen dioxide, particles and fine particles at LHR2, Oaks Road, Harlington and Green Gates and, at Harlington, to measure ozone as an additional pollutant. | Not applicable | On going | Percentage of annual data capture | None | All sites capture a minimum of 90% of possible data |

[9] See Fig. 5 – $NO_2$ monitoring sites and 2008/9 source apportionment estimates.

| Objective | Action | Expected $NO_X$ emission reduction | Timescale | PIs | Interactions and trade-offs | Targets |
|---|---|---|---|---|---|---|
| | 1.2. We will make monitoring results available on the Heathrow AirWatch website within 24 hours of collection. | Not applicable | On going | Percentage of time data is uploaded on time | None | Data is uploaded within 24 hours after collection for 95% of the time |
| Air quality assessment. | 1.3. We will produce an annual $NO_X$ emissions inventory of pertinent airport-related emissions (e.g. aircraft emissions). | Not applicable | Annually | Total annual airport-related $NO_X$ emissions | None | Complete annual inventory by 30 June each year |
| | 1.4. We will use the results of the annual $NO_X$ emissions inventory to review the efficacy of the action plan. | Not applicable | Annually | Percentage of actions on track | None | Publish in annual report |
| | 1.5. We will make information from our annual $NO_X$ emissions inventory update available to LBs Hillingdon and Hounslow; Slough and Spelthorne Borough Councils; the Mayor of London and other relevant local authorities on request. | Not applicable | Annually | Number of stakeholders that receive the inventory update | None | Send information to relevant stakeholders by 31st August each year |
| | 1.6. In order to predict the potential impact of this Strategy we will conduct a future forecast and dispersion model for 2015 and 2020. | Not applicable | 2011 | Forecast total annual airport-related $NO_X$ emissions in 2015 and 2020 | None | Complete dispersion modelling by 31 December 2011 |

| Objective | Action | Expected $NO_X$ emission reduction | Timescale | PIs | Interactions and trade-offs | Targets |
|---|---|---|---|---|---|---|
| | 1.7. We will conduct an air quality emissions inventory and dispersion modelling for 2015, along with an assessment of source apportionment at key sites. We will forecast emissions and model for 2020. | Not applicable | 2016 | Total annual airport-related $NO_X$ emissions for 2015 and forecast to 2020 | None | Complete dispersion modelling by 31 December 2016 |
| | 1.8. We will conduct an air quality emissions inventory and dispersion modelling for 2020, along with an assessment of source apportionment at key sites. We will forecast emissions and model for 2025. | Not applicable | 2021 | Total annual airport-related $NO_X$ emissions for 2020 and forecast to 2025 | None | Complete dispersion modelling by 31 December 2021 |
| | 1.9. We will analyse our air quality monitoring data annually to better understand the relationship between airport activity and local air quality. | Not applicable | On going | Production of an annual air quality monitoring report | None | Complete analysis of airport-funded monitoring sites by 31st August each year |
| | 1.10. In considering future airport infrastructure, we will continue to evaluate different options from an emissions perspective and seek opportunities to utilise the best practicable solutions to cut emissions. | Not applicable | On going | Number of evaluations conducted | Noise and $CO_2$ | Complete airport infrastructure evaluations when needed |

| Objective | Action | Expected $NO_X$ emission reduction | Timescale | PIs | Interactions and trade-offs | Targets |
|---|---|---|---|---|---|---|
| Automatic data collection of key airport sources. | 1.11. We will scope out what new information can be captured by an existing or enhanced airport system to track aircraft ground movements. | Not applicable | 2012 | Feasibility assessment carried out | None | Assess the feasibility of automatically tracking aircraft ground movements via an enhanced airport system and confirm requirements by 2012 |
| | 1.12. We will work with our airport partners to investigate the feasibility of developing cost-effective automatic data collection to increase the accuracy of emissions inventories and dispersion modelling and to assess impacts on $NO_X$ and $CO_2$ to enable the best trade-off. | Not applicable | 2013 | To be developed as data collection allows | Noise and $CO_2$ | Completion of feasibility study by 2013 |
| | 1.13. We will continue to co-ordinate with all relevant HAL departments the data we need for our air quality assessments. | Not applicable | On going | Collect all necessary data | Noise and $CO_2$ | Collect data annually as required from the NTK system, car parks, airside fuel use and utilities fuel use |
| | 1.14. We will upgrade our airside vehicle license database to provide suitable data needed for air quality assessments. | Not applicable | 2012 | To be confirmed once database established | $CO_2$ | Production of a new database by 2012 |

| Objective | Action | Expected $NO_X$ emission reduction | Timescale | PIs | Interactions and trade-offs | Targets |
|---|---|---|---|---|---|---|
| | 1.15. We will audit our airside vehicle license database against relevant company self assessments from the Clean Vehicle Programme. | Not applicable | 2012 | Percentage accuracy between data bases determined | $CO_2$ | Determine accuracy between databases by 2012 |
| | 1.16. We will investigate the feasibility of fitting vehicle identification units to all of the HAL fleet by 2013 and develop an implementation plan by 2011 to do so, including data collection. | Not applicable | 2011<br><br>2013 | Production of implementation plan<br><br>Percentage of vehicles fitted with vehicle identification units | $CO_2$ | Production of HAL fleet implementation plan<br><br>100% of HAL owned or leased vehicles fitted with vehicle identification units |
| | 1.17. We will consult with airport users to define a standard for data recorded by vehicle telematics units which are fitted to all vehicles with an airside apron pass. | Not applicable | 2011 | Standard defined | $CO_2$ | Definition of standard by 2011 |
| | 1.18. We will consult with airport users to define a timeline for vehicle identification units to be fitted to all vehicles with an airside apron pass. | Not applicable | On going | Number of vehicles fitted with vehicle identification units | $CO_2$ | To establish date by when 100% of the airside fleet to be fitted with vehicle identification units |

| Objective | Action | Expected $NO_X$ emission reduction | Timescale | PIs | Interactions and trade-offs | Targets |
|---|---|---|---|---|---|---|
| **2. To reduce $NO_X$ emissions we control, guide and influence to help achieve compliance with the EU air quality limit values** | | | | | | |
| Reduce emissions from aircraft | 2. We will review our landing charges on an annual basis and within the review we will seek opportunities to incentivise the use of cleaner aircraft | High | Annually | Percentage of ATMs by CAEP2, 4 and 6. | Noise and $CO_2$ | Percentage of ATMs equivalent to CAEP4 and above:<br>• 95% by 2015<br>• 100% by 2020 |
| | 2.1. We will work with NATS to develop a Heathrow specific target to reduce $NO_X$ emissions for aircraft operations on the ground by the end of 2012. | Medium | 2012 | Aircraft emissions from ground operations | Noise and $CO_2$ | Publication of NATS-related $NO_X$ and $CO_2$ reduction target in 2012 |
| | 2.2. Together with our partners in Sustainable Aviation and CAA we will develop a best practice guide for ground operations and departures by the end of 2012 which will aim to optimise the operational performance of departing aircraft with regard to emissions, balanced with noise. | Low | 2015 | Percentage of airlines signed up to adopt guidance | Noise and $CO_2$ | At least 50% of airlines operating at Heathrow to have signed up to adopt guidance contained in the code of practice by 2015 |
| | 2.3. Following our introduction of tighter running time allowances for auxiliary power units (APUs) in 2011, we will review them further in 2014 to assess whether they can be tightened further in 2015. | Medium | 2015 | Publication of new running time allowances | None | Review APU running time allowances in 2015 |

| Objective | Action | Expected $NO_X$ emission reduction | Timescale | PIs | Interactions and trade-offs | Targets |
|---|---|---|---|---|---|---|
| | 2.4. We will monitor compliance of APU running time compared to the allowances in the relevant OSI. | Medium | 2011 | Percentage compliance with the running time allowances | None | Monitor compliance against APU allowances in our OSI:<br>• 72% compliance in 2011<br>• 85% compliance in 2015<br>• compliance in 2020 to be confirmed |
| | 2.5. We will seek to ensure fixed electrical ground power (FEGP) is available for a minimum of 99% of the time to encourage its use at fixed stands during aircraft turn around as opposed to running auxiliary power units. | Medium<br><br>Medium | On going<br><br>On going | Percentage of FEGP availability reported on monthly.<br><br>Findings of review of FEGP provision | Noise and $CO_2$<br><br>Noise and $CO_2$ | Maintain FEGP availability at 99%, tracked using HAL's fault reporting system.<br><br>Regular review of FEGP provision and ensure it is fit for purpose. |
| | 2.6. We will seek to ensure pre-conditioned air (PCA) is available, at stands where it is fitted, for a minimum of 98% of the time to encourage its use during aircraft turn around as opposed to running auxiliary power units. | Medium<br><br>Medium | On going<br><br>On going | Percentage of PCA availability reported on monthly.<br><br>Findings of review of PCA provision | Noise and $CO_2$<br><br>Noise and $CO_2$ | Maintain PCA availability at 98%, tracked using HAL's fault reporting system.<br><br>Regular review of PCA provision and ensure it is fit for purpose |
| | 2.7. We will fit all new and refurbished code E and F stands with PCA. | Medium | On going | Percentage of code E and F stands fitted with PCA | Noise and $CO_2$ | 100% of new and refurbished code E and F stands fitted with PCA |

| Objective | Action | Expected $NO_X$ emission reduction | Timescale | PIs | Interactions and trade-offs | Targets |
|---|---|---|---|---|---|---|
| Reduce emissions from airside vehicles. | 2.8. We will work with our Clean Vehicle Programme and Sustainability Partnership members to help implement actions to reduce emissions from the airside fleets, including behavioural changes and vehicle technology (e.g. electric, hybrids, biofuels and hydrogen). | High | On going | Total $NO_X$ and $CO_2$ emissions from the airside fleet. | $CO_2$ | To be determined in the Heathrow Vehicle Emission Action Plan; to be published in 2011 |
| | 2.9. We will work with airport companies to ensure all vehicles with an airside license are compliant with the age regulation requirements of the current vehicle OSIs. | Medium | 2012 | Production of action plan | $CO_2$ | Produce an action plan to reduce the numbers of exempted airside vehicles |
| | 2.10. We will carry out exhaust emissions checks to VOSA standards as part of our Vehicles Safety check programme and take enforcement action against those vehicles which are non-compliant. | low | On going | Number of annual checks<br><br>Proportion of non-compliant vehicles | $CO_2$ | To carry out a minimum of 400 checks per year |
| | 2.11. We will revise training materials to include reference to eco driving for all drivers who require an airside driving permit. | Low | 2012 | Percentage of staff that have had training | $CO_2$ | Introduce revised eco driver training materials into training package in 2012 for all new and retested drivers |

| Objective | Action | Expected $NO_X$ emission reduction | Timescale | PIs | Interactions and trade-offs | Targets |
|---|---|---|---|---|---|---|
| | 2.12. We will review the Vehicles and Equipment Airside – Requirements OSI with the aim of introducing minimum exhaust emission standards by 2013. | Medium | 2013 | Introduce emission standards into the relevant OSI | $CO_2$ | Introduce specific exhaust emission standards into the Vehicles and Equipment Airside – Requirements OSI by 2013 |
| | 2.13. To help HAL benefit from the introduction of low and zero emission vehicle technology, we will work with our vehicle provider to develop guidance on selecting the most suitable vehicles. | Low | 2011 | Percentage of low and zero emission vehicles<br>Average fleet $CO_2$ and $NO_X$ emissions | $CO_2$ | Develop guidance on the selection of low and zero emission vehicles in the HAL fleet by 2011 |
| | 2.14. We will evaluate the benefits of replacing HAL pool cars with car club vehicles and roll out to all HAL vehicles where it is cost effective to do so. | Low | On going | To be confirmed once evaluation is completed | $CO_2$ | Evaluate the benefits of replacing pool cars with car club vehicles by 2012 |
| | 2.15. To encourage the use of low and zero emission vehicles on the airport we will seek to provide an adequate and appropriate fuelling infrastructure based on a cost-benefit approach, including safeguarding land for future use. | Medium | On going | Percentage of low and zero emission vehicles with an airside license | $CO_2$ | Develop a target to increase the proportion of low and zero emission vehicles with an airside license |

| Objective | Action | Expected $NO_X$ emission reduction | Timescale | PIs | Interactions and trade-offs | Targets |
|---|---|---|---|---|---|---|
| Reduce emissions from landside vehicles. | 2.16. We will work with our Clean Vehicle Programme and Sustainability Partnership members to reduce emissions from the airport-related landside fleets. | High | 2011 | $NO_X$ and $CO_2$ emissions from airport-related vehicles | $CO_2$ | To be determined in the Heathrow Vehicle Emission Action Plan; to be published in 2011 |
| | 2.17. We will seek to incorporate into our Sustainable Transport Plan air quality objectives to develop the transport provision relevant to Heathrow. | High | 2012 | $NO_X$ and $CO_2$ emissions from airport-related landside vehicles | Noise and $CO_2$ | To provide evidence in our Sustainable Transport Plan that air quality objectives are incorporated by 2012 |
| | 2.18. We will support the Hytec project to bring 15 hydrogen taxis to London in 2012. | Low | 2012 | Emissions calculated for the trips made by hydrogen taxis | $CO_2$ | Calculate the emissions savings from use of hydrogen taxis to and from Heathrow (data to be collected as part of the project) |
| Reduce emissions from fixed plant. | 2.19. We will continue to manage the HAL-owned boiler plant in compliance with the Pollution Prevention and Control Permit. | Low | On going | Number of formal notifications made to the Environment Agency declaring a breach of permit emission limits | $CO_2$ | Not to exceed emission limit values as outlined in the pollution prevention and control permit |

| Objective | Action | Expected $NO_X$ emission reduction | Timescale | PIs | Interactions and trade-offs | Targets |
|---|---|---|---|---|---|---|
| | 2.20. We will conduct a 'Best Available Techniques' analysis of all our major boiler plant and then seek secured funding to implement where possible appropriate techniques to manage air pollution emissions responsibly within a suitable time scale. | Not applicable | 2015<br><br>2020 | Complete cost benefit analysis | $CO_2$ | Completion of cost-benefit analysis by 2015<br>Fitting emissions reduction technologies or adopting new techniques where appropriate; driven from the cost benefit analysis by 2020 |
| | 2.21. We will design new heating and boiler plant to meet all regulatory emission limits and incorporate best available techniques balanced with fuel efficiency, carbon emissions and cost. | Low | on going | Number of methods assessed. | $CO_2$ | On a case by case basis, assess methods to reduce air pollution emissions to a minimum, following the principles of best available techniques without incurring excessive cost |

| Objective | Action | Expected $NO_X$ emission reduction | Timescale | PIs | Interactions and trade-offs | Targets |
|---|---|---|---|---|---|---|
| **3. To demonstrate we are using the best practicable measures to reduce Heathrow's contribution to air quality, balanced against the other operational needs, and to ensure our strategy is understood by key stakeholders** | | | | | | |
| Supporting new technology | 3.1. We will publish the aircraft fleet profile (CAEP2, CAEP4, CAEP6 etc) at Heathrow on an annual basis in order to track progress towards a cleaner fleet. | Not applicable | Annually | Percentage of ATMs by CAEP2, 4 and 6 | Noise and $CO_2$ | Percentage of ATMs equivalent to CAEP4 and above:<br>• 95% by 2015<br>• 100% by 2020. |
| | 3.2. We will develop a matrix of aircraft types and engine fits based on noise and $NO_X$ emissions to help develop our landing charges fee structure. | Not applicable | 2011 | Matrix produced | Noise and $CO_2$ | Produce a matrix of aircraft types and engine fits based on noise and $NO_X$ emissions by 2011 |
| | 3.3. We will continue to collaborate on and develop appropriate new methods of air quality assessment. | Not applicable | On going | Number of projects completed | • None | To have completed:<br>• Micro-scale monitoring with University of Cambridge by 2014<br>Particulate monitoring with BA by 2014 |

| Objective | Action | Expected $NO_X$ emission reduction | Timescale | PIs | Interactions and trade-offs | Targets |
|---|---|---|---|---|---|---|
| | 3.4. We will investigate the $NO_X$ impact of reduced engine taxiing and will assess other potentially new operational measures that may be beneficial. | Not applicable | On going | Number of projects completed | $CO_2$ | To have completed:<br>• Assessment of reduced-engine taxiing on $NO_X$ emissions in 2011<br>Review in 2012 |
| | 3.5. We will investigate the current and future vehicle and fuel technologies that can potentially reduce $NO_X$ emissions from the airside and landside fleets and incorporate into a Heathrow Vehicle Emission Action Plan, to be published in 2012. | Not applicable | 2012 | Develop and publish action plan | Noise and $CO_2$ | Publish a Heathrow Vehicle Emission Action Plan, to be published in 2012 |
| | 3.6. We will seek to support the trials of new fuels and technologies for vehicles and fixed applications, and trial them ourselves if appropriate, to assess their cost-benefit for deployment, such as electric vehicles, biofuels and hydrogen. | High | On going | Number of trials completed | $CO_2$ | Measure of emissions reduction to be confirmed |

| Objective | Action | Expected $NO_X$ emission reduction | Timescale | PIs | Interactions and trade-offs | Targets |
|---|---|---|---|---|---|---|
| Benchmarking | 3.7. We will carry out a survey of residents' opinions of air quality to help develop clear messages to explain the airport's impact and key activities being pursued to reduce emissions. | Not applicable | 2011 | Survey completed | $CO_2$ | Production of report to be confirmed |
| | 3.8. Using independent consultants, we will conduct a benchmark survey of air quality management regimes and airside operations at other comparable airports in 2011, 2015 and 2020. | Not applicable | 2011, 2015 and 2020 | Relative position of Heathrow | Noise and $CO_2$ | LHR benchmarks favourably with other airports |
| Health and safety | 3.9. We will undertake occupational exposure monitoring at least once a year in undercrofts and other high risk areas to ensure on going compliance with air quality related occupational exposure limits. | Not applicable | 2012 | Monitoring regime in place | Noise, particles and $CO_2$ | Develop appropriate monitoring regime in 2012 |
| Providing regular air quality updates. | 3.10. We will produce quarterly and annual air quality summaries and publish them on the BAA website, along with comparison of our performance against our KPIs. | Not applicable | On going | Number of reports published | None | Publish four quarterly and one annual reports |

| Objective | Action | Expected $NO_X$ emission reduction | Timescale | PIs | Interactions and trade-offs | Targets |
|---|---|---|---|---|---|---|
| | 3.11. We will develop a table of ATMs by CAEP emissions standards and publish by 31 March each year. | Not applicable | Annually | Production of table | Noise and $CO_2$ | Production of table by 31 March each year |
| | 3.12. We will make quarterly summary reports available to the HAQWG, HACC and LFF within one month of the end of each quarter. | Not applicable | On going | Production of reports | None | Production of four quarterly reports |
| | 3.13. We will investigate what additional information is needed to inform local stakeholders about air quality. | Not applicable | On going | Production of information | None | Define the additional information as required |
| Influencing air quality improvements. | 3.14. We will establish a data sharing working group with NATS and airlines to inform our air quality assessment work. | Not applicable | 2011 | Establish working group | None | Terms of reference for working group established by 31 December 2011 |
| | 3.15. We will support the introduction of more stringent CAEP emission standards. | Not applicable | On going | Evidence of lobbying for more stringent CAEP standards | Noise and $CO_2$ | To support the introduction of more stringent CAEP standards (CAEP/8 to be introduced 31/12/2012) |

| Objective | Action | Expected $NO_X$ emission reduction | Timescale | PIs | Interactions and trade-offs | Targets |
|---|---|---|---|---|---|---|
| | 3.16. We will work with the Heathrow Sustainability Partnership to update and relaunch the Heathrow Clean Vehicle Programme. | Not applicable | 2012 | Number of members | $CO_2$ | Relaunch of Clean Vehicle Programme in 2012 |
| | 3.17. We will seek to ensure HAL reaches Diamond status in the Clean Vehicles Programme for the assessed year 2012. | Not applicable | 2013 | HAL CVP performance grade | $CO_2$ | HAL attains Diamond status by 2013 |
| | 3.18. We will continue to engage with Defra, GLA, TfL and HAQWG local authorities to ensure relevant national, regional and local policies to improve air quality are fully informed of issues at Heathrow Airport. | Not applicable | On going | Number of meetings with each stakeholder. | $CO_2$, noise and other sustainability areas | Minimum of one meeting per year with each organisation |

# Appendix 2 – Tables and Figures

## Table 1. Overview of legal duties in relation to air quality

| Organisation | Summary of air quality responsibilities |
|---|---|
| European Union (EU) | Sets the EU framework in terms of air quality improvements and enforces compliance with limit values |
| Defra (UK Government) | Sets the national framework for air quality improvement through a National Air Quality Strategy and assesses the additional work needed by the Mayor of London (for London only) and English local authorities to achieve the EU limit values and any additional UK air quality objectives.<br>Sets local air quality management (LAQM) framework.<br>Recognised by the EU as the statutory body responsible for meeting the EU limit values |
| Mayor of London | Legally obliged to write an Air Quality Strategy for London which contains additional measures towards meeting the EU limit values and any additional UK air quality objectives.<br>Guides London borough LAQM focus and assesses their air quality review and assessment work. |
| Local authorities (London boroughs) | Have a legal duty to regularly review and assess air quality against the EU limit values and any UK air quality objectives.<br>If air quality is assessed as breaching these limit values and objectives, local authorities have a duty to declare the area an Air Quality Management Area (AQMA) and write an action plan with additional measures to help improve air quality. |

## Table 2. EU Air Quality Limits for $NO_2$ and $PM_{10}$

| Pollutant | Standard | Criteria | Date to be achieved by and maintained thereafter |
|---|---|---|---|
| **Nitrogen dioxide ($NO_2$)** | Hourly limit value for the protection of human health | 1 hour mean of 200 $\mu g/m^3$ not to be exceeded more than 18 times a calendar year | 1st Jan 2010 |
| | Annual limit value for the protection of human health | Calendar year mean of 40 $\mu g/m^3$ | 1st Jan 2010 |
| **Particulate matter less than 10 microns ($PM_{10}$)** | 24-Hour limit value for the protection of human health | 24 hour mean of 50 $\mu g/m^3$ not to be exceeded more than 35 times a calendar year | 1st Jan 2005 |
| | Annual limit value for the protection of human health | Calendar year mean of 40 $\mu g/m^3$ | 1st Jan 2005 |
| **Particulate matter less than 2.5 microns ($PM_{2.5}$)** | Annual limit value for the protection of human health | Calendar year mean of 25 $\mu g/m^3$ | 1st Jan 2015 |
| | Annual indicative limit value for the protection of human health | Calendar year mean of 20 $\mu g/m^3$ | 1st Jan 2020 |
| | Population exposure concentration obligation | Calendar year mean of 20 $\mu g/m^3$ | 1st Jan 2015 |
| | Population Exposure reduction target at urban background sites relative to the national average | 10 -20% reduction | 2020 |
| **Nitrogen oxides ($NO_X$)** | Annual limit for the protection of vegetation | calendar year mean of 30 $\mu g/m^3$ | 19th July 2001 |

## Table 3. UK Air quality objectives from the Air Quality Strategy 2007 for $NO_2$, $PM_{10}$ and $PM_{2.5}$

| Pollutant | Concentration | Measured As | Date to be achieved by and maintained thereafter |
|---|---|---|---|
| **Nitrogen dioxide ($NO_2$)** | 200 µg/m$^3$ not to be exceeded more than 18 times a year<br><br>40 µg/m$^3$ | 1 hour mean<br><br>Annual mean | 31st Dec 2005<br><br>31st Dec 2005 |
| **Particles ($PM_{10}$) (gravimetric)[a]** | 50 µg/m$^3$ not to be exceeded more than 35 times a year<br><br>40 µg/m3 | 24 hour mean<br><br>annual mean | 31st Dec 2004<br><br>31st Dec 2004 |
| **Particles ($PM_{2.5}$)** | 25 µg/m$^3$<br><br>Target of 15% reduction in concentrations at urban background | annual mean<br><br>annual mean | 2020<br><br>Between 2010 and 2020 |

a. Measured using the European gravimetric transfer sampler or equivalent.

## Table 4. pollutants measured at automatic air pollution monitoring sites close to Heathrow Airport

| | | | | Pollutants measured | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Monitoring site** | **Owner** | **Site type** | **Grid reference** | **NO** | **$NO_2$** | **$PM_{10}$** | **$PM_{2.5}$** | **$SO_2$** | **$O_3$** |
| LHR2 | HAL | Airport | 508399, 176746 | x | x | x | x | | |
| Harlington | HAL | Background? | 508300, 177800 | x | x | x | x | | x |
| Green Gates | HAL | Urban background? | 505630, 176930 | x | x | x | x | | |
| Oaks Road | HAL | Urban background | 505714, 174503 | x | x | x | x | | |
| Harmondsworth | LB Hillingdon | Background | 505561, 177661 | x | x | x | | | |
| Sipson | LB Hillingdon | Urban background | 507750, 176750 | x | x | | | | |
| Oxford Avenue | LB Hillingdon | Roadside | 509557, 176994 | x | x | x | | | |
| Hayes | LB Hillingdon | Roadside | 510283, 178905 | x | x | x | | | |
| Cranford | LB Hounslow | Suburban | 510371, 177198 | x | x | x | | x | x |
| Hatton Cross | LB Hounslow | Roadside | 509355, 174989 | x | x | x | | | |
| London Hillingdon | Defra | Suburban | 506900, 178600 | x | x | | | | x |
| Slough Colnbrook | Slough Borough Council | Urban background | 503542, 176827 | x | x | x | | | |

**Table 5. $NO_x$ emissions for 2008/9 by source category; fractional change from equivalent 2002 values**

| Source category | | | Emissions (tonnes/year)[1] | | | FD[2] % |
|---|---|---|---|---|---|---|
| **Airport** | | | | | | |
| Aircraft | | | 4443.59 | | | 7.2 |
| | Ground level | | | 1637.41 | | -1.5 |
| | | Taxi-out | | | 212.78 | -22.0 |
| | | Hold | | | 166.21 | 11.7 |
| | | Take-off roll | | | 717.51 | 9.9 |
| | | Landing roll | | | 40.37 | 4.5 |
| | | Taxi-in | | | 132.39 | -10.5 |
| | | APU | | | 346.06 | -10.2 |
| | | Engine testing | | | 22.08 | 41.8 |
| | Elevated | | | 2806.17 | | 13.0 |
| | | Initial climb | | | 869.62 | 32.0 |
| | | Climb out | | | 1398.22 | 6.1 |
| | | Approach | | | 538.33 | 6.3 |
| Airside vehicles/plant | | | 260.49 | | | 10.0 |
| | Road vehicles | | | 138.41 | | -11.0 |
| | Off-road vehicles | | | 122.09 | | 50.1 |
| Car parks etc | | | 18.27 | | | -31.1 |
| | Public car parks[3] | | | 11.62 | | -30.1 |
| | Staff car parks | | | 5.07 | | -27.7 |
| | Taxis (TFP and forecourts) | | | 1.58 | | -45.1 |
| Stationary sources | | | 283.74 | | | 58.5 |
| | Heating plant | | | 283.60 | | 58.6 |
| | Fire Training Ground | | | 0.14 | | 0.0 |
| **Road network** | | | 2463.59 | | | -31.0 |
| | LDVs | | | 1170.49 | | N/A |
| | HDVs | | | 1293.11 | | N/A |

1 Values quoted to 0.01 tonne for convenience in taking ratios etc. and should not be taken as indicative of the precision of the estimates
2 Fractional Difference=100*(2008/9 value-2002 value)÷2002 value
3 Includes car rental

## Table 6. $PM_{10}$ emissions for 2008/9 by source category; fractional change from equivalent 2002 values

| Source category | | | Emissions (tonnes/year)[1] | | | FD[2] % |
|---|---|---|---|---|---|---|
| **Airport** | | | | | | |
| Aircraft | | | 51.02 | | | 7.1 |
| | Ground level | | | 36.34 | | -1.4 |
| | | Taxi-out | | | 4.38 | -22.7 |
| | | Hold | | | 3.35 | 9.5 |
| | | Take-off roll | | | 3.39 | 33.8 |
| | | Landing roll | | | 0.55 | 14.3 |
| | | Tyre wear | | | 5.98 | 20.0 |
| | | Brake wear | | | 9.07 | 15.1 |
| | | Taxi-in | | | 2.78 | -13.6 |
| | | APU | | | 6.31 | -27.1 |
| | | Engine testing | | | 0.52 | 42.3 |
| | Elevated | | | 14.69 | | 36.4 |
| | | Initial climb | | | 3.35 | 51.2 |
| | | Climb out | | | 6.15 | 31.8 |
| | | Approach | | | 5.19 | 33.3 |
| Airside vehicles/plant | | | 21.43 | | | 16.0 |
| | Exhaust | | | 17.75 | | 21.6 |
| | | Road | | | 5.44 | -31.6 |
| | | Off-road | | | 12.31 | 85.2 |
| | Fugitives | | | 3.68 | | -5.3 |
| | | Road | | | 2.97 | -23.4 |
| | | Off-road | | | 0.70 | N/A |
| Car parks etc | | | 1.64 | | | -0.3 |
| | Exhaust | | | 0.75 | | -17.7 |
| | | Public car parks[2] | | | 0.35 | -10.6 |
| | | Staff car parks | | | 0.15 | -8.7 |
| | | Taxis | | | 0.26 | -29.3 |
| | Fugitives | | | 0.88 | | 21.5 |
| | | Public car parks[2] | | | 0.70 | 42.6 |
| | | Staff car parks | | | 0.17 | -19.9 |
| | | Taxis | | | 0.01 | -50.4 |
| Stationary sources | | | 26.08 | | | 14.6 |
| | Heating plant | | | 26.08 | | 14.6 |
| | Fire Training Ground | | | <0.01 | | 0.0 |
| **Road network** | | | 239.34 | | | 84.0[4] |
| | Exhaust | | | 74.78 | | -42.5 |
| | | LDV | | | 52.14 | N/A |
| | | HDV | | | 22.64 | N/A |
| | Fugitives | | | 164.56 | | N/A |

1 Values quoted to 0.01 tonne for convenience in taking ratios etc. and should not be taken as indicative of the precision of the estimates
2 Fractional Difference=100*(2008/9 value-2002 value)÷2002 value
3 Includes car rental
4 2002 value did not include fugitives
N/A – not available for 2002

## Table 7. Assessment of normalised annual $NO_X$ emissions

| | 2002 | 2008/9 | 2009 | 2010 |
|---|---|---|---|---|
| **Aircraft movements** | 466,554 | 470,029 | 466,393 | 460,546 |
| **Proportion of movements by narrow bodied aircraft** | 72.8% | 65.0% | 65.1% | 65.7 |
| **Proportion of movements by wide bodied aircraft** | 27.2% | 35.0% | 34.9% | 34.3 |
| **Ground level aircraft $NO_X$ emissions (tonnes)** | 1,661.6 | 1,652.3 | 1,618.3 | 1,535.78 |
| **Proportion of $NO_X$ emissions by narrow bodied aircraft** | 33.9% | 28.1% | 27.9% | 28.1 |
| **Proportion of $NO_X$ emissions by wide bodied aircraft** | 66.1% | 71.9% | 72.1% | 71.9 |
| **passengers (mppa)** | 63.01 | 65.93 | 65.91 | 65.88 |
| **passengers per movement** | 135.1 | 140.3 | 143.3 | 143.0 |
| **LTO NOx emission per passenger (g/passenger)[1]** | 65.80 | 68.00 | 67.01 | 64.75 |
| **Ground level NOx emission per movement (kg/ATM)[1]** | 2.70 | 2.70 | 2.69 | 2.64 |

1. LTO ground–level emissions from main engines only (omitting APU and engine testing)

# Appendix 3 – Review of the 2007-11 Air Quality Action Plan

Approximately half of the actions from the *2007-11 Heathrow Air Quality Action Plan* are on-going and have been incorporated into this new Strategy – comprising 32 actions. In total 18 actions were achieved, leaving 11 which were not. The number of actions not achieved is high because the *Air Quality Action Plan* attempted to anticipate a number of possible actions the developing *Surface Access Strategy* (SAS) could contain. Hindsight, has shown this is not a successful approach and although this Strategy makes reference to additional areas which need action, specific measures will be defined by the appropriate strategies; e.g. the *Surface Access Strategy* and *Heathrow Emission Vehicle Action Plan.*

| Objective Area | Total number of actions set | Status | | |
|---|---|---|---|---|
| | | Achieved | On going | Not achieved |
| Aircraft | 12 | 6 | 6 | - |
| Airside Vehicles | 16 | 6 | 9 | 1 |
| BAA influencing others | 1 | - | 1 | - |
| Fixed Sources | 1 | - | 1 | - |
| General Air Quality Management | 12 | 3 | 9 | - |
| Landside vehicles | 18 | 2 | 9 | 7 |
| Airside, other | 1 | 1 | - | - |
| **Total** | **61** | **18** | **34** | **8** |

# Key outcomes

## Aircraft

- Maximise use of FEGP (fixed electrical ground power) – a number of actions were put in place to monitor and target FEGP usage & availability. FEGP availability is over 98% and is fitted to all permanent stands. FEGP is widely used, with airlines being charged for use through landing charges.
- Maximise use of PCA (pre-conditioned air) – PCA is fitted at all T5 stands and some on T3. It will be installed on all new and refurbished JX and JW stands. We will continue to work with airlines to ensure maximum use.
- APU (auxiliary power unit) restrictions – we have seen a drop in APU use over recent years, as well as increasing compliance with the relevant OSI. The increased availability of FEGP is the main way of reducing APU use and we will continue to assess the additional positive impact of using PCA.

## Airside vehicles

- CVP incentive scheme – In April 2007, several CVP members were awarded an incentive scheme grant (over £35,000) for projects that reduced emissions at Heathrow. In addition, we set a 'clean vehicle definition' in 2008 to move the business away from purely age-based limits.
- CVP compulsory membership – The CVP is not designed to support compulsory membership.

## BAA influencing others

- Work with aviation and business partners to reduce $NO_X$ emissions – We held a first workshop in 2009 and continue to work with key airlines to understand the impact of operational changes.

## General Air Quality Management

- Review $PM_{2.5}$ monitoring – We completed the review in 2009 and all HAL financed monitoring sites now measure $PM_{2.5}$ as well as $PM_{10}$.

## New actions

A data performance standard was a specific action needed to help us prepare the new *2008/09 Heathrow Emissions Inventory.* It was not included in HAL's Air Quality Action Plan 2007 – 2011. The collection of a wide range of high quality data is crucial to improve our on-going understanding and is needed to track the air quality impacts of our management techniques and other action taken by airport partners.

# Appendix 4 – Abbreviations and glossary

## Abbreviations

| | |
|---|---|
| µg/m$^3$ | Micrograms per cubic metre |
| APU | Auxiliary power unit |
| AQMA | Air quality management area |
| ASAS | Airport Surface Access Strategy |
| ATM | Air traffic movement |
| CAA | Civil Aviation Authority |
| CAEP | Committee on Aviation Environmental Protection |
| CDA | Continuous Descent Approach |
| $CO_2$ | Carbon dioxide |
| CVP | HAL Clean Vehicles Programme |
| Defra | Department for Environment, Food & Rural Affairs |
| DfT | Department for Transport |
| EU | European Union |
| FEGP | Fixed electrical ground power |
| HACC | Heathrow Area Consultative Committee |
| HAL | Heathrow Airport Ltd |
| HAQWG | Heathrow Air Quality Working Group |
| ICAO | International Civil Aviation Organisation |
| KPI | Key performance indicator |
| LB | London borough |
| LAQM | Local Air Quality Management |
| LFF | Local Focus Forum |
| LHR | London Heathrow Airport |
| LTO | Landing and take-off cycle |
| NGO | Non-governmental organisation |
| NO | Nitrogen oxide |
| $NO_2$ | Nitrogen dioxide |
| $NO_X$ | Nitrogen oxides |
| $O_3$ | Ozone |
| OSIs | Airside operational safety instruction |

| | |
|---|---|
| PCA | Pre-conditioned air |
| $PM_{10}$ | Particulate matter less than 10 microns |
| $PM_{2.5}$ | Particulate matter less than 2.5 microns |
| PSDH | Project for the Sustainable Development of Heathrow |
| VOSA | Vehicle and Operator Services Agency |

## Glossary

**ADMS-Airport** – Atmospheric Dispersion Modelling System for Airports – one of a family of dispersion models developed and marketed by Cambridge Environmental Research Consultants. ADMS-Airport is specifically written to calculate the dispersion of emissions from aircraft engines.

**Air quality action plan** local authorities are legally required to write an air quality action plan for each AQMA they declare. It contains actions to reduce emissions and so reduce concentrations of specific pollutants.

**Air quality limit value** maximum allowable concentration for a specific air pollutant set by the EU. They are defined in EU Directives and have an associated target date for compliance.

**Air quality objective** maximum allowable concentration for a specific air pollutant set by the UK. They are set out in Air Quality Regulations for England, Scotland, Wales and Northern Ireland.

**Annual mean** usually based on a calendar year, the average of all concentrations for a specific pollutant measured over that time base.

**Apron** the area where aircraft are parked to be loaded, unloaded, refueled, or boarded by passengers. It is usually close to terminals.

**AQMA** – air quality management area – a defined geographical area where a local authority has measured or predicted one or more air quality limit values are exceeded and where action is needed to reduce concentrations.

**Atmospheric dispersion model** a mathematical method (usually computer based) to estimate the concentration of pollutants over a geographical area, based on an emissions inventory and using a set of known variables. ADMS-Airport is used by HAL.

**Auxiliary power unit** (APU) an engine, usually located on the rear of aircraft, which provides electrical power when main engines are switched off.

**Average** – see mean.

**Concentration** the mass of a substance in a given volume of air at a receptor site.

**Congestion Charge** a charge levied against certain vehicle types when driven into a specific geographical area.

**Dispersion model** – see Atmospheric dispersion model.

**Emission** the mass of a substance released from a given source.

**Emission inventory** compilation of data used to calculate the quantity of emissions from specific sources based on their geographical location and time of release; typically for a calendar year.

**Emission source** groups of processes with common emission characteristics, e.g. airports or roads.

**Euro standards** maximum allowable mass of specific air pollutants to be emitted from the exhaust of road vehicles as set out by the EU in a number of Directives. (see Stage standards).

**Exceedance** breach of a EU air quality standard or UK air quality limit value.

**FAST** A user-friendly software tool used by HAL based on a specific modelling study to allow scenario testing.

**Heathrow Study Area** an 81km$^2$ zone around the airport (503000, 172000 to 512000, 181000).

**Local authority** defined by the an Act of Parliament, it enacts powers delegated under legislation by the UK government.

**London Air Quality Strategy** the Greater London Authority Act 1999, requires the Mayor of London to produce an Air Quality Strategy as one of several strategies for Greater London.

**London borough** collective description for the 32 London local authorities and Corporation of London.

**Low Emission Zone** – LEZ – a geographical area where certain vehicle use is restricted based on vehicle type and/or exhaust emissions.

**Mean** result of adding two or more amounts together and dividing the total by the number of amounts. Commonly referred to as average.

**Microgram** (µg) one millionth of a gram.

**µg/m$^3$** milligrams per cubic metre of air. The European standard unit of measurement for concentration.

**Micrometre** (µm) one millionth of a metre. Also referred to as a micron.

**NATS** Provides air traffic services to UKs major airports. The acronym originally stood for 'National Air Traffic Services'.

**Nitrogen dioxide** commonly produced from the oxidation of atmospheric nitrogen during high temperature combustion and via photochemical reaction between nitric oxide (NO) and ozone ($O_3$) in air.

**Nitric oxide** formed from the oxidation of atmospheric nitrogen during high temperature combustion and the main constituent of $NO_x$. Also known as nitrogen monoxide.

**NO** – see nitrogen monoxide.

**$NO_2$** – see nitrogen dioxide.

**$NO_x$** – see oxides of nitrogen.

**Oxides of Nitrogen** a mixture of gases produced during high temperature combustion and made up of NO and $NO_2$.

**Particles** microscopic portions of solid matter suspended in air. Also known as particulates, particulate matter (PM), fine particles and soot. See $PM_{10}$ and $PM_{2.5}$.

**$PM_{10}$** microscopic particles with an aerodynamic diameter of 10 microns or less.

**$PM_{2.5}$** microscopic particles with an aerodynamic diameter of 2.5 microns or less.

**Project for the Sustainable Development of Heathrow** (PSDH) recommended methodologies to assess air quality at airports; from the production of emission inventories to subsequent dispersion modelling using ADMS-Airport.

**Receptor site** specific location where air pollution from a specific source or sources may have an impact.

**Stage standards** maximum allowable mass of specific air pollutants to be emitted from the exhaust of non-road engines as set out by the EU in a number of Directives (see Euro standards).

**Terminal** an airport building used to board or disembark passengers from aircraft.

**Undercroft** the area of the apron which is relatively open on three sides but covered by a terminal or similar building.

**UK Air Quality Strategy** establishes the framework for air quality improvements in England, Scotland, Wales and Northern Ireland and is a requirement of the Environment Act 1995.