EAST DEVON DISTRICT LOCAL PLAN
NOISE IMPACT APPRAISAL/EXETER AIRPORT
(A5441/R2)
NOTES OF MEETING OF NOISE ADVISORS
WITH RESPECT TO NOISE OF ENGINE TESTING
AT EXETER INTERNATIONAL AIRPORT

APPENDIX 2

- Working Copy of Notes, including without modification alterations/additions suggested by I Wollacott, V Cole, W Stubbs.

- BAP Note 02: Ground Running Noise Assessment Small and Medium Aircraft, ref: A5441/DC/NO2.

WORKING COPY

NOTES OF MEETING OF NOISE ADVISORS WITH RESPECT TO NOISE OF ENGINE TESTING AT EXETER INTERNATIONAL AIRPORT

VENUE: Exeter International Airport
TIME: 13.30 hours
DATE: 1st June 2001

PRESENT:

Geoff Myers - (GM)	Managing Director, Exeter International Airport
Mike Foster - (MF)	Technical & Safety Manager, Exeter International Airport.
Rob Thomas - (RT)	Managing Director, British European.
Ian Wallocot - (IW)	British European.
Mike House - (MH)	Noise Adviser to Exeter International Airport.
John Maidment - (JM)	Principal Planning Officer, East Devon District Council.
Vernon Cole - (VC)	Cole Jarman Associates, Noise Adviser to Wilcon Homes, Clyst Hayes.
Bill Stubbs - (WS)	Wimtec Environmental, Noise Adviser to Redrow/Persimmon/Prowtring, Southbrook.
Jeff Charles - (JC)	Bickerdike Allen Partners, Noise Adviser to East Devon District Council.

AGENDA

ACTION

A draft agenda had been circulated by post (dated 17th May) to all present, it was agreed to adopt this Agenda, subject to inclusion prior to items (I) and (2) of a brief update by John Maidment of the programme for the East Devon Local Plan. MF agreed to chair the meeting. It was agreed that notes on the meeting should be prepared for agreement by those present

JGC

[EXTRA ITEM] LOCAL PLAN

John Maidment reported that the Local Plan programme was now speeding up, and the issue of noise (and in particular engine test noise) needed early resolution. The housing developers are presenting their schemes to the Council on 11th June. The relevant Committee meets on the 21st June and then on the 20th July to finalise the Local Plan. It is intended that the Local Plan will go on deposit in September 2001.

1) Engine Ground Running (EGR) Noise Criteria.

JC advised that he had contacted the noise experts prior to the meeting and sought their response on noise criteria.

WS explained that 65 dB L_{Amax} had been proposed by BA as a criterion for night time engine testing at Heathrow T5 Inquiry and the Local Authority had proposed 60 dB L_{Amax}. At Plymouth, 65 dB L_{Amax} was proposed with a long term aim of 60 dB L_{Amax}. High noise levels from night time engine running affect people at Heathrow and Plymouth and these criteria are put forward on the basis of criteria for noise reduction. At Exeter, we have the opportunity to avoid future noise problems from engine testing by making the best choice for the location of a new residential site and therefore the criterion should be the most severe, to avoid placing constraints on the future plans of the Airport. In BS8233 and WHO 2000, 45 dB L_{Amax} is referred to as an internal noise level

and with a worst case 10 dB for an open window, this produces 55 dB L_{Amax} as an external criterion.

WS also advised that in view of the low night time noise levels around Exeter Airport there is also an argument for taking account of the background noise as in the MH report of 31 October 1999.

WS indicated that there was usually a 10 dB difference between daytime and night-time noise criteria, but that a daytime test produced exactly the same noise level as a night time test.

VC tabled a note on his Assessment Thresholds, and this is attached to these notes. In essence VC proposed for night-time 65 dB L_{Amax}
and for daytime 55 dB $L_{Aeq,16h}$

MH noted that his 1999 report delineated use of the BS 4142 approach, where the criterion relates to the typical background noise level for the locality, Appendix C.3.5. MH noted that his approach had been illustrated in the Bickerdike Allen Partners: Noise Appraisal Report, reference A5441/R1 of February 2001 in Table 2. In essence the night-time criterion is -

Engine Test dB $L_{Aeq,5m}$ not to exceed the background noise,
and for the daytime criterion.
Engine Test dB $L_{Aeq,1h}$ not to exceed the background noise.
When excess is 5 dB likelihood of complaints 'marginal'
When excess is 10 dB complaints likely.

2) Current and Future Occurrence of EGR Tests
Daytime and Night-time and Aircraft Types Involved.

RT advised that at Exeter base maintenance is carried out for the aircraft fleet of British European, which includes BAe 146 (Series 100, 200 and 300), Bombardier (de Havilland), Dash 8 (Series 200, 300 and soon Q400), Bombardier (Canadair) CRJ 200 ER and Shorts 360 aircraft. RT advised that at Exeter 75% of the maintenance is carried out for third parties, and mentioned specifically the Fokker F27 of Channel Express and ATR42. With regard to the future, mention was made of the BAE Systems Avro RJX-100 aircraft which are joining the British European fleet, and the possible third party work on Airbus A320 and Boeing 757 aircraft.

RT advised that operations currently allow the related engine testing to be carried out in line with the Code of Practice. That limits night-time testing in the hours 23.00-06.00. Because of the unavailability of early ground run testing at other Airports, for instance LCY, RT advised that some early morning testing in the period 05.00-06.00 would be necessary, and suggested one such operation per fortnight. The number of daytime tests could be around 5 per day, split equally between turbo fan and propeller aircraft.

RT advised that he expected in the future less testing of the Fokker F27 aircraft and more on BAe 146, Dash 8 and Canadair CRJ types.

3) EGR Test Form and Duration.

RT advised that he would make available two different aircraft from those tested by MH, specifically a CRJ-200 and a Dash 8-200. It was agreed that each aircraft should be operated at idle, mid point and high power setting during the tests. The aircraft will be operated for sufficient time for adequate noise measurements to be made, 5 mins per condition was mentioned.

RT mentioned that the aircraft APU's would have to be operated during the tests. The aircraft would be located at threshold on runway 31. The tests would be carried out during one night as selected by RT. RT

4) Noise Parameters to be Measured.

It was agreed that all parties should measure during the tests the background noise at their location prior to the tests and then for each aircraft the L_{Amax}, $L_{Aeq,T}$, and the $^1/_3$ octave band levels.

The background noise should also be re-measured after the engine tests.

The noise meters should use the 'SLOW' setting where appropriate.

5) Noise Monitor Locations.

It was agreed to measure the noise at a height of 1.5m above local ground level at the locations selected by the parties. These are shown on the attached map. With regard to access, each party to arrange access with landowners. It was agreed that to assess the noise at first floor bedroom level 2 dB could be added to the measured values. (N.B. JC and EDDC have still to identify their measurement sites).

6) Noise Monitoring Weather Conditions.

It was agreed that the testing would require dry and calm conditions. If some wind was present it should be from the SW direction, and be less than 5m/s.

MF agreed to provide weather data from the Airports' nearest weather station to the aircraft test position. MF

7) Noise Reporting Procedure.

It was agreed that all raw data noise from the tests will be provided to JC, who will collate the data and issue it to all parties JC

8) Witnessing/Collaboration on Tests.

It was agreed that the noise experts should meet prior to the proposed engine test and using one calibrator all noise measuring equipment shall be calibrated. JC/WS/VC/MH

JC advised that on behalf of EDDC he would intend to witness the measurements at both residential sites, if practicable. JC

JM mentioned that he would seek involvement of his colleagues in the Environmental Health Department. JM

9) Administration of Tests.

RT advised that he would quickly establish possible dates for the test, and noted that this related to having crew available for the CRJ. RT

RT advised he would appoint one of his engineers, Stephen Kontoravdis to administer the test, and be the contact during the test. RT

JC agreed to issue to RT a full contact list for the test engineers. JC

It was agreed to meet before the tests at British European, and British European will make available facilities for meeting during the test and parking. RT

Airside passes will be provided to MH and JC and others as advised in advance. MF

10) Noise Prediction for Non-tested Aircraft Types.

JC issued a paper on prediction of engine test noise to the noise experts, and sought their views as to whether the approach based on the FAA INM model would be acceptable to assess the relative noise on non-tested aircraft types

to the Exeter results arising from the original work by MH on the BAe and Fokker F27, and the results from the proposed tests on the CRJ and Dash 8 aircraft. MH advised that his test results related to the aircraft operating with all engines on high power. WS/VC/MH

11 Any Other Business

Background Noise Measurement

JC sought guidance on the selection of an appropriate background noise, a pre-requisite for evaluation of impact using the BS 4142 approach. It was agreed to adopt for the critical night period, 05.00-06.00, 35 dB(A) unless the proposed new testing indicates this level is inappropriate. That value had been agreed at the earlier technical meeting of noise advisors of 29th November 2000.

Unmitigated Noise Levels

MH raised whether consideration was to be given to the effect of measures to mitigate engine test noise. JC indicated that he was not aware of any proposal to provide such measures, and therefore presumed the parties did not currently propose such, and therefore JCs advice to the Council had to be on the basis of unmitigated noise levels. It was also noted that for those located facing the open end of any three sided ground running pen no decrease in engine noise would arise.

A5441 NOTE: 02
EAST DEVON DISTRICT LOCAL PLAN
GROUND RUNNING NOISE ASSESSMENT – SMALL AND MEDIUM AIRCRAFT

The current intention is to assess the ground running noise from a variety of aircraft types at Exeter Airport. Previously daytime noise contours for engine testing (ground running) of a BAe146 aircraft were produced by Michael House, and were included as Figure 20 of his report of 31 October 1999. These contours were reproduced by Wimtec Environmental Limited in their report of June 2000, as Figure 4.

The previous contours, discussed above, were produced using the Integrated Noise Model (INM) of the Federal Aviation Administration. It is proposed for the current assessment to again use this software as a basis with supplementary information from on site trials by key aircraft types. This has the benefit of limiting the amount of on site measurement, particularly if many aircraft types are involved, and allows the varying location of ground operations to be considered.

The initial suggestion is therefore to use the INM model to generate "reference" noise levels for aircraft types and then use the trials to check on these levels for key aircraft and propagation details. This note details below a summary of the current information, from measurements and the INM software, and also a number of matters that require discussion.

Summary of Current Ground Running Information

Contours modelling ground noise have been produced using the Integrated Noise Model (INM) of the Federal Aviation Administration, version 6.0a. To model ground noise from engine testing, "runup" operations, INM requires details of the aircraft and its engine settings. The program then computes the noise levels and uses a common directivity pattern to determine the levels around the aircraft at various distances. An example output, for a BAe146-300, is attached and relates to all engines operating at 5000 lb thrust. This is equivalent in noise terms to a single engine operating at full thrust.

Ground runs usually relate to a single engine, where low or high thrust settings can be selected, or a combination of engines at low thrust. The INM model requires a single thrust to be selected, which is then applied to all engines. This agrees with the directivity pattern used, which is symmetric around the longitudinal axis of the plane.

To model a high thrust run with a single engine using the INM model, requires the use of a thrust setting that would diminish the noise level by $10*\log(N/N_T)$ dB, where N is the number of operative engines (1), and N_T is the total number of engines (2 or 4). To model a high thrust ground run of a single engine therefore requires the determination of the thrust which reduces the noise level from the maximum thrust on all engines case by 3 or 6 dB.

By using a fixed point at 90° to the orientation of the aircraft the effect of altering the aircraft type and thrust setting has been investigated and the results are summarised in the table below. In summary this found, for the aircraft types considered, the noise levels from idling are around 76 d8 @ 152m and those from a single engine at "full" power are around 90 d8 @ 152m.

Aircraft Type	Idle Thrust [1]	Idle Noise Level [2] @ 152m	Equivalent "Full" Power Thrust [3]	"Full" Power Noise Level [4] @ 152m
B737-300	2,200 lb	80 dB	n/a	92 dB
8737-500	2,000 lb	78 dB	17,500 lb	89 dB
B757 RR	4,000 lb	74 dB	35,500 lb	91 dB
CRJ (CL601)	922 lb	74 d8	6,800 lb	86 d8
8Ae146-300	700 lb	75 dB	5,000 lb	87 dB

Notes: [1] Assumed equal to 10% of maximum static thrust.
[2] Level at 90° to the orientation of the aircraft with all engines idling.
[3] Thrust which when applied to all engines gives noise levels equal to a single engine at "Full" power.
[4] Level at 90° to the orientation of the aircraft with the equivalent of a single engine at "Full" power.

BAe146

A comparison has been made for the BAe146 between the predicted levels and measured levels by British Aerospace Civil Aircraft Division at 152m. The comparison is for a single engine running at full thrust and is contained in an attached figure as a polar plot. For most of the angles the two levels are similar, the exception is the angles of 240° to 300°, on the opposite side of the aircraft to the engine running. For these angles the fuselage of the aircraft forms a barrier, this is not taken into account in INM that, as described above, assumes all engines in operation. The INM therefore over predicts the level at these angles.

For the angles with a view of the engine, 0° to 180°, the agreement is good, the INM predicting slightly higher values in front of the aircraft (0° to 30°) and slightly lower values towards the rear (120° to 150°). Taking logarithmic averages of the levels at these angles (0° to 180°) finds the measured 1.4 dB higher, however if all angles are considered the predicted levels are slightly higher on average by 0.2 dB. This is particularly relevant given the suggested procedure regarding directionality.

Recent measurements by BAP at an airport of BAe146 ground running measured a range of noise levels due to the variety of engine settings used. For a position at 45° to the aircraft the highest levels measured for "High" power runs were 101 dB L_{Aeq} at 50m. This will most closely relate to a short period of one engine at full thrust. Using this level and a conservative rate of distance attenuation, 8 dB per doubling of distance, a level of 88 dB is predicted at 152m. This compares well with the 87 d8 predicted by INM and the 86 dB previously measured by British Aerospace.

Boeing 737-300

Further consideration has been given to the noise from the 737-300. Specifically it has been assumed that to the side of the aircraft the effect of the far engine will be small, as the fuselage screens it, and a contribution of 1 d8 has been allowed for. To predict the noise levels, on the side of the operating engine, both engines are therefore set at the desired thrust and 1 dB is taken off the predicted levels.

For the 737-300 this results in levels at 90° to the orientation of the aircraft, on the side of the operating engine at 152m, of 79 dB with one engine idling and 94 d8 with one engine at full power.

These predictions for the 737-300 have been compared with measured data given in the British Airways report of Nov 1990 regarding their maintenance base at Gatwick Airport. This contains measurements at 400ft which have been adjusted to a reference distance of 152m (500ft) using 6 dB/dd. The comparisons for one engine idling and separately one engine at full power are shown on the attached figures.

For the idling case good agreement if found towards the front and rear of the engine (15 – 45° & 120 – 165°) where the maximum levels occur, around 80 dB(A). To the side of the engine (60 – 105°) the INM predicts significantly greater noise levels, this may be a function of the uniform directivity pattern.

For the full power case good agreement occurs towards the front of the aircraft and at the rear (15 – 90° & 165°). To the rear of the aircraft and to the side (105 – 150°) the INM under predicts the noise level and remains in the low 90's for most of the angle. The measured level shows a significant increase in noise in this areas with levels up to 99 dB(A). Again this may be partially due to the relatively uniform directivity pattern used by INM. Looking the angles from 15° to 165° finds the measured levels generally higher, by 2.5 dB using a logarithmic average. However if all angles are considered the average predicted levels, being equal on the side away from the operating engine, will be very similar to the average measured levels. This is particularly relevant given the suggested procedure regarding directionality.

Turboprops

Ground noise from turboprop aircraft has been reviewed and is summarised in the table below. The data has been obtained from measurements at several airports including most recently Exeter Airport, and from the Integrated Noise Model (INM), version 6.0a.

The surveys were conducted during specific activities at Exeter Airport and one of the others. The remaining survey was a long-term survey undertaken with a monitor that was set to trigger when a particular level was reached. The information from this long-term monitor was then compared with the ground run records.

Ground Running Noise Level (dB(A) @ 152m)				
Aircraft Type	Ground Idle		"Full" Power	
	From Measurements	Predicted by INM	From Measurements	Predicted by INM
Dash 7	67[1]	-	82[1]	-
Dash 7 & 8	<76[2]	-	83[3]	-
Fk 27	-	81[4]	84 – 92[5]	85[4]

NB. Noise levels given at a position to the side of the aircraft, 90° or 270° to the orientation of the nose of the aircraft, unless otherwise stated.

(1) Based on two engines in operation. Measurements made at 155° and 235° to the orientation of the nose of the aircraft (ie. to the rear at the side).

(2) Measurements made using a trigger level, some of the ground runs did not exceed this level. Value given lowest value measured.

(3) Average level from the measured runs, taken from range of 76 to 91 d8(A).

(4) Both engines operating.

(5) Measured at 0° and 120° with both engines operating.

With regard to the "Full" power values, a reference noise level of 85 dB(A) appears appropriate, accepting as shown above that occasionally higher values will occur.

With regard to "ground idle" values the available information is poor, however we would expect them to be much less than "Full" power. Looking at measured taxiing noise levels measured at 50m from aircraft, as the ground idle and taxiing levels are similar, finds the following measured values for twin turbo-props:

ATP	81.8 dB(A)
Fokker 50	83.2 dB(A)
Jetstream 41	87.8 dB(A)
Jetstream 31	80.6 dB(A)
Saab 360	76.5 dB(A)
Saab 2000	80.7 dB(A)

This indicates a logarithmic average of 81 dB(A) at 50m, on the assumption of 8 dB per doubling of distance this suggests 68 d8(A) as the typical taxiing level at 152m.

Matters for Discussion

In addition to the general details of the assessment method, the following matters will require discussion:

- The directionality of the source.

  Aircraft when undertaking a ground run can be locally highly directional. This is particular the case on a multi-engined aircraft when only one engine is operating. The INM software uses a common directivity pattern that assumes all engines are operating equally. As discussed above, comparisons at 152m between the predicted and measured levels for certain aircraft have generally found reasonable comparison, in the region closest to the operating engines.

  At Exeter Airport the receiver locations are much further away than the "reference" distance of 152m. At these distances the directionality of the source will be reduced, in addition the orientation of the aircraft is not fixed and so a preferential position cannot be assumed. A suggestion is therefore to take the average level around the source.

- The ground attenuation between the source and the receivers.

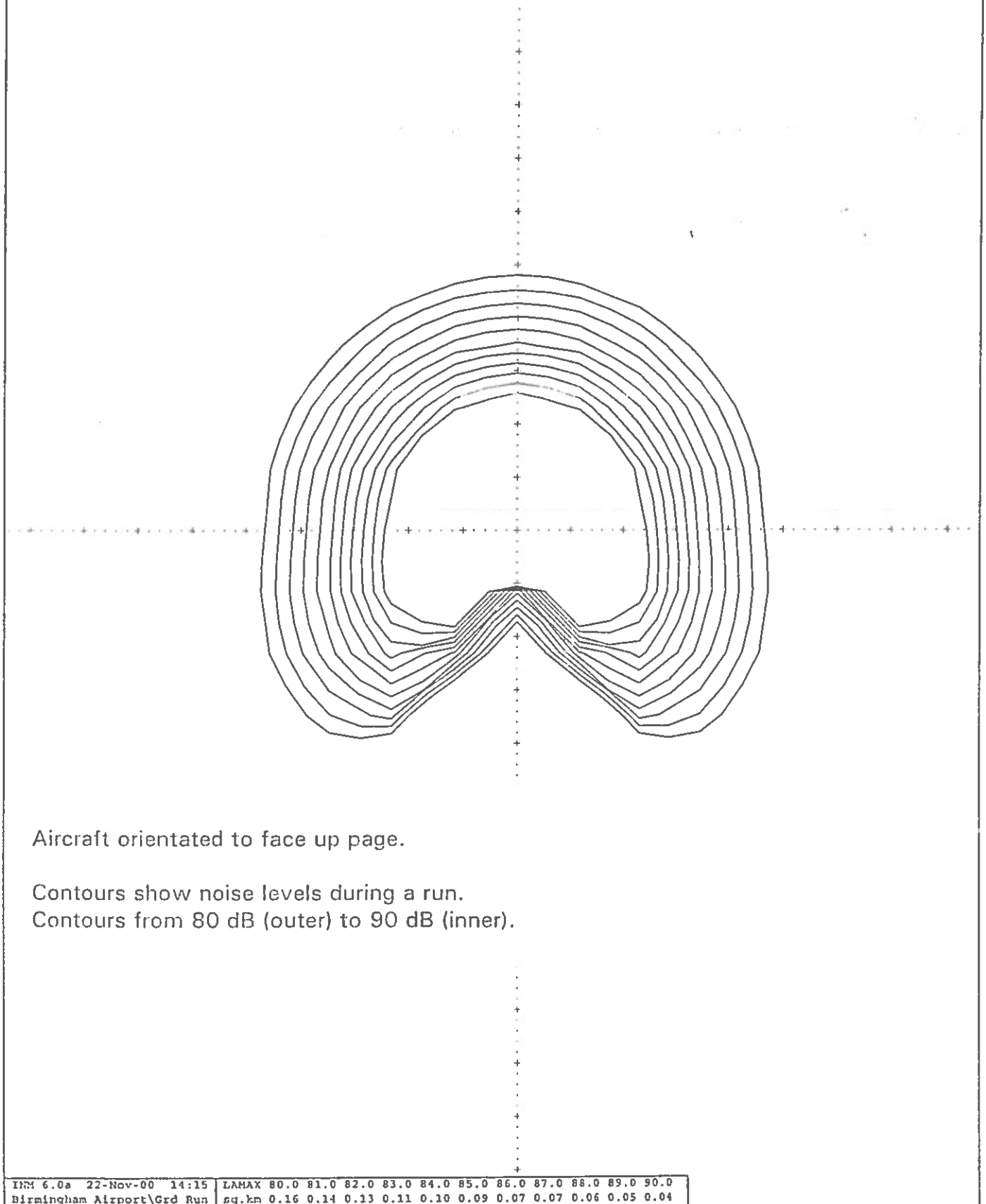
  As an starting point one a standard rate could be applied with adjustments following the trial.

- The effect of weather conditions.
- The appropriate criteria.

Attached: Figures: BAe146-300 Noise from Ground Running
BAe146 Ground Noise
Boeing 737-300 Noise from Idle Ground Running
Boeing 737-300 Noise from Full Power Ground Running

BAe146-300
Noise from Ground Running

All 4 Engines at 5000 lb Thrust
(equivalent to single engine at "Full" power)



Aircraft orientated to face up page.

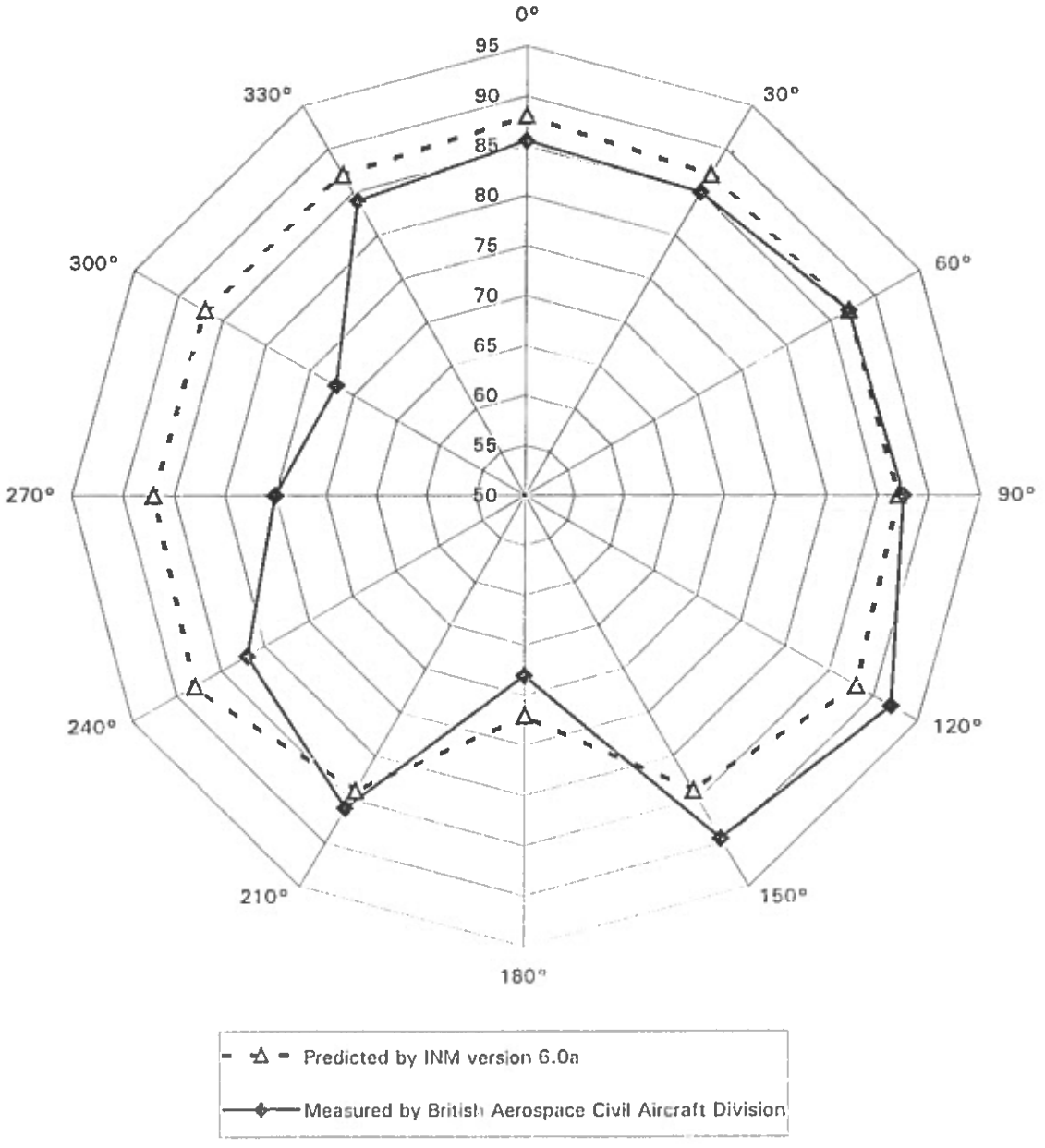
Contours show noise levels during a run.
Contours from 80 dB (outer) to 90 dB (inner).

INM 6.0a 22-Nov-00 14:15	LAMAX 80.0 81.0 82.0 83.0 84.0 85.0 86.0 87.0 88.0 89.0 90.0
Birmingham Airport\Grd Run	sq.km 0.16 0.14 0.13 0.11 0.10 0.09 0.07 0.07 0.06 0.05 0.04
Scale 1 cm = 50 m	color

BAe 146 GROUND NOISE

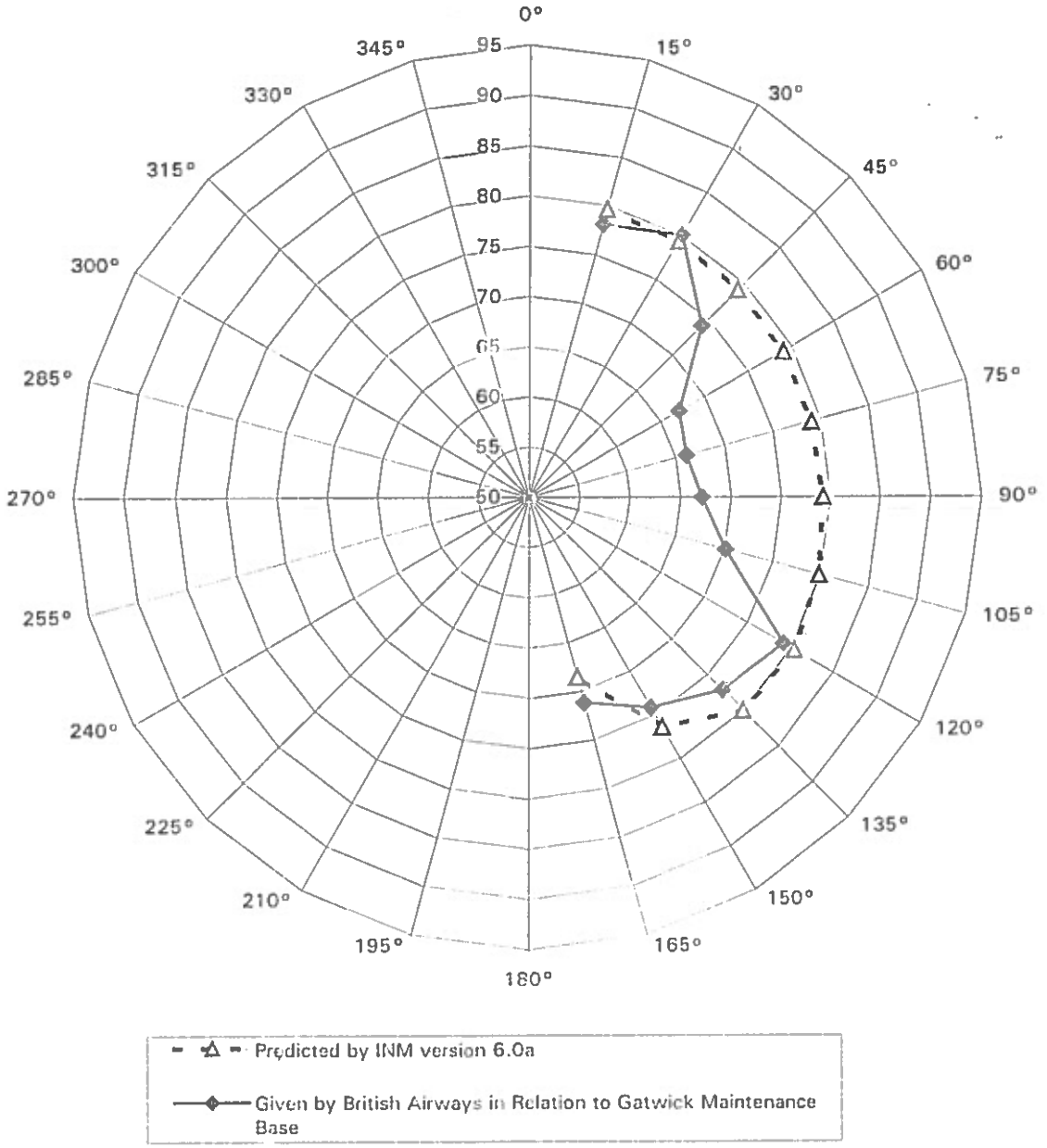
NOISE LEVEL (dB(A)) AT 152m (500ft)
SINGLE ENGINE (No.4) AT FULL THRUST (6970 lb)

NB. No.4 Engine is the Outer Engine on the Starboard (Right) Side.



737-300 GROUND NOISE

NOISE LEVEL (dB(A)) AT 152m (500ft)
SINGLE ENGINE AT IDLE THRUST (2200 lb)



737-300 GROUND NOISE

NOISE LEVEL (dB(A)) AT 152m (500ft)
SINGLE ENGINE AT FULL THRUST (22000 lb)