Environmental Research and Consultancy Department

Civil Aviation Authority

ERCD REPORT 0304

Stansted Airport: A Study of Aircraft Noise Insulation Boundaries

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Summary

This report describes the work undertaken by ERCD during 2000 and 2001 to inform proposals for a new sound insulation scheme around Stansted Airport.

July 2003

The authors of this report are employed by the Civil Aviation Authority. The work reported herein was carried out under a Letter of Agreement placed on 22 May 2003 by the Department for Transport. Any views expressed are not necessarily those of the Secretary of State for Transport.

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Enquiries regarding the content of this publication should be addressed to:
Environmental Research and Consultancy Department, Directorate of Airspace Policy, Civil Aviation Authority, CAA House, 45-59 Kingsway, London, WC2B 6TE

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Executive Summary

The first Stansted noise insulation programme came into effect on 1 June 1991. The boundary, which had been drawn up by a working group including representatives from Stansted Airport Limited (STAL), the Department for Transport (DfT) and other organisations, was based on a forecast noise climate and traffic forecasts of the number and types of aircraft likely to be operating when the airport reached 78,000 passenger air transport movements (PATMs); equivalent to 8 million passengers per annum (mppa).

STAL undertook a commitment to review the programme when the actual noise climate associated with Stansted operating at 8 mppa was known, and to introduce a further programme related to any increase in the PATM approved by Parliament.

Passenger throughput at Stansted reached 8 mppa in the summer of 1999 and in July 1999 Parliament approved a new PATM limit of 185,000 per annum (equivalent to 15 mppa).

This report describes specific tasks that required inputs from ERCD. These were to establish the actual noise climate for Stansted operating at 8 mppa and to compare this with the original scheme, to consider the criteria on which a new scheme should be based and to generate noise exposure maps, based on forecasts of aircraft movements and operations, when traffic reaches 185,000 PATMs or 15 mppa.

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1 Introduction

1.1 This report describes the work performed by ERCD during 2000 and 2001 to inform proposals for a new sound insulation scheme at Stansted. These were developed jointly by STAL, DfT and ERCD after a review of the noise insulation programme which came into effect on 1 June 1991. The original scheme boundary was based on forecasts of the noise exposures that would be experienced when air traffic reached a limit of 78000 PATMs/year, equivalent to 8 mppa. That passenger throughput was reached in the summer of 1999 at which time Parliament approved a new limit of 185000 PATMs/year equivalent to 15 mppa. The proposals for a further scheme are therefore based on that level of traffic.

1.2 Specific tasks that required inputs from ERCD were:

- To establish the actual noise climate for Stansted at 8 mppa and compare this with the original forecasts;
- To consider the criteria on which a new scheme should be based; and
- To generate appropriate noise exposure maps based on forecasts of aircraft movements and operations when traffic reaches 185000 PATMs/yr or 15 mppa.

This report outlines the framework of the studies and summarises the work and its conclusions.

2 The 1991 scheme boundary

2.1 The 1991 boundary was defined by overlaying forecast average day and night[1] Leq contours - 66 dBA Leq (16 hour) and 57 dBA Leq (8 hour) - and single event 90 dBA *footprints* for various noisy night-time movements. Following the practice in earlier Heathrow and Gatwick schemes, the footprints notionally related to the noisiest aircraft that averaged at least one movement per night on each of the approach and departure routes. Under the night restrictions in force at the time, the noisiest aircraft permitted to operate (classified as 'NN/B') had footprint areas of 4 square miles on departure and 2.5 square miles on arrival.

2.2 However, it was noted that if the one-per-night rule were applied strictly, some of the qualifying footprints would be considerably smaller than these limits and on some routes, no aircraft type reached an average of one movement per night. Therefore, the SEL footprints were calculated according to a mix of the noisiest aircraft which together met the one-per-night criterion, subject to the 4/2.5 square mile limit. These are referred to here as *composite worst footprints* which are explained in **Appendix A**. Their shapes were representative of aircraft following typical height, speed and noise emission profiles. One set was based on the characteristics of the narrow-bodied twin-jets; another on typical large twin-turbo propeller aircraft - both aircraft expected to be operating when traffic reached 8 mppa. All the contours and footprints used for defining the 1991 scheme boundary are illustrated in **Figure 2.1**.

1 The addition of a night time noise contour reflected the results of sleep disturbance studies by DORA (Reports 8008 and 8513) which tended to point to adopting an average of night noise rather than a single maximum noise event as the criterion for sleep disturbance. However, as the scientific evidence was limited, being based on very small amounts of data, it did not justify setting aside a maximum noise event criterion. Instead, the boundary combined the 57 dBA Leq night contour with night noise footprints.

3 Actual 8 mppa noise exposures (Summer 1999)

3.1 Overview

3.1.1 The aim was to establish what aircraft noise exposures were actually generated around Stansted by the 8 mppa traffic - in comparable terms to those on which the 1991 scheme boundary was based, and taking care not to understate the impact in any way. Thus the same three noise components were determined: daytime and night-time Leq contours and composite worst departure and arrival footprints on the different routes.

3.1.2 The noise maps were to be related to traffic during the 8 hour night period (2300 – 0700) as that was the basis used in the original scheme. Consideration was given to whether they should cover only the night quota period (2330 – 0600) as defined in the night flying restrictions since 1993. This was rejected because the footprints would have been smaller (due to omission of noisier aircraft types operating in the shoulder hours 2300-2330 and 0600-0700) and would not have provided a like-for-like comparison for the purposes of the review.

3.2 8 mppa Leq contours

3.2.1 To minimise the effects of any annual perturbation from average operating conditions, the 1999 16 hour day 66 dBA Leq and 8 hour night 57 dBA Leq contours were based on a standardised modal split of 77% south-west / 23% north-east. This was the 20-year average modal split from 1980 to 1999 inclusive. The corresponding average day and night traffic data are given in **Tables 3.1 to 3.4**. The calculated Leq contours are shown in **Figure 3.1**. All the calculations were based on observed 1999 flight profiles, actual ground tracks/dispersions etc. - i.e. those used to compute the published 1999 historical Leq contours for daytime (**Ref 1**).

3.3 8 mppa SEL footprints

3.3.1 In considering what footprints to use for the review, aircraft types/variants were first ranked by the areas enclosed by their 90 dBA SEL footprints for ‘straight-out’ departures. These are listed in **Table 3.5** and a selection of departure footprints are illustrated in **Figure 3.2**. For arrivals the aircraft types/variants were ranked by their SEL at 2 kilometres to threshold - see **Table 3.6** - thereby avoiding distortions that would be caused by reverse thrust noise which varies somewhat randomly between types. The 1999 footprints for the composite worst aircraft were then calculated according to a mix of the noisiest aircraft which together met the one-per-night rule (and no longer subject to the 4 and 2.5 square mile limit) - see **Appendix A and Tables 3.7 and 3.8**.

4 Comparison of actual 8 mppa noise exposures with 1991 forecasts

4.1 The 1999 contours and footprints are illustrated in **Figure 4.1**. Their enclosed areas are listed in **Table 4.1**.

4.2 The composite boundary formed by the envelope of the actual 8 mppa Leq contours and SEL footprints are compared with the 1991 scheme boundary[2] in **Figure 4.2**. The enclosed areas are very similar, 24.2 square kilometres forecast and 23.7 square kilometres actual, but not surprisingly there are some differences in shape, primarily due to differences between assumed and actual flight tracks.

5 Criteria for a new scheme

5.1 Air Noise

5.1.1 It was noted that the appropriateness of the original criteria, for day 66 dBA Leq (16 hour) and, for night, 57 dBA Leq (8 hour) supplemented by 90 dBA SEL footprints, had been reinforced by guidance subsequently published in PPG24 (September 94). However, that document acknowledged that the scientific basis for the night-time criteria was less well established than that for daytime noise. ERCD (then NATS/DORA) were therefore asked to review the latest research on night-time noise effects and advise whether 90 dBA SEL remains an appropriate criterion.

5.1.2 ERCD's review is at **Appendix B**. The conclusion was that:

"The justification for incorporating a 90 dBA SEL footprint into a noise insulation scheme boundary remains unchanged. If anything, the evidence upon which it was originally specified has been reinforced by the findings from more recent studies." Reference was made to three studies, then ongoing, that were intended to inform government decisions on possible further research into night noise. Those studies were subsequently reported[3] and, after considering the findings, the Government decided to commission a major new study[4] of aircraft noise both during the day and night, having concluded that a new full-scale objective sleep study would be unlikely to add significantly to understanding; and that concentrating instead on further research into subjective responses was the right way forward. That study commenced in December 2001 and is still underway.

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2 The 1991 scheme boundary shown here is based on the contours/footprints generated at the time. This boundary was subsequently adjusted by STAL to account for local conditions at certain specific locations.

3 Porter ND, Kershaw AD, Ollerhead JB, Adverse effects of night-time aircraft noise; NATS R&D Report 9964, March 2000
Flindell, IH et al., Aircraft Noise and Sleep – 1999 UK Trial Methodology Study, 27 November 2000.
Diamond ID et al., Perceptions of Aircraft Noise, Sleep and Health, December 2000.

4 Announced in DETR News Release 269, 8 May 2001.

5.2 Ground Noise

5.2.1 Airport ground noise (other than noise from start of roll and reverse thrust, which are included in the aircraft noise contours) had not been taken into account in determining the original scheme. This had attracted some criticism as some properties known as Coopers Villas, close to the airport boundary and affected by noise from the cargo terminal, were outside the boundary of the insulation programme - even though Stansted Airport Ltd had subsequently contributed to the cost of insulating these properties.

5.2.2 A 1998 NATS Report[5] described a study carried out at Heathrow, Gatwick and Stansted between 1995 and 1997. Phase 1 of the study provided an insight into which sources of ground noise during the night were significant at each airport. Wind direction was found to be crucial in determining the degree of propagation of ground noise into the community. Local road traffic appeared to be a major source of noise, with airport ground noise just one of the many sources contributing to the overall noise environment. At times the airport ground noise component could not readily be isolated and measured as a separate source. There were instructions in place at each of the airports, giving guidance to ground staff on reducing the emission of noise at night. However, it was found that scope existed for further development and more rigorous enforcement of the instructions.

5.2.3 In Phase 2 of the study, measurements were carried out in a total of 14 residential areas around the three airports during the Summer of 1996. The main airport based contributors to the noise environment were found to be taxiing aircraft, airport service vehicles, sirens, auxiliary power units (APUs) and ground running of aircraft engines. The audibility of these sources in the local communities was again shown to be strongly influenced by wind direction, and road traffic noise played a key role in masking ground noise sources emanating from the airport.

5.2.4 The report found that at Stansted, at the four sites closest to the passenger terminal – Coopers Villas, Molehill Green, Takeley and Tye Green (see **Figure 5.1**) – the main night-time ground noise source was the taxiing of turboprop aircraft, which at times reached levels of up to 30 dBA above background levels; noise from taxiing jet aircraft rarely reached comparable levels above background. In addition, noise from the running of APUs and aircraft engines in the alpha apron area were also regularly audible. At the other two monitoring sites, at Bishop's Stortford and Birchanger, the background noise level was dominated by road traffic noise, particularly from the M11 motorway. The studies showed that wind direction was crucial in determining the degree of propagation of ground noise and that because of the relative paucity of buildings on the airfield at Stansted ground noise tended to propagate more readily into the local communities compared with Heathrow.

5.2.5 No specific criteria for the likely 'acceptability' of airport ground noise were found; as a result the noise levels in the residential areas were compared with more general criteria used to benchmark environmental noise. On the basis of these criteria it was suggested that there are certain characteristics of ground noise, such as distinct events with tonal features that are likely to cause adverse reactions in the communities.

5 R&D Report 9850: Night-time Ground Noise, August 1998 (a study carried out by the unit that is now ERCD).

5.2.6 In light of the findings, the report included suggestions for restrictions on the use of noisy equipment at night and engineering controls to mitigate the community impact of ground noise. These have since been followed up by STAL and implemented where practicable - including measures to reduce taxiing noise, engine running and the disturbance from APUs and further disturbance from baggage trolleys travelling over blocked paving. STAL subsequently commissioned further studies of ground noise and further measures are being investigated. Details, provided by STAL, are at **Appendix C**. Future airport development will lead to more buildings to the south east of the terminal aprons, providing some screening. It was concluded that, together, these measures should prevent any substantial increase in ground noise at night in relation to the present approved level of airport development.

5.2.7 Although the substantial NATS study indicated that it might be appropriate to provide some insulation for homes affected by ground noise, it was noted that, as yet, there is no commonly agreed scientific method for comparing the effects of ground noise with those of air noise on the disturbance felt by local people. It was therefore agreed that, for the purposes of any new noise insulation proposals, a criterion for unacceptable ground noise should be based simply on distance from identifiable sources of ground noise, or from the airport boundary. This should be taken into account along with air noise criteria when defining a noise insulation scheme boundary.

5.2.8 Of four sites identified in R&D Report 9850 as being affected to some degree by night-time airport ground noise, two, Molehill Green and Tye Green, were within the boundary of the 1991 noise insulation programme. The third site, Coopers Villas, was insulated subsequently, as noted above.

5.2.9 The fourth site at Takeley will be affected by the new A120 road, due to be completed by autumn 2003, which will run between it and the airport. Comparisons with the situation at Birchanger indicate that, once the road is open, road traffic will be the main source of night-time noise in Takeley.

5.2.10 Taking all these factors into account, it was concluded that any residential property as close, or closer, to an operational area of the airport as Coopers Villas should receive protection against ground noise and be included within the boundary of the further noise insulation scheme. On that basis, a minimum criterion of significant ground noise would be "within 540 metres of an operational area of the airport".

5.2.11 However, as this 540 metre boundary dissected the village of Burton End and because aircraft maintenance activity that affects that village (although restricted to daytime) is likely to increase with the increase in air traffic[6], it was concluded that the ground noise boundary distance should be increased to 600 metres. Specifically, it should be proposed that protection against ground noise should be provided "within the borders created by the M11 and the new A120, and where not applicable, within 600 metres of the apron boundary". The boundary so formed is shown in **Figure 5.1**.

[6] A part of the airport nearest Burton End is used primarily for emergency cargoes, and maintenance hangars. The other main source of noise in this area is from helicopter operations, although at present there are relatively few helicopter movements and no significant increase is forecast.

6 Definition of a new scheme boundary for 15 mppa

6.1 Traffic Forecasts

6.1.1 STAL, in conjunction with BAA, produced forecasts of the timing and also traffic types and routes when traffic is likely to be reach 15 mppa/185,000 movements per annum. Additional movements of about 10%, representing cargo and other traffic not counted against the PATM limit, were included. Passenger traffic was forecast to reach 15 mppa by December 2004 and 185,000 PATM by 2006 or perhaps earlier[7].

6.1.2 Crucial assumptions underpinning the traffic forecasts, including the distribution of traffic between departure routes (which is essential for noise contouring and footprint purposes) are set out below.

6.2 Modal Split

6.2.1 It was decided to use the standard split averaged over the previous 20 years. This is 77% south-west / 23% north-east, as described in paragraph 3.1.

6.3 Departure Routes

6.3.1 Contrary to assumptions made in 1991, it is considered that there is now no prospect of the Dover 23 departure route being withdrawn or of the High Performance departure routes[8] being introduced. It has been the policy of successive Governments to maintain long term stability of the noise preferential departure routes. Any proposals for changes would have to be subject to full assessment and consultation and it is unlikely that any could be introduced before the end of 2004. No changes were therefore assumed in compiling the traffic forecasts or in calculating the noise contours and footprints; the mean tracks and dispersions were those observed in 1999 (and used in the 8 mppa review).

6.4 Night Restrictions

6.4.1 The present night restrictions regime is that announced by the Minister for Aviation in June 1999; it applies from 31 October 1999 until the end of the summer season 2004[9]. In relation to the traffic forecasts, the most significant aspects of the announcement were:

a) the retention of the night period (2300 - 0700) and the night quota period (2330 - 0600);

b) the size of the movements limits and night quota for summer 2004, 7000 and 4950 respectively for Stansted;

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7 It was originally forecast that passenger traffic at Stansted would reach 15 mppa by the end of 2004. More recent trends at Stansted suggest now that 15 mppa will be reached by the end of 2002. However, this does not invalidate the new scheme boundary because (a) any changes to the day and night Leq contours due to aircraft type changes will be small, in particular any B737-200 aircraft still flying must be certificated to Chapter 3 – not the noisier Chapter 2 marks and (b) the night noise footprints together with the ground noise component contribute more to the overall boundary than the day/night Leq contours.

8 It was confirmed in July 1995 that the proposed HP departure routes were not going to be introduced and that the Dover/Lydd route would continue in operation.

9 On 8 April 2003 DfT published a consultation paper on night flying restrictions at Heathrow, Gatwick and Stansted proposing to extend the present night restrictions for a further year to 30 October 2005.

c) the extension of the restrictions on aircraft classified as QC/8 on arrival or departure to match those already in place for aircraft classified QC/16;

d) the decision to ban aircraft classified as QC/4 from being scheduled to land or take off between 2330 and 0600 (the night quota period) from the start of 2002 summer season at all three airports[10] and

e) the undertaking to make provision for Stansted noise quotas and movements limits to be reviewed ahead of 2004 if there is strong growth at the airport and if a further increase in the PATM limit were approved.

6.4.2 In respect of (e) it was noted that the PATM limit was increased to 185,000 soon after the night restrictions were announced. STAL, however, indicated that they would not be seeking an early review of the noise quotas and movements limits and that the night-time noise forecasts should not anticipate an increase. It was also noted that no results were yet available for use from either the EPNL monitoring programme or the review of the QC system. Subject to these limitations, the traffic forecasts took account of all other factors identified above.

6.4.3 The resulting day and night-time summary traffic forecasts for use in the calculation of 16 hour day and 8 hour night noise contours for a further scheme are set out in **Tables 6.1 and 6.2**.

6.5 15 mppa Leq contours

6.5.1 The daily aircraft movement numbers forecast for the average 16 hour day are shown, by aircraft type, for departures (by SID) and for arrivals in **Table 6.3 (a) and (b)** for north-westerly (Runway 23) and south-easterly (Runway 05) mode operations respectively. Corresponding data for the 8 hour 'night' period are displayed in **Tables 6.4 (a) and (b)**. The resultant 66 dBA Leq 16 hour day and the 57 dBA Leq 8 hour 'night' contours are displayed in **Figure 6.1** where it may be seen that the 16 hour day contour lies entirely inside the larger night contour.

6.6 15 mppa night-time SEL footprints

6.6.1 Whilst Leq contours are uniquely defined by the average aircraft movements, a 'worst' single aircraft footprint, notionally that of the noisiest aircraft expected to average at least one movement per night, could be defined in different ways. But as no single type was forecast to reach one movement a night on average, the 1991 scheme boundary allowed for a *composite worst aircraft* on each route. The 8 mppa actual footprints were calculated in an equivalent manner (Appendix A, paragraph 3.2 and Figure 4.1).

6.6.2 An alternative approach would be to adopt an absolute worst case scenario; i.e. assuming at least one movement per night, on each route, of the noisiest aircraft permitted to operate under the night restrictions. It was expected that the 15 mppa limit would be reached in 2004 when the noisiest types permitted to be scheduled during the 6.5 hour night quota period would be QC/2 aircraft. QC/4 aircraft would be permitted to be scheduled in the balance of the night period (2300 – 2330 and 0600 – 0700).

[10] In June 1999 the Government decided to ban aircraft classified as QC/4 from being scheduled to land or take off between 2330 and 0600 at all three airports from the start of the 2002 summer season, subject to the results of the EPNL monitoring and of the QC system review. Subsequently, because of delays to the technical work, it was not possible to confirm the ban formally but the airport companies operate it on a voluntary basis.

6.6.3 A composite worst footprint would take account of the noisiest traffic in the full 8 hour night period, some (in the shoulder periods) noisier than the noisiest QC/2, but to reach the one-per-night average it would also have to take account of quieter aircraft. This might be considered to dilute the original purpose of the night-time footprint as a worst ‘single event’ criterion. Although a ‘noisiest QC/2’ footprint takes no account of the relatively infrequent noisier (QC/4) aircraft in the shoulder hours, dispensing with the one-per-night requirement would produce a larger footprint than the composite worst on every departure route. Moreover, using a QC/2 footprint in this way would provide a strong link with the night restrictions and protect local people from possible inaccuracies in the forecast mix of night-time traffic.

6.6.4 For these reasons it was proposed that the *noisiest QC/2 footprint* be adopted. This would best be defined statistically - a hypothetical aircraft positioned at the top of the QC/2 band but having footprint shapes averaged across all 2-, 3- and 4-engined aircraft in the London fleets. How this aircraft was defined is also described in **Appendix A**.

6.7 Proposed Boundary

6.7.1 The various Leq contours and footprints for the 1999 (8 mppa) review and the forecast 2004 (15 mppa) scenarios are shown in **Figures 6.2 and 6.3**. Possible 15 mppa scheme boundaries are compared with the existing 1991 boundary in **Figures 6.4 and 6.5**.

6.7.2 **Figure 6.2** shows the 1999 8 mppa 16 hour day 66 dBA Leq contour (blue), the 8-hour night 57 dBA Leq contour (red) plus the envelope of the composite worst 90 dBA SEL footprints based on the 8-hour traffic data (green). Also shown on this Figure is the contour which formed the basis of the existing scheme boundary in black. It can be seen that the 16 and 8 hour Leq contours lie completely within the envelope of the composite worst 90 dBA SEL footprints. The traffic data used to generate the Leq contours and composite worst footprints are in **Tables 3.1 - 3.8**.

6.7.3 **Figure 6.3** shows the forecast 15 mppa 16 hour day 66 dBA Leq (blue), the forecast 8 hour 57 dBA Leq contour (red) plus the envelope of the 90 SEL footprints (green) generated by ‘average worst’ QC/2 aircraft operating on every route. Also shown on this Figure is the existing scheme boundary in black. With minor exceptions to the sides of the runways[11], the 16 and 8 hour Leq contours are again completely within the footprint envelope. The traffic data used to generate the Leq contours can be found in **Tables 6.1 - 6.4**.

6.7.4 **Figure 6.4** shows the existing scheme boundary (black), the 8 mppa review boundary (green), the proposed 15 mppa boundary (red) and the ground noise boundary (blue). Note that the 15 mppa boundary line shown takes account of where the 8 hour night 57 dBA Leq contour is just fractionally larger than the envelope of the ‘average worst’ QC/2 footprints. **Figure 6.5** shows the same boundaries overlaid on a map.

6.7.5 **Figure 6.6** shows the 15 mppa air noise boundary (red), the 8 mppa air noise review boundary (green) and the ground noise boundary (light blue). Areas common to both the 8 and 15 mppa air noise boundaries are shown in brown. Also shown on this Figure is the new M11/A120 link roads (dark blue).

[11] These are difficult to see but the red 8 hour night 57 dBA Leq contour is very slightly wider to the sides of the middle of the runway.

References

1 Monkman D J, Edmonds L E, Rhodes D P, White S
Noise Exposure Contours for Stansted Airport 1999
ERCD Report 2003

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Table 3.1

STANSTED 1999 AVERAGE SUMMER 16 HOUR DAY MOVEMENTS RUNWAY 23 (77%)											
	Departures							Arrivals		Departures+ Arrivals	
						Total		Total		Total	Total
ANCON TYPE	BUZ	DVR	CLN	No NPR	VFR	Excl Circuit	Circuit	Excl Circuit	Circuit	(Excl Circuits)	(Circuits)
B707	0.42	0.28	0.13	0.00	0.00	**0.83**	**0.00**	**0.83**	**0.00**	**1.66**	**0.00**
B727C2	0.32	0.60	0.01	0.00	0.00	**0.93**	**0.00**	**0.79**	**0.00**	**1.72**	**0.00**
B727C3	0.46	0.87	0.02	0.00	0.00	**1.35**	**0.00**	**1.14**	**0.00**	**2.49**	**0.00**
B733	14.72	13.64	6.85	0.00	0.00	**35.21**	**0.02**	**35.07**	**0.02**	**70.28**	**0.04**
B737	21.30	5.35	2.43	0.02	0.00	**29.10**	**0.02**	**28.23**	**0.02**	**57.33**	**0.04**
B73N	3.25	2.13	2.23	0.04	0.00	**7.65**	**0.02**	**7.52**	**0.02**	**15.17**	**0.04**
B744	0.00	0.59	0.15	0.00	0.00	**0.74**	**0.00**	**0.47**	**0.00**	**1.21**	**0.00**
B743	0.03	0.00	0.00	0.00	0.00	**0.03**	**0.00**	**0.04**	**0.00**	**0.07**	**0.00**
B741	0.00	0.00	0.00	0.00	0.00	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
B742C2	0.13	0.03	0.14	0.00	0.00	**0.30**	**0.00**	**0.39**	**0.00**	**0.69**	**0.00**
B742C3	0.18	0.03	0.18	0.00	0.00	**0.39**	**0.00**	**0.34**	**0.00**	**0.73**	**0.00**
B747SP	0.09	0.08	0.00	0.00	0.00	**0.17**	**0.00**	**0.16**	**0.00**	**0.33**	**0.00**
B757C	0.13	0.02	0.02	0.00	0.00	**0.17**	**0.00**	**0.05**	**0.00**	**0.22**	**0.00**
B757R	2.24	0.47	0.36	0.02	0.00	**3.09**	**0.00**	**3.00**	**0.00**	**6.09**	**0.00**
B762	0.00	0.04	0.00	0.00	0.00	**0.04**	**0.00**	**0.16**	**0.00**	**0.20**	**0.00**
B763	0.52	0.08	0.00	0.02	0.00	**0.62**	**0.00**	**0.12**	**0.00**	**0.74**	**0.00**
B777	0.02	0.00	0.00	0.00	0.00	**0.02**	**0.00**	**0.02**	**0.00**	**0.04**	**0.00**
BA11	2.32	0.85	0.75	0.00	0.00	**3.92**	**0.00**	**3.53**	**0.00**	**7.45**	**0.00**
BA46	16.10	4.19	2.32	0.02	0.00	**22.63**	**0.00**	**22.78**	**0.00**	**45.41**	**0.00**
CONC	0.01	0.00	0.00	0.00	0.00	**0.01**	**0.00**	**0.01**	**0.00**	**0.02**	**0.00**
DC10	0.00	0.21	0.04	0.00	0.00	**0.25**	**0.02**	**0.25**	**0.02**	**0.50**	**0.04**
DC9	0.05	0.00	3.96	0.00	0.00	**4.01**	**0.00**	**4.00**	**0.00**	**8.01**	**0.00**
DC87	0.02	0.00	0.00	0.00	0.00	**0.02**	**0.00**	**0.02**	**0.00**	**0.04**	**0.00**
EA30	0.02	0.45	0.16	0.00	0.00	**0.63**	**0.00**	**1.26**	**0.00**	**1.89**	**0.00**
EA31	0.37	0.65	0.11	0.02	0.00	**1.15**	**0.00**	**1.12**	**0.00**	**2.27**	**0.00**
EA32	2.79	1.70	0.24	0.02	0.00	**4.75**	**0.00**	**4.33**	**0.00**	**9.08**	**0.00**
EA33	0.05	0.00	0.00	0.00	0.00	**0.05**	**0.00**	**0.04**	**0.00**	**0.09**	**0.00**
EA34	0.00	0.00	0.00	0.00	0.00	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
EXE2	0.16	0.06	0.04	0.00	0.00	**0.26**	**0.01**	**0.45**	**0.01**	**0.71**	**0.02**
EXE3	2.91	1.10	0.62	0.05	0.00	**4.68**	**0.12**	**4.89**	**0.12**	**9.57**	**0.24**
FK10	3.03	4.39	3.81	0.05	0.00	**11.28**	**0.00**	**11.70**	**0.00**	**22.98**	**0.00**
FK28	0.00	0.00	0.00	0.00	0.00	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
L101	0.08	0.00	0.00	0.00	0.00	**0.08**	**0.00**	**0.08**	**0.00**	**0.16**	**0.00**
LTT	12.14	8.70	4.93	0.09	0.00	**25.86**	**0.05**	**27.14**	**0.05**	**53.00**	**0.10**
MD11	1.07	0.00	0.17	0.00	0.00	**1.24**	**0.03**	**1.27**	**0.03**	**2.51**	**0.06**
MD80	0.50	1.13	0.18	0.02	0.00	**1.83**	**0.00**	**1.91**	**0.00**	**3.74**	**0.00**
SP	0.00	0.02	0.00	0.00	0.05	**0.07**	**0.00**	**0.05**	**0.00**	**0.12**	**0.00**
STP	0.18	0.00	0.02	0.02	0.14	**0.36**	**0.00**	**0.35**	**0.00**	**0.71**	**0.00**
STT	0.11	0.79	0.12	0.04	0.08	**1.14**	**0.06**	**1.10**	**0.06**	**2.24**	**0.12**
TU54	0.00	0.00	0.00	0.00	0.00	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
VIS/VAN	0.89	0.04	0.06	0.02	0.00	**1.01**	**0.00**	**1.19**	**0.00**	**2.20**	**0.00**
Total	**86.61**	**48.49**	**30.05**	**0.45**	**0.27**	**165.87**	**0.35**	**165.80**	**0.35**	**331.67**	**0.70**

Table 3.2

STANSTED 1999 AVERAGE SUMMER 16 HOUR DAY MOVEMENTS RUNWAY 05 (23%)											
	Departures							Arrivals		Departures+ Arrivals	
ANCON TYPE	BUZ	DVR	CLN	No NPR	VFR	Total Excl Circuit	Circuit	Total Excl Circuit	Circuit	Total (Excl Circuits)	Total (Circuits)
B707	0.12	0.06	0.06	0.01	0.00	0.25	0.00	0.25	0.00	0.50	0.00
B727C2	0.11	0.16	0.01	0.00	0.00	0.28	0.00	0.23	0.00	0.51	0.00
B727C3	0.15	0.24	0.01	0.00	0.00	0.40	0.00	0.34	0.00	0.74	0.00
B733	4.53	4.10	1.90	0.00	0.00	10.53	0.01	10.48	0.01	21.01	0.02
B737	6.43	1.57	0.70	0.00	0.00	8.70	0.01	8.43	0.01	17.13	0.02
B73N	0.94	0.69	0.66	0.00	0.00	2.29	0.01	2.24	0.01	4.53	0.02
B744	0.00	0.19	0.03	0.00	0.00	0.22	0.00	0.14	0.00	0.36	0.00
B743	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.02	0.00
B741	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B742C2	0.04	0.01	0.04	0.00	0.00	0.09	0.00	0.12	0.00	0.21	0.00
B742C3	0.05	0.01	0.05	0.00	0.00	0.11	0.00	0.10	0.00	0.21	0.00
B747SP	0.04	0.01	0.00	0.00	0.00	0.05	0.00	0.05	0.00	0.10	0.00
B757C	0.04	0.01	0.00	0.00	0.00	0.05	0.00	0.02	0.00	0.07	0.00
B757R	0.66	0.20	0.05	0.01	0.00	0.92	0.00	0.90	0.00	1.82	0.00
B762	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.05	0.00	0.06	0.00
B763	0.15	0.03	0.00	0.00	0.00	0.18	0.00	0.04	0.00	0.22	0.00
B777	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.02	0.00
BA11	0.71	0.28	0.16	0.01	0.00	1.16	0.00	1.05	0.00	2.21	0.00
BA46	4.87	1.15	0.74	0.00	0.00	6.76	0.00	6.80	0.00	13.56	0.00
CONC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DC10	0.00	0.06	0.01	0.00	0.00	0.07	0.01	0.07	0.01	0.14	0.02
DC9	0.03	0.00	1.16	0.00	0.00	1.19	0.00	1.20	0.00	2.39	0.00
DC87	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.02	0.00
EA30	0.02	0.11	0.06	0.00	0.00	0.19	0.00	0.37	0.00	0.56	0.00
EA31	0.12	0.18	0.03	0.01	0.00	0.34	0.00	0.33	0.00	0.67	0.00
EA32	0.82	0.52	0.07	0.00	0.00	1.41	0.00	1.29	0.00	2.70	0.00
EA33	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.02	0.00
EA34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EXE2	0.04	0.02	0.01	0.00	0.00	0.07	0.00	0.14	0.00	0.21	0.00
EXE3	0.80	0.33	0.23	0.04	0.00	1.40	0.03	1.46	0.03	2.86	0.06
FK10	0.91	1.31	1.15	0.00	0.00	3.37	0.00	3.50	0.00	6.87	0.00
FK28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L101	0.02	0.00	0.00	0.00	0.00	0.02	0.00	0.02	0.00	0.04	0.00
LTT	3.55	2.71	1.47	0.00	0.00	7.73	0.02	8.11	0.02	15.84	0.04
MD11	0.32	0.00	0.05	0.00	0.00	0.37	0.01	0.38	0.01	0.75	0.02
MD80	0.18	0.32	0.04	0.00	0.00	0.54	0.00	0.57	0.00	1.11	0.00
SP	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.02	0.00	0.03	0.00
STP	0.04	0.03	0.00	0.01	0.03	0.11	0.00	0.11	0.00	0.22	0.00
STT	0.05	0.22	0.03	0.01	0.03	0.34	0.02	0.33	0.02	0.67	0.04
TU54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
VIS/VAN	0.26	0.01	0.03	0.00	0.00	0.30	0.00	0.36	0.00	0.66	0.00
Total	26.06	14.53	8.75	0.10	0.06	49.50	0.12	49.54	0.12	99.04	0.24

Table 3.3

STANSTED 1999 AVERAGE SUMMER 8 HOUR NIGHT MOVEMENTS RUNWAY 23 (77%)											
	Departures							Arrivals		Departures + Arrivals	
						Total		Total		Total	Total
ANCON TYPE	BUZ	DVR	CLN	No NPR	VFR	Excl Circuit	Circuit	Excl Circuit	Circuits	(Excl Circuits)	(Circuits)
B707		0.00	0.00	0.00	0.00	**0.01**	**0.00**	**0.00**	**0.00**	**0.01**	**0.00**
B727C2	0.01	0.03	0.04	0.00	0.00	**0.10**	**0.00**	**0.25**	**0.00**	**0.35**	**0.00**
B727C3	0.03	0.05	0.06	0.01	0.00	**0.16**	**0.00**	**0.35**	**0.00**	**0.51**	**0.00**
B733	0.04	0.21	0.02	0.00	0.00	**0.63**	**0.00**	**0.71**	**0.00**	**1.34**	**0.00**
B737	0.40	0.00	0.00	0.00	0.00	**0.08**	**0.00**	**0.79**	**0.00**	**0.87**	**0.00**
B73N	0.08	0.01	0.01	0.00	0.00	**0.04**	**0.00**	**0.27**	**0.00**	**0.31**	**0.00**
B744	0.02	0.02	0.01	0.00	0.00	**0.03**	**0.00**	**0.17**	**0.00**	**0.20**	**0.00**
B743	0.00	0.00	0.00	0.00	0.00	**0.00**	**0.00**	**0.01**	**0.00**	**0.01**	**0.00**
B747SP	0.00	0.00	0.00	0.00	0.00	**0.00**	**0.00**	**0.01**	**0.00**	**0.01**	**0.00**
B741	0.00	0.00	0.00	0.00	0.00	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
B742C2	0.00	0.00	0.00	0.00	0.00	**0.00**	**0.00**	**0.02**	**0.00**	**0.03**	**0.00**
B742C3	0.00	0.00	0.01	0.00	0.00	**0.01**	**0.00**	**0.02**	**0.00**	**0.03**	**0.00**
B757C	0.00	0.01	0.02	0.00	0.00	**0.06**	**0.00**	**0.02**	**0.00**	**0.08**	**0.00**
B757R	0.03	0.09	0.22	0.00	0.00	**0.87**	**0.00**	**1.08**	**0.00**	**1.95**	**0.00**
B762	0.56	0.02	0.12	0.00	0.00	**0.15**	**0.00**	**0.04**	**0.00**	**0.19**	**0.00**
B763	0.01	0.06	0.00	0.00	0.00	**0.06**	**0.00**	**0.55**	**0.00**	**0.61**	**0.00**
B777	0.00	0.00	0.00	0.00	0.00	**0.02**	**0.00**	**0.01**	**0.00**	**0.03**	**0.00**
BA11	0.02	0.02	0.01	0.00	0.00	**0.06**	**0.00**	**0.44**	**0.00**	**0.50**	**0.00**
BA46	0.03	0.52	0.02	0.01	0.00	**1.33**	**0.00**	**1.09**	**0.00**	**2.42**	**0.00**
CONC	0.78	0.00	0.00	0.00	0.00	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
DC10	0.00	0.00	0.01	0.00	0.00	**0.01**	**0.00**	**0.02**	**0.00**	**0.03**	**0.00**
DC9	0.00	0.00	0.01	0.00	0.00	**0.01**	**0.00**	**0.00**	**0.00**	**0.01**	**0.00**
DC87	0.00	0.00	0.00	0.00	0.00	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
EA30	0.00	1.13	0.04	0.00	0.00	**1.61**	**0.02**	**0.95**	**0.02**	**2.56**	**0.04**
EA31	0.44	0.00	0.01	0.00	0.00	**0.02**	**0.00**	**0.02**	**0.00**	**0.04**	**0.00**
EA32	0.01	0.14	0.00	0.00	0.00	**0.89**	**0.00**	**1.28**	**0.00**	**2.17**	**0.00**
EA33	0.75	0.00	0.00	0.00	0.00	**0.00**	**0.00**	**0.01**	**0.00**	**0.01**	**0.00**
EA34	0.00	0.00	0.00	0.00	0.00	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
EXE2	0.00	0.01	0.01	0.00	0.00	**0.05**	**0.00**	**0.03**	**0.00**	**0.08**	**0.00**
EXE3	0.03	0.15	0.07	0.00	0.00	**0.77**	**0.00**	**0.35**	**0.00**	**1.12**	**0.00**
FK10	0.55	0.68	0.01	0.00	0.00	**0.73**	**0.00**	**0.30**	**0.00**	**1.03**	**0.00**
FK28	0.04	0.00	0.00	0.00	0.00	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
L101	0.00	0.01	0.00	0.00	0.00	**0.02**	**0.00**	**0.02**	**0.00**	**0.04**	**0.00**
LTT	0.01	0.94	1.25	0.31	0.00	**5.56**	**0.00**	**4.20**	**0.00**	**9.76**	**0.00**
MD11	3.06	0.11	0.04	0.00	0.00	**0.22**	**0.00**	**0.20**	**0.00**	**0.42**	**0.00**
MD80	0.07	0.11	0.06	0.00	0.00	**0.29**	**0.00**	**0.19**	**0.00**	**0.48**	**0.00**
SP	0.12	0.00	0.00	0.00	0.00	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
STP	0.00	0.00	0.02	0.01	0.01	**0.10**	**0.00**	**0.10**	**0.00**	**0.20**	**0.00**
STT	0.06	0.01	0.01	0.02	0.00	**0.08**	**0.08**	**0.06**	**0.08**	**0.14**	**0.16**
TU54	0.04	0.00	0.00	0.00	0.00	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
VIS/VAN	0.00	0.02	0.00	0.01	0.00	**0.84**	**0.00**	**0.65**	**0.00**	**1.49**	**0.00**
	0.81										
Total	**8.00**	**4.35**	**2.08**	**0.37**	**0.01**	**14.81**	**0.10**	**14.21**	**0.10**	**29.02**	**0.20**

Table 3.4

STANSTED 1999 AVERAGE SUMMER 8 HOUR NIGHT MOVEMENTS RUNWAY 05 (23%)

	Departures							Arrivals		Departures + Arrivals	
						Total		Total		Total	Total
ANCON TYPE	BUZ	DVR	CLN	No NPR	VFR	Excl Circuit	Circuit	Excl Circuit	Circuit	(Excl Circuits)	(Circuits)
B707		0.00	0.00	0.00	0.00	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
B727C2	0.00	0.01	0.01	0.00	0.00	**0.03**	**0.00**	**0.07**	**0.00**	**0.10**	**0.00**
B727C3	0.01	0.01	0.02	0.00	0.00	**0.04**	**0.00**	**0.11**	**0.00**	**0.15**	**0.00**
B733	0.01	0.06	0.00	0.00	0.00	**0.18**	**0.00**	**0.21**	**0.00**	**0.39**	**0.00**
B737	0.12	0.00	0.00	0.00	0.00	**0.03**	**0.00**	**0.23**	**0.00**	**0.26**	**0.00**
B73N	0.03	0.00	0.00	0.00	0.00	**0.00**	**0.00**	**0.08**	**0.00**	**0.08**	**0.00**
B744	0.00	0.01	0.00	0.00	0.00	**0.01**	**0.00**	**0.05**	**0.00**	**0.06**	**0.00**
B743	0.00	0.00	0.00	0.00	0.00	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
B747SP	0.00	0.00	0.00	0.00	0.00	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
B741	0.00	0.00	0.00	0.00	0.00	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
B742C2	0.00	0.00	0.00	0.00	0.00	**0.00**	**0.00**	**0.01**	**0.00**	**0.03**	**0.00**
B742C3	0.00	0.00	0.00	0.00	0.00	**0.00**	**0.00**	**0.01**	**0.00**	**0.01**	**0.00**
B757C	0.00	0.00	0.00	0.00	0.00	**0.01**	**0.00**	**0.01**	**0.00**	**0.02**	**0.00**
B757R	0.01	0.03	0.07	0.00	0.00	**0.27**	**0.00**	**0.32**	**0.00**	**0.59**	**0.00**
B762	0.17	0.01	0.04	0.00	0.00	**0.05**	**0.00**	**0.01**	**0.00**	**0.06**	**0.00**
B763	0.00	0.02	0.00	0.00	0.00	**0.02**	**0.00**	**0.17**	**0.00**	**0.19**	**0.00**
B777	0.00	0.00	0.00	0.00	0.00	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
BA11	0.00	0.00	0.00	0.00	0.00	**0.01**	**0.00**	**0.13**	**0.00**	**0.14**	**0.00**
BA46	0.01	0.15	0.00	0.00	0.00	**0.38**	**0.00**	**0.33**	**0.00**	**0.71**	**0.00**
CONC	0.23	0.00	0.00	0.00	0.00	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
DC10	0.00	0.00	0.00	0.00	0.00	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
DC9	0.00	0.00	0.00	0.00	0.00	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
DC87	0.00	0.00	0.00	0.00	0.00	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
EA30	0.00	0.34	0.01	0.00	0.00	**0.48**	**0.00**	**0.29**	**0.00**	**0.77**	**0.00**
EA31	0.13	0.00	0.00	0.00	0.00	**0.00**	**0.00**	**0.01**	**0.00**	**0.01**	**0.00**
EA32	0.00	0.04	0.00	0.00	0.00	**0.27**	**0.00**	**0.38**	**0.00**	**0.65**	**0.00**
EA33	0.23	0.00	0.00	0.00	0.00	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
EA34	0.00	0.00	0.00	0.00	0.00	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
EXE2	0.00	0.00	0.00	0.00	0.00	**0.01**	**0.00**	**0.01**	**0.00**	**0.02**	**0.00**
EXE3	0.01	0.04	0.02	0.00	0.00	**0.23**	**0.00**	**0.11**	**0.00**	**0.34**	**0.00**
FK10	0.17	0.20	0.00	0.00	0.00	**0.21**	**0.00**	**0.09**	**0.00**	**0.30**	**0.00**
FK28	0.01	0.00	0.00	0.00	0.00	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
L101	0.00	0.00	0.00	0.00	0.00	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
LTT	0.00	0.28	0.37	0.09	0.00	**1.65**	**0.00**	**1.25**	**0.00**	**2.90**	**0.00**
MD11	0.91	0.03	0.01	0.00	0.00	**0.06**	**0.00**	**0.06**	**0.00**	**0.12**	**0.00**
MD80	0.02	0.03	0.02	0.00	0.00	**0.08**	**0.00**	**0.06**	**0.00**	**0.14**	**0.00**
SP	0.03	0.00	0.00	0.00	0.00	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
STP	0.00	0.00	0.00	0.00	0.00	**0.02**	**0.00**	**0.03**	**0.00**	**0.05**	**0.00**
STT	0.02	0.00	0.00	0.01	0.00	**0.02**	**0.02**	**0.02**	**0.02**	**0.04**	**0.04**
TU54	0.01	0.00	0.00	0.00	0.00	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
VIS/VAN	0.00	0.01	0.00	0.00	0.00	**0.25**	**0.00**	**0.19**	**0.00**	**0.44**	**0.00**
	0.24										
Total	**2.37**	**1.27**	**0.57**	**0.10**	**0.00**	**4.31**	**0.02**	**4.24**	**0.02**	**8.55**	**0.04**

Table 3.5

AREA OF 90 dBA SEL DEPARTURE FOOTPRINTS RANKED BY LARGEST TO SMALLEST	
ANCON TYPE	**AREA SQ KM**
BA11	59.17
B742C3	55.74
B727C2	54.15
B707	41.19
B727C3	29.12
B737	26.49
B744	17.51
DC9	16.39
MD80	16.14
DC10	15.16
MD11	11.76
L101	11.24
EA30	11.16
B762	8.28
B777	7.80
EA31	7.15
B763	6.71
EA33	6.71
DC87	5.94
EXE2	5.00
B73N	4.82
EXE3	4.67
VIS/VAN	4.65
B733	4.52
B757C	3.81
EA32	3.63
MD90	3.39
BA46	3.00
CRJ	2.71
CRJX	2.71
B736	2.66
B717	2.55
B738	2.43
B757R	2.42
FK10	2.27
LTT	1.26

Table 3.6

ARRIVAL NOISE AT 2KM TO THRESHOLD RANKED BY NOISIEST TO QUIETEST	
ANCON TYPE	**dBA SEL**
B707	103.6
B727C2	102.9
L101	101.2
DC10	101.0
MD11	100.6
BA11	100.4
B744	100.1
B727C3	99.5
EA30	99.5
DC9	98.7
EA31	98.7
VIS/VAN	98.5
B763	97.4
B762	96.9
B777	96.2
B757C	95.9
B737	95.4
EXE2	94.7
B73N	94.5
EA32	94.0
B733	93.8
B757R	93.1
LTT	93.1
MD80	91.7
BA46	91.2
EXE3	90.7
FK10	90.1

Table 3.7

STANSTED 1999 (8 MPPA) COMPOSITION OF TYPES MAKING UP COMPOSITE WORST FOOTPRINT ON EACH DEPARTURE ROUTE

RUNWAY 23 BUZ/BKY/CPT		**RUNWAY 23 DVR/LYD/LAM**		**RUNWAY 23 CLN**	
TYPE	CONTRIBUTION	TYPE	CONTRIBUTION	TYPE	CONTRIBUTION
EA30	31.06%	EA30	48.20%	B727C2	22.99%
B737	13.41%	MD80	11.80%	B727C3	18.54%
MD80	12.25%	B727C2	10.79%	B762	10.54%
BA11	11.23%	B727C3	9.67%	MD80	10.28%
B727C2	10.28%	MD11	8.60%	BA11	6.28%
B727C3	7.37%	BA11	7.86%	B757R	5.65%
MD11	5.21%	B744	2.33%	MD11	4.99%
B707	2.61%			EA30	4.74%
EXE3	2.36%			EXE3	3.47%
				LTT	2.41%
				B744	1.86%
				DC9	1.74%
				DC10	1.61%
Other*	4.22%	Other	0.75%	Other	4.90%
Totals	100.00%		100.00%		100.00%

RUNWAY 05 BUZ/BKY/CPT		**RUNWAY 05 DVR/LYD/LAM**		**RUNWAY 05 CLN**	
TYPE	CONTRIBUTION	TYPE	CONTRIBUTION	TYPE	CONTRIBUTION
EA30	18.86%	EA30	50.63%		No footprint
VIS/VAN	14.51%	B727C2	7.22%		total number less
B737	10.33%	MD80	6.46%		than one
EXE3	10.32%	FK10	6.06%		
EA32	9.91%	BA46	6.00%		
BA11	7.69%	MD11	4.71%		
B733	7.05%	B727C3	3.89%		
B727C2	7.04%	B733	3.62%		
MD80	6.29%	EXE3	2.49%		
B727C3	3.79%	B744	2.34%		
MD11	3.06%	EA32	1.94%		
		B763	1.79%		
		B762	1.10%		
Other	1.15%	Other	1.75%		
Totals	100.00%		100.00%		

* Other types whose contribution is less than 1%

Table 3.8

STANSTED 1999 (8 MPPA) COMPOSITION OF TYPES MAKING UP COMPOSITE WORST FOOTPRINT ON EACH ARRIVAL ROUTE

RUNWAY 23		RUNWAY 05	
TYPE	CONTRIBUTION	TYPE	CONTRIBUTION
B727C2	35.11%	EA30	26.22%
BA11	34.74%	BA11	14.46%
MD11	16.54%	B727C2	13.85%
B742C2	4.77%	VIS/VAN	13.65%
B742C3	2.39%	B727C3	9.95%
L101	1.90%	MD11	6.99%
DC10	1.81%	B744	5.19%
B743	1.20%	B763	3.90%
		B742C2	3.36%
		B742C3	1.68%
Other*	1.54%	Other	0.75%
Totals	100.00%		100.00%

* Other types whose contribution is less than 1%

Table 4.1

STANSTED 1999 Review 8 mppa

Leq contours	Area sq. km	Area sq. miles
16 hour day	12.7	4.9
8 hour night	9.8	3.8
90 dBA SEL footprints		
Rwy 23 BUZ/BKY/CPT	15.6	6.0
Rwy 23 DVR	14.5	5.6
Rwy 23 CLN	10.1	3.9
Rwy 05 BUZ/BKY/CPT	8.4	3.2
Rwy 05 DVR	8.0	3.1
Rwy 23 arrival	5.9	2.3
Rwy 05 arrival	4.7	1.8

Table 6.1

STANSTED 2004 (15 mppa) AVERAGE SUMMER DAY 16 HOURS						
ANCON TYPE		**Ave no. Departures**		**Ave no. Arrivals**		**Ave no. Departures+Arrivals**
EA30		0.78		0.78		1.55
EA32		44.72		44.72		89.44
EA33		1.16		1.16		2.31
B717		9.22		9.22		18.45
B733		42.26		42.26		84.52
B736		32.95		32.95		65.89
B738		34.35		34.35		68.69
B744		2.78		2.78		5.55
B757C		2.31		2.28		4.59
B757R		5.23		5.25		10.48
B762		0.50		0.60		1.10
B763		9.56		9.46		19.01
B777		1.09		1.09		2.18
MD11		2.22		2.22		4.44
MD80		1.00		1.00		2.01
MD90		2.01		2.01		4.02
BA46		30.91		30.91		61.82
CRJ		9.93		9.93		19.86
CRJX		28.26		28.26		56.52
FK10		10.25		10.25		20.50
DC870		0.40		0.40		0.80
LTT		22.82		22.82		45.65
STT		9.34		9.34		18.68
VISVAN		0.79		0.79		1.59
B742C3		0.51		0.51		1.01
EXE3		6.31		6.31		12.63
STP		0.87		0.87		1.74
SP		0.07		0.07		0.15
Totals		**312.59**		**312.59**		**625.19**

Table 6.2

STANSTED 2004 (15 mppa) AVERAGE SUMMER NIGHT 8 HOURS			
ANCON TYPE	**Ave no. Departures**	**Ave no. Arrivals**	**Ave no. Departures+Arrivals**
EA30	2.23	2.23	4.47
EA32	2.32	2.32	4.63
EA33	0.02	0.02	0.04
B717	1.35	1.35	2.69
B733	0.52	0.52	1.04
B736	0.71	0.71	1.41
B738	1.08	1.08	2.17
B757C	2.32	2.32	4.63
B757R	0.62	0.62	1.23
B762	0.11	0.11	0.22
B763	1.43	1.43	2.87
MD11	1.21	1.21	2.41
BA46	2.79	2.79	5.58
CRJX	1.58	1.58	3.17
FK10	0.52	0.52	1.03
LTT	2.80	2.80	5.60
STT	1.28	1.28	2.55
VISVAN	1.11	1.11	2.22
EXE3	0.79	0.79	1.59
STP	0.16	0.16	0.32
Totals	**24.94**	**24.94**	**49.87**

Table 6.3a

STANSTED 2004 (15 mppa) AVERAGE SUMER 16 HOUR DAY MOVEMENTS RUNWAY 23 (77%)							
					Total	Total	Total Departures
ANCON TYPE	BUZ	CLN	DVR	No NPR	Departures	Arrivals	+Arrivals
EA30	0.28	0.20	0.13	0.00	0.60	0.60	1.20
EA32	12.81	11.08	10.55	0.00	34.44	34.44	68.87
EA33	0.57	0.12	0.20	0.00	0.89	0.89	1.78
B717	1.61	1.63	3.87	0.00	7.10	7.10	14.20
B733	13.87	8.06	10.60	0.00	32.54	32.54	65.08
B736	14.60	5.85	4.91	0.00	25.37	25.37	50.74
B738	12.64	7.37	6.44	0.00	26.45	26.45	52.89
B744	1.23	0.24	0.67	0.00	2.14	2.14	4.27
B757C	1.15	0.08	0.54	0.00	1.78	1.76	3.54
B757R	2.15	0.16	1.71	0.00	4.03	4.05	8.07
B762	0.31	0.00	0.08	0.00	0.39	0.46	0.85
B763	5.01	0.33	2.01	0.00	7.36	7.28	14.64
B777	0.24	0.11	0.49	0.00	0.84	0.84	1.68
MD11	1.54	0.07	0.11	0.00	1.71	1.71	3.42
MD80	0.00	0.77	0.00	0.00	0.77	0.77	1.55
MD90	0.00	1.53	0.01	0.00	1.55	1.55	3.09
BA46	14.93	2.92	5.95	0.00	23.80	23.80	47.60
CRJ	3.12	1.54	2.99	0.00	7.64	7.64	15.29
CRJX	11.27	4.13	6.36	0.00	21.76	21.76	43.52
FK10	1.58	2.24	4.07	0.00	7.89	7.89	15.78
DC870	0.30	0.00	0.00	0.00	0.31	0.31	0.61
LTT	11.44	1.76	4.38	0.00	17.57	17.57	35.15
STT	4.23	0.83	2.14	0.00	7.19	7.19	14.39
VISVAN	0.57	0.01	0.03	0.00	0.61	0.61	1.22
B742C3	0.26	0.02	0.11	0.00	0.39	0.39	0.78
EXE3	2.85	0.67	1.35	0.00	4.86	4.86	9.72
STP	0.46	0.07	0.13	0.00	0.67	0.67	1.34
SP	0.04	0.00	0.01	0.00	0.06	0.06	0.11
Totals	119.06	51.80	69.83	0.00	240.70	240.70	481.39

Table 6.3b

STANSTED 2004 (15 mppa) AVERAGE SUMER 16 HOUR DAY MOVEMENTS RUNWAY 05 (23%)							
					Total	Total	Total Departures
ANCON TYPE	BUZ	CLN	DVR	No NPR	Departures	Arrivals	+Arrivals
EA30	0.08	0.06	0.04	0.00	0.18	0.18	0.36
EA32	3.83	3.46	2.99	0.01	10.29	10.29	20.57
EA33	0.17	0.04	0.06	0.00	0.27	0.27	0.53
B717	0.48	0.54	1.09	0.00	2.12	2.12	4.24
B733	4.16	2.53	3.02	0.01	9.72	9.72	19.44
B736	4.36	1.80	1.41	0.01	7.58	7.58	15.16
B738	3.77	2.27	1.85	0.00	7.90	7.90	15.80
B744	0.38	0.07	0.19	0.00	0.64	0.64	1.28
B757C	0.34	0.02	0.14	0.00	0.51	0.51	1.01
B757R	0.66	0.07	0.50	0.00	1.23	1.23	2.45
B762	0.09	0.00	0.02	0.00	0.12	0.12	0.23
B763	1.53	0.11	0.56	0.00	2.20	2.20	4.39
B777	0.08	0.02	0.14	0.00	0.25	0.25	0.50
MD11	0.46	0.02	0.02	0.00	0.51	0.51	1.02
MD80	0.00	0.23	0.00	0.00	0.23	0.23	0.46
MD90	0.00	0.46	0.00	0.00	0.46	0.46	0.92
BA46	4.46	0.92	1.71	0.01	7.11	7.11	14.22
CRJ	0.94	0.49	0.86	0.00	2.28	2.28	4.57
CRJX	3.37	1.34	1.78	0.01	6.50	6.50	13.00
FK10	0.48	0.70	1.18	0.00	2.36	2.36	4.71
DC870	0.09	0.00	0.00	0.00	0.09	0.09	0.18
LTT	3.42	0.55	1.27	0.01	5.25	5.25	10.50
STT	1.27	0.26	0.62	0.00	2.15	2.15	4.30
VISVAN	0.17	0.00	0.01	0.00	0.18	0.18	0.37
B742C3	0.08	0.01	0.03	0.00	0.12	0.12	0.23
EXE3	0.86	0.21	0.38	0.00	1.45	1.45	2.90
STP	0.14	0.02	0.04	0.00	0.20	0.20	0.40
SP	0.01	0.00	0.00	0.00	0.02	0.02	0.03
Totals	35.70	16.22	19.92	0.06	71.90	71.90	143.79

Table 6.4a

STANSTED 2004 (15 mppa) AVERAGE SUMER 8 HOUR NIGHT MOVEMENTS RUNWAY 23 (77%)										
						Total		Total		Total Departures
ANCON TYPE	BUZ	CLN	DVR	No NPR		Departures		Arrivals		+Arrivals
EA30	0.68	0.35	0.70	0.00		1.72		1.72		3.44
EA32	0.52	0.27	1.00	0.00		1.78		1.78		3.57
EA33	0.02	0.00	0.00	0.00		0.02		0.02		0.03
B717	0.39	0.13	0.52	0.00		1.04		1.04		2.07
B733	0.20	0.04	0.16	0.00		0.40		0.40		0.80
B736	0.02	0.15	0.37	0.00		0.54		0.54		1.09
B738	0.33	0.07	0.43	0.00		0.83		0.83		1.67
B757C	0.81	0.31	0.67	0.00		1.78		1.78		3.57
B757R	0.18	0.04	0.25	0.00		0.47		0.47		0.95
B762	0.03	0.01	0.05	0.00		0.09		0.09		0.17
B763	0.80	0.05	0.25	0.00		1.10		1.10		2.21
MD11	0.81	0.02	0.09	0.00		0.93		0.93		1.86
BA46	1.05	0.19	0.91	0.00		2.15		2.15		4.29
CRJX	0.41	0.08	0.73	0.00		1.22		1.22		2.44
FK10	0.20	0.01	0.19	0.00		0.40		0.40		0.80
LTT	1.09	0.41	0.66	0.00		2.16		2.16		4.31
STT	0.92	0.02	0.04	0.00		0.98		0.98		1.97
VISVAN	0.81	0.01	0.03	0.00		0.85		0.85		1.71
EXE3	0.27	0.11	0.23	0.00		0.61		0.61		1.22
STP	0.10	0.01	0.01	0.00		0.12		0.12		0.24
Totals	9.64	2.27	7.28	0.00		19.20		19.20		38.40

Table 6.4b

STANSTED 2004 (15 mppa) AVERAGE SUMER 8 HOUR NIGHT MOVEMENTS RUNWAY 05 (23%)										
						Total		Total		Total Departures
ANCON TYPE	BUZ	CLN	DVR	No NPR		Departures		Arrivals		+Arrivals
EA30	0.20	0.13	0.19	0.00		0.51		0.51		1.03
EA32	0.16	0.09	0.28	0.00		0.53		0.53		1.06
EA33	0.01	0.00	0.00	0.00		0.01		0.01		0.01
B717	0.12	0.04	0.15	0.00		0.31		0.31		0.62
B733	0.06	0.01	0.05	0.00		0.12		0.12		0.24
B736	0.00	0.06	0.10	0.00		0.16		0.16		0.33
B738	0.10	0.02	0.12	0.00		0.25		0.25		0.50
B757C	0.24	0.10	0.19	0.00		0.53		0.53		1.07
B757R	0.06	0.01	0.07	0.00		0.14		0.14		0.28
B762	0.01	0.00	0.01	0.00		0.03		0.03		0.05
B763	0.25	0.01	0.07	0.00		0.33		0.33		0.66
MD11	0.25	0.01	0.02	0.00		0.28		0.28		0.55
BA46	0.32	0.06	0.26	0.00		0.64		0.64		1.28
CRJX	0.12	0.04	0.20	0.00		0.36		0.36		0.73
FK10	0.06	0.00	0.06	0.00		0.12		0.12		0.24
LTT	0.33	0.13	0.19	0.00		0.64		0.64		1.29
STT	0.28	0.00	0.01	0.00		0.29		0.29		0.59
VISVAN	0.24	0.00	0.01	0.00		0.25		0.25		0.51
EXE3	0.08	0.03	0.07	0.00		0.18		0.18		0.36
STP	0.03	0.00	0.00	0.00		0.04		0.04		0.07
Totals	2.92	0.76	2.05	0.01		5.74		5.74		11.47

Intentionally Blank

Figure 2.1
Component parts of the 1991 Stansted noise insulation grants scheme boundary

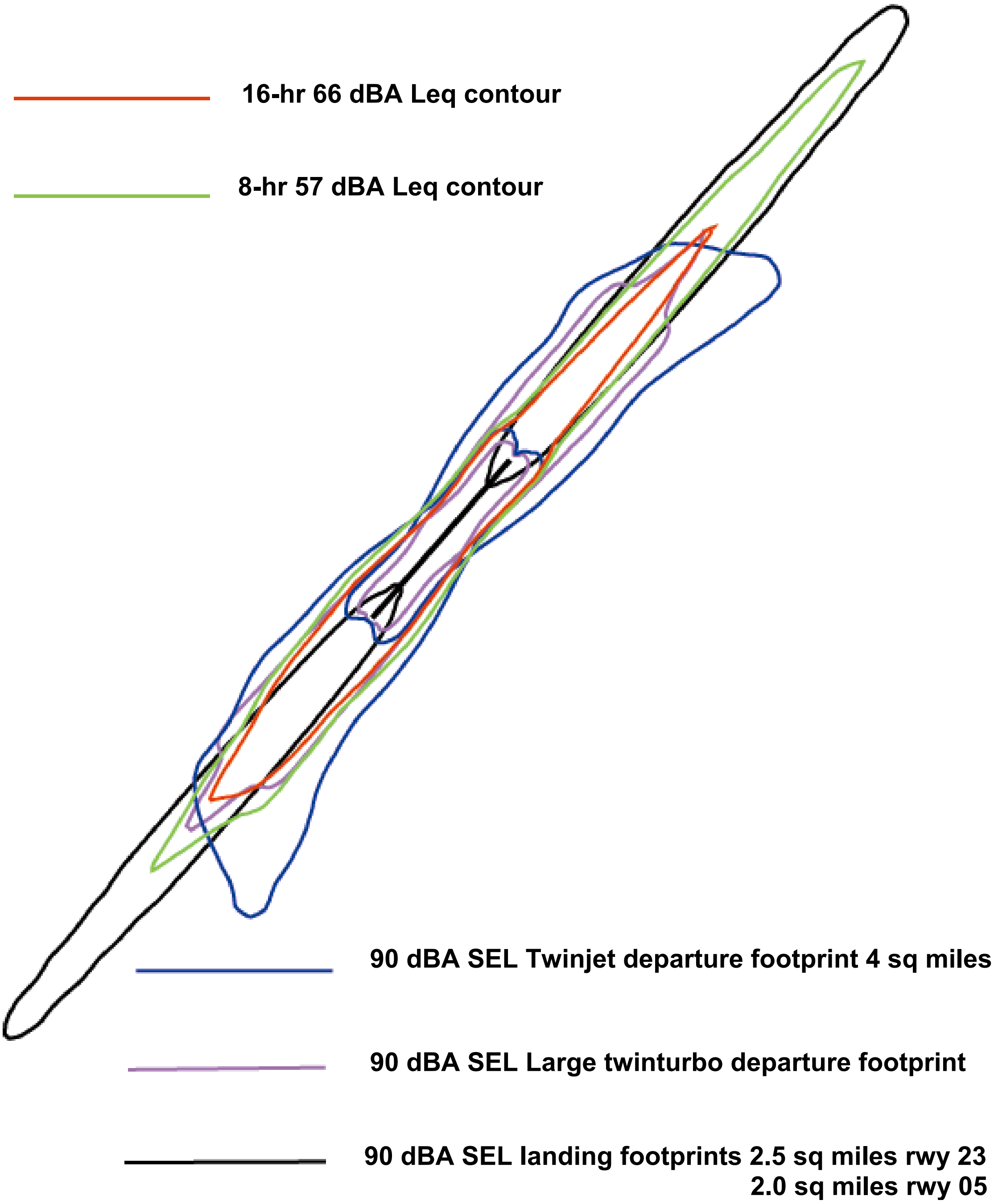


Figure 3.1
Stansted 1999 average mode (77% south-west / 23% north-east) 16 hour day 66 dBA Leq and 8 hour night 57 dBA Leq contours.

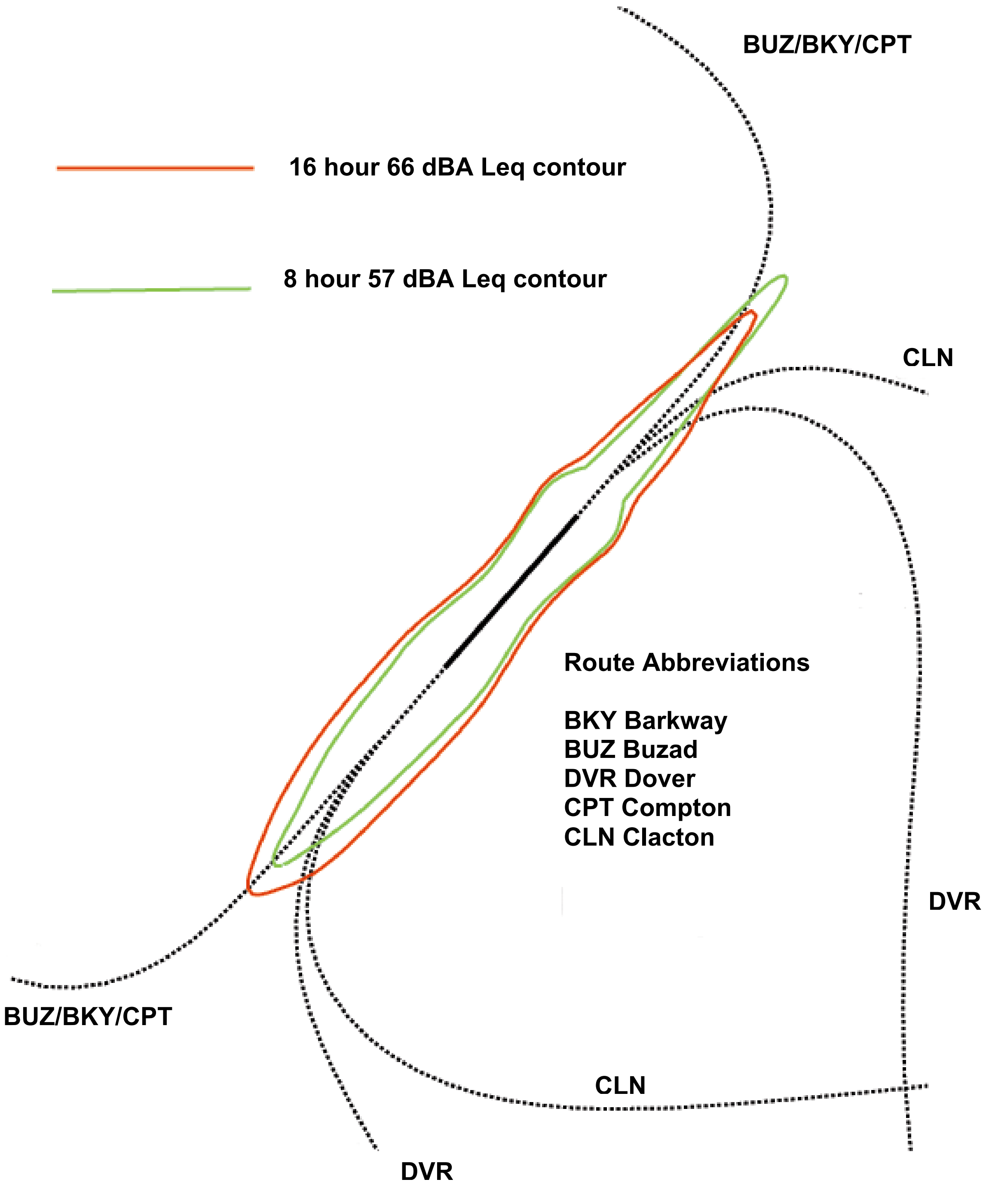


Figure 3.2

90 dBA SEL Departure footprints on straight out route
No dispersion

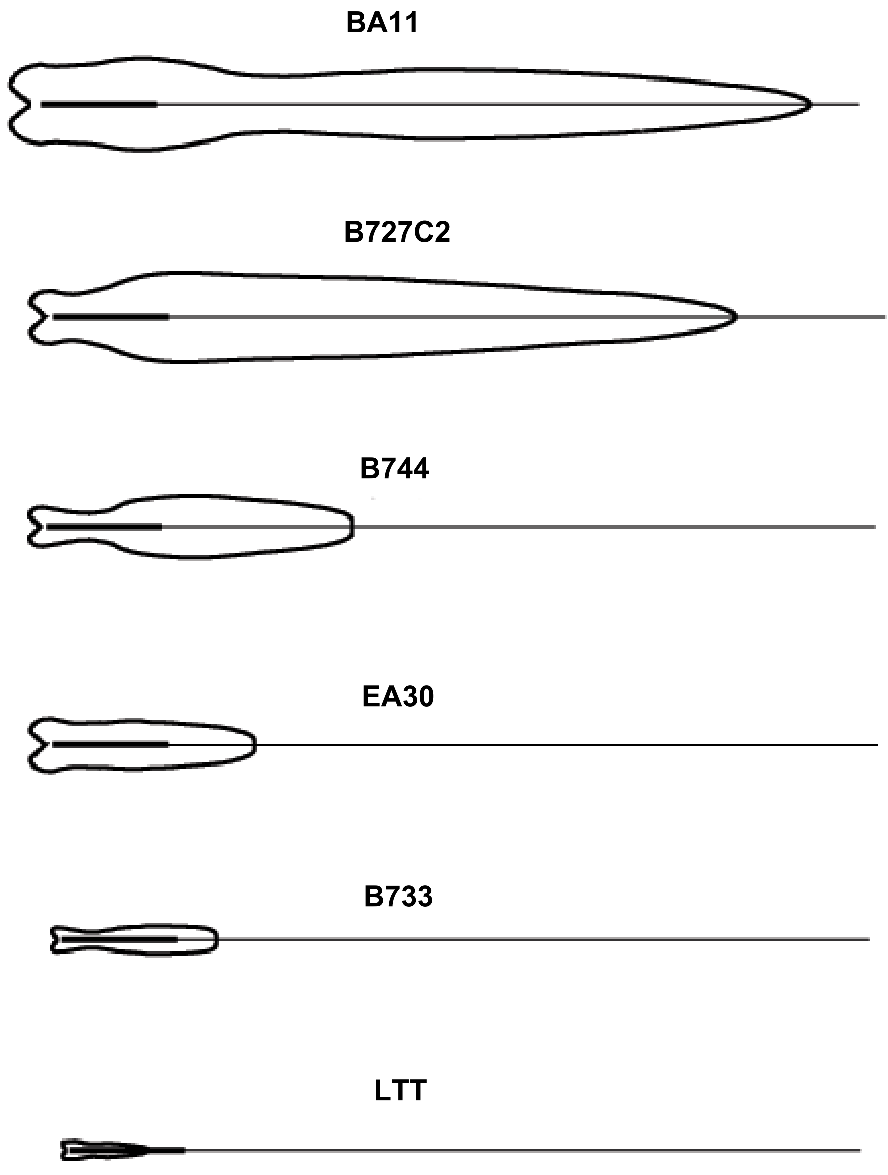


Figure 4.1
Stansted 1999 Contours and Footprints

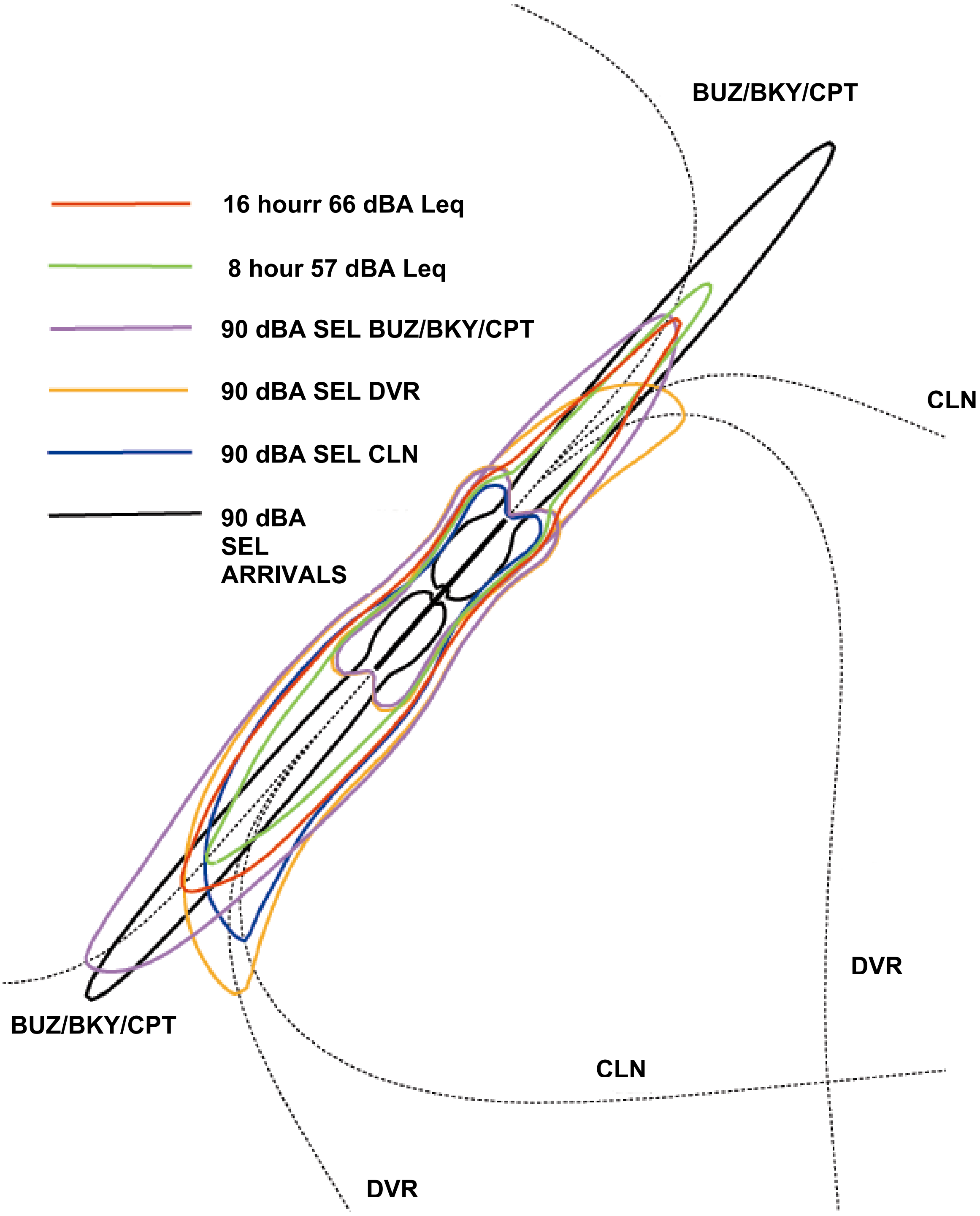


Figure 4.2
Stansted 1991 scheme boundary (black) and 1999 review (red)

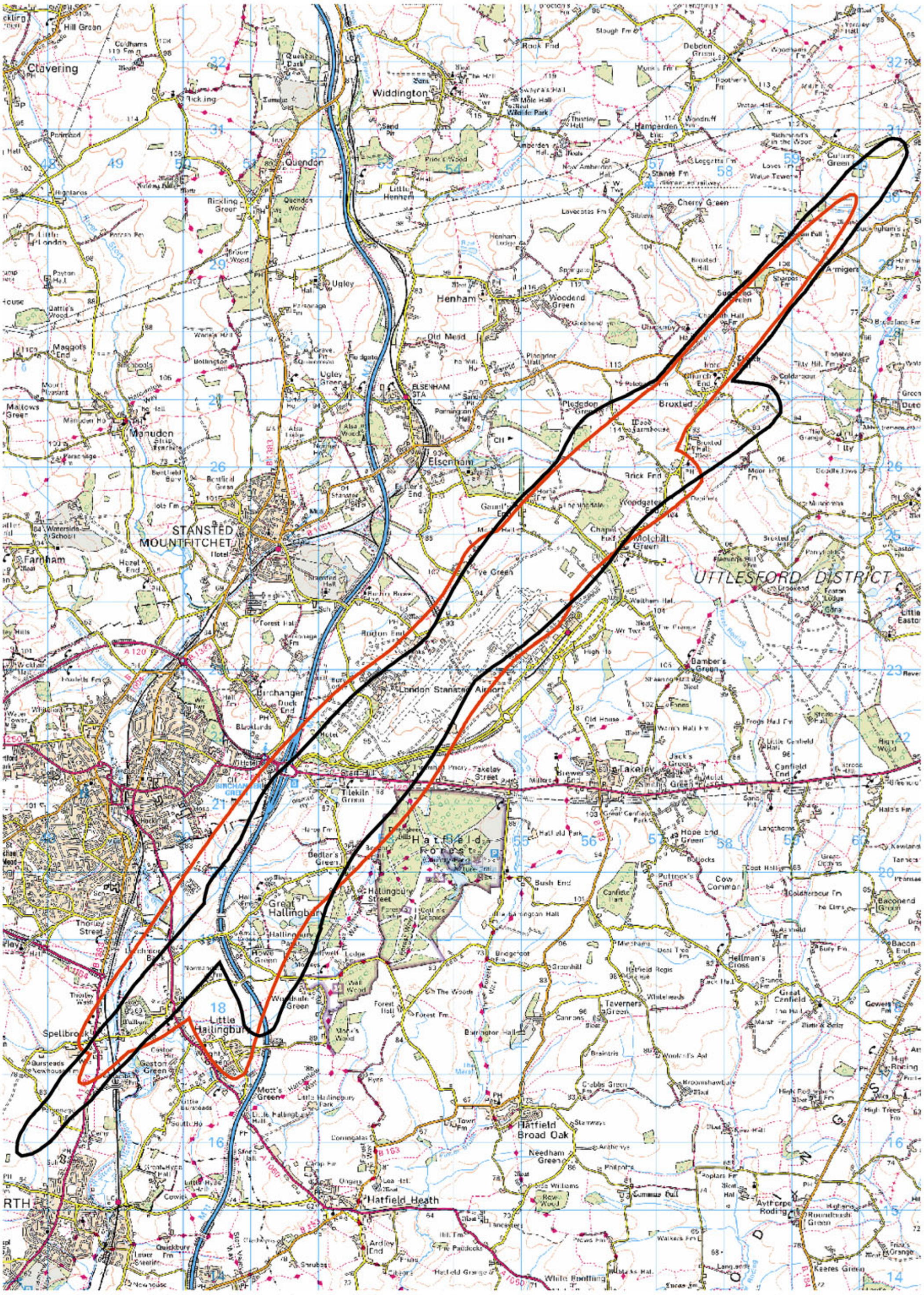


Figure 5.1
Ground noise boundary 600m (red) new M11/A120 link road (blue)

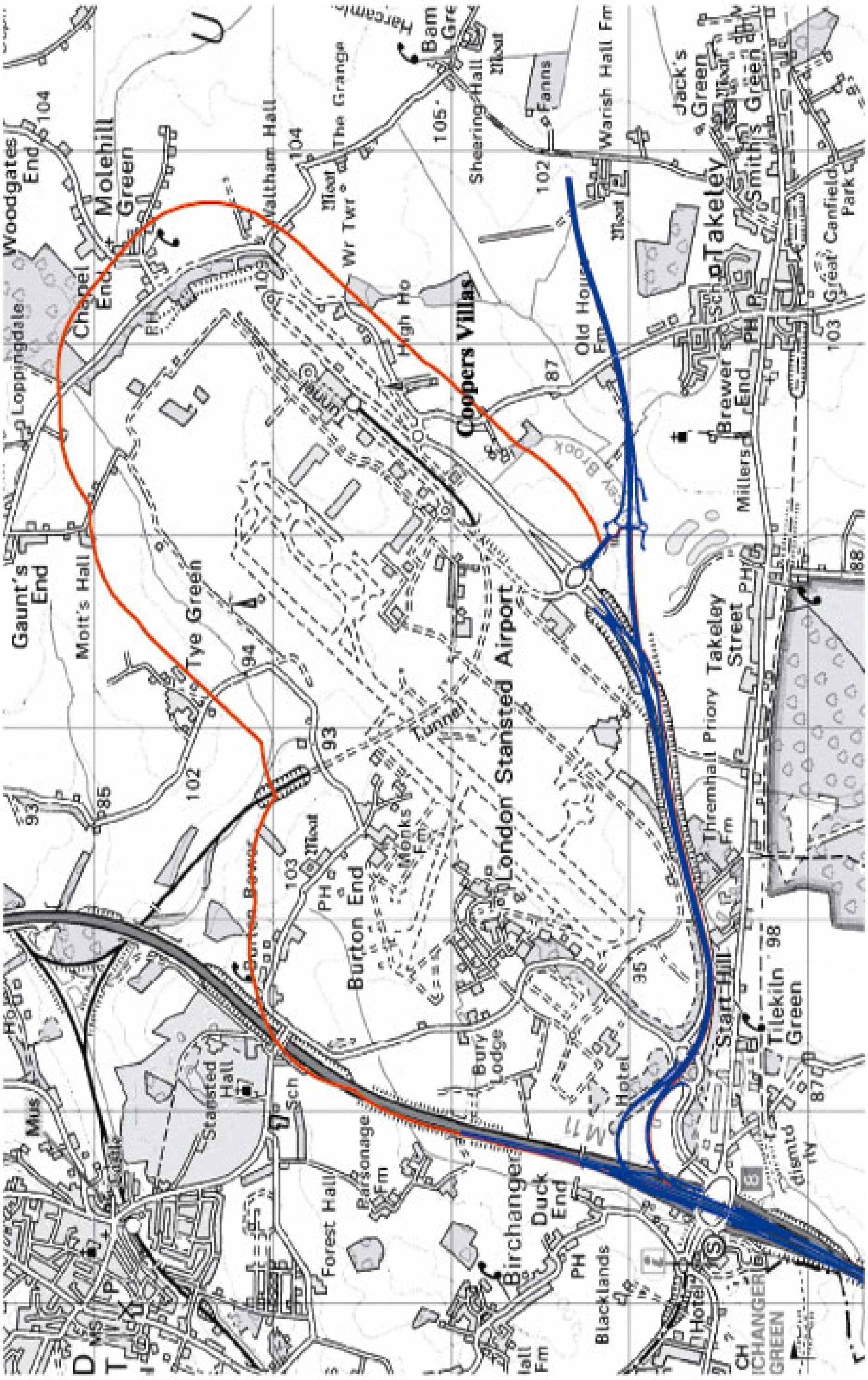


Figure 6.1
Stansted 2004 average mode (77% south-west / 23% north-east) 16 hour day 66 dBA Leq and 8 hour night 57 dBA Leq Contours and Footprints

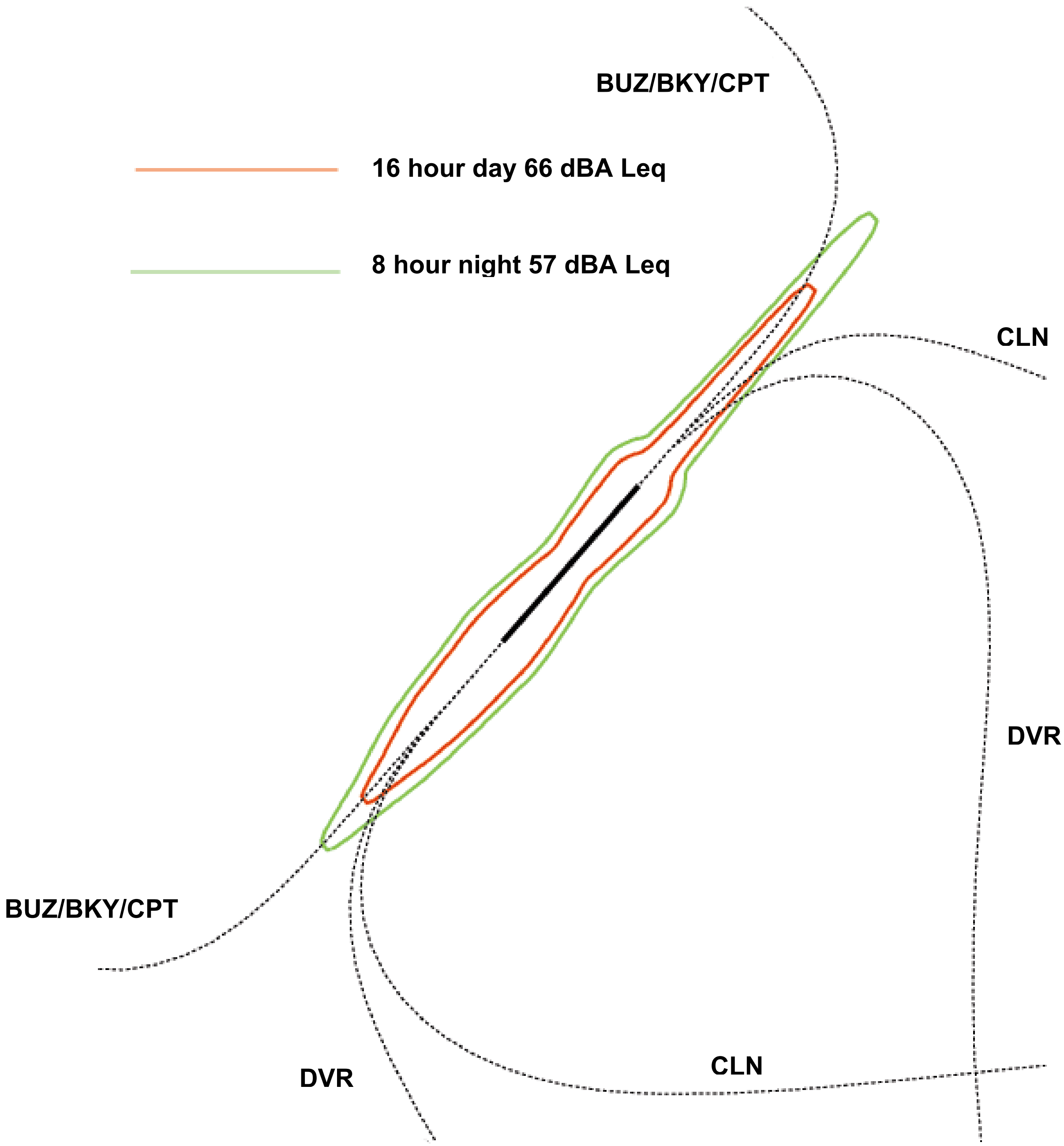


Figure 6.2
Stansted 8 mppa review 1999

Figure 6.3
Stansted at 15 mppa (2004)

16 hour day 66 dBA Leq contour (blue)

8 hour night 57 dBA Leq contour (red)

Envelope of average worst QC 2 footprint 90 dBA SEL on every route (green)

Original scheme boundary (black)

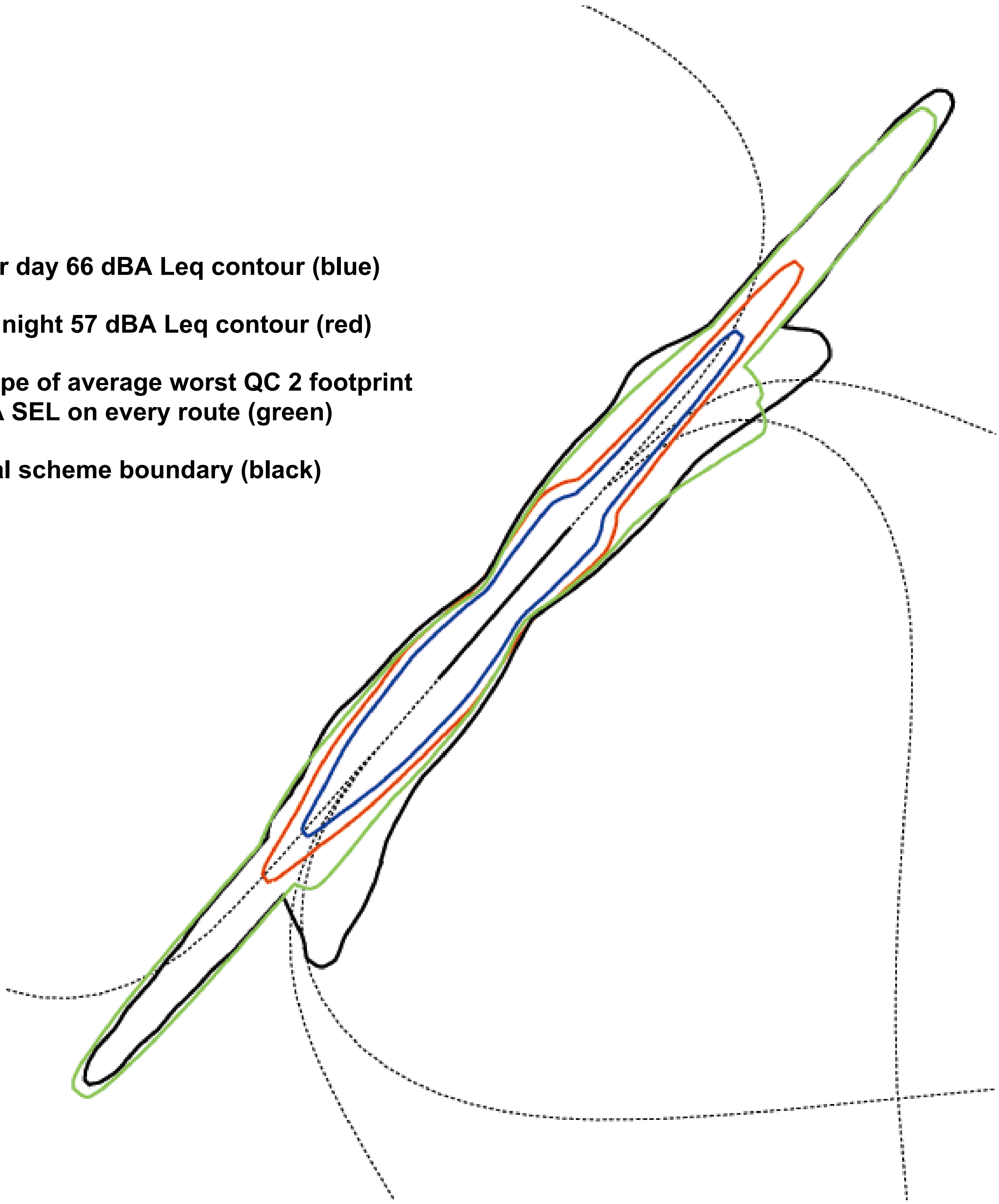


Figure 6.4
Stansted noise exposures

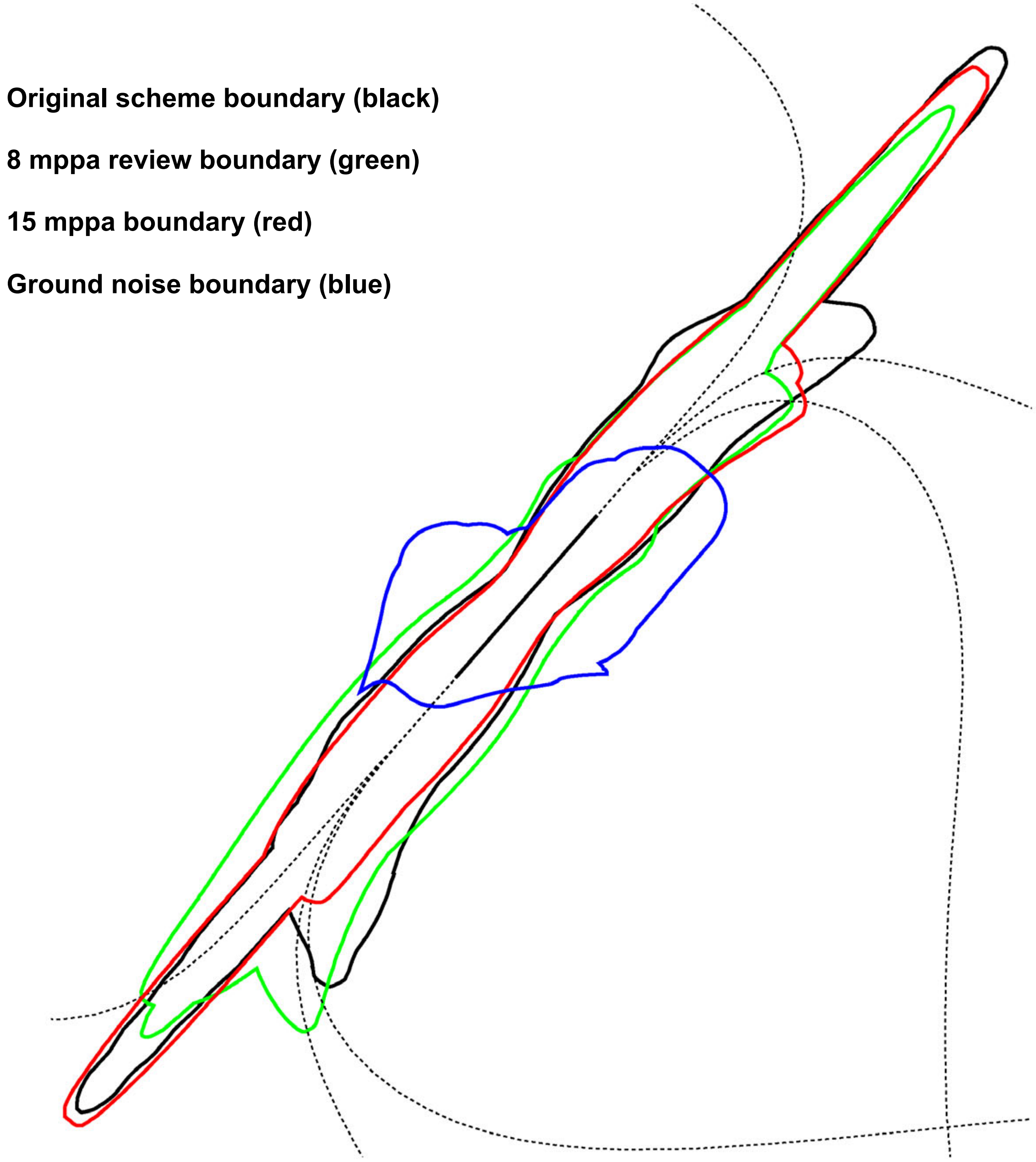


Figure 6.5
Stansted noise exposures

Original scheme boundary (black), 8 mppa review scheme (green), 15 mppa air noise scheme (red), Ground noise (blue)

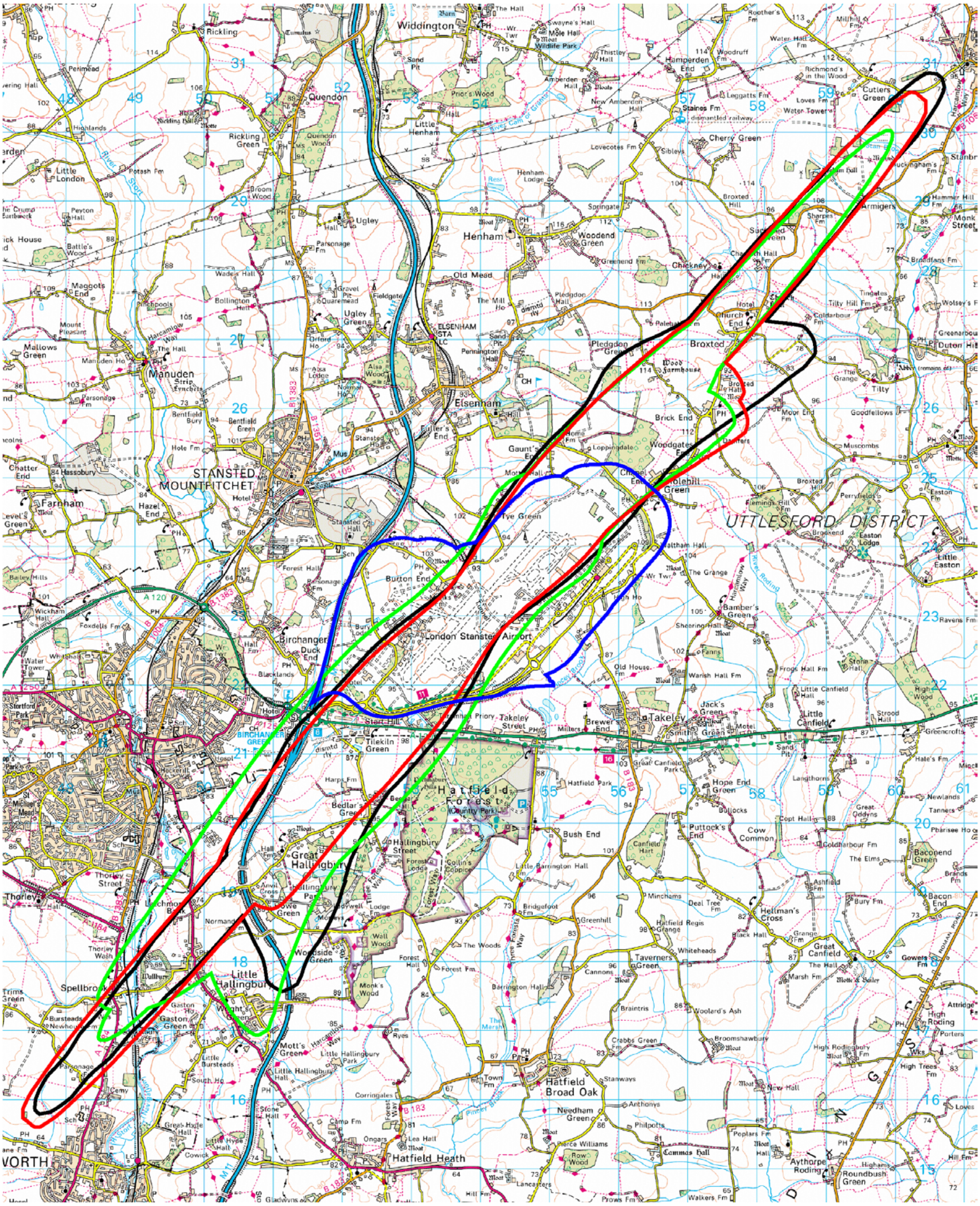
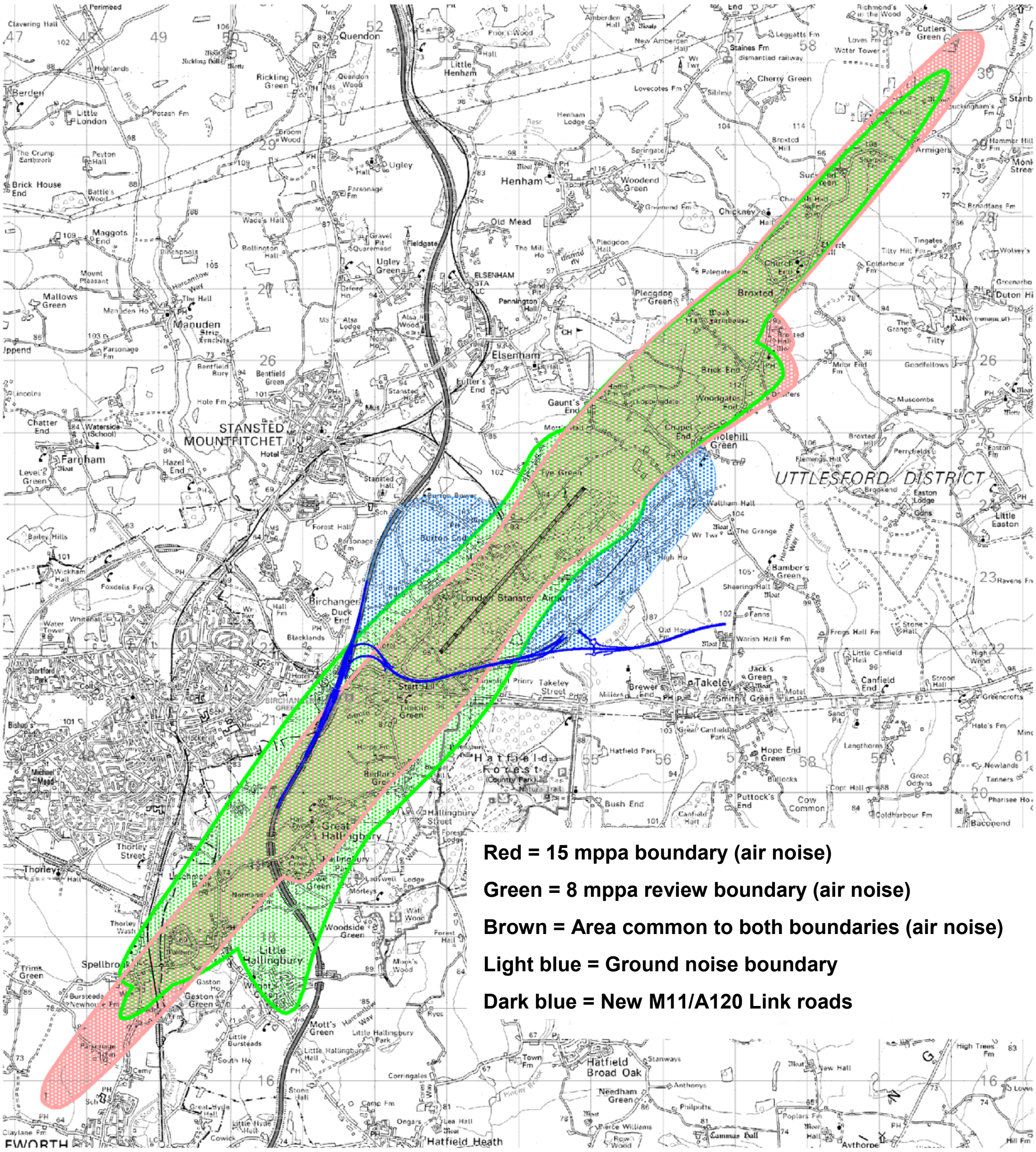


Figure 6.6
Stansted Airport Noise Insulation Schemes



Appendix A Definition of night-time SEL footprints

A1 Composite worst noise footprints

A1.1 Previous noise insulation schemes for the designated airports have included, as part of the eligibility boundary, the single event noise footprint of ‘the noisiest aircraft type that operates at least once per night’, on average. The basis for this criterion comes from various studies of noise induced sleep disturbance, the 1992 CAA Field Study among them, which indicate that, below a certain threshold, single noise events are unlikely to awaken people no matter how frequently they occur. Single event noise footprints are merged with noise exposure contours (e.g. Leq) to provide ‘protection’ against sleep disturbance as well as against general annoyance.

A1.2 Research suggests that the threshold level is around 90 dBA SEL (corresponding to about 80 dBA Lmax) outdoors. At higher levels the risk of being awakened from sleep is around 1 in 75[12]. Accepting this, the boundary outside which there would be no noise-induced awakening would be the 90 dBA SEL footprint of the noisiest aircraft to operate. Only homes inside this footprint would need to be insulated in order to reduce sleep disturbance.

A1.3 However, if this aircraft operated very rarely, once a month say, such a boundary might be considered excessively cautious, i.e. too large. Applying the 1 in 75 rule, an average person living within it would be awakened by the aircraft noise just once in 6 years - even without noise insulation. In this case it might be considered more reasonable to choose a higher level footprint or the footprint of a less noisy but more common aircraft type. It was this kind of reasoning that led to the one-per-night restriction in earlier schemes which, for a 90 dBA SEL threshold, would raise the average probability of awakening - in non-insulated homes within the footprint - to about 5 times per year (once in 75 nights).

A1.4 The requisite footprints were those of the noisiest aircraft types that averaged at least one movement per night on each of the arrival and departure routes[13]. Noisiest, in this context was taken to mean the aircraft with the largest footprint area, regardless of the footprint shape. This approach was straightforward to apply and understand and, provided the noisiest aircraft operating exceeded one movement per night, it would achieve the intended result.

A1.5 But it does not if (a) the most commonly operated types are not the noisiest, nor (b) if no single aircraft type reaches an average of one movement per night. Although strict interpretation of the one-per-night rule yields a footprint component that is smaller than that of the noisiest aircraft (or eliminates the footprint altogether), the threshold level could still be exceeded at least once per night in some areas. If it is accepted that the probability of sleep disturbance depends not on the type of aircraft but the amount of noise generated, this is the essential criterion. Thus, in the original scheme (Section 2), and in its review (Section 3), the footprint component was defined as that of a notional composite worst aircraft. This is the average footprint of a mixture of aircraft types whose movements add up to one per night on average, and is the largest of any such combination. Put another way, the composite worst footprint on any route is the largest footprint that can be constructed by summing the contributions

12 In the 1992 Field Study, this was the estimated probability of being awakened by outdoor SELs between 90 and 105dBA.

13 Noisiest was defined as 'noisiest permitted' under the then existing night restrictions.

from different aircraft totalling, on average, one movement per night. Of course, if the noisiest aircraft happen to operate at least once per night, its actual footprint would qualify.

A1.6 A potential weakness of a scheme based on a composite worst aircraft is that whereas Leq contours are relatively insensitive to the precise mix of aircraft types in the forecast (as all types are included), the composite worst SEL footprint will be averaged over a relatively small number of types. As particular aircraft tend to have very distinctive noise footprint characteristics the composite worst footprint might be excessively sensitive to the precise forecast mix of types.

A1.7 It was therefore concluded that a safer option would be to define a hypothetical but typical aircraft with noise performance characteristics that place it at the top of the QC/2 band, the noisiest aircraft permitted to operate during the night restrictions period - an *average worst QC/2 aircraft*. Numerous options were considered; the approach selected was to average the footprint shapes of all QC/2 aircraft in the ANCON database. Allowing for variations between airports, these numbered 26 for departures, 30 for arrivals and covered 2, 3 and 4 engined aircraft.

A1.8 The ANCON types used (across all 3 airports - 1999 data) were as follows:

EA30
EA31
EA33
EA34
B757C
B757R
B762
B763
MD11
B777

A1.9 The SELs of the above types were calculated at 6.5 kilometre flyover and 450 metre sideline (departure) and 2 kilometre to threshold (arrival) – the certification reference points. The mean of the flyover and sideline SEL values (departures) and the arrival SEL at 2 kilometres to threshold (arrival) were then converted to EPNdB using individual departure and arrival SEL to EPNL conversion factors for each type. These 'in-service' EPNLs were compared with the QC/2 limiting EPNL and, where necessary, adjustments were made to the ANCON noise/power/distance (NPD) curves to ensure that the relevant ANCON types produced EPNL values that were just at the QC/2 limit. Once all the adjustments had been made, the average (of 2, 3 and 4 engined) worst (limit of QC/2) footprints (90 dBA SEL) were generated via ANCON using the adjusted NPD data.

Appendix B Is 90 dBA SEL still an appropriate criterion?

B1 General

B1.1 The previous Stansted scheme was developed shortly after the replacement of the old NNI and PNdB noise metrics by Leq and SEL(dBA). As prior Heathrow and Gatwick scheme boundaries had been constructed by amalgamating 50NNI daytime contours and 95 PNdB night footprints, a logical starting point was to consider what their equivalents would be in the then new metrics. Although the correlation between the old and new metrics was not exact, it was concluded that, for the same physical noise exposures, the equivalents were approximately 66 dBA Leq(16 hour) and 90 dBA SEL. This note addresses the question of whether 90 dBA SEL remains an appropriate noise insulation criterion for night-time noise[14].

B1.2 The night-related component of the original Heathrow and Gatwick boundaries, i.e. a single event limit of 95 PNdB, was based on available evidence reviewed in CAA Paper 78011.

B2 CAA Paper 78011: Noise and Sleep, June 1978

B2.1 The main conclusions relevant to aircraft noise, were as follows.

a) There was no threshold noise level which caused people to wake[15], the proportion of people awakening increased steadily with noise level.

b) Outdoor noise event levels of 90 - 105 EPNdB (approximately 77 - 92 dBA Lmax) would not disturb most people asleep indoors[16].

c) Many factors influenced response: older people, especially women were more easily disturbed; sleep interference was also related to the numbers of noise events, the type of noise and to whether the exposure was regular (leading to habituation).

d) People were less likely to be disturbed during the stages of deepest sleep, usually during the first few hours, so that a given noise was more likely to wake people towards the end of their night's sleep than around midnight.

e) Experiments on sleep deprivation (in which test subjects are deliberately kept awake) had indicated that loss of two or three hours sleep had a measurable effect on people's performance the following day, but disturbance on this scale would not be caused by normal exposures to noise from aircraft or other environmental sources. Very little evidence was available on the effects of more limited sleep disturbance, disturbance being an EEG arousal or stage change, or an awakening, however brief.

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14 The equivalent average SEL was 90.5 dBA. However, it was difficult to determine reliable SEL footprints for specific aircraft. The scheme boundary therefore encompassed SEL footprints having enclosed areas (4 sq km for departures and 2.5 sq km for arrivals) that were used in the 1980 and 1989 noise insulation schemes at Heathrow and Gatwick. These footprints were equivalent to approximately 90 dBA SEL.

15 Expressions such as 'wake', and 'awaken' usually have specific meanings in research reports; these are often related to study methodologies. They may reflect 'next day recollections, overt reactions (e.g. pressing buttons), or physical measurements (such as EEG).

16 These outdoor noise levels were estimated from indoor levels assuming 25dB to be a typical figure of attenuation for aircraft noise in a bedroom.

B2.2 The conclusion that disturbance was more likely to result from noisier aircraft contributed to the Government's review of night flying policy for new restrictions from 1978. Separate quotas were established for "noisier" and "quieter" aircraft on the basis of their 95 PNdB footprint areas. It was subsequently reported that 95 PNdB was a cautious estimate of the awakening threshold based on laboratory studies (DORA Report 8008: Aircraft Noise and Sleep Disturbance: final report, August 1980).

B2.3 Since the previous Stansted noise insulation scheme was implemented, the Report of a Field Study of Aircraft Noise and Sleep Disturbance has been published. This confirmed that a level around 90 dBA SEL is a significant marker for night noise disturbance.

B3 Report of a Field Study of Aircraft Noise and Sleep Disturbance, Department of Transport, December 1992

B3.1 Among the conclusions were the following.

a) Sleep disturbance is no different from other subjective human responses to noise in that there is a very great variability between people.

b) While deviations from the average responses are large, even so, very few people experiencing night-time aircraft noise near airports are at risk of any substantial sleep disturbance from it, even at the highest event levels; and specifically:

   i) at outdoor noise events below 90 dBA SEL (approximately 80 dBA Lmax), average sleep disturbance rates were unlikely to be affected and, at the higher levels in the events studied (mostly in the range 90 - 100 dBA SEL, 80 - 90 dBA Lmax), the chance of the average person being wakened by an aircraft noise event was about 1 in 75; and

   ii) that risk of arousal due to aircraft noise had to be compared with an average of 18 nightly awakenings from all causes; thus even large numbers of night movements would be likely to cause very little increase in the average person's nightly awakenings.

c) Therefore there was no evidence to suggest that aircraft noise was likely to cause harmful after effects by significantly increasing awakenings from sleep (in the majority; effects on very sensitive people have not been further analysed).

d) Susceptibility to sleep disturbance varied markedly. For aircraft noise related disturbance, the 2-3% most sensitive people could be over twice as likely to be disturbed as the average person and the 2-3% least sensitive less than half as likely.

B4 Present position

B4.1 It has been possible to re-examine the key findings of the 1992 UK field study in light of additional analysis of the data and the results of more recent independent field studies.

B4.2 A quantity of EEG data was collected during the 1992 field study (Oll92). The primary purpose was to validate and calibrate the principal measurement technique of actimetry. This provided a source of additional information on sleep disturbance, albeit limited, that actimetry could not obtain. A total of 178 nights of EEG data were obtained from 46 subjects living around the airports and the data were synchronised with simultaneous measurements of outdoor aircraft noise levels made at each site. Subsequent to the publication of the 1992 UK field study report, this EEG data were analysed in further detail (Hum99). The results gave support to the main actimetry-based finding that very few people living near airports are at risk of substantial sleep disturbance due to aircraft noise.

B4.3 Recently, following further development of computer-based statistical analysis procedures, it has been possible to perform simultaneous multi-variate analysis of a larger set of the 1992 actimetry data. This involved approximately eighty-five thousand observations, about 60% more than the original data set. This reanalysis appears to confirm that the key findings of the Field Study remain valid.

B4.4 Since the 1992 UK field study, a number of similar studies have been conducted in the USA (Fid94, Fid95, Fid98). Like the 1992 UK study, these studies involved in-home measurements of sleep disturbance in areas near airports. However the methodologies were not identical. A principal difference was that in the 1992 UK study, awakenings were inferred from limb movements whereas, in the US studies, awakenings were 'behaviourally confirmed'; test subjects pressed buttons when they awakened. The UK and US results are compared with each other and with other data previously reviewed by Pearsons and co-workers (Pea95) in Figure B1[17].

B4.5 Figure B1 shows 'prevalence of awakening' plotted against indoor event noise level SEL. For the purposes of this comparison, 20dB has been subtracted from the DORA noise levels to allow for the attenuation of sound transmitted from outdoors to indoors. Actual attenuations for individual homes would of course have varied markedly about the mean[18].

B4.6 Several features of Figure B1 are striking. First, although there is an obvious positive association between noise event level and awakening, the data indicate that where indoor noise event levels are less than 80-90 dBA SEL, i.e. except close to the flight paths of the very noisiest civil jet aircraft, incidences of awakening are typically less than about 5%[19]. Second, across the wide range of levels below this limit, the probability of awakening increases very slowly with noise level - around 1% for each 10 dB increase in noise (which broadly corresponds with a doubling of perceived loudness). Third, the US data exhibits substantial scatter, especially between studies. Fourth, notwithstanding this scatter and despite being derived by different methodologies, the US and UK results, and indeed the results from the 'previous' studies, all convey the same message - that, in the home, awakenings are infrequent and only weakly correlated with noise. This is in marked contrast to the findings of laboratory work.

B4.7 But there is one conspicuous difference that raises a question concerning cause and effect. The noise-awakening relationship inferred from the UK study levels out as indoor SEL falls below 70 dBA, while no such trend is obvious in the US data. This is

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17 Final version of this Figure is displayed in R&D Report 9964.

18 Actual attenuations are likely to vary between about 10 and 35 dB depending on type and state of windows. What average to assume is a matter of judgement; note for example that in CAA Paper 78011 a figure of 25 dB was adopted.

19 The 'FS adjusted' data (cross symbols) in Figure B1 show the estimated probability of being awakened by an aircraft noise event (see para. 13). This becomes significant above 70 dBA SEL indoors (90 dBA outdoors) and reaches about 4% above 90 dB indoors/110 dB outdoors. The statistical analysis reported in Oll92 showed that the average probability for events exceeding 90 dBA outdoors was about 1.3%; i.e.1 in 75.

related to the principal conclusion drawn from the UK study; that below 90 dBA SEL outdoors (equivalent to above about 70 dBA indoors), aircraft noise would be unlikely to disturb sleep. This followed from the observation that, in the absence of aircraft noise, the probability of awakening - due to all other causes - remained at around 2%. The question this raises is whether the 1992 UK field study data should be adjusted to account for this residue before comparing it with the US results. The 'FS Adjusted' data in Figure B1 (UK field study findings from Oll92 adjusted to compare with the US results) show that the consequences of this adjustment are that the UK mean wakening rates would be lower than those of the US studies.

B4.8 Overlaid on Figure B1 are some currently quoted criteria regarding noise and sleep disturbance. These include 'guideline threshold values', suggested by the Health Council of the Netherlands (HCN94) and the Community Noise Report (Ber95). In the Community Noise Report a limit of 45 dBA Lmax indoors is recommended where noise exposure is intermittent. The report of the Health Council of the Netherlands (HCN94) concluded that evidence supports the existence of causal relationships between night-time noise exposure and changes in sleep pattern, changes in sleep stages and awakening, and subjective sleep quality. The level below which no response is observed, the observation threshold for awakenings, was defined as 60 dBA SEL indoors. Included for comparison is the awakening threshold identified in the UK 1992 study (70 dBA SEL indoors ~ 90 dBA outdoors). Also shown is a dose-response curve recommended by FICAN, the US Federal Interagency Committee on Aviation Noise (FIC97).

B4.9 The various guidelines are in broad accordance with the observations; the evidence suggests they are sufficiently conservative that adherence to the guidelines should ensure little or no noise-induced awakening from sleep.

B4.10 Thus there appears to be no real conflict between the 1992 UK field study results and other comparable evidence that relates to aircraft noise and sleep in the home. There is also no change in the findings from reanalysis work of the UK 1992 field study - suggesting the findings are still valid today.

B4.11 DfT commissioned two studies to investigate the need for possible further research in this area, one concerned with methodology, the other a social survey to explore the public's perceptions of the effects of aircraft noise at night (see footnote 2 and Para 5.1.2 of the main text).

B4.12 While robust scientific evidence linking night-time noise to health impairment has yet to be found, the possibility that such a relationship exists cannot be rejected. It is believed that a long term research goal must be to determine whether aircraft noise can actually be detrimental to people's health.

B4.13 It may be that noise-induced awakening from sleep is just one factor, possibly only a small one, in a complex web of cause-effect interactions involving night-time aircraft noise. Some UK researchers speculate that annoyance reactions to night-time aircraft noise could turn out to be a more significant risk to health. But night-time aircraft noise exposures at Heathrow were markedly higher 20 years ago and there is no evidence that gave rise to serious health problems.

B4.14 The 1992 UK study was concerned mainly with sleep disturbance. It did not directly address the questions of whether aircraft noise interferes with the process of going to sleep or causes people to awaken from their sleep prematurely, thus reducing the amount of sleep.

B5 **Conclusion**

B5.1 The justification for incorporating a 90 dBA SEL footprint into a noise insulation scheme boundary remains unchanged. If anything, the evidence upon which it was originally specified has been reinforced by the findings from more recent studies.

References

Ber95 Berglund and Lindvall, Community noise, document prepared for the World Health Organisation, Archives of the Center for Sensory Research, Stockholm University and Karolinska Institute, Volume 2, Issue 1, 1995.

FIC97 Effects of Aviation Noise on Awakenings from Sleep, US Federal Interagency Committee on Aviation Noise (FICAN), June 1997 (www. fican.org).

Fid94 Fidell S et al., Noise-induced sleep disturbance in residential settings, BBN Systems and Technologies, Armstrong Laboratory, AL/OE-TR-1994-0131, BBN Report 7932, February 1994.

Fid95 Fidell S et al., Noise-induced Sleep Disturbance in Residences Near Two Civil Airports, BBN Acoustic Technologies Division, NASA Contractor Report 198252, December 1995.

Fid98 Fidell S et al., Field Studies of Habituation to Change in Nighttime Aircraft Noise and of Sleep Motility Measurement Methods, BBN Technologies for US Air Force, BBN 8195, March 1998.

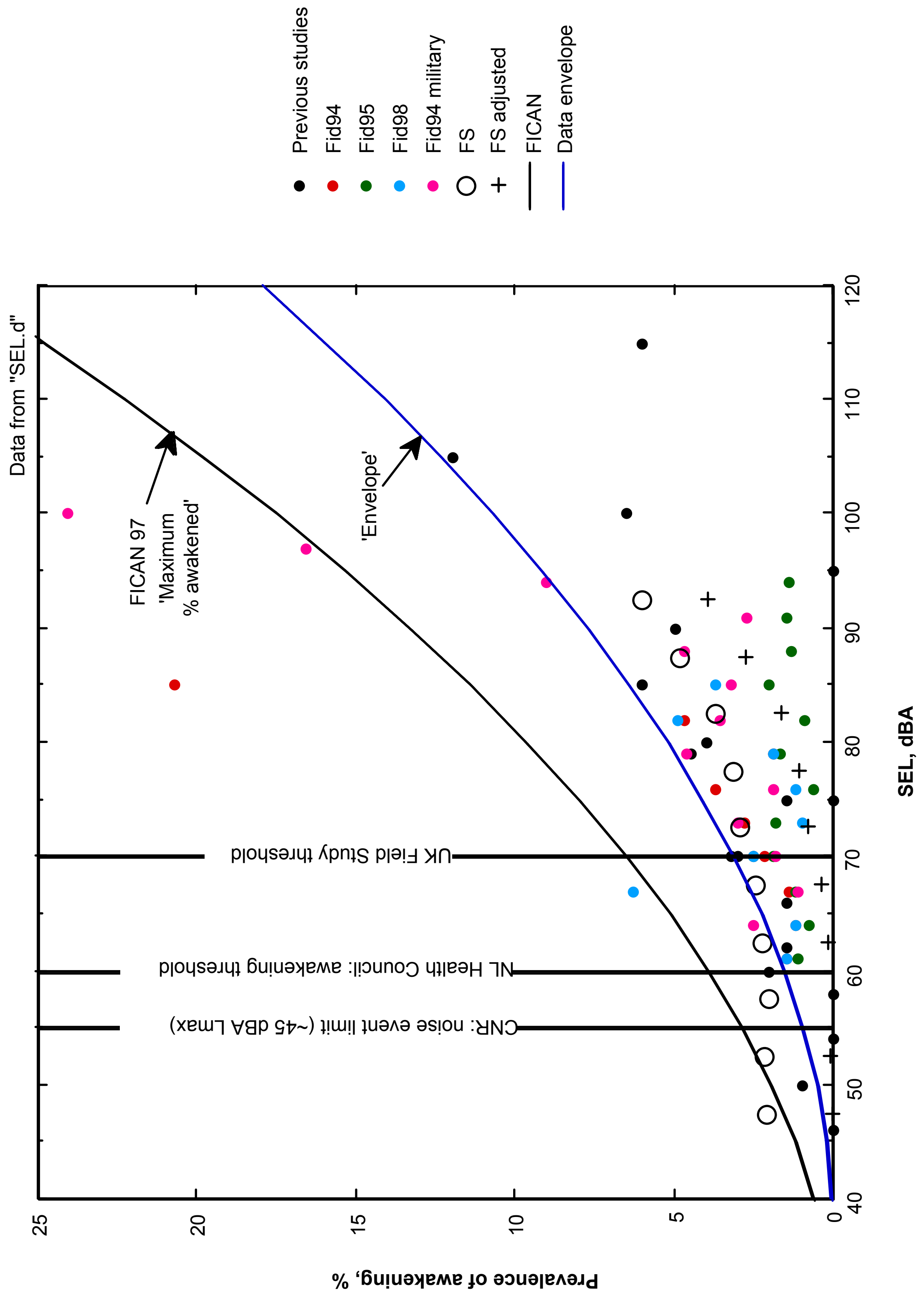
HCN94 Health Council of the Netherlands, Committee of Noise and Health: Noise and Health. The Hague, Report 1994/15E, September 1994.

Hum99 Hume K., Effects of aircraft noise on sleep; EEG-based measurements, Manchester Metropolitan University, 2000 (available to download at www.cate.mmu.ac.uk/CAAreport0603.pdf).

Oll92 Ollerhead J B et al, Report of a field study of aircraft noise and sleep disturbance, Department of Transport, December 1992.

Pea95 Pearsons K S et al, Predicting noise-induced sleep disturbance, Journal of the Acoustical Society of America, 97(1), 331-338, January 1995.

FIGURE B1


Data from "SEL.d"
Previous studies
Fid94
Fid95
Fid98
Fid94 military
FS
FS adjusted
FICAN
Data envelope
FICAN 97
'Maximum
% awakened'
'Envelope'
UK Field Study threshold
NL Health Council: awakening threshold
CNR: noise event limit (~45 dBA Lmax)
Prevalence of awakening, %
SEL, dBA
0
5
10
15
20
25
40
50
60
70
80
90
100
110
120

Appendix C STAL Report on measures at Stansted since the publication of R&D Report 9850 on ground noise

C1 General

C1.1 As a result of the findings of the NATS report, Stansted Airport Ltd (STAL) reviewed the airport's night-time ground noise restrictions and has made changes as follows:

- Properties at Coopers Villas have been double glazed in association with Uttlesford District Council.

- Additional runway turn-offs and taxi-ways have reduced taxiing distances and the need for aircraft to hold on stand.

- All fully operational stands on the south side of the airport have been fitted with fixed electrical ground power (FEGP).

- A Director's Notice[20] has been issued relating to the following activities:

  Engine running for test and maintenance purposes
  Noise from taxiing aircraft
  Noise from Air Start Equipment.

  To ensure that the environmental impact of aircraft related noise on the local community is kept to a minimum, aircraft operators with maintenance commitments at the airport are expected to plan their schedule to avoid the need for ground running of engine at night (2300-0700 local time) or in the early morning and late evening.

- A separate Director's Notice[21] covers requirements to use FEGP and control and notification of use procedures for Ground Power Units (GPUs) and aircraft Auxiliary Power Units (APUs).

- Power backs have been greatly reduced with the aim of cessation by the end of the year.

- The Takeley by-pass has been given approval as part of the A120 Stansted Airport – Braintree trunk road improvement and is planned to be opened in 2004.

- Phase II of the 15mppa planning consent has commenced which will result in further buildings along the south east side of the terminal aprons.

- No further airport roads will be constructed with blocked paving.

[20] Director's Notice DN/13/03.

[21] Director's Notice DN/12/03

C2 Flindell Report (STN 1030) into Aircraft Engine Ground Running at Stansted

C2.1 Ian H Flindell & Associates were commissioned by STAL to review noise propagation from the existing facilities and to review noise management options. The recommendations from the report were then offered as a basis for consultation on best practicable solutions with Uttlesford District Council (UDC) (in accordance with planning condition C.90F), which could then lead to an agreed timetable for implementation.

C2.2 The investigation involved:

i) A comprehensive analysis of all completed engine ground running request-approval-confirmation forms over an 11 month period;

ii) a comprehensive existing background noise survey at ten representative community sites; and

iii) a series of calculations of predicted noise levels at the same sites for Boeing 747 sized aircraft engine ground running, at both low and high power settings, over a complete range of all possible aircraft headings (whether practical or not) at each of ten on-airport sites for comparison purposes.

Existing 1999 background noise levels (hourly LA90 and Leq) were measured at the ten sites over four consecutive weeks in August and September 1999. The sites were selected as being generally representative of the different types of residential area located at different distances and in different directions around the airport. The sites were:

Farm Cottage, Tye Green (OS Grid ref. 554240 224500)
Appletree House, Fullers End (OS Grid ref. 553800 225600)
Motts Hall, Gaunts End (OS Grid ref. 555000 225050)
The Forge, Molehill Green (OS Grid ref. 556375 224700)
2 Coopers Villas, Takeley (OS Grid ref. 5555500 222825)
1 Bury Villas, Bamber's Green (OS Grid ref. 557350 223020)
15 Garnetts, Takeley (OS Grid ref. 555900 221700)
Glenmore, Takeley Street (OS Grid ref. 554050 221300)
351a Birchanger Lane, Birchanger (OS Grid ref. 551275 222425)
1 Chestnut Cottages, Burton End (OS Grid ref. 553575 223450)

C2.3 Copies of all engine run request-approval-confirmation forms for the period between 1 March 1999 and 3 February 2000 were analysed and a comprehensive data base of all 423 requests for that period was constructed of which 229 were confirmed. The data base showed that there were nine confirmed engine runs between 2300 and 0700 hours during the period.

C2.4 To predict noise levels the B747 aircraft with RB211 engines was selected as being representative of a generic worse case aircraft type for engine ground running. Boeing data for a single B747 RB211 engine run up at 25%, 50%, 75% and 100% power at 10 degree increments around the aircraft starting at 0 degrees at the nose was used. The Boeing data was measured at 46 metre radial distance and was extrapolated out to 150 metre radial distance using the standardised 20 log (d/150)+0.02 (d-150) distance attenuation rule as developed for the Heathrow Terminal 5 public inquiry. Using this engine data a spreadsheet was developed to calculate noise levels at the ten receiver locations (see above) for each of the following potential engine ground running sites:

Compass base near to existing FLS apron
Existing FLS apron
Block 52 on taxiway Juliet in front of existing FLS apron
Block 44 by Hotel Golf cross taxiway on taxiway Juliet
Block 18 on taxiway Hotel
Block 20 0n taxiway Hotel
On taxiway Hotel eastern extension in line with Delta apron stands 72 and 73 (to be constructed as part of Phase 2 development)
Block 106 on taxiway Golf
Possible new engine ground running apron to east of FLS hanger
Possible new engine ground running apron to west of existing cargo centre behind airport fire station.

C3 Conclusions of the Report

C3.1 The available evidence suggests that engine ground running noise at Stansted is not a major issue and that the current procedures appear to be achieving their main objective of limiting engine ground running noise to a minimum consist with flight safety.

C3.2 It was recommended that further investigations be made into the possibility of using different engine ground running sites under different wind speed and direction conditions to minimise aggregate noise levels outside the airport boundary in different directions before considering further noise screen options.

C3.3 So far as the type of noise screening is concerned, it was considered that some ideas that should work well in theory do not always work so well in practice and that, although all new technical developments in these areas should be kept under review, the three sided ground running pen seems to be the best all round solution at present, subject to sufficient space being available.

C3.4 Having considered the report, UDC responded that it believes the solution[22] would be to evaluate a second noise wall on the north east side of the FLS diamond hanger site, facing to the south west, to provide for aircraft running with their engines facing into wind whichever runway direction was in operation.

[22] STAL will shortly be applying to UDC for planning permission for a second noise pen on the NE side of the FLS diamond hangar site. To comply with the 25 mppa s106 agreement this must be constructed and in use by October 2004.