Environmental Research and Consultancy Department

ERCD REPORT 0205

Quota Count Validation Study: Noise Measurements and Analysis

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Summary

This report describes a study that was undertaken on behalf of the Department for Transport's Aircraft Noise Monitoring Advisory Committee (ANMAC) to monitor the noise performance of aircraft in relation to their quota count (QC) classifications (or bands). *Operational noise levels*, measured in EPNdB at airport locations equivalent to the noise certification measurement positions, were acquired and analysed for a large range of aircraft types that operate at night at Heathrow, Gatwick and Stansted airports. For the majority of aircraft types monitored, the operational noise levels correlated well with the QC bands. However, large differences between the operational noise levels and the QC bands were observed for a few aircraft types.

April 2003

Prepared on behalf of the Department for Transport by the Civil Aviation Authority

On behalf of ERCD, his co-authors would like to acknowledge the substantial contribution made to this study by their friend and colleague Mike Smith who sadly passed away on 17 June 2000.

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Glossary of Terms

A-weighted — A weighting that is applied to the electrical signal within a noise-measuring instrument as a way of simulating the way the human ear responds to a range of acoustic frequencies.

aal — Aircraft height above the aerodrome level

AIP — Aeronautical Information Publication (UK Air Pilot)

ANMAC — Aircraft Noise Monitoring Advisory Committee. The committee is chaired by the Department for Transport and comprises representatives of the airlines, Heathrow, Gatwick and Stansted airports and airport consultative committees.

BAA — BAA plc. The company which owns and runs Heathrow, Gatwick and Stansted airports (amongst others).

Certificated Noise Levels — The ICAO aircraft noise certification procedure for subsonic aircraft over 5,700 kg requires three separate noise measurements to be made at *approach*, *lateral* and *flyover* locations. The three certificated noise levels (measured in EPNdB) are determined within tight tolerances and normalised to standard atmospheric conditions.

dB — Decibel units describing sound level or changes of sound level.

EPNdB — The measurement unit for EPNL.

EPNL — Effective Perceived Noise Level (measured in EPNdB). Its measurement involves analyses of the frequency spectra of noise events as well as the duration of the sound.

ERCD — Environmental Research and Consultancy Department of the Civil Aviation Authority.

ICAO — International Civil Aviation Organisation

kts — Knots (nautical miles per hour)

NATS — National Air Traffic Services Ltd. NATS provides air traffic control services at several major UK airports, including Heathrow, Gatwick and Stansted.

NTK — Noise and Track Keeping monitoring system. The NTK system associates radar data from air traffic control radar with related data from both fixed (permanent) and mobile noise monitors at prescribed positions on the ground.

Operational Noise Levels — The average EPNLs derived from measurements near the airports that are comparable to the certificated noise levels.

SOR — Start-of-roll: The position on a runway where aircraft commence their take-off runs.

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1 Introduction

1.1 Background

1.1.1 The current scheme for classifying aircraft for night restrictions purposes at Heathrow, Gatwick and Stansted airports came into operation on 24 October 1993. The restrictions specify a night period (2300-0700 hours) during which the noisiest types of aircraft may not be scheduled to land or take off. In addition, between 2330 and 0600 hours (the night quota period) aircraft movements are restricted by movement limits and noise quotas that are set for each summer and winter season.

1.1.2 The noise quota is designed to encourage the use of quieter aircraft. Aircraft movements (arrivals or departures) count against the noise quota according to their quota count (QC) classifications - which are intended to indicate their relative contributions to the total impact of aircraft noise on the airport surroundings. Noisier aircraft carry a higher QC classification. The classification of aircraft for this purpose is based on their certificated noise levels and each aircraft type is classified separately for arrival and departure.

1.1.3 Following the proposal of January 1993 (Ref 1), it was announced on 6 July 1993 that ANMAC would oversee the monitoring of noise performance of aircraft covered by the QC classifications. The intention was to discover if any aircraft was performing significantly above and/or below its QC classification and, if necessary, to review its classification.

1.1.4 The monitoring work was undertaken on behalf of ANMAC by the Environmental Research and Consultancy Department[1] (ERCD) of the Civil Aviation Authority. This report describes the measurement and analysis techniques that were developed. The results of the monitoring work are also included. When considering this it must be remembered that they relate specifically to aircraft operations at the three London airports - the results should not be taken as representative of similar operations at other airports.

1.2 Study approach

1.2.1 In 1992/3, BAA installed a new Noise and Track Keeping (NTK) system at the three London airports. The NTK system matches air traffic control radar data (i.e. aircraft flight paths) to related noise measurements from both fixed (permanent) and mobile noise monitors at prescribed ground positions[2]. The 1993 proposal stated that data from the NTK system should be used to verify the relative noise classification of aircraft types. Aircraft noise levels were to be measured in EPNdB, the aircraft noise certification unit. At the time, the London airports' NTK system was believed to be the first anywhere in the world with a capacity to measure EPNLs (in addition to A-weighted metrics).

1.2.2 Fieldwork to support the development of procedures for routine monitoring of the QC classification system was approved by ANMAC in the summer of 1993. However, it soon became apparent that although higher EPNLs were measured accurately, the system could not deliver valid EPNLs for quieter noise events. Subsequent

[1] This department was previously known as the Department of Safety, Environment and Engineering and subsequently the Department of Operational Research and Analysis (of National Air Traffic Services Ltd).

[2] The fixed noise monitors are sited approximately 6.5 km from the start-of-roll (SOR) positions on the runways and are used to detect departure noise limit infringements.

development and testing of improved system software - jointly by ERCD, BAA and the NTK equipment manufacturers - took several years and it was not until June 1998 that the first EPNL-equipped noise monitors became fully operational.

1.2.3 Installation of new EPNL modules across the system took some further time and ANMAC agreed that, to minimise further delay, it would be sensible to develop the test procedures in parallel using the limited number of noise monitors that had been upgraded, rather than wait for the remainder to be modified. In a trial study, a series of EPNL measurements for this purpose were made at Stansted and Heathrow between July 1998 and April 1999.

1.2.4 The conclusions from the trial study were used to shape the monitoring and analysis techniques for the main monitoring study. That commenced in December 1999, by when the remaining NTK noise monitors had been upgraded to measure EPNLs, and was performed consecutively at all three airports. **Figure 1** shows the sequence and timing of the various elements of the study.

1.3 Report contents

1.3.1 This report is structured as follows:

- Section 2 presents the rationale behind the use of certificated noise data for the QC system.
- Section 3 briefly describes the sources of data and the methods used to analyse them.
- Section 4 explains how the main study benefited from the results of the trial study.
- Section 5 presents the results of the study and describes some of the factors that can give rise to differences between operational and certificated noise levels.
- Section 6 presents the conclusions of the study.

1.3.2 Supporting technical details are presented in four appendices:

- Appendix A presents the results of the trial study.
- Appendix B presents the numerical results of the main study.
- Appendix C considers whether the distribution of measured noise levels for quieter aircraft types are 'normal' (or Gaussian) in shape (so that statistically valid conclusions can be drawn).
- Appendix D considers possible sources of measurement uncertainty.

2 The QC System

2.1 QC classification and its relationship to noise certification

2.1.1 Before 1993, aircraft 'night noise (NN) categories' were related to noise footprint areas - calculated from data supplied by the aircraft manufacturers (and checked by the UK certification authority) using the then current CAA aircraft noise contour model. But practical experience led to the conclusion that the scheme was too complex and the input data too unreliable; an alternative was required that was more transparent and more easily administered (Ref 1). The QC classifications introduced in 1993 were therefore based on official *certificated noise levels* because these are (i) generally considered to be reliable indicators of aircraft noise performance, (ii) available for practically every civil transport aircraft operating in the western world, (iii) openly published and therefore readily applied by administrators of the scheme, and (iv) correlated well with noise footprint areas which, as before, were taken to be appropriate measures of 'noise impact'.

2.1.2 The last criterion is crucial as it is important that the night restrictions limit the amount of aircraft noise. To understand why the QC system is considered to meet this requirement it is necessary to examine the essential aspects of aircraft noise certification.

2.1.3 The certification procedure, laid down in Chapter 3 of ICAO Annex 16, Volume 1 (Ref 2), requires determination of aircraft arrival and departure EPNLs, see **Figure 2**. Three 'reference points' are specified: *approach*, under a 3 degree descent path 2000 m from the runway threshold; *lateral* (or sideline), 450 m to the side of the initial climb after lift-off (or 650 m for Chapter 2 aircraft[3]) - at the longitudinal position where noise is greatest; and *flyover*, under the departure climb path, 6500 m from start-of-roll (SOR). EPNLs are obtained under stringent test conditions which are subject to the scrutiny of the certificating authorities. Certification levels are determined within tight tolerances and normalised to standard atmospheric conditions.

2.1.4 To decide how the certification data might best be applied, the relationships between noise event levels at the certification reference points and the areas of operational noise footprints were studied using the same noise contour model that underpinned the prior NN system. It was found that, for arrivals, footprint areas were highly correlated with the level at the approach reference point. For departures a high correlation was obtained when the sideline and flyover levels, Ls and Lf were simply averaged, the result being referred to as the 'departure' noise level Ld = (Ls + Lf)/2. It was evident therefore that, for the purposes of classifying aircraft noise, certificated noise levels (used in this way) could replace the previously used footprint areas. However, as it was a requirement that arrivals and departures were 'exchangeable' - i.e. that replacing an arrival by a departure with the same classification, or vice-versa, should have no net effect on the total noise impact - any classification, whether for an arrival or a departure, should indicate the same footprint area.

2.1.5 The analysis showed that, for a given numerical value, Ld is indicative of a substantially larger footprint than La. Put another way, for the same noise footprint

[3] The first noise standards for aircraft were defined in Chapter 2 of ICAO Annex 16 and aircraft that met them became known as *'Chapter 2'* aircraft. From 1977 onwards, more stringent *'Chapter 3'* noise standards were introduced. Since 1 April 2002, Chapter 2 aircraft above 34,000 kg (MTOW) have not been permitted to operate at UK airports, other than in most exceptional circumstances.

areas, La is considerably greater than Ld. This is because the approach reference point is much nearer to the aircraft flight path than the lateral and flyover points. This difference had somehow to be accounted for by the system. The solution adopted was to calculate a qualifying noise level for arrivals by subtracting a fixed differential from La; this was set at 9 EPNdB (see paragraphs 2.2.3 - 2.2.4). Thus, in summary, the two *qualifying levels* were:

For departures[4]: Ld = [EPNL(lateral) + EPNL(flyover)]/2

For arrivals: La = EPNL(approach) - 9

2.1.6 On average, the areas enclosed by noise footprints double with each 3 decibel (dB) increase in the associated qualifying levels. This is understandable as 3 dB is equivalent to a twofold change of noise energy. This means that, to a first approximation, an aircraft with a qualifying level 3 dB greater than another contributes twice as much to the noise impact around an airport. In impact terms, one movement of the noisier aircraft is equivalent to two movements of the less noisy aircraft - regardless of whether the movements are arrivals or departures. This explains the logic of the quota count. The relative contribution of any one aircraft movement to the total noise impact around an airport is measured by its QC classification. The overall impact is proportional to the total quota count, i.e. the sum of the products QC classification x number of movements.

2.1.7 Aircraft are classified on the basis of their qualifying noise levels into seven QC categories (or bands) as follows:

QUALIFYING LEVEL	QC CLASSIFICATION
Greater than 101.9 EPNdB	16
99 - 101.9 EPNdB	8
96 - 98.9 EPNdB	4
93 - 95.9 EPNdB	2
90 - 92.9 EPNdB	1
Less than 90 EPNdB	0.5
Less than 87 EPNdB	Exempt[5]

2.2 Reliability of QC classification

2.2.1 For the purposes of noise certification, aircraft are flown under test conditions and using operating procedures that are designed to demonstrate the effectiveness of the built-in noise control technology - not necessarily to reproduce noise levels that will occur in normal airline service. Thus operational noise levels at the standard reference points, even when measured in EPNdB, will usually differ from certification values for reasons explained below.

[4] To allow for the difference in lateral certification position between Chapter 2 and Chapter 3, an adjustment of +1.75 EPNdB is applied to the average departure levels of Chapter 2 aircraft.

[5] Exempt aircraft are those which, on the basis of their noise certification data, are classified at less than 87 EPNdB and, in the case of jet aircraft, also have a maximum certificated weight not exceeding 11,600 kg.

2.2.2 For approach noise certification, ICAO Annex 16 specifies maximum landing weight[6], and an aircraft configuration (including speed and deployment of flaps and undercarriage) that will produce the highest possible EPNL at the measurement position. In airline service, aircraft rarely land at maximum weight although, at 2 km from threshold, they are established on the ILS glideslope with either final or reduced landing flap selected. Thus, in normal service, arrival noise measured at the approach reference point might generally be expected to be lower than in certification.

2.2.3 The validity of the 9 EPNdB 'differential' (paragraph 2.1.5) has on occasions been questioned because:

- basing it (originally) on gross footprint areas neglected the fact that a substantial part of the departure footprint (unlike approach noise) falls on airport land;
- it was originally based on the noise performance of 1980s aircraft fleets; the improved climb performance of more modern aircraft is likely, on average, to shrink departure footprints, relative to arrivals; and
- even when the arrival and departure footprints are equal in area, peak noise levels inside the arrival footprints are greater.

2.2.4 To overcome these limitations, a new analysis of the relationships between noise footprints and certificated noise levels has recently been completed using a very large amount of up-to-date information from the airports' NTK systems, and much more advanced noise modelling methodology (Ref 3). It was concluded that, although some variance is unavoidable in any practical system, the essential components of the QC classification process, namely (1) the relationship between qualifying level and QC classification and (2) the 9 EPNdB differential, cannot be improved upon in any practicable way.

2.2.5 A departing aircraft takes off and climbs using high engine power so as to minimise the ground roll and thereafter gain height as quickly as possible. But, when it is safe to do so, power is reduced (i.e. 'cut back') in order to minimise engine wear and tear. For departures, ICAO Annex 16 certification requires maximum aircraft weight and maximum engine power for take-off and initial climb to ensure the highest possible noise level at the lateral measurement position. During that initial part of the departure the aircraft configuration is set to ensure that the aircraft is as high as possible before passing the flyover reference point. But before that point is reached, power is cut back and aircraft configuration adjusted to ensure minimal certificated flyover noise (subject to maintaining flight safety and a specified minimum climb gradient).

2.2.6 In normal operation, take-off power is always sufficient to ensure safety but might be less than maximum in order to extend engine life. The lateral level might thus be less than certificated. After initial climb, the power is cut back, typically at a lower height above aerodrome level (aal) than in certification, but often not to the same degree - in order to maintain a greater rate of climb. The depth of 'cutback' in a noise abatement operating procedure involves a balance between these factors. Specific procedures depend upon operating weight, atmospheric conditions, local noise-abatement operating restrictions and the need to operate economically.

[6] In keeping with common usage, the term 'weight' is used in place of 'mass' throughout this report although, strictly speaking, they are different entities.

2.2.7 For departures, the operational differences between normal airline service and certification mean that noise is distributed differently along and about the flight path. Thus reducing take-off power lessens lateral noise but also decreases the initial climb rate. This in turn increases flyover noise because the aircraft passes the reference point at a lower height. Consequently, a trade-off between the lower lateral levels and higher flyover levels is often achieved for departures in normal airline service.

2.3 Assessment of QC rankings

2.3.1 The overall objective of the monitoring study was to verify the relative noise classification of aircraft types. It was accepted at the outset that this would involve determining EPNLs under 'operational' conditions at the three certification measurement points. But since the certification levels are determined from tests conducted under tightly controlled conditions, it was also recognised that there was little chance of these levels ever being replicated precisely in day-to-day airline service. ANMAC accepted that the aims of the study would be met by determining whether certification adequately *ranked* aircraft in terms of operational noise; not whether operational noise levels matched certification.

3 Measurement and Analysis Procedures

3.1 The operational noise levels for each aircraft type had to be determined using the airports' NTK systems. For present purposes, an aircraft *type* means one whose certificated noise levels are recorded by national certification authorities - in the UK, the CAA's Noise Certification Group. Thus an aircraft *type* here is defined by a specific airframe (by manufacturer, model and variant), specific engines and a specific (certificated) weight. Different versions (sometimes even different examples of a variant) of a particular aircraft model might be powered by different engines and be certificated to operate at different maximum weights. Each of these has to be regarded as a different type. The QC classification for each aircraft type was obtained from the Airports Noise Restrictions Notice, which is updated by the CAA's Noise Certification Group and published on behalf of the Department for Transport in the supplement to the UK AIP each summer and winter season (e.g. Ref 4).

3.2 For present purposes, 'operational noise levels' are defined as mean EPNLs derived from measurements near the airports that are comparable to the certificated EPNLs; whether at the standard flyover, lateral and approach reference positions or the QC-qualifying departure and arrival noise levels (equivalent to those defined in paragraph 2.1.5). A distinction is made between the directly *measured* noise levels and the reference *operational* noise levels that are estimated from the measurements. Those estimates were made via analyses of the following data extracted from the airports' NTK systems - for individual aircraft operations:

- aircraft type, including variant and engine fit;
- aircraft registration;
- date and time;
- take-off or landing;
- runway;
- call sign (including airline operator);
- radar-measured flight path (aircraft position relative to an airfield reference point) at sequential intervals of time (approximately 4 seconds apart);

- maximum certificated take-off weight[7] (MTOW); and
- noise level(s) in EPNdB recorded by appropriate noise monitors.

3.3 Before considering comparisons of operational EPNLs with certificated values it is essential to recognise the differences between the measurement processes of certification and airport noise monitoring that are summarised below. These are quite separate to the differences between aircraft operating procedures used during certification and normal airline operation that were pointed out in paragraphs 2.2.2 and 2.2.5 - 2.2.7.

3.4 Differences between operational and certification noise measurements

3.4.1 Certificated noise levels are measured using microphones positioned 1.2 m above a level, flat and not excessively absorptive ground surface at reference positions equivalent to those shown in **Figure 2** (see paragraph 2.1.3). The levels are then adjusted to standard day conditions; i.e. to equal the levels that would have been measured had the tests[8] been performed when the atmospheric conditions were equal to the standard values. Sufficient data are acquired to ensure that the certificated EPNLs are determined with 90% confidence intervals of not more than ±1.5 EPNdB (although in practice this is usually bettered by a large margin).

3.4.2 Measured *flyover* and *approach* EPNLs are obtained from NTK monitors positioned as near as possible to, but not usually at, the certification reference points. The NTK microphones are mounted either 6 m (fixed) or 3.5 m (mobile) above the ground surface, principally to reduce interference from ground objects (unwanted reflectors of sound sources) and to minimise the risks of vandalism. For departures the fact that many aircraft commence turns before reaching 6.5 km from SOR means that some pass well to the side of the flyover monitors rather than directly over them. Landing aircraft on the other hand are normally fully established on the ILS (3 degree) descent path at the approach reference point 2 km from the runway threshold so that lateral deviations are relatively small.

3.4.3 It is practically impossible to determine 'true' *lateral* noise levels of aircraft departing airports due to the wide variation in departure flight tracks. Instead, 'pseudo-lateral' noise levels were determined as described in Reference 6 from measurements made directly beneath the initial climb paths whilst aircraft still maintained take-off power settings. Reference 6 shows that these estimates correlate well with actual lateral noise levels (see paragraphs 3.7.5 - 3.7.9).

3.4.4 Flyover noise levels were determined from fixed monitor measurements. All fixed monitors are positioned, as closely as possible, to a point 6.5 km along each departure route from the normal start-of-roll on each runway to ensure uniformity of the departure noise limits between the airports and between the different aircraft

[7] Although MTOW was obtained from the NTK system, MLW (maximum certificated landing weight) was not available. For this study, MLW data were obtained either from the relevant airlines or from a register of civil jet-aircraft.

[8] The certification requirements are specified in References 2 and 5 (ICAO Annex 16 and the associated Technical Manual). The method by which the certification levels of a modern aircraft are determined is complex and, for a new aircraft type, involves a major test and data reduction programme. But variants of pre-existing types can be certificated by alternative means under what is commonly referred to as a 'family plan'. Under these procedures, often involving ground testing, the effects of aircraft modifications (e.g. different engines) are determined independently and the differences applied to the original (flight tested) certification results.

routes (Ref 7). Other levels were measured using specially positioned mobile monitors (see Section 4).

3.4.5 For any individual aircraft type, mean measured EPNLs were determined by averaging sufficient measurements to achieve a 95% confidence interval no greater than ±1.0 EPNdB. No adjustments for atmospheric conditions are applied to the results; the mean EPNLs are simply those experienced at the three designated airports under actual prevailing conditions. However, to ensure that extreme weather did not bias the results unduly, data were rejected if atmospheric conditions lay outside specified limits.

3.5 Weather windows

3.5.1 ICAO Annex 16 requires that Chapter 3 noise certification tests are carried out under the following atmospheric conditions:

- No precipitation;
- Average wind speed not above 12 kts and crosswind not above 7 kts (at 10 m above the ground);
- Temperature not above 35°C and not below -10°C and relative humidity not above 95% and not below 20% (over the whole noise propagation path);
- Relative humidity and temperature over the whole noise propagation path such that the sound attenuation in the one-third octave band centred on 8 kHz will not be more than 12 dB/100 m.

3.5.2 As well as limiting data scatter, the certification 'weather window' also ensures that highly attenuating atmospheric conditions are avoided during the tests (in order to maximise the certificated noise levels). To reduce variance further, the certification data are then corrected to the following 'standard day' conditions:

- Atmospheric pressure of 1013.25 hPa;
- Zero wind;
- Temperature of 25°C;
- Relative humidity of 70%.

3.5.3 Since it is totally impractical to correct operational noise levels to the same standard day conditions, measurements recorded under extreme conditions were instead excluded from the analysis to limit data scatter and the effects of extreme weather variations as much as possible. Weather readings, recorded 10 m above ground, were obtained from the UK Meteorological Office stations at each airfield and noise measurements were rejected if they did not meet the following criteria recommended by ISO (Ref 8)[9]:

- No precipitation;
- Wind speed not above 10 kts;
- Relative humidity and temperature such that the sound attenuation in the one-third octave band centred on 8 kHz will not be more than 10 dB/100 m.

[9] Typically, this led to between 30-40% of noise measurements being excluded from the analysis because of unfavourable weather conditions.

3.6 Effect of microphone height on measured noise levels

3.6.1 Measured aircraft noise levels can depend on the height of the microphone above the ground surface. This is because sound arrives at the microphone directly from the source but also as 'echos' from nearby reflecting surfaces - including possibly the ground itself. Reliable 'free field' measurements can only be obtained from microphones positioned in reflection-free locations. As the ground cannot normally be avoided, this usually requires that the ground surface in the vicinity of the reflection point is soft; i.e. sound-absorptive. A grassy surface is usually recommended; surfaces to avoid include asphalt, concrete or water, all of which are acoustically hard.

3.6.2 For this study, as in practically all aircraft noise measurement exercises including certification testing, monitors were sited in non-obstructed areas with soft or grassy ground cover. But even if the surfaces were not fully absorptive, it was considered unlikely that the differences between the certification microphone height of 1.2 m and the NTK heights of 3.5 and 6 m would themselves be the cause of any significant mismatch between certificated and operational noise levels. This is because, unless the ground surface is highly reflective, differences would only arise at low elevation angles (between the direction of sound propagation and the ground surface). As data for elevation angles less than 60 degrees were excluded, the effects would be negligibly small (see paragraph 3.7.2).

3.6.3 This was checked as part of preliminary fieldwork in 1993 by comparing aircraft noise levels measured simultaneously (over soft ground) at the different microphone heights. These revealed no significant (or consistent) difference between pairs of measurements recorded across a number of sites at Heathrow and Gatwick. It was therefore concluded that EPNL noise measurements for the study could be carried out at the standard NTK monitor heights without the need for adjustments.

3.7 Calculation of operational noise levels

3.7.1 The operational flyover and approach noise levels are the mean EPNLs estimated to be caused at the relevant certification reference points. These were calculated from the mean measured levels by accounting for displacements of the monitor positions from the reference points, both horizontally and vertically. The calculations were based on the assumption that EPNL is a function only of the minimum slant distance of the receiver point from the aircraft flight path - that is, the small changes to engine power settings that might have occurred between the reference positions and the noise monitor positions were disregarded.

3.7.2 Potential errors due to the effects of *lateral attenuation* - a difference in level between noise radiated downwards and that propagated to the side of an aircraft flight track[10] - were minimised by excluding from the analysis any aircraft passing more than 30 degrees from overhead of the noise monitor (i.e. data for elevation angles less than 60 degrees were excluded). The minimum slant distances between the flight path and the two relevant ground positions, the monitor location and the certification reference point (the latter always being vertically below the flight path), were determined from an analysis of the NTK radar data using special CAA

[10] There are several factors that affect the propagation of noise sideways from an aircraft. These include 'shielding' of engine noise sources by the fuselage; the disruption of sound propagation by the aerodynamic flow-fields around the engines, wings and fuselage; and also the absorptive qualities of the ground at low angles of incidence.

software[11], see **Figure 3**. Allowance was made for (1) any difference between the slant distances, and (2) any difference in ground elevation between the heights of the monitor and the runway. The EPNL differences were estimated using industry supplied (and aircraft-type specific) 'Noise-Power-Distance' (NPD) relationships, which give EPNLs as a function of engine power at different slant distances from the aircraft.

3.7.3 Operational flyover levels estimated from measurements made beyond 6.5 km from SOR were based on an assumption of a 4% climb gradient: At Heathrow, Gatwick and Stansted, aircraft are required to maintain a minimum climb gradient of 4% after reaching 6.5 km from SOR[12] (Ref 9). This assumption was necessary to keep the computer analysis within manageable proportions (although climb rates can vary significantly between different aircraft types, differences between the assumed and actual climb gradients would have a negligible effect upon the calculation of the operational flyover levels). However, so as not to overestimate flyover levels for any aircraft types, measurements from fixed monitors positioned less than 6.5 km from SOR were not used because of a greater risk that engine power might not be cut back there.

3.7.4 Since some of the departure routes involve turning flight tracks close to the airports, it was recognised that turns will cause a reduction of climb rate for some aircraft. Depending on the rate of the turn, noise on the ground below turning aircraft may be higher than below non-turning aircraft at the same distance from SOR. For aircraft that operate exclusively on 'turning' routes this may lead to higher average flyover EPNLs, all other things being equal. Because the majority of aircraft types that were monitored operated on more than one departure route (i.e. on straight and turning routes), the potential effects of a turn on an aircraft's operational noise level were most likely mitigated. However, it should be recognised that the measured noise levels will tend to be higher than they would have been had the aircraft operated exclusively on straight routes.

3.7.5 It is generally recognised that lateral noise levels are much more difficult to determine accurately than flyover and approach levels, since the longitudinal position of the 450 m lateral reference point is not fixed. To measure the lateral level directly at an airport would require a row of monitors along the sidelines (both left and right) of each flight track. As actual departure tracks at the three London airports are widely dispersed about the nominal noise preferential route centrelines, this is practically impossible. An alternative, simpler procedure to that laid down in ICAO Annex 16 was therefore needed for use in the process of QC monitoring.

3.7.6 On average, the peak lateral noise from jet-powered aircraft occurs when the aircraft is at a height of around 1000 ft (300 m). At 1000 ft, the elevation of the aircraft viewed from the 450 m sideline is around 35 degrees and the slant distance is about 550 m. Thus, assuming no significant difference between the sound emitted in the 35 degree and 90 degree directions, the lateral noise level would be replicated

[11] In ERCD's radar analysis program, the 'raw' radar data from the NTK system are first smoothed using a three-stage centre-averaging algorithm (a process which is widely recognised internationally for this purpose). Locations between these smoothed radar 'node' points are then estimated using a localised polynomial fit of each of x, y and z (ht) value, independently against time. Closest points (slant distances) to monitors are found non-analytically by calculating the distances from the monitor of a very large number of such locations and taking the smallest value.

[12] The minimum climb gradient of 4% applies until aircraft reach an altitude of 4000 ft at Heathrow or 3000 ft at Gatwick or Stansted (or 4000 ft for night-time departures at Stansted).

550 m directly beneath the aircraft. Accordingly, provided the aircraft speed and the engine power remain the same for a sufficiently long time, the lateral level could be estimated from measurements at a point directly under the flight path when the aircraft is 550 m above it.

3.7.7 A supporting study was carried out to investigate whether this would provide a practicable solution for estimating lateral noise under everyday operational conditions. The study, for which data were collected for a range of jet-powered aircraft at Gatwick airport, is fully described in Reference 6. It was concluded that the (mean) lateral EPNL could be estimated to within 1 EPNdB of the 'true' value by adjusting noise measurements made beneath the take-off power climb to a nominal slant distance of 600 m - a little greater than the 'theoretical' 550 m due to some lateral directionality (on average, aircraft radiate a little less sound towards the sideline than downwards). These estimates are referred to here as *pseudo-lateral* noise levels - not *true* lateral levels but highly correlated with them. ANMAC accepted that pseudo-lateral noise levels could be substituted for lateral levels for the purposes of the QC monitoring study.

3.7.8 However, at heights of 600 m (2000 ft), aircraft are usually not still at take-off power and so the high-power noise level from the aircraft at this height had to be estimated by extrapolating noise levels measured below 1000 ft, where the aircraft are always operating at take-off power[13].

3.7.9 The merits of the pseudo-lateral methodology were effectively endorsed by a recommendation that a Working Group of the Committee on Aviation Environmental Protection (CAEP) had given to ICAO in 1995 (Ref 10): that the use of lateral measurements for the certification of propeller-driven heavy aircraft should be discontinued - because that practice had raised severe practical difficulties. The proposed alternative was to measure full power take-off noise directly under the flight path. Subsequently, in November 1997, the CAEP proposal was added to Annex 16 as an alternative to the traditional 450 m lateral procedure (after 18 March 2002 it became the *only* full power certification procedure for propeller-driven heavy aircraft). Although propeller aircraft were not studied in the Gatwick tests, the full power certification procedure states that measurements should be made 650 m under the flight path. The marginally smaller 600 m slant distance indicated by the Gatwick results for jets can be attributed to the very different spectral and directional characteristics of jet and propeller-powered aircraft.

[13] Before 1 November 2001, the minimum height at which cutback was permitted in the UK was 1000 ft aal; after this date, the minimum permitted height was reduced to 800 ft aal. Rejecting measurements collected after 1 November 2001 for aircraft above 800 ft would have significantly reduced pseudo-lateral data samples at Stansted during winter 2001/02. However, because the majority of operators still tend to cutback between 1000-1500 ft, it is not expected that including data for aircraft above 800 ft at Stansted would have affected the overall conclusions of the study.

3.8 Operational departure and arrival EPNLs

3.8.1 Operational noise levels for comparison with the QC-qualifying levels are calculated from the operational flyover, (pseudo) lateral and approach EPNLs in the same way, i.e:

For departures[14]: Ld = [EPNL(pseudo-lateral) + EPNL(flyover)]/2

For arrivals: La = EPNL(approach) - 9

4 Measurement Programme

4.1 Trial study

4.1.1 The purpose of the trial study, which was undertaken at Stansted between July and September 1998 and then at Heathrow between January and April 1999 was to help identify monitoring requirements for routine assessment of operational QC noise levels. As well as developing and testing data analysis procedures in preparation for the main study, two key tasks were:

(a) to establish suitable monitoring sites representative of the certification reference positions; and

(b) to estimate the number of flights that needed to be measured to determine reliable mean EPNLs for any particular aircraft type.

4.1.2 The site selection criteria were:

- Proximity to the reference measurement points for mobile sites only (approach and pseudo-lateral) as flyover levels were to be measured at fixed monitors;
- Relatively flat ground;
- Free of obstructions such as trees and buildings, and of any large reflective surfaces;
- Free from excessive ambient noise;
- Over flown by as many (required) aircraft as possible; and also
- Secure and accessible.

4.1.3 The 'traffic mix' of different aircraft types at Stansted and Heathrow was considered varied enough to eliminate any need to collect measurements at Gatwick for the trial study (i.e. most aircraft types at Gatwick could be monitored at Stansted and/or Heathrow).

4.1.4 **Figures 4, 5 and 6** show the approach and pseudo-lateral monitoring sites selected at Heathrow, Gatwick and Stansted respectively, as well as the positions of the fixed noise monitors. (Stansted fixed monitor 1 was relocated to site 10 at the end of summer 2001 and Heathrow fixed monitors B and H did not become operational until summer 2001.)

4.1.5 Results from the trial study at Stansted and Heathrow are given in Appendix A. When considering these it should be remembered that the trial data were collected to test and develop the measurement and analysis procedures, not to assess the

[14] To allow for the difference in lateral certification position between Chapter 2 and Chapter 3, an adjustment of +1.75 EPNdB is applied to the average departure levels of Chapter 2 aircraft to calculate their QC classifications. However, in the process of QC monitoring it is not necessary to adjust the measured pseudo-lateral levels of Chapter 2 aircraft in the same way, since the measurements already relate to the 450 m lateral position.

operational noise performance of the subject aircraft. The trial made it very clear that since the numbers of movements at night are relatively small, it would take an excessively long time to collect data for all the aircraft types of interest (i.e. those that operate at night at the three London airports). It was concluded that it would be important to consider using both daytime and night-time data in the main study. ANMAC agreed that this would be acceptable provided it could be demonstrated that operational differences (weather conditions, operational procedures, take-off and landing weights, etc.) between day and night monitoring periods do not cause significant variations of EPNL, see paragraphs 4.2.6 - 4.2.10.

4.2 Main study

4.2.1 The key objectives for the main monitoring study, which took place between December 1999 and August 2002, were:

(a) to collect and analyse data for aircraft types that operate at night in both summer and winter conditions;

(b) to determine whether daytime data could be used to supplement night-time measurements; and

(c) to identify which aircraft type classifications, if any, should be reconsidered.

4.2.2 In order to meet these objectives, data were required from all three airports in both summer and winter conditions. To make best use of the NTK system mobile monitors (used to measure approach and pseudo-lateral noise), monitoring was carried out consecutively at all three airports, for approximately 4 months in each season (see **Figure 1**).

4.2.3 In general noise data were acquired more rapidly during the summer months than in the winter. This was due largely to the more favourable (for noise measurement) weather conditions in summer, but also partly to slightly higher traffic levels.

4.2.4 In total across all three airports, valid operational EPNLs were determined for 40,446 arrivals and 38,460 departures. These have been grouped by aircraft type defined by the airframe, engine fit and maximum certificated take-off or landing weights. The results are tabulated in **Tables B1 to B16** of Appendix B. Mean operational noise levels are presented separately for (i) night-time, (ii) daytime and (iii) 24 hr periods together with the associated sampling statistics.

4.2.5 Conventional statistical theory is based on an assumption that the data are normally distributed. To confirm this was appropriate for the monitored aircraft noise data, particularly for quieter types for which lower noise levels may not always be detected, some additional analyses were made of early monitored data. Full details are reported in Appendix C.

4.2.6 Atmospheric differences (i.e. temperature and relative humidity) between day and night periods might produce consistently different rates of absorption and hence result in different mean noise levels for the same source emission. To assess the likely effect of the weather variations on the measured EPNLs, the data were tested for day-night temperature and relative humidity differences using a theoretical aircraft noise propagation model (Ref 11).

4.2.7 Using average temperature and humidity values for daytime and night-time periods, noise level differences (i.e. daytime EPNL *minus* night-time EPNL) were predicted at each reference position for a typical high-bypass ratio aircraft[15]. The results below indicate that average day-night temperature and humidity differences during the data collection periods at each airport were unlikely to have any measurable effect on EPNL differences.

PREDICTED DAY-NIGHT DIFFERENCE, EPNdB
(Based on average temperature and humidity conditions)

	Summer	Winter
Approach	-0.2	0.0
Pseudo-lateral	-0.1	0.0
Flyover	-0.1	0.1

4.2.8 Wind speed differences between day and night may also have affected both noise propagation and aircraft performance, both of which can affect noise on the ground. However, since noise measurements acquired in high wind speeds (i.e. greater than 10 kts) were rejected for this study, the effect of any differences on the measured noise levels was most likely mitigated. Nevertheless, the magnitude of the differences were examined using mean hourly wind data acquired from Meteorological Office weather stations based at each airfield. The analysis revealed average day-night wind speed differences in summer and winter of between 1 and 2 kts (i.e. lower at night). Such small day-night variances were, on average, unlikely to have any measurable effect on EPNL differences.

4.2.9 The above analysis indicates that, as extreme conditions were avoided, there is only a small risk of significant day-night EPNL differences being caused by weather and atmospheric effects. However, for some aircraft types, the use of different operating procedures by daytime and night-time operators might cause significant noise level differences. The same is true of day-night differences in take-off and landing weights. For aircraft which, according to daytime data, appear to be at variance with their QC classifications, further information would be required from the relevant operators to rule out any differences between day and night operating weights and/or procedures.

4.2.10 Analysis of the average EPNLs for arrivals and departures at each airport revealed average day-night noise level differences of less than 1 EPNdB for aircraft types where large enough samples were available for comparison in each period (i.e. results with 95% confidence intervals of ±1 EPNdB or less). Statistical tests were also used to compare the average daytime and night-time noise levels[16]. In most cases, the noise level differences were not statistically significant. Of those that were statistically significant, the majority of the day-night differences were small in absolute terms (most were less than 1 EPNdB) and therefore unlikely to affect the conclusions of the study.

[15] The predictions were based on a B757-200. The differences are not expected to vary significantly for other high-bypass ratio designs.

[16] Two-sample t tests were used to compare the average noise levels of aircraft that operated during the day and at night.

4.2.11 The average summer-winter noise level differences at each airport (i.e. summer EPNL *minus* winter EPNL) were less than 1 EPNdB for both arrivals and departures. In most cases, the differences were not statistically significant. Of those that were, most were less than 1 EPNdB. On the basis of these results, ANMAC accepted that the summer and winter data sets could be pooled according to aircraft type descriptions where necessary. For the few cases where noise level differences between seasons were large, the variance would be evident by the width of the 95% confidence intervals of the pooled results.

4.2.12 Because the classification of aircraft for QC purposes applies equally at all three airports, the measured data have been pooled for aircraft types that operate at more than one airport (see **Tables B17 and B18** of Appendix B). For these types, the majority of the noise level differences between any two airports (again, where large enough samples were available for comparison) were small in absolute terms. Again, for the few cases where large noise level differences exist between different airports this was considered justifiable, as the variance would be evident by the width of the 95% confidence intervals of the pooled results.

4.2.13 In **Tables B17 and B18**, both the QC classification and the certificated noise levels (average of flyover and lateral for departures) are shown for each aircraft type. The QC classification for each type was obtained from the Airports Noise Restrictions Notice (see paragraph 3.1). Most certificated noise levels were obtained from publicly available aircraft noise certification databases (e.g. Ref 12) - others were acquired directly from the airline operators or, for UK registered aircraft, from the CAA's Noise Certification Group.

4.2.14 The operational departure EPNL is the arithmetic mean of the pseudo-lateral and flyover levels estimated from the measured noise levels. A virtue of this statistic is that it is less sensitive to variations in aircraft operating procedure than either of the constituents alone (because higher flyover levels often tend to be paired with lower lateral levels and vice versa). But of course to define operational averages, both constituents have to be determined. A practical problem is that to measure EPNL, a high signal-to-noise ratio[17] is required, otherwise the NTK system rejects the measurement as being insufficiently accurate. This means that occasionally, only one of the two measurements, lateral or flyover, was recorded for a particular flight.

4.2.15 This problem is compounded by the fact that the pseudo-lateral measurement has to be made whilst the aircraft is still at take-off power, i.e. before cutback. To guard against measuring post-cutback noise as far as possible, pseudo-lateral measurements were rejected for aircraft above 1000 ft (see paragraph 3.7.8), even though a valid flyover EPNL may have been registered for the same flight.

[17] The term signal-to-noise ratio is used to describe the noise level of the aircraft event relative to the background level. The higher the signal-to-noise ratio, the greater the difference between the aircraft event and the background level.

4.2.16 A consequence of these two factors is that 'paired' pseudo-lateral and flyover measurements comprise only a small proportion (on average, less than half) of the data collected. If 'non-paired' measurements were rejected, it would undoubtedly have taken much longer to acquire sufficient data to verify the QC classifications. Checks carried out on the preliminary monitored data indicated that, across a range of different aircraft types, the average difference between using paired and non-paired measurements was less than 0.5 EPNdB (on average, slightly higher departure levels were obtained using paired events). To improve the rate of data acquisition (and consequently, the confidence intervals of the mean departure levels), paired and non-paired data were pooled for this study.

5 Comparison of Operational and Certificated EPNLs

5.1 Arrivals

5.1.1 Across the three airports, operational arrival EPNLs were determined for 112 different aircraft types (**Table B17** of Appendix B). The EPNLs (adjusted by -9 EPNdB) and 95% confidence intervals are compared with the QC bands in **Figure 7** (for Exempt and QC/0.5 aircraft) and **Figure 8** (for QC/1 to QC/4). In both these diagrams the certificated noise levels (again, adjusted by -9 EPNdB) are also shown for comparison with the measured results.

5.1.2 The diagrams clearly show that although most operational levels lie within the relevant QC bands, for a few the 95% confidence intervals lie outside them. The operational levels of 8 aircraft types (out of 112) lie entirely above their QC bands and 4 of these exceed their certificated levels by more than 3 EPNdB (i.e. the width of a QC band), see **Table 1**.

5.1.3 On the other hand, operational EPNLs (including the associated 95% confidence intervals) for 19 aircraft types lie below their QC bands (**Figure 8**). This is perhaps unsurprising since aircraft rarely land at maximum weight (and often land with reduced landing flap selected). For 5 of these types the levels are more than 3 EPNdB below their QC band (**Table 1**).

5.1.4 Since there is no lower noise level limit for the QC/0.5 category, it is possible that the measured noise level of a QC/0.5 rated aircraft could lie within the QC/0.5 band but still exceed its certificated level by more than 3 EPNdB. It can be seen in **Figure 7** that the operational level of one aircraft falls within the QC/0.5 band but exceeds its certificated level by almost 4 EPNdB. Conversely, the measurement results for other QC/0.5 rated aircraft types are seen to better their certificated noise levels by more than 3 EPNdB (see paragraphs 5.3.11 - 5.3.12).

5.2 Departures

5.2.1 Across the three airports, operational departure EPNLs were determined for 76 aircraft types (**Table B18** of Appendix B). The departure results are compared with the QC bands and the certificated noise levels in **Figure 9** (Exempt and QC/0.5 aircraft) and **Figure 10** (QC/1 to QC/4).

5.2.2 For a majority of aircraft types monitored, the operational departure noise levels match or, in some cases, better their QC classifications. However, the measurements for 30 aircraft types (out of 76), most of which are twin-engine aircraft, are seen to lie above their departure QC bands. The operational noise level for one of these types exceeds its QC/1 band limit by more than 3 EPNdB, see **Table 2**.

5.3 Comments on the results

5.3.1 For each aircraft type, sufficient measurements were made to determine operational (mean) noise levels within a 95% confidence interval of ±1 EPNdB. This simply means that the actual mean levels at the measuring microphones are estimated to that level of accuracy; not that those mean levels should match the aircraft's certificated levels.

5.3.2 When relying on operational noise measurements to assess the efficacy of the QC system, it has to be clearly understood that many factors can give rise to significant differences between noise levels in certification and normal airline operation. These include the following:

1) The monitoring results are actual average operational EPNLs at Heathrow, Gatwick and Stansted – that is, they are sample averages and therefore estimates of the ‘true’ population averages. Many variable factors including weather, aircraft weights and operating procedures contribute to the scatter of individual EPNLs and it is the effects of these which are 'averaged out' by gathering large data samples. That random error decreases with the size of the sample.

2) But regardless of how many measurements were made, some mean operational levels might not be equal to the true population averages at the London reference locations - because of bias in the measurements due to, for example, errors in radar measured flight paths, limitations of the pseudo-lateral methodology, inaccurate or inappropriate NPD data, pooling of data (e.g. day and night, summer and winter), etc.

3) And even if there were no measurement bias and the aircraft flew standard certification procedures at maximum certificated weights, there would still be many good reasons why the operational levels would not match certification. These include different atmospheric conditions, microphone locations and heights, ground surfaces, etc. Consequent EPNL differences may be expected to depend also on the spectral and directional characteristics of individual aircraft types.

4) Added to the above are uncertainties about the use of noise certification data from publicly available aircraft databases (e.g. Ref 12). For any specific aircraft, one set of (three) certificated noise levels corresponds to a particular aircraft certification status including, for example, certificated weight, engine power setting, approach flap setting and engine modifications. However, all this information might not be recorded in the certification database and, unless the database entries are linked to actual aircraft registrations, there is a risk of some entries being misinterpreted. ICAO/CAEP technical working groups are currently investigating 'possibilities for standardising the noise documents and facilitating access to the noise certification information of individual aircraft'.

5.3.3 In short, the in-service EPNLs determined by NTK monitoring are naturally more variable than certificated EPNLs, which are measured under more tightly constrained procedures. For this study, the overall accuracy of the measurements is limited by various sources of uncertainty (NTK noise monitors, radar data, data sampling errors and bias, etc.). Further consideration is given to the various uncertainties associated with the measurement process in Appendix D.

5.3.4 These reservations need to be kept in mind, when considering possible reasons for some of the larger differences (both positive and negative) between operational and certificated EPNLs that are apparent in **Figures 7 to 10**. Notwithstanding the factors listed above, some of the differences may be explained, at least partly, by the differences between certificated and in-service operating procedures.

5.3.5 Arriving aircraft rarely land at maximum weight and often land with reduced landing flap selected. Consequently, arrivals noise measured at the approach reference point may be expected to be lower than in certification. Indeed, for most aircraft types monitored this was the case, although large positive differences were observed for some aircraft types (**Table 1**). These differences cannot be explained in operational terms.

5.3.6 The unusually low approach noise levels for some aircraft types shown in **Figure 8** may also be explained by the special acoustic linings that have been fitted to their engines. The UK noise type certificates for these aircraft do not distinguish between the different types of engine 'treatments' that are available and the certificated noise levels relate to the noisier variants.

5.3.7 Aircraft must be designed to continue taking off safely in the event of an engine failure. This means that two, three and four engine aircraft have to be capable of climbing at their appropriate minimum climb gradients[18] with, respectively, 50%, 67% and 75% of their full power. With all engines operating, aircraft have 'surplus' power for take-off and, using full take-off power in certification, they reach the greatest possible heights (before power is cut back) to ensure minimal certificated flyover noise at the 6.5 km point. In normal airline service, not all the surplus power is used (to reduce engine wear and tear) so they are lower at the 6.5 km position. As a consequence their operational EPNLs at the flyover position generally exceed the certificated values. Although this is offset by some improvement at the (pseudo) lateral position, the balance is not always fully restored and the average operational departure noise level is often greater than certificated.

5.3.8 Average departure noise level differences between normal operation and certification tend to be greater for twin-engine aircraft than for three or four engine aircraft, because their power surplus is greater. This tendency is reflected in the departure results shown in **Figures 9 and 10** (and **Table 2**), where the greatest (positive) differences, in some cases 3 EPNdB or more, are for twin-engine types.

[18] Design safety criteria specify different minimum climb gradients for two, three, and four engine aircraft.

5.3.9 In **Tables 1 and 2** (and **Figures 7 to 10**) many of the airframe/engine combinations appear at more than one maximum take-off (MTOW) or landing (MLW) weight. Aircraft are certificated at one of several possible weights to allow airlines to opt for a model most appropriate for its intended stage lengths and routes - which is important when landing charges are linked to those weights.

5.3.10 It is therefore theoretically possible that an aircraft certificated *above* a certain weight could exceed its QC rating but another aircraft (with the same airframe/engine combination) certificated *below* that weight could comply with its QC rating because of lower operational noise levels (by virtue of routinely lower operating weights). However, in **Figures 7 to 10** there are no cases where the measured noise levels of a particular airframe/engine combination certificated *above* a particular weight exceed the QC band limit but comply with the QC rating at *all* other lower weights.

5.3.11 Since there is no lower noise level limit for the QC/0.5 category, it is possible that the measured noise levels of QC/0.5 rated aircraft could better their certificated noise levels by more than 3 EPNdB but still lie within the QC/0.5 band (see paragraph 5.1.4). Listed in **Table 3(a)** for arrivals are the QC/0.5 rated aircraft that, based on their measured results, could be re-classified into a lower QC category if one existed (i.e. into a 'QC/0.25' category, for qualifying noise levels less than 87 EPNdB). There are no similar cases for departures where QC/0.5 rated aircraft could be re-classified into a lower QC category.

5.3.12 In addition, the certificated noise levels of several QC/0.5 rated aircraft shown in **Figures 7 and 9** would fall within a lower QC/0.25 band, if it existed. However, the measured noise levels for some of these 'potential' QC/0.25 rated aircraft types are greater than 86.9 EPNdB (i.e. the measured levels would lie above the upper limit of a QC/0.25 category), see **Tables 3(b) and 3(c)**. Thus, the certificated levels for these aircraft would classify them as QC/0.25, if the category existed, but their measured levels would fall within a 3 EPNdB-wide QC/0.5 band.

5.3.13 Under the present arrangements, aircraft classified as QC/8 or QC/16 on arrival or departure may not be scheduled to land or take-off between 2300-0700 hrs (Ref 4). As a result, no night-time measurements have been recorded for QC/8 or QC/16 aircraft during the monitoring period at any of the three airports. Although daytime noise measurements for these types have been recorded by the NTK systems, their mean operational noise levels have not been calculated for this study. However, it should be noted that the operational (daytime) noise levels for some quieter QC/8 or QC/16 aircraft might fall within the QC/4 band. In such cases, it is theoretically possible that QC/8 or QC/16 aircraft might be permitted to operate at night if they were re-classified as QC/4.

6 Summary and Conclusions

6.1 Through a comprehensive analysis of airport noise and flight path monitoring data, mean operational aircraft noise levels, in units of EPNdB at points equivalent to the certification reference positions, have been determined for many aircraft types that operate at night (in summer and winter) at Heathrow, Gatwick and Stansted. The 95% confidence intervals associated with the mean operational EPNLs are, by design, no greater than ±1 EPNdB, although for the majority of aircraft types monitored the 95% confidence intervals are very much less than this. The results are therefore considered to be reliable and worthwhile.

6.2 The operational EPNLs have been compared against the QC classifications, separately for arrivals and departures. For arrivals, operational EPNLs were generally expected to be somewhat lower than in certification, by virtue of lower than maximum operating weights. For most aircraft types monitored, this was found to be the case; the measured approach levels for 93% of aircraft fell inside, or below, the QC bands. However, in a small number of cases (7%), the operational EPNLs exceeded the QC band limits and, in some cases, exceeded the certificated levels by more than 3 EPNdB. These large positive differences between normal operation and certification cannot be explained in operational terms.

6.3 For a majority of aircraft types monitored (61%), operational departure EPNLs were also found to match or better their QC classifications. Differences between operational and certification noise were generally greater for twin-engine aircraft than for three or four engine aircraft; 24 of the 30 aircraft that exceeded the QC band limits were twin-engine types. Operational differences between normal airline service and certification, particularly for faster climbing twin-engine types, mean that noise is distributed differently along and about the flight path. Generally, measured in-service (pseudo) lateral levels are expected to be lower than in certification but flyover levels can be significantly higher. As a result, a trade-off between the lateral and flyover noise levels may not be achieved for some aircraft types, which may explain, at least partly, the large measured differences for some types.

6.4 When deciding whether or not certification adequately ranks aircraft in terms of operational noise, it will need to be remembered that operational noise levels are naturally more variable than certificated EPNLs. The (many) factors that can give rise to differences between noise levels in normal airline operation and certification have been discussed. It must also be noted that the operational EPNLs relate specifically to aircraft operations and local measurement conditions at the three London airports and should not therefore be taken as representative of similar operations at other airports.

References

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Table 1 Arrivals: Noise Measurements Above or Below QC Bands

ABOVE / BELOW QC BAND	TYPE	ENGINE	MLW (t)	QC	IN-SERVICE QC (ACCORDING TO MEASURED DATA)	DIFFERENCE, EPNdB MEASUREMENT - QC LIMIT	MEASUREMENT - CERTIFICATION
ABOVE	B747-200	JT9D-7J	265.4	4	8	1.3	3.2
	B747-200	RB211-524D4	285.8	2	4	0.3	0.3
	B747-400	RB211-524G/HT	295.8	2	4	1.2	2.3
	B747-400	RB211-524G	295.8	2	4	2.4	3.5
	B747-400	RB211-524G/H	285.8*	2	4	2.9	4.4
	B767-300 (ER)	RB211-524H	136.0	1	2	1.5	4.3
	BAe 1-11 500	Spey 512-14DW	39.5	1	2	1.0	1.2
	Lockheed L-188C	501-D13A	44.5	0.5	1	0.1	2.4
BELOW	DC-10-30	CF6-50C2	197.6	4	2	-0.6	-2.4
	DC-10-30	CF6-50C2	197.2	4	2	-1.2	-3.0
	DC-10-30	CF6-50C2	192.3	4	2	-1.5	-3.1
	DC-10-30	CF6-50C2	186.4	4	2	-1.4	-2.5
	A300B4-203	CF6-50C2	134.0	2	1	-0.2	-1.1
	B737-200 Adv	JT8D-15	39.9	2	1	-2.4	-4.2
	B737-300	CFM56-3B1	52.9	1	0.5	-0.5	-1.4
	B737-300	CFM56-3B1	51.7	1	0.5	-2.9	-3.8
	B737-300	CFM56-3B2	54.9	1	0.5	-2.3	-3.4
	B737-300	CFM56-3B2	51.7	1	0.5	-2.9	-3.8
	B737-300	CFM56-3B2	49.9	1	0.5	-4.3	-5.2
	B737-300	CFM56-3C1	54.9	1	0.5	-4.1	-5.3
	B737-300	CFM56-3C1	51.7	1	0.5	-3.4	-4.3
	B737-300	CFM56-3C3	54.9	1	0.5	-3.7	-4.8
	B737-400	CFM56-3C1	56.3	1	0.5	-3.1	-4.4
	B737-400	CFM56-3C1	54.9	1	0.5	-2.5	-3.7
	B737-400	CFM56-3C1	50.2	1	0.5	-1.3	-2.5
	B737-500	CFM56-3B1	49.9	1	0.5	-2.5	-3.3
	B737-500	CFM56-3C1	49.9	1	0.5	-1.7	-2.5

* At this certificated weight, the measured noise levels for two other variants of the RB211-524 powered B747-400 fall within the QC/2 band. The large variation of measured noise level for this type may be explained by the use of different operating procedures, including reduced landing flap.

Table 2 Departures: Noise Measurements Above or Below QC Bands

ABOVE / BELOW QC BAND	TYPE	ENGINE	MTOW (t)	QC	IN-SERVICE QC (ACCORDING TO MEASURED DATA)	DIFFERENCE, EPNdB MEASUREMENT - QC LIMIT	MEASUREMENT - CERTIFICATION
ABOVE	B737-200 Adv	JT8D-15	53.0	4	8	0.7	0.7
	B747-400	RB211-524G	396.9	4	8	0.7	1.0
	B747-400	RB211-524G	381.0	4	8	0.9	1.9
	B747-400	RB211-524H	396.9	4	8	0.6	1.1
	B747-400	RB211-524H2	396.9	4	8	0.3	0.8
	B747-400	RB211-524H2	381.0	4	8	0.2	1.2
	B737-200 Adv	JT8D-15 (HK)	53.0	2	4	1.0	3.7
	MD-11F	CF6-80C2D1F	280.3	2	4	2.0	2.8
	MD-83	JT8D-219	72.6	2	4	0.7	2.6
	MD-87	JT8D-219	63.5	1	4	4.0	5.1
	B767-300 (ER)	RB211-524H	158.0	1	2	1.3	2.0
	B737-300	CFM56-3B1	61.2	0.5	1	1.4	2.9
	B737-300	CFM56-3B1	61.0	0.5	1	1.2	2.8
	B737-300	CFM56-3B1	59.0	0.5	1	0.4	2.4
	B737-300	CFM56-3B1	58.0	0.5	1	1.7	3.9
	B737-300	CFM56-3B1	56.5	0.5	1	1.5	4.0
	B737-300	CFM56-3B2	63.3	0.5	1	0.9	2.0
	B737-300	CFM56-3B2	62.8	0.5	1	1.2	2.4
	B737-300	CFM56-3C1	63.3*	0.5	1	0.4	1.4
	B737-300	CFM56-3C1	61.3*	0.5	1	0.5	2.0
	B737-300	CFM56-3C1	58.1*	0.5	1	0.9	3.1
	B737-300	CFM56-3C1	57.8*	0.5	1	0.8	3.0
	B737-400	CFM56-3C1	62.8	0.5	1	0.7	1.0
	B737-800	CFM56-7B24	75.0	0.5	1	0.2	0.4
	B757-200	RB211-535E4	113.4	0.5	1	2.4	2.7
	B757-200	RB211-535E4	108.9	0.5	1	2.4	3.3
	B757-200	RB211-535E4	104.3	0.5	1	2.4	3.9
	B757-200	RB211-535E4	102.1	0.5	1	1.5	3.3
	B757-200	RB211-535E4	101.8	0.5	1	1.2	3.0
	B757-200	RB211-535E4	100.3	0.5	1	1.4	3.5
BELOW	B767-300 (ER)	CF6-80C2B7F	184.6	2	1	-0.2	-0.9
	BAe 748-2B	Dart 536-2	21.1	2	1	-0.8	-2.5
	L-188C	AN 501-D13A	52.6	2	1	-0.2	-0.5
	A320-214	CFM56-5B4/P	77.0	1	0.5	-0.3	-1.2
	A320-231	V2500-A1	77.0	1	0.5	-0.1	-0.6
	A320-231	V2500-A1	75.5	1	0.5	-0.2	-0.3

* The measured noise level for the B737-300/CFM56-3C1/61.7t MLW falls within the QC/0.5 band.

Table 3(a) QC/0.5 Arrivals: Noise Measurements Below QC Band

ABOVE / BELOW QC BAND	TYPE	ENGINE	MLW (t)	QC	IN-SERVICE QC (ACCORDING TO MEASURED DATA)	DIFFERENCE, EPNdB MEASUREMENT - QC LIMIT	MEASUREMENT - CERTIFICATION
BELOW	A320-211	CFM56-5A1	64.5	0.5	0.25	-1.1	-1.3
	A320-212	CFM56-5A3	64.5	0.5	0.25	-1.7	-1.7
	A320-231	V2500-A1	64.5	0.5	0.25	-0.9	-1.5
	A321-211	CFM56-5B3/P	77.8	0.5	0.25	-0.7	-1.5
	A321-211	CFM56-5B3/P	75.5	0.5	0.25	-0.9	-1.4
	ATR42-300	PW120	16.9	0.5	0.25	-0.7	-1.5
	ATR42-300	PW120	16.4	0.5	0.25	-1.0	-1.7
	Avro RJ100	LF507-1F	40.1	0.5	0.25	-3.9	-5.5
	B737-700	CFM56-7B24	60.8	0.5	0.25	-0.2	-0.3
	B737-800	CFM56-7B24	66.4	0.5	0.25	-1.1	-1.6
	B737-800	CFM56-7B26	66.4	0.5	0.25	-1.2	-1.7
	B737-800	CFM56-7B26	65.3	0.5	0.25	-2.1	-2.5
	BAe 146-300	ALF502R-5	37.7	0.5	0.25	-3.7	-3.7

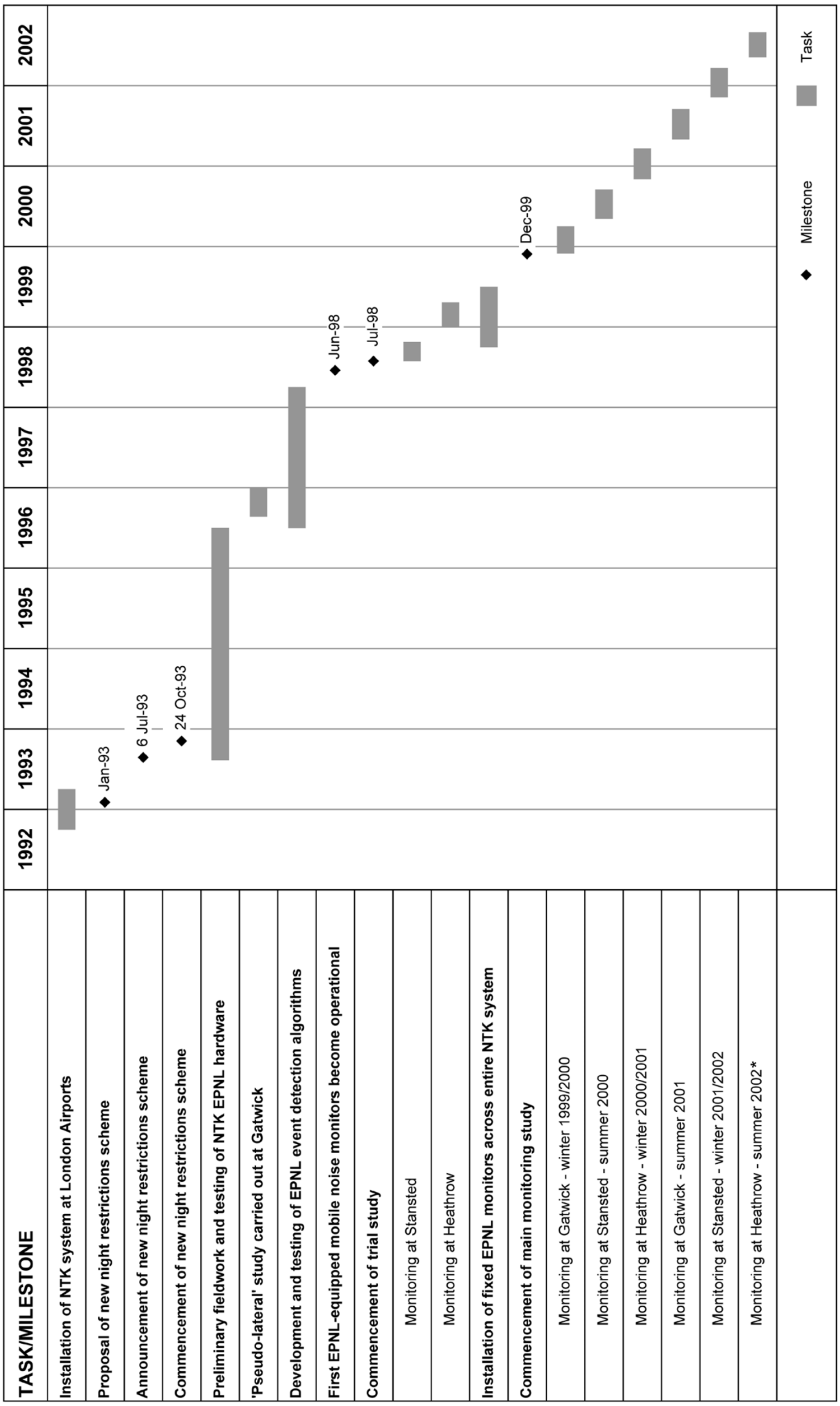
Table 3(b) Potential 'QC/0.25' Arrivals: Noise Measurements Above QC Band

ABOVE / BELOW QC BAND	TYPE	ENGINE	MLW (t)	QC	IN-SERVICE QC (ACCORDING TO MEASURED DATA)	DIFFERENCE, EPNdB MEASUREMENT - QC LIMIT	MEASUREMENT - CERTIFICATION
ABOVE	B757-200	RB211-535E4	95.3	0.25	0.5	1.5	2.2
	B757-200	RB211-535E4	90.0	0.25	0.5	1.7	2.6
	B757-200	RB211-535E4	89.8	0.25	0.5	1.6	2.5
	B757-300	RB211-535E4-B	101.6	0.25	0.5	3.0	3.5
	B767-200 (ER)	CF6-80C2	126.1	0.25	0.5	0.4	0.4
	B767-200 (ER)	CF6-80C2B2	126.1	0.25	0.5	0.8	0.8
	B767-200 (ER)	CF6-80C2B4	126.1	0.25	0.5	0.7	0.9

Table 3(c) Potential 'QC/0.25' Departures: Noise Measurements Above QC Band

ABOVE / BELOW QC BAND	TYPE	ENGINE	MTOW (t)	QC	IN-SERVICE QC (ACCORDING TO MEASURED DATA)	DIFFERENCE, EPNdB MEASUREMENT - QC LIMIT	MEASUREMENT - CERTIFICATION
ABOVE	BAe 146-200	ALF502R-5	42.4	0.25	0.5	1.6	2.2
	BAe 146-200	ALF502R-5	42.2	0.25	0.5	1.4	2.0
	BAe 146-300	ALF502R-5	44.2	0.25	0.5	0.7	1.2

Figure 1 QC Validation Programme



* Since arrivals account for the majority of night-time operations at Heathrow, summer 2002 monitoring was restricted to arrivals only.

Figure 2 Aircraft Noise Certification Measurement Points
(in relation to illustrative noise footprints)

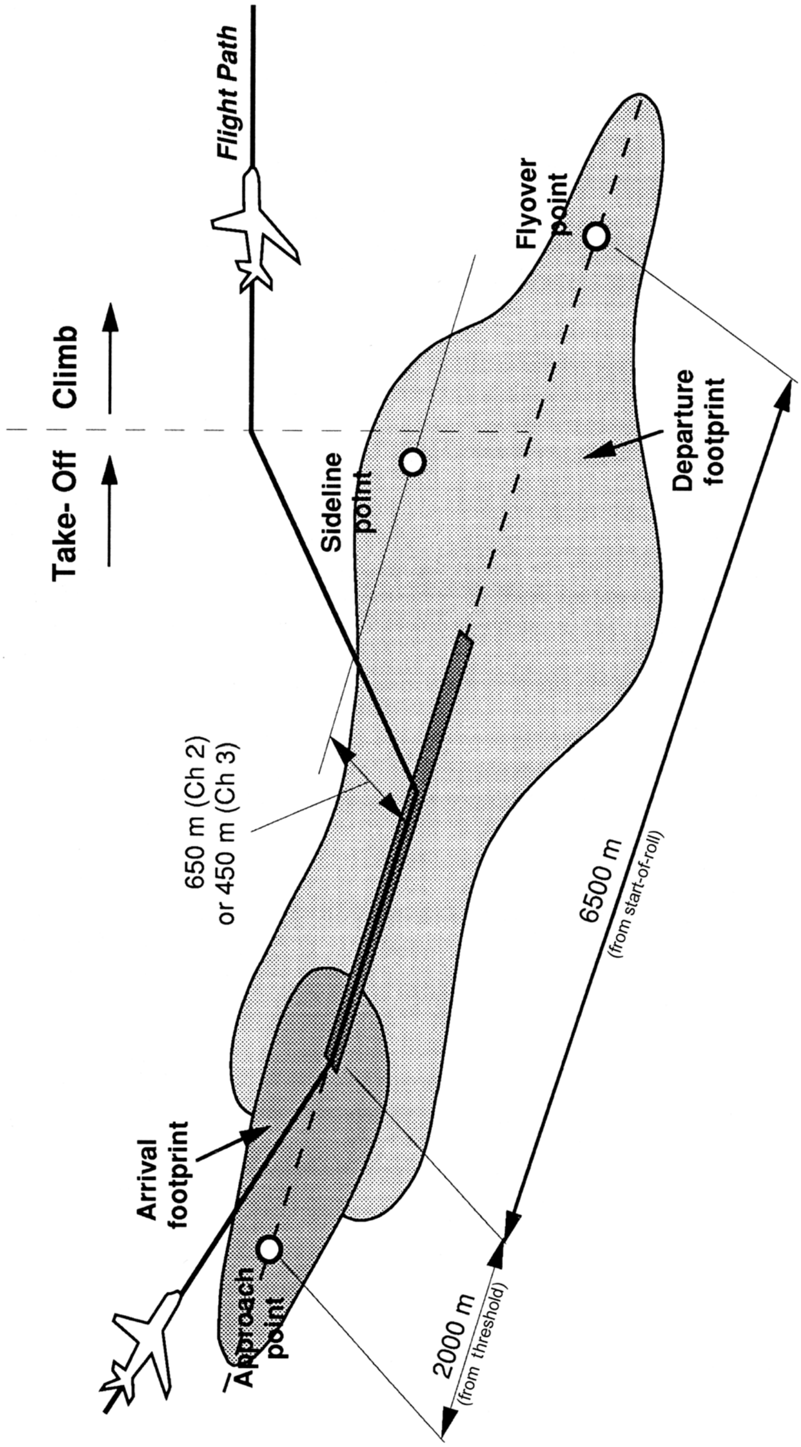


Figure 3 Estimation of Operational Noise Levels at the Reference Points

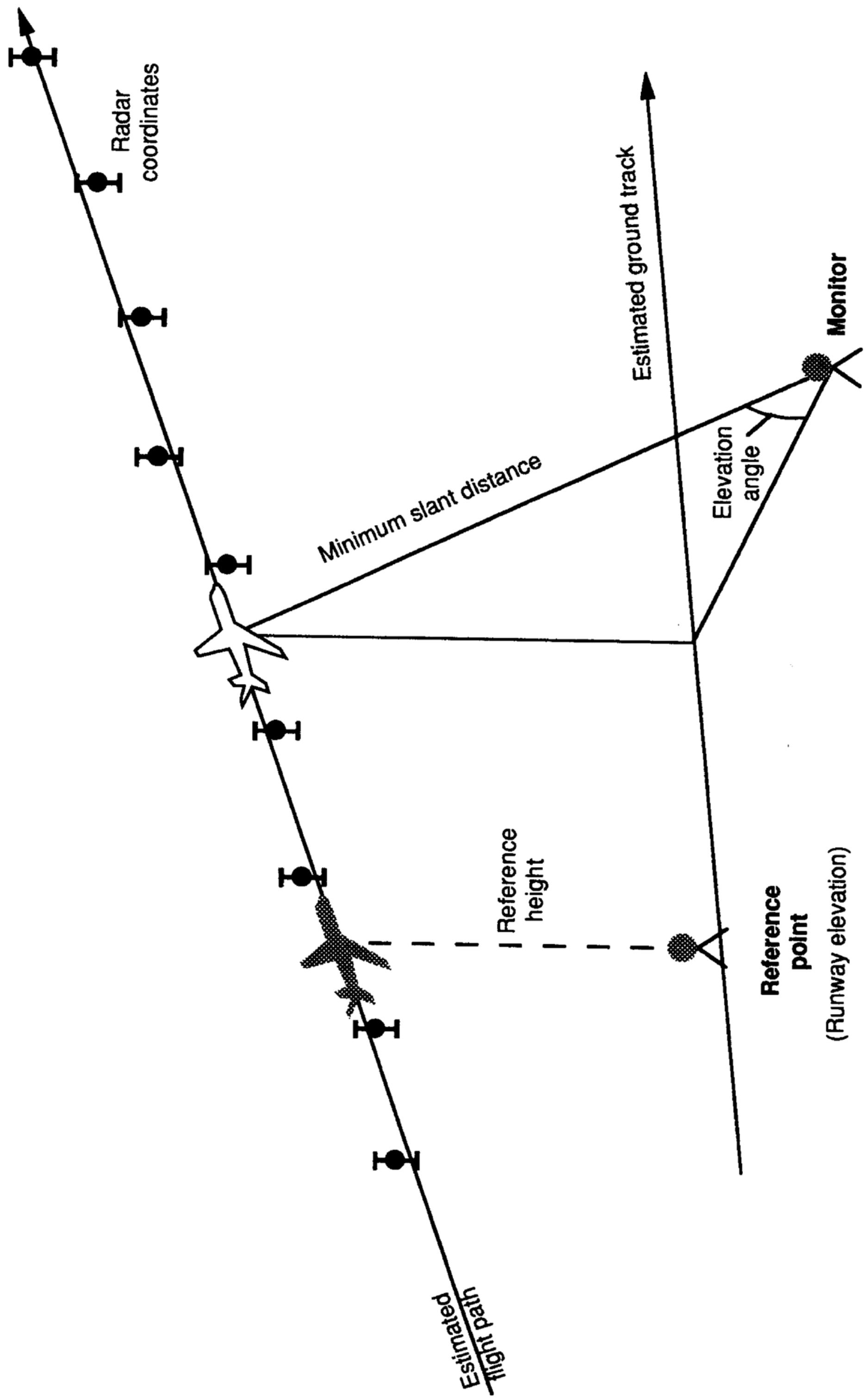


Figure 4 Noise Monitor Locations at Heathrow

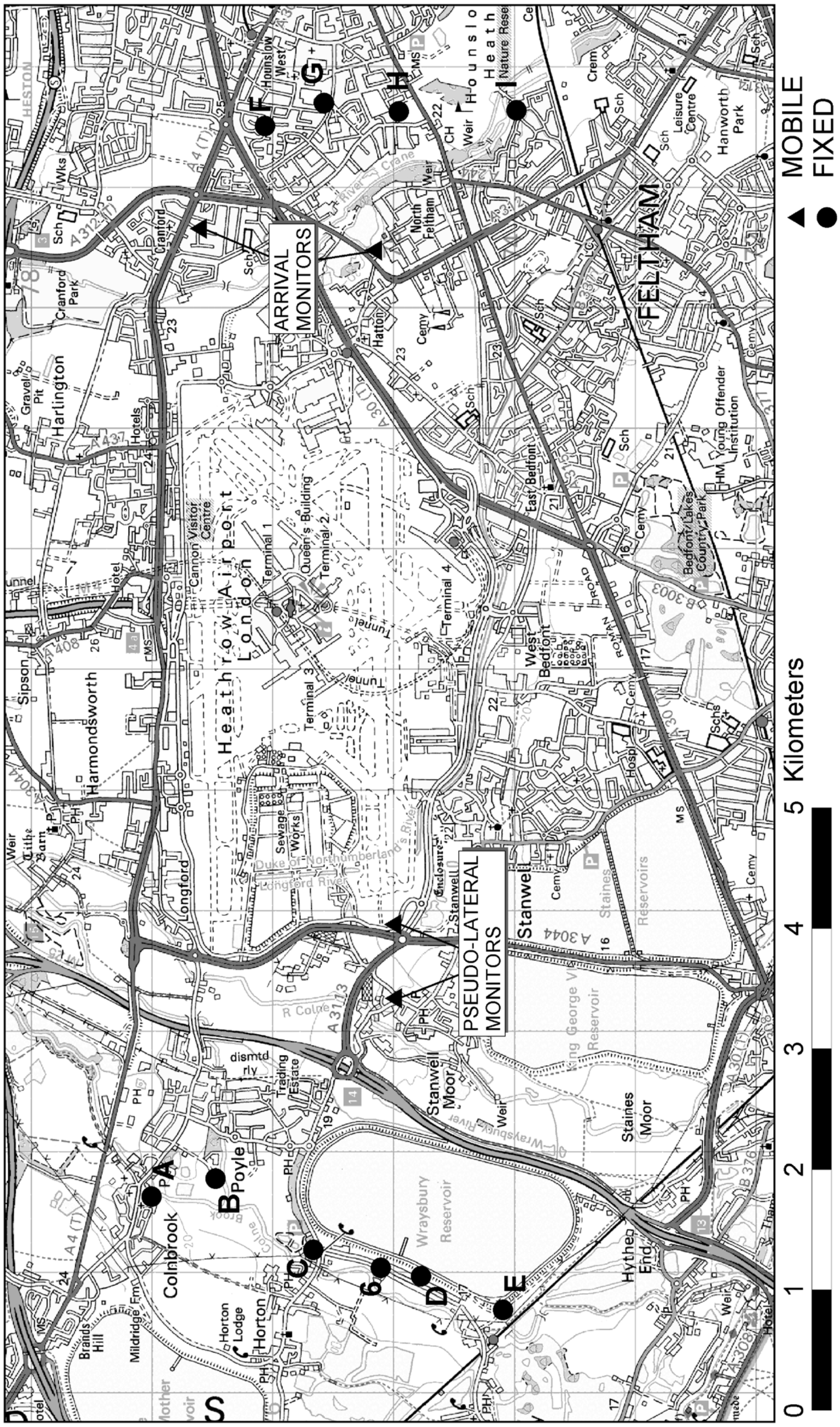


Figure 5 Noise Monitor Locations at Gatwick

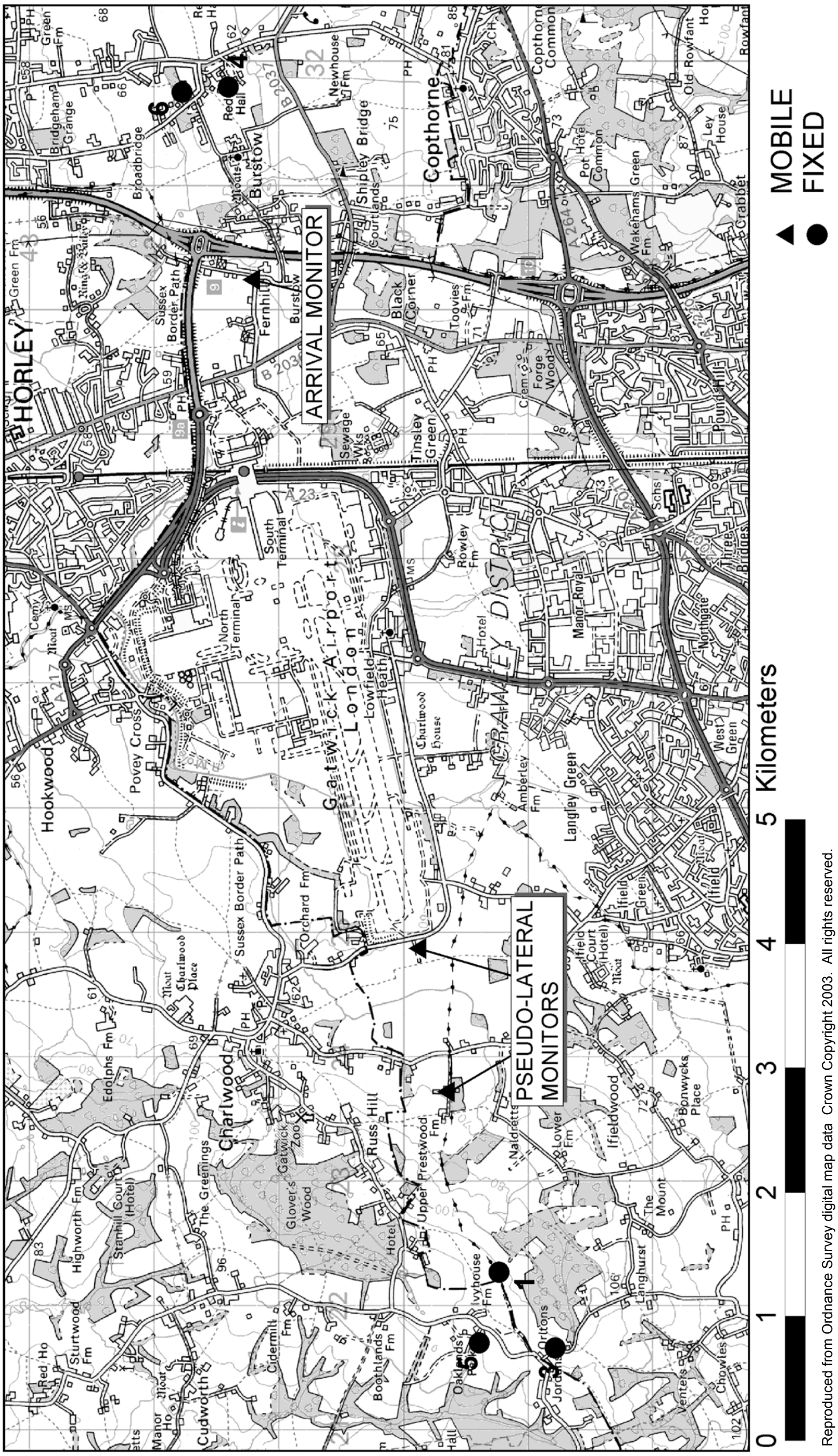


Figure 6 Noise Monitor Locations at Stansted

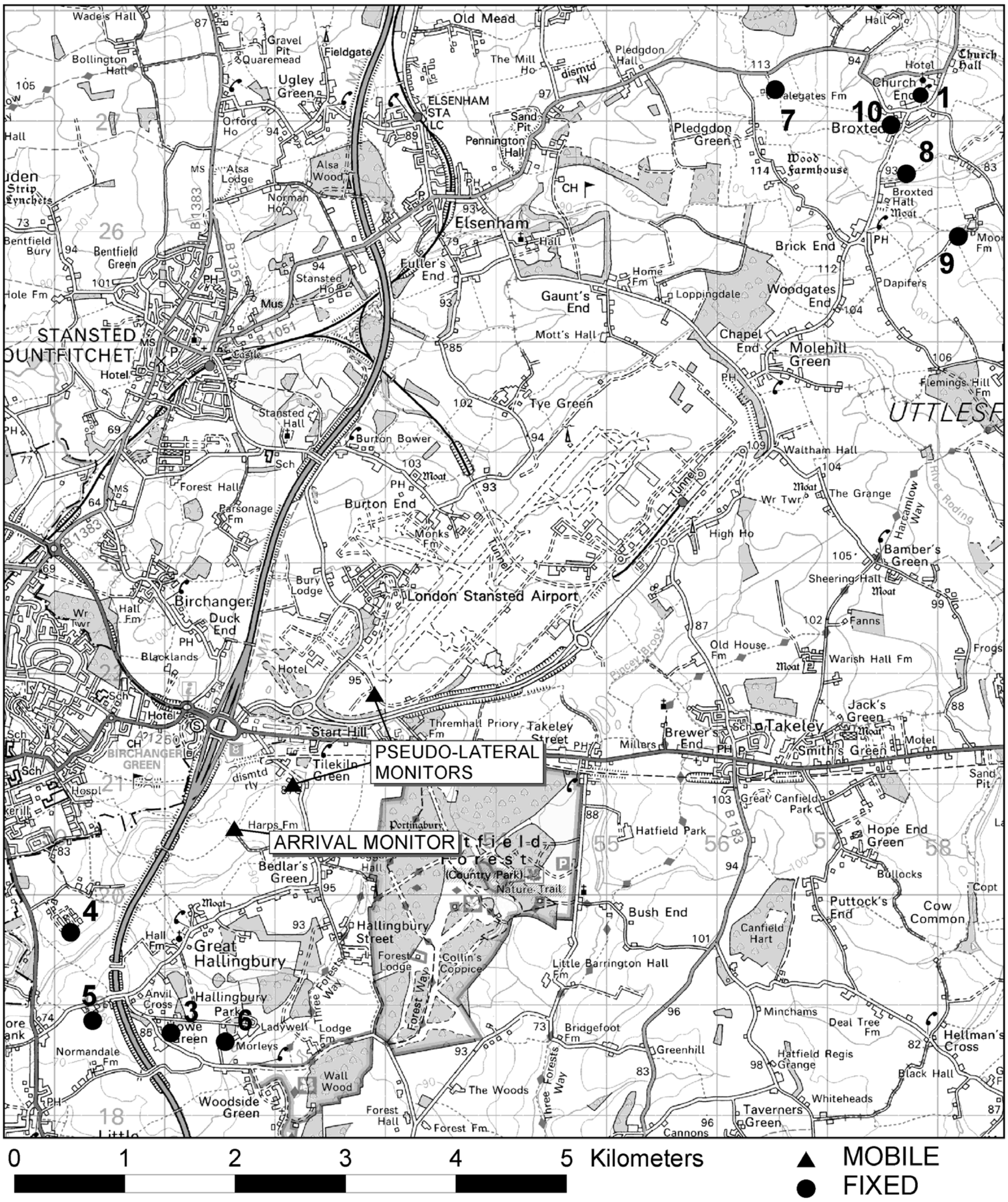


Figure 7 Pooled Approach EPNLs (Exempt - QC/0.5)

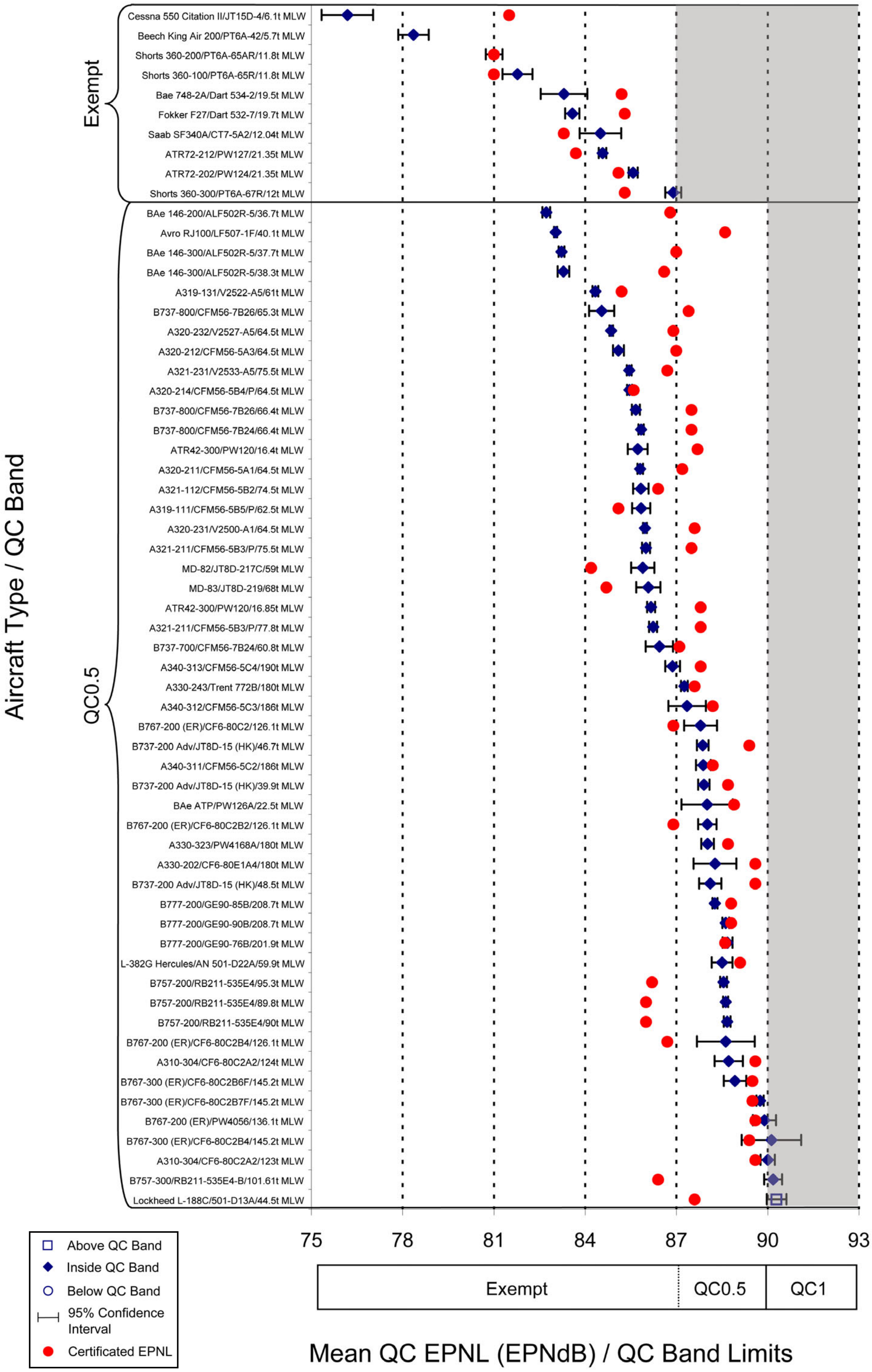


Figure 8 Pooled Approach EPNLs (QC/1 - QC/4)

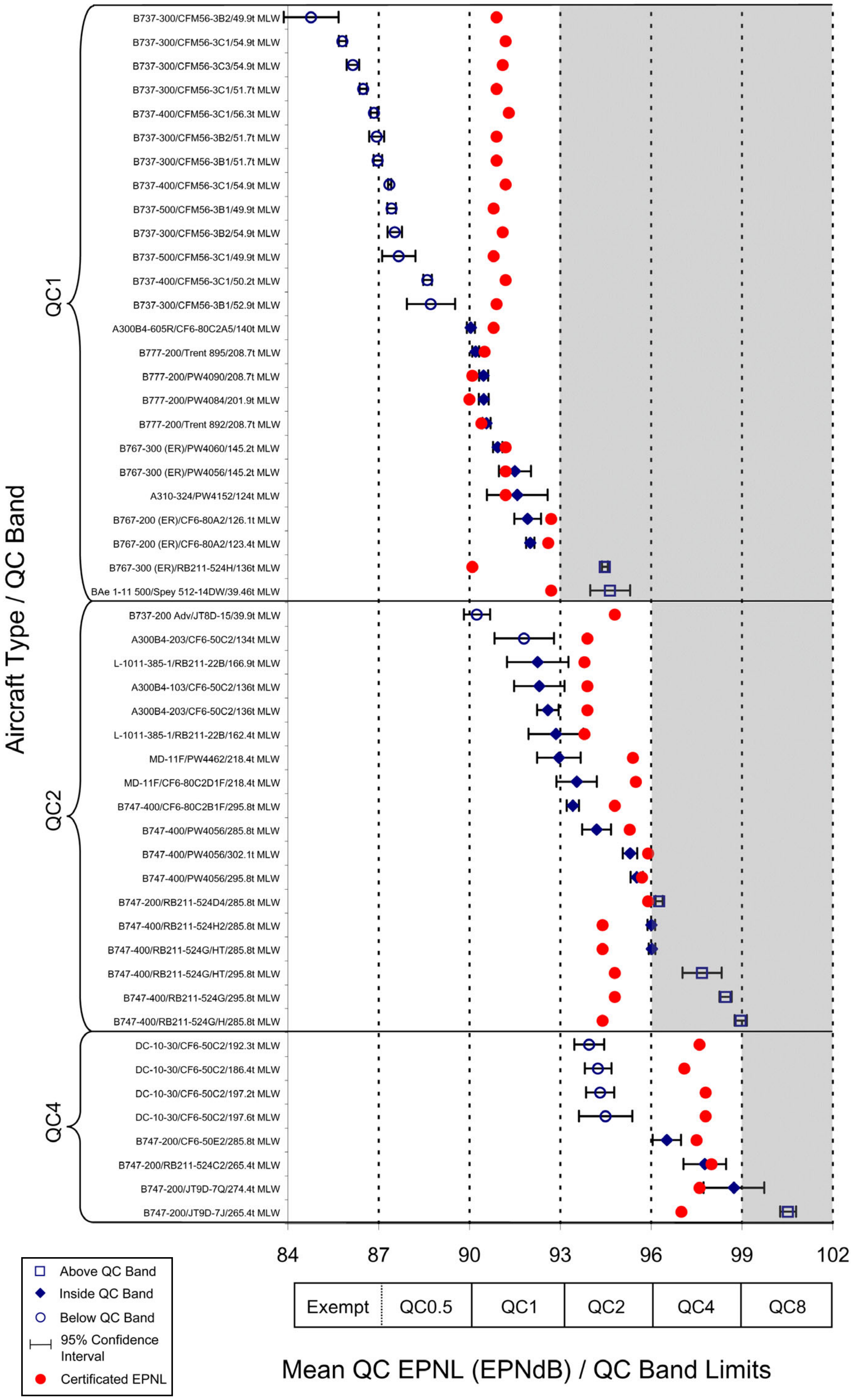


Figure 9 Pooled Departure EPNLs (Exempt - QC/0.5)

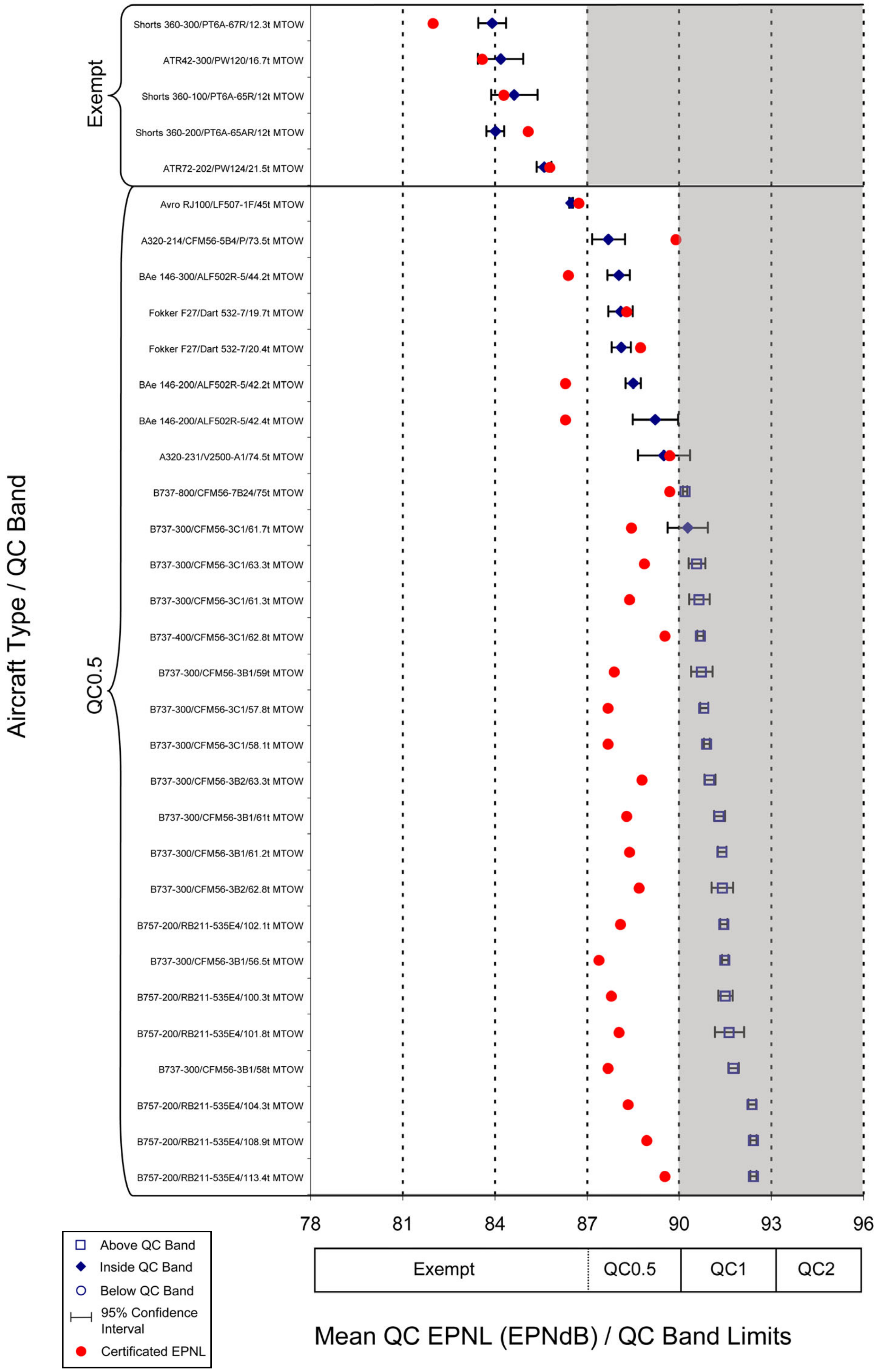
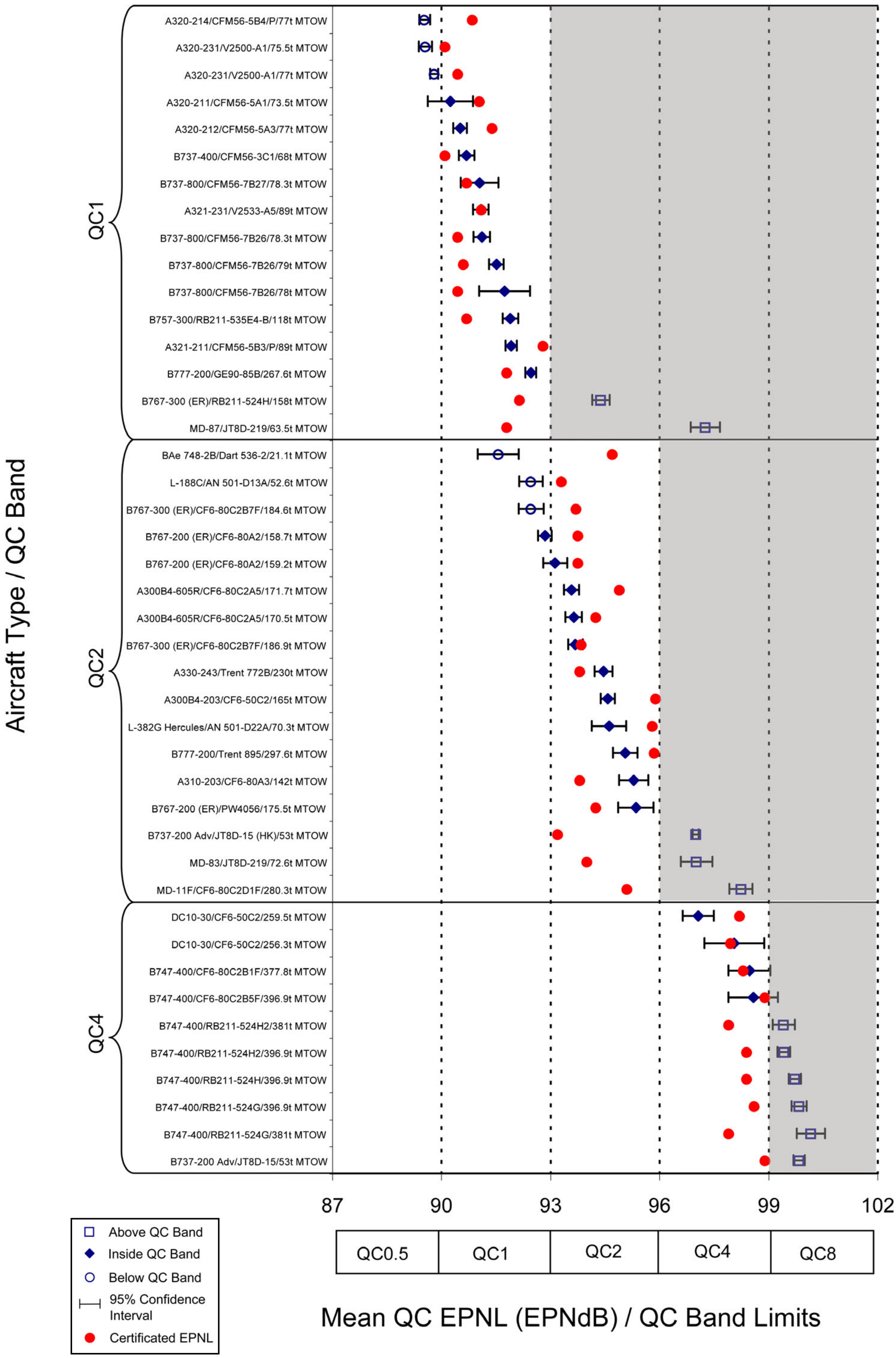


Figure 10 Pooled Departure EPNLs (QC/1 - QC/4)



Appendix A The Trial Study

A1 Calculation of operational noise levels

A1.1 Measurements for the trial study were collected (during the day and at night) at Stansted between July and September 1998 and at Heathrow between January and April 1999. To estimate operational EPNLs, NTK-measured approach and flyover noise levels were adjusted to account for monitor displacements from the exact certification reference points. Because the fixed monitors had not been upgraded to measure EPNLs by the start of the trial study, flyover levels at Stansted were measured using a single mobile monitor located close to one of the existing fixed sites. However, frequent monitor failure (caused by poor battery life) limited departure data largely to pseudo-lateral points and the Stansted analysis was restricted to arrivals only. (By the time monitoring commenced at Heathrow, all the relevant fixed monitors had been upgraded.)

A1.2 For arrivals, the measured levels were adjusted to a reference slant distance of 120 m, which, for certification, is the height of the aircraft above the 2 km approach point. For departures, flyover levels were adjusted for slant distance to account for fixed monitor displacements from the nominal flyover reference point at 6.5 km from start-of-roll. Pseudo-lateral levels were calculated as described in Reference A1. To reduce the complexity of the analysis for the trial study, the EPNL differences were estimated using a 'standard' sound attenuation rate for all aircraft types, which was based on an average NPD decay rate for a range of representative aircraft types. Although this did not affect the conclusions of the trial, using an average decay rate instead of the individual NPD decay curves may have introduced adjustment errors (for some aircraft types) of up to 0.5 and 1.0 EPNdB for arrivals and departures respectively. (For the main study, the EPNL differences were estimated using the NPD relationships for each aircraft type).

A2 Results

A2.1 When considering the trial results it should be remembered that the data were collected to test and develop the measurement and analysis procedures, not to assess the operational noise performance of the subject aircraft.

A2.2 Approach measurements were collected and analysed for 22 aircraft types at Stansted (a total of 701 EPNL values). For arrivals at Heathrow, data were collected for 53 different aircraft types (a total of 6,564 EPNL values). For Heathrow departures, data were collected for 54 aircraft types, at both the pseudo-lateral and flyover locations (a total of 13,980 EPNL values).

A2.3 **Figure A1** compares the operational noise levels with the QC bands for Stansted arrivals. For each aircraft type (6 props and 16 jets), both the measured average level (adjusted by -9 EPNdB) and the associated 95% confidence interval are shown. Details of the analysis are listed in **Table A1**. Although an exact match between the measurements and the QC bands for all aircraft types was not to be expected, **Figure A1** shows that, within the 95% confidence limits, all except one aircraft type generated noise levels that matched or bettered their QC ratings. Since arrivals noise measured at the approach reference point in normal service could be expected to be lower than in certification, the Stansted trial results were unsurprising.

A2.4 The Stansted measurements were subjected to further analysis to investigate whether there was any significant difference in the measured noise levels between day and night operations for the same aircraft. The EPNL data were split into daytime (0600-2330) and night-time (2330-0600) measurements. Of the sub-samples formed, at least 6 day and 6 night measurements were available for 6 different aircraft types - see **Table A2**. The results and corresponding statistical 't-tests' indicated that only for one aircraft, the ATR72-202, is the observed difference statistically significant, the night value being 1.8 EPNdB higher. Although the majority of the day-night differences were not statistically significant, the data were insufficient to support reliable conclusions.

A2.5 **Figures A2 to A5** compare the measured EPNLs at Heathrow with the QC bands. **Figure A2** shows the approach results for Exempt and QC/0.5 aircraft; **Figure A3** for QC/1 to QC/16 approaches. **Figure A4** shows the departure results for QC/0.5 to QC/1 aircraft; **Figure A5** for QC/2 to QC/16 departures. For each aircraft type, both the average measured level and the 95% confidence interval are shown. Numerical results are listed in **Tables A3 and A4**.

A2.6 For arrivals, data were collected for 53 different aircraft types, 2 props and 51 jets. Departure data were collected for 54 different aircraft types. However, these cover jets only since (i) there are fewer propeller-powered aircraft operating from Heathrow (compared to Stansted), and (ii) their generally lower noise levels were more difficult to separate from background noise.

A2.7 The results shown in **Figures A2 to A5** indicate that most of the aircraft monitored at Heathrow met or bettered their QC ratings. However, the confidence intervals of 14 aircraft types lie entirely above their QC band limits.

A2.8 Further analysis was planned to investigate whether, for individual aircraft types, there was any statistically significant difference in average EPNLs between day and night operations. However, aircraft operations during the night period account for a very small percentage of the total traffic at Heathrow. Due to the paucity of night-time operations at Heathrow, insufficient trial data were collected to allow reliable comparisons of day and night EPNLs.

A3 Effect of aircraft anti-ice protection

A3.1 During all ground and flight operations where icing can occur (defined as visible moisture present in air - i.e. in cloud or air- at indicated total air temperatures less than 10ºC and/or when visibility is below 1000 m), a minimum power setting which may be higher than flight idle has to be used in order to provide sufficient anti-icing capabilities to de-ice both the engines and the wing leading edges, using hot air from the engines. Thus, it is possible that the measured noise levels of the same aircraft type, operating in temperatures above and below 10ºC, could differ significantly due to the different engine speeds. To investigate the possible of effect of aircraft anti-ice systems on the mean noise levels, a small-scale analysis of the Heathrow trial data was undertaken. The data were analysed to see whether there were significant differences in average EPNLs for data collected in the following temperature conditions[1]:

- Less than 10ºC (i.e. assuming anti-ice protection is in use);
- Greater than 10ºC (i.e. assuming no anti-ice protection).

[1] The temperature readings for this analysis were obtained from the Met Office weather station at Heathrow (10 m above ground level) and are not expected to differ significantly from the actual indicated total air temperatures.

A3.2 The approach, flyover and pseudo-lateral data were sub-divided by temperature into 2 groups and compared. Attention was confined to aircraft type groups of more than 18 data points. The 2 groups of mean EPNLs are plotted against each other in **Figure A6** for comparison. Overall, a one-to-one relationship can be seen between the two groups of measurements. The effect of aircraft anti-ice systems on the mean noise levels would be noticeable in these figures if all data points were displaced by large amounts from the diagonal lines. However, the results show no consistent difference between the mean noise levels of aircraft operating in temperatures above and below 10ºC. Overall, for both arrivals and departures, there were an equal number of positive and negative differences between the mean EPNLs.

Reference

A1 Smith M J T and White S: A Practical Method for Estimating Operational Lateral Noise Levels: ERCD Report 0206, April 2003.

Table A1 Stansted Approach EPNLs (Trial Data)

				POOLED EPNL (24HR), EPNdB				
TYPE	**ENGINE**	**MLW (t)**	**QC**	**MEAN**	**STD DEV**	**COUNT**	**STD ERR**	**95% CI**
A300B4-203F	CF6-50C2	136.0	2	102.0	0.9	10	0.3	0.6
A320-231	V2500-A1	64.5	0.5	94.2	1.0	17	0.2	0.5
ATR42-300	PW120	16.4	0.5	96.9	1.6	15	0.4	0.9
ATR72-202	PW124	21.4	Exempt	93.9	1.7	56	0.2	0.5
B737-200	JT8D-15 (HK)	46.7	0.5	97.5	1.4	39	0.2	0.5
B737-200	JT8D-15/15A	48.5	2	101.0	3.2	151	0.3	0.5
B737-200	JT8D-17A	35.9	2	101.9	2.2	15	0.6	1.2
B737-300	CFM56-3C1	54.9	1	94.7	0.7	8	0.2	0.6
B737-400	CFM56-3C1	56.3	1	97.7	2.5	15	0.6	1.4
B737-500	CFM56-3C1	51.7	1	95.2	1.1	18	0.3	0.5
B757-200	RB211-535E4	95.3	0.5	97.5	1.5	35	0.3	0.5
BAe 1-11 500	Spey 512-14DW	35.8	1	104.4	2.2	63	0.3	0.6
BAe 146-200	ALF502R-5	36.7	0.5	92.3	1.2	43	0.2	0.4
BAe 146-300	ALF502R-5	38.3	0.5	92.8	1.6	74	0.2	0.4
BAe Jetstream 41	TPE331-14G/HR-80	10.1	Exempt	87.0	0.8	8	0.3	0.7
DC9-40	JT8D-11 (HK)	46.3	1	96.6	1.2	8	0.4	1.0
Embraer 120	PW118	10.8	Exempt	92.7	0.6	12	0.2	0.4
Fokker 100	Tay 620-15	39.9	0.5	93.5	1.7	56	0.2	0.5
Fokker 50	PW125B	19.0	0.5	95.0	0.8	27	0.2	0.3
MD-11F	CF6-80C2D1F	218.4	2	102.2	3.1	11	0.9	2.1
MD-87	JT8D-219	59.0	0.5	95.4	1.5	8	0.5	1.3
Shorts 360-300	PT6A-67R	12.0	Exempt	95.6	1.4	12	0.4	0.9

Table A2 Comparison of Night-time and Daytime Approach EPNLs at Stansted (Trial Data)

		NIGHT-TIME EPNL, EPNdB					DAYTIME EPNL, EPNdB					DIFFERENCE
AIRCRAFT	**ENGINE**	**MEAN**	**STD DEV**	**COUNT**	**STD ERR**	**95% CI**	**MEAN**	**STD DEV**	**COUNT**	**STD ERR**	**95% CI**	**NIGHT-DAY**
B737-200 Adv	JT8D-15/15A	101.1	3.8	8	1.3	3.2	101.0	3.1	143	0.3	0.5	0.1
BAe 146-300	ALF502R-5	93.1	1.0	6	0.4	1.0	92.8	1.7	68	0.2	0.4	0.3
ATR72-202	PW124	95.4	0.9	10	0.3	0.6	93.6	1.7	46	0.3	0.5	1.8
B757-200	RB211-535E4	97.1	1.0	11	0.3	0.7	97.7	1.7	24	0.3	0.7	-0.6
A320-231	V2500-A1	94.5	0.8	7	0.3	0.7	94.0	1.1	10	0.3	0.8	0.5
Shorts 360-300	PT6A-67R	94.9	1.3	6	0.5	1.4	96.4	1.2	6	0.5	1.3	-1.5

Table A3 Heathrow Approach EPNLs (Trial Data)

				POOLED EPNL (24HR), EPNdB				
AIRCRAFT	**ENGINE**	**MLW (t)**	**QC**	**MEAN**	**STD DEV**	**COUNT**	**STD ERR**	**95% CI**
A300B4-120	JT9D-59A	134.0	2	103.0	2.2	19	0.5	1.1
A300B4-603	CF6-80C2A3	138.0	1	100.3	1.8	39	0.3	0.6
A300B4-605R	CF6-80C2A5	140.0	1	100.4	2.0	78	0.2	0.5
A300B4-622R	PW4158	140.0	1	102.6	1.7	19	0.4	0.8
A310-304	CF6-80C2A2	124.0	0.5	98.8	2.1	43	0.3	0.6
A320-111	CFM56-5A1	63.0	0.5	95.7	1.6	143	0.1	0.3
A320-211	CFM56-5A1	64.5	0.5	95.2	1.6	396	0.1	0.2
A320-214	CFM56-5B4	64.5	0.5	96.6	1.5	32	0.3	0.5
A320-231	V2500-A1	64.5	0.5	96.3	1.1	47	0.2	0.3
A321-111	CFM56-5B1	75.0	0.5	97.7	1.5	97	0.2	0.3
A321-112	CFM56-5B2	74.5	0.5	95.7	1.5	99	0.2	0.3
A321-131	V2530-A5	73.5	0.5	95.9	1.2	30	0.2	0.4
A321-211	CFM56-5B3/P	77.8	0.5	96.3	1.8	149	0.1	0.3
A321-231	V2533-A5	75.5	0.5	95.6	1.5	182	0.1	0.2
A340-311	CFM56-5C2	186.0	0.5	98.0	1.9	67	0.2	0.5
A340-312	CFM56-5C3	186.0	0.5	98.2	1.9	26	0.4	0.8
A340-313	CFM56-5C4	190.0	0.5	97.9	1.6	55	0.2	0.4
ATR72-201	PW124	21.4	Exempt	98.4	1.3	19	0.3	0.6
B737-200 Adv	JT8D-15/15A	45.8	2	101.4	2.3	21	0.5	1.0
B737-300	CFM56-3B1	54.9	1	96.4	1.7	115	0.2	0.3
B737-300	CFM56-3B2	54.9	1	96.6	2.0	201	0.1	0.3
B737-300	CFM56-3C1	54.9	1	96.7	1.9	145	0.2	0.3
B737-400	CFM56-3B2, 3C1	56.3	1	97.6	1.9	678	0.1	0.1
B737-500	CFM56-3B1	51.7	1	96.4	1.9	400	0.1	0.2
B737-500	CFM56-3C1	51.7	1	96.6	2.1	129	0.2	0.4
B737-800	CFM56-7B26	66.4	0.5	97.3	1.6	25	0.3	0.7
B747-100	JT9D-7A	265.4	8	111.0	1.9	54	0.3	0.5
B747-200	RB211-524D4	285.8	2	106.9	1.5	108	0.1	0.3
B747-400	CF6-80C2B1F	295.8	2	103.8	2.2	145	0.2	0.4
B747-400	PW4056	302.1	2	105.6	1.6	121	0.1	0.3
B747-400	RB211-524G	295.8	2	108.3	2.0	41	0.3	0.6
B747-400	RB211-524H2	285.8	2	106.1	2.0	127	0.2	0.4
B757-200	RB211-535C	95.3	1	101.3	1.7	942	0.1	0.1
B757-200	RB211-535E4	95.3	0.5	97.5	1.6	393	0.1	0.2
B767-200	CF6-80A2	126.1	1	101.6	1.6	52	0.2	0.4
B767-200	JT9D-7R4D	136.1	2	102.0	2.1	34	0.4	0.7
B767-300	CF6-80C2B6	145.2	0.5	100.4	2.4	67	0.3	0.6
B767-300	CF6-80C2B6F	145.2	0.5	99.2	2.0	44	0.3	0.6
B767-300	PW4060	145.2	1	101.3	2.5	80	0.3	0.6
B767-300	RB211-524H	136.0	1	105.0	2.4	473	0.1	0.2
B777-200	GE90-85B	208.7	0.5	98.1	1.2	56	0.2	0.3
B777-200	PW4090	208.7	1	100.0	1.6	76	0.2	0.4
B777-200	Trent 890	208.7	1	100.6	1.9	20	0.4	0.9
BAe 146-200	ALF502R-5	36.7	0.5	93.9	1.6	29	0.3	0.6
Concorde	Olympus 593-610	185.1	16	118.3	1.3	29	0.2	0.5
DC-10-30	CF6-50C2	197.8	4	105.4	2.6	27	0.5	1.0
Fokker 50	PW125B	19.0	0.5	96.8	1.3	33	0.2	0.5
L-1011-500	RB211-524B4	166.9	2	105.4	1.3	19	0.3	0.6
MD-11	CF6-80C2D1F	218.4	2	102.6	1.6	19	0.4	0.8
MD-80	JT8D-217C	68.0	0.5	97.7	2.0	144	0.2	0.3
MD-83	JT8D-219	68.0	0.5	97.4	1.6	57	0.2	0.4
MD-87	JT8D-217C	59.0	0.5	96.3	1.7	61	0.2	0.4
MD-90	V2525-D5	64.4	0.5	94.4	1.7	59	0.2	0.4

Table A4 Heathrow Departure EPNLs (Trial Data)

				POOLED EPNL (24HR), EPNdB									
				FLYOVER					PSEUDO-LATERAL				
AIRCRAFT	**ENGINE**	**MTOW (t)**	**QC**	**MEAN**	**STD DEV**	**COUNT**	**STD ERR**	**95% CI**	**MEAN**	**STD DEV**	**COUNT**	**STD ERR**	**95% CI**
A300B4-120	JT9D-59A	157.5	2	93.8	1.2	27	0.2	0.5	91.1	1.7	31	0.3	0.6
A300B4-603	CF6-80C2A3	165.0	2	93.1	1.7	30	0.3	0.7	89.5	1.9	49	0.3	0.5
A300B4-605R	CF6-80C2A5	171.7	2	94.6	1.4	138	0.1	0.2	92.2	2.2	129	0.2	0.4
A300B4-622R	PW4158	171.7	2	96.4	2.0	28	0.4	0.8	94.5	2.2	24	0.4	0.9
A310-203	CF6-80A3	142.0	2	95.1	2.0	32	0.4	0.7	92.1	1.6	51	0.2	0.4
A310-304	CF6-80C2A2	157.0	2	92.5	1.7	44	0.3	0.5	90.4	1.9	42	0.3	0.6
A320-111	CFM56-5A1	68.0	1	91.4	1.5	107	0.1	0.3	87.3	3.5	171	0.3	0.5
A320-211	CFM56-5A1	73.5	1	91.0	1.4	351	0.1	0.1	87.3	3.2	447	0.2	0.3
A320-231	V2500-A1	75.5	1	90.4	1.3	41	0.2	0.4	87.6	1.5	57	0.2	0.4
A321-111	CFM56-5B1	83.0	1	91.8	4.1	106	0.4	0.8	88.7	1.7	184	0.1	0.2
A321-112	CFM56-5B2	83.0	1	90.9	1.5	80	0.2	0.3	87.9	1.7	107	0.2	0.3
A321-211	CFM56-5B3/P	85.0	1	90.4	1.2	81	0.1	0.3	88.8	1.6	163	0.1	0.3
A321-231	V2533-A5	89.0	1	90.9	1.3	146	0.1	0.2	87.8	1.6	149	0.1	0.3
A340-311	CFM56-5C2	260.0	2	99.6	2.8	60	0.4	0.7	90.8	1.8	96	0.2	0.4
A340-312	CFM56-5C3	260.0	2	95.6	2.4	23	0.5	1.1	89.9	1.9	54	0.3	0.5
A340-313	CFM56-5C4	275.0	2	98.0	2.7	91	0.3	0.6	91.3	1.8	118	0.2	0.3
B737-200 Adv	JT8D-15, 15A	52.4	4	100.6	2.2	30	0.4	0.8	97.5	1.8	29	0.3	0.7
B737-300	CFM56-3B1	62.8	0.5	90.4	1.7	35	0.3	0.6	86.3	1.8	130	0.2	0.3
B737-300	CFM56-3B2	63.3	0.5	89.9	1.8	106	0.2	0.4	85.5	2.1	259	0.1	0.3
B737-300	CFM56-3C1	63.3	0.5	90.6	2.1	73	0.3	0.5	86.2	2.1	130	0.2	0.4
B737-400	CFM56-3C1	68.0	0.5	90.6	2.0	377	0.1	0.2	87.0	2.1	532	0.1	0.2
B737-400	CFM56-3C1	68.6	1	92.5	1.6	29	0.3	0.6	88.0	2.2	68	0.3	0.5
B737-500	CFM56-3B1	60.6	0.5	89.3	2.3	199	0.2	0.3	85.6	2.9	432	0.1	0.3
B737-500	CFM56-3C1	62.3	0.5	89.7	1.9	60	0.2	0.5	85.6	2.0	139	0.2	0.3
B747-100	JT9D-7A	332.9	16	107.8	1.6	128	0.1	0.3	101.3	1.8	155	0.1	0.3
B747-200	JT9D-7J	369.2	16	103.3	2.5	21	0.5	1.1	100.9	1.8	25	0.4	0.7
B747-200	RB211-524D4	377.8	8	104.2	2.4	197	0.2	0.3	96.7	1.8	288	0.1	0.2
B747-400	CF6-80C2B1F	396.9	4	100.6	2.1	107	0.2	0.4	96.1	1.6	154	0.1	0.2
B747-400	PW4056	394.6	4	100.8	1.6	28	0.3	0.6	96.7	1.8	47	0.3	0.5
B747-400	PW4056	396.9	4	102.1	1.9	72	0.2	0.4	97.9	1.9	158	0.2	0.3
B747-400	RB211-524G	396.9	4	102.6	2.7	39	0.4	0.9	96.6	1.5	113	0.1	0.3
B747-400	RB211-524H2	396.9	4	102.9	2.3	229	0.2	0.3	96.8	1.2	402	0.1	0.1
B757-200	RB211-535C	99.7	0.5	90.8	2.0	671	0.1	0.2	86.3	2.3	1150	0.1	0.1
B757-200	RB211-535E4	99.7	0.5	90.0	2.1	186	0.2	0.3	86.5	2.1	234	0.1	0.3
B767-200	CF6-80A2	159.2	2	95.8	1.9	60	0.2	0.5	92.7	1.8	73	0.2	0.4
B767-200	JT9D-7R4D	163.3	2	95.2	1.4	20	0.3	0.7	91.9	2.1	26	0.4	0.8
B767-300	CF6-80C2B4	175.5	2	94.7	1.1	20	0.3	0.5	91.6	1.7	28	0.3	0.7
B767-300	CF6-80C2B6	185.1	2	95.1	1.9	113	0.2	0.4	92.6	1.7	156	0.1	0.3
B767-300	CF6-80C2B6F	185.1	2	93.1	3.0	43	0.5	0.9	90.0	2.5	53	0.3	0.7
B767-300	PW4060	186.9	2	96.4	2.6	97	0.3	0.5	92.8	2.5	140	0.2	0.4
B767-300	RB211-524H	158.0	1	95.7	1.7	546	0.1	0.1	91.1	1.8	817	0.1	0.1
B777-200	GE90-76B	242.7	1	94.0	1.3	40	0.2	0.4	88.5	1.3	86	0.1	0.3
B777-200	GE90-85B	267.6	1	93.7	1.4	100	0.1	0.3	88.6	1.4	155	0.1	0.2
BAe 146-200	ALF502R-5	42.2	0.5	90.5	3.0	23	0.6	1.3	84.1	2.0	43	0.3	0.6
Concorde	Olympus 593-610	185.1	16	118.9	3.4	53	0.5	0.9	117.3	2.8	46	0.4	0.8
DC-10-30	CF6-50C2	259.5	4	98.5	3.7	38	0.6	1.2	96.3	1.7	35	0.3	0.6
L-1011-500	RB211-524B4	231.3	4	100.1	2.5	25	0.5	1.0	95.0	2.0	33	0.3	0.7
MD-11	CF6-80C2D1F	286.0	2	97.9	2.3	44	0.3	0.7	95.0	2.5	43	0.4	0.8
MD-80	JT8D-217C	63.5	1	96.9	2.0	87	0.2	0.4	94.2	1.7	61	0.2	0.4
MD-80	JT8D-217C	67.8	2	97.1	2.0	91	0.2	0.4	93.8	1.5	55	0.2	0.4
MD-83	JT8D-219	63.5	1	96.5	3.1	39	0.5	1.0	93.5	1.6	20	0.4	0.7
MD-83	JT8D-219	72.8	2	97.0	2.3	77	0.3	0.5	94.5	1.7	44	0.3	0.5
MD-87	JT8D-217C	63.5	1	96.4	1.9	124	0.2	0.3	93.4	1.2	59	0.2	0.3
MD-90	V2525-D5	70.8	0.5	89.7	1.5	26	0.3	0.6	85.6	1.5	52	0.2	0.4

Figure A1 Trial Results: Stansted Approach EPNLs (Exempt - QC/2)

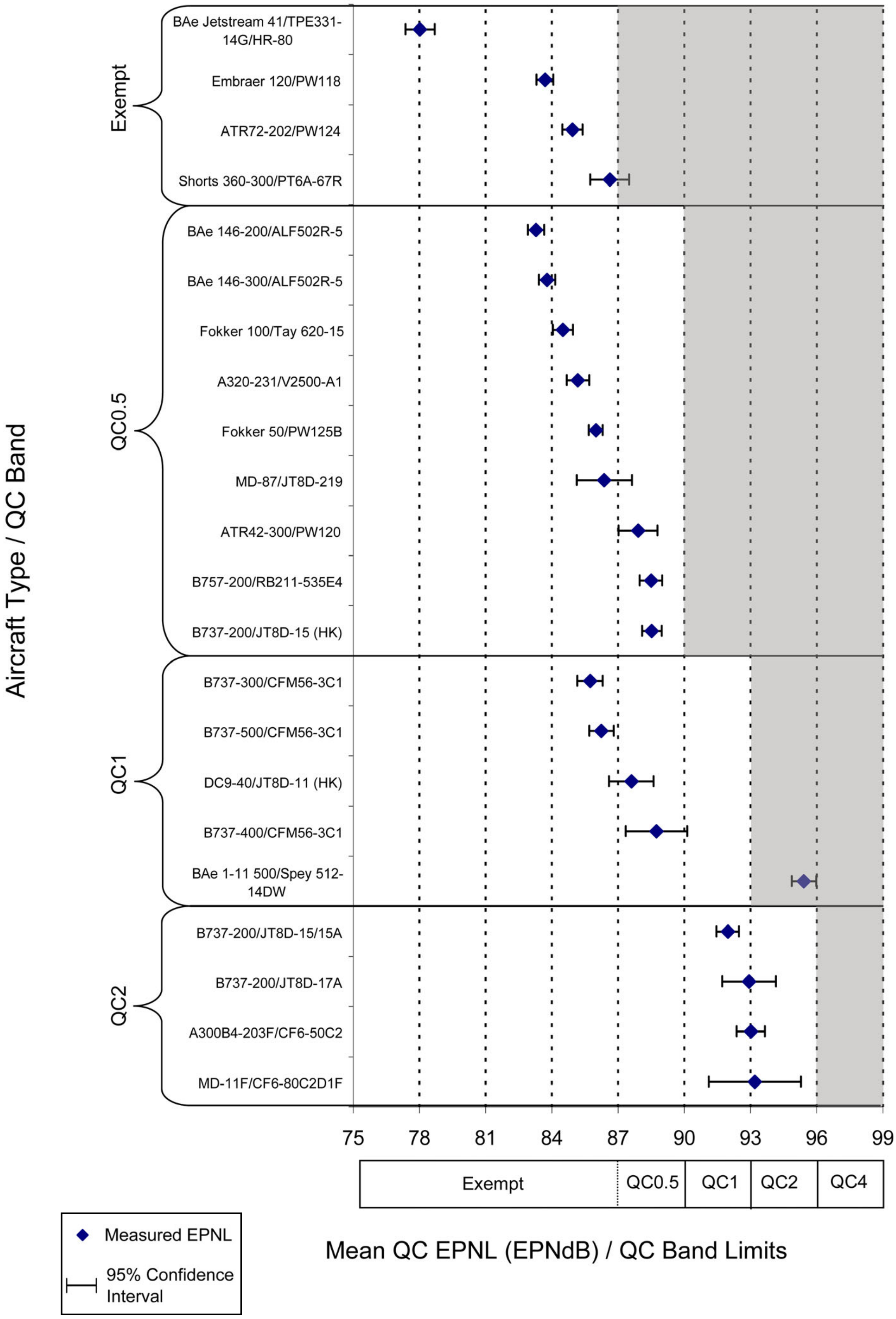


Figure A2 Trial Results: Heathrow Approach EPNLs
(Exempt - QC/0.5)

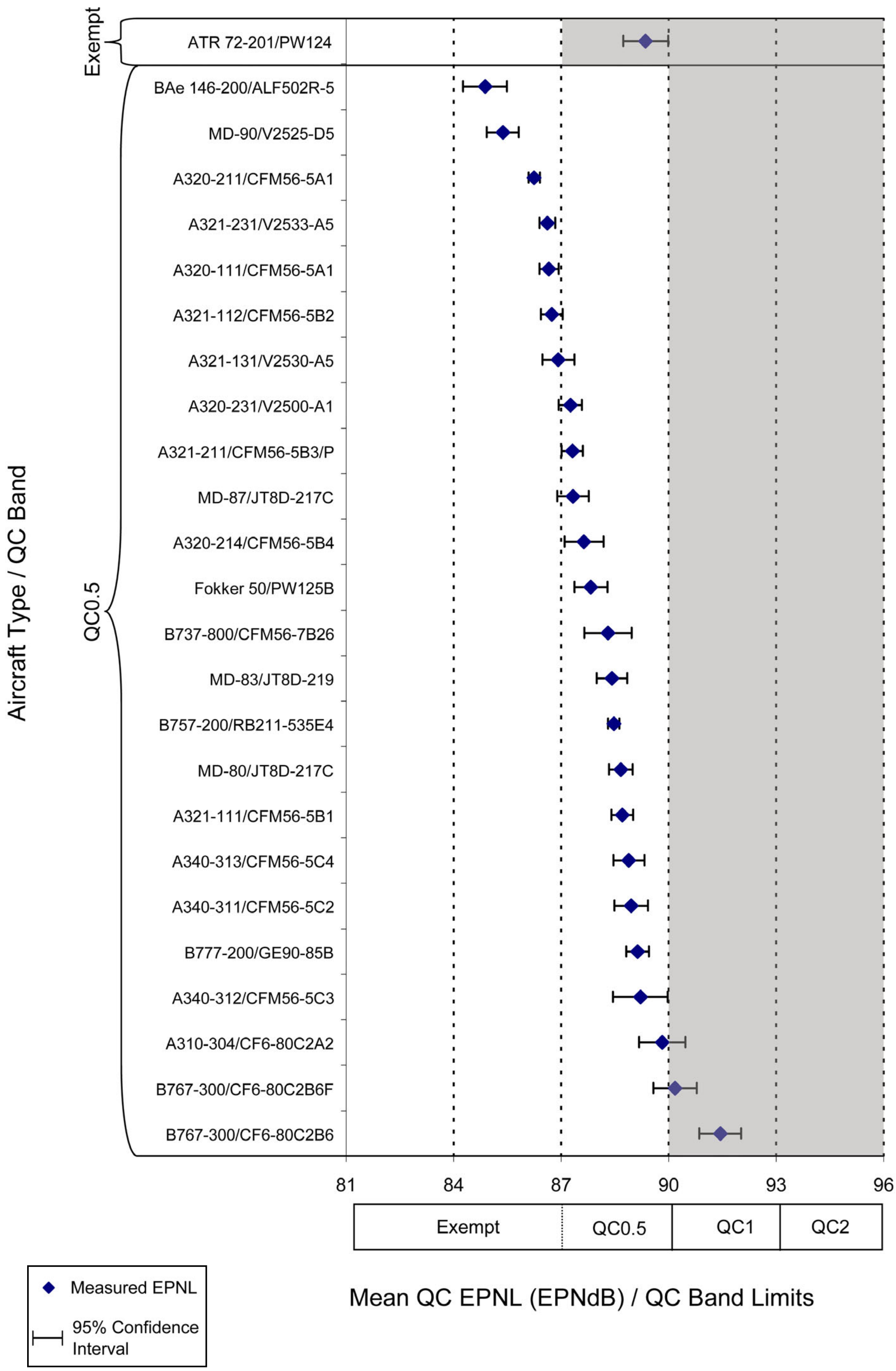


Figure A3 Trial Results: Heathrow Approach EPNLs
(QC/1 - QC/16)

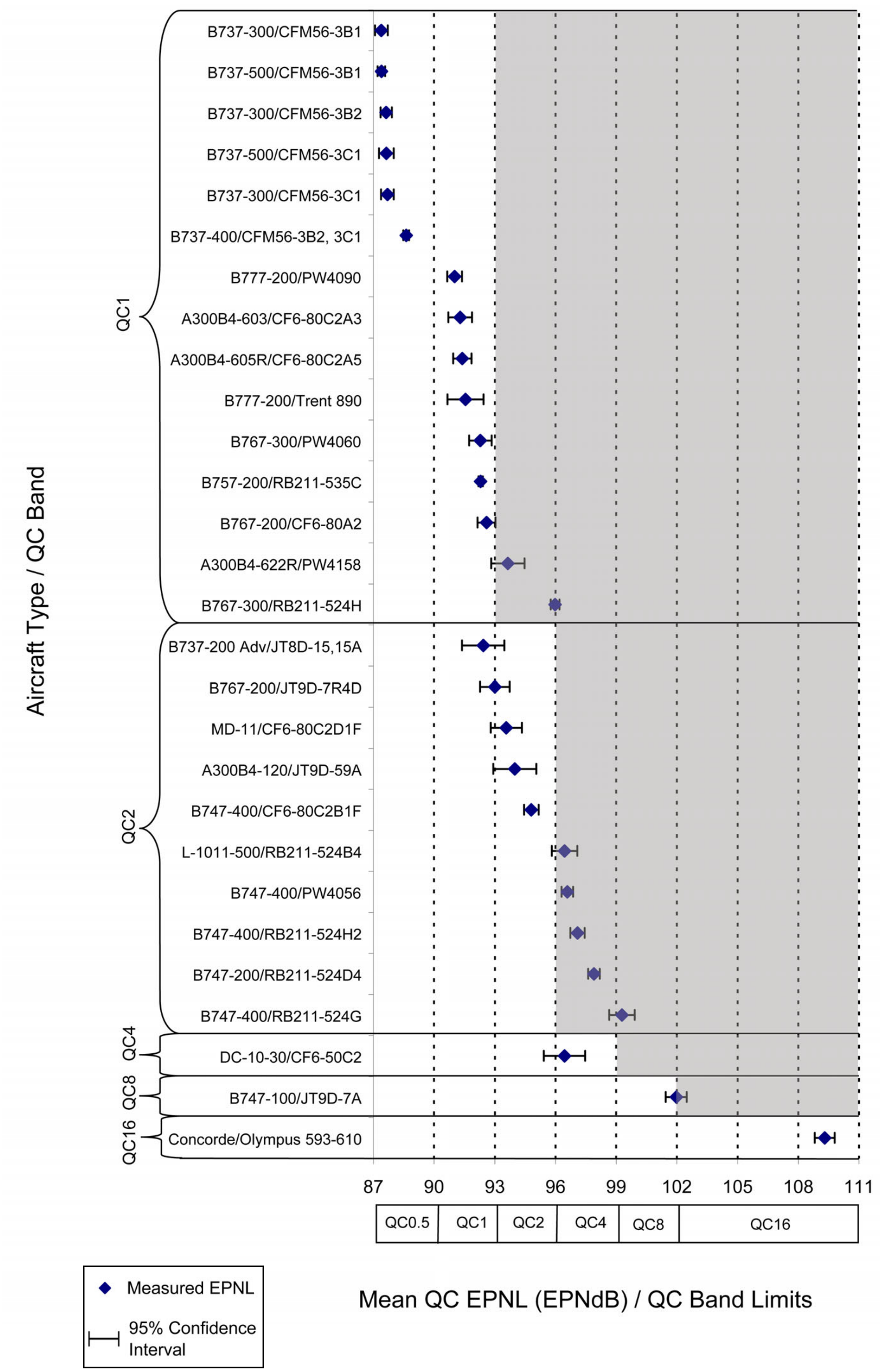


Figure A4 Trial Results: Heathrow Departure EPNLs
(QC/0.5 - QC/1)

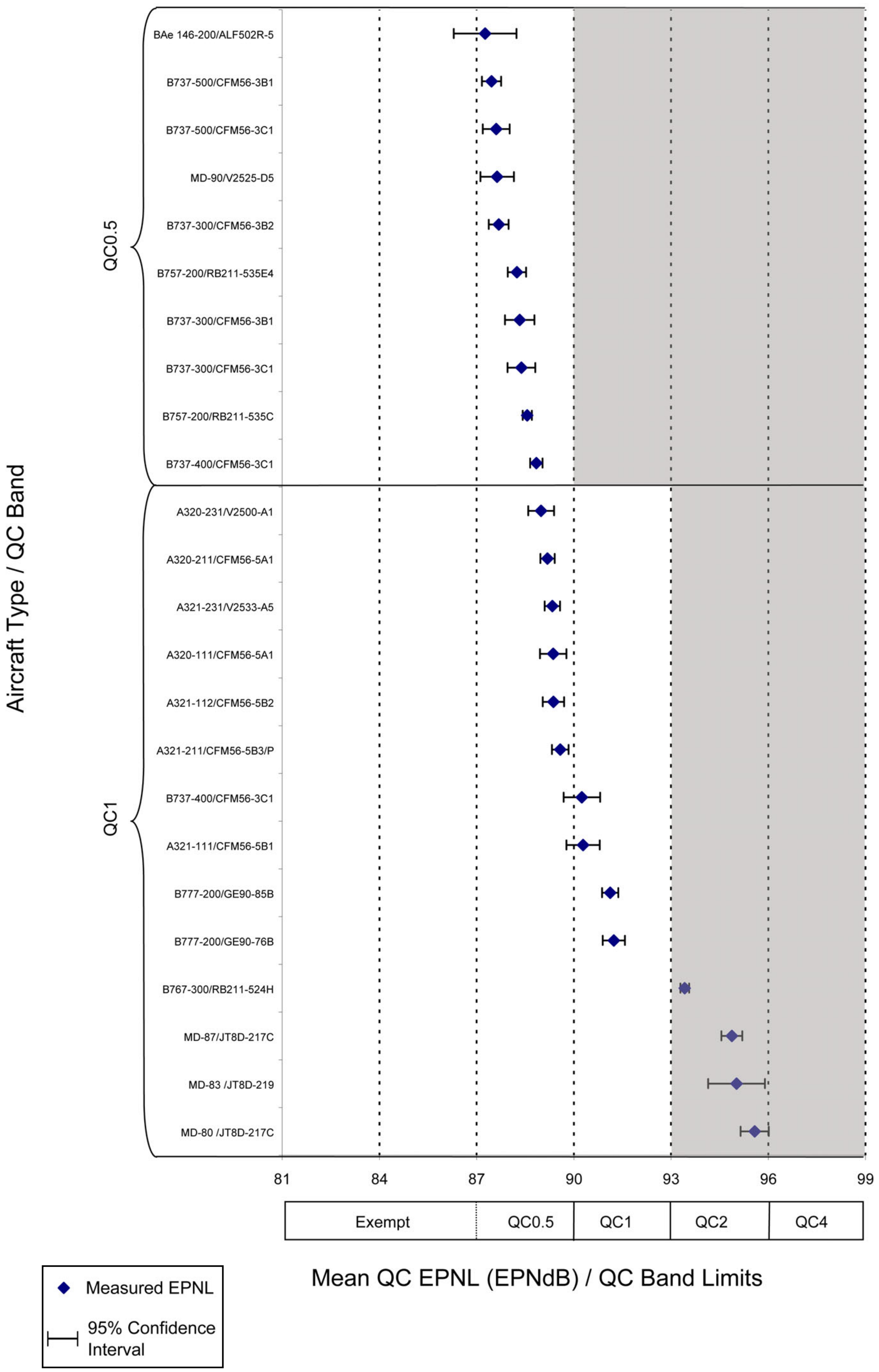


Figure A5 Trial Results: Heathrow Departure EPNLs (QC/2 - QC/16)

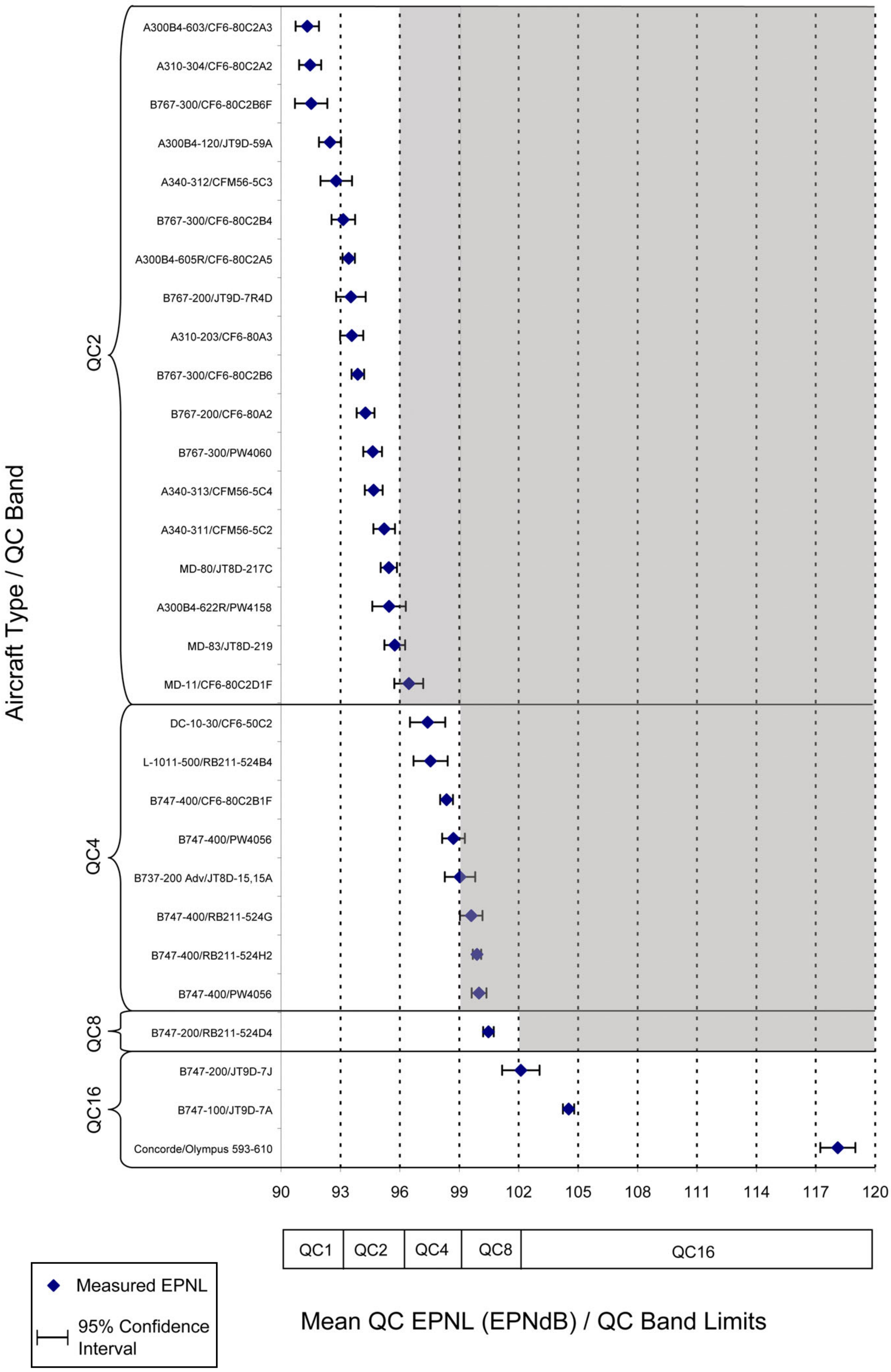
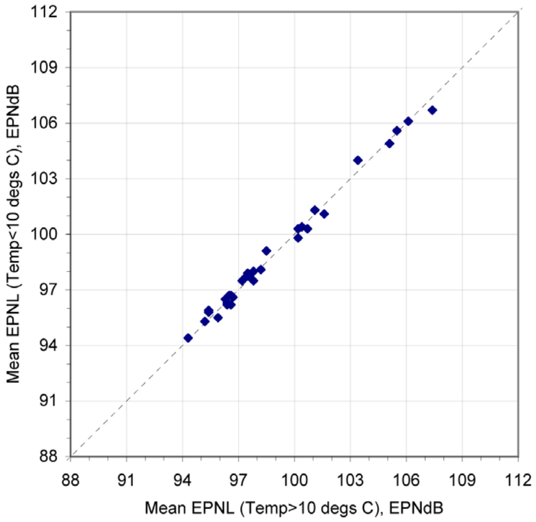
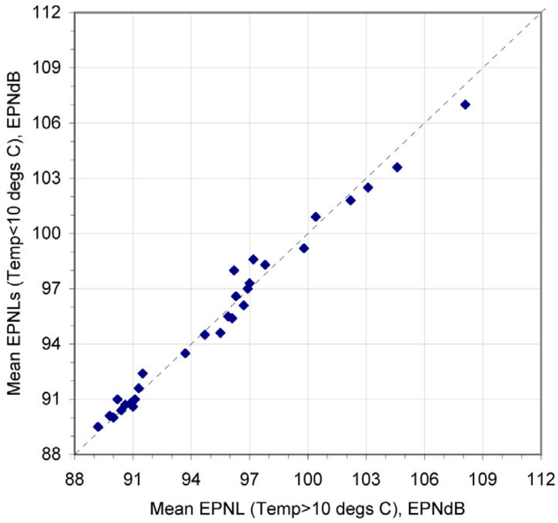


Figure A6 Trial Results: Comparison of Mean EPNLs (Above and Below 10ºC)

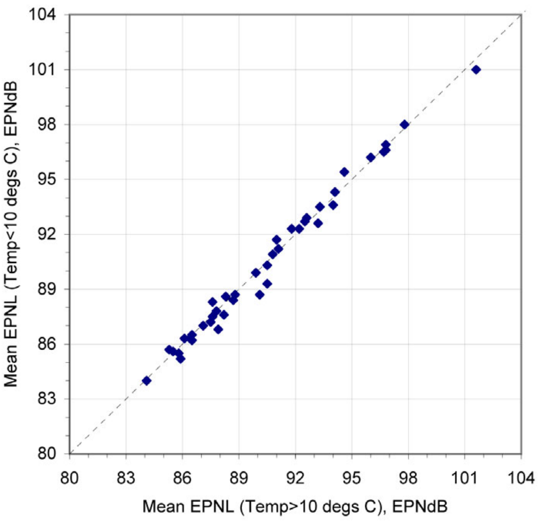
(a) Approach



(b) Flyover



(c) Pseudo-lateral



Appendix B Numerical Results

B1 In total across all three airports, valid operational EPNLs were determined for 40,446 arrivals and 38,460 departures. **Tables B1 to B4** present the numerical results for each season (summer and winter) at Heathrow airport. **Tables B5 to B10** and **Tables B11 to B16** present similar results for Gatwick and Stansted airports respectively. In each table, the arrival, flyover or pseudo-lateral results are broken down into (i) night-time only, (ii) daytime only and (iii) 24 hr measurement periods. Both the 95% confidence interval ('95% CI') for the mean and the QC classification are displayed for each aircraft type.

B2 **Tables B17 and B18** show the 'pooled' arrival and departure results (i.e. day and night, for all airports in all seasons) for those aircraft types with 95% confidence intervals of ±1 EPNdB or better. Also shown in **Tables B17 and B18** are the certificated noise levels (average of flyover and lateral for departure) for each aircraft type. Most certificated noise levels were obtained from publicly available aircraft noise certification databases. Others were acquired directly from the airline operators or, for UK registered aircraft, from the CAA's Noise Certification Group. Whilst every effort has been made to ensure that the certificated EPNLs shown in these tables are correct, it should be recognised that, in some cases, these might differ from the 'true' values due to the large number of (similar) variants that exist for some aircraft types.

Table B1 Heathrow Approach EPNLs (Winter 2000/2001)

				NIGHT-TIME EPNL, EPNdB					DAYTIME EPNL, EPNdB					24HR (POOLED) EPNL, EPNdB				
TYPE	ENGINE	MLW (t)	QC	MEAN	STD DEV	COUNT	STD ERR	95% CI	MEAN	STD DEV	COUNT	STD ERR	95% CI	MEAN	STD DEV	COUNT	STD ERR	95% CI
A310-304	CF6-80C2A2	123.0	0.5	99.0	1.0	10	0.3	0.7	99.0	1.2	93	0.1	0.2	99.0	1.2	103	0.1	0.2
A319-111	CFM56-5B5/P	62.5	0.5	96.5	-	1	-	-	94.8	1.2	64	0.2	0.3	94.8	1.2	65	0.1	0.3
A320-211	CFM56-5A1	64.5	0.5	96.1	-	1	-	-	95.0	1.3	447	0.1	0.1	95.0	1.3	448	0.1	0.1
A320-232	V2527-A5	64.5	0.5	95.9	1.3	2	0.9	11.7	94.3	1.3	424	0.1	0.1	94.3	1.3	426	0.1	0.1
A321-231	V2533-A5	75.5	0.5	94.4	1.2	14	0.3	0.7	94.6	1.3	618	0.1	0.1	94.6	1.3	632	0.1	0.1
A330-243	Trent 772B	180.0	0.5	96.2	0.8	3	0.5	2.0	96.6	1.3	88	0.1	0.3	96.6	1.3	91	0.1	0.3
A340-311	CFM56-5C2	186.0	0.5	97.5	1.5	17	0.4	0.8	97.1	1.6	63	0.2	0.4	97.2	1.6	80	0.2	0.4
A340-313	CFM56-5C4	190.0	0.5	95.9	1.0	7	0.4	0.9	96.2	1.3	48	0.2	0.4	96.1	1.3	55	0.2	0.4
B737-300	CFM56-3B1	52.9	1	96.3	0.8	3	0.5	2.0	98.0	1.7	17	0.4	0.9	97.7	1.7	20	0.4	0.8
B737-300	CFM56-3B2	54.9	1	97.0	1.4	6	0.6	1.5	97.4	1.5	63	0.2	0.4	97.4	1.5	69	0.2	0.4
B737-300	CFM56-3C3	54.9	1	97.1	0.4	2	0.3	3.6	97.0	1.4	7	0.5	1.3	97.0	1.2	9	0.4	0.9
B737-500	CFM56-3B1	49.9	1	96.7	-	1	-	-	96.4	1.5	428	0.1	0.1	96.4	1.5	429	0.1	0.1
B737-500	CFM56-3C1	49.9	1	96.8	-	1	-	-	96.7	1.5	30	0.3	0.6	96.7	1.5	31	0.3	0.6
B747-200	JT9D-7Q	274.4	4	108.5	3.0	2	2.1	27.0	108.1	1.7	8	0.6	1.4	108.2	1.8	10	0.6	1.3
B747-200	RB211-524D4	285.8	2	105.4	1.1	23	0.2	0.5	105.6	1.4	166	0.1	0.2	105.5	1.3	189	0.1	0.2
B747-400	PW4056	285.8	2	105.7	1.3	2	0.9	11.7	103.1	1.7	55	0.2	0.5	103.2	1.8	57	0.2	0.5
B747-400	PW4056	295.8	2	104.9	1.1	34	0.2	0.4	104.3	1.5	103	0.1	0.3	104.4	1.4	137	0.1	0.2
B747-400	PW4056	302.1	2	104.1	1.2	17	0.3	0.6	104.2	1.4	71	0.2	0.3	104.2	1.4	88	0.1	0.3
B747-400	RB211-524H2	285.8	2	106.2	1.8	163	0.1	0.3	105.3	1.7	430	0.1	0.2	105.5	1.8	593	0.1	0.1
B747-400	RB211-524G	295.8	2	107.7	0.9	23	0.2	0.4	107.4	1.3	34	0.2	0.5	107.5	1.1	57	0.1	0.3
B747-400	RB211-524G/H	285.8	2	108.2	1.0	29	0.2	0.4	107.8	1.3	25	0.3	0.5	108.0	1.1	54	0.1	0.3
B767-200 (ER)	CF6-80A2	126.1	1	101.2	-	1	-	-	101.3	0.9	33	0.2	0.3	101.3	0.8	34	0.1	0.3
B767-300 (ER)	PW4056	136.1	1	101.3	0.9	5	0.4	1.1	-	-	-	-	-	101.3	0.9	5	0.4	1.1
B767-300 (ER)	PW4056	145.2	1	100.7	1.0	8	0.4	0.8	100.4	1.3	14	0.3	0.8	100.5	1.2	22	0.3	0.5
B767-300 (ER)	PW4060	145.2	1	99.5	0.5	2	0.4	4.5	100.5	1.5	119	0.1	0.3	100.5	1.5	121	0.1	0.3
B777-200	GE90-76B	201.9	0.5	97.7	0.7	14	0.2	0.4	97.7	1.0	105	0.1	0.2	97.7	0.9	119	0.1	0.2
B777-200	GE90-85B	208.7	0.5	98.2	0.7	8	0.2	0.6	97.8	1.2	129	0.1	0.2	97.8	1.2	137	0.1	0.2
B777-200	GE90-90B	208.7	0.5	98.2	1.2	8	0.4	1.0	97.8	1.1	119	0.1	0.2	97.9	1.1	127	0.1	0.2
B777-200	PW4084	201.9	1	99.4	0.9	5	0.4	1.1	99.3	1.2	62	0.2	0.3	99.3	1.1	67	0.1	0.3
B777-200	PW4090	208.7	2	99.2	0.9	2	0.6	8.1	99.4	1.2	110	0.1	0.2	99.4	1.2	112	0.1	0.2
B777-200	Trent 895	208.7	1	99.5	0.9	14	0.2	0.5	99.4	1.2	108	0.1	0.2	99.4	1.2	122	0.1	0.2
Beech King Air 200	PT6A-41	5.7	Exempt	88.2	-	1	-	-	90.6	2.2	2	1.6	19.8	89.8	2.0	3	1.2	5.0
Fairchild SA227	TPE331	6.4	Exempt	88.6	-	1	-	-	-	-	-	-	-	88.6	-	1	-	-

Table B2 Heathrow Flyover EPNLs (Winter 2000/2001)

				NIGHT-TIME EPNL, EPNdB					DAYTIME EPNL, EPNdB					24HR (POOLED) EPNL, EPNdB				
TYPE	ENGINE	MTOW (t)	QC	MEAN	STD DEV	COUNT	STD ERR	95% CI	MEAN	STD DEV	COUNT	STD ERR	95% CI	MEAN	STD DEV	COUNT	STD ERR	95% CI
A330-243	Trent 772B	230.0	2	93.3	1.4	3	0.8	3.5	94.3	1.3	96	0.1	0.3	94.3	1.3	99	0.1	0.3
B747-400	CF6-80C2B1F	377.8	4	106.2	-	1	-	-	100.2	1.7	60	0.2	0.4	100.3	1.8	61	0.2	0.5
B747-400	RB211-524G	396.9	4	104.9	-	1	-	-	101.7	1.5	235	0.1	0.2	101.7	1.6	236	0.1	0.2
B747-400	RB211-524H	396.9	4	99.6	-	1	-	-	101.8	1.9	375	0.1	0.2	101.8	1.9	376	0.1	0.2
B767-300 (ER)	RB211-524H	158.0	1	95.8	1.0	2	0.7	9.0	94.6	1.7	275	0.1	0.2	94.6	1.7	277	0.1	0.2
B777-200	GE90-85B	267.6	1	93.2	-	1	-	-	93.5	1.4	179	0.1	0.2	93.5	1.4	180	0.1	0.2
B777-200	Trent 895	297.6	2	92.6	-	1	-	-	95.5	1.5	68	0.2	0.4	95.4	1.5	69	0.2	0.4
DC-10-30	CF6-50C2	256.3	4	98.6	-	1	-	-	99.6	2.1	9	0.7	1.6	99.5	2.0	10	0.6	1.4

Table B3 Heathrow Pseudo-lateral EPNLs (Winter 2000/2001)

				NIGHT-TIME EPNL, EPNdB					DAYTIME EPNL, EPNdB					24HR (POOLED) EPNL, EPNdB				
TYPE	ENGINE	MTOW (t)	QC	MEAN	STD DEV	COUNT	STD ERR	95% CI	MEAN	STD DEV	COUNT	STD ERR	95% CI	MEAN	STD DEV	COUNT	STD ERR	95% CI
A330-243	Trent 772B	230.0	2	95.4	0.2	3	0.1	0.5	94.8	1.3	65	0.2	0.3	94.8	1.3	68	0.2	0.3
B747-400	CF6-80C2B1F	377.8	4	98.6	-	1	-	-	96.6	2.4	48	0.3	0.7	96.6	2.4	49	0.3	0.7
B747-400	RB211-524G	396.9	4	97.6	0.8	2	0.6	7.2	97.9	1.7	256	0.1	0.2	97.9	1.7	258	0.1	0.2
B747-400	RB211-524H	396.9	4	96.0	-	1	-	-	97.6	1.6	484	0.1	0.1	97.6	1.6	485	0.1	0.1
B767-300 (ER)	RB211-524H	158.0	1	98.6	-	1	-	-	94.1	1.4	117	0.1	0.3	94.2	1.5	118	0.1	0.3
B777-200	GE90-85B	267.6	1	93.9	-	1	-	-	91.9	1.5	94	0.2	0.3	91.9	1.5	95	0.2	0.3
B777-200	Trent 895	297.6	2	94.7	-	1	-	-	94.7	1.1	48	0.2	0.3	94.7	1.1	49	0.2	0.3
DC-10-30	CF6-50C2	256.3	4	95.3	-	1	-	-	97.9	3.6	5	1.6	4.5	97.5	3.4	6	1.4	3.6

Table B4 Heathrow Approach EPNLs (Summer 2002)

				NIGHT-TIME EPNL, EPNdB					DAYTIME EPNL, EPNdB					24HR (POOLED) EPNL, EPNdB				
TYPE	ENGINE	MLW (t)	QC	MEAN	STD DEV	COUNT	STD ERR	95% CI	MEAN	STD DEV	COUNT	STD ERR	95% CI	MEAN	STD DEV	COUNT	STD ERR	95% CI
A300B4-605R	CF6-80C2A5	140.0	1	98.7	-	1	-	-	99.1	1.0	49	0.1	0.3	99.1	1.0	50	0.1	0.3
A319-131	V2522-A5	61.0	0.5	93.1	-	1	-	-	93.3	1.2	615	0.0	0.1	93.3	1.2	616	0.0	0.1
A320-211	CFM56-5A1	64.5	0.5	94.2	-	1	-	-	94.6	1.3	299	0.1	0.1	94.6	1.3	300	0.1	0.1
A320-214	CFM56-5B4/P	64.5	0.5	94.3	1.2	4	0.6	1.9	94.6	1.0	207	0.1	0.1	94.6	1.0	211	0.1	0.1
A320-232	V2527-A5	64.5	0.5	94.0	1.0	21	0.2	0.5	93.6	1.1	916	0.0	0.1	93.6	1.1	937	0.0	0.1
A321-112	CFM56-5B2	74.5	0.5	98.4	-	1	-	-	94.8	1.3	102	0.1	0.3	94.8	1.3	103	0.1	0.3
A321-211	CFM56-5B3/P	77.8	0.5	94.5	0.7	4	0.4	1.1	95.2	1.2	291	0.1	0.1	95.2	1.2	295	0.1	0.1
A321-231	V2533-A5	75.5	0.5	93.2	1.1	3	0.6	2.7	94.4	1.3	281	0.1	0.2	94.4	1.3	284	0.1	0.2
A330-243	Trent 772B	180.0	0.5	95.7	-	1	-	-	96.2	1.1	53	0.2	0.3	96.2	1.0	54	0.1	0.3
A340-311	CFM56-5C2	186.0	0.5	96.3	1.1	18	0.3	0.5	96.6	1.4	51	0.2	0.4	96.5	1.3	69	0.2	0.3
A340-312	CFM56-5C3	186.0	0.5	96.1	-	1	-	-	96.4	1.2	16	0.3	0.6	96.3	1.2	17	0.3	0.6
A340-313	CFM56-5C4	190.0	0.5	96.2	0.9	9	0.3	0.7	95.6	1.4	65	0.2	0.3	95.7	1.4	74	0.2	0.3
B737-300	CFM56-3C1	51.7	1	97.9	-	1	-	-	97.1	1.8	48	0.3	0.5	97.1	1.8	49	0.3	0.5
B737-400	CFM56-3C1	50.2	1	97.3	-	1	-	-	97.6	1.5	417	0.1	0.1	97.6	1.5	418	0.1	0.1
B747-400	PW4056	295.8	2	105.1	1.1	21	0.2	0.5	104.6	1.1	26	0.2	0.4	104.8	1.1	47	0.2	0.3
B747-400	PW4056	302.1	2	104.7	1.3	25	0.3	0.5	104.3	1.4	24	0.3	0.6	104.5	1.3	49	0.2	0.4
B747-400	RB211-524G/HT	285.8	2	105.5	1.8	177	0.1	0.3	104.8	1.6	493	0.1	0.1	105.0	1.7	670	0.1	0.1
B747-400	RB211-524G/HT	295.8	2	107.9	-	1	-	-	106.6	1.7	28	0.3	0.7	106.7	1.7	29	0.3	0.6
B747-400	RB211-524G	295.8	2	107.5	1.2	28	0.2	0.5	107.3	1.0	31	0.2	0.4	107.4	1.1	59	0.1	0.3
B747-400	RB211-524G/H	285.8	2	107.9	1.1	28	0.2	0.4	107.9	0.9	40	0.1	0.3	107.9	1.0	68	0.1	0.2
B767-300 (ER)	CF6-80C2B7F	145.2	0.5	99.6	-	1	-	-	98.8	1.4	19	0.3	0.7	98.8	1.4	20	0.3	0.7
B767-300 (ER)	RB211-524H	136.0	1	105.7	0.8	2	0.6	7.2	104.0	1.4	348	0.1	0.1	104.0	1.5	350	0.1	0.2
B777-200	GE90-85B	208.7	0.5	99.0	-	1	-	-	97.3	1.0	83	0.1	0.2	97.3	1.0	84	0.1	0.2
B777-200	GE90-90B	208.7	0.5	97.9	0.6	5	0.3	0.7	97.6	0.9	109	0.1	0.2	97.6	0.9	114	0.1	0.2
B777-200	PW4084	201.9	1	98.7	-	1	-	-	99.6	1.0	116	0.1	0.2	99.6	1.0	117	0.1	0.2
B777-200	PW4090	208.7	1	99.8	1.1	8	0.4	0.9	99.5	0.9	89	0.1	0.2	99.6	1.0	97	0.1	0.2
B777-200	Trent 892	208.7	1	100.9	-	1	-	-	99.6	1.1	256	0.1	0.1	99.6	1.1	257	0.1	0.1
B777-200	Trent 895	208.7	1	101.7	-	1	-	-	99.6	1.0	107	0.1	0.2	99.6	1.0	108	0.1	0.2
HS 125-700B	TFE731-3R-1H	10.0	Exempt	95.3	0.4	2	0.3	3.6	95.7	-	1	-	-	95.4	0.4	3	0.2	1.0
Learjet 60	PW305A	8.9	Exempt	90.0	-	1	-	-	88.0	-	1	-	-	89.0	1.4	2	1.0	12.6

Table B5 Gatwick Approach EPNLs (Winter 1999/2000)

				NIGHT-TIME EPNL, EPNdB					DAYTIME EPNL, EPNdB					24HR (POOLED) EPNL, EPNdB				
TYPE	ENGINE	MLW (t)	QC	MEAN	STD DEV	COUNT	STD ERR	95% CI	MEAN	STD DEV	COUNT	STD ERR	95% CI	MEAN	STD DEV	COUNT	STD ERR	95% CI
A300B4-203	CF6-50C2	134.0	2	101.0	1.7	3	1.0	4.2	100.7	1.7	11	0.5	1.1	100.8	1.7	14	0.5	1.0
A300B4-605R	CF6-80C2A5	140.0	1	98.9	1.3	6	0.5	1.4	98.9	2.0	77	0.2	0.5	98.9	1.9	83	0.2	0.4
A320-212	CFM56-5A3	64.5	0.5	90.5	-	1	-	-	94.0	1.4	54	0.2	0.4	94.0	1.5	55	0.2	0.4
A320-231	V2500-A1	64.5	0.5	94.8	1.3	22	0.3	0.6	94.9	1.2	140	0.1	0.2	94.9	1.2	162	0.1	0.2
A321-211	CFM56-5B3/P	75.5	0.5	94.8	1.2	4	0.6	1.9	95.3	1.3	26	0.3	0.5	95.3	1.3	30	0.2	0.5
A321-211	CFM56-5B3/P	77.8	0.5	-	-	-	-	-	95.7	2.8	6	1.1	2.9	95.7	2.8	6	1.1	2.9
A321-231	V2533-A5	75.5	0.5	93.2	-	1	-	-	93.3	2.0	2	1.4	18.0	93.3	1.4	3	0.8	3.5
A330-243	Trent 772B	180.0	0.5	95.9	1.4	14	0.4	0.8	95.7	1.3	60	0.2	0.3	95.7	1.3	74	0.2	0.3
ATR42-300	PW120	16.9	0.5	95.7	1.3	10	0.4	0.9	95.1	1.3	363	0.1	0.1	95.2	1.3	373	0.1	0.1
ATR72-202	PW124	21.4	Exempt	95.8	0.9	5	0.4	1.1	94.6	1.5	405	0.1	0.1	94.6	1.5	410	0.1	0.1
B727-200	JT8D-17A	71.7	2	102.2	1.1	3	0.6	2.7	102.4	2.9	21	0.6	1.3	102.4	2.7	24	0.6	1.1
B737-300	CFM56-3C1	51.7	1	94.7	-	1	-	-	94.3	1.6	330	0.1	0.2	94.3	1.6	331	0.1	0.2
B737-300	CFM56-3C3	54.9	1	94.1	-	1	-	-	95.0	1.8	95	0.2	0.4	95.0	1.8	96	0.2	0.4
B737-400	CFM56-3C1	54.9	1	95.7	1.7	3	1.0	4.2	96.1	1.9	1263	0.1	0.1	96.1	1.9	1266	0.1	0.1
B737-400	CFM56-3C1	56.3	1	93.9	2.8	2	2.0	25.2	95.8	1.8	1070	0.1	0.1	95.8	1.8	1072	0.1	0.1
B737-800	CFM56-7B26	65.3	0.5	93.7	1.6	8	0.6	1.3	93.5	1.0	27	0.2	0.4	93.5	1.2	35	0.2	0.4
B747-200	CF6-50E2	285.8	4	104.6	1.1	5	0.5	1.4	106.1	1.4	6	0.6	1.5	105.4	1.5	11	0.5	1.0
B747-200	JT9D-7J	265.4	4	109.4	0.5	3	0.3	1.2	109.2	1.4	47	0.2	0.4	109.2	1.3	50	0.2	0.4
B747-200	JT9D-7Q	274.4	4	107.1	3.1	3	1.8	7.7	107.4	2.6	8	0.9	2.2	107.3	2.6	11	0.8	1.7
B747-200	RB211-524D4	285.8	2	104.4	1.4	10	0.4	1.0	104.9	1.3	97	0.1	0.3	104.9	1.3	107	0.1	0.2
B747-400	RB211-524H2	285.8	2	104.4	1.8	104	0.2	0.4	104.1	2.0	293	0.1	0.2	104.2	1.9	397	0.1	0.2
B757-200	RB211-535E4	89.8	0.5	97.2	1.9	40	0.3	0.6	97.1	1.8	210	0.1	0.2	97.1	1.8	250	0.1	0.2
B757-200	RB211-535E4	90.0	0.5	97.0	2.0	33	0.3	0.7	97.0	1.8	209	0.1	0.2	97.0	1.8	242	0.1	0.2
B757-200	RB211-535E4	95.3	0.5	97.7	1.6	23	0.3	0.7	96.9	1.9	138	0.2	0.3	97.0	1.9	161	0.1	0.3
B767-200 (ER)	CF6-80A2	123.4	1	99.4	1.2	4	0.6	1.9	100.2	1.5	53	0.2	0.4	100.2	1.5	57	0.2	0.4
B767-200 (ER)	CF6-80A2	126.1	1	-	-	-	-	-	98.9	1.8	7	0.7	1.7	98.9	1.8	7	0.7	1.7
B767-200 (ER)	CF6-80C2	126.1	0.5	98.3	0.2	2	0.1	1.8	96.7	1.6	34	0.3	0.6	96.8	1.6	36	0.3	0.5
B767-200 (ER)	CF6-80C2B2	126.1	0.5	96.9	1.2	29	0.2	0.5	97.1	1.7	81	0.2	0.4	97.0	1.6	110	0.2	0.3
B767-200 (ER)	CF6-80C2B4	136.1	0.5	98.8	1.2	2	0.8	10.8	95.4	0.7	5	0.3	0.9	96.4	1.8	7	0.7	1.7
B767-200 (ER)	PW4056	136.1	0.5	96.4	-	1	-	-	98.3	1.6	24	0.3	0.7	98.3	1.7	25	0.3	0.7
B767-300 (ER)	CF6-80C2B7F	145.2	0.5	99.8	1.7	17	0.4	0.9	98.4	2.1	70	0.3	0.5	98.7	2.1	87	0.2	0.4
B767-300 (ER)	RB211-524H	136.0	1	102.8	1.4	56	0.2	0.4	102.6	1.6	107	0.2	0.3	102.6	1.5	163	0.1	0.2
B777-200	GE90-85B	208.7	0.5	97.0	0.9	28	0.2	0.3	97.2	1.3	229	0.1	0.2	97.2	1.2	257	0.1	0.1
BAe 1-11 500	Spey 512-14DW	35.8	1	102.3	-	1	-	-	102.0	2.8	11	0.8	1.9	102.1	2.7	12	0.8	1.7
Bae 748-2A	Dart 534-2	19.5	Exempt	97.7	0.5	3	0.3	1.2	-	-	-	-	-	97.7	0.5	3	0.3	1.2
Cessna F406 Caravan II	PT6A-112	4.5	Exempt	90.4	5.4	2	3.8	48.5	-	-	-	-	-	90.4	5.4	2	3.8	48.5
DC-10-30	CF6-50C2	186.4	4	104.4	0.3	2	0.2	2.7	102.8	1.6	23	0.3	0.7	102.9	1.6	25	0.3	0.7
DC-10-30	CF6-50C2	188.7	4	-	-	-	-	-	102.4	-	1	-	-	102.4	-	1	-	-
DC-10-30	CF6-50C2	192.3	4	102.7	1.0	5	0.4	1.2	102.7	2.0	31	0.4	0.7	102.7	1.9	36	0.3	0.6
DC-10-30	CF6-50C2	197.6	4	-	-	-	-	-	103.5	2.8	41	0.4	0.9	103.5	2.8	41	0.4	0.9
DC-10-30	CF6-50C2-R	192.3	4	104.3	-	1	-	-	106.9	2.2	4	1.1	3.5	106.4	2.3	5	1.0	2.9
Fokker F27	Dart 532-7	19.7	Exempt	93.5	1.4	13	0.4	0.8	92.5	1.9	28	0.4	0.7	92.8	1.8	41	0.3	0.6
L1011-385-1	RB211-22B	162.4	2	102.6	0.7	2	0.5	6.3	101.7	1.6	11	0.5	1.1	101.9	1.5	13	0.4	0.9
Shorts 360-100	PT6A-65AR	11.8	Exempt	88.4	-	1	-	-	90.8	0.1	2	0.1	0.9	90.0	1.4	3	0.8	3.5
Shorts 360-100	PT6A-65R	11.8	Exempt	92.3	1.0	3	0.6	2.5	-	-	-	-	-	92.3	1.0	3	0.6	2.5
Shorts 360-300	PT6A-67R	12.0	Exempt	96.6	1.1	11	0.3	0.7	95.7	0.9	18	0.2	0.4	96.0	1.1	29	0.2	0.4

Table B6 Gatwick Flyover EPNLs (Winter 1999/2000)

				NIGHT-TIME EPNL, EPNdB					DAYTIME EPNL, EPNdB					24HR (POOLED) EPNL, EPNdB				
TYPE	ENGINE	MTOW (t)	QC	MEAN	STD DEV	COUNT	STD ERR	95% CI	MEAN	STD DEV	COUNT	STD ERR	95% CI	MEAN	STD DEV	COUNT	STD ERR	95% CI
A300B4-605R	CF6-80C2A5	171.7	2	91.1	1.5	12	0.4	1.0	91.4	2.0	80	0.2	0.4	91.4	1.9	92	0.2	0.4
A320-212	CFM56-5A3	77.0	1	85.3	-	1	-	-	88.7	1.4	63	0.2	0.4	88.7	1.5	64	0.2	0.4
A320-231	V2500-A1	74.5	0.5	89.4	-	1	-	-	87.9	0.8	8	0.3	0.7	88.1	0.9	9	0.3	0.7
A320-231	V2500-A1	75.5	1	86.3	1.7	7	0.6	1.6	87.7	1.2	89	0.1	0.3	87.6	1.3	96	0.1	0.3
A320-231	V2500-A1	77.0	1	-	-	-	-	-	88.0	1.3	59	0.2	0.3	88.0	1.3	59	0.2	0.3
A321-211	CFM56-5B3/P	89.0	1	89.5	3.7	2	2.6	33.2	90.0	1.3	37	0.2	0.4	89.9	1.4	39	0.2	0.5
A330-243	Trent 772B	230.0	2	89.5	-	1	-	-	93.4	1.1	50	0.2	0.3	93.3	1.2	51	0.2	0.3
ATR42-300	PW120	16.7	Exempt	79.8	-	1	-	-	84.3	2.5	99	0.3	0.5	84.3	2.6	100	0.3	0.5
ATR72-202	PW124	21.5	Exempt	80.8	-	1	-	-	84.8	1.7	280	0.1	0.2	84.8	1.8	281	0.1	0.2
B737-200 Adv	JT8D-15/15A	54.2	2	-	-	-	-	-	93.3	1.9	10	0.6	1.4	93.3	1.9	10	0.6	1.4
B737-200 Adv	JT8D-15/15A	55.1	2	-	-	-	-	-	97.2	2.6	8	0.9	2.2	97.2	2.6	8	0.9	2.2
B737-200 Adv	JT8D-15/15A	56.5	2	93.6	-	1	-	-	96.3	1.7	5	0.8	2.1	95.8	1.9	6	0.8	2.0
B737-400	CFM56-3C1	62.8	0.5	-	-	-	-	-	89.0	1.9	2177	0.0	0.1	89.0	1.9	2177	0.0	0.1
B737-400	CFM56-3C1	64.6	0.5	-	-	-	-	-	88.2	1.4	6	0.6	1.5	88.2	1.4	6	0.6	1.5
B737-400	CFM56-3C1	65.8	0.5	91.6	-	1	-	-	91.0	-	1	-	-	91.3	0.4	2	0.3	3.6
B737-400	CFM56-3C1	68.0	1	-	-	-	-	-	89.0	1.9	134	0.2	0.3	89.0	1.9	134	0.2	0.3
B737-800	CFM56-7B26	78.3	1	86.1	2.6	3	1.5	6.5	89.1	2.0	28	0.4	0.8	88.9	2.2	31	0.4	0.8
B747-400	RB211-524H2	381.0	4	-	-	-	-	-	100.6	1.4	48	0.2	0.4	100.6	1.4	48	0.2	0.4
B747-400	RB211-524H2	396.9	4	100.4	-	1	-	-	100.3	1.4	231	0.1	0.2	100.3	1.4	232	0.1	0.2
B757-200	RB211-535E4	100.3	0.5	-	-	-	-	-	88.7	1.9	21	0.4	0.9	88.7	1.9	21	0.4	0.9
B757-200	RB211-535E4	102.1	0.5	-	-	-	-	-	88.9	1.4	38	0.2	0.5	88.9	1.4	38	0.2	0.5
B757-200	RB211-535E4	104.3	0.5	87.0	1.2	3	0.7	3.0	89.5	1.7	136	0.1	0.3	89.5	1.7	139	0.1	0.3
B757-200	RB211-535E4	108.9	0.5	89.3	2.2	6	0.9	2.3	90.2	1.8	267	0.1	0.2	90.2	1.8	273	0.1	0.2
B757-200	RB211-535E4	111.6	0.5	-	-	-	-	-	89.6	1.2	19	0.3	0.6	89.6	1.2	19	0.3	0.6
B757-200	RB211-535E4	113.4	0.5	82.8	3.9	2	2.8	35.0	90.2	1.9	143	0.2	0.3	90.1	2.1	145	0.2	0.3
B767-200 (ER)	CF6-80A2	159.2	2	85.2	1.2	4	0.6	1.9	91.9	2.3	78	0.3	0.5	91.6	2.6	82	0.3	0.6
B767-300 (ER)	CF6-80C2B7F	184.6	2	85.4	0.8	4	0.4	1.3	90.4	3.0	23	0.6	1.3	89.6	3.3	27	0.6	1.3
B767-300 (ER)	CF6-80C2B7F	186.9	2	88.9	3.1	3	1.8	7.7	91.1	2.7	53	0.4	0.7	91.0	2.8	56	0.4	0.7
B777-200	GE90-85B	267.6	1	-	-	-	-	-	92.5	1.6	224	0.1	0.2	92.5	1.6	224	0.1	0.2
BAe 125-700B	TFE-731-3R-1H	11.6	0.5	89.9	1.8	2	1.3	16.2	88.0	2.3	8	0.8	1.9	88.3	2.3	10	0.7	1.6
Avro RJ100	LF507-1F	45.0	0.5	85.3	-	1	-	-	87.5	1.5	332	0.1	0.2	87.5	1.5	333	0.1	0.2
BAe 748 2A	Dart 534-2	20.0	1	89.3	2.0	6	0.8	2.1	91.5	0.9	3	0.5	2.2	90.0	2.0	9	0.7	1.5
BAe 748 2A	Dart 534-2	20.2	1	89.0	2.3	3	1.3	5.7	-	-	-	-	-	89.0	2.3	3	1.3	5.7
Cessna F406 Caravan II	PT6A-112	4.5	Exempt	78.2	1.0	2	0.7	9.0	-	-	-	-	-	78.2	1.0	2	0.7	9.0
DC10-30	CF6-50C2	251.7	4	92.4	-	1	-	-	97.4	2.5	12	0.7	1.6	97.0	2.7	13	0.7	1.6
DC10-30	CF6-50C2	256.3	4	-	-	-	-	-	96.1	3.1	3	1.8	7.7	96.1	3.1	3	1.8	7.7
DC10-30	CF6-50C2	259.5	4	89.5	-	1	-	-	96.5	2.5	65	0.3	0.6	96.3	2.6	66	0.3	0.6
DC10-30	CF6-50C2	263.1	4	-	-	-	-	-	95.9	4.0	11	1.2	2.7	95.9	4.0	11	1.2	2.7
Falcon 900	TFE 731-5A-1C	20.6	0.5	83.8	-	1	-	-	91.2	3.7	3	2.1	9.2	89.3	4.8	4	2.4	7.6
Fokker F27	Dart 532-7	19.7	0.5	89.4	1.0	4	0.5	1.6	89.1	1.3	12	0.4	0.8	89.2	1.2	16	0.3	0.6
Fokker F27	Dart 532-7	20.4	0.5	90.4	1.8	15	0.5	1.0	89.8	1.8	14	0.5	1.0	90.1	1.8	29	0.3	0.7
Shorts 360-100	PT6A-65AR	12.0	Exempt	-	-	-	-	-	86.1	-	1	-	-	86.1	-	1	-	-
Shorts 360-100	PT6A-65R	12.0	Exempt	83.1	1.3	3	0.8	3.2	-	-	-	-	-	83.1	1.3	3	0.8	3.2
Shorts 360-300	PT6A-67R	12.3	Exempt	84.3	1.0	13	0.3	0.6	84.9	0.7	14	0.2	0.4	84.6	0.9	27	0.2	0.4

Table B7 Gatwick Pseudo-lateral EPNLs (Winter 1999/2000)

				NIGHT-TIME EPNL, EPNdB					DAYTIME EPNL, EPNdB					24HR (POOLED) EPNL, EPNdB				
TYPE	ENGINE	MTOW (t)	QC	MEAN	STD DEV	COUNT	STD ERR	95% CI	MEAN	STD DEV	COUNT	STD ERR	95% CI	MEAN	STD DEV	COUNT	STD ERR	95% CI
A300B4-605R	CF6-80C2A5	171.7	2	93.3	2.9	3	1.7	7.2	95.1	2.0	62	0.3	0.5	95.0	2.1	65	0.3	0.5
A320-212	CFM56-5A3	77.0	1	93.4	-	1	-	-	92.7	1.4	55	0.2	0.4	92.7	1.4	56	0.2	0.4
A320-231	V2500-A1	74.5	0.5	92.4	-	1	-	-	90.8	1.3	8	0.5	1.1	90.9	1.3	9	0.4	1.0
A320-231	V2500-A1	75.5	1	-	-	-	-	-	90.7	1.2	82	0.1	0.3	90.7	1.2	82	0.1	0.3
A320-231	V2500-A1	77.0	1	-	-	-	-	-	90.7	1.6	58	0.2	0.4	90.7	1.6	58	0.2	0.4
A321-211	CFM56-5B3/P	89.0	1	95.8	2.8	2	2.0	25.2	93.6	1.7	23	0.4	0.7	93.8	1.8	25	0.4	0.7
A330-243	Trent 772B	230.0	2	-	-	-	-	-	95.1	1.6	59	0.2	0.4	95.1	1.6	59	0.2	0.4
ATR42-300	PW120	16.7	Exempt	-	-	-	-	-	88.0	6.8	25	1.4	2.8	88.0	6.8	25	1.4	2.8
ATR72-202	PW124	21.5	Exempt	-	-	-	-	-	86.7	1.9	97	0.2	0.4	86.7	1.9	97	0.2	0.4
B737-200 Adv	JT8D-15/15A	54.2	2	-	-	-	-	-	98.0	0.3	2	0.2	2.7	98.0	0.3	2	0.2	2.7
B737-200 Adv	JT8D-15/15A	55.1	2	-	-	-	-	-	99.4	2.1	8	0.7	1.8	99.4	2.1	8	0.7	1.8
B737-200 Adv	JT8D-15/15A	56.5	2	-	-	-	-	-	99.1	1.6	4	0.8	2.5	99.1	1.6	4	0.8	2.5
B737-400	CFM56-3C1	62.8	0.5	-	-	-	-	-	92.4	1.6	683	0.1	0.1	92.4	1.6	683	0.1	0.1
B737-400	CFM56-3C1	64.6	0.5	-	-	-	-	-	89.9	0.0	2	0.0	0.0	89.9	0.0	2	0.0	0.0
B737-400	CFM56-3C1	65.8	0.5	-	-	-	-	-	90.9	-	1	-	-	90.9	-	1	-	-
B737-400	CFM56-3C1	68.0	1	93.5	-	1	-	-	92.1	2.0	47	0.3	0.6	92.1	2.0	48	0.3	0.6
B737-800	CFM56-7B26	78.3	1	-	-	-	-	-	91.9	1.3	23	0.3	0.6	91.9	1.3	23	0.3	0.6
B747-400	RB211-524H2	381.0	4	-	-	-	-	-	98.2	1.0	100	0.1	0.2	98.2	1.0	100	0.1	0.2
B747-400	RB211-524H2	396.9	4	-	-	-	-	-	98.5	1.5	317	0.1	0.2	98.5	1.5	317	0.1	0.2
B757-200	RB211-535E4	100.3	0.5	-	-	-	-	-	94.0	1.2	12	0.3	0.8	94.0	1.2	12	0.3	0.8
B757-200	RB211-535E4	102.1	0.5	-	-	-	-	-	94.2	1.4	31	0.3	0.5	94.2	1.4	31	0.3	0.5
B757-200	RB211-535E4	104.3	0.5	-	-	-	-	-	93.9	1.6	81	0.2	0.4	93.9	1.6	81	0.2	0.4
B757-200	RB211-535E4	108.9	0.5	96.4	1.2	2	0.8	10.8	94.7	2.0	146	0.2	0.3	94.7	2.0	148	0.2	0.3
B757-200	RB211-535E4	111.6	0.5	-	-	-	-	-	94.8	1.2	6	0.5	1.3	94.8	1.2	6	0.5	1.3
B757-200	RB211-535E4	113.4	0.5	92.3	-	1	-	-	94.5	1.6	71	0.2	0.4	94.5	1.6	72	0.2	0.4
B767-200 (ER)	CF6-80A2	159.2	2	-	-	-	-	-	95.1	1.5	48	0.2	0.4	95.1	1.5	48	0.2	0.4
B767-300 (ER)	CF6-80C2B7F	184.6	2	-	-	-	-	-	96.8	1.8	23	0.4	0.8	96.8	1.8	23	0.4	0.8
B767-300 (ER)	CF6-80C2B7F	186.9	2	-	-	-	-	-	96.1	1.5	38	0.2	0.5	96.1	1.5	38	0.2	0.5
B777-200	GE90-85B	267.6	1	92.2	-	1	-	-	91.9	1.4	255	0.1	0.2	91.9	1.3	256	0.1	0.2
BAe 125-700B	TFE-731-3R-1H	11.6	0.5	91.0	-	1	-	-	90.5	1.0	8	0.4	0.8	90.5	1.0	9	0.3	0.8
Avro RJ100	LF507-1F	45.0	0.5	-	-	-	-	-	87.5	1.8	175	0.1	0.3	87.5	1.8	175	0.1	0.3
BAe 748 2A	Dart 534-2	20.0	1	88.0	1.2	4	0.6	1.9	86.9	-	1	-	-	87.8	1.2	5	0.5	1.5
BAe 748 2A	Dart 534-2	20.2	1	85.2	-	1	-	-	-	-	-	-	-	85.2	-	1	-	-
Cessna F406 Caravan II	PT6A-112	4.5	Exempt	77.6	-	1	-	-	-	-	-	-	-	77.6	-	1	-	-
DC10-30	CF6-50C2	251.7	4	97.9	2.4	2	1.7	21.6	96.6	2.6	18	0.6	1.3	96.7	2.5	20	0.6	1.2
DC10-30	CF6-50C2	256.3	4	-	-	-	-	-	95.2	1.0	6	0.4	1.0	95.2	1.0	6	0.4	1.0
DC10-30	CF6-50C2	259.5	4	96.4	1.1	2	0.8	9.9	96.3	2.0	69	0.2	0.5	96.3	2.0	71	0.2	0.5
DC10-30	CF6-50C2	263.1	4	-	-	-	-	-	96.9	1.1	9	0.4	0.8	96.9	1.1	9	0.4	0.8
Falcon 900	TFE 731-5A-1C	20.6	0.5	-	-	-	-	-	91.5	-	1	-	-	91.5	-	1	-	-
Fokker F27	Dart 532-7	19.7	0.5	87.7	2.3	6	0.9	2.4	88.3	1.2	7	0.5	1.1	88.0	1.7	13	0.5	1.0
Fokker F27	Dart 532-7	20.4	0.5	89.3	1.9	20	0.4	0.9	87.8	2.2	18	0.5	1.1	88.6	2.1	38	0.3	0.7
Shorts 360-100	PT6A-65AR	12.0	Exempt	83.2	-	1	-	-	-	-	-	-	-	83.2	-	1	-	-
Shorts 360-100	PT6A-65R	12.0	Exempt	83.3	5.0	4	2.5	8.0	-	-	-	-	-	83.3	5.0	4	2.5	8.0
Shorts 360-300	PT6A-67R	12.3	Exempt	82.4	2.2	20	0.5	1.0	82.7	2.4	23	0.5	1.0	82.6	2.3	43	0.4	0.7

Table B8 Gatwick Approach EPNLs (Summer 2001)

				NIGHT-TIME EPNL, EPNdB					DAYTIME EPNL, EPNdB					24HR (POOLED) EPNL, EPNdB				
TYPE	ENGINE	MLW (t)	QC	MEAN	STD DEV	COUNT	STD ERR	95% CI	MEAN	STD DEV	COUNT	STD ERR	95% CI	MEAN	STD DEV	COUNT	STD ERR	95% CI
A300B4-605R	CF6-80C2A5	140.0	1	99.4	1.5	121	0.1	0.3	98.9	1.5	235	0.1	0.2	99.1	1.5	356	0.1	0.2
A300B4-103	CF6-50C2	136.0	2	101.1	-	1	-	-	-	-	-	-	-	101.1	-	1	-	-
A300B4-203	CF6-50C2	136.0	2	102.6	-	1	-	-	101.8	-	1	-	-	102.2	0.6	2	0.4	5.4
A310-304	CF6-80C2A2	124.0	0.5	97.5	0.7	2	0.5	6.3	97.8	0.4	5	0.2	0.5	97.7	0.5	7	0.2	0.5
A310-324	PW4152	124.0	1	100.1	-	1	-	-	100.6	1.2	7	0.5	1.1	100.6	1.2	8	0.4	1.0
A319-132	V2524-A5	61.0	0.5	93.7	-	1	-	-	-	-	-	-	-	93.7	-	1	-	-
A320-211	CFM56-5A1	64.5	0.5	95.1	1.0	2	0.7	9.0	94.4	1.1	25	0.2	0.5	94.4	1.1	27	0.2	0.4
A320-212	CFM56-5A3	64.5	0.5	94.4	1.3	34	0.2	0.5	94.1	1.4	141	0.1	0.2	94.1	1.4	175	0.1	0.2
A320-214	CFM56-5B4/P	64.5	0.5	94.7	1.1	179	0.1	0.2	94.3	1.2	313	0.1	0.1	94.4	1.2	492	0.1	0.1
A320-231	V2500-A1	64.5	0.5	95.4	1.1	284	0.1	0.1	94.9	1.1	545	0.0	0.1	95.1	1.1	829	0.0	0.1
A320-232	V2527-A5	64.5	0.5	94.3	1.1	26	0.2	0.4	94.1	1.2	65	0.1	0.3	94.2	1.1	91	0.1	0.2
A321-211	CFM56-5B3/P	75.5	0.5	95.4	1.2	115	0.1	0.2	94.9	1.4	255	0.1	0.2	95.0	1.3	370	0.1	0.1
A321-231	V2533-A5	75.5	0.5	94.1	1.0	63	0.1	0.3	93.4	1.1	61	0.1	0.3	93.8	1.1	124	0.1	0.2
A330-202	CF6-80E1A4	180.0	0.5	95.8	-	1	-	-	97.3	2.5	50	0.4	0.7	97.3	2.5	51	0.4	0.7
A330-243	Trent 772B	180.0	0.5	96.8	1.1	60	0.1	0.3	96.1	1.2	215	0.1	0.2	96.3	1.3	275	0.1	0.2
A330-323	PW4168A	180.0	0.5	97.3	1.2	81	0.1	0.3	96.8	1.7	123	0.2	0.3	97.0	1.5	204	0.1	0.2
ATR 42-300	PW120	16.9	0.5	96.9	-	1	-	-	94.6	1.0	3	0.6	2.5	95.2	1.4	4	0.7	2.2
ATR 72-212	PW127	21.4	Exempt	93.7	1.2	2	0.8	10.8	93.6	1.0	250	0.1	0.1	93.6	1.0	252	0.1	0.1
Avro RJ100	LF507-1F	40.1	0.5	92.9	1.5	69	0.2	0.4	92.0	1.4	2764	0.0	0.1	92.0	1.4	2833	0.0	0.1
BAe 146-200	ALF502R-5	36.7	0.5	91.5	1.2	20	0.3	0.6	91.8	1.4	354	0.1	0.1	91.8	1.4	374	0.1	0.1
BAe 146-300	ALF502R-5	37.7	0.5	93.1	1.0	18	0.2	0.5	92.3	1.5	430	0.1	0.1	92.4	1.4	448	0.1	0.1
B737-200 Adv	JT8D-15 (HK)	48.5	0.5	99.3	-	1	-	-	96.9	1.3	21	0.3	0.6	97.0	1.4	22	0.3	0.6
B737-300	CFM56-3B1	51.7	1	96.7	1.8	3	1.0	4.5	95.5	2.5	7	0.9	2.3	95.9	2.3	10	0.7	1.6
B737-300	CFM56-3B2	51.7	1	96.8	1.7	42	0.3	0.5	96.1	2.1	100	0.2	0.4	96.3	2.0	142	0.2	0.3
B737-300	CFM56-3B2	54.9	1	97.4	0.8	4	0.4	1.3	96.4	1.0	7	0.4	0.9	96.8	1.0	11	0.3	0.7
B737-300	CFM56-3C1	51.7	1	95.1	0.7	2	0.5	6.3	96.1	1.8	553	0.1	0.2	96.1	1.8	555	0.1	0.2
B737-300	CFM56-3C1	54.9	1	95.9	1.7	28	0.3	0.7	94.8	1.6	220	0.1	0.2	94.9	1.6	248	0.1	0.2
B737-300	CFM56-3C3	54.9	1	96.9	2.0	13	0.6	1.2	95.0	1.8	179	0.1	0.3	95.1	1.9	192	0.1	0.3
B737-400	CFM56-3C1	54.9	1	97.6	1.8	72	0.2	0.4	96.4	1.7	3528	0.0	0.1	96.4	1.7	3600	0.0	0.1
B737-400	CFM56-3C1	56.3	1	97.7	2.1	9	0.7	1.6	96.9	2.5	50	0.4	0.7	97.1	2.4	59	0.3	0.6
B737-700	CFM56-7B24	60.8	0.5	94.8	-	1	-	-	95.5	0.9	17	0.2	0.5	95.4	0.9	18	0.2	0.4
B737-800	CFM56-7B26	66.4	0.5	94.8	1.5	132	0.1	0.3	94.6	1.4	303	0.1	0.2	94.6	1.4	435	0.1	0.1
B737-800	CFM56-7B27	66.4	0.5	96.4	2.2	12	0.6	1.4	-	-	-	-	-	96.4	2.2	12	0.6	1.4
B747-200	CF6-50E2	285.8	4	105.3	1.3	6	0.5	1.4	105.7	0.9	11	0.3	0.6	105.6	1.0	17	0.2	0.5
B747-200	JT9D-7J	265.4	4	109.7	-	1	-	-	109.8	1.3	58	0.2	0.3	109.8	1.3	59	0.2	0.3
B747-200	RB211-524C2	265.4	4	107.3	2.5	3	1.4	6.2	107.0	1.4	19	0.3	0.7	107.1	1.5	22	0.3	0.7
B747-200	RB211-524D4	285.8	2	105.8	1.6	3	0.9	4.0	105.2	1.2	167	0.1	0.2	105.2	1.2	170	0.1	0.2
B747-400	CF6-80C2B1F	295.8	2	102.5	1.2	16	0.3	0.6	102.4	1.7	249	0.1	0.2	102.4	1.7	265	0.1	0.2
B747-400	RB211-524G/HT	285.8	2	105.9	1.8	173	0.1	0.3	104.3	1.7	171	0.1	0.3	105.1	1.9	344	0.1	0.2

Table B8 Gatwick Approach EPNLs (Summer 2001), continued

				NIGHT-TIME EPNL, EPNdB					DAYTIME EPNL, EPNdB					24HR (POOLED) EPNL, EPNdB				
TYPE	ENGINE	MLW (t)	QC	MEAN	STD DEV	COUNT	STD ERR	95% CI	MEAN	STD DEV	COUNT	STD ERR	95% CI	MEAN	STD DEV	COUNT	STD ERR	95% CI
B757-200	RB211-535E4	89.8	0.5	98.0	1.6	382	0.1	0.2	97.7	1.6	867	0.1	0.1	97.8	1.6	1249	0.0	0.1
B757-200	RB211-535E4	90.0	0.5	98.2	1.4	197	0.1	0.2	97.8	1.6	454	0.1	0.1	97.9	1.5	651	0.1	0.1
B757-200	RB211-535E4	95.3	0.5	98.0	1.6	199	0.1	0.2	97.5	1.6	490	0.1	0.1	97.7	1.6	689	0.1	0.1
B757-300	RB211-535E4-B	101.6	0.5	99.4	1.5	28	0.3	0.6	99.1	1.8	103	0.2	0.4	99.2	1.7	131	0.1	0.3
B767-200 (ER)	CF6-80A2	123.4	1	101.5	1.2	92	0.1	0.2	101.0	1.2	207	0.1	0.2	101.2	1.2	299	0.1	0.1
B767-200 (ER)	CF6-80C2B4	126.1	0.5	97.9	1.3	5	0.6	1.6	97.9	1.6	5	0.7	2.0	97.9	1.4	10	0.4	1.0
B767-200 (ER)	PW4056	136.1	0.5	100.1	1.3	3	0.8	3.2	99.2	1.5	43	0.2	0.5	99.2	1.5	46	0.2	0.4
B767-300 (ER)	CF6-80C2B4	145.2	0.5	99.3	2.1	4	1.1	3.3	99.1	1.9	13	0.5	1.1	99.1	1.9	17	0.5	1.0
B767-300 (ER)	CF6-80C2B6F	145.2	0.5	98.1	1.2	10	0.4	0.9	97.9	1.6	64	0.2	0.4	97.9	1.6	74	0.2	0.4
B767-300 (ER)	CF6-80C2B7F	145.2	0.5	99.1	1.6	235	0.1	0.2	98.6	1.9	532	0.1	0.2	98.8	1.8	767	0.1	0.1
B767-300 (ER)	PW4060	145.2	1	99.7	1.1	38	0.2	0.4	99.6	1.2	167	0.1	0.2	99.6	1.2	205	0.1	0.2
B767-300 (ER)	RB211-524H	136.0	1	103.5	1.4	184	0.1	0.2	103.3	1.4	283	0.1	0.2	103.4	1.4	467	0.1	0.1
B777-200	GE90-85B	208.7	0.5	97.2	1.0	48	0.1	0.3	97.1	1.1	275	0.1	0.1	97.1	1.1	323	0.1	0.1
B777-200	GE90-90B	208.7	0.5	97.4	0.8	12	0.2	0.5	97.4	1.1	136	0.1	0.2	97.4	1.1	148	0.1	0.2
B777-200	Trent 895	208.7	1	99.0	1.1	45	0.2	0.3	98.8	1.1	153	0.1	0.2	98.9	1.1	198	0.1	0.2
Beech King Air 200	PT6A-41	5.7	Exempt	91.8	2.5	2	1.8	22.5	89.1	2.6	2	1.8	23.4	90.5	2.6	4	1.3	4.1
DC-10-15	CF6-50C2F	164.9	2	105.3	-	1	-	-	102.6	1.2	3	0.7	3.0	103.3	1.6	4	0.8	2.5
DC-10-30	CF6-50C2	182.8	4	104.9	3.4	3	2.0	8.4	103.0	1.1	5	0.5	1.4	103.7	2.2	8	0.8	1.8
DC-10-30	CF6-50C2	186.4	4	103.7	1.5	9	0.5	1.2	103.5	1.6	19	0.4	0.8	103.6	1.5	28	0.3	0.6
DC-10-30	CF6-50C2	192.3	4	103.3	1.1	5	0.5	1.4	103.3	2.3	19	0.5	1.1	103.3	2.0	24	0.4	0.8
DC-10-30	CF6-50C2	197.2	4	103.3	1.3	10	0.4	0.9	103.3	2.0	56	0.3	0.5	103.3	1.9	66	0.2	0.5
MD-11F	CF6-80C2D1F	218.4	2	98.5	-	1	-	-	-	-	-	-	-	98.5	-	1	-	-
MD-82	JT8D-217C	59.0	0.5	97.0	2.3	3	1.3	5.7	94.8	1.9	103	0.2	0.4	94.9	2.0	106	0.2	0.4
MD-83	JT8D-219	68.0	0.5	96.8	2.6	13	0.7	1.6	94.9	2.1	108	0.2	0.4	95.1	2.2	121	0.2	0.4
Cessna 550 Citation II	JT15D-4	6.1	Exempt	87.3	-	1	-	-	87.0	1.2	3	0.7	3.0	87.1	1.0	4	0.5	1.6
Cessna 650 Citation VII	TFE731-4R-2S	9.1	Exempt	89.6	-	1	-	-	86.4	-	1	-	-	88.0	2.3	2	1.6	20.7
Fairchild Dornier 328JET	PW306B	14.1	0.5	91.3	-	1	-	-	-	-	-	-	-	91.3	-	1	-	-
Fokker F27	Dart 532-7	19.7	Exempt	93.3	1.4	48	0.2	0.4	92.7	1.2	54	0.2	0.3	93.0	1.3	102	0.1	0.3
HS 125-700B	TFE731-3R-1H	10.0	Exempt	91.7	1.7	4	0.9	2.7	90.8	1.7	6	0.7	1.8	91.1	1.7	10	0.5	1.2
L-1011-385-1	RB211-22B	166.9	2	102.3	0.7	2	0.5	6.3	101.1	2.1	17	0.5	1.1	101.3	2.1	19	0.5	1.0
Piper PA-23-250	IO-540-C4B5	2.4	Exempt	84.2	-	1	-	-	83.7	2.9	2	2.1	26.1	83.9	2.1	3	1.2	5.2
Piper PA-42-720	PT6A-61	5.1	Exempt	90.4	-	1	-	-	-	-	-	-	-	90.4	-	1	-	-
Cessna F406 Caravan II	PT6A-112	4.5	Exempt	86.7	1.7	11	0.5	1.1	-	-	-	-	-	86.7	1.7	11	0.5	1.1
Saab SF340A	CT7-5A2	12.0	Exempt	94.3	1.4	3	0.8	3.5	93.1	0.4	2	0.3	3.6	93.8	1.2	5	0.5	1.5
Shorts 360-200	PT6A-65AR	11.8	Exempt	90.4	1.5	41	0.2	0.5	89.7	1.8	46	0.3	0.5	90.0	1.7	87	0.2	0.4

Table B9 Gatwick Flyover EPNLs (Summer 2001)

				NIGHT-TIME EPNL, EPNdB					DAYTIME EPNL, EPNdB					24HR (POOLED) EPNL, EPNdB				
TYPE	ENGINE	MTOW (t)	QC	MEAN	STD DEV	COUNT	STD ERR	95% CI	MEAN	STD DEV	COUNT	STD ERR	95% CI	MEAN	STD DEV	COUNT	STD ERR	95% CI
A300B4-605R	CF6-80C2A5	170.5	2	90.7	2.1	21	0.5	1.0	92.0	1.6	232	0.1	0.2	91.9	1.7	253	0.1	0.2
A300B4-605R	CF6-80C2A5	171.7	2	91.3	1.8	35	0.3	0.6	92.2	1.5	216	0.1	0.2	92.1	1.6	251	0.1	0.2
A310-304	CF6-80C2A2	153.0	2	91.6	-	1	-	-	91.9	1.8	6	0.7	1.9	91.8	1.7	7	0.6	1.6
A320-211	CFM56-5A1	73.5	1	89.4	0.5	2	0.4	4.5	88.7	1.4	19	0.3	0.7	88.8	1.4	21	0.3	0.6
A320-212	CFM56-5A3	73.5	1	85.2	0.4	2	0.3	3.6	90.2	1.8	3	1.0	4.5	88.2	3.0	5	1.3	3.7
A320-212	CFM56-5A3	77.0	1	88.7	1.7	42	0.3	0.5	89.1	1.5	115	0.1	0.3	89.0	1.5	157	0.1	0.2
A320-214	CFM56-5B4/P	73.5	0.5	86.9	1.2	2	0.8	10.8	86.9	1.2	23	0.3	0.5	86.9	1.2	25	0.2	0.5
A320-214	CFM56-5B4/P	77.0	1	88.2	1.9	39	0.3	0.6	88.2	1.7	310	0.1	0.2	88.2	1.7	349	0.1	0.2
A320-231	V2500-A1	73.5	0.5	87.4	0.9	3	0.5	2.2	90.9	-	1	-	-	88.3	1.9	4	1.0	3.0
A320-231	V2500-A1	75.5	1	88.8	1.2	16	0.3	0.6	89.2	1.2	85	0.1	0.3	89.1	1.2	101	0.1	0.2
A320-231	V2500-A1	77.0	1	87.7	1.4	48	0.2	0.4	87.8	1.4	434	0.1	0.1	87.8	1.4	482	0.1	0.1
A321-211	CFM56-5B3/P	89.0	1	90.2	1.3	17	0.3	0.7	89.4	1.7	257	0.1	0.2	89.4	1.7	274	0.1	0.2
A321-231	V2533-A5	89.0	1	86.1	-	1	-	-	89.0	1.5	141	0.1	0.2	89.0	1.5	142	0.1	0.2
Avro RJ100	LF507-1F	45.0	0.5	87.8	3.9	2	2.8	35.0	86.2	1.8	1745	0.0	0.1	86.2	1.8	1747	0.0	0.1
DC-10-30	CF6-50C2	256.3	4	95.6	0.9	4	0.5	1.4	97.5	2.6	21	0.6	1.2	97.2	2.5	25	0.5	1.0
DC-10-30	CF6-50C2	259.5	4	96.4	2.6	15	0.7	1.4	96.7	2.8	39	0.4	0.9	96.6	2.7	54	0.4	0.7
MD-82	JT8D-217C	67.8	2	94.8	2.7	4	1.4	4.3	94.0	1.7	4	0.9	2.7	94.4	2.1	8	0.7	1.8
MD-83	JT8D-219	72.6	2	94.4	2.0	19	0.5	1.0	94.6	1.9	88	0.2	0.4	94.5	1.9	107	0.2	0.4
B737-300	CFM56-3B1	61.2	0.5	86.6	2.8	3	1.6	7.0	87.2	3.0	5	1.3	3.7	87.0	2.7	8	1.0	2.3
B737-300	CFM56-3B2	62.8	0.5	88.2	2.5	3	1.4	6.2	89.0	1.6	11	0.5	1.1	88.9	1.7	14	0.5	1.0
B737-300	CFM56-3C1	60.6	0.5	87.6	1.9	6	0.8	2.0	88.1	1.8	3	1.0	4.5	87.8	1.8	9	0.6	1.4
B737-300	CFM56-3C1	61.7	0.5	88.5	1.1	4	0.6	1.8	89.1	1.8	17	0.4	0.9	89.0	1.7	21	0.4	0.8
B737-400	CFM56-3C1	65.8	0.5	89.8	3.5	6	1.4	3.7	-	-	-	-	-	89.8	3.5	6	1.4	3.7
B737-400	CFM56-3C1	68.0	1	85.6	2.2	2	1.6	19.8	89.2	1.9	268	0.1	0.2	89.2	1.9	270	0.1	0.2
B737-700	CFM56-7B24	70.1	0.5	89.2	-	1	-	-	90.7	0.2	2	0.1	1.8	90.2	0.9	3	0.5	2.2
B737-800	CFM56-7B26	78.0	1	90.2	1.2	8	0.4	1.0	90.3	1.4	23	0.3	0.6	90.3	1.4	31	0.3	0.5
B737-800	CFM56-7B26	78.3	1	89.3	1.5	58	0.2	0.4	89.7	1.8	167	0.1	0.3	89.6	1.8	225	0.1	0.2
B737-800	CFM56-7B26	79.0	1	89.6	2.0	51	0.3	0.6	89.8	1.6	158	0.1	0.3	89.8	1.7	209	0.1	0.2
B737-800	CFM56-7B27	78.3	1	89.5	1.1	11	0.3	0.7	89.7	-	1	-	-	89.5	1.0	12	0.3	0.6
B747-400	RB211-524G	381.0	4	101.7	-	1	-	-	101.3	1.8	39	0.3	0.6	101.3	1.8	40	0.3	0.6
B757-200	RB211-535E4	100.3	0.5	89.2	2.1	5	0.9	2.6	89.7	1.0	95	0.1	0.2	89.7	1.1	100	0.1	0.2
B757-200	RB211-535E4	101.8	0.5	90.8	1.4	4	0.7	2.2	90.2	1.9	31	0.3	0.7	90.3	1.8	35	0.3	0.6
B757-200	RB211-535E4	102.1	0.5	89.4	1.0	27	0.2	0.4	89.5	1.2	338	0.1	0.1	89.5	1.2	365	0.1	0.1
B757-200	RB211-535E4	104.3	0.5	90.1	1.7	46	0.3	0.5	90.6	1.4	281	0.1	0.2	90.6	1.4	327	0.1	0.2
B757-200	RB211-535E4	108.9	0.5	90.3	1.9	71	0.2	0.4	90.7	1.5	710	0.1	0.1	90.6	1.6	781	0.1	0.1
B757-200	RB211-535E4	113.4	0.5	90.4	1.6	107	0.2	0.3	90.6	1.6	863	0.1	0.1	90.6	1.6	970	0.1	0.1
B757-300	RB211-535E4-B	118.0	1	89.7	0.6	5	0.3	0.7	89.8	1.1	128	0.1	0.2	89.8	1.1	133	0.1	0.2
B767-200 (ER)	CF6-80A2	158.7	2	91.0	1.2	10	0.4	0.9	91.0	1.5	185	0.1	0.2	91.0	1.5	195	0.1	0.2
B767-200 (ER)	CF6-80A2	159.2	2	93.1	0.3	2	0.2	2.7	91.5	1.3	46	0.2	0.4	91.6	1.3	48	0.2	0.4
B767-200 (ER)	PW4056	175.5	2	92.4	-	1	-	-	93.1	1.6	56	0.2	0.4	93.1	1.6	57	0.2	0.4
B767-300 (ER)	CF6-80C2B7F	184.6	2	89.2	1.6	16	0.4	0.9	90.2	1.7	146	0.1	0.3	90.1	1.7	162	0.1	0.3
B767-300 (ER)	CF6-80C2B7F	186.9	2	89.9	1.9	58	0.2	0.5	90.9	2.2	466	0.1	0.2	90.8	2.2	524	0.1	0.2
Cessna 650 Citation VII	TFE731-4R-2S	10.2	Exempt	85.7	-	1	-	-	85.0	-	1	-	-	85.4	0.5	2	0.4	4.5
Fokker F27	Dart 532-7	20.4	0.5	88.2	1.2	39	0.2	0.4	87.4	1.4	36	0.2	0.5	87.8	1.4	75	0.2	0.3
HS 125-700B	TFE731-3R-1H	11.6	0.5	89.9	-	1	-	-	87.5	2.8	11	0.8	1.9	87.7	2.7	12	0.8	1.7
Shorts 360-200	PT6A-65AR	12.0	Exempt	85.3	1.4	20	0.3	0.7	85.1	1.1	21	0.2	0.5	85.2	1.2	41	0.2	0.4

Table B10 Gatwick Pseudo-lateral EPNLs (Summer 2001)

				NIGHT-TIME EPNL, EPNdB					DAYTIME EPNL, EPNdB					24HR (POOLED) EPNL, EPNdB				
TYPE	ENGINE	MTOW (t)	QC	MEAN	STD DEV	COUNT	STD ERR	95% CI	MEAN	STD DEV	COUNT	STD ERR	95% CI	MEAN	STD DEV	COUNT	STD ERR	95% CI
A300B4-605R	CF6-80C2A5	170.5	2	95.7	1.3	11	0.4	0.9	95.4	1.4	108	0.1	0.3	95.4	1.4	119	0.1	0.3
A300B4-605R	CF6-80C2A5	171.7	2	95.0	1.6	16	0.4	0.9	95.4	1.5	114	0.1	0.3	95.4	1.5	130	0.1	0.3
A310-304	CF6-80C2A2	153.0	2	95.8	-	1	-	-	93.9	0.5	3	0.3	1.2	94.4	1.0	4	0.5	1.6
A320-211	CFM56-5A1	73.5	1	91.6	1.8	2	1.3	16.2	91.7	1.3	18	0.3	0.6	91.7	1.3	20	0.3	0.6
A320-212	CFM56-5A3	73.5	1	90.6	-	1	-	-	90.6	0.4	5	0.2	0.5	90.6	0.4	6	0.2	0.4
A320-212	CFM56-5A3	77.0	1	92.0	1.1	28	0.2	0.4	91.8	1.1	118	0.1	0.2	91.9	1.1	146	0.1	0.2
A320-214	CFM56-5B4/P	73.5	0.5	88.6	-	1	-	-	88.5	1.4	21	0.3	0.6	88.5	1.3	22	0.3	0.6
A320-214	CFM56-5B4/P	77.0	1	89.8	1.0	42	0.2	0.3	90.1	1.3	369	0.1	0.1	90.1	1.2	411	0.1	0.1
A320-231	V2500-A1	73.5	0.5	90.8	0.9	3	0.5	2.2	90.0	-	1	-	-	90.6	0.8	4	0.4	1.3
A320-231	V2500-A1	75.5	1	90.9	1.3	27	0.3	0.5	90.7	1.3	135	0.1	0.2	90.7	1.3	162	0.1	0.2
A320-231	V2500-A1	77.0	1	90.8	1.1	55	0.1	0.3	90.6	1.2	516	0.1	0.1	90.6	1.2	571	0.1	0.1
A321-211	CFM56-5B3/P	89.0	1	92.9	1.4	25	0.3	0.6	92.8	1.4	299	0.1	0.2	92.8	1.4	324	0.1	0.2
A321-231	V2533-A5	89.0	1	90.6	1.7	2	1.2	15.3	89.5	1.4	151	0.1	0.2	89.5	1.4	153	0.1	0.2
Avro RJ100	LF507-1F	45.0	0.5	86.4	0.8	6	0.3	0.8	86.4	1.2	1616	0.0	0.1	86.4	1.2	1622	0.0	0.1
DC-10-30	CF6-50C2	256.3	4	99.2	1.8	6	0.7	1.9	99.3	1.9	23	0.4	0.8	99.3	1.8	29	0.3	0.7
DC-10-30	CF6-50C2	259.5	4	99.6	1.5	19	0.3	0.7	98.8	1.7	55	0.2	0.5	99.0	1.7	74	0.2	0.4
MD-82	JT8D-217C	67.8	2	98.2	0.1	2	0.1	0.9	97.3	-	1	-	-	97.9	0.5	3	0.3	1.2
MD-83	JT8D-219	72.6	2	99.4	0.6	4	0.3	1.0	99.1	1.1	9	0.4	0.8	99.2	1.0	13	0.3	0.6
B737-300	CFM56-3B1	61.2	0.5	91.4	1.0	2	0.7	9.0	91.5	0.8	8	0.3	0.7	91.5	0.8	10	0.3	0.6
B737-300	CFM56-3B2	62.8	0.5	91.8	-	1	-	-	92.5	-	1	-	-	92.2	0.5	2	0.4	4.5
B737-300	CFM56-3C1	60.6	0.5	90.1	-	1	-	-	91.6	1.1	6	0.4	1.2	91.4	1.1	7	0.4	1.0
B737-300	CFM56-3C1	61.7	0.5	91.7	-	1	-	-	91.5	0.9	10	0.3	0.6	91.6	0.8	11	0.2	0.5
B737-400	CFM56-3C1	65.8	0.5	93.5	1.0	7	0.4	0.9	-	-	-	-	-	93.5	1.0	7	0.4	0.9
B737-400	CFM56-3C1	68.0	1	93.0	0.0	2	0.0	0.0	92.3	1.2	111	0.1	0.2	92.3	1.2	113	0.1	0.2
B737-700	CFM56-7B24	70.1	0.5	91.2	0.4	2	0.3	3.6	91.6	0.4	2	0.3	3.6	91.4	0.4	4	0.2	0.6
B737-800	CFM56-7B26	78.0	1	93.6	1.7	8	0.6	1.4	93.1	2.7	25	0.5	1.1	93.2	2.5	33	0.4	0.9
B737-800	CFM56-7B26	78.3	1	92.8	0.7	32	0.1	0.3	92.9	1.7	115	0.2	0.3	92.8	1.5	147	0.1	0.2
B737-800	CFM56-7B26	79.0	1	93.0	1.3	20	0.3	0.6	93.2	1.3	141	0.1	0.2	93.2	1.3	161	0.1	0.2
B737-800	CFM56-7B27	78.3	1	92.6	0.7	10	0.2	0.5	92.7	-	1	-	-	92.6	0.6	11	0.2	0.4
B747-400	RB211-524G	381.0	4	98.9	0.4	2	0.3	3.6	99.0	1.3	152	0.1	0.2	99.0	1.3	154	0.1	0.2
B757-200	RB211-535E4	100.3	0.5	93.6	0.2	2	0.1	1.8	93.4	0.9	52	0.1	0.3	93.4	0.8	54	0.1	0.2
B757-200	RB211-535E4	101.8	0.5	92.4	0.7	2	0.5	6.3	93.0	0.9	29	0.2	0.3	93.0	0.9	31	0.2	0.3
B757-200	RB211-535E4	102.1	0.5	93.3	0.9	21	0.2	0.4	93.4	0.7	227	0.0	0.1	93.4	0.7	248	0.0	0.1
B757-200	RB211-535E4	104.3	0.5	94.3	2.3	27	0.4	0.9	93.9	1.2	178	0.1	0.2	94.0	1.4	205	0.1	0.2
B757-200	RB211-535E4	108.9	0.5	94.1	0.7	37	0.1	0.2	94.1	0.9	368	0.0	0.1	94.1	0.9	405	0.0	0.1
B757-200	RB211-535E4	113.4	0.5	94.3	1.8	48	0.3	0.5	94.1	1.1	508	0.0	0.1	94.1	1.2	556	0.1	0.1
B757-300	RB211-535E4-B	118.0	1	92.9	-	1	-	-	94.0	1.4	142	0.1	0.2	94.0	1.4	143	0.1	0.2
B767-200 (ER)	CF6-80A2	158.7	2	94.6	0.8	8	0.3	0.7	94.6	1.0	161	0.1	0.2	94.6	1.0	169	0.1	0.2
B767-200 (ER)	CF6-80A2	159.2	2	94.9	0.7	3	0.4	1.7	94.1	0.9	38	0.1	0.3	94.2	0.9	41	0.1	0.3
B767-200 (ER)	PW4056	175.5	2	97.8	-	1	-	-	97.6	1.9	49	0.3	0.5	97.6	1.9	50	0.3	0.5
B767-300 (ER)	CF6-80C2B7F	184.6	2	94.2	-	1	-	-	94.2	1.0	59	0.1	0.3	94.2	1.0	60	0.1	0.3
B767-300 (ER)	CF6-80C2B7F	186.9	2	94.8	1.1	14	0.3	0.6	96.7	2.1	302	0.1	0.2	96.6	2.1	316	0.1	0.2
Cessna 650 Citation VII	TFE731-4R-2S	10.2	Exempt	88.3	0.1	2	0.1	0.9	87.9	-	1	-	-	88.2	0.2	3	0.1	0.5
Fokker F27	Dart 532-7	20.4	0.5	87.6	1.5	60	0.2	0.4	86.5	1.3	55	0.2	0.4	87.0	1.5	115	0.1	0.3
HS 125-700B	TFE731-3R-1H	11.6	0.5	90.1	-	1	-	-	89.6	2.3	11	0.7	1.5	89.7	2.2	12	0.6	1.4
Shorts 360-200	PT6A-65AR	12.0	Exempt	82.9	1.3	63	0.2	0.3	82.6	1.8	66	0.2	0.4	82.8	1.6	129	0.1	0.3

Table B11 Stansted Approach EPNLs (Winter 2001/2002)

				NIGHT-TIME EPNL, EPNdB					DAYTIME EPNL, EPNdB					24HR (POOLED) EPNL, EPNdB				
TYPE	ENGINE	MLW (t)	QC	MEAN	STD DEV	COUNT	STD ERR	95% CI	MEAN	STD DEV	COUNT	STD ERR	95% CI	MEAN	STD DEV	COUNT	STD ERR	95% CI
A300B4-103	CF6-50C2	136	2	101.4	1.1	5	0.5	1.4	101.2	-	1	-	-	101.3	1.0	6	0.4	1.0
A300B4-203	CF6-50C2	136	2	101.6	1.5	34	0.3	0.5	101.7	1.3	9	0.4	1.0	101.6	1.4	43	0.2	0.4
A320-231	V2500-A1	64.5	0.5	94.7	1.2	20	0.3	0.6	94.8	0.9	24	0.2	0.4	94.7	1.0	44	0.2	0.3
A321-211	CFM56-5B3/P	75.5	0.5	94.3	1.6	8	0.6	1.3	93.5	1.4	11	0.4	0.9	93.8	1.5	19	0.3	0.7
A321-211	CFM56-5B3/P	77.8	0.5	95.4	1.1	6	0.4	1.2	95.0	0.9	11	0.3	0.6	95.1	1.0	17	0.2	0.5
ATR42-300	PW120	16.4	0.5	94.6	1.7	29	0.3	0.6	94.5	2.1	16	0.5	1.1	94.6	1.8	45	0.3	0.5
B727-225RE (Super 27)	JT8D-217C/15	74.4	1	98.4	2.6	6	1.1	2.7	98.2	2.2	10	0.7	1.6	98.3	2.3	16	0.6	1.2
B737-200 Adv	JT8D-15 (HK)	39.9	0.5	98.7	2.0	6	0.8	2.1	97.0	1.9	347	0.1	0.2	97.0	1.9	353	0.1	0.2
B737-200 Adv	JT8D-15 (HK)	46.7	0.5	96.9	0.7	3	0.4	1.7	97.3	1.7	195	0.1	0.2	97.3	1.7	198	0.1	0.2
B737-300	CFM56-3B1	51.7	1	96.3	1.5	8	0.5	1.3	96.1	1.6	370	0.1	0.2	96.1	1.6	378	0.1	0.2
B737-300	CFM56-3B2	49.9	1	92.2	1.7	2	1.2	15.3	94.0	1.6	14	0.4	0.9	93.8	1.7	16	0.4	0.9
B737-300	CFM56-3B2	51.7	1	99.7	-	1	-	-	95.6	2.3	111	0.2	0.4	95.6	2.3	112	0.2	0.4
B737-300	CFM56-3B2	54.9	1	95.0	1.3	3	0.8	3.2	96.1	1.8	142	0.2	0.3	96.1	1.8	145	0.1	0.3
B737-300	CFM56-3C1	54.9	1	95.3	1.6	17	0.4	0.8	94.7	1.5	410	0.1	0.1	94.7	1.5	427	0.1	0.1
B737-800	CFM56-7B24	66.4	0.5	95.3	2.1	45	0.3	0.6	94.9	1.5	1052	0.0	0.1	94.9	1.6	1097	0.0	0.1
B737-800	CFM56-7B26	66.4	0.5	95.0	0.8	2	0.6	7.2	95.3	1.7	11	0.5	1.1	95.3	1.5	13	0.4	0.9
B747-400F	CF6-80C2B5F	302.1	2	102.3	1.0	2	0.7	9.0	103.2	3.2	29	0.6	1.2	103.1	3.1	31	0.6	1.1
B757-200	RB211-535E4	89.8	0.5	96.3	1.8	13	0.5	1.1	97.0	1.5	25	0.3	0.6	96.8	1.6	38	0.3	0.5
B757-200	RB211-535E4	90.0	0.5	95.1	-	1	-	-	96.8	1.4	5	0.6	1.7	96.5	1.5	6	0.6	1.6
B757-200	RB211-535E4	95.3	0.5	95.8	-	1	-	-	96.7	-	1	-	-	96.3	0.6	2	0.4	5.4
B767-200 (ER)	CF6-80C2B4	126.1	0.5	97.8	-	1	-	-	94.8	-	1	-	-	96.3	2.1	2	1.5	18.9
B767-300 (ER)	CF6-80C2B7F	147.9	0.5	99.0	3.4	18	0.8	1.7	96.8	-	1	-	-	98.8	3.3	19	0.8	1.6
BAe 748-2A	Dart 534-2	19.5	Exempt	92.0	1.6	14	0.4	0.9	91.6	1.3	17	0.3	0.7	91.8	1.4	31	0.3	0.5
BAe 146-200	ALF502R-5	36.7	0.5	91.4	1.4	43	0.2	0.4	91.8	1.3	22	0.3	0.6	91.5	1.4	65	0.2	0.3
BAe 146-300	ALF502R-5	37.7	0.5	92.7	0.9	10	0.3	0.6	92.1	1.5	315	0.1	0.2	92.1	1.5	325	0.1	0.2
BAe 146-300	ALF502R-5	38.3	0.5	92.2	0.8	2	0.6	7.2	92.2	1.5	156	0.1	0.2	92.2	1.5	158	0.1	0.2
BAe ATP	PW126A	22.5	0.5	96.9	1.1	8	0.4	0.9	97.5	-	1	-	-	97.0	1.1	9	0.4	0.8
Beech King Air 200	PT6A-42	5.7	Exempt	87.2	0.5	4	0.3	0.8	87.4	0.8	6	0.3	0.8	87.4	0.7	10	0.2	0.5
MD-11F	CF6-80C2D1F	218.4	2	103.2	3.2	4	1.6	5.1	102.7	3.4	74	0.4	0.8	102.7	3.3	78	0.4	0.7
MD-11F	PW4462	218.4	2	102.4	1.5	8	0.5	1.3	101.6	2.1	22	0.4	0.9	101.8	2.0	30	0.4	0.7
Cessna 550 Citation II	JT15D-4	5.8	Exempt	84.8	-	1	-	-	87.7	3.1	4	1.6	4.9	87.2	3.0	5	1.3	3.7
Cessna 550 Citation II	JT15D-4	6.1	Exempt	86.0	1.7	4	0.9	2.7	85.0	1.2	4	0.6	1.9	85.5	1.5	8	0.5	1.3
Fokker F27	Dart 532-7	19.7	0.5	93.5	1.7	4	0.9	2.7	92.8	2.1	6	0.9	2.2	93.1	1.9	10	0.6	1.4
Fokker F27	Dart 532-7	19.7	Exempt	89.0	0.5	2	0.4	4.5	-	-	-	-	-	89.0	0.5	2	0.4	4.5
GAC G-IV Gulfstream IV	Tay 611-8	26.5	0.5	90.3	-	1	-	-	90.3	1.5	7	0.6	1.4	90.3	1.4	8	0.5	1.2
Learjet 60	PW305A	8.9	Exempt	87.4	-	1	-	-	87.0	1.0	5	0.4	1.2	87.1	0.9	6	0.4	0.9
Lockheed L-382G Hercules	AN 501-D22A	59.9	0.5	97.4	0.9	16	0.2	0.5	97.6	1.0	13	0.3	0.6	97.5	0.9	29	0.2	0.3
Shorts 360-100	PT6A-65R	11.8	Exempt	90.6	0.8	5	0.4	1.0	90.5	2.3	9	0.8	1.8	90.5	1.9	14	0.5	1.1
Shorts 360-200	PT6A-65AR	11.8	Exempt	90.7	2.7	10	0.9	1.9	89.5	1.5	32	0.3	0.5	89.8	1.9	42	0.3	0.6
Shorts 360-300	PT6A-67R	12.0	Exempt	95.7	1.5	24	0.3	0.6	96.4	1.4	19	0.3	0.7	96.0	1.5	43	0.2	0.5

Table B12 Stansted Flyover EPNLs (Winter 2001/2002)

				NIGHT-TIME EPNL, EPNdB					DAYTIME EPNL, EPNdB					24HR (POOLED) EPNL, EPNdB				
TYPE	ENGINE	MTOW (t)	QC	MEAN	STD DEV	COUNT	STD ERR	95% CI	MEAN	STD DEV	COUNT	STD ERR	95% CI	MEAN	STD DEV	COUNT	STD ERR	95% CI
A300B4-203	CF6-50C2	165.0	2	93.5	0.9	18	0.2	0.4	92.6	1.6	54	0.2	0.4	92.9	1.5	72	0.2	0.4
A320-231	V2500-A1	77.0	1	89.6	0.0	2	0.0	0.0	90.0	1.2	42	0.2	0.4	90.0	1.2	44	0.2	0.4
A321-211	CFM56-5B3/P	89.0	1	90.8	-	1	-	-	92.2	1.1	41	0.2	0.3	92.1	1.1	42	0.2	0.3
ATR42-300	PW120	16.7	Exempt	85.9	1.0	2	0.7	9.0	83.3	2.0	4	1.0	3.2	84.2	2.1	6	0.9	2.2
ATR42-300	PW120	16.9	Exempt	85.0	1.8	2	1.3	16.2	-	-	-	-	-	85.0	1.8	2	1.3	16.2
B727-225RE (Super 27)	JT8D-217C/15	88.7	2	96.2	2.8	2	2.0	25.2	95.9	3.3	31	0.6	1.2	96.0	3.2	33	0.6	1.1
B737-200 Adv	JT8D-15 (HK)	53.0	2	97.5	5.5	2	3.9	49.4	96.4	2.9	1382	0.1	0.2	96.4	2.9	1384	0.1	0.2
B737-300	CFM56-3B1	56.5	0.5	-	-	-	-	-	90.8	1.6	236	0.1	0.2	90.8	1.6	236	0.1	0.2
B737-300	CFM56-3B1	58.0	0.5	-	-	-	-	-	90.8	1.6	85	0.2	0.3	90.8	1.6	85	0.2	0.3
B737-300	CFM56-3B1	59.0	0.5	89.9	1.5	25	0.3	0.6	90.0	1.6	33	0.3	0.6	90.0	1.5	58	0.2	0.4
B737-300	CFM56-3B1	61.0	0.5	-	-	-	-	-	90.1	1.6	54	0.2	0.4	90.1	1.6	54	0.2	0.4
B737-300	CFM56-3B1	61.2	0.5	-	-	-	-	-	90.5	1.6	148	0.1	0.3	90.5	1.6	148	0.1	0.3
B737-300	CFM56-3B2	62.8	0.5	-	-	-	-	-	90.6	1.6	59	0.2	0.4	90.6	1.6	59	0.2	0.4
B737-300	CFM56-3B2	63.3	0.5	91.1	-	1	-	-	90.1	1.6	254	0.1	0.2	90.1	1.6	255	0.1	0.2
B737-300	CFM56-3C1	57.8	0.5	-	-	-	-	-	90.1	1.9	143	0.2	0.3	90.1	1.9	143	0.2	0.3
B737-300	CFM56-3C1	58.1	0.5	90.6	-	1	-	-	90.1	1.6	234	0.1	0.2	90.1	1.6	235	0.1	0.2
B737-300	CFM56-3C1	61.2	0.5	-	-	-	-	-	90.5	2.0	12	0.6	1.3	90.5	2.0	12	0.6	1.3
B737-300	CFM56-3C1	63.3	0.5	91.9	-	1	-	-	90.4	1.6	177	0.1	0.2	90.4	1.6	178	0.1	0.2
B737-700 (BBJ)	CFM56-7B26	77.6	0.5	88.7	-	1	-	-	88.6	1.6	19	0.4	0.8	88.6	1.5	20	0.3	0.7
B737-800	CFM56-7B24	75.0	0.5	-	-	-	-	-	89.5	1.6	672	0.1	0.1	89.5	1.6	672	0.1	0.1
B747-400	CF6-80C2B5F	396.9	4	91.3	3.1	6	1.3	3.3	95.2	2.9	48	0.4	0.8	94.8	3.1	54	0.4	0.8
B757-200	RB211-535E4	104.3	0.5	-	-	-	-	-	90.7	1.9	18	0.4	0.9	90.7	1.9	18	0.4	0.9
B757-200	RB211-535E4	113.4	0.5	-	-	-	-	-	90.5	2.3	26	0.5	0.9	90.5	2.3	26	0.5	0.9
BAe 748 2A	Dart 534-2	21.1	1	90.5	2.1	3	1.2	5.2	92.5	1.3	6	0.5	1.4	91.9	1.8	9	0.6	1.4
BAe 146-200	ALF502R-5	42.2	0.5	88.9	1.8	17	0.4	0.9	89.5	1.6	16	0.4	0.9	89.2	1.7	33	0.3	0.6
BAe 146-200	ALF502R-5	42.4	0.5	92.0	1.6	4	0.8	2.5	89.8	1.3	11	0.4	0.9	90.4	1.7	15	0.4	0.9
BAe 146-300	ALF502R-5	44.2	0.5	88.7	1.4	9	0.5	1.1	89.4	1.3	22	0.3	0.6	89.2	1.3	31	0.2	0.5
MD-11F	CF6-80C2D1F	280.3	2	95.4	3.0	3	1.7	7.5	95.3	2.9	118	0.3	0.5	95.3	2.9	121	0.3	0.5
Lockheed L-382G Hercules	AN 501-D22A	70.3	2	95.0	1.7	39	0.3	0.6	96.2	2.1	22	0.4	0.9	95.4	1.9	61	0.2	0.5
Shorts 360-100	PT6A-65R	12.0	Exempt	84.3	2.5	2	1.8	22.5	85.3	1.0	4	0.5	1.6	85.0	1.4	6	0.6	1.5
Shorts 360-200	PT6A-65AR	12.0	Exempt	85.7	0.9	3	0.5	2.2	85.2	1.7	5	0.8	2.1	85.4	1.4	8	0.5	1.2
Shorts 360-300	PT6A-67R	12.3	Exempt	82.9	2.5	4	1.3	4.0	86.5	2.6	5	1.2	3.2	84.9	3.1	9	1.0	2.4

Table B13 Stansted Pseudo-lateral EPNLs (Winter 2001/2002)

				NIGHT-TIME EPNL, EPNdB					DAYTIME EPNL, EPNdB					24HR (POOLED) EPNL, EPNdB				
TYPE	ENGINE	MTOW (t)	QC	MEAN	STD DEV	COUNT	STD ERR	95% CI	MEAN	STD DEV	COUNT	STD ERR	95% CI	MEAN	STD DEV	COUNT	STD ERR	95% CI
A300B4-203	CF6-50C2	165.0	2	95.2	0.9	8	0.3	0.8	95.6	1.0	30	0.2	0.4	95.5	1.0	38	0.2	0.3
A320-231	V2500-A1	77.0	1	-	-	-	-	-	90.4	1.0	42	0.2	0.3	90.4	1.0	42	0.2	0.3
A321-211	CFM56-5B3/P	89.0	1	-	-	-	-	-	93.3	1.3	38	0.2	0.4	93.3	1.3	38	0.2	0.4
ATR42-300	PW120	16.7	Exempt	84.2	3.0	5	1.3	3.7	82.9	1.5	12	0.4	1.0	83.3	2.1	17	0.5	1.1
ATR42-300	PW120	16.9	Exempt	84.1	2.9	5	1.3	3.6	83.0	1.6	13	0.4	1.0	83.3	2.0	18	0.5	1.0
B727-225RE (Super 27)	JT8D-217C/15	88.7	2	-	-	-	-	-	102.8	1.3	13	0.4	0.8	102.8	1.3	13	0.4	0.8
B737-200 Adv	JT8D-15 (HK)	53.0	2	-	-	-	-	-	98.7	1.4	818	0.0	0.1	98.7	1.4	818	0.0	0.1
B737-300	CFM56-3B1	56.5	0.5	-	-	-	-	-	91.5	1.1	119	0.1	0.2	91.5	1.1	119	0.1	0.2
B737-300	CFM56-3B1	58.0	0.5	-	-	-	-	-	91.4	1.0	37	0.2	0.3	91.4	1.0	37	0.2	0.3
B737-300	CFM56-3B1	59.0	0.5	91.7	0.9	20	0.2	0.4	91.3	1.1	23	0.2	0.5	91.5	1.0	43	0.2	0.3
B737-300	CFM56-3B1	61.0	0.5	-	-	-	-	-	90.5	1.2	20	0.3	0.6	90.5	1.2	20	0.3	0.6
B737-300	CFM56-3B1	61.2	0.5	-	-	-	-	-	90.7	1.1	59	0.1	0.3	90.7	1.1	59	0.1	0.3
B737-300	CFM56-3B2	62.8	0.5	-	-	-	-	-	92.2	1.1	33	0.2	0.4	92.2	1.1	33	0.2	0.4
B737-300	CFM56-3B2	63.3	0.5	-	-	-	-	-	91.9	0.9	124	0.1	0.2	91.9	0.9	124	0.1	0.2
B737-300	CFM56-3C1	57.8	0.5	-	-	-	-	-	91.0	1.1	75	0.1	0.3	91.0	1.1	75	0.1	0.3
B737-300	CFM56-3C1	58.1	0.5	-	-	-	-	-	90.8	1.3	153	0.1	0.2	90.8	1.3	153	0.1	0.2
B737-300	CFM56-3C1	61.2	0.5	-	-	-	-	-	92.9	2.1	13	0.6	1.3	92.9	2.1	13	0.6	1.3
B737-300	CFM56-3C1	63.3	0.5	-	-	-	-	-	90.8	1.3	73	0.2	0.3	90.8	1.3	73	0.2	0.3
B737-700 (BBJ)	CFM56-7B26	77.6	0.5	95.0	-	1	-	-	91.7	2.9	26	0.6	1.2	91.8	2.9	27	0.6	1.1
B737-800	CFM56-7B24	75.0	0.5	-	-	-	-	-	91.0	1.0	963	0.0	0.1	91.0	1.0	963	0.0	0.1
B747-400	CF6-80C2B5F	396.9	4	99.2	1.2	2	0.8	10.8	97.9	1.3	18	0.3	0.6	98.0	1.3	20	0.3	0.6
B757-200	RB211-535E4	104.3	0.5	-	-	-	-	-	94.0	0.8	11	0.2	0.5	94.0	0.8	11	0.2	0.5
B757-200	RB211-535E4	113.4	0.5	93.9	-	1	-	-	94.1	1.2	15	0.3	0.7	94.1	1.1	16	0.3	0.6
BAe 748 2A	Dart 534-2	21.1	1	89.7	0.6	2	0.4	5.4	90.5	2.7	3	1.6	6.7	90.2	2.0	5	0.9	2.5
BAe 146-200	ALF502R-5	42.2	0.5	87.7	1.0	5	0.4	1.2	86.9	1.2	11	0.4	0.8	87.2	1.2	16	0.3	0.6
BAe 146-200	ALF502R-5	42.4	0.5	88.2	0.9	5	0.4	1.1	87.8	0.8	6	0.3	0.8	88.0	0.8	11	0.2	0.5
BAe 146-300	ALF502R-5	44.2	0.5	87.8	1.7	2	1.2	15.3	87.3	1.2	62	0.2	0.3	87.3	1.2	64	0.2	0.3
MD-11F	CF6-80C2D1F	280.3	2	100.5	-	1	-	-	100.3	1.8	40	0.3	0.6	100.3	1.7	41	0.3	0.5
Lockheed L-382G Hercules	AN 501-D22A	70.3	2	94.3	1.6	24	0.3	0.7	95.1	1.7	20	0.4	0.8	94.7	1.7	44	0.3	0.5
Shorts 360-100	PT6A-65R	12.0	Exempt	84.3	1.9	6	0.8	2.0	83.8	1.8	4	0.9	2.9	84.1	1.8	10	0.6	1.3
Shorts 360-200	PT6A-65AR	12.0	Exempt	83.5	1.9	19	0.4	0.9	82.3	2.0	24	0.4	0.8	82.8	2.0	43	0.3	0.6
Shorts 360-300	PT6A-67R	12.3	Exempt	81.8	3.0	12	0.9	1.9	81.5	3.2	11	1.0	2.1	81.7	3.1	23	0.6	1.3

Table B14 Stansted Approach EPNLs (Summer 2000)

				NIGHT-TIME EPNL, EPNdB					DAYTIME EPNL, EPNdB					24HR (POOLED) EPNL, EPNdB				
TYPE	ENGINE	MLW (t)	QC	MEAN	STD DEV	COUNT	STD ERR	95% CI	MEAN	STD DEV	COUNT	STD ERR	95% CI	MEAN	STD DEV	COUNT	STD ERR	95% CI
A300B4-203	CF6-50C2	136.0	2	101.7	1.0	3	0.6	2.5	101.3	0.9	6	0.4	0.9	101.4	0.9	9	0.3	0.7
A320-214	CFM56-5B4/P	64.5	0.5	94.3	1.1	4	0.6	1.8	93.5	1.1	6	0.4	1.2	93.8	1.1	10	0.3	0.8
A320-231	V2500-A1	64.5	0.5	94.1	1.0	23	0.2	0.4	93.6	1.0	17	0.2	0.5	93.9	1.0	40	0.2	0.3
A321-211	CFM56-5B3/P	75.5	0.5	94.2	3.1	2	2.2	27.9	95.0	1.1	4	0.6	1.8	94.8	1.7	6	0.7	1.8
A321-231	V2533-A5	75.5	0.5	92.7	1.3	5	0.6	1.6	93.4	1.2	3	0.7	3.0	93.0	1.2	8	0.4	1.0
Antonov 12BP	AI-20M	61.0	2	101.0	-	1	-	-	-	-	-	-	-	101.0	-	1	-	-
ATR42-300	PW120	16.4	0.5	94.7	1.5	7	0.6	1.4	94.9	1.3	43	0.2	0.4	94.9	1.3	50	0.2	0.4
B737-200 Adv	JT8D-15	39.9	2	101.0	2.2	4	1.1	3.5	99.2	2.7	147	0.2	0.4	99.2	2.7	151	0.2	0.4
B737-200 Adv	JT8D-15 (HK)	39.9	0.5	95.5	2.0	3	1.2	5.0	96.4	1.5	55	0.2	0.4	96.3	1.5	58	0.2	0.4
B737-200 Adv	JT8D-15 (HK)	46.7	0.5	95.8	1.9	4	1.0	3.0	96.0	1.3	99	0.1	0.3	96.0	1.4	103	0.1	0.3
B737-200 Adv	JT8D-15 (HK)	48.5	0.5	97.1	-	1	-	-	97.2	1.3	28	0.2	0.5	97.2	1.3	29	0.2	0.5
B737-300	CFM56-3B1	51.7	1	95.7	1.9	21	0.4	0.9	95.6	1.3	66	0.2	0.3	95.6	1.4	87	0.2	0.3
B737-300	CFM56-3B2	51.7	1	96.6	1.1	2	0.8	9.9	95.3	1.1	25	0.2	0.5	95.4	1.1	27	0.2	0.4
B737-300	CFM56-3C1	51.7	1	94.7	1.5	16	0.4	0.8	94.9	1.2	48	0.2	0.3	94.9	1.3	64	0.2	0.3
B737-800	CFM56-7B24	66.4	0.5	94.9	1.3	4	0.7	2.1	94.3	1.3	101	0.1	0.3	94.3	1.3	105	0.1	0.3
B747-200	RB211-524C2	265.4	4	103.7	-	1	-	-	105.0	2.8	2	2.0	25.2	104.6	2.1	3	1.2	5.2
B757-200	RB211-535E4	89.8	0.5	96.5	1.2	21	0.3	0.5	96.7	1.3	35	0.2	0.4	96.6	1.2	56	0.2	0.3
B757-200	RB211-535E4	95.3	0.5	99.3	2.0	3	1.2	5.0	96.5	1.4	9	0.5	1.1	97.2	2.0	12	0.6	1.3
B767-300 (ER)	CF6-80C2B7F	147.9	0.5	97.0	1.7	9	0.6	1.3	-	-	-	-	-	97.0	1.7	9	0.6	1.3
BAe 1-11 500	Spey 512-14DW	39.5	1	103.6	2.1	3	1.2	5.2	103.7	1.6	22	0.3	0.7	103.6	1.6	25	0.3	0.7
BAe 146-200	ALF502R-5	36.7	0.5	91.4	1.1	21	0.2	0.5	91.7	1.6	17	0.4	0.8	91.6	1.3	38	0.2	0.4
BAe 146-300	ALF502R-5	37.7	0.5	92.9	0.4	2	0.3	3.6	92.0	1.2	101	0.1	0.2	92.0	1.2	103	0.1	0.2
BAe 146-300	ALF502R-5	38.3	0.5	91.9	-	1	-	-	92.6	1.2	49	0.2	0.3	92.6	1.2	50	0.2	0.3
Beech King Air 200	PT6A-41	5.7	Exempt	86.2	0.2	2	0.1	1.8	-	-	-	-	-	86.2	0.2	2	0.1	1.8
MD-11F	CF6-80C2D1F	218.4	2	105.4	5.2	2	3.7	46.7	101.7	3.1	21	0.7	1.4	102.1	3.4	23	0.7	1.5
MD-11F	PW4462	218.4	2	103.9	2.2	2	1.6	19.8	-	-	-	-	-	103.9	2.2	2	1.6	19.8
MD-82	JT8D-217A	59.0	0.5	94.0	-	1	-	-	-	-	-	-	-	94.0	-	1	-	-
Cessna 550 Citation II	JT15D-4	5.8	Exempt	82.8	1.8	2	1.3	16.2	84.6	1.8	5	0.8	2.2	84.1	1.9	7	0.7	1.8
Cessna 550 Citation II	JT15D-4	6.1	Exempt	83.4	0.3	2	0.2	2.7	83.6	0.6	4	0.3	1.0	83.5	0.5	6	0.2	0.5
Fokker F27	Dart 532-7	19.7	Exempt	91.8	1.6	15	0.4	0.9	91.2	1.1	22	0.2	0.5	91.4	1.4	37	0.2	0.5
Lockheed L-188A	AN 501-D13A	43.4	0.5	98.1	1.6	4	0.8	2.5	98.3	1.2	3	0.7	3.0	98.2	1.3	7	0.5	1.2
Lockheed L-188C	AN 501-D13A	44.5	0.5	99.2	1.4	14	0.4	0.8	99.3	0.8	25	0.2	0.3	99.3	1.0	39	0.2	0.3
Partenavia P.68B	IO-360-A1B6	2.0	Exempt	79.0	-	1	-	-	-	-	-	-	-	79.0	-	1	-	-
Piper PA-31-350 Chieftain	TIO-540-J2BD	3.2	Exempt	94.1	-	1	-	-	87.7	-	1	-	-	90.9	4.5	2	3.2	40.4
Saab SF340A	CT7-5A2	12.0	Exempt	93.4	-	1	-	-	93.4	1.7	15	0.4	0.9	93.4	1.6	16	0.4	0.9
Shorts 360-100	PT6A-65R	11.8	Exempt	90.8	1.1	13	0.3	0.7	90.7	1.8	13	0.5	1.1	90.7	1.5	26	0.3	0.6
Shorts 360-200	PT6A-65AR	11.8	Exempt	90.0	1.6	9	0.5	1.2	90.7	1.3	12	0.4	0.8	90.4	1.5	21	0.3	0.7
Shorts 360-300	PT6A-67R	12.0	Exempt	95.8	1.8	23	0.4	0.8	95.4	0.9	18	0.2	0.4	95.6	1.5	41	0.2	0.5

Table B15 Stansted Flyover EPNLs (Summer 2000)

				NIGHT-TIME EPNL, EPNdB					DAYTIME EPNL, EPNdB					24HR (POOLED) EPNL, EPNdB				
TYPE	ENGINE	MTOW (t)	QC	MEAN	STD DEV	COUNT	STD ERR	95% CI	MEAN	STD DEV	COUNT	STD ERR	95% CI	MEAN	STD DEV	COUNT	STD ERR	95% CI
A300B4-203	CF6-50C2	165.0	2	93.3	2.1	42	0.3	0.7	93.7	1.5	94	0.2	0.3	93.6	1.7	136	0.1	0.3
A310-203	CF6-80A3	142.0	2	94.7	-	1	-	-	94.3	1.2	28	0.2	0.5	94.3	1.1	29	0.2	0.4
A320-214	CFM56-5B4/P	77.0	1	88.1	1.7	6	0.7	1.8	89.7	1.0	75	0.1	0.2	89.6	1.2	81	0.1	0.3
A320-231	V2500-A1	77.0	1	89.4	2.0	20	0.4	0.9	89.8	1.3	169	0.1	0.2	89.8	1.4	189	0.1	0.2
A321-211	CFM56-5B3/P	89.0	1	91.8	1.1	10	0.3	0.8	91.4	1.5	159	0.1	0.2	91.4	1.4	169	0.1	0.2
A321-231	V2533-A5	89.0	1	86.7	1.9	5	0.8	2.4	91.1	1.2	210	0.1	0.2	91.0	1.4	215	0.1	0.2
Antonov 26B	AI-24VT	24.0	2	93.6	-	1	-	-	-	-	-	-	-	93.6	-	1	-	-
ATR42-300	PW120	16.7	Exempt	84.2	2.4	4	1.2	3.8	87.1	-	1	-	-	84.8	2.4	5	1.1	3.0
ATR42-300	PW120	16.9	Exempt	82.4	-	1	-	-	86.7	3.0	6	1.2	3.1	86.0	3.2	7	1.2	3.0
ATR72-202	PW124B	21.5	Exempt	85.2	1.5	3	0.9	3.7	85.2	1.1	14	0.3	0.6	85.2	1.1	17	0.3	0.6
B727-200	JT8D-7B (HK)	80.9	4	95.1	1.5	4	0.8	2.4	97.6	1.8	4	0.9	2.9	96.3	2.0	8	0.7	1.7
B737-200 Adv	JT8D-15	53.0	4	94.8	3.4	2	2.4	30.5	97.7	2.3	807	0.1	0.2	97.6	2.3	809	0.1	0.2
B737-200 Adv	JT8D-15 (HK)	53.0	2	94.7	1.5	8	0.5	1.3	96.0	2.4	2117	0.1	0.1	96.0	2.4	2125	0.1	0.1
B737-300	CFM56-3B1	56.5	0.5	91.0	1.7	12	0.5	1.1	91.1	1.7	578	0.1	0.1	91.1	1.7	590	0.1	0.1
B737-300	CFM56-3B1	58.0	0.5	92.6	0.5	5	0.2	0.6	91.4	1.7	183	0.1	0.2	91.4	1.7	188	0.1	0.2
B737-300	CFM56-3B1	61.0	0.5	92.5	1.4	8	0.5	1.2	90.9	1.6	177	0.1	0.2	91.0	1.6	185	0.1	0.2
B737-300	CFM56-3B1	61.2	0.5	91.6	1.1	9	0.4	0.8	91.1	1.8	396	0.1	0.2	91.1	1.8	405	0.1	0.2
B737-300	CFM56-3B2	62.8	0.5	91.2	2.2	3	1.3	5.5	90.6	2.0	14	0.5	1.2	90.7	2.0	17	0.5	1.0
B737-300	CFM56-3C1	57.8	0.5	90.3	1.8	5	0.8	2.2	90.5	1.9	372	0.1	0.2	90.5	1.9	377	0.1	0.2
B737-300	CFM56-3C1	58.1	0.5	90.5	1.6	18	0.4	0.8	90.7	1.8	754	0.1	0.1	90.7	1.8	772	0.1	0.1
B737-300	CFM56-3C1	61.2	0.5	88.4	1.1	6	0.4	1.2	89.8	1.8	89	0.2	0.4	89.7	1.8	95	0.2	0.4
B737-800	CFM56-7B24	75.0	0.5	88.6	-	1	-	-	89.9	1.6	1001	0.1	0.1	89.9	1.6	1002	0.1	0.1
B737-800	CFM56-7B26	79.0	1	90.0	0.5	3	0.3	1.2	91.0	1.2	27	0.2	0.5	90.9	1.2	30	0.2	0.4
B747-400	CF6-80C2B5F	396.9	4	100.2	3.6	12	1.0	2.3	97.8	5.0	72	0.6	1.2	98.1	4.9	84	0.5	1.1
B757-200	RB211-535E4	104.3	0.5	91.8	1.7	13	0.5	1.0	91.7	1.7	128	0.2	0.3	91.7	1.6	141	0.1	0.3
B757-200	RB211-535E4	108.9	0.5	91.4	1.3	6	0.5	1.4	91.3	1.4	5	0.6	1.7	91.4	1.3	11	0.4	0.9
B757-200	RB211-535E4	113.4	0.5	90.6	2.3	19	0.5	1.1	92.0	1.8	63	0.2	0.5	91.7	2.0	82	0.2	0.4
B767-200	JT9D-7R4D	140.6	2	94.6	1.6	6	0.7	1.7	93.6	0.2	2	0.1	1.8	94.3	1.4	8	0.5	1.2
B767-200 (ER)	JT9D-7R4D	163.3	2	88.6	-	1	-	-	95.3	-	1	-	-	92.0	4.7	2	3.3	42.2
B767-200 (ER)	JT9D-7R4E	175.5	2	92.6	-	1	-	-	-	-	-	-	-	92.6	-	1	-	-
BAe 748-2B	Dart 536-2	21.1	2	92.8	0.8	2	0.6	7.2	92.4	1.4	16	0.4	0.7	92.5	1.4	18	0.3	0.7
BAe 146-200	ALF502R-5	42.2	0.5	89.3	1.8	34	0.3	0.6	89.7	1.4	66	0.2	0.3	89.6	1.6	100	0.2	0.3
BAe 146-300	ALF502R-5	44.2	0.5	88.0	1.1	11	0.3	0.7	87.2	2.6	9	0.9	2.0	87.6	1.9	20	0.4	0.9
MD-11F	CF6-80C2D1F	280.3	2	95.0	5.9	2	4.2	53.0	95.9	2.9	161	0.2	0.5	95.9	2.9	163	0.2	0.4
MD-83	JT8D-219	72.6	2	94.0	4.2	8	1.5	3.5	95.6	2.7	24	0.6	1.1	95.2	3.2	32	0.6	1.2
MD-87	JT8D-219	63.5	1	94.5	2.3	21	0.5	1.0	95.1	2.8	156	0.2	0.4	95.1	2.8	177	0.2	0.4
Cessna 550 Citation II	JT15D-4	6.0	Exempt	79.9	-	1	-	-	85.9	-	1	-	-	82.9	4.2	2	3.0	37.7
Cessna 650 Citation III	TFE731-3-100S	9.8	Exempt	90.8	-	1	-	-	-	-	-	-	-	90.8	-	1	-	-
Fokker F27	Dart 532-7	19.7	0.5	88.9	1.1	20	0.2	0.5	89.5	1.3	18	0.3	0.6	89.1	1.2	38	0.2	0.4
Fokker F27	Dart 532-7	20.4	0.5	89.6	3.0	2	2.1	27.0	90.5	1.9	21	0.4	0.9	90.4	2.0	23	0.4	0.9
Fokker F27	Dart 532-7	20.8	0.5	89.8	-	1	-	-	-	-	-	-	-	89.8	-	1	-	-
Lockheed L-188A	AN 501-D13A	51.3	1	90.4	1.6	2	1.1	14.4	91.7	1.1	10	0.3	0.8	91.5	1.2	12	0.3	0.8
Lockheed L-188C	AN 501-D13A	52.6	2	92.1	1.6	68	0.2	0.4	91.7	1.4	47	0.2	0.4	92.0	1.6	115	0.1	0.3
Lockheed L-382G Hercules	AN 501-D22A	70.3	2	91.8	1.7	9	0.6	1.3	94.1	2.7	9	0.9	2.1	93.0	2.5	18	0.6	1.2
Shorts 360-100	PT6A-65R	12.0	Exempt	86.5	2.4	8	0.8	2.0	86.9	2.2	6	0.9	2.3	86.6	2.2	14	0.6	1.3
Shorts 360-200	PT6A-65AR	12.0	Exempt	83.5	-	1	-	-	85.9	1.3	7	0.5	1.2	85.6	1.5	8	0.5	1.3
Shorts 360-300	PT6A-67R	12.3	Exempt	85.1	2.1	24	0.4	0.9	86.0	2.9	8	1.0	2.4	85.3	2.3	32	0.4	0.8
Shorts SC.5 Belfast	Tyne 515-101W	104.8	1	94.5	0.4	3	0.2	1.0	98.9	4.1	10	1.3	2.9	97.9	4.0	13	1.1	2.4

Table B16 Stansted Pseudo-lateral EPNLs (Summer 2000)

				NIGHT-TIME EPNL, EPNdB					DAYTIME EPNL, EPNdB					24HR (POOLED) EPNL, EPNdB				
TYPE	ENGINE	MTOW (t)	QC	MEAN	STD DEV	COUNT	STD ERR	95% CI	MEAN	STD DEV	COUNT	STD ERR	95% CI	MEAN	STD DEV	COUNT	STD ERR	95% CI
A300B4-203	CF6-50C2	165.0	2	96.2	1.0	24	0.2	0.4	95.8	0.8	68	0.1	0.2	95.9	0.9	92	0.1	0.2
A310-203	CF6-80A3	142.0	2	96.9	-	1	-	-	96.2	1.0	27	0.2	0.4	96.2	1.0	28	0.2	0.4
A320-214	CFM56-5B4/P	77.0	1	92.0	0.8	5	0.4	1.0	92.7	1.1	90	0.1	0.2	92.7	1.1	95	0.1	0.2
A320-231	V2500-A1	77.0	1	92.8	1.4	27	0.3	0.6	92.6	1.1	205	0.1	0.2	92.7	1.1	232	0.1	0.1
A321-211	CFM56-5B3/P	89.0	1	95.0	2.2	14	0.6	1.3	95.1	1.3	123	0.1	0.2	95.1	1.4	137	0.1	0.2
A321-231	V2533-A5	89.0	1	94.4	0.3	2	0.2	2.7	93.6	0.9	220	0.1	0.1	93.6	0.9	222	0.1	0.1
Antonov 26B	AI-24VT	24.0	2	89.0	-	1	-	-	-	-	-	-	-	89.0	-	1	-	-
ATR42-300	PW120	16.7	Exempt	82.9	1.9	12	0.5	1.2	82.0	1.8	33	0.3	0.6	82.2	1.8	45	0.3	0.5
ATR42-300	PW120	16.9	Exempt	83.1	1.3	11	0.4	0.9	83.2	2.1	25	0.4	0.9	83.2	1.8	36	0.3	0.6
ATR72-202	PW124B	21.5	Exempt	88.2	0.4	2	0.3	3.6	85.7	1.3	47	0.2	0.4	85.8	1.3	49	0.2	0.4
B727-200	JT8D-7B (HK)	80.9	4	98.7	3.0	2	2.1	27.0	98.7	3.3	2	2.3	29.6	98.7	2.6	4	1.3	4.1
B737-200 Adv	JT8D-15	53.0	4	100.0	-	1	-	-	102.0	1.9	597	0.1	0.2	102.0	1.9	598	0.1	0.2
B737-200 Adv	JT8D-15 (HK)	53.0	2	96.4	1.3	6	0.5	1.4	97.4	1.9	1606	0.0	0.1	97.4	1.9	1612	0.0	0.1
B737-300	CFM56-3B1	56.5	0.5	92.5	1.5	12	0.4	1.0	92.0	0.9	493	0.0	0.1	92.1	0.9	505	0.0	0.1
B737-300	CFM56-3B1	58.0	0.5	92.1	0.0	2	0.0	0.0	92.5	0.8	147	0.1	0.1	92.5	0.8	149	0.1	0.1
B737-300	CFM56-3B1	61.0	0.5	93.0	0.8	8	0.3	0.7	91.9	1.0	175	0.1	0.1	92.0	1.0	183	0.1	0.1
B737-300	CFM56-3B1	61.2	0.5	93.5	0.6	6	0.2	0.6	92.1	1.0	269	0.1	0.1	92.2	1.0	275	0.1	0.1
B737-300	CFM56-3B2	62.8	0.5	93.1	0.0	2	0.0	0.0	93.3	0.8	11	0.2	0.5	93.3	0.7	13	0.2	0.4
B737-300	CFM56-3C1	57.8	0.5	91.7	1.1	4	0.6	1.8	91.2	1.0	302	0.1	0.1	91.2	1.0	306	0.1	0.1
B737-300	CFM56-3C1	58.1	0.5	91.7	1.2	16	0.3	0.6	91.3	1.0	644	0.0	0.1	91.3	1.0	660	0.0	0.1
B737-300	CFM56-3C1	61.2	0.5	92.5	2.0	8	0.7	1.7	91.5	1.3	76	0.1	0.3	91.6	1.4	84	0.2	0.3
B737-800	CFM56-7B24	75.0	0.5	90.1	-	1	-	-	90.4	1.6	1246	0.0	0.1	90.4	1.6	1247	0.0	0.1
B737-800	CFM56-7B26	79.0	1	93.2	0.8	5	0.4	1.0	92.7	1.2	25	0.2	0.5	92.8	1.1	30	0.2	0.4
B747-400	CF6-80C2B5F	396.9	4	101.9	1.4	6	0.6	1.5	101.3	2.2	40	0.3	0.7	101.3	2.1	46	0.3	0.6
B757-200	RB211-535E4	104.3	0.5	94.9	0.5	16	0.1	0.3	94.7	0.8	112	0.1	0.1	94.7	0.8	128	0.1	0.1
B757-200	RB211-535E4	108.9	0.5	95.4	0.7	8	0.2	0.6	95.6	0.8	9	0.3	0.6	95.5	0.7	17	0.2	0.4
B757-200	RB211-535E4	113.4	0.5	95.9	1.3	13	0.4	0.8	95.1	0.8	44	0.1	0.2	95.3	0.9	57	0.1	0.2
B767-200	JT9D-7R4D	140.6	2	96.7	1.1	6	0.4	1.2	95.9	-	1	-	-	96.6	1.1	7	0.4	1.0
B767-200 (ER)	JT9D-7R4D	163.3	2	97.8	-	1	-	-	97.5	0.6	2	0.4	5.4	97.6	0.5	3	0.3	1.2
B767-200 (ER)	JT9D-7R4E	175.5	2	95.0	-	1	-	-	-	-	-	-	-	95.0	-	1	-	-
BAe 748-2B	Dart 536-2	21.1	2	90.7	0.1	2	0.1	0.9	90.6	1.0	18	0.2	0.5	90.6	0.9	20	0.2	0.4
BAe 146-200	ALF502R-5	42.2	0.5	87.7	1.6	32	0.3	0.6	87.5	1.0	73	0.1	0.2	87.6	1.2	105	0.1	0.2
BAe 146-300	ALF502R-5	44.2	0.5	88.0	1.1	14	0.3	0.6	87.6	1.8	12	0.5	1.1	87.8	1.4	26	0.3	0.6
MD-11F	CF6-80C2D1F	280.3	2	104.3	-	1	-	-	101.1	1.4	70	0.2	0.3	101.2	1.5	71	0.2	0.4
MD-83	JT8D-219	72.6	2	97.6	-	1	-	-	99.7	1.4	11	0.4	0.9	99.5	1.5	12	0.4	1.0
MD-87	JT8D-219	63.5	1	100.7	1.4	2	1.0	12.6	99.4	1.4	52	0.2	0.4	99.5	1.4	54	0.2	0.4
Cessna 550 Citation II	JT15D-4	6.0	Exempt	84.1	-	1	-	-	85.7	2.0	22	0.4	0.9	85.6	2.0	23	0.4	0.9
Cessna 650 Citation III	TFE731-3-100S	9.8	Exempt	92.1	-	1	-	-	-	-	-	-	-	92.1	-	1	-	-
Fokker F27	Dart 532-7	19.7	0.5	86.5	1.2	21	0.3	0.5	87.0	2.1	28	0.4	0.8	86.8	1.8	49	0.3	0.5
Fokker F27	Dart 532-7	20.4	0.5	85.1	0.8	3	0.5	2.0	87.6	2.0	19	0.5	1.0	87.2	2.1	22	0.4	0.9
Fokker F27	Dart 532-7	20.8	0.5	88.3	1.7	2	1.2	15.3	88.3	0.2	2	0.1	1.8	88.3	1.0	4	0.5	1.6
Lockheed L-188A	AN 501-D13A	51.3	1	94.9	-	1	-	-	91.3	2.6	2	1.8	23.4	92.5	2.7	3	1.6	6.7
Lockheed L-188C	AN 501-D13A	52.6	2	93.1	1.0	42	0.2	0.3	92.6	2.0	21	0.4	0.9	92.9	1.4	63	0.2	0.4
Lockheed L-382G Hercules	AN 501-D22A	70.3	2	93.6	1.4	9	0.5	1.1	93.7	1.4	10	0.4	1.0	93.6	1.4	19	0.3	0.7
Shorts 360-100	PT6A-65R	12.0	Exempt	83.7	1.7	28	0.3	0.7	82.8	1.1	13	0.3	0.7	83.4	1.6	41	0.2	0.5
Shorts 360-200	PT6A-65AR	12.0	Exempt	82.3	1.9	4	1.0	3.0	82.8	1.6	36	0.3	0.5	82.7	1.6	40	0.3	0.5
Shorts 360-300	PT6A-67R	12.3	Exempt	83.2	2.7	63	0.3	0.7	83.1	3.1	56	0.4	0.8	83.2	2.9	119	0.3	0.5
Shorts SC.5 Belfast	Tyne 515-101W	104.8	1	96.1	-	1	-	-	94.7	1.7	8	0.6	1.4	94.8	1.6	9	0.5	1.2

Table B17 Pooled Approach EPNLs (All Airports, Day + Night)

				APPROACH EPNL, EPNdB					
TYPE	ENGINE	MLW (t)	QC	MEAN	STD DEV	COUNT	STD ERR	95% CI	CERT.
A300B4-103	CF6-50C2	136.0	2	101.3	0.9	7	0.3	0.8	102.9
A300B4-203	CF6-50C2	134.0	2	100.8	1.7	14	0.5	1.0	102.9
A300B4-203	CF6-50C2	136.0	2	101.6	1.3	54	0.2	0.4	102.9
A300B4-605R	CF6-80C2A5	140.0	1	99.0	1.5	489	0.1	0.1	99.8
A310-304	CF6-80C2A2	123.0	0.5	99.0	1.2	103	0.1	0.2	98.6
A310-304	CF6-80C2A2	124.0	0.5	97.7	0.5	7	0.2	0.5	98.6
A310-324	PW4152	124.0	1	100.6	1.2	8	0.4	1.0	100.2
A319-111	CFM56-5B5/P	62.5	0.5	94.8	1.2	65	0.1	0.3	94.1
A319-131	V2522-A5	61.0	0.5	93.3	1.2	616	0.0	0.1	94.2
A320-211	CFM56-5A1	64.5	0.5	94.8	1.3	775	0.0	0.1	96.2
A320-212	CFM56-5A3	64.5	0.5	94.1	1.4	230	0.1	0.2	96.0
A320-214	CFM56-5B4/P	64.5	0.5	94.5	1.1	713	0.0	0.1	94.6
A320-231	V2500-A1	64.5	0.5	95.0	1.1	1075	0.0	0.1	96.6
A320-232	V2527-A5	64.5	0.5	93.9	1.2	1454	0.0	0.1	95.9
A321-112	CFM56-5B2	74.5	0.5	94.8	1.3	103	0.1	0.3	95.4
A321-211	CFM56-5B3/P	75.5	0.5	95.0	1.4	425	0.1	0.1	96.5
A321-211	CFM56-5B3/P	77.8	0.5	95.2	1.2	318	0.1	0.1	96.8
A321-231	V2533-A5	75.5	0.5	94.4	1.3	1051	0.0	0.1	95.7
A330-202	CF6-80E1A4	180.0	0.5	97.3	2.5	51	0.4	0.7	98.6
A330-243	Trent 772B	180.0	0.5	96.3	1.3	494	0.1	0.1	96.6
A330-323	PW4168A	180.0	0.5	97.0	1.5	204	0.1	0.2	97.7
A340-311	CFM56-5C2	186.0	0.5	96.9	1.5	149	0.1	0.2	97.2
A340-312	CFM56-5C3	186.0	0.5	96.3	1.2	17	0.3	0.6	97.2
A340-313	CFM56-5C4	190.0	0.5	95.9	1.4	129	0.1	0.2	96.8
ATR42-300	PW120	16.4	0.5	94.7	1.6	95	0.2	0.3	96.7
ATR42-300	PW120	16.9	0.5	95.2	1.3	377	0.1	0.1	96.8
ATR72-202	PW124	21.4	Exempt	94.6	1.5	410	0.1	0.1	94.1
ATR72-212	PW127	21.4	Exempt	93.6	1.0	252	0.1	0.1	92.7
Avro RJ100	LF507-1F	40.1	0.5	92.0	1.4	2833	0.0	0.1	97.6
B737-200 Adv	JT8D-15	39.9	2	99.2	2.7	151	0.2	0.4	103.8
B737-200 Adv	JT8D-15 (HK)	39.9	0.5	96.9	1.9	411	0.1	0.2	97.7
B737-200 Adv	JT8D-15 (HK)	46.7	0.5	96.9	1.7	301	0.1	0.2	98.4
B737-200 Adv	JT8D-15 (HK)	48.5	0.5	97.1	1.3	51	0.2	0.4	98.6
B737-300	CFM56-3B1	51.7	1	96.0	1.6	475	0.1	0.1	99.9
B737-300	CFM56-3B1	52.9	1	97.7	1.7	20	0.4	0.8	99.9
B737-300	CFM56-3B2	49.9	1	93.8	1.7	16	0.4	0.9	99.9
B737-300	CFM56-3B2	51.7	1	95.9	2.1	281	0.1	0.2	99.9
B737-300	CFM56-3B2	54.9	1	96.5	1.8	225	0.1	0.2	100.1
B737-300	CFM56-3C1	51.7	1	95.5	1.9	999	0.1	0.1	99.9
B737-300	CFM56-3C1	54.9	1	94.8	1.6	675	0.1	0.1	100.2
B737-300	CFM56-3C3	54.9	1	95.1	1.8	297	0.1	0.2	100.1
B737-400	CFM56-3C1	50.2	1	97.6	1.5	418	0.1	0.1	100.2
B737-400	CFM56-3C1	54.9	1	96.4	1.8	4866	0.0	0.1	100.2
B737-400	CFM56-3C1	56.3	1	95.8	1.9	1131	0.1	0.1	100.3
B737-500	CFM56-3B1	49.9	1	96.4	1.5	429	0.1	0.1	99.8
B737-500	CFM56-3C1	49.9	1	96.7	1.5	31	0.3	0.6	99.8
B737-700	CFM56-7B24	60.8	0.5	95.4	0.9	18	0.2	0.4	96.1
B737-800	CFM56-7B24	66.4	0.5	94.8	1.5	1202	0.0	0.1	96.5
B737-800	CFM56-7B26	65.3	0.5	93.5	1.2	35	0.2	0.4	96.4
B737-800	CFM56-7B26	66.4	0.5	94.7	1.4	448	0.1	0.1	96.5
B747-200	CF6-50E2	285.8	4	105.5	1.2	28	0.2	0.5	106.5
B747-200	JT9D-7J	265.4	4	109.5	1.4	109	0.1	0.3	106.0
B747-200	JT9D-7Q	274.4	4	107.7	2.2	21	0.5	1.0	106.6
B747-200	RB211-524C2	265.4	4	106.8	1.7	25	0.3	0.7	107.0
B747-200	RB211-524D4	285.8	2	105.3	1.3	466	0.1	0.1	104.9
B747-400	CF6-80C2B1F	295.8	2	102.4	1.7	265	0.1	0.2	103.8
B747-400	PW4056	285.8	2	103.2	1.8	57	0.2	0.5	104.3
B747-400	PW4056	295.8	2	104.5	1.4	184	0.1	0.2	104.7
B747-400	PW4056	302.1	2	104.3	1.4	137	0.1	0.2	104.9
B747-400	RB211-524G	295.8	2	107.5	1.1	116	0.1	0.2	103.8
B747-400	RB211-524G/H	285.8	2	108.0	1.1	117	0.1	0.2	103.4
B747-400	RB211-524G/HT	285.8	2	105.0	1.8	1014	0.1	0.1	103.4
B747-400	RB211-524G/HT	295.8	2	106.7	1.7	29	0.3	0.6	103.8
B747-400	RB211-524H2	285.8	2	105.0	2.0	990	0.1	0.1	103.4

Table B17 Pooled Approach EPNLs (All Airports, Day + Night), continued

				APPROACH EPNL, EPNdB					
TYPE	ENGINE	MLW (t)	QC	MEAN	STD DEV	COUNT	STD ERR	95% CI	CERT.
B757-200	RB211-535E4	89.8	0.5	97.6	1.7	1593	0.0	0.1	95.0
B757-200	RB211-535E4	90.0	0.5	97.7	1.7	899	0.1	0.1	95.0
B757-200	RB211-535E4	95.3	0.5	97.5	1.7	864	0.1	0.1	95.2
B757-300	RB211-535E4-B	101.6	0.5	99.2	1.7	131	0.1	0.3	95.4
B767-200 (ER)	CF6-80A2	123.4	1	101.0	1.3	356	0.1	0.1	101.6
B767-200 (ER)	CF6-80A2	126.1	1	100.9	1.4	41	0.2	0.4	101.7
B767-200 (ER)	CF6-80C2	126.1	0.5	96.8	1.6	36	0.3	0.5	95.9
B767-200 (ER)	CF6-80C2B2	126.1	0.5	97.0	1.6	110	0.2	0.3	95.9
B767-200 (ER)	CF6-80C2B4	126.1	0.5	97.6	1.5	12	0.4	1.0	95.7
B767-200 (ER)	PW4056	136.1	0.5	98.9	1.6	71	0.2	0.4	98.6
B767-300 (ER)	CF6-80C2B4	145.2	0.5	99.1	1.9	17	0.5	1.0	98.4
B767-300 (ER)	CF6-80C2B6F	145.2	0.5	97.9	1.6	74	0.2	0.4	98.5
B767-300 (ER)	CF6-80C2B7F	145.2	0.5	98.7	1.8	874	0.1	0.1	98.5
B767-300 (ER)	PW4056	145.2	1	100.5	1.2	22	0.3	0.5	100.2
B767-300 (ER)	PW4060	145.2	1	99.9	1.4	326	0.1	0.2	100.2
B767-300 (ER)	RB211-524H	136.0	1	103.5	1.5	980	0.0	0.1	99.1
B777-200	GE90-76B	201.9	0.5	97.7	0.9	119	0.1	0.2	97.6
B777-200	GE90-85B	208.7	0.5	97.3	1.2	801	0.0	0.1	97.8
B777-200	GE90-90B	208.7	0.5	97.6	1.1	389	0.1	0.1	97.8
B777-200	PW4084	201.9	1	99.5	1.1	184	0.1	0.2	99.0
B777-200	PW4090	208.7	1	99.5	1.1	209	0.1	0.2	99.1
B777-200	Trent 892	208.7	1	99.6	1.1	257	0.1	0.1	99.4
B777-200	Trent 895	208.7	1	99.2	1.2	428	0.1	0.1	99.5
BAe 1-11 500	Spey 512-14DW	39.5	1	103.6	1.6	25	0.3	0.7	101.7
BAe 146-200	ALF502R-5	36.7	0.5	91.7	1.4	477	0.1	0.1	95.8
BAe 146-300	ALF502R-5	37.7	0.5	92.2	1.4	876	0.0	0.1	96.0
BAe 146-300	ALF502R-5	38.3	0.5	92.3	1.4	208	0.1	0.2	95.6
Bae 748-2A	Dart 534-2	19.5	Exempt	92.3	2.2	34	0.4	0.8	94.2
BAe ATP	PW126A	22.5	0.5	97.0	1.1	9	0.4	0.8	97.9
Beech King Air 200	PT6A-42	5.7	Exempt	87.4	0.7	10	0.2	0.5	N/A*
Cessna 550 Citation II	JT15D-4	6.1	Exempt	85.2	1.7	18	0.4	0.8	90.5
DC-10-30	CF6-50C2	186.4	4	103.2	1.6	53	0.2	0.4	106.1
DC-10-30	CF6-50C2	192.3	4	103.0	1.9	60	0.2	0.5	106.6
DC-10-30	CF6-50C2	197.2	4	103.3	1.9	66	0.2	0.5	106.8
DC-10-30	CF6-50C2	197.6	4	103.5	2.8	41	0.4	0.9	106.8
Fokker F27	Dart 532-7	19.7	Exempt	92.6	1.6	182	0.1	0.2	94.3
L-1011-385-1	RB211-22B	162.4	2	101.9	1.5	13	0.4	0.9	102.8
L-1011-385-1	RB211-22B	166.9	2	101.3	2.1	19	0.5	1.0	102.8
Lockheed L-188C	501-D13A	44.5	0.5	99.3	1.0	39	0.2	0.3	96.6
Lockheed L-382G Hercules	AN 501-D22A	59.9	0.5	97.5	0.9	29	0.2	0.3	98.1
MD-11F	CF6-80C2D1F	218.4	2	102.5	3.4	102	0.3	0.7	104.5
MD-11F	PW4462	218.4	2	102.0	2.0	32	0.4	0.7	104.4
MD-82	JT8D-217C	59.0	0.5	94.9	2.0	106	0.2	0.4	93.2
MD-83	JT8D-219	68.0	0.5	95.1	2.2	121	0.2	0.4	93.7
Saab SF340A	CT7-5A2	12.0	Exempt	93.5	1.5	21	0.3	0.7	92.3
Shorts 360-100	PT6A-65R	11.8	Exempt	90.8	1.6	43	0.2	0.5	90.0
Shorts 360-200	PT6A-65AR	11.8	Exempt	90.0	1.7	150	0.1	0.3	90.0
Shorts 360-300	PT6A-67R	12.0	Exempt	95.9	1.4	113	0.1	0.3	94.3

* Certificated noise levels measured in A-weighted decibels (dBA), not in EPNdB

Table B18 Pooled Departure EPNLs (All Airports, Day + Night)

				FLYOVER EPNL, EPNdB					PSEUDO-LATERAL EPNL, EPNdB					DEPARTURE EPNL, EPNdB	
TYPE	ENGINE	MTOW (t)	QC	MEAN	STD DEV	COUNT	STD ERR	95% CI	MEAN	STD DEV	COUNT	STD ERR	95% CI	MEAN	CERT.
A300B4-203	CF6-50C2	165.0	2	93.3	1.7	208	0.1	0.2	95.8	0.9	130	0.1	0.2	94.6	95.9
A300B4-605R	CF6-80C2A5	170.5	2	91.9	1.7	253	0.1	0.2	95.4	1.4	119	0.1	0.3	93.6	94.3
A300B4-605R	CF6-80C2A5	171.7	2	91.9	1.7	343	0.1	0.2	95.2	1.7	195	0.1	0.2	93.6	94.9
A310-203	CF6-80A3	142.0	2	94.3	1.1	29	0.2	0.4	96.2	1.0	28	0.2	0.4	95.3	93.8
A320-211	CFM56-5A1	73.5	1	88.8	1.4	21	0.3	0.6	91.7	1.3	20	0.3	0.6	90.2	91.1
A320-212	CFM56-5A3	77.0	1	88.9	1.5	221	0.1	0.2	92.1	1.3	202	0.1	0.2	90.5	91.4
A320-214	CFM56-5B4/P	73.5	0.5	86.9	1.2	25	0.2	0.5	88.5	1.3	22	0.3	0.6	87.7	89.9
A320-214	CFM56-5B4/P	77.0	1	88.5	1.7	430	0.1	0.2	90.6	1.6	506	0.1	0.1	89.5	90.9
A320-231	V2500-A1	74.5	0.5	88.1	0.9	9	0.3	0.7	90.9	1.3	9	0.4	1.0	89.5	89.7
A320-231	V2500-A1	75.5	1	88.4	1.5	197	0.1	0.2	90.7	1.2	244	0.1	0.2	89.6	90.1
A320-231	V2500-A1	77.0	1	88.4	1.6	774	0.1	0.1	91.2	1.5	903	0.0	0.1	89.8	90.5
A321-211	CFM56-5B3/P	89.0	1	90.3	1.9	524	0.1	0.2	93.5	1.7	524	0.1	0.1	91.9	92.8
A321-231	V2533-A5	89.0	1	90.2	1.8	357	0.1	0.2	91.9	2.3	375	0.1	0.2	91.1	91.1
A330-243	Trent 772B	230.0	2	94.0	1.4	150	0.1	0.2	95.0	1.5	127	0.1	0.3	94.5	93.8
ATR42-300	PW120	16.7	Exempt	84.3	2.5	111	0.2	0.5	84.1	4.7	87	0.5	1.0	84.2	83.6
ATR72-202	PW124	21.5	Exempt	84.8	1.7	298	0.1	0.2	86.4	1.8	146	0.1	0.3	85.6	85.8
Avro RJ100	LF507-1F	45.0	0.5	86.4	1.8	2080	0.0	0.1	86.5	1.3	1797	0.0	0.1	86.5	86.8
B737-200 Adv	JT8D-15	53.0	4	97.6	2.3	809	0.1	0.2	102.0	1.9	598	0.1	0.2	99.8	98.9
B737-200 Adv	JT8D-15 (HK)	53.0	2	96.2	2.6	3509	0.0	0.1	97.8	1.9	2430	0.0	0.1	97.0	93.2
B737-300	CFM56-3B1	56.5	0.5	91.0	1.7	826	0.1	0.1	92.0	1.0	624	0.0	0.1	91.5	87.4
B737-300	CFM56-3B1	58.0	0.5	91.2	1.7	273	0.1	0.2	92.3	0.9	186	0.1	0.1	91.8	87.7
B737-300	CFM56-3B1	59.0	0.5	90.0	1.5	58	0.2	0.4	91.5	1.0	43	0.2	0.3	90.7	87.9
B737-300	CFM56-3B1	61.0	0.5	90.8	1.6	239	0.1	0.2	91.8	1.1	203	0.1	0.2	91.3	88.3
B737-300	CFM56-3B1	61.2	0.5	90.9	1.8	561	0.1	0.1	91.9	1.2	344	0.1	0.1	91.4	88.4
B737-300	CFM56-3B2	62.8	0.5	90.3	1.8	90	0.2	0.4	92.5	1.1	48	0.2	0.3	91.4	88.7
B737-300	CFM56-3B2	63.3	0.5	90.1	1.6	255	0.1	0.2	91.9	0.9	124	0.1	0.2	91.0	88.8
B737-300	CFM56-3C1	57.8	0.5	90.4	1.9	520	0.1	0.2	91.2	1.0	381	0.1	0.1	90.8	87.7
B737-300	CFM56-3C1	58.1	0.5	90.5	1.8	1007	0.1	0.1	91.2	1.1	813	0.0	0.1	90.9	87.7
B737-300	CFM56-3C1	61.3	0.5	89.7	1.8	95	0.2	0.4	91.6	1.4	84	0.2	0.3	90.7	88.4
B737-300	CFM56-3C1	61.7	0.5	89.0	1.7	21	0.4	0.8	91.6	0.8	11	0.2	0.5	90.3	88.5
B737-300	CFM56-3C1	63.3	0.5	90.4	1.6	178	0.1	0.2	90.8	1.3	73	0.2	0.3	90.6	88.9
B737-400	CFM56-3C1	62.8	0.5	89.0	1.9	2177	0.0	0.1	92.4	1.6	683	0.1	0.1	90.7	89.6
B737-400	CFM56-3C1	68.0	1	89.1	1.9	404	0.1	0.2	92.2	1.5	161	0.1	0.2	90.7	90.1
B737-800	CFM56-7B24	75.0	0.5	89.7	1.6	1674	0.0	0.1	90.7	1.4	2210	0.0	0.1	90.2	89.7
B737-800	CFM56-7B26	78.0	1	90.3	1.4	31	0.3	0.5	93.2	2.5	33	0.4	0.9	91.7	90.5
B737-800	CFM56-7B26	78.3	1	89.5	1.8	256	0.1	0.2	92.7	1.5	170	0.1	0.2	91.1	90.5
B737-800	CFM56-7B26	79.0	1	89.9	1.7	239	0.1	0.2	93.1	1.3	191	0.1	0.2	91.5	90.6
B737-800	CFM56-7B27	78.3	1	89.5	1.0	12	0.3	0.6	92.6	0.6	11	0.2	0.4	91.0	90.7

Table B18 Pooled Departure EPNLs (All Airports, Day + Night), continued

				FLYOVER EPNL, EPNdB					PSEUDO-LATERAL EPNL, EPNdB					DEPARTURE EPNL, EPNdB	
TYPE	ENGINE	MTOW (t)	QC	MEAN	STD DEV	COUNT	STD ERR	95% CI	MEAN	STD DEV	COUNT	STD ERR	95% CI	MEAN	CERT.
B747-400	CF6-80C2B1F	377.8	4	100.3	1.8	61	0.2	0.5	96.6	2.4	49	0.3	0.7	98.5	98.3
B747-400	CF6-80C2B5F	396.9	4	96.8	4.6	138	0.4	0.8	100.3	2.4	66	0.3	0.6	98.6	98.9
B747-400	RB211-524G	381.0	4	101.3	1.8	40	0.3	0.6	99.0	1.3	154	0.1	0.2	100.2	97.9
B747-400	RB211-524G	396.9	4	101.7	1.6	236	0.1	0.2	97.9	1.7	258	0.1	0.2	99.8	98.6
B747-400	RB211-524H	396.9	4	101.8	1.9	376	0.1	0.2	97.6	1.6	485	0.1	0.1	99.7	98.4
B747-400	RB211-524H2	381.0	4	100.6	1.4	48	0.2	0.4	98.2	1.0	100	0.1	0.2	99.4	97.9
B747-400	RB211-524H2	396.9	4	100.3	1.4	232	0.1	0.2	98.5	1.5	317	0.1	0.2	99.4	98.4
B757-200	RB211-535E4	100.3	0.5	89.5	1.3	121	0.1	0.2	93.5	0.9	66	0.1	0.2	91.5	87.8
B757-200	RB211-535E4	101.8	0.5	90.3	1.8	35	0.3	0.6	93.0	0.9	31	0.2	0.3	91.6	88.1
B757-200	RB211-535E4	102.1	0.5	89.4	1.2	403	0.1	0.1	93.5	0.9	279	0.1	0.1	91.5	88.1
B757-200	RB211-535E4	104.3	0.5	90.6	1.7	625	0.1	0.1	94.2	1.3	425	0.1	0.1	92.4	88.4
B757-200	RB211-535E4	108.9	0.5	90.5	1.7	1065	0.1	0.1	94.3	1.3	570	0.1	0.1	92.4	89.0
B757-200	RB211-535E4	113.4	0.5	90.6	1.8	1223	0.1	0.1	94.2	1.3	701	0.0	0.1	92.4	89.6
B757-300	RB211-535E4-B	118.0	1	89.8	1.1	133	0.1	0.2	94.0	1.4	143	0.1	0.2	91.9	90.7
B767-200 (ER)	CF6-80A2	158.7	2	91.0	1.5	195	0.1	0.2	94.6	1.0	169	0.1	0.2	92.8	93.8
B767-200 (ER)	CF6-80A2	159.2	2	91.6	2.2	130	0.2	0.4	94.7	1.3	89	0.1	0.3	93.1	93.8
B767-200 (ER)	PW4056	175.5	2	93.1	1.6	57	0.2	0.4	97.6	1.9	50	0.3	0.5	95.3	94.3
B767-300 (ER)	CF6-80C2B7F	184.6	2	90.0	2.0	189	0.1	0.3	94.9	1.8	83	0.2	0.4	92.5	93.7
B767-300 (ER)	CF6-80C2B7F	186.9	2	90.8	2.2	580	0.1	0.2	96.5	2.1	354	0.1	0.2	93.7	93.9
B767-300 (ER)	RB211-524H	158.0	1	94.6	1.7	277	0.1	0.2	94.2	1.5	118	0.1	0.3	94.4	92.2
B777-200	GE90-85B	267.6	1	93.0	1.6	404	0.1	0.2	91.9	1.4	351	0.1	0.1	92.5	91.8
B777-200	Trent 895	297.6	2	95.4	1.5	69	0.2	0.4	94.7	1.1	49	0.2	0.3	95.1	95.9
BAe 146-200	ALF502R-5	42.2	0.5	89.5	1.6	133	0.1	0.3	87.5	1.2	121	0.1	0.2	88.5	86.3
BAe 146-200	ALF502R-5	42.4	0.5	90.4	1.7	15	0.4	0.9	88.0	0.8	11	0.2	0.5	89.2	86.3
BAe 146-300	ALF502R-5	44.2	0.5	88.6	1.7	51	0.2	0.5	87.5	1.2	90	0.1	0.3	88.0	86.4
BAe 748-2B	Dart 536-2	21.1	2	92.5	1.4	18	0.3	0.7	90.6	0.9	20	0.2	0.4	91.6	94.7
DC10-30	CF6-50C2	256.3	4	97.7	2.6	38	0.4	0.9	98.4	2.5	41	0.4	0.8	98.1	98.0
DC10-30	CF6-50C2	259.5	4	96.5	2.6	120	0.2	0.5	97.7	2.3	145	0.2	0.4	97.1	98.2
Fokker F27	Dart 532-7	19.7	0.5	89.2	1.2	54	0.2	0.3	87.0	1.8	62	0.2	0.5	88.1	88.3
Fokker F27	Dart 532-7	20.4	0.5	88.8	2.0	127	0.2	0.4	87.4	1.8	175	0.1	0.3	88.1	88.8
Lockheed L-188C	AN 501-D13A	52.6	2	92.0	1.6	115	0.1	0.3	92.9	1.4	63	0.2	0.4	92.5	93.3
Lockheed L-382G Hercules	AN 501-D22A	70.3	2	94.8	2.3	79	0.3	0.5	94.4	1.7	63	0.2	0.4	94.6	95.8
MD-11F	CF6-80C2D1F	280.3	2	95.6	2.9	284	0.2	0.3	100.8	1.6	112	0.2	0.3	98.2	95.1
MD-83	JT8D-219	72.6	2	94.7	2.2	139	0.2	0.4	99.3	1.2	25	0.2	0.5	97.0	94.0
MD-87	JT8D-219	63.5	1	95.1	2.8	177	0.2	0.4	99.5	1.4	54	0.2	0.4	97.3	91.8
Shorts 360-100	PT6A-65R	12.0	Exempt	85.7	2.3	23	0.5	1.0	83.5	1.9	55	0.3	0.5	84.6	84.3
Shorts 360-200	PT6A-65AR	12.0	Exempt	85.3	1.3	57	0.2	0.3	82.8	1.7	212	0.1	0.2	84.0	85.1
Shorts 360-300	PT6A-67R	12.3	Exempt	85.0	2.0	68	0.2	0.5	82.8	2.8	185	0.2	0.4	83.9	82.0

Appendix C Noise Measurements for Quieter Aircraft Types

C1 The noise levels generated by an aircraft type vary with a number of factors such as aircraft weight, operating procedure (including turns on departure) and weather. The aim in this study is to estimate the true average levels of each noise-significant type (for all operations of the type) to an agreed level of accuracy. Conventional statistical theory used to analyse the data is based on the properties of the so-called normal (or Gaussian) distribution. This is a familiar 'bell-shaped' curve, the shape of which can be precisely defined in terms of its mean and variance (or standard deviation, s.d.). The distributions of aircraft noise levels, like those of very many physical variables, are usually found to be close to normal[1]. Provided this is the case, and the sample is large enough, the mean and variance of a set of measurements are statistics that approximate the true values within known confidence limits.

C2 Unless there is clear evidence to suggest otherwise, normality is often assumed, as the statistical tests are robust enough to work well, even if the distribution is only approximately normal. In cases of doubt, there are statistical criteria against which the degree of normality can be checked quantitatively.

C3 Data distributions can be distorted or 'biased' by systematic influences on the measured variable. In this case, the influence of concern is that of ambient background noise on the detection of aircraft noise events and the measurement of their dB levels. Even if the event is detected, its EPNL might not be measured accurately, or at all, if the maximum level during the event does not exceed the background level by at least 10 dB. Such influences have been encountered in previous ANMAC studies, for example during the arrivals project (Ref C1), where the noise levels of some quieter aircraft were not measurable at monitoring locations furthest from the airfield.

C4 **Figures C1 and C2** show the measured distributions of EPNLs of all arriving and departing aircraft that were measured at Gatwick in winter 1999/2000. These are 'histograms', which classify the noise levels in 1 EPNdB bands. Superimposed on each histogram is the equivalent normal distribution; i.e. the one having the same mean and s.d. as the data. Clearly the histograms bear little resemblance to the normal distributions. This is because the distributions contain measurements from a number of different aircraft types with different mean levels: they are effectively aggregations of several different normal distributions. When different aircraft types are separated, their distributions become more bell-shaped.

C5 **Figures C3 to C7** show the distributions of approach EPNLs for some 'quieter' Exempt and QC/0.5 aircraft included in **Figure C1** which would be more susceptible to data loss. Similar graphs are presented in **Figures C8 to C12** for some of the quieter departures in **Figure C2**. In each figure, the upper diagram (i) is a histogram, again with the equivalent normal distribution superimposed. In the lower diagrams (ii) the same data are plotted in the form of 'Q-Q' probability distributions that turn the theoretical normal curves into diagonal straight lines - if the measured distributions were exactly normal, the data points would fall onto those lines.

C6 It can be seen that, in most cases, the distributions in **Figures C3 to C12** resemble the theoretical normal distributions quite closely. Generally, the more the

[1] The term 'normal' here does not imply that this is a usual or expected distribution. In fact, a perfectly normal distribution is unusual in practice but most distributions approximate to this shape.

measurements, the better the agreement. The 'degrees of normality' were examined using the Kolmogorov-Smirnov (K-S) goodness-of-fit test, which quantifies the discrepancy between the distribution of the measurements and the normal distribution. The results are tabulated below: here K-S significance statistics of less than 0.05 would indicate that the data are unlikely to be normally distributed.

FIGURE REFERENCE	AIRCRAFT TYPE	QC BAND	K-S SIGNIFICANCE
C3	ATR42-300	0.5	>0.200
C4	ATR72-202	Exempt	0.151
C5	B777-200	0.5	0.060
C6	F27	Exempt	>0.200
C7	SD360-300	Exempt	0.155
C8	ATR42-300	Exempt	0.095
C9	ATR72-202	Exempt	>0.200
C10	B737-400	0.5	>0.200
C11	BAe146/RJ100	0.5	>0.200
C12	SD360-300	Exempt	>0.200

C7 Thus it is confirmed that all these distributions can be considered normal, in most cases with a very high probability. It is concluded that conventional statistical analysis is valid for the study. Moreover, since the aircraft considered, all either Exempt or QC/0.5 types, are among the quietest operating at any of the three airports, there is no evidence to suggest that any part of the monitoring study is likely to have been susceptible to bias caused by data loss due to ambient masking.

Reference

C1 Noise from Arriving Aircraft: Final Report of the ANMAC Technical Working Group, DETR, December 1999.

Figure C1

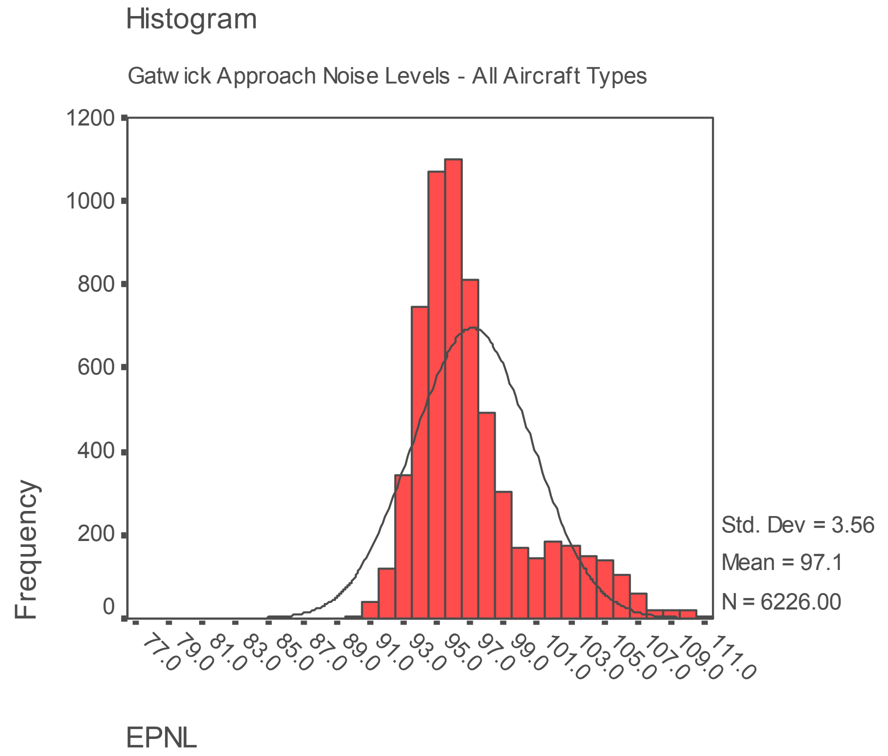


Figure C2

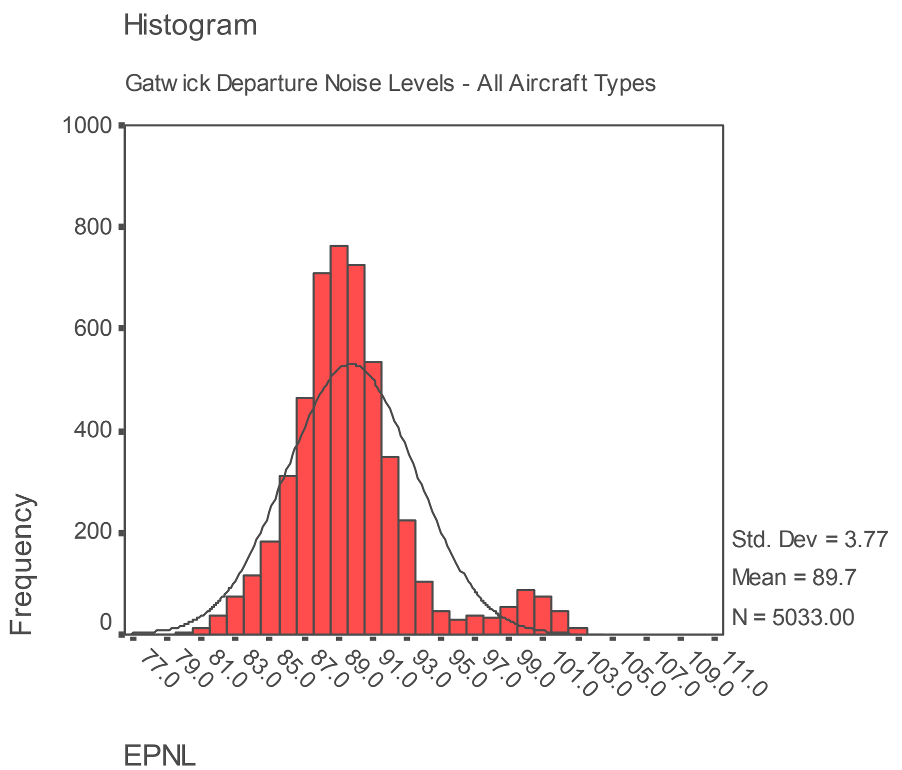
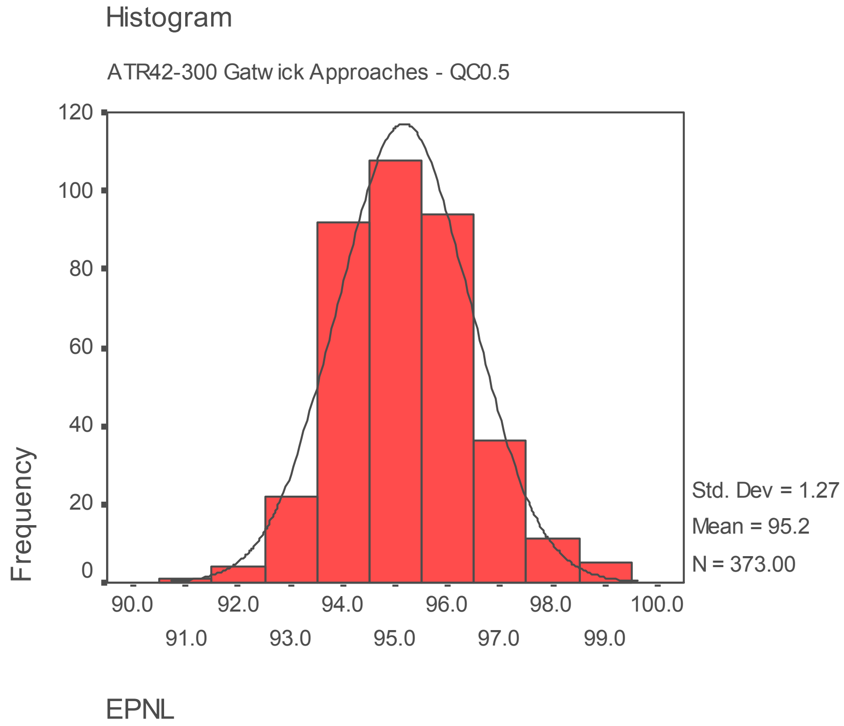


Figure C3(i)



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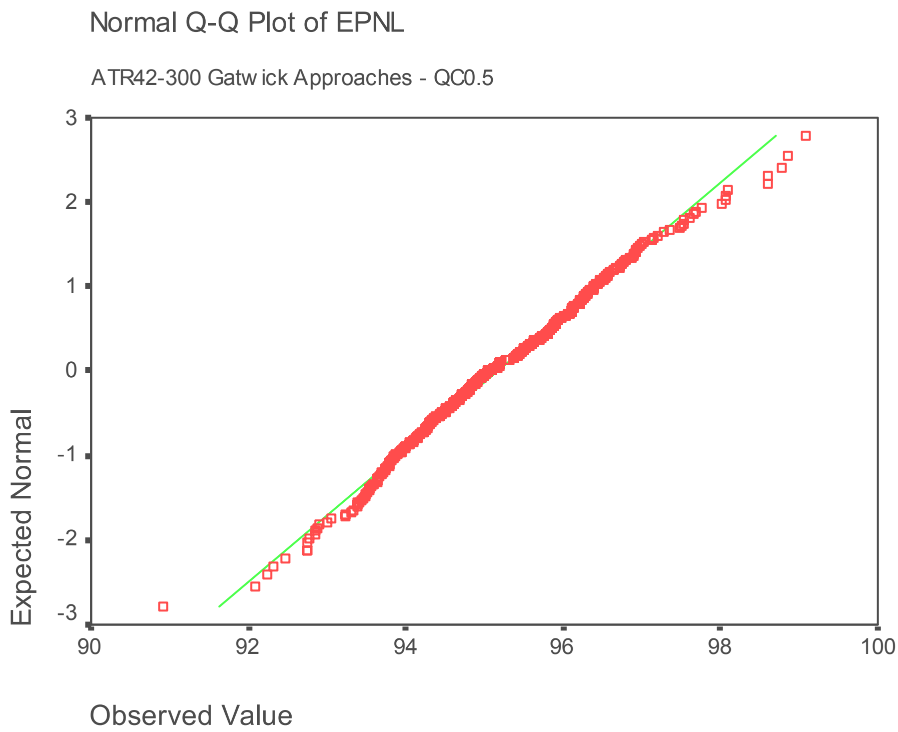
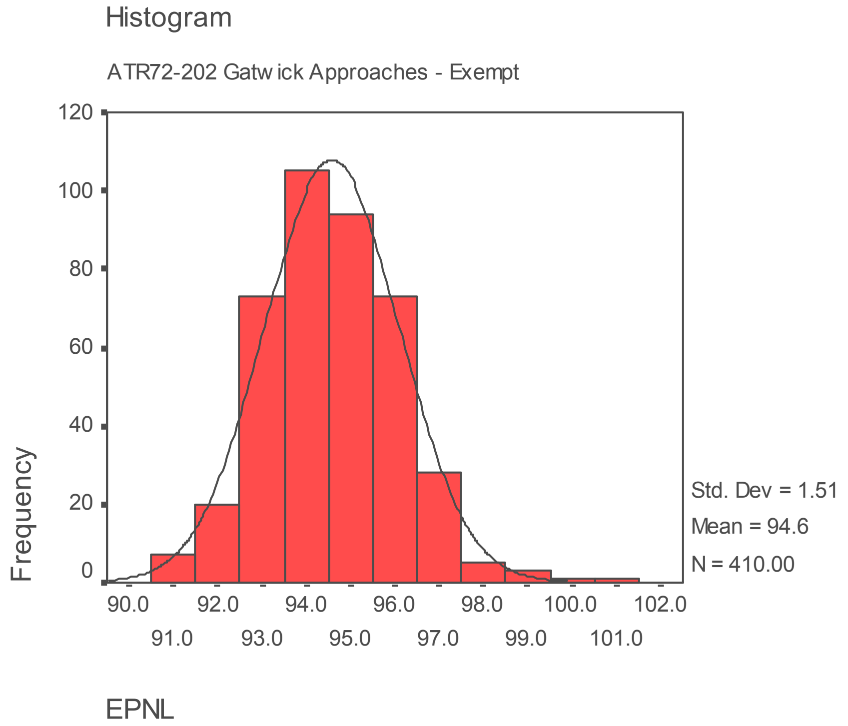


Figure C4(i)



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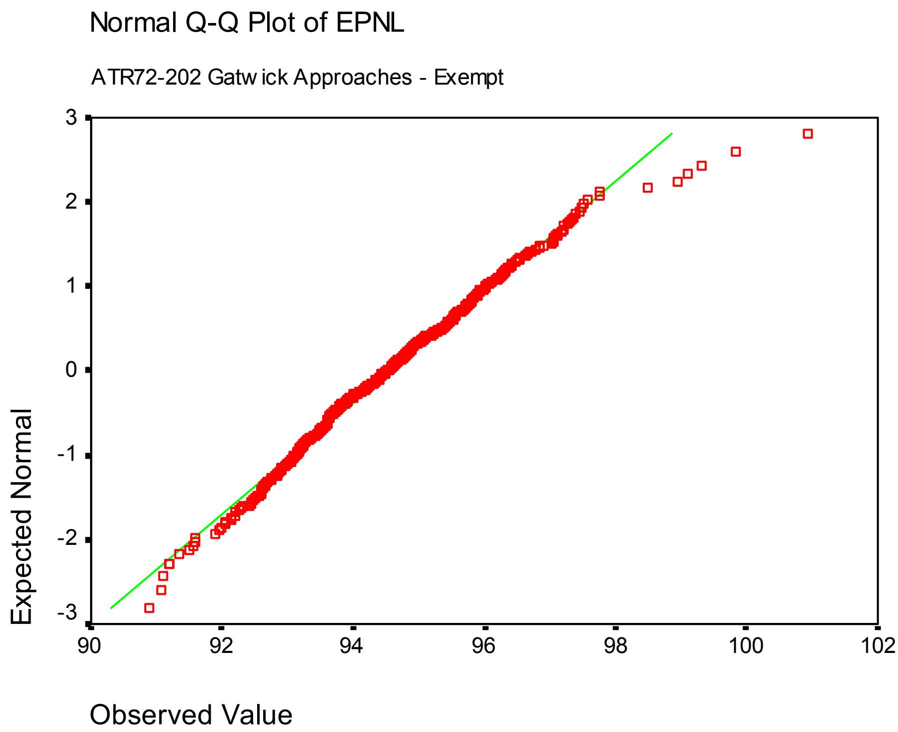
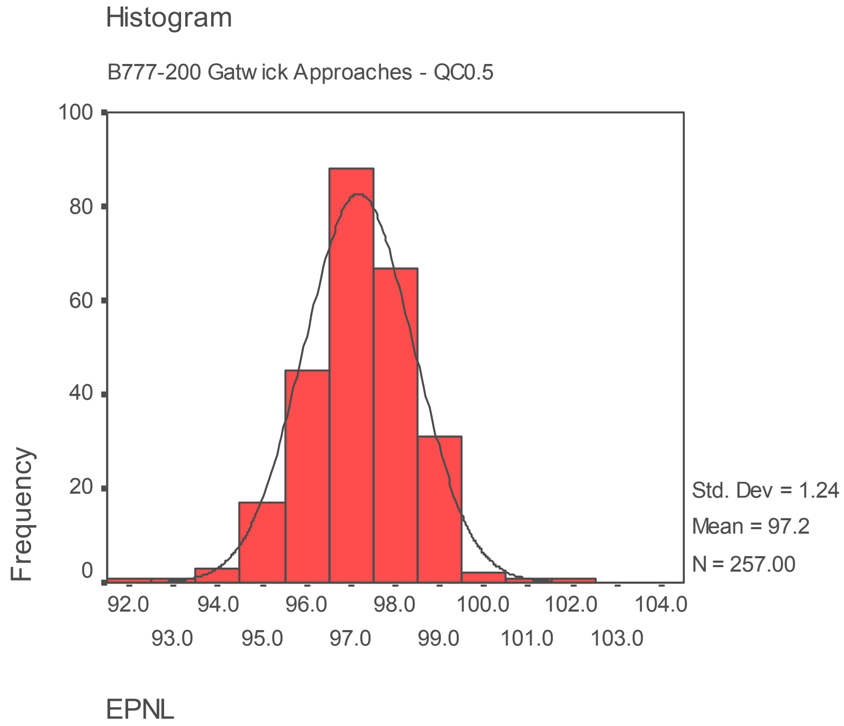


Figure C5(i)



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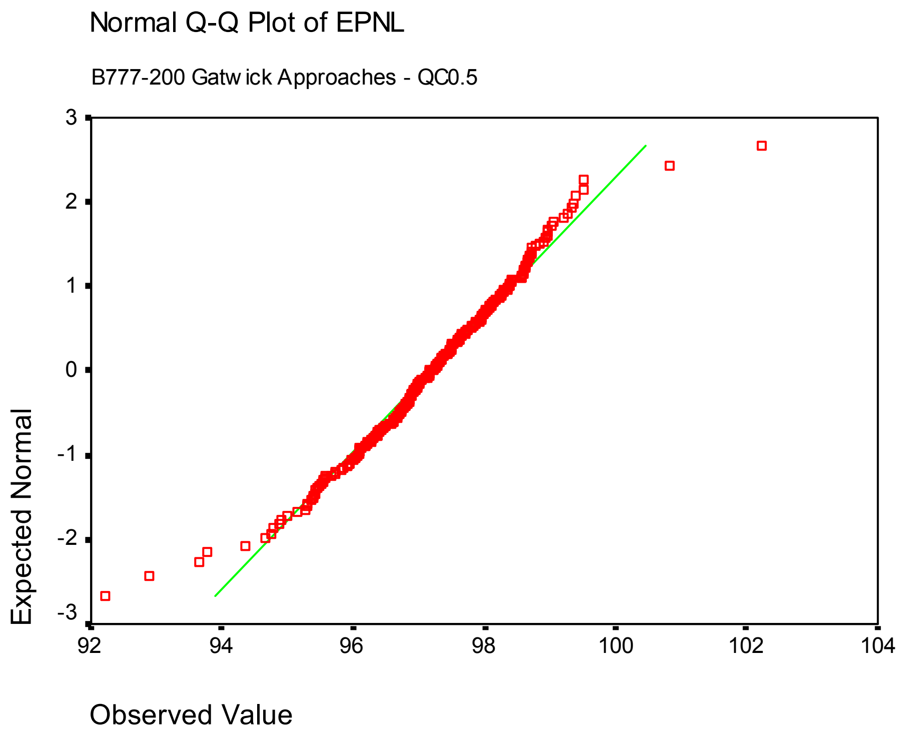
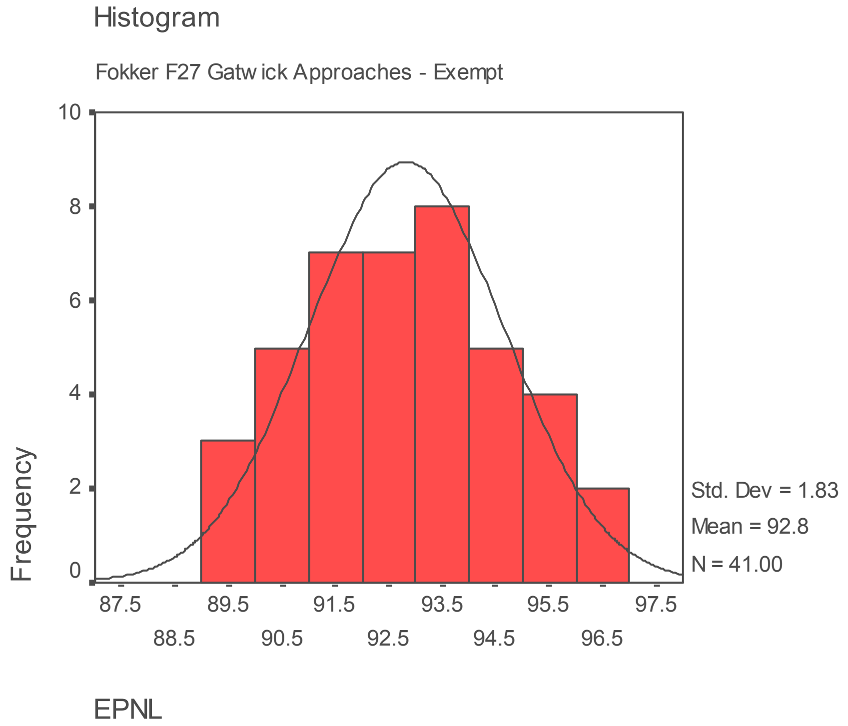


Figure C6(i)



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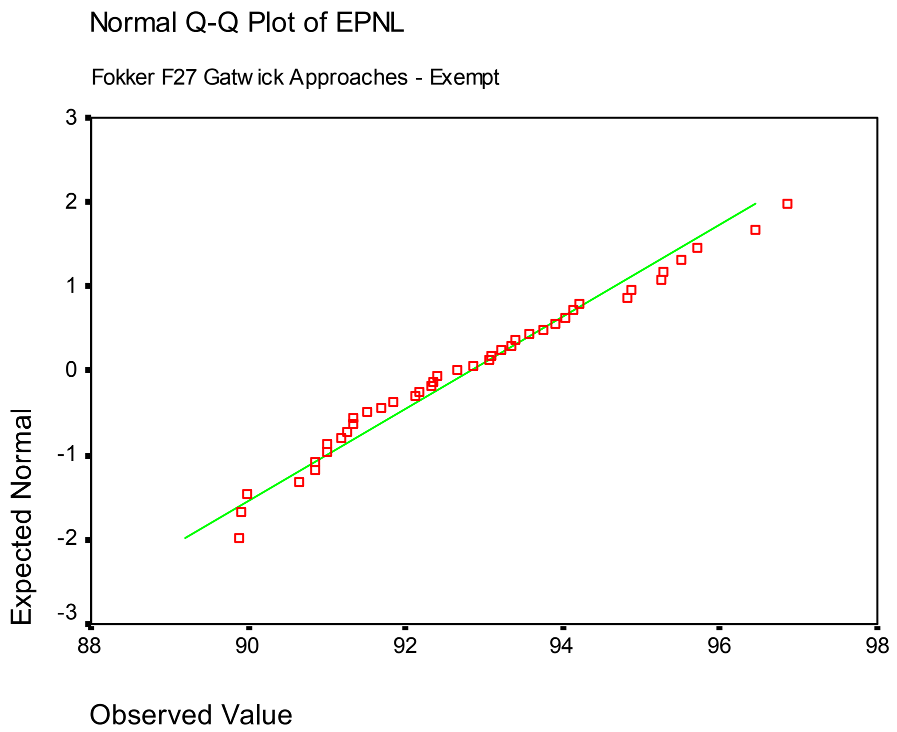
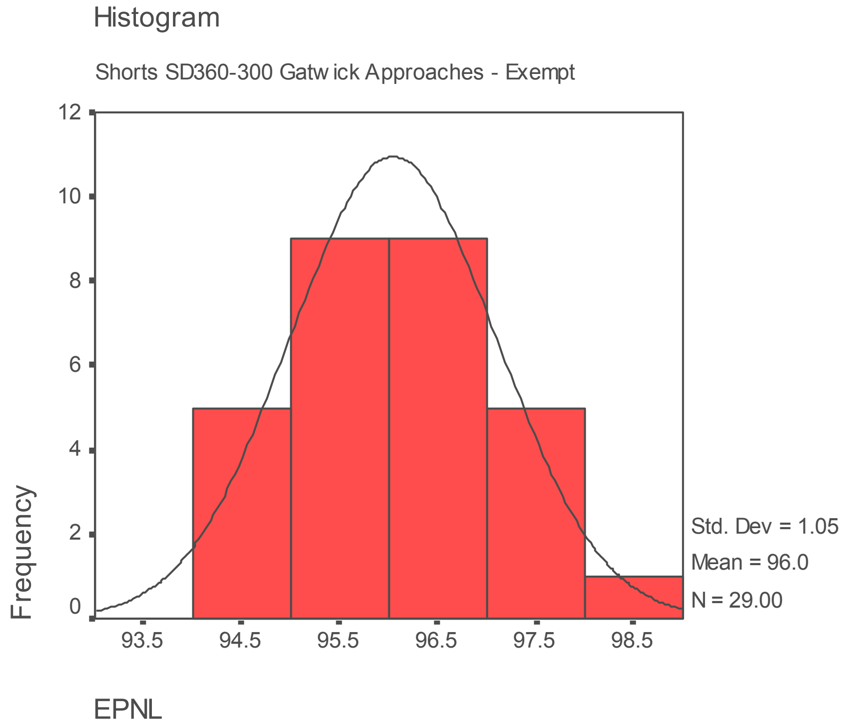


Figure C7(i)



(ii)

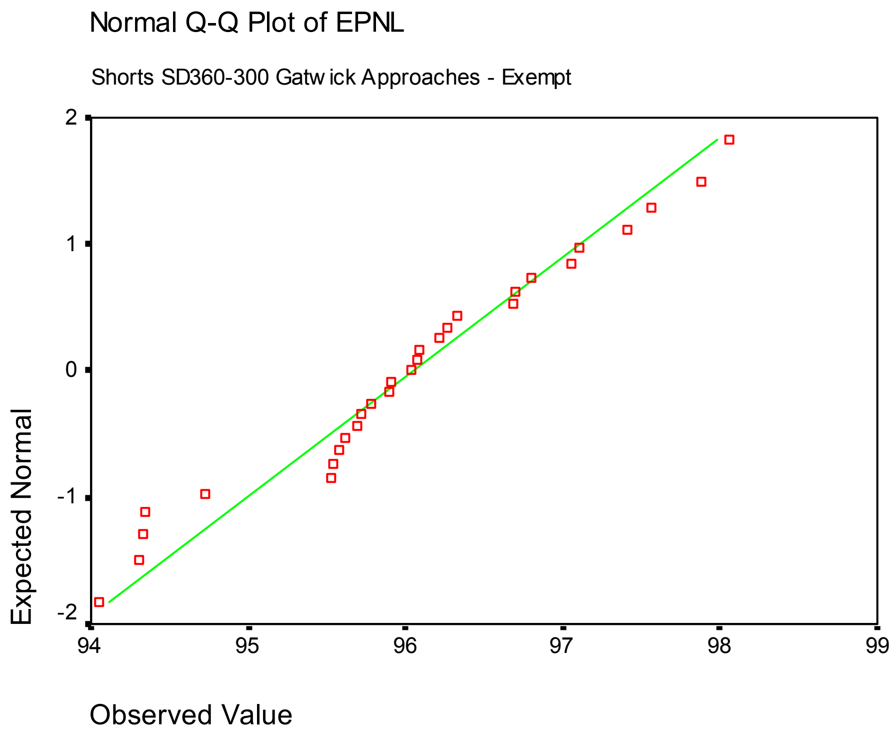
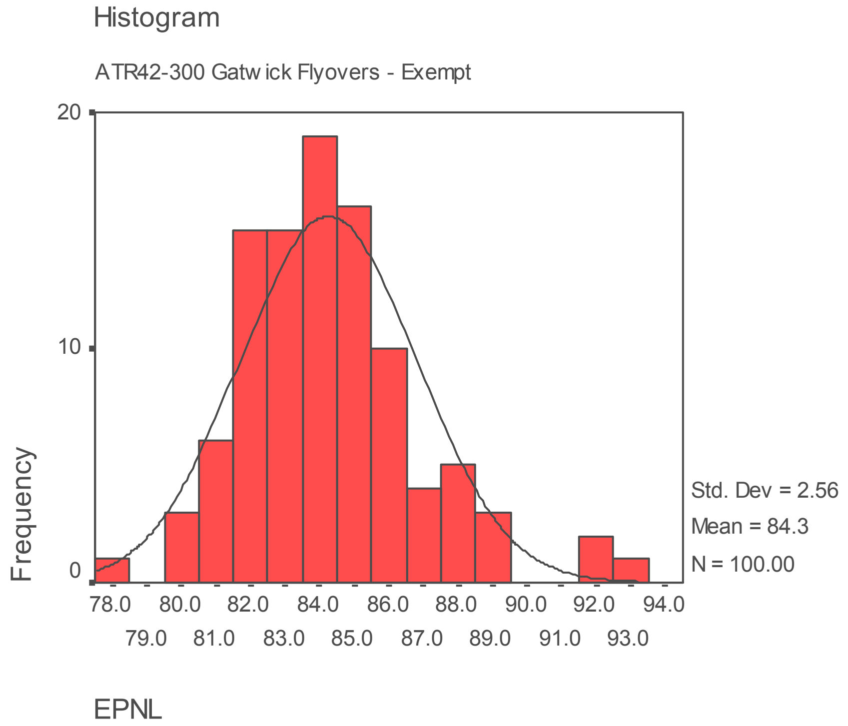


Figure C8(i)



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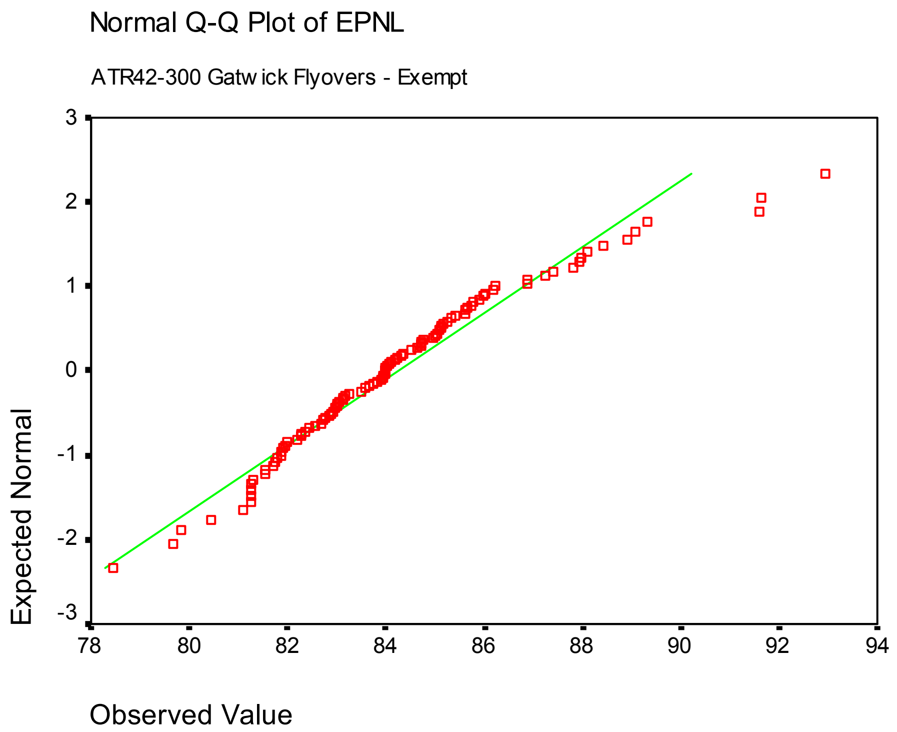
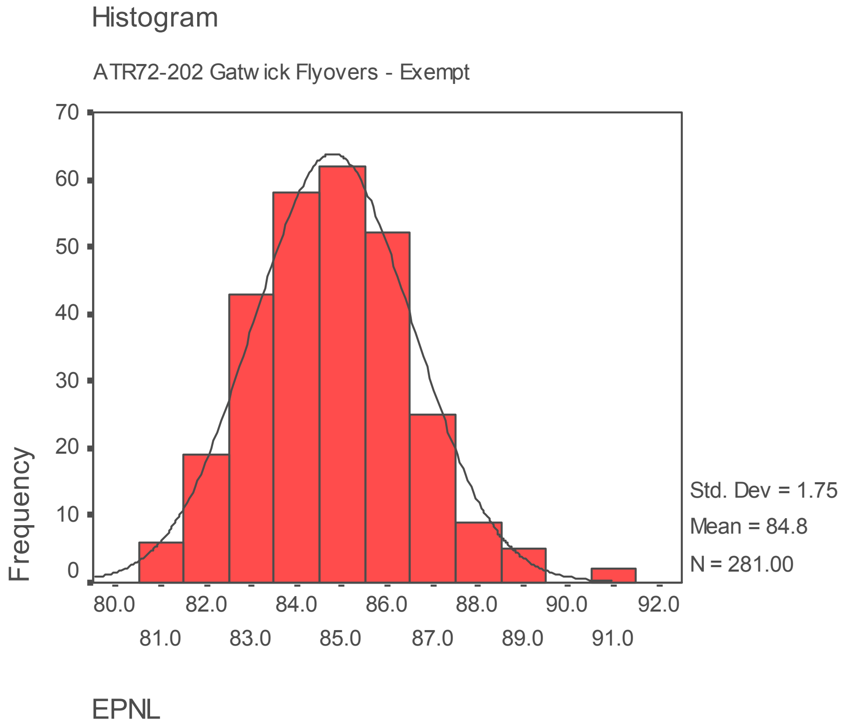


Figure C9(i)



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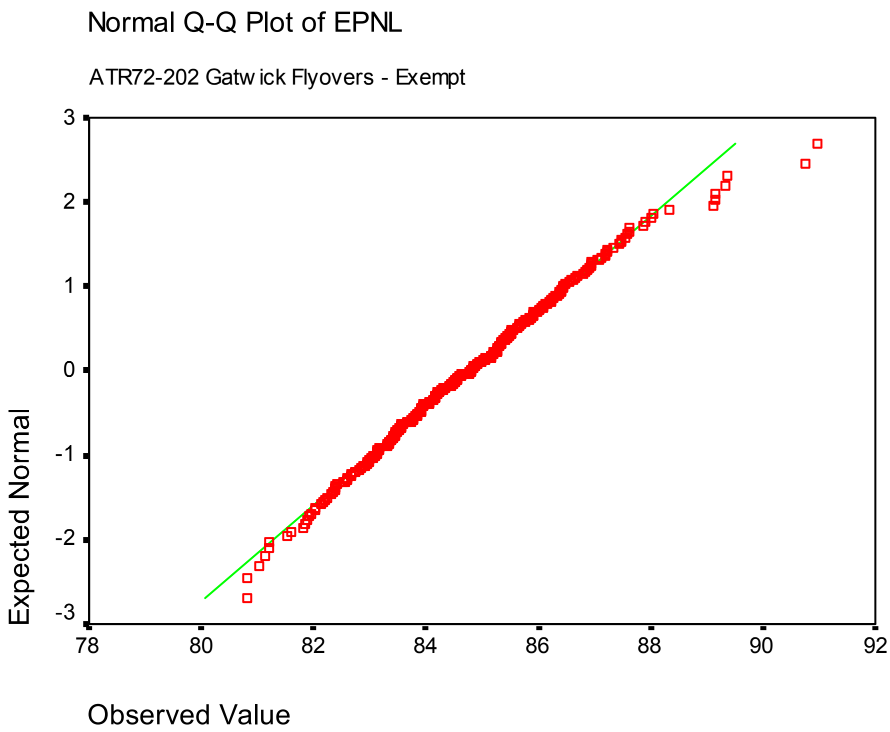
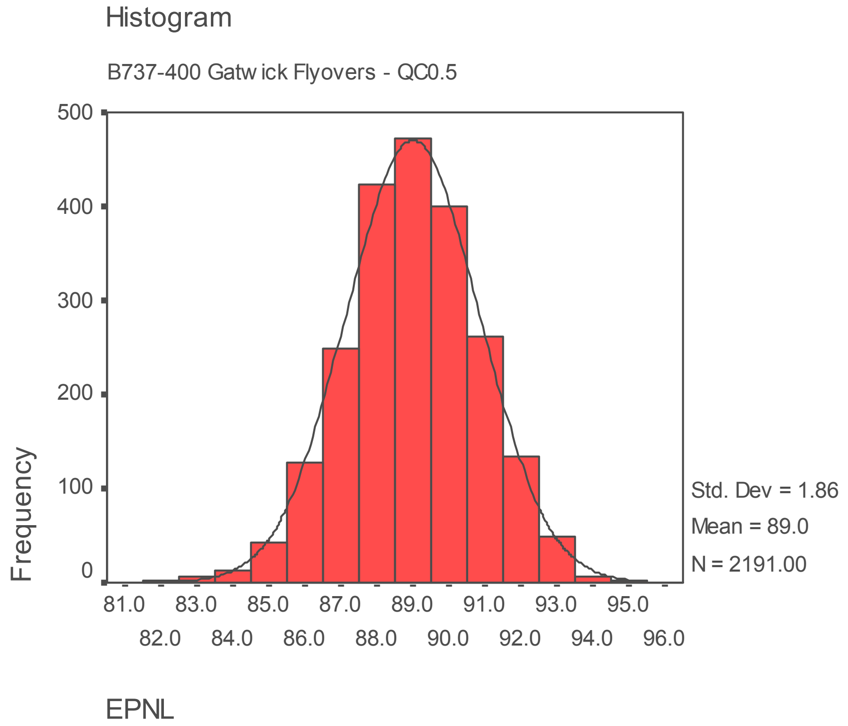


Figure C10(i)



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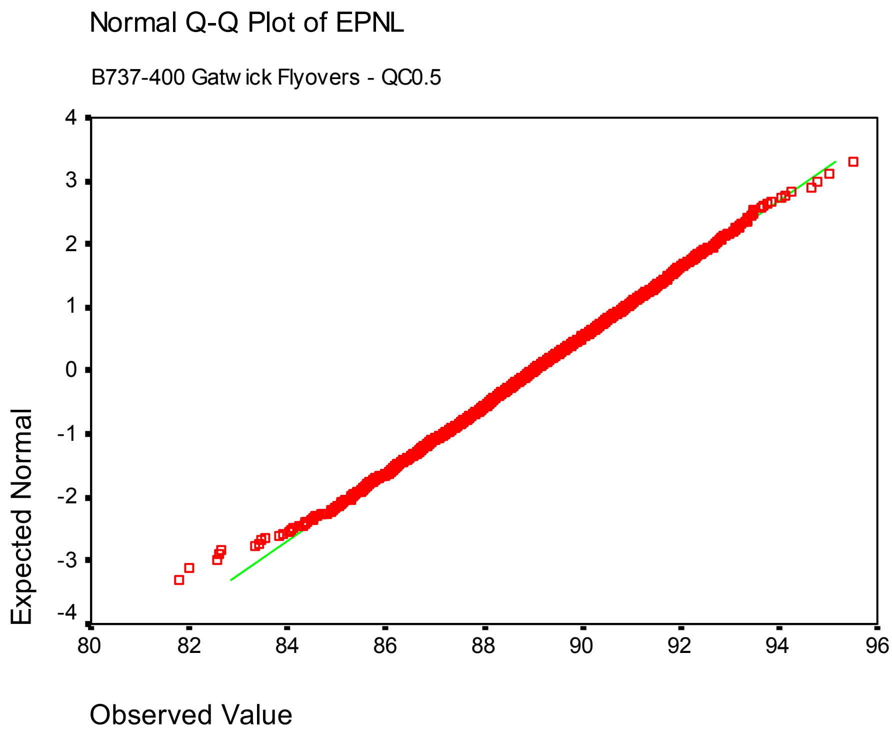
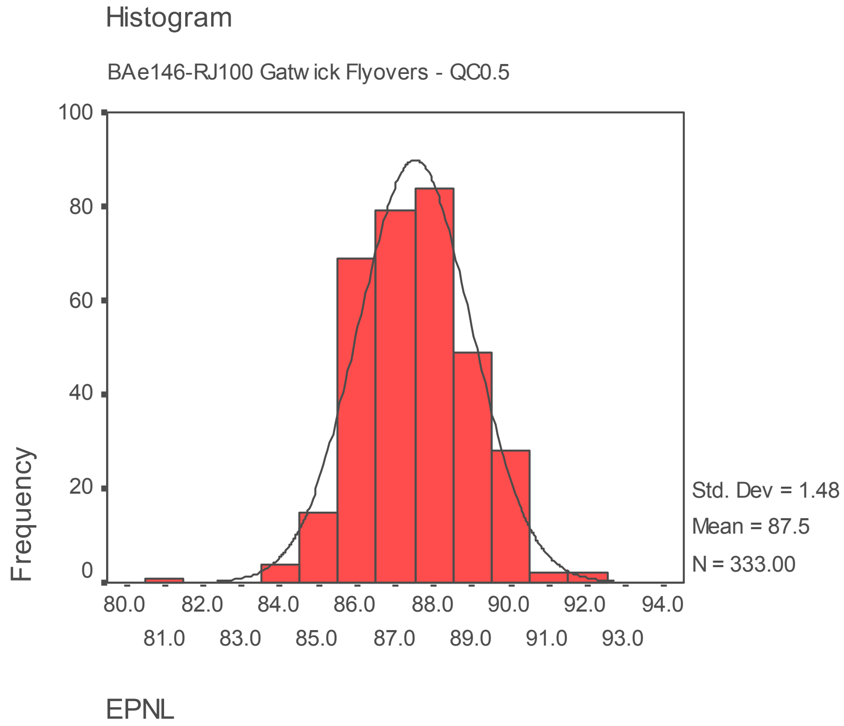


Figure C11(i)



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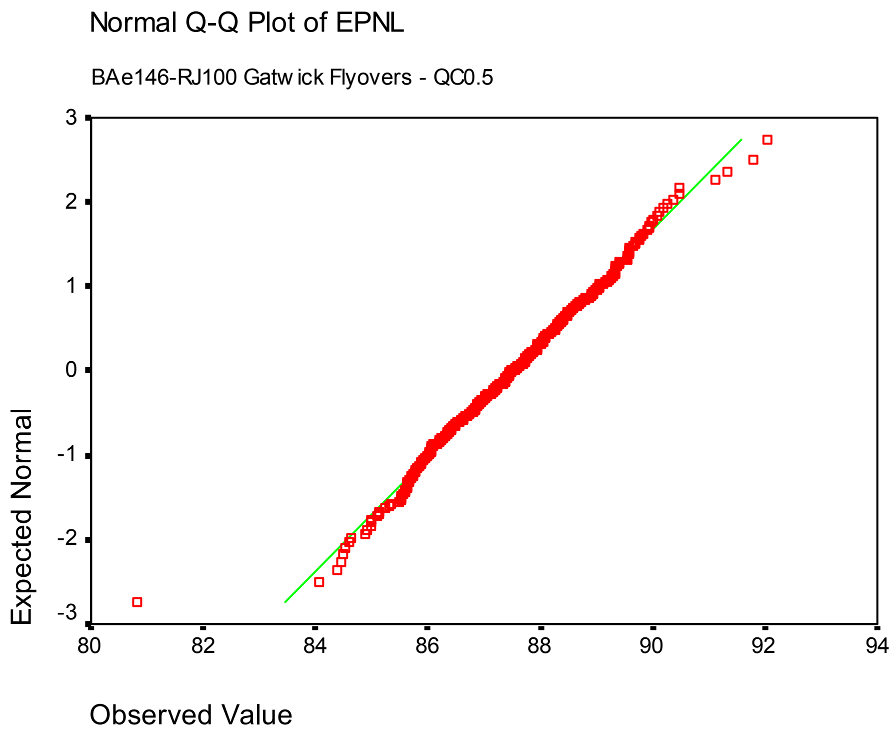
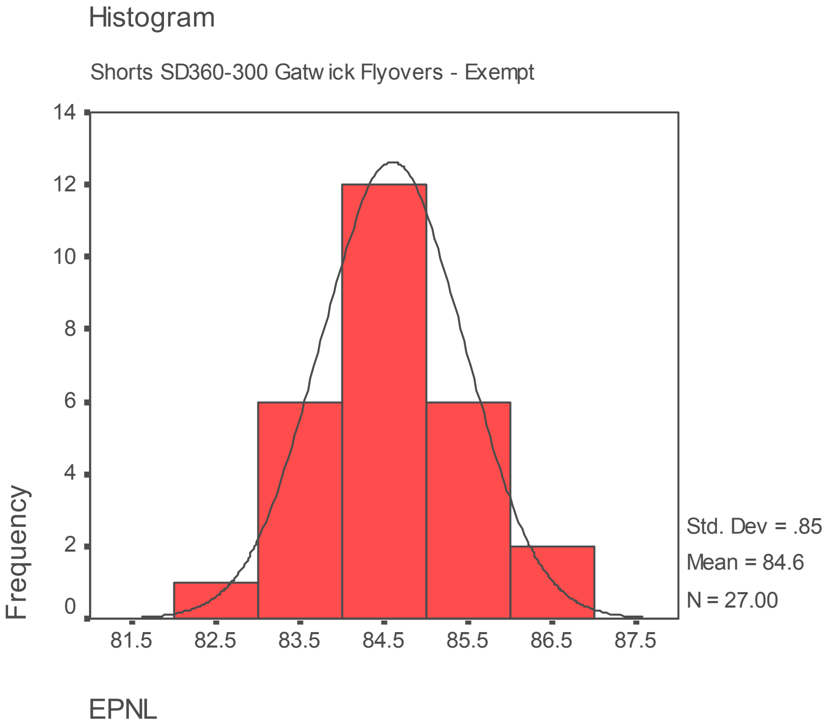


Figure C12(i)



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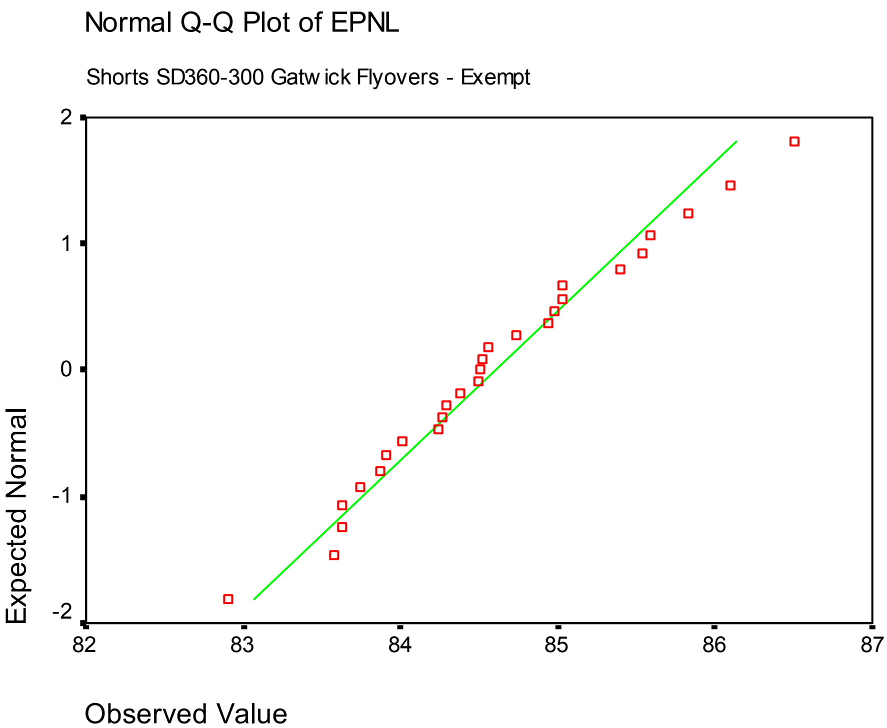

Appendix D Sources of Measurement Uncertainty

D1 General

D1.1 The overall accuracy of the measurements is limited by (1) that of the 'measurement system' (microphone, signal conditioning, analysers, radar accuracy and positional adjustments, etc.) and (2) the representativeness of the sample of measurements (or data set)[1]. These may be termed respectively *measurement* and *sampling* errors.

D1.2 The in-service EPNLs determined by NTK monitoring are naturally more variable than certificated EPNLs, which are measured under much more tightly constrained operational conditions (including adjustment of the EPNLs to standard day conditions). Aside from measurement errors, variations of EPNL from flight to flight of a particular aircraft type/variant are attributable principally to operational and environmental factors including:

- aircraft operating procedures and flight paths,
- aircraft weight,
- microphone location, and
- atmospheric and meteorological conditions.

D2 Noise monitors

D2.1 The accuracy of the noise measurements is also subject to uncertainties associated with the NTK sound level meters. The requirements for sound level meters are specified in IEC 60651[2] (Ref D1), which places instruments in one of four grades, designated Types 0, 1, 2 and 3 in order of decreasing accuracy.

D2.2 All the NTK noise monitors meet the requirements of a 'Type 1' precision grade instrument and are also subjected to regular calibration checks. The accuracy of the monitors is verified every three months by means of on-site acoustic calibration checks. Daily electrostatic calibration checks are also carried out automatically to confirm the day-to-day performance of the NTK system. Furthermore, each instrument is removed from service on an annual basis and calibrated by an approved calibration agency in order to verify its Type 1 precision. This annual calibration is traceable to UK National Standards.

D3 NTK positional data

D3.1 The height data output by the NTK system are derived from SSR Mode C transmissions of pressure altimeter readings from the aircraft. The resolution of these Flight Level data (which are referenced to a reference atmospheric pressure of 1013.25 hPa) is 100 ft. Below Flight Level 60 (corresponding to an altitude of approximately 6000 ft), the Flight Level is adjusted by the NATS radar data processing system to QNH, i.e. the altitude relative to mean sea level at the London Area local atmospheric pressure. The radar data are then transferred to the airports' NTK systems, which apply the appropriate airfield elevation adjustment, so the data

[1] The EPNLs associated with individual flights of a particular aircraft vary, typically by around 6 EPNdB. The accuracy of the measured average - as an estimate of the 'true' average of all flights - is limited only by the number of measurements; the more the measurements, the greater the accuracy.

[2] In May 2002, IEC 60651 was replaced by IEC 61672-1 (the new international standard for sound level meters), which specifies two performance categories, Class 1 and Class 2.

stored in the NTK represent the aircraft heights above aerodrome level (aal) at a nominal reference point. Sources of inaccuracy for any individual data point include:

- *SSR Mode C Correspondence Error*. As the Mode C transponder reports the Flight Level, which has a resolution of 100 ft, the error introduced from this resolution is a maximum of ±50 ft (on the basis that Flight Level data are rounded to the nearest 100 ft).

- *Altimetry System Error.* The altimeter barometric pressure is subject to on-board measurement accuracy and local pressure variations. The magnitude of these errors is not usually known unless there is some external reference to the aircraft height, but in this context it is considered to be of the order of ±50 ft at most.

- *Conversion errors*. Examples are errors introduced by pressure corrections, the time base of the radar, and co-ordinate transformations (e.g. SSR polar to Cartesian co-ordinates). These factors may contribute further possible height errors of the order of at most 25 ft.

D3.2 The error values given above are broadly-based estimates from NATS. The sum of the error values, 125 ft, is of course indicative of a 'worst case' and in no way represents typical or routine inaccuracy of the system. Indeed, this has been confirmed in a recent study that was carried out to assess the accuracy of the NTK radar data at the London airports (Ref D2). Also note that for the QC monitoring study, the individual height readings (values typically every 4 seconds) were smoothed by ERCD's bespoke radar data processing software, so much of the impact of the coarse resolution was removed before the data were used to calculate aircraft heights relative to the noise monitors.

D3.3 The accuracy in aircraft position (i.e. ground track) as indicated by the NTK system is dependent on the aircraft's location relative to the radar head[3]. The range data (distance between the radar head and the aircraft) have a resolution of 1/16 nm (116 m). Thus, resolution errors in this direction could be of the order of ±60 m. At 90° to this direction, the accuracy decreases with distance from the radar head, as it depends on the resolution of the azimuth angle, 0.088°. At locations close to the vicinity of the NTK fixed monitors (approximately 6.5 km from the radar head at each airport), resolution in this direction is approximately 10 m.

D3.4 As with the height data, when these individual position readings (values typically every 4 seconds) are smoothed, much of the uncertainty associated with the coarse resolution is removed and the overall accuracy of the data is considerably better than the worst case. Furthermore, since the analysis is generally based on large samples of data (rather than individual flights), the effect of any possible inaccuracy in the data on the average measured EPNLs are substantially mitigated and there is no reason to suspect any consistent bias in the average estimates.

D4 Adjustment of measured noise levels

D4.1 EPNLs were measured as close as possible to the certification reference points. The corresponding noise levels at those reference points were estimated by applying a correction to allow for any difference between the measured slant distance and the height of the aircraft above the reference point. The adjustments for slant distance

[3] The primary radar heads at the three London airports are all located within the airport boundaries.

were made in accordance with industry supplied Noise-Power-Distance (NPD) relationships for each aircraft type.

D4.2 Although the NPD data are normally derived from the noise certification process, not all airframe/engine combinations are available. For such cases, it was necessary to use substitute aircraft, based on the best available match of the existing NPD data. In addition, the measured noise levels were not corrected back to the atmospheric conditions on which the NPD data are based. However, because of (i) the stringent weather window used for the study and (ii) the relatively small differences between the propagation distances involved, it is not expected that these factors would affect significantly the overall accuracy of the measurements.

References

D1 IEC 60651: Sound level meters, International Electrotechnical Commission (IEC), 1979.

D2 Cadoux R E and White S: An Assessment of the Accuracy of Flight Path Data used in the Noise and Track-Keeping System at Heathrow, Gatwick and Stansted Airports: ERCD Report 0209, March 2003.