RAF BRIZE NORTON ENVIRONMENTAL APPRAISAL
STAGE 1: NOISE ASSESSMENT

Version 1.2
Dated: 31-May-14

DIO Ops Projects
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RAF Brize Norton Environmental Appraisal

Stage 1: Noise Assessment

31 May 2014

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Executive Summary

The purpose of this report is to:

- Summarise the existing (baseline) data regarding environmental noise at RAF Brize Norton from previous AMEC reports and other data in the public domain;
- Identify relevant indicators for the monitoring and assessment of changes in noise exposure levels;
- Identify any gaps in data or information to be considered for further assessment; and,
- Present recommendations for future work (scoping).

The proposed reflagging, including the retirement of the C130K and introduction of the A330 and A400M will result in some changes to the noise environment at the Station. This report considers the available baseline information and identifies the data required to quantify those changes.

This report considers available data in respect of complaints, noise contours, and survey data from multiple aircraft and for multiple receptors. This includes data on the aircraft associated with complaints (where this is known), the proportion of air traffic movements associated with each aircraft type, and the duration of EGR in total and for each aircraft type.

The decision to restrict C130 EGR activities on the south-side bays at RAF Brize Norton has resulted in a significant improvement in noise exposure levels in the vicinity of the village of Black Bourton. Additionally there appears to have been a general reduction in daytime levels for all residential areas covered. However, to some extent the process of moving EGR testing away from the south side bays does appear to have resulted in the export of noise to other residential areas in the vicinity of the base, as there have been increases in complaints from Brize Norton village over the same timescales.

Qualitatively, the introduction of the A400M as the replacement for the C130 is unlikely to result in a significant reduction in noise emissions, other than through noise management procedures. The retirement of the Tri-Star and transfer of its duties to the A330 Voyager may have a slight beneficial effect, but it is not clear that this would be a perceptible effect.

Although there is a significant body of data available relating to aircraft noise, EGR and noise levels in the communities around RAF Brize Norton, further work is recommended in order to quantify the effects of the planned reflagging and the ongoing improvements to noise management.
# Abbreviations and Military Acronyms

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>AADT</td>
<td>Average Annual Daily Travel</td>
</tr>
<tr>
<td>AAR</td>
<td>Air to Air Refuelling</td>
</tr>
<tr>
<td>Alarp</td>
<td>As low as reasonably possible</td>
</tr>
<tr>
<td>APF</td>
<td>Aviation Policy framework</td>
</tr>
<tr>
<td>APU</td>
<td>Auxiliary Power Unit</td>
</tr>
<tr>
<td>AT</td>
<td>Air Transport</td>
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<tr>
<td>ATC</td>
<td>Air Traffic Control</td>
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<td>ATM</td>
<td>Air Traffic Movement</td>
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<td>dB</td>
<td>Decibel</td>
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<tr>
<td>DIO</td>
<td>Defence Infrastructure Organisation</td>
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<tr>
<td>DMRB</td>
<td>Design Manual for Roads and Bridges</td>
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<td>DSEA</td>
<td>Defence Safety and Environmental Authority</td>
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<tr>
<td>EGR</td>
<td>Engine Ground Run</td>
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<tr>
<td>EPA</td>
<td>The Environmental Protection Act 1990</td>
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<td>FSTA</td>
<td>Future Strategic Tanker Aircraft</td>
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<td>GSE</td>
<td>Ground Support Equipment</td>
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<td>Hz</td>
<td>Hertz</td>
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<td>IEMP</td>
<td>Integrated Environmental Management Plan</td>
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<td>JSP</td>
<td>Joint Service Publications</td>
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<td>LCWG</td>
<td>Local Consultation Working Group</td>
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<td>MilFLIP</td>
<td>Military Flight Information Publications</td>
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<tr>
<td>MOD</td>
<td>Ministry of Defence</td>
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<tr>
<td>MRO</td>
<td>Maintenance, Repair and Overhaul</td>
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<td>NAS(M)</td>
<td>Noise Ameliorisation Scheme (Military)</td>
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<tr>
<td>OSD</td>
<td>Out of Service Date</td>
</tr>
<tr>
<td>RAF</td>
<td>Royal Air Force</td>
</tr>
<tr>
<td>RAFCAM</td>
<td>RAF Centre for Aviation Medicine</td>
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<td>RTS</td>
<td>Release to Service</td>
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</tbody>
</table>
# Contents

1. Introduction  
   1.1 Background and Understanding  
   1.2 Aerodrome Noise  
   1.3 Refleeting of RAF Brize Norton  
   1.4 RAF Brize Norton Responses to Identified Noise Impacts  

2. Legislation and Guidance  
   2.1 National Legislation  
   2.2 MOD Policy  
   2.3 National and International Guidance Relating to Noise  

3. Approach  
   3.1 Community Noise Levels  
   3.2 Complaints  
   3.3 Aircraft Comparison on Community Noise Exposure  
   3.4 On-base Noise Exposure  
   3.5 Air Traffic Movements and EGR Duration  
   3.6 Surface Traffic Noise  
   3.7 Indicators and Metrics  
   3.8 Gap Analysis  

4. Summary of Baseline Data  
   4.1 Complaints  
   4.2 Community Noise Levels  
   4.3 Onsite Noise Levels  
   4.4 Air Traffic Movements  
   4.5 Engine Ground Running (EGR)  
   4.6 Traffic Data  

5. Discussion  
   5.1 Complaints
6. Summary and Recommendations

6.1 Summary 33
6.2 Recommended Indicators 34
6.3 Gap Analysis 35
6.4 Scope of Future Work 36
6.5 Conclusions 37

Table 1.1 Summary of Studies Undertaken to Date 2
Table 1.2 Non-AMEC Documents Referenced in this Report 3
Table 2.1 BS8233:2014 Indoor Ambient Noise Levels for Dwellings 9
Table 2.2 NAS(M) Scheme Summary 11
Table 4.1 Total Complaints Received 14
Table 4.2 Summary of Noise Monitoring 18
Table 4.3 Air Traffic Control Data for Air Traffic Movements 25
Table 4.4 Average Daily and Annual EGR Durations by Aircraft 2011-2013 27
Table 5.1 Average Day and Night Noise Levels in the Community 30
Table 5.2 Summary of On-Station Noise Levels 2013 31
Table A.1 Typical Noise Levels A-4
Table A.2 Response to Change in Noise Level A-4

Figure 4.1 Complaints by Location 2008, 2011 and 2013 15
Figure 4.2 Complaints by Activity 2008, 2011 and 2013 16
Figure 4.3 Complaints by Aircraft Type (where identified) 2008, 2011, 2013 17
Figure 4.4 RAFCAM Administrative Adjusted Noise Contours 20
Figure 4.5 Air traffic Movements by Aircraft Type 26
Figure 4.6 Monitoring locations used in 2011 and 2013 28

Annex A Glossary of Terms
1. Introduction

1.1 Background and Understanding

1.1.1 AMEC Environment and Infrastructure UK (AMEC) have been commissioned by Defence Infrastructure Organisation (DIO) to undertake a baseline and scoping report considering environmental noise related to activities at Royal Air Force (RAF) Brize Norton. In particular, the effects on environmental noise from the retirement of the VC10, C130K and Tri-Star aircraft and reflecting to introduce the A400M and increase the use of the A330 Voyager are of importance in relation to the scoping of future work.

1.1.2 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 UK’s 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.

1.1.3 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 and, until recently, the Lockheed L-1011 Tri-Star.

1.1.4 Environmental noise from aircraft operations in the air has always occurred at RAF Brize Norton, however noise from other ground-based activities including Engine Ground Running (EGR) has also occurred from the base. In the summer of 2011 the Lockheed C130 Hercules (C130) fleet and associated personnel and support were transferred from RAF Lyneham to RAF Brize Norton.

1.1.5 This is the most recent significant change in the operation of the fleet. Further changes are ongoing, including additional fleet changes, improvements to service personnel accommodation, road traffic routes within the station, and changes in operational procedures, particularly in relation to noise management. All of these factors have the potential to result in changes to the ambient and background noise climate within the base and its surroundings.

1.1.6 The purpose of this report is to:

- Summarise the existing (baseline) data regarding environmental noise at RAF Brize Norton from previous AMEC reports and other data in the public domain (and where possible identify likely changes to this due to reflecting at RAF Brize Norton);
- Identify relevant indicators for the monitoring of changes in noise levels;
• Identify any gaps in data or information that would be necessary for further assessment; and

• Present recommendations for future work (scoping), in particular the quantification of the effects of reflecting on community noise levels.

1.1.7 This report considers the available baseline information as at 31 March 2014, and identifies the data required to further quantify and monitor those changes.

**Previous AMEC Noise Reports**

1.1.8 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**

<table>
<thead>
<tr>
<th>Date</th>
<th>Study</th>
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<tr>
<td>February 2012</td>
<td>Further indicative noise modelling to assess potential noise control measures being considered by RAF Brize Norton.</td>
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<tr>
<td>March 2012</td>
<td>Measurements of VC10 EGR noise to understanding differences in noise levels between the VC10 and C130 aircraft.</td>
</tr>
<tr>
<td>May 2012</td>
<td>Measurements of A400M EGR to identify noise characteristics and directivity. Consideration of noise impacts at sensitive receptors at on-base locations.</td>
</tr>
<tr>
<td>August 2012</td>
<td>Publication of all technical investigations as outlined above in a report released under the Freedom of Information Act.</td>
</tr>
<tr>
<td>March/April 2013</td>
<td>4-week long noise survey to re-assess noise exposure at communities surrounding the base during a range of weather conditions.</td>
</tr>
<tr>
<td>June/July 2013</td>
<td>Additional, 4 week survey to compensate for a lack of westerly conditions in the March/April survey.</td>
</tr>
<tr>
<td>May 2013 – September 2013</td>
<td>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.</td>
</tr>
<tr>
<td>October 2013</td>
<td>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.</td>
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</table>
Other Noise Reports

1.1.9 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

<table>
<thead>
<tr>
<th>Author</th>
<th>Date</th>
<th>Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>MOD</td>
<td>February 2014</td>
<td>Noise Amelioration Scheme (Military) (NAS(M)) Assessment.</td>
</tr>
<tr>
<td>MOD</td>
<td>August 2013</td>
<td>Brize Norton Noise management.</td>
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</table>

1.2 Aerodrome Noise

1.2.1 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).

1.2.2 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.

1.2.3 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

1.3.1 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.

VC10

1.3.2 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

1.3.3 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

1.3.4 The C130 fleet was transferred from RAF Lyneham to RAF Brize Norton in the Summer of 2011. The C130K variant reached its Out of Service Date (OSD) in October 2013 when the remaining four K variants were retired. The C130Js 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

1.3.5 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

1.3.6 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 are now flying directly to and from 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

1.3.7 The first aircraft is due to be delivered to RAF Brize Norton in September 2014. A total of 22 aircraft have been ordered and are expected to arrive at a rate of 1 per month. The aircraft are similar in nature to the C130J in the form of a turbo-prop military transport aircraft.

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1 Minutes of the local consultation working group general meeting, held at RAF Brize Norton (20 Jan 14)
2 http://www.raf.mod.uk/rafbrizenorton/newsweather/index.cfm?storyid=95A73DBE-5056-A318-A8395A7777727429

Draft - See Disclaimer
1.4 RAF Brize Norton Responses to Identified Noise Impacts

1.4.1 RAF Brize Norton has implemented a series of measures since 2011 to help minimise noise from ground and air noise at communities surrounding the base. RAF Brize Norton published a summary of noise management orders in August 2013\(^3\). These have included:

- All EGRs must be conducted in accordance with the policy. To minimize noise disturbance to the local community EGRs are primarily to take place during ‘normal working hours’. Specific permission is required from the DOC (or OC Ops) for EGRs outside of normal working hours. For requests for EGRs outside normal hours the DOC is to follow an authorisation procedure. It should be noted however that only TANSOR, NS, Operational and Theatre specific tasks will be accepted;

- To minimize noise disturbance to the local community, engine ground runs (EGRs) are to be conducted under the following restrictions:
  - **a. 0700 - 1900(L) – (Normal Working Hours)** To minimize noise disturbance to the local community, engine ground runs (EGRs) are primarily to take place between 0700 and 1900 hrs (L) Mon to Sat and 0830 – 1900 hrs (L) on Sun;
  - **b. 1900 - 2300(L) – (Outside Normal Hours)** EGR requests between 1900-0700 hrs (L) require the approval of the DOC;
  - **c. 2300 - 0700(L) – (Quiet Hours)** Permission for any EGRs during this period is to be obtained from OC Ops. To avoid disturbance to the local community between 2300 and 0700 (0830L on Sun) all C130 low and high power EGRs are to take place on taxiway G or Bays 60-69 (subject to nil pax movements on bays 51-58).

- All C130 EGRs (Low & High power) are restricted to Bays 60-69 and Taxiway G. However in operational extremis high powered ground runs may be conducted on Bays 71 - 74 and 81 - 82 (aircraft facing south);

- Visual circuits are planned to avoid Witney and where possible other local villages. The visual circuit altitude is 1800 QNH\(^4\);

- The minimum flight height has been changed to 1800 QNH above Witney, Shilton, Minster Lovell, Bampton, Clanfield and Aston\(^5\);

- A permanent Environmental Noise Working Group has been established to improve the generation of noise and noise amelioration\(^6\);

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\(^3\) 20130819-RAF BRIZE NORTON NOISE MANAGEMENT, 19 August 2013
[http://www.raf.mod.uk/rafbrizenorton/raf/cms/mediafiles/8568DFD1_5056_A318_A88CF78FB19CE3DF.pdf](http://www.raf.mod.uk/rafbrizenorton/raf/cms/mediafiles/8568DFD1_5056_A318_A88CF78FB19CE3DF.pdf)

\(^4\) MilFLIP Brize Norton Issue 49 12 December 2013, UK MOD

\(^5\) MilFLIP Brize Norton Issue 49 12 December 2013, UK MOD

\(^6\) 20131118-RAF BZN Report, Air Commodore David Lee
• Towing of C130 aircraft to areas on Station as far as possible away from the surrounding communities before engine ground runs are conducted\(^7\);

• C130 aircraft are no longer permitted to routinely use reverse thrust to park on bays 70-82;

• The base will operate noise-reduced ground procedures – e.g. use of Ground Power Units instead of aircraft Auxiliary Power Units, and the towing of aircraft to test Bays (as opposed to taxi-ing under aircraft power);

• Training flights are now only conducted during weekday daytime hours, unless they are essential to operations. Operational flights outside these times must be authorised by a Station Executive or his nominated deputy.

\(^7\) 20131118-RAF BZN Report, Air Commodore David Lee
2. Legislation and Guidance

2.1 National Legislation

Environmental Protection Act 1990

2.1.1 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.

2.1.2 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.

2.2 MOD Policy

2.2.1 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).

2.2.2 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).8

2.2.3 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).

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2.2.4 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:

"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."

2.3 National and International Guidance Relating to Noise

2.3.1 The following non-statutory guidance has been considered in assessing the potential impacts of noise:

**UK Government Policy**

2.3.2 Current Government policy relating to aircraft noise and national planning guidance advises that 57 decibels (dB) $L_{Aeq, 16hr}$ is used to signify ‘the approximate onset of significant community annoyance’, during the day for air noise. The Government’s Aviation Policy Framework (APF) also requires that, as a minimum, households are offered relocation assistance by civil airports where they are exposed to 69 dB $L_{Aeq, 16hr}$ or more and that community buildings are offered acoustic insulation where they are exposed to 63 dB $L_{Aeq, 16hr}$ or more. For residential properties, the APF states that airport operators should contribute towards acoustic insulation where a change of +3dB in air noise levels also results in residential premises being exposed to levels of 63 dB $L_{Aeq, 16hr}$ or more.


2.3.3 WHO guidelines advise that for outdoor living areas (e.g. gardens, balconies, etc.), noise levels should be below 55 dB(A) $L_{Aeq, 16hr}$ in order to avoid serious annoyance, and below 50 dB(A) $L_{Aeq, 16hr}$ in order to avoid moderate annoyance, during the day.

**WHO ‘Night Noise Guidelines for Europe’ (2009)**

2.3.4 The 2009 WHO publication ‘Night Noise Guidelines for Europe’ includes a guideline value of 42 dB $L_{night}$ (outside) for self reported sleep disturbance and increased average motility. The publication also presents a night noise guideline of 40 dB $L_{night}$ (outside) for night-time noise and an interim target of 55 dB aimed at situations where achievement of the 40 dB target is not achievable for various reasons.

**BS 8233:2014 Guidance on Sound Insulation and Noise Reduction For Buildings**

2.3.5 This British Standard provides advice for sound insulation in buildings and includes advice on acceptable internal noise levels for resting and sleeping. This guidance is summarised in Table 2.1.
Table 2.1 BS8233:2014 Indoor Ambient Noise Levels for Dwellings

<table>
<thead>
<tr>
<th>Activity</th>
<th>Location</th>
<th>Daytime 07:00-23:00hrs</th>
<th>Night-time 23:00-07:00</th>
</tr>
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<tbody>
<tr>
<td>Resting</td>
<td>Living Room</td>
<td>35 dB L_{Aeq, 16hr}</td>
<td>N/A</td>
</tr>
<tr>
<td>Dining</td>
<td>Dining room/area</td>
<td>40 dB L_{Aeq, 16hr}</td>
<td>N/A</td>
</tr>
<tr>
<td>Sleeping (daytime resting)</td>
<td>Bedroom</td>
<td>35 dB L_{Aeq, 16hr}</td>
<td>30 dB L_{Aeq, 8hr}</td>
</tr>
</tbody>
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BS4142 Method for Rating Industrial Noise Affecting Mixed Residential and Industrial Areas

2.3.6 This standard is applicable to noise that is industrial in nature. Although it does not apply to aircraft noise it may apply to plant or machinery such as GSE.

2.3.7 BS4142 provides a method for rating industrial noise, including adding a penalty for noise with characteristics such as a hiss, bang, clatter or tone, and compares this rating level against the prevailing background noise level. Where the rating level is higher than the background level, and the greater the difference, the more likely it is that the noise will result in complaints.

Design Manual for Roads and Bridges (DMRB)

2.3.8 Volume 11 of DMRB contains guidance on the assessment of noise from road traffic. This includes advice that a change of 1 dB L_{A10, 18h} is the smallest perceptible in the short term, and that in the long term a 3 dB L_{A10, 18h} change is considered perceptible.

2.3.9 DMRB advises that a change in noise level of +/-1 dB L_{A10, 18h} is equivalent to a 25% increase or a 20% decrease in traffic flow over the 18-hour reference period, assuming other factors remain unchanged and a change in noise level of +/-3 dB L_{A10, 18h} is equivalent to a 100% increase or a 50% decrease in traffic flow.

RAF Brize Norton Plans

2.3.10 The RAF Brize Norton Integrated Estate Management Plan (IEMP) provides discrete objectives regarding the Station estate management. This allows the estate management to align its strategy with that of the customer/user (MOD) requirements. The IEMP is reviewed monthly, subject to a formal annual review and is designed to nest within DIO Site Guidance.

2.3.11 Current Station construction and redevelopment activities (in preparation for the new aircraft fleets) are managed for compliance with legislation and MOD policy using the IEMP and Environmental Management Systems. Changes to site activities, due to changes to the built environment, are incorporated into existing management systems.

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2.3.12 RAF Brize Norton environmental policy commits the Station to\textsuperscript{11}:

- Develop a noise amelioration programme to influence the operation of aircraft, with the aim of minimising, where possible, noise generation and the over-flying of populated areas; and
- Seek to minimise the impact of noise from all aspects of the operation of aircraft and the airbase.

**Noise Amelioration Scheme (Military) (NAS(M))**

2.3.13 The Noise Amelioration Scheme (Military) (NAS(M)) is a non-statutory direct assistance scheme for residents who live within the eligibility areas of military airfields and ranges. The scheme is part of MOD’s noise mitigation programme, which aims to reduce the effect of noise disturbance from military activities to those who live close to a military airfield or range.

2.3.14 The eligibility areas are defined by noise contours which record the average levels of sound around the airfield or range. The contour is defined by the $L_{Aeq,16h}$ which is the average level of noise produced by the activities throughout the 16 hour period.

2.3.15 Introduction of a NAS(M) is considered on a station by station basis and has three eligibility criteria that residents living in the immediate vicinity of a military airfield may be entitled to:

\textsuperscript{11} [http://www.raf.mod.uk/rafbrizenorton/organisation/proggateway.cfm](http://www.raf.mod.uk/rafbrizenorton/organisation/proggateway.cfm)
### Table 2.2  NAS(M) Scheme Summary

<table>
<thead>
<tr>
<th>Noise Level</th>
<th>Eligibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>$L_{Aeq,16h}$ 72dB contour</td>
<td>Owners of properties within this contour may receive an offer for the MOD to purchase. If the owners do not wish to sell, they may be offered the MOD acoustic glazing package.</td>
</tr>
<tr>
<td>$L_{Aeq,16h}$ 66dB contour</td>
<td>Owners of properties within this contour may receive an offer of a grant to install an acoustic insulation package comprising of acoustic double glazing system of at least 6.4L/12/10 for all bedrooms, living rooms, and kitchens (where the kitchen forms a substantial part of the living space). Bathrooms are not considered to be living rooms, nor are conservatories. Package may also include installation of passive acoustic louvered ventilation systems or mechanical acoustically louvered ventilation systems if in kitchens.</td>
</tr>
<tr>
<td>$L_{Aeq,16h}$ 63dB contour</td>
<td>Applies to noise sensitive areas such as schools/colleges, hospitals, care homes. Owners of these properties may receive an offer of a grant for installation an appropriate acoustic insulation package. The grant will only apply to buildings built or converted for use before the publication of the white paper, ‘Future of air transport in the UK 2003’ as it is expected that any development given planning permission after that date would have been built with the appropriate noise insulation.</td>
</tr>
</tbody>
</table>

---

3. **Approach**

### 3.1 Community Noise Levels

3.1.1 This report has been compiled from existing data held by AMEC and other data in the public domain using the documents referenced in, and described in Section 1.1.1 and Section 1.1.2. No new noise models or calculations have been undertaken for the preparation of this report.

3.1.2 The findings of the previous reports have been summarised to provide an overview of the baseline noise levels in the communities around RAF Brize Norton for which data is available including:

- Alvescot;
- Bampton;
- Black Bourton;
- Brize Norton;
- Filkins;
- Lew.

3.1.3 Information relating to on-site noise levels has been based on measurements undertaken for a variety of purposes relating to the investigation of EGR noise.

### 3.2 Complaints

3.2.1 A review of noise-related complaints was completed for 2008 (before RAF Lyneham activities were relocated to Brize Norton) and 2011 (after relocation). 2013 was also evaluated to provide context.

3.2.2 The complaint records were manually reviewed and entered into a spreadsheet before analysis of the complaint location, activity type and aircraft involved (where identified). Complaints were received from approximately 60 locations in the three separate years reviewed.

### 3.3 Aircraft Comparison on Community Noise Exposure

3.3.1 Noise monitoring data has carefully reviewed to identify the relative difference in noise in the communities from the VC10, C130 and A400M to enable a qualitative assessment of the likely changes that will result from the reflector at RAF Brize Norton. This information relates specifically to EGR rather than air noise or other ground noise activities such as taxiing, as no specific data is available for the latter.
3.4 **On-base Noise Exposure**

3.4.1 A high level review of monitoring data has been undertaken to identify areas on-base that are subject to high noise levels and would benefit from improvements to sound insulation. Information relating to on-site noise levels has been based on measurements undertaken for a variety of purposes relating to the investigation of EGR noise.

3.5 **Air Traffic Movements and EGR Duration**

3.5.1 AT movements and EGR are two of the primary noise sources at RAF Brize Norton and changes in noise exposure levels can be explained and described through information relating to movements and EGR durations.

3.5.2 AT movement data has been provided by AT Control at RAF Brize Norton for 2010 and 2013 and has been reviewed to provide a high level baseline, and comparison between these years. EGR duration data has been compiled from the RAFCAM 2014 report to provide a baseline of average daily and annual EGR duration.

3.6 **Surface Traffic Noise**

3.6.1 A high level review of traffic data for roads around the base has been undertaken to assess whether the changes in traffic flow resulting from the re-station of the C130 and other development would constitute a level that would be classed as a perceptible change in traffic noise.

3.7 **Indicators and Metrics**

3.7.1 The available baseline data, findings from the previous reports and examples of performance indicators from civilian airports have been reviewed. These have been used to provide suggestions of potential performance indicators which could be used to quantify changes in noise levels in the community and on-base in the future. These may arise as a result of fleet and operational changes, including the implementation of noise management procedures.

3.8 **Gap Analysis**

3.8.1 A gap analysis has been undertaken to identify further data, measurements or modelling that could be beneficial in measuring and monitoring progress with regards to noise management protocols, inform the development of future performance indicators and further quantify the changes in noise levels around RAF Brize Norton that are likely to result from re-reflecting.
4. Summary of Baseline Data

4.1 Complaints

4.1.1 Complaint data for 2008, 2011 and 2013 has been reviewed. These give a snapshot of the number of complaints, the location of the complainant and the reason for the complaint, which in some cases includes identification of the aircraft type involved. However, there is not sufficient data to draw reliable conclusions about developing, temporal trends, only a direct comparison between years.

Numbers of noise Complaints received by the Station

4.1.2 Complaints have increased significantly between 2008 and the present, as shown in Table 4.1 below, although there was a slight decrease in complaints in 2013 compared with 2011.

Table 4.1 Total Complaints Received

<table>
<thead>
<tr>
<th>Year</th>
<th>2008</th>
<th>2011</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of complaints</td>
<td>39</td>
<td>255</td>
<td>241</td>
</tr>
</tbody>
</table>

Location of Complainants

4.1.3 Noise complaints about aircraft and aircraft related noise come from a wide area with complaints from up to 60 locations in the three years that have been reviewed. Figure 4.1 below shows the number of complaints from each location for each year. Figure 4.2 shows activity associated with complaints.

4.1.4 A significant number of complaints were from unspecified locations in 2011 (45) compared with zero in 2008 and seven in 2013.

4.1.5 The greatest number of complaints from one location has come from Black Bourton (105 in 2011 and 86 in 2013). In 2013 there appears to have been a significant increase in noise complaints from four locations.

• Brize Norton (43 in 2013 compared with 4 in 2011);
• Mill Farm (22 in 2013 compared with 6 in 2011);
• Asthall (19 in 2013 compared with 19 in 2011); and
• Westwell (17 compared with 0 in 2011).

4.1.6 Complaints from Bampton have reduced by two thirds in 2013 (6) compared with 2011 (18), and complaints in Witney have reduced in 2013 (2) compared with 2008 (7).
Figure 4.1 Complaints by Location 2008, 2011 and 2013
Some complaints fall into more than one category and have therefore been counted more than once.
4.1.7 In 2008 the majority of complaints were in relation to low flying aircraft. In 2011 a more significant proportion of complaints was about ‘general noise’ and EGR, and several records in 2011 note that the concern was about a marked increase in noise with respect to previous emissions from the station.

4.1.8 In 2013 the reasons for complaints was more widespread, but non-aircraft-related complaints, for example, noise from dogs and shooting were recorded for the first time. Engine Ground Running complaints reduced in 2013 but still accounted for the greatest proportion of specific complaints (29%). Complaints concerning noise from overflying, low flying and takeoff increased in 2013 compared with complaints in 2008 and 2011.

**Aircraft Type associated with Complaints**

4.1.9 It is important to note that the aircraft type is often not specified by the complainant and so must be identified during subsequent investigations. However, for the majority of complaints the aircraft type is not known.

4.1.10 Where the aircraft type was identified the number of complaints associated with each aircraft type is shown in Figure 4.3 below. This indicates that the C130/Hercules is involved in the greatest proportion of complaints where the aircraft type is known. Complaints about noise from VC10 aircraft have reduced since 2008, with the aircraft since retired.

**Figure 4.3 Complaints by Aircraft Type (where identified) 2008, 2011, 2013**

Some complaints are counted more than once if multiple aircraft types were identified
4.2 Community Noise Levels

4.2.1 Community noise levels are addressed in several of the reports listed in Tables 1.1 and 1.2. Full details of the methodology applied are provided in each of the reports. The information provided in these reports can be used to help describe and present community noise levels and the noise sources observed in the locality. Full details of the methodology applied are provided in each of the reports.

4.2.2 Several community noise surveys have been carried out as part of these reports, as summarised in Table 4.2 below:

- Brize Norton (107 Station Road) in 2011, 2012, 2013;
- Alvescot (nr. Springfield Boarding Cattery) in 2013;
- Brize Norton (4 Moat Close) in 2013; and
- Black Bourton (Mill Farm) in 2013.

<table>
<thead>
<tr>
<th>Report Reference</th>
<th>Survey dates</th>
<th>Total Survey duration</th>
<th>Locations</th>
</tr>
</thead>
<tbody>
<tr>
<td>30976 11571i1</td>
<td>December 2011</td>
<td>1 week</td>
<td>Alvescot, Brize Norton, Black Bourton, Bampton</td>
</tr>
<tr>
<td>30976 12221i1</td>
<td>June 2012</td>
<td>3 days</td>
<td>On base accommodation. Alvescot, Brize Norton, Black Bourton, Bampton</td>
</tr>
<tr>
<td>30976 Final Report rr030i4</td>
<td>26Feb-28Mar 2013</td>
<td>1 month</td>
<td>Alvescot, Brize Norton, Black Bourton, Bampton, Brize Norton (Moat Close), Alvescot (Springfield Cattery), Black Bourton (Mill Farm).</td>
</tr>
</tbody>
</table>

4.2.3 Figure 4.6 (at end of this chapter) shows the monitoring locations used in 2011 and 2013, and the results for day and night time at each. Those used in 2011 were concerned with off-base (community) noise. In 2013 some on-base receptors and additional community receptors were added.

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4.2.4 The noise levels in Figure 4.4 are an average level for day and night, but it should be noted that these represent a wide range of noise levels measured over the survey periods.

4.2.5 The initial investigations were predominantly concerned with the Engine Ground Running component of noise generated by RAF Brize Norton, as this was the main issue raised in complaints about noise. The introduction of the C130 Hercules fleet to RAF Brize Norton in 2011 was perceptible to local communities and the change in noise was a significant factor in these complaints. The community noise studies undertaken by AMEC therefore considered:

• Comparison of EGR from VC10 and C130;
• Comparison of EGR from A400M and C130; and
• Overall Community noise including all noise sources.

4.2.6 In addition to the studies conducted by AMEC the RAFCAM study “A report on an Environmental Noise Survey of Aircraft Activity at RAF Brize Norton”\(^\text{13}\) was undertaken to carry out a Noise Amelioration Scheme (military) (NAS(M)) assessment. The report considered average daily movements including engine ground runs to determine the relevant noise contours and identify the potential entitlement under the NAS(M). Figure 4.4 shows the administrative adjusted contours that are recommended for use as the basis for the NAS(M) at RAF Brize Norton.

\(^\text{13}\) A report of an Environmental Noise Survey of Aircraft Activity at RAF Brize Norton. RAFCAM Report No OEM/04/14 dated January 2014
Community Exposure

Alvescot

4.2.7 Measurements taken at the Alvescot location have identified a modest level of overall noise exposure from the base. Maximum noise level events were found to be in relation to aircraft arrivals and departures rather than EGR. Other noise sources were also audible, notably intermittent road traffic noise from the B4020. Alvescot noise levels in 2013 (Day 56 dB L_{Aeq,T}, Night 48 dB L_{Aeq,T}) were found to be consistent with those in 2011 (Day 55 dB L_{Aeq,T}, Night 47 dB L_{Aeq,T}). In both years average daytime L_{Aeq} noise levels fell below the Government policy criterion of 57dB(A), and only marginally exceed the WHO upper value for serious annoyance in outdoor living areas.

4.2.8 An additional monitoring location in north Alvescot was added in 2013, at Springfield Cattery. Noise in this area is dominated by aircraft take-off and landings. Daytime average L_{Aeq} noise levels at 65.8 dB significantly exceed the WHO daytime criterion of 55 dB(A) to avoid serious annoyance in outdoor living areas. Night-time average L_{Aeq} noise levels at 56 dB also significantly exceed the 40 dB(A) WHO night noise guideline, and also marginally exceed the 55dB(A) interim target.
4.2.9 The NAS(M) contours confirm this and show this area to be within the 66 dB contour indicating that the location is significantly affected by air noise.

4.2.10 There were five complaints from Alvescot in 2011 but none in 2013.

**Bampton**

4.2.11 The monitoring location at Bampton was found to be the quietest of the measured locations. Noise exposure levels at this location are influenced by a wide range of extraneous noise sources such as passing road traffic. Noise levels in Bampton were compliant with the WHO guidance values in 2011 and 2013. The latest monitoring in 2013 appears to show an improvement, as levels at this location now comply with the lower, 50 dB(A) value of WHO for moderate annoyance in outdoor living areas whereas in 2011 they were compliant with the 55 dB(A) target at 53 dB $L_{A_{eq, 16h}}$. Night time noise levels at Bampton are also compliant with the interim target for night time and at 42 dB $L_{A_{eq, 8h}}$ in 2013 and 37 dB $L_{A_{eq, 8h}}$ in 2011 are close to the WHO night noise guidelines target of 40 dB $L_{A_{eq, 8h}}$.

4.2.12 There were 18 complaints from Bampton in 2011 and six in 2013 which supports this improvement found in the monitoring data.

**Black Bourton**

4.2.13 During the early surveys in 2011 and 2012 the dominant noise source in Black Bourton was from EGR due to C130 and VC10 aircraft undertaking EGR on the south-side bays. Other noise from the base was audible, such as take-off and landings, but during periods of EGR the noise levels in Black Bourton increased significantly, with ambient levels during these activities being very high. Modelling and monitoring identified that EGR at particular stands had a significant effect on noise levels at Black Bourton and recommendations were made to minimise this impact.

4.2.14 In 2013 when the survey was repeated with EGR having been relocated a significant decrease of around 15 dB in daytime average exposure was noted in Black Bourton. Average daytime $L_{A_{eq}}$ noise levels at M3 Black Bourton, whilst previously exceeding the guideline limits by a significant margin, now fall below the Government policy criterion of 57dB(A) for aircraft noise, and only marginally exceed the WHO upper value for serious annoyance in outdoor living areas.

4.2.15 The NAS(M) contours confirm this and show Black Bourton to be outside the 63 dB contour.

4.2.16 There were 105 noise complaints from Black Bourton in 2011 and 86 in 2013.

**Brize Norton**

4.2.17 The noise climate at the Brize Norton monitoring location (M2) is dominated by aircraft arrivals and departures. Overall, daytime noise levels at the monitoring location in 2011 were found to be above a threshold which for air noise would be considered to mark the onset of community annoyance. Engine ground running was found to have a minor effect on the overall noise climate at Brize Norton however levels were influenced by EGR on the 60’s bays to the north of the runway. With the changes implemented by RAF Brize Norton, the measurements in 2013 were approximately 5 dB lower than in 2011 during the day, although the report notes that wind direction during the surveys may have overstated this improvement.
4.2.18 The 2013 average daytime $L_{Aeq}$ noise levels of 56 dB $L_{Aeq,T}$ are compliant with the Government policy criterion of 57 dB(A) and only marginally exceed the WHO upper value for serious annoyance in outdoor living areas. It appears the implementation of noise amelioration measures have achieved a substantial improvement in Brize Norton, which was previously non-compliant with both of these values.

4.2.19 Other noise sources such as road traffic noise from Station Road are audible within Brize Norton. The monitoring location was positioned at the southern extremity of the village and may therefore not be fully representative of the noise environment for the whole community.

4.2.20 A second monitoring location was added in 2013 at Moat Close, at the northern edge of the village. Levels at this location (M6) were lower than those at M2 at 52 dB $L_{Aeq,T}$ during the day and 46 dB $L_{Aeq,T}$ at night.

4.2.21 Although the average noise levels have reduced there were four noise complaints from Brize Norton in 2011 and 43 in 2013. The increase from complaints may be due to the relocation of C130 EGR.

Filkins
4.2.22 Filkins is shown in the NAS(M) study to be just outside the 63 dB contour. These results indicate that noise exposure in Filkins may exceed the Government policy criterion of 57 dB(A), and the WHO upper value for serious annoyance in outdoor living areas. There was one noise complaint from this area in 2011 and two in 2013, all relating to over-flights or low flying aircraft. This location is on the extended runway centre line and therefore will be subject to aircraft over-flights.

4.2.23 Filkins is within 600m of the A361. It is likely that road traffic noise forms part of the background noise environment at this location. However, it is unlikely that traffic associated with RAF Brize Norton makes up a significant proportion of this traffic.

4.2.24 No noise monitoring data is available for this area.

Kencot
4.2.25 Kencot is shown in the NAS(M) study to be within the 63-66 dB contour. The village is located on the extended runway centreline and is therefore subject to aircraft over-flights which are likely to be the dominant noise source.

4.2.26 The NAS(M) study results indicate that noise exposure in Kencot exceed the Government policy criterion of 57 dB(A), and the WHO upper value for serious annoyance in outdoor living areas. There were five complaints about noise from Kencot in 2011 (relating to general or continuous noise) and two in 2013 (relating to low flying aircraft and circuits).

4.2.27 No noise monitoring data is available for this area.

Lew
4.2.28 An area north of Lew is shown in the NAS(M) report to be within the 72 dB contour which would exceed the Government policy criterion of 69 dB(A), and the WHO upper value for serious annoyance in outdoor living areas. There were four noise complaints from Lew in 2013 relating to night-time noise and over-flights.
4.2.29 No noise monitoring data is available for this area.

**Comparison of Effects of Aircraft Type on Community Noise Exposure**

4.2.30 The majority of complaints received in 2008, 2011 and 2013 did not specify the aircraft associated with the complaint, but in the cases where an aircraft type was specified the C130/Hercules was attributed to the greatest number of complaints. There are significantly fewer complaints in relation to the Tri-Star, although there was an increase in complaints attributed to the Tri-Star in 2013 (18 in 2013 compared to 4 in 2011) but the reason for this is not known.

4.2.31 Based on the information reviewed, the only aircraft specific information available regarding community noise exposure relates to aircraft Engine Ground Running. The AMEC reports have compared noise levels from aircraft EGR from three aircraft in particular,

- VC10 (now retired);
- C130 Hercules;
- A400M (to be introduced in 2014)

4.2.32 Note that monitoring work to date does not currently include any data specific to EGR operations for the Tri-Star.

4.2.33 Two types of measurement were taken, the first was close to the aircraft to ascertain the noise levels close to the aircraft and identify their respective emissions and directivity. The second was to compare how the noise compared within the surrounding communities.

4.2.34 At source, in comparison with VC10 and C130, noise emissions from the A400M is around 5-10dB(A) higher at the front and sides of the aircraft, and 7-10dB(A) higher at the rear.

4.2.35 Measured noise levels within the surrounding communities from the A400M, C130 and VC10 aircraft were not directly comparable as they were located at different stand locations during their respective engine ground runs. However, it was noted that in each instance the highest measured noise levels were recorded at Black Bourton, with levels from the VC10 and C130 roughly 10 dB(A) higher than those from the north-facing A400M on Stand 67.

4.2.36 The highest measured broadband noise levels from the A400M and C130 occurred during the full power engine runs. The measured noise levels from the A400M are lower than those from the C130 however the measured spectral shape is similar.

4.2.37 There is a clear tone at around 100 hertz (Hz) from the C130 full power engine runs at Black Bourton and a similar tone from the A400M between 100-125Hz. During both engine runs the majority of noise is present in the mid-frequency bands between 315Hz-2kHz.
4.2.38 The introduction of the A400M is therefore likely to result in similar or slightly higher noise levels from engine ground running, and would have a similar tonal character to the C130. In contrast, the VC10 did not have any tonal characteristics and was perceived as broadband noise within the communities.

4.3 Onsite Noise Levels

4.3.1 Long term noise monitoring undertaken in March/ April and June/ July for the EGR/ meteorological study (Reference 30976rr030i4) included measurements at various on-base locations. These measurements were undertaken for a variety of purposes, but chiefly in relation to assessment work aircraft EGR activities.

B3 Officers Mess and B4 Junior Ranks

4.3.2 Daytime average $L_{Aeq}$ noise levels at B3 and B4 are consistently and significantly higher than the WHO upper guideline value of 55 dB(A) to avoid serious annoyance in outdoor living areas, and the Government policy criterion of 57 dB(A) for aircraft noise. Similarly, night-time average $L_{Aeq}$ noise levels are well in excess of 40dB(A) WHO target levels for night-time noise outside properties. Noise exposure levels at these locations should be considered high for both day and night-time periods.

4.3.3 Noise levels at this location were heavily influenced by airfield activity. The NAS(M) contours show these areas to be within the 66-72 dB contour which demonstrates that air noise significantly affects these locations

B5 SFA

4.3.4 Daytime average $L_{Aeq}$ noise levels are compliant with the WHO daytime criterion of 55 dB(A) to avoid serious annoyance in outdoor living areas. However, night-time average $L_{Aeq}$ noise levels exceed 40 dB(A) WHO night noise guidelines, but comply with the 55dB(A) interim target. Noise exposure levels at B5 should be considered acceptable, although monitoring results show that certain noise events can be of a high level. The NAS(M) contours show these areas to be outside the 63 dB contour.

4.3.5 Noise exposure levels at the on-base locations seem to show that in general, noise levels at sensitive locations on-base are exposed to higher levels of noise than those located off-base.

4.3.6 This supports the case for the RAF for ongoing work in relation to on-base noise reduction and mitigation measures (e.g. base accommodation sound insulation).

4.4 Air Traffic Movements

4.4.1 Air Traffic Control (ATC) data has been provided by RAF Brize Norton for 2010 and 2013 and is shown in Table 4.4/Figure 4.6 below. The data indicates an overall increase in fixed wing air traffic of around 30% between the two years, although there has been a decrease in the number of helicopter movements. The annual increase has been divided by 220 in order to provide a conservative indication of how many air traffic movements per day are represented by this increase. This data is recommended as the baseline for assessing the annual Air Traffic movements (ATM).
4.4.2 These increases in fixed wing activities would support the observed increase in noise from the base between 2010 and 2013.

Table 4.3  Air Traffic Control Data for Air Traffic Movements

<table>
<thead>
<tr>
<th>Aircraft type</th>
<th>Air Traffic Movement Type</th>
<th>ATMs 2010</th>
<th>ATMs 2013</th>
<th>Change14</th>
<th>Average Daily Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed wing</td>
<td>Approach (no T/Gs or L/As)</td>
<td>4327</td>
<td>5636</td>
<td>1309</td>
<td>6.0</td>
</tr>
<tr>
<td></td>
<td>Landing roll (no T/Gs or L/As)</td>
<td>4327</td>
<td>5636</td>
<td>1309</td>
<td>6.0</td>
</tr>
<tr>
<td></td>
<td>Take-off roll (no T/Gs or L/As)</td>
<td>4273</td>
<td>5672</td>
<td>1399</td>
<td>6.4</td>
</tr>
<tr>
<td></td>
<td>Initial climb out (no T/Gs or L/As)</td>
<td>4273</td>
<td>5672</td>
<td>1399</td>
<td>6.4</td>
</tr>
<tr>
<td></td>
<td>Approach (T/Gs &amp; L/As)</td>
<td>4952</td>
<td>6452</td>
<td>1500</td>
<td>6.8</td>
</tr>
<tr>
<td></td>
<td>Initial climb out (T/Gs &amp; L/As)</td>
<td>4952</td>
<td>6452</td>
<td>1500</td>
<td>6.8</td>
</tr>
<tr>
<td>Helicopter</td>
<td>Total Helicopters</td>
<td>1838</td>
<td>1792</td>
<td>-46</td>
<td>-0.2</td>
</tr>
</tbody>
</table>

4.4.3 Figure 4.6 shows the number and type of movements by aircraft for 2010 and 2013. It is clear from this that the C130J Hercules are responsible for the greatest proportion of fixed wing movements. The Tri-Star produced a significant proportion of touch and go movements, while the Airbus 330 was responsible for over 20% of take-off and landing movements.

4.4.4 It is not clear whether the retirement of the Tri-Star and C130 will reduce the number of ATMs as a whole, i.e. if the same number of movements would transfer to an alternative aircraft type, such as the A400M. It is assumed, for the purposes of this report, that the number of movements will remain similar, but that the proportion of each aircraft type will change over time.

14 Positive number indicates an increase and negative number indicates a decrease
### 4.5 Engine Ground Running

#### General

4.5.1 The AMEC reports contain a substantial body of data on EGR, including noise modelling with noise contours. The reports have also carried out extensive studies of the potential benefits of a ground running pen. The October 2013 report considered the effects of meteorology on the propagation of noise from EGR and has established a model to predict these effects during a range of meteorological conditions (wind speed and direction, atmospheric stability, temperature etc.).

4.5.2 In 2011 EGR was shown to have a significant impact on noise levels in Black Bourton, but also that changes implemented by RAF Brize Norton have now reduced these impacts. The 2013 report indicates a significant reduction in noise from EGR at Black Bourton due to the relocation of most C130 EGR to north of the runway (60’s buays). It is recommended that the A400M is subject to similar noise management protocols to control EGR noise.
Daily EGR Data

4.5.3 The RAFCAM report\textsuperscript{15} provides daily EGR time periods 11 months from July 2011 to June 2012 and two months from September to October 2013.

4.5.4 The worst case of these times is shown in Table 4.4 below. The annual figures are based on 220 days.

Table 4.4 Average Daily and Annual EGR Durations by Aircraft 2011-2013

<table>
<thead>
<tr>
<th>Aircraft Type</th>
<th>Average Daily Duration (minutes)</th>
<th>Annual Duration (hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boeing 757</td>
<td>0.2</td>
<td>0.7</td>
</tr>
<tr>
<td>Boeing 767</td>
<td>0</td>
<td>0.5</td>
</tr>
<tr>
<td>Airbus A330</td>
<td>4</td>
<td>14</td>
</tr>
<tr>
<td>Hercules C130</td>
<td>112</td>
<td>411</td>
</tr>
<tr>
<td>C17</td>
<td>69</td>
<td>254</td>
</tr>
<tr>
<td>Tri-Star</td>
<td>34</td>
<td>125</td>
</tr>
</tbody>
</table>

4.6 Traffic Data

4.6.1 Road vehicles are the principle mode of transport to and from the base. Road traffic noise from the base’s activity is likely to be most felt in areas around the base such as in Carterton and in outlying areas such as Shilton.

4.6.2 Traffic data (Average Annual Daily Traffic (AADT)) has been compared for 2011 and 2013 for roads surrounding the base. Although there is an increase in traffic as a result of the increase in personnel on site, this is not greater than the 25% required for a 1 dB increase in traffic (the smallest perceptible increase in traffic noise).

4.6.3 Noise level calculations have not been undertaken as at this time there is only AADT data available.

\textsuperscript{15} A report of an Environmental Noise Survey of Aircraft Activity at RAF Brize Norton. RAFCAM Report No OEM/04/14 dated January 2014
Figure 4.6 Monitoring locations used in 2011 and 2013.
5. Discussion

5.1 Complaints

5.1.1 Noise complaints relating to RAF Brize Norton come from a wide area, with complaints from up to 60 locations over a three year period (see Section 4.1). The greatest number of complaints from one location has come from Black Bourton (105 in 2011 and 86 in 2013). In 2013 there appear to have been an increase in complaints from Brize Norton (43 in 2013 compared with 4 in 2011), Mill Farm (22 in 2013 compared with 6 in 2011), Asthall (19 in 2013 compared with 19 in 2011) and Westwell (17 compared with none in 2011).

5.1.2 In 2008 the majority of complaints were in relation to low flying aircraft whereas in 2011 a more significant proportion of complaints concerned ‘general noise’ and Engine Ground Running. Several records in 2011 note that complainants noted a significant increase in noise from the base.

5.1.3 In 2013 the reasons for complaints was more widespread, but non-aircraft-related complaints, for example, noise from dogs and shooting were recorded for the first time. Engine Ground Running complaints reduced in 2013 but still accounted for the greatest proportion of complaints (29%). Complaints about noise from overflying, low flying and takeoff increased in 2013.

5.1.4 The C130/ Hercules is involved in the greatest proportion of complaints where the aircraft type is known.

5.1.5 Analysis of the complaints suggests that complaints are closely related to perceptible changes in the baseline environment, especially when the change is visible, as well as audible (e.g. where new aircraft can be both seen and heard). The re-stationing of the C130 fleet marks a large, noticeable change in the environment, and it will be important to consider this in relation to future fleet changes and the introduction of the A400M.

5.1.6 The reason for the reduction in complaints in 2013 is not clear. It is possible that the reduction is partially due to people adjusting to the changes in the noise climate and awareness of the noise management procedures being implemented by RAF Brize Norton to minimise noise emissions. The reduction in complaints from Black Bourton, corresponding with an increase in complaints from Brize Norton, would however suggest that the relocation of EGR activities has been a factor. Asthall and Westwell are at distances of 5-7km from the Station and not within any of the NAS(M) contours. Thus, the reason for the increase in complaints, in this area, is not clear and may be related to training circuits.

5.1.7 When the community noise levels and complaints data is considered together, there are positive indications that the noise management protocols implemented by RAF Brize Norton are reducing noise levels and annoyance from station activities.
Community Noise Levels

5.1.8 A summary of noise levels measured by AMEC in the community areas around RAF Brize Norton\textsuperscript{16} are shown in Table 5.1.

\begin{table}[h]
\centering
\caption{Average Day and Night Noise Levels in the Community}
\begin{tabular}{|l|c|c|c|}
\hline
Location & Time Period & Noise Level L\text{Aeq,T} dB & Change* \\
\hline
M1 (Alvescot) & Day & 55 & 56 & 1 \\
 & Night & 47 & 48 & 1 \\
M2 (Brize Norton) & Day & 60 & 56 & -4 \\
 & Night & 51 & 50 & -1 \\
M3 (Black Bourton) & Day & 71 & 57 & -14 \\
 & Night & 59 & 50 & -9 \\
M4 (Bampton) & Day & 53 & 48 & -5 \\
 & Night & 37 & 42 & 5 \\
M5 (Alvescot) & Day & - & 66 & N/A \\
 & Night & - & 56 & N/A \\
M6 (Brize Norton) & Day & - & 52 & N/A \\
 & Night & - & 46 & N/A \\
M7 (Mill Farm) & Day & - & 49 & N/A \\
 & Night & - & 42 & N/A \\
\hline
\end{tabular}
\textsuperscript{*}A positive number in the Change column indicates an increase, a negative number indicates a decrease
\end{table}

The community noise levels in 2013 were generally lower than those measured in 2011, which is considered to be due to the improvements in noise management procedures implemented by the Station. There is evidence that significant improvements have been achieved with respect to these WHO guideline noise limits at some locations. For example, average daytime L\text{Aeq} noise levels at M3 Black Bourton, whilst previously exceeding the guideline limits by a significant margin, now fall below the Government policy criterion of 57dB(A), and only marginally exceed the WHO upper value for serious annoyance in outdoor living areas.

Similarly, at M1 Alvescot and M2 Brize Norton, average daytime L\text{Aeq} noise levels are compliant with the Government policy criterion of 57dB (A), and only marginally exceed the WHO upper value for serious annoyance in outdoor living areas. A substantial improvement is apparent in the latter, which was previously non-compliant with both of these values. A modest improvement has been found at Alvescot.

\textsuperscript{16} It should be noted that surveys have been undertaken over several days, and that these summaries give an overview. For detailed table of survey results please see the original reports.
5.1.11 Average daytime $L_{Aeq}$ noise levels at M4 Bampton were compliant with the guidance values prior to 2013, and remain so, although again there appears to have been an improvement, as they now also comply with the lower, 50dB(A) value of WHO for moderate annoyance in outdoor living areas.

5.1.12 Average night-time $L_{Aeq}$ noise levels at M1 Alvescot, M2 Brize Norton and M3 Black Bourton remain non-compliant with the WHO night-time noise guideline of 40dB(A) $L_{night}$ (outside), but comply with the interim target of 55dB(A). Average night-time $L_{Aeq}$ noise level at M4 Bampton marginally exceed the WHO night-time noise guideline of 40dB(A).

**On-station Noise Levels**

5.1.13 A summary of noise levels measured by AMEC in the noise sensitive areas within RAF Brize Norton are shown in Table 5.2.

**Table 5.2 Summary of On-Station Noise levels 2013**

<table>
<thead>
<tr>
<th>Time Period</th>
<th>Average Noise Level $L_{Aeq,T}$ dB (2013)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1 Runway West</td>
<td>Day</td>
</tr>
<tr>
<td></td>
<td>Night</td>
</tr>
<tr>
<td>B2 Runway East</td>
<td>Day</td>
</tr>
<tr>
<td></td>
<td>Night</td>
</tr>
<tr>
<td>B3 Officers' Mess</td>
<td>Day</td>
</tr>
<tr>
<td></td>
<td>Night</td>
</tr>
<tr>
<td>B4 Junior Ranks</td>
<td>Day</td>
</tr>
<tr>
<td></td>
<td>Night</td>
</tr>
<tr>
<td>B5 SFA</td>
<td>Day</td>
</tr>
<tr>
<td></td>
<td>Night</td>
</tr>
</tbody>
</table>

5.1.14 In general, noise levels at noise sensitive locations on-base are exposed to higher levels of noise than those located off-base.

5.1.15 This supports the case for the RAF for ongoing work in relation to on-base noise reduction and mitigation measures (e.g. base accommodation sound insulation).

**Road Traffic**

5.1.16 Although road traffic has increased in the areas around the base, the most significant increases are on roads within the station. Road traffic in the community has increased by less than 2% on most roads, with the exception of Carterton Road (W) where traffic has increased by around 25% (daily traffic). Although the weekly traffic changes may be slightly increased, the changes in road traffic sound levels would be less than 1-3 dB; considered to be minor in the short term and negligible in the long term.
Engine Ground Running

5.1.17 The decision to restrict C130 EGR activities on the south-side bays at RAF Brize Norton has resulted in a significant improvement in noise exposure levels in the vicinity of the village of Black Bourton.

5.1.18 Additionally, based on the limited information available (4 monitoring positions only in 2011 and 2013), there appears to have been a general reduction in daytime levels for all residential areas covered. However, to some extent the process of moving EGR testing away from the south side bays does appear to have resulted in the export of noise to other residential areas in the vicinity of the base, as there have been increases in complaints from Brize Norton village over the same timescales.

5.1.19 The introduction of the A400M is therefore likely to result in similar or slightly higher noise levels from engine ground running, and would have a similar tonal character to the C130. In contrast, the VC10 did not have any tonal characteristics and was perceived as broadband noise within the communities.

5.1.20 This means that issues surrounding the C130 EGR are likely to remain with the introduction of the A400M.

5.1.21 Data from 2013 and 2014 indicates that the overall number of EGRs has reduced. This is a positive indication but this would need to be monitored over a longer time period to demonstrate that this is a significant and ongoing reduction resulting from the noise management commitments at RAF Brize Norton.

Aircraft Noise

5.1.22 ATC data for 2010 and 2013 indicates that there has been an increase in fixed wing air traffic movements of around 30%, although there has been a decrease in the number of helicopter movements between 2010 and 2013. This may be responsible for complaints relating to increases in noise from the base.

5.1.23 No baseline information is currently available which relates measured noise levels to fixed wing aircraft movements on the ground or airside. Whilst noise monitoring in October/December 2011 (1 week periods), and in March/April and June/July 2013 (4 week periods) included numerous normal/typical aircraft movements to and from the base, the accompanying analysis work was strongly focused on noise emissions to selected nearby residential areas, due to EGR activities at the base. Consequently, there is currently no detailed information with regards to noise levels generated by individual aircraft movements, although limited information in this area could potentially be derived from the available noise data (subject to the provision of suitable ATM logs).

5.1.24 The NAS (M) report gives the best available information of the influence of fixed wing aircraft on noise levels, but the NAS (M) contours also include rotary aircraft and EGR sources. To predict the effects of changes to the fleet we need to disaggregate the aircraft noises to identify the contribution made by each source by type.
6. Summary and Recommendations

6.1 Summary

6.1.1 There is significant data available in respect of complaints, noise contours, and survey data from multiple aircraft and for multiple receptors. This includes data on the aircraft associated with complaints (where this is known), the proportion of air traffic movements associated with each aircraft type, and the duration of EGR in total and for each aircraft type.

6.1.2 This provides a high level baseline against which future changes can be compared. However, a clear process for RAF Brize Norton to monitor and record relevant information in a consistent format in future would enable data to be compared over time to draw clearer conclusions about the effect of changes to operations, noise management, and the noise implications of the fleet etc.

6.1.3 In order to fully quantify the effects of refleeting it would be necessary to identify the comparative usage of the resulting fleet. It has been assumed for the purposes of this report that the retirement of the C130-J and replacement with A400M will not result in fewer air traffic movements or reduced EGR time.

6.1.4 Previous AMEC reports have indicated that the C130 has higher and more tonal noise emissions than the VC10, and that the A400M has a similar noise profile to the C130 but with different directionality. It is therefore concluded that the replacement of the C130 with the A400M is unlikely to result in a significant reduction in EGR noise emissions other than through noise management procedures. There is no data available at the moment that can provide any insight regarding the change in air noise that can be expected due to refleeting and the introduction of the A400M.

6.1.5 There is very little data associated with noise emissions from the Tri-Star available from the analyses currently available. The Tri-Star is associated with the fewest complaints and lowest EGR duration of the three aircraft types that are due to be (or have already been) retired. They do have a significant proportion of ATMs, but it is assumed that the duties of this aircraft will be taken on by the replacement A330 so that there would be no net decrease in activity.

6.1.6 The A330 is shown to have very low EGR durations, but it is not clear whether these will increase as the Voyager takes on the role previously performed by the Tri-Star. It is therefore concluded that the retirement of the Tri-Star and transfer of its duties to the A330 Voyager may have a slight beneficial effect but it is not clear that this would be a perceptible effect.

6.1.7 Further work is therefore recommended in section 6.4 so that the potential effects of the refleeting can be more adequately assessed.
6.2  Recommended Indicators

6.2.1 In order to appraise environmental performance over time and measure the effectiveness of managerial interventions, it can be useful to identify “performance indicators”, i.e. measurable outcomes that can be compared annually or following operational changes. The baseline figure should be established and then performance recorded on an ongoing basis.

6.2.2 Performance indicators are used by many civilian airports in the UK and across the world as a way of evaluating and reporting progress. There a number of indicators and tools that are used by civil airports however these may not be appropriate for RAF Brize Norton, due to the nature of the activities at the base (military/ engineering as opposed to predominantly civil/ transport). Many civil airports prepare annual noise performance reports to inform stakeholders of their impacts and the associated level of activity.

6.2.3 A range of potential indicators are proposed in Section 0- 0, as follows:

Noise Complaint Statistics
- Noise complaint statistics attributable to noise source, location and aircraft type (if applicable).

Community Noise Levels
- Annual aircraft noise contouring presenting:
  - Population and/or area exposed to 57 dB L_{Aeq 16h};
  - Population and/or area exposed to 63 dB L_{Aeq 16h};
  - Population and/or area exposed to 66 dB L_{Aeq 16h};
  - Population and/or area exposed to 69 dB L_{Aeq 16h};
  - Percentage of eligible properties claiming assistance under NAS(M).
- Annual community noise monitoring reports:
  - Observed and long-term measured data regressed against activities.

Engine ground running
- Total number of hours of EGR by month/year, and by aircraft;
- Number of night time EGRs;
- Number of weekend EGRs.

Air Traffic Movements
- Monthly or annual numbers of fixed wing movements by aircraft type;
- Monthly or annual numbers of rotary movements;
- Number of night flights by aircraft type.
Aircraft Noise Profiles

- For each aircraft in the fleet:
  - Air noise reference levels/footprints for each aircraft in the fleet coupled to number of movements. This could take the form of aircraft event contours;
  - EGR noise levels including notable characteristics and likely impacts on surrounding communities.

- Profiles to be provided and presented prior to the introduction of any new aircraft to the fleet.

6.3 Gap Analysis

Air Noise

6.3.1 As outlined above, the analyses performed by AMEC on noise monitoring data from 2011/2013 were strongly focused upon the investigation of noise at nearby residential areas due to EGR activities at the base.

6.3.2 RAFCAM have completed noise modelling for EGR and aircraft movements (combined) to produce contours for NAS(M) but in order to determine the effect of reflecting and cost/benefit of other management measures, this data needs to be disaggregated so that the effect of the different aircraft and changes in aircraft fleet can be determined.

6.3.3 Consequently, there is no current information relating noise levels measured on or off base to air traffic movements either on the ground or airside.

6.3.4 Subject to the provision of suitably detailed and complete logs, it may be possible in principle to complete such an analysis potentially providing such information as:

- Noise levels at the runway ends (west and east) and equivalent off-site residential areas during taxiing, landings and takeoffs;
- Noise levels at other on-base accommodation and amenity locations during taxiing, landings and takeoffs;
- Noise levels at other off-base residential areas during taxiing, landings and takeoffs;
- Analysis of noise levels by aircraft type;
- Analysis of noise levels by taxi route;
- Impacts of changing fleet numbers and airframe types on noise arising from ground and airside traffic movements, both in the past and in future.

6.3.5 The results of the above would not only be useful in terms of characterising the current baseline, and assessing potential future changes in noise emissions with respect to, for example, the retirement of the C130 fleet/introduction of the A400M, but also potentially further informing the NAS(M) report produced by RAFCAM in early 2014.
6.3.6 However, it should be noted that since the 2011/2013 surveys were designed to capture information relating to noise propagation during EGR activities, there a number of potential limitations with regards to the efficacy of such an analysis. These include, for example, the selection and positioning of monitoring locations and the time domain resolution of the monitoring data (1-minute). For these reasons, it is likely that any such analysis would be effective for a limited number of monitoring locations (e.g. the runway ends and, possibly, the associated off-base residential locations).

6.3.7 Therefore, a comprehensive overview of both the baseline and future noise levels association with ATM is likely to require a combination of data analysis (from existing surveys), further bespoke monitoring work and noise contour modelling, as outlined in Section 7.4.

6.3.8 There is no baseline noise monitoring data for several of the communities identified as being within the NAS(M) contours including Filkins, Kencot, Carterton and Lew. Further data from communities where there have been a significant number of complaints would also be useful in understanding the source and character of this noise and to ascertain the reason for complaints.

6.3.9 As outlined above, it is expected that the changes in traffic noise have been minor since the increase in traffic flows is less than 50%. However, in order to have a complete baseline it is recommended that traffic noise modelling is included in future assessments to fully assess the impact of changes and to illustrate road traffic noise levels around the base. Traffic noise monitoring would complement this action.

6.4 Scope of Future Work

6.4.1 The following work is recommended for assessment of baseline and future noise levels on and off base associated with reflecting, as well as changes in road traffic, air traffic, engine ground running and other activities, and to provide on-going monitoring against agreed performance indicators. This will require agreement with the customer.

Stage 2: Quantification of the Effects of reflecting

- Agree the assumptions for future ATMs and the likely requirements for EGR for new aircraft such as A400M and A330;
- A new survey of EGR noise for aircraft types where no data is already available, to observe and measure other noise sources such as takeoff and landings of aircraft, and to undertake community and traffic noise measurements at selected locations. It is noted that this will not include Tri-Star as the aircraft has been retired;
- Noise modelling of EGR for other aircraft types to provide a full assessment of the resulting differences within communities and on Station. This will enable an assessment of likely effects of reflecting on noise emissions due to EGR activity;
• Preparation of a full ground noise model that includes aircraft taxiing to inform other mitigation measures that may help reduce noise from Station activities;

• Noise modelling of air noise (takeoffs and landings) to demonstrate relative differences between aircraft noise emission and changes in noise due to reflecting and how this affects exposure levels. This should be undertaken on an aircraft by aircraft basis and for the $L_{Aeq, 16\text{hr}}$ under NAS(M);

• Produce aggregated and dis-aggregated noise contours for air noise, ground noise and traffic noise to test impact of changes to fleet and/or infrastructure (for example, engine running pens);

Improved Baseline Data
• Noise model of traffic noise using data from traffic survey. AADT data will need to be converted to AAWT data for this.

Ongoing Performance Monitoring
• Long term annual community noise monitoring at historic and selected receptors. Monitoring should become targeted and prescriptive to reflect the nature of the complaints and concerns as air noise monitoring requires a different approach to general environmental noise monitoring. Community engagement is vital;

• Measurements of internal noise levels following upgrades to sound insulation of dwellings on-base.

6.5 Conclusions

6.5.1 With respect to air noise, the changes due to reflecting are best understood through noise modelling.

6.5.2 Although there is a significant body of data available relating to aircraft noise, EGR and noise levels in the communities around RAF Brize Norton, further work is recommended in order to quantify the effects of the planned reflecting and the ongoing improvements to noise management.

6.5.3 The decision to restrict C130 EGR activities on the south-side bays at RAF Brize Norton has resulted in a significant improvement in noise exposure levels in the vicinity of the village of Black Bourton.

6.5.4 Additionally there appears to have been a general reduction in daytime levels for all residential areas covered. However, to some extent the process of moving EGR testing away from the south side bays does appear to have resulted in the export of noise to other residential areas in the vicinity of the base, as there have been increases in complaints from Brize Norton village over the same timescales.

6.5.5 Qualitatively, the introduction of the A400M as the replacement for the C130 is unlikely to result in a significant reduction in noise emissions other than through noise management procedures. The retirement of the Tri-Star and transfer of its duties to the A330 Voyager may have a slight beneficial effect, but it is not clear that this would be a perceptible effect.
### Annex A

**Glossary of Terms**

4 Pages

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMEC</td>
<td>AMEC Environment and Infrastructure UK Limited. Lead consultant in the preparation of the noise investigations presented in this report.</td>
</tr>
<tr>
<td>Auxiliary Power Unit (APU)</td>
<td>The APU is a device within the aircraft that provides energy for functions other than propulsion. These functions may include power to start the main engines, or air conditioning within the cabin whilst passengers are boarding.</td>
</tr>
<tr>
<td>Background Noise Level</td>
<td>Usually expressed in the $L_{A90}$ noise parameter. Is described as the existing noise environment in the absence of the noise source under investigation. Expresssed in decibels (dB).</td>
</tr>
<tr>
<td>Bays</td>
<td>A designated area of airfield apron prepared for parked aircraft, usually to allow passengers or freight to be loaded or unloaded safely.</td>
</tr>
<tr>
<td>Broadband Noise Levels</td>
<td>Presented as a single level rather than a number of levels across constituent frequencies. Usually used to describe the ‘overall noise level’. Expressed in decibels (dB).</td>
</tr>
<tr>
<td>C130</td>
<td>C130 Hercules Aircraft Four propeller engine aircraft, part of the RAF’s Air Transport fleet and used primarily to carry troops, passengers or freight.</td>
</tr>
<tr>
<td>Daytime</td>
<td>Generally agreed to be between 0700hrs – 2300hrs local time</td>
</tr>
<tr>
<td>Decibels (dB)</td>
<td>The main units used in acoustics. A decibel is a measure of magnitude of sound, changes in sound level and a measured of sound insulation. dB are a logarithmic unit.</td>
</tr>
<tr>
<td>Detuning Facility</td>
<td>A purpose built structure used for aircraft engine ground running. At RAF Brize Norton there is a VC10 detuning facility.</td>
</tr>
<tr>
<td>Downwind Conditions</td>
<td>Conditions experienced when the prevalent wind direction is in the direction of the receptor under investigation</td>
</tr>
<tr>
<td>Engine Ground Running (EGR)</td>
<td>Engine Ground Running involves engine checks that involve temporarily advancing the throttles to ensure that engines are capable of producing a number of thrust settings such as those required for taxiing and take-off.</td>
</tr>
<tr>
<td>Engine Ground Running Pen</td>
<td>Structures specifically designed to reduce noise levels within surrounding areas from aircraft engine ground running activities. They are usually open at one end to allow aircraft access and typically include a rear blast deflector and acoustically treated sidewalls.</td>
</tr>
<tr>
<td>Extraneous Noise Events</td>
<td>Noise events influencing the background noise environment that are not related the specific noise source under investigation. These may include road traffic movements passing the Sound Level Meter (SLM) whilst measuring noise from the aircraft.</td>
</tr>
<tr>
<td>Frequency Narrow Band Analysis</td>
<td>Analysis of noise across its constituent frequencies.</td>
</tr>
<tr>
<td>Ground Noise</td>
<td>Noise from ground-based aircraft activities, such as aircraft taxiing or engine running.</td>
</tr>
<tr>
<td>Ground Power Unit (GPU)</td>
<td>A power source that can be used by aircraft at stands. Generally have lower noise emissions and can be used as an alternative to aircraft APU.</td>
</tr>
<tr>
<td>Ground Service Equipment (GSE)</td>
<td>Equipment found at an airport used to service aircraft between flights. The equipment is used for ground power operations, aircraft mobility, and loading operations (passengers / freight).</td>
</tr>
<tr>
<td>Term</td>
<td>Description</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Inaudible</td>
<td>A noise source is either outside the human audibility range or is masked by existing background noise levels.</td>
</tr>
<tr>
<td>Meteorological Conditions</td>
<td>The prevailing environmental conditions due to weather. These include wind direction, temperature and humidity.</td>
</tr>
<tr>
<td>MRO (Maintenance Repair Overhaul)</td>
<td>All maintenance operations required in retaining or restoring an aircraft to a state in which it can perform its required function.</td>
</tr>
<tr>
<td>Night-time</td>
<td>Generally agreed to be between 2300hrs – 0700hrs local time.</td>
</tr>
<tr>
<td>Noise Directivity</td>
<td>Directivity is a measure of the directional characteristic of a sound source i.e. the measure of the dominance of a noise in one direction over others.</td>
</tr>
<tr>
<td>Octave Frequency Bands</td>
<td>A set of internationally agreed frequency bands that are referred to by their centre frequencies. Presenting a noise in its octave bands rather than as a broadband level can give a better understanding of whether there is an tonal aspects to the noise present.</td>
</tr>
<tr>
<td>Physical Mitigation</td>
<td>Physical structures used to impede, dissipate or reduce the propagation of noise between a source and receiver. An example of physical mitigation is an acoustic barrier.</td>
</tr>
<tr>
<td>Sound Frequency</td>
<td>Frequency is a property of sound that most determines pitch and is measured in hertz (Hz). The audible range for the human ear is generally 20Hz to 20kHz. Sounds outside this range are usually inaudible.</td>
</tr>
<tr>
<td>Sound Level Meter (SLM)</td>
<td>Instrument for monitoring and recording noise levels</td>
</tr>
<tr>
<td>Sound Power Level (dB)</td>
<td>The sound power level is a property of a noise source and is independent of the acoustic environment that it is in. It is usually used to describe the amount of noise produced at source.</td>
</tr>
<tr>
<td>Sound Pressure Level (dB)</td>
<td>The sound pressure level is a property of a noise source that is dependent on the acoustic environment that it is in. For example a different sound pressure level can be attributed to the same source at different distances from it.</td>
</tr>
<tr>
<td>Specific Noise Level</td>
<td>The amount of noise at a particular location resulting from the noise source under investigation. Expressed in decibels (dB).</td>
</tr>
</tbody>
</table>
Noise Terminology

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. A doubling of the noise energy emitted by a particular source equates to an increase of 3 dB(A) in the sound pressure level at a particular location.

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 A.1.

The noise levels given in Table A.1 are sound pressure levels (Lp) and describe the noise level at a point in space. Noise levels vary over time depending on noise generating activities. The following noise indicators are referenced during the assessment and are described below:

- \( L_{Aeq} \), \( T \) 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. \( L_{Aeq}, T \) is considered the best general purpose index for environmental noise. The term \( T \) represents the duration of the event or reference period;
- \( L_{A90} \) 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;
- \( L_{A50} \) and \( L_{A10} \) refer to the level exceeded for 50% and 10% of the measurement period respectively. \( L_{A10} \) is widely used as a descriptor of traffic noise;
- \( L_{Amax} \) is maximum recorded noise level during the measurement period;
- \( L_{Aeq, 8hr} \) is a measure ‘night’ noise which may apply over any assessment base i.e. a specific date, week or year. \( L_{Aeq, 8hr} \) is referenced by much UK noise policy and is defined between 2300-0700hrs;
- \( L_{Aeq, 16hr} \) is a measure ‘daytime’ noise which may apply over any assessment base i.e. a specific date, week or year. \( L_{Aeq, 16hr} \) is referenced by much UK noise policy and is defined between 0700-2300hrs; and
- SEL (the Sound Exposure Level) \((L_{AE})\) is a measure of sound energy, and is the sound pressure level which, if occurring over a period of one second would contain the same amount of energy as the sound event in question.
### Table A.1  Typical Noise Levels

<table>
<thead>
<tr>
<th>Appropriate Noise Level, $L_{Aeq, T}$ (dB)</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Limit of hearing</td>
</tr>
<tr>
<td>30</td>
<td>Rural area at night, no wind or adverse weather conditions</td>
</tr>
<tr>
<td>40</td>
<td>Library</td>
</tr>
<tr>
<td>50</td>
<td>Quiet office without noisy machinery, such as typewriters</td>
</tr>
<tr>
<td>60</td>
<td>Normal conversation</td>
</tr>
<tr>
<td>70</td>
<td>In car noise without radio</td>
</tr>
<tr>
<td>80</td>
<td>Household vacuum cleaner</td>
</tr>
<tr>
<td>100</td>
<td>Pneumatic drill</td>
</tr>
<tr>
<td>140</td>
<td>Threshold of pain</td>
</tr>
</tbody>
</table>

When comparing steady state noise levels, it is important to consider human responses and perception. Error! Reference source not found, presents an overview of human perception when comparing two different noise levels.

### Table A.2  Response to Change in Noise Level

<table>
<thead>
<tr>
<th>Change in Noise Level, dB(A)</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 3</td>
<td>Difficult to perceive</td>
</tr>
<tr>
<td>&gt; 3</td>
<td>Perceptible</td>
</tr>
<tr>
<td>10</td>
<td>Up to a doubling of perceived loudness</td>
</tr>
<tr>
<td>&gt; 10</td>
<td>Over a doubling of perceived loudness</td>
</tr>
</tbody>
</table>