

Environmental charging – Review of impact of noise and NO_x landing charges

CAP 1119



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Contents

Summary	6
Section 1 Purpose and scope	8
Section 2 Principles of noise-related charging	10
Previous studies	10
The legal position	10
UK Law	10
European Law	11
Guidance on noise-related charges	12
Charging parameters	15
ICAO noise certification	15
ACI Aircraft Noise Rating Index	16
Quota Count	17
Section 3 Noise-related charging in practice	19
Charging elements and values (as applied in 2013/14)	19
Historical charges	22
Charges relating to time of day	24
Section 4 Possible effects of noise-related charges	27
Charge differentials	27
Noise-related charges in the context of overall airport charges	31
Section 5 Principles of emissions-related charging	35
Previous studies	35
The legal position	35
UK Law	35
European Law	36
Guidance on NO _x emissions-related charges	37
Charging parameters	38
Ascertained NO _x Emission	38

Section 6	Emission-related charging in practice	39
	Charging elements and values (as applied in 2013/14)	39
	Historical emissions standards	40
	Historical charges	41
Section 7	Possible effects of emissions-related charges	43
Section 8	Issues for consideration	44
	Absolute vs relative noise levels	44
	Linear vs stepped charging categories	44
	Potential trade-offs	45
	Approach	46
	Cap and Trade	46
	Polluter Pays	47
	Value of intervention	47
	Harmonisation	49
Section 9	Conclusions	50
	Noise	50
	Emissions	52
	Common to noise and emissions	52
	Good practice principles	53
Appendix A	Previous studies	54
Appendix B	Sources of information	56

Summary

This review has been prepared to provide information in relation to the Department for Transport's (DfT) Aviation Policy Framework (APF) and new Night Noise Restrictions at Heathrow, Gatwick and Stansted, and to meet an objective of the Civil Aviation Authority's (CAA) Environmental Strategy.

Noise-related and NO_x emissions-related landing charging schemes have been reviewed for the airports designated by the Secretary of State for noise management, and three non-designated UK airports for comparison. Historical charging data has been obtained covering the last twelve years.

Background information is presented on how environmental charges should be applied, including the governing legislation and parameters used to set the charges. An analysis of how they are actually applied in practice, and then any possible effects arising due to the charges is presented. In light of this, issues that should be considered when setting new charging schemes and developing proposals for new policy options are also explored.

The main finding is that although differential environmental landing charges have some incentive effects but they are unlikely to be the main financial driver for using quieter and less-polluting aircraft. More effective charging schemes could be developed which drive improvements through the setting of more appropriate charge differentials, and by earlier introduction of the higher charges for categories of aircraft that exhibit poor noise and NO_x performance relative to emerging standards.

Under the CAA's current price regulation of Heathrow, Gatwick and Stansted, increases in environmental landing charges would have to be counter-balanced by decreases in other airport charges. As noise and emissions-related landing charges are relatively low compared to per-passenger charges there could be scope to do this.

However, there is a possibility that increasing charges significantly above current rates would become operating restrictions before driving fleet changes. Options to increase incentives may therefore be restricted to increasing differentials rather than absolute charges, while addressing potential trade-offs with other environmental and economic factors, and factors relating to consumer choice and experience.

The study concludes by highlighting a number of principles which we consider to constitute good practice in the setting of airport noise and emissions charges:

- a) Noise charging categories should be based on ICAO certification data, namely the margin to Chapter 3, to incentivise best-in-class.
- b) Noise charging categories should be of equal width, typically 5 EPNdB, or narrower, to ensure adequate differentiation of noise performance.
- c) The noise charging categories used at a given airport should cover the full range of aircraft in operation at the airport. This range should be reviewed periodically and modified as appropriate.
- d) Noise charges for operations occurring at night should be greater than those that occur during the day.
- e) Where noise-related charge differentials occur depending on the time of day of an operation, the scheduled time of the operation should be used as oppose to the actual time. Penalties may be used to disincentivise operations scheduled to occur on the cusp of the night period that regularly fall into the night period.
- f) There should be a clear distinction between noise-related landing charges and any non-noise-related charges, e.g. demand-related charges.
- g) Charging schemes should ideally be harmonised across airports within the UK. Aircraft should be treated similarly from one airport to another, even if the charges at each airport are different.

SECTION 1

Purpose and scope

This review aims to provide information relating to the Department for Transport's (DfT) Aviation Policy Framework (APF) and new Night Noise Restrictions at Heathrow, Gatwick and Stansted, and to meet an objective of the Civil Aviation Authority's (CAA) Environmental Strategy.

In the Aviation Policy Framework¹ the Government recognises that 'the acceptability of any growth in aviation depends to a large extent on the industry tackling its noise impact'. It accepts, however, 'that it is neither reasonable nor realistic for such actions to impose unlimited costs on industry. Instead, efforts should be proportionate to the extent of the noise problem and numbers of people affected'.

As part of the range of options available for reducing noise, the Government states that 'airports should consider using differential landing charges to incentivise quieter aircraft'. Consequently, it has asked the CAA to investigate the use of differential landing fees in order to ensure that airports and airlines are better incentivised to use aircraft that are best in class, and to ensure that the cost of noise disturbance, particularly at night, is sufficiently reflected in these fees.

The next Night Noise Restrictions regime is due to come into force in 2014. In line with the Government's aspirations as presented in the APF, these may cause, or at least need to reflect, changes to penalties, landing charges and monitoring arrangements.

The CAA has published its environmental strategy (CAA and the Environment) which sets out a work programme to ensure that the CAA takes a coordinated and consistent approach to addressing the importance of environmental issues. One area of the work programme (IM5) involves working with Government and stakeholders to identify how noise and emissions (principally oxides of nitrogen, NO_x) related landing charges may incentivise the introduction of new quieter and cleaner aircraft technology.

This paper has been prepared in response to all of the above, beginning with sections 2 to 4 which address noise charging, followed by sections 5 to 7 which address emissions charging (where emissions refers specifically to NO_x emissions which affect local air quality). These sections cover background information on how

1 Aviation Policy Framework, Department for Transport, March 2013

environmental charges should be applied, a review of how they are actually applied in practice, and any possible effects arising due to the charges. Issues that should be considered when setting new charging schemes and developing proposals for new policy options are explored in section 8. Conclusions are presented in section 9, including a list of principles which we consider to constitute good practice in the setting of airport noise and emissions charges.

Noise-related and emissions-related charging schemes have been reviewed for the airports designated by the Secretary of State for noise management, i.e. Heathrow (LHR), Gatwick (LGW) and Stansted (STN), as these are of particular interest to the DfT. Charging schemes for Manchester (MAN), East Midlands (EMA) and Birmingham (BHX) have also been assessed for comparison, at DfT's request, since these are also among the busiest airports in the UK. Historical charging data has been obtained covering the last twelve years.

SECTION 2

Principles of noise-related charging

Previous studies

Studies into noise-related landing charges have previously been published. Some examples of such studies are presented in Appendix A. One of the studies highlighted the desirability for standardisation and harmonisation of charging schemes.

The legal position

UK Law

Under subsection (1) of Section 38 of the Civil Aviation Act 2006², an aerodrome authority may fix its charges in respect of an aircraft or a class of aircraft by reference (among other things) to:

- a) any fact or matter relevant to the amount of noise caused by the aircraft or the extent or nature of any inconvenience resulting from such noise, for the purpose of encouraging the use of quieter aircraft and reducing inconvenience from aircraft noise;
- b) (paragraph relates to emissions, see section 5, page 35);
- c) any fact or matter relevant to the effect of the aircraft on the level of noise or atmospheric pollution at any place in or in the vicinity of the aerodrome, for the purpose of controlling the level of noise or atmospheric pollution in or in the vicinity of the aerodrome so far as attributable to aircraft taking off or landing at the aerodrome;
- d) any failure by the operator of the aircraft to secure that any noise or emissions requirements applying to the aircraft are complied with, for the purpose of promoting compliance with noise or emissions requirements.

Subsection (4) gives the Secretary of State a power to direct specific aerodrome authorities to fix their charges in exercise of any power conferred by subsection (1); and any such order may contain directions as to the manner in which those charges are to be so fixed. The fixing of charges may be implemented through setting differential landing fees.

² Civil Aviation Act 2006, Chapter 34, Part I, Section 38: Aerodrome charges: noise and emissions

Additionally, subsection (5) says that in directing an aerodrome, the Secretary of State shall have regard to the interests of persons who live in the area in which the aerodrome is situated.

In Section 38, 'aerodrome authority' means a person owning or managing an aerodrome licensed under an Air Navigation Order; and 'charges', in relation to an aerodrome authority, means the charges the authority makes for the use of an aerodrome so licensed which is owned or managed by the authority.

The Airport Charges Regulations 2011³ implements Airport Charges Directive (see below) in the UK. Regulation 14 identifies that 'Airport charges set by a regulated airport operator must not discriminate between airport users'. This 'does not prevent a regulated airport operator from varying airport charges for reasons relating to the public and general interest, including for reasons relating to the environment, where the criteria used for varying the charges are relevant, objective and transparent'.

European Law

The Airport Charges Directive⁴ sets common principles for the levying of airport charges (not including charges for the remuneration of en route, terminal air navigation and ground-handling services, and assistance to passengers with disabilities and reduced mobility) at Community airports. This Directive shall apply to any airport located in a territory subject to the Treaty and open to commercial traffic whose annual traffic is over five million passenger movements and to the airport with the highest passenger movement in each Member State.

This Directive gives rise to an expectation that airports should publish their charges, although this is not explicitly stated as a requirement. The UK implementing regulations require that airports publish their airport charges. Article 3 of the Directive says that airport charges should not discriminate among airport users, but this does not mean that airports must charge everyone the same amount. Article 3 also says that charges may be modulated for issues of public and general interest, including environmental issues. Article 10 states that the level of airport charges may be differentiated according to the quality and scope of such services and their costs or any other objective and transparent justification.

Our interpretation is that the Directive is concerned with flexibility rather than firmly enunciated principle. Article 3 prohibits discrimination, but expressly does not prevent modulation of charges for issues of general interest including

³ Statutory Instrument 2011 No. 2491 Transport. The Airport Charges Regulations 2011

⁴ Directive 2009/12/EC of the European Parliament and of the Council of 11 March 2009 on airport charges

environmental issues, and 'the criteria used for such a modulation shall be relevant, objective and transparent'. The Directive also operates without prejudice to the right of States to apply additional regulatory measures that are not incompatible with it, including economic oversight measures, such as the approval of charging systems and/or the level of charges (Article 1(5)). For me the key to the ACD is consultation and transparency. This is followed through in the UK Airport Charges Regulations 2011, in Regulation 14 for example.

Article 4(1) of the 'Balanced Approach' Directive 2002/30/EC⁵ states that in addition to the Balanced Approach, Member States 'may also consider economic incentives as a noise management measure'. The UK Aerodromes Regulations 2003⁶ transpose this into UK law at Regulation 5(1)(b).

There is also governance on charges other than those strictly related to landing aircraft. For example, under the Single European Sky Charging Regulations for Air Navigation Services, Article 16 addresses the modulation of air navigation charges. As such, Member States may, following consultation, modulate such charges incurred by airlines to reflect their efforts to 'reduce the environmental impact of flying'. This may apply to en route charges or terminal air navigation charges, the latter often being wrapped up in the airport's wider charges to airlines.

Guidance on noise-related charges

Noise-related charges are one of several types of airport charge. Guidance on airport charges is provided by the International Civil Aviation Organisation (ICAO) in their Document ref. 9082 ICAO's Policies on Charges for Airports and Air Navigation Services⁷.

Consultation on changes to charging systems and levels is required to ensure that airports give adequate information to operators relating to the proposed changes and gives proper consideration to the views of operators and the effect the charges will have on them. Agreement between airports and operators is desirable, but where it is not reached, the airport is free to impose the charges proposed, subject to a right of appeal.

5 Directive 2002/30/EC of the European Parliament and of the Council of 26 March 2002 on the establishment of rules and procedures with regard to the introduction of noise-related operating restrictions at Community airports

6 Statutory Instrument 2003 No. 1742 Civil Aviation. The Aerodromes (Noise Restrictions) (Rules and Procedures) Regulations 2003

7 Document 9082, ICAO's Policies on Charges for Airports and Air Navigation Services, Ninth Edition, ICAO, 2012

According to Regulation 9 of the Airport Charges Regulations 2011, if a regulated airport operator intends to change the system or level of airport charges at an airport that it manages, it must give at least four months notice before the change has effect. This would not give airlines enough time to change their fleet, however, it may influence decisions on the allocation of aircraft to particular routes. Structural changes such as increasing the differentials for noisier aircraft are often signalled around a year in advance of their implementation.

ICAO Doc 9082 provides guidance on noise-related charges. According to section II paragraph 8, noise-related charges should:

- be levied only at airports experiencing noise problems;
- be designed to recover no more than the costs applied to the alleviation or prevention of actual noise problems;
- be associated with the landing fee, possibly by means of surcharges or rebates, taking into account the noise certification provisions of ICAO Annex 16 in respect of aircraft noise levels;
- be non-discriminatory between users; and
- not be established at such levels as to be prohibitively high for the operation of certain aircraft.

Measures to alleviate or prevent noise problems, which are funded by the noise-related charges, are described in Appendix 1 of Doc 9082 as:

- Noise-monitoring systems, noise-suppressing equipment and noise barriers;
- Land or property acquired around airports; and
- Soundproofing of buildings near airports and other noise alleviation measures arising from legal or governmental requirements.

ICAO recommends the costs incurred in implementing such measures may, at the discretion of states, be attributed to airports and recovered from the users, and that states have the flexibility to decide on the method of cost recovery and charging to be used in the light of local circumstances. When noise-related charges are to be levied, consultations should take place on any items of expenditure to be recovered from users.

The guidance in ICAO Doc 9562 Airport Economics Manual⁸ suggests that the 'effective perceived noise level (EPNL) of the aircraft concerned could be used as a charging or rebating parameter'. This is embodied in the guidance in section

⁸ ICAO Document 9562, Airport Economics Manual, First Edition, ICAO, Second Edition

II.8 of Doc 9082, referred to above, whereby the certification provisions of ICAO Annex 16 are based on EPNL. Doc 9562 also clarifies that 'the sophistication or complexity in the design of the scale would vary according to local circumstances and requirements' and that the 'scale could be linear or in steps'⁹.

ICAO's Environmental committee, in reviewing the future of the noise certification scheme, agreed the following purpose for noise certification¹⁰:

'The prime purpose of noise certification is to ensure that the latest available noise reduction technology is incorporated into aircraft design demonstrated by procedures which are relevant to day to day operations, to ensure that noise reduction offered by technology is reflected in reductions around airports.'

The reference to 'latest available noise reduction technology' emphasises that noise certification standards are intended to be technology-following, rather than driving the development of new technology. A key reason for this is to ensure that standards can be met with safe certified technology. The standards therefore act primarily as a back stop to the process of phasing out older aircraft.

The European Civil Aviation Conference ECAC-CEAC document ECAC/24-1 Noise Charges and Rebates gives additional recommendations on: a common framework and methodology for how charges (and rebates) should be calculated; characterisation of arrival and departure noise levels; maximum variation of noise charges; information to the public, evaluation and proportionality of noise charges to noise impacts. The latter advises that unit noise charges at arrival and at departure should reflect the relative impacts of arrivals and departures for populations around the airport (Article 3).

Finally, one of the principal elements of the ICAO's Balanced Approach to Aircraft Noise Management¹¹ is Land-use planning and management measures. This can be categorized as planning, mitigation and financial instruments. As well as capital improvements and tax incentives, the latter includes noise-related airport charges. The financial instruments are intended to generate revenue to assist in funding noise mitigation efforts.

The Balanced Approach reflects the provisions of the Civil Aviation Act 1982 that noise-related airport charges may be levied by national governments, local governments or the airport authority at airports experiencing noise problems. It identifies that the application of noise-related charges should follow the relevant

9 'Linear' is taken to refer to a 'continuous', rather than 'stepped' scale. In the case of noise, a continuous scale could be used but the relationship could be either linear or logarithmic

10 ICAO Document 9886, Report of the Seventh Meeting of the ICAO Committee for Aviation Environmental Protection, February 2007.

11 ICAO Document 9829, Guidance on the Balanced Approach to Aircraft Noise Management

principles in ICAO's Policies on Charges for Airports and Air Navigation Services (Doc 9082), as mentioned above.

Cost sources associated with noise-related charges are set out in the Balanced Approach as: the cost of the charge to airlines, and downstream administrative and legal costs.

Charging parameters

ICAO noise certification

According to the seventh meeting of the Committee on Aviation Environment Protection (CAEP) in 2007, 'the prime purpose of noise certification is to ensure that the latest available noise reduction technology is incorporated into aircraft design demonstrated by procedures which are relevant to day to day operations, to ensure that noise reduction offered by technology is reflected in reductions around airports'.

Where EPNL is used as a charging (or rebating) parameter, as explained in the previous section, the recommendation is that the certification provisions of ICAO Annex 16 are used.

Type certification of aircraft includes noise certification, whereby testing is undertaken to measure noise levels during the take-off and landing phases of operation. Three measurements are taken: flyover and sideline (lateral) during take-off, and approach during landing. These tests are carried out in a controlled manner and the three certification noise levels are first compared with the limits as defined in ICAO Annex 16 to establish compliance with the various chapter standards.

The Chapter 2 standard became applicable in 1972 as the first noise standard for subsonic jet aeroplanes. The phase out of Chapter 2 aircraft was completed on 1 April 2002¹².

The Chapter 3 standard became applicable in 1978 and set a limit on the cumulative noise level (based on the arithmetic sum of the three certification noise levels) around 16 dB lower than the Chapter 2 limit. Chapter 3 then became a reference against which the subsequent noise standard was defined. For aircraft below the Chapter 3 limits, the cumulative margin is then calculated by summing the margin under the Chapter 3 limits for the three measurements.

The Chapter 4 standard required all new aircraft type designs to have a cumulative margin of 10 EPNdB or more as of 1 January 2006. In other words, the Chapter 4

¹² Since 2002, 'Chapter 2' aircraft (of over 34 tonnes maximum take-off weight or with more than 19 seats) have no longer been allowed to operate at EU airports

limit represents an increase in stringency of 10 EPNdB (cumulative) relative to the Chapter 3 limit.

The new Chapter 14 standard was agreed in February 2013 as the fourth ICAO noise standard for large transport aeroplanes. It represents an increase in stringency of 7 EPNdB (cumulative) relative to the Chapter 4 cumulative levels and will apply to new aircraft types submitted for certification on or after 31 December 2017. For aircraft of maximum certificated take-off mass of less than 55 tonnes, the new standard will apply on or after 31 December 2020. Additionally, this is the first standard that incorporates even more stringent limit criteria for aircraft with a maximum certificated take-off mass of less than 8,618 kg.

Limits may be exceeded for one or two of the three noise measurements provided that:

- The sum of the exceedances is not greater than 3 EPNdB for Chapter 3 (4 EPNdB for Chapter 2);
- No single exceedance is greater than 2 EPNdB for Chapter 3 (3 EPNdB for Chapter 2); and
- The total exceedance is offset by the margin under the limit(s) for the remaining measurements.
- The Chapter 3 limits are not exceeded at any of the measurement points, and the sum of the differences at any two measurement points between the certification noise levels and the Chapter 3 limits are not less than 2 EPNdB for the Chapter 4 standard.
- The measurements are not less than 1 EPNdB below the Chapter 3 limits at each certification point for the Chapter 14 standard.

The ICAO limits, within chapter standards, vary with Maximum Take-off Weight (MTOW) in order that aircraft are treated comparably taking account of their size (weight). As such, the system is designed to address 'in-class' noise performance in order that the oldest and noisiest aircraft are phased out over time.

ACI Aircraft Noise Rating Index

Beyond the ICAO Chapter categories, there are further subdivisions again based on the cumulative margin below the Chapter 3 limit. These categories accord with the cumulative margin thresholds for the Airports Council International (ACI) Aircraft Noise Rating Index and are used in some airport charging systems to achieve a greater level of refinement in the noise categorisation of aircraft types.

The aircraft noise categories for different cumulative margins are as follows:

- Chapter 3 High - Cumulative Margin of between 0 and 5 EPNdB
- Chapter 3 Base - Cumulative Margin of between 5 and 10 EPNdB
- Chapter 4 High - Cumulative Margin of between 10 and 15 EPNdB
- Chapter 4 Base - Cumulative Margin of between 15 and 20 EPNdB
- Chapter 4 Low - Cumulative Margin of 20 EPNdB or more

Table 1 below shows examples of aircraft types meeting the various noise category criteria. Different airframe/engine variants of a given aircraft type may have different cumulative margins and therefore the aircraft type may fall into more than one noise category.

Table 1: Proportions of aircraft noise certification variants¹³

Aircraft Type	Chapter 2	Chapter 3	Chapter 3	Chapter 4	Chapter 4	Chapter 4
		High	Base	High	Base	Low
A319				4%	80%	16%
A320				33%	59%	8%
A321			34%	58%	8%	
A330				56%	39%	4%
A340						100%
A380						100%
B737-700				50%	50%	
B737-800/900				89%	11%	0%
B747-200		52%	42%	7%		
B747-400			5%	61%	32%	2%
B757-200				30%	38%	32%
B767-300		3%	9%	30%	49%	9%
B767-400					100%	
B777-200				5%	46%	49%
B777-300				7%	91%	2%
EMB-170			8%	92%		
MD82			21%	77%	2%	

¹³ Data from: European Aviation Safety Agency (EASA) Type-certificate data sheet for noise database (TCDSN), Jets Issue 14

Quota Count

Some charging systems use the Quota Count (QC) system as a charging parameter.

The Quota Count (QC) system was introduced as part of a new night restrictions regime for Heathrow, Gatwick and Stansted in 1993 (Ref 1). Aircraft movements (arrivals or departures) count against a noise quota for each airport according to their QC classifications. The method by which QC classifications are determined was based on a 1991 analysis of aircraft noise data that was then available. The QC classification is intended to reflect the contribution made by an aircraft to the total noise impact around an airport, the latter being expressed by the total Quota Count, i.e. the sum of the QC classifications of all arrivals and departures. Classifications are assigned separately for arrivals and departures.

QC classifications describe absolute noise levels, but in relative terms on a scale: a QC/1 aircraft is deemed to have twice the impact of a QC/0.5 aircraft, a QC/2 aircraft has four times the impact and so on. The QC classifications of aircraft are determined from their certificated noise levels, which are measured in EPNdB. Although certificated EPNLs can fall anywhere within a wide range, they are grouped for practical QC purposes into 3 EPNdB-wide bands (although the highest and lowest bands are unlimited). Because a 3 EPNdB difference in noise level corresponds to a two-fold difference in noise energy, successive QC classifications increase by multiples of two.

QC classifications make no allowance for the MTOW of the aircraft. Therefore, as smaller aircraft are generally quieter than larger aircraft, they will generally be described by a lower QC classification.

SECTION 3**Noise-related charging in practice**

The charging elements relevant to this study, i.e. those which could be used to incentivise the use of quieter aircraft, are discussed in this section which looks at the current (or latest available) noise charges.

Charging elements and values (as applied in 2013/14)

Information on the charging systems adopted by individual airports is available from the airports themselves. Further information on the sources of information used in this study is given in Appendix B. Details of the charging systems in use at the study airports reviewed are presented in Table 2.

Table 2: Summary of charging systems at the study airports (2013/14)

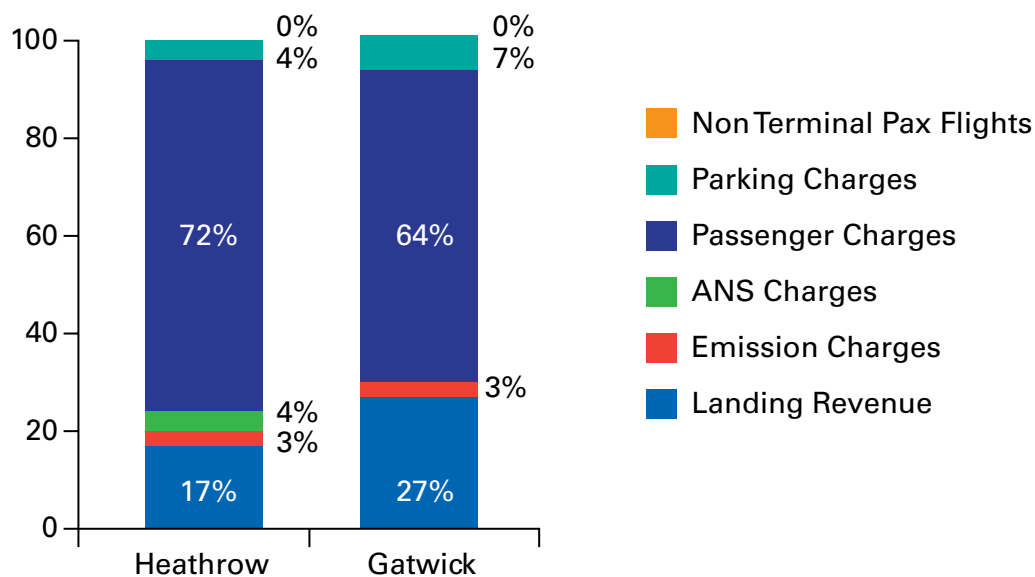
	Heathrow	Gatwick	Stansted	Manchester	Birmingham	East Midlands
Runway charge	Landing	Landing and Departure	Landing	Departure	Departure	Departure (landing and departure separately for freight)
Weight parameter	MTOW (stepped)	MTOW (stepped)	MTOW (stepped)	'Maximum Take Off Weight Authorised' (semi-continuous, rate changes at 25t and 120t)	MTOW (continuous)	MTOW (> 5.8t continuous)
Noise parameter(s)	ICAO/ACI noise category	ICAO/ACI noise category & QC	ICAO/ACI noise category & QC	ICAO/ACI noise category & QC	n/a	QC
Ch2	300%	300-338%	300%	170%	n/a	n/a
Ch3 high	300%	150%	150%	100%	n/a	n/a
Ch3 base	100%	100%	100%	100%	n/a	n/a
Ch3 minus	n/a	90%	90%	n/a	n/a	n/a
Ch4 high	60%	85%	90%	100%	n/a	n/a
Ch4 base	50%	85%	90%	100%	n/a	n/a
Ch4 minus	30%	85%	90%	100%	n/a	n/a
Night period, local time	01:00-04:30	n/a	n/a	n/a	n/a	23:30-06:00
Night surcharge	150%	0%	0%	0%	0%	25% (if QC/4+)
Night surcharge, Freight (if different to passenger)	n/a	n/a	n/a	n/a	n/a	Shoulder periods (06:01-07:00 & 21:01-23:29): 306% Night period (23:30-06:00): 410-479% depending on QC.
Off-peak	n/a	Winter 24h per day, and Summer 13:00-18:00 & 20:00-07:00	Winter 24h per day	Reduced winter rates. Combinations of QC values and time periods from 05:30-22:59	n/a	n/a
Off-peak reduction	n/a	67-71% (summer), 67-100% (winter)	74%	19% (MTOW > 25t) > 19% (MTOW > 120t)	n/a	n/a
Off-peak reduction, Freight (if different to passenger)	n/a	n/a	n/a	48%	n/a	n/a

At the designated airports, it is only the runway landing charges which are relevant to noise management. The charge on landing is assessed and payable on the basis of the Maximum Total Weight Authorised¹⁴ as recorded by the airport companies on 1 April of each year, and noise certification values for side-line, flyover and approach for all flights. The other charging categories have no clear dependency on the noisiness of the aircraft or what time of day the aircraft are flying. This is perhaps with the exception of the per-passenger charge which will be greater for larger aircraft which tend to be noisier than the smaller lower capacity aircraft.

Figure 1 below illustrates the revenue that Heathrow and Gatwick forecast for 2013/14 proportionally according to the various types of charge imposed. Total revenues of £1.5bn and £300m were anticipated at Heathrow and Gatwick respectively during this year. These revenues were calculated using the information given in the conditions of use consultation documents¹⁵ for these airports.

Figure 1

Forecast revenues at Heathrow and Gatwick



At the non-designated airports studied, various charging parameters are in use. Many of these are relevant to noise management, though none are specifically

¹⁴ Maximum Total Weight Authorised in relation to an aircraft means the maximum total weight of the aircraft and its contents at which the aircraft may take-off anywhere in the world in the most favourable circumstances in accordance with the Certificate of Airworthiness in force in respect of the aircraft

¹⁵ Heathrow Airport, Airport Charges for 2013/14, Consultation Document, Date: 26th October 2012 and Gatwick Airport Charges Group – Consultation on airport charges 2013/14, 31st October 2012.

charges on landing so strictly speaking cannot be considered noise-related charges according to ICAO Doc 9082.

Historical charges

The ICAO noise standards exist to ensure, in the most part, comprehensive uptake of new aircraft technology by certain dates as described below. They also put some pressure on the aviation industry to design and manufacture quieter aircraft. To summarise the history of how the various standards came into effect:

- Aircraft that did not meet the Chapter 2 standard¹⁶ were not permitted to be operated at European airports from 2002, unless exempted under very narrow circumstances (e.g. a Head of State flight, mercy flight or maintenance positioning flight).
- In the same year the Chapter 3 'marginally compliant'¹⁷ definition was introduced in the EU, and the rules governing the phasing out of such aircraft transposed into UK law via the implementation regulations¹⁸ which took effect on 6th August 2003.
- In June 2001, on the basis of recommendations made by the fifth meeting of the Committee on Aviation Environmental Protection (CAEP/5), the Council adopted the Chapter 4 noise standard, and on 1 January 2006, the new standard became applicable to newly certificated aeroplanes and to Chapter 3 aeroplanes for which re-certification to Chapter 4 is requested.
- Looking to the future (thus for information only in this retrospective study), the new ICAO Chapter 14 noise standard was agreed in February 2013 and will come into effect from 31st December 2017 for aircraft with MTOW of 55 tonnes or higher, and 31st December 2020 for aircraft with MTOWs less than 55 tonnes.

While there has been a progressive tightening of international aircraft noise standards, noise-related charges at all six airports have also risen over the years. For example at Heathrow, considering the lowest noise category in 2001/2 (Chapter 3 Minus) and 2012/13 (Chapter 4 Minus), and accounting for an average inflation rate over this period of 3.2%, the increase in equivalent charge is 35% of the charge in 2001/2.

16 Specifically, civil jet aeroplanes exceeding 34 tonnes Maximum Total Weight Authorised (MTWA)

17 Aircraft with a cumulative margin of between 0 and 5 EPNdB. This made the distinction between Chapter 3 aircraft that were within the noisy and quiet halves of the range. Also described as Chapter 3 High.

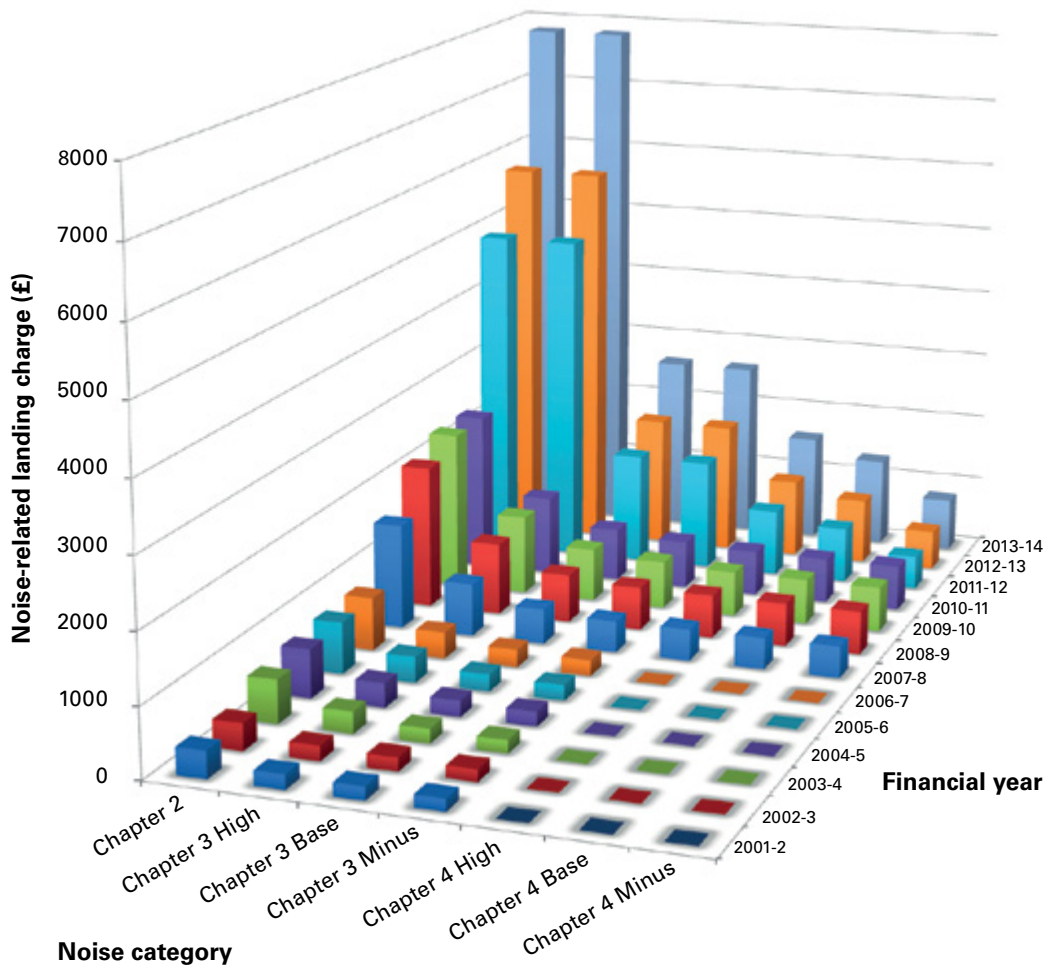
18 Statutory Instrument 2003 No. 1742 Civil Aviation. The Aerodromes (Noise Restrictions) (Rules and Procedures) Regulations 2003

There has also been an upward trend in charges within noise categories, presumably intended to incentivise the use of quieter aircraft. For example at Heathrow, scaling up the charge for a Chapter 3 Base aircraft in 2001/2 to 2012/13, again assuming inflation at a rate of 3.2%, and comparing this with the charge for a Chapter 3 base in 2012/13, there is an increase in charge of over 300%.

Charging categories have also changed over time, with the introduction of categories with lower noise level criteria (namely the Chapter 4 categories described in section 2, page 17) to accommodate the emerging aircraft types with improving noise performance.

The noise-related (landing) charges, per noise category, between 2001/2 and 2013/14 at Heathrow are illustrated in Figure 2 below.

Figure 2
Noise-related charges at Heathrow Airport¹⁹



¹⁹ In the absence of data for 2002-3, mindful that charges increase from one year to the next, the 2001-2 charges have been presented for this year.

Figure 2 shows that the most significant relative increases in charge for Chapter 2 and 3 aircraft compared with the quieter Chapter 4 aircraft occurred in 2011/12. This shows that there was a lag of around five years between the introduction of the Chapter 4 standard in 2006 and any appreciable noise-related landing charge incentives.

Aircraft not meeting the Chapter 2 standard have not been permitted to operate at EU airports since 2002, nearly a decade before the significant relative increase in landing charge for Chapter 2 aircraft. Furthermore, the voluntary phasing out of Chapter 3 'marginally compliant' aircraft began in 2003 and, again, it took around eight years for relevant charges to rise significantly.

This highlights that charging rates have followed changes in aircraft technology rather than driven them. As previously mentioned, this is the declared ICAO policy for all environmental standards, i.e. they should be technology-following, not technology-forcing. However, fleet decisions may be made in the light of an expectation of changes to charging regimes (as well as other factors such as quotas and bans), not least because aircraft are such long-term assets. If noisier aircraft are expected to become more expensive, then that may change buying decisions in advance of the charging regimes actually being introduced.

Charges for a given year are usually announced during the preceding year. When airports make changes to their structure of charges, they may be announced up to three years in advance. As these time-frames are less than the five to ten years lag between the introduction of new noise standards and incentivising pricing, any expectation of increasing charges for noisier aircraft will most likely be founded on industry precedence rather than specific changes to airport charging schemes.

Charges relating to time of day

The charges at all the airports which were reviewed, except Stansted, incorporate an element which depends upon the time of day when a chargeable operation occurs.

Our current understanding is that noise from night-time aircraft operations causes a greater adverse effect in humans than noise from daytime operations²⁰. As such, some noise charging schemes disincentivise night operations.

The time of the chargeable operation may be defined as the actual time or the scheduled time of the operation. Using the actual time of operation perhaps appears to better reflect the 'polluter pays' principle than using the scheduled

²⁰ As concluded in report: Perceptions of Aircraft Noise, Sleep and Health. University of Southampton, Cardiff University, Queen Mary and Westfield College, and BRE to Civil Aviation Authority, December 2000

departure time, i.e. the airline pays for the disturbance of a daytime or a night-time noise event accordingly. However, a daytime operation scheduled to occur on the cusp of the night period may be delayed or brought forward into the night period for reasons outside the airline's control. The higher charge would therefore be levied, whether or not it is the fault of the airline. Using the scheduled time as a basis for noise-related landing charges will result in more predictable charges and may be more effective in influencing airlines' scheduling decisions. An additional system of penalties may be applied to deter daytime scheduled services from regularly falling into the night period.

Of the six airports studied, the simplest case of setting time-of-day charge differentials occurs at Heathrow whereby all aircraft landing during the night period will incur charges that are 2.5 times the normal charges in the day period. Of the airports, Heathrow's night charge provides the greatest incentive against night-time operations considering only the effect of charging. As night-time capacity is scarce at Heathrow due to the night restrictions, the elevated charges may also reflect demand.

The temporal charging scheme is relatively complex at Gatwick. Base charges are around 3-3.5 times higher at peak times compared with off-peak times during the summer. The peak periods broadly occupy the morning and early evening rather than the night period. As the off-peak periods include night-time hours up to 07:00, there is, in effect, an incentive to operate at night instead of during the day in the summer months. There is no peak/off-peak differentiation in winter which means that the same rate applies for operations of aircraft in a given noise category irrespective of the time of operation. There is no charge for Chapter 3 Base and Chapter 4 aircraft during the winter, during the day or night. The temporal element of the charging system at Gatwick therefore appears to offer incentives to operate during the sensitive night period in the summer, and no disincentives to operate during the night in winter.

Birmingham Airport operates a night noise violation surcharge which although has a noise-management function, does not constitute a noise-related charge. It has therefore not been given further consideration in this study.

An off-peak charge is levied at Manchester for aircraft which meet certain QC values departing at certain times of day, presumably based on demand. These off-peak times include 05:30-06:59 during the night period, and the evening period 19:00-22:59 (local times based on scheduled departure times). This, in effect, provides an adverse noise incentive, i.e. offering 19% and 48% lower charges to some passenger and freight aircraft respectively, which operate during the early morning and evening. These periods are generally considered to be more sensitive than the daytime. As QC values are a measure of the absolute

noise produced by an aircraft, airport charges set on the basis of QC values, like those at Manchester, use higher charges to deter noisier aircraft (with higher QC ratings) and lower charges to encourage quieter aircraft (with lower QC ratings). Conversely, as ICAO standards vary with MTOW, other airports which set their charges on the basis of these and the ACI Aircraft Noise Rating Index aim to incentivise best-in-class performance.

At East Midlands, a passenger aircraft night surcharge of 25% of the runway charge applies to all passenger aircraft departing during the core night period that fall into QC categories above QC/2. Additional charges are levied on cargo aircraft which equate to an increase of over 300% for arrivals and/or departures between 06:00-07:00 or 21:01-23:29, and a 410-479% (depending on the noisiness of the aircraft) increase for arrivals and/or departures between 23:30-06:00 local time. East Midlands' charging structure does offer a significant incentive against night-time operations by noisier aircraft types, and in particular, against night-time freight operations. As for Manchester airport, East Midlands uses QC values as a charging basis, i.e. considering absolute rather than relative noise levels. All runway charges, shoulder/night supplement charges and noise surcharges for freight are based on the time recorded by East Midlands Airport Air Traffic Control (ATC) that the aircraft wheels either touched down on the runway on arrival or left the runway on departure.

The charging structures at Heathrow and East Midlands provide means for the airlines to internalise some of the costs of night-time noise disturbance. Birmingham offers disincentives for night-time operations, though not through noise-related charging per se. Some of the charges at Gatwick and Manchester, by contrast, incentivise operating at night. Stansted does not incorporate an element which depends upon the time of day when a chargeable operation occurs.

SECTION 4

Possible effects of noise-related charges

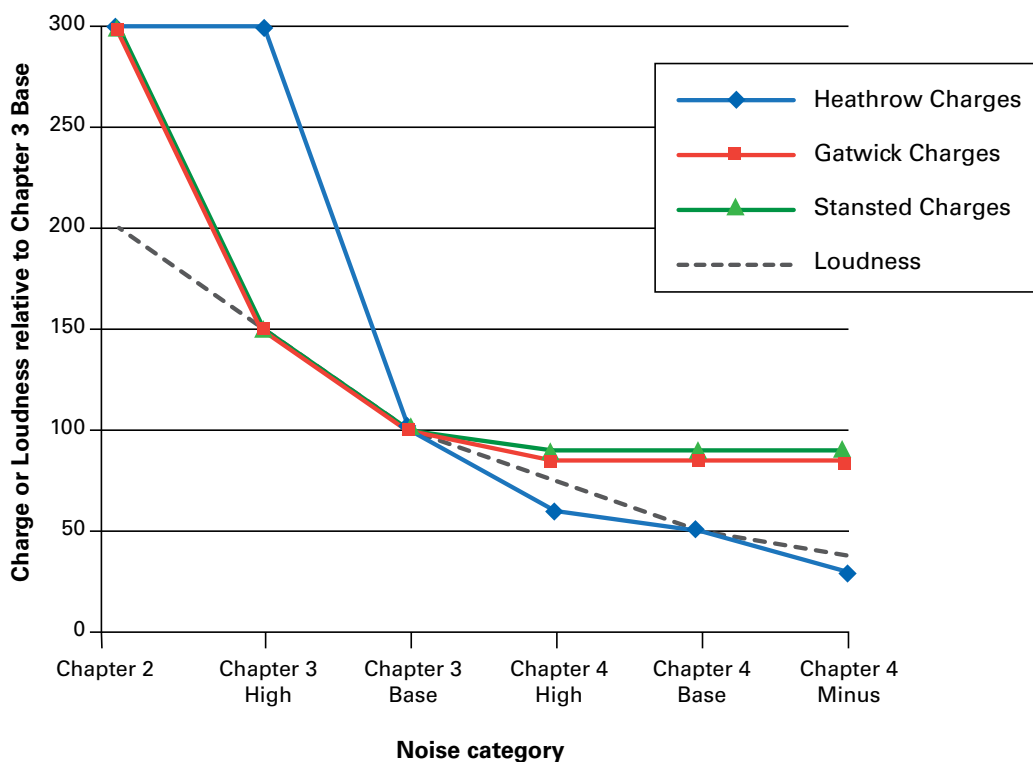
Charge differentials

The analysis here considers only the charging differentials between aircraft of different noise categories at airports which levy such charges (i.e. the designated airports) for the charging year 2013/14. Figure 3 shows typical noise-related (landing) charges for each noise category, normalised to the Chapter 3 Base charge for each airport (data from Table 2).

An additional line is plotted which indicates the relative loudness of the categories. Adopting the commonly used rule-of-thumb that a 10 dB increase approximately equates to a doubling of loudness, the dashed line is normalised to the Chapter 3 Base level of loudness.

Figure 3

Relative noise charges for different noise categories²¹ at the designated airports



²¹ Based on 2013/14 charges at Heathrow (for aircraft >16T, daytime), Gatwick (peak) and Stansted (for aircraft >16T and <55T, peak).

It can be seen that all airports impose relatively much higher charges for the prohibited Chapter 2 aircraft compared to the Chapter 3 Base charge, i.e. no less than 300%. Charges for Chapter 3 High are closer to the base charge, with the exception of Heathrow which imposes the same charge as for Chapter 2 operations. This analysis suggests significant disincentives for use of a Chapter 2 aircraft (exemptions are permitted under exceptional circumstances), and at Heathrow, Chapter 3 High aircraft as well. However, as the law dictates that Chapter 2 aircraft should not operate, the disincentive to use Chapter 2 aircraft will have no material effect.

Heathrow levies progressively lower charges for categories that are quieter than Chapter 3 Base. Considering the relative loudness curves, Heathrow's charges reflect the noisiness of the categories reasonably well; except, as mentioned above, for the Chapter 3 High charge which appropriately disincentivises the use of aircraft which have been, or are in the process of being, phased out.

At Gatwick and Stansted, there is a marginal lower charge relative to the base charge for all categories which are quieter than Chapter 3 Base. The Chapter 4 charges at these airports clearly do not reflect the reducing noisiness of these categories. This is discussed in more detail in relation to Figure 5 later in this section.

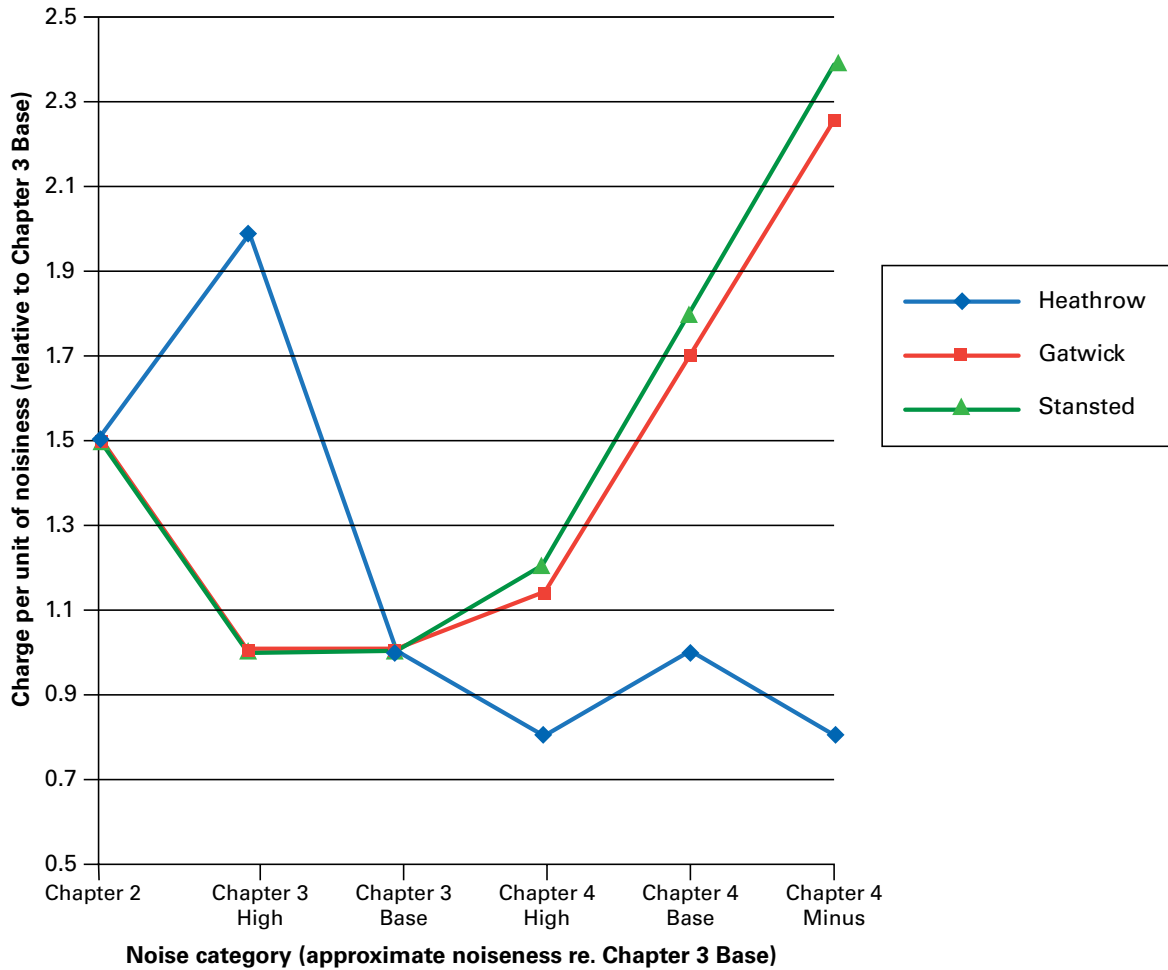
There is also a marginal incentive to use a Chapter 3 Minus over a Chapter 3 Base aircraft at Gatwick and Stansted. This category is not included in the figure as it is based on the same cumulative margin criteria as Chapter 3 Base, but requires aircraft to be QC/1 or less on both arrival and departures.

This data can also be expressed as the ratio of charge per 'unit of loudness', to illustrate the relative 'noise value for money' of the category charges at the designated airports. This is presented in Figure 4, which shows that at Heathrow, operating the quieter Chapter 4 aircraft is less expensive, per unit of noise, than operating the noisier Chapter 3 and Chapter 2 aircraft. This may mean that airlines operating the relatively noisier aircraft at Heathrow internalise some of the cost of their enterprise.

Figure 4 also shows that at Gatwick and Stansted, the worst noise value for money is offered for the use of the quieter Chapter 4 aircraft, and the best value is offered for the noisier Chapter 3 aircraft. This model may therefore disincentivise airlines from using these quieter aircraft.

Figure 4

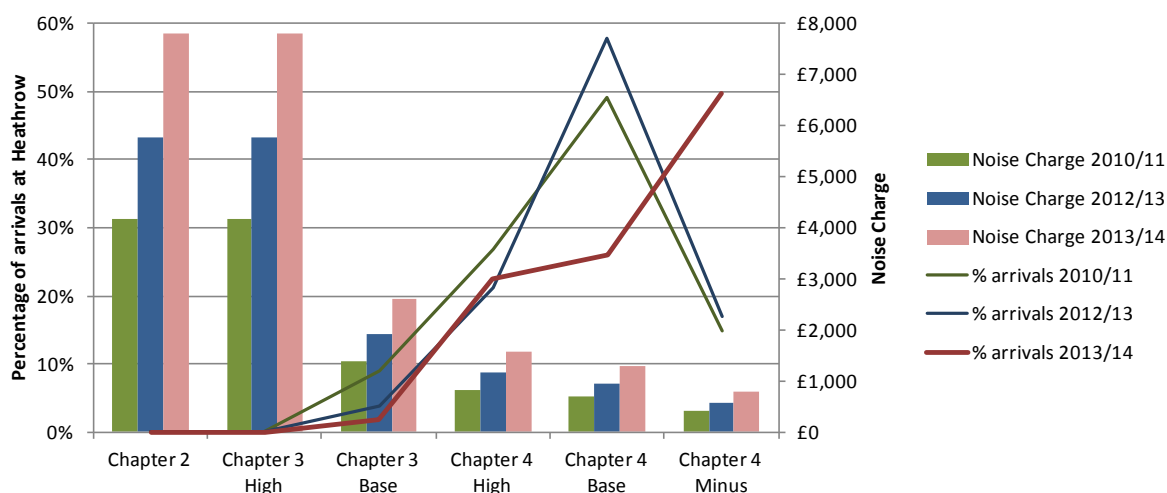
Relative noise charges per unit noisiness relative to Chapter 3 Base at the designated airports



The majority of modern aircraft operating in Europe fall within Chapter 4. This is illustrated by the lines in Figure 5 which represent the proportions of arrivals of aircraft in different noise categories anticipated at Heathrow in 2010/11, 2012/13 and 2013/14. The bars indicate the landing charges levied at Heathrow for aircraft of different noise categories in the corresponding years.

Figure 5

Proportion of arrivals, and charges, for aircraft in different noise categories at Heathrow



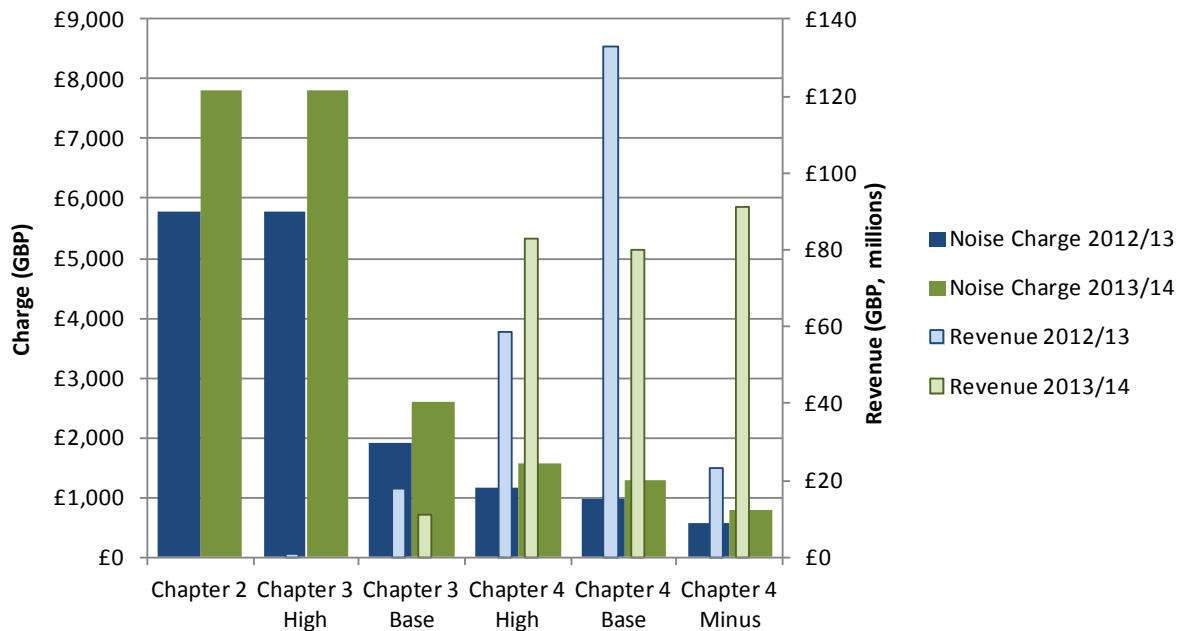
The majority of aircraft at Heathrow fall within the quieter Chapter 4 noise categories, and face the lower landing charges. Between the 2010/11 and 2013/14, the anticipated fleet mix profile moved towards the quieter Chapter 4 aircraft, with a stark move to Chapter 4 Minus aircraft in 2013/14. Considering the differences between the Chapter 4 category charges, there is a modest incentive to move towards the quieter end of Chapter 4 at Heathrow. Considering Table 2 and Figure 3, however, at Gatwick and Stansted there is no additional landing charge incentive to use an aircraft that is quieter than the Chapter 4 High and Chapter 3 Minus category respectively, which make up the majority of aircraft types operating at these airports.

In this context, the high charges for Chapter 2 and Chapter 3 High, which on face value appear to offer a clear disincentive to use noisy aircraft, have a limited ability to 'bite' owing to the relatively low numbers of aircraft to which they apply. The most meaningful charge differentials, where they exist, are therefore between the quieter Chapter 4 categories.

An alternative illustration is provided in Figure 6 below, which shows that at Heathrow in 2012/13, the highest revenues from landing charges were predicted to come from aircraft meeting the Chapter 4 Base standard. In 2013/14, the revenues were predicted to be more evenly distributed across Chapter 4. In both cases, revenues for the Chapter 2 and Chapter 3 High aircraft make up a negligible proportion of the total charges which reflects the low numbers of operations of these aircraft.

Figure 6

Charges and revenues from noise-related charges for Heathrow in 2012/13 and 2013/14



Currently there is insufficient differentiation between the aircraft with higher cumulative margins that make up the vast majority of operations. The system could introduce greater incentives by further differentiating the charges for aircraft with higher cumulative margins.

Noise-related charges in the context of overall airport charges

Noise-related (landing) charges are a component of the airport charges (see section 3 and Figure 1). Airport charges typically comprise:

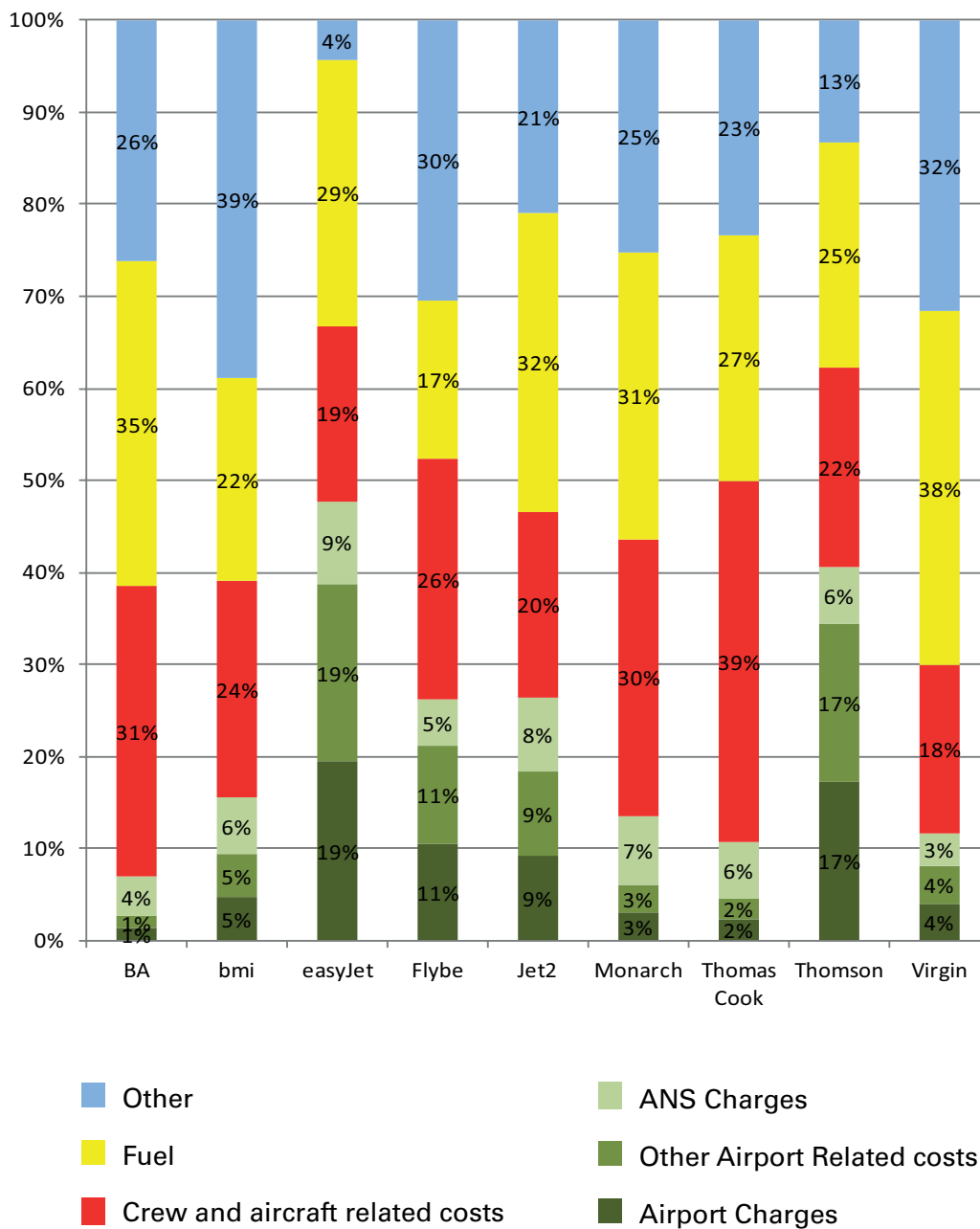
- Landing and departure fees;
- Emissions charges
- Air Navigation Services (ANS) charges
- Passenger charges
- Parking charges; and
- Charges relating to non-terminal passenger flights

Referring to Figure 1, in 2013/14, landing charges were forecast to account for 17% of a total of £1.5bn revenue at Heathrow, and 27% of £300m at Gatwick for example.

Further to this, the airport charges (of which landing charges are a component) constitute only a proportion of the total charges which an airline faces. Figure 7 below shows the cost breakdown by type for various airlines in 2011/12.

Figure 7

Airline cost breakdown (2011/12)²²



²² Source: CAA UK Airline Financial Tables, based on annual profit and loss, airline appropriation and balance sheet statistics collected from major UK Airlines

Based on this information, airport charges range from 1% for British Airways to 19% for easyJet. As seen in the examples for Heathrow and Gatwick above, around a quarter of the airport charges constitute the landing/runway charges. Therefore, the noise-related landing charges may comprise from less than 1% up to around 5% of total charges according to the available data.

Any landing/runway charge differentials would in turn only apply to a proportion of the total charges for the operations of an airline's fleet. These differentials consequently make a limited relative contribution to an airline's costs, diluting the incentives when considered in terms of the total charges faced by airlines. Viewed in isolation, these relatively small differences may not appear to be able to have a significant influence on purchasing and/or operating decisions when balanced with factors such as fuel-efficiency or adherence to departure noise limits. However, their contribution is likely to be meaningful as one of a basket of measures (including penalties for departure noise and track-keeping infringements).

Comparing noise-related landing charge costs with fuel costs, for airlines such as BA and Virgin who operate a significant proportion of long-haul services, fuel may be up to 38% of total costs yet the noise-related landing charge is about 1%.

Once legislative requirements are met, commercial considerations would have a large influence on the decisions made by airlines on which aircraft types to use. The aim would be to save costs in the areas which contribute most to the overall airline costs. This might prioritise the use of higher capacity aircraft that can reduce per passenger costs, as well as the reduction of fuel costs, both in preference to reducing noise related landing charges.

This approach would incentivise replacing fleets with newer, larger, more fuel-efficient aircraft. By virtue of being newer, these aircraft will typically be quieter in class than the older models they replace, as they will need to meet ICAO chapter standards which become more stringent over the course of the service life of the aircraft.

Obtaining further incremental reductions in noise levels produced by new aircraft types often incurs a reduction in fuel efficiency. E.g. fitting sound absorbing linings to engine cowls adds weight which increases fuel-burn. This may either disincentivise the use of quieter aircraft types, or result in a fuel-efficiency trade-off where meeting certain noise limits has significant commercial implications.

Airline purchases of aircraft are a long-term decision, with potentially significant lead times from order to delivery depending on the state of an aircraft manufacturer's order book. A time lag between imposing higher charges on noisier aircraft and the greater use of quieter aircraft at the airport would therefore be expected. If airlines have a mix of aircraft types in their fleet, with some being

noisier than others, they might be expected to react more quickly to incentives to use quieter aircraft at a particular airport.

An additional factor is the differences between airlines' regarding their flexibility in fleet planning and aircraft route allocation. For instance, an airline based at one airport only may not be able to move an aircraft out of the airport but a foreign flag carrier with a varied fleet may allocate the noisy aircraft in the fleet to an airport with less onerous noise-related charges.

Depending upon an airline's circumstances, differential charges may therefore accelerate the replacement of aircraft by the order of one to two years, and may influence the choice of aircraft used for a new service. Any influence the charges may have on such decisions would be in the balance with other drivers for which priorities may be higher or lower.

We have also seen that some airports also have peak/off-peak differential landing charges to encourage airlines to use larger aircraft during peak times. Conversely they may have very low, or even zero landing charges at off-peak times to encourage airlines to use slots that otherwise would not be used. Being intended to provide incentives for operations at certain times of day, these may lead to beneficial noise effects if peak periods are chosen to coincide with times of day when people are most sensitive to noise (i.e. night-time). However, where other periods are chosen (for other reasons such as spreading slot demand), adverse noise effects may result. Either way, for transparency and to avoid unintended consequences such as these, there should be a clear distinction between demand-related and noise-related differential landing charges.

Overall, differential landing charges would have some incentivising effects but they are unlikely to be the main financial driver for introducing quieter aircraft. The improvements in aircraft technology appear to have been driven by other factors such as tightening international noise standards and meeting other noise restrictions (e.g. departure noise limits and quota count criteria). To have a more significant impact, landing charge differentials would need to increase within the Chapter 4 noise categories thus incentivising only the quietest aircraft types. Landing charges for noisier aircraft may also have to rise considerably to have any real impact.

SECTION 5

Principles of emissions-related charging

Previous studies

Studies into NO_x emissions landing charges have previously been published. Some examples of such studies are presented in Appendix A.

The legal position

UK Law

Under subsection (1) of Section 38 of the Civil Aviation Act 2006²³, an aerodrome authority may fix its charges in respect of an aircraft or a class of aircraft by reference (among other things) to:

- a) (paragraph relates to noise, see section 2, page 10);
- b) any fact or matter relevant to the amount or nature of emissions produced by the aircraft or the extent or nature of any atmospheric pollution resulting from such emissions, for the purpose of encouraging the use of aircraft which produce lower emissions of any substance which contributes to atmospheric pollution;
- c) any fact or matter relevant to the effect of the aircraft on the level of noise or atmospheric pollution at any place in or in the vicinity of the aerodrome, for the purpose of controlling the level of noise or atmospheric pollution in or in the vicinity of the aerodrome so far as attributable to aircraft taking off or landing at the aerodrome;
- d) any failure by the operator of the aircraft to secure that any noise or emissions requirements applying to the aircraft are complied with, for the purpose of promoting compliance with noise or emissions requirements.

Subsection (4) gives the Secretary of State a power to direct specific aerodrome authorities to fix their charges exercise of any power conferred by subsection (1); and any such order may contain directions as to the manner in which those charges are to be so fixed. The fixing of charges may be implemented through setting differential landing fees.

²³ Civil Aviation Act 2006, Chapter 34, Part I, Section 38: Aerodrome charges: noise and emissions

Additionally, subsection (5) says that in directing an aerodrome, the Secretary of State shall have regard to the interests of persons who live in the area in which the aerodrome is situated.

In Section 38, 'aerodrome authority' means a person owning or managing an aerodrome licensed under an Air Navigation Order; and 'charges', in relation to an aerodrome authority, means the charges the authority makes for the use of an aerodrome so licensed which is owned or managed by the authority.

European Law

Repeating the elements of section 2, page 11 which apply to emissions as well as noise, the Airport Charges Directive²⁴ sets common principles for the levying of airport charges (not including charges for the remuneration of en route, terminal air navigation and ground-handling services, and assistance to passengers with disabilities and reduced mobility) at Community airports. This Directive shall apply to any airport located in a territory subject to the Treaty and open to commercial traffic whose annual traffic is over five million passenger movements and to the airport with the highest passenger movement in each Member State.

This Directive gives rise to an expectation that airports should publish their charges, although this is not explicitly stated as a requirement. The UK implementing regulations require that airports publish their airport charges. Article 3 of the Directive says that airport charges should not discriminate among airport users, but this does not mean that airports must charge everyone the same amount. Article 3 also says that charges may be modulated for issues of public and general interest, including environmental issues. Article 10 states that the level of airport charges may be differentiated according to the quality and scope of such services and their costs or any other objective and transparent justification.

There is also governance on charges other than those strictly related to landing aircraft. For example, under the Single European Sky Charging Regulations for Air Navigation Services, Article 16 addresses the modulation of air navigation charges. As such, Member States may, following consultation, modulate such charges incurred by airlines to reflect their efforts to 'reduce the environmental impact of flying'. This may apply to en route charges or terminal air navigation charges, the latter often being wrapped up in the airport's wider charges to airlines.

²⁴ Directive 2009/12/EC of the European Parliament and of the Council of 11 March 2009 on airport charges

Guidance on NOx emissions-related charges

As for noise, emissions-related charges are one of several types of airport charge for which adequate consultation preceding any change is required.

ICAO Doc 9082 provides guidance on emissions-related aircraft charges to address local air quality (LAQ) problems at or around airports. Costs incurred in mitigating or preventing the problem may be attributed to airports and recovered from the users. States have the flexibility to decide on the method of cost recovery and charging to be used in the light of local circumstances.

In the event that emissions-related charges are to be levied, section II.9 of Doc 9082 states that the charges:

- should be levied only at airports with a defined existing or projected LAQ problem and should be designed to recover no more than the costs of measures applied to the mitigation or prevention of the damage caused by the aircraft;
- should be established in a transparent manner, and the share directly attributable to aircraft should be properly assessed;
- should be designed to address the LAQ problem in a cost-effective way;
- should be designed to recover the costs of addressing the LAQ problem at airports from the users in a fair and equitable manner;
- should be non-discriminatory between users; and
- should not be established at such levels as to be prohibitively high for the operation of certain aircraft.

In addition, it is recommended that:

- in levying LAQ emissions-related charges, special consideration be given to the need to reduce the potential impact on the developing world;
- emissions-related charges could be associated with the landing charges, possibly by means of surcharges or rebates, or in the form of separate charges but should be subject to the proper identification of costs;
- the aircraft emissions charges scheme be based on data that most accurately reflect the actual operations of aircraft. In the absence of such data, ICAO standardized landing/take off (LTO) cycle times-in-mode should be used (Annex 16 – Environmental Protection to the Convention on International Civil Aviation, Volume II – Aircraft Engine Emissions); and

- any State imposing LAQ emissions-related charges on aircraft that are in international operation should annually report the existence of such charging schemes to ICAO. The charging authority should maintain records regarding the fees collected and the use of funds to be made available to all users.

Charging parameters

Ascertained NOx Emission

An aircraft's Ascertained NOx Emission means the product of the Engine NOx Emission as set out in an Airport's Emission Database and the number of engines on the aircraft. NOx charges, in practice, are based on absolute NOx emitted, not by reference to applicable ICAO standards as is the case for noise. This appears to be more in accordance with the 'polluter pays' principle, but is less aligned with the 'best in class' approach adopted by noise-charging.

SECTION 6

Emission-related charging in practice

Charging elements and values (as applied in 2013/14)

At Heathrow and Gatwick airports, there is an emission-based charge which is payable on the basis of the Aircraft's Ascertained NOx Emission²⁵.

At Heathrow, a NOx emissions charge of £7.76 per kilogram of NOx applies to all aircraft over 8,618 kg.

At Gatwick, a NOx emissions charge of £5.26 per kilogram of NOx applies to all aircraft over 8,618 kg.

For example, considering common narrow-body twin aircraft types at Heathrow, the charge per-rotation for an Airbus A319 with IAE-V2522 engines would be around £150 at Heathrow and £100 at Gatwick.

Considering a common wide-body twin operating at Heathrow, the charge per-rotation for a Boeing 777-200ER with Rolls-Royce Trent 895 engines is £870 at Heathrow, and £590 at Gatwick.

Considering common wide-body quad aircraft types at Heathrow, the charge for a Boeing 747-400 with Rolls-Royce RB211-524G-T engines would be around £780 at Heathrow and £530 at Gatwick. By comparison, the charge for an Airbus A380 with Rolls-Royce Trent 970 engines would be around £1,030 at Heathrow and £700 at Gatwick.

The above illustrative calculations are based on the publically-accessible EASA Aircraft Engine Emissions Databank. They use the 'LTO total mass of oxides of nitrogen'²⁶ parameter in light of not having access to the BAA Emission Database.

For Heathrow and Gatwick, the charges increase proportionally with the ascertained NOx emission level, so logic would dictate that the incentive is for airlines to minimise emissions rather than strive for best-in-class performance. For example, an Airbus A380 pays a higher NOx charge than a Boeing 747-400 because despite having a greater NOx margin, it is a larger aircraft which emits more total NOx.

²⁵ Aircraft's Ascertained NOx Emission means the product of the Engine NOx Emission as set out in the BAA Emission Database and the number of engines on the aircraft

²⁶ The total mass of oxides of nitrogen emitted during the LTO cycle (sum of time in mode x fuel flow x average EI at each of the four power settings).

Another distinction between this and the noise charging is that there are discrete charging categories in use for noise charging, whereas emissions are rated for charging purposes on a linear scale. In light of this, where there is a tendency for the distinction between noise-related and demand-related landing charges to blur, this is not the case for NO_x emissions charges which are clearly and separately defined. This is beneficial to transparency.

No emissions charge is levied at Stansted, Manchester, Birmingham and East Midlands. ICAO Doc 9082 states that emissions-related charges should be levied only at airports with a defined existing or projected LAQ problem. Due to the locations of these airports with respect to populated areas and/or their level of activity, these airports may not have a defined existing or projected LAQ problem, hence they do not levy a NO_x charge.

Historical emissions standards

The ICAO Committee on Aircraft Environmental Protection (CAEP) standards exist to ensure, in the most part, comprehensive uptake of the new technology by certain dates as described below. They also put some pressure on the aviation industry to design and manufacture less polluting aircraft engines.

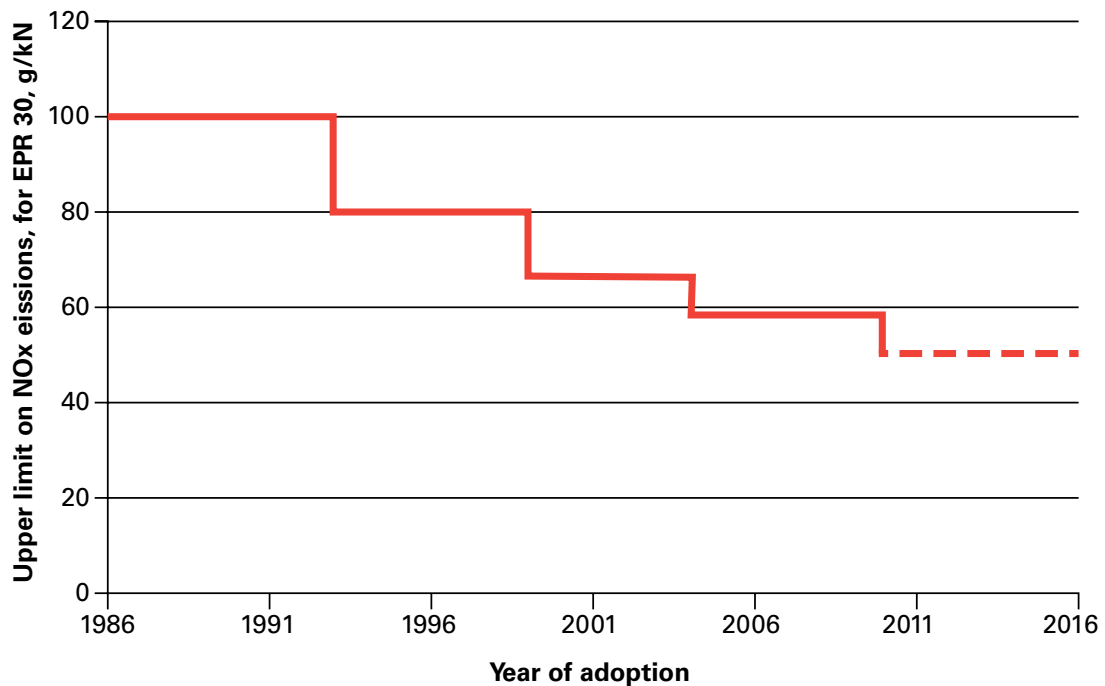
The development of the CAEP NO_x standards is summarised below, and illustrated in Figure 8.

- The CAEP/1 NO_x standard was adopted in 1981 which applied to newly manufactured engines from 1986. It established an upper limit on NO_x emissions at 100 g/kN of rated engine thrust for Engine Pressure Ratio (EPR) 30.
- The CAEP/2 NO_x standard was adopted by ICAO in 1993. This reduced emission limits by 20% to 80 g/kN for EPR 30. This standard applied to newly certified engines from 1996 and to already-certified newly manufactured engines from 2000.
- The CAEP/4 NO_x standard was adopted by ICAO in 1999. This applied to newly certified engines and reduced emission limits by an additional 16% to 67 g/kN for EPR 30 and smaller percentage reductions for EPR greater than 30 beginning in 2004. This standard does not apply to newly-manufactured engines from old designs to offer protection of asset values of existing fleets.
- The CAEP/6 NO_x standard was adopted by ICAO in 2004 and introduced in 2008. Again this applies to newly certified aircraft jet engines and is 12% more stringent than the previous standard.

- The CAEP/8 NO_x standard was adopted by ICAO in 2010 and will be introduced in 2014. This will be a further 15% more stringent than the CAEP/6 standard for newly certified large jet engines.

Figure 8

Development of CAEP NO_x standards



Since most engines in production already meet the standard by the date the standards are adopted, the NO_x standards are broadly 'technology-following' as intended. As previously mentioned, this is the declared ICAO policy for all environmental standards, i.e. they should be technology-following, not technology-forcing. Considering the lead time between adoption and introduction, they also put pressure on the aviation industry to design and manufacture less polluting aircraft engines.

Historical charges

At both Heathrow and Gatwick, the emissions-related NO_x charge remained steady at £1 per kilogram of NO_x from their introduction in around 2004 until around 2007 when the charge began to rise. The charges rose to £6.69 at Heathrow, and £4.80 at Gatwick, in 2012/13. Taking account of inflation over the period from 2006/7 to 2012/13 at a rate of 3.4%, this corresponds to increases in charges in real terms of 448% and 293% at Heathrow and Gatwick respectively.

Considering the changes in the emissions-related charges in the context of the changing standards, the charges were introduced around the time of the application of the CAEP/4 standard and the rises in charge anticipated the introduction of the CAEP/6 standard. Without a significant lag between the introduction of the new standards and the rise in charge, which would otherwise allow for market penetration of the new complying technology, there may be some evidence for the charging systems driving improvements on this basis alone.

It could also be argued that the charges were long-overdue, and should have been introduced in the 1980's when the first ICAO NOx standard was introduced.

SECTION 7

Possible effects of emissions-related charges

To put emissions charges into context, Heathrow forecasts receiving about £47m from emissions charges for 2013/4. Total revenue from airport charges is expected to be £1.5bn, i.e. emissions constitute about 3% of total airport charges. In 2011/12 revenue from airport charges was about 57% of Heathrow's total revenue²⁷.

Section 6, page 40 identified that emissions-related charges scale linearly with LTO emissions. Therefore, if there is a significant difference between the emissions of two different aircraft (airframe/engine configurations) within a class, the charges will be correspondingly different. The examples given for a Boeing 747-400 and A380 illustrate how the latter, despite being newer, is larger with a greater passenger capacity than the former, emits more NO_x leading to a 32% higher charge.

A specific example of where improvements in emissions performance has occurred by modifying aircraft engines on in-service aircraft is the Rolls Royce modification on the RB211-524G and -524H engines. By fitting a Trent 700 combustor, their NO_x emissions were substantially lowered. Re-designated RB211-524G-T and -524H-T, NO_x emissions were reduced by over 40%. The engines on 60% of British Airways' fleet of Boeing 747-400s were modified, possibly as a consequence of the NO_x charge.

In other instances, where engine improvements have been made available as part of continuous product development, airlines have selected these improved variants of the same engine to fulfil remaining orders.

However, section 4 highlighted that airport charges are typically a small proportion of an airline's total costs, so the associated incentives for airlines to use aircraft with increasingly lower NO_x emissions may be small.

²⁷ Calculated from Heathrow Airport Charges Consultation Document 2013/14, p.48

SECTION 8

Issues for consideration

Absolute vs relative noise levels

The ICAO noise limits are proportional to maximum take-off mass between 35 and 280-400 tonnes. The cumulative margin discussed above is relative to the noise limit, so a large aircraft with a large margin can still produce more noise than a smaller aircraft with a smaller margin. For example:

- An A320 with a margin of around -8 dB is QC/1
- An A380 with a margin of around -27 dB is QC/2 (i.e. noisier than QC/1)

The A380 is noisier, in absolute terms, than the A320 even though the A380 performs better in relative terms having almost 20 dB more margin than the A320.

Historically, a view has been taken that using the cumulative noise margin as a basis for setting charges encourages best-in-class aircraft to be used. There is a risk, however, that higher charges and/or greater charge differentials could incentivise a smaller aircraft to be replaced by a larger aircraft that is noisier despite having a greater margin.

Linear vs stepped charging categories

As previously mentioned, ICAO Doc 9562 clarifies that 'the sophistication or complexity in the design of the scale would vary according to local circumstances and requirements' and that the 'scale could be linear or in steps'.

Noise-related charges are calculated on a stepped scale according to their ICAO chapter / ACI noise rating category where each step is 5 dB wide. In theory, to achieve incentives through charge differentials, wider categories means fewer categories, hence greater charge differentials between them. This may result in inequity between charges for aircraft with similar noise performance just above and just below a category boundary.

It may also result in potentially unfair application of charges in certain cases where an airline operates an aircraft below the take-off weight to which the noise certification results apply. As mentioned in section 2, the noise category is directly informed by certification noise levels. Reducing the take-off weight usually reduces noise emissions, which could put the aircraft in the quieter/cheaper noise category than that which the certification levels dictate.

Adding more categories reduces their width, and reduces the charge differential between categories. In the limiting case where the width of the categories tends to zero, the stepped scale becomes a linear (continuous) charging scale. This avoids the inequity at category boundaries, but is more complicated to administrate.

A linear scale such as this would most likely be based on the cumulative margin of the aircraft type (or even individual airframe). This would add complexity to the administration of the scheme, which may be difficult to justify under current practice. Sections 3 and 4 show that the highest charges are for prohibited and a relatively small number of the noisiest aircraft types, whereas the charge differentials between Chapter 3 Minus and Chapter 4 categories are small if not zero.

Where noise-related charge differentials are applied, it might be desirable to consider narrower categories or a linear scale to reduce or remove the inequity and potential unfairness at category boundaries.

NO_x charges are already calculated on a linear scale for aircraft over 8,618 kg at Heathrow and Gatwick. The system is sophisticated in that the charge is proportional to NO_x emissions. There is no scope for inequity in charges for aircraft categorised close to a category boundary, in the same way as exists for noise charging. The system has operated this way for the past decade, so by implication, the level of sophistication is not unduly onerous to administrators.

Potential trade-offs

Noise, emissions and any CO₂-related charges should be set such that they provide the correct relative incentives according to the Government's policies. The APF states that 'Government expects that at the local level, individual airports working with the appropriate air traffic service providers should give particular weight to the management and mitigation of noise, as opposed to other environmental impacts, in the immediate vicinity of airports, where this does not conflict with the Government's obligations to meet mandatory EU air quality targets'.

Disincentivising night operations may reduce choice to passengers if such services were to be ceased, and potentially worsen the passenger experience if, as a result, passengers are required to depart or arrive in the middle of the night at the non-UK airport. Reducing services may also cause price escalation hence reducing value for money for passengers.

Also relating to time-of-day incentives, some charging structures attempt to incentivise off-peak operations at times of day when demand is lower. If the aim was changed to encourage operations during the day when sensitivity to noise is generally lower, this may have an impact on commercial aspects of the airport's

operation. A balance should be struck between the various aims of the incentives which are likely to be different between airports, but as previously mentioned, there should be a clear distinction between demand-related and noise-related differential landing charges.

Approach

Cap and Trade

Using a similar concept to the 'cap and trade' approach which forms the basis of the CO₂ European Union Emissions Trading Scheme (EU-ETS), a noise and/or NOx emissions trading scheme could be adopted. As with other 'cap and trade' systems, the benefit of such an approach is that it would lead the aircraft operators to internalise some of the costs of the impacts of their commercial activity on local communities.

Such economic instruments would be complex to implement in practice and further work would be required to establish the feasibility of such approaches. For the purposes of illustration, a stylised example of how such a system might work for noise control was provided in our Aviation Policy for the Environment²⁸ document and is reproduced here:

- The primary capacity cap at airports would be expressed in terms of noise emissions, rather than aircraft movements as at present;
- A 'noise emissions envelope' or quota would be set for each airport level, for example based on modelled estimations of the population affected at a given noise level;
- Initial 'noise allocations' would be given to airlines operating at each airport. These allocations would be made on the basis of past performance;

The size of the overall cap would be reduced over time, for example in line with the long-term trend of technological improvement. This ensures residents get continued benefit from technological improvements.

As capacity caps are no longer expressed in terms of aircraft movements, aircraft operators who outperform the cap can potentially benefit from increased throughput at an airport, subject to satisfying safety requirements. Airlines are therefore incentivised to address fleet noise performance in order to generate additional flights, subject to infrastructure and operational constraints. Alternatively, noise-efficient airlines can sell surplus quotas to other operators.

²⁸ CAA Insight Note 2: Aviation Policy for the Environment, Page 34

Although it is not a landing charge as such, the current Night Noise Quota scheme in operation at the designated airports is already a cap and trade scheme, albeit with limited trade capability, especially at Heathrow, because of the movement constraints.

Polluter Pays

A suggestion has been made at European Parliament, under the 'polluter pays' principle, that noise-related landing charges could be based not solely on certified aircraft noise levels, but on noise impact, i.e. noise contour areas and the populations enclosed by it. This goes some way to address ECAC/24-1 Article 3 (see section 2, page 14 above) and exhibits some fairness towards local residents.

The proposal would not, however, be equitable at Heathrow where noise impact is clearly dependent on runway mode. Because the average population density to the east of the airport is significantly greater than that to the west, the Stage 1 Consultation for the current Night Noise Restrictions showed up to twelve times more people living within the arrival noise footprints for a generic QC/4 aircraft to the east of the airport compared with those to the west²⁹.

Whether the operations are easterly or westerly depends principally on the wind direction, which is outside the airlines' control. If noise-related charges are based on noise impact, differentials may be very significant and due more to population distribution than the noisiness of the aircraft.

As an aim of the noise-related charges is to incentivise the airlines' use of quieter aircraft, a system which incorporates price differentials which are not directly related to aircraft types does not meet the aim.

Value of intervention

In light of the majority of current aircraft fleets meeting Chapter 4, the most meaningful charge differentials are therefore between the quieter Chapter 4 categories. Effective charging systems based on noise categories require there to be charge differentials between the Chapter 4 categories. Charging systems could introduce greater incentives by further differentiating the charges for aircraft with higher cumulative margins.

More effective charging schemes could be developed which drive improvements by earlier introduction of the higher charges for categories of aircraft that exhibit

²⁹ Arrival SEL footprints for Heathrow in Section 3 of Annex C of the Night Flying Restrictions at Heathrow, Gatwick and Stansted Stage 1 of Consultation on Restrictions to apply from 30 October 2005

poor noise and NO_x performance relative to emerging standards. Providing clearer time-bound foresight on how charging will change in the future may be a means for achieving this, within the bounds of the principle that ICAO standards are technology-following.

Under the CAA's current price regulation of Heathrow, Gatwick and Stansted, increases in environmental landing charges could be accommodated but would have to be counter-balanced by decreases in other charges. As noise-related landing charges are relatively low compared to per-passenger charges, and emissions-related landing charges are even lower, there could be scope to do this.

Any higher charging levels would need to be chosen carefully, however, as an environmental charge which is so high as to make the operation non-profitable could be considered to be an operating restriction if the service is consequently withdrawn. This outcome would be in violation of the guidance of ICAO Doc. 9082. In line with current practice, charge increases would need to be announced prior to their introduction so as to provide sufficient notice to airlines to take any necessary action.

However, there is every possibility that, due to the difference in timeframes between setting charges (short-term) and fleet replacement (long-term), increasing charges significantly above current rates would become operating restrictions before driving fleet changes. Options to increase incentives may therefore be restricted to increasing differentials rather than absolute charges, while addressing the adverse effects of the trade-offs (e.g. time-of-day charge differentials which encourage night operations).

Consideration should also be given to potential trade-offs with other environmental factors (namely emissions affecting local air quality and CO₂ emissions), economic factors and factors relating to consumer choice and experience.

Airlines endeavour to minimise fuel-burn to reduce their fuel costs, which are a significant proportion of their operating costs. As emissions and fuel-burn are broadly proportional to each other, a strong incentive already exists for airlines to reduce emissions, even if indirectly. Conversely, reducing the noisiness of aircraft is often accompanied by slight increases in fuel-burn, which in isolation may result in a disincentive. It should, however, be emphasised that although noise charging may not offer such a strong short-term incentive, airports should plan future charges that will bite in the longer-term to put pressure on airlines to plan accordingly.

Harmonisation

Owing to the legislative framework and international guidance which sets common principles for the setting of charges, there is a potential desirability for harmonising charging systems amongst airports. This has been highlighted in previous studies on environmental charging.

There could be merit in harmonising charging schemes at airports within the UK. It would simplify the process, potentially reduce an administrative burden on airlines, aid transparency and hopefully build stakeholder support. Ideally, aircraft should be treated similarly from one airport to another, even if the charges at each airport are different.

SECTION 9

Conclusions

The key conclusions and messages for policy makers and airport authorities in developing charging policy are as follows.

Noise

The monetary incentives designed to encourage airlines to use the quietest aircraft vary from airport to airport. The designated airports levy landing charges in the strict sense of the ICAO guidance, whereas the non-designated airports tend to levy other surcharges and penalties which, although do serve a noise-management role, do not meet the criteria for noise-related landing charges.

The designated airports levy significantly higher runway charges on the noisier aircraft types (compared to the charges on the quieter types), but these aircraft tend to comprise a small proportion of the active fleet. The most meaningful charge differentials are between the quieter Chapter 4 noise categories which account for the majority of aircraft in service. At Heathrow, the Chapter 4 category charges approximately follow the relative loudness of the categories and offer better noise value for money than charges for Chapter 2 and 3 aircraft. At Gatwick and Stansted, there are no charge differentials between the Chapter 4 categories. Furthermore, charges for Chapter 4 aircraft offer worse noise value for money than charges for Chapter 3 aircraft, potentially disincentivising the use of the quieter aircraft.

Currently there is limited means to incentivise the very quietest types. The system could introduce greater incentives by increasing the charges for lower margins, and reducing the charges for higher margins. More generally, a charging system should cover the full range of aircraft in operation at the airport and comprise charging differentials throughout the range.

The charging differentials appear to be relatively small compared to the overall airport charges met by airlines. This may reduce the effect of any intended incentives to operate quieter aircraft. They may, however, influence decisions such as when to replace aging aircraft and what aircraft type to use for a new service, and should be set at appropriate levels to enable this wherever possible.

Furthermore, the charging differentials may contribute to a basket of measures, including noise and track-keeping penalties, that collectively has a beneficial effect

in the shorter-term. The 'non-landing charge' noise penalties imposed by some of the non-designated airports may offer incentives to use quieter aircraft.

Noise-related charges have changed over time, and any resulting incentives have followed improvements in aircraft technology rather than driven them. This is the declared ICAO policy for all environmental standards. The improvements in quiet aircraft technology appear to have been driven more by factors such as tightening international noise standards, meeting other noise restrictions and pressure from local communities. However, an expectation that charges on noisy aircraft will increase may have contributed to the improvements.

Some airports implement charge differentials between operations occurring, or scheduled to occur, at certain times of day, providing a means for the airlines to internalise some of the costs of night-time noise disturbance. Such charges generally relate to noise management, though are not noise-related landing charges per se. Some airports offer disincentives for night-time operations, reflecting a general heightened sensitivity to aircraft noise occurring during the night as oppose to day, while others disincentivise operations at other times for other reasons such as demand. In some cases of the latter, an incentive to operate at night is inadvertently provided. There should be a clear distinction between demand-related and noise-related differential landing charges.

Historically, a view has been taken that using the cumulative noise margin as a basis for setting charges encourages best-in-class aircraft to be used. There is a risk, however, that higher charges could incentivise a smaller aircraft to be replaced by a larger aircraft that is noisier despite having a greater margin.

It might be desirable to consider narrower categories or a linear (continuous) scale to reduce or remove the inequity at category boundaries. In making any such decision, the increase in fairness would need to be balanced against the added complexity in administrating the system. Categories of equal width would aid transparency and avoid unnecessary complexity. Adopting this approach and using the margin to Chapter 3 as a basis for the system means reference no longer needs to be made to the ICAO chapter definitions. This avoids the complication of accommodating the new Chapter 14 standard which is 7 EPNdB below the Chapter 4 standard and does not lend itself to equal width categories (typically 5 EPNdB). Ultimately, since this approach is still takes into account the noise certification provisions of ICAO Annex 16 in respect of aircraft noise levels, ICAO guidance on setting noise-related charges is clearly met in this regard.

Emissions

Of the airports considered in this review, only Heathrow and Gatwick provided some incentives to use best-in-class aircraft in terms of levels of NOx emissions.

Emissions-related charges scale linearly with NOx emissions which may vary significantly between different aircraft within the same class. In these cases, the charges will be correspondingly different.

Where there is a tendency for the distinction between noise-related and demand-related landing charges to blur, this is not the case for NOx emissions charges which are clearly and separately defined. This is beneficial to transparency.

However, airport charges are typically a small proportion of an airline's total costs, so the associated incentives for airlines to use aircraft with best-in-class NOx-performance may be small compared to other drivers.

Common to noise and emissions

Differential environmental landing charges may have some incentivising effects but they are unlikely to be the main financial driver for using quieter and less-polluting aircraft. More effective charging schemes could be developed which drive improvements by earlier introduction of the higher charges for categories of aircraft that exhibit poor noise and NOx performance relative to emerging standards. Providing clearer time-bound foresight on how charging will change in the future may be a means for achieving this.

Under the CAA's current price regulation of Heathrow, Gatwick and Stansted, increases in environmental landing charges could be accommodated but would have to be counter-balanced by decreases in other charges. As noise-related landing charges are relatively low compared to per-passenger charges, and emissions-related landing charges are even lower, there could be scope to do this.

However, there is every possibility that, due to the difference in timeframes between setting charges (short-term) and fleet replacement (long-term), increasing charges significantly above current rates would become operating restrictions before driving fleet changes. Options to increase incentives may therefore be restricted to increasing differentials rather than absolute charges, while addressing the adverse effects of the trade-offs.

Any policy interventions would need to consider potential trade-offs with other environmental factors (namely emissions affecting local air quality and CO₂ emissions), economic factors and factors relating to consumer choice and experience.

There could be merit in harmonising charging schemes at airports within the UK. This would simplify the process, potentially reduce an administrative burden on airlines, aid transparency and hopefully build stakeholder support.

Good practice principles

This study has highlighted a number of principles which we consider to constitute good practice in the setting of airport noise and emissions charges:

- a) Noise charging categories should be based on ICAO certification data, namely the margin to Chapter 3, to incentivise best-in-class.
- b) Noise charging categories should be of equal width, typically 5 EPNdB, or narrower, to ensure adequate differentiation of noise performance.
- c) The noise charging categories used at a given airport should cover the full range of aircraft in operation at the airport. This range should be reviewed periodically and modified as appropriate.
- d) Noise charges for operations occurring at night should be greater than those that occur during the day.
- e) Where noise-related charge differentials occur depending on the time of day of an operation, the scheduled time of the operation should be used as oppose to the actual time. Penalties may be used to disincentivise operations scheduled to occur on the cusp of the night period that regularly fall into the night period.
- f) There should be a clear distinction between noise-related landing charges and any non-noise-related charges, e.g. demand-related charges.
- g) Charging schemes should ideally be harmonised across airports within the UK. Aircraft should be treated similarly from one airport to another, even if the charges at each airport are different.

APPENDIX A

Previous studies

Öko-Institut e.V., Report into noise-related landing charges

In May 2004, the Öko-Institut e.V. published a report titled Economic measures for the reduction of the environmental impact of air transport: noise related landing charges³⁰. This was commissioned by the Federal Environmental Agency in Germany.

This study examines, with an LTO-charging (Landing and Take-off) model differentiated according to aircraft-noise emissions and incentives for air transport companies for the use of less-noisy aircraft. The results of the study are based on a comprehensive status-quo analysis of European LTO-charging models; they demonstrate the need for harmonised development of this kind of instrument as an incentive, in order to be able to obtain transparency and comprehensibility.

The study concludes with a set of guidelines for the development of a harmonised system of noise-related charges that it suggests must be considered in future. In the opinion of the project team, the perspectives and principles of the further development of the economic instrument of noise-related LTO charges can be summarised as follows:

‘Standardization and harmonization of structure, systematics and bases for assessment is necessary, in order to place greater emphasis on the objective of noise mitigation and to make the levying and effectiveness of charges more transparent, without competition between airports at the cost of noise mitigation. Differentiation of landing and take-off as well as of the timing of flight movements through the spread and level of charges in absolute terms, as well as the time-related dynamization of the system and consideration of the nuisance effect in the vicinity of an airport, are necessary in order to define the specific circumstances at individual airports. Effective monitoring and reporting, as well as the strengthening of the financing function, can encourage the transparency and effectiveness of the instrument in the medium and long term.’

³⁰ Economic measures for the reduction of the environmental impact of air transport: noise related landing charges (FKZ 201 96 107), Öko-Institut e.V., May 2004

Jacobs Consultancy, Review of Airport Charges

This report sets out to identify all of the charges which are used to recover or contribute to the infrastructure and environmental costs associated with the arrival at, and departure from, an airport by a sample of eight different aircraft types, carrying a typical passenger load on an international flight. In order to ensure consistency in the comparisons made, the results do not necessarily represent actual amounts paid directly or indirectly by passengers.

The Review contains comments on the Index of charges, provides a description of the charges and of the specific effects of security charges, and discusses a number of issues which influence the level at which charges are set and the system employed in the US where airport charging systems differ from those in the rest of the world. It provides a review of pricing formulae at a number of airports around the world but does not include ground handling charges in the analysis.

LeighFisher, Review of Airport Charges 2011

For more than 20 years, LeighFisher has produced an annual report which sets out to help airport management teams, investors, finance sector analysts, and airlines gain a better understanding of how airports worldwide stack up in terms of relative operational and financial efficiency.

The report compares the sum of aeronautical arrival and departure charges at 50 of the world's busiest airports for a sample of eight aircraft that are most predominant in airline fleets. The report also provides an extensive historical background of aeronautical charging systems and methods of airport price regulation. In addition to being a benchmarking resource, the report can be used to inform pricing discussions between airports, regulators, and airline users.

APPENDIX B**Sources of information**

The systems of charges at airports are, in general, published annually. Records to the current financial year (2013/14) have been obtained for Heathrow, Gatwick and Stansted since 2001/2, and Manchester, East Midlands and Birmingham since 2002/3.

At the designated airports, the airport charges are set out in the Conditions of Use (CoU) documents. Data has been obtained from consultation documents relating to the subsequent year's scheme.

Manchester Airport publishes a Schedule of Charges and Terms, and Conditions of Use document, and Birmingham Airport publishes a Fees and Charges document. Both of these apply from 1 April for the given publication year. East Midlands Airport publishes a Scale of Fees and Charges plus Standard Conditions of Use document which applies from 1 May for the given publication year.

These documents contain a comprehensive schedule of the Airport Charges, i.e. the charges imposed on airlines by airports. Charging elements include the following: passenger/cargo aircraft runway charges, General Aviation (GA) charges, charges on landing, charges on passengers (departing, facilities, security, disabled, persons of reduced mobility), noise penalties, Air Traffic Services charge, baggage handling and ground handling charges, and aircraft parking charges.

There are differences in the charging structures for airports, some reflecting differences in their shares of the market. For example, Birmingham and East Midlands Airport make provision for training flights, and Manchester for military operations.