Environmental Research and Consultancy Department

Civil Aviation Authority

R&D REPORT 9850

Night-Time Ground Noise

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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 10 July 1998 by the Department of the Environment, Transport and the Regions. Any views expressed are not necessarily those of the Secretary of State for Transport.

ISBN 0 86039 926 5

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Published by TSO (The Stationery Office) on behalf of the UK Civil Aviation Authority.

Printed copy available from:
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Strategy and Development Directorate
National Air Traffic Services Ltd

S&DD File Reference
8RD/13/001/02

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SUMMARY

This report describes a study of ground based noise at Heathrow, Gatwick and Stansted airports at night (between 2300 to 0700 hours) commisioned by the Department of the Environment, Transport and the Regions (DETR). The study was presented as a series of papers to the Aircraft Noise Monitoring Advisory Committee (ANMAC); this report consolidates those papers. It describes three phases of work, preliminary observations, a Phase 1 pilot study and a Phase 2 study. Options for potential ground noise mitigation measures are suggested and many of these suggestions have already been adopted at the airports.

National Air Traffic Services Ltd, London, August 1998

EXECUTIVE SUMMARY

A Ground Noise at Night study has been undertaken at Heathrow, Gatwick and Stansted airports on behalf of the Aircraft Noise Monitoring Advisory Committee. The aim of the study was to develop an understanding of the sources of ground noise at the airports during the period 2300 to 0700 hours and to consider the potential for measures to mitigate the impact of ground noise on the surrounding communities. The work was divided into three stages; a preliminary observation, a pilot study (Phase 1) and a main study (Phase 2). The preliminary observations were used to define the likely ground noise sources and the community areas for study. The Phase 1 work developed a fuller understanding of the sources of ground noise. The Phase 2 study took a structured approach to the noise monitoring in key 'target' areas in the communities close to the airports.

Phase 1 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 traffic appeared to be a major source of noise, with airport ground noise just one of 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 are 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.

Phase 2 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, auxilliary 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.

It was found that no specific criteria for the likely 'acceptability' of airport ground noise were available; 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 is suggested that there are certain characteristics of ground noise that are likely to cause adverse reactions in the communities.

Administrative control measures to restrict the use of noisy equipment on the airports at night and engineering controls to mitigate the community impact of ground noise are suggested as a result of the work conducted in the study. Many of these suggestions have already been adopted at the airports.

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GLOSSARY OF TERMS

ANMAC	Aircraft Noise Monitoring Advisory Committee
APU	Auxiliary Power Unit
DETR	Department of Environment, Transport and the Regions
DORA	Department of Operational Research & Analysis (of National Air Traffic Services Ltd.)
FEGP	Fixed Electrical Ground Power
GAL	Gatwick Airport Ltd
GPU	Ground Power Unit
HAL	Heathrow Airport Ltd
IATA	International Air Transport Association
ILS	Instrument Landing System
NIS	Noise Insulation Scheme
STAL	Stansted Airport Ltd
WHO	World Health Organisation

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1. INTRODUCTION

Background

1.1 In 1995 the Department of Operational Research & Analysis (DORA) were asked by the Aircraft Noise Monitoring Advisory Committee (ANMAC[1]) to investigate airport ground noise at night at Heathrow, Gatwick and Stansted airports. This included consideration of the possible need for controls and, where relevant, to suggest possible mitigation measures.

1.2 Airport ground noise is defined as that which is generated as a result of airport operations other than by aircraft in flight or taking off and landing. In order to determine whether amelioration and control might be needed and to improve the means for assessing ground noise at night, a better understanding was required.

1.3 A study of airport ground noise at night around Heathrow, Gatwick and Stansted (between 2300 to 0700 hours) was conducted and reported to ANMAC through a series of papers. This document consolidates those ANMAC papers.

Noise assessment

1.4 The assessment of daytime noise from aircraft in flight is relatively well developed. The noise of aircraft in flight has relatively high sound levels, it can affect large numbers of people, and it can be defined fairly accurately by measurement or mathematical modelling. Daytime noise from aircraft in flight, taking off, or landing, is studied at Heathrow, Gatwick and Stansted using noise contours, produced annually by DORA on behalf of the DETR.

1.5 However the assessment of ground noise at night is less well developed. Ground noise at night is relatively low in level, it affects fewer people than does the noise from aircraft in flight, and it is very difficult to define and quantify.

1.6 Some typical sources of airport ground noise include:

a) *On-airport sources:* aircraft auxiliary power units (APUs), aircraft main engines (propeller and jet powered), run up, taxiing, idling (stationary), breakaway (from rest), air-side service vehicles, aircraft maintenance activities and airport plant noise.

b) *Off-airport sources:* land-side airport traffic, airport rail traffic and commercial noise from airport related industry.

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[1] ANMAC was established in 1988, its terms of reference are to advise the Department of Environment, Transport and the Regions (DETR) on aircraft noise and track keeping matters at Heathrow, Gatwick and Stansted airports and on the interpretation of the results of such monitoring. ANMAC is chaired by the DETR.

Study approach

1.7 The study took a phased approach:

a) preliminary observations, carried out in August 1995;

b) a pilot study (Phase 1), carried out during October to November 1995 ; and

c) a main study (Phase 2), carried out in summer 1996.

1.8 The findings of each phase were used to shape the analysis in the next phase. The aim of the preliminary observations and Phase 1 was to define the ground noise environment in the communities local to the airports and to identify and develop an understanding of the ground noise sources.

1.9 Having identified the likely sources of ground noise at night and the community areas where it was audible, Phase 2 took a more structured approach to the monitoring of ground noise in key community target areas in order to develop options for consideration as mitigation measures.

Report contents

1.10 This report is structured as follows:

- Section 2 of summarises the preliminary observations and the pilot study (Phase 1).
- Section 3 describes Phase 2 of the work.
- Section 4 presents a number of suggestions for potential mitigation measures.
- Section 5 discusses the need to ‘benchmark’ ground noise.
- Section 6 presents conclusions of the study.
- Appendix A describes the preliminary observations carried out at the three airports from 6 – 8 August 1995.
- Appendices B, C and D respectively describe the Phase 1 assessments at Heathrow, Gatwick and Stansted.
- Appendices E, F and G give further details on the Phase 2 assessments at Heathrow, Gatwick and Stansted respectively.

2. PRELIMINARY OBSERVATIONS & PHASE 1

2.1 Prior to committing to a detailed study of airport ground noise at night, an understanding of the likely ground noise sources and the general ground noise environment in the communities around the airports was needed. A brief preliminary investigation and a pilot (Phase 1) study were carried out to develop knowledge of the ground noise environment. Consequently the need for the main study (Phase 2) was identified. The measurements for the preliminary study were carried out in August 95 and for the Phase 1 study during October to November 95.

2.2 The work carried out in the first two stages of the project included:

a) a desk based assessment of the ground noise environment, including an initial literature review and examination of airport layouts and standing instructions[2];

b) observations to develop an understanding of the sources of ground noise around the airports;

c) a brief investigation of the night-time noise climates in the vicinities of Heathrow, Gatwick and Stansted.

2.3 The detailed findings of the preliminary investigation stage of the project are reported in Appendix A. Appendices B, C and D describe the results of the Phase 1 investigations at Heathrow, Gatwick and Stansted respectively.

Discussion of Preliminary Observations and Phase 1

General

2.4 The preliminary observations and Phase 1 demonstrated a variety of different ground noise sources and led to a number of suggestions for low cost procedural controls:

a) Promotion of Awareness. Some people working at the airports (eg aircraft operators, handling agents, airport ground staff, air traffic control staff) appeared to be genuinely unaware of the potential of activities to generate noise in the surrounding communities. The promotion of more general awareness could lead to much tighter control over the sources of ground noise. For example, general questions which should always be considered by operational staff include:

– Could noisy tasks be left until the morning?

[2] Standing instructions cover GAL's and STAL's Managing Director's Instructions (MDIs) and HAL's Operational Safety Instructions (OSIs).

- Could the task be carried out in a less noise sensitive location (from which the noise will not propagate into the local community)?

- Could a quieter procedure or item of equipment be substituted?

b) Monitoring. Although standing instructions for mitigating the impact of ground noise existed at all the airports, it was unclear at this stage whether they were sufficient or always complied with. Monitoring compliance with the standing instructions was defined as a useful exercise.

c) Effective planning. Steps to prevent the propagation of ground noise into the communities are best implemented at the airport planning stage by more effective use of buildings as noise shields. Noise emission can also be reduced by the effective planning of aprons. For example, at Stansted the use of cul-de-sac aprons leads to noise being generated by aircraft both waiting for stands and waiting to depart. Such noise could be reduced by the use of satellites, with a one way traffic system for aircraft, which minimises the need for queuing. Similarly, the design and planning of access routes to the airports can have an impact on the effect of airport-related road traffic noise. An example of this is the proposed adjustment of the A120 route at Stansted, which will obviate the need for airport traffic to take a 'short cut' through Takeley, and thus reduce the level of local traffic noise.

2.5 All three airports keep ground running logs, which are used to help identify the cause of night-time noise complaints. Heathrow airport also keeps logs of APU and GPU usage throughout the night period. It might be useful to adopt this procedure at the other airports, as the APU/GPU logs may be of use in both identifying the cause of complaints and in monitoring compliance with the standing instructions.

Heathrow

2.6 During Phase 1 the most significant source of ground noise at Heathrow between 2300 and 0400 hours was found to be the ground running of aircraft engines for maintenance. Following Phase 1, revised management controls were introduced in a new 'Instruction' at Heathrow in February 97. Heathrow Airport Limited (HAL) also took steps to ensure that the new Instruction was properly communicated through wide distribution and presentations to airlines and handlers. The new Instruction included the following:

a) A reduced permitted duration of engine running per night. This restricts engine running to 150 minutes per night, but with a separate high power duration of 60 minutes and a rolling 30-day average of high power running of 20 minutes. The latter limits the running over a period of nights to lower than the permitted nightly maximum.

b) The definition of ‘high power’ was tightened to avoid any room for ambiguity.

c) Engine runs at night must take place in a noise pen.

d) Certain types of maintenance work are prohibited at night.

e) Duty patrols take place every night checking that GPUs are not being used on stands where serviceable FEGP is available. Where GPUs are found in use a request is made to turn them off - failure to do so results in a £500 noise infringement fine.

f) ‘Check start’ short duration runs on stands are heavily restricted depending on location.

g) New GPUs purchased by handlers which may be used at night must meet the noise criteria specified in the IATA Handling Manual.

h) Airlines are required to plan their maintenance work such that night engine runs are kept to a minimum.

i) Permission from HAL needs to be sought for all runs at night and high power runs by day.

j) Multiple runs at the same time are encouraged to reduce the overall noise exposure time.

2.7 Specific constraints apply to the operation of Terminal 4 at night:

a) Certain taxiway routes to and from the terminal are not to be used.

b) No running of aircraft engines may take place at night on the ‘S’ and ‘V’ aprons.

c) No APUs may be run on these aprons at night.

Gatwick

2.8 During Phase 1 the most significant source of ground noise at Gatwick was found to be the taxiing of arriving and departing aircraft. This was generated intermittently during the early and late periods of the night; in the summer months it would occur throughout the night.

2.9 During Phase 1 the BAA Managing Director’s Instructions (MDIs) relating to ground operations at Gatwick were reviewed and superseded by MDI/7/96. Further details are in Appendix F. At the time of the Phase 1 study, a review of Gatwick’s development strategy had commenced which included consideration of policies relating to ground noise.

Stansted

2.10 During Phase 1 the most significant source of ground noise at Stansted was found to be the taxiing of arriving and departing aircraft, particularly turboprops. No changes to the existing procedures were made following Phase 1. However, a number of initiatives were started, including the following:

a) Enhanced monitoring of engine runs for maintenance during the night period aimed at accumulating data which may assist in the siting of a future noise attenuation facility.

b) A programme to monitor and encourage the use of Fixed Electrical Ground Power units in preference to Ground Power Units or Auxiliary Power Units.

c) A phasing out of 'power back' operations[3].

d) The introduction of additional taxiways in the terminal areas which will at certain times reduce the holding of aircraft either waiting to move to or from aircraft stands.

e) The installation of FEGP facilities on all newly developed stands together with phased installation on those stands currently not equipped.

f) Discouraging the use of solid wheeled vehicles and reducing the use of block paving to decrease road noise.

Recommendations for the Phase 2 Study

2.11 Following the preliminary observations and Phase 1 ANMAC decided there was a need for a further study (Phase 2).

2.12 It was decided that the main thrust of the Phase 2 study would be a structured approach to measure and identify the airport ground noise in key 'target areas'. Based on knowledge gained during the preliminary observations and Phase 1, the target areas were selected as those most likely to be affected by ground noise at night. Residential areas where the ground noise from the airport was dominant in relation to other noise sources, such as motorway traffic, were given priority and efforts would be made to include worst case conditions, ie strong winds blowing from the airports onto the target areas. An assessment of the complaints data relating to ground noise at night were used to assist in the selection of target areas.

[3] 'power back' operations are where turbo-prop aircraft use propellers in reverse pitch to push back from the stand.

3. PHASE 2 STUDY

Introduction

3.1 The key requirements for Phase 2 were as follows:

a) Noise levels were to be determined between 2300 and 0700 hours in key target areas around Heathrow, Gatwick and Stansted airports.

b) A total of 30 nights of target area monitoring were to be completed during Summer 1996.

c) Monitoring under worst case wind conditions at each of the target areas was a priority.

d) 'Snapshot'[4] measurements were to be carried out in communities that had not been assessed during Phase 1.

3.2 This section reports on work completed in Phase 2. It sets out the research methodology and presents the study findings. Detailed descriptions of the ground noise sources audible in the target areas around each airport are given in Appendices E, F and G together with updated airport standing instructions relating to ground noise.

Methodology

3.3 The target areas selected for monitoring are listed in Table 1. The sites referred to at each airport are shown in Figure 1 for Heathrow, Figure 2 for Gatwick, and Figure 3 for Stansted. All the areas were residential locations where ground noise was likely to be dominant relative to other noise sources, such as road traffic. Target areas were identified using local knowledge gained during Phase 1 and by reference to complaints data gathered from airports and local authorities. In order to ensure complete coverage of conditions within each selected area more than one monitoring point was used in some target areas.

3.4 The number of monitoring nights completed at each airport were as follows: Heathrow 10, Gatwick 8 and Stansted 13. Except for one night at Gatwick, two sites were used for monitoring, giving a total of 61 sets of data - a total of 488 hours of time histories and notes. One night at Stansted was used to complete snapshot measurements at Birchanger, to the west of Stansted; the findings of these snapshot measurements are presented in Appendix G. It was intended to make snapshot measurements at Stanwell Moor during Phase 2 but on study nights the wind conditions were not suitable for these measurements. The wind

[4] 'Snapshot' measurements are defined as those of short duration, eg less than 30 minutes, taken to give an indication of the noise environment. The term distinguishes the measurements taken in the earlier parts of the study from those in Phase 2, which were taken over 8 hour periods.

conditions on each of the monitoring nights are shown in Tables 2, 3 and 4 for Heathrow, Gatwick and Stansted respectively.

3.5 At each site a record of the A-weighted equivalent continuous noise level (Leq) for every second was made over the entire night-time period. In order that the sources could be identified at the analysis stage, noise events were electronically tagged using four coding buttons on the sound level meter. Each coding button was used to represent a particular noise source. The coding categories could be varied but those most commonly used were: aircraft movements; airport noise; road traffic noise and other noise sources. To aid analysis by DORA staff, the data from each monitoring night were converted into noise time history traces; a selection of these traces are presented in this report. In addition to the electronic noise logging, the general noise environment and significant noise events at the monitoring site were noted throughout each night. These notes were used to annotate the time histories. Control Tower runway logs and BAA ground running, auxiliary power unit (APU) and ground power unit (GPU) logs were also consulted where kept by the airport operator.

3.6 The standard microphone height for general noise monitoring is 1.2 m. ANMAC members had identified the need for simultaneous test measurements at 1.2 m and 4.0 m (nominal bedroom height), to ensure that the noise level was not likely to be significantly different between the two. Tests were undertaken on several nights during Phase 2 and a comparison between the noise levels at the two heights revealed no consistent difference between the two measurements. In the light of this finding it was decided to monitor at the standard microphone height of 1.2 m.

Findings

General

3.7 A summary of the major sources of ground noise at each airport is given below, Tables 5, 6 and 7 provide tabular summaries of the noise sources heard at Heathrow, Gatwick and Stansted respectively.

3.8 Figures 4, 5 and 6 show the average noise levels in the target areas for the three airports. In these charts, each data-point represents an average Leq value for every hour during the night period; a nightly Leq (2300 to 0700) is also included for each target area. The averages cover upwind and downwind monitoring and include noise from all sources including airborne aircraft noise, traffic noise and other community noise events, and are designed to give an indication of the local noise climate at each of the target areas.

3.9 More detailed analyses at each of the target areas are given in Appendices E, F and G for Heathrow, Gatwick and Stansted respectively.

Heathrow

3.10 As Table 5 shows, taxi noise was the most frequently noted source of ground noise at all target areas around Heathrow. The principal source of ground noise at Heathrow between 2300 and 0400 hours is engine running and APUs in operation in the maintenance areas, which are generally the most active parts of the airport during the night. This is especially apparent in the communities around Waye Avenue and Cains Lane. The dominant source of ground noise after 0400 hours is arriving aircraft taxiing to the terminal buildings. All target areas were exposed to road traffic noise during the night period.

3.11 The temporal pattern of activity at and around the airport is clearly displayed in Figure 4, which shows the average hourly Leq noise levels throughout the night from all noise sources. The higher noise levels at the start and end of the night period relate to increased activity both at the airport and on nearby roads. Air noise and taxiing noise from early morning arrivals after 0400 cause a notable increase in the average noise level, particularly at sites close to the runways and taxiways (Waye Avenue area and Longford). The noise levels at Longford in the period between 0200 and 0400 reflect the proximity of the site to the A4, M25 and M4.

Gatwick

3.12 The dominant source of ground noise at Gatwick was the taxiing of aircraft to and from the terminal stands. This ground noise source was often audible, although at much lower levels, when the target areas were upwind of the airport. The audibility of taxiing noise in upwind conditions is probably due to the open nature of the terrain around Gatwick. As Table 6 shows, the next most commonly noted source of ground noise was engine start-ups prior to departure. When aircraft taxiing was not audible, the low level sound of what was thought to be APUs and GPUs was occasionally heard, but often masked by road traffic noise from the A23 (which was intermittently audible in all target areas). No ground running of aircraft engines was heard by DORA staff while monitoring was being conducted at Gatwick.

3.13 Unlike at Heathrow, where airport activity is concentrated in the first and last parts of the night period, activity at Gatwick is more evenly distributed throughout the night-time, with a slight dip between 0100 and 0400. This is reflected by the noise levels shown in Figure 5.

Stansted

3.14 The main night-time ground noise source at Stansted is the taxiing of aircraft. In Table 7 taxiing events are divided into turboprop and jet aircraft. Turboprop aircraft are treated separately because, relative to jet aircraft, they emit higher noise levels whilst taxiing. Noise from taxiing turboprops can sometimes reach levels, in target areas, of up to 30 dBA above background; noise from taxiing jet aircraft rarely reach comparable levels above the background. The relative paucity of buildings on the airfield means that ground noise tends to propagate more readily into the local communities than at Heathrow. Noise from the running of APUs and aircraft engines on Apron A is also regularly audible, especially in the target areas closest to the passenger terminal. Road traffic noise was audible in all target areas during Phase 2, although less so in the sites closest to the airport. As with Gatwick, the dip in activity in the middle of the night is not as great as at Heathrow; the effect of this on the noise levels can be seen in Figure 6.

Key Issues

3.15 During the analysis of the Phase 2 data, it became clear that there were a number of key ground noise issues that are important at the airports. The following issues are considered below:

- the effect of wind direction on the propagation of ground noise;
- the effect of road traffic on ground noise audibility;
- taxiing aircraft;
- ground noise from airport service vehicles and sirens;
- the audibility of auxiliary power units;
- ground running of aircraft engines.

The effect of wind direction on the propagation of ground noise

3.16 On a total of eight monitoring nights (two each at Heathrow and Gatwick and four at Stansted) target areas were selected to allow a comparison of the propagation of ground noise into the target areas in upwind and downwind conditions. Representative examples of the effect of wind direction on ground noise propagation from the eight nights are given below. Only sites where ground noise had previously been heard were chosen for the comparisons.

Heathrow

3.17 On the night of 6/7 August 1996 simultaneous upwind and downwind monitoring was carried out at Heathrow. The two sites chosen were Kingston Avenue in the Cains Lane area and Longford. A northwesterly wind meant that Kingston Avenue was downwind of the airport and Longford was upwind. Previous experience at these sites has shown that ground noise is frequently heard in downwind conditions.

3.18 No incidences of ground noise were reported in Longford while monitoring in upwind conditions; road traffic noise from the M25 and the A4 was the dominant noise source. At Kingston Avenue (downwind) the noise environment throughout the night was dominated by APU noise and a non-specific hum emanating from the airport. From 0400 onwards taxi noise from early morning arrivals was frequently audible at Kingston Avenue, but never audible at Longford, where road traffic noise was still the dominant noise source.

3.19 Figures 7 and 8 show the time histories for the two sites between 0600 and 0700. The time history in Kingston Avenue (downwind) shows that there was a high level of activity on the airport during the period and, between the arrivals, taxi noise and general airport drone were significant contributors to the noise environment. Despite the high level of activity on the airfield, Figure 8 shows that none of the ground noise was audible at Longford (upwind), where taxi noise had been a significant noise source in downwind monitoring; on this upwind occasion road traffic noise was dominant (the spikes in the time history trace are due to cars passing by the monitoring point at a distance of 5m). Comparison of Figures 7 and 8 show that the noise level due purely to road traffic at the upwind site was significantly higher than the ground noise level at the downwind site.

Gatwick

3.20 On the night of 27/28 June 1996 upwind versus downwind monitoring was undertaken at Gatwick. With a light southwesterly wind Povey Cross and the Cherry Lane area were selected as the downwind and upwind sites respectively.

3.21 At Povey Cross (downwind) taxiing, airport service vehicles and engine start-ups were frequently audible during the night period. Figure 9 shows the effect of an aircraft taxiing on the time history at the downwind site, an average elevation of the noise level by around 5 dBA, the event was not audible at the upwind site. At Cherry Lane (upwind) ground noise, predominantly aircraft taxiing, was occasionally audible - see Figure 10.

3.22 A general impression of the incidence of measured ground noise in upwind and downwind conditions can be gained by comparing Figures 9 and 10. These time histories show the same hour period for both sites. At the downwind site the noise environment is complex with ground noise sources mixing with road traffic noise from the nearby A23. At the upwind site the incidence of ground noise is significantly lower resulting in a flatter time history and a lower general noise level. The higher noise level at Povey Cross (downwind) is the result of a mixture of the close proximity of the A23 to that site and the presence of non specific airport ground noise.

3.23 Some ground noise was audible at the upwind site, unlike the Heathrow monitoring at Longford in upwind conditions. There are two likely reasons for this; in the Heathrow example the wind was moderate, in the Gatwick example the wind was lighter and the paucity of buildings between the airfield and the Cherry Lane area allows noise to propagate more freely.

Stansted

3.24 On the night of 16/17 September 1996 upwind versus downwind monitoring was undertaken at Stansted. Takeley and Tye Green were upwind and downwind of Stansted airport respectively.

3.25 Ground noise from taxiing aircraft and APUs running in the Apron area formed part of the noise environment at the downwind site at Tye Green throughout the night. Road traffic noise was also audible at the downwind site but was not loud enough to mask the ground noise sources. At Takeley (upwind), road traffic on the A120 dominated the noise environment and except for occasional plant noise, ground noise was virtually inaudible during the monitoring period.

3.26 Figure 11 shows the time history of noise monitoring at Takeley (upwind) between 2315 and 2325. The two distinct peaks in the trace were caused by local road traffic passing by the monitoring point. The general noise level remained around 40 dBA, being defined by road traffic on the A120. Figure 12 shows data obtained at Tye Green (downwind) over the same period, where the average level, defined by an APU running in the apron area, was around 10 dBA higher than at the upwind site.

3.27 Figures 13 and 14 show the time histories from the same sites between 0125 and 0145. The taxiing of two aircraft preparing for departure was heard briefly at Takeley (upwind); only one of the aircraft was heard departing. The time history at Tye Green (downwind) over the same period shows that the taxiing aircraft were clearly audible, raising the noise level by up to 25 dBA and two aircraft were heard departing. The second aircraft was heard later at Tye Green (downwind) than at Takeley (upwind); the wind was southwesterly, meaning that the upwind site would only have heard the easterly departure as it became

airborne, past the monitoring point. A similar effect can be seen in Figures 15 and 16 on the same night, an arriving B727 and its subsequent taxiing noise were clearly audible at the downwind site, raising the noise level by up to 20 dBA, but not audible at the upwind site.

The effect of road traffic on ground noise audibility

3.28 It was noted in Phase 1 that ground noise from the airport was often masked by road traffic noise. For access purposes, Heathrow, Gatwick and Stansted airports are all situated near to major roads. The roads around the three airports can be divided into three types:

a) *Motorways:* The traffic on the motorways adjacent to the airports (the M4, M25, M23 and M11) was found to be fairly constant throughout the night period. The noise of traffic from the motorways was characterised by a constant drone caused by vehicle tyres on the road surface. Different road surfaces produced noise with different frequency characteristics. On the M11 near Stansted there is a gradient in the motorway, thus as well as the usual tyre related drone, the noise heard on this stretch of the road had a strong engine noise component, as vehicles increased power to climb the hill.

b) *'A' roads:* Traffic on 'A' roads around the airports was generally less heavy than that on motorways in the night period. In noise terms the result of this was that the traffic was less of a drone and the vehicles were more discernible as individual noise events which, depending on the proximity of the monitoring site to the road, could often mask airport ground noise.

c) *Small roads local to the monitoring sites:* The effect of traffic on small roads local to the monitoring sites was often significant in terms of short term noise levels, but generally transient in nature.

3.29 In summary, experience from Phase 2 monitoring suggests that the ability of traffic to mask any ground noise is dependent on the interaction of the following factors:

a) The load of traffic on the road. Heavy load traffic will cause a constant drone in the noise environment that can often mask ground noise sources. Lighter loads will have a more transient effect on the noise environment, possibly masking ground noise for the duration of the car passing by.

b) The proximity of road to the monitoring site. As with ground noise sources, the strength of the noise signal decays with increasing distance from the source.

c) Whether the road is upwind or downwind of the monitoring site. If the road is upwind of the monitoring site it will generally not be audible, unless there is no other noise source present or the road is very busy.

d) The level of ground noise. This is linked to the proximity of the monitoring site to the airport and whether the monitoring site is upwind or downwind of airport. Sites such as Waye Avenue at Heathrow and Coopers Villas at Stansted are generally less susceptible to the masking effects of road traffic as they are close to the ground noise sources, which usually dominate the noise environment when present.

3.30 The plan for Phase 2 was to locate target areas away from road traffic noise to allow the accurate identification and measurement of ground noise sources. In spite of this aim, in the absence of ground noise from the airport, distant motorway and local road traffic noise dominated the noise environment in all target areas. A proportion of the road traffic around the airports at night is likely to be attributable to airport operations, however it was not possible to quantify this proportion as part of this study.

Taxiing Aircraft

3.31 As shown in Tables 5, 6 and 7, taxiing was the most frequently heard source of ground noise during Phase 2 monitoring. Examples of the effect of taxiing on the noise environment in the target areas are presented here for each airport.

Heathrow

3.32 The majority of taxiing noise at Heathrow was associated with the early morning arrivals that started at 0400 hours. At this time road traffic on the Bath Road and the Great Southwest Road was beginning to become evident in the noise environment; which meant that the tonal taxi noise, while still strongly audible, was often mixed with the broadband noise from road traffic. The effect of taxiing noise from the early morning arrivals on the overall noise level was therefore difficult to quantify. The audibility of noise from taxiing aircraft was also significantly affected by wind direction, at all target sites in upwind conditions taxi noise was either inaudible or rarely audible. At sites close to the taxiing aircraft, wind was a less important factor in determining audibility.

3.33 Figure 17 shows the effect of a single aircraft taxiing prior to departure from runway 27R on the noise level at Clevedon Gardens in the Waye Avenue area, 3.3 km to the east of the central terminal area. Although notes made at the time say that the taxiing jet aircraft was clearly audible, due to the tonal quality of the noise source the time history only shows a 3 to 5 dBA increase in noise level. This is typical of the effect of taxiing noise on the time histories at Heathrow.

Gatwick

3.34 Generally noise levels due to taxiing were higher than at Heathrow. This is probably due to the relatively clear propagation paths between the terminal area and the residential areas to the south, west and east of the airport. In upwind conditions taxiing noise was still audible, although at lower levels, at most target areas around Gatwick airport, unlike at Heathrow.

3.35 Figure 18 shows the significant effect of taxiing aircraft on the noise environment at Povey Cross, the noise level being raised by 6 to 8 dBA by a manoeuvring B747. Several aircraft taxiing on the airfield raised the noise level in Medlar Close (the southernmost site in the Cherry Lane area, over 3 km to the south of the airfield) by up to 20 dBA between approximately 0116 and 0131 as can be seen in Figure 19. A 20 dBA increase in noise level due to taxiing noise was at the higher end of the typical levels at Gatwick, a 10 dBA increase over background being more common.

Stansted

3.36 Most of the strongly audible taxiing aircraft at Stansted were turboprops, which have significantly different noise characteristics to taxiing jet aircraft. The majority of jet aircraft using Stansted at night were quieter types, such as the BAe 146 (Avro RJ 70/80/100). Experience suggests that turboprop aircraft are generally noisier than these jets while taxiing. This is illustrated in Figure 20 which shows the effect a BAe 146 and an Shorts 360 turboprop taxiing on the noise level at Tye Green. The second of the two events, the Shorts 36 prop taxiing for departure reaches levels 20 dBA above the background, the BAe 146 aircraft conducting similar manoeuvres 10 minutes earlier gave rise to noise levels 10 dBA above background.

3.37 The audibility of taxiing aircraft was significantly reduced in upwind conditions, although to a lesser extent for turboprop aircraft. The community at Tye Green were particularly susceptible to noise from taxiing aircraft due to the short propagation path and lack of obstacles between the dwellings and the airfield. Coopers Villas is a similar distance from the airfield, but tended to be less susceptible to taxiing noise if the aircraft turned to the northeast after leaving Apron A, because of the barrier effect of the terminal building and local houses. In such cases, the majority of taxiing noise heard at Coopers Villas would be from aircraft on the apron before moving out onto the taxiway.

Ground Noise from Airport Service Vehicles

3.38 For the purpose of this study airport service vehicles include tugs used to move aircraft, and trolley trucks used to move cargo and baggage. This category of noise source also includes sirens on the vehicles moving around the airport. The noise from airport service vehicles generally has a transient effect on the noise environment in the communities around Heathrow and Stansted, this type of ground noise was very rarely noted at Gatwick. In many cases the noise emitted by the sirens on the airport service vehicles is not readily measurable in terms of overall sound pressure level, due to their tonal characteristics. The siren noise, however, is often audible and therefore deserves treatment in this study.

Airport Vehicles

3.39 Figure 21 shows the time history of noise monitoring at Waye Avenue, Heathrow, between 0220 and 0235 hours on 21 August 1996. The time history trace shows that the effect an aircraft tug moving around the maintenance area on the overall noise level is limited, but the event was clearly audible in the local community.

3.40 The effect on the noise level at Coopers Villas to the south of Stansted airport of a baggage trolley, or other airport vehicle, travelling over an irregular concrete surface on the airfield at Stansted can be seen in Figure 22. As the vehicle passes over ruts in the concrete apron surface it causes the noise level to rise instantaneously by 10 dBA or more. The noise level produced by a car passing within 10 m of the microphone shows the significance of the impact noise from the baggage trolley in noise level terms. At Stansted the noise from airport vehicles was only heard at Coopers Villas and Molehill Green, but being mentioned on 23 occasions in five nights of monitoring, it was a relatively frequent source of noise in these communities.

Sirens

3.41 A time history recorded at Waye Avenue while a siren was sounding in the maintenance area at Heathrow is shown in Figure 23. The siren was coded when it became audible but as can be seen from the time history trace it had little or no effect on the overall noise level, due to the tonal nature of the source. For comparison, the noise level created by an arrival on runway 27L (passing to the south of the monitoring point) is also shown on the trace.

Audibility of Auxiliary Power Units

3.42 The noise emitted by APUs on aircraft are also tonal in nature, and were frequently audible in the communities around the three airports, but again rarely had a noticeable effect on the time history traces unless the APU in operation was close to the monitoring site. A consideration of the audibility of APUs at each airport is given below.

Heathrow

3.43 In downwind conditions in the target areas close to Heathrow, APU noise was regularly audible, but rarely had an effect on the overall sound pressure level. Experience from monitoring suggests that the maintenance areas to the east of the airfield were the most significant source of APU noise.

3.44 At sites in the community close to the maintenance areas, the level of APU noise was occasionally high enough to have an effect on the time history traces: Figure 24 shows an APU running in the maintenance area raising the noise level by up to 8 dBA in Clevedon Gardens, 1 km away. Such an elevation in the noise level was generally only seen in relatively quiet parts of the night period because at other times APU noise was readily masked by other noise sources. At target areas further from the maintenance areas, such as Stanwell, APU noise was rarely heard.

Gatwick

3.45 The target areas of Povey Cross and South Horley were the only areas where noise from APUs was regularly audible, due to their relatively close proximity to the terminal area at Gatwick. Although the tonal noise of APUs was audible it was rarely loud enough to raise the noise level significantly in the local communities, as can be seen in the time history trace from Lechford Road shown in Figure 25.

3.46 APU noise was rarely audible during monitoring at Charlwood and the Cherry Lane target area, and when heard, did not have a significant effect on the overall noise level.

Stansted

3.47 The majority of aircraft at Stansted airport use Apron A, adjacent to the cargo terminal, during the night-time period. The stands on Apron A are equipped with FEGP, making it unnecessary for aircraft on that apron to use APUs for long periods. A large proportion of the aircraft operating at Stansted during the night-time period are turboprop aircraft. In general turboprop aircraft are not fitted with APUs, (although manufacturers of types such as ATR42s and

ATR72s do offer optional APUs), and so would be expected to use the FEGP supplied.

3.48 Observations from Phase 1 of the Ground Noise study showed that despite the availability of FEGP numerous jet aircraft opted to run APUs during turnaround. Experience from monitoring during Phase 2 suggested that APUs were still regularly in use for prolonged periods by aircraft during the night-time period.

3.49 The most important factor governing the audibility of APUs in the communities around Stansted was the proximity of the monitoring sites to the airport; APUs were only heard in target areas close to the terminal area, (Takeley, Coopers Villas, Molehill Green and Tye Green). At these sites the noise from APUs, whilst clearly audible, rarely had a significant effect on the overall noise level. Figure 26 shows an example of an APU running in the terminal area raising the noise level in Molehill Green by around 8 dBA. During two nights of monitoring at Bishop's Stortford and one night at Birchanger, APU noise was not heard.

Ground Running of Aircraft Engines

3.50 During Phase 1 it was found that more ground running of aircraft engines took place at Heathrow than at the other two airports. Results from Phase 2 suggest that the incidence of ground running of engines at night has been significantly reduced since Phase 1. Whilst the number of ground runs at Heathrow have decreased since DORA first made night-time visits to the airports, a number were still recorded there and at Stansted. Below is a brief discussion of ground running at each airport.

Heathrow

3.51 Table 8 shows the number of engine runs logged by HAL for each of the nights when monitoring took place in Phase 2 at Heathrow. Also included in Table 8 is a summary of the number of logged ground runs that were audible in the target areas for each night; a dash indicates that the site was not used on a particular night. A large number of logged engine ground runs were not audible during Phase 2 monitoring. On a few occasions during Phase 2 monitoring, engine running was heard in the communities which was not accounted for on HAL log sheets. This may indicate some non-reporting of engine runs by operators, or possibly inaccurate source identification by monitoring staff.

3.52 Ground running engines were audible to varying extents in all target areas. At Longford, Stanwell and Harlington ground runs were audible, but did not have a significant effect on the overall noise level. Noise from ground running was loudest at monitoring sites in the Cains Lane and Waye Avenue areas. At these

sites ground running in both the central terminal area and the maintenance areas were audible, but the maintenance area runs produced higher noise levels. Figure 27 shows an increase of up to 15 dBA over background noise level caused by a B737 in the running pen in the nearby maintenance area for 8 minutes. The spike in the time history just before 0216 relates to a car passing the monitoring point at 3m, which forms a useful comparison to the noise level from the running aircraft.

Gatwick

3.53 No ground runs were reported by GAL during the 8 nights of monitoring conducted at Gatwick, and none were heard by DORA staff.

Stansted

3.54 Stansted Airport Limited (STAL) keep a log of all engine runs. STAL ground running log sheets indicate that there was one ground run during the 12 nights of Phase 2 monitoring. The reported run was not heard by DORA staff. Notes made during monitoring indicate however that there were 8 occasions when aircraft engines were heard running on the airfield, which could not be associated with an aircraft movement listed in the control tower runway logs. Figure 28 shows one such engine running noise heard in Molehill Green, which at its peak, in downwind conditions, exceeded the ambient noise level by 15 dBA.

4. MITIGATION MEASURES

4.1 One objective of this study was to identify areas where ground noise mitigation measures might benefit the communities around the airports. This section describes the mitigation measures that were suggested to ANMAC and presents an update on measures taken by the airports. As noted in section 2, BAA had already initiated a variety of actions following the results of the preliminary observations and pilot study (Phase 1).

4.2 In general, before introducing any noise mitigation measures, a detailed assessment of their practicality, applicability to specific problems and their cost effectiveness is required, which was outside the scope of this study. The mitigation measures that have been identified from this study have been classified into two categories:

a) Administrative controls. Aimed at controlling ground noise at source, based on adjustments to operational practice.

b) Engineering controls. Measures that attempt to restrict noise propagating into the local communities.

Administrative Controls

4.3 Following Phase 1 of this study, new controls on ground running of aircraft engines at Heathrow were introduced. These appear to have contributed to a reduction of the noise generated by this activity. This type of administrative control has the potential to bear significant benefits for local communities at a relatively low cost. Scope for similar types of measures are suggested here.

APU and GPU use

4.4 The standing instructions for all three airports set out procedures for the minimisation of APU and GPU noise. During Phase 2, APU noise and to a much lesser extent GPU noise were audible in the target areas. This may have been due to either non compliance with the procedures or the need to further improve them. There might be scope for investigating the extent and reasons for the use of APUs and GPUs.

4.5 Where the APUs are a dominant source of ground noise and the main reason for an adverse response, introducing FEGP and encouraging its use could be a positive step towards reducing community reaction.

4.6 At Heathrow a restriction on the use of APUs has been discussed with operators to limit its use to a fixed time after arrival and before departure, and only for essential maintenance work that requires the use of APUs. FEGP is already

provided on 93% of passenger related stands in order to minimise the use of GPUs. To encourage FEGP use, operators are charged for it when the aircraft is on stand whether or not they use it.

4.7 This approach will naturally promote the use of fixed power and might reduce the impact of ground noise if applied at Gatwick and Stansted. Since the study Gatwick Airport Limited (GAL) have been considering the case for increasing FEGP availability on aircraft stands. Currently Gatwick has FEGP on 61 of its 91 stands. Stansted Airport Limited (STAL) have recently carried out a monitoring exercise on the use of FEGPs during the night period. This indicated that in most cases FEGPs were used in preference to GPUs or APUs. However, in an attempt to further increase the FEGP usage and following discussions with the operators, a second monitoring exercise will be carried out. Enforcement measures may be considered in the future.

4.8 Consideration is also being given to the introduction of new equipment which will enable turbo prop aircraft also to use FEGP. This is currently not possible due to an incompatibility in the electrical system on turbo props.

Ground Running of Aircraft Engines

4.9 There could be scope for liaison between the different operators at the three airports to identify policies that have been successful in the past in reducing the incidence of ground running at night.

4.10 There also appeared to be an opportunity for improved monitoring at Stansted to ensure that ground operations staff are notified of all incidences of ground running at night. STAL's Director Notices on the ground running of engines, APUs, GPUs and FEGP have recently been reviewed following consultation with the Operators. The revised documents will provide for the closer management of all engine running for maintenance both during the day and night periods. It will also encompass controls on the use of tail mounted engines and restrictions on the use of APU'S and GPU's when FEGP is available. Following discussion with the operators it was agreed that a phasing out of 'power backs' would take place. This has lead to a reduction of such manoeuvres at night. The revised documents also include the following enhancements:

a) greater control on ground running by turbo prop aircraft;

b) a requirement that all runs are co-ordinated and recorded by Airfield Operations, including more detailed recording of prevailing weather conditions;

c) the use of ground idle thrust whilst taxiing thereby reducing blast, noise and fuel emissions.

4.11 BA and GAL are currently developing proposals to construct an engine testing pen at Gatwick.

Taxiing aircraft

4.12 Taxiing aircraft make a significant contribution to the ground noise environment around the airports at night. The suggestion to ANMAC was to consider operational changes that might reduce the noise impact of taxiing aircraft. BAA noted at ANMAC that taxi noise is controlled by a number of factors, such as:

- the Night Restrictions, which limit the number of arrivals and departures in the defined night period;
- ATC and pilots seek to minimise taxiing distances for landing aircraft;
- the use of idle thrust is normally required to maintain safe taxiing speeds.

Audits

4.13 HAL is carrying out 3 audits a year of the records covering the use of the 2 noise pens, by monitoring the noise throughout the night generated in the pens and comparing the resulting times to the logged times of engine runs that were given permission. The audits have been designed to include checking that the runs that took place were justified, and to highlight the need to minimise APU use during maintenance work at night.

Engineering Controls

Noise Barriers

4.14 The use of barriers or bunds placed in the noise source to receiver path can lead to useful noise reduction in some cases, and as such can be useful in protecting communities from noise. However, barriers do not provide a ready solution to noise control problems in all cases. For example, for optimised performance they must be located either close to the source or the receiver and as a rule of thumb, must at least be large enough to make the source invisible to the receiver. Barriers and bunds are most effective at attenuating higher frequency noise; low frequency components of noise sources tend to diffract over the top and around the side of such noise control installations.

4.15 One objective of Phase 2 was to identify areas that may benefit in theory from the use of physical noise reduction measures. Two areas at Heathrow and two

at Stansted have been identified for consideration[5]. A comprehensive study of each site would be needed to fully quantify the potential noise benefits of a bund or barrier installation, together with discussion with the airports of associated practicalities.

a) Noise from the maintenance areas at Heathrow regularly propagates into the densely populated Waye Avenue area to the east of the airport. High frequency APU noise was heard from this area of the airport for protracted periods during Phase 2 as well as tonal noise from sirens. The introduction of a barrier between the dwellings in the Waye Avenue area and the maintenance aprons might help to reduce the impact of these noise sources on the neighbouring communities. To a lesser extent, (due to the low frequency components in the sources) a barrier might also help to reduce the noise impact of vehicles and GPUs on the maintenance aprons. (NB a barrier already exists adjacent to the north and north-east of the maintenance area.)

b) The noise levels recorded at Longford on three monitoring nights showed that there might be potential for mitigation measures to reduce the community noise exposure. The Leq values presented in Figure 4 however include noise from all sources; noise from the M25, M4 and A4 are frequently dominant at this site, as well as noise from taxiing early morning departures. A possible mitigation measure for this area would involve siting a barrier to the south of the site, adjacent to the airport perimeter, to reduce the propagation of taxiing noise into the community. Because of the significant distances between the community and the noise sources, the intervening obstacle would have to be of considerable size, to prevent diffraction of the noise over the top of the barrier. One consideration for this mitigation measure, due to the site's proximity to aircraft operations, would be the clearance between any proposed barrier and the aircraft or the airport navigation aids. Following this suggestion HAL investigated the practicalities of a barrier to the south of Longford. They identified that the safe operation of the Instrument Landing System (ILS) would restrict the height of such a barrier to only 2.3m, which is insufficient to have any impact on the ground noise propagation.

c) Aprons B and C at Stansted are effectively shielded from the communities to the southeast of the airport by the terminal building. The southeastern end of Apron A however, is relatively open, leaving a clear noise transmission path between the apron and the communities in Coopers Villas and Takeley. Apron A is the most heavily used area of Stansted in the night period, being adjacent to the cargo terminal which serves the majority of the

[5] Due to the large distances and the nature of the terrain between the target areas and noise sources at Gatwick, noise barriers are not likely to be an effective noise control solution.

operations during the night. Engine start-ups, taxiing aircraft, airside vehicles and APU noise emanating from Apron A was regularly heard in Coopers Villas during Phase 2 visits. A noise barrier to the southeastern end of Apron A might afford protection to the residents of Coopers Villas and (to a lesser extent) Takeley from the noise sources concentrated in that area of the airport.

d) A clear noise propagation path also exists between the main apron areas at Stansted and the small settlement at Tye Green. At this site taxiing, engines starting up, APUs, airside vehicles and sirens were all heard emanating from the airfield during Phase 2. A barrier to the south of the site might help to protect the community from these noise sources. In this case, as at Longford, the distance between the noise sources and the site is relatively large, so any acoustic shielding would have to be of considerable size. Due to the nature of the intervening terrain, the barrier would need to be close to the residences at Tye Green.

Sirens

4.16 Tonal noise from sirens on airport service vehicles can be audible in communities around the airports. Where warning sirens have been identified as a problem, consideration should be given to specifically designing them so that they can perform their function, ie to attract attraction, at the same time as reducing their impact on the surrounding community. This will include considering their level and characteristics. These may involve the introduction of environmentally sensitive devices that concentrate sound energy to the area where people require the warning, or reducing the siren level whilst retaining it at a level at which it could still be audible in the relevant area.

Noise Insulation

4.17 Some of the target areas studied in Phase 2 were outside of the air noise insulation grant scheme, it might be appropriate to give special consideration to providing insulation for homes in areas particularly affected by ground noise.

4.18 HAL have now increased the scope of the Heathrow Noise Insulation Scheme (NIS) so that all the properties in the Waye Avenue Area are offered insulation as are those of Longford, parts of Cains Lane and Stanwell, Hatton and Hounslow. This will provide for either free secondary glazing or 50% of the cost of replacement high specification double glazing, to any windows in all rooms. All the residential properties within this area are being offered this service. Currently the majority of properties in the increased NIS area, including the Waye Avenue area roads studied by DORA, have applied for insulation.

5. BENCHMARKING

5.1 The need to 'benchmark' ground noise had been raised during the course of the work. In this context benchmarking refers to the comparison of measured noise levels with criteria relating to the likely 'acceptability' of the noise. In the UK, there are no generally adopted benchmarking procedures or accepted criteria specifically applicable to the assessment of the impact of ground noise around airports at night.

5.2 There are a number of factors which are likely to be important in determining 'acceptability' and that should be taken into account in any benchmarking procedure. These can be both acoustic and non-acoustic in nature:

a) The audibility, duration and temporal nature of the noise. An assessment based on these factors would have to consider the degree to which individuals may be habituated to certain noise sources.

b) The degree to which airport generated noise stands out from the general background noise. For example, whether the airport noise is louder or has different characteristics to the ambient noise. Any criterion adopted may have to use measures of the features of the noise rather than an energy equivalent level.

c) The degree to which local people consider noisy activities are necessary.

d) The extent to which people perceive the noise may disturb their sleep.

5.3 In the absence of specific criteria or benchmarking procedures for airport ground noise, it was considered whether any existing procedures for the assessment of other environmental noise at night could help in interpreting the data collected in this study. These existing procedures may imply likely response of humans to noise sources but it is important to note that they are not tailored specifically for ground noise sources and therefore must be treated with caution. A brief summary of standards and guidance material that may be relevant in the ground noise context is given below.

a) *BS 4142: Method of rating industrial noise affecting mixed residential and industrial areas (Ref 1).* This standard is used to predict the likelihood of complaints arising from industrial developments. BS 4142 compares the noise level of an existing industrial source or a prediction of a proposed source with a measurement of the background noise level in a nearby community, making corrections to the noise level for the existence of strong tones, bangs and hisses in the noise character of the source. In cases where sources have discernible tonal characteristics, a BS 4142 assessment of the noise source would add a 5 dBA fixed penalty to the specific level of the noise source. The likelihood of complaint due to the specific noise source is rated on the basis of whether the specific noise of the source level (measured

as Leq) exceeds the local background noise level (measured in L_{90}) by 10 dB(A) or more.

b) *Planning Policy Guidance PPG 24: Planning and Noise (Ref 2).* This guidance is intended for use in the planning of noise-sensitive buildings near existing sources of noise. PPG 24 only addresses the issue of noise levels in areas for planned development: Ground noise is mentioned as an additional characteristic of noise from aerodromes which should be addressed in any assessment of the planning of noise sensitive developments. PPG24 sets out noise exposure categories, related to local noise levels in Leq terms, where development should not be planned in order to minimise the impact of noise. Whilst PPG 24 is not designed for use retrospectively, the noise categories might give an indication of levels likely to be regarded as acceptable in the communities local to the airports.

c) *World Health Organisation (WHO) 'Environmental Health Criteria 12 - Noise' (Ref 3).* This suggests a steady-state level of 35 dBA indoors[6] and 45 dBA outdoors as a target to 'preserve the restorative process of sleep' during the night-time period.

Benchmarking of the study findings

5.4 Comparison of the study results with the assessment procedures outlined above might be useful in the benchmarking of ground noise. The difficulty with this is that ground noise is very variable, in terms of its noise level, its incidence and its characteristics. These factors are likely to affect its impact on the surrounding community. This variability is dependent upon the following factors:

a) *The direction of the wind.* Wind direction has a significant effect on the audibility of ground noise. A ground noise source that is typically audible at a given site in downwind conditions is often not audible when the site is upwind of the airport.

b) *The level of activity on the airfield.* Airside observations during the study indicated that there are some events that occurred on the airfields on a regular basis. There are other noisy activities that do not occur regularly, such as emergency maintenance. The level of activity also varies between airports.

c) *The location of the monitoring site in relation to the ground noise source.* Certain ground noise sources, such as taxiing aircraft and airside vehicles, move around the airfield, other sources occur at different points around the airfield, eg: engine start-ups, ground runs and APU and GPU running.

[6] A draft revision to the Criteria 12 document, if it were adopted, would reduce the night-time internal recommendation from 35 to 30 dBA, along with the need to consider maximum event levels and a measure of the number of events.

d) *The presence of other noise sources.* On many occasions the airport ground noise was masked by other sources of noise; this was particularly the case for road traffic noise.

5.5 The above factors, make any evaluation of ground noise in terms of 'typical' or 'representative average' noise levels extremely difficult. A more practical approach may be to categorise the ground noise environment around the airports in terms of the nature of the noise sources as follows:

a) *Non-specific airport noise.* At all three airports there existed a general non specific airport 'drone' which was difficult to identify, but was probably due to distant APU and GPU use, airport plant and other airside equipment. The airport drone is often partially tonal, but is frequently masked or mixed with other noise sources such as local community noise, off airport plant and road traffic. This type of noise is relatively unobtrusive and therefore unlikely to be considered 'unacceptable'.

b) *Tonal noise.* When tonal sources such as APUs, distant taxiing and GPUs are closer to the receiver they become more defined and the likelihood of impact on the community is greater. Such noises are likely to be intrusive in communities because, despite having little effect on the overall noise level, they are often audible above the background.

c) *Distinct noise events.* These are well defined in noise terms, such as nearby taxiing aircraft, engines starting up, ground running, and APUs or GPUs starting up near to communities and are the most likely to be considered 'unacceptable'. In the worst case these types of events have been noted to raise the noise level in nearby communities by up to 30 dBA.

5.6 Using BS 4142 principles, the tonal and distinct noises would be treated as increasing the perceived noise and in turn this could lead to a prediction of an increased likelihood of complaint. The procedure in BS 4142 advises that source noise levels 10 dBA above the background level are likely to cause complaint. On numerous occasions during the study, ground noise sources were found to increase noise levels by 10 dBA or more above background[7]. In fact data from the airports gathered in Phase 1 to assist the selection of the Phase 2 target areas, show that some complaints concerning ground noise have been received from the residents of some of the target areas.

5.7 PPG 24 presents the recommended noise exposure categories for building new dwellings near existing mixed noise sources. It states that planning permission should not normally be granted where the 8 hour Leq (2300 and 0700) lies between 57 and 66 dBA. If houses were to be built in the areas where the data presented in Figures 4, 5 and 6, were measured, planning permission would not

[7] Note: the Phase 2 data collection methodology is not wholly comparable with that of BS 4142.

normally be granted in the Waye Avenue area and Longford[8]. All other target areas, except Birchanger at Stansted, would fall in the PPG 24 category that advises that, in building new houses, noise should be taken into account and that an adequate level of protection against noise should be ensured.

5.8 The WHO criterion encompasses noise from all sources and as such is particularly difficult to apply specifically to ground noise. A comparison of the nightly 8 hour Leqs given in Figures 4, 5 and 6 with the WHO outdoor 45 dBA steady state night-time criterion shows that it is only met at Birchanger.

5.9 It must however be stressed that the WHO criterion represents the lowest threshold above which the ability to sleep soundly might be impaired. As noise increases above this level there would be an increasing likelihood of disturbance. The criteria only provide general guidance on what might be considered acceptable but the time period over which the noise exposure is received and nature of the noise also need to be taken into account.

[8] In upwind conditions the noise level at Longford was purely due to traffic noise on the A4, M4 and M25 and local roads.

6. CONCLUSIONS

6.1 The study monitoring has provided an insight into the noise from ground based operations heard in the local communities around the three airports at night.

6.2 It has become clear that there are a number of key issues important in the assessment of night-time ground noise from the three airports:

- the effect of wind direction on the propagation of ground noise;
- the effect of road traffic on ground noise audibility;
- taxiing aircraft;
- ground noise from airport service vehicles and sirens;
- the audibility of auxiliary power units;
- ground running of aircraft engines.

6.3 The noise from taxiing aircraft has been found to be a main component of the ground noise heard in the surrounding communities of all three airports at night. For Heathrow the taxiing of aircraft is largely restricted to the period after 0400; at Gatwick and Stansted it is more evenly distributed throughout the night period. It is suggested that consideration is given to exploring opportunities for reducing the impact of such noise.

6.4 It was found that traffic on the roads around the three airports forms a major part of the local noise environment, often to the extent of masking noise from the airports.

6.5 Phase 2 has suggested that there are certain characteristics of noise that are likely to cause an adverse reaction, such as distinct events and noise with tonal features, which may not be considered acceptable within the communities around the airports.

6.6 The findings led to a number of suggestions for mitigation measures which were considered by ANMAC and remitted to the airports and their noise and track working groups and consultative committees. The measures suggested for consideration included administrative controls relating to APU noise, GPU noise and ground running noise, and engineering controls relating to the introduction of further noise barriers and noise insulation, and addressing the issues of taxiing aircraft and sirens. Many of those suggestions have already been considered by the three airports and various mitigation measures have been taken.

6.7 In the absence of standardised procedures relating to the assessment of ground noise the need to develop a benchmarking procedure with which to judge the impact of ground noise has been recognised. Factors to consider in such a procedure have been suggested.

7. REFERENCES

1 British Standards Institution: BS 4142 Method of rating industrial noise affecting mixed residential and industrial areas, 1997.

2 Department of Environment: Planning Policy Guidance PPG 24: Planning and Noise (Ref 2).

3 The World Health Organisation: Noise-Environmental Health Criteria 12', Geneva, Switzerland, 1980.

Table 1: Phase 2 Target Areas

Airport	**Target Area**
Heathrow	Waye Avenue Area
	Cains Lane Area
	Stanwell
	Longford
	Harlington
Gatwick	Povey Cross
	South Horley
	Cherry Lane Area
	Charlwood
Stansted	Takeley
	Coopers Villas
	Bishop's Stortford
	Molehill Green
	Tye Green

Table 2: Wind conditions experienced in target areas at Heathrow Airport

DATE	LOCATION	WIND CONDITION
04/08/96	Harlington, Field Close	Downwind
04/08/96	Longford, Bath Rd	Downwind
05/08/96	Harlington, Field Close	Downwind
05/08/96	Longford, Bath Rd	Downwind
06/08/96	Cains Lane Area, Kingston Ave	Downwind
06/08/96	Longford, Bath Rd	Upwind
07/08/96	Waye Ave	Downwind
07/08/96	Waye Ave Area, Clevedon Gdns	Downwind
12/08/96	Cains Lane Area, Edward Rd	Downwind
12/08/96	Cains Lane Area, The Gardens	Downwind
13/08/96	Cains Lane Area, The Gardens	Downwind
13/08/96	Stanwell Moor, Brook Close	Downwind
14/08/96	Cains Lane Area, Edward Rd	Variable
14/08/96	Cains Lane Area, Kingston Ave	Variable
18/08/96	Cains Lane Area, The Gardens	Upwind
18/08/96	Harlington, Field Close	Downwind
19/08/96	Waye Ave	Variable
19/08/96	Waye Ave Area, Clevedon Gdns	Variable
20/08/96	Waye Ave	Downwind
20/08/96	Waye Ave Area, Burnham Gdns	Downwind

Table 3: Wind conditions experienced in target areas at Gatwick Airport

DATE	LOCATION	WIND CONDITION
17/06/96	Cherry Lane, Medlar Close	Downwind
17/06/96	Cherry Lane, Rec ground	Downwind
18/06/96	Cherry Lane, Medlar Close	No Wind
18/06/96	Cherry Lane, Rec ground	No Wind
19/06/96	Charlwood, Perrylands	Downwind
24/06/96	Povey Cross, Withey Medows	No Wind
24/06/96	South Horley, Lechford Rd	No Wind
25/06/96	Charlwood, Perrylands	Upwind
25/06/96	South Horley, Lechford Rd	Downwind
27/06/96	Cherry Lane, Rec ground	Upwind
27/06/96	Povey Cross, Withey Medows	Downwind
11/08/96	Cherry Lane, Medlar Close	No Wind
11/08/96	Povey Cross, Withey Medows	No Wind
08/09/96	Cherry Lane, Rec ground	Downwind
08/09/96	South Horley, Lechford Rd	Upwind

Table 4: Wind conditions experienced in target areas at Stansted Airport

DATE	LOCATION	WIND CONDITION
01/07/96	Molehill Green, School Lane	Downwind
01/07/96	Tye Green	Downwind
02/07/96	Takeley, Takeley School	Upwind
02/07/96	Tye Green	Downwind
03/07/96	Molehill Green, School Lane	Downwind
03/07/96	Takeley, Beech Close	Upwind
04/07/96	Coopers Villas	Downwind
04/07/96	Takeley, Takeley School	Downwind
30/07/96	Molehill Green, Murryfield Farm	Downwind
30/07/96	Tye Green	Downwind
31/07/96	Coopers Villas	Downwind
31/07/96	Molehill Green, Chapel End	Downwind
01/08/96	Coopers Villas	Downwind
01/08/96	Takeley, Beech Close	Downwind
09/09/96	Bishop's Stortford	Variable
09/09/96	Tye Green	Variable
10/09/96	Coopers Villas	Downwind
10/09/96	Takeley, Takeley School	Downwind
15/09/96	Bishop's Stortford	Variable
15/09/96	Molehill Green, School Lane	Upwind/ Variable
16/09/96	Takeley, Beech Close	Upwind
16/09/96	Tye Green	Downwind
17/09/96	Coopers Villas	Upwind
17/09/96	Takeley, Takeley School	Upwind
23/09/96	Birchanger	Downwind/ Variable
23/09/96	Tye Green	Variable

Table 5: Ground Noise Sources at Heathrow Airport[9]

Heathrow	Longford		Harlington		Waye Ave		Cains Lane		Stanwell		
	3 Nights		3 Nights		6 Nights		7 Nights		1 Night		
Type of Event	**Number**	**%[10]**	**Number**	**%[10]**	**Number**	**%[10]**	**Number**	**%[10]**	**Number**	**%[10]**	**Overall**
Taxi Noise	32	62	56	50	45	41	102	60	14	70	249
Engine Runs	3	6	7	6	6	5	7	4	3	15	26
Engine Start-ups	5	10	10	9	4	4	21	12	0	0	40
Engine power down	0	0	7	6	0	0	8	5	1	5	16
Airside Vehicles	4	8	0	0	8	7	2	1	0	0	14
Non-Specific GN	3	6	8	7	11	10	10	6	0	0	32
APU	5	10	10	9	18	16	9	5	0	0	42
GPU	0	0	0	0	4	4	0	0	0	0	4
Sirens	0	0	13	12	15	14	11	6	2	10	41
Total No. of Events	**52**		**111**		**111**		**170**		**20**		**464**

[9] The numbers of events refer to the number of times each source was mentioned in coding notes. The lists give no indication of the durations and levels of the sources, but are included to give an idea of their relative frequency during the monitoring.

[10] Indicates the percentage of all mentioned ground noise events at the site attributable to this source.

Table 6: Ground Noise Sources at Gatwick Airport[11]

Gatwick	Charlwood		Povey Cross		South Horley		Cherry Lane		
	2 Nights		3 Nights		3 Nights		7 Nights		
Type of Event	**Number**	**%[12]**	**Number**	**%[12]**	**Number**	**%[12]**	**Number**	**%[12]**	**Overall**
Taxi Noise	41	80	73	70	68	60	133	80	315
Engine Runs	0	0	0	0	0	0	0	0	0
Engine Start-ups	6	12	19	18	23	20	16	10	64
Engine power down	2	4	4	4	10	9	3	2	19
Airside Vehicles	0	0	2	2	0	0	0	0	2
Non-Specific GN	2	4	2	2	4	4	11	7	19
APU	0	0	3	3	9	8	1	1	13
GPU	0	0	1	1	0	0	3	2	4
ens	0	0	1	1	0	0	0	0	1
Total No. of Events	**51**		**105**		**114**		**167**		**437**

[11] The numbers of events refer to the number of times each source was mentioned in coding notes. The lists give no indication of the durations and levels of the sources, but are included to give an idea of their relative frequency during the monitoring.

[12] Indicates the percentage of all mentioned ground noise events at the site attributable to this source.

Table 7: Ground Noise Sources at Stansted Airport[13]

Stansted	Tye Green		Molehill Green		Takeley		Coopers Villas		Bishop's Stortford		Birchanger		
	6 Nights		5 Nights		7 Nights		5 Nights		2 Nights		1 Night		
Type of Event	**Number**	**%[14]**	**Number**	**%[14]**	**Number**	**%[14]**	**Number**	**%[14]**	**Number**	**%[14]**	**Number**	**%[14]**	**Overall**
Jet Taxi Noise	48	34	69	43	32	24	72	34	1	10	5	24	227
Turboprop Taxi Noise	71	50	34	21	66	49	47	22	7	70	14	67	239
Engine Runs	0	0	4	3	2	1	6	3	0	0	0	0	12
Engine Start-ups	6	4	17	11	9	7	22	10	0	0	0	0	54
Turboprop Engine Start-ups	5	4	1	1	5	4	7	3	0	0	0	0	18
Engine power down	0	0	3	2	2	1	4	2	0	0	0	0	9
Airside Vehicles	0	0	3	2	0	0	20	9	0	0	0	0	23
Non-Specific GN	3	2	15	9	11	8	16	7	0	0	2	10	47
APU	8	6	12	8	3	2	17	8	0	0	0	0	40
GPU	0	0	0	0	0	0	2	1	0	0	0	0	2
Sirens	1	1	1	1	6	4	1	0	2	20	0	0	11
Total No. of Events	**142**		**159**		**136**		**214**		**10**		**21**		**682**

[13] The numbers of events refer to the number of times each source was mentioned in coding notes. The lists give no indication of the durations and levels of the sources, but are included to give an idea of their relative frequency during the monitoring.

[14] Indicates the percentage of all mentioned ground noise events at the site attributable to this source.

Table 8 Ground Running at Heathrow Airport

		Number of Audible Engine Runs at each Target Area								
		Longford	**Harlington**	**Waye Avenue area**			**Cains Lane area**			**Stanwell**
Date	Number of Logged Engine Runs 23:00-07:00 hrs	Bath Road	Field Close	Waye Avenue	Clevedon Gardens	Burnham Gardens	Edward Road	The Gardens	Kingston Avenue	Brook Close
4/5th Aug.	2	2	2	-	-	-	-	-	-	-
5/6th Aug.	3	0	0	-	-	-	-	-	-	-
6/7th Aug.	8	0	-	-	-	-	-	-	1	-
7/8th Aug.	1	-	-	1	0	-	-	-	-	-
12/13th Aug.	3	-	-	-	-	-	1	0	-	-
13/14th Aug.	9	-	-	-	-	-	-	3	-	2
14/15th Aug.	8	-	-	-	-	-	1	-	1	-
18/19th Aug.	8	-	3	-	-	-	-	1	-	-
19/20th Aug.	4	-	-	0	0	-	-	-	-	-
20/21st Aug.	4	-	-	2	-	2	-	-	-	-

- indicates that the monitoring site was not used that night

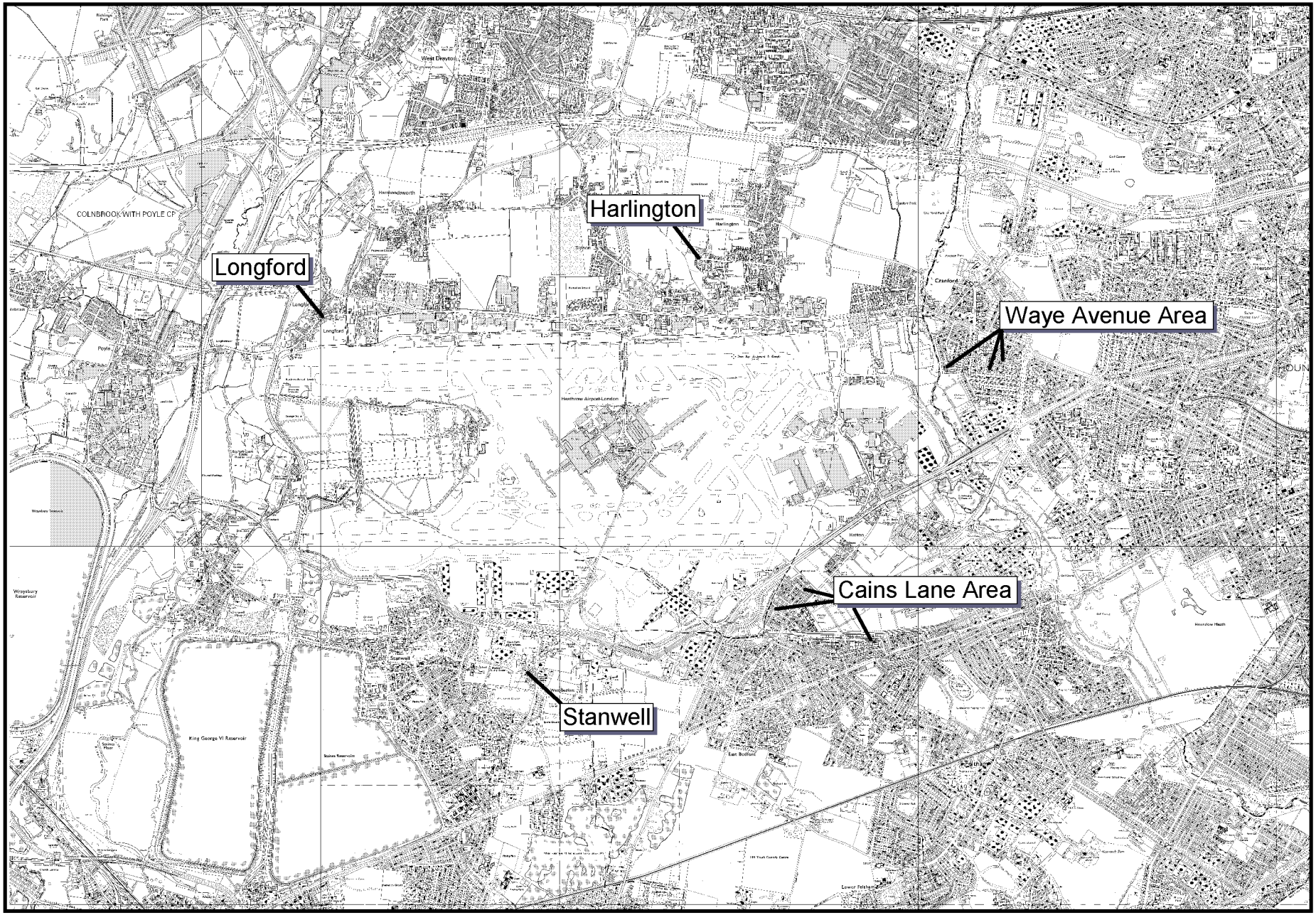


Figure 1: Heathrow Monitoring Sites

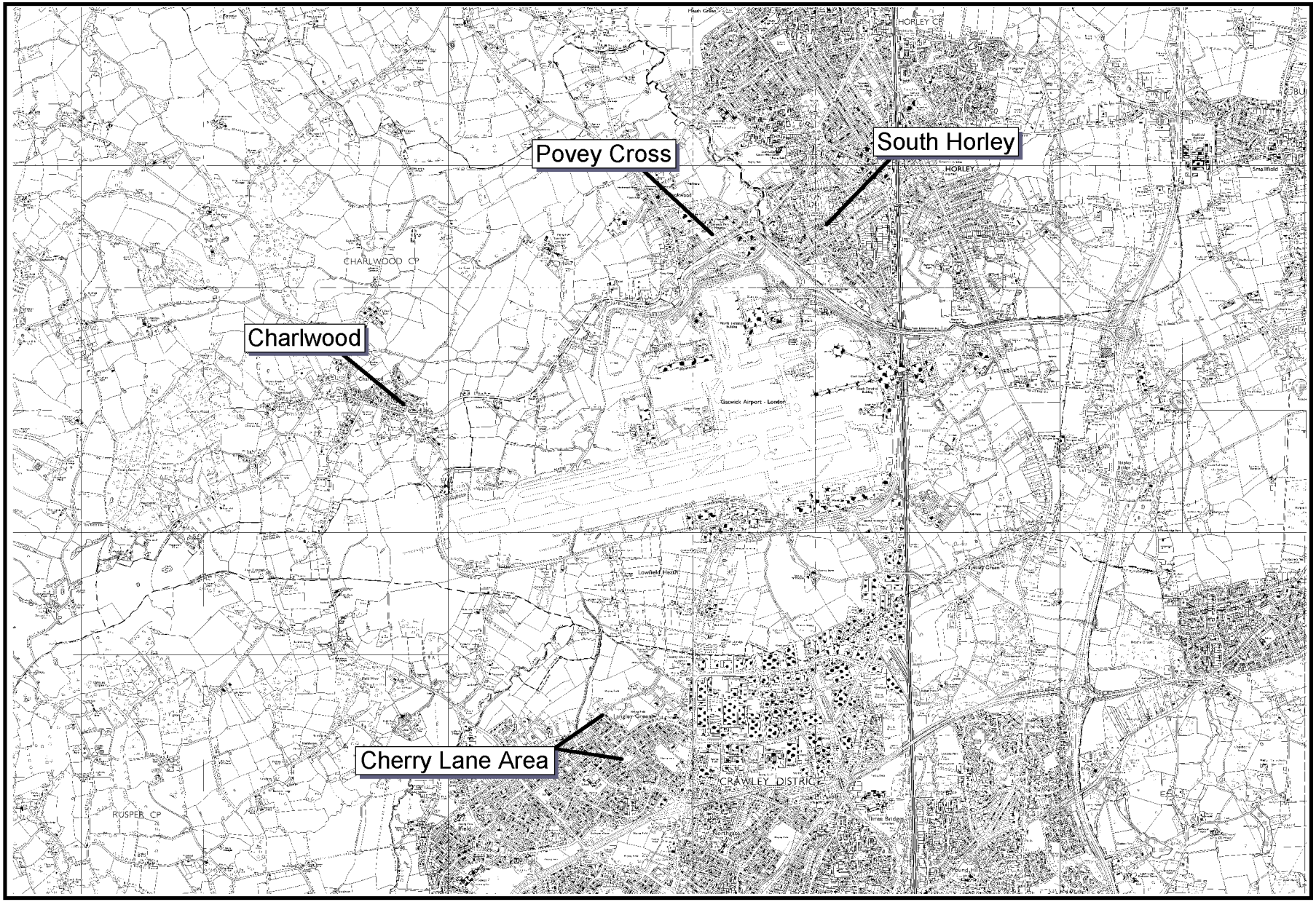


Figure 2: Gatwick Monitoring Sites

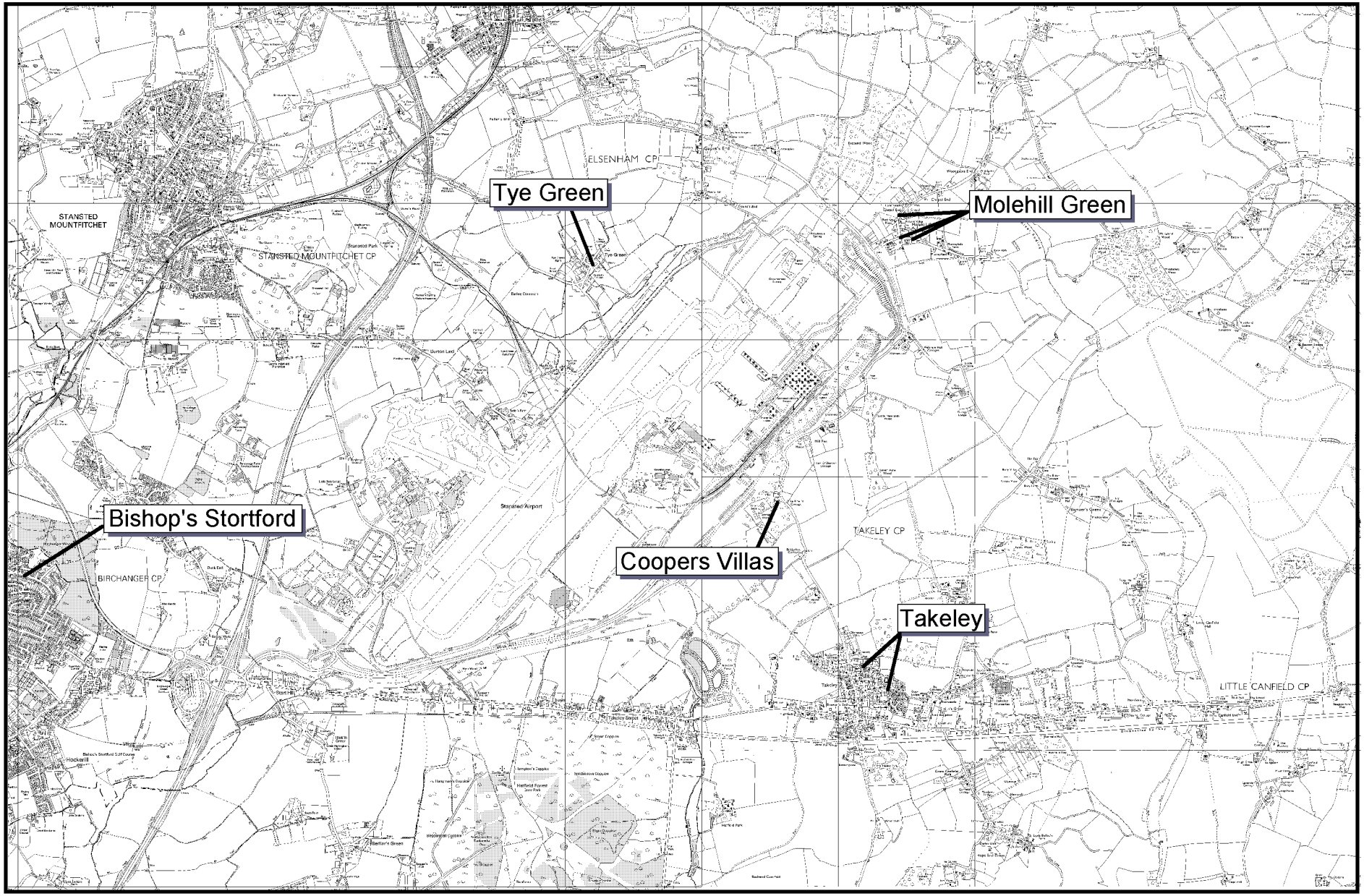
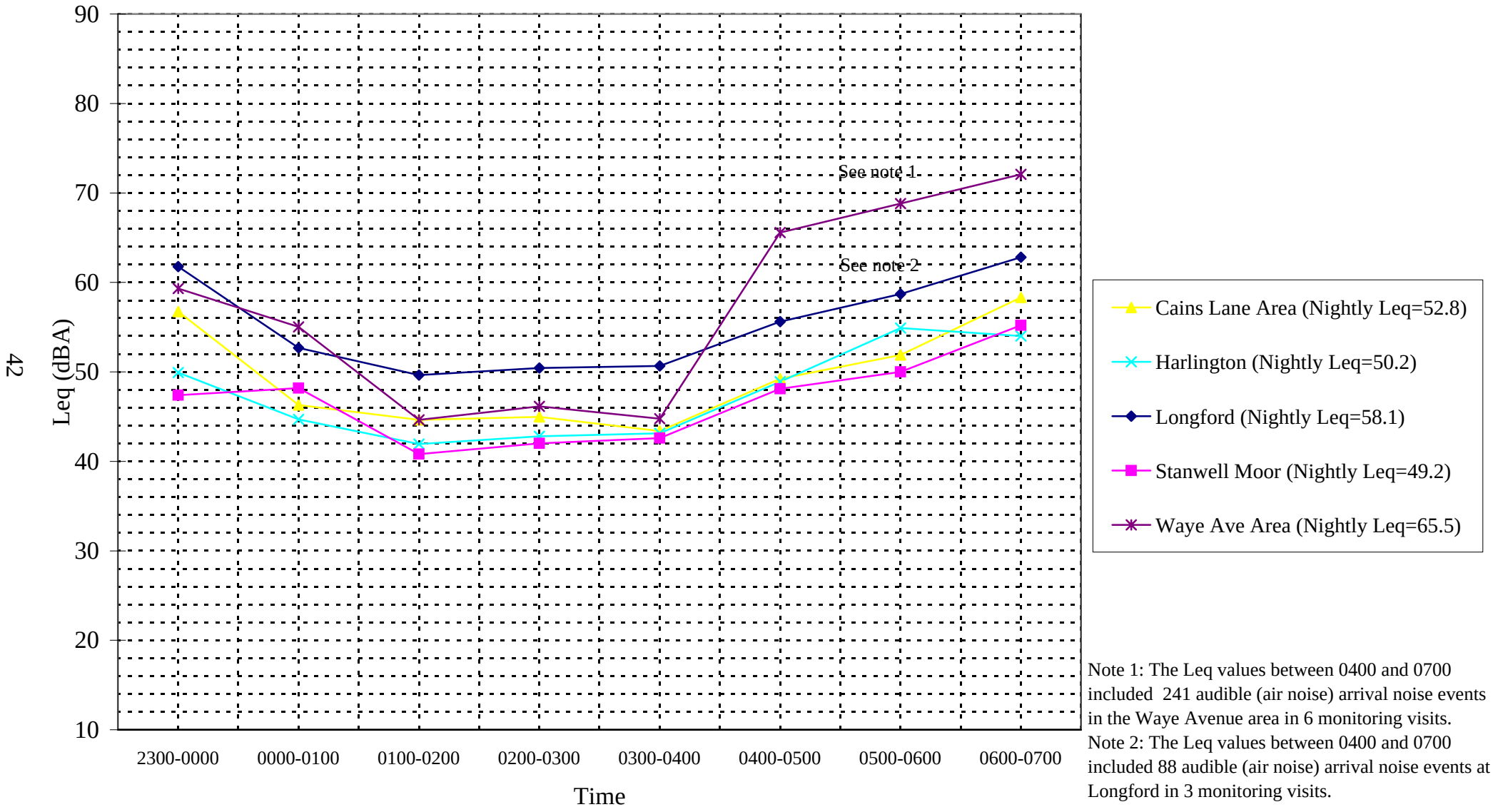


Figure 3: Stansted Monitoring Sites

Figure 4: Average Leq values by target area at Heathrow



Note 1: The Leq values between 0400 and 0700 included 241 audible (air noise) arrival noise events in the Waye Avenue area in 6 monitoring visits.
Note 2: The Leq values between 0400 and 0700 included 88 audible (air noise) arrival noise events at Longford in 3 monitoring visits.

Figure 5: Average Leq values by target area at Gatwick

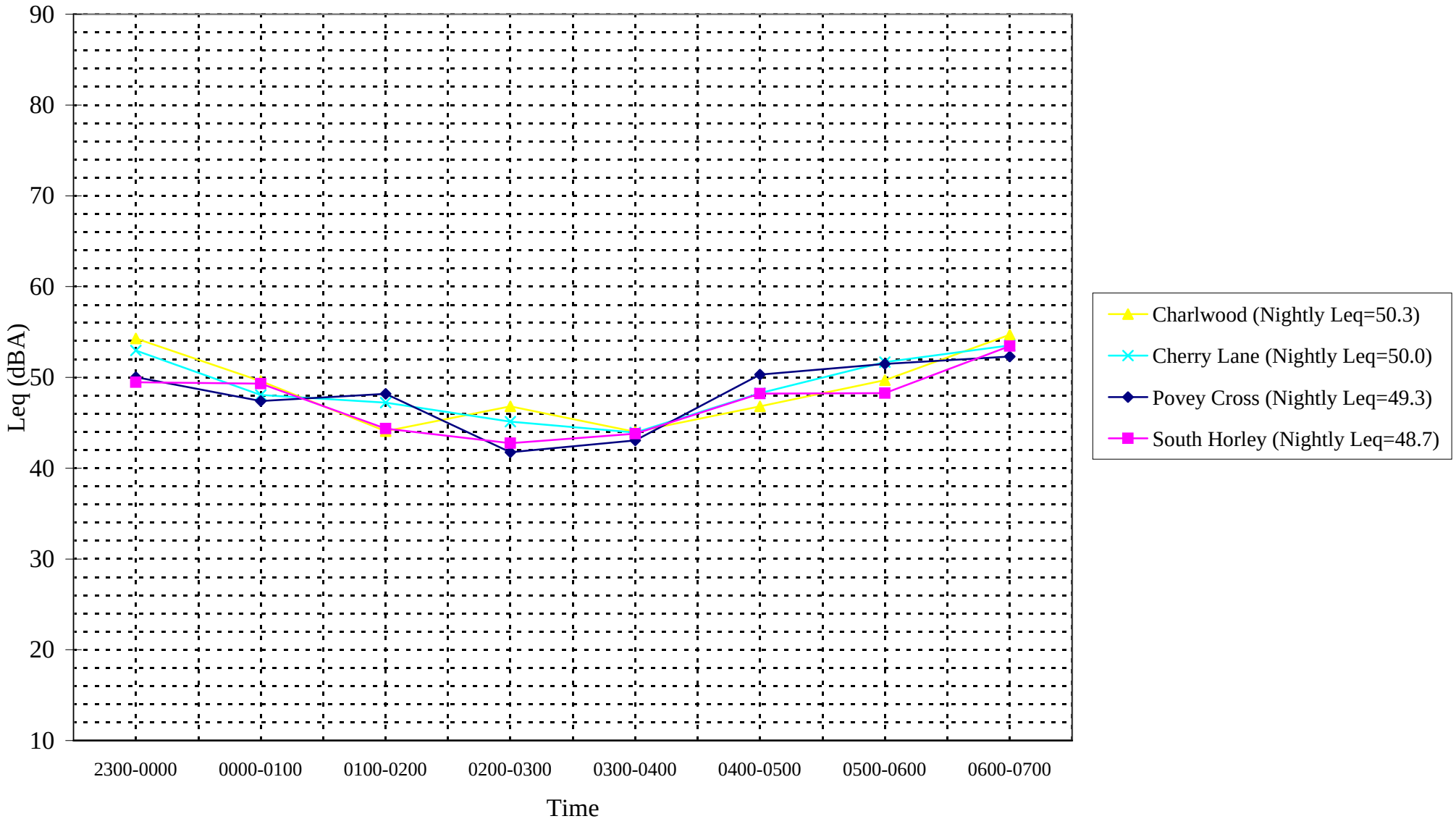


Figure 6: Average Leq values by target area at Stansted

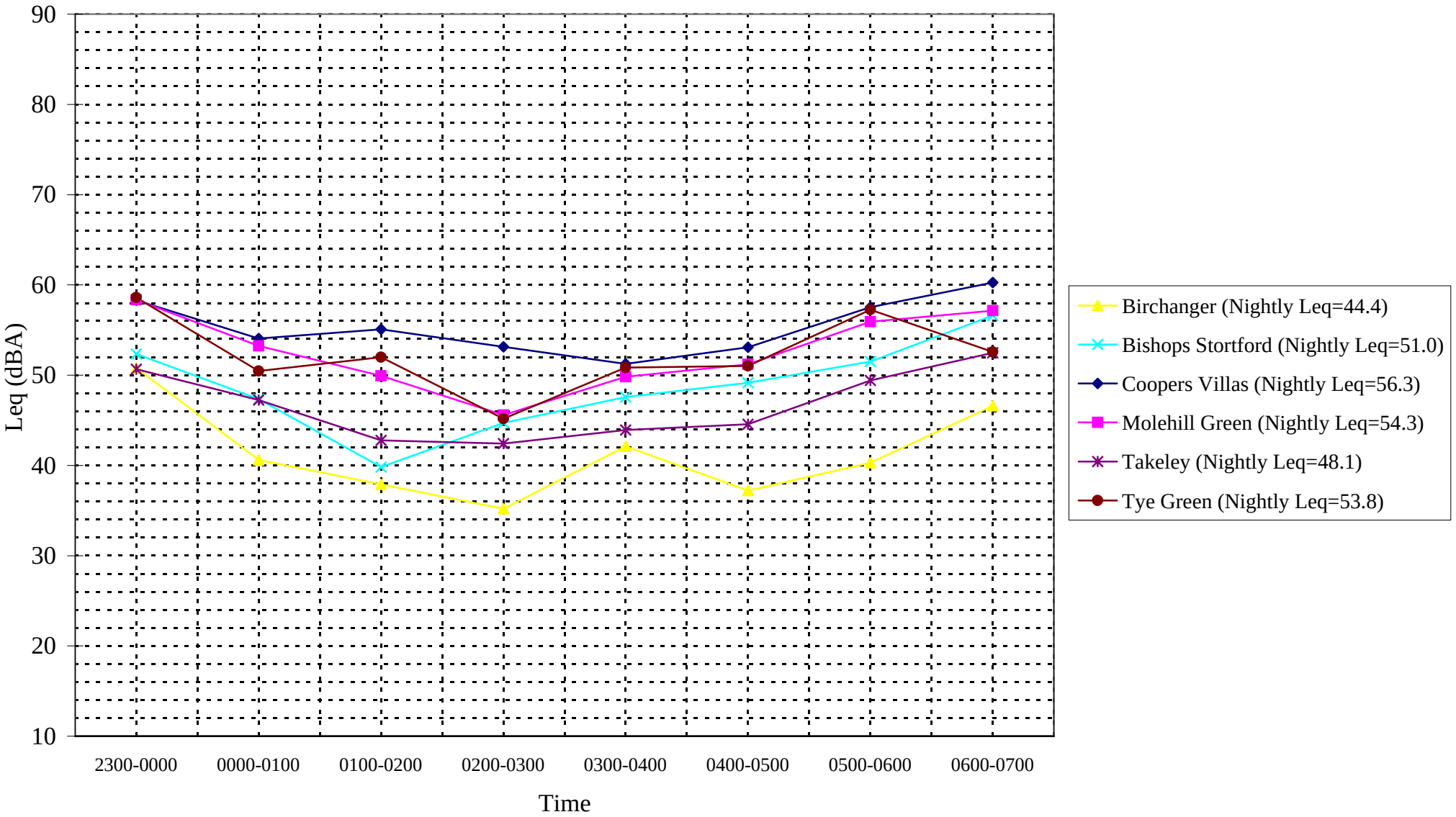


Figure 7: Time History at Kingston Ave, Heathrow, 06 August 1996

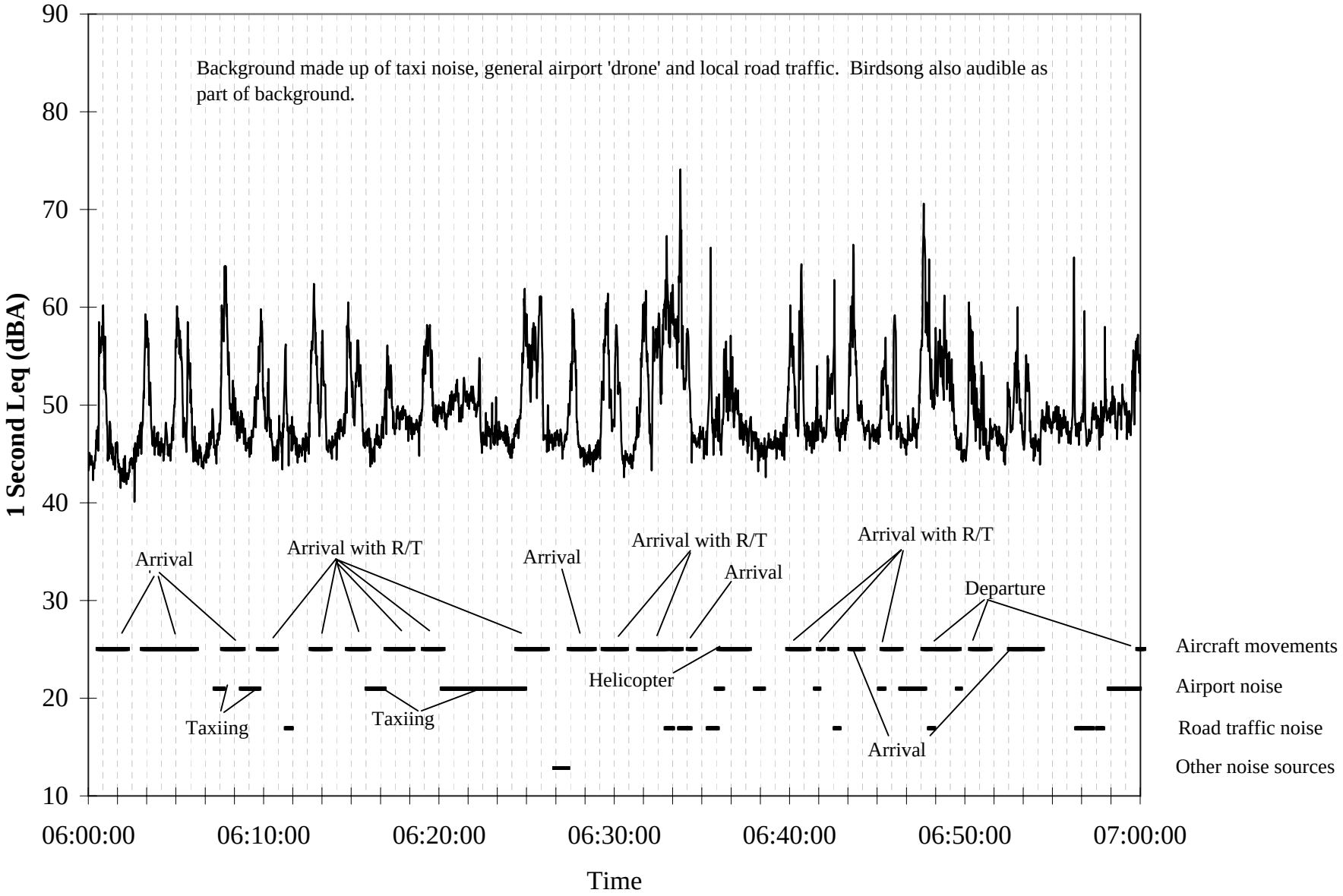


Figure 8: Time History at Longford, Heathrow, 06 August 1996

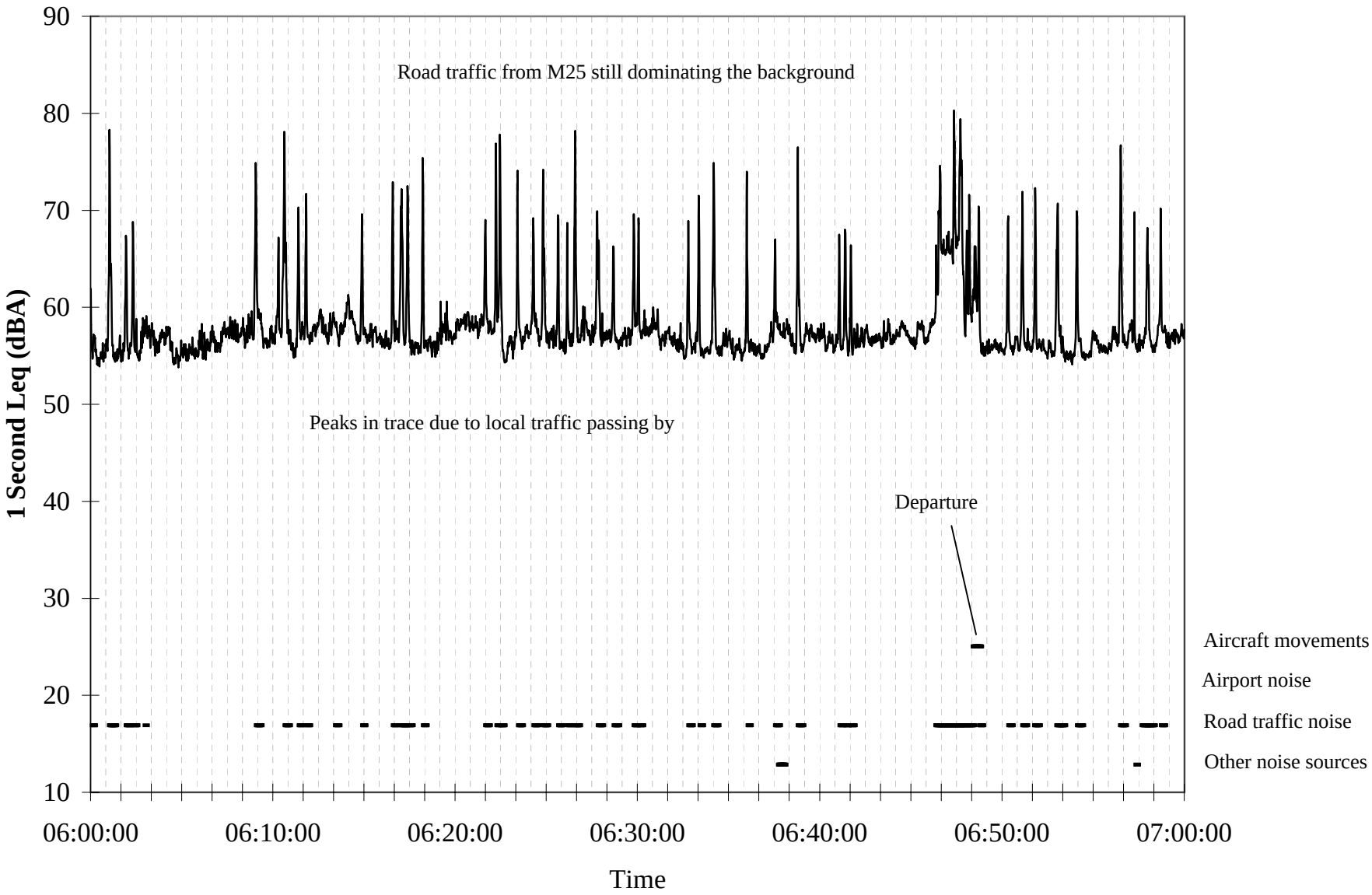


Figure 9: Time History at Povey Cross, Gatwick, 28 June 1996

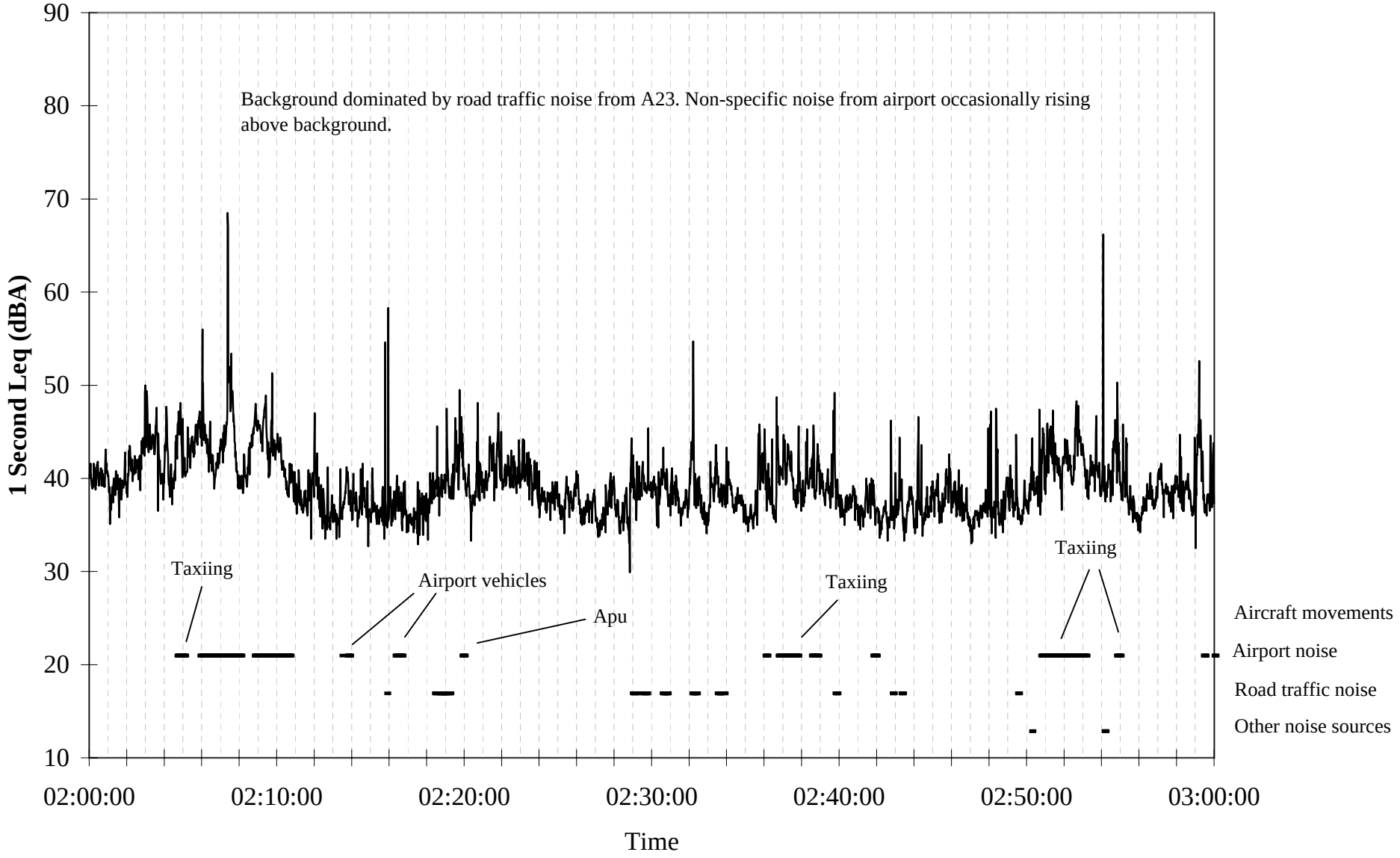


Figure 10: Time History at Cherry Lane, Gatwick, 28 June 1996

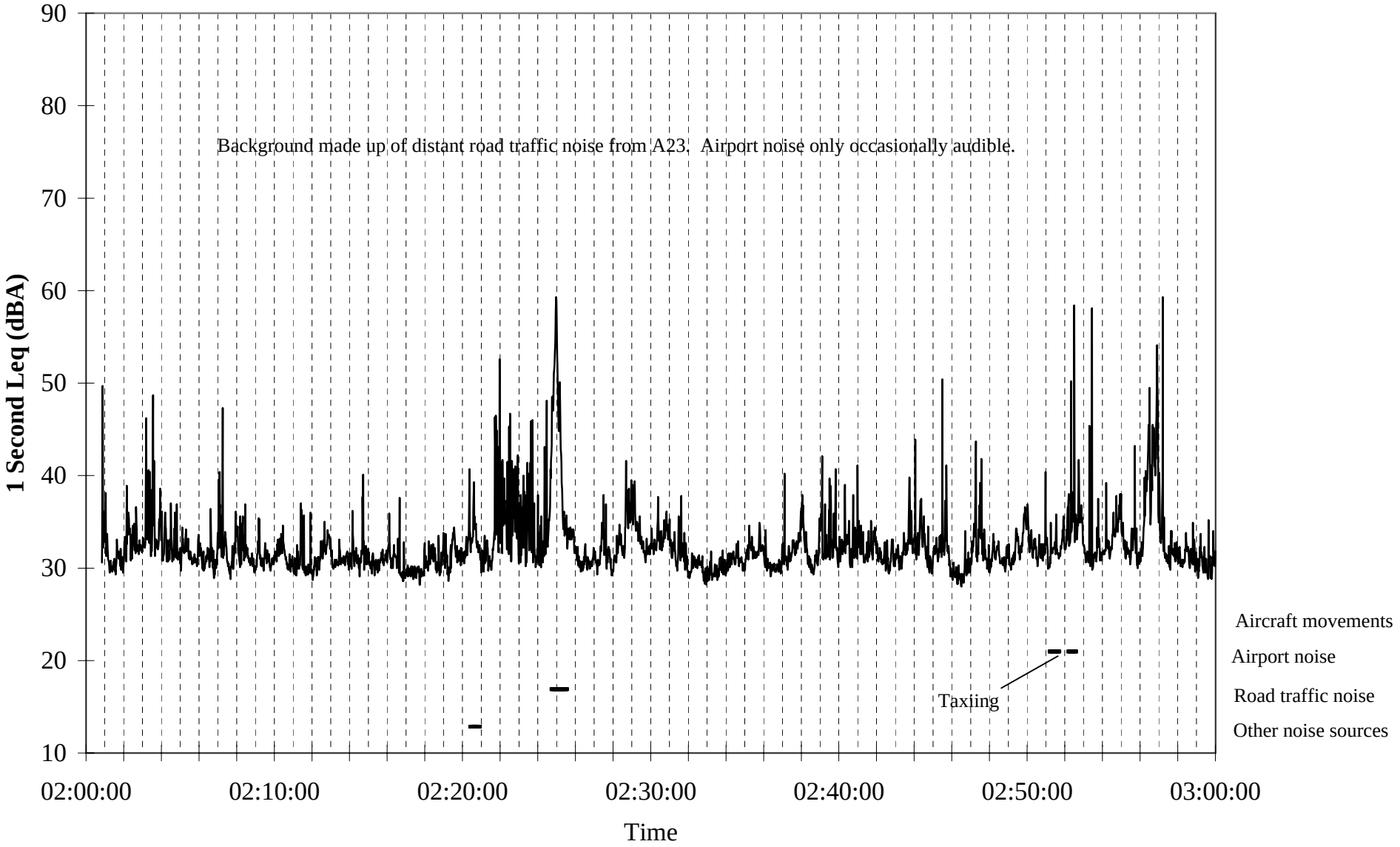


Figure 11: Time History at Takeley, Stansted, 16 September 1996

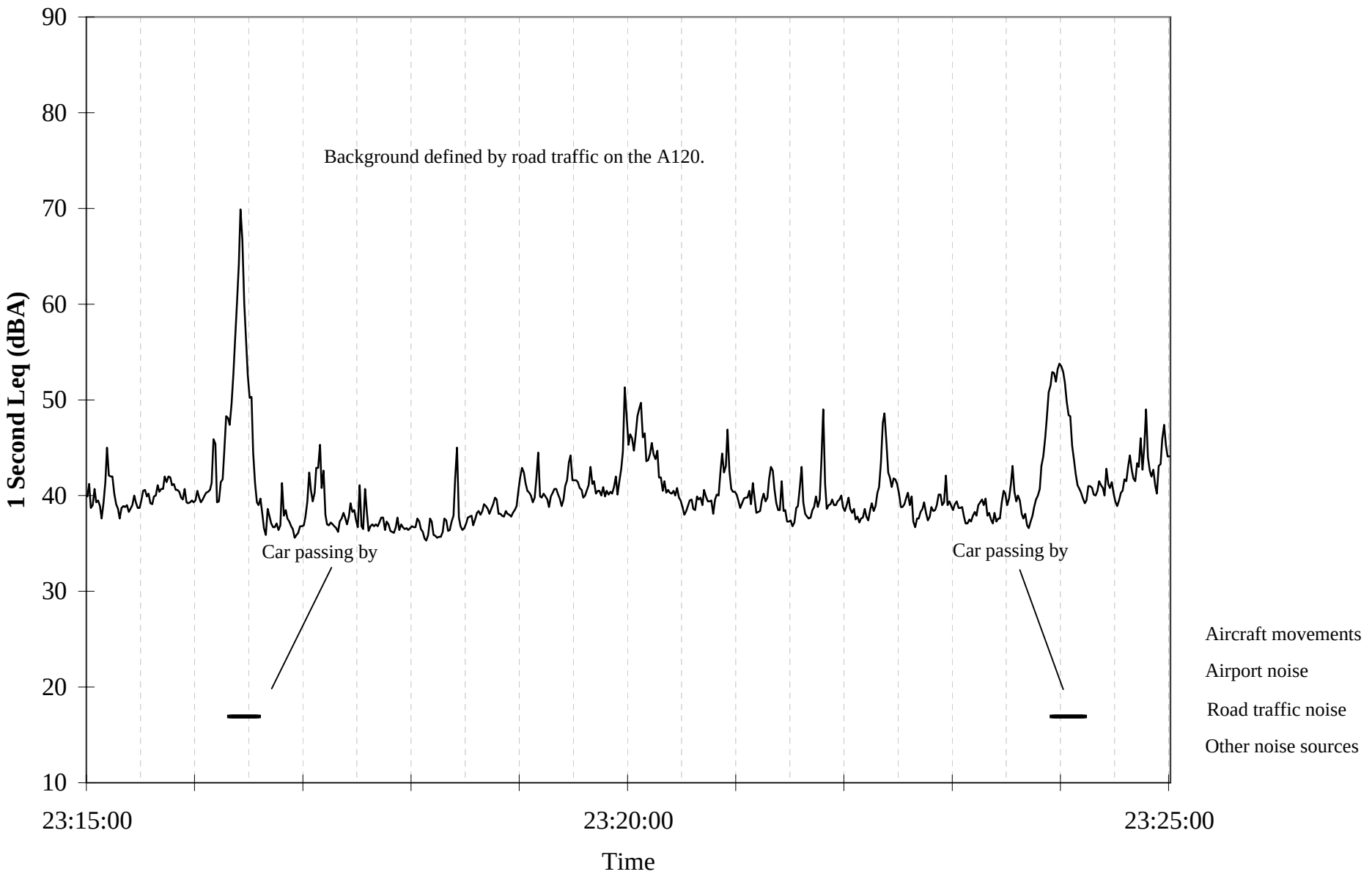


Figure 12: Time History at Tye Green, Stansted, 16 September 1996

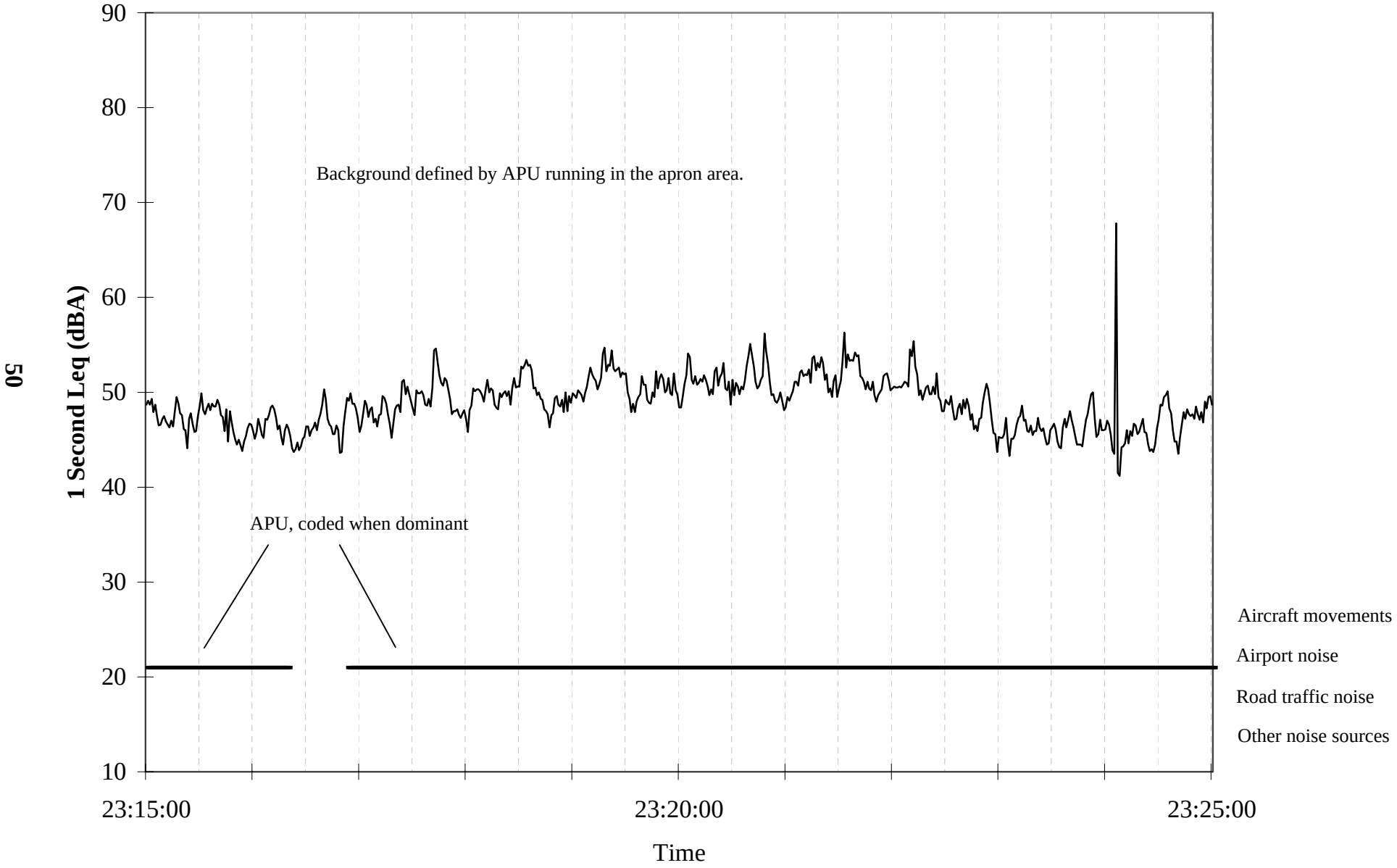


Figure 13: Time History at Takeley, Stansted, 17 September 1996

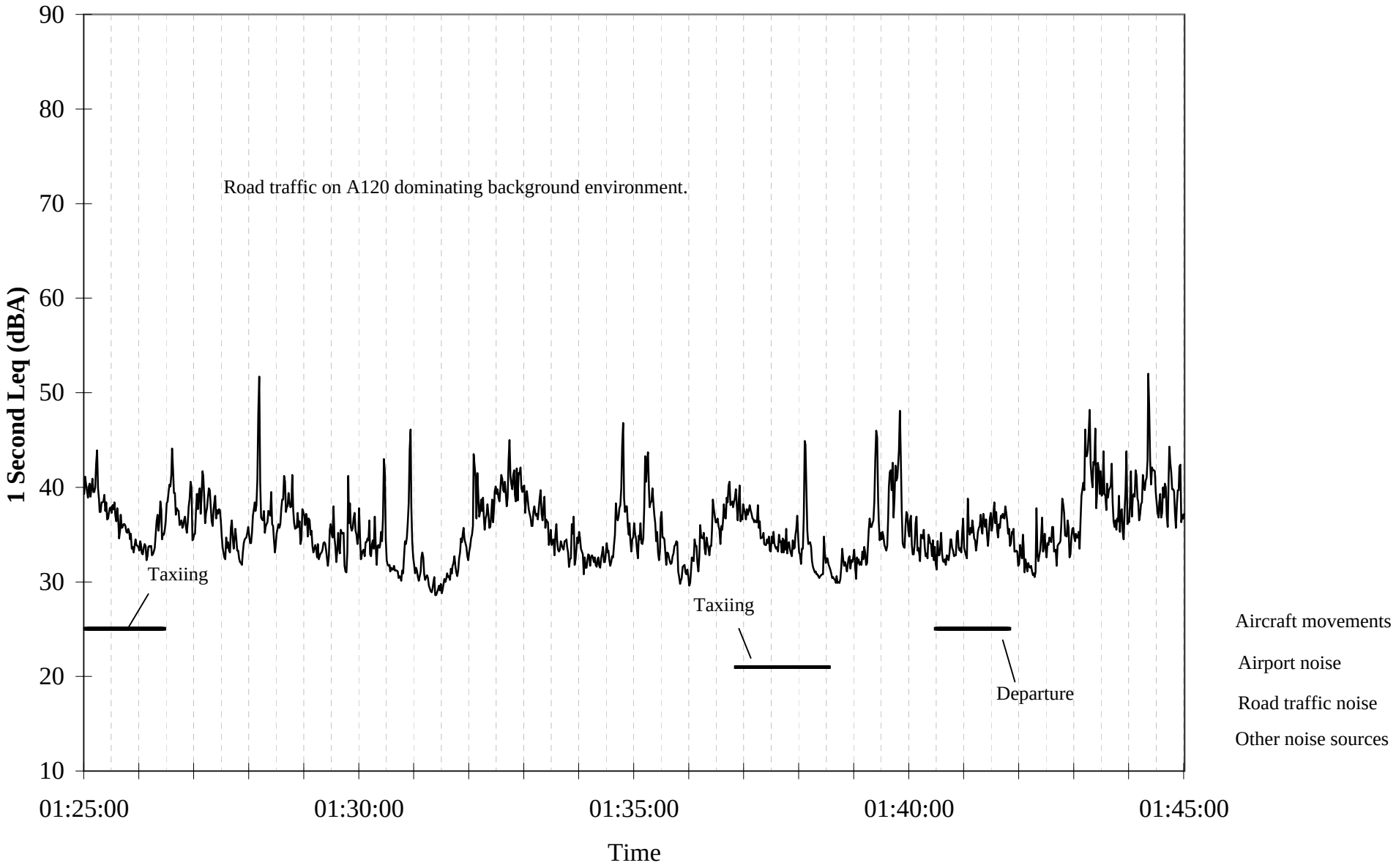


Figure 14: Time History at Tye Green, Stansted, 17 September 1996

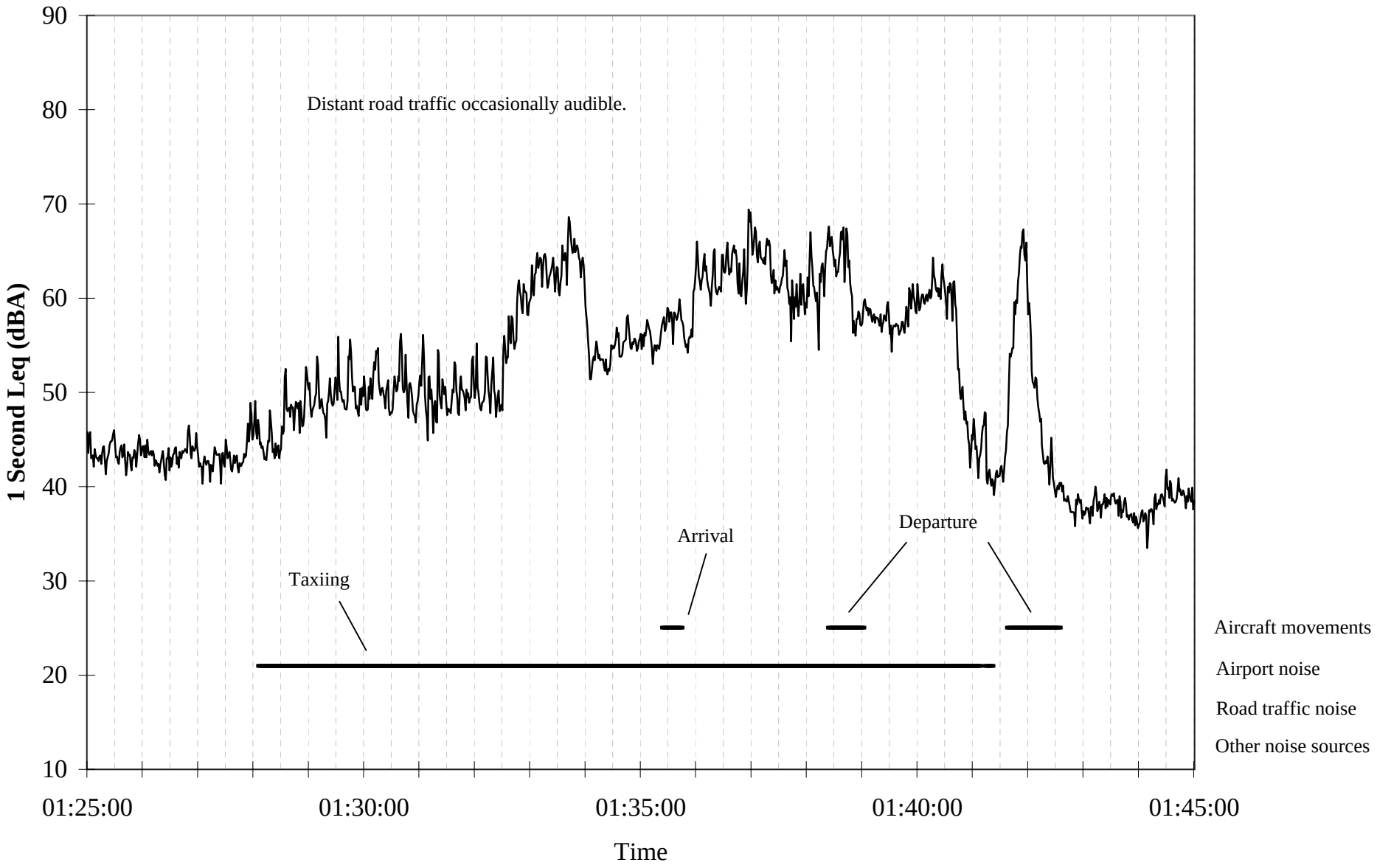


Figure 15: Time History at Takeley, Stansted, 17 September 1996

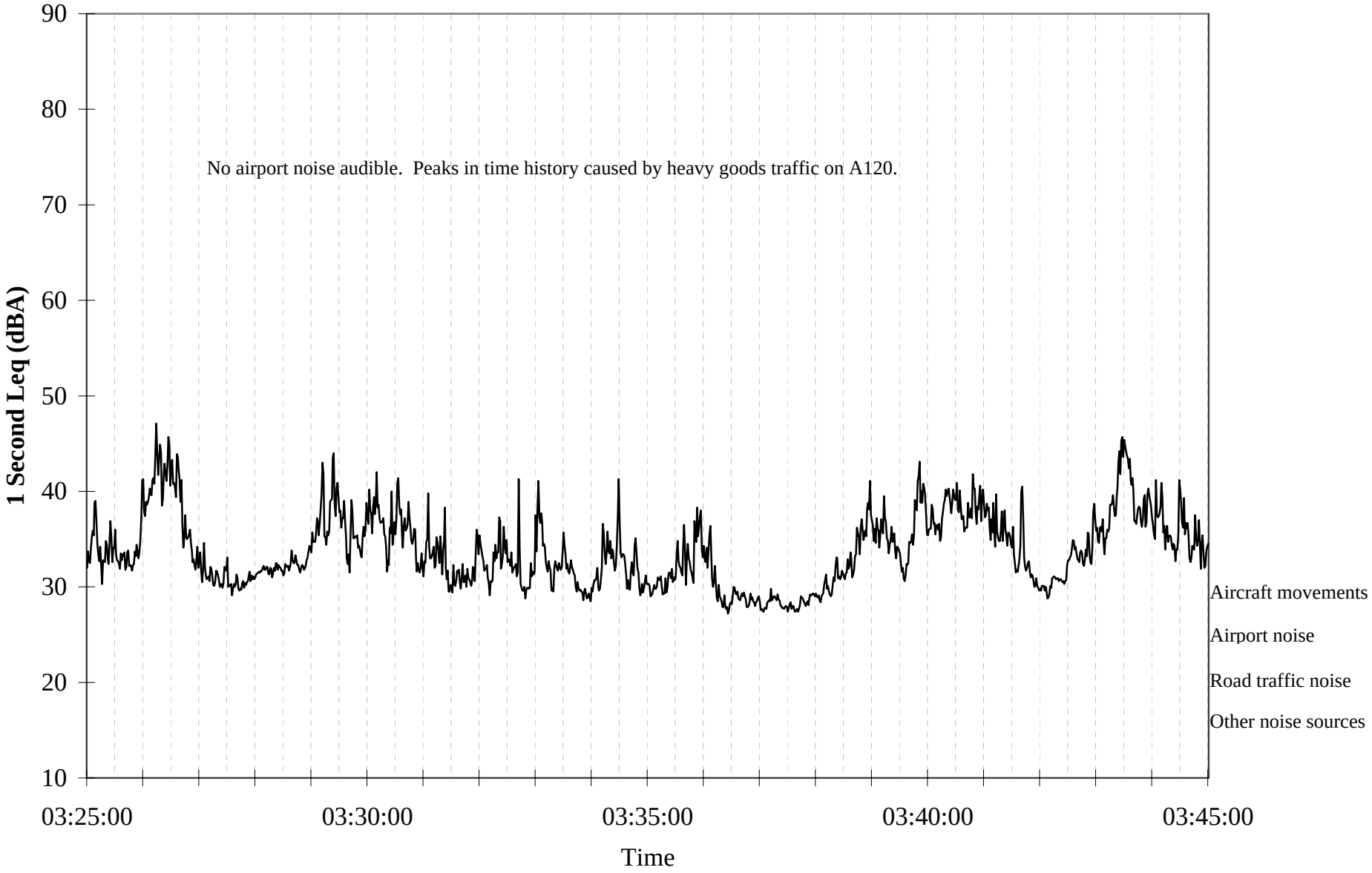


Figure 16: Time History at Tye Green, Stansted, 17 September 1996

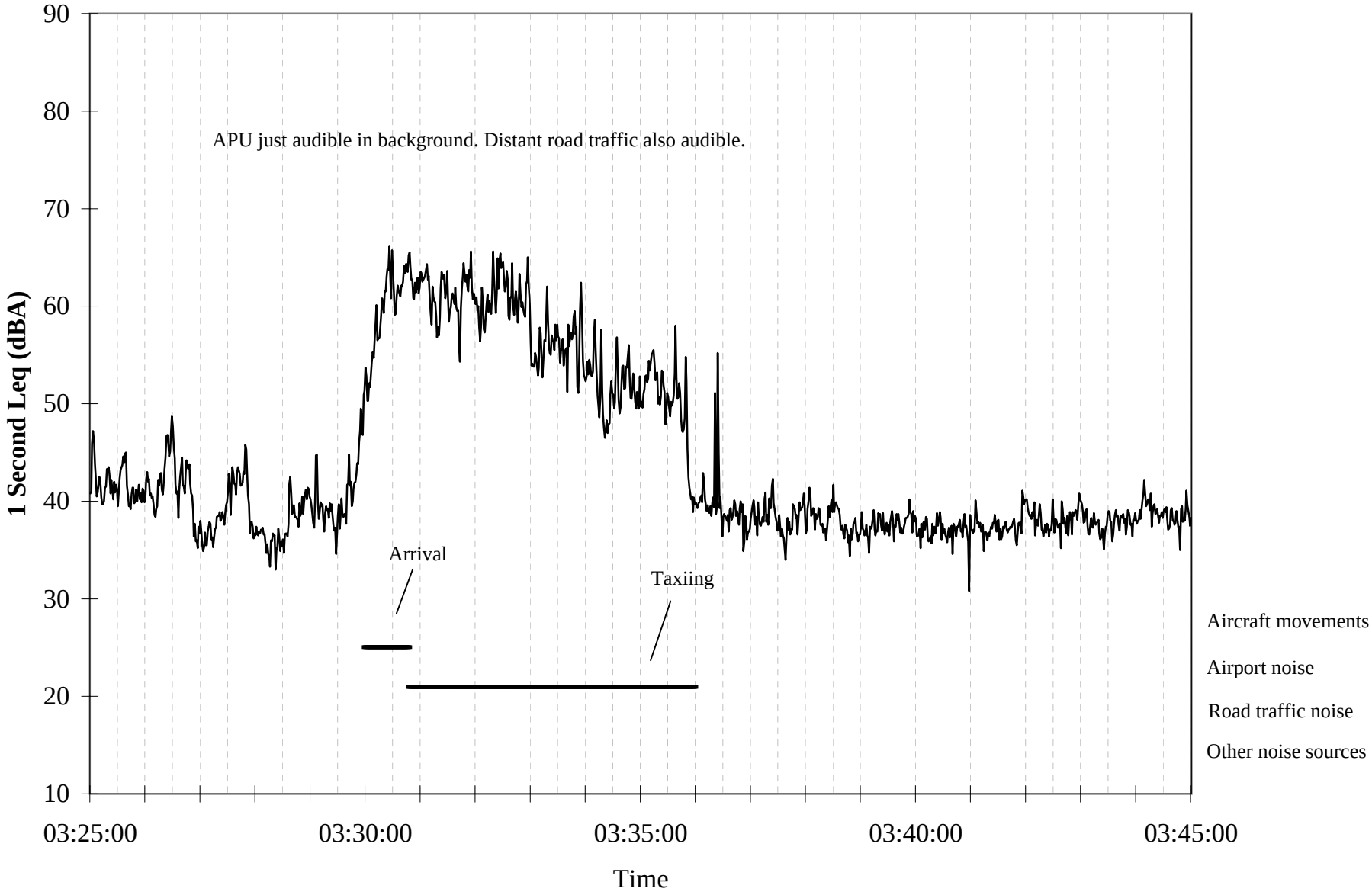


Figure 17: Time History at Clevedon Gdns, Heathrow, 07 August 1996

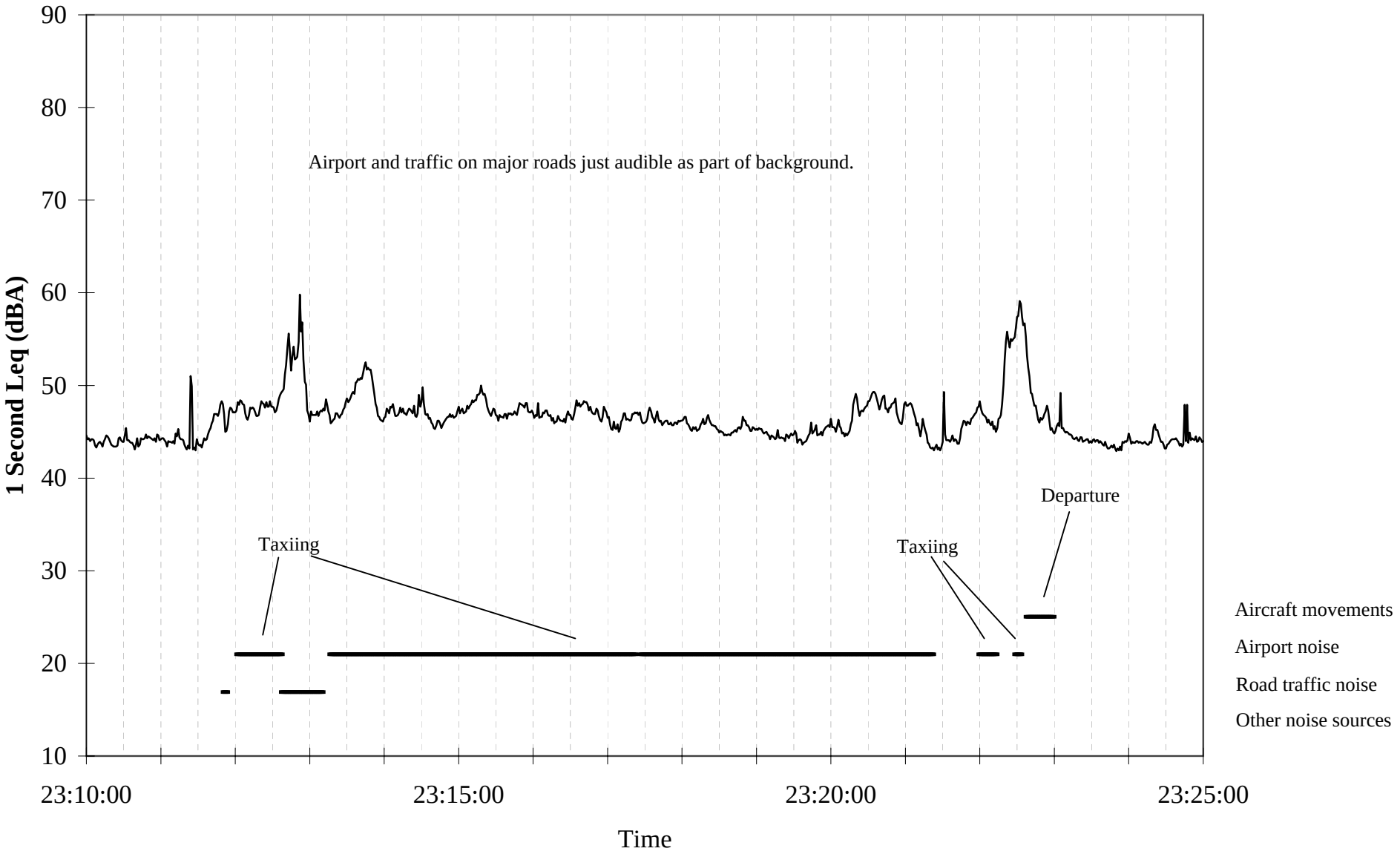


Figure 18: Time History at Povey Cross, Gatwick, 25 June 1996

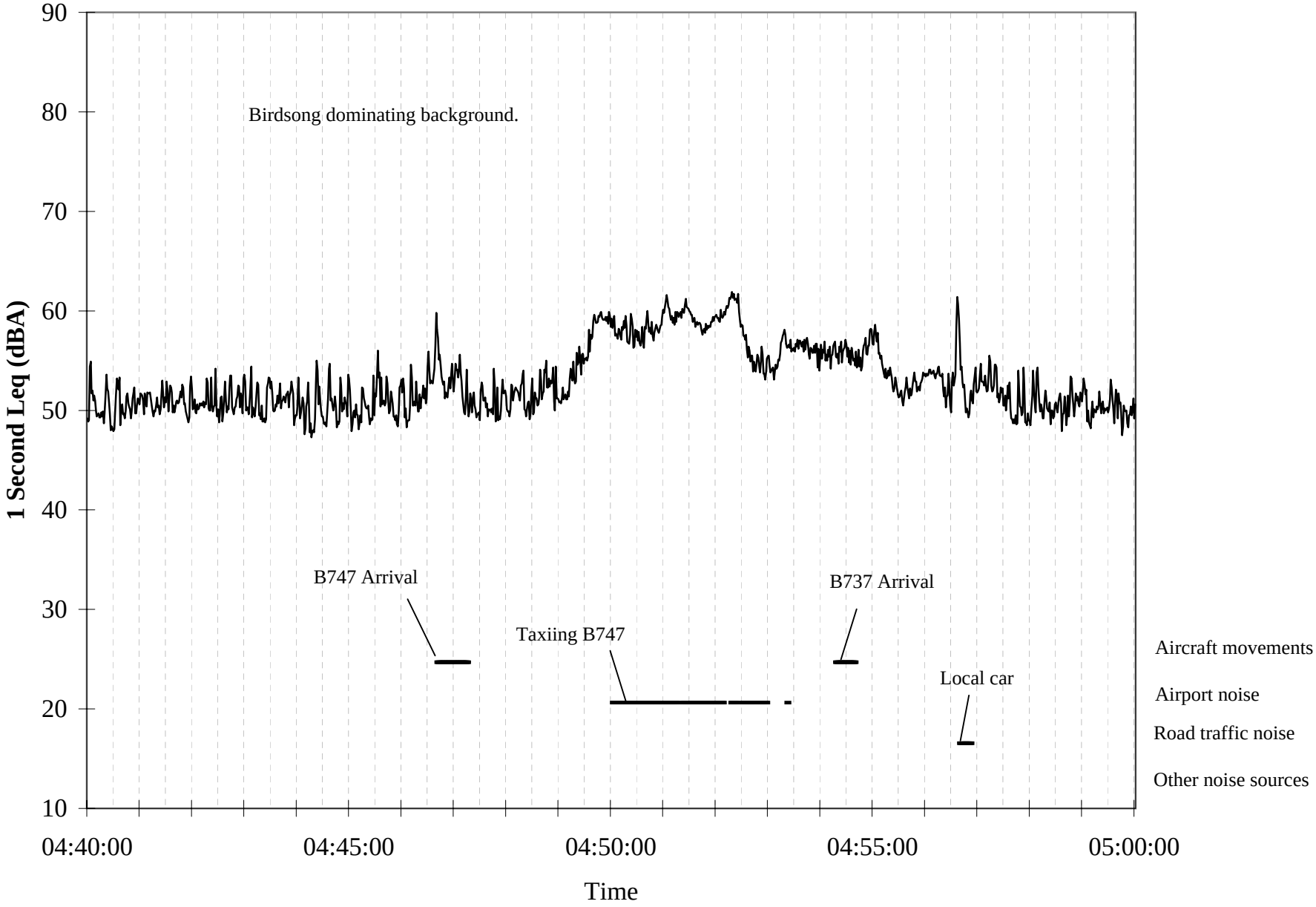


Figure 19: Time History at Medlar Close, Gatwick, 18 June 1996

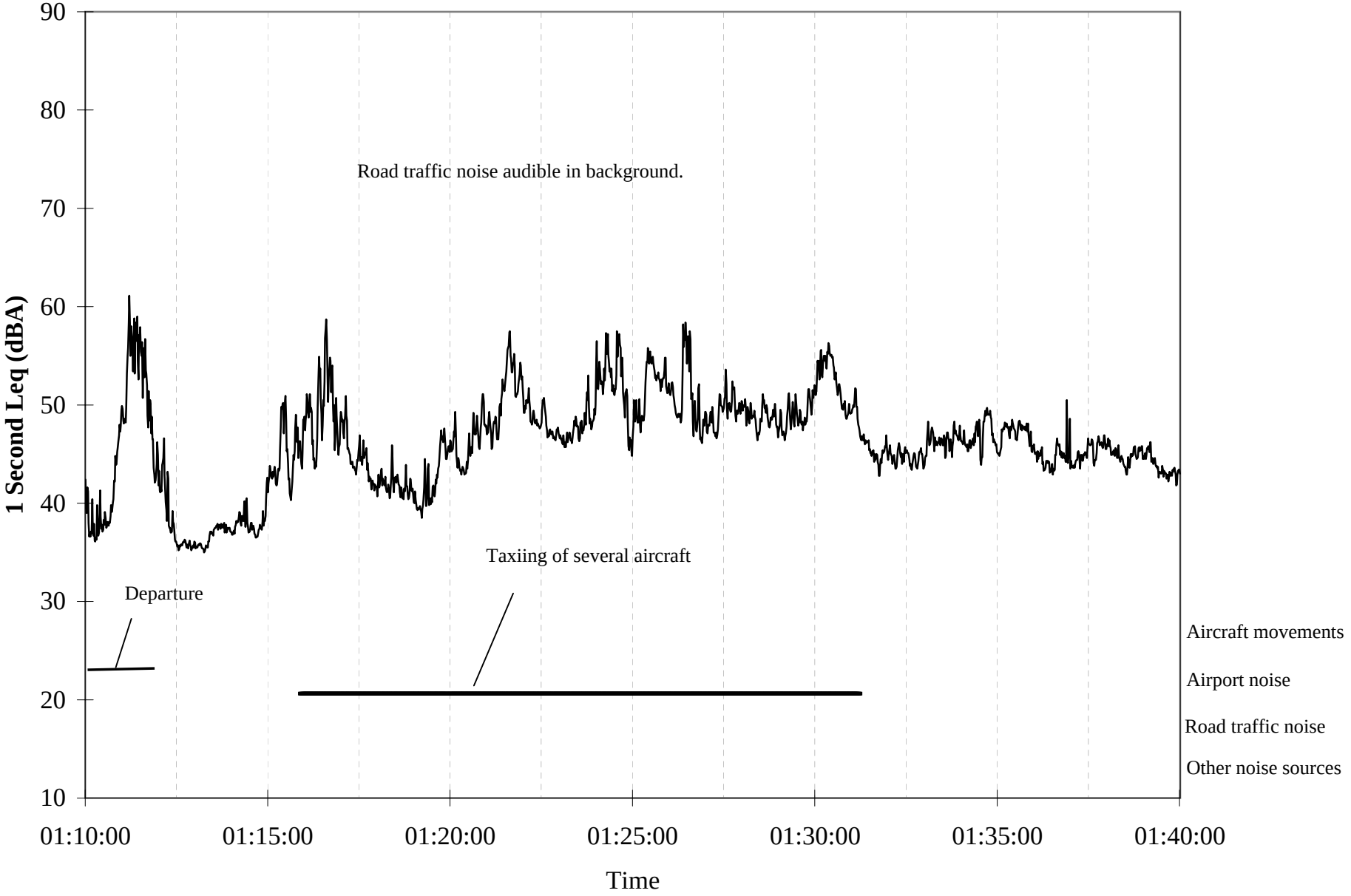


Figure 20: Time History at Tye Green, Stansted, 03 July 1996

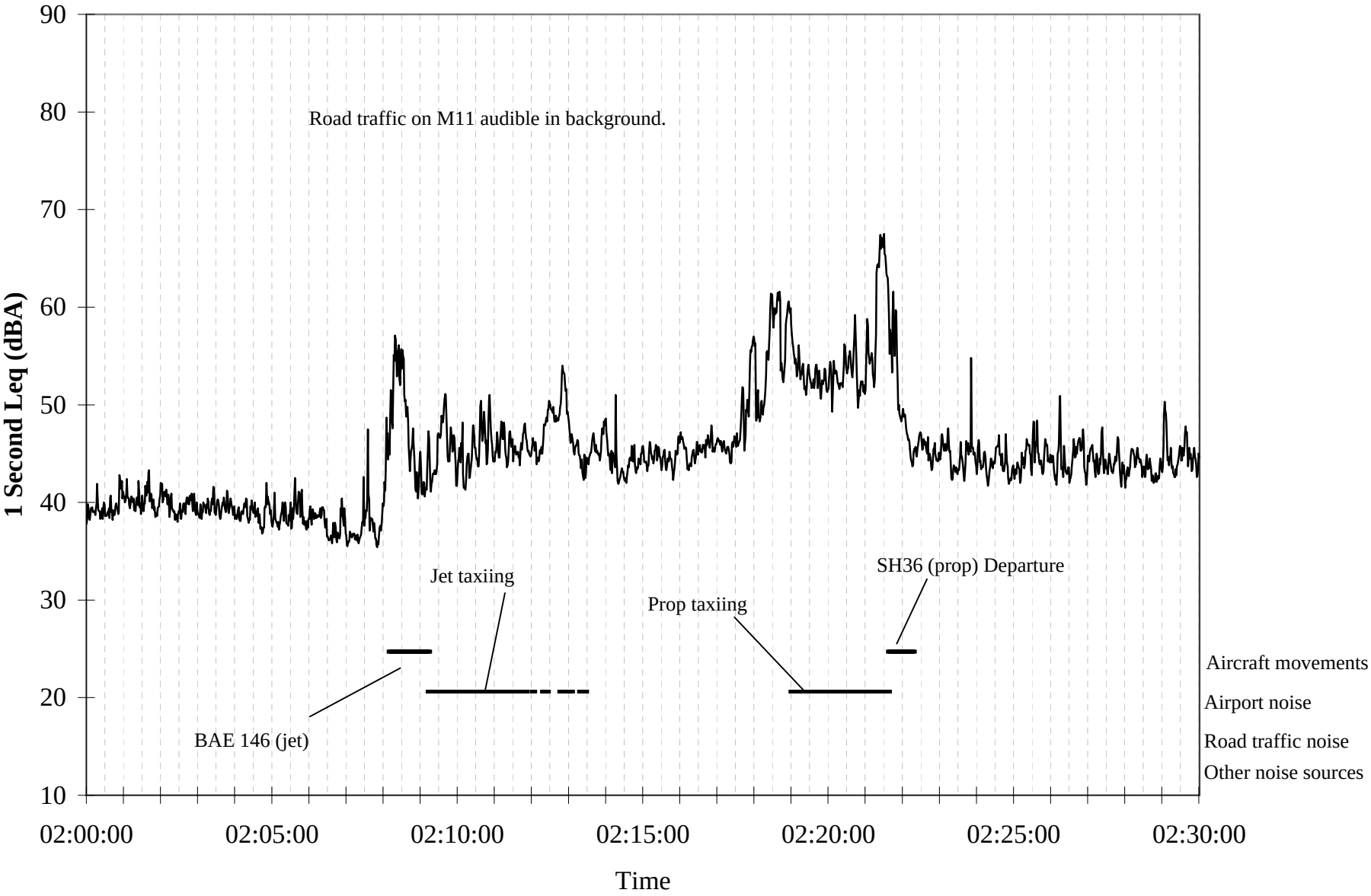


Figure 21: Time History at Waye Avenue, Heathrow, 21 August 1996

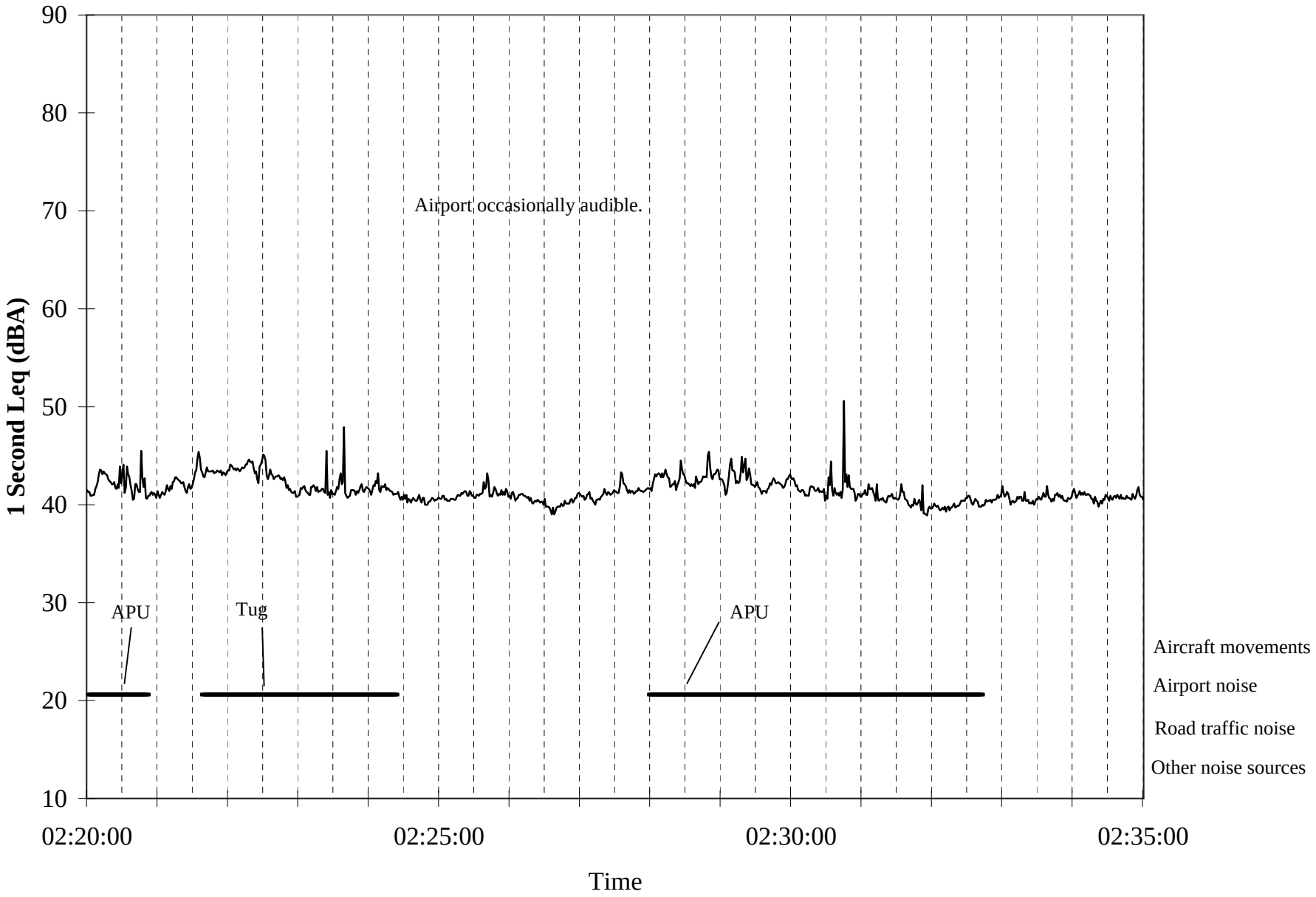
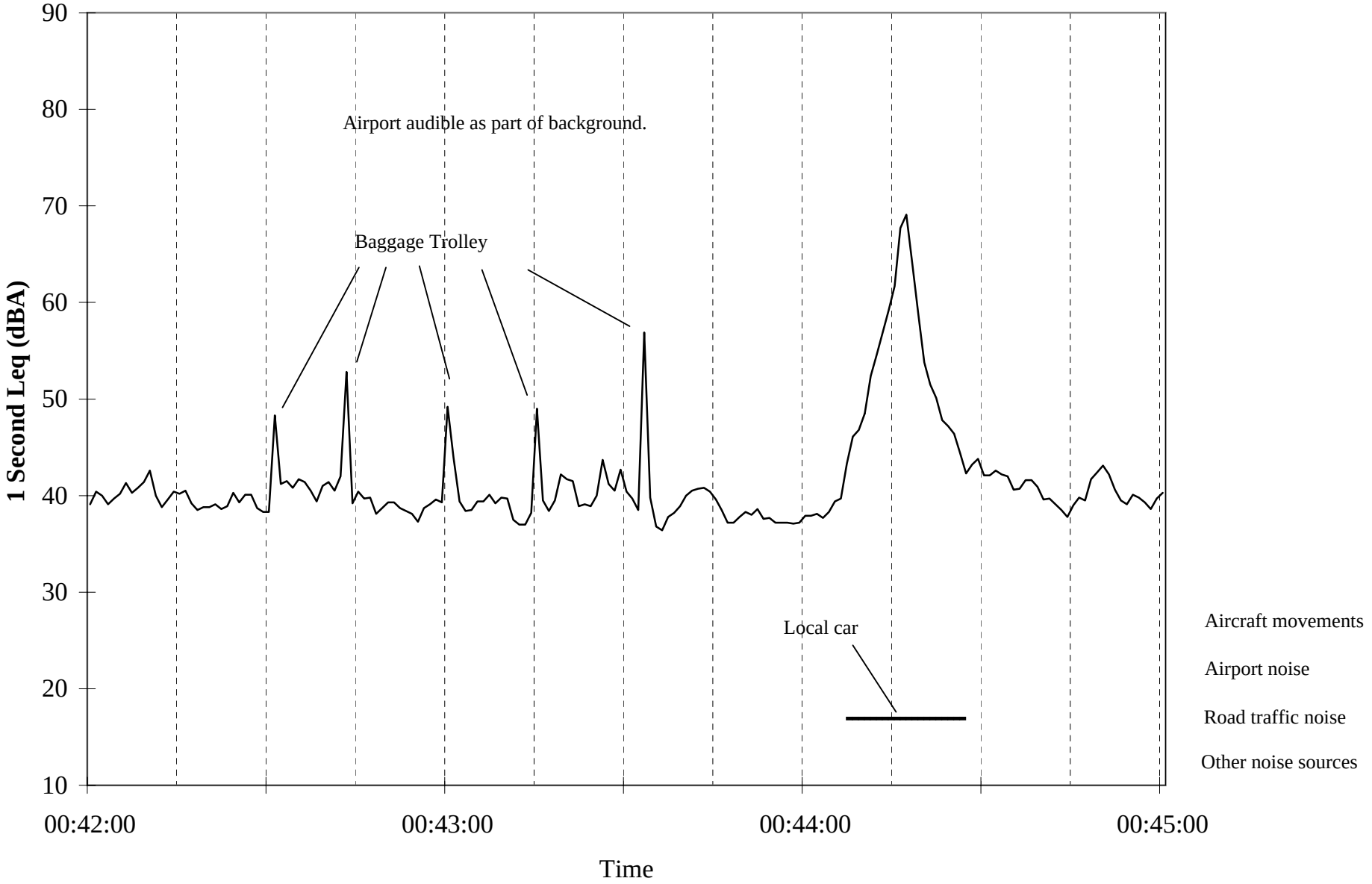


Figure 22: Time History at Coopers Villas, Stansted, 05 July 1996



09

Figure 23: Time History at Waye Avenue, Heathrow, 21 August 1996

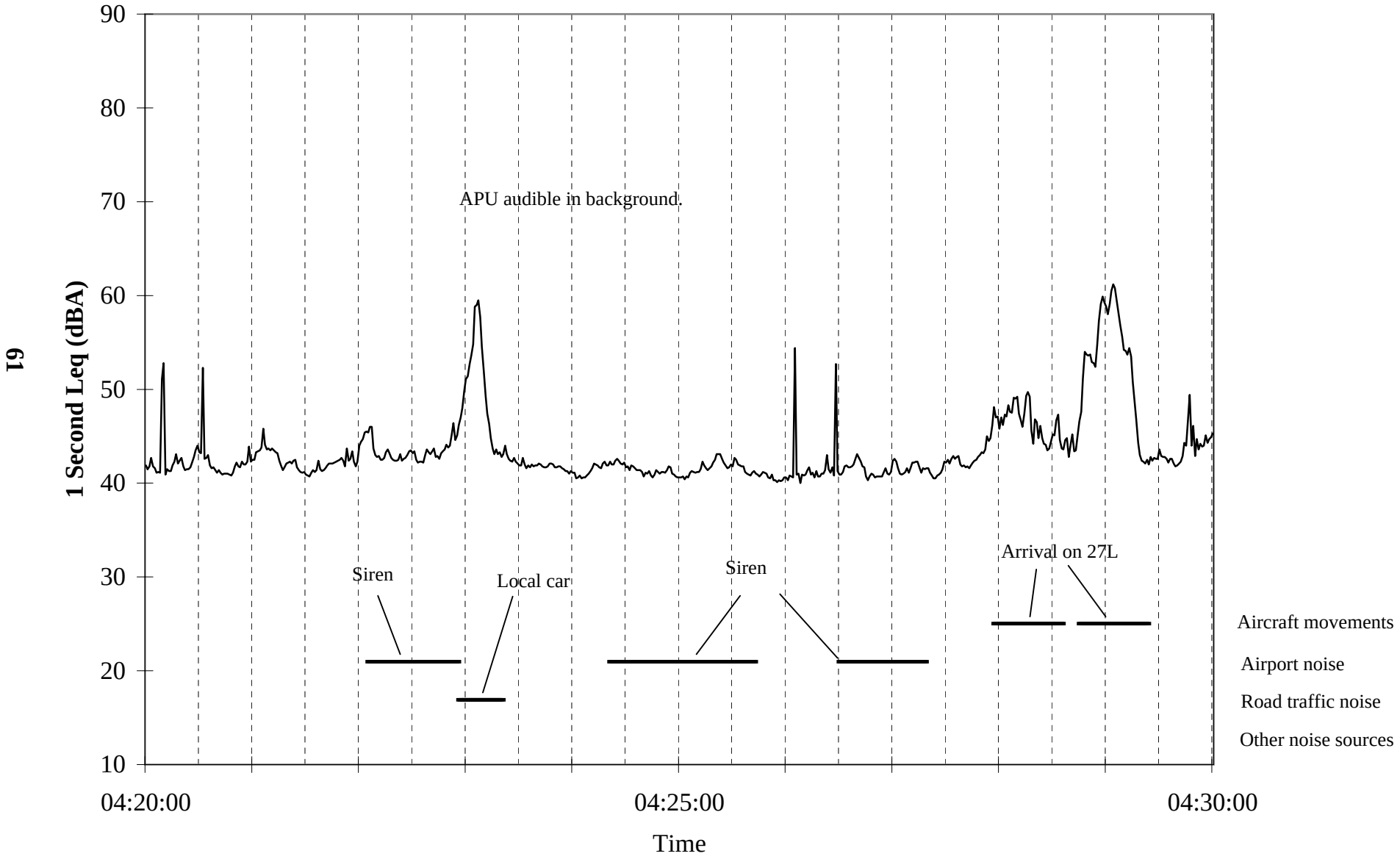


Figure 24: Time History at Clevedon Gdns, Heathrow, 08 August 1996

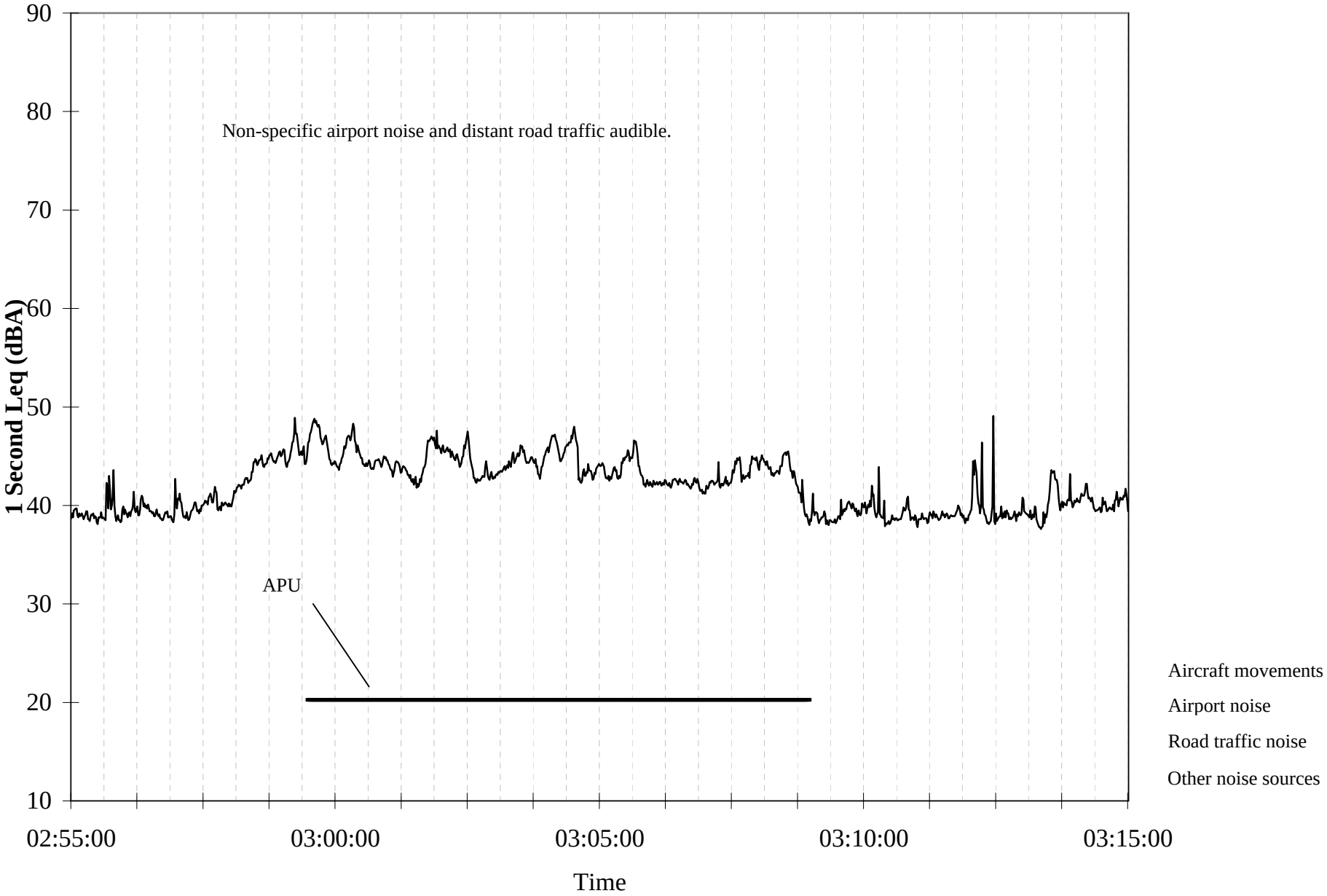


Figure 25: Time History at Lechford Road, Gatwick, 25 June 1996

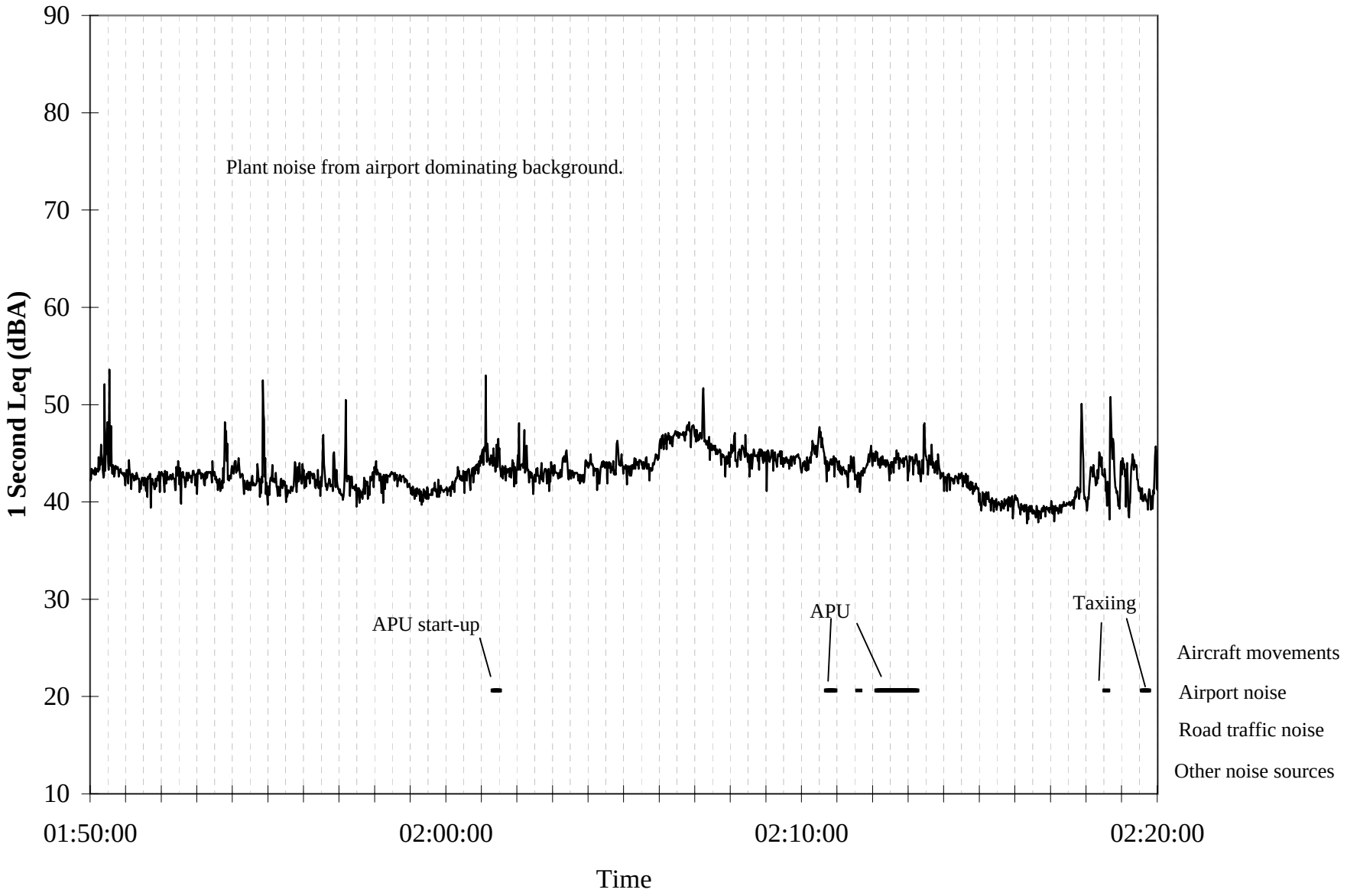


Figure 26: Time History at Molehill Green, Stansted, 16 September 1996

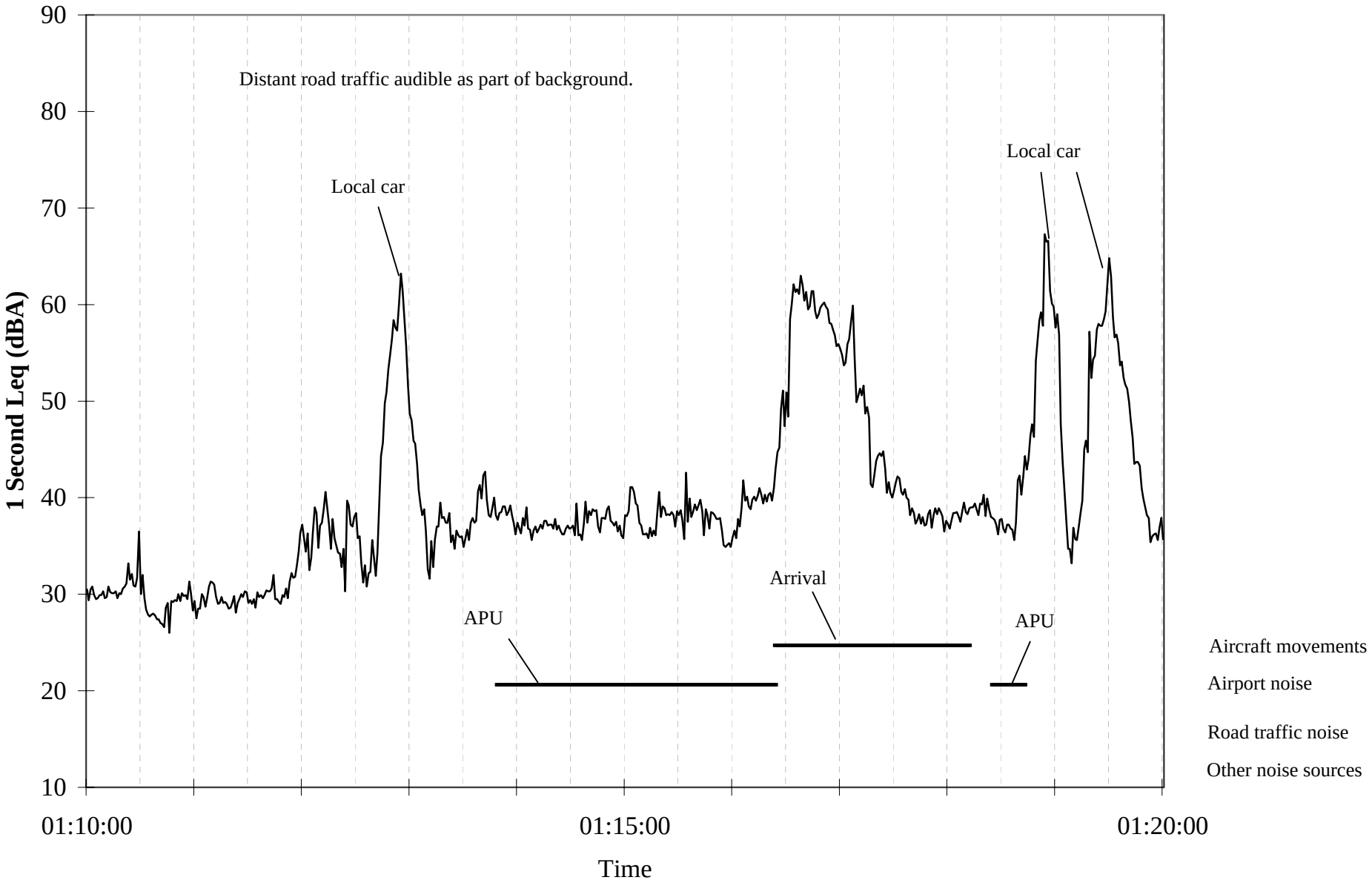


Figure 27: Time History at Waye Avenue, Heathrow, 21 August 1996

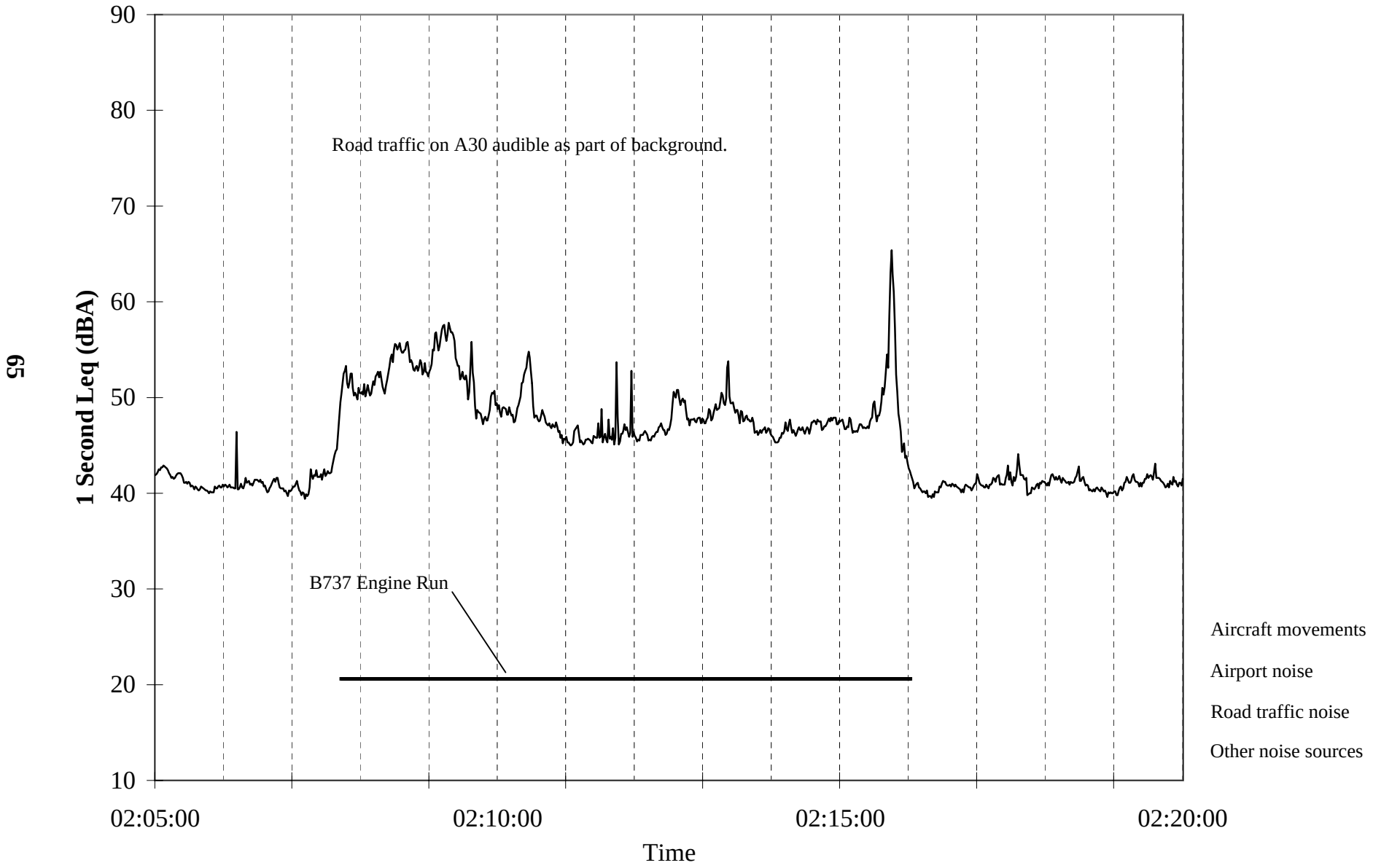
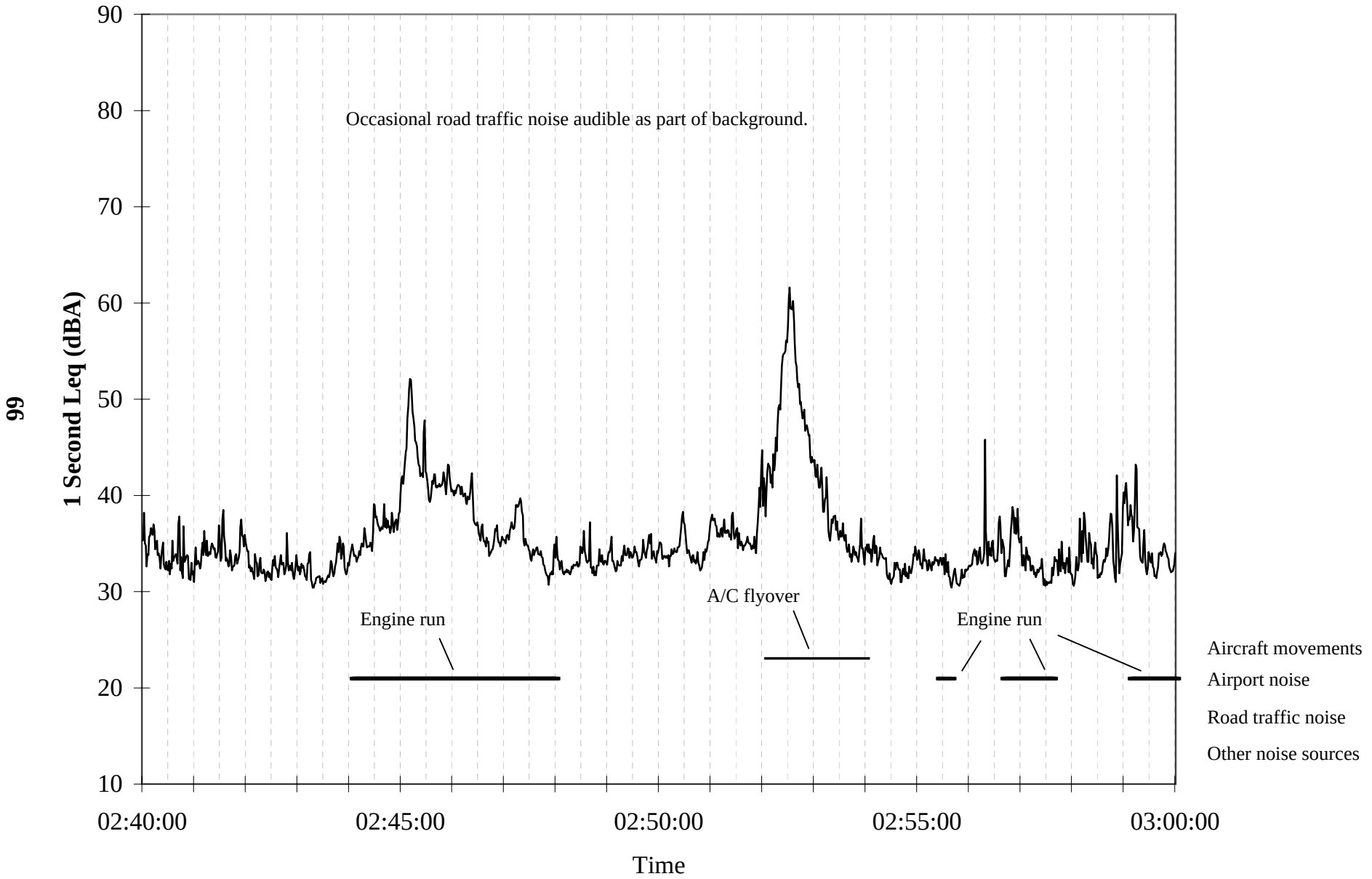


Figure 28: Time History at Molehill Green, Stansted, 01 August 1996



APPENDIX A

PRELIMINARY PHASE OBSERVATIONS

General

A.1 Ground noise, for the purposes of this exercise, was taken to include the following sources:

- Aircraft whilst taxiing around the airport
- Aircraft auxiliary power units (APUs)
- The ground running of aircraft engines
- The movement of airside vehicles whilst moving around the airport
- Plant associated with buildings within the airport perimeter

Heathrow

Methodology

A.2 Heathrow Airport was visited between 2300 (local time) on the 6th August 1995 and 0700 on 7th August 1995.

A.3 There was no cloud cover during the majority of the monitoring period, a front arrived over the area at 0500 and gave 100 percent cover. There was a moderate northeasterly breeze, with occasional gusting, the wind picked up towards the end of the night. The temperature was 17-18.5°C during the monitoring period.

A.4 Twenty three sites were identified where residents were likely to experience ground noise around Heathrow Airport. The airport perimeter was taken as that area bounded by the western, eastern, northern and southern sections of the airport perimeter road. Sites were located in residential areas at 1.5, 2.0, 2.5, and 3.0 kilometres from the centre of the airport. Each site was visited and background noise levels were measured. The sites visited are shown on Figure A1. For each site identification number, the first two Figures describe the distance from the centre of the airport in kilometres, the last Figure refers to the individual site number. For instance site 2.0.1 was the first site surveyed at 2.0 km from the airport centre.

A.5 At each site the extent to which ground noise was audible above the general background level was noted. Where ground noise was audible at the sites at

3.0 km from the centre of the airport, more distant sites were surveyed until ground noise became inaudible.

General Description of Noise Environment.

A.6 Ground noise was heard at fourteen of the twenty three sites.

A.7 The noise environment in the residential areas around Heathrow Airport can be split into two separate zones by a line running east to west through the airport. The noise environment to the north of the airport is dominated by the two large roads in the area, the M4 motorway and the Bath Road (A4), and is characterised by reasonably high background levels with L_{90}s[15] measured on the night between 40 and 53 dBA. The area to the south of the airport was not affected by road noise to the same extent, this was reflected in lower background noise levels, with measured L_{90}s in the range 37 to 50 dBA.

Location of Noise Sources

A.8 The level of ground noise depends on the precise location of sources within the airport boundary. Areas inside the airport perimeter that were thought to influence the noise environment of the local residents significantly were:

A.9 Cargo area: Located to the southwest of the central area of the airport, the sound of cargo moving vehicles and HGV lorries were clearly audible at times in the area immediately southwest of the cargo area. The noise was noticeable at points at a distance of 2.0 km from the airport centre, and just audible at selected points 2.5 km from the airport centre. The cargo area was also thought to be the source of some APU noise and ground running noise, at both 2.0 and 2.5 km sites.

A.10 Terminal 4: Located to the south of the airport central area, the sound of APUs was thought to emanate from this area. APU noise was audible at both the 2.0 km and 2.5 km sites to the southwest of the Terminal 4 area although the precise location of the source(s) was not clear.

A.11 Maintenance area: Situated to the west of the central area, the maintenance area contributed to the background noise of sites to the southeast of the airport. The noise sources here were thought to include the ground running of aircraft engines and APU noise. The audibility of the noise from the maintenance area varied. The sound of ground running was audible at one site, 3.0 km from the airport centre, but was not discernible at some closer sites. The probable reason for this was that although the shielding from the very large buildings in

[15] The term 'background' is used in this paper to indicate the residual noise present when no particular source was perceived to dominate the noise environment. L_{90} is the A-weighted sound pressure level exceeded for 90% of the duration (here typically 15 minutes) of the measurement.

the maintenance area was effective at shorter distances, diffraction (around the buildings) and refraction caused by the wind and possibly by temperature gradients) brought the noise back down to ground level at greater distances.

A.12 Other significant localised noise sources included:

a) Plant noise: Noise from plant on the roofs of the Forte Post House Hotel and the Heathrow Park Thistle Hotel, both located to the north of the airport, had an effect on the noise climate in the locality of the hotels. Some non-airport plant noise was in evidence in the western part of Stanwell where there were some industrial areas.

b) Road traffic noise: Most sites surveyed experienced road traffic noise. Sites to the north of the airport were almost all affected by significant levels of noise from either the M4 motorway or the Bath Road, and in some cases both. The Great Southwest Road that runs along the area to the southeast of the airport affected the noise climate of several of the sites around it. The effect of road noise was noticeable in the period between 0400 and 0530 when the noise of intermittent passing vehicles could mask the ground noise audible in the sites to the southeast of the airport.

Meteorological Effects on the Audibility of Ground Noise

A.13 It was noted that the degree to which ground noise was audible was strongly dependent on the direction and strength of the wind. When ground noise was heard it varied in its level as the wind gusted. It is likely that the prevalence of ground noise in the sites to the south of the airport was partly due to the northeasterly wind that predominated during the survey period: A southwesterly wind might have led the sites to the north of the airport to experience ground noise.

A.14 The effect of temperature inversions on the propagation of the sound from within the airport perimeter is also likely to have an effect on the distribution of the noise among the residential areas around the airport. These inversions that occur as a result of layers of different air temperature can cause sound propagation paths to refract. Such inversions are not uncommon during summer nights as the ground cools and absorbs heat from the lower layers of air.

Identification of Noise Sources

A.15 It is usually possible to distinguish between the sound of an aircraft taxiing, an APU running or the ground testing of engines. However, it is not always simple to determine where the sound is coming from due to meteorological effects. The effects of the weather on noise were outlined above; wind speed,

direction and temperature inversions all make the task of accurately identifying the noise source a more difficult one.

Gatwick

Methodology

A.16 Gatwick Airport was visited between 2300 on 7th August 1995 and 0700 on 8th August 1995.

A.17 There was 70 percent cloud cover during the most of the night, the cloud thinned towards the end. There was a moderate northeasterly breeze, which weakened towards the middle of the night-time period. The temperature was between 13 and 15 °C.

A.18 Eighteen sites were visited (Figure A2). The airport perimeter was taken as that area bounded by the eastern, northern and southern sections of the airport perimeter road and the Lowfield Heath Road to the western side. Sites were again identified in residential areas at 1.5, 2.0, 2.5, and 3.0 kilometres from the centre of the airport. Each site was visited and background noise levels were taken. At each site the extent to which ground noise was audible above the general background level was noted.

General Description of Noise Environment

A.19 The noise environment in the residential areas around Gatwick Airport is characterised by very low background levels; the L_{90} during the monitoring period was in the range 31 to 42 dBA. Ground noise was heard at five of the eighteen sites surveyed.

Location of Noise Sources

A.20 During the observation night, the most noticeable ground noise at Gatwick Airport came from the maintenance area and terminal area located in the eastern part of the airport site.

A.21 Significant localised (off-airport) noise sources included:

Rail noise: Noise from local trains and the Gatwick Express on the rail line on the east of the airport site contributed to the noise environment of most sites in the area.

Road traffic noise: Two main roads service the Gatwick Airport area, the M23 and the A23. The M23 was a source of constant noise throughout the night, traffic was lighter on the A23 during the night, but occasional traffic noise was heard at most of the sites within 0.5 km of the road.

Plant noise: Industrial areas to the north and south of the eastern end of the airport site formed a source of plant noise in the night-time period. It was noted that this plant noise occasionally masked the ground noise from the airport in the residential areas near to the industrial areas.

Meteorological Effects on the Audibility of Ground Noise

A.22 As with Heathrow Airport, the degree to which ground noise was audible was strongly dependent on the direction and strength of the wind. When ground noise was heard it varied in its level as the wind gusted. It is expected that the existence of ground noise in the sites to the south of the airport was to some extent a function of the northeasterly wind that predominated during the survey period. It was noted that when the wind dropped towards the middle of the night period, ground noise was audible at one site located at 1.5 km to the northwest of the South Terminal area.

A.23 Again, as with Heathrow Airport, it is possible that temperature inversions effected the propagation of ground noise at Gatwick Airport.

Stansted

Methodology

A.24 Stansted Airport was visited between 2300 on 8th August 1995 and 0700 on 9th August 1995.

A.25 There was 90 percent light cloud cover during the majority of the monitoring period and the cloud cleared towards 0400. There was a light northeasterly breeze, which dropped to almost nothing by the middle of the night-time period. The temperature was between 10 and 13 °C.

A.26 Sixteen sites were chosen around Stansted Airport to sample the night-time ground noise experience of the residents of the area. The airport perimeter in the case of Stansted Airport was taken as that area bounded by the marked by the thick dark line in Figure A3.

A.27 Sites were located in residential areas at 1.5, 2.0, 2.5, and 3.0 km from the centre of the airport. In addition to these, sites were surveyed at Takeley Primary School, Coopers Villas, and at the long stay car park. Each site was visited and background noise levels were taken. At each site the extent to which ground noise was audible above the general background level was noted.

General Description of Noise Environment

A.28 The ambient noise environment in the residential areas around Stansted Airport is characterised by very low background levels; the L_{90}s during the monitoring period were typically in the range 23 and 45 dBA.

A.29 Ground noise was heard at six of the sixteen sites surveyed.

Location of Noise Sources

A.30 The observations suggested that most of the ground noise at Stansted Airport was originating in the terminal area located in the southeastern part of the airport site, and in the site of the old terminal area to the north of the south end of the runway.

A.31 Significant localised (off-airport) noise sources included:

Road traffic noise: The main road servicing the Stansted Airport area is the M11. Noise from the M11 was present throughout the night period. Traffic was lighter on the road after midnight, but noise was heard at most of the sites within 2.0 km of the road. The surface of the M11 motorway is concrete, which tends to cause more noise than asphalt. An interesting effect of the type of road surface was the noise generated by heavy goods vehicles during the night-time period. In the early hours of the morning the percentage of heavy vehicles on the motorway tended to increase, thus raising the noise level due to the road. The noise generated by the heavy vehicles produced a reasonably constant broadband drone; but occasionally a particularly fast moving vehicle produced a more high pitched sound above the drone. This noise could easily have been mistaken for APU noise.

Plant noise: Plant noise was generated by the shops and hotels in Stansted Mountfitchet. Plant noise thought to be generated from within the airport was occasionally audible in those areas near to the airport where the background level was particularly low.

A.32 Very little other noise was noted during the monitoring period except occasional domestic events such as dogs barking and car alarms.

Meteorological Effects on the Audibility of Ground Noise

A.33 Occasional gusts of wind during the night-time period had an effect on the propagation of the noise from the airport. As the wind dropped the noise levels stabilised.

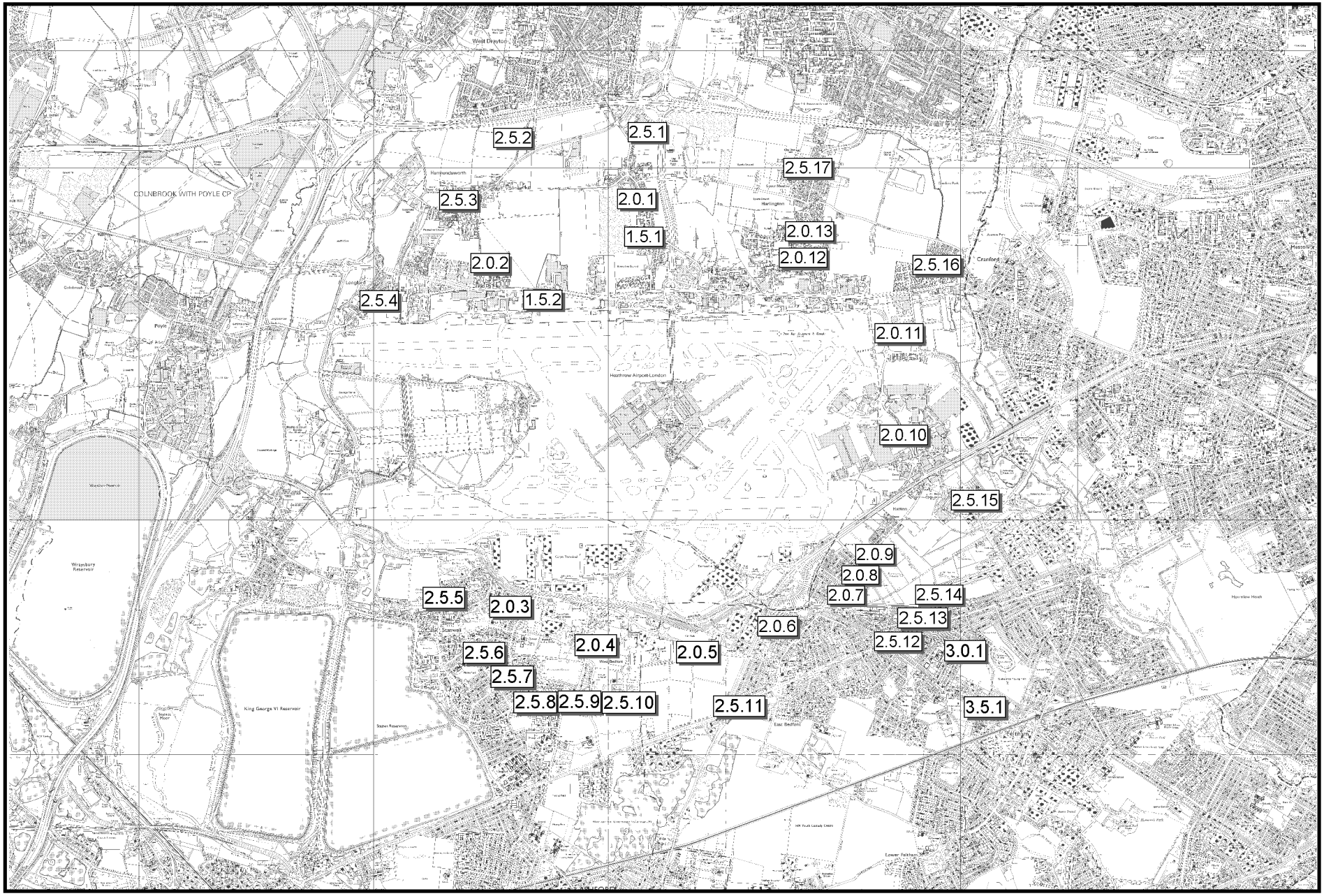


Figure A1: Heathrow Site Plan

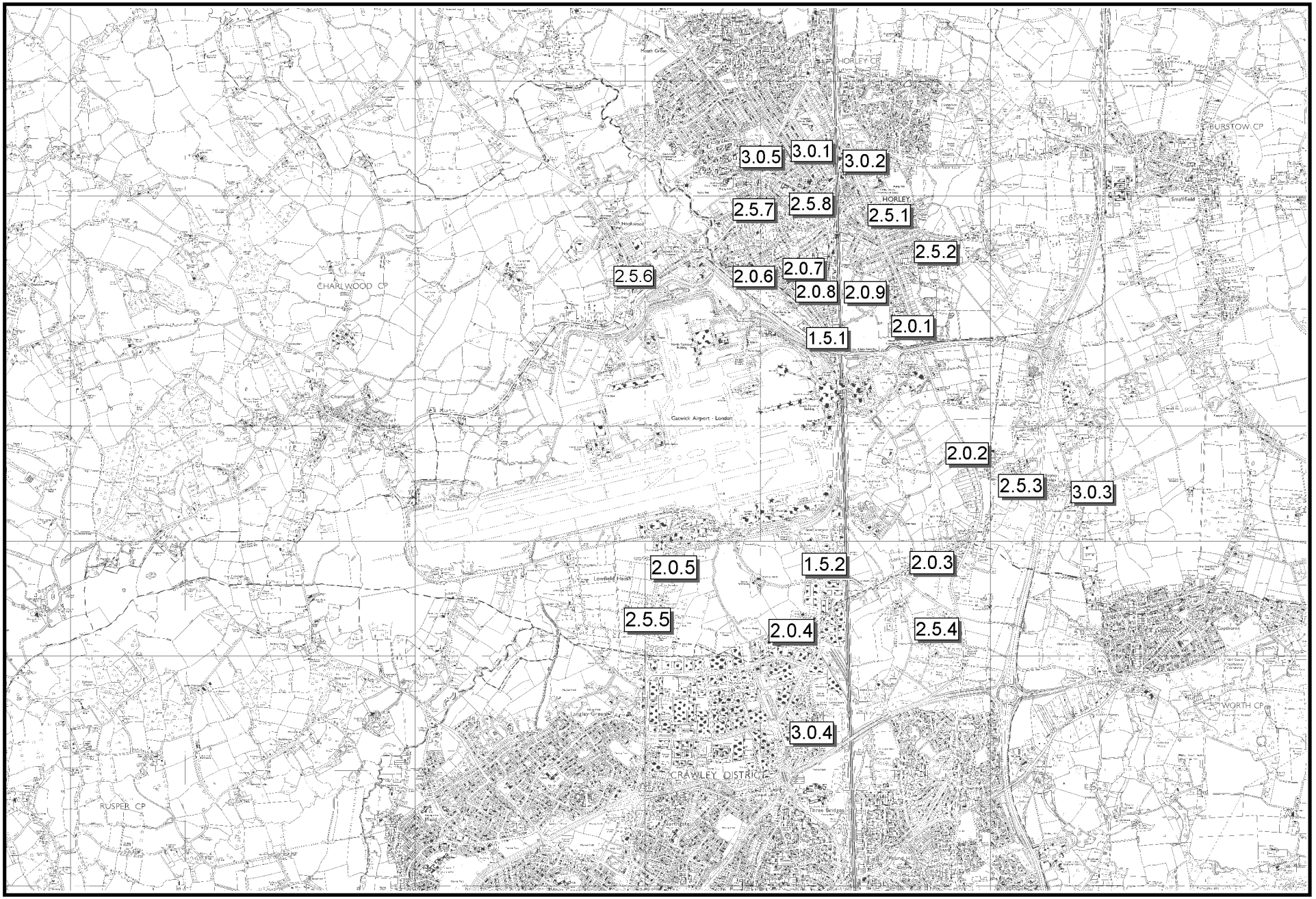


Figure A2: Gatwick Site Plan

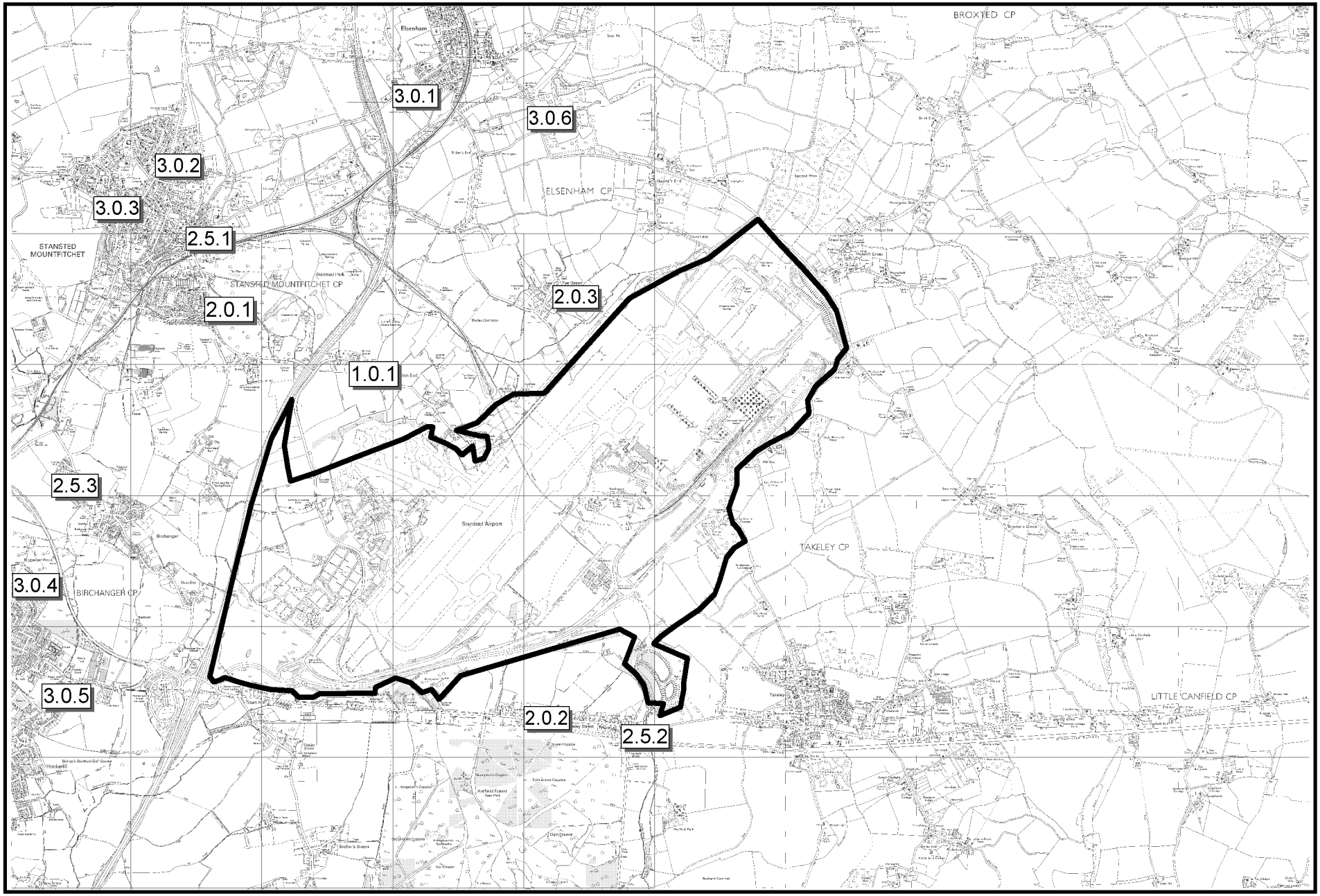


Figure A3: Stansted Site Plan

APPENDIX B

HEATHROW - PHASE 1 ASSESSMENT OF NIGHT-TIME GROUND NOISE

On-Airport Observations

B.1 Observations were made from the control tower veranda, which is about 35 m above the ground. The control tower is located in the central area of the airport (Figure B1). From this location the operations on the southern, eastern and northern parts of the airfield were visible, but the western end of the airfield was partially obscured due to the layout of the tower. The obscured area encompasses some of the Terminal 3 aprons.

B.2 The most significant source of ground noise at Heathrow between 2300 and 0400 hours is the ground running of aircraft engines for maintenance. After 0400 hours the dominant source of noise is arriving aircraft taxiing to the stands. A description of the general observations of noisy activities on the airport is given below.

B.3 Maintenance areas. Little noise could be heard from the maintenance areas at the observation point because of prevailing westerly wind conditions. However, these areas were observed to be the busiest parts of the airport during the night. On the three nights when observations were made, an average of 10 - 15 aircraft were towed to and from the maintenance areas. Whilst the towing of aircraft is carried out to minimise taxi noise, once in the maintenance area APUs and main engines were often run. A visit to the roads surrounding the maintenance areas endorsed the fact that engine and APU running was taking place.

B.4 Cargo terminal. In the preliminary study the cargo terminal was thought to be the source of APU and ground running noise. However, the airside observations in Phase 1 suggested that this may not have been the case. There was little or no activity around the aircraft in the cargo terminal area: the engine noise heard in the preliminary phase is likely to have been due to operations at Terminal 4 or the maintenance areas. However, noise is generated in the cargo terminal by vehicles delivering and collecting freight to and from the south facing bays which are directly adjacent to the airport perimeter. The dominant component of the road traffic noise on the South Perimeter Road adjacent to the cargo area is from heavy goods vehicles, a significant number of which are going to and from the cargo terminal.

B.5 Terminal 4. APU noise emanating from this area is due to aircraft parked on the ‘T stands’ which are on the airfield side of the terminal. Such noise is generated by aircraft arriving in the early morning period (0400 hours onwards). During the period 0000 to 0400 hours there was little activity on the

T stands apart from the towing of aircraft to and from the maintenance area. Aircraft arriving between 0400 and 0700 that were directed to the stands nearest the perimeter side of the terminal (the 'S' and 'V' stands) were moved onto stand with engines off, using tugs.

B.6 Plant noise: Plant noise from Terminal 4, the cargo area and off-airport buildings was clearly audible on a visit to the southern part of the airport perimeter. There was a significant amount of plant noise from the buildings in the central area audible from the control tower. It is expected that under strong wind conditions this noise could carry beyond the airport perimeter.

B.7 Central terminal area: Very little noise from the stands in the central area was heard. Any noise being made was masked by the noise from the express rail link works in the area immediately north of the control tower. However, reference to BAA APU, GPU and ground running logs show that the use of APUs and GPUs and ground running are all common in this area during the night. After 0400 hours taxi noise due to early morning long haul arrivals emanated from the Terminal 3 side of the central terminal area.

Standing Instructions

B.8 The BAA Operational Safety Instructions (OSI/62/93, Ref A1) relate to noise and ground operations. The instructions cover engine ground runs, use of APUs and GPUs and specific noise restrictions for Terminal 4. The document requires that:

(a) Aircraft operators should plan their maintenance to minimise ground running at night and if a ground run is needed permission must be sought from an operations controller. The company conducting the ground runs has to keep a record of those for which authorisation was required, and on completion of the engine running, notify an operations controller of the exact start and stop times.

(b) GPUs are not to be used if serviceable fixed ground power (FEGP) is available. If GPUs are used they should be shut down promptly after use.

(c) APUs should not be used as a substitute for GPUs or FEGP.

(d) No APUs are to be run on the Terminal 4 site between 2330 and 0630 hours, and no maintenance that involves the running of aircraft engines can be carried out on Terminal 4 stands at any time.

Observations

B.9 A significant degree of non-compliance seemed to occur at Terminal 4. Ground running log sheets, supplied by HAL Noise Complaints Unit, covering the periods 1 to 31 October 1995, 6 to 8 November 1995 and the 15 to 16 November 1995, (a total of 37 days) were obtained. Occurrences of ground running of aircraft engines on Terminal 4 stands are summarised below.

	Total	Night-time (2300-0700)	Daytime (0700-2300)
'T' Stands	35	4	31
'V' Stands	12	2	10
'S' Stands	11	0	11
Total Runs	58	6	52

B.10 During one night of monitoring in the communities around Heathrow two ground running events were heard that did not appear on the HAL log sheets.

Community Measurements and Observations

Population Counts

B.11 Figure B2 shows segment lines drawn through the area around Heathrow. The reference point for the airport corresponds to a position in the middle of the Central terminal area (CTA), OS co-ordinates 507520, 175850. Figure B3 gives the population counts for each segment. These Figures show that around Heathrow all segments are highly significant in terms of population, although the SW-W and W-NW segments are noticeably lower in density than the others (they include the large Staines reservoir areas).

Wind Conditions

B.12 Figure B4 shows night-time (2300 to 0800 hours local time) wind data in 10-degree interval polar form. The scale indicates the number of nights that the wind was in any particular direction for the 10 years from January 1985; the coloured bands represent the proportion of nights at any particular speed. The plot clearly shows the predominance of south-southwesterly winds. Relatively few nights have an easterly component. Figure B5 shows a similar plot of wind data covering the period August '95 to March '96, during which all the measurements and observations were made. This plot shows a significantly

greater easterly component than expected from the long-term data. The less smooth appearance is due to the smaller sample. The range of wind directions and strengths experienced during the four visits included light northeasterly, moderate northeasterly, variable strength (light to moderate) southwesterly and a variable strength westerly.

Observations and Measurements In Each Segment

N-NE

B.13 The main population in this segment is concentrated around Harlington High street. Airport ground noise was audible in the region in northeasterly, westerly and southwesterly wind conditions at 2.0 km from the central terminal area (CTA). The main source of airport noise was taxiing aircraft on the northern side of the airfield. However, the overall noise environment in this segment was defined by noise from local pass-by traffic and vehicles on the M4. To the north the segment is bounded by the M4 motorway which maintained a significant traffic flow throughout the night and dominated all sites within 0.5 km, irrespective of wind conditions.

B.14 Buildings along the Bath Road seem to provide an effective noise barrier that stopped much of the noise generated on the airfield propagating into the populated area. Road traffic noise was heard in the residential areas immediately to the north of the Bath Road, but it was not possible to ascertain whether this noise was due to traffic on the Bath Road or the M4.

NE-E

B.15 The maintenance area at the eastern side of the airport is less than 0.5 km from a dense area of housing, the closest roads being Waye Avenue and Berkeley Avenue. Time histories of the noise in Waye Avenue and Berkeley Avenue under westerly and southwesterly wind conditions respectively are shown in Figures B6 and B7. The effect on the local noise environment of a Boeing 747 running at high power in the new running pen (adjacent to the airport perimeter) is clearly illustrated in Figure B6. In Figure B7 the less defined effect of a Concorde in the 'Tristar pen' (on the airfield side of the maintenance area) running a low power engine check, can be seen. In the absence of ground runs the noise environment in these sites was still dominated by noise from the airport, generally noise from activity in the No.1 maintenance area.

B.16 At monitoring points close to maintenance area 1 ground noise was clearly discernible irrespective of wind direction. In northeasterly wind conditions airport ground noise was not heard at a point 1.0 km away from the maintenance area. The extent of the propagation of the ground noise was found to be limited to the roads adjacent to the airport. Populated areas further

from the airport boundary on the northern side of the Bath Road were generally not affected by noise from the airport.

E-SE

B.17 The area of housing closest to the airport boundary is Cains Lane, located 2.0 km from the CTA, 1.5 km from the maintenance area and 1.0 km from Terminal 4 stands. Two recordings of the noise climate were taken at Cains Lane on separate nights and are shown in Figures B8 (variable southwesterly/south southwesterly wind) and B9 (moderate westerly wind). These show the effect of ground noise at the airport relative to the local road traffic pass-bys. However, they do not show the tonal aspects of some ground noise sources such as taxiing aircraft or APUs, which lead to increased audibility over the background.

B.18 Ground noise from the airport was occasionally discernible in northeasterly wind conditions. The extent of audibility was unpredictable, with airport-based noise most likely to be audible in those areas away from the local main roads. The noise of an aircraft ground running registered 50 dBA 1.0 km from the airport perimeter in a moderate northeasterly wind. It was notable that in this case the background level (when there was no apparent airport or other noise source) was very low (L_{90} = 38 dBA). In light northeasterly winds very little airport ground noise was heard in this area.

B.19 Ground noise was frequently audible in westerly wind conditions in the absence of road traffic noise. The airport noise was masked completely by traffic when roads were located near to the observation points. The ground noise heard at the sites in this area had a strong tonal character suggesting that it was possibly due to APUs running in the Terminal 4, cargo or maintenance areas, or the noise from taxiing early morning arrivals.

SE-S

B.20 There are dwellings located in this segment less than 0.5 km away from the Terminal 4 site. These are situated behind a noise screen erected to protect residents from noise emanating from Terminal 4 activities. In moderate northeasterly wind conditions ground noise including ground running and taxiing or APU running was audible in this area, although occasionally masked by local road traffic. The ground noise, although low level, was still audible 1.0 km away from the airport boundary where background values were typically in the range 37-42 dBA (L_{90}). The ground noise was less frequently audible in this area in lighter northeasterly wind conditions.

B.21 In southwesterly and westerly wind conditions ground noise was rarely audible in this segment. Some faint tonal noise was audible in the road closest to Terminal 4.

S-SW

B.22 The residential areas close to the airport boundaries are concentrated around roads running southwards away from the cargo terminal area, with a densely populated estate 0.75 km from the airport boundary. In northeasterly wind conditions the background noise level was lower than typically found on the eastern side of the airport. In such conditions ground noise was clearly audible at sites close to the airport perimeter; sources included Terminal 4 and cargo area plant noise, ground running aircraft and APU running. A ground run heard at 0.5 km from the airport perimeter registered 56-57 dBA. The same ground noise sources were also audible at lower levels in the more densely populated areas further from the airport, although frequently masked by the rustling of trees and other local noise events.

B.23 In westerly and southwesterly wind conditions ground noise was not clearly audible and the noise environment was dominated by local traffic noise and traffic on the M25 motorway.

SW-W

B.24 The density of the population in this segment is lower than in the S-SW segment. The residential formation is very similar, with the population concentrated around the local main roads. The closest housing to the airport boundary is approximately 0.5 km from the cargo area. Stanwell Moor is located around 3.3 km from the reference and almost 2.0 km from any of the recognised ground noise sources. In northeasterly wind conditions ground noise was audible in the residential areas close to the airport, but only at low levels. The sources included APUs and ground running, thought to be emanating from the maintenance area, 4.0 km away. The ground noise was frequently masked by local traffic passing by. When the wind was blowing from the west or southwest no airport ground noise was audible.

W-NW

B.25 The main land use in this sector is given over to airport-related services such as hotels, car parks and car hire businesses. There is, however, a small settlement at Longford 2.5 km from the CTA and 4.5 km from maintenance area 1. In northeasterly wind conditions ground noise was rarely audible here, and was restricted to the noise of an aircraft thought to be taxiing to the western end of the airport for a late night departure. The background noise level, as with many other sites to the west of the airfield, was low in the northeasterly wind, with an L_{90} of 43 dBA. The noise environment was

dominated by birdsong, occasional Bath Road traffic and plant noise from the local hotels and businesses.

B.26 In westerly and southwesterly wind low level ground noise was occasionally heard, and the reverse thrust of a late night arrival was clearly audible. Traffic noise from the Bath Road dominated the noise environment. It is expected that in southeasterly wind conditions airport ground noise would be audible in Longford.

NW-N

B.27 The dwellings in this segment, as with those in the N-NE segment, are clustered around the main local road (Sipson Road). The local roads and the M4 motorway dominate the noise environment in northeasterly wind conditions. Little ground noise was heard in any of the six residential sites visited. At the sites on the Bath Road there was a significant noise contribution from road vehicles, much of which are probably airport related. As with the N-NE segment the built-up area on the north side of the Bath Road formed an effective noise barrier protecting those dwellings to the north of the Bath Road. Any airport noises heard here were not measurable because of masking by noise from local and M25 traffic and the shielding effect of the buildings along the Bath Road.

B.28 In southwesterly and westerly wind conditions taxiing noise could occasionally be heard in the residential areas closest to the airport. On one occasion an aircraft was faintly audible ground running on the stands on the eastern side of the Central terminal area at a distance of 1.0 km from residential houses on Sipson Road.

References:

BAA Operational Safety Instruction, OSI/62/93: Aircraft Engine Ground Runs, The Use Of Auxiliary Power Units, The Use Of Ground Power Units, And Noise Restrictions For Terminal 4, Issued 24 November 1993.

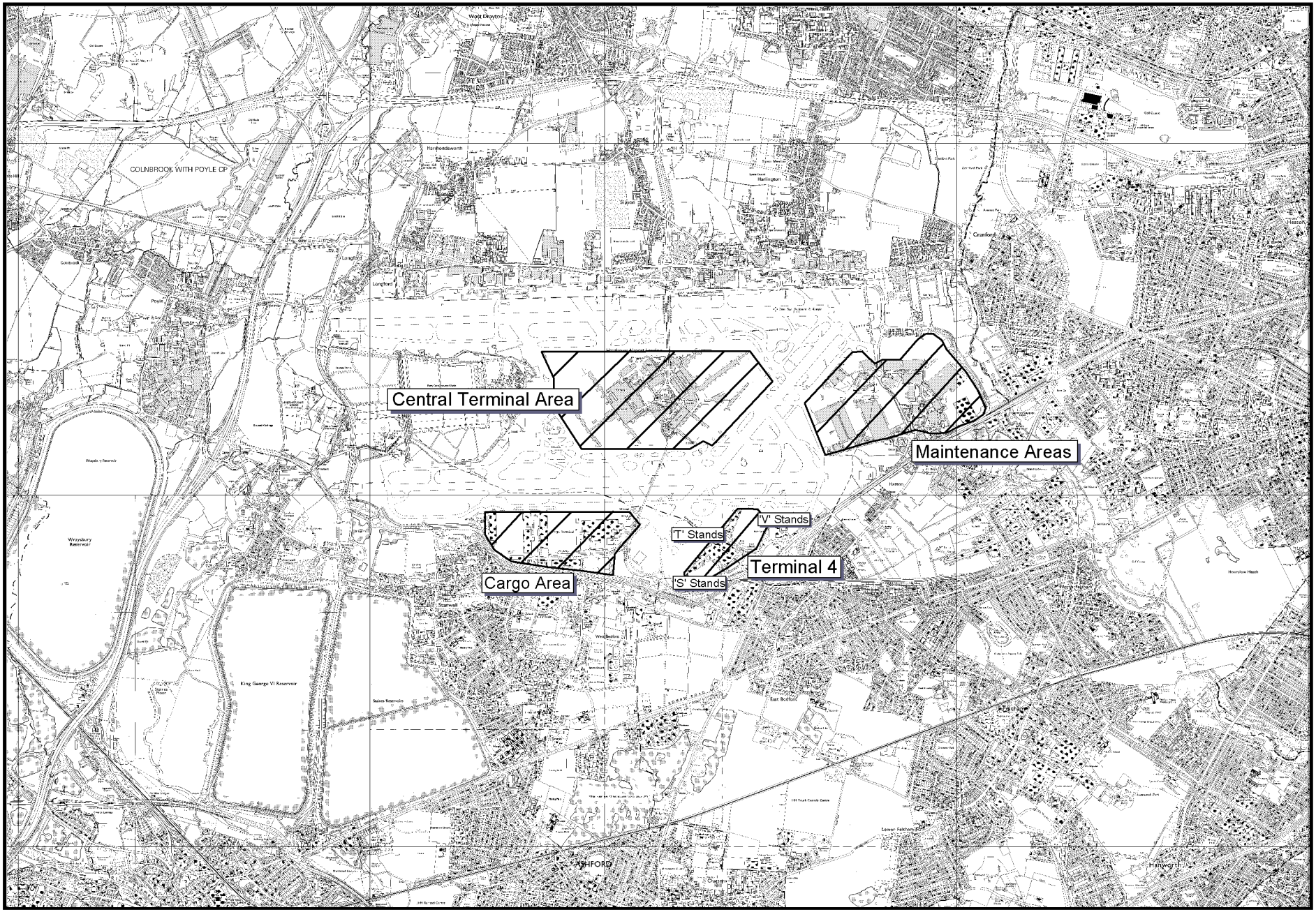
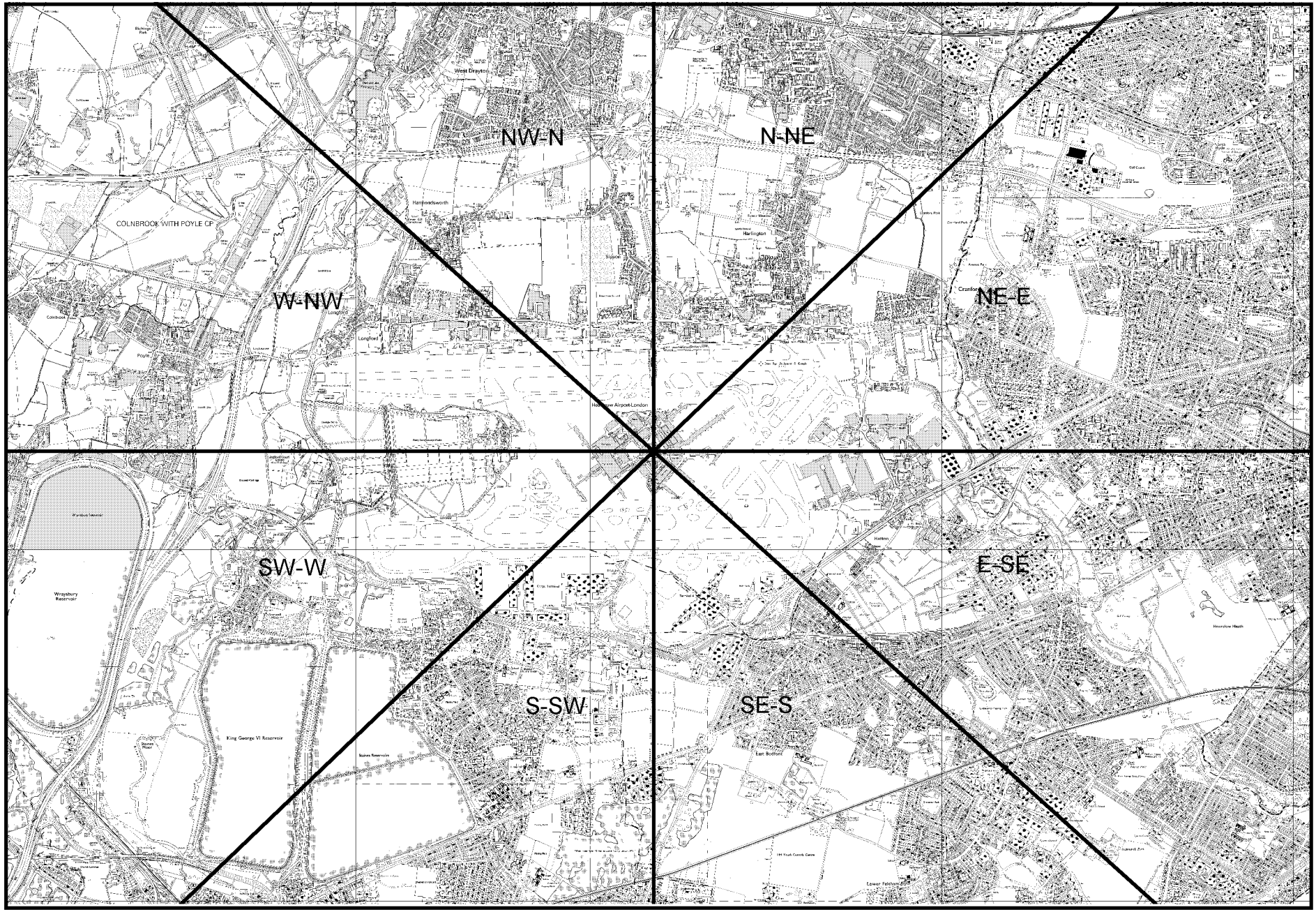


Figure B1: Heathrow Site Plan



HEATHROW
SCALE 1:45000

Figure B2: Heathrow Area Showing Reference Segments

Figure B3: Heathrow Population Counts by Segment

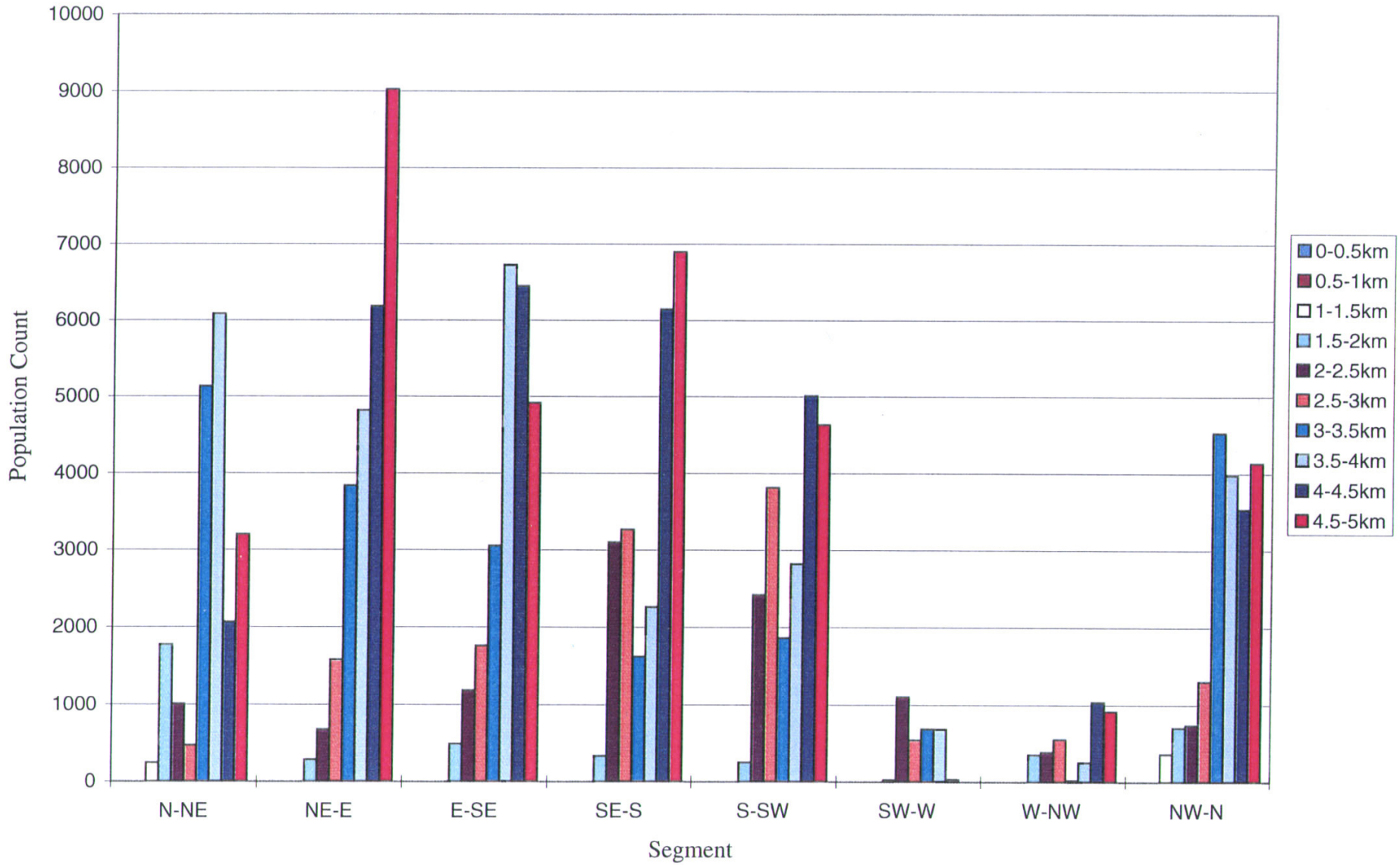


Figure B4: Heathrow Wind Directivity 1/1/85 to 31/12/94

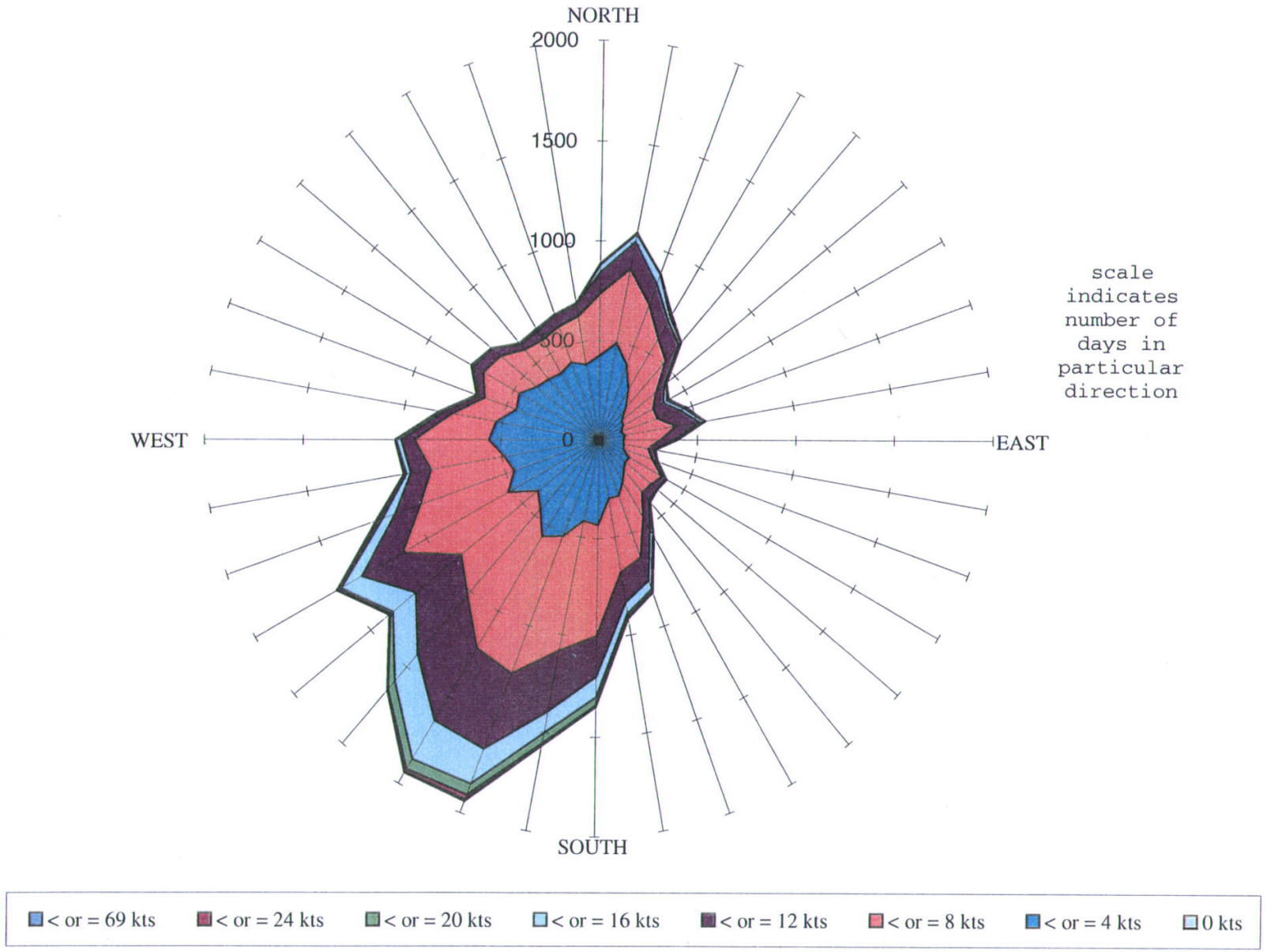


Figure B5: Heathrow Wind Directivity 1/8/95 to 31/3/96

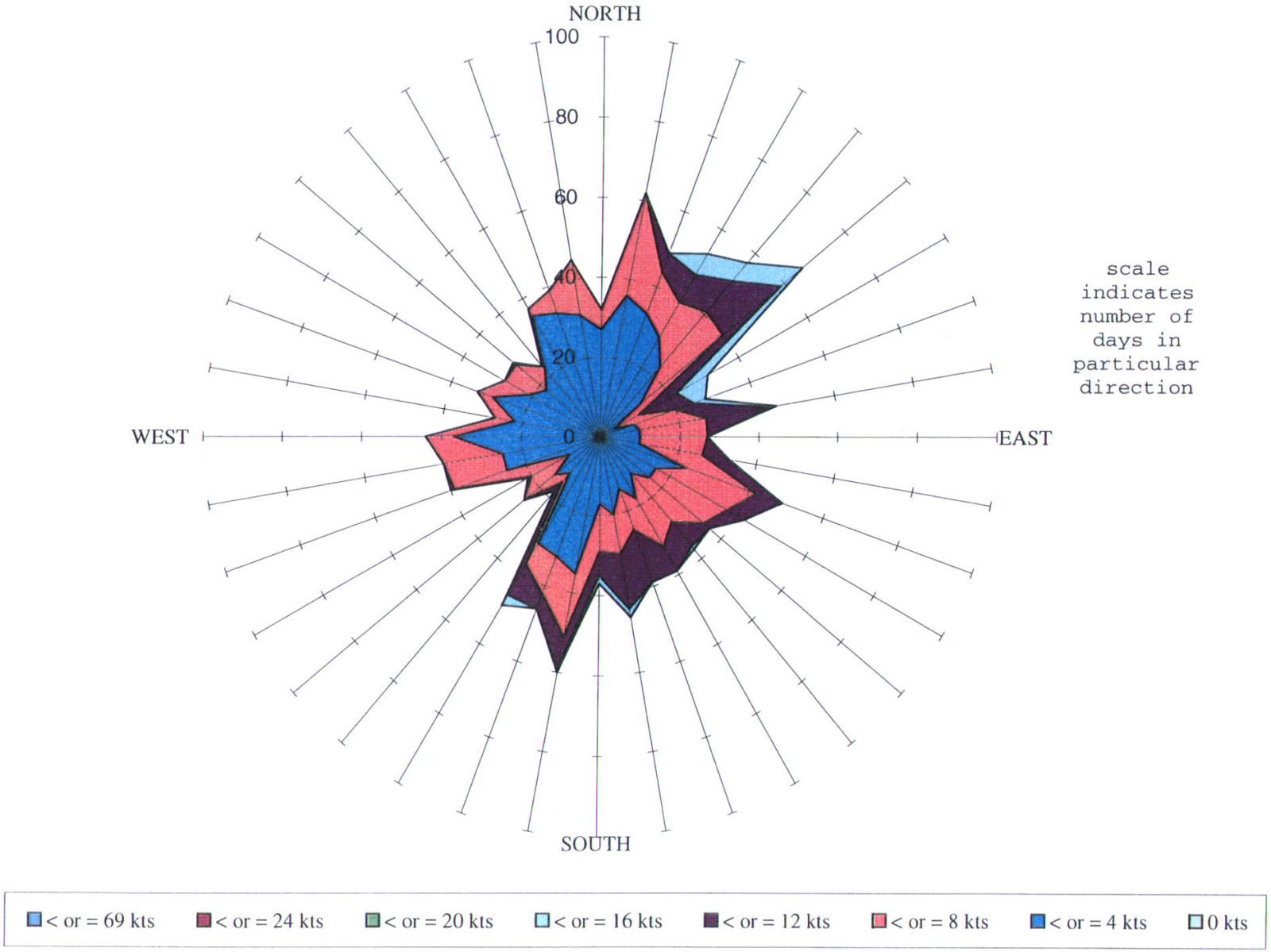


Figure B6: Time History at Waye Avenue, 2.8km from reference at Heathrow

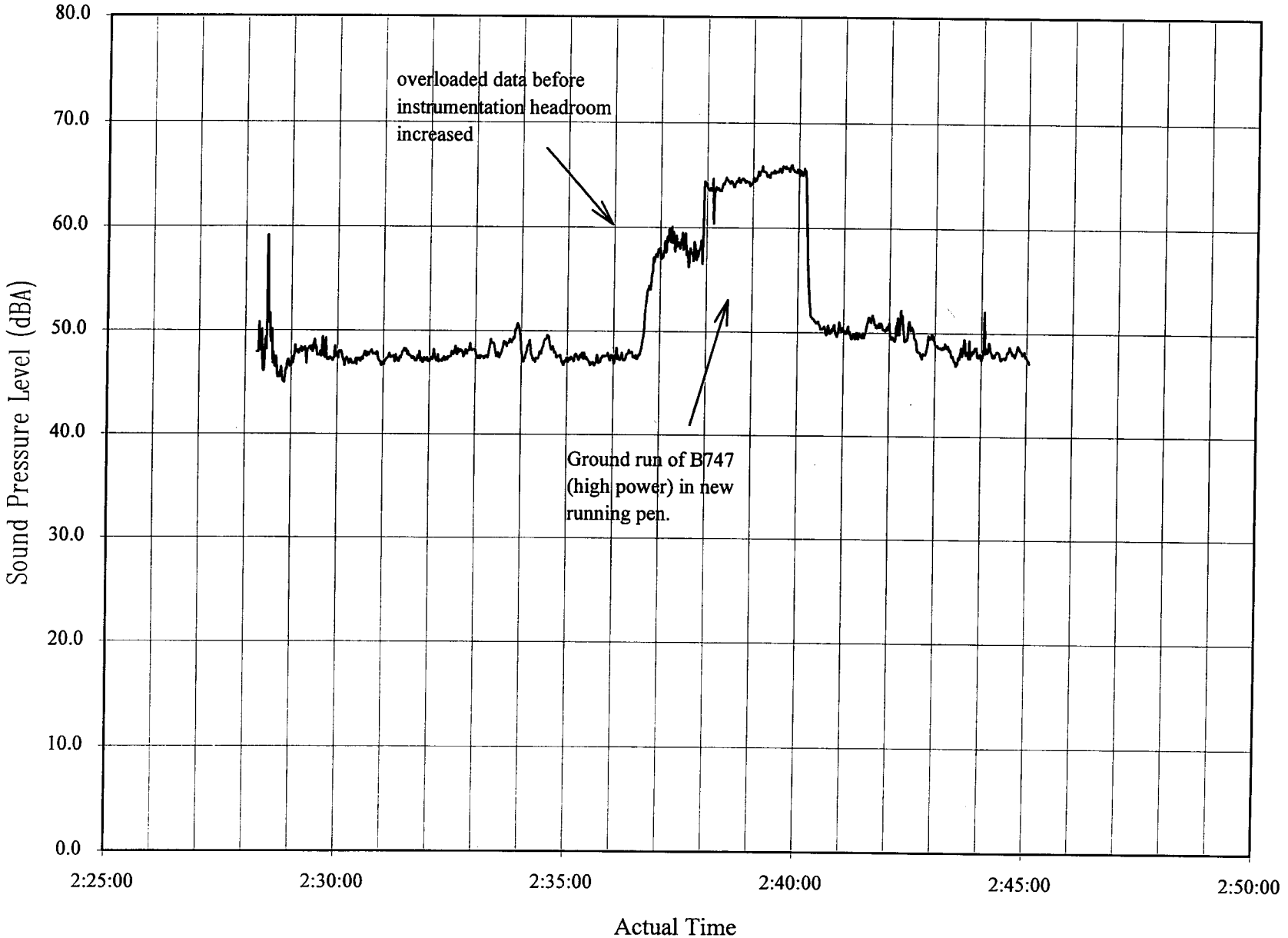


Figure B7: Time History at Berkeley Avenue, 2.9km from reference at Heathrow

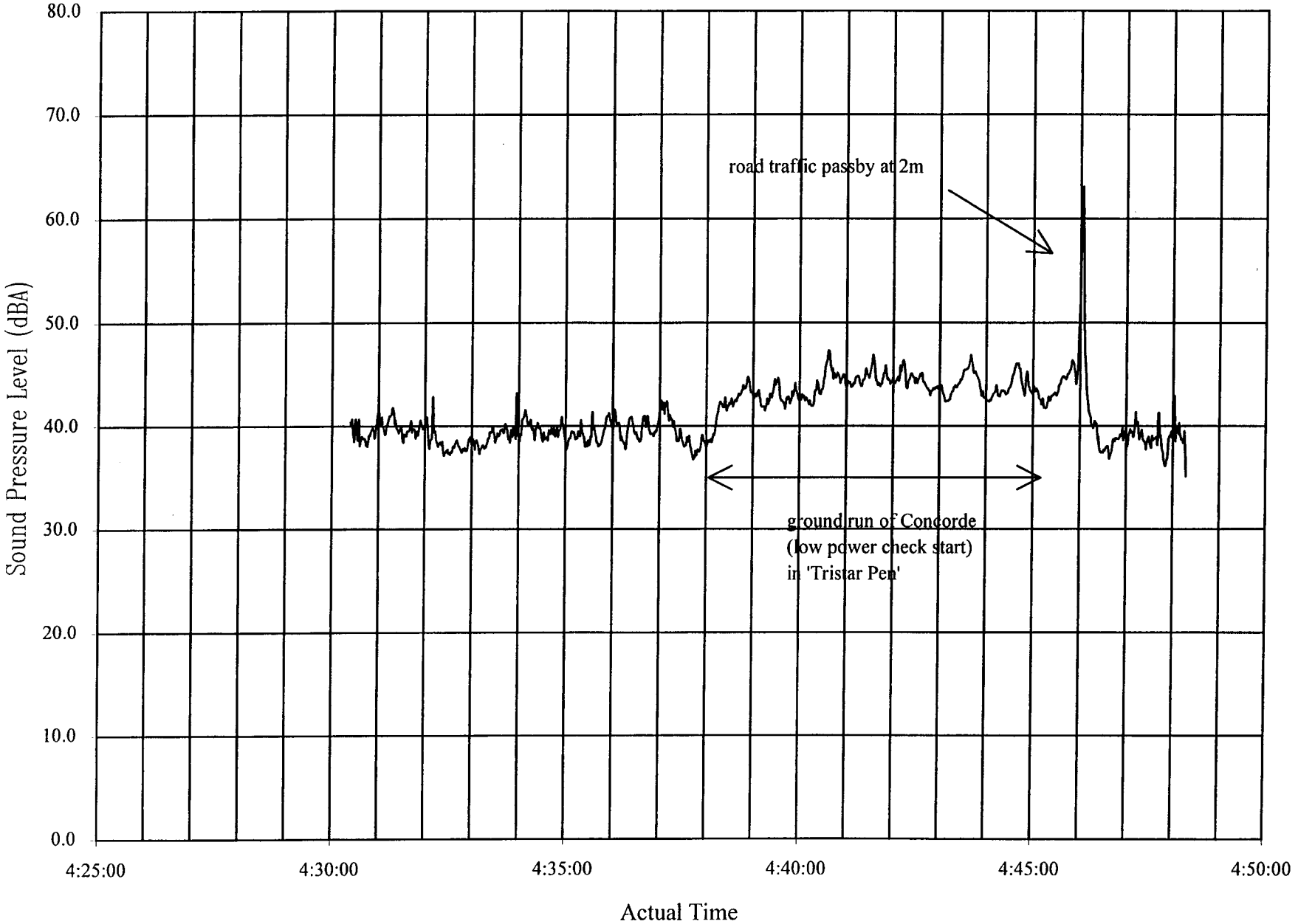


Figure B8: Time History at Cains Lane, 1.9km from reference at Heathrow Airport

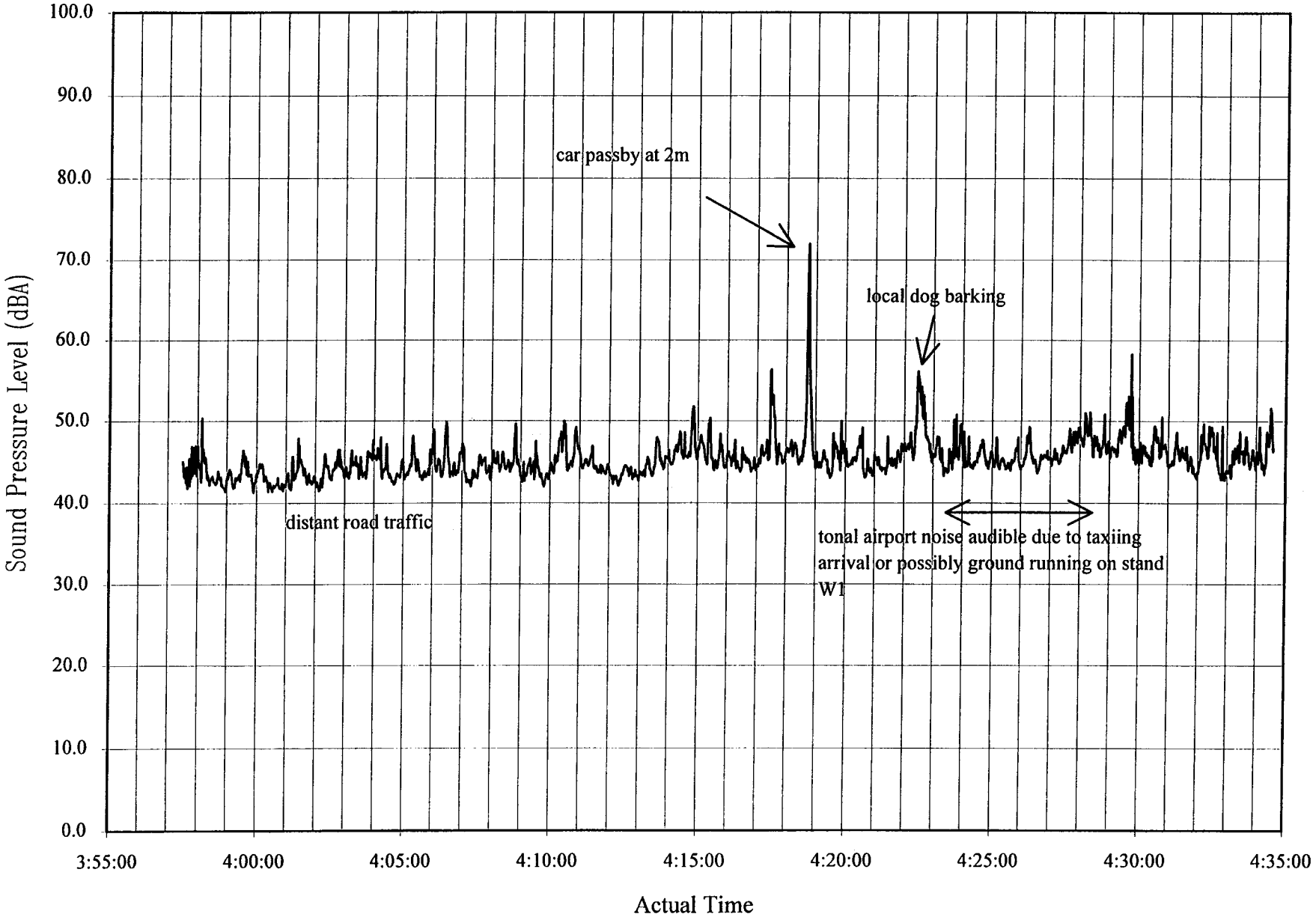
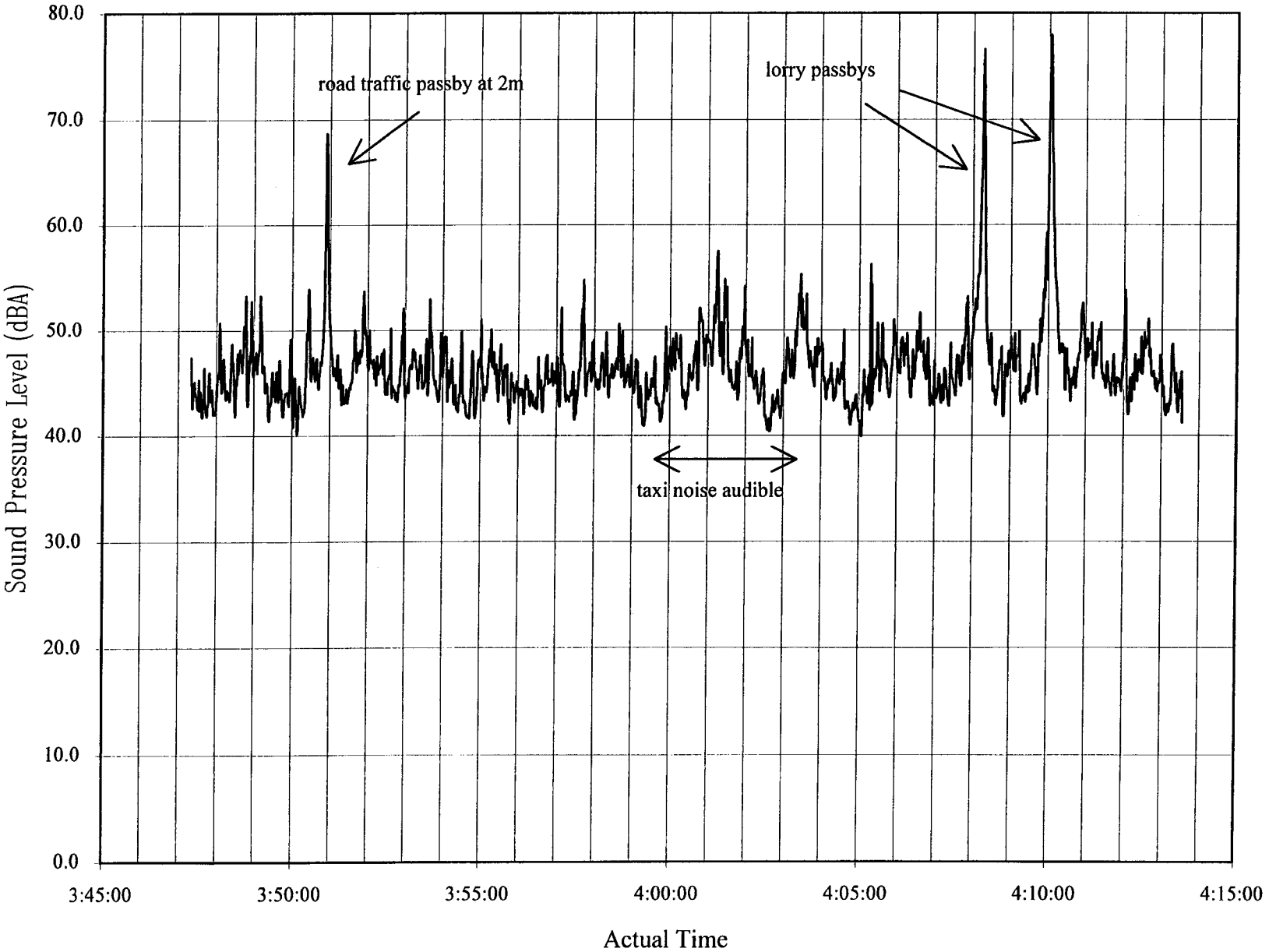


Figure B9: Time History at Cains Lane, 1.9km from reference at Heathrow



APPENDIX C

GATWICK - PHASE 1 ASSESSMENT OF NIGHT-TIME GROUND NOISE

On-Airport Observations

C.1 Observations were made from 25m above the ground, on the balcony of the 5th floor of the Old Control Tower building situated to the southwest of the cargo area, see Figure C1. This position offered views of most of the cargo area, the South Terminal aprons, the maintenance area and the southern part of the North Terminal Apron.

C.2 The loudest source of ground noise at Gatwick is the taxiing of arriving and departing aircraft. This is generated intermittently during the early and late periods of the night (in the summer months it would occur throughout the night). In the absence of taxi noise, activities taking place around the terminal and cargo area on the northern side of the runway, and maintenance activities on the southern side of the airport are the primary sources of ground noise; the specific noise sources in each of these areas are described below.

C.3 Cargo Apron: The vantage point provided only a partial view of the cargo apron. Some stands at the far western end of the Cargo Apron were not visible. Observations and information gained from listening to Gatwick ATC radio suggested that the cargo apron was preferred for cargo and passenger aircraft that were in need of maintenance. On numerous occasions during the three monitoring nights permission to tug aircraft from terminal stands to the cargo apron was requested from ATC. On a visit airside it was found that the noise emanating from the cargo area was from GPUs powering aircraft on the western end of the apron. Some higher frequency tonal noise due to the running of the systems onboard the aircraft on this apron was noted. Airside observations also revealed that aircraft on the cargo apron stands ran APUs for prolonged periods.

C.4 On all three nights impact noise from the shunting and relocating of cargo pallets was heard emanating from the stands adjacent to block 68. Noise from this area could propagate relatively unhindered to the Horley Gardens Estate to the north of the airport.

C.5 Terminal area: Some ‘on stand maintenance’ of aircraft around the terminals was noted. This practice did not appear to generate noise other than that from vehicles in attendance: it seems therefore to be an insignificant source in terms of the airport as a whole. All pier served stands (those adjacent to the North and South terminals) are served by fixed electrical ground power (FEGP). Power at the other stands was provided by GPUs, although the majority of aircraft parked on the more remote stands were not powered during the night

period. An airside visit was made to ascertain the extent of APU and GPU use on the airfield. Several aircraft adjacent to stands on the North Terminal, as well as several on the satellite area on the South Terminal, were using GPUs. Some aircraft on the South Terminal were running APUs in preparation for departure. Taxi noise associated with arrivals and departures was a noise source in this area.

C.6 Maintenance area: On a visit to this area three aircraft using GPUs were parked outside the maintenance hangars. Work was being conducted inside the hangars which was generating some noise. British Airways' new type of GPUs were in use here; these were significantly quieter than the older Gatwick Handling (GH) GPUs used elsewhere on the airfield.

Standing Instructions

C.7 BAA MDI 36/92, MDI 27/94 and MDI 2/95 refer to the use of APUs, GPUs and ground running of aircraft engines for maintenance at Gatwick airport; they also outline planning conditions on the North Terminal. The notices are summarised here:

a) MDI 36/92 is concerned with special restrictions on the use of aircraft stands on the North Terminal and in essence states that operations such as APU/GPU use and ground running of main engines is prohibited during the night period except in emergencies.

b) MDI 27/94 refers to the use of APUs and high tail mounted engines at the airport. It requires that APUs are:

- shut down on arrival at a stand where FEGP is available, as soon as the passengers have disembarked;
- not restarted until 45 minutes before planned departure time.

c) MDI 2/95 states that high power night-time running of aircraft engines is not permitted in the period 2300 to 0700 hours, except for high bypass ratio engines at low maximum thrust settings. Start-stop engine tests may be permitted in the night period in emergencies, but not on North Terminal stands.

C.8 During Phase 1 discussions with BAA representatives from Gatwick revealed that a new MDI relating to ground noise was due to be issued. This 1996 MDI is now due to be updated in Autumn 1998.

Observations

C.9 APUs and GPUs are run during the night period on and around the North Terminal. General compliance with the other instructions during the monitoring period was noted.

Community Measurements and Observations

Population Counts

C.10 Figure C2 shows the segment lines drawn through the area around Gatwick. The OS co-ordinates of the chosen reference point for Gatwick Airport are TQ 527560, 140750. This reference point was chosen as the most representative centrepoint of the chief airport ground noise sources, corresponding to a position at the eastern end of the northern runway. Figure C3 gives the population counts for each segment. The generally lower population density around Gatwick as compared with Heathrow is immediately clear. The most significant segments at Gatwick are revealed as the SE-S & S-SW segments (Crawley) and to a lesser extent the NW-N & N-NE segments (corresponding to Horley).

Wind Conditions

C.11 Figure C4 shows night-time (2300 hours to 0800 hours local time) wind data divided into 10-degree polar intervals. The scale shows the number of nights the wind was in a particular direction over the period from January 1985 to the end of 1994; the coloured bands represent the proportion of nights where the wind is at a particular speed. As with Heathrow the predominant wind is a south-southwesterly, but there is a more noticeable east-northeasterly component at Gatwick. Figure C5 shows the August ‘95 to March ‘96 data corresponding to the Phase 1 monitoring period which show a far greater northerly (especially northeasterly) wind component and far smaller westerly component than the long-term data.

Observations and Measurements In Each Segment

C.12 The observations and measurements at Gatwick were made over two nights in the presence of light northeasterly or light northerly winds.

N-NE

C.13 This segment contains the bulk of the town of Horley, the centre of which lies about 2.5 km from the reference point. Numerous sites within Horley were visited and, although occasional departures were heard, airport ground noise was inaudible at all sites except one at the southern edge of Horley, 1.5 km from the reference. A faint non-specific (and non-tonal) ground noise rumble

was intermittently heard. At all sites the most prevalent noise source was local pass-by and distant (M23 motorway) road traffic. The South Central train service to Gatwick runs hourly throughout the night, and the noise from trains on this line passing through Horley dominated the noise environment up to a kilometre to the west of the track. No other airport-related trains run during the night.

C.14 The general impression during the visits was that, the rail line apart, ground noise was an extremely minor contributor to the overall noise environment. Clearly, a northeasterly wind would tend to minimise the ground noise exposure, and observations in the presence of the more predominant southwesterly winds are necessary before the effect of ground noise can properly be assessed. It seems likely though that even with an unfavourable wind the built-up nature of Horley will effectively screen much of the noise from the airport, leaving only the southern edge with any potentially significant exposure.

C.15 Wind direction is also likely to have an effect on the level of screening afforded by the airport buildings themselves. The taxiing of arrivals in westerly mode to the terminals will generally take longer and be more exposed to local residents than that of arrivals in easterly mode. Conversely, westerly departures are likely to involve significantly less taxiing along the exposed western end of the runway than do easterly departures. It is therefore the taxiing associated with westerly arrivals and easterly departures in the presence of southwesterly winds that is most likely to be audible in Horley.

NE-E

C.16 The main population centre in this segment is the village of Smallfield, but this lies just beyond the M23 motorway which is by far the most dominant noise source in the vicinity. Between the M23 and the airport the southeastern edge of Horley extends into this segment. At all sites the dominant noise source was road traffic on the A23. Occasionally some airport noise was thought to be audible, but was insignificant and unmeasurable. A southwesterly wind would undoubtedly increase the propagation of airport noise into this segment, but would also be likely to increase the A23 road traffic noise exposure. A significant portion of the road traffic on the A23 is likely to be airport-related, and this, together with the rail link, seemed to form the most important source of ground noise in this segment.

E-SE

C.17 Close in to the airport (1.3 km from reference) ground running, APU, taxiing and what sounded like tractor noise were clearly audible and dominated the background when present. Most of this airport noise appeared to be coming from the maintenance area to the south of the runway. Although noise

appeared to be generated in the maintenance area, these buildings serve as a barrier against much of the noise produced on the northern side of the airport. At around 2.0 km from the reference, local road traffic and trains passing by dominated, with noise from the M23 in the background. APU/taxiing tones were just audible but not measurable. At 3.0 km from the reference the noise environment was dominated by the M23. The most significant population centre in this segment is the village of Copthorne, but this lies 4.0 km from the reference point and beyond the M23 motorway, which will certainly render any airport ground noise sources insignificant.

SE-S

C.18 Between the A2011 and the airport lies a largely industrial area. In this area the noise background[16] was largely defined by local plant noise and road traffic (heavy goods vehicles were frequent), with the rail line and local construction work intermittently significant. Beyond the A2011 at 1.6 km some tonal noise from the airport was thought to be heard but was easily confused with or masked by the plant noise. At 2.6 km the airport was just audible as a non-specific low frequency drone, which was frequently masked by local noise sources. The drone heard was possibly attributable to GPU use.

C.19 Beyond a distance of around 2.5 km this segment becomes highly residential, including the Pound Hill and Three Bridges areas which are bounded on the north by the A2011. Beyond the A2011, however, very little penetration of the airport ground noise is likely because of the screening effect of the buildings, any residual airport noise being largely masked by local and A2011/A264 road traffic noise. The most significant ground noise sources are likely to be the rail line and road traffic. Given the observations at other sites around the airport, some taxi noise is likely to be audible but not intrusive in the residential communities. Otherwise the airport will only be discernible, and probably not measurable, as a faint drone in the background. With southerly wind components the airport is likely to be completely inaudible.

S-SW

C.20 At a distance of 1.5 km a propeller aircraft was clearly audible taxiing, producing a maximum 53 dBA compared with a background typically in the range 40-43 dBA. Beyond 2.5 km this segment becomes highly residential and includes the Northgate, Ifield and Langley Green areas. The noise of the airport did penetrate significantly into the residential community, generally being audible as a kind of low frequency rumble or drone. At 2.6 km the ground noise level was estimated to be around 42 dBA. Figure C6 shows

[16] The term 'background' is used in this paper to indicate the residual noise present when no particular source was perceived to dominate the noise environment.

measurements made at this distance where the airport provided a relatively constant background but did not appear subjectively to be as loud as other local sources such as rustling trees and birdsong.

C.21 At 4 km a propeller aircraft preparing to take off produced around 45 dBA compared with a minimum measured background level of 39 dBA. At 4.6 km the airport was still audible but largely unmeasureable. Its level was estimated to be around 37 dBA. As Figure C7 shows, the measurements at this distance were made at a time of the morning when road traffic flow is already significant, and compared to the local traffic noise the contribution of the ground noise to the average noise level is negligible. In general, the airport sources at each site, in comparison to the level of local sources, did not appear to be intrusive and (taxiing apart) were barely measurable. Given that the prevailing wind at the time of these observations was a light northerly, it seems likely that with a southerly wind component the airport will be largely inaudible.

SW-W

C.22 The absence of other significant sources and the clear propagation path means that ground noise is likely to be relatively clearly audible in this segment, although population density is very low. Close to the airport boundary (1.5 km from the reference) the dominant background noise was from GPUs, producing a level of around 50 dBA. Further out (2.6 km from reference) the GPUs were still clearly audible, the level of ground noise being around 41 dBA.

W-NW

C.23 This segment contains the village of Charlwood just to the northwest of the western end of the runway, about 3 km from the reference point. No ground noise was heard in Charlwood during the visit, the noise environment being dominated by local sources such as birds and traffic pass-bys along the Charlwood road. Again, the relatively open propagation path and generally low background noise from other sources means that an unfavourable wind is likely to result in a significant degree of ground noise being audible. An easterly wind, although blowing ground noise towards Charlwood, will generally result in less taxiing of arrivals since the terminal buildings are towards the eastern end of the runway. Noise from taxiing of easterly departures may, however, be clearly audible. The Echo hold at the western end of the airport (less than 1 km from Charlwood) was previously used for engine running. However, a new taxiway for easterly departures means that this is no longer the case since ATC use the area to queue aircraft.

NW-N

C.24 This segment includes the Povey Cross area with hotels and hospital, just north of the northern terminal buildings, and also the western edge of Horley. At a site in Povey Cross 1.7 km from the reference but only 0.5 km from the airport perimeter no ground noise was audible. The minimum measured level of 35 dBA represents distant road traffic noise. However, since the site was upwind at the time, it cannot be inferred that ground noise will not generally be audible here. Given the proximity of Povey Cross to the airport, and the observations made in other downwind segments, it seems very likely that ground noise will be clearly audible here in unfavourable wind conditions. Some ground noise is also likely still to be audible in the western edge of Horley, particularly taxiing of westerly arrivals when there is a significant southerly wind component. It is relevant to note that there is no reason for the use of GPUs on the North Terminal. GPUs should, therefore, not form a significant source of ground noise for residents in Povey Cross.

References:

BAA Managing Director's Instruction 27/94: Restrictions On The Use Of High Mounted Tail Engines And Auxiliary Power Units, Issued July 1994.

BAA Managing Director's Instruction 2/95: Ground Running Of Aircraft Engines For Maintenance, Issued December 1994.

BAA Managing Director's Instruction 36/92: North Terminal: Planning Conditions Affecting The Use Of Aircraft Stands, Issued October 1992.

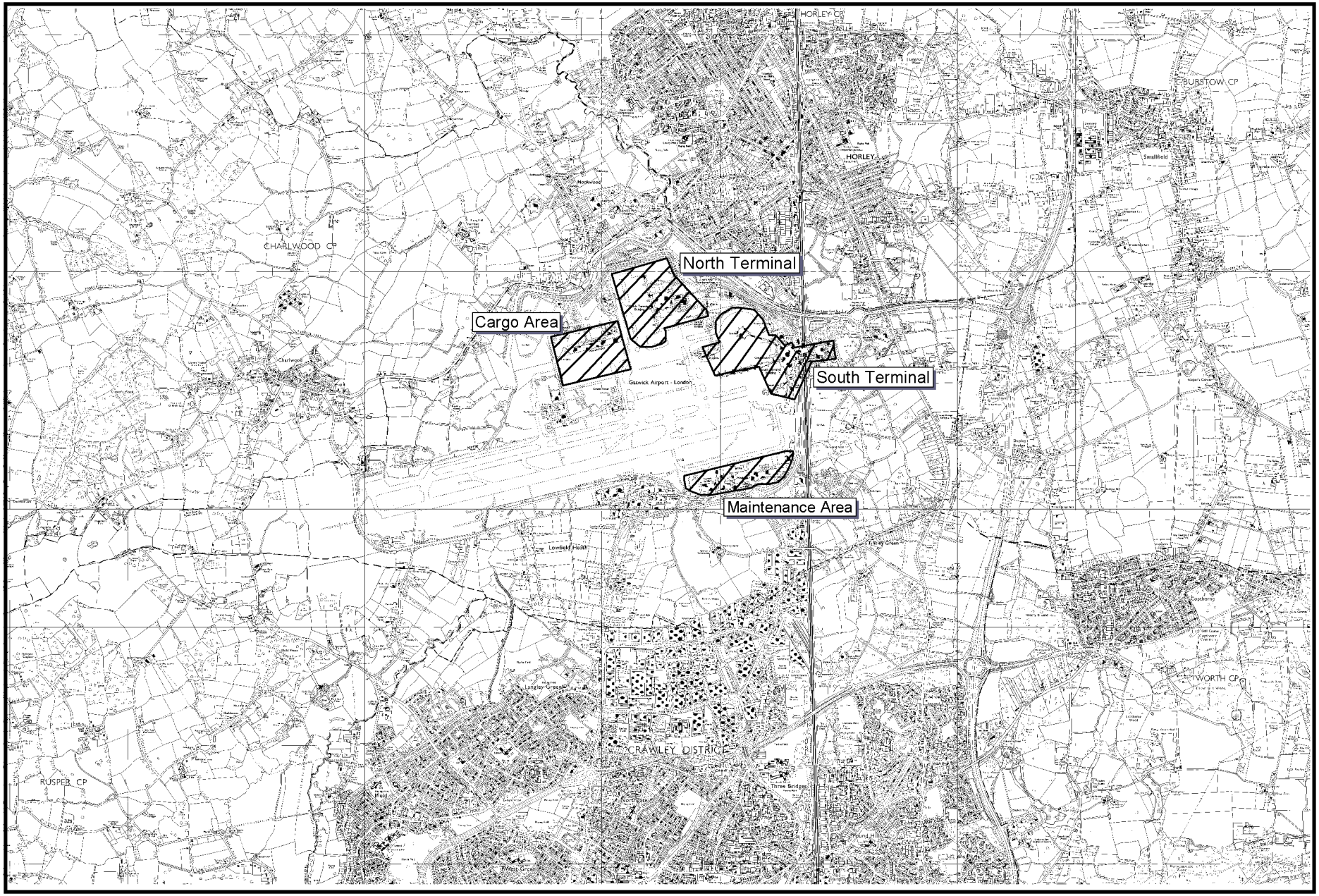


Figure C1: Gatwick Site Plan

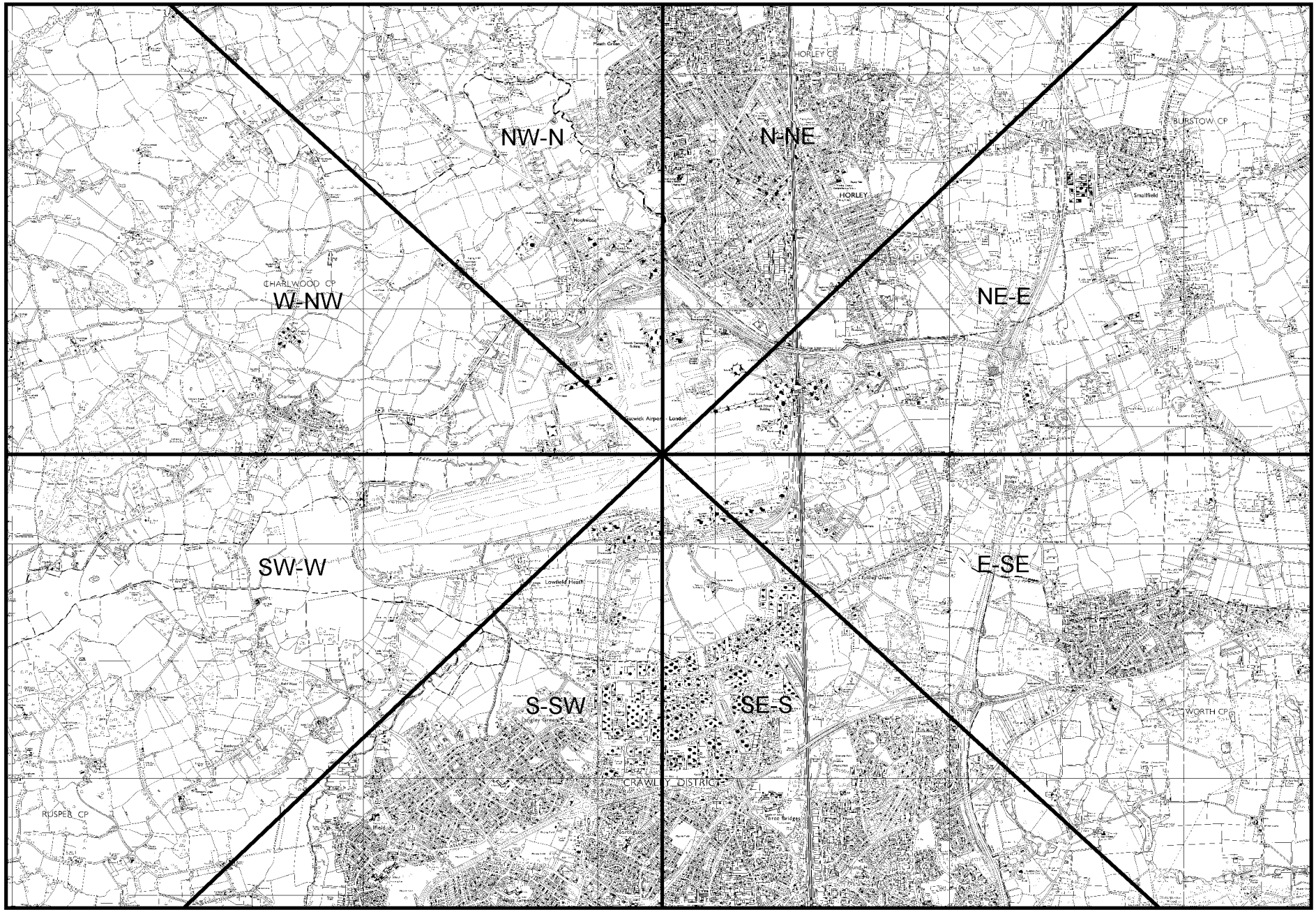


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Figure C2: Gatwick Area Showing Reference Segments

Figure C3: Gatwick Population Counts by Segment

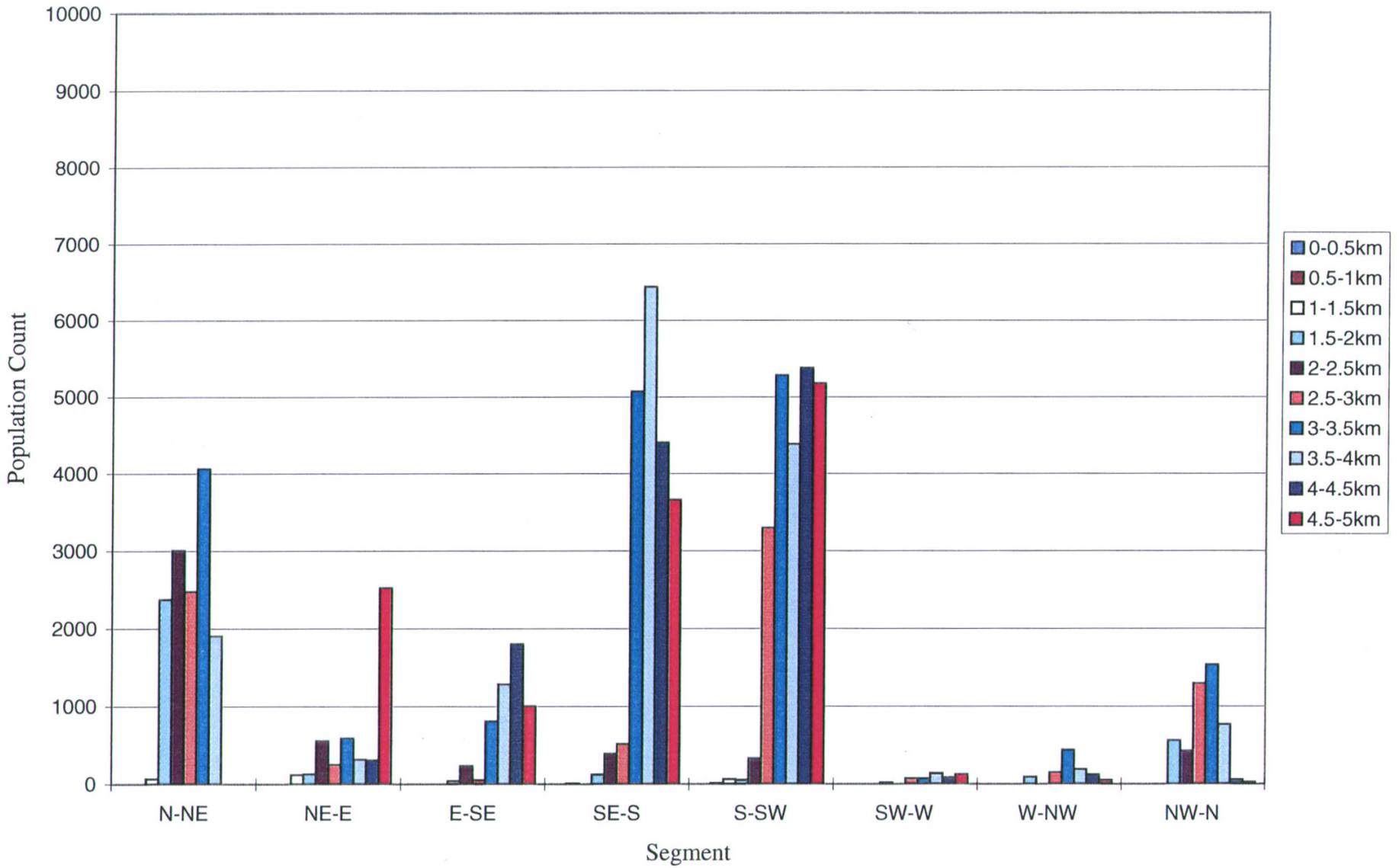


Figure C4: Gatwick Wind Directivity 1/1/85 to 31/12/94

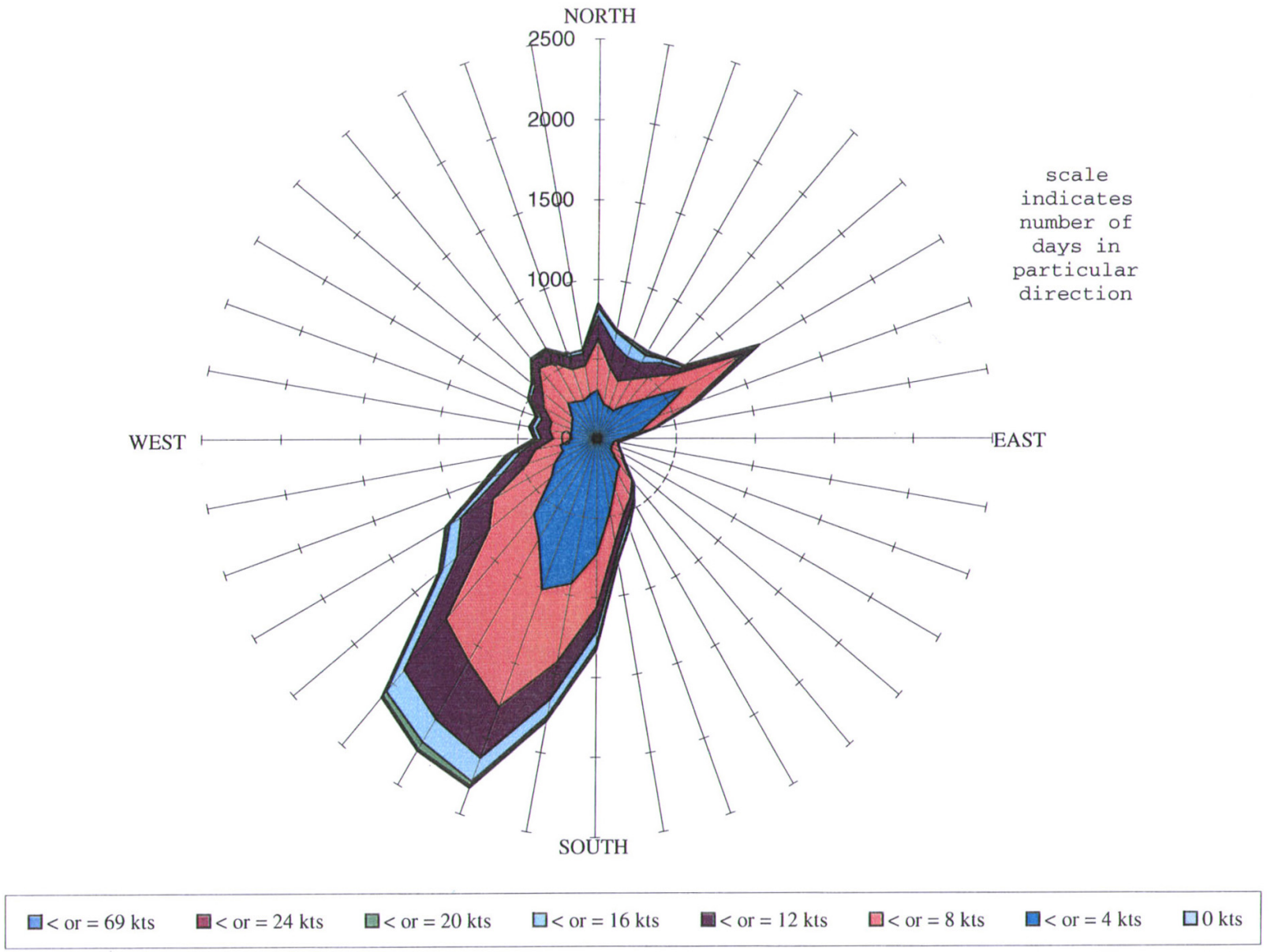


Figure C5: Gatwick Wind Directivity 1/8/95 to 31/3/96

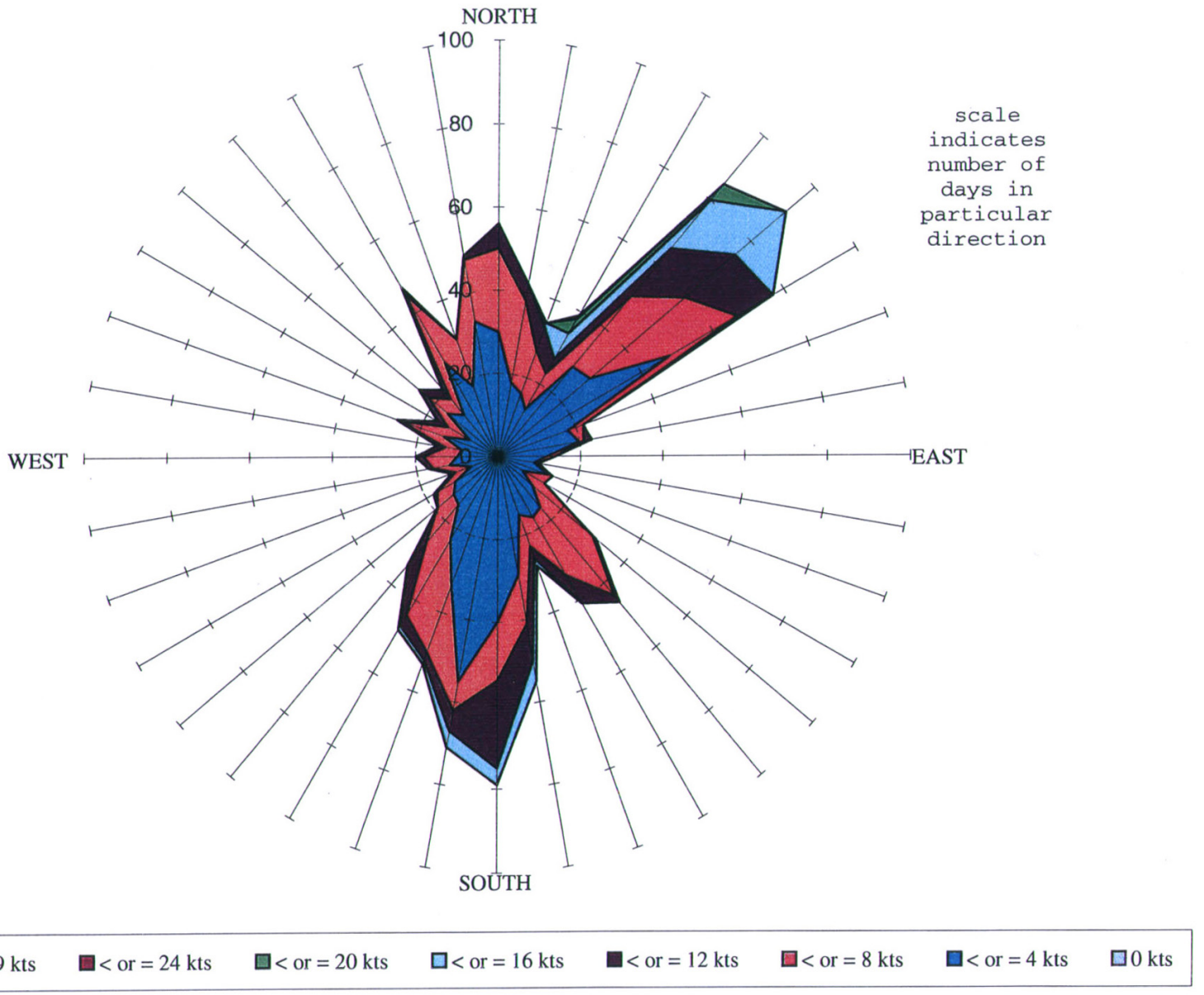


Figure C6: Time History at Cherry Lane, 2.6km from Gatwick Airport

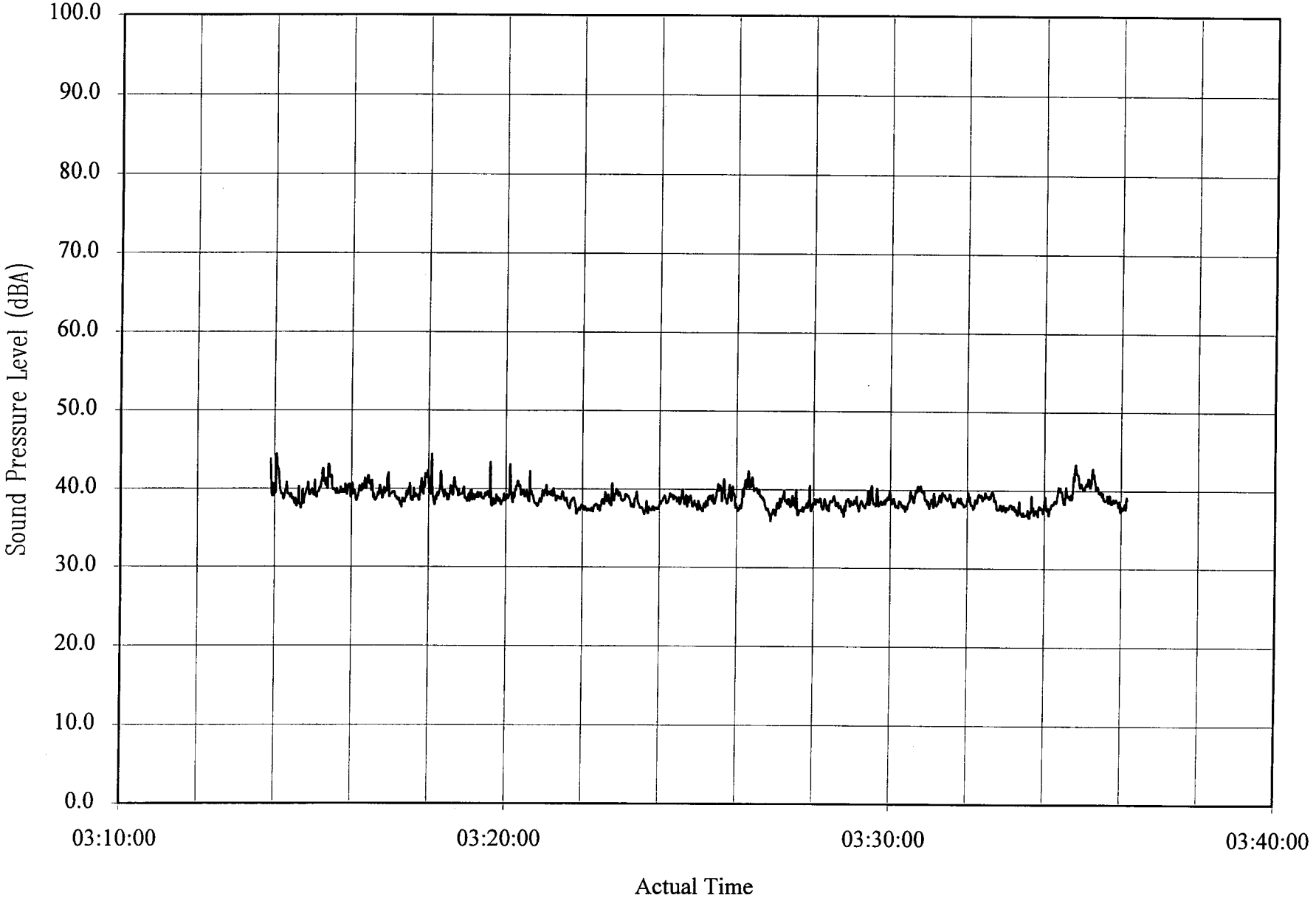
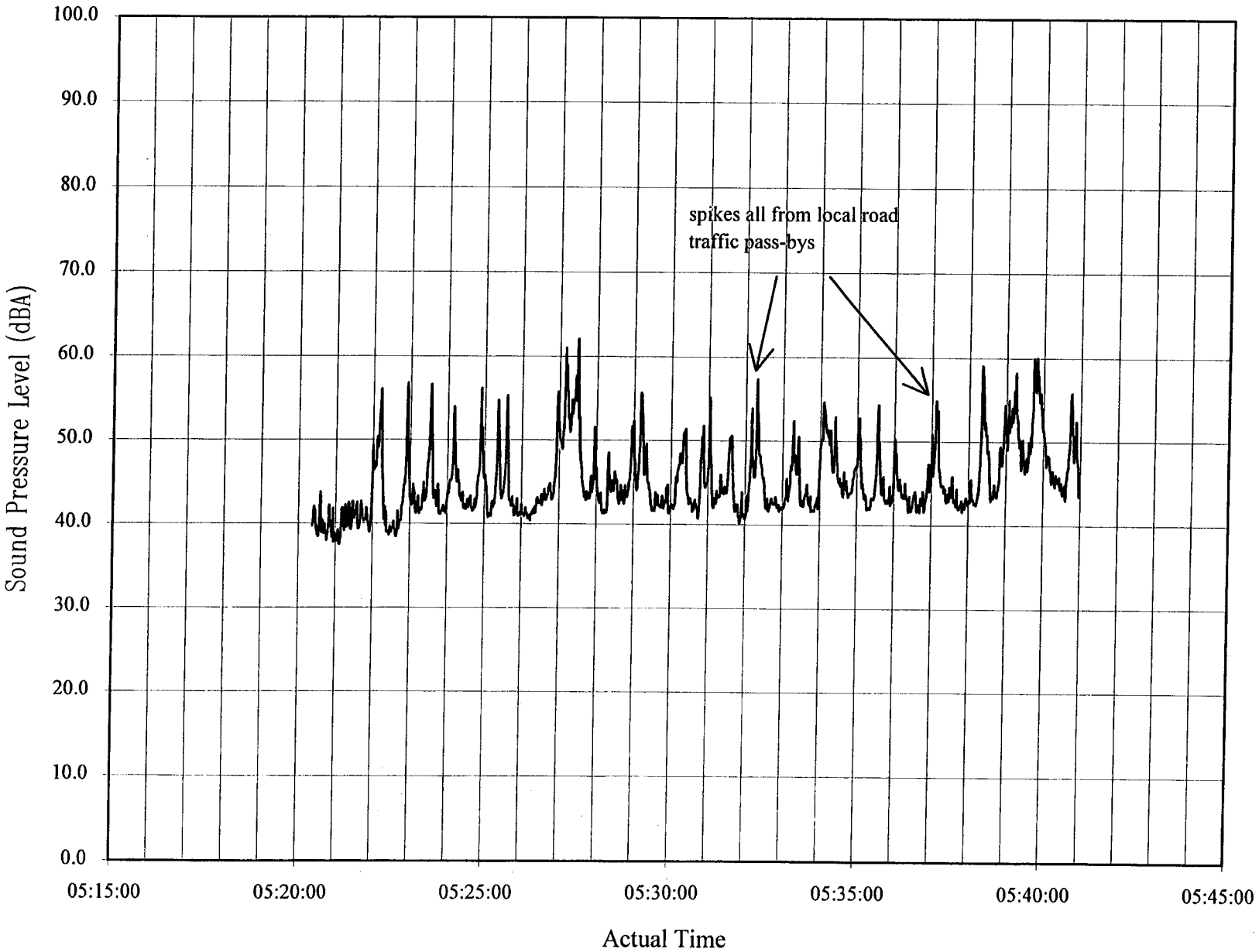


Figure C7: Time History at Rusper Road Playing Field, 4.6km from Gatwick Airport



APPENDIX D

STANSTED - PHASE 1 ASSESSMENT OF NIGHT-TIME GROUND NOISE

On-Airport Observations

D.1 The new BAA Fire Station watch tower located opposite the A Apron (at the southern end of the main terminal area) was used to observe airside operations from a height of around 7m, see Figure D1. This point offered unobstructed views of most of the A Apron, the runway and taxiways and the southern side of the Business Aviation Terminal. The B and C Aprons were obscured from view.

D.2 The main terminal area on the southern side of the runway forms the focus for ground noise at the airport. The General Aviation Terminal and the FLS maintenance hangar are other possible sources of noise. A description of the general observations of noisy activities on the airport is given below.

D.3 Main terminal area: The majority of activity takes place in the main terminal area, which consequently is the principal source of ground noise at Stansted. The most important component of the ground noise is associated with aircraft movements throughout the night; the taxi noise associated with arriving, departing and repositioning aircraft often masks plant and GPU noise.

D.4 For much of the night cargo traffic operates to and from the A Apron, adjacent to the Phase 1 monitoring point. Cargo movements were steady throughout the night period. Noise in the early part of the night (between 2300 and 0200 hours) was dominated by turboprop movements in and out of the cargo area, as well as some turboprops taxiing under their own power to re-position around the airport. High noise levels were produced by the turbo-prop aircraft running engines on stand prior to departure and taxiing. Apron A is a cul-de-sac and the aircraft queuing to gain access to, and egress from, the apron caused high noise levels for prolonged periods.

D.5 In the period between 0400 and 0600 hours movements were predominantly jet aircraft, most commonly BAe 146 type. These aircraft typically kept their APUs running for the whole period at the stands on the A-Apron, despite the existence of FEGP links on the apron. This use of APUs produced a significant noise which might be expected to propagate into local communities; the ‘A’ stands used by cargo aircraft are relatively unshielded by the terminal buildings and airbridges.

D.6 The shuttling of cargo in pallets for the BAe 146 aircraft was very noisy. When the rest of the airport is free from movements this noise - which has a

significant impulsive component - would probably be audible in surrounding communities where the background noise levels are very low.

D.7 APUs were commonly used on the stands and while aircraft were under tow to and from the apron areas. No GPUs were seen in use on the 'A' Apron, although a low frequency rumble audible throughout the night period suggested that they were in use in parts of the terminal obscured from view. On a previous airside visit GPUs were seen in use on the C apron, where APUs were also run during aircraft maintenance.

D.8 Low frequency plant-type noise was audible. This could have been generated in the terminal buildings, but could also have been due to GPUs running on the aprons. It was difficult to identifying such noise sources as they were often masked by noise from APUs or aircraft movements.

D.9 General Aviation Terminal: This area, in the northwest of the airfield, was predominantly quiet during the monitoring period, although a previous visit had shown that there is a large maintenance hangar in this area. The hangar was out of site of the observation point, but aircraft were seen being towed towards the area. The previous visit to this area identified tonal compressor-type noise emanating from this hangar. This type of tonal noise is likely to be audible in surrounding communities.

D.10 FLS maintenance hangar: This building on the southern side of the airport was illuminated during the observation period, suggesting activity inside and therefore a further possible noise source.

Standing Instructions

D.11 BAA Director's Notices 11/91, 14/91 and 9/95 provide guidance on the use of APUs, GPUs, FEGP and the ground running of engines for maintenance. The guidance notes for use of APUs, GPUs and FEGP do not specifically mention the night-time period but generally require that the noise from APUs is reduced as far as possible; the use of APUs, GPUs and FEGP being restricted to the minimum necessary for the operation of aircraft. For certain aircraft types, the directive covering ground running of engines confines this operation to the daytime period (0700-2300 hours), except in cases where there are urgent operational reasons for a run. However, engine running during the night-time period can be undertaken in exceptional circumstances for:

a) Propeller driven aircraft.

b) High bypass turbojets at low power.

c) Muffled runs.

d) Start/stop procedures.

D.12 The directive recommends that these operations are conducted, when possible, in the FLS Aerospace muffler area located to the south of runway 23, near block 52.

Observations

D.13 A single visit airside found that maintenance was taking place on jet aircraft positioned on the C apron stands. This maintenance included the running of APUs and the ground running of engines; it was not known whether the work was being conducted 'in exceptional circumstances' or why the FLS muffler was not being used.

Community Measurements and Observations

Population Counts

D.14 Figure D2 shows the segment lines drawn through the area around Stansted. The OS co-ordinates of the chosen reference point for Stansted Airport are TL 554600, 223600. This corresponds to a position roughly midway between Apron A and the runway as shown in Figure D2. Figure D3 gives the population counts for each segment. The Figures illustrate clearly the far lower population surrounding Stansted as compared with Gatwick and Heathrow. The most significant segments here are: the SE-S segment (including Takeley); the W-NW segment (Stansted Mountfitchet); the NW-N segment (Elsenham), and the SW-W segment that includes the edge of Bishop's Stortford, which extends from a distance of 4.5 km outwards.

Wind Conditions

D.15 The wind data represented in Figure D4 shows the predominant wind to be a southwesterly, with other directions relatively evenly distributed. Figure D5 shows the August '95 to March '96 data which does not show the same southwesterly predominance, the biggest single component being a south-southeasterly.

Observations and Measurements In Each Segment

D.16 The observations and measurements at Stansted were made over two nights in the presence of light northeasterly, light northwesterly and still wind conditions.

N-NE

D.17 Because no population clusters were apparent in this segment no measurements or observations were made. However, given the paucity of roads and other sources of noise, ground noise might be expected to be relatively clearly audible.

NE-E

D.18 A small community exists in this segment at Molehill, approximately 2.2 km from the reference point. An earth bund at the edge of the airfield appeared to afford some degree of protection from airport noise, though precisely how much was not determined. The site was visited when the prevailing wind was a light northwesterly, and the airport was only faintly audible. The plot shown in Figure D6 shows the sound pressure level time history at the time of the visit and reveals an extremely low background level (L_{90}=32 dBA)[17]. No specific aircraft movements were reported on the Air Traffic Control (ATC) radio at the time.

D.19 Given the low ambient background level it might be expected that propeller planes taxiing would be audible at this site, especially with a southwesterly wind. However, given this site's proximity to the roads serving the south side of the airport, it also seems likely that a significant source of airport noise is airport-related road traffic such as shift workers arriving and departing.

E-SE

D.20 Coopers Villas, a small group of houses, lies within this segment at 1.2 km from the reference point. Noise from the airport is clearly audible here, the most significant of which is that produced by taxiing turboprop aircraft. In the presence of a light northwesterly wind a maximum level of 74 dBA was measured at the front of the houses (which face away from the airfield) for one such aircraft taxiing out of Apron A. The significance of such a level in comparison to the background is highlighted by Figure D7 which shows measurements made while no activity was reported on the ATC radio (L_{90}=39 dBA). During these measurements the airport was still audible as a general mix of APU, GPU and plant noise. The highly significant road traffic pass-bys shown on the plot are also likely to be associated with the airport since the nearby road connects the A120 with the southern airport entrance.

[17] The term 'background' is used in this paper to indicate the residual noise present when no particular source was perceived to dominate the noise environment. L_{A90} is the A-weighted sound pressure level exceeded for 90% of the duration (here typically 15 minutes) of the measurement.

D.21 In the presence of a light northeasterly breeze there was still significant airport noise at this site. Engine noise produced 46 dBA and taxiing for departure 56 dBA compared with an ambient background level of around 27 dBA.

SE-S

D.22 The village of Takeley lies within this segment at a distance of around 2.5 km from the reference. With a light northwesterly wind general airport ground noise is clearly audible, and Figure D8 (showing measurements made under this wind condition) shows the significant protrusion of taxiing noise above the background. The background itself comprises a significant degree of non-specific ground noise and local road traffic noise.

D.23 In the presence of a light northeasterly breeze the background level was extremely low (L_{90}=23 dBA), comprising mainly noise from the A120. In a light northwesterly the L_{90} was 40 dBA. A turboprop engine run-up (34 dBA) and taxiing were clearly audible. It seems probable that a significant degree of the road traffic on the A120 would be airport related, with some turning north off the A120 through Takeley to the south side of the airport.

S-SW

D.24 A few houses lie in this segment along the A120. Airport ground noise was audible adjacent to the A120 in both light northeasterly and northwesterly winds, although the most significant source is the A120 itself, with noise from the M11 also audible. Thus, although turboprop taxiing is likely to be clearly audible, the road traffic on the A120 is likely to make by far the greatest contribution to the noise environment.

SW-W

D.25 The village of Birchanger lies approximately 3.5 km from the reference point. The eastern edge of Bishop's Stortford nearly 5 km, from the reference point. The M11 motorway runs between these populated areas and the airport, and thus an easterly wind component is likely to increase both the levels of airport and M11 noise in these communities. The M11 noise was observed to significantly mask the general airport noise, in part because its concrete surface leads to a tonal road traffic noise character not unlike APU noise. The rail link from London to Stansted does not run through Bishop's Stortford between about 2335 and 0535 hours and so can be disregarded as far as night-time ground noise is concerned.

D.26 The built-up nature of Bishop's Stortford means that much of the housing is protected from airport noise by intervening housing which acts as a noise barrier. At a distance of 5 km and further the noise environment is likely to be dominated by local road traffic noise. However, taxiing noise was clearly

audible in the presence of a light north-northwesterly breeze just outside Birchanger at a distance of 4.1 km, although the background appeared to be dominated by M11 noise.

D.27 Some additional observations were made east of the M11 at the long stay car park (2.1 km) where both general ground noise and turboprop taxiing noise were clearly heard over the M11 noise in windless conditions.

W-NW

D.28 At Burton Bury (1.9 km), whilst the M11 dominated the background, the airport was clearly audible even with a northwesterly breeze.

D.29 The town of Stansted Mountfitchet lies approximately 3.5 km from the noise sources. As with Bishop's Stortford to the south, the M11 runs between the airport and the community and serves to mask a significant amount of the general airport noise. Taxiing manoeuvres were not heard within the town when known to be occurring on the airfield (light northeasterly and north-northwesterly breezes). Some degree of ground noise was marginally audible but the dominant source of noise within the town was local road traffic noise with local plant noise and noise from the M11 forming most of the background. It seems likely, given the open propagation path, that some turboprop taxiing would be audible at the eastern edge of the town, especially with an easterly wind component. However, the eastern edge is only 1 km or so from the M11 and this will undoubtedly dominate the background noise. As with Bishop's Stortford, the London to Stansted rail-link does not run through Stansted Mountfitchet during the night-time period.

NW-N

D.30 There is a small community at Tye Green, 1 km from the reference point, which is significantly exposed to the airport. With a light northeasterly breeze ground noise was clearly audible here, forming a background level of approximately 37 dBA, with aircraft movements and engine runs significantly higher (a propeller engine running produced 54 dBA). During a visit with a northwesterly breeze, no airport noise could be heard (an arriving aircraft could not be heard taxiing). During this visit the background level was defined purely by noise from the M11.

D.31 The village of Elsenham lies approximately 3 km from the noise sources. No ground noise was heard here with a light northeasterly breeze, the dominant background source was the M11 motorway less than a kilometre to the west. It seems likely that turboprop taxiing will be audible here, especially with a southeasterly wind, given the observations made at other sites of comparable distance.

References:

BAA Director's Notice 11/91: Restrictions On The Use Of High Mounted Tail Engines And Auxiliary Power Units, Issued 25 March 1991.

BAA Director's Notice 14/91: Aircraft fixed electrical ground power system, Issued 12 March 1991.

BAA Director's Notice 9/95: Ground Running Of Aircraft Engines For Maintenance, Issued 5 June 1995.

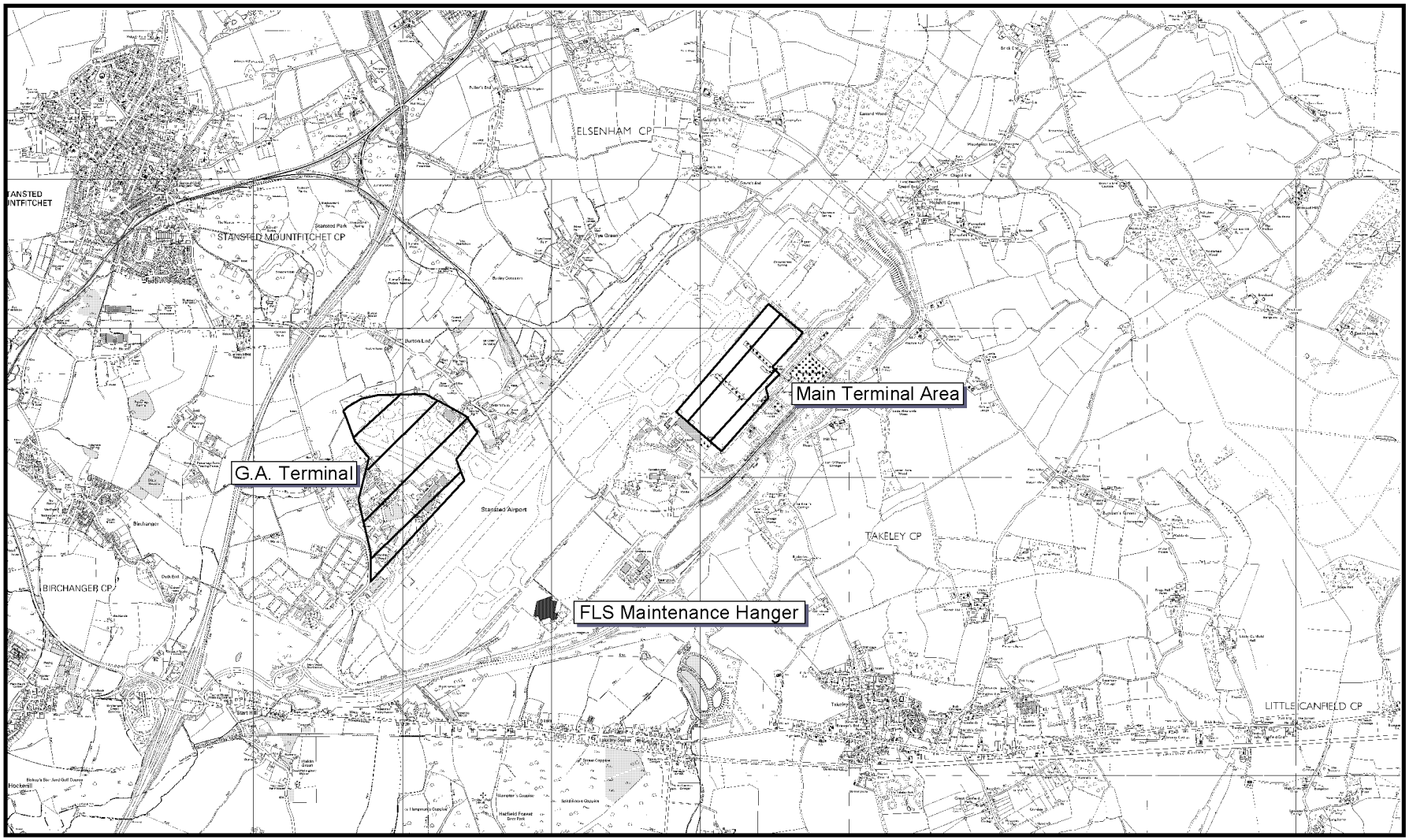


Figure D1: Stansted Site Plan

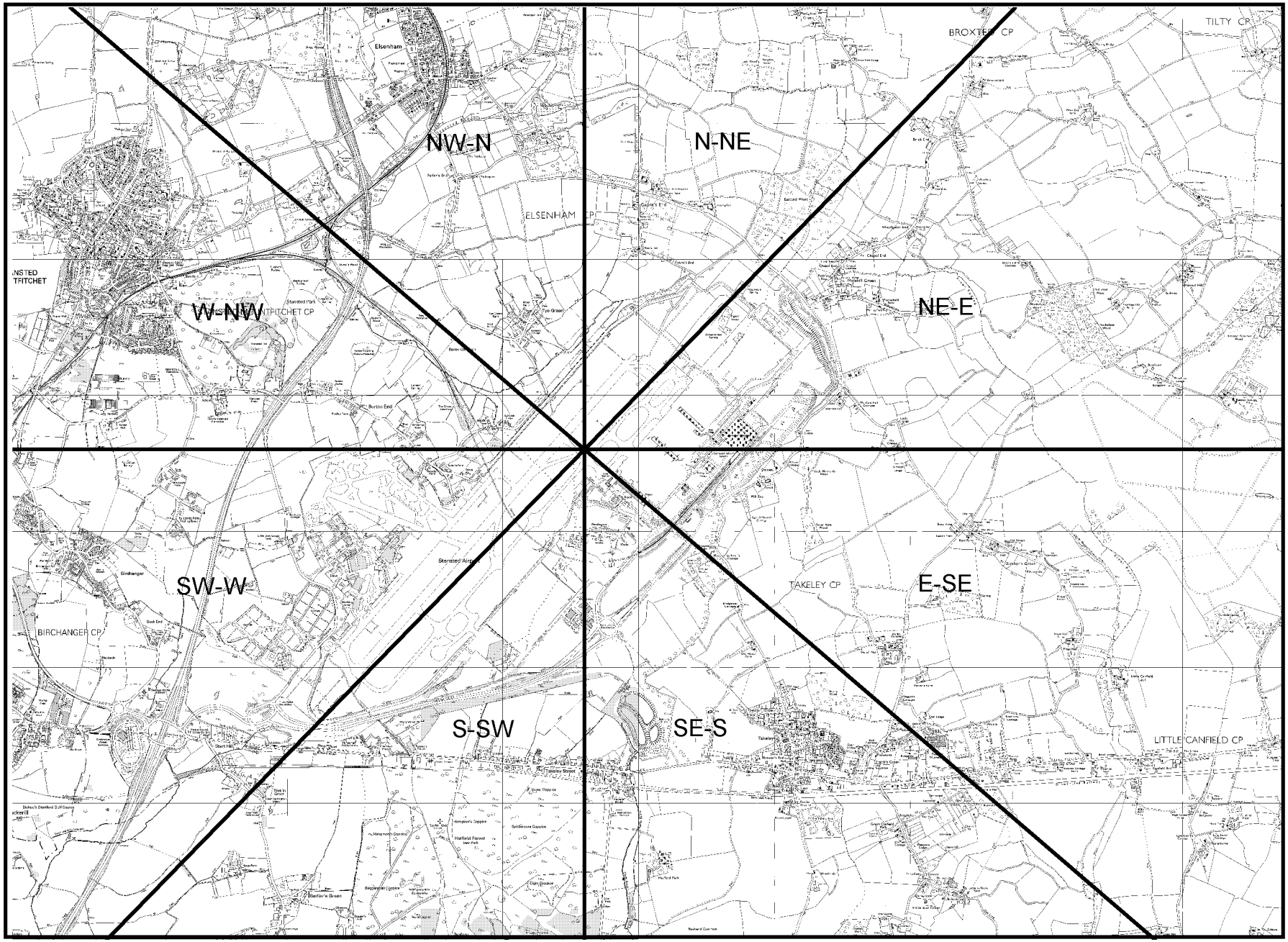


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Figure D2: Stansted Area Showing Reference Segments

Figure D3: Stansted Population Counts by Segment

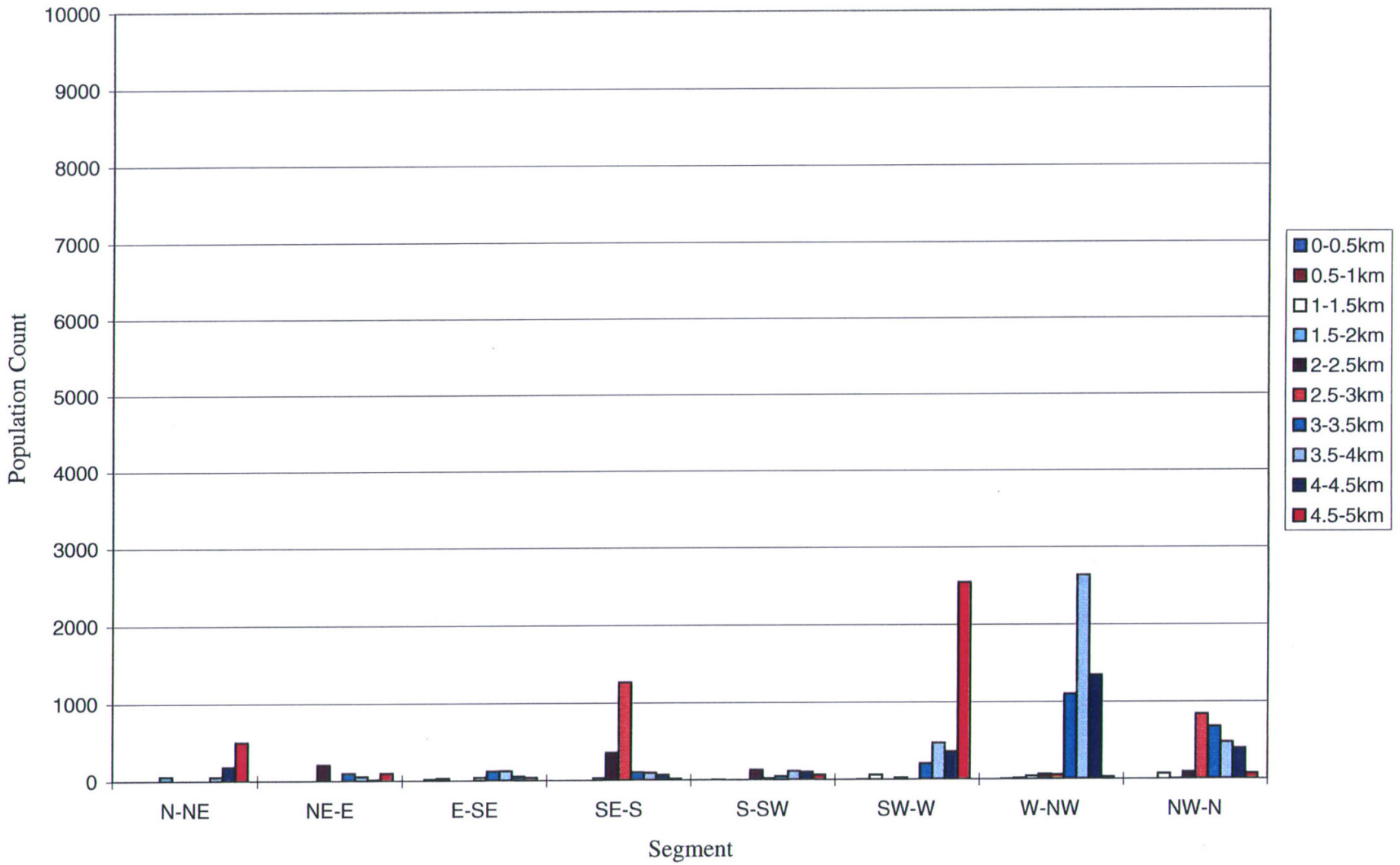


Figure D4: Stansted Wind Directivity 1/1/85 to 31/12/94

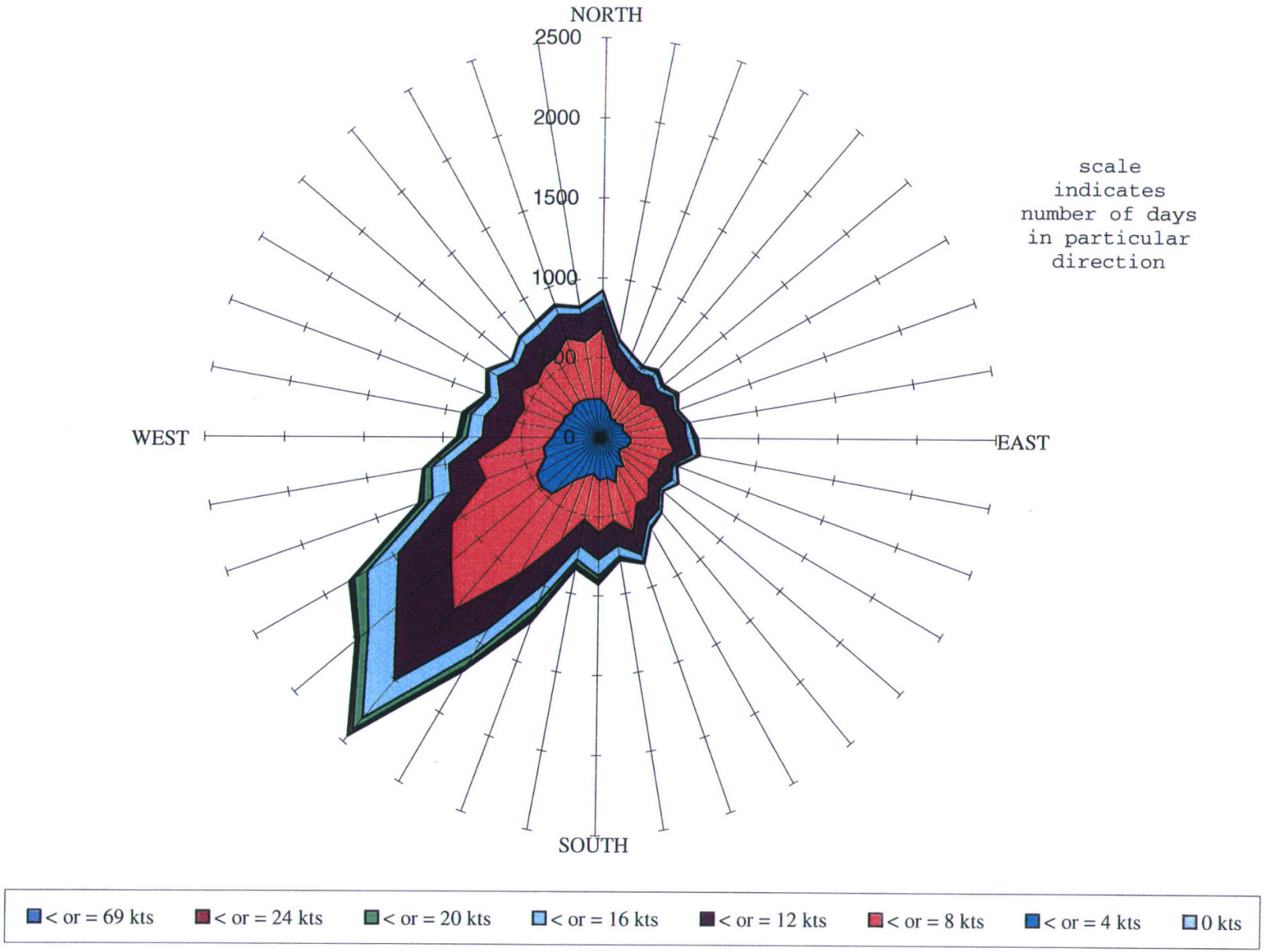


Figure D5: Stansted Wind Directivity 1/8/95 to 31/3/96

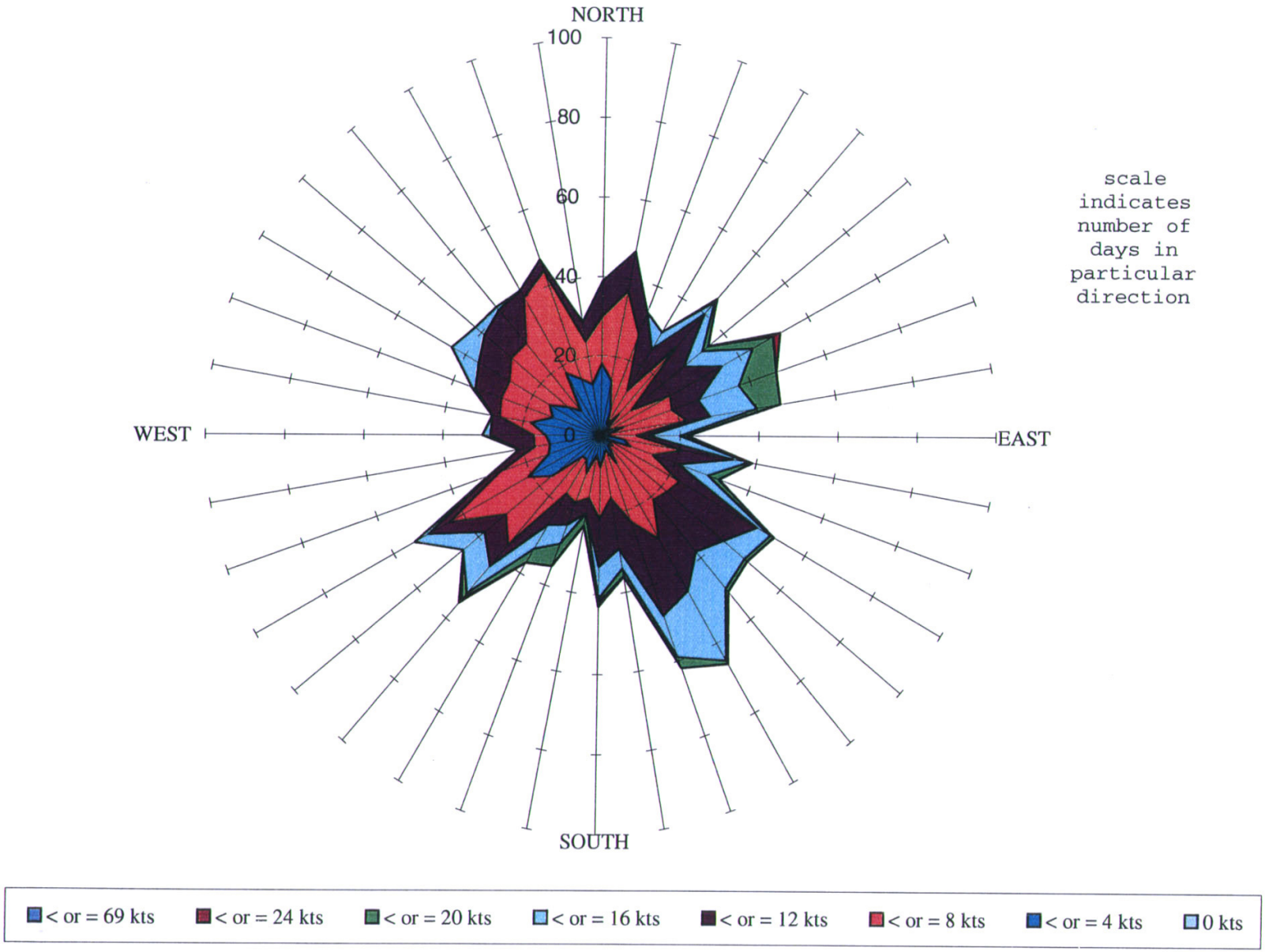


Figure D6: Time History at Mole Hill, 2.1km from Stansted Airport

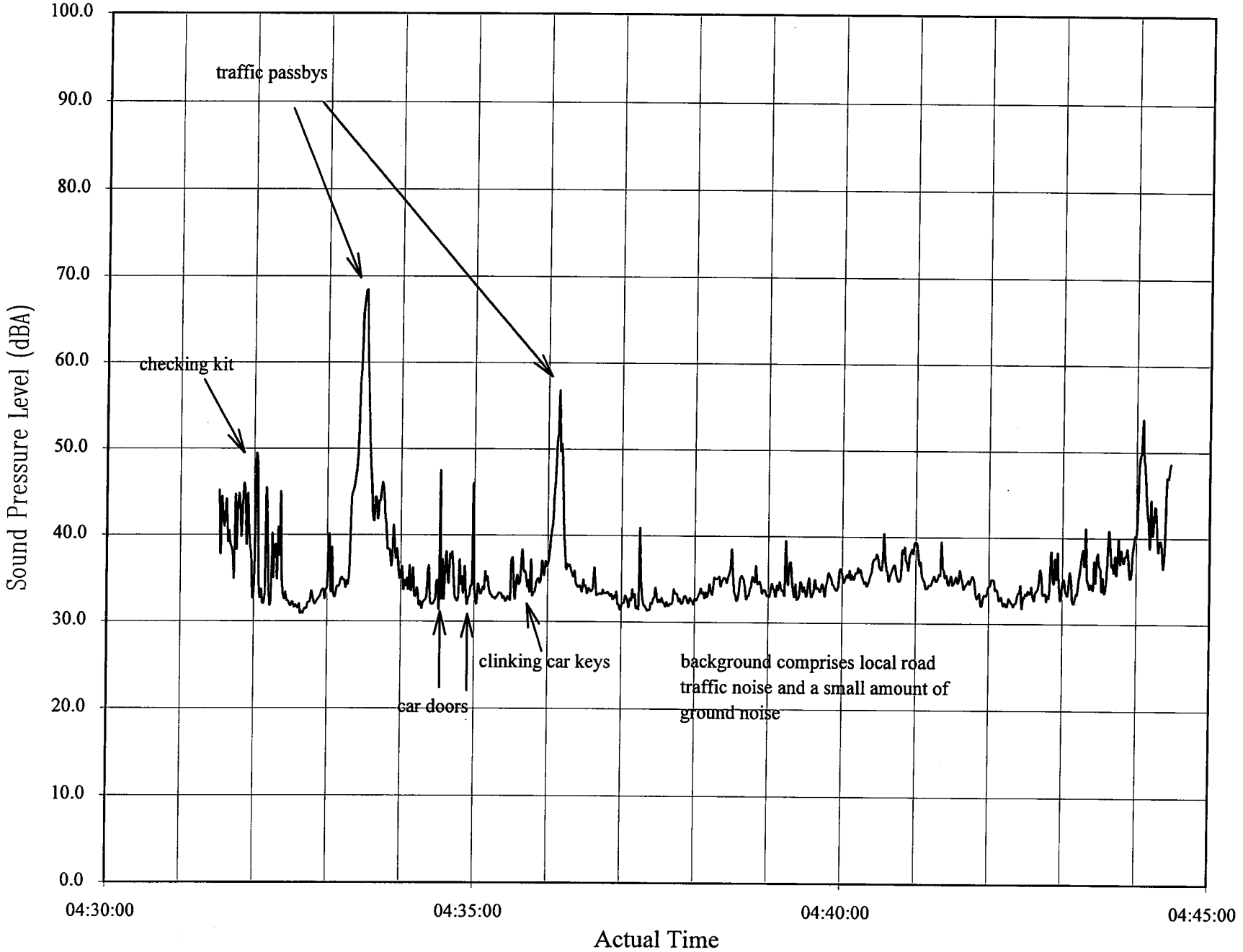


Figure D7: Time History at Coopers Villas, 1.2km from Stansted Airport

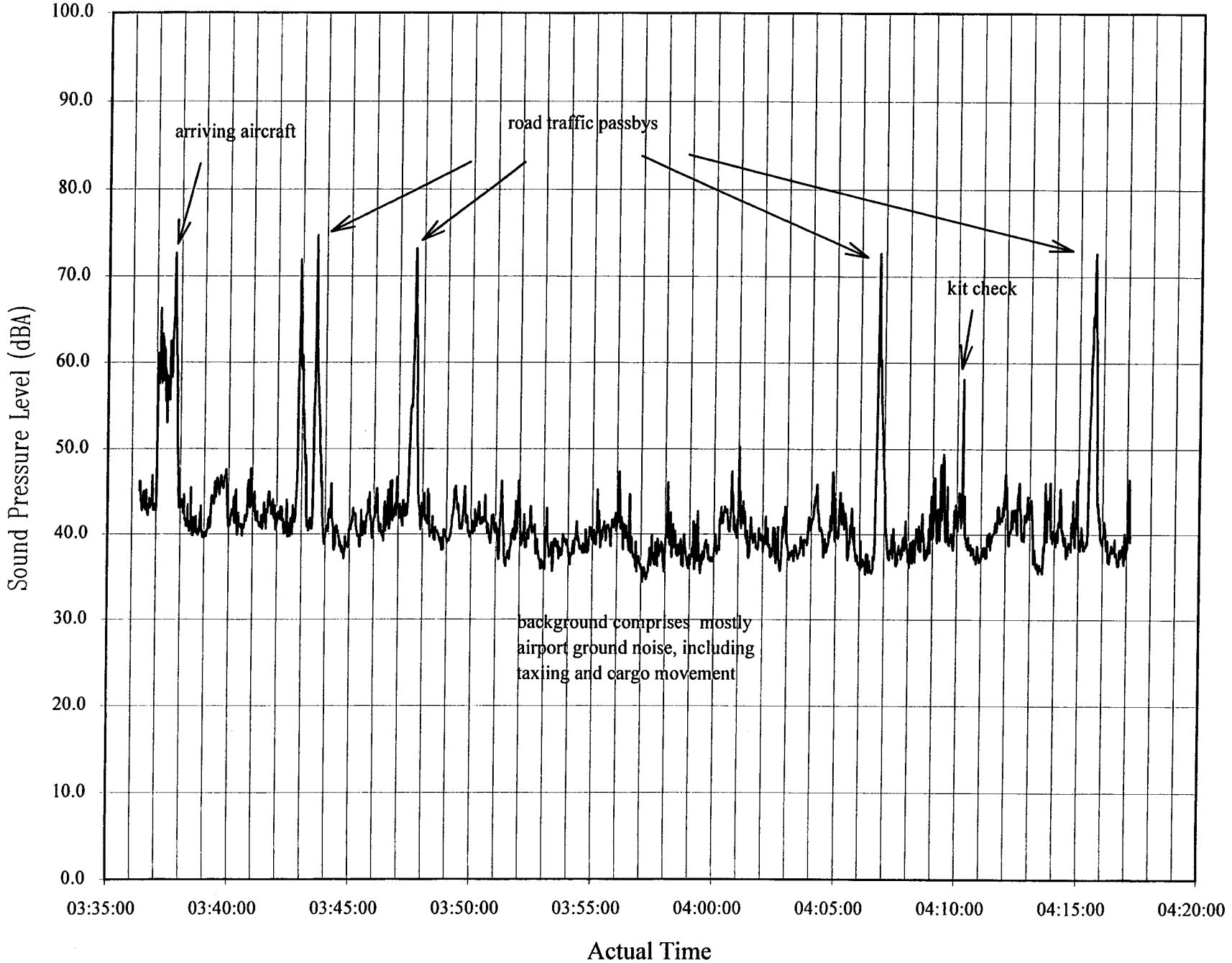
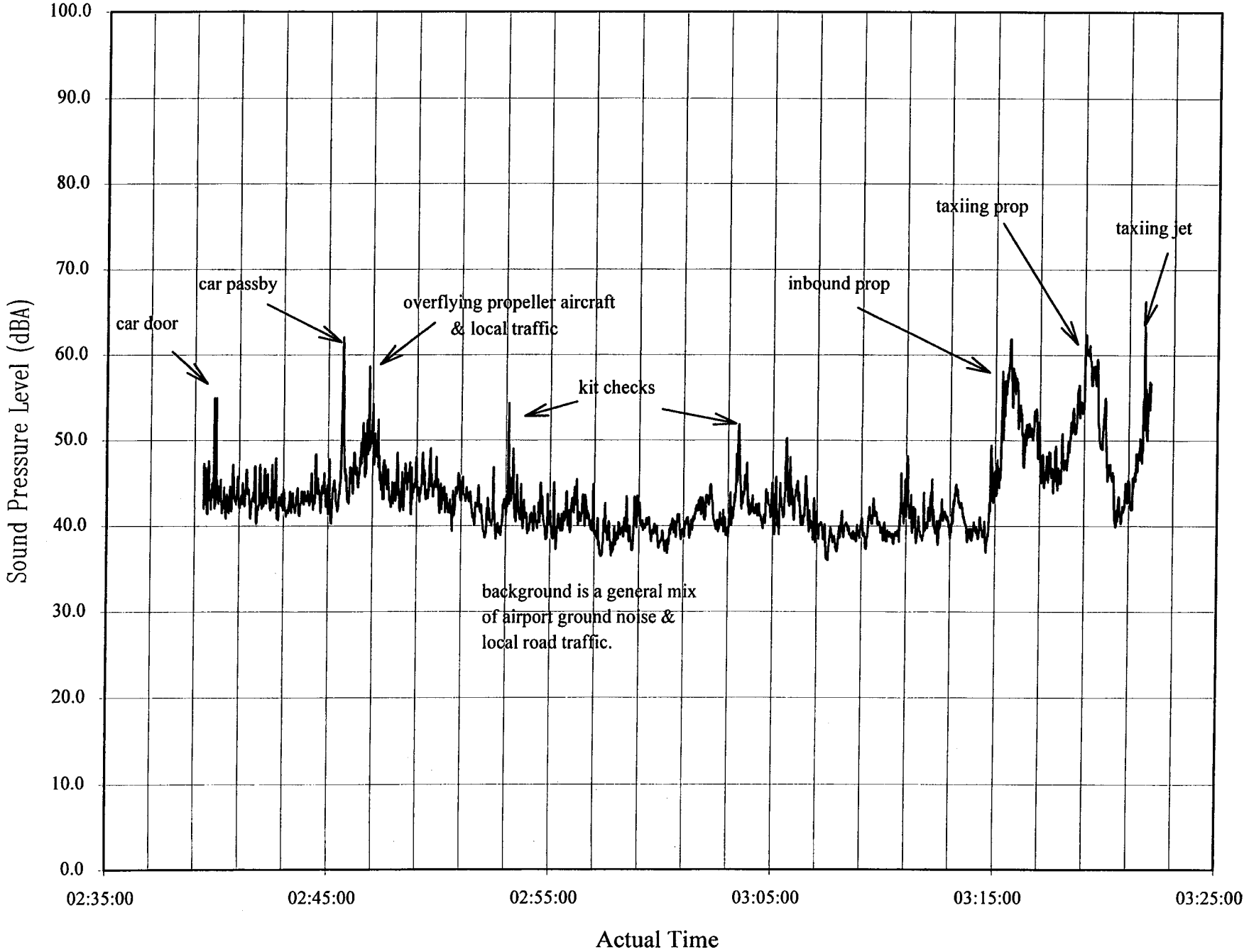


Figure D8: Time History at Takely Primary School, 2.6km from Stansted Airport



APPENDIX E

PHASE 2 - HEATHROW

Revised Standing Instructions

E.1 In February 1997 the BAA Operational Safety Instruction (OSI/62/93) relating to noise and ground operations was superseded by a revised set of instructions, OSI/10/97; which is reviewed below.

E.2 OSI/10/97 sets out procedures for engine ground running and check starts, the use of GPUs and APUs, requirements for airside construction works, Terminal 4 planning permission conditions and the use of reverse thrust in the night-time period. The declared aim of the procedures is to 'minimise the frequency and duration of ground noise generated by aircraft and associated equipment, consistent with aircraft safety requirements'.

Ground Running

E.3 All engine running is kept to a minimum in the night period (2300 to 0700) commensurate with the operator's next days operations. All engine runs in the night period require permission in advance from the Airfield Operations Safety Unit. All high power runs at night must take place in a ground running pen.

E.4 The maximum total ground running time between 2300 and 0700 on a single night must not exceed 150 minutes; the maximum time for high power running must not exceed 60 minutes on any one night or exceed a rolling 30 day average of 20 minutes.

GPU Use

E.5 HAL seeks to encourage the use of new quieter GPU models. Where FEGP is available, GPUs should not be used. Use of a GPU at a stand with serviceable FEGP will incur a surcharge to the operator of £500. When GPUs are used they should be shut down promptly after use. GPUs used between 2330 and 0600 must conform to IATA noise criteria (Airport Handling Manual 910: 85 dB at 4.6 m from the perimeter of the equipment at a height of 1.5 m from the ground). If a company is found using a GPU between 2330 and 0600 that does not conform to IATA standards, on a stand with serviceable FEGP they will incur a surcharge of £1000.

E.6 All new or replacement GPUs must meet the IATA standard; all existing mobile equipment must meet the standard by 1 January 1999.

APU Use

E.7 APUs are not to be used as a substitute for FEGP or GPUs at any time and must be shut down at the earliest possible opportunity on arrival at a stand. The APU may only be restarted for essential cabin checks or for a planned departure. No APUs are to be used in the cargo area or on Terminal 4 (except on the T Apron, or in an emergency) between 2330 and 0600.

Airside Construction Works

E.8 HAL will ensure that all companies are aware of the requirements of the Environmental Protection Act 1990 that apply at Heathrow airport and will ensure that all local instructions are adhered to.

Terminal 4

E.9 No aircraft maintenance work that involves the running of aircraft engines is to be undertaken on the Terminal 4 site at any time. Noise levels from Terminal 4 are monitored from outside of the airport at certain times.

Target Areas

Longford

E.10 Situated to the northwest of the airport, Longford is immediately adjacent to the airfield perimeter 2.5 km from the Central terminal area (CTA). When the target area was downwind of the airport, taxi noise from early morning arrivals defined the background environment, over 60 percent of ground noise events heard at Longford were taxiing aircraft. Over the three nights monitored at Longford, three ground runs were heard, only one having a significant effect on the noise level, raising it by 5 dBA. A handful of other ground noise events were noted at Longford, occasional APU noise was audible, as were airside vehicles; these sources had little effect on the overall noise level. In the absence of airport ground noise road traffic on the A4 and local roads dominated the background noise environment. When Longford was upwind of the airport, no ground noise was audible and the background noise environment was defined by road traffic on the A4 and M25.

Harlington

E.11 Harlington is located to the north of the airport between the M4 and A4, 1.7 km from the CTA. The noise environment in Harlington was heavily dominated by road traffic on the M4 and A4. When the airport was audible it was often a non-specific ‘drone’ which could be heard. Sirens from the maintenance area were audible at this site on 13 occasions over the three nights when DORA staff were in attendance. Seven engine runs were audible

at this site in Phase 2, but only two of those had a significant impact on the background noise level (an elevation of between 5 and 10 dBA). From 0400 hours onwards, taxi noise from early morning arrivals was clearly discernible above the general background of road traffic noise, taxiing accounted for over half of the noted ground noise events.

Waye Avenue Area

E.12 The monitoring sites in the Waye Avenue area are located between 2.5 and 3 km to the east of the CTA and between 0.5 and 0.9 km from the maintenance area. A total of six visits were made to the sites in the Waye Avenue area during Phase 2. In southerly and westerly wind conditions, airport ground noise was frequently heard at the monitoring sites around the Waye Avenue area. Due to the proximity of the maintenance area, the following ground noise sources were audible at the Waye Avenue area sites:

a) ground running aircraft in the running pens,

b) APU noise from aircraft on the maintenance aprons and,

c) sirens from the hanger doors and airside vehicles.

E.13 Six ground runs were audible during the visits made to this area, most were not measurable. Two of the runs increased the noise level in the locality by between 10 and 15 dBA; runs in the maintenance area were more audible at these sites than runs on the CTA. The tonal characteristics of the APU noise meant that while the noise was audible, the overall sound pressure levels did not significantly rise above the background level. The noise from nearby road traffic (on the A4, A312 and A30), which was broadband in nature, usually dominated the background environment. Just over 40 percent of ground noise events in the Waye Avenue area were taxi noise from early morning arrivals. One third of all arrivals heard at this site used reverse thrust.

Cains Lane Area

E.14 Situated on the southern side of the airport, the monitoring sites in the Cains Lane area are between 2 and 2.9 km from the CTA and between 0.7 and 1.5 km from Terminal 4. The area was visited on seven occasions during Phase 2. Ground noise sources heard at these sites included ground running and taxiing aircraft, APUs and sirens from the maintenance area. On occasions when APU noise was heard it was thought to come from the maintenance area. Terminal 4 was generally inaudible, probably due to noise attenuation by a noise barrier situated between the terminal and the Cains Lane area. The noise from road traffic on the A30 was constantly audible in the background and could have masked noise from Terminal 4. Road construction works were operating close to the No. 1 maintenance area throughout the monitoring

sessions in the Cains Lane area. On most nights this was clearly audible, probably masking any low level ground noise. As with all the other monitoring sites, taxi noise from early morning arrivals (0400 hours onwards) contributed significantly to the background environment. Reverse thrust was especially apparent, with over half of all the noted arrivals heard using it.

Stanwell

E.15 Stanwell is situated 2 km south of the CTA between the A30 and Southern Perimeter Road. One night of measurements was made at Stanwell where the dominant source of airport ground noise heard (from approximately 0400 hours onwards) was the taxiing of aircraft having arrived on runway 27L. For much of the rest of the night-time period, road traffic dominated the general background noise environment, including contributions from heavy goods vehicles in the area around the cargo terminal. Very little other ground noise was heard, possibly due to masking by machinery noise from a rail-link construction site near the cargo terminal area. The rail-link construction machinery noise was clearly audible for most of the night, occasionally comparable in level to the road traffic noise.

APPENDIX F

PHASE 2 - GATWICK

Revised Standing Instructions

F.1 In March 1996 The BAA Managing Director's Instructions (36/92, 27/94 and 2/95) relating to ground operations at Gatwick were superseded by MDI/7/96; which is reviewed here.

F.2 MDI/7/96 sets out procedures for engine ground running, the use of GPUs and APUs, and North Terminal planning conditions.

Ground Running

F.3 Forward planning of maintenance tasks should be used to reduce the requirement for ground running at night (2200 to 0700). Unmuffled high power running is not permitted, except by high by-pass ratio engines at low maximum thrust levels; only one engine may be run at a time.

F.4 Unmuffled flight idle power running of high by-pass engines may be permitted for pressing operational reasons; unmuffled running for any other engine types is not permitted. Muffled engine running will only be permitted for urgent reasons. Start-stop engine testing may be permitted, but will be restricted to areas away from the North Terminal except in an emergency.

F.5 Turboprop aircraft are subject to the same conditions as jet aircraft, however engine running may be permitted between 0600 - 0700 and 2200 - 2300.

GPU and APU Use

F.6 The instruction requires that operators be aware of noise impact upon the local community when acquiring new ground service equipment. The use of GPUs that do not comply with EEC Standards for noise suppression (85 dBA at 7 m) is prohibited at Gatwick.

F.7 APU use should be minimised, in particular APUs should be shut down on arrival as soon as FEGP is available and passengers have disembarked. APUs should not be restarted until 45 minutes prior to planned departure, except in exceptional circumstances with permission from the Operations Duty Manager.

North Terminal Restrictions

F.8 Unless an emergency situation prevails the following restrictions apply:

a) On stands 53-63 no APUs are to be operated and no 'start-stop' testing to be carried out between 2300 and 0700.

b) In addition to the above conditions aircraft using stands 64 to 68 are limited to tow on tow off operations between 2300 and 0700.

Target Areas

Charlwood

F.9 The village of Charlwood is located 3 km west of the terminal buildings at Gatwick and was visited on two occasions during Phase 2. The dominant source of ground noise in Charlwood was the taxiing of aircraft, which accounted for 80 percent of all the noted ground noise events at the site. In upwind conditions, ground noise from the airport could not be heard and road traffic noise was minimal because there are few large roads nearby, resulting in a very low background level, often in the range 30 - 35 dBA. With an easterly wind the site was both downwind of the airport and the M23 and A23; in these conditions airport ground noise and road traffic were both clearly audible with the road traffic noise occasionally masking airport ground noise.

Povey Cross

F.10 Povey Cross situated 0.7 km north of the terminal buildings, was visited three times during Phase 2 (monitoring was started on a fourth night but stopped when the wind changed direction). At this site the major source of ground noise, accounting for nearly 70 percent of the noted ground noise events, was aircraft taxiing to and from the terminal stands. Road traffic noise from the nearby A23 and A217 was regularly audible, often masking airport ground noise. During the 3 nights of monitoring at Povey Cross, 19 engine start-ups on the nearby aprons were heard, although few were measurable above the ambient noise level. General plant noise from the airport was audible for long periods on monitoring nights but never significantly louder than the background of road traffic on the A23 and A217.

South Horley

F.11 South Horley is located 1 km north east of the terminal buildings; the A23 lies between South Horley and the airport. The site was visited on four occasions but monitoring was suspended on one night due to a change in wind direction. With a southwesterly wind, airport ground noise was frequently audible around the Horley area, although at times masked by road traffic noise from

the A23. Taxiing aircraft and engine start-ups accounted for 80 percent of the total number of noted ground noise events. In upwind and no wind conditions, airport ground noise was significantly less audible but a few louder taxiing movements could still be heard.

Cherry Lane Area

F.12 Sites in the Cherry Lane area were visited on seven occasions during Phase 2. The area is situated 3.5 km southwest of the terminal buildings and is separated from the airfield by a area of flat grass land. Under northerly wind conditions, airport ground noise clearly propagates into the Cherry Lane communities in the absence of any intervening obstacles. A non specific airport drone, possibly due to APUs or GPUs running in the maintenance area or cargo terminal, was frequently audible, although not measurable as the sound heard was often tonal in character. Taxi noise was always clearly audible accounting for just under 80 percent of noted ground noise events. Taxi noise appeared, to a certain extent, unaffected by variations in wind direction, although if taxiing was audible in upwind conditions it was at lower levels.

APPENDIX G

PHASE 2 - STANSTED

Standing Instructions

G.1 BAA Director's Notices 11/91, 14/91 and 9/95 provide guidance on the use of APUs, GPUs, FEGP and the ground running of engines for maintenance at Stansted. The guidance notes for use of APUs, GPUs and FEGP do not specifically mention the night-time period but generally require that the noise from APUs is reduced as far as possible; the use of APUs, GPUs and FEGP being restricted to the minimum necessary for the operation of aircraft. For certain aircraft types, the directive covering ground running of engines confines this operation to the daytime period (0700-2300 hours), except in cases where there are urgent operational reasons for a run. However, engine running during the night-time period can be undertaken in exceptional circumstances for:

a) Propeller driven aircraft.

b) High bypass turbojets at low power.

c) Muffled runs.

d) Start/stop procedures.

G.2 The directive recommends that these operations are conducted, where ever possible, in the FLS Aerospace muffler area located to the south of runway 23, near block 52.

Target Areas

Tye Green

G.3 The small community at Tye Green, located 1 km northwest of the main apron area at Stansted, was visited on six occasions. In westerly wind conditions, the major source of ground noise audible in Tye Green was the taxiing noise from aircraft moving around the airfield (over 80 percent of the noted ground noise events were taxiing aircraft). Other ground noise sources audible at the site included engines starting up, APUs, airside vehicles and sirens. However, in downwind conditions, airport plant noise and the drone of APUs regularly defined the general noise environment, without having an impact on the overall sound level.

G.4 When aircraft were departing to the east on runway 05, taxiing became less audible as the aircraft were taxiing away from the monitoring point. In

upwind conditions the airport was generally quieter with no noise from APUs or GPUs audible and road traffic on the M11 dominated the background.

Molehill Green

G.5 Molehill Green is situated approximately 1.8 km to the northwest of the main apron area at Stansted. During the five nights of observations in Molehill Green, taxiing was frequently audible, accounting for 65 percent of the noted ground noise events. Engine running noise and APU noise formed a significant part of the general background at Molehill Green; on four occasions engines were heard running without an associated arrival or departure. The loudest run elevated the noise level in Molehill Green by 20 dBA; it was more common to experience running that was just audible but had little effect on the overall noise level. From 0500 hours onwards there was a considerable increase in the amount of local road traffic passing through Molehill Green, which often masked airport ground noise.

Takeley

G.6 The village of Takeley is situated 2 km south of the passenger terminal, adjacent to the A120. The neighbourhood was visited on seven occasions in Phase 2. With a northwesterly wind present, making the site downwind of the airport, taxiing noise was measured, in some instances at over 10 dBA above the background level. Tonal, non specific plant noise from the airport, although not measurable, was regularly audible as part of the general noise environment. Very little ground noise was audible in Takeley when the site was upwind of the airport, road traffic on the A120 was clearly audible and regularly dominated the background in upwind conditions.

Coopers Villas

G.7 The majority of the aircraft movements at Stansted in the night period are cargo operations concentrated around Apron A. The proximity of Coopers Villas to Apron A (less than 1 km) meant that noise from cargo aircraft running their engines and APUs was often audible, at times masking local road traffic passing 25 m away from the monitoring point. During the five nights in Phase 2 when DORA staff were in attendance at this site, 22 engine start-ups were heard. Taxiing formed a significant part of the audible ground noise, although to a lesser extent in upwind conditions. General plant noise from the airport buildings was also frequently heard as part of the background.

Bishop's Stortford

G.8 Bishop's Stortford is situated 6 km west of the main terminal area at Stansted Airport, the site was visited twice during Phase 2 monitoring. The M11 motorway runs between the town and the airport. With a northeasterly wind,

making the site downwind of the airport and the M11, the background was almost exclusively dominated by road traffic noise, from both the motorway and local roads. The road traffic noise was significant enough to mask any airport ground noise apart from intermittent engine noise from taxiing aircraft. On most occasions the effect of taxi noise on the noise level was marginal, typically causing an increase of 3 dBA above the background noise level, which was due to road traffic noise. Only 10 ground noise events were audible in the sixteen hours spent monitoring at Bishop's Stortford.

Birchanger

G.9 The village of Birchanger lies on the outskirts of Bishop's Stortford, 5 km west of the terminal building and separated from the airport by the M11. Birchanger was selected for snapshot measurements in Phase 2 because it was not visited in Phase 1. Ground noise was heard on arrival at the site and it was decided that a complete night of monitoring would be undertaken at the site, rather than undertake snapshot measurements.

G.10 The taxiing of jet and turboprop aircraft was the dominant source of airport noise during the single night of monitoring. Noise from traffic on the M11 was a significant source of noise throughout the night, often dominating the noise environment. Taxiing accounted for over 90 percent of the noted ground noise events during the night, generally raising the noise level by between 5 and 10 dBA. Tonal ground noise from APUs and GPUs was occasionally audible but frequently masked by road traffic on the M11 and rarely had a significant effect to on the overall noise level.