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Noise Data from the First Year of Scheduled Concorde Operations at Heathrow Airport - London

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Directorate of Operational Research and Analysis
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DORA Report 7703

CAA Paper 77007

Noise Data from the First Year of Scheduled Concorde Operations at Heathrow Airport - London

A Report prepared for the Department of Trade

SUMMARY

Noise, flight path and complaints data gathered at Heathrow during the first year of scheduled Concorde Operations are presented and some comparisons made with noise from other aircraft and with earlier Concorde endurance flights. Trends in the data have been examined and an assessment made of the effect of these operations on the noise exposure in the vicinity of Heathrow.

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CONTENTS

CONTENTS

CONTENTS

1 INTRODUCTION

1.1 Scheduled passenger flights by Concorde commenced at Heathrow on 21 January 1976. The initial service was operated by British Airways between London and Bahrain at a frequency of two round trips per week, and this service was maintained during the first four months. Operations to Washington started on 24 May 1976 at a frequency of two round trips per week, the Bahrain service being temporarily halved in frequency until the end of July. During August and September, the level of Concorde operations from Heathrow was four round trips per week, two to Bahrain and two to Washington. From early October one Bahrain trip was replaced by one to Washington and this weekly service - three round trips to Washington and one round trip to Bahrain - was maintained throughout the rest of the first year.

1.2 During these Concorde operations data concerning the noise levels received on the ground in the vicinity of the airport were gathered by the Civil Aviation Authority, using mobile equipment at a pattern of temporary measuring sites, and by the British Airports Authority using the official noise monitoring system. For many Concorde movements, a record of the flight path was derived from the radar system at London Air Traffic Control Centre.

1.3 This paper presents summaries of the noise and position data gathered during the first year of Concorde scheduled operations at Heathrow airport and examines some of the sources of variability within these data. It compares the noise of the Concorde scheduled flights with the noise made by other aircraft and with the noise made by Concorde during the 1975 pre-operational endurance trials. The data are also arranged to show possible trends, over this initial period, in Concorde noise levels and flight path. An assessment is given of Concorde's contribution to the noise exposure around Heathrow, during the three peak summer months, in terms of the Noise and Number Index.

1.4 This special programme of data collection during the first year of scheduled Concorde operations at Heathrow was carried out for the Department of Trade. During the final four months it was possible to reduce the rate of data collection without impairing the effectiveness of the survey, and at twelve months this special programmed ended. Noise data on Concorde will still be gathered from time-to-time as part of the CAA's general programme of noise studies for the Department of Trade. This report supersedes CAA Paper 76040, which presented the data gathered during the first eight months, and concludes this noise assessment.

2 DATA ACQUISITION

2.1 Noise data have been gathered from two sources - measurements made by Directorate of Operational Research & Analysis, CAA (DORA), at a number of temporary sites and measurements made by BAA at the

fixed sites of the permanent noise monitoring system. The positions of all sites are shown in Figures 1 and 2 and detailed in Table I. The temporary sites, on which mobile equipment was stationed, were initially situated under the expected flight paths and at distances of about 5, 10 and 30 km from start-of-roll on departure and 1.5 and 6.5 km from threshold on arrival. The arrival sites were later supplemented by some further away from the airport at distances of 12, 16 and 20 km from threshold and another departure site at 20 km from start-of-roll was brought into use. The fixed noise monitoring sites, which are permanent installations of the BAA, lie between the temporary 5 and 10 km departure sites. The fixed monitoring sites were also used to measure noise on arrival although only two sites to the east of the airport, F1 and F3, are under the landing glidepaths.

2.2 For each movement observed, three relevant temporary sites were usually manned and all the relevant fixed monitoring sites were activated, unless unserviceable. In addition to measuring the noise of the Concorde movement, the noise levels of a sample of other aircraft were measured for comparison, some before and some after the Concorde flyover, as far as accuracy of timing allowed. This synchronous sampling procedure was adopted to minimise the effect of varying meteorological conditions and to provide the comparison which might seem most apposite to people experiencing Concorde noise. The total sample of subsonic aircraft noise levels collected in this way is considered to be representative of the total traffic at the airport and it was gathered under similar meteorological conditions. The mean values are quite well established by the sizes of the samples and are considered to be mutually comparable, but the extreme values are those of the samples and should not be read as the extremes of the whole population from which the samples are drawn and which would naturally lie further out. The extremes of the samples are given as an indication of variability within the sample.

2.3 The DORA measurements were made using a precision sound level meter and tape recorder. The recordings were subsequently processed to give values of noise level in PNdB for each movement measured; for Concorde movements the PNdB value was based on octave band analysis and for other movements the value was estimated by the addition of a constant to the noise level in dB'A'. Durations at 10 dB below peak level were estimated for all movements measured and these data were later supplemented by durations above 90 PNdB where applicable.

2.4 Supporting data noted for each Concorde movement included the runway, route, weight, time of departure or arrival, temperature, humidity and wind speed and direction. The normal Standard Instrument Departure Clearances for Bahrain flights were Midhurst 20 and 22 (Woodley/Midhurst) on westerly operations and Seaford 37 (Ockham/Dunsfold) on easterly operations whilst arrivals from Bahrain were

normally routed via Biggin. For route proving purposes, two Bahrain flights (Nos 120 and 124) were routed out on Dover 26 and 28 (Epsom/Biggin) and in via Lambourne. Washington flights were routed on departure via Woodley on Brecon 26, 28 or 37 and on arrival via Woodley and Ockham. Outbound routes are shown by broken lines in Figures 5 et seq.

2.5 For most Concorde movements, data describing the actual path flown has been obtained from the secondary surveillance radar systems at the London Air Traffic Control Centre. From these data separate plots of ground track and climb or descent profiles are provided in Figures 5 - 18 for each movement observed.

2.6 Since the variability of noise levels under the approach path was much less than that under the departure path, noise measurements were not made for all arrivals. In particular, arrivals from Washington were not measured at the temporary sites since such measurements were not expected to differ from those obtained from Bahrain arrivals.

3 PRESENTATION OF DATA

3.1 In the first year of Concorde operations at Heathrow, 165 departures and 164 arrivals were scheduled to take place. Due to two cancellations and one flight which returned to Heathrow with mechanical trouble and departed later, 164 departures and 163 arrivals actually rate as Air Transport Movements and are included in this report. The pattern of Concorde operations at Heathrow airport during the year is given in Table II which shows the build-up of traffic to Bahrain and Washington and the Heathrow runway utilisation. For comparison, the corresponding data for all other fixed wing traffic at Heathrow is also given in this table.

3.2 The Concorde noise data are shown in Tables III (departures) and IV (arrivals) and summarised in Figure 3 (departures) and 4 (arrivals). For the purpose of these presentations, the data from corresponding mobile sites on different routes have been combined, even though the distances from the runway do not exactly correspond, and the noise level quoted for each movement at the fixed monitoring system is the highest level recorded at any site or sites during that movement.

3.3 The Concorde position or flight path data are presented in two ways. Figures 5 - 10 show the ground tracks and climb and descent profiles for the first, second and third four-month periods separately and for departures and arrivals separately. These presentations are intended to give overall impressions of the areas affected by Concorde noise, and they also show the effectiveness of the positioning of the temporary noise measuring sites for departures. Figures 11 - 18 show selected tracks and profiles in

detail and cover an early month and a later month of both Bahrain and Washington operations.

4 COMPARISON OF NOISE DATA: AVERAGE NOISE LEVELS

4.1 Concorde noise levels at the various sites are compared with the noise levels produced by samples of other aircraft at the same sites, and at roughly the same times, in Tables V and VI and Figures 19 - 23. The number of subsonic aircraft in each measured sample is given in the Tables and Figures. On departure Concorde was generally a few PNdB noisier than the older long-range jets at the fixed monitoring points and noticeably noisier both closer to and further from the airport. At the arrival sites, Concorde was a few PNdB noisier than the older long-range jets, except at 1.5 km from runway threshold where it was on a par with the B 707.

4.2 Concorde departures to Washington are shown to be generally a few PNdB noisier than those to Bahrain. Table III shows them also to be heavier and paragraph 6.2 explains that this increased noise is related to the increased weight. No difference in noise level is expected between arrivals from the two origins since such weight differences as exist do not have a marked effect on the landing noise levels.

4.3 The measured durations of the Concorde noise excursions are compared with those of other aircraft in Tables VII and VIII where the durations are measured between the points which are 10 dB below the peak value and in Tables IX and X which refer to the time during which the noise level was greater than 90 PNdB. Whilst the "10 dB down" duration is an accepted way of characterising this feature of aircraft noise, it is perhaps an unsatisfactory basis for comparing two noises which differ in both magnitude and peakiness, especially if the aim of the comparison is to determine which noise is more disturbing to people. The duration over 90 PNdB does indicate the time for which certain activities such as conversation or listening to the radio may be interrupted. Duration over 90 PNdB can only be measured when the peak noise level actually exceeds 90 PNdB and when it is not masked by the noise of the following aircraft as frequently happens near the airport. Because of this and also because the estimation of duration over 90 PNdB was not started until some way through the period covered by this report, the relevant tables show many blank spaces where the data are not available or are insufficient to merit inclusion. In summary, the duration '10 dB down' is shorter for Concorde than other aircraft in the first few kilometres of departure because of the former's higher initial speed. The duration above 90 PNdB is generally longer for Concorde due to its higher peak noise level except shortly after take-off where it is broadly comparable with subsonic jets.

4.4 Figure 24 shows a limited comparison of the Concorde noise levels obtained during scheduled operations with some earlier noise data gathered during the endurance trials which took place in the summer and autumn of 1975. The noise levels from the scheduled departure flights are of the same magnitude but have a smaller spread than those of the endurance trials, which may be due to the wider variety of destinations, routes, weights and pilots involved in the latter. The two sets of data show little differences in arrival noise levels.

5 COMPARISON OF NOISE DATA: HIGH NOISE LEVELS

5.1 This section, with Table XI, is new material not presented in the earlier 8 month report. Its objective is to show Concorde noise in relation to abnormally loud overflights of the British Airports Authority's fixed monitoring sites. Concorde has used only runways 10R, 28L and 28R for departure. Table XI deals with departures on these three runways which it treats separately from departures on the other runways which are little used; no Concorde, and only a few subsonic jet departures have taken place from them.

5.2 The term *exceedence* is used when a departure registers more than 110 PNdB at any fixed monitoring site, and the noise level of this exceedence is taken from the site which recorded the loudest value. It is perhaps worth noting that the regulation which is applied to subsonic departures, but not to Concorde, requires that during the hours from 7 am to 11 pm the noise level at any monitor shall not exceed 110 PNdB and, also, that after passing the monitors each aircraft shall make a decreasing level of noise. Unserviceability of the automatic monitoring system accounts for the "no record" entries against Concorde in Table XI and also for a slight imprecision in the subsonic jet totals.

5.3 Table XI shows that on westerly departures, which is the preferred direction of operation at Heathrow, Concorde exceeded 110 PNdB as often as not, but its exceedences did not range as high as those of the subsonic jets. On the less frequent easterly departures Concorde usually exceeded 110 PNdB and these exceedences covered the same range of noise levels as did those of the subsonic jets. Of the total of 164 Concorde departures, nearly 1 in 3 made 110 PNdB or less; the others contributed rather less than 5% of all exceedences for the year on the three runways considered. Whenever there was a Concorde departure from Heathrow, subsonic jets recorded a higher or equal noise level at the relevant fixed monitoring sites on 2 days out of 3. On westerly operations, Concorde compared more favourably than on easterlies and registered the highest noise level of the day on only 1 day in 6, but on easterly operations on nearly 2 days out of 3.

6 POSSIBLE TRENDS IN DATA

6.1 The measured noise levels at each site or group of corresponding sites and the highest noise levels recorded at the fixed noise monitoring points on departure, are presented in Figures 25 - 28 as time series by plotting each value against its flight serial number. Some of these figures might have been expected to show one or more of three features: firstly, an initial reduction due to improvements in operating techniques with experience; secondly, an increase in the spread or range of departure noise levels with the introduction of the higher weight Washington operations; thirdly, a variation with ambient temperature. None of these features is immediately apparent from the time series plots so a more detailed examination was carried out using linear multiple regression.

6.2 Table XII shows the result of the regression analysis for departures measured at the 5 and 10 km sites. The data from all three 5 km sites have been combined in one regression of noise levels against weight, temperature, head-wind component and a factor to account for the three sites not being at exactly the same distance from start-of-roll. For the 10 km sites the analysis had to be simplified since accounting for head-wind is complicated by the commencement of a turn and accounting for varying distance of measuring sites is complicated by the thrust and rate-of-climb reduction at the fixed monitoring points. At this distance, only the data from one site, A2, were included in a regression of noise level against weight and temperature. Both regressions are highly significant; that at 5 km shows that noise level is very clearly dependent on weight and temperature whilst at 10 km the dependency, though less, is still present. These results agree with the expectation on technical grounds of an increase in noise level with increasing temperature and weight which should be more marked closer to the airport than further away.

6.3 Two features of the flight paths used for approach are shown as a time series in Figure 29. Bearing in mind that new crews are being introduced as the series progresses and that for some arrivals in the summer months there will have been manoeuvres called for by air traffic control during peak traffic flows, there is a falling trend in both features which is in the direction of improving the noise environment.

7 COMPLAINT DATA

7.1 The number of complaints which were made specifically about the noise of each Concorde movement are listed in Tables III and IV and are broken down in Table XIII by type of movement, direction of operation of the airport and, on a coarse basis, area of origin. The data are also presented as time series in Figure 30 and the departure data are plotted against noise levels at the departure measuring sites in Figures 31 and 32.

7.2 The larger number of complaints from easterly as against westerly departures and from westerly arrivals as compared with easterly arrivals reflects the much larger population to the east of the airport. A similar population difference can account for the larger number of complaints arising from areas outside the fixed monitoring points. Departures account for nearly double the number of complaints from arrivals which is consistent with Concorde being noticeably noisier on departure than on arrival.

7.3 A positive feature of the Concorde complaint data is their relation with noise level - the noisier departures tend to generate more complaints. There are exceptions to this but the general trend is fairly obvious by inspection of the figures and is not inconsistent with previous experience of complaints and community response.

8 EFFECT OF CONCORDE OPERATIONS ON NOISE EXPOSURE

8.1 An assessment of the effect of the Concorde scheduled operations on the noise exposure around Heathrow has been made in terms of the Noise and Number Index (NNI). Two sets of NNI contours were produced and are shown, in Figure 33, superimposed on a map of the area. One set relates to the actual traffic using the airport, including Concorde movements, whilst the other set is an estimate of what the noise exposure would have been if the Concorde movements had been replaced by the same number of movements of a suitable subsonic aircraft. Both sets of contours are related to the actual traffic during the three peak summer months (mid June to mid September) of 1976, daytime only (0600 - 1800 GMT), in conformity with the convention for calculating the NNI. For clarity, only the 55, 45 and 35 NNI contours are shown.

8.2 By inspection, the differences between the contours are small and confined mainly to areas overflown by Concorde departures, particularly those when the airport is operating to the west. The differences are most noticeable in the 35 NNI contour, the 55 NNI contour being virtually unchanged.

8.3 Quantifying such small differences is difficult and every method has its limitations but a method has been used which is thought to present results which are more meaningful than most. Estimates were made of the size of population whose noise exposure was increased by selected increments of NNI due to the Concorde operations. Because both population and NNI data are not available on a geographically continuous basis, but only at intervals related to specific small areas, these estimates carry a large measure of uncertainty. According to these estimates nobody experienced an increase of 1 NNI or more, and some 18,000 people experienced an increase of at least ½ NNI. Obviously, many more people experienced very small increases less than ½ NNI, but the gross

uncertainties associated with an estimate of the number so affected ruled it out.

8.4 Two features of this assessment are noteworthy. The main change in the NNI falls on the areas under Concorde's departure routes and is not close to the airport as might have been expected but further away where the NNI value lies between 35 and 40. This is consistent with the comparison of Section 4 which shows large differences in noise level between Concorde and other aircraft at 30 km from start-of-roll. In these outer regions, where the noise exposure lies between 35 and 40 NNI, an increase of ½ NNI raises the proportion of people who rate themselves highly annoyed by ½%. (Ref: Aircraft Noise: Review of Aircraft Departure Routeing Policy, Noise Advisory Council, London 1974).

9 GENERAL OBSERVATIONS

9.1 This is our final report to the Department of Trade on Concorde's first year of scheduled operations at Heathrow (London) Airport. Some of its limitations need to be noted. Firstly, no special survey was made of people's attitudes to Concorde, and, therefore, when we refer to Concorde's environmental impact we can do so only in terms of its addition to the general noise climate and to the official Noise and Number Index which measures 'community annoyance'. Secondly, we are required only to review the historical record and, therefore, when we refer to trends during the first year, we do not imply that these are sufficient to indicate future conditions.

9.2 In its first year of operations, Concorde has made 164 scheduled departures and 163 scheduled arrivals, slightly more than three per week. These movements have been spread over four different routes and four runways so that residents around Heathrow who have actually heard Concorde will have found it a very infrequent experience.

9.3 The environmental impact of 327 Concorde movements has been very small indeed. We estimate that they have added between ½ and 1 to the Noise and Number Index for roughly 18,000 residents, most of whom live between 35 and 45 NNI, and that no area has suffered an increase of more than 1 NNI. Overall, Heathrow has some 1.6 million residents who experienced between 35 and 45 NNI.

9.4 Concorde has shown itself to be a noisy aircraft, but when stating just how noisy it is one must take account of the fact that successive flights of the same type of aircraft show a wide scatter in noisiness and one must also be clear what stage of the flight is being referred to. Concorde, like most aircraft, is noisier on take-off than on landing. Concorde is at its noisiest on departure between the airport boundary fence and the official noise monitoring sites and it has been

substantially noisier than subsonic aircraft here. At the fixed monitoring sites, 1 departure in 3 has recorded the loudest noise of the day from any of the three runways used by Concorde. However, these levels have been no higher than the loudest subsonic departure. Moreover, approximately 1 Concorde departure in 3 has met the statutory requirement for subsonic aircraft of 110 PNdB or less. Concorde's 164 departures have produced rather less than 5% of the year's exceedences over 110 PNdB at the British Airports Authority's fixed monitoring sites.

9.5 Trends are not easily discerned through the changing situation of Concorde's first year. New routes have been brought into operation, operating techniques have developed, new flight crews have been brought into service, air traffic control has been acquiring experience and there have been substantial temperature changes, including an unusually hot summer. However, Concorde seems to have become a little quieter.

9.6 The full year's operations endorse the findings of our earlier report, (CAA Paper 76040) on the first eight months, which comprised 98 scheduled departures and 98 scheduled arrivals. These findings are reproduced in Appendix A.

ACKNOWLEDGEMENTS

Some of the data presented in this report was collected and supplied by other organisations. Acknowledgement is made of the co-operation and assistance given by Air Traffic Control Evaluation Unit, London Air Traffic Control Centre, British Airways, British Airports Authority and to the Department of Trade for the supply of complaint data.

APPENDIX A

EXCERPT FROM CAA PAPER NO 76040

"Noise Data from the First Eight Months of Scheduled Concorde Operations at Heathrow Airport - London"

"GENERAL OBSERVATIONS

The main features shown by the Concorde data presented are:-

a) the noise levels measured on the ground from scheduled Concorde operations at Heathrow are higher, on average, than the corresponding measurements from other aircraft types.

b) the impact of Concorde scheduled operations on the noise disturbance around Heathrow is small since the frequency of these operations is small.

c) the impact is most noticeable further away from the airport rather than close to it.*

d) whilst many Concorde movements generate no complaints the more noisy movements generate several complaints. "

* Editorial Note:

This refers to the environmental impact as represented by the increase in the Noise and Number Index.

Table I Noise Measuring Sites

Site number	General location	Map reference	Distance from start-of-roll or threshold (km) / Distance to side of nominal track (km)			
DEPARTURES			Runway (destination)			
Mobile sites			28L (B+W)	28R (B+W)	10R (B)	10R (W)
A1	Middle marker, Stanwell Moor	043751	4.7/0			
A2	Old Windsor	986748	10/0			
A3	Middle marker, Poyle	037764		5.2/0		
A4	Sunnymeads	994756		10/0		
A5	Middle marker, Hatton	102752			5.0/0	5.0/0
A6	Twickenham	142729			9.5/0	9.5/0.6
B1	Woodley	779733	31/0	31/0		
B2	Ockham	099585			27/0	
B3	Nuptown	888735	20/0.3	20/0.3		
B4	Esher	139645			20/0	20/4.5
Fixed sites						
F1	Cranford	102766			5.0/1.5	5.0/1.4
F2	Hounslow	122758			6.5/1.5	6.5/1.0
F3	Hounslow	129751			7.2/1.2	7.2/0.8
F4	Hounslow Heath	130743			7.8/0.7	7.9/0.2
F5	Hounslow Heath	125737			7.6/0	7.8/0.4
F6	Hanworth	120732			7.4/0.8	7.7/1.2
F10	Wraysbury	005742	8.4/0.7	8.9/1.6		
F11	Sunnymeads	002754	8.6/0.4	8.8/0.4		
F12	Horton	013760	7.5/1.0	7.5/0.1		
F13	Colnbrook	022772	6.6/2.2	6.6/0.8		
ARRIVALS			Runway			
Mobile sites			28L	28R	10R	10L
C1	East Sheen	209755	12/0			
C2	Duke's Meadow, Chiswick	209768		12/0		
C3	Outer marker, Isleworth	158753	7.0/0			
C4	Outer marker, Osterley	158766		6.9/0		
C5	Middle marker, Hatton	102752	1.5/0			
C6	Middle marker, Cranford	106766		1.7/0		
C7	Windsor	918746			14/0	
C8	Oakley Green	929762				12/0
C9	Outer marker, Old Windsor	986749			7.0/0	
C10	Outer marker, Southlea	989763				6.3/0
C11	Middle marker, Poyle	037764				1.6/0
C12	Middle marker, Stanwell Moor	043751			1.3/0	
C13	Chelsea	278782		19/1.2		
C14	Battersea	285770		20/9		
C15	Clapham	288756	20/0			
C16	Walham Green	255769		17/0		
C17	Wandsworth Park	247754	16/0			
Fixed sites						
F1	Cranford	102766		1.3/0		
F2	Hounslow	122758	3.3/0.9			
F3	Hounslow	129571	4.0/0.2			
F10	Wraysbury	005742			5.1/0.7	
F11	Sunnymeads	002754			5.3/0.5	
F12	Horton	013760				4.0/0.3
F13	Colnbrook	022772				3.0/0.9

NOTES Destinations: B = Bahrain, W = Washington.

Distances to sites associated with arrivals on runways 10R and 10L are measured from inset thresholds.

Table II Concorde Operations at Heathrow Airport

Operation	Runway	First 4 months	Second 4 months	Third 4 months	First year
Concorde Departures to Bahrain	28L	5	7	8	20
	28R	15	9	5	29
	10L	0	0	0	0
	10R	16	10	5	31
	All	36	26	18	80
Concorde Departures to Washington	28L	0	11	12	23
	28R	0	14	21	35
	10L	0	0	0	0
	10R	0	11	15	26
	All	0	36	48	84
Concorde departures		36	62	66	164
Concorde Arrivals from Bahrain	28L	17	9	6	32
	28R	5	8	5	18
	10L	12	9	6	27
	10R	2	0	1	3
	All	36	26	18	80
Concorde Arrivals from Washington	28L	0	21	21	42
	28R	0	6	11	17
	10L	0	8	11	19
	10R	0	1	4	5
	All	0	36	47	83
Concorde arrivals		36	62	65	163
All Concorde movements		72	124	131	327
All departures	28L	10254	14534	13868	38656
	28R	16882	19021	16502	52405
	10L	1063	184	147	1394
	10R	15800	16670	13479	45949
	+ 05R) 23L)	18	0	11	29
	All	44017	50409	44007	138433
All arrivals	28L	17541	21258	16354	55153
	28R	9254	12763	13092	35109
	10L	13945	15042	12409	41396
	10R	2329	1558	1087	4974
	+ 05R) 23L)	936	6	959	1901
	All	44005	50267	43901	138533
All movements		88022	101036	87908	276966

Table III Summary of Data for Concorde Departures

Departure number	Date	Runway	Destn (1)	Weight tonnes	Temporary sites (2)				Fixed sites		Number of complaints
					Noise level PNdB				Highest level	Site (4)	
					5 km	10 km	20 km	30 km			
1	21 Jan	28L	B	180	135	109			112	11	3
2	26 Jan	28R	B	179	121	109			114	12	1
3	28 Jan	10R	B	173	122	116		104	112	4	6
4	2 Feb	10R	B	174	128			105	112	1	7
5	4 Feb	10R	B	173	129	108		101	111	1	0
6	9 Feb	28L	B	170	132	104			109	12	0
7	11 Feb	28R	B	174	124	109			112	12/13	1
8	16 Feb	10R	B	169	121	110		101	110	1/4	0
(3) 8A	16 Feb	10R	B	169					112	5	0
9	18 Feb	10R	B	174	130	112			115	4	4
10	23 Feb	28R	B	167	128	101			112	12/13	1
11	25 Feb	28R	B	169	127	103		98	110	13	0
12	1 Mar	28L	B	171	130	104			108	12	0
13	3 Mar	10R	B	167	125	110		104	110	1/4	1
14	8 Mar	10R	B	168	127	105		105	110	1/3	1
15	10 Mar	28R	B	164	123	104			108	12	1
16	15 Mar	10R	B	175					114	4	2
17	17 Mar	10R	B	167	128	104		105	111	3	0
18	22 Mar	10R	B	168		109		103	110	1	0
19	24 Mar	28R	B	167	123	107		95	109	12	1
20	29 Mar	28R	B	170	123	107		100	111	12	1
21	31 Mar	28R	B	169		108		89	113	12	1
22	5 Apr	28R	B	175	128	105		94	111	12	0
23	7 Apr	28R	B	169		109		102	113	12	1
24	12 Apr	10R	B	174	133	110		107	117	4	12
25	14 Apr	28L	B	164		105			107	11	0
26	19 Apr	10R	B	166					111	1	5
27	21 Apr	10R	B	171		110		105	115	4	8
28	26 Apr	10R	B	173	132	111		106	113	3/4	2
29	28 Apr	10R	B	166	125	103		107	113	3	2
30	3 May	28R	B	166	125	105		87	109	12	0
31	5 May	28R	B	173	131			105	114	12	0
32	10 May	28L	B	165	136	111		101	112	11	1
33	12 May	28R	B	164	121	106		96	110	12	0
34	17 May	28R	B	172	131	106		106	112	12	0
35	19 May	28R	B	169	128	99		74	108	12	0
36	24 May	10R	W	179	133				119	4	66
37	26 May	28R	B	166	130	107		85	111	12	0
38	29 May	28R	W	178	133				117	12	4
39	31 May	28R	B	169	129	108		86	112	12	0
40	3 Jun	10R	W	177	134				118	4	23
41	5 Jun	28R	W	179	134	106		104	112	13	10
42	7 Jun	28L	B	170	137	111		96	112	11	3
43	10 Jun	28L	W	179	136	113		108	112	11	2
44	12 Jun	28L	W	179	136				109	11	4
45	14 Jun	28R	B	167	132	105			113	12	1
46	17 Jun	28R	W	178	134	99		104	113	13	4
47	19 Jun	28R	W	178	134	98			113	12/13	3
48	21 Jun	28L	B	169	134	110		89			3
49	24 Jun	28R	W	179	134	103		107	111	13	7
50	26 Jun	28R	W	179		99		104	110	13	7
51	28 Jun	10R	B	172					117	4	18
52	1 Jul	10R	W	180	130	116			117	4	15
53	3 Jul	28L	W	176		110			111	11	6
54	5 Jul	10R	B	169	135			98	114	4	0
55	8 Jul	28L	W	179	135	115		105	113	11	6
56	10 Jul	28L	W	180	138				111	11	2
57	12 Jul	10R	B	168	134	112		103	115	4	5
58	15 Jul	28R	W	179		104	107		116	12	3
59	17 Jul	28R	W	181		108			113	12	3
60	19 Jul	28R	B	172	130	102	110		112	12	1
61	22 Jul	28L	W	179		110	111	107	110	11	2
62	24 Jul	28L	W	180		111			112	11	3
63	26 Jul	10R	B	174	132	117		109	115	4	6
64	29 Jul	28R	W	177	134	104	112				1
65	30 Jul	28R	W	178	133	108	110		113	12	0
66	31 Jul	28R	W	181	136	102			113	12/13	0
67	2 Aug	28L	B	164	130	109	103		107	11	1
68	4 Aug	28L	B	165	136	111	111		107	11	4
69	5 Aug	28L	W	178	138	111	110		109	12	3
70	7 Aug	28L	W	180					112	11	4

Table IV Summary of Data for Concorde Arrivals

Arrival number	Date	Runway	(1) Origin	Weight tonnes	Mobile sites (2) Noise level PNdB						Fixed sites		Number of complaints
					1.5 km	7 km	12 km	16 km	20 km	19 km	Highest level	(3) Site	
1	22 Jan	28L	B	95	122	112	103				116	3	2
2	27 Jan	28L	B	96	125	110	102				113	3	2
3	29 Jan	10R	B	99	128	112	102				105	11	0
4	3 Feb	10L	B	94	122	110	101				109	12	0
5	5 Feb	10L	B	96	126	110	102				108	12	0
6	10 Feb	28L	B	95	126	106	104				113	3	0
7	12 Feb	28L	B	93			109				115	3	10
8A	16 Feb	10L	R								105	13	2
8	17 Feb	10L	B	99	122	112	99				102	13	0
9	19 Feb	10R	B	101							103	11	0
10	24 Feb	28L	B	100	123	107	105				114	3	0
11	26 Feb	28L	B	99							115	3	0
12	2 Mar	28R	B	97							123	1	0
13	4 Mar	10L	B	100							106	12	1
14	9 Mar	28L	B	100							111	3	3
15	11 Mar	28L	B	98							100	3	0
16	16 Mar	28R	B	100							127	1	0
17	18 Mar	10L	B	100							108	12	0
18	23 Mar	10L	B	101		109	100				110	12	1
19	25 Mar	28L	B	99				102	102	83	116	3	3
20	30 Mar	28L	B	98			104	103		82	114	3	0
21	1 Apr	28L	B	99				101	101	80	116	3	0
22	6 Apr	28L	B	100				103	103	84	113	3	2
23	8 Apr	28L	B	98			103	100	105				1
24	13 Apr	28R	B	96			103	99	106		126	1	1
25	15 Apr	10L	B	102									1
26	20 Apr	10L	B	94							107	12	0
27	22 Apr	10L	B	102	123	112	104				108	12	0
28	27 Apr	10L	B	95		108	103				108	12	0
29	29 Apr	28R	B	99			99	99		89	124	1	0
30	4 May	28L	B	97				101	95	91	113	3	0
31	6 May	10L	B	99	124		100				107	12	0
32	11 May	28R	B	96				102	95	102	123	1	2
33	13 May	28L	B	96				101	89	87	115	3	1
34	18 May	28L	B	99					97	87	109	3	0
35	20 May	28L	B	98							114	3	0
36	25 May	28L	W	100							113	3	2
37	27 May	28L	B	100				102	101	85	113	3	0
38	30 May	28L	W	98							114	3	4
39	1 Jun	28L	B	97	123			103		87	116	3	3
40	4 Jun	28L	W	98									1
41	6 Jun	28L	W	99							104	2	15
42	8 Jun	28R	B	98									7
43	11 Jun	28L	W	97							113	3	5
44	13 Jun	28L	W	98							114	3	5
45	15 Jun	28L	B	99	116						106	3	1
46	18 Jun	28L	W	99							115	3	7
47	21 Jun	28L	W	95							113	3	3
48	22 Jun	28R	B	97				101		88	126	1	3
49	25 Jun	28L	W	98							112	3	22
50	27 Jun	28L	W	102									13
51	29 Jun	10L	B	99	114		104						5
52	2 Jul	10L	W	100							97	13	1
53	4 Jul	10L	W	103							98	13	3
54	6 Jul	10L	B	96	128	107	99						0
55	9 Jul	28L	W	98									11
56	11 Jul	10L	W	96							99	13	2
57	13 Jul	28L	B	100				102	99		115	3	4
58	16 Jul	28L	W	98							114	3	5
59	18 Jul	28L	W	100							113	3	2
60	20 Jul	28R	B	100				101	101	95	125	1	5
61	23 Jul	28L	W	96							113	3	1
62	25 Jul	28L	W	99							105	12	3
63	27 Jul	28L	B	97				103	103	83			3
64	29 Jul	28L	W	96							115	3	3
65	31 Jul	28R	W	96							125	1	0
66	1 Aug	28R	W	100							127	1	3
67	3 Aug	28R	B	100				107	100	89	127	1	0
68	5 Aug	28R	B	96	126	112	110				128	1	0
69	6 Aug	28L	W	99							113	3	1

Table IV Continuation

Arrival number	Date	Runway	(1) Origin	Weight tonnes	Mobile sites (2)						Fixed sites		Number of complaints
					Noise level PNdB						Highest level	(3) Site	
					1.5 km	7 km	12 km	16 km	20 km	19 km			
70	8 Aug	10L	W	100							107	12	2
71	10 Aug	10L	B	98	120	110							6
72	12 Aug	28L	B	98	127	107	103						3
73	13 Aug	28R	W	99							127	1	4
74	15 Aug	10L	W	98									4
75	17 Aug	10L	B	96	121	113	102				104	12	0
76	19 Aug	10L	B	96	120	109	103				110	12	9
77	20 Aug	10L	W	100							107	12	2
78	22 Aug	10R	W	100							107	11	2
79	24 Aug	10L	B	99	122	109	104				103	12	1
80	26 Aug	10L	B	97	120	105	101				103	12	7
81	27 Aug	10L	W	96							106	12	1
82	29 Aug	28R	W	101							126	1	5
83	31 Aug	28L	B	98	125	104					104	12	0
84	2 Sep	28R	B	96	124	110							2
85	3 Sep	28L	W	101							113	3	1
86	5 Sep	28L	W	102							112	3	1
87	7 Sep	28L	B	99	122	107	105						1
88	9 Sep	28L	B	99	124						112	3	1
89	10 Sep	28R	W	92							125	1	1
90	12 Sep	28R	W	102									1
91	14 Sep	28R	B	96	122						126	1	1
92	16 Sep	28R	B	97	125	110							0
93	17 Sep	28L	W	98							114	3	0
94	19 Sep	28L	W	99							114	3	7
95	21 Sep	10L	B	97	123	112					108	12	0
96	23 Sep	10L	B	97	126	104					108	12	0
97	24 Sep	10L	W	100									0
98	26 Sep	28R	W	103							127	1	5
99	28 Sep	28R	B	96	126	112	107				129	1	2
100	30 Sep	10L	B	97	125	114	103						17
101	1 Oct	28L	W	102							115	3	5
102	3 Oct	28L	W	102							116	3	0
103	5 Oct	28L	B	97	126	114					114	3	5
104	6 Oct	28R	W	99									1
105	8 Oct	10L	W	100									0
106	10 Oct	10L	W	101							105	12	1
107	12 Oct	28L	B	98							113	3	2
108	13 Oct	28L	W	100							114	3	1
109	15 Oct	28L	W	100									2
110	17 Oct	10L	W	104							104	12	0
111	19 Oct	28L	B	97							114	3	0
112	20 Oct	28L	W	102	126	103					114	3	3
113	22 Oct	10L	W	100							109	12	0
114	24 Oct	10L	W	102							109	12	0
115	27 Oct	28L	W	100									4
116	28 Oct	28L	B	97							114	3	1
117	29 Oct	28L	W	99							116	3	1
118	31 Oct	28L	W	101							114	3	0
119	3 Nov	28R	W	99									2
120	(4) 4 Nov	28L	B	99	126	111							1
121	5 Nov	28R	W	101							127	1	1
122	7 Nov	10R	W	102									0
123	11 Nov	28L	W	100									
124	(4)11 Nov	28R	B	102	126	111	102				127	1	2
125	12 Nov	28L	W	103							115	3	0
126	15 Nov	28L	W	103									2
127	17 Nov	28R	W	100							126	1	6
128	18 Nov	10L	B	99	126	110	101				109	12	7
129	19 Nov	10L	W	101							109	12	0
130	21 Nov	28L	W	102							114	3	1
131	24 Nov	28L	W	99							115	3	1
132	25 Nov	28R	B	113							107	10	14
133	26 Nov	28R	W	113							127	1	5
134	28 Nov	28L	W	102							114	3	1
135	1 Dec	10R	W	101							109	11	0
136	2 Dec	28L	B	95									1
137	3 Dec	28R	W	100							125	1	1

Table IV Continuation

Arrival number	Date	Runway	(1) Origin	Weight tonnes	Mobile sites (2) Noise level PNdB						Fixed sites		Number of complaints
					1.5 km	7 km	12 km	16 km	20 km	19 km	Highest level	(3) Site	
138	5 Dec	10R	W	102									0
139	8 Dec	28L	W	98							113	3	1
140	9 Dec	28R	B	94	126						124	1	0
141	10 Dec	28L	W	101							113	3	1
142	12 Dec	28L	W	102							113	3	0
143	15 Dec	10R	W	98							108	11	0
144	16 Dec	10L	B	98	123								3
145	17 Dec	10L	W	101							107	12	0
146	19 Dec	10L	W	99									0
147	22 Dec	28L	W	99									0
148	23 Dec	10R	B	111									5
149	24 Dec	10L	W	95							108	11	0
150	29 Dec	10L	W	98									0
151	30 Dec	10L	B	99									9
152	31 Dec	10L	W	101									0
153	2 Jan	28R	W	98							125	1	0
154	5 Jan	28L	W	100							113	3	1
155	6 Jan	28R	B	97	121						123	1	2
156	7 Jan	28L	W	98							113	3	0
157	12 Jan	28R	W	99							124	1	0
158	13 Jan	10L	B	110									0
159	14 Jan	28R	W	99							126	1	0
160	16 Jan	28R	W	99							123	1	2
161	19 Jan	28L	W	100							113	3	0
162	20 Jan	10L	B	97	123	111	104				109	12	5

NOTES (1) B = BAHRAIN, W = WASHINGTON, R = Returned due to mechanical trouble.

(2) The results for corresponding sites on different approaches have been listed together under their nominal distance from threshold. 1.5 km - C5/C6/C11, 7 km - C3/C4/C10, 12 km - C1/C2/C8, 16 km - C16/C17, 20 km - C14/C15, 19 km - C13 (1.2 km north of extended centre-line of runway 28R).

(3) The prefix F has been omitted from the fixed monitoring site number in this column.

(4) These arrivals were routed via Lambourne.

Table V Comparison of Departure Noise Levels

Aircraft type		Noise level (PNdB)[2]				
		Temporary measuring sites Distance from start-of-roll				Fixed Sites
		A1/A3/A5 5 km	A2/A4/A6 10 km	B3/B4 20 km	B1/B2 30 km	Highest level
Concorde (all)	Range[1]	121/139	97/119	100/115	74/109	105/124
	Mean	131.1	108.0	108.4	100.2	112.3
	Log av	133.2	110.2	109.8	103.6	113.8
	Sample	109	112	36	47	158
Concorde (Bahrain)	Range	121/136	99/117	102/115	74/109	106/118
	Mean	129.9	108.0	108.1	98.9	111.4
	Log av	131.6	110.0	109.3	102.7	112.4
	Sample	64	66	16	36	78
Concorde (Washington)	Range	129/139	98/117	100/115	101/108	105/124
	Mean	134.2	107.9	109.2	104.3	113.2
	Log av	134.8	110.5	110.3	105.7	114.9
	Sample	45	46	20	11	80
B707 (longhaul)	Range	100/123	83/120	80/101	76/95	94/118
	Mean	113.1	99.2	92.0	85.8	105.6
	Log av	113.7	104.1	94.0	87.2	109.2
	Sample	76	78	35	19	45
B707 (others)	Range	97/120	83/104	78/97	70/90	94/111
	Mean	107.6	95.2	89.8	79.3	102.5
	Log av	110.0	97.1	91.9	82.2	104.5
	Sample	94	84	33	29	49
S/VC10	Range	103/126	93/110	*	*	99/114
	Mean	115.9	101.7			106.8
	Log av	118.6	105.1			107.8
	Sample	59	48			33
B747	Range	95/122	74/108	78/95	77/95	91/117
	Mean	109.2	92.0	90.2	84.9	102.8
	Log av	111.9	96.4	91.1	86.8	105.6
	Sample	212	167	54	62	168
Trident	Range	98/124	77/112	80/104	71/99	96/114
	Mean	115.1	99.3	94.3	87.1	105.6
	Log av	116.5	104.0	96.8	91.1	107.0
	Sample	350	269	75	99	255
Tristar	Range	93/110	73/98	*	72/84	92/99
	Mean	101.0	84.8		77.5	94.8
	Log av	102.6	89.0		79.4	95.3
	Sample	46	43		8	21
BAC 1-11	Range	100/124	76/110	79/99	64/99	98/110
	Mean	111.0	95.7	90.2	85.6	104.2
	Log av	113.3	99.8	92.2	89.3	105.0
	Sample	127	77	24	17	79

NOTES (1) Range is given in the form minimum/maximum.

(2) Noise levels of other aircraft were recorded at each site during short periods immediately preceding and following a Concorde movement.

* No data available.

Table VI Comparison of Arrival Noise Levels

Aircraft type		Noise level (PNdB)[2]					
		Temporary measuring sites Distance from runway threshold					
		C5/C6/C11 1.5 km	C3/C4/C10 7 km	C1/C2/C8 12 km	C16/C17 16 km	C14/C15 20 km	C13[3] 19 km
Concorde (Bahrain)	(1) Range	114/128	103/114	99/110	95/107	89/106	82/102
	Mean	123.5	109.5	103.0	101.8	99.8	87.5
	Log av	124.2	110.3	103.9	102.2	101.5	92.3
	Sample	41	34	32	17	14	15
B707	Range	114/128	93/11	84/101	77/100	70/98	70/91
	Mean	121.9	103.9	93.7	91.3	90.3	77.7
	Log av	122.9	106.0	95.6	93.6	94.4	81.3
	Sample	54	36	47	39	31	30
S/VC10	Range	107/120	98/103	90/95	*	87/96	*
	Mean	115.8	100.2	93.3		93.0	
	Log av	117.1	100.6	93.7		94.5	
	Sample	8	5	4		3	
B747	Range	102/120	93/109	86/98	76/100	72/96	68/94
	Mean	112.5	98.1	90.5	88.5	87.9	80.0
	Log av	114.2	99.7	91.6	91.5	90.9	85.2
	Sample	51	31	43	22	15	15
Trident	Range	103/126	86/112	82/108	78/100	76/101	68/100
	Mean	116.0	100.3	90.9	90.7	87.8	82.2
	Log av	117.6	103.1	93.3	93.5	92.1	88.1
	Sample	119	84	89	49	40	46
Tristar	Range	106/111	94/98	84/90	78/89	76/93	74/80
	Mean	108.1	95.9	87.6	85.4	83.1	77.0
	Log av	108.4	96.0	87.9	86.1	84.7	77.4
	Sample	21	15	13	8	8	8
BAC 1-11	Range	104/119	85/109	72/93	76/94	75/95	69/91
	Mean	110.7	93.6	84.6	86.0	84.4	75.6
	Log av	112.0	96.2	86.0	88.1	88.3	82.5
	Sample	74	70	67	29	27	26

NOTES (1) Range is given in the form minimum/maximum.

(2) Noise level of other aircraft was recorded at each site during short periods immediately preceding and following a Concorde movement.

(3) Site C13 is 19 km from the runway threshold and 1.2 km north of runway 28R extended centre-line.

* No data available.

Table VII Comparison of Departure Durations, 10 dB Down

Aircraft type		Duration (seconds) 10 dB down[2]			
		Temporary measuring sites Distance from start-of-roll			
		A1/A3/A5 5 km	A2/A4/A6 10 km	B3/B4 20 km	B1/B2 30 km
Concorde (all)	Range[1]	3/19	10/40	14/43	13/57
	Mean	6.0	19.4	23.4	30.5
	Sample	110	108	37	46
Concorde (Bahrain)	Range	3/19	10/40	15/43	13/57
	Mean	6.7	19.5	23.5	31.3
	Sample	65	66	17	36
Concorde (Washington)	Range	3/10	10/34	14/33	20/51
	Mean	5.0	19.2	23.4	27.6
	Sample	45	42	20	10
B707 (long haul)	Range	5/29	13/44	17/55	20/81
	Mean	12.1	25.4	26.3	32.4
	Sample	87	80	35	20
B707 (others)	Range	7/36	16/50	25/57	17/59
	Mean	17.4	28.9	32.8	32.9
	Sample	91	85	36	25
S/VC10	Range	8/49	11/44	*	*
	Mean	17.1	28.1		
	Sample	64	46		
B747	Range	4/27	11/55	16/33	14/51
	Mean	9.5	23.4	23.6	27.5
	Sample	216	171	50	59
Trident	Range	6/32	7/56	18/58	20/58
	Mean	14.6	26.0	32.5	36.1
	Sample	355	276	79	89
Tristar	Range	6/23	14/50	*	16/67
	Mean	13.2	28.6		32.6
	Sample	48	31		7
BAC 1-11	Range	7/38	11/89	14/58	21/66
	Mean	18.2	34.1	37.9	42.4
	Sample	136	67	27	14

NOTES (1) Range is given in the form minimum/maximum.

(2) Durations of other aircraft were recorded at each site during short periods immediately preceding and following a Concorde movement.

* No data available.

Table VIII Comparison of Arrival Durations, 10 dB Down

Aircraft type		(2) Duration (seconds) 10 dB down				
		Temporary measuring sites Distance from Runway Threshold				
		C5/C6/C11 1.5 km	C3/C4/C10 7 km	C1/C2/C8 12 km	C16/C17 16/km	C14/C15 20 km
Concorde	Range (1)	2/9	6/19	13/26	17/33	15/36
	Mean	4.6	11.9	19.7	23.2	23.9
	Sample	37	32	29	18	14
B707	Range	2/6	6/22	9/47	13/35	11/60
	Mean	4.6	12.3	20.5	24.0	25.3
	Sample	54	37	47	41	21
S/VC10	Range	4/6	11/23	20/33	*	22/40
	Mean	4.9	16.0	27.0		33.0
	Sample	7	5	3		4
B747	Range	4/8	10/27	15/33	15/63	21/40
	Mean	5.6	15.6	25.3	26.4	27.8
	Sample	55	32	39	20	11
Trident	Range	3/8	8/30	14/38	10/44	14/42
	Mean	4.7	15.8	23.9	26.0	27.1
	Sample	116	81	66	47	29
Tristar	Range	4/8	14/21	17/38	24/43	11/45
	Mean	6.0	15.9	26.4	31.7	28.0
	Sample	20	15	12	9	5
BAC 1-11	Range	4/9	10/32	14/40	9/36	16/36
	Mean	5.6	16.9	25.3	23.9	25.6
	Sample	89	59	47	26	15

NOTES (1) Range is given in the form minimum/maximum.

(2) Durations of other aircraft were recorded at each site during short periods immediately preceding and following a Concorde movement.

* No data available.

Table IX Comparison of Departure Durations, Above 90 PNdB

Aircraft type		Duration (seconds) above 90 PNdB[2]			
		Temporary measuring sites Distance from start-of-roll			
		A1/A3/A5 5 km	A2/A4/A6 10 km	B3/B4 20 km	B1/B2 30 km
Concorde (all)	Range[1]	4/35	15/47	29/49	1/49
	Mean	24.2	29.7	37.0	33.3
	Sample	61	100	35	34
Concorde (Bahrain)	Range	10/35	15/47	31/49	1/49
	Mean	24.3	29.2	36.6	32.5
	Sample	27	58	17	25
Concorde (Washington)	Range	4/33	17/46	29/47	27/42
	Mean	24.1	30.5	37.5	35.4
	Sample	34	42	18	9
B707 (long haul)	Range	12/35	1/33	3/33	*
	Mean	23.1	20.7	12.9	
	Sample	66	63	27	
B707 (others)	Range	17/43	1/36	6/42	*
	Mean	25.9	18.8	19.0	
	Sample	61	74	13	
S/VC10	Range	21/59	3/60	*	*
	Mean	37.2	33.3		
	Sample	45	39		
B747	Range	8/29	1/28	1/16	1/9
	Mean	16.5	14.0	7.0	5.3
	Sample	181	99	26	6
Trident	Range	17/47	1/50	1/34	1/29
	Mean	29.2	30.2	19.0	10.4
	Sample	230	201	66	32
Tristar	Range	6/18	1/13	*	*
	Mean	13.2	9.9		
	Sample	38	7		
BAC 1-11	Range	19/47	2/51	2/26	1/13
	Mean	30.6	27.0	13.0	6.8
	Sample	101	50	16	5

NOTES (1) Range is given in the form minimum/maximum.

(2) Durations of other aircraft were recorded at each site during short periods immediately preceding and following a Concorde movement.

* No data available.

Table X Comparison of Arrival Durations, Above 90 PNdB

Aircraft type		(2) Duration (seconds) above 90 PNdB				
		Temporary measuring sites Distance from Runway Threshold				
		C5/C6/C11 1.5 km	C3/C4/C10 7 km	C1/C2/C8 12 km	C16/C17 16 km	C14/C15 20 km
Concorde (Bahrain)	(1) Range Mean Sample	9/36 22.7 25	7/28 21.7 23	16/32 23.9 18	19/35 26.4 17	14/30 22.3 14
B707	Range Mean Sample	5/21 13.9 36	1/22 13.7 27	1/27 11.3 28	1/18 8.8 28	2/25 12.2 18
S/VC10	Range Mean Sample	*	*	*	*	*
B747	Range Mean Sample	10/19 12.9 23	7/16 12.5 20	1/15 8.3 10	1/18 7.7 6	6/20 12.8 5
Trident	Range Mean Sample	7/23 11.9 87	3/26 15.0 57	1/15 12.0 23	2/33 11.9 26	1/19 9.3 15
Tristar	Range Mean Sample	8/15 11.1 18	3/13 9.4 14	*	*	*
BAC 1-11	Range Mean Sample	8/20 11.0 65	3/17 9.2 39	*	1/9 4.0 5	1/9 6.2 6

NOTES (1) Range is given in the form minimum/maximum.

(2) Durations of other aircraft were recorded at each site during short periods immediately preceding and following a Concorde movement.

* No data available.

Table XI Incidence of High Noise Levels (> 110 PNdB) Recorded at Fixed Noise Monitoring Sites

Runway	Aircraft type	110 + less	111	112	113	114	115	116	117	118	119	120	121	122	123	124	Number >110	No record	No. of departures
28L	Concorde	23	5	7	3	1		1									17	3	43
	B707/DC8		12	26	19	11	6	8	5	3							90		
	B747		3	11	3	3	1										21		
	VC10		1	9	1	2											13		
	Trident		38	42	27	5	4	3	1								120		
	Others		1	1													2		
	All subsonic	30000	55	89	50	21	11	11	6	3							246		30500
28R	Concorde	21	7	10	14	5	1	3	1								41	2	64
	B707/DC8		54	101	85	35	22	6	6	6	3						318		
	B747		6	17	13	5	5	2	2								50		
	VC10		12	22	7	2	3	1									47		
	Trident		115	172	84	21	13	5	1	2							413		
	Others		7	9	2	1											19		
	All subsonic	41000	194	321	191	64	43	14	9	8	3						847		42000
10R	Concorde	5	5	5	5	4	6	6	6	8	3	(4) 1		(4) 1		(4) 1	51	1	57
	B707/DC8		47	94	62	52	28	22	9	7	8	1 (2)			1 (2)		331		
	B747		12	29	18	16	11	4	2		1						93		
	VC10		14	21	5	2	1										43		
	Trident		117	179	83	45	28	6									458		
	Others		11	15	2	4											32		
	All subsonic	34500	201	338	170	119	68	32	11	7	9	1			1		957		35500
28L + 28R + 10R	Concorde	49	17	22	22	10	7	10	7	8	3	1		1		1	109	6	164
	B707/DC8		113	221	166	98	56	35	21	16	11	1			1		739		
	B747		21	57	34	24	17	6	4		1						164		
	VC10		27	52	13	6	4	1									103		
	Trident		272	393	194	71	45	14	2	2							993		
	Others		19	25	4	5											53		
	All subsonic	106000	450	748	411	204	122	57	26	18	12	1			1		2050		108000
10L	B747/DC8		2	4	5	3	1	3	3	3			(1) 1			(1) 2	27		
	B747		2	2	4	1	2	1	2		1						15		
	VC10			2							1						3		
	Trident		7	24	22	16	3	4	2	5							83		
	Others		2	11	6	3	4		3								29		
	All subsonic		13	43	37	23	10	8	10	8	2		1			2	157		1100

NOTES Fixed monitoring sites where certain high noise levels were recorded are shown thus, (1).
Distances of these sites from start-of-roll are (1) 5.1 km, (2) 7 km, (4) 7.8 km.

Table XII Regression of Noise Level on Temperature and Weight

5 km SITES A1, A3 AND A5 COMBINED - SAMPLE SIZE = 110

L = 188 + 0.39W + 0.23T - 0.28w - 32.6 log(D-10000)				
	Coefficient	95% Confidence interval		
r = 0.87	W	0.31	to	0.46
r^2 = 0.76	T	0.18	to	0.28
s.d = 2.12	w	-0.37	to	-0.19
Very highly significant	log(D - 10000)	-40.8	to	-24.5
	Constant	154	to	221

10 km SITE A2 - SAMPLE SIZE = 25

L = 79 + 0.15W + 0.29T				
	Coefficient	95% Confidence interval		
r = 0.71	W	0.01	to	0.30
r^2 = 0.50	T	0.15	to	0.43
s.d = 2.33	Constant	53	to	105
Very highly significant				

L = Noise level, PNdB

W = Take-off weight, tonnes

T = Ambient temperature, ^{o}C

w = Headwind component, knots

D = Distance to monitor from start-of-roll, feet

Table XIII Analysis of Complaints Data

Movement type	Area where the complaints originated	Direction of operation of the airport		Total
		Westerly	Easterly	
Departures	Inside fixed ring	62	50	112
	Outside fixed ring	117	440	557
	Total	179	490	669
Arrivals	Inside fixed ring	39	11	50
	Outside fixed ring	219	92	311
	Total	258	103	361
All	Inside fixed ring	101	61	162
	Outside fixed ring	336	532	868
	Total	437	593	1030

NOTE The 'fixed ring' refers to the ring of fixed measuring sites as shown in Figure 2.

KEY TO FIGURES 3, 4 and 19 - 24

Maximum value

Logarithmic average

Mean

Minimum value

$$\text{Mean} = \frac{1}{n}\sum_{i=1}^{n} L_i$$

$$\text{Logarithmic average} = 10 \text{ Log} \left[\frac{1}{n}\sum_{i=1}^{n} 10^{L_i/10} \right]$$

L_i = noise level of i th aircraft

n = number of noise levels in sample

The values shown in these figures and given in the corresponding tables are derived from samples of synchronous measurements whose sizes are stated in the figures and tables. In most cases the sample is large enough to give a good estimate of the mean and logarithmic average. No sample can determine the extreme values of the whole population from which it was drawn and, in practice, values are liable to be found outside the maximum and minimum of the sample.

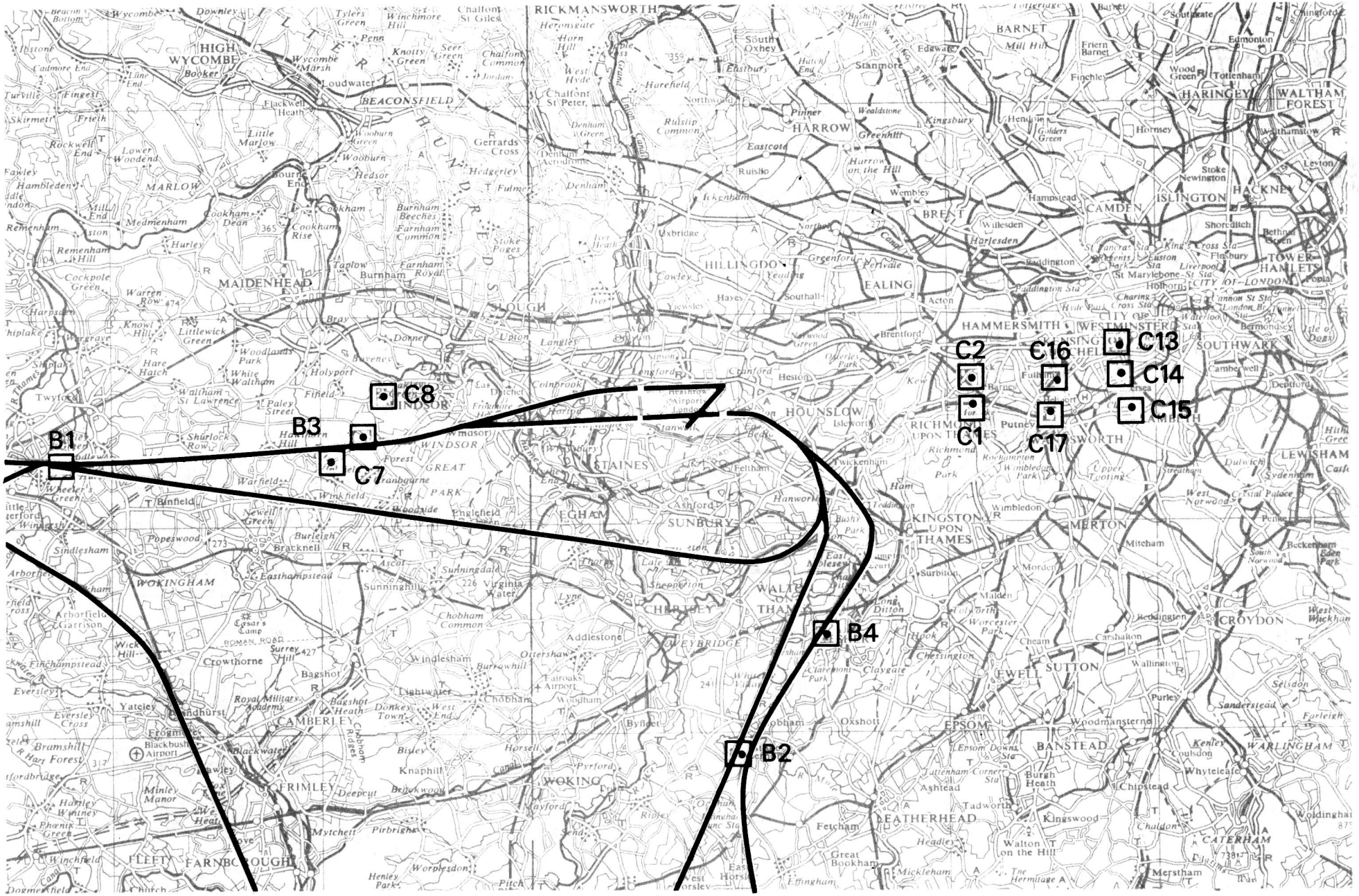


Fig 1 Concorde Measuring Sites

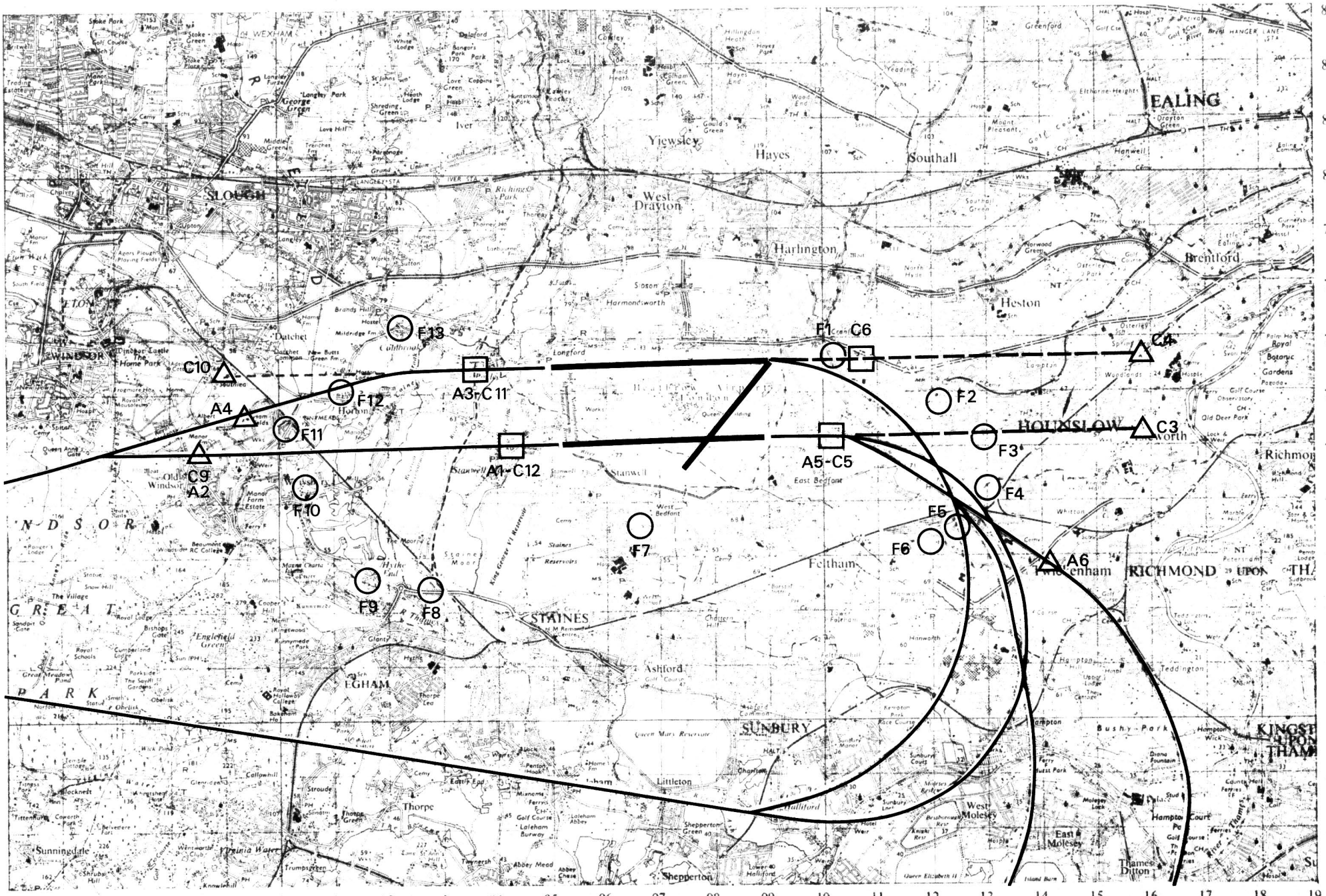


Fig 2 Concorde Measuring Sites

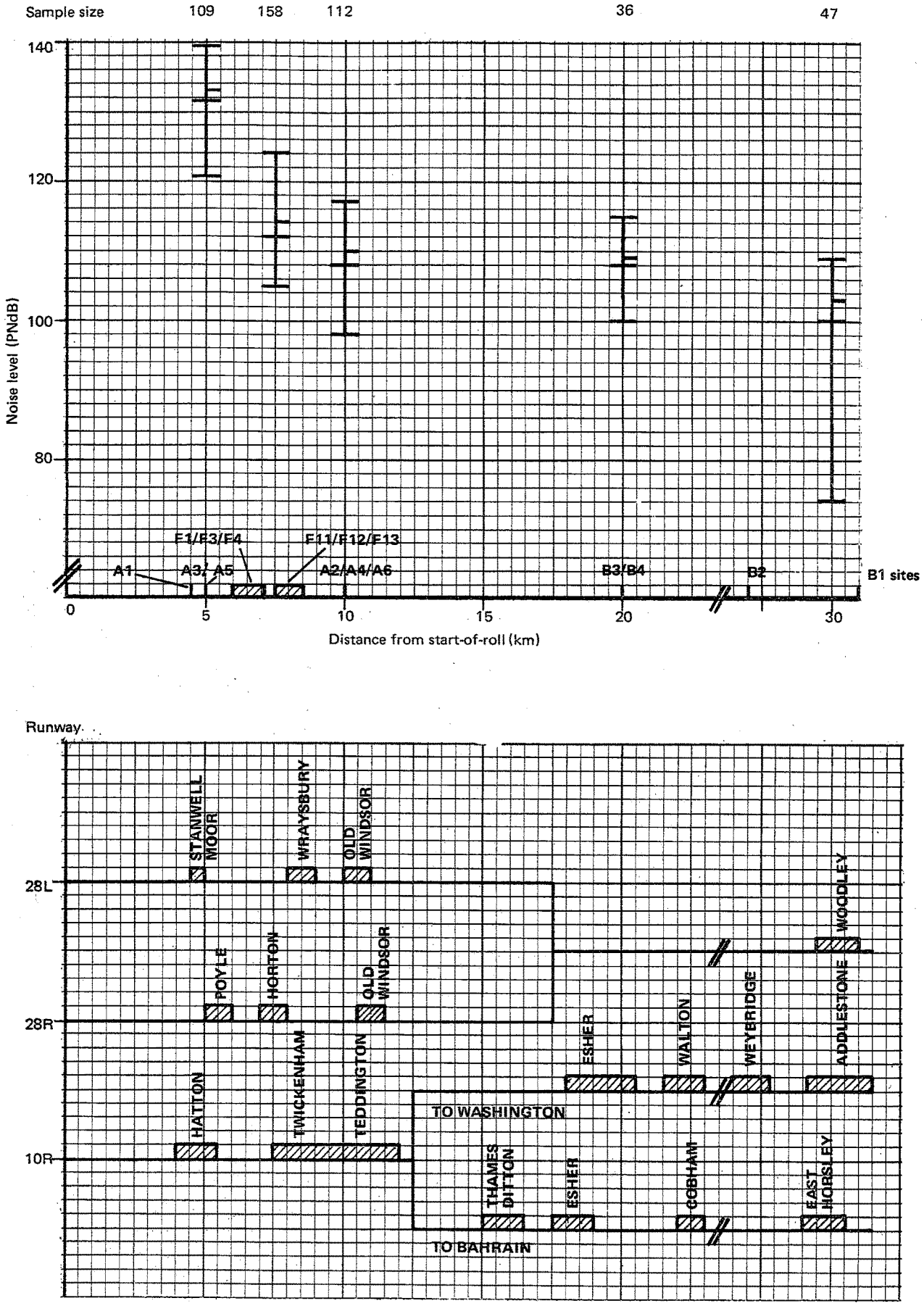
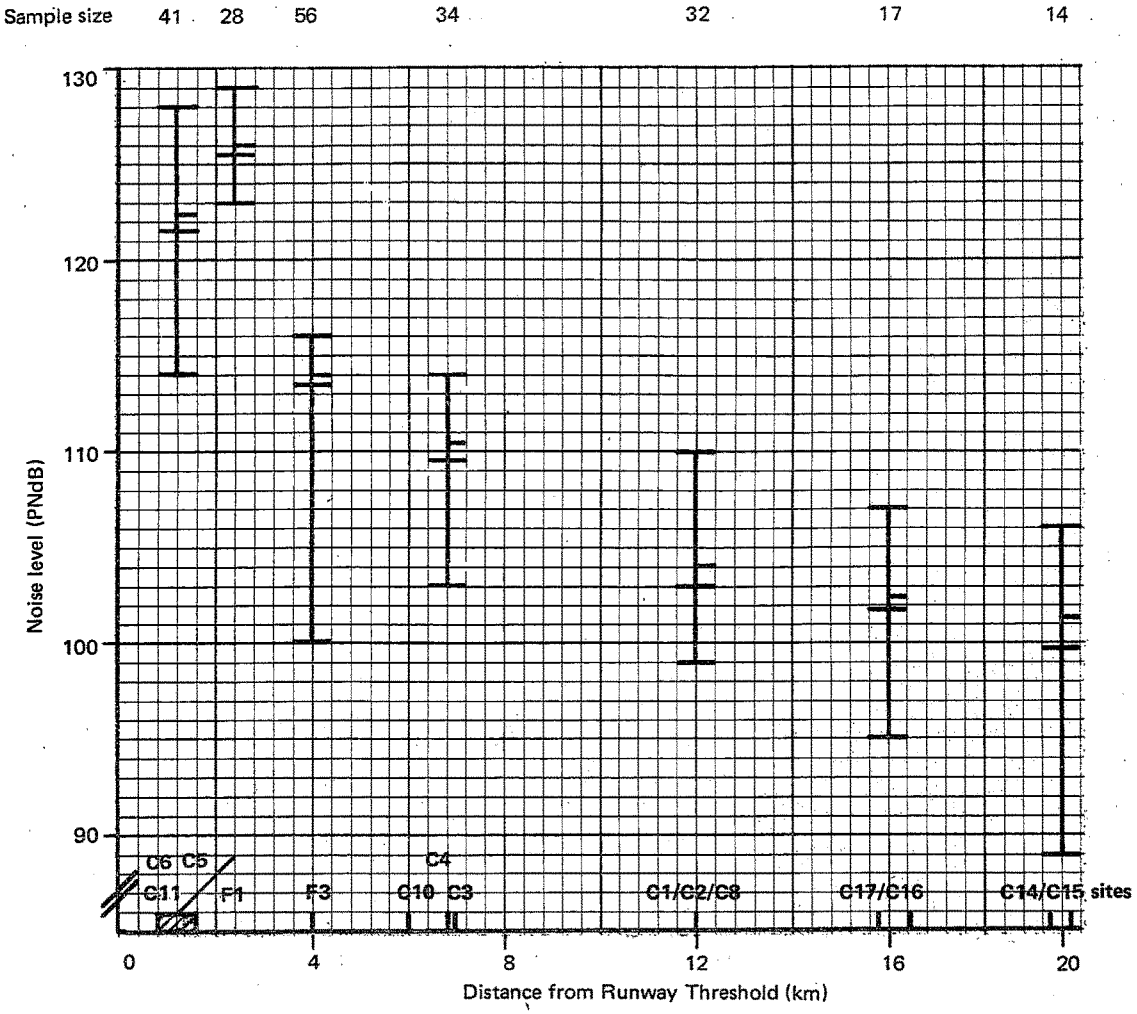


Fig 3 Concorde Departures – Measured Noise Level and Areas Affected



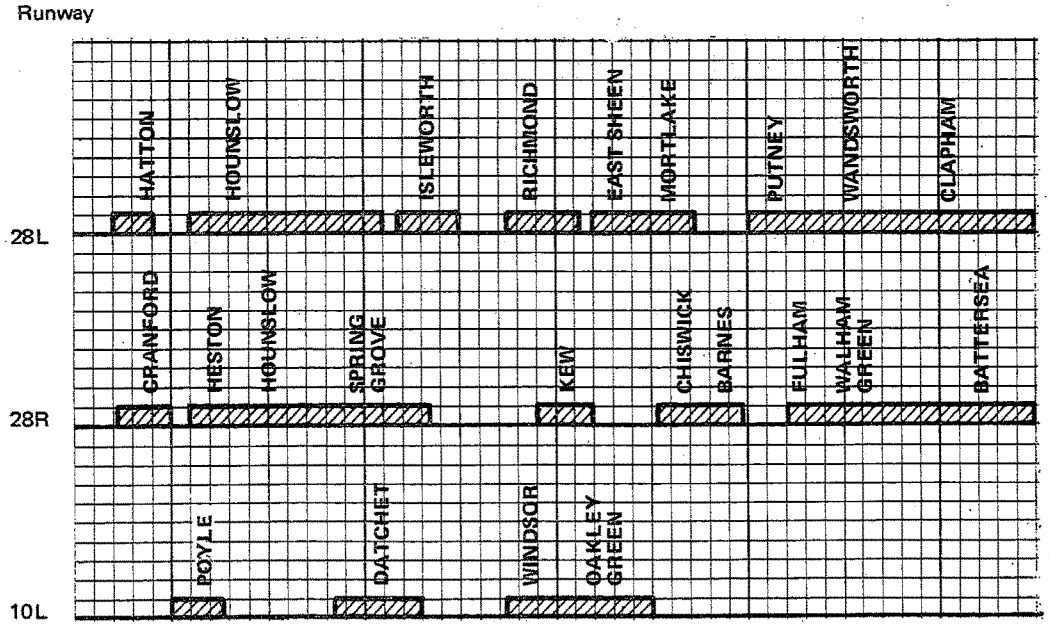
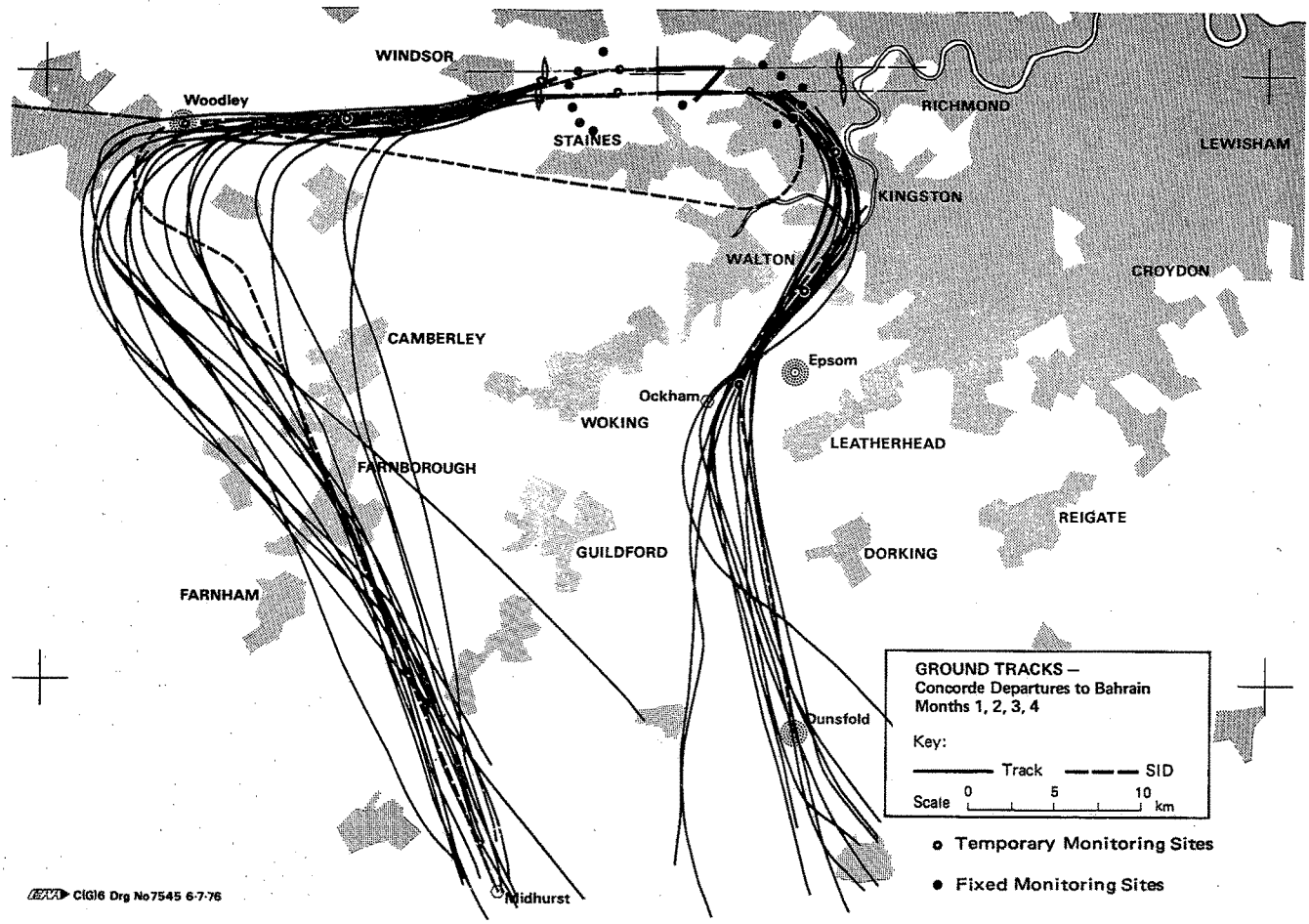


Fig 4 Concorde Arrivals – Measured Noise Level and Areas Affected



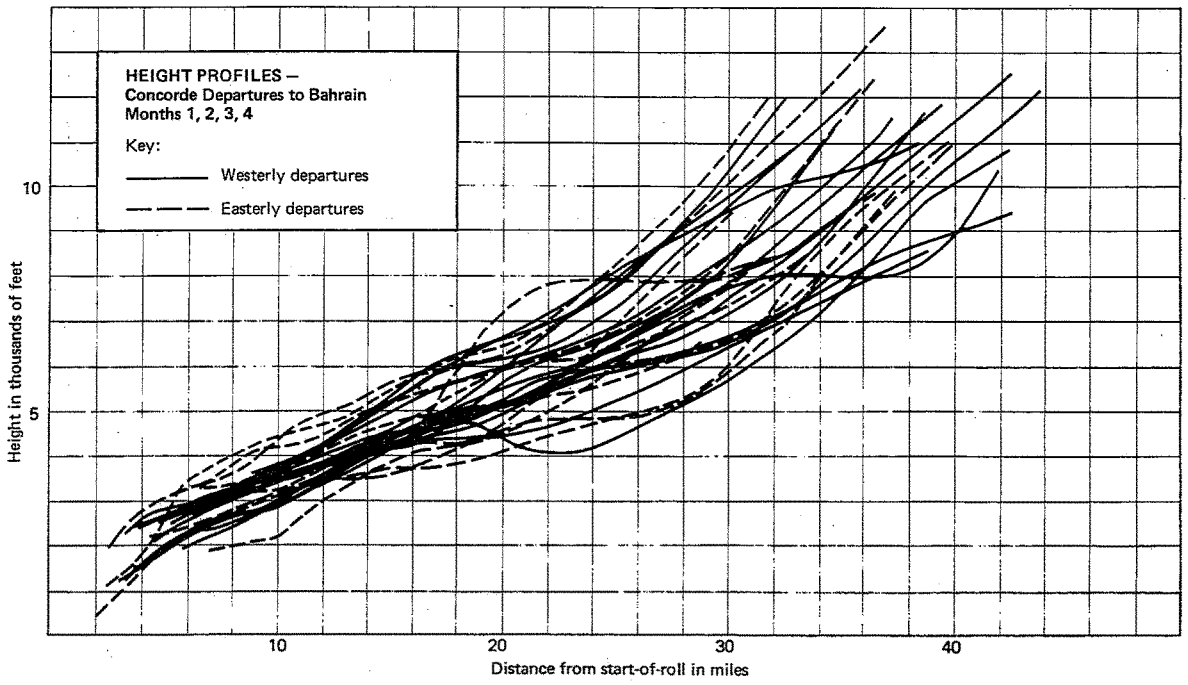
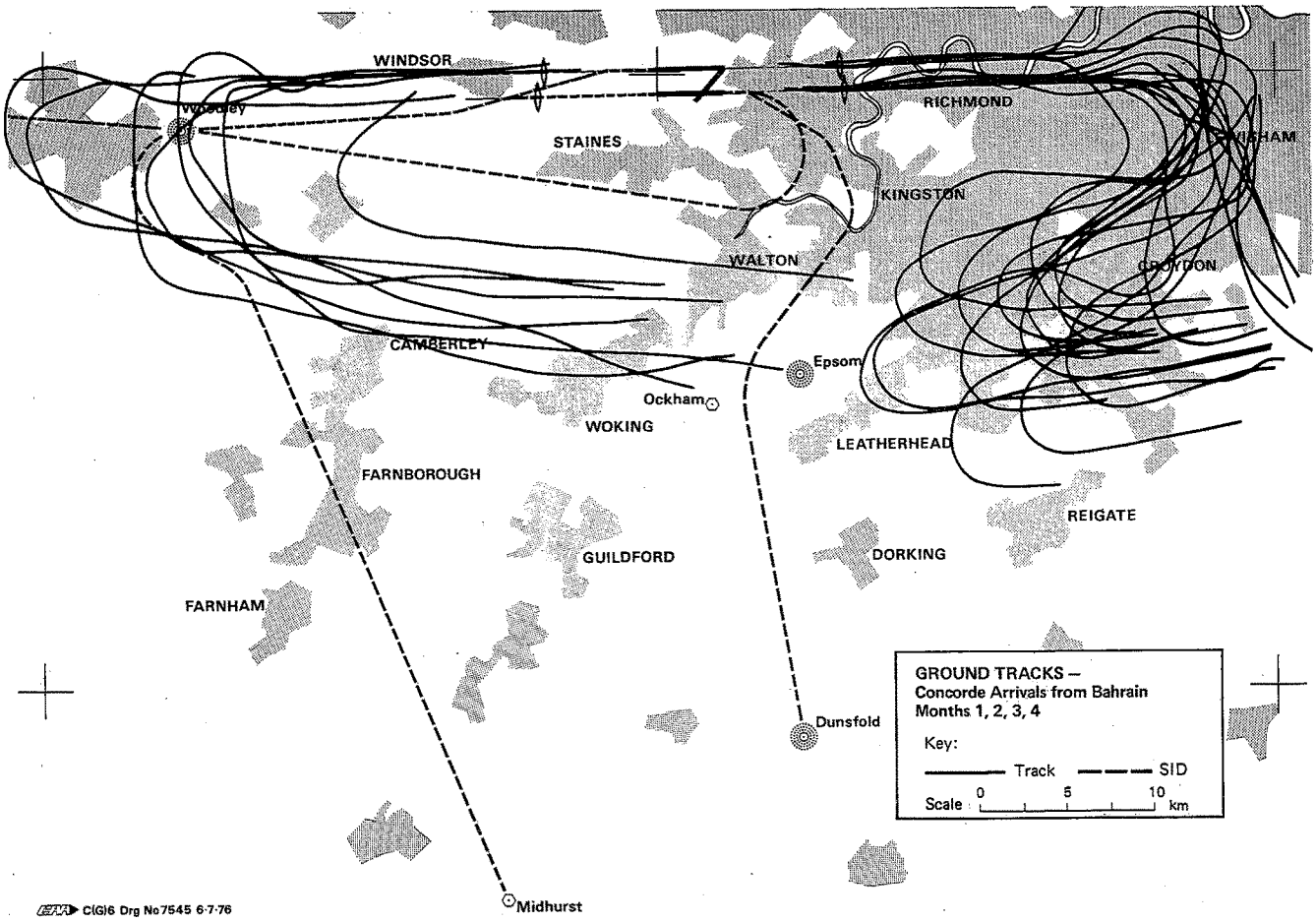


Fig 5 Flight Path Data, Concorde Departures, First Four Months



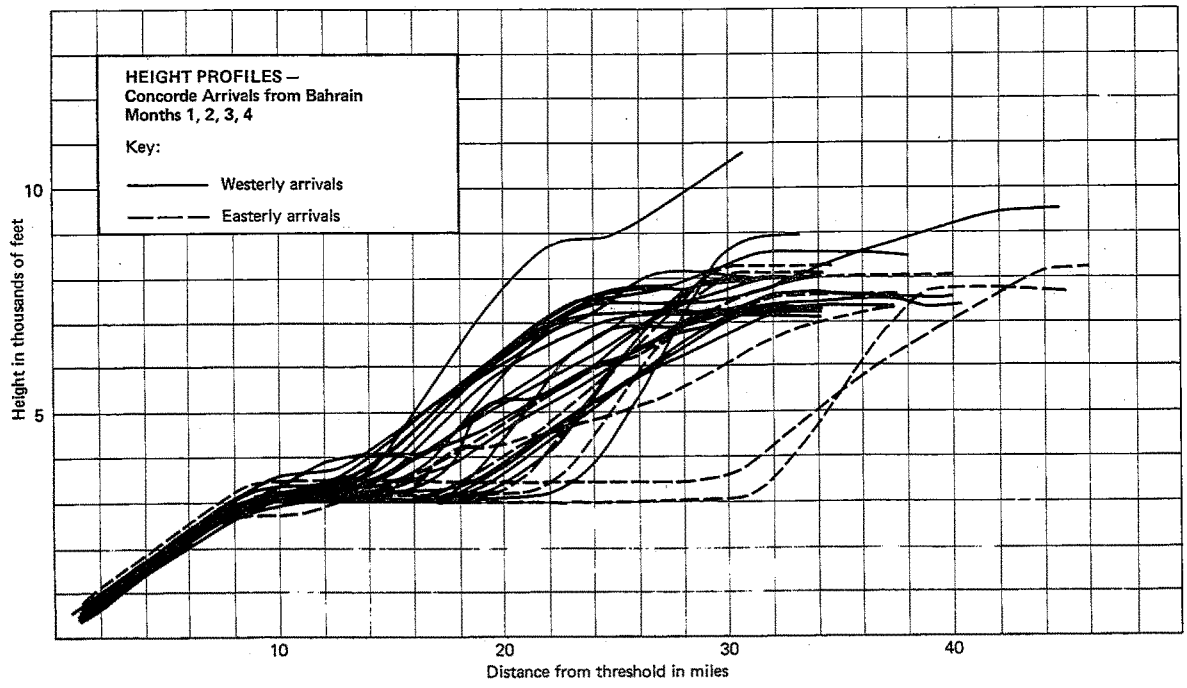
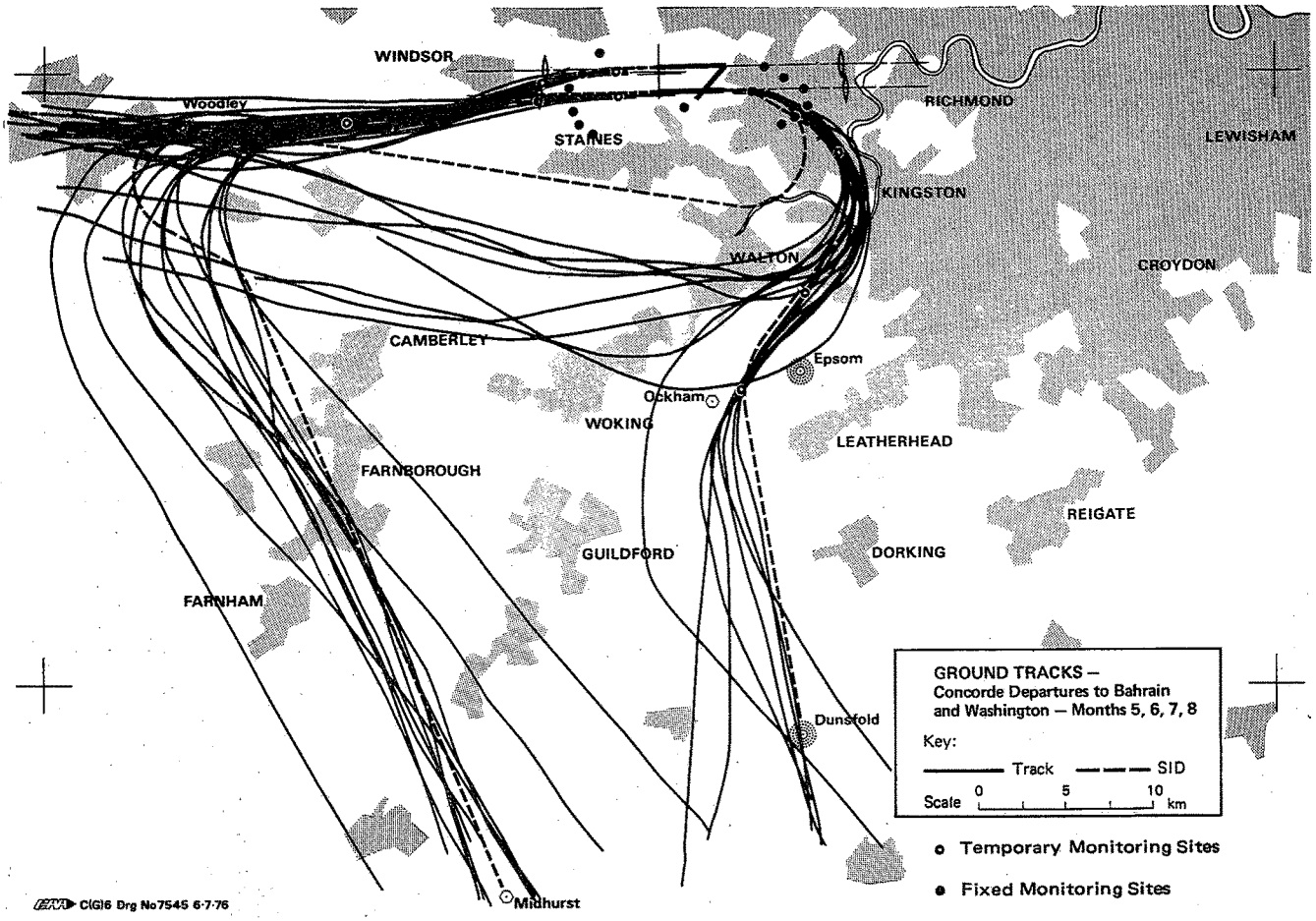


Fig 6 Flight Path Data, Concorde Arrivals, First Four Months



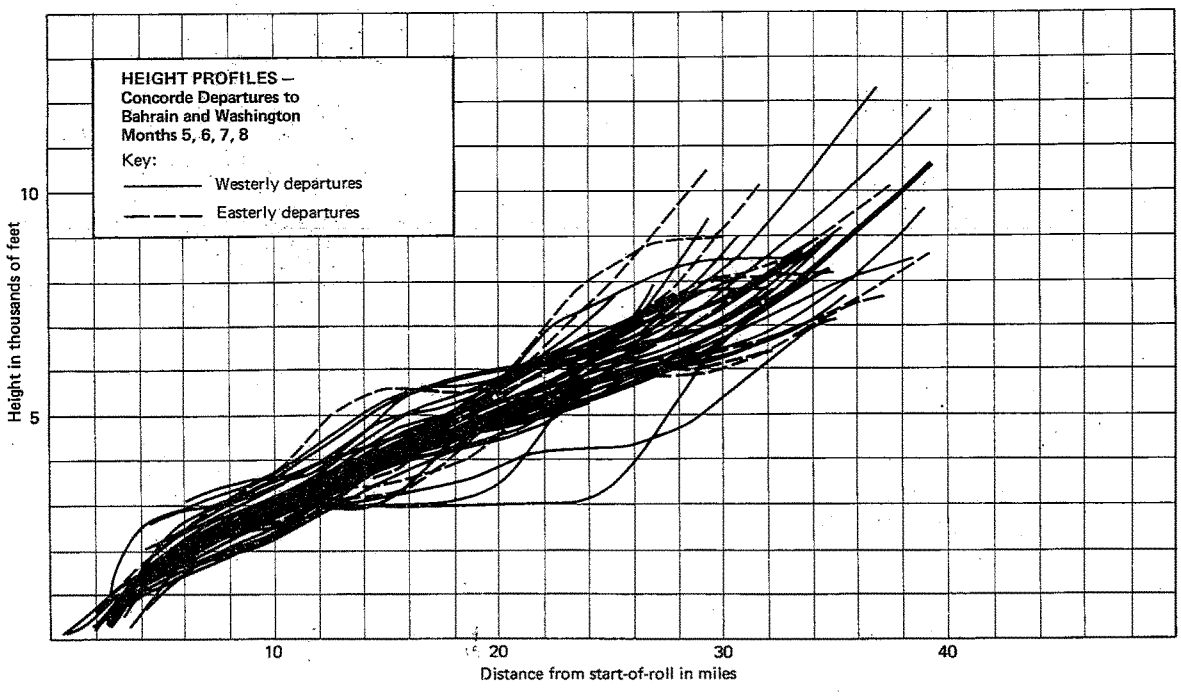
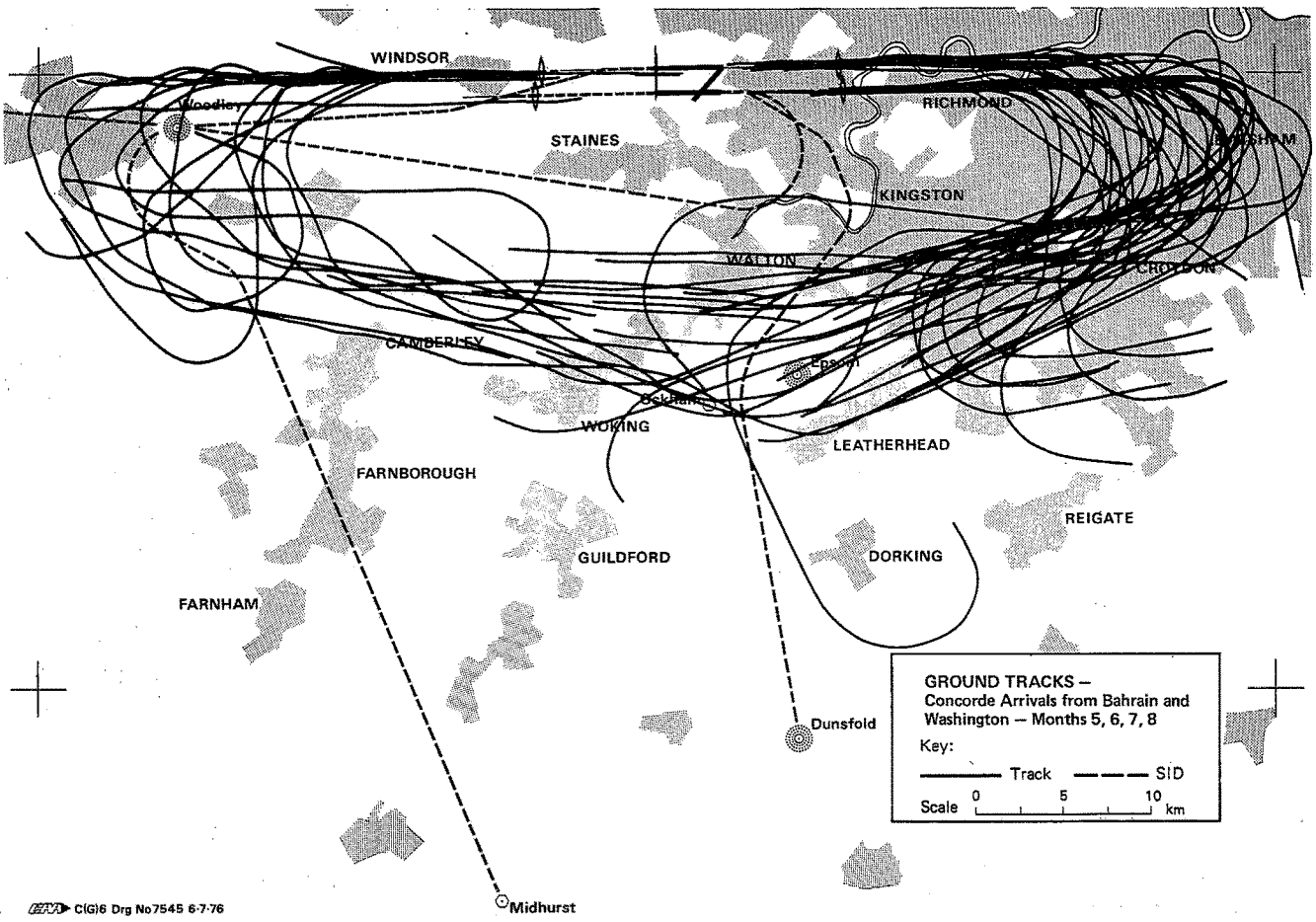


Fig 7 Flight Path Data, Concorde Departures, Second Four Months



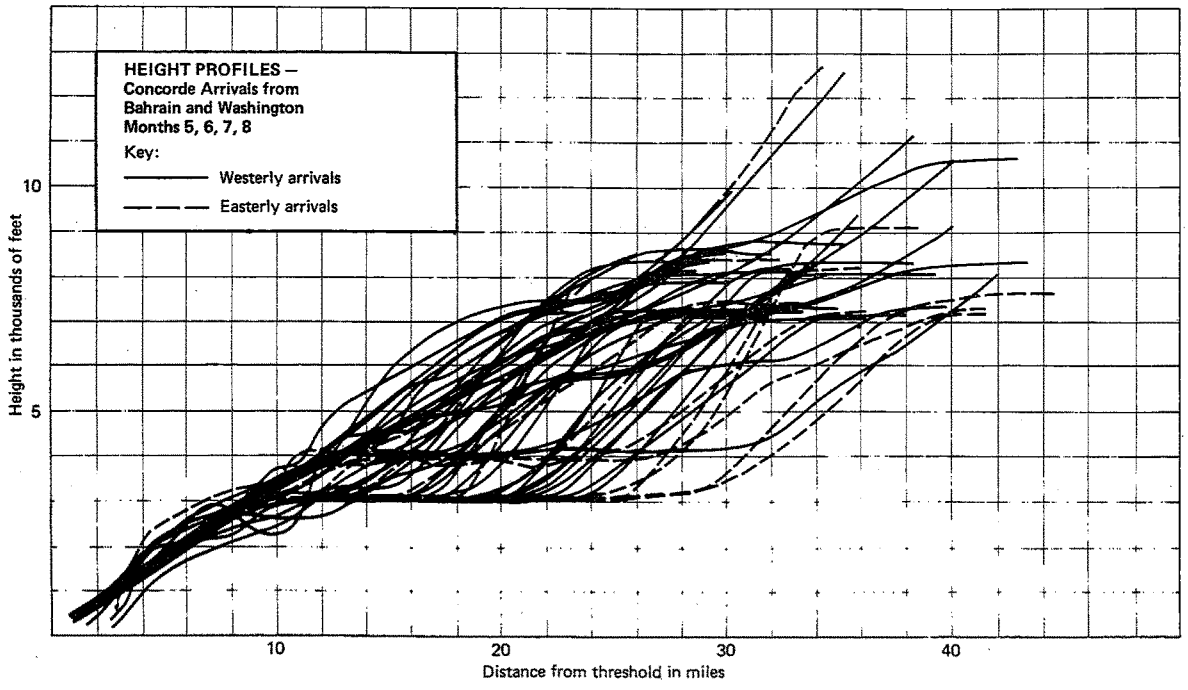
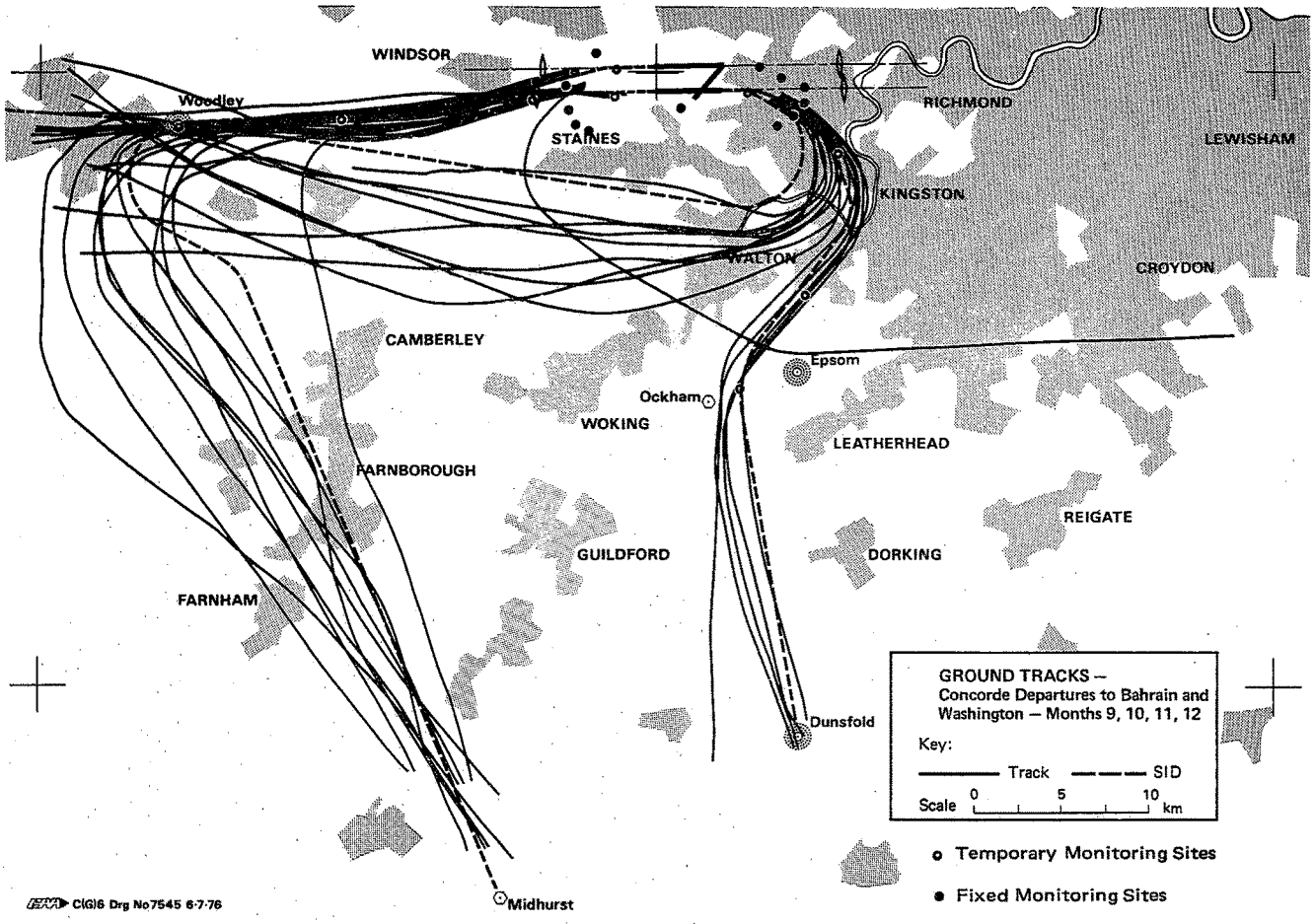


Fig 8 Flight Path Data, Concorde Arrivals, Second Four Months



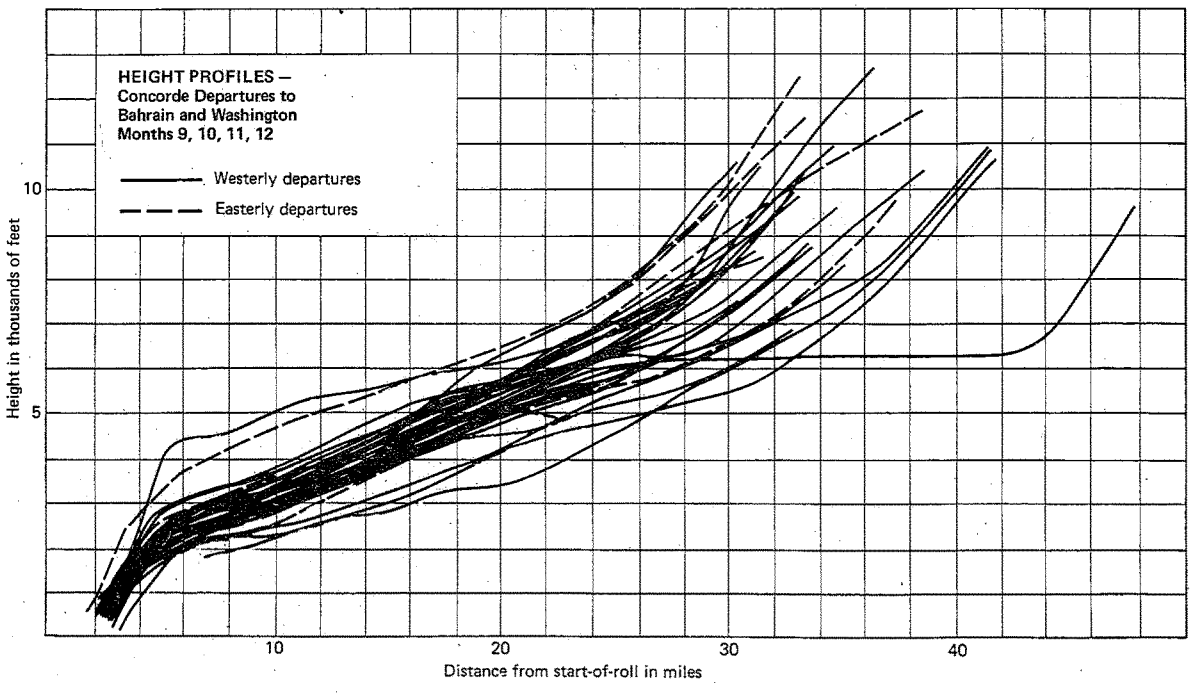
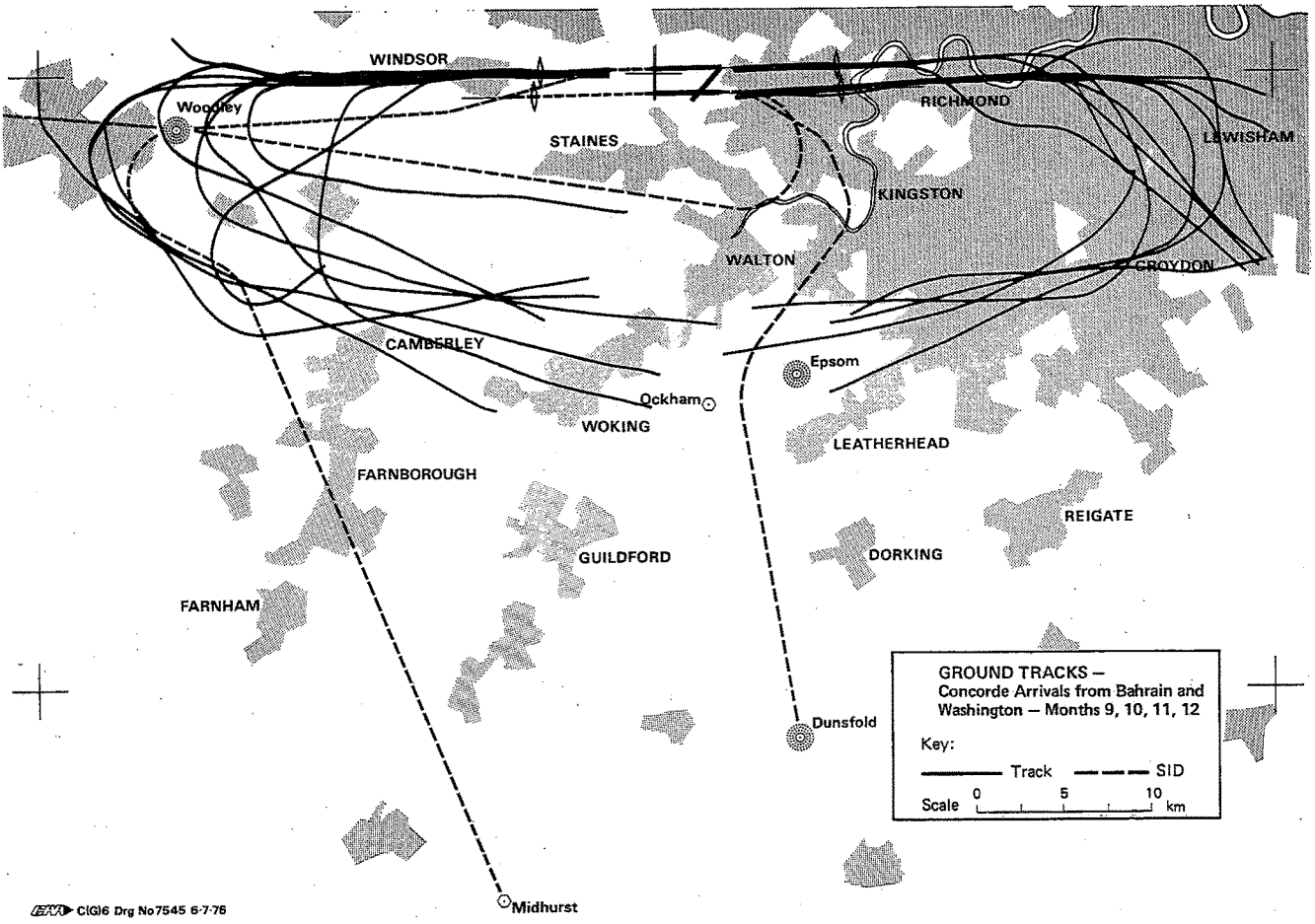


Fig 9 Flight Path Data, Concorde Departures, Third Four Months



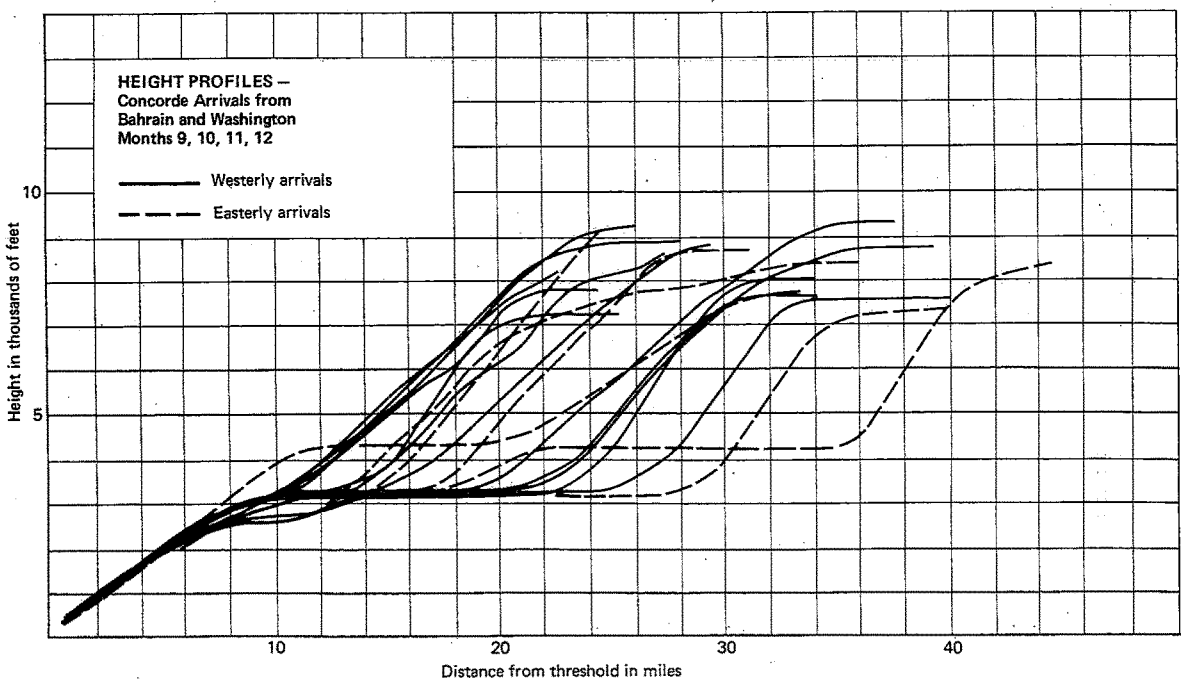
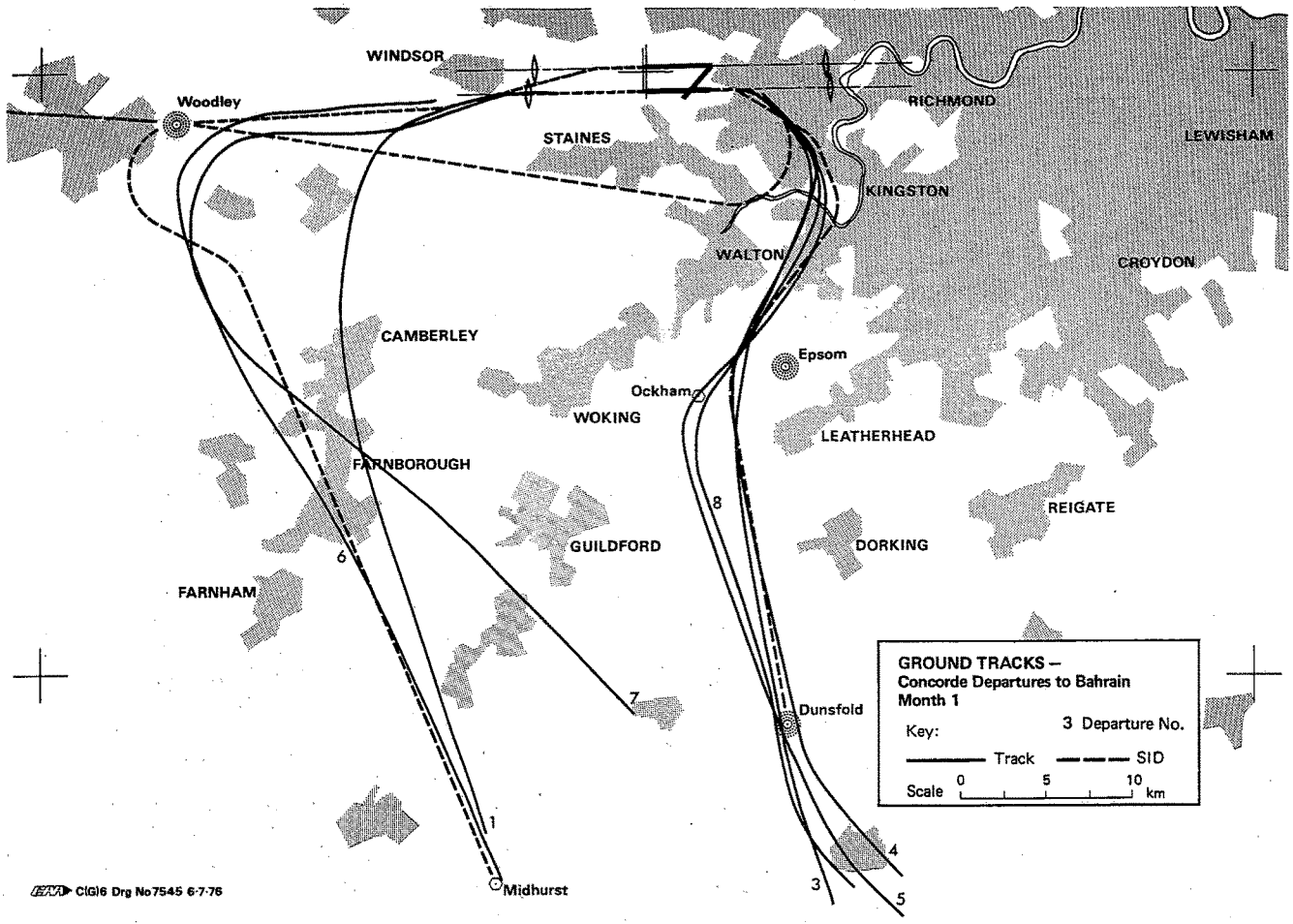


Fig 10 Flight Path Data, Concorde Arrivals, Third Four Months



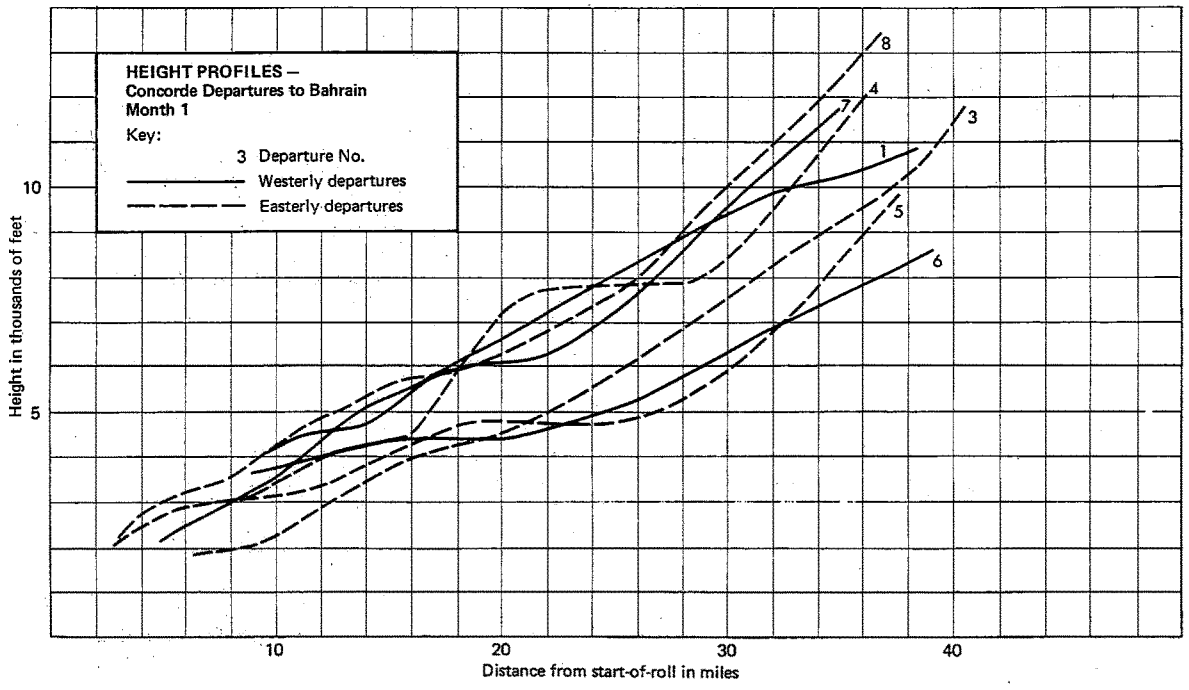
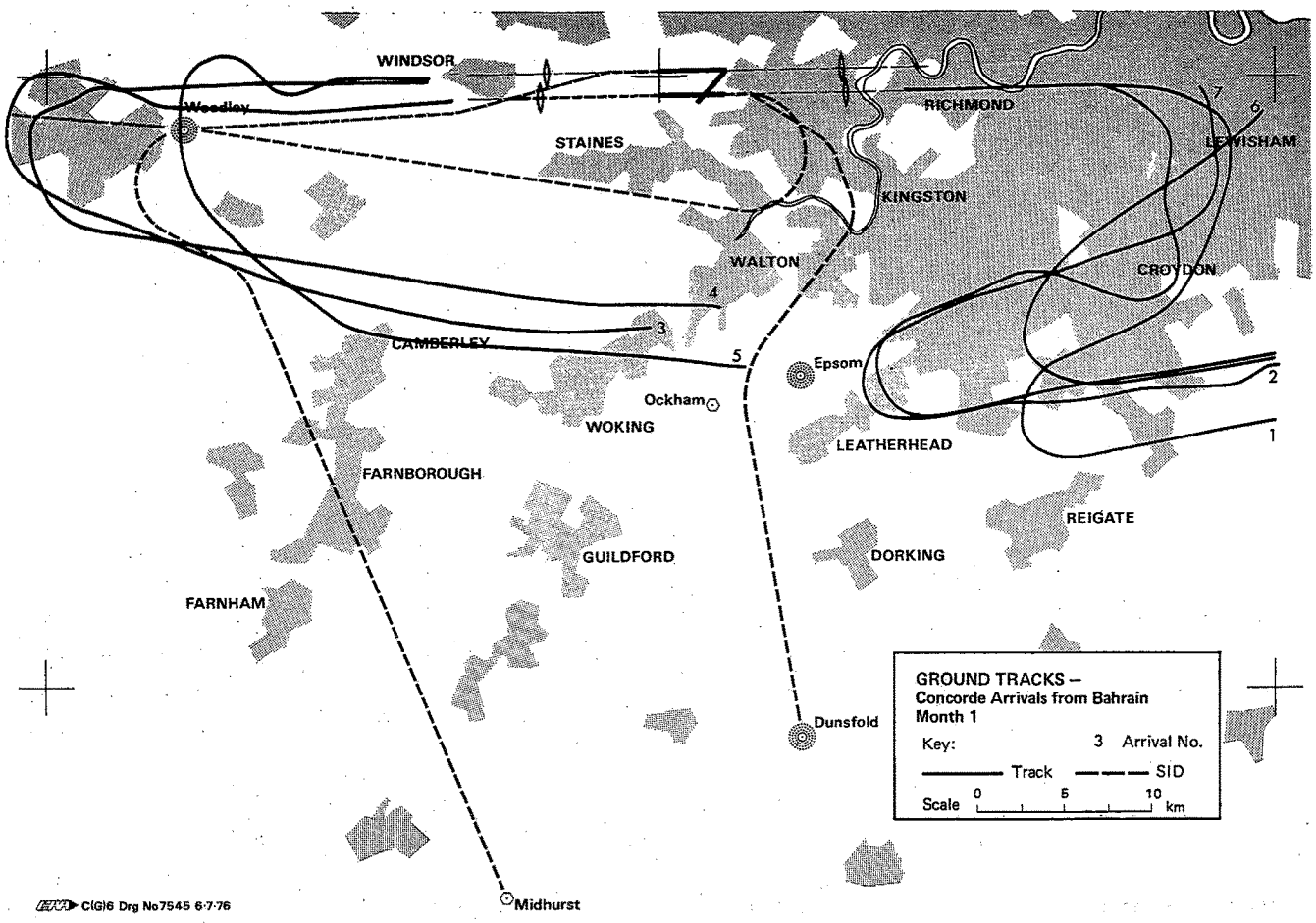


Fig 11 Flight Path Data, Departures to Bahrain, Month 1



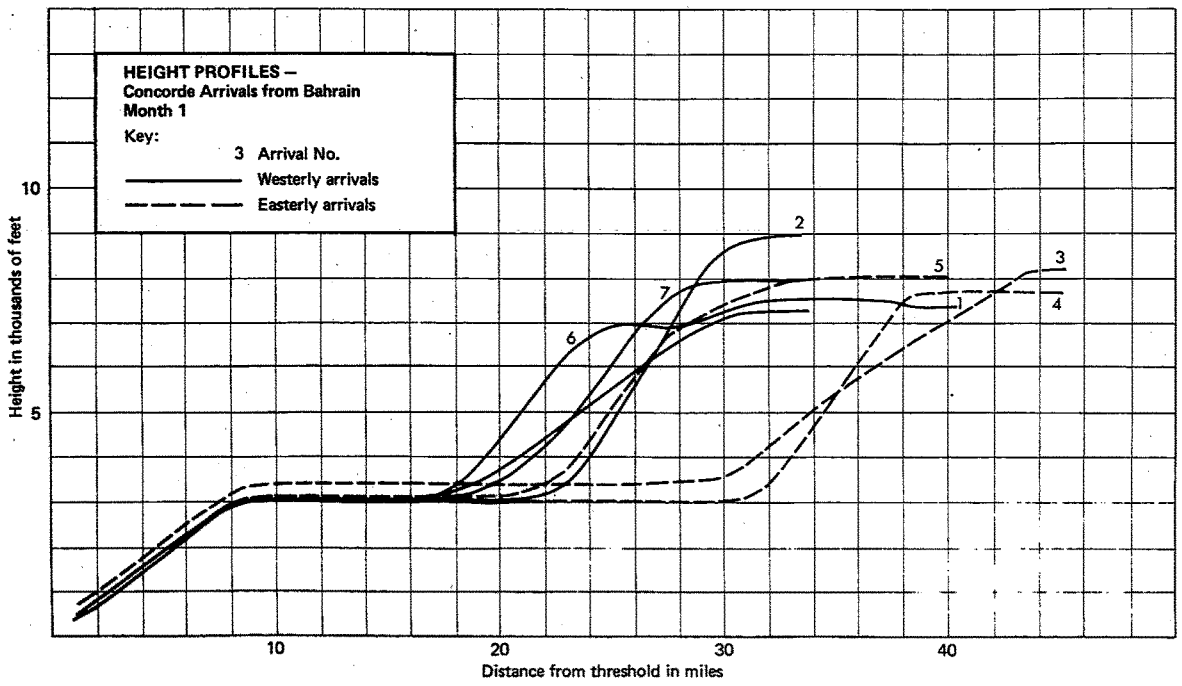
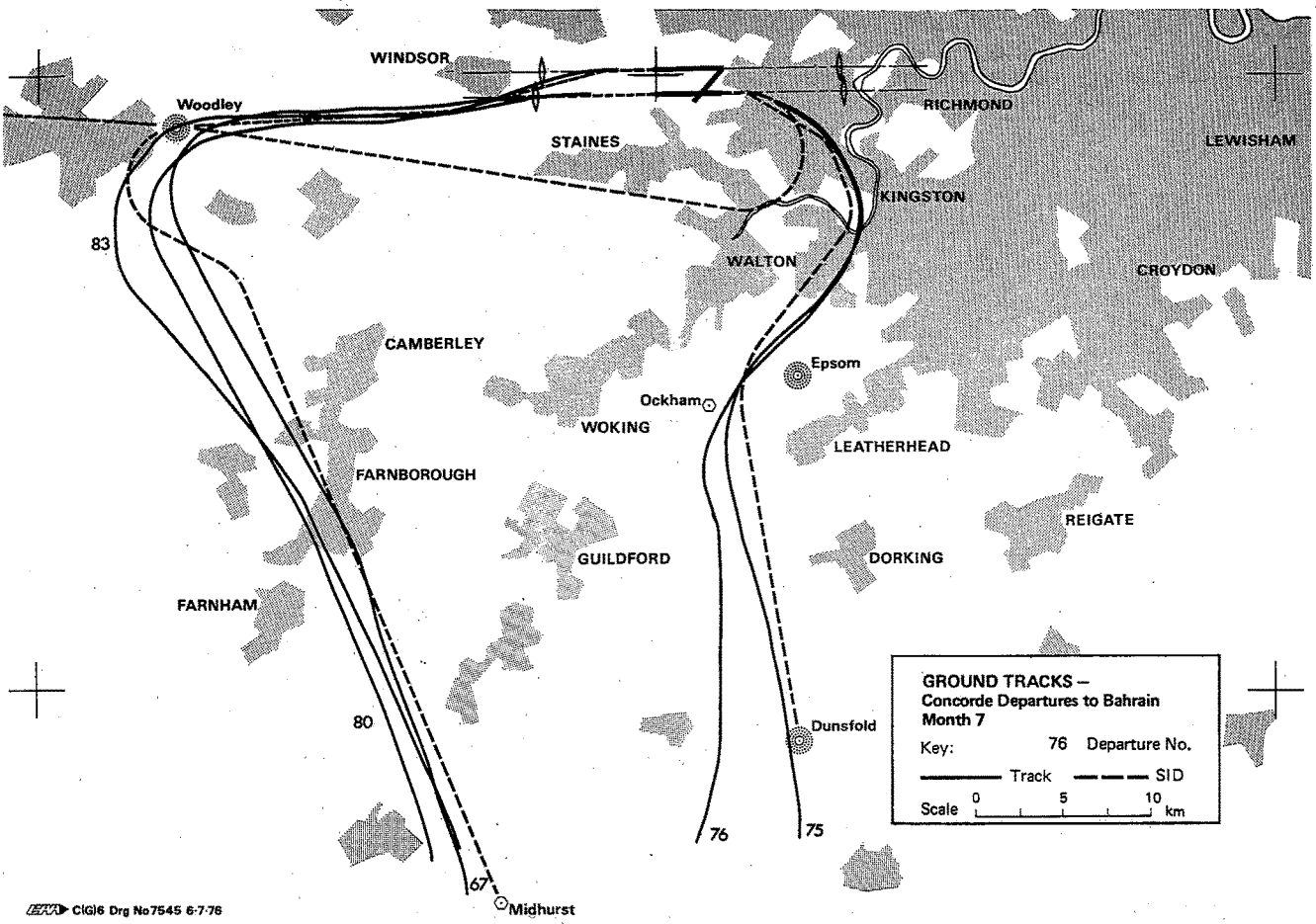


Fig 12 Flight Path Data, Arrivals from Bahrain, Month 1



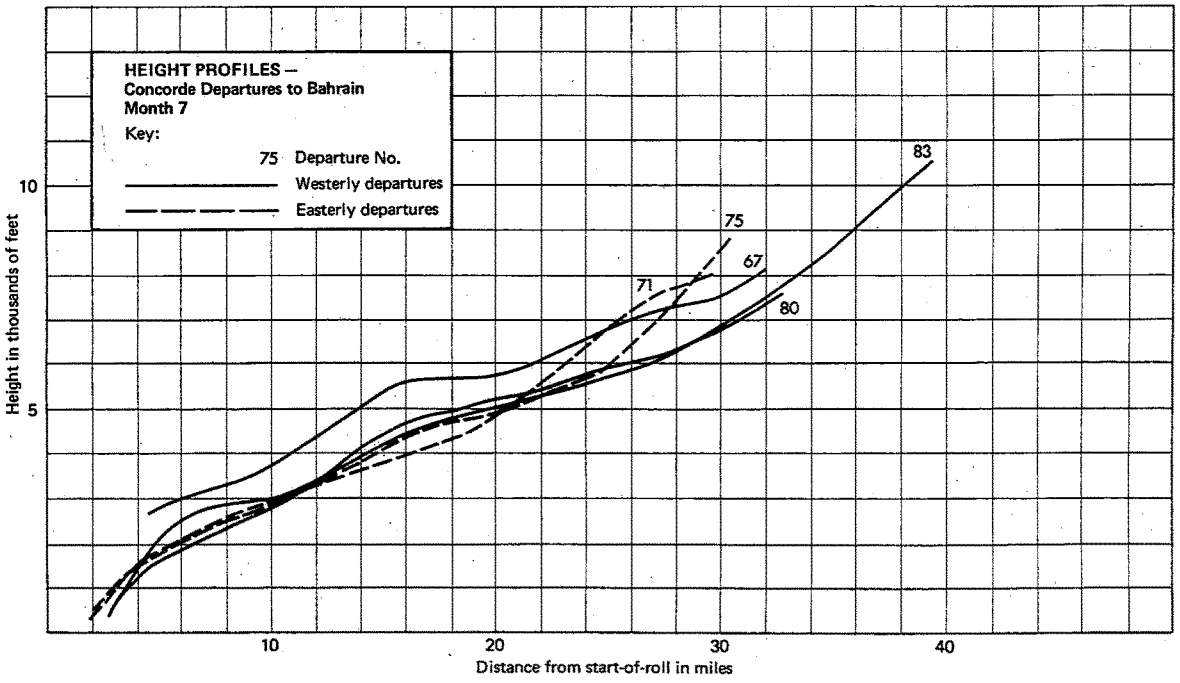
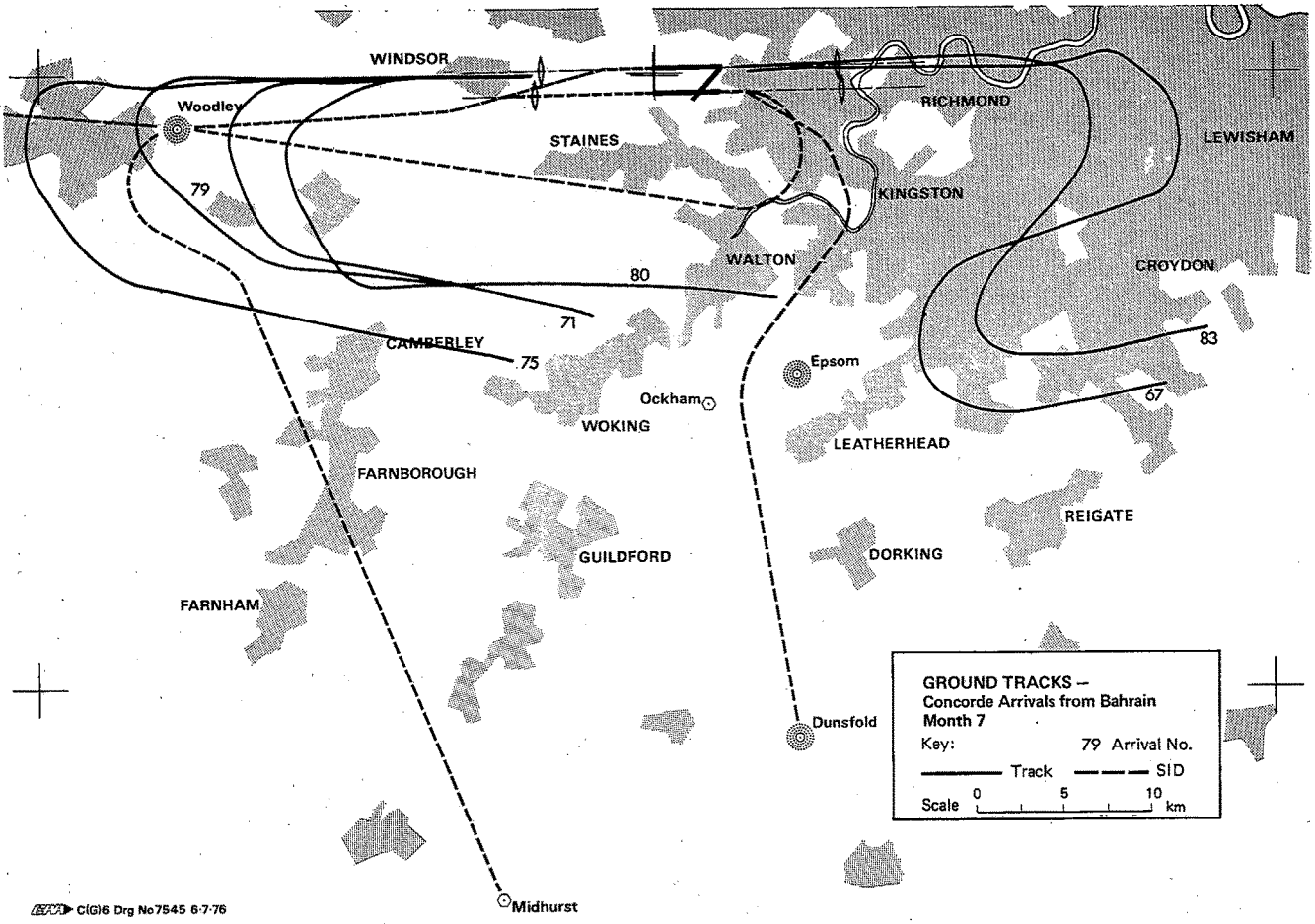


Fig 13 Flight Path Data, Departures to Bahrain, Month 7



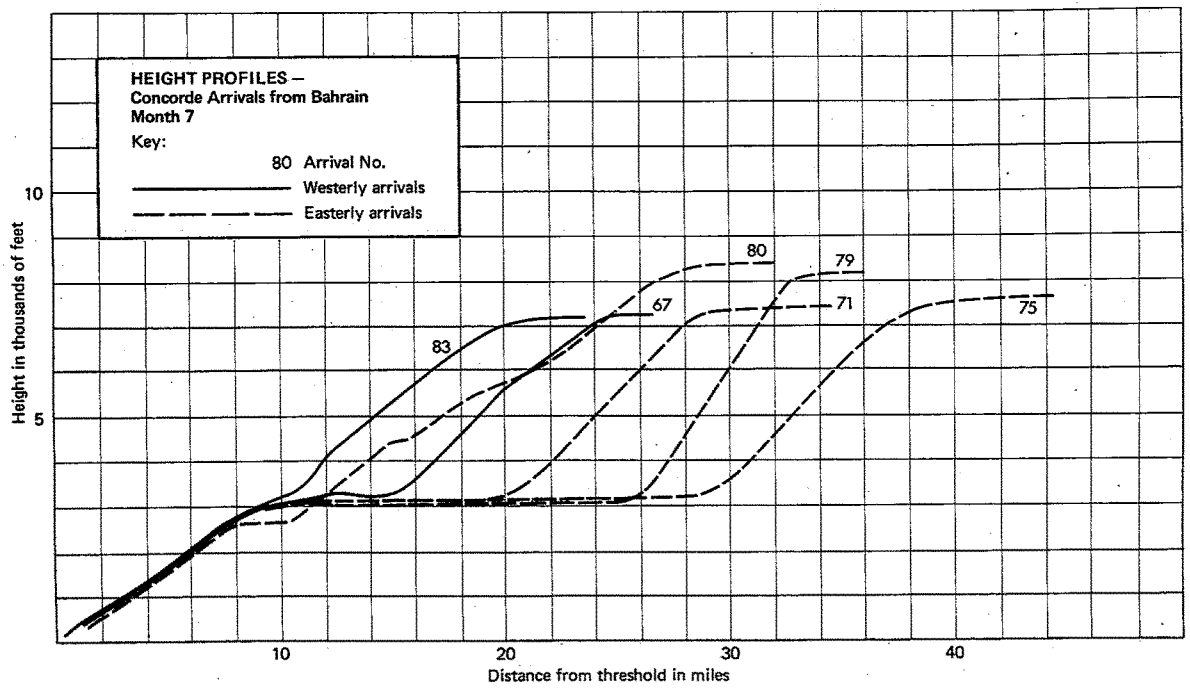
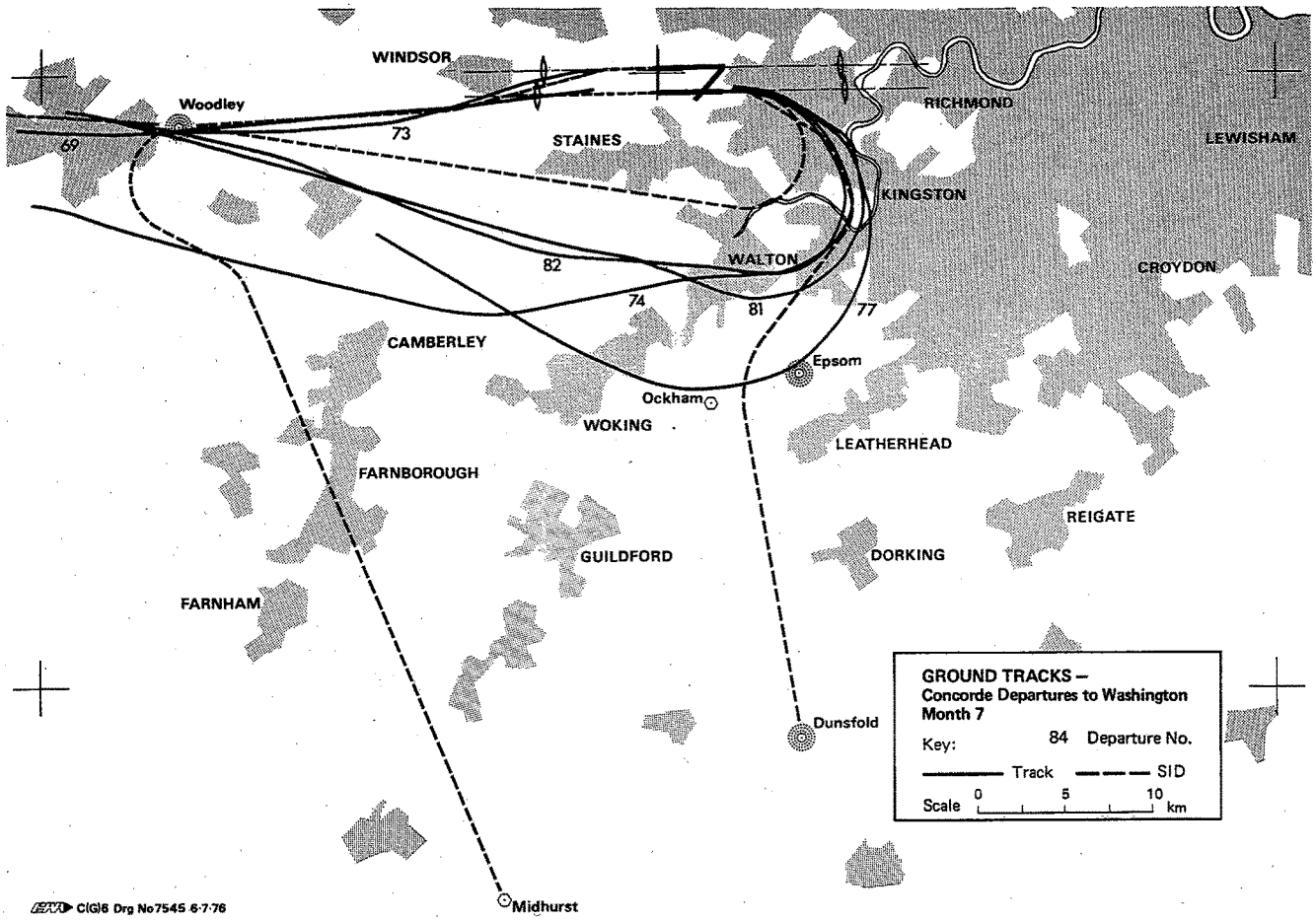


Fig 14 Flight Path Data, Arrivals from Bahrain, Month 7



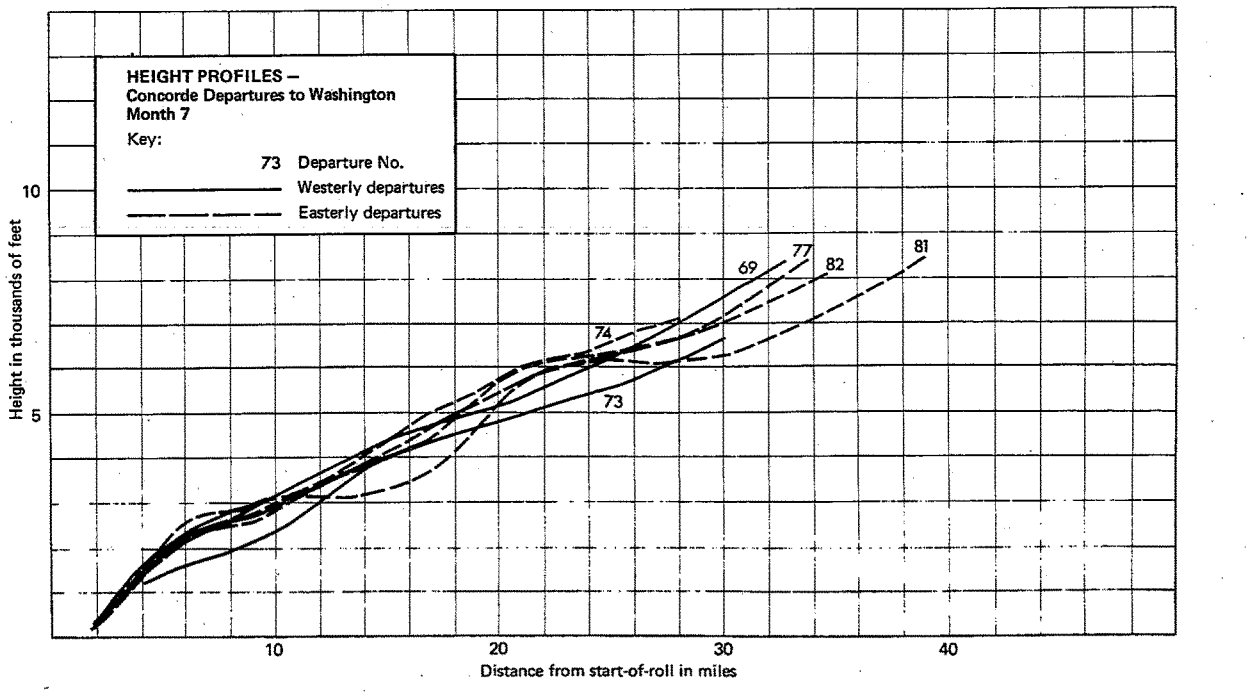
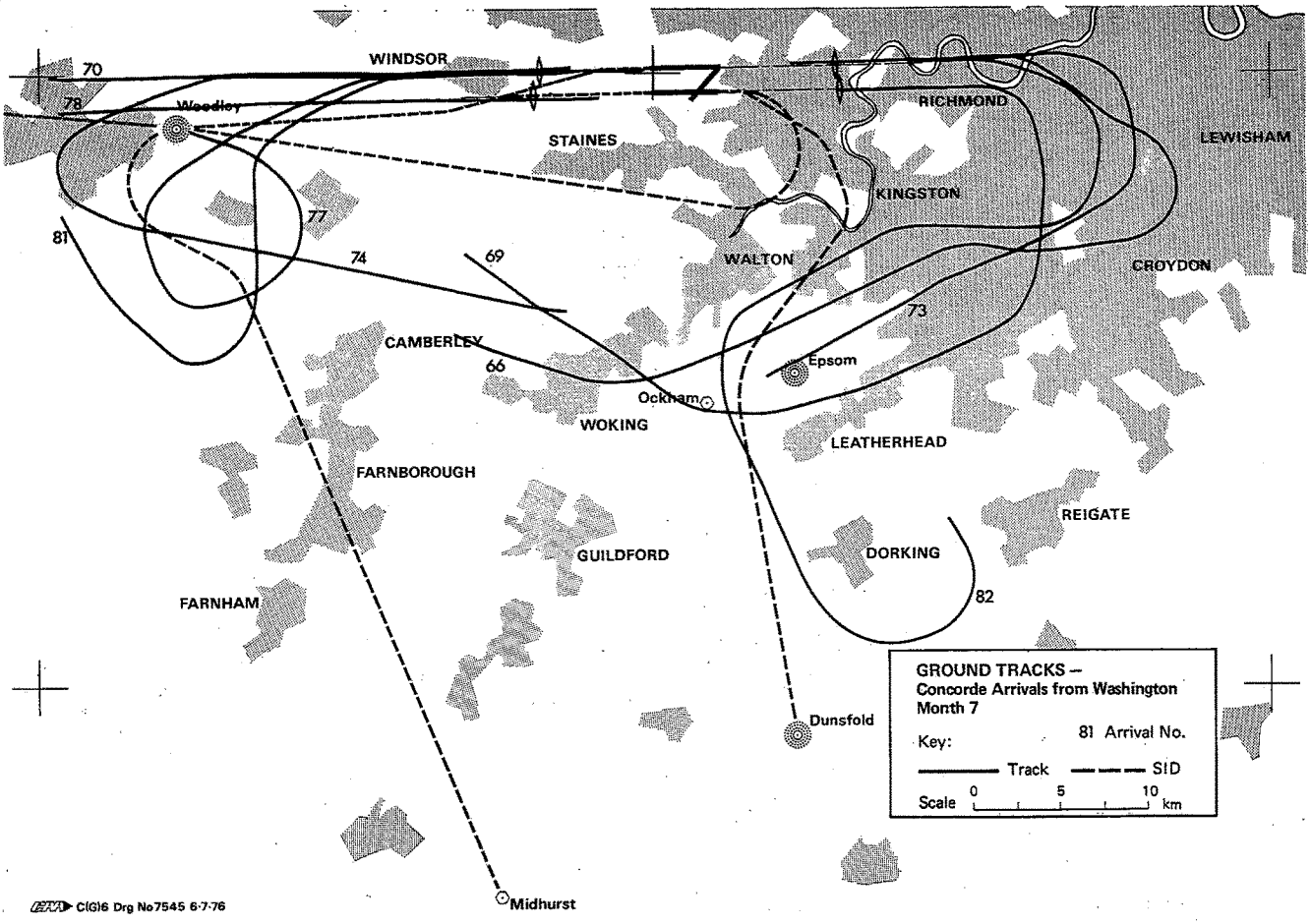


Fig 15 Flight Path Data, Departures to Washington, Month 7



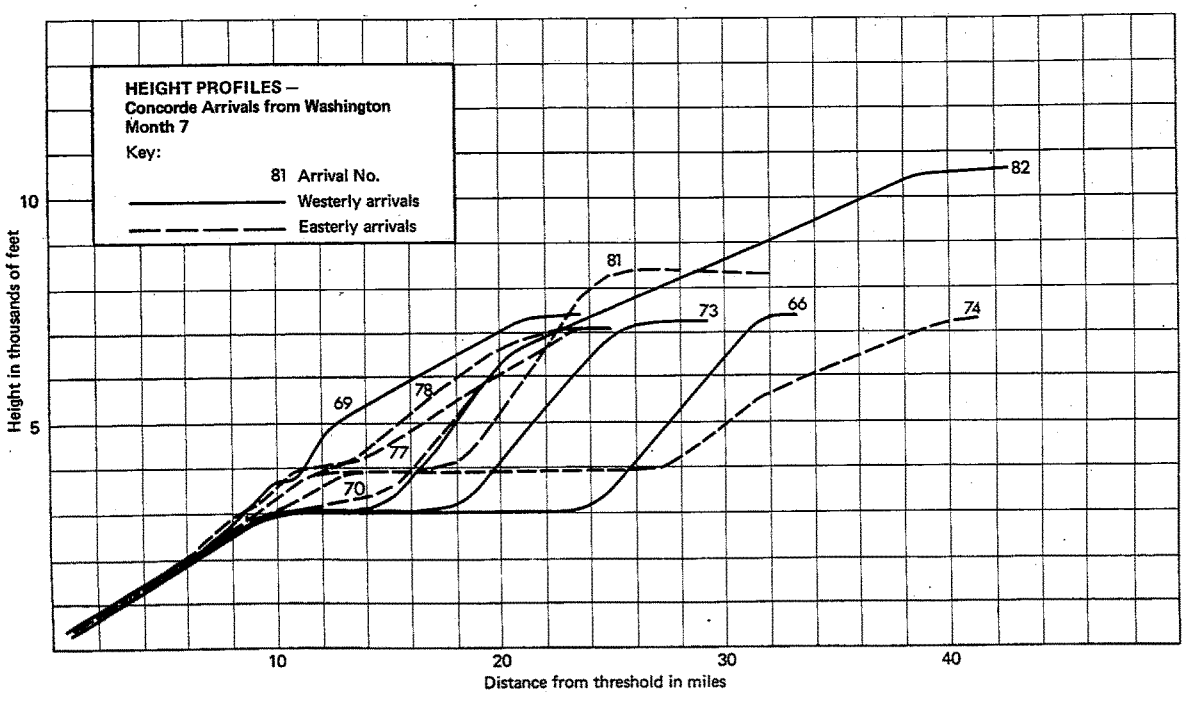
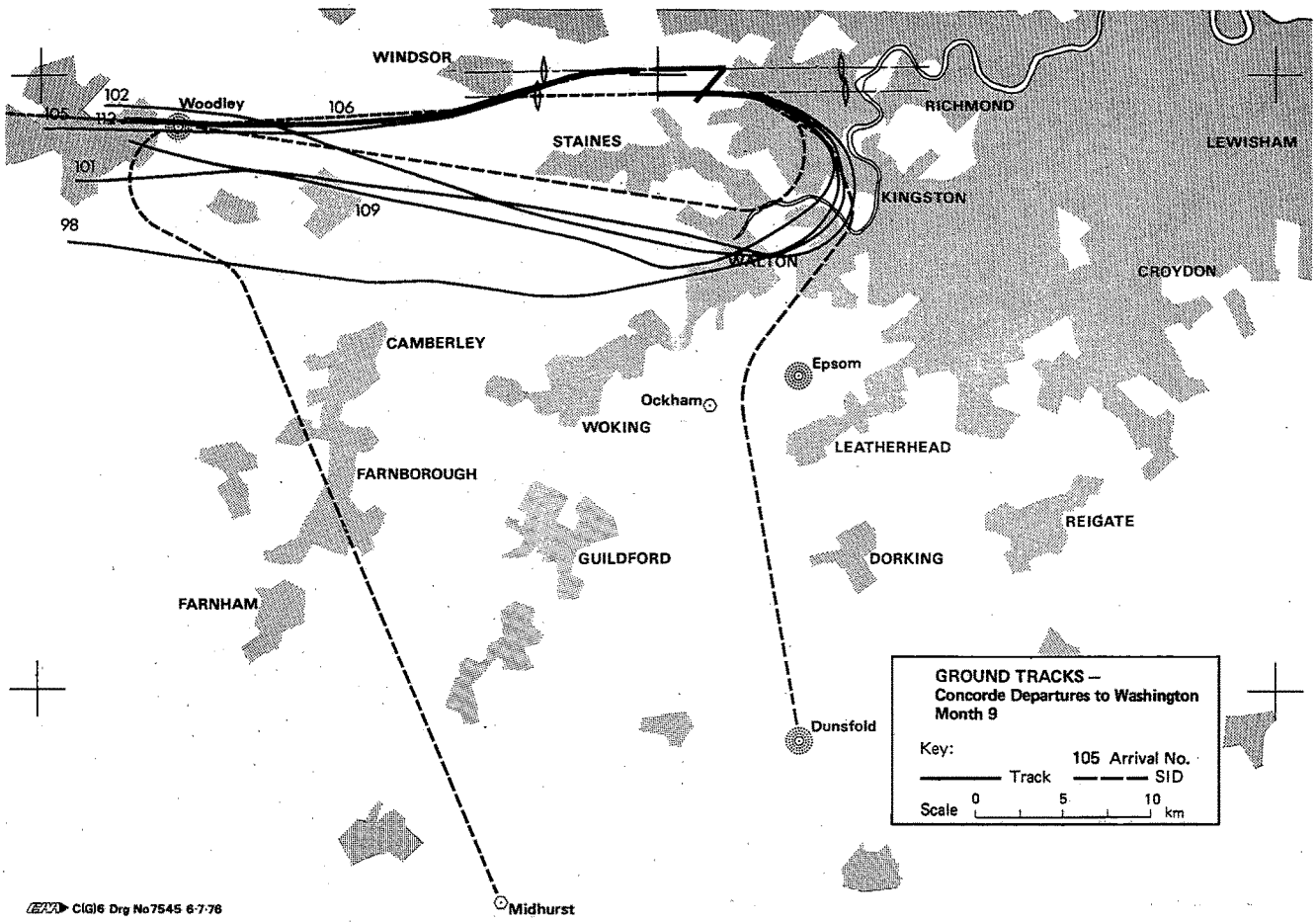


Fig 16 Flight Path Data, Arrivals from Washington, Month 7



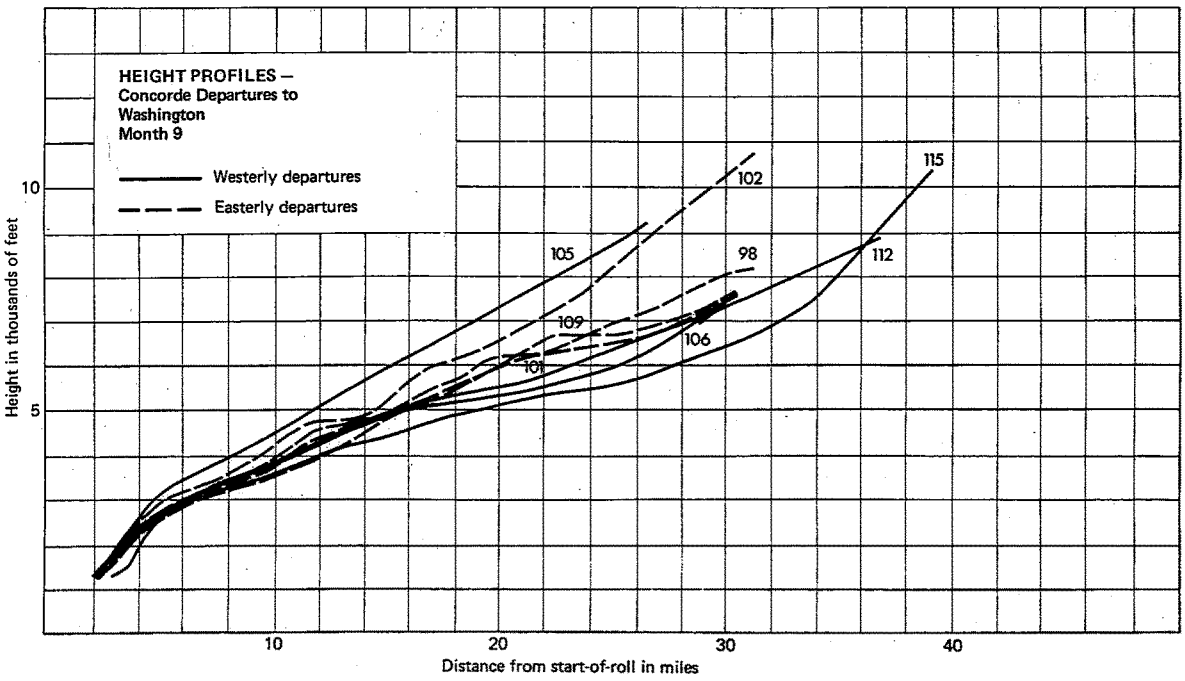
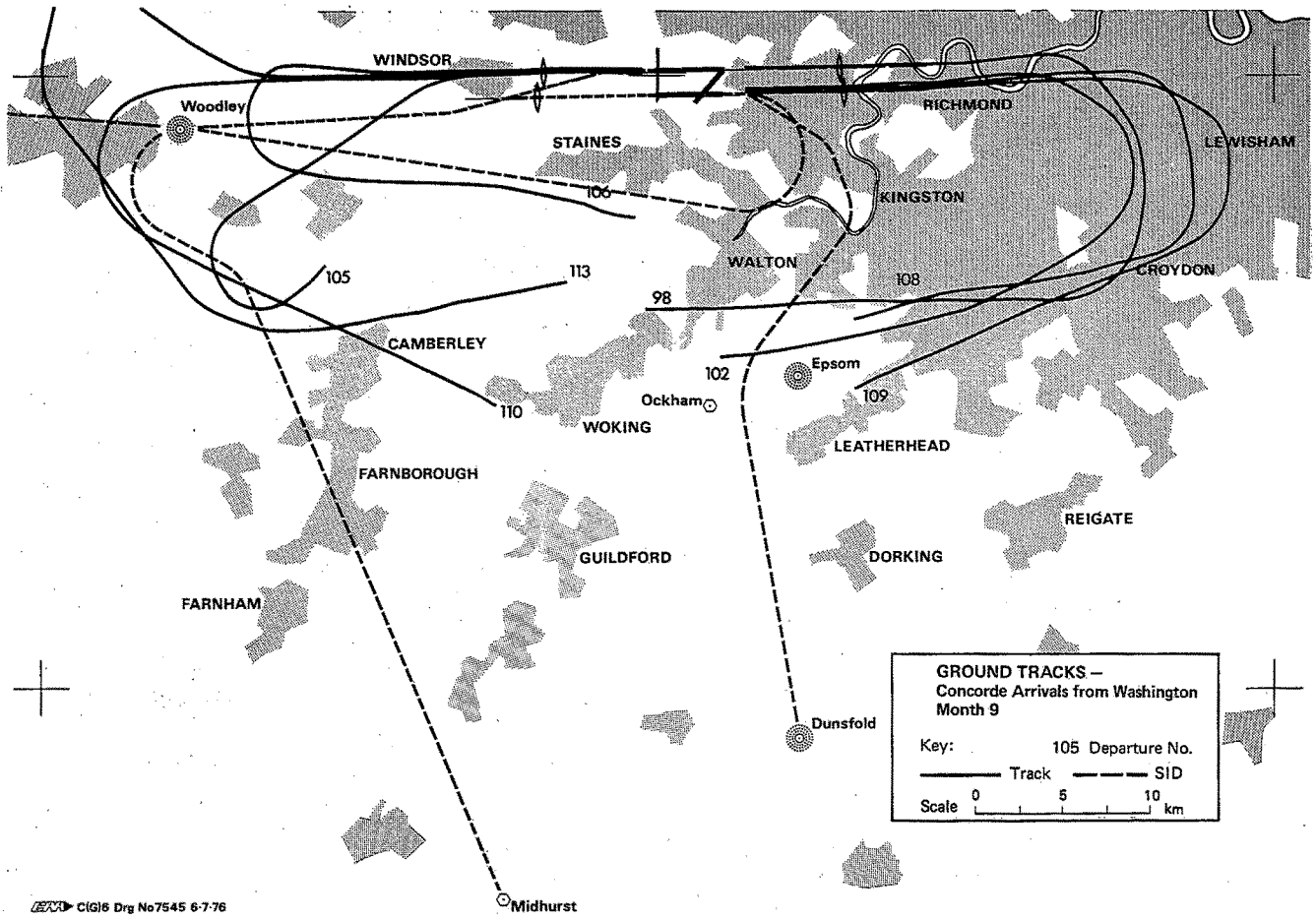


Fig 17 Flight Path Data, Departures to Washington, Month 9



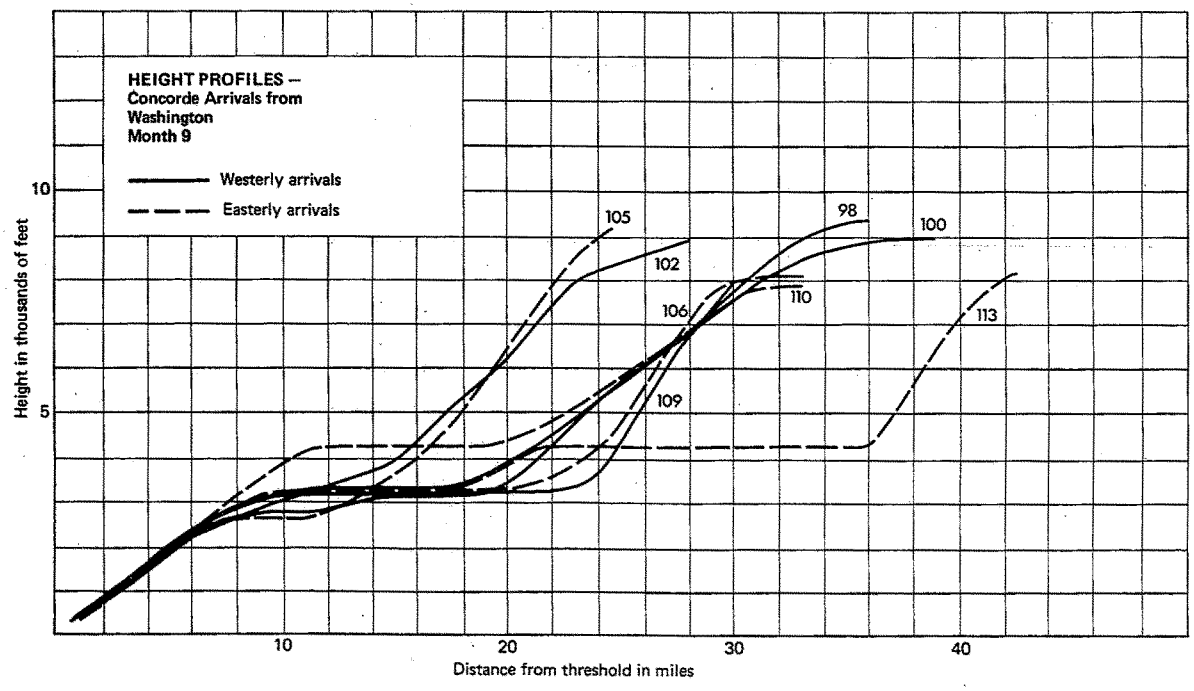


Fig 18 Flight Path Data, Arrivals from Washington, Month 9

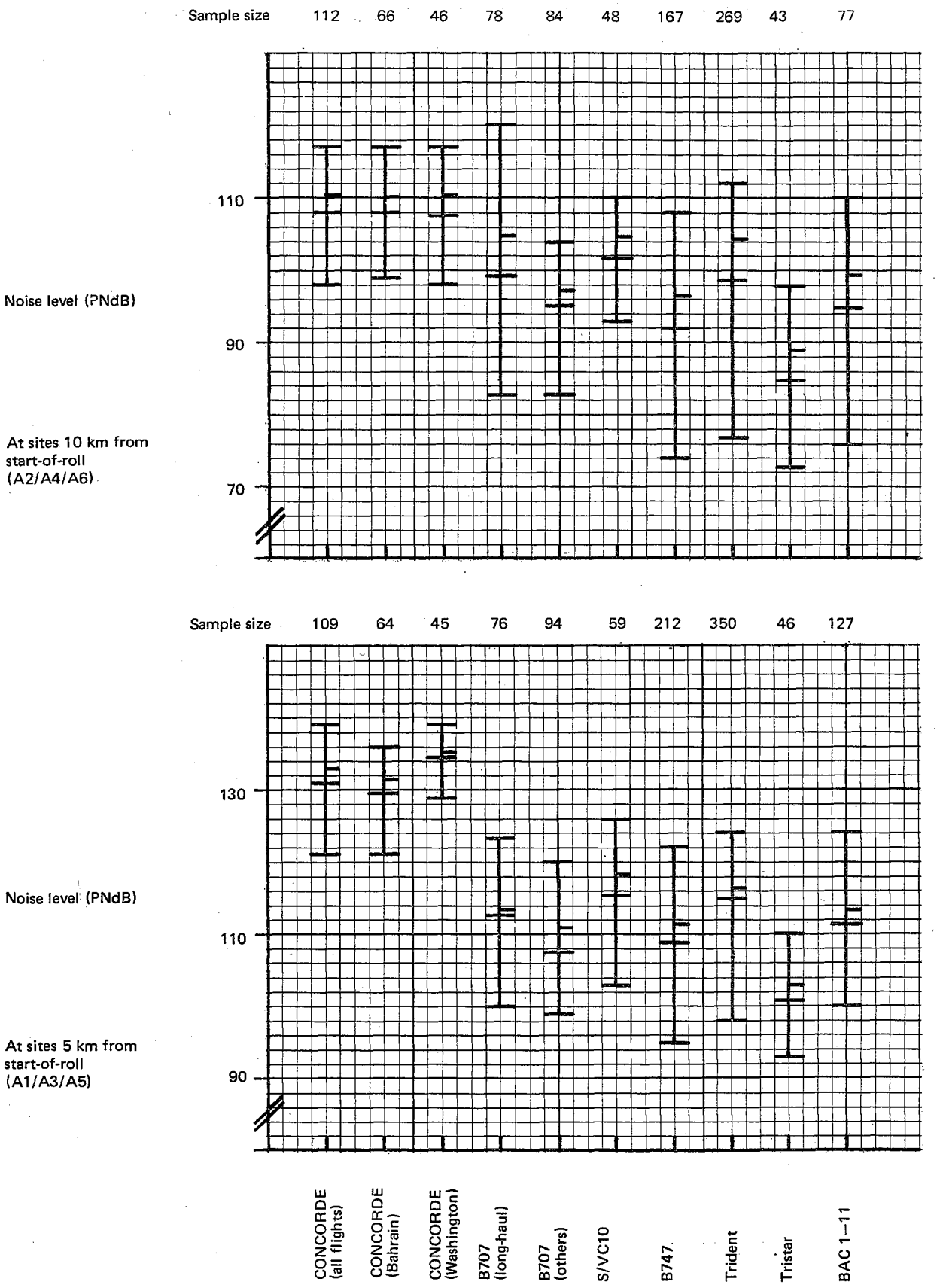


Fig 19 Departures — Comparison of Noise Level of Concorde and Other Aircraft Types at Mobile Measuring Sites

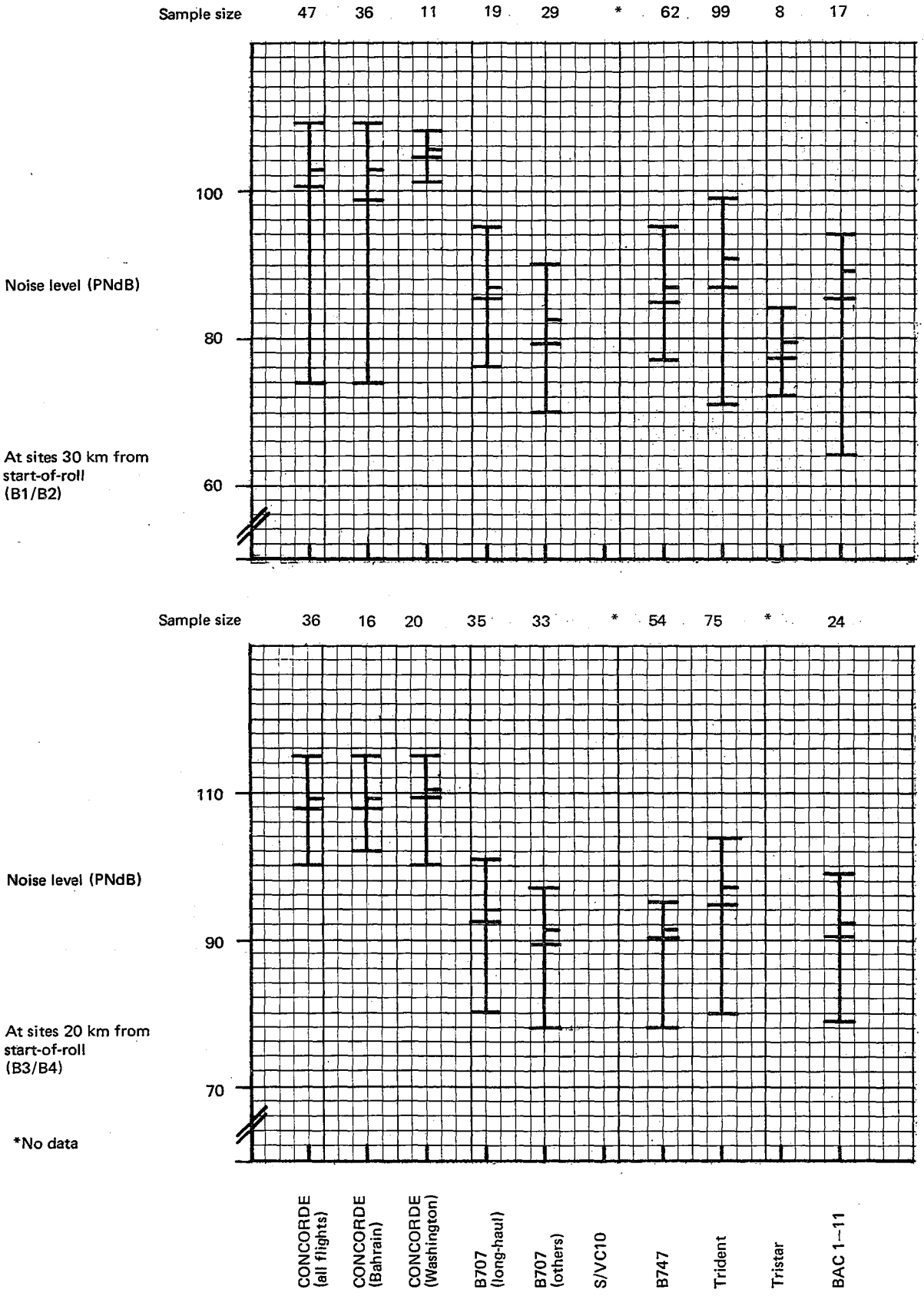


Fig 20 Departures — Comparison of Noise Level of Concorde and Other Aircraft Types at Mobile Measuring Sites

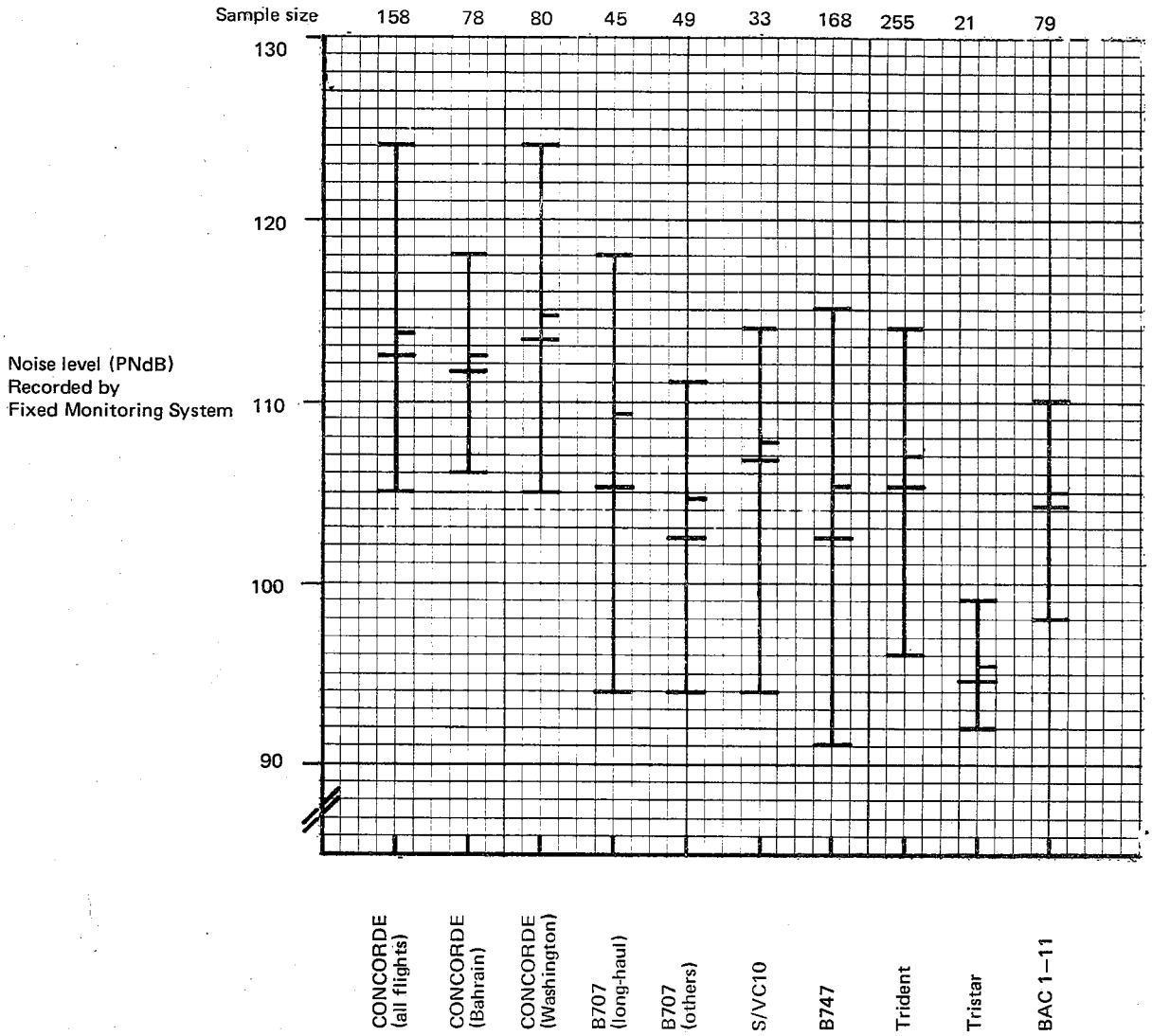


Fig 21 Departures – Comparison of Noise Level of Concorde and Other Aircraft Types at Fixed Measuring Sites

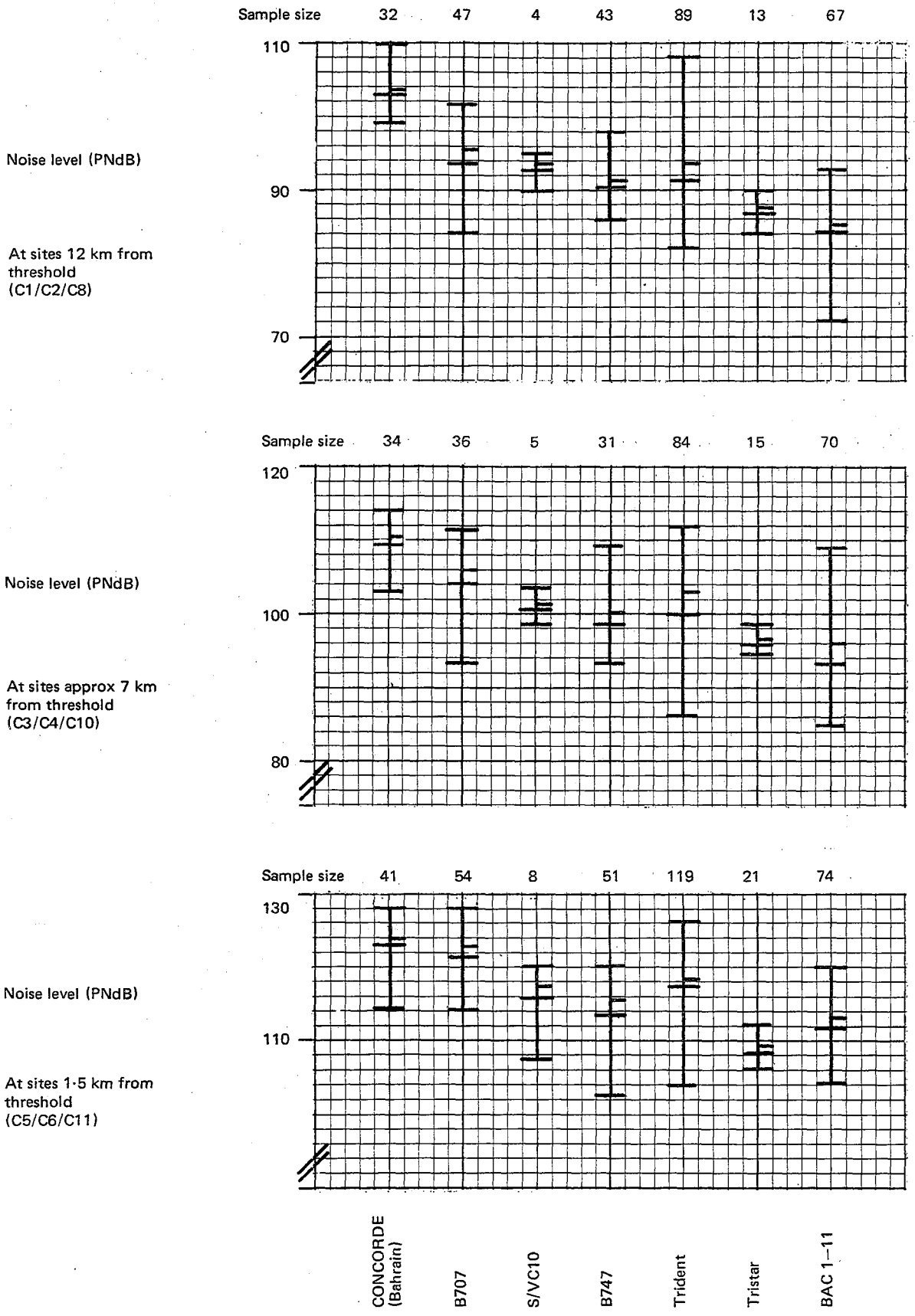


Fig 22 Arrivals — Comparison of Noise Level of Concorde and Other Aircraft Types at Mobile Measuring Sites

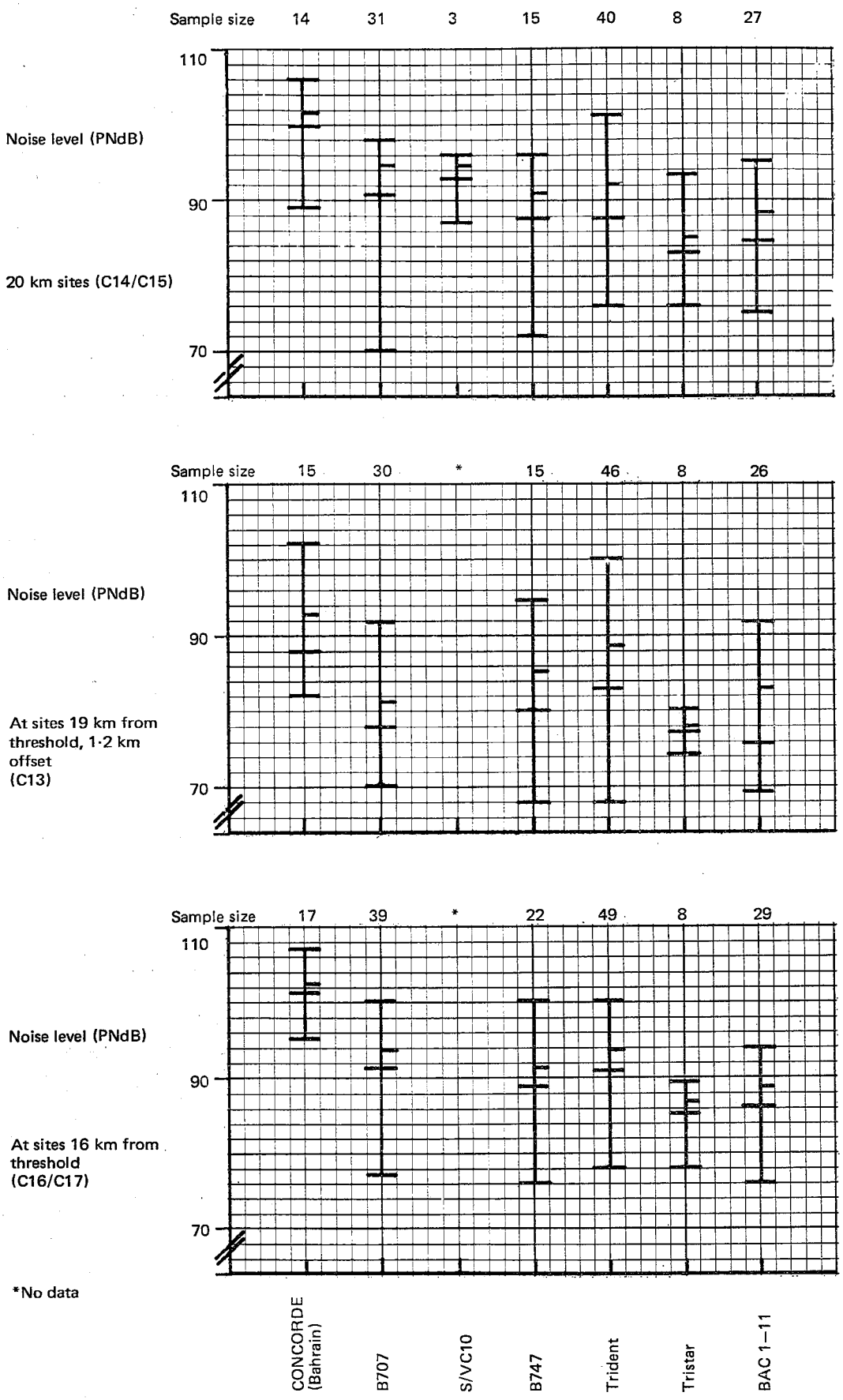
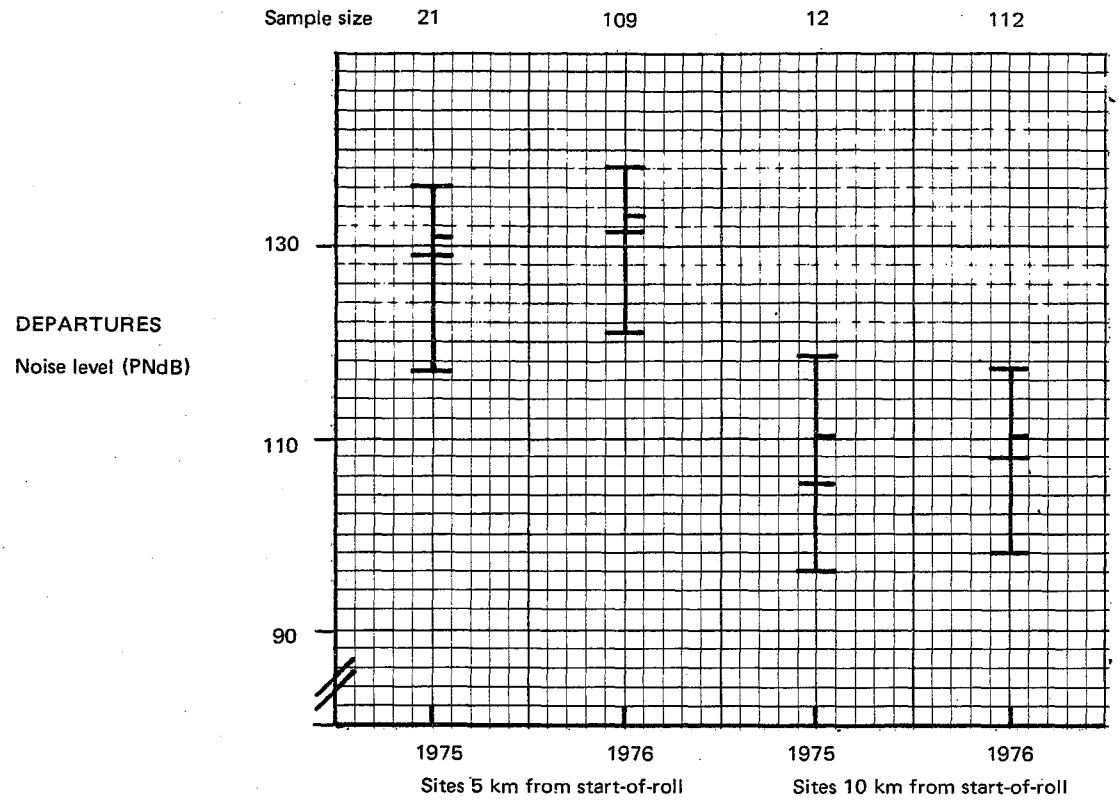


Fig 23 Arrivals – Comparison of Noise Level of Concorde and Other Aircraft Types at Mobile Measuring Sites



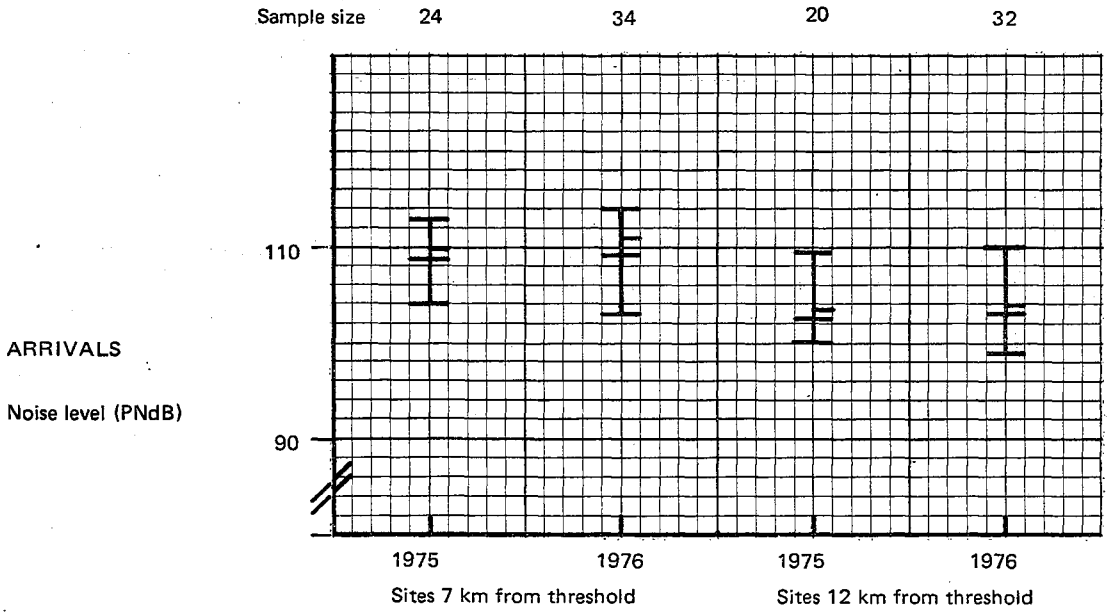


Fig 24 Comparison of Concorde Noise Level for the 1975 Endurance Trials and the 1976 Scheduled Operations

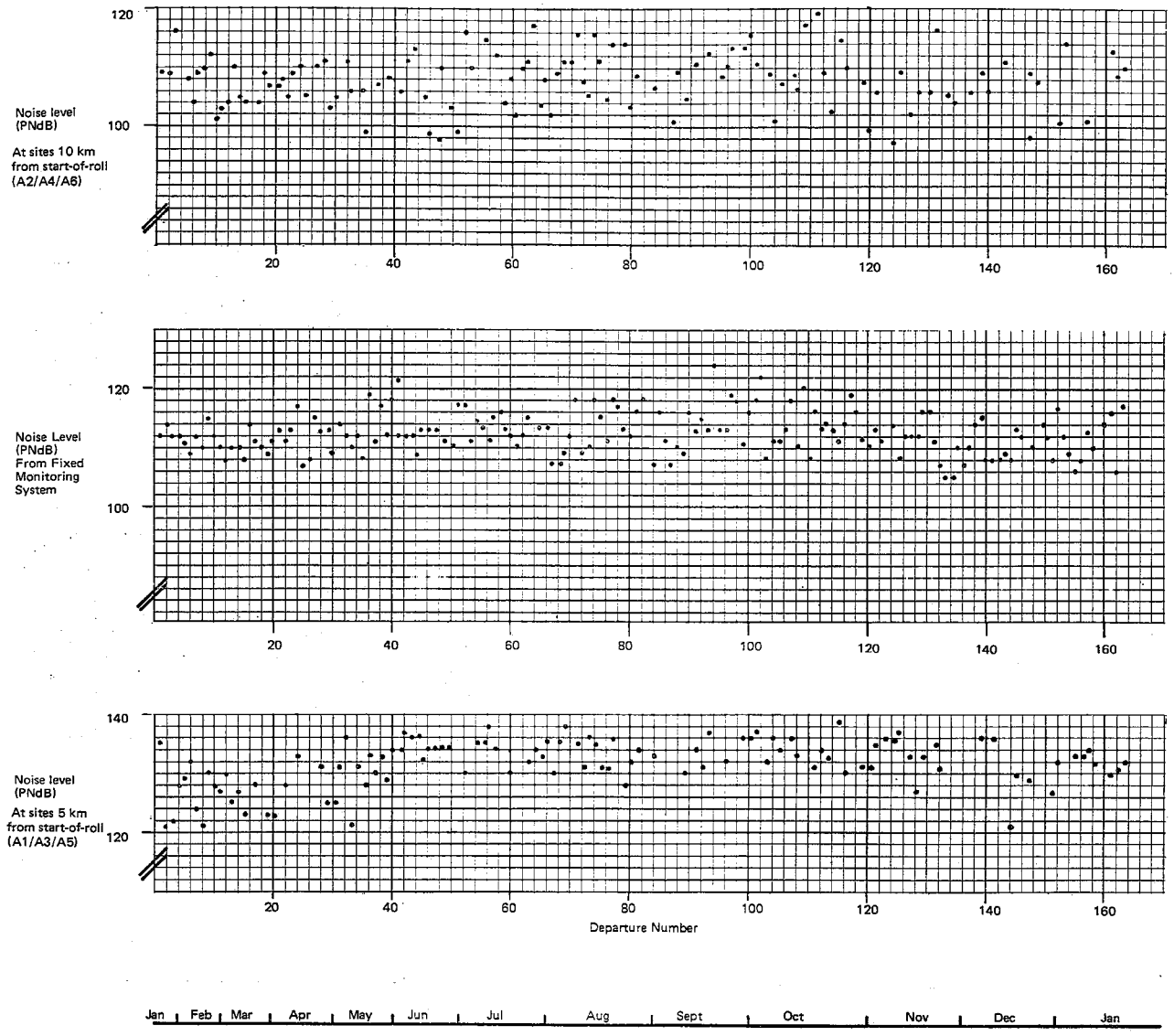


Fig 25 Concorde Departures — Measured Noise Level

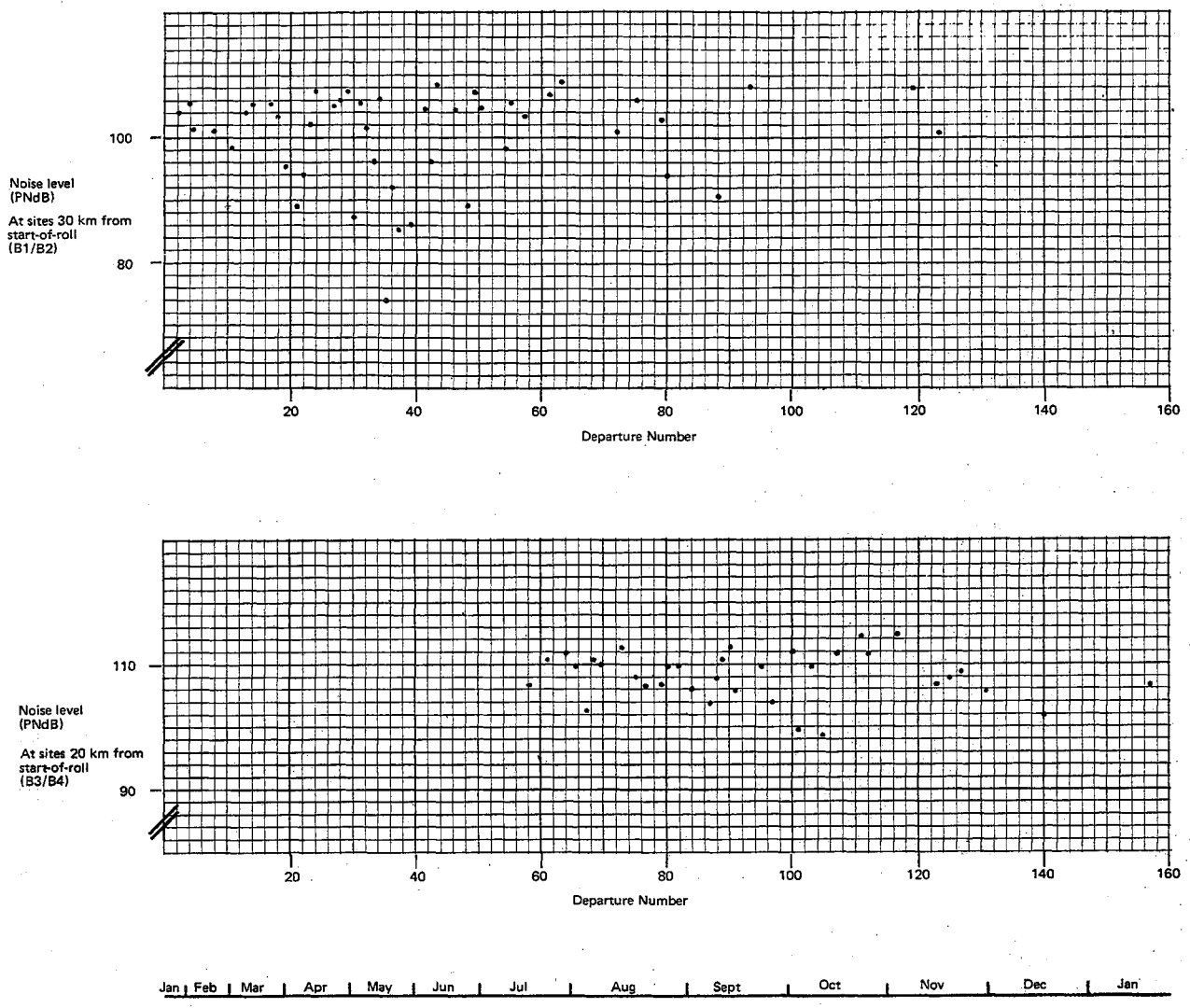


Fig 26 Concorde Departures – Measured Noise Level

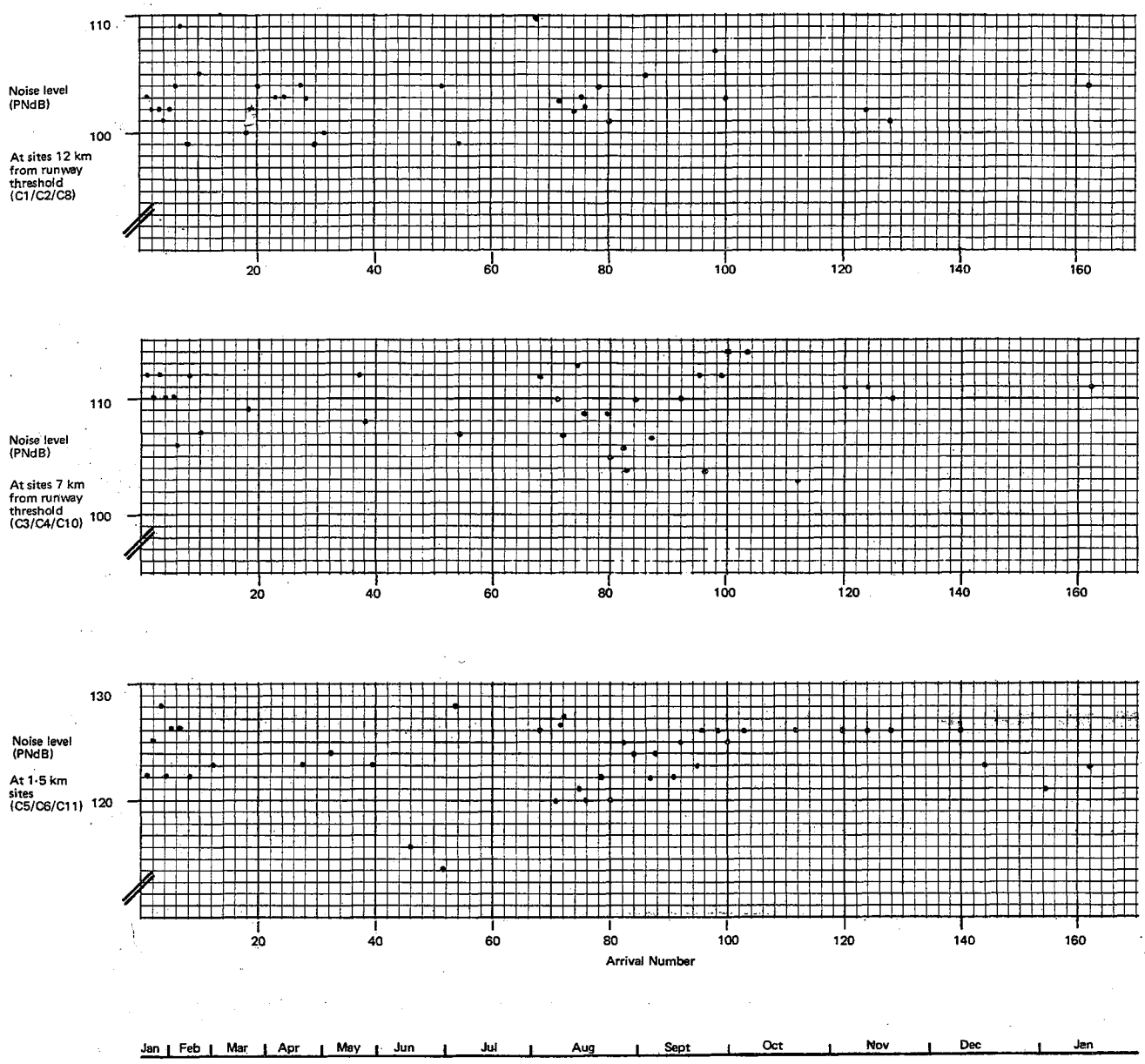


Fig 27 Concorde Arrivals — Measured Noise Level

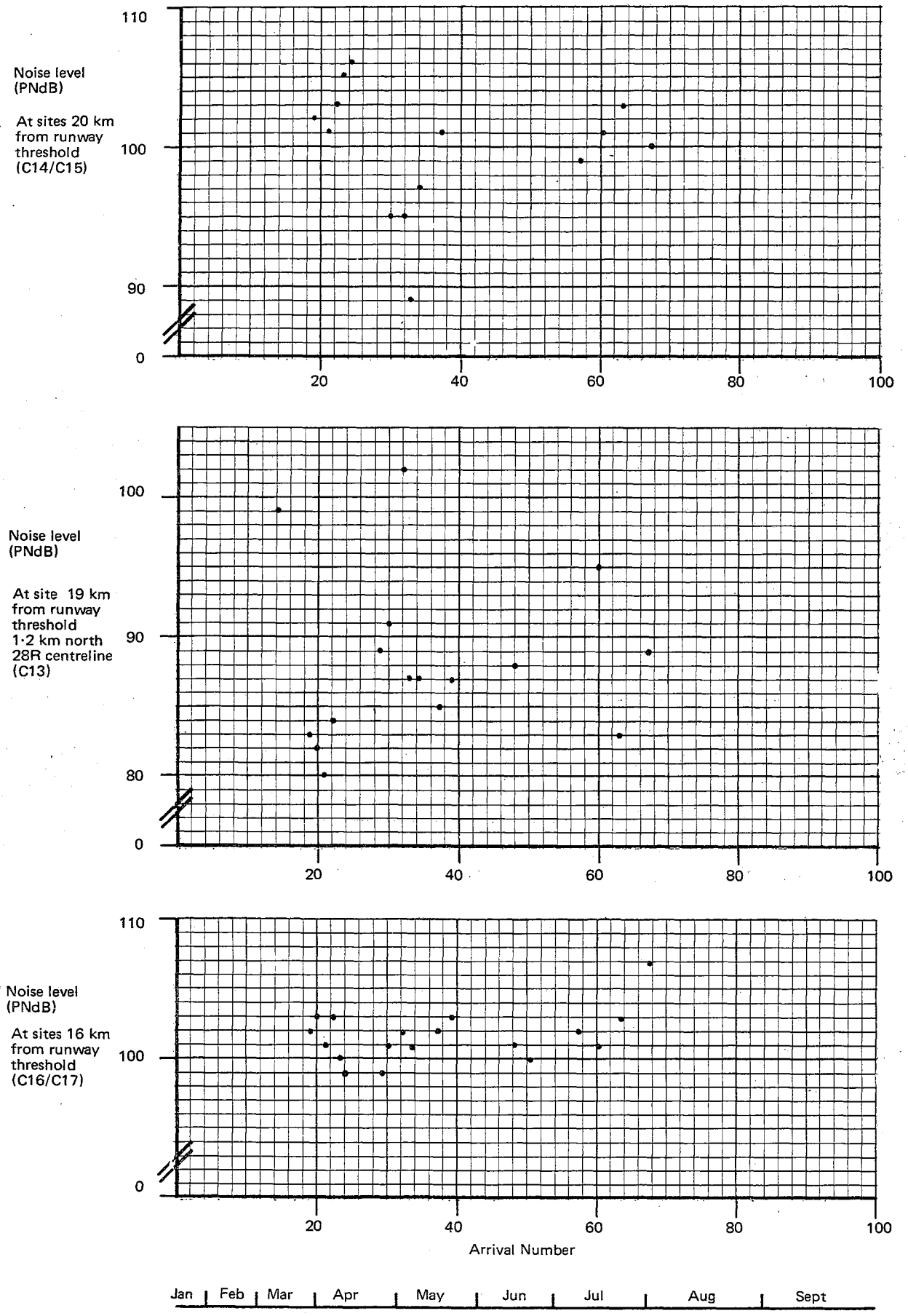


Fig 28 Concorde Arrivals – Measured Noise Level

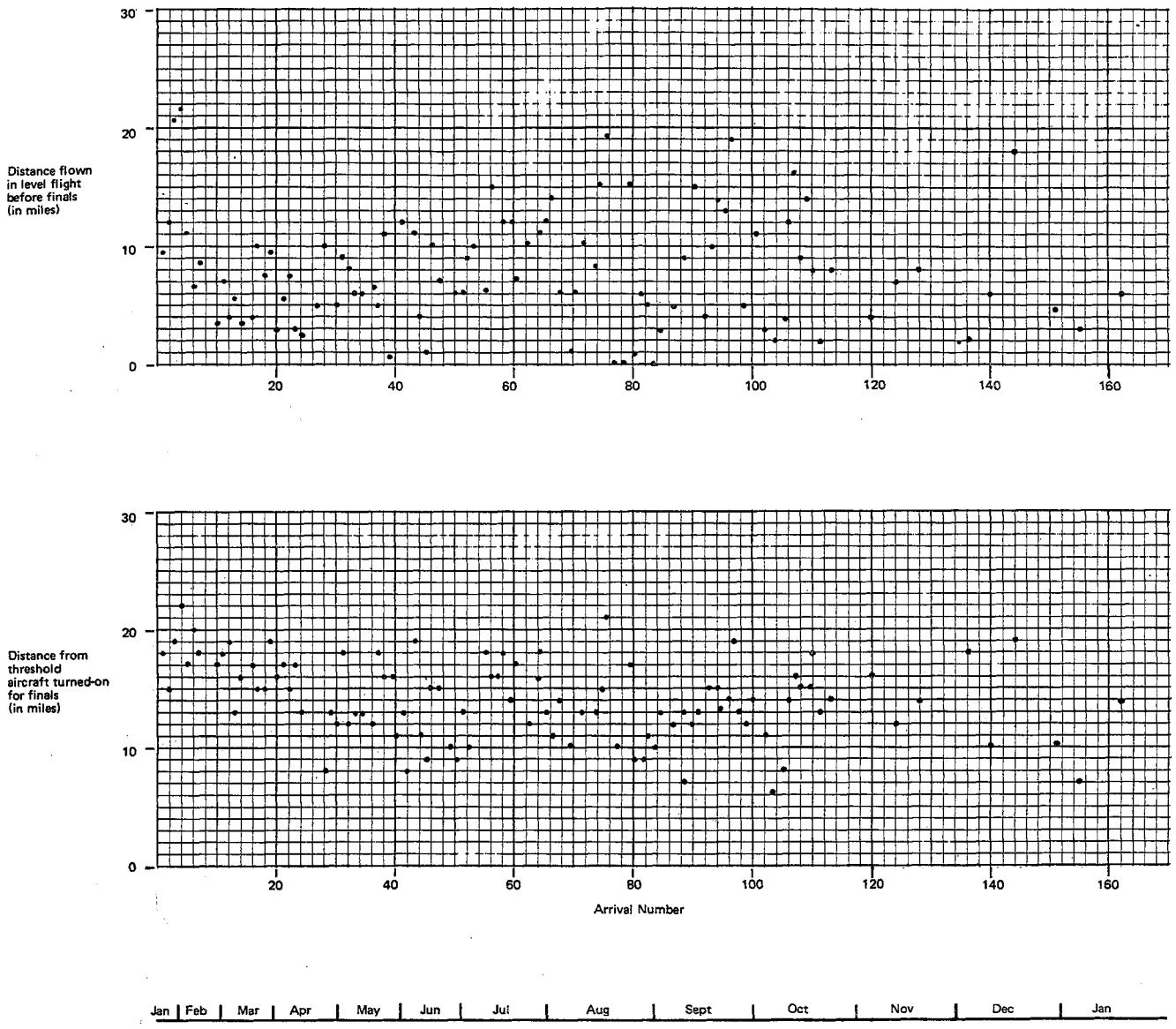


Fig 29 Concorde Arrivals — Positional Data

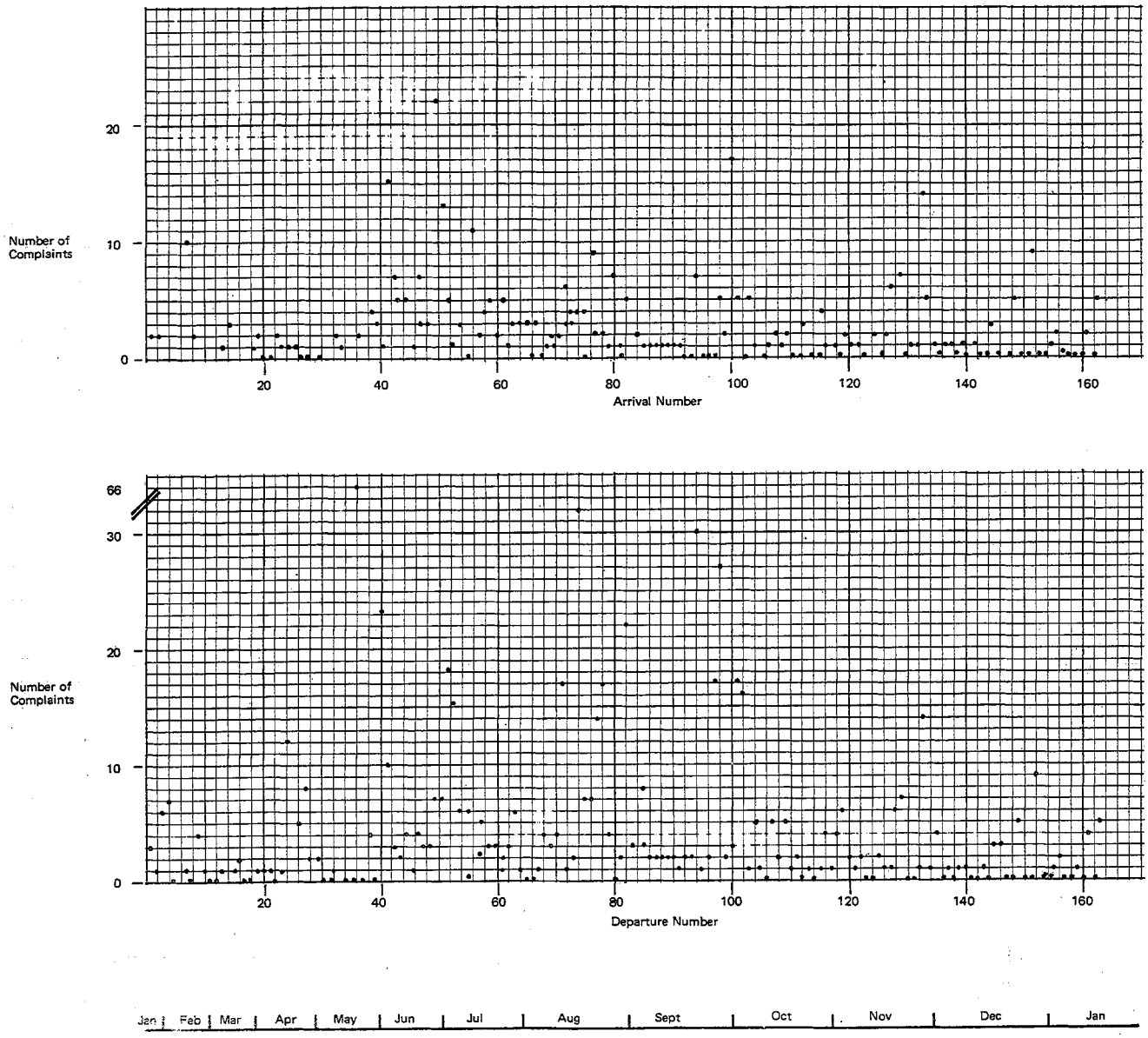
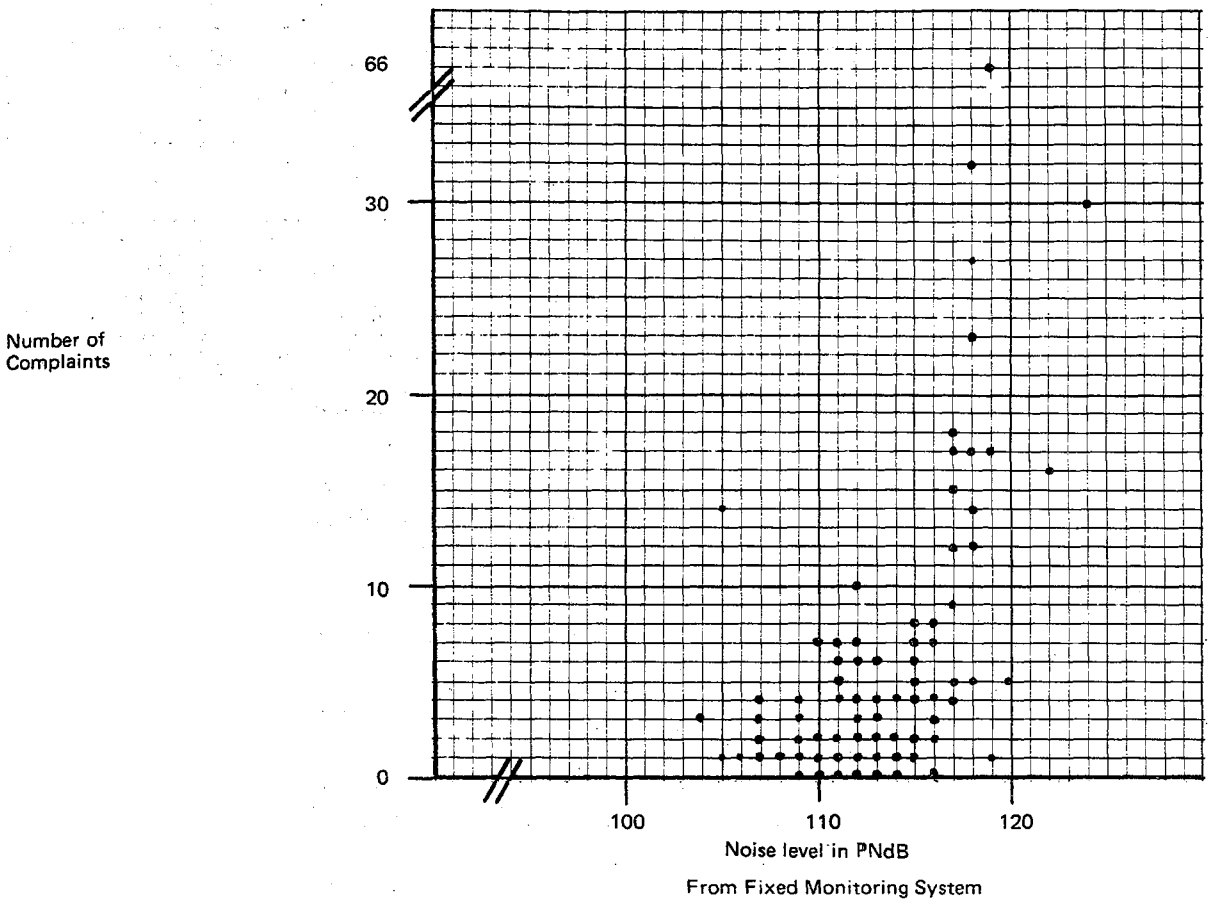


Fig 30 Concorde Complaints Data



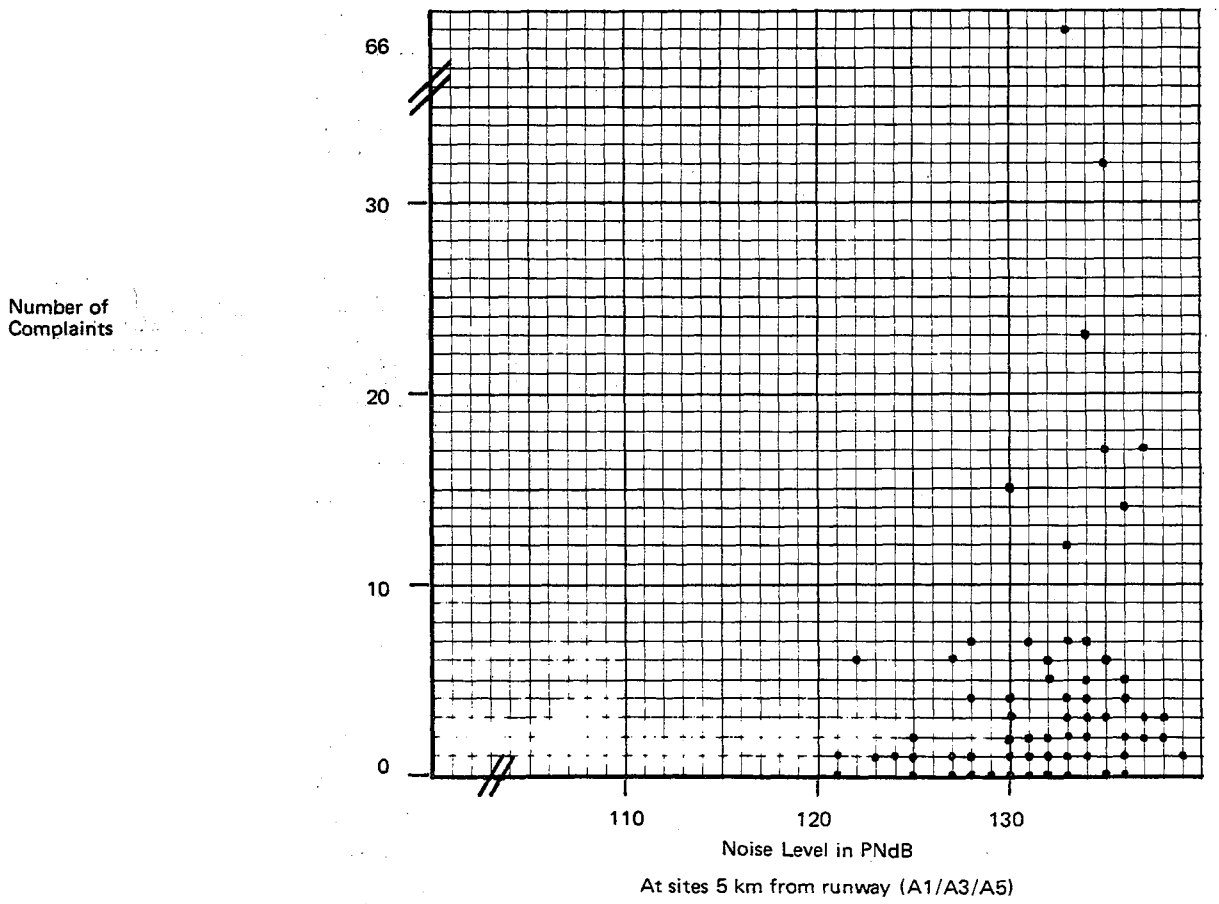
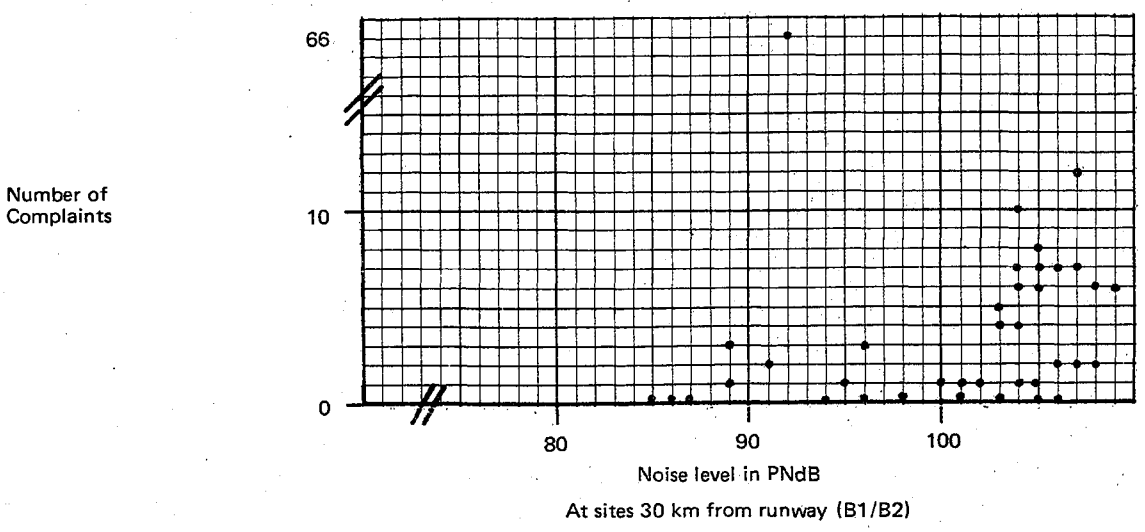
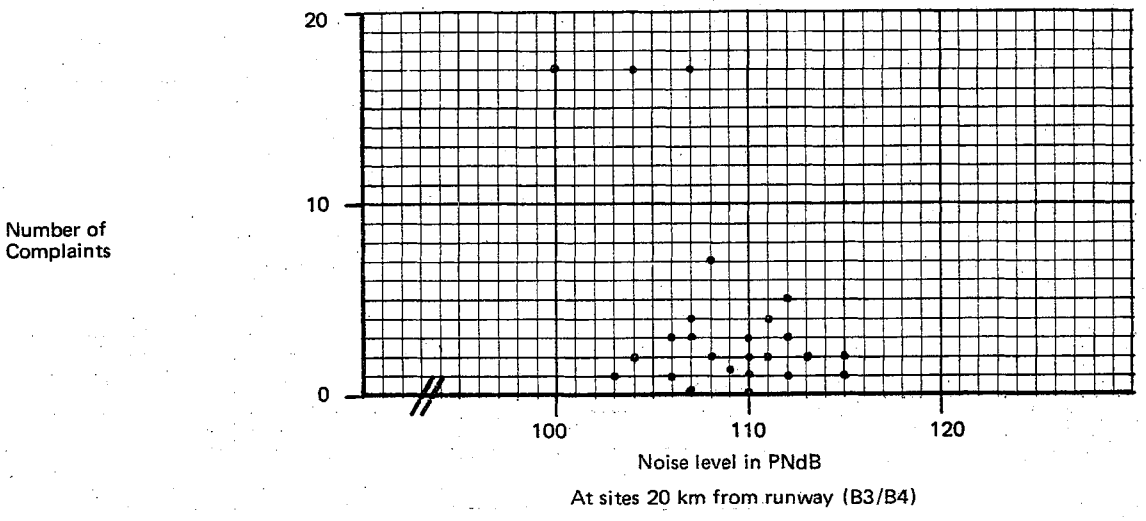


Fig 31 Departures — Concorde Complaints Data





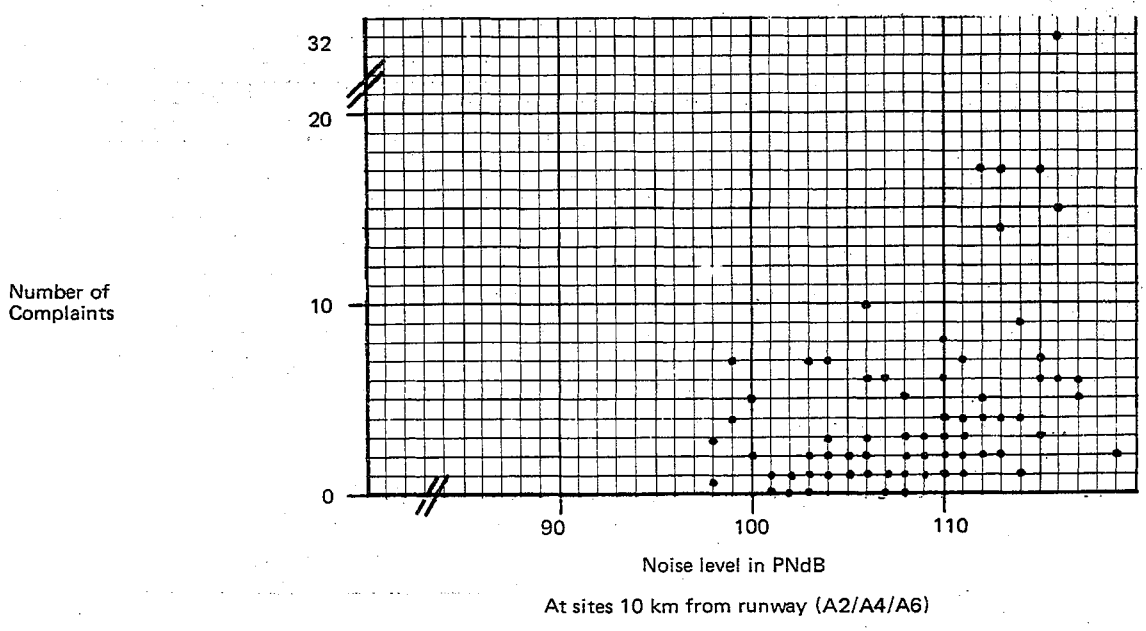


Fig 32 Departures — Concorde Complaints Data

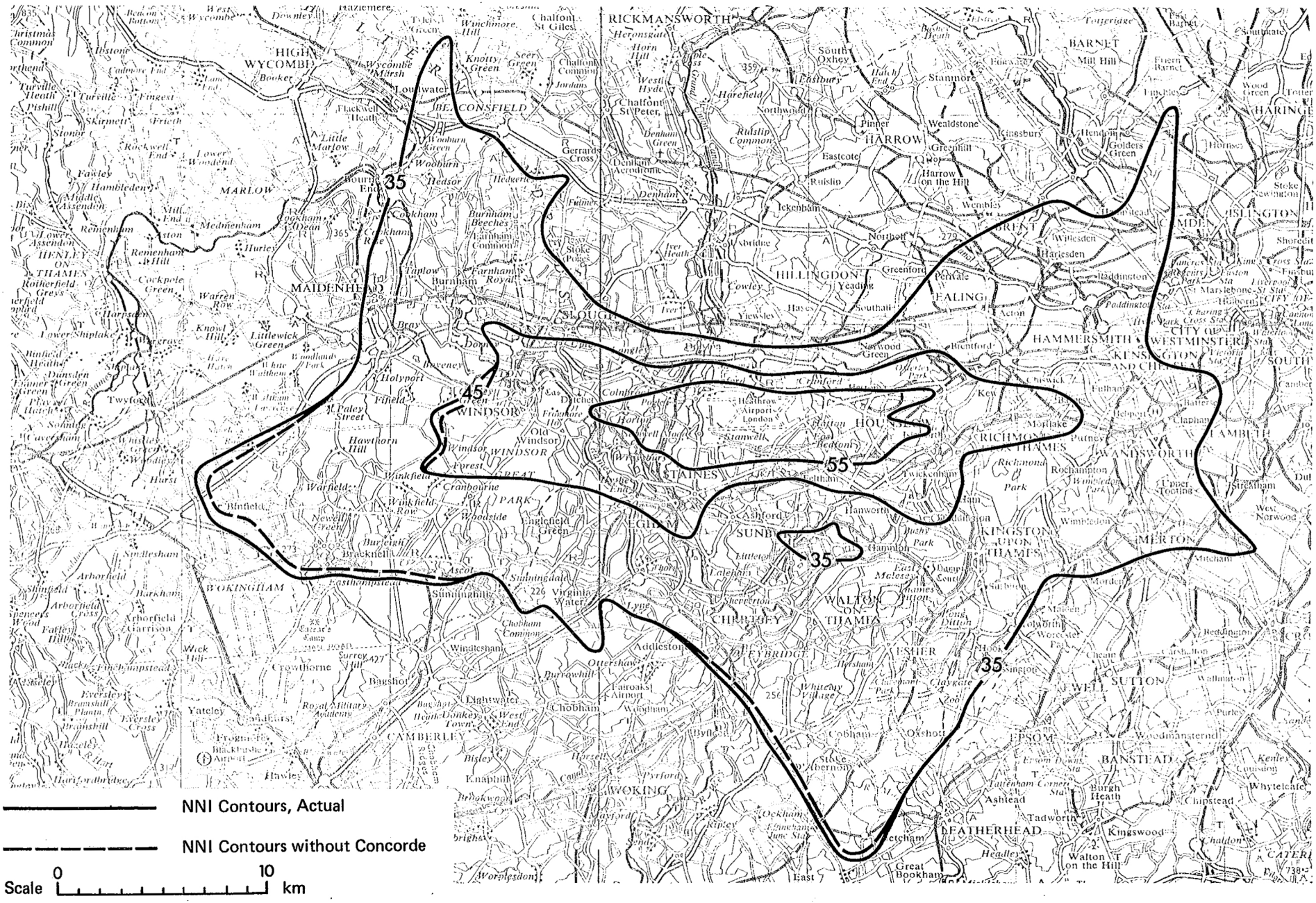


Fig 33 Effect of Scheduled Concorde Movements on Noise Exposure (NNI) around Heathrow, 1976