Defence
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RAF Brize Norton Environmental Appraisal

Comparative Assessment of Aircraft Noise Emissions

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Defence Infrastructure Organisation

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Comparative Assessment of Aircraft Noise Emissions

October 2014

AMEC Environment & Infrastructure UK Limited

Executive Summary

Purpose of this Report

This report has been produced for the purpose of summarising and comparing the available noise data for the A400M.

The A400M will arrive at RAF Brize Norton on Monday 6th October and be commissioned shortly thereafter. It is of interest and importance to the local community to understand the noise implications of the introduction of this new aircraft.

This report is mainly concerned with Engine Ground Running (EGR) noise as this is the source of the majority of noise complaints received by RAF Brize Norton. The report therefore compares the noise emissions from EGR of the A400M with the other aircraft in use at the base; the C130J, the A330 and the C17.

Available data for takeoff and landing is also presented.

The comparison study indicates that the A400M is quieter in flight than the C17, C130 and VC10. However, under high power runs, the A400M has higher noise emissions. This should be considered within the airport noise management plan. The position of the APU should also be considered when selecting the stands to be used as the directivity of the A400M is opposite to that of the C130. However, it should be noted that the number of hours of EGR required for the A400M are estimated to be lower than for the C130 and C17.

There are limitations to this study and it is recommended that a full modelling exercise is completed to quantify the effects of refleeting on the community. It is understood that this exercise is being undertaken by RAFCAM for air noise.

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Contents

1. Introduction

1.1 Background and Understanding

AMEC Environment and Infrastructure UK (AMEC) have been commissioned by Defence Infrastructure Organisation (DIO) to undertake a comparison of noise levels from engine ground running activities of various aircraft at Royal Air Force (RAF) Brize Norton.

RAF Brize Norton is the largest station in the RAF with approximately 5800 Service Personnel, 1200 contractors and 300 Civilian staff members. RAF Brize Norton is of national strategic importance as the UKs military air transport hub and Airport of Embarkation. The station is the home of the RAF's Strategic and Tactical Air Transport (AT) and Air-to-Air Refuelling (AAR) forces and provides capability and support for UK Defence, NATO and coalition Operations. Noise is an inevitable consequence of these activities and the base's function.

Historically, RAF Brize Norton has been associated with the Vickers VC10 jet aircraft, which were withdrawn from service in 2013 after 47 years. The base also accommodates other large aircraft such as the C-17 Globemaster, the A330 Voyager, the C130J Hercules, and until recently, the Lockheed L-1011 Tri-Star. From October 2014, the A400M Atlas will be introduced to RAF Brize Norton.

It is of great interest and importance to the local community to understand whether the introduction of the A400M will change the noise climate in the surrounding area.

A previous AMEC report published in April 2014 reviewed the available noise data of aircraft noise emissions and community noise levels to identify areas where further information was required to provide a model to show the effects of refleeting. This interim report provides an introduction to the A400M and its noise characteristics, and will be followed by a further report and noise model to quantify the effects of refleeting at RAF Brize Norton.

This assessment aims to provide DIO and RAF Brize Norton with an understanding of the noise emissions from engine ground running of all the aircraft on base and to determine whether the introduction of the A400M will require any changes to the noise management programme currently employed.

Previous AMEC Noise Reports

AMEC has undertaken a number of recent studies in relation to noise from RAF Brize Norton. These are summarised in Table 1.1 with studies focused on noise arising from EGR, particularly from the C130 aircraft. These were commissioned by DIO in direct response to noise complaints received at the Station from surrounding communities.

Table 1.1 Summary of Studies Undertaken to Date

Date	Study
October 2011 – December 2011	Original week-long noise surveys to determine level and nature of noise exposure from C130 EGR in communities.
	Measurements of C130 EGR to identify noise characteristics and directivity.
	Initial modelling to determine wider community exposure.
	Indicative modelling assessment of alternative stands and engine running pens to assess potential benefits.
February 2012	Further indicative noise modelling to assess potential noise control measures being considered by RAF Brize Norton.
March 2012	Measurements of VC10 EGR noise to understanding differences in noise levels between the VC10 and C130 aircraft.
May 2012	Measurements of A400M EGR to identify noise characteristics and directivity.
	Consideration of noise impacts at sensitive receptors at on-base locations.
August 2012	Publication of all technical investigations as outlined above in a report released under the Freedom of Information Act.
March/April 2013	4-week long noise survey to re-assess noise exposure at communities surrounding the base during a range of weather conditions.
June/July 2013	Additional, 4 week survey to compensate for a lack of westerly conditions in the March/ April survey.
May 2013 – September 2013	Development of software tool to calculate C130 EGR noise under prevailing weather conditions using standard modelling methodology, adapted based on March/April and June/July 2013 monitoring results.
	Comparison of noise exposure at receptors at and around RAF Brize Norton from measurements obtained in original October 2011 survey.
October 2013	Evaluation of changes in noise exposure from the base against the levels of exposure measured in October 2011 prior to the implementation of the measures recommended in previous reports.
	Investigation of any further management procedures which may help manage noise exposure from C130 EGR in light of prevailing weather conditions.
April 2014	Review of available baseline information and identification of the additional data required to investigate and model the noise effects of refleeting.

Other Noise Reports

The following documents prepared by other organisations also consider noise from operations and activities at RAF Brize Norton and have been referenced in the preparation of this report.

Table 1.2 Non-AMEC Documents Referenced in this Report

Author	Date	Study
Royal Air Force Centre of Aviation Medicine (RAFCAM)	January 2014	OEM/04/14 A report on an environmental noise survey at RAF Brize Norton. Noise Amelioration Scheme (Military) (NAS(M)) Assessment.
MOD	February 2014	Noise Amelioration Scheme (Military) (NAS(M)) Assessment.
MOD	August 2013	Brize Norton Noise management.
MOD	September 2010	Joint Service Publication (JSP) 148 MOD Corporate Environmental Protection Manual: Environmental Noise.
Airbus	July 2014	External noise Study Item for UK : A400M ANP data Technical Report Ref M090RP1429764
Airbus	July 2014	External noise Study Item for UK : A400M Run up noise results Ref M090RP1424866
Airbus Military	2011	UK MOB Noise Information: Maintenance Aspects

1.2 Aerodrome Noise

The noise produced by aerodromes is generally typically split into three categories:

- **Air noise** (i.e. aircraft on the runway during landing and take-off and in-flight during descent/ final approach, climb-out and cruise);
- **Ground noise** (i.e. aircraft running Auxiliary Power Units (APUs) on stand whilst in park mode: Ground Service Equipment (GSE) handling of stationary aircraft, aircraft taxiing to the runway threshold and queuing and holding prior to departure, aircraft 'start-of-roll' for departures, fixed-plant in airport buildings and facilities, and aircraft Engine Ground Running (EGR) including any associated Maintenance Repair Overhaul (MRO) operations; and,
- **Surface Access Noise** (i.e. noise from the modes of transport used by personnel and people who work and/or reside at the base).

The consideration and assessment of these noise sources is undertaken in isolation, however it should be recognised that these noise sources combine to result in the ambient and background noise climate that is experienced at and in the vicinity of any aerodrome. Some locations may experience only one of these noise sources whereas another may be affected by all three.

Each of these noise sources have different characteristics and can result in different responses, such as annoyance or complaint.

1.3 Refleeting of RAF Brize Norton

As discussed in Section 1.1, there are on-going changes to the aircraft fleet at RAF Brize Norton. The following sections provide a summary of recent and upcoming changes in the fleet[1].

VC10

The VC10 was withdrawn from service at RAF Brize Norton in September 2013 after 47 years of service. The VC10 in its final role at RAF Brize Norton was as an air tanker providing air-to-air refuelling (AAR). It performed this role from 1993.

Tri-Star

The Tri-Star retired from service on 24 March 2014 as an RAF AT and AAR asset. The Tri-Star's duties have been taken over by the Voyager.

C130 Hercules

The C130 fleet was transferred from RAF Lyneham to RAF Brize Norton in the Summer of 2011. The C130-K variant reached its Out of Service Date (OSD) in October 2013 when the remaining four K variants were retired. The C130-J fleet continue to fulfil their tactical operational role and had recently been involved in the operations in the Central African Republic and assisted with the Philippines disaster relief effort.

C-17 Globemaster

The C-17 fleet continues to maintain its worldwide operational commitment. Its global reach was used to good effect in December when the aircraft was used for the short notice extraction of a large number of entitled personnel from South Sudan.

A330 Voyager

The MOD selected the A330, following an open competition, to provide the replacement air-to-air refuelling and air transport capability through the Future Strategic Tanker Aircraft (FSTA) programme. The A330 (also known as the Voyager K2/K3) began air-to-air refuelling (AAR) operations with Typhoon in late May 2013, with a formal Release to Service (RTS) on 15 August 2013. A330 Voyagers have served operations in Afghanistan, improving the travel experience of the troops deploying to and from the operational theatre. In addition they have replaced the Tri-Star in the Air to Air Refuelling role.

A400M Atlas

The first aircraft is due to be delivered to RAF Brize Norton on 6th October 2014. A total of 22 aircraft have been ordered and are expected to arrive at a rate of one per month. The aircraft are similar in nature to the C130-J in the form of a turbo-prop military transport aircraft.

[1] Minutes of the local consultation working group general meeting, held at RAF Brize Norton (20 Jan 14)

1.4 Scope

The assessment has been undertaken to the following scope:

- Undertake a one week noise survey of EGR noise for aircraft types where no data is already available (A330 and C17),
- To observe and if possible measure other noise sources such as takeoff and landings of all aircraft (A330, C130J, A400M, C17)
- Obtain data for the A400M from Airbus where measurements are not possible
- Analysis of the measurements and those from previous reports to provide a comparison between aircraft

A subsequent report will use the data from this assessment to create a noise model which will be used to test and quantify the effects of future refleeting at RAF Brize Norton. This will use the outputs provided by RAFCAM.

2. Noise terminology

2.1 Key Noise Terms

The ratio between the quietest audible sound and the loudest tolerable sound is a million to one in terms of the change in sound pressure. Due to this wide range, a scale based on logarithms is used in noise level measurement. The scale used is the decibel (dB) scale which extends from 0 to 140 decibels (dB), corresponding to the intensity of the sound pressure level.

The ear has the ability to recognise a particular sound depending on the pitch or frequencies found at the source. Microphones cannot differentiate noise in the same way as the ear; and to counter this weakness the noise measuring instrument applies a correction to correspond more closely to the frequency response of the ear. The correction factor is called "A-weighting" and the resulting measurements are written as dB(A). "A-weighting" refers to the noise level that represents the human ear's response to sound.

The dB(A) unit is internationally accepted and has been found to correspond well with people's subjective reaction to noise. Typical dB(A) noise levels for familiar noises are given in Table 2.1:

Table 2.1 Typical Noise Levels

Sound Pressure Level, L_p (dB re 20μPa)	**Example**
0	Threshold of hearing for normal young people
20	Recording studio, ambient level
40	Quiet residential neighbourhood, ambient level
60	Department store, restaurant , speech levels
80	Next to busy highway, shouting
100	Textile mill; press room with presses running; punch press and wood planers, at operator's position
120	Ship's engine room; rock concert; in front and close to speakers
140	Moon launch at 100m; artillery fire; gunner's position Threshold of pain

Source: Engineering Noise Control – Theory and Practice, Third Edition, Bies and Hanson, 2003

The noise levels given in Table 10.2 are sound pressure levels (L_p) and describe the noise level at a point in space. Sound power levels (L_w) are used to describe the noise output of a noise source. Noise levels vary over time depending on noise generating activities. The following indices are used to take account of these variations:

- L_{Aeq} is the equivalent continuous sound level and is the sound level of a steady sound having the same energy as a fluctuating sound over the same period. It is possible to consider this level as the ambient noise encompassing all noise at a given time. L_{Aeq} is considered the best general purpose index for environmental noise;
- L_{A90} index represents the noise level exceeded for 90 percent of the measurement period and is used to indicate quieter times during the measurement period. It is usually referred to as the background noise level;
- L_{A10} refers to the level exceeded for 10% of the measurement period. L_{A10} is widely used as a descriptor of traffic noise;
- L_{Amax} is maximum recorded noise level during the measurement period.
- In addition, the following definitions may be helpful when reading this report:
- Ambient Noise: Totally encompassing sound in a given situation at a given time usually composed of sound from many sources near and far;
- Background Noise: (See $L_{A90,T}$). The A-weighted sound pressure level of the residual noise at the assessment position that is exceeded for 90% of a given time interval, T, measured using the fast time weighting;
- Fast Time Weighting: A sound pressure level measurement using a 125ms moving average time weighting period is said to have been determined using 'fast weighting'.
- Free Field: Signifies that a noise measurement has been undertaken in 'free field' conditions i.e. away from any reflecting facades e.g. building facades, close boarded fencework etc.

3. Legislation and Policy

3.1 National Legislation

Environmental Protection Act 1990

The primary legislation concerning environmental noise impacts is the Environmental Protection Act 1990 (EPA). This states in Section 79 (1)(g) that a statutory nuisance includes *"noise emitted from premises so as to be prejudicial to health or a nuisance"*. However, section 79(2) states that Section 79(1)(g) above does not apply in relation to premises

(a) Occupied on behalf of the Crown for naval, military or air force purposes or for the purposes of the department of the Secretary of State having responsibility for defence, or;

(b) Occupied by or for the purposes of a visiting force;

and *"visiting force"* means any such body, contingent or detachment of the forces of any country as is a visiting force for the purposes of any of the provisions of the Visiting Forces Act 1952.

Therefore, the EPA s79(1)(g) does not apply to RAF Brize Norton in respect of enforcement by the courts, however, the MOD is aware of the potential for noise to cause annoyance, nuisance and harm to health and takes these concerns seriously through its own policy.

3.2 MOD Policy

The MOD, despite its exemptions, endeavours to act as a 'good neighbour' to their local communities and has implemented its own Departmental policy, defence regulations and guidance covering environmental impacts. These are recorded in a series of Joint Service Publications (JSP).

JSP 815 describes in high-level terms the corporate system for the management of environmental protection and safety in the MOD. JSP 815 is a live document and is updated on a rolling basis. It is owned and published by the Defence Safety and Environment Authority (DSEA)[2].

The fundamental objective of this planning statement is that risk to the health and safety of anyone conducting or affected by defence activities is reduced 'as low as reasonably practicable' (ALARP).

Embedded within this are a series of environmentally related manuals including JSP 418 the MOD Corporate Environmental Protection Manual (which is publically available). JSP 418 outlines that MOD activities shall, as far as reasonably practicable be conducted:

[2] https://www.gov.uk/government/publications/jsp-815-defence-environment-and-safety

"so as to minimise the noise generated whilst achieving operational imperatives (including those which are an operational necessity), to reduce disturbance to local communities including residential areas (both Service and public) together with impacts on domestic animals and wildlife and their habitat."

4. Methodology

4.1 Noise survey methodology

As part of this assessment, new noise measurements were carried out for the A330 and C17 whilst undertaking EGR. These have been compared with data collected as described in previous AMEC reports from October 2011-May 2012. The methodology used for the September 2014 surveys was comparable with that of the previous measurements.

Measurements were undertaken using Rion NA28 'Class 1' integrating sound level meters. The instrumentation was set up to simultaneously log L_{Aeq}, L_{A90}, L_{A10}, L_{Amin} and L_{Amax}, (in addition to other) parameters over 1 minute sampling periods. The noise measurements were undertaken in one-third octave frequency bands between 12.5 Hz to 20 KHz in order to identify any tonal or potentially annoying characteristics of the engine running noise.

All measurements were undertaken, where possible, in accordance with BS 7445: Part 1:2003[3] and BS 4142:1997[4] and during dry and calm weather conditions.

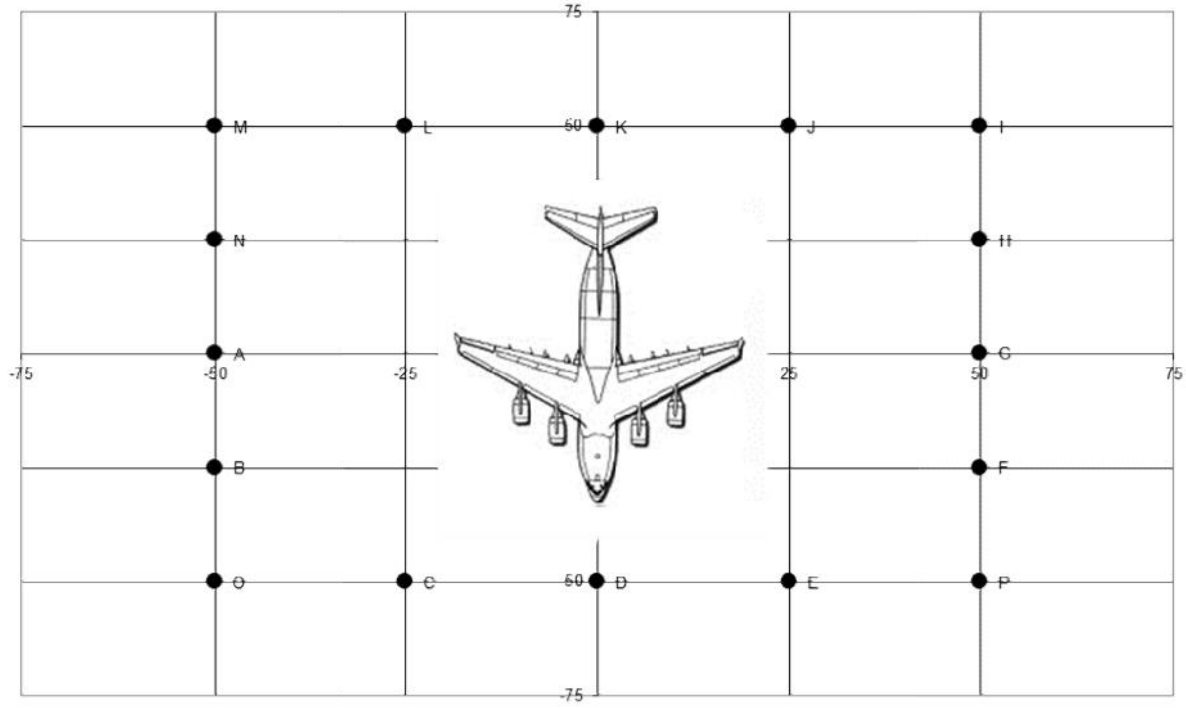
The measurements were taken in the form of a 'round robin' as shown in Figure 4.1

EGR Measurement Locations. Figure 4.1, with measurements taken at each until such time as the L_{Aeq} noise level for the measurement had stabilised.

[3] Acoustics - Description and Measurement of Environmental Noise - Part 1: Basic Quantities and Procedures. British Standards Institution, BS 7445:Part 1:2003.

[4] Method for rating industrial noise affecting mixed residential and industrial areas. British Standards Institution, BS 4142:1997.

Figure 4.1 EGR Measurement Locations



The measurements have been corrected to a set distance of 50m and analysed in order to derive sound power level information and a 'directivity pattern' for the noise emissions.

4.2 Comparative Analysis methodology

Engine Ground Running

The main aspects of engine ground running noise are:

- Overall noise emission levels
- Directivity - are noise emissions greater from a particular side or location around the aircraft?
- Tonality – does the EGR noise emit any noticeable tones that would increase the risk of annoyance?

The comparative assessment therefore considers these factors and considers whether any differences would necessitate a different approach to noise management.

Takeoff and landing

Noise-Power-Distance (NPD) has been provided by Airbus for the A400M[5]. This data has been presented in a format along with arrival and departure procedures that make it comparable with the data held within the Federal Aviation Administration's (FAA) Integrated Noise Model (INM). INM hold NPD data for a number of aircraft types including the VC10, C17 and C130. Using the NPD held within INM, a rudimentary comparison has been undertaken.

Landing and departure procedures and their profile differ within the INM dataset according to each aircraft. To facilitate a comparison, focus has been given to initial take-offs and final approaches where the aircraft are most likely to be under 4000ft and where aircraft configurations are readily understood.

The comparisons use the worst case high power take-off and high power approach settings for engine noise.

It should be noted that these comparisons may differ following a noise modelling exercise where other factors such as the following will influence the resultant noise level:

- Altitude between the aircraft and the ground taking into account terrain;
- The airspeed of the aircraft and the duration of the aircraft for a particular procedure;
- The bank angle of the aircraft (applicable before final approach and after initial departures);
- Atmospherics;
- Directivity;
- Ground effects; and
- The aircraft procedure during take-off and landing.

The provide a categorical understanding of the relative differences in the noise emissions between the aircraft, an air noise model constructed using INM could be developed for Brize Norton and noise event footprints / contours developed to identify the relative impact of a single event.

The comparisons consider three parameters, the EPNL, L_{Amax} and SEL. These are defined below:

Effective Perceived Noise Level (EPNL)

The perceived noise level (PNL) is a rating scale used to determine the subjective noise of an aircraft noise event taking into account any tones such as engine whine. The Effective Perceived Noise Level (EPNL) modifies the PNL to include a correction for tones and the duration of the noise event. This is used widely in the assessment of aircraft noise.

[5] External noise Study Item for UK : A400M ANP data Technical Report Ref M090RP1429764 July 2014

L_{Amax}

L_{Amax} is maximum (A-weighted) recorded noise level during the measurement period

SEL (Sound Exposure Level, or Single Event Level)

The SEL (Sound Exposure Level, or Single Event Level) is the sound level over one second that would have the same energy content as the whole event.

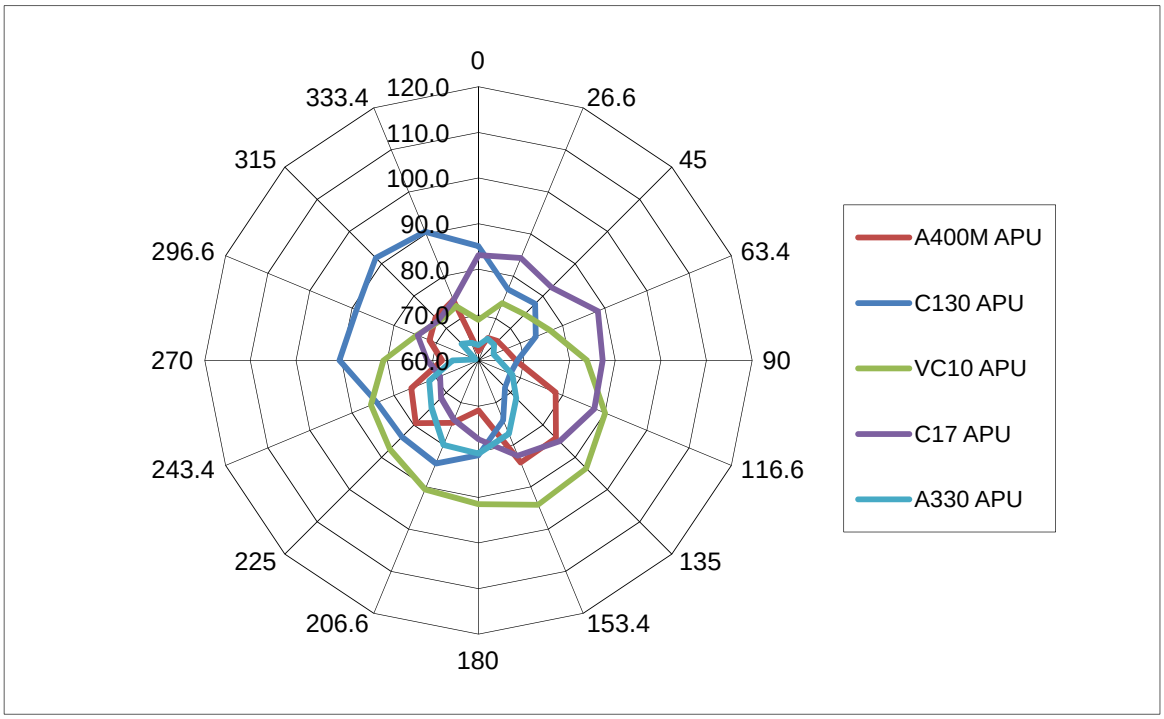
5. Results

5.1 Engine Ground Running

Auxiliary Power Unit (APU) Noise Levels

The results for engine ground running under auxiliary power are shown in Figure 5.1.

Figure 5.1 EGR APU Comparison



This shows that the A400M has lower noise emissions when running its APU than the C130, C17 and VC10. However the directivity of the noise emissions are shown to be to the right of the A400M, which contrasts with the C130 where emissions are to the left of the aircraft.

High Power Engine Ground Running Noise Levels

The results for engine ground running at high power settings are shown in Figure 5.12. High power runs were undertaken at the maximum power level allowed on the ground, and the power level is shown in the figure. The A330 could not be run at high power during the AMEC measurements and so is not included in this comparison.

Figure 5.2 EGR High Power Comparison

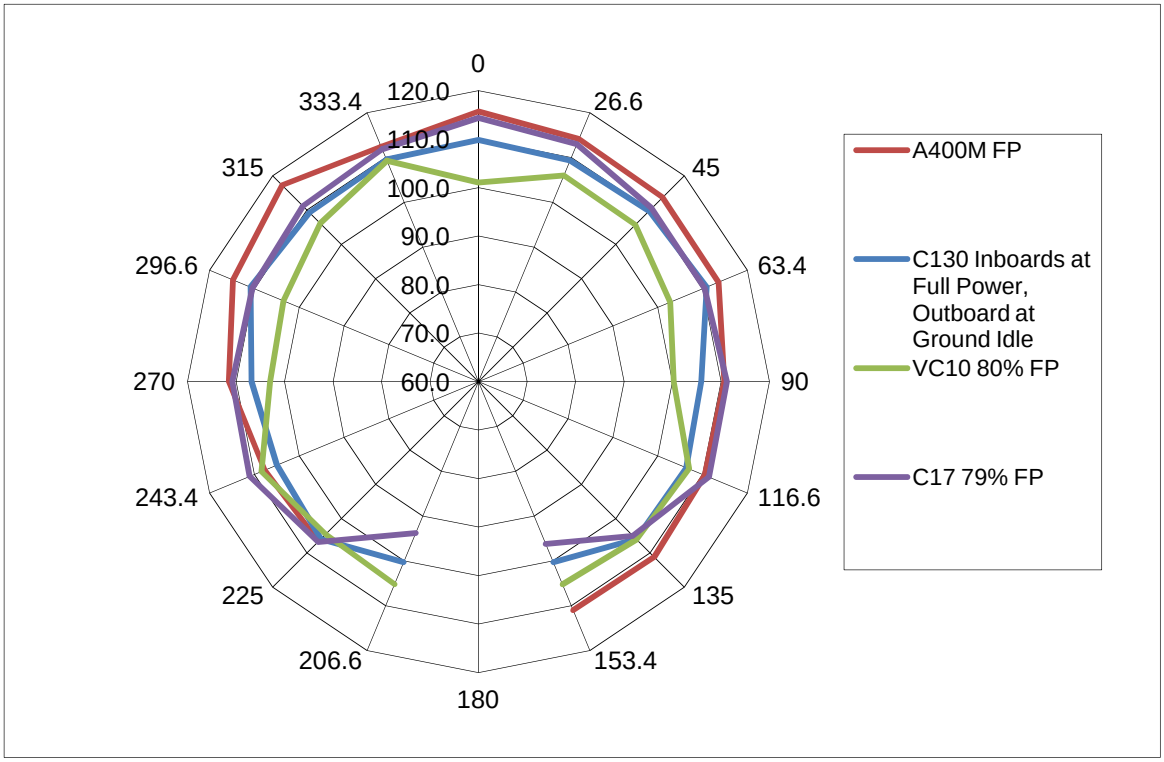


Figure 5.2 demonstrates that there is less directivity of noise emissions during full power EGR. The A400M has higher emissions during high power EGR than was measured for the other aircraft types.

Tonality

Previous AMEC studies have considered the presence of tones during EGR as well as overall noise emissions. These have indicated that the C130 emissions can be highly tonal, producing a low frequency tone at 100Hz.

Work undertaken by AMEC in 2012 shows that during Low Speed Ground Idle (LSGI) the A400M produces tones at 160Hz which are most apparent and pronounced to the front and the rear of the aircraft. During Normal Ground Idle (NGI) and High Power EGR, the A400M produces a tone at around 112Hz at most positions around the aircraft. The locations at which this tone is most apparent are those which are nearest to the wing tips. At locations to the rear of the aircraft tonal characteristics of the noise level are less apparent.

It is reasonable to conclude that during EGR, the A400M will produce noise levels of similar magnitude and character to the C130.

Number of EGRs

RAF Brize Norton have advised that each A400M aircraft will need to undertake EGR once every two months. Assuming that there will be 22 aircraft and that each ground run lasts for one hour this would equate to 132 hours of EGR annually. If ground runs are extended to two hours the duration would increase to 264 hours. As is the case with the C130, not all of the EGR would be at high power settings.

This figure has been assumed in Table 5.1 for comparison purposes.

Table 5.1 EGR Annual Duration

Aircraft Type	Annual Duration (hours)
Airbus A330	14
Hercules C130	411
C17	254
A400M*	132 - 264

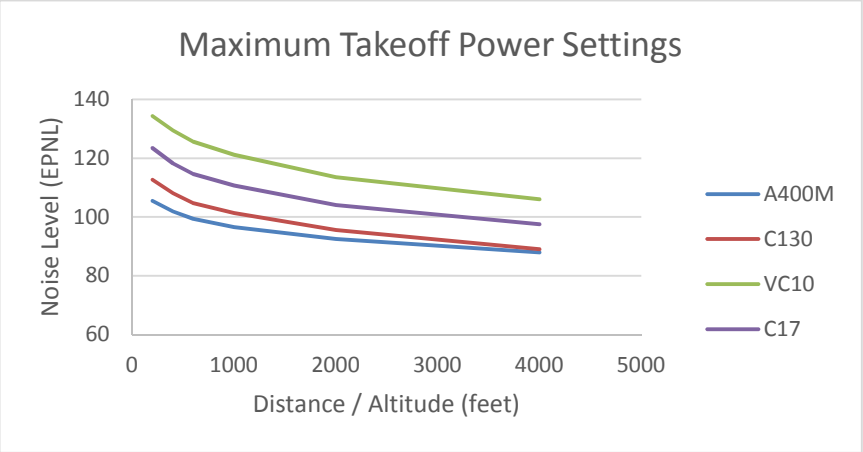
*Estimated based on assumption of one EGR every two months per aircraft

The estimated duration of EGR for the A400M is therefore lower than for the C130 and comparable with the C17. The VC10 has not been considered in this comparison as no historic data has been made available and that is has now retired from service.

5.2 Take-off

Based on the rudimentary comparison of NPD curves, Figure 5.3 shows the A400M to be quieter during high power take-offs than the other aircraft becoming comparable with the C130 at higher altitudes. The C130 is shown to have lower noise emissions during take-off than the C17 or VC10. At higher altitudes the A400M's noise emissions become comparable with the C130.

Figure 5.3 EPNL Comparison of Maximum Take off Settings



The L_{Amax} comparison in Figure 5.4 shows the A400M to be quieter during takeoff than the other aircraft . The C130 is shown to have lower noise emissions during high power take-off than the C17 or VC10.

Figure 5.4 L_{Amax} Comparison of Maximum Take off Settings

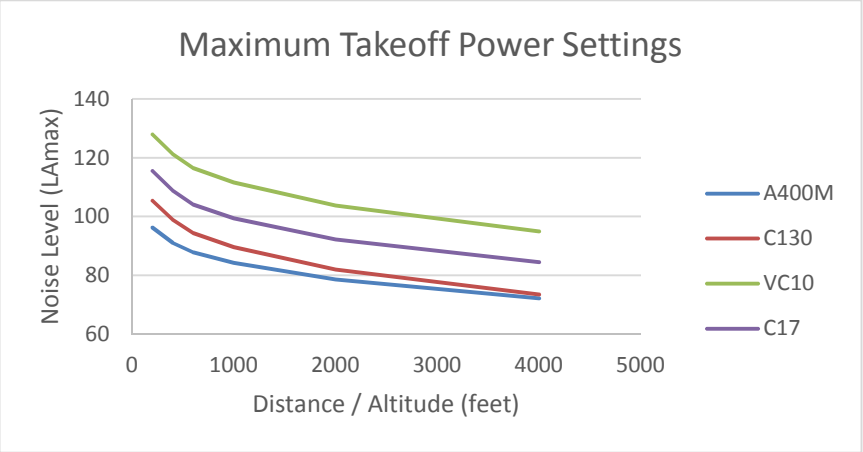
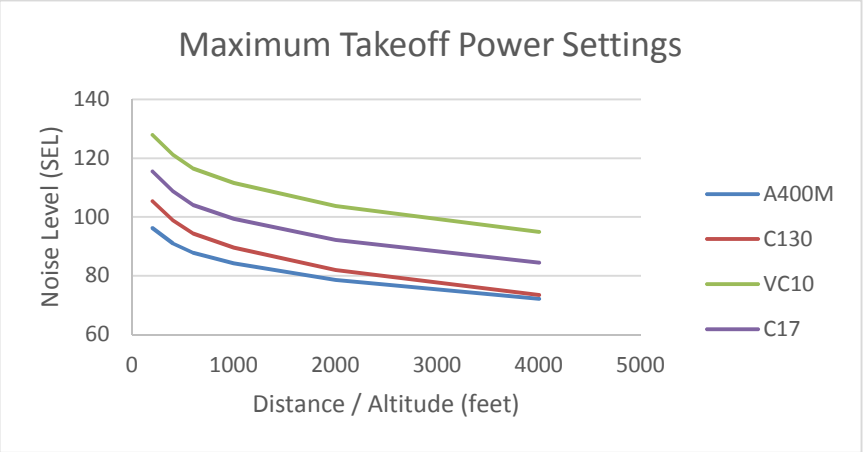


Figure 5.5 provides the comparison between SEL levels for the aircraft. This shows the A400M to have lower SEL emissions during take-off than the other aircraft. The C130 is shown to have lower SEL emissions during take-off than the C17 or VC10.

Figure 5.5 SEL Comparison of Maximum Take off Settings



5.3 Landing

The high power landing data in Figure 5.6 shows the A400M to have lower EPNL emissions than the VC10, C130 and C17. EPNL levels for the C130, C17 and VC10 are very similar at lower altitudes.

Figure 5.6 EPNL Comparison of High Power Landing

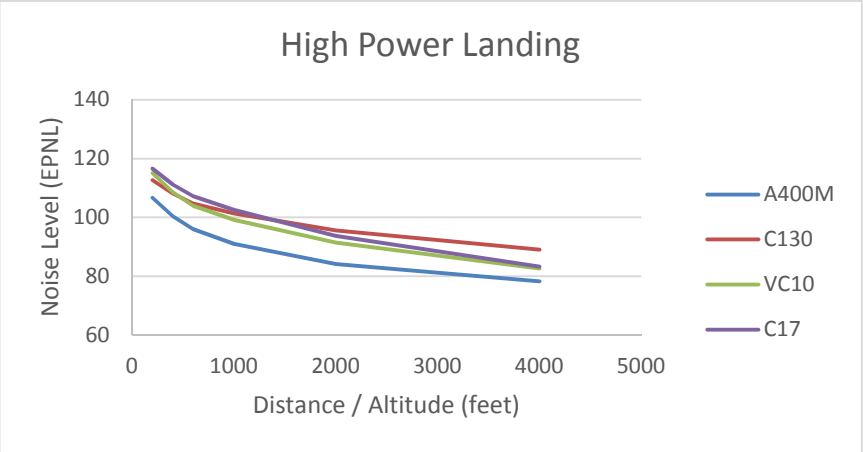


Figure 5.7 shows the L_{Amax} data for high power landing. This indicates significantly lower emissions from the A400M when compared to the C130 and C17. They are substantially lower than those for the VC10. The C130 and C17 have very similar L_{Amax} levels.

Figure 5.7 L_{Amax} Comparison of High Power Landing

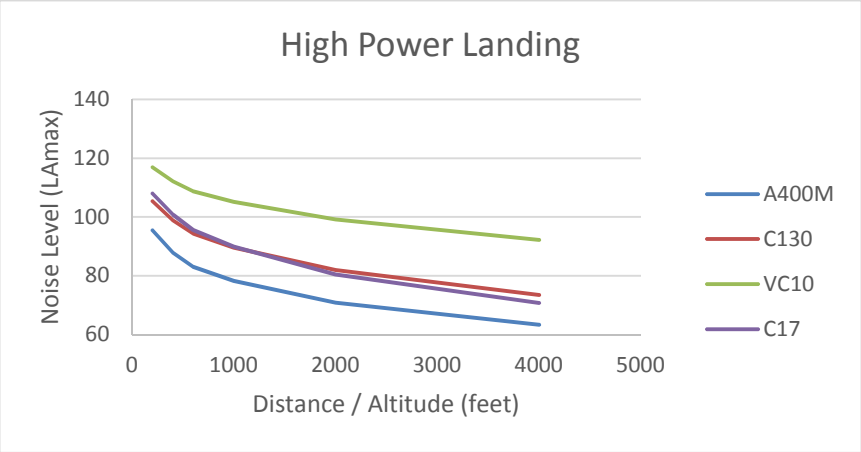


Figure 5.8 SEL Comparison of High Power Landing

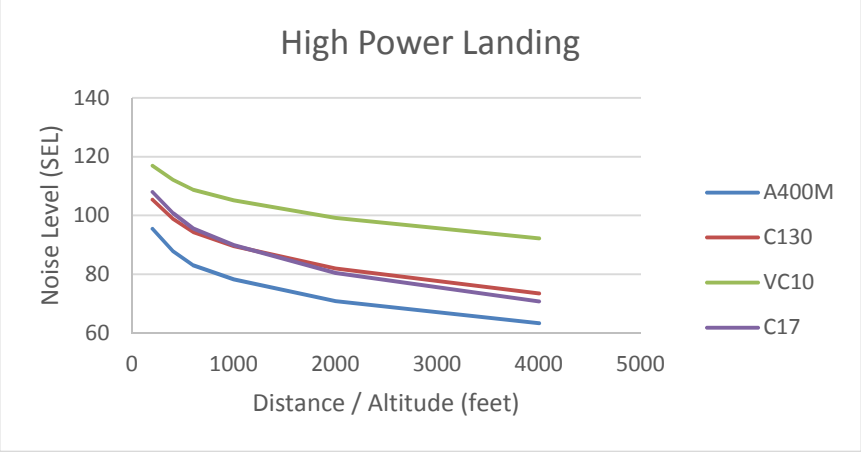


Figure 5.8 shows the comparison of SEL data for high power landing. This data also indicates significantly lower emissions from the A400M when compared to the C130 and C17 and substantially lower than those for the VC10. The C130 and C17 have very similar SEL levels.

6. Summary

6.1 Comparison of Aircraft Noise Emissions

Table 6.1 provides a simplified summary of the comparative study above by ranking each aircraft relative to the others. The lowest noise emissions are ranked 1(pale blue), and the highest are ranked 4 (orange).

Table 6.1 Summary of Comparative study

Activity	VC10	C17	C130	A400M
Engine Ground Running				
APU	4	2	3	1
High Power	1	2	3	4
High Power Initial Take-off				
EPNL	4	3	2	1
L_{Amax}	4	3	2	1
SEL	4	3	2	1
High Power Landing				
EPNL	3	2	4	1
L_{Amax}	4	2.5	2.5	1
SEL	4	2.5	2.5	1

1 represents lowest emissions, 4 represents highest emissions

The comparison study indicates that the A400M is quieter in flight during initial take-offs and final approaches than the C17, C130 and VC10. However, under high power EGR, the A400M has higher noise emissions. This should be considered within the airport noise management plan. The position of the APU should also be considered when selecting the stands to be used as the directivity of the A400M is opposite to that of the C130. However, it should be noted that the A400M EGR requirements are estimated to be lower than for the C130 and C17.

6.2 Limitations

The above comparative study considers the worst case emissions under specific circumstances using INM data for the in-flight data. As outlined in Section 4.2, there are a number of limitations in the comparison relying on NPD information alone. It is therefore recommended that the single events are modelled using INM for each of the aircraft using approach and departure procedures that occur at RAF Brize Norton. It is recommended that this takes the form of noise event footprints using the SEL, EPNL and L_{Amax} metrics. When modelled, it is possible that the comparison may yield difference results.

7. Conclusion

7.1 Conclusion

The comparative analysis indicates that the A400M has lower noise emissions in flight than the C17, VC10 and C130.

However, during high power EGR, the A400M has higher noise emissions than the C17, VC10 and C130. This should be considered within the airport noise management plan. The position of the APU should also be considered when selecting the stands to be used as the directivity of the A400M is opposite to that of the C130. However, it should be noted that the A400M EGR requirements (in respect of frequency and annual duration) are estimated to be lower than for the C130 and C17.

The analysis has also indicated that during EGR, the A400M will produce noise levels of similar magnitude and character to the C130 with both having a tonal characteristic in the 100Hz range.

7.2 Next Steps

A subsequent report will use the data from this, previous AMEC reports and INM to create a noise model which will be used to test and quantify the effects of future refleeting at RAF Brize Norton on community noise levels from engine ground running. It is understood that RAFCAM will be undertaking a separate noise modelling exercise regarding the effects on the NAS(M) contours.