Air quality management at European airports

B. Owen, D.W. Raper, J.W.S. Longhurst, D.E. Conlan
Atmospheric Research and Information Centre, Department of Environmental and Geographical Sciences, Manchester Metropolitan University, Chester Street, Manchester M1 5GD, UK

Abstract

Airports are dynamic economic enterprises which are also sources of air pollution. The success of airport air quality management will in part enable the ambitious development plans of the industry to be realised. This paper considers the current state of air quality management at European airports and the future of air quality assessment and management. It examines the technical pressures and management structures and processes for air quality management and considers the future evolution of these issues within Europe.

Introduction

Increasing environmental pressures are being placed upon the aviation industry. It is likely that such pressures will continue to grow and they may have significant influence upon the future development of airports throughout Europe. The ecomonic benefits which result from the growth and operation of an airport are felt across large geographical areas, ranging from regions within national boundaries to entire countries. However, the environmental costs are primarily borne by the local environment surrounding an airport and the residents of its neighbouring communities [1]. Historically, environmental protection measures have generally been introduced either as a result of legislative requirements, or as a direct consequence of local community pressure [1]. Environmental pressures vary from country to country across Europe and from one airport to another, in part reflecting differences in social and political attitudes and also arising from historical events which may have heightened the awareness of particular issues. The high population density of Europe and the fact that airlines and passengers prefer those airports which are closest to the centres of population, means that environmental protection and

air quality is of considerable importance to European airports.

Air Quality at European Airports

Numerous pollutants are emitted from fuel combustion and other airport activities. The most important of these are oxides of nitrogen (NOx), hydrocarbons (HC) and carbon monoxide (CO). Ozone (O_3) is an important secondary pollutant. Emissions occur from many mobile, point and area sources within and around an airport including aircraft operations, aircraft ground support units, airside vehicles, power plant, and fuel storage. Road traffic, particularly landside road traffic, is the major source of NOx in the vicinity of an airport [2].

The calculation of future emissions from the ICAO 'average airport' illustrate how both hydrocarbon and NOx emissions will change as technology and other factors change over the next 10 - 12 years [3]. Taking into account traffic forecasts and changes in the aircraft fleet mix ICAO have compared the 1987 and 2005 aircraft engine emissions from an 'average airport'. The reference airport handles 21 million passengers in 1987 with 140 000 air movements each with a seat load factor of 70%. Calculations for 2005 replace Chapter 2 aircraft with Chapter 3 aircraft equipped with present engine technology and a doubling of passengers throughput is assumed. By 2005 the total mass of HC emissions will have fallen by 71%, CO emissions will have fallen by 18% but NOx emissions will rise by 110%. The forecast serves to illustrate the scale of changes in aircraft emissions and highlights the increasing role of NOx emissions. These findings have been borne out by emission estimation studies of several airports in the UK [4, 5, 6].

Such future changes need to be evaluated in the context of downward pressure on other emission sources and the tightening of air quality standards together with the legitimate expectations of the general public for a cleaner environment. Such expectations allied to the activities of pressure groups can give rise to pressure for change especially where the public perceive an airport to be a major pollution source [7].

Air Quality Management at European Airports

Over the last 10 years or so many European airports have carried out air quality assessments. Initially, studies were driven by legislation (e.g. Denmark [8]) or in relation to specific environmental concerns (e.g. acid deposition in Sweden [9]). Much more typically, air quality studies have been carried out for planning and EIA purposes such as Heathrow, Terminal 5 [4, 10, 11] Zurich [12] and the new Oslo airport at Gardermoen [13]. In order to review progress with air quality management the Environment Committee of ACI (Airports Council International) Europe surveyed member airports on environmental

control practices [14]. The questionnaire was circulated to all ACI Europe member airports of which 104 replied. The findings of the questionnaire with regard to air quality are summarised and presented here.

Management Structures for Air Quality

The complexity of the management structure designed to handle enivonmental issues at different airports is related to the extent to which such pressures act upon them [14]. Over one third of responding airports indicated that they had staff with specific responsibility for environmental matters. Unfortunately, no breakdown of staff numbers for air quality within the environment departments was provided. Twenty indicated the existence of an environment department or unit within their corporate structure. Several UK airports have a corporate environment statement or mission statement [15]. At some airports, the level of staffing within the environment department is significant with a total of 34 people employed in the environment department of one ACI member airport [14]. In some countries, (Spain, the Czech Republic) specific environmental expertise is maintained within a centralised airports administrative body rather than at individual airports. Many airports have indicated that they use consultants and other outside bodies to advise on environmental management. Environmental staff are often located within the operations directorate, technical directorate or marketing or public relations departments (particularly when they are focused on dealing with noise and odour problems). The issues are also frequently grouped together with health and safety (the employees' working environment). Differences in management structures for air quality and the location of the decision maker in relation to the site of the problem may be important in explaining different response strategies to air quality problems.

Air Quality Monitoring

The airport management structures and decision making capabilities must be aware of and responsive to the concerns of the regulatory authorities and the local community. In order to address these concerns airports need air quality management tools in the form of monitoring and modelling. Of the 104 airports which responded to the ACI Europe questionnaire, 23 undertake regular air quality monitoring. However, quite clearly the majority of airports (81) do not have any form of air quality monitoring. It appears that those airports which have a monitoring facility are generally those with large numbers of air traffic movements. The key pollutants which are measured are NOx and HCs [14].

In the fifteen year period between 1975-1989, 13 airports installed some form of monitoring equipment [14]. During the period 1990-93 a further 10 airports installed monitoring equipment. This suggests that the pressure upon certain airports during the 1990s has led to an increased awareness of the necessity to

undertake air quality monitoring. Interestingly a further 14 airports are planning to install some form of monitoring by 1998 which lends weight to the increasing importance of air quality as an environmental issue facing airports.

Only five airports have installed monitoring equipment in response to national or local legislation, the majority of airports have made a voluntary decision to install monitoring equipment [14]. Data collected by the monitoring stations are generally utilised for information only and do not appear to be overtly used in formulating policy nor in anticipatory pollution prevention. A few airports take measures to reduce ground based emissions at airports. Two airports report restrictions on the use of auxiliary power units as a means to reduce emissions. Two airports place restrictions on apron vehicle use and similarly two airports have restrictions on vehicle types. Only one airport reported that it used restrictions on ground manoeuvring as a means to reduce emissions of gaseous pollutants. Interestingly, no airport reported the use of restrictions on road traffic access as a means for reducing emissions [14]. Air quality monitoring undertaken at European airports thus appears to act as a useful source of information but does not appear to have a significant influence on airport operations.

Table 1. Air Quality Monitoring [14]

No. of airports monitoring air quality (of 104)	23
Airports with air quality monitoring in response to: Local Legislation Regional Legislation National Legislation Proactive Decision	 2 0 3 17
Airports with air quality or emission related capacity constraints	2
Airports planning to install air quality monitoring	14

Air Quality Modelling

Air quality modelling is usually performed in tandem with monitoring. Air quality data which are collected as part of monitoring studies are necessary to verify and refine the output of the modelling study. However, modelling is a simulation exercise and the accuracy of its output is conditioned by the accuracy of emission estimates and the quality of meteorological data and the robustness of the built-in assumptions as well as other factors. Modelling emissions from airport sources is a complex task as a myriad of small to large sources have to be taken into consideration and source types include line (and slanted line for aircraft which are taking off), area and point. Moreover, airport emissions should be modelled alongside emissions from local and regional sources and longer range pollution should also be considered.

Consequently, the complex task of modelling airport sources becomes even more so as other complicated and diverse sources are brought into the process. However, to predict the impact of airport growth, or to test the performance of a mitigation strategy, air quality modelling is necessary.

Of the 104 airports which responded to the questionnaire, only 11 have previously conducted air quality modelling [14]. Five of these airports modelled their emissions during the 1980s while the remainder commissioned studies during the 1990s. As an indication of the non-routine nature of modelling, 4 airports expect not to model emissions again until the end of the 1990s, the remainder have no plans to model air quality in the future. Models have been used either as planning or environmental tools at most airports although 4 airports indicated that modelling has been used to meet both of these needs. Eleven airports reported that they were planning to commission air quality modelling in the future, although no timescales were given [14]. Unlike air quality monitoring there are no indications that modelling is becoming a priority for airport managements. In general, the modelling which has been conducted has simulated emissions from key on-airport sources and sources outside the airport. Modelling was conducted to meet the demands of either planning or environmental requirements and in some cases both. Modelling is generally conducted on an ad hoc basis rather than being a routine procedure undertaken regularly as part of an integrated air quality management strategy.

Table 2. Air Quality Modelling [14]

No. of airports which have used dispersion modelling (of 104)	11
Airports which use air quality modelling as: Planning tool Environmental tool Planning and environmental tool	 7 8 4
Airports planning air quality modelling	11

Environmental Impact Statement

Any major development at an airport, typically a new runway or terminal, will potentially have a significant impact upon the local environment. This can result from the construction process or its subsequent operation. Because major developments often unlock further capacity for the airport, this is an additional impact which needs to be assessed. In consequence, environmental impact assessment (EIA) can encompass all these effects of a development and may involve a prediction of the environmental impact of the facility and the entire airport when it is being used to capacity.

Legislation in member states of the EU requires an EIA to be undertaken prior to consideration of a planning application for certain developments. The results of such work is summarised in an Environmental Statement (ES). Approximately two thirds of airports which responded to the questionnaire indicated that they had undertaken EIAs prior to recent major developments [14]. Although seven airports reported having undertaken the work on a voluntary basis, the remainder were carried out as a legal requirement. Legislation normally defines the scale of a project which would necessitate an EIA to be undertaken, although some airports have integrated the assessment process into their normal internal project management systems for all developments.

The majority of ESs have been produced during the last five years reflecting increased awareness and legislative changes particularly within the EU. Such a comprehensive approach is therefore comparatively new and it can be anticipated that the ES will become progressively more sophisticated in the future. In many countries, the most recent and relevant ES is taken as the base line model from which any subsequent ones are developed. In general, an EIA included an estimation of the current level of impact if the airport on the local environment and its future impact if the new development were to go ahead and that if it were not. Air pollution is the most commonly covered topic together with noise, in such studies [14]. Odour is the next most commonly covered topic. Issues of particular importance vary between countries depending upon the geographical location of the airport and cultural and historical differences. For example, greater emphasis will be placed upon air quality in countries where air quality legislation is tighter or where the topic has political significance.

The development of air quality management at many airports can be seen to be clearly linked to the demands of environmental impact legislation. Once the management of an airport undertakes a systematic and comprehensive assessment of the air quality impact of their operation and growth, awareness is heightened within the company. The fact that such information is then often placed in the public domain increases the awareness and interest of airport neighbours, environmental and political groups.

Air Quality Management At Airports in the Future

Emissions of certain gaseous pollutants at and around European airports are expected to increase in line with the predicted growth in air traffic movements [3]. As such it is assumed by many in the aviation industry that air quality issues will have to be addressed if the industry is to develop in a sustainable way [16]. EU legislation has lead to several airports undertaking environmental assessments of their current and future operations which in turn has lead to greater awareness of air quality issues within the airport's corporate structure. It is also recognised that air quality issues, if not addressed properly, can

present a possible constraint to expansion. The installation of air quality monitoring equipment at a number of airports has been undertaken as a voluntary decision and not in response to legislation for the majority of cases. This can be seen both a result of the increased awareness within the corporate structure of air quality issues and as a response to public pressure for information and improved air quality and environmental standards. However, it is worth noting that air quality monitoring is still undertaken at only a minority of European airports and it appears that those airports with a monitoring facility are generally those with large numbers of air traffic movements. Air quality modelling has not been undertaken to the same extent as monitoring and is considered to be a non-routine exercise, principally undertaken as part of an EIA. Air quality modelling is an involved exercise and modelling does not appear to be viewed as an integral part of air quality management by most airports. The introduction of legislation may encourage greater integration of the modelling and monitoring components of air quality management at European airports. For example, in the UK, the development of the National Air Quality Strategy as part of the Environment Act 1995 Part IV will require air quality reviews in all local authorities and will require the designation of Air Quality Management Areas where air quality standards are at risk. Dispersion models will be required to determine the nature and scale of any future risk to standards. On this basis, many UK airports will have to work with or lead their regional partners in developing, applying and interpreting the output from such models on a systematic and regular basis. Futhermore, the EU Framework Directive on Ambient Air Quality and Management (COM(95) 312) describes a similar approach to air quality management. The daughter Directives will stipulate air quality objectives and air quality limit values and will provide guidance on monitoring and modelling methods [17].

Conclusions

Many European airports have recognised that air quality is a key environmental issue and a number have undertaken air quality monitoring programmes on a voluntary basis sometimes forming part of a corporate environmental strategy. It is notable however, that air quality data obtained from monitoring programmes have generally been used for information purposes only and airports do not appear to be overtly utlising these data in formulating policy or in anticipatory pollution prevention. A more integrated approach to air quality management is likely to encourage a more dynamic relationship between operational decisions at an airport and its air quality management functions. Air quality dispersion modelling has also played some part in air quality management at airports. However, due to the complexity of modelling airport sources, modelling has had a fairly limited application at airports. Dispersion modelling studies have tended to be non-routine and often conducted for planning purposes, for example, forming part of an EIA to accompany an application for expansion or development. As the aviation industry develops

and airport capacities grow, questions concerning air quality will continue to be asked and guidance sought, particularly as advances are made in the scientific community's knowledge of air quality impacts on human health. In response to this, many European airports are introducing or continuing existing air quality monitoring programmes. Although dispersion modelling has not played a regular role in air quality management at European airports, it seems likely that the future role of dispersion modelling will increase as a more integrated approach to air quality management evolves.

References

[1] Longhurst, J.W.S & Raper, D.W. The impact of aircraft and vehicular exhaust emissions on Airport air quality. Paper presented at the International Civil Airports Association Seminar 'Aircraft Noise and Air Pollution: the Impact on Airport Capacity', Brussels, February 5th-7th. ICAA, Brussels. 1990

[2] Longhurst, J.W.S.; Raper, D.W. & Conlan, D.E. Local and Regional Air Quality Impacts of Airport Operations *The Environmentalist 16(2)* 1996 forthcoming

[3] Nitsche, V. & Walker, P. Assessment of the future total emissions from an average Airport, taking into account the traffic forecast and changes in the fleet mix. Paper presented at the International Civil Aviation Organisation, Committee on Aviation Environmental Protection Technical Issues Sub Group, Willamsburg, Va., USA, 15-17th October. ICAO/CAEP/TISG BIP6/1. 1990

[4] British Airports Authority *Heathrow Terminal 5. Environmental statement. Air quality modelling study.* BAA, Gatwick. 1992

[5] Manchester International Airport plc *Manchester Airport Second Runway : Environmental Statement* MA plc, Manchester 1994

[6] Birmingham International Airport plc *Outline Planning Application for the Expansion of the Passenger Terminal Facilities and Related Infrastructure: Environmental Statement* 1995

[7] Longhurst, J.W.S. The context of the aviation: air quality debate. Paper presented at the 'International Air Quality Seminar' 4 6th November 1991, Birmingham International Airport. 1991

[8] Fenger, J., Berkowitz, R. Stenfalk, L., Jensen, A.B., Nielsen, T, Pilegaard, K & Nielsen, P.A. *Luftkvalirersundersogelser ved Kobenhavns Lufthavn 1988 - 1989.* DMU, Roskilde. 1990

[9] Westerberg, J. Environmental regulation of air traffic in Sweden. Paper presented at the 'International Air Quality Seminar' 4 - 6th November 1991, Birmingham International Airport. 1991

[10] British Airports Authority *Heathrow Terminal 5. Consultation on an environmental statement. Stage 2. Air quality.* BAA, Gatwick. 1992

[11] British Airports Authority *Heathrow Terminal 5. Consultation on an environmental statement. Stage 1. Air quality measurement survey.* BAA, Gatwick. 1992

[12] Brunner, W., Hanson, J., Hildesheimer, G., Huber, H., and Schurter, E. *Umweltbilanz Synthese* Flughafen Zurich Airport Authority, Zurich, Switzerland. 1991

[13] Gronskei, K.E., Gram, F. & Kibsgaard, A. *Hovedflyplass Gardermoen. Luftforurensning ved alternative utbyggingsplaner.* NILU Report, O-91053, Lillestom, Norway. 1992

[14] Airports Council International European Region (ACI) Environment Handbook ACI Europe, PPS Publications Ltd, Surrey, UK 1995

[15] British Airports Authority *Heathrow Airport Limited (HAL) Environmental Performance Report* BAA, Gatwick. 1995

[16] Raper, D.W., Wayson, R.L., Bowby, W and Longhurst, J.W.S *Airports and Air Quality Issues - the European Perspective.*23 International Air Transportation Conference, American Society of Civil Engineers, Air Transport Division, Virginia USA. 1994

[17] National Society for Clean Air *NSCA Pollution Handbook* Brighton 1996