

CAA Guidance on the Application of the Airspace Change Process

CAP 725



Published by the Civil Aviation Authority, 2016

Civil Aviation Authority,
Aviation House,
Gatwick Airport South,
West Sussex,
RH6 0YR.

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Previously published as DAPMS Document No. 334 1 June 1998

First edition of CAP 725 22 April 2002

Second edition 28 May 2004

Third edition 30 March 2007

Fourth edition 15 March 2016

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The latest version of this document is available in electronic format at www.caa.co.uk, where you may also register for e-mail notification of amendments.

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Revision History

Edition 1 April 2002

The first edition of the Airspace Change Process was published within CAP 724 'The Airspace Charter', in May 1996, enabling any organisation to initiate a change to the airspace arrangements. The Airspace Change Process was revised and the Airspace Charter republished in March 2002. However, during these revisions, additional guidance was compiled and published in a separate document, CAP 725 Guidance on the Airspace Change Process.

Edition 2 May 2004

The opportunity has been taken to incorporate extensive changes to the narrative on the basis of SARG's past experience with airspace change proposals.

Edition 3 March 2007

As a consequence of the practical experience gained over the past few years a need was identified to enhance the Airspace Change Process. A review was initiated to further strengthen the soundness and stability of the UK airspace arrangements. The entire Airspace Change Process has been revamped following extensive consultation exercise with all major interest groups. This new manual takes account of the need for transparency and consistency and enables a potential Change Sponsor to follow the Airspace Change Process. It also provides greater clarity on the roles and responsibilities of a Change Sponsor and those of the Regulator; and importantly, in the activities of a consultation exercise and the environmental assessment of any proposed change.

Edition 4 March 2016

This Edition reflects the reorganisation of the CAA in January 2014 and changes to the various policies that underpin the Process, including the Government's 'Guidance to the Civil Aviation Authority on Environmental Objectives Relating to the Exercise of its Air Navigation Functions' published in January 2014. This Edition


also formalises a number of activities currently accepted as best practice that have been adopted over recent years.

Foreword

The Airspace Change Process was first published within CAP 724 – 'The Airspace Charter', in May 1996, enabling any organisation to initiate a change to UK airspace arrangements. The Airspace Change Process was revised in 2002 and subsequently, again in 2007 to its current form. During that period CAP 725 'CAA Guidance on the Application of the Airspace Change Process' has formed the guidance for the way in which sponsors progress airspace change proposals and the way in which the CAA judges those proposals.

We are currently reviewing the process and tools that we use to make decisions about changes to airspace in the UK. We will consult publicly on any changes that we intend to make to the current Airspace Change Process. As part of that consultation, we will be engaging with a wide range of interested parties, including communities affected by aircraft noise.

Meanwhile, it was also recognised that CAP 725 itself required updating to reflect the reorganisation of the CAA in January 2014 and changes to the various policies that underpin the Process, not least the Government's 'Guidance to the Civil Aviation Authority on Environmental Objectives Relating to the Exercise of its Air Navigation Functions'. As a consequence CAP 725 is being re-issued to reflect these administrative and policy changes; this re-issue does not prejudice the outcome of the CAA's consultation on revising the Airspace Change Process.



Group Director, Safety and Airspace Regulation Group

14 March 2016

Glossary

Airspace Change Proposal – Abbreviations and Acronyms

<u>AAA</u>	<u>Airspace, ATM and Aerodromes, a department within SARG</u>
ACC	Area Control Centre
ACP	Airspace Change Proposal
ADMS	Atmospheric Dispersion Modelling System - generic name for local air quality models available from Cambridge Environmental Research Consultants (CERC). The applicable variant for the purposes of this document is ADMS-Airport, which is an extension of ADMS-Urban
agl	Above ground level
AIC	Aeronautical Information Circular
AIE	Average Individual Exposure
AIP	UK Integrated Aeronautical Information Package
AIRAC	Aeronautical information regulation and control
amsl	Above mean sea level
ANASE	Attitudes to Noise from Aviation Sources in England
ANCON	Aircraft Noise Contour Model (<u>UK DfT Aircraft Noise Model</u>)
ANIS	Aircraft Noise Index Study
ANSP	Air Navigation Service Provider
AONB	Area of Outstanding Natural Beauty
<u>AR</u>	<u>Airspace Regulation, a section within AAA</u>
AQMA	Air Quality Management Area
ATC	Air Traffic Control
ATCO	Air Traffic Control Officer

ATM	Air Traffic Management a section within AAA
ATM	Air Traffic Management
atm	Air transport movement
ATS	Air Traffic Service
ATSU	Air Traffic Service Unit
ATZ	Aerodrome Traffic Zone
BADA	Base of Aircraft Data
CAA	Civil Aviation Authority
CAEP	Committee on Aviation Environmental Protection
CAP	Civil Aviation Publication
CAS	Controlled Airspace
CAT	Commercial Air Transport
<u>CCO</u>	<u>Continuous Climb Operations</u>
<u>CDO</u>	Continuous Descent <u>Operations</u>
CO ₂	Carbon Dioxide
COMEAP	Committee on the Medical Effects of Air Pollutants
CPRE	Campaign to Protect Rural England
CTA	Control Area
CTR	Control Zone
dB	Decibel units
dBA	Decibel units measured on an A-weighted scale
DEFRA	Department for the Environment, Food and Rural Affairs
DfT	Department for Transport, previously known as the Department of the Environment, Transport and the Regions (DETR), the Department of Transport, Local Government and the Regions (DTLR) or the Department of Transport (DoT)

DoT	Department of Transport, since renamed Department for Transport
ECAC	European Civil Aviation Conference
EEA	European Environment Agency
ERCD	Environmental Research and Consultancy Department (of <u>PPT</u>)
FAA	Federal Aviation Administration (USA)
ft	Feet
GA	General Aviation
GDP	Gross Domestic Product
H ₂ O	Water
Hz	Hertz
IAIA	International Association for Impact Assessment
IAP	Instrument Approach Procedure
ICAO	International Civil Aviation Organisation
IFR	Instrument Flight Rules
ILS	Instrument Landing System
INM	Integrated Noise Model (US DAA Aircraft Noise Model)
ISBN	International Standard Book Number
JSP	Joint Services Publication
kg	Kilogram
LDEN	Day-evening-night sound level
Leq	Equivalent continuous sound level
Lmax	Maximum sound level
LNight	Night sound level
LPLD	Low Power/Low Drag
LTO	Landing and take-off
mb	Millibar – a unit of pressure, one thousandth of a bar equivalent to

	100 pascals
MoD	Ministry of Defence
N70	Noise contour describing the number of noise events above 70 dBA Lmax. Typically, contours ranging from 10 events to 500 events over 70 dBA Lmax are plotted
N80	Noise contour describing the number of noise events above 80 dBA Lmax. Typically, contours ranging from 10 events to 500 events over 80 dBA Lmax are plotted
NATMAC	National Air Traffic Management Advisory Committee
NATS	National Air Traffic Services Ltd
NDB	Non-Directional Beacon
Newton	Unit of force, equal to the force that would give a mass of one kilogramme an acceleration of one metre per second per second
NGO	Non-Governmental Organisational
nm	Nautical mile
NNI	Noise and Number Index
NO	Nitric Oxide
NO ₂	Nitrogen Dioxide
NOX	Term used to describe the sum of nitric oxide (NO), nitrogen dioxide (NO ₂), and other oxides of nitrogen
NPR	Noise Preferential Route
NPV	Net Present Value
O ₂	Oxygen
OS	Ordinance Survey
PANS	Procedures for Air Navigation Services
Pascal	Unit of pressure equivalent to 1 Newton per square metre
<u>PBN</u>	<u>Performance-based Navigation</u>

PEI	Person-Event Index
PM10	Particulate Matter – 10 microns
POST	Parliamentary Office of Science and Technology
<u>PPT</u>	<u>Policy Programmes Team, a department within the CAA</u>
PSDH	Project for Sustainable Development of Heathrow
RCEP	Royal Commission on Environmental Pollution
RFI	Radiative Forcing Index
RNAV	Area Navigation
RNP	Required Navigation Performance
<u>SARG</u>	<u>Safety and Airspace Regulation Group</u>
SARPs	Standards and Recommended Practices
SEL	Sound Exposure Level
SES	Single European Sky
SID	Standard Instrument Departure
SRG	Safety Regulation Group (of the CAA)
SSR	Secondary Surveillance Radar
SSSI	Sites of Specific Scientific Interest – UK
STAR	Standard Arrival Route
TCAS	Traffic Alert & Collision Avoidance System
TMA	Terminal Control Area
tonne	1,000 kilograms
UAR	Upper Air Route
VFR	Visual Flight Rules
VOR	VHF Omni-directional Ranging
VRP	Visual Reference Point
W.m-2	Watts per square metre – the unit of measurement for sound

	intensity or radiative forcing
WGS 84	World Geodetic System 1984 – an earth fixed global reference system
WHO	World Health Organization
$\mu\text{g.m}^{-3}$	Micrograms per cubic metre – a measure of pollutant concentration

Introduction

Statutory Duties

In exercising its air navigation functions, the CAA must give priority to maintaining a high standard of safety in the provision of air traffic services in accordance with its statutory duties set out in Section 70(1) of the Transport Act 2000 (ISBN 0 10 543800 6).

- The CAA must exercise its air navigation functions in the manner it thinks best calculated;
 - to secure the most efficient use of airspace consistent with the safe operation of aircraft and the expeditious flow of air traffic;
 - to satisfy the requirements of operators and owners of all classes of aircraft;
 - to take account of the interests of any person (other than an operator or owner of an aircraft) in relation to the use of any particular airspace or the use of airspace generally;
 - to take account of any guidance on environmental objectives given to the CAA by the Secretary of State after the coming into force of this section;
 - to facilitate the integrated operation of air traffic services provided by or on behalf of the armed forces of the Crown and other air traffic services;
 - to take account of the interests of national security;
 - to take account of any international obligations of the United Kingdom notified to the CAA by the Secretary of State (whatever the time or purpose of the notification).
1. In addition, the CAA will also consider Government policies on the future development of air transport and have due regard for the NATS (En-route) Licence.

2. The CAA's Air Navigation functions are to be considered by the Group Director, SARG.
3. A change to the use or classification of airspace in the UK can take many forms and may be simple and straightforward to implement with little noticeable operational or environmental impact. Conversely, a change may be complex and involve significant alterations to existing airspace arrangements that impact upon the various airspace user groups and the general public. All airspace changes are unique and, regardless of scale, will require some form of consultation. Changes to airspace arrangements, which fall within the scope of this document as set out below, should only be made after consultation that includes consideration and assessment of the environmental impacts outlined in Annex B. The level of consultation will be determined by the 'impact' that the change will have on others and not the 'size' of the change itself.
4. The purpose of this document is to provide detailed guidance and a better understanding of the process by which changes to the dimensions, classification or use of UK airspace are implemented. This document describes the recommended process for submitting an airspace change proposal rather than setting out the technical design criteria, and although it draws from several reference documents (refer to Annex 1 to Appendix A), it is essential that Change Sponsors refer to these source documents and do not rely on CAP 725 as their sole source of information, direction and guidance. This document provides a framework for the stages and activities ordinarily involved, from the conception of the need for an airspace change through to regulatory decision and, finally, if appropriate, implementation. It also provides specific guidance for conducting the consultation exercise and sets out the requirement for the completion of consultation, operational and environmental reports.
5. It is impossible to provide all of the answers a Change Sponsor may need as many of the issues will invariably be local in their nature and Change Sponsors may be faced with situations specific to their own needs without precedent elsewhere. Consequently, in addition to this guidance, Change

Sponsors should maintain close contact with the assigned SARG AAA Project Leader in order to seek additional clarification and guidance where necessary in order to avoid delays and inefficient use of resources.

Application of the Airspace Change Process

6. An airspace change is characterised by a change to the notified airspace arrangements in the UK AIP and is normally characterised by one or more of the following conditions:
- i. Changes to the International Civil Aviation Organization (ICAO) airspace classification either through the creation of a higher classification than currently exists, or in some cases through the removal of existing controlled airspace of Classes A, C, D¹ or E;
 - ii. Changes to the lateral or vertical dimensions of existing Controlled Airspace (CAS);
 - iii. The introduction of, or changes to, Standard Instrument Departure routes (SIDs), Standard Arrival Routes (STARs) or Noise Preferential Routes (NPRs) within controlled airspace. Standard Departure Routes (SDRs) and NPRs where they exist outside controlled airspace are not covered by this Process. However, aerodrome operators are strongly recommended to adopt the same principles when considering the need for new or amended SDRs and NPRs under these circumstances;
 - iv. Introduction of, or significant changes to existing², Holding Patterns;
 - v. Changes to Area Control Centre (ACC) arrangements resulting in modifications to the existing published ATS route structure. Changes to ACC sector boundaries that have no additional environmental impact

¹ In the UK, controlled airspace will normally be classified as ICAO Classification A, C or D. The normal default background classification will be Class G, unless flight safety or ATM management reasons indicate a requirement for a higher classification. A full description of the ICAO Airspace Classifications as they are applied in the UK can be found at AIP ENR 1.4.

² In this context, 'significant' is determined as a complete re-alignment or re-orientation of the hold or a lowering of the minimum holding altitude. Changes due to magnetic variation do not need to be addressed by means of an airspace change.

over that currently experienced are not normally subject to the Airspace Change Process, unless one of the characteristics described here occurs as a direct consequence of the revised arrangements;

- vi. Delegation of ATS to an adjacent State;
 - vii. Changes to the lateral or vertical dimensions of Danger Areas, Restricted or Prohibited Airspace, Temporary Reserved Areas or significant changes in their operational use, other than emergency situations or matters of National Security;
 - viii. Changes to existing published terminal patterns and procedures where the net effect results in changes to the lateral dispersion or lowering in altitude of traffic within controlled airspace; and
 - ix. Significant changes to the hours of operation of existing airspace structures.
7. As an Aerodrome Traffic Zone (ATZ) assumes the classification of the airspace in which it is established, the Airspace Change Process is not used for their establishment. Instead, any request for the establishment of an ATZ will follow the procedure described at Appendix I of the Airspace Charter.
8. Procedures for the establishment of Visual Reference Points (VRPs) are currently described in Aeronautical Information Circular (AIC) 18/2004 (Yellow 129) dated 1 April 2004.
9. In all cases, Change Sponsors should seek advice from the SARG Project Leader at an early stage of their planning in order to determine how the Airspace Change Process affects their particular proposal.

Sponsorship of an Airspace Change

10. Anybody can initiate, and thus, sponsor, an airspace change. Principally, SARG believes that a Change Sponsor will be one of the following:
- i. An aerodrome operator;

- ii. An Air Navigation Service Provider (ANSP); or
- iii. A combination of aerodrome operator and ANSP.
- iv. The Regulator (CAA/SARG).

Roles and Responsibilities

11. The key participants involved in any airspace change will have the following roles and responsibilities:

SARG:

- i. Owns, and is fully responsible for, the Airspace Change Process;
- ii. Provides guidance to a Change Sponsor on the application of the Process and fulfilling the operational, environmental and consultation requirements, but not to assist a Change Sponsor in developing the airspace designs of a Formal Proposal for submission to Group Director, SARG;
- iii. Scrutinises and assesses a Change Sponsor's Formal Proposal against the regulatory requirements;
- iv. Approves/Rejects the Change Sponsor's Formal Proposal and refers that decision to the Secretary of State for Transport where it considers that the proposal represents a significant environmental disbenefit.
- v. Must be openly and transparently accountable for the regulatory decision-making; and
- vi. Fulfil its statutory duties and meets the Direction from the Secretaries of State for Transport and Defence for the overall interest of airspace users.

Change Sponsor:

- i. Owns the Airspace Change Proposal to modify airspace arrangements and is responsible for developing its change proposal, whilst ensuring that it satisfies and/or enhances safety, improves capacity and mitigates, as far as practicable, any environmental impacts in line with

the provisions of the DfT's Environmental Guidance provided to the CAA;

- ii. Accountable for identifying relevant stakeholders and conducting an effective consultation exercise;
- iii. Designs and carries out consultation on the operational and environmental impacts of the proposed airspace change; and
- iv. In light of the responses to the consultation exercise, a Change Sponsor is accountable for the decisions to modify or not modify its proposed airspace design.

Stakeholders/Consultees:

- i. Contributes to the consultation process by providing relevant opinions/considerations on the effects of an airspace change proposal as it affects their particular group to the Change Sponsor in a timely manner;
- ii. Informs a Change Sponsor of other stakeholders that have not been engaged during a consultation exercise; and
- iii. Shares information and research undertaken that is relevant to the Airspace Change Proposal.

Focus Groups:

- i. Provides advice and opinions on the Change Sponsor's airspace design option(s);
- ii. Highlights potential consequences that have been overlooked in the airspace change design option(s); and
- iii. Assists a Change Sponsor with the identification of stakeholders and the formulation of the consultation material.

AAA Project Leader:

- i. Acts as the Change Sponsor's main point of contact in SARG;
- ii. Compiles/coordinates all elements of the regulatory assessment; and
- iii. Ensures guidance is provided to Change Sponsors regarding any Airspace Change Process queries.

Overview of the Airspace Change Process

Stage 1	Framework Briefing
Stage 2	Proposal Development
Stage 3	Preparing for Consultation
Stage 4	Consultation and Formal Proposal Submission
Stage 5	Regulatory Decision
Stage 6	Implementation
Stage 7	Operational Review

12. Airspace Change Proposals will be handled according to the standard published Process as set out in this document. In contemplating any airspace change, it is essential that consideration be given to the implications that a move from the status quo will have on the operations of the Change Sponsor, those of other airspace users, aerodrome operators, ANSPs and the general public.
13. SARG reserves the right to implement a 'Fast Track' process, as set out in CAP 724 – The Airspace Charter, reserved specifically for use by SARG in the unlikely event that urgent 'safety critical' or national security changes are needed. In such cases, SARG will liaise closely with the ANSP in developing an Airspace Change Proposal and in its implementation.
14. Airspace Change Proposals completed and put forward in accordance with the standard published Process will need to convince the Group Director, SARG, of the need for, and merits of, the proposed airspace change in terms of safety, efficiency, providing environmental benefits or mitigating its environmental impact to the greatest extent possible. Change Sponsors should note from the outset that it is vital that they give careful consideration to the implications of the proposed change on their own operations/activities, those of other airspace users and the general public living beneath existing and proposed controlled airspace. Thus, Change

Sponsors should be aware when developing their initial design proposals that these may need to be adapted to reflect and balance the competing requirements of the stakeholders. During Stage 1 – Framework Briefing, SARG will brief potential Change Sponsors on the viability of their embryonic Proposal, give guidance on the consultation requirements and provide advice about identifying stakeholder organisations. The success of an airspace change proposal will depend upon the ability of the Change Sponsor to satisfy the regulatory requirements as demonstrated through the quality of the operational and environmental analysis, the thoroughness of the consultation and, subsequently, its formal submission to SARG as a fully developed Airspace Change Proposal.

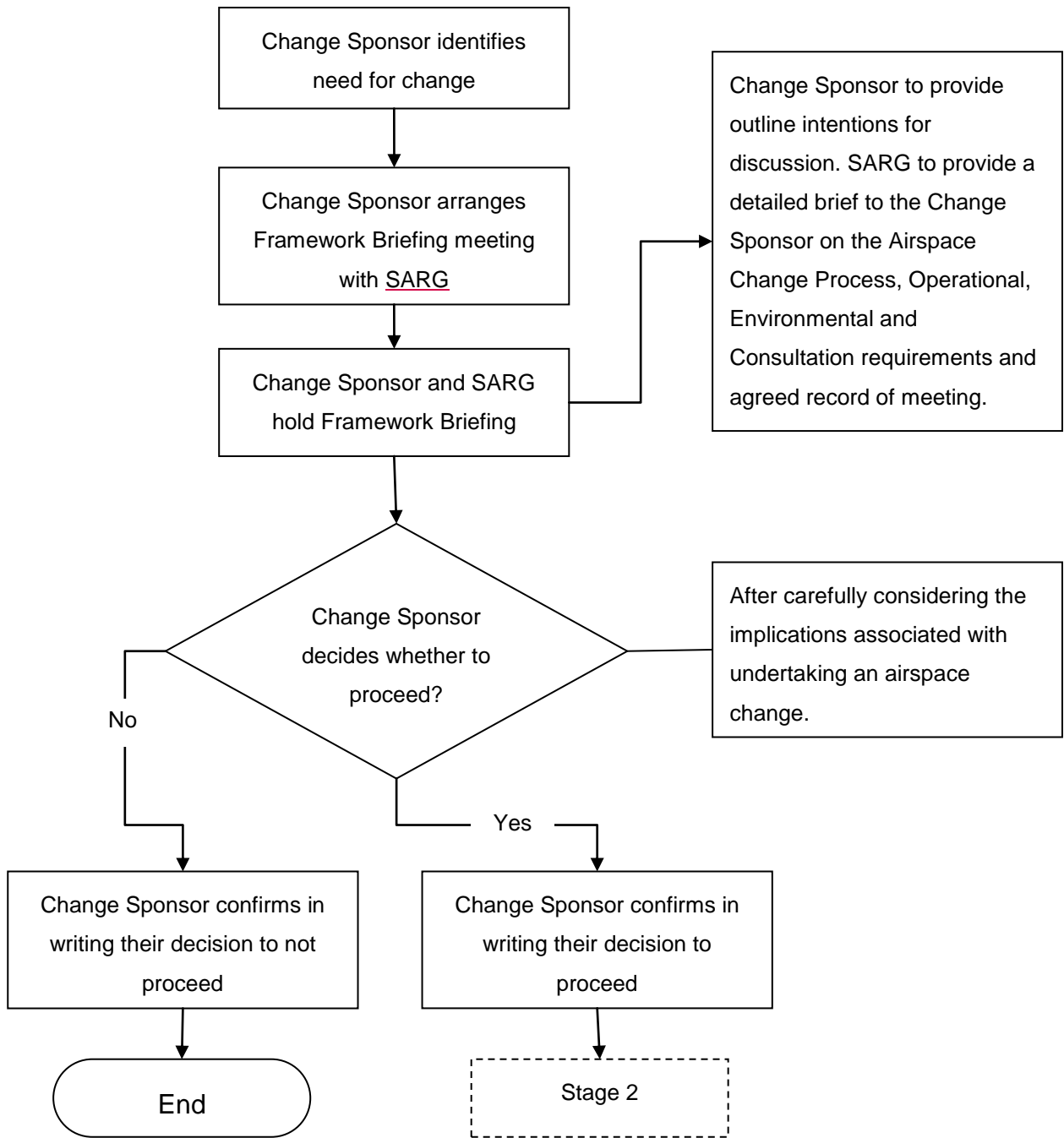
15. A timescale for completion of the full Process cannot be pre-determined. However, SARG has set a timeframe for the Regulatory Decision stage of 16 weeks. The amount of resource that a Change Sponsor would need to devote to proposal development, consultation, adaptation and documentation could be considerable and would invariably affect the length of the Process, as would the complexity and sensitivity of a proposal. For example, the nature of the consultation might require that an iterative process of ‘consult-refine-consult’ is necessary and this would need to be considered when looking ahead to implementation timescales.
16. It is likely that Change Sponsors will receive opposition to their Airspace Change Proposals from one or more stakeholder groups. Objections may come at any time during the Process (up to Regulatory Decision) from airspace users, adjacent ANSPs, local government, the public or environmental interest groups. In some cases it may be possible, and in some cases necessary, to modify airspace change proposals to accommodate such opposition. Change Sponsors should remain alert to the possibility of an opposition group leading a campaign against their Airspace Change Proposal, which could result in considerable delays to the completion of the Sponsor Consultation and Proposal Development stages of the Process; such activity should be reported to the SARG Project Leader without delay. Change Sponsors may at least need to reconsider planned change implementation dates in such circumstances. They may

even have to withdraw the Airspace Change Proposal altogether. SARG will make the final decision that will be based on an assessment of full objective submissions from all parties concerned notwithstanding the requirement to refer its decision to the Secretary of State for Transport in the event that the proposed change will result in a significant environmental disbenefit.

17. A Change Sponsor must consider the MoD as another airspace stakeholder and thus consult the MoD with regard to any proposed changes. Notwithstanding, SARG will continue to fulfil its statutory duties with regard to MoD (on national security grounds) as well as DfT (on environmental matters).

Stage 1

Framework Briefing



- 1.1 Initially, prospective sponsors should submit CAA Form DAP1916 to enable SARG Manager AR to assess whether the Airspace Change Process might apply and to allocate a SARG Case Officer/point of contact as necessary. On identifying a need for changing the airspace arrangements, it is strongly advised that the Change Sponsor arrange a meeting with SARG as a fundamental first step in the Airspace Change Process. As all airspace changes are unique in their own right, the Framework Briefing is the occasion when Change Sponsors can discuss with the Regulator their intentions, any issues/concerns that are currently being experienced and how/why they believe that changing the airspace arrangements will address these difficulties. In a similar way, it provides an opportunity for the Regulator (CAA/SARG) to provide appropriate and tailored advice and guidance on the specific requirements. This meeting is important to discuss the high-level implications of a proposed airspace change. It also provides a Change Sponsor with an appropriate foundation to start developing the Airspace Change Proposal whilst ensuring that the proposed modifications to the airspace will satisfy individual needs and be proportionate with regard to others affected.

Outline Intentions

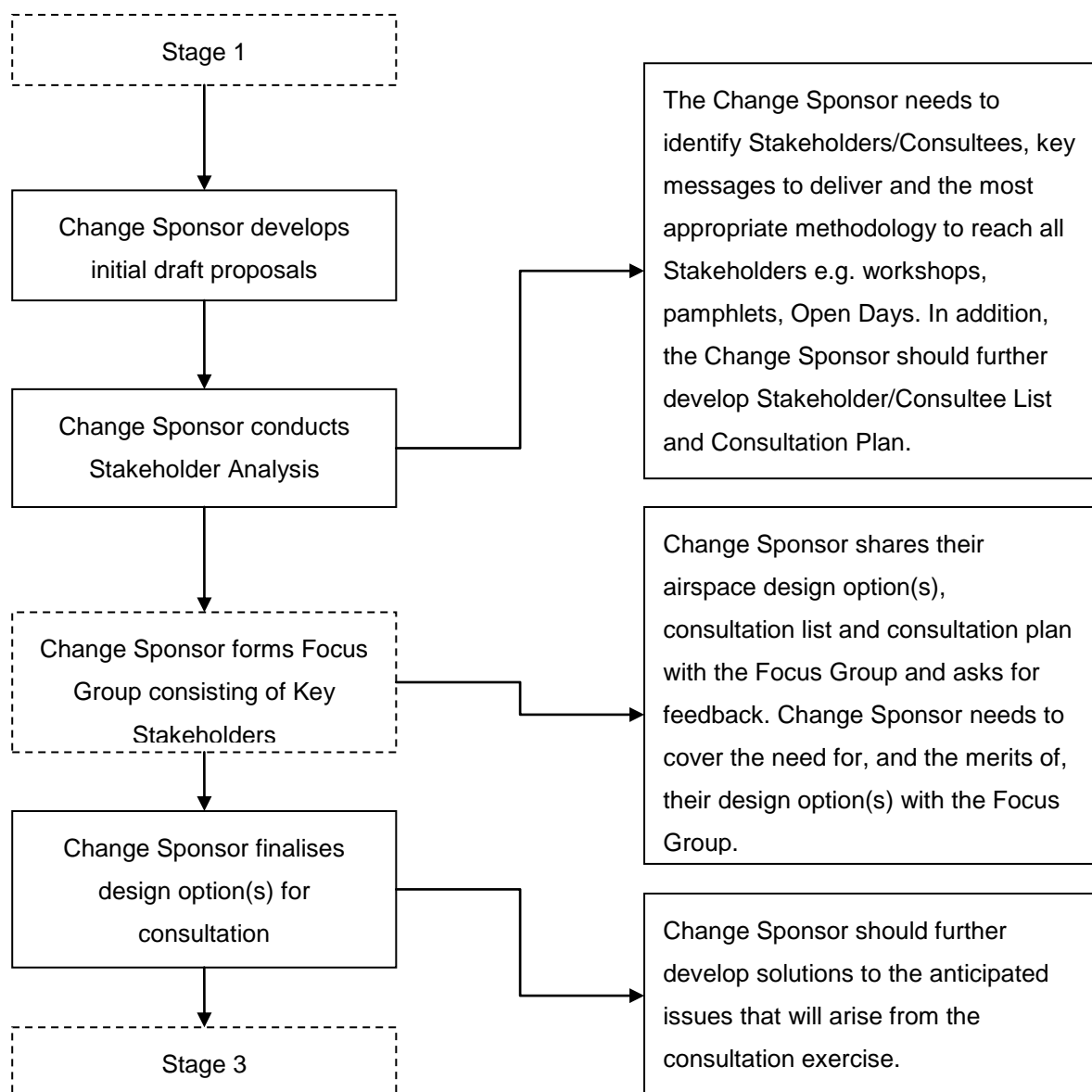
- 1.2 Change Sponsors should not develop a draft proposal at this stage but come prepared to discuss the requisites of their Airspace Change Proposal. The outline intentions must include:
- Background and Justification for the proposed change;
 - An initial assessment of the impact of the proposed change on all airspace users;
 - The Environmental Aims/Assumptions;
 - An initial assessment of the environmental implications of the proposed change;
 - An initial assessment of the Stakeholders/Consultees and an outline Consultation Plan;
 - An initial assessment of the impact of the proposed change on the airspace arrangements in adjoining States (where appropriate); and
 - Identification of any connectivity to European Airspace Programmes, including relevant timescales (where appropriate).
- 1.3 During the discussions, SARG staff will listen to the Change Sponsor's line of reasoning and will provide the appropriate advice and guidance as to

the best way forward. As part of the meeting, SARG staff will give a detailed verbal brief on:

- The Process itself;
 - The Environmental Requirements (refer to Appendix B);
 - The Consultation Requirements (including Stakeholder Analysis, Focus Groups, Recording and Handling Consultation Responses, (refer to Consultation Record Sheet at Appendix C), and the Assessment Criteria that will be used to assess the consultation during the Regulatory Decision stage); and
 - The structure of the formal Airspace Change Proposal submission (refer to Appendix C) as well as the assessment criteria that will be used to assess the airspace and infrastructure requirements during the Regulatory Decision stage.
- 1.4 A SARG Project Leader will also be established for all the Change Sponsor's future enquiries. With the aim of being as fair and consistent as possible, the presentational material and minutes of the discussions will be provided in writing within two weeks of the meeting in an effort to avoid any misinterpretations before the consultation is initiated.
- 1.5 Following the briefing, Change Sponsors must confirm, in writing, their intention to proceed or not with the development of a Proposal.

Stage 2

Proposal Development



- 2.1 Having identified a need for change and having attended the Framework Briefing, the Change Sponsor begins to develop and analyse detailed airspace design options that would satisfy their needs. All design options must be compliant with the technical criteria contained within the various documents set out in Annex 1 to Appendix A.

- 2.2 Where Change Sponsors are developing initial draft proposals, it would be sufficient to consider environmental matters in broad terms to begin with, but nevertheless bear in mind that a detailed environmental assessment will be required when finalising the design option(s) for consultation. The environmental impact of airspace design options must be considered from the outset and will vary from one airspace change to another. Guidance on completing a full environmental assessment of an airspace change is contained in Appendix B, which describes the methodologies and metrics that would enable SARG to assess the environmental impact of Proposals in accordance with CAA's statutory duties. Therefore, the Change Sponsor should discuss their general intentions for environmental assessment with the SARG Project Leader at the beginning of the Proposal Development stage and, if necessary, with PPT Environmental Research and Consultancy Department staff who will provide expert advice.
- 2.3 Development of design options should also proceed under the headings detailed in: Airspace Change Proposal – Operational Report in Appendix A, and which form the basic structure on which to build a formal proposal.
- 2.4 It is vital that the Change Sponsor identifies any critical interdependencies with neighbouring ANSPs (operational/technical/ training) and puts in place plans to resolve any issues that arise.

Stakeholder Analysis

- 2.5 Once there is sufficient clarity in the airspace design options, the Change Sponsor can continue to identify all the different parties affected by these design options by conducting a 'stakeholder analysis'. The CAA defines stakeholders as representative groups who are, or might be, affected – either positively or negatively – by any action taken by the Change Sponsor. It is important to think broadly about the affected parties beyond direct airspace users, or organisations that have a known interest. For example, the Proposal might impact on other sectors of the population outside the immediate environs of the airport. All Regional, County, District, Borough Councils and Unitary Authorities, whose area of responsibility might be over flown, especially if it is the first time this will occur, must be considered as 'stakeholders'. In addition, those authorities (including Parish/Community Councils), not falling into the above category but which have previously shown an interest – either positive or negative – in the Change Sponsor's business activities must be considered. 'The Local Government Companion' (ISBN 10: 0 11 7027 67 7), published by The Stationery Office, provides a definitive guide to the functions and people of local government. Members of the SARG's National Air Traffic

Management Advisory Committee (NATMAC) are to be regarded as stakeholders/consultees and members' contact details will have been provided at the end of the Framework Briefing stage. In addition, various environmental groups such as Natural England, the National Trust, National Parks, Scottish Natural Heritage, the Countryside Council for Wales, the Environment and Heritage Services in Northern Ireland and Non-Governmental Organisations (NGOs) such as CPRE, may also be considered as 'stakeholders'. Change Sponsors should also consider Areas of Outstanding Natural Beauty (AONB), Conservation Areas and Sites of Special Scientific Interest -UK (SSSIs) during its proposal development.

- 2.6 If the stakeholder analysis is utilised correctly, it will greatly assist with producing a complete list of consultees to be used during the critical Consultation Stage. In addition, it will assist with identifying appropriate methodologies to reach the consultees and may also serve to highlight 'key messages' for use in communicating the proposed airspace change to consultees. Guidance on how to conduct a stakeholder analysis can be covered, on request, as part of the Framework Briefing.

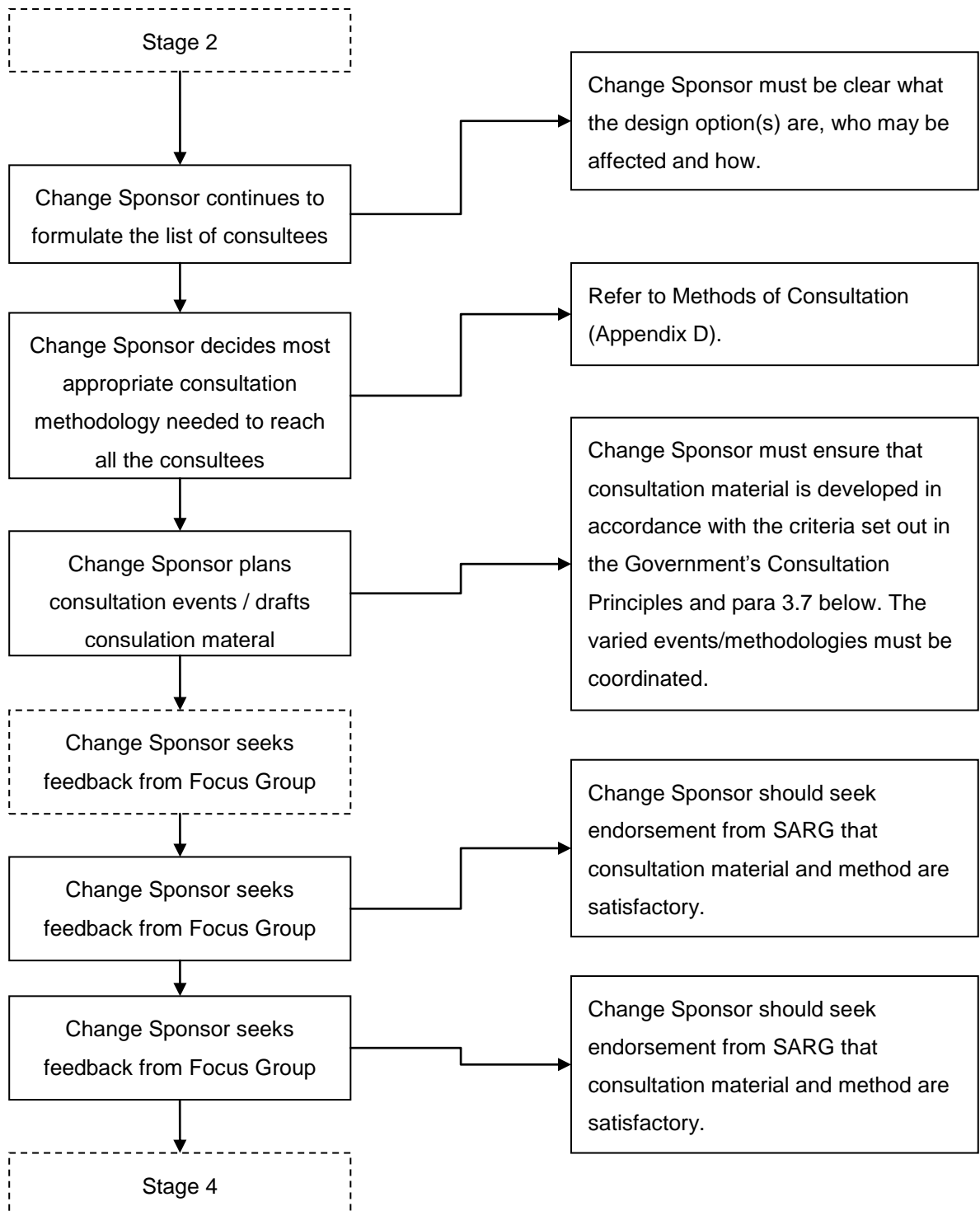
Focus Group

- 2.7 Once all affected parties have been identified, it is recommended that the Change Sponsor invites some of these parties from a cross-section of those affected to form a Focus Group. This is not, however, a mandatory requirement. The purpose of using a Focus Group is to provide the Change Sponsor with views and potentially highlight previously overlooked consequences of a particular design option prior to formal consultation (refer to Appendix D). Aerodromes with an airport consultative committee may consider utilising this forum as its Focus Group. The role of the Focus Group is not to endorse or hinder the Change Sponsor's Proposal. Areas where the Focus Group can contribute significantly are:
- The development of the design options;
 - Identification of what will be considered important by stakeholders/consultees and the potential resolution of issues;
 - Identification of additional stakeholders/consultees and the most appropriate methods of reaching them;
 - Assistance with the formulation of the consultation material to ensure that it will be clear and understood by the stakeholders/consultees – this will also help get any messages across better; and

- Highlight areas that need clarification/additional information.
- 2.8 The Change Sponsor may seek to modify the Proposals in the light of the Focus Group's feedback. Once the modification is complete, the Change Sponsor must also provide feedback to the Focus Group. Further guidance on the role of the Focus Group can be covered, on request, as part of the Framework Briefing.
- 2.9 If the Change Sponsor chooses not to form a Focus Group, it should continue with the formulation of the design options in preparation for the consultation stage.

Stage 3

Preparing for Consultation



- 3.1 The Change Sponsor and Consultees must fully understand the purpose of the consultation exercise. From a Change Sponsor's perspective, consultation is about attaining or confirming views and opinions about the impact of a particular Airspace Change Proposal. Consultees have a crucial role in providing relevant and timely feedback to the Change Sponsor in the form of their views and opinions on the impact of a particular Airspace Change Proposal. Consensus is not necessary nor should it be expected. However, a Change Sponsor will be accountable for their decisions to either accommodate or disregard consultees' responses and for providing timely feedback to the consultees. These decisions and actions will be scrutinised and form part of the SARG's assessment criteria at the Regulatory Decision stage.
- 3.2 The Change Sponsor will have already identified all the different parties affected by the design options during the 'stakeholder analysis'. All these parties will automatically form the 'list of consultees' and will need to be consulted; be aware that there could still be others that are identified during the Consultation Stage with whom the Change Sponsor will need to engage. Work now focuses on attaining all the correct contact details. Identifying the most appropriate method of consultation (refer to Appendix D) with those affected by the design options is equally important. Whilst the bulk of consultation will probably be by correspondence, it may also be appropriate to visit organisations or even undertake 'road-shows' in order to explain the proposed change. In many cases, a Proposal may need to be adapted in the light of the feedback received.
- 3.3 It might be useful to use a timetable that identifies completion dates for key tasks associated with the consultation exercise. In circumstances where a number of methods have been utilised to involve the public to develop a particular design option, the responses gained through these different methods will need to be integrated into the Change Sponsor's Formal Proposal submission to the CAA.
- 3.4 The Change Sponsor should seek feedback from the Focus Group, and subsequently SARG, before finalising the consultation material and consultation methodologies.
- 3.5 Change Sponsors must conduct their consultation exercise in accordance with the Government's Consultation Principles. In addition, SARG expects Change Sponsors to take account of the following six criteria adopted from previous consultation guidance:
- Consult widely throughout the process, allowing a minimum of 12 weeks for written consultation at least once during the development of the Airspace Change Proposal;

- Be clear about what the Proposals are, who may be affected, what questions are being asked and the timescale for responses;
- Ensure that the consultation is clear, concise and widely accessible;
- Give feedback regarding the responses received and how the consultation process influenced the Airspace Change Proposal;
- Monitor the effectiveness of the consultation, including the use of a designated Consultation Co-ordinator; and
- Ensure the consultation follows better regulation best practice principles -Proportionality; Accountability; Consistency; Transparency; and Targeting.

Consultation Documentation

- 3.6 The Change Sponsor must set out what the Airspace Change Proposal is and how it affects the various stakeholders. If a single design option is being consulted upon, it would be advantageous to briefly state what other options have been considered and give the reasons why these options have been discarded.
- 3.7 To ensure the effectiveness of the consultation documentation, the following guidelines should prove beneficial:
- **Be clear/use plain language:** Set out what it is that needs to be known and why, and make it clear to those who are being consulted. State from the start what is being consulted upon (e.g. routes, timings of operations) and what is not being consulted upon (e.g. safety requirements). It is likely that there will be a number of consultation documents for different audiences, e.g. using technical terms for aviation or environmental consultees, but using non-technical language and avoiding jargon/acronyms for the public. In consultation material aimed at members of the public, it is also recommended that issues such as vectoring and aircraft track/routes are included and carefully explained;
 - **Be sensitive:** People could be concerned about criticising the Proposal and may not want their personal details published. State

whether or not responses will be treated in confidence. These wishes must be respected to comply with the Data Protection Act;

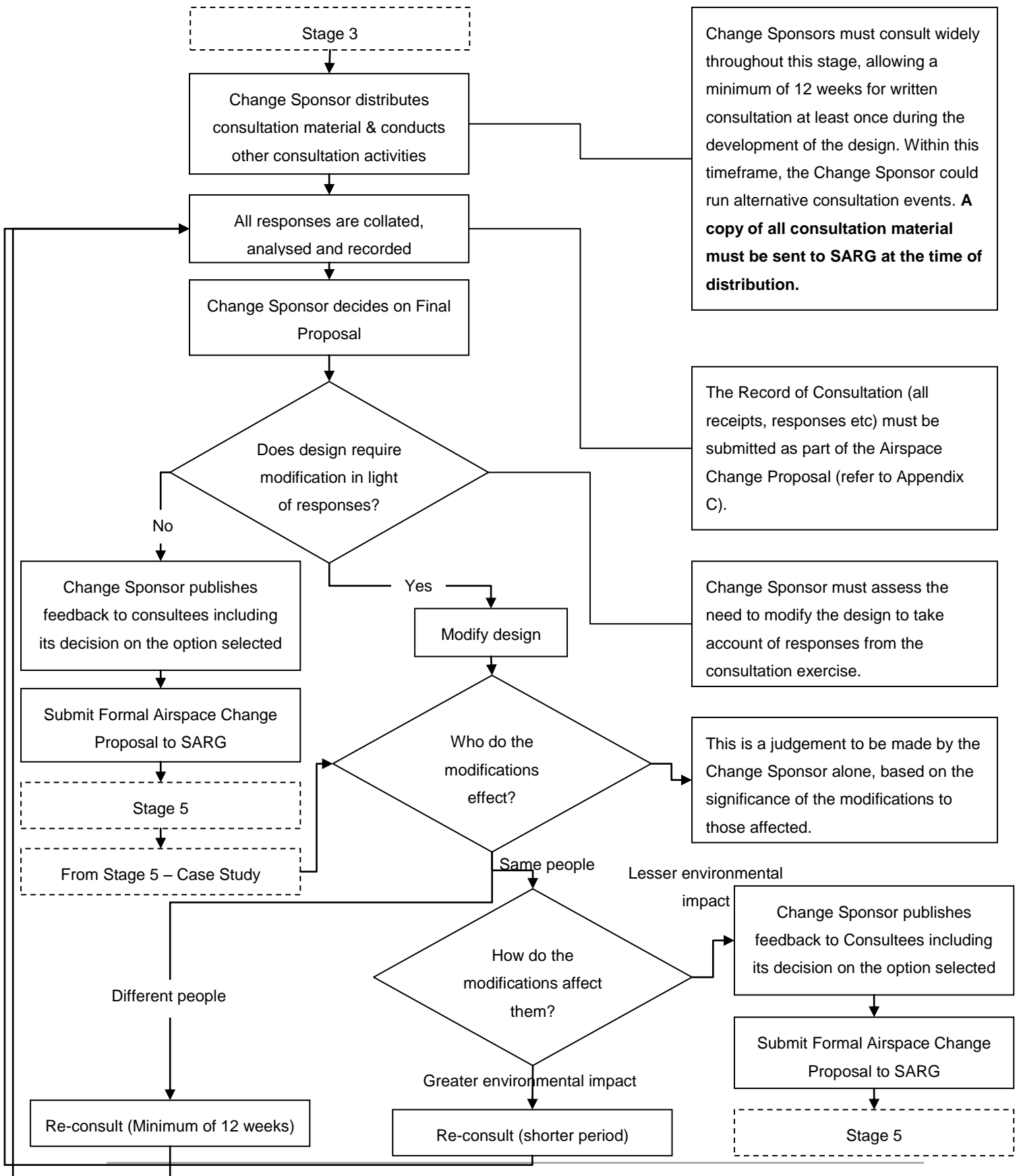
- Be realistic: Be realistic about the skills and resources that consultees have available, and what is needed to carry out the consultation effectively;
- Be flexible/use more than one method: Do not rely on any single method of consultation. There are many ways of finding out what people think and want. Some are simple and cost relatively little; others can take months and a significant amount of money. What is done depends on what needs to be known, how the results will be used, and how much money, time and expertise is available;
- Publicise: The CAA understands the importance of and supports the need for public engagement on changes to airspace arrangements. Before launching into consultation, Change Sponsors must let people know what is happening so that all who want to can input their views. Listen to them and value their contributions. Publicise the consultation through the local media (such as local/regional newspapers and radio stations) to promote greater public awareness of the proposed airspace changes. Other consultation events are also encouraged, such as utilising open/public meetings as well as providing access to consultative material at some local libraries and via the Internet;
- Help people participate: Consider the proposals for consultation from the users' point of view. Sending out a questionnaire might be easy, but will enough people want to fill in forms? Do not assume that they know something just because others do. Making it simple will encourage more people to participate. Whilst most consultations utilise electronic media, consider those who do not have regular access to the internet and consider what means might be employed to facilitate engagement with those groups.
- Expect the unexpected: Be aware that the results may be very different from those expected. Don't be discouraged if this happens. A Change Sponsor's credibility will increase if it deals with the more

difficult and unexpected results, rather than make the changes that are easiest. Be prepared to challenge long-standing beliefs.

- 3.8 Within the consultation document, the Change Sponsor must also briefly set out the subsequent stages in the Airspace Change Process and when the feedback from the consultation exercise is likely to be published.
- 3.9 The Change Sponsor must also state whom consultees should respond to and who to direct queries regarding the Proposal. Within the consultation documentation, a Change Sponsor must include details for the SARG point of contact, responsible for overseeing the Change Sponsor's consultation process. It must be made clear that the role of this individual only covers complaints regarding the Change Sponsor's adherence to the consultation process; all other responses will be referred back to the Change Sponsor. The contact details for this individual are:
- Airspace Regulator (Coordination)
Airspace, ATM and Aerodromes
Safety and Airspace Regulation Group
CAA House
45-59 Kingsway
London
WC2B 6TE
- E-mail: airspace.policy@caa.co.uk
- 3.10 Before stating the deadline for responses, a Change Sponsor should provide a reasonable period of time for consultees to respond to the Proposal. The time period will depend on the Proposal but a minimum of 12 weeks is considered reasonable; however, Change Sponsors must consider a longer consultation period at certain times of the year, for example during the summer holiday and the Christmas periods. This will allow sufficient time for committees to meet and for national bodies to consult their members. The CAA will, however, consider abbreviated consultation periods where there are justifiable operational or technical constraints applicable to the proposal. The sponsor will need to supply SARG with the details of such constraints at an early stage, preferably Stage 1 (Framework Briefing).
- 3.11 Once the Change Sponsor has finalised the design options and completed all the necessary consultation documentation, including any charts, adequate time will have to be allowed for publication and distribution to consultees.

Stage 4

Consultation and Formal Proposal Submission



- 4.1 Consultation is a two-way relationship in which the Change Sponsor asks for, and receives, feedback on its design option(s).
- 4.2 The Change Sponsor launches the Consultation phase. As it does so, every effort should be made to bring the consultation to the attention of all interested parties. As well as using the Internet, the Change Sponsor should consider publicising the consultation in ways most appropriate for the consultees it wishes to reach, such as local/regional newspapers and radio stations. It is likely that there would be a significant period of inactivity during the first few weeks after consultation is launched before responses begin to be received.
- 4.3 A copy of all consultation material must be sent to SARG at the time of distribution.**

Recording Results

- 4.4 The Change Sponsor must ensure that accurate and complete records are kept of all responses, whether received through a formal written consultation or more interactive methods. Copies of all correspondence between Change Sponsors and consultees, together with an audit trail of any changes to the Proposal that arise from the consultation, are to form part of the Change Sponsor's Formal Proposal submission to SARG. An example of a Consultation Record Sheet template can be found at Appendix C.
- 4.5 The Change Sponsor must be able to demonstrate to SARG that all reasonable steps have been taken to elicit a response from consultees. When the response deadline notified in the consultation documentation is approaching, it is recommended that follow-up letters are distributed to all those who have yet to reply. On receipt of an objection or acceptance/support without any accompanying explanation, the Change Sponsors should request the reason for the objection.

Analysing the Results

- 4.6 The Consultation Record Sheet template also allows for the Change Sponsor to identify the key issues and themes that emerge from its consultation exercise. It is important to be able to separate the practical or realistic issues and themes from those that cannot be addressed by the Change Sponsor (e.g. aspects that arise from the consultation that are not

related to the proposed change, such as Government policy, still need to be recorded). Further guidance on handling such cases would be covered in the Framework Briefing and would be available from the [SARG](#) Project Leader.

- 4.7 Commitment is key to effective consultation. The Change Sponsor must be prepared to respond to what it learns and to make changes, even if this requires major modifications, if it is appropriate. The analysis of the responses to the consultation should identify the issues and key themes. Once the issues and the key themes have been identified, the Change Sponsor will be in a position to consider how to incorporate them into the design option(s) where appropriate.
- 4.8 If a number of design options were consulted upon, the Change Sponsor must use the information originating from the consultation exercise in order to assist with its selection of the most appropriate design option it intends to submit to [SARG](#) as its Formal Airspace Change Proposal.

Modifications to the Design and further Round(s) of Consultation

- 4.9 There may be a need to modify the design after the consultation exercise, whether to take account of responses from the consultation exercise or otherwise. In the following four cases the Change Sponsor should adopt the practice set out below:
- Any change to the Proposal that introduces additional airspace or new routes, or alters the intended use of the existing airspace where the changes will now affect parties previously not consulted, must now be consulted and Change Sponsors must apply the minimum 12-week consultation period;
 - Change Sponsors must also re-consult when changes to the Proposal have been made that have a negative environmental impact on those parties previously consulted, however, the 12-week consultation period might be reduced depending on the significance of the environmental impact of the changes;
 - However, if changes to the Proposal have a positive environmental impact on those parties previously consulted, a Change Sponsor does not have to re-consult; and

- If changes are made that do not affect parties then there would be no need for further consultation.
- 4.10 In any other case where there is a need to modify the design after the consultation exercise, the Change Sponsor must consider whether it is necessary to reconsult. The Change Sponsor must take into account the significance of the modifications both in terms of the people affected and the severity of the effects. The Change Sponsor should reconsult unless he is satisfied it is unnecessary to do so.
- 4.11 Where reconsultation takes place on the basis of amendments made in the light of earlier consultation, a shorter period may be appropriate.
- 4.12 If further consultation is needed, it will be necessary for the Change Sponsor to keep separate, accurate and complete records of all responses from the further rounds, whether received through a formal written consultation or more interactive methods. Copies of all correspondence between Change Sponsors and consultees, together with an audit trail of any changes to the Proposal that arise from the rounds of consultation, are to form part of the Change Sponsor's Formal Proposal submission to SARG. Similarly, the Change Sponsor must be able to demonstrate that it has taken reasonable steps to elicit a response from consultees.
- 4.13 It is not envisaged, nor expected, that consultation becomes a never-ending process of consult-modify-consult. At the point at which the Change Sponsor considers that issues raised have been accommodated, to the extent possible, then the Proposal should be submitted to SARG who will be the arbiter of whether the Change Sponsor has acted 'reasonably' in meeting the needs of stakeholders.
- 4.14 The Change Sponsor may need to negotiate certain issues with operational stakeholders and reach a balanced judgement in order to reach a decision on the final design option. In all cases, SARG needs to know how the final design option was selected as a result of Change Sponsor Consultation. Equally, the Change Sponsor may consider, for good reason, that it is not possible to modify the Proposal. In this case, the Change Sponsor must inform the consultee accordingly and ensure that the matter be brought to the attention of SARG.

Feedback from the Consultation Exercise

- 4.15 On completing the analysis and deciding how to proceed, the Change Sponsor should provide feedback on the consultation exercise to consultees. This should, as a minimum, set out the issues and key themes

identified through the consultation and how the Change Sponsor intends to address them. The feedback document must indicate the Change Sponsor's proposed design option that it is submitting to SARG and provide explanations of why popular recommendations for changing the proposed design option(s) as set out in the consultation documentation have not been carried forward. The Change Sponsor should also briefly explain the next stage in the Process – Regulatory Decision by SARG – and highlight the role of the Group Director, SARG, as being that of the 'Decision-Maker'.

- 4.16 The Change Sponsor should notify the consultees that in the event that a representative organisation wishes to present new evidence or data to the Group Director, SARG, for his consideration prior to making his regulatory decision regarding a Change Sponsor Proposal, the representative organisation must submit, in writing, the information to the following address:

Group Director
Safety and Airspace Regulation Group
CAA House
45-59 Kingsway
London
WC2B 6TE

Formal Proposal Submission

- 4.17 Having completed the Airspace Change Proposal, the Change Sponsor should formally submit one hard master copy, one electronic copy of the Airspace Change Proposal and one electronic copy of the proposal, suitably redacted to remove confidential/commercially sensitive information, to SARG for Regulatory Decision. The redacted version of the Formal Proposal will be published on the CAA website once a regulatory decision has been reached. **There must not be any aspects contained within the Change Sponsor's Formal Proposal submitted to SARG that have not been consulted upon unless the Change Sponsor can fully support the omission with good reasons.**
- 4.18 A Change Sponsor must submit the documentation as set out below in order to address the various areas for assessment by SARG. These structured reports will enable SARG to perform an accurate analysis to achieve a well-informed and thorough regulatory decision:

Operational Requirements (refer to Appendix A):

- i. Justification for the Change and Analysis of Change Options;
- ii. Airspace Description;
- iii. Supporting Infrastructure/Resources;
- iv. Operational Impact;
- v. Economic Impact;
- vi. Safety Management;
- vii. Airspace and Infrastructure Requirements; and
- viii. Supporting Maps, Charts and Diagrams.

Environmental Report (refer to Appendix B):

- i. Description of Airspace Change;
- ii. Traffic Forecasts;
- iii. An assessment of the effects on noise;
- iv. An assessment of the change in fuel burn/CO₂;
- v. An assessment of the effect on local air quality; and
- vi. An economic valuation of environmental impact.

Consultation Report (refer to Appendix C):

- i. Executive Summary;
- ii. Overview of Responses;
- iii. Useable Responses;
- iv. Modifications to the Proposal; and
- v. Supporting Documentation.

4.19 Within the Formal Proposal, the Change Sponsor will need to have identified a preferred AIRAC target implementation date and an alternative date (or dates), these dates having been agreed, in principle, with SARG staff. Should the change be approved, SARG and the Change Sponsor will implement the change in accordance with the Change Sponsor's requirements, subject to any subsequent agreement to do otherwise or in the event of any unforeseen circumstances.

4.20 Change Sponsors should note that, following a decision by the Group Director, SARG, to approve an airspace change, actual implementation could take up to three months to complete, the precise timescale being dependent upon AIP publication cycles. It is, therefore, imperative that Change Sponsors should identify, within their Formal Proposals, a realistic

implementation date and a reserve date that would allow for proper consideration (by SARG) of any further consultation on the Proposal that might become necessary, and for the proper drafting and promulgation of documentation, including, where appropriate, VFR chart changes. In most cases, promulgation would be not less than one AIRAC cycle (28 days notice after the publication of the relevant documentation) prior to effective date, although for major changes (for example those involving extensive new procedures, cross-border airspace, etc.), two AIRAC cycles (56 days) would normally be necessary.

- 4.21 Finally, Change Sponsors must ensure that sufficient numbers of suitably qualified staff are available to provide air traffic services following the implementation of a change. To that end, implementation planning must address training and examination requirements (subject, of course, to the nature of the change); specialist advice and input on any such requirements may be sought from the AAA Air Traffic Management section.

Stage 5

Regulatory Decision

- 5.1 There are two main phases associated with the Regulatory Decision stage. First, the Proposal will be checked by the Regulator to see if all the specified documentation is included as part of the Proposal submission (See Figure 1: Documentation Check). The second and most important phase is the Regulator's analysis of the technical merits behind the Proposal against the stipulated requirements (See Figure 2: Case Study). SARG shall aim to provide a regulatory decision within a total time of 16 weeks from the confirmation of a successful documentation check.
- 5.2 At the Documentation Check phase, upon receipt of the Airspace Change Proposal, SARG will initially check to establish if all the necessary sections meet the Formal Proposal submission requirements as described in paragraph 4.18. Following this, SARG will either confirm acceptance that all the Proposal documentation has been satisfactorily received by SARG or request further information from the Change Sponsor in order to complete the Proposal documentation. Progression to the Case Study phase cannot be made until the SARG Case Officer has confirmed receipt of all the necessary Proposal documentation. At this point the 'clock will stop' as per the regulatory decision timeframe.
- 5.3 Once the Proposal has been assessed for completeness, it will progress on to the next phase of Regulatory Decision, the Case Study, the purpose of which is to allow AAA AR the opportunity to satisfy itself that the Proposal is justified. This will involve the participation of other CAA departments, primarily within AAA ATM. Exceptionally, when considering a particularly complex Airspace Change Proposal, the Change Sponsor may also be invited to contribute.
- 5.4 During the Case Study, all the information provided within the Airspace Change Proposal will be scrutinised and assessed against SARG's Proposal Requirements. The Case Study may reveal areas of potential weakness in the Proposal that may need remedial action by means of clarification questions or further development. In such cases the SARG Case Officer will submit clarification questions to the Change Sponsor, stipulating the timescale (usually 28 days) in which a response must reach SARG so as to facilitate the earliest resumption of the Case Study. Change Sponsors should note that the Process timeline would be suspended pending SARG's receipt of the supplementary material. This could result in delaying implementation of the proposed change by at least

one AIRAC cycle or, where complex changes are involved, two AIRAC cycles.

Figure 1: Documentation check

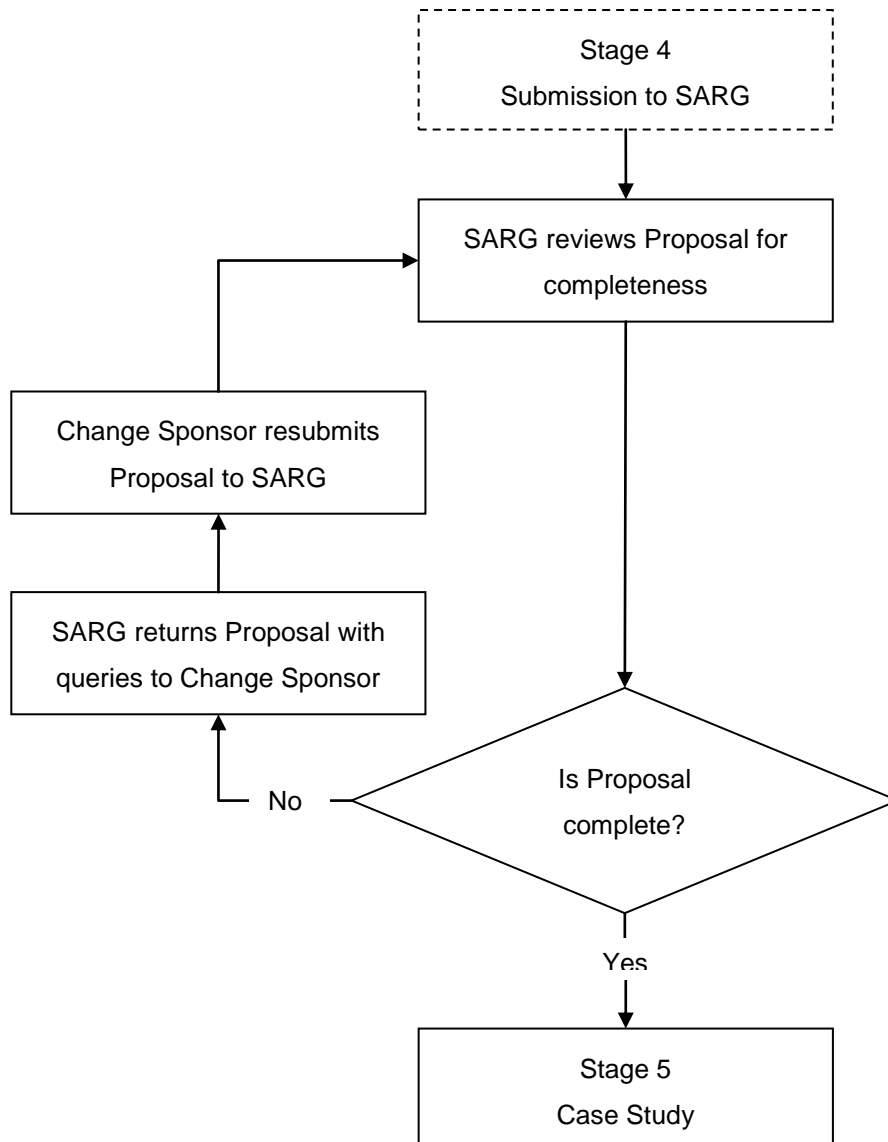
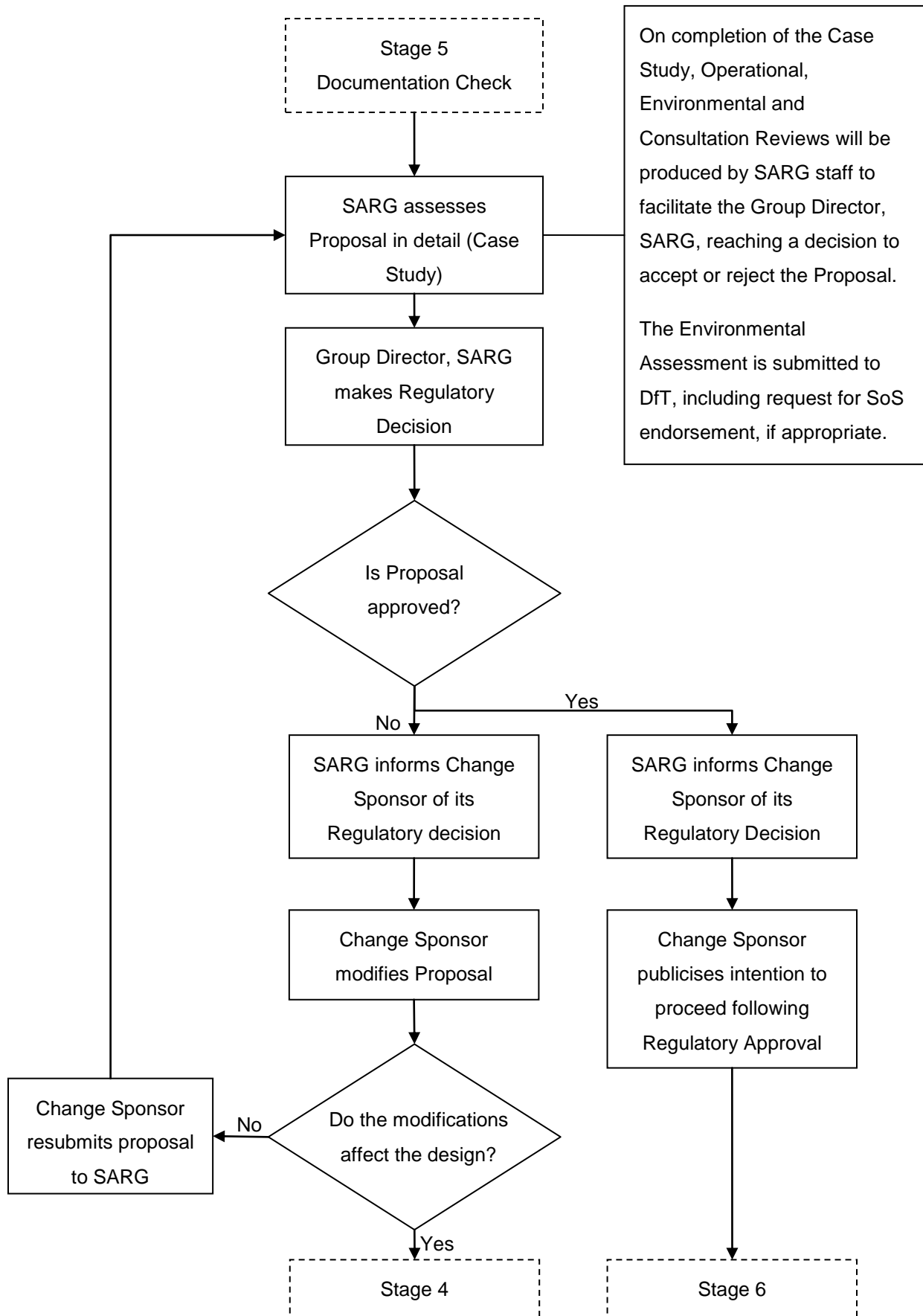


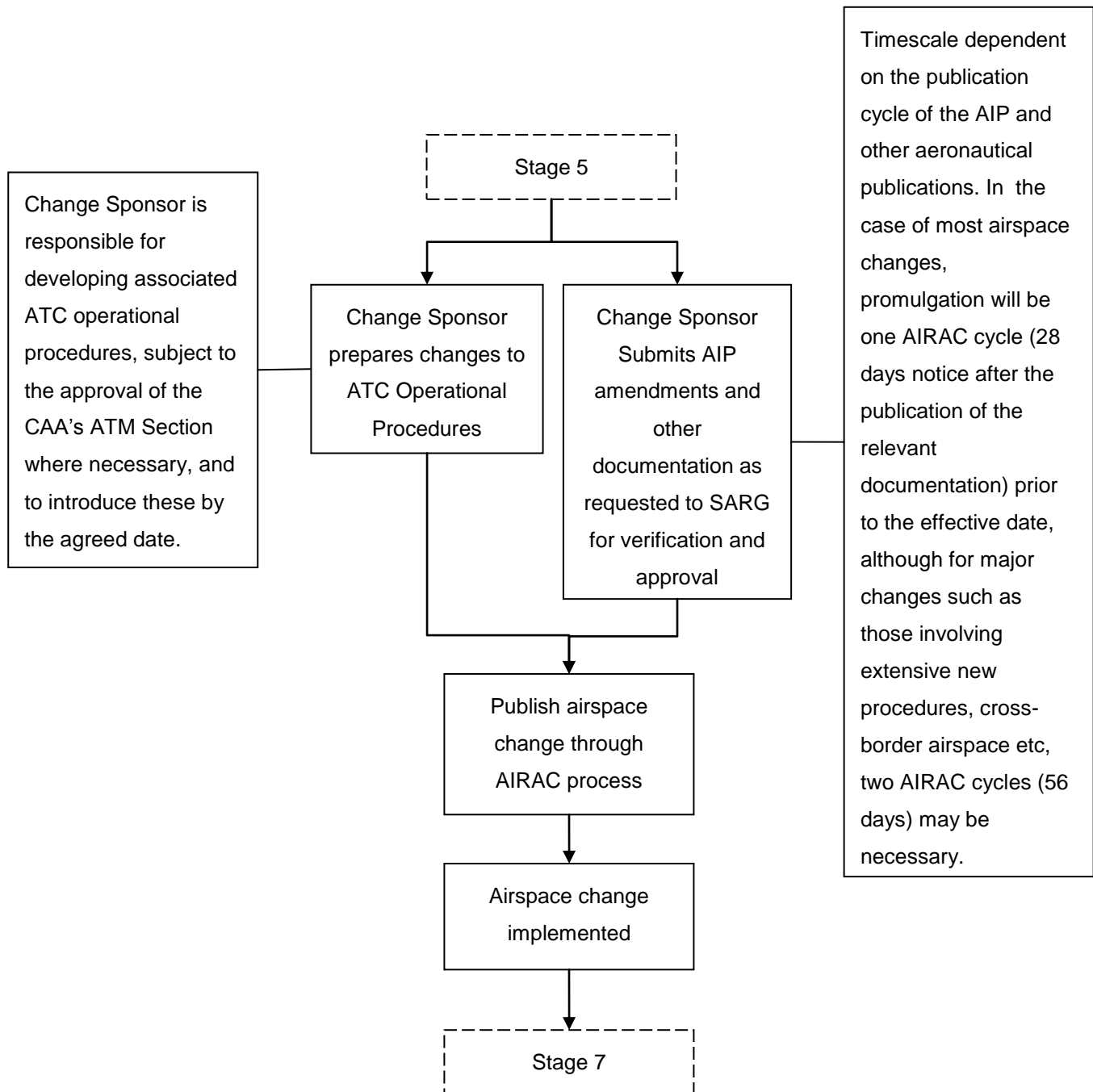
Figure 2: Case study



- 5.5 The Case Study will enable SARG to determine whether there is a case for an airspace change and whether that case is answered by the Formal Proposal. In particular, it will establish whether SARG will:
- Seek supplementary information on the Proposal from the Change Sponsor in order to conclude the Case Study at a later date; or
 - Agree that the Proposal fully meets all requirements and recommend to the Group Director, SARG, that the Proposal be approved, or be rejected providing an explanation of why this should be the case.
- 5.6 In each case, Change Sponsors will be notified immediately of the outcome of the Case Study's recommendations to the Group Director, SARG.
- 5.7 The Group Director, SARG, makes the regulatory decision to approve or reject the Airspace Change Proposal. The Change Sponsor will be notified of the Group Director's decision. Similarly, the CAA will publicise its regulatory decision in the form of a Press Release (ideally in conjunction with the Change Sponsor). Some regulatory decisions may be conditional. Under such circumstances, a Change Sponsor will be informed, as part of the approval notification, of any post implementation analysis that is expected to be carried out as part of the Post Implementation Review, and of the likely date for this Review. This analysis would need to be agreed by the Change Sponsor prior to regulatory approval.

Stage 6

Implementation

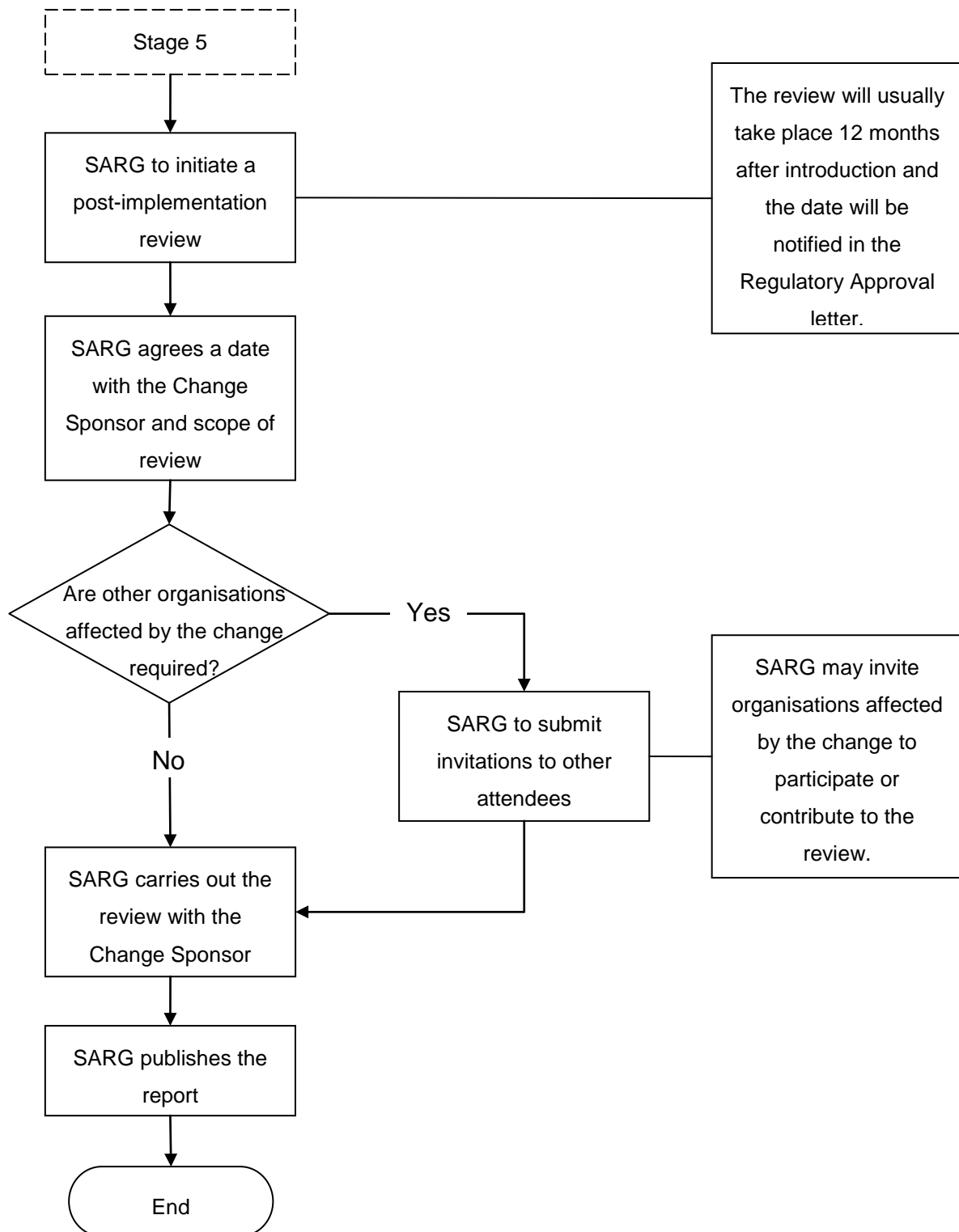


- 6.1 Following regulatory approval of an Airspace Change Proposal, SARG will, in conjunction with the Change Sponsor, carry out the necessary actions to promulgate the change in the UK AIP and other national regulatory documents. The effective date of an airspace change will, of course, have been previously agreed between SARG and the Change Sponsor, the proposed implementation date and a reserve date having been stated in the Formal Proposal.
- 6.2 The exact timescale for the promulgation of a particular change will be dependent upon the nature and scale of the change proposal and the AIP publication cycle. In the case of most airspace changes, promulgation will be not less than one AIRAC cycle (28 days notice after the publication of the relevant documentation) prior to effective date of a change, although for major changes, for example those involving extensive new procedures, cross-border airspace, etc., two AIRAC cycles (56 days) will normally be necessary. Given sufficient notice, it may also be possible to adjust the publication cycles of the CAA's various VFR charts in order to incorporate airspace changes as close to their implementation date as possible.
- 6.3 As part of the implementation process, Change Sponsors need to consider the extent of the AIP amendments their airspace change will generate. Changes that result in Flight Planning arrangements must be co-ordinated with NATS. In the case of terminal airspace changes, these may go beyond the Change Sponsor's entry in the Aerodrome (AD) section and require changes to the En-Route (ENR) and General (GEN) sections or the AD entries of adjacent aerodromes. Similarly, en-route or off-route changes may impact upon SIDs, STARs, instrument flight procedure and terminal airspace structure charts within the AD section. En-route or off-route changes may also impact upon the airspace structures of adjoining States. Consideration must, therefore, be given to the impact upon the AIP as a whole, and possibly the AIPs of neighbouring States; SARG staff are available to provide advice and assistance to Change Sponsors in this aspect of the Airspace Change Process.
- 6.4 Following the decision to implement an Airspace Change Proposal, it will be necessary to take action to bring the change to the attention of the aviation community in addition to the formal promulgation. This will initially take the form of an AIC outlining the details of the change (including effective date and, where appropriate or feasible, a map of the revised airspace structure). Ideally, any such AIC should be published at least one month prior to the distribution of the AIP amendment containing the airspace change.
- 6.5 Change Sponsors should also consider how they intend to notify the members of the local community and other stakeholder groups (whom they

have consulted) on the outcome of the consultation and planned dates for implementation of the changes. In order to publicise a forthcoming change to as many airspace users (and perhaps service providers) as widely as possible, there may be a need for articles to be submitted to the MoD and (for example) the commercial GA press, local GA events or the local press. These can be as brief or as detailed as considered necessary.

Stage 7

Operational Review



- 7.1 Following the implementation of any airspace change, SARG will expect the controlling authority (or authorities) of the airspace concerned to monitor and assess the efficacy of the change. Notwithstanding this, SARG will seek to carry out a post-implementation review at a date notified in the approval notice. The purpose of the operational review meeting will be to assess and validate the success of an airspace arrangement and its progress to date to identify any operational issues that may have arisen since the introduction of the change. This will normally be at the 12-month point following implementation.
- 7.2 This is necessary in order to identify any subsequent requirements to bring about further changes to ATC patterns and procedures, and indeed further changes to airspace structures, the need for which can only be determined through operational experience.
- 7.3 As part of this validation process SARG will, in the case of terminal airspace changes seeking modification to, or the creation of, controlled airspace, expect controlling authorities to record the number of CTR and CTA transits, where appropriate to the airspace classification in question, and those occasions when requests to cross the airspace is refused. The reason why transit is refused should also be recorded if at all possible.
- 7.4 The nature of each review will be determined by the scale and impact of the change itself. Reviews of minor changes may be conducted by correspondence, whereas more significant changes may require SARG staff to visit the unit concerned. In the case of the latter course, at a civil ATSU this may be done in conjunction with a routine periodic ATM inspection. The net result of each review should be the same – to ensure that the revised arrangements are working as anticipated. If this is determined not to be the case, changes to the arrangements may have to be made.
- 7.5 The Review may need to include an assessment of the environmental impact of the changes. In particular, it will be necessary to assess if the anticipated environmental benefits have been delivered and, if not, why not. Maintaining adequate data to support this aspect of the review will be vitally important.

Appendix A

Airspace Change Proposal – Operational Report

Introduction

A.1 Following the conclusion of Sponsor Consultation the Change Sponsors will need to convince SARG of the merits of their change proposal. It is, therefore, necessary to produce a Formal Proposal for submission to SARG for consideration. In order to ensure that the various areas for assessment by SARG are addressed, Change Sponsors should submit the documentation with clearly defined sections as per the following headings:

- Justification for the Change and Analysis of Change Options;
- Airspace Description;
- Supporting Infrastructure/Resources;
- Operational Impact;
- Economic Impact (refer to Appendix B, Section 9);
- Safety Management;
- Airspace and Infrastructure Requirements; and
- Supporting Maps, Charts and Diagrams.

A.2 This is a basic structure upon which to build a Formal Proposal with each heading being applicable to a greater or lesser extent, depending on the context of the Proposal. The following paragraphs are provided for guidance/clarification of information expected under each section, however, Change Sponsors should remain aware of the need to add to this basic structure should the need arise (based upon the size and scope of the change Proposal).

Justification for Change and Analysis of Change Options

A.3 The Formal Proposal must include a clear explanation of the proposed change, reasons why the change is required and the options that have

been considered, including the 'do nothing' option. Justification for the proposed option in favour of the other options considered must be included.

- A.4 Change Sponsors must note that the cornerstone of any justification for the establishment of, or increase to, controlled airspace will be an assessment of the 'threat' posed to the continued safety of operation resulting from the retention of the current airspace structure (i.e. the 'do nothing' option). In addition, the Formal Proposal must also state the operational efficiency benefits any increase in controlled airspace will confer.

Airspace Description

- A.5 The Proposal should provide a full description of the proposed change including the following:
- The type of route or structure; e.g. Airway, UAR, Conditional Route, Advisory Route, CTR, SIDs/STARs, Holding Patterns, etc.;
 - The hours of operation of the airspace and any seasonal variations;
 - Interaction with domestic and international en-route structures, TMAs or CTAs with an explanation of how connectivity is to be achieved. Connectivity to aerodromes not connected to CAS should be covered;
 - Airspace buffer requirements (if any);
 - Supporting information on traffic data including statistics and forecasts for the various categories of aircraft movements (Passenger, Freight, Test and Training, Aero Club, Other) and Terminal Passenger numbers³;
 - Analysis of the impact of the traffic mix on complexity and workload of operations;

³ To be based upon monthly airport air traffic movement and passenger data as submitted to the CAA. Guidance on the requisite supporting statistical evidence will be provided to those Change Sponsors who, at the time of the proposed change, do not submit such data to the CAA. All traffic forecast data submitted (as described in Appendix B, paragraph 34, page 8) with an Airspace Change Proposal will be treated in confidence and will not be divulged to other parties without prior consent. As a general rule, traffic forecasts should be provided at least 5 years in advance.

- Evidence of relevant draft Letters of Agreement or Memoranda of Understanding, including any arising out of consultation and/or Airspace Management requirements;
- Evidence that the Airspace Design is compliant with ICAO Standards and Recommended Practices (SARPs) and any other UK Policy or filed differences, and UK policy on the Flexible Use of Airspace (or evidence of mitigation where it is not);
- The proposed airspace classification with justification for that classification;
- Demonstration of commitment to provide airspace users equitable access to the airspace as per the classification and where necessary indicate resources to be applied or a commitment to provide them in-line with forecast traffic growth. 'Management by exclusion' would not be acceptable; and
- Details of and justification for any delegation of ATS.

Supporting Infrastructure/Resources

A.6 The Proposal should include evidence to support RNAV and conventional navigation as appropriate, including primary and secondary surveillance radar (SSR) and other navigation aid coverage together with details of planned availability and contingency procedures. It should also include evidence of communications infrastructure including R/T coverage, again with availability and contingency procedures. The effects of failure of equipment, procedures and/or personnel with respect to the overall management of the airspace must be considered. The Proposal must provide effective responses to the failure modes that will enable the functions associated with airspace to be carried out including details of navigation aid coverage, unit personnel levels, separation standards and the design of the airspace in respect of existing international standards or guidance material. A clear statement on SSR code assignment requirements is also required. Finally, the Proposal should include evidence of sufficient numbers of suitably qualified staff required to provide air traffic services following the implementation of a change.

Operational Impact

- A.7 An analysis of the impact of the change on all airspace users, airfields and traffic levels must be provided, and include an outline concept of operations describing how operations within the new airspace will be managed. Specifically, consideration should be given to:
- Impact on IFR General Air Traffic and Operational Air Traffic or on VFR General Aviation (GA) traffic flow in or through the area;
 - Impact on VFR operations (including VFR Routes where applicable);
 - Consequential effects on procedures and capacity, i.e. on SIDS, STARS, and/or holding patterns. Details of existing or planned routes and holds;
 - Impact on aerodromes and other specific activities within or adjacent to the proposed airspace; and
 - Any flight planning restrictions and/or route requirements.
- A.8 Evidence of mitigation of the effects of the change on any of the above must also be provided.

Economic Impact

- A.9 Change Sponsors may develop, where practicable, a short economic impact assessment which includes all categories of operations, users and those likely to be affected by the change. The economic impact should cover both the operational economic impact (covering areas such as savings or cost associated with resultant changes to track mileage for both Commercial Air Transport (CAT) and GA traffic, impact on recorded delays, etc. as appropriate) and the environmental economic impact (refer to Appendix B, Section 9).

Safety Management

- A.10 Safety Management is an intrinsic element of any airspace change. Units should be operating a safety management system in accordance with the

provisions laid down in CAP 670 – ATS Safety Requirements – and in the Single European Sky Common Requirements (CRs) or military equivalent arrangements. For airspace changes, SARG requires that certain Airspace and Infrastructure Requirements be satisfied (detailed below in paragraph 11). Civil ATS Change Sponsors should be aware that AAA ATM (will be fully involved in the Regulatory Decision stage of the Airspace Change Process.

Airspace and Infrastructure Requirements

A.11 A key element of any change proposal is the need to demonstrate that the proposed airspace change complies with the Airspace and Infrastructure Requirements. The Airspace and Infrastructure Requirements are derived from SES Regulations, ICAO SARPs and ECAC/Eurocontrol requirements, and any additional requirements to satisfy UK Policy. These are as follows:

- The airspace structure must be of sufficient dimensions with regard to expected aircraft navigation performance and manoeuvrability to fully contain horizontal and vertical flight activity in both radar and non-radar environments⁴;
- Where an additional airspace structure is required for radar control purposes, the dimensions shall be such that radar control manoeuvres can be contained within the structure, allowing a safety buffer. This safety buffer shall be in accordance with agreed parameters as set down in SARG Policy Statement ‘Safety Buffer Policy for Airspace Design Purposes Segregated Airspace’;
- The Air Traffic Management (ATM) system must be adequate to ensure that prescribed separation can be maintained between aircraft within the airspace structure and safe management of interfaces with other airspace structures;

⁴ Airspace designs will be predicated on a radar or non-radar environment; loss of radar would require contingency arrangements to be developed to ensure continued safety of aircraft operations.

- Air Traffic Control (ATC) procedures are to ensure required separation between traffic inside a new airspace structure and traffic within existing adjacent or other new airspace structures;
- Within the constraints of safety and efficiency, the airspace classification should permit access to as many classes of user as practicable;
- There must be assurance, as far as practicable, against unauthorised incursions. This is usually done through the classification and promulgation;
- Pilots shall be notified of any failure of navigational facilities and of any suitable alternative facilities available and the method of identifying failure and notification should be specified;
- The notification of the implementation of new airspace structures or withdrawal of redundant airspace structures shall be adequate to allow interested parties sufficient time to comply with user requirements. This is normally done through the AIRAC cycle;
- There must be sufficient R/T coverage to support the ATM system within the totality of proposed controlled airspace;
- If the new structure lies close to another airspace structure or overlaps an associated airspace structure, the need for operating agreements shall be considered;
- Should there be any other aviation activity (low flying, gliding, parachuting, microlight site, etc.) in the vicinity of the new airspace structure and no suitable operating agreements or ATC Procedures can be devised, the Change Sponsor shall act to resolve any conflicting interests; and
- Airspace changes in respect of ATS Routes and Terminal Airspace (CTR/CTA) structures are subject to additional requirements as specified in the paragraphs below.

A.12 ATS Routes:

- There must be sufficient accurate navigational guidance based on in-line VOR/DME or NDB or by approved RNAV derived sources, to

contain the aircraft within the route to the published RNP value in accordance with ICAO/Eurocontrol Standards;

- Where ATS routes adjoin Terminal Airspace there shall be suitable link routes as necessary for the ATM task; and
- All new routes should be designed to accommodate P-RNAV navigational requirements.

A.13 Terminal Airspace (CTR/CTA):

- The airspace structure shall be of sufficient dimensions to contain appropriate procedures, holding patterns and their associated protected areas;
- There shall be effective integration of departure and arrival routes associated with the airspace structure and linking to designated runways and published IAPs;
- Where possible, there shall be suitable linking routes between the proposed terminal airspace and existing en-route airspace structure;
- The airspace structure shall be designed to ensure that adequate and appropriate terrain clearance can be readily applied within and adjacent to the proposed airspace;
- Suitable arrangements for the control of all classes of aircraft (including transits) operating within or adjacent to the airspace in question, in all meteorological conditions and under all flight rules, shall be in place or will be put into effect by Change Sponsors upon implementation of the change in question (if these do not already exist);
- Change Sponsors shall ensure that sufficient VRPs are established within or adjacent to the subject airspace to facilitate the effective integration of VFR arrivals, departures and transits of the airspace with IFR traffic;
- There shall be suitable availability of radar control facilities;
- Change Sponsors shall, upon implementation of any airspace change, devise the means of gathering (if these do not already exist) and of maintaining statistics on the number of aircraft transiting the airspace in question. Similarly, Change Sponsors shall maintain

records on the numbers of aircraft refused permission to transit the airspace in question, and the reasons why. Change Sponsors should note that such records would enable ATS Managers to plan staffing requirements necessary to effectively manage the airspace under their control; and

- All new procedures should, wherever possible, incorporate Continuous Descent Approach (CDA) profiles after aircraft leave the holding facility associated with that procedure.

A.14 Off-Route Airspace Structures:

- If the new structure lies close to another airspace structure or overlaps an associated airspace structure, the need for operating agreements shall be considered; and
- Should there be any other aviation activity (military low flying, gliding, parachuting, microlight site etc.) in the vicinity of the new airspace structure and no suitable operating agreements or ATC Procedures can be devised, the Change Sponsor shall act to resolve any conflicting interests.

Diagrams, Charts and Documents

A.15 Formal Proposals must include diagrams and descriptions of the airspace proposed, clearly showing the dimensions and WGS84 co-ordinates of the proposed changes. The division of complex airspace structures must be clearly annotated, in accordance with charting convention as far as possible. An explanation for each proposed structure must be given to substantiate the need.

A.16 Charts should be drawn to a clearly stated scale, and the Formal Proposal must contain at least one chart showing the change proposal in its entirety. Similarly, an overlay of proposed changes must appear on at least one current airspace chart in order to illustrate the difference between current and proposed structures. In most cases, the CAA 1:500 000 series VFR charts can form the basis of such drawings, although it is recognised that

1:250 000 VFR or other charts will suffice, subject to the nature of the proposed change.

- A.17 The Change Sponsor must include draft amendments (CAA Form 933) to reflect any changes to the UK Aeronautical Information Publication (AIP) including changes affecting adjacent airspace structures. A list of current UK AIP pages affected by the proposed change must be included in the detail of the Proposal.

Appendix A annex 1

References and selected bibliography

- CAA, CAP 32, The UK AIP (which notifies some UK differences and variations from SARPs and PANS)
- CAA, CAP 493, Manual of Air Traffic Services – Part 1 (which reflects the UK application of PANS-ATM)
- CAA, CAP 670, ATS Safety Requirements
- CAA, CAP 724, The Airspace Charter
- CAA Paper 91010, Outline of the method for the determination of Separation Standards for future Air Traffic Systems
- CAA, Safety Buffer Policy for Airspace Design Purposes Segregated Airspace
- HM Government Consultation Principles July 2012 – <https://www.gov.uk/government/publications/consultation-principles-guidance>
- Guidance to the Civil Aviation Authority on the environmental factors it should take into account when exercising its air navigation functions. DfT January 2014 – <https://www.gov.uk/government/publications/air-navigation-guidance>
- Eurocontrol, ASM.ETI.ST08.5000-HBK-01-00, Airspace Management Handbook for the application of the Flexible Use of Airspace
- Eurocontrol, Doc 94.70.08 EATCHIP, Report on Organisational Structures and Procedures Required for the Application of the Concept of the Flexible Use of Airspace
- Eurocontrol, NAV .ET1.ST10, Guidance Material for the Design of Terminal Procedures for Area Navigation
- ICAO Annex 2, Rules of the Air
- ICAO Annex 3, Meteorology
- ICAO Annex 4, Aeronautical Charts
- ICAO Annex 6, Operation of Aircraft
- ICAO Annex 10, Aeronautical Telecommunications
- ICAO Annex 11, Air Traffic Services
- ICAO Annex 15, Aeronautical Information Services

- ICAO Annex 16, Environmental Protection
- ICAO Doc 4444, PANS-ATM Procedures for Air Navigation Services – Air Traffic Management
- ICAO Doc 7030, Regional Supplements
- ICAO Doc 8168, PANS OPS Volumes 1 and 2 – Procedures for Air Navigation Services – Aircraft Operations
- ICAO Doc 9426, ATS Planning Manual
- ICAO Doc 9613, Manual on Required Navigation Performance (RNP)
- ICAO Doc 9689, Manual on Airspace Planning Methodology for Determination of Separation Minima
- MoD, JSP550, Military Flying Regulations
- MoD, JSP552, Military Air Traffic Services
- The Stationery Office, The Local Government Companion (2003 edition) – www.tsoshop.co.uk/bookstore
- The Stationery Office, Transport Act 2000 – www.opsi.gov.uk/acts/acts2000/20000038.htm

Appendix B

Airspace Change Proposal – Environmental Requirements

Section 1 – Introduction

- B.1 The Civil Aviation Authority (Air Navigation) Directions 2001 (incorporating Variation Direction 2004) (HMG, 2001) requires the CAA to take into account ‘the need to reduce, control and mitigate as far as possible the environmental impacts of civil aircraft operations, and in particular the annoyance and disturbance caused to the general public arising from aircraft noise and vibration, and emissions from aircraft engines’. In order to achieve this, SARG requires Change Sponsors to provide an environmental assessment. Every airspace change will be different and the extent of environmental assessment will vary from case to case. It is the function of this document to assist those preparing airspace change proposals in providing sufficient environmental information for public consultation and to inform the decision-making process.
- B.2 In order to ensure that the various areas for environmental assessment by SARG are addressed, Change Sponsors **should** submit the documentation with the following clearly defined sections:
- Description of the airspace change (refer to paragraphs 25 – 33);
 - Traffic forecasts (refer to paragraphs 34 – 38);
 - An assessment of the effects on noise (refer to Sections 4 and 5);
 - An assessment of the change in fuel burn/CO₂ (refer to Section 6);
 - An assessment of the effect on local air quality (refer to Section 7);
- and
- An economic valuation of environmental impact, if appropriate (refer to Section 9).
- B.3 This document gives a broad outline of relevant methodologies for use in environmental assessment. It is not a complete instruction manual on all

aspects of the topic. Readers should consult the further reading Annex or seek expert assistance where relevant. The purpose of this document is to provide clarification of the requirements for environmental information in the submission of an Airspace Change Proposal. It does not place additional obligations on Change Sponsors over that contained in current legislation and guidance issued by the Department for Transport (DfT) and other Government departments.

- B.4 Guidance to the CAA from DfT (2014 – paragraph 1.4) provides additional clarity on the Government's environmental objectives relating to air navigation in the UK. However, when considering airspace changes, there may be other legitimate operational objectives, such as the overriding need to maintain an acceptable level of air safety, the desire for sustainable development, or to enhance the overall efficiency of the UK airspace network, which need to be considered alongside these environmental objectives. It is up to the CAA to determine the most appropriate balance between these competing characteristics.
- B.5 The Government's Airspace Policy Framework (DfT, 2013) recognises the benefits of the expansion in air travel, but promotes a balanced approach to securing the benefits of aviation. The Framework makes clear that the acceptability of growth in aviation depends to a large extent on the industry continuing to tackle its noise impact and confirms that the Government expects the industry at all levels to continue to address noise and other environmental impacts.
- B.6 In March 2005 the Government revised its sustainable development strategy (DEFRA, 2005) which replaces the sustainable strategy outlined in the guidance on environmental objectives (DTLR, 2002). The revised strategy takes account of new developments since 1999 and, in particular, the Energy white paper (DTI, 2003) and international initiatives. The aim of the new sustainable development strategy is to build upon the old one, not depart from it.

- B.7 The guiding principles of the latest UK sustainable development strategy are:
- Living within environmental limits;
 - Ensuring a strong, healthy and just society;
 - Achieving a sustainable economy;
 - Promoting good governance; and
 - Using sound science responsibly.
- B.8 For a policy to be sustainable, it must respect all five of these principles though recognising that some policies will place more emphasis on certain principles than others. Any trade-offs should be made in an explicit and transparent way.
- B.9 The strategy discusses indicators for sustainable consumption and production although a definitive list of indicators has yet to be published. These indicators are being developed to demonstrate ‘decoupling’. That is, measuring success in breaking the link between economic growth and environmental damage. For aviation, greenhouse gases and gross domestic product (GDP) have been suggested, although exact details have yet to be published.
- B.10 The environmental impact of an airspace change **must** be considered from the outset. The Change Sponsor **should** discuss their general intentions for environmental assessment with the SARG Project Leader and, if necessary, with ERCD staff who will provide expert advice. These discussions **should** take place before any form of external consultation. Each airspace change is specific and raises different issues, while the guidance in this document is, of necessity, quite general.
- B.11 Environmental science is continually evolving and this document describes assessment methods applicable at the date of publication. New methodologies based on sound principles may well be developed. This document will therefore be subject to review and updating in order to ensure that it reflects ‘best practice’.

- B.12 Airspace changes are increasingly the subject of public debate and it is important that environmental assessment and associated public consultation are carried out thoroughly. Incomplete consideration of environmental issues will cause delays to the handling of airspace change proposals.
- B.13 It is extremely important for Change Sponsors to discuss the general nature of the change with the SARG Project Leader. This can prevent wasted effort. For example, it may be that the Change Sponsor can demonstrate by approximate calculations, that some effects of an option are relatively small. In such an instance, the SARG Project Leader could indicate that there would be little point in further refinements to the calculation. The message is that analysis should be proportionate to the utility of the information gained from it.
- B.14 The following terms are used here to indicate the degree of compliance expected from Change Sponsors in following this guidance:
- **Must** – Change Sponsors are to meet the requirements in full when this term is used;
 - **Should** – Change Sponsors are to meet these requirements unless there is sufficient reason which must be agreed in writing with the SARG Project Leader and the circumstances recorded in the formal airspace change documentation; and
 - **May** – Change Sponsors decide whether this guidance is appropriate to the circumstances of the airspace change.
- B.15 Where these three words are used in relation to actions by Change Sponsors, the words have been emboldened in the text.
- B.16 The following text is divided into eight sections:
- Section 2 – Principles of Environmental Assessment;
 - Section 3 – Inputs to the Environmental Assessment;
 - Section 4 – Noise: Standard Techniques;
 - Section 5 – Noise: Supplementary Methods;
 - Section 6 – Climate Change;

- Section 7 – Local Air Quality;
- Section 8 – Tranquillity and Visual Intrusion; and
- Section 9 – Economic Valuation of Environmental Impact.

Section 2 – Principles of Environmental Assessment

- B.17 There are many definitions of environmental assessment. For the purposes of this document the UK definition (DOE, 1989) will be used: ‘A technique and a process by which information about the environmental effects of a project is collected, both by the developer and from other sources, and taken into account by the planning authority in forming their judgements on whether the development should go ahead’. The developer here is understood to be the Change Sponsor, the development is the airspace change and the planning authority is the Group Director, SARG, or, in exceptional circumstances, the Secretary of State for Transport .
- B.18 Airspace changes are subject to the scrutiny of the Process established in the main document rather than those that would govern a project falling within the Town and Country Planning Regulations or those that are subject to a public planning inquiry. Environmental assessment, within the scope of this document, includes all environmental impacts that the CAA has an obligation (placed on it by Government) to consider, both by the Directions (HMG, 2001) and the Guidance (DfT, 2014). It is considered unlikely that airspace changes will have a direct impact on animals, livestock and biodiversity. However, Change Sponsors should remain alert to the possibility and may be required to include these topics in their environmental assessment. Further guidance will be issued on a case-by-case basis where applicable. If appropriate, the issue of bird strikes in relation to the Proposal should be addressed as a safety issue. Safety aspects should be considered separately from environmental issues.

Purpose of Environmental Assessment

- B.19 The function of environmental assessment is to ensure that environmental considerations are explicitly addressed and incorporated within the

planning and decision making process for an airspace change. This takes into account the statutory duties on the CAA and guidance on environmental objectives promulgated by the DfT ([2013](#)). Environmental assessment should set out the base case or current situation so that changes can be clearly identified.

Basic Principles

B.20 Environmental assessment (adapted in part from international guidelines produced by the International Association for Impact Assessment (IAIA, 1999)) should be:

- **Purposive** – informing decision making;
- **Rigorous** – applying best available scientific knowledge, including methodologies and techniques relevant to the problem under investigation;
- **Practical** – resulting in information and outputs that assist with problem solving and are acceptable to, and capable of implementation by Change Sponsors;
- **Relevant** – providing sufficient, reliable and usable information for planning and decision-making;
- **Cost-effective** – achieving objectives within the limits of available information, time, resources and methodology;
- **Focused** – concentrating on significant environmental effects and key issues;
- **Adaptive** – adjusting to the realities, issues and circumstances of proposals under review without compromising the integrity of the process and be iterative, incorporating lessons learned throughout the proposal's life cycle;
- **Participative** – providing appropriate opportunities to inform and involve interested and affected individuals and groups, ensuring that their inputs and concerns should be considered in decision making;
- **Interdisciplinary** – ensuring that appropriate techniques and experts in the relevant technical disciplines are involved;

- **Credible** – implemented with professionalism, rigour, fairness, objectivity, impartiality and balance;
- **Integrated** – addressing the interrelationships between social, economic and environmental aspects;
- **Transparent** – having clear, easily understood requirements; ensuring public access to information; identifying the factors that are to be taken into account in decision making and recognising limitations and difficulties; and
- **Systematic** – resulting in full consideration of all relevant information on the affected environment, of proposed alternatives and their impacts and of measures necessary to monitor and investigate residual effects.

B.21 The principles of rigour and cost-effectiveness together imply that each environmental assessment should be proportionate to the airspace change and its impact. Each airspace change is different and a proportional approach ensures that the environmental information is sufficient for purpose but not excessive.

B.22 Change Sponsors are to assist SARG in meeting the environmental objectives in the manner specified.

Environmental Assessment Users

B.23 Environmental assessment is required to assist and inform two different audiences – the public and the decision-maker. Moreover, it must cater for the technical expert and those affected by the changes, who can only be assumed to have a general knowledge of aviation or environmental matters. The public will certainly expect a description of the airspace change written in readily understandable, non-technical language. However, some people may wish to read the full technical detail or to provide it to technical experts employed for that purpose. It is important that the level of detail is appropriate to these audiences.

B.24 A technical document containing a comprehensive and complete description of the airspace change including the environmental impact will

be required and must be produced for all airspace changes. This is the document that will be used as a primary source in decision-making. It **may** also be appropriate for Change Sponsors to produce a more general description of the airspace change and the rationale for its proposal in an easy-to-read style for public consumption. If such an additional separate document is produced, it **must** contain details of the environmental impact of the proposal. It is important that both documents are made available to the public and that they are wholly consistent. Provision of this non-technical document will enable members of the public without expertise in either aviation or environmental science to understand the impact while providing sufficient technical information to enable a sound decision to be made based on accurate and detailed information.

Section 3 – Inputs to the Environmental Assessment

- B.25 The inputs to the environmental assessment process are derived from two sources:
- Airspace design; and
 - Traffic forecasts.

B.26 These are examined in turn.

Airspace Design

- B.27 The airspace design **must** take account of the altitude-based priorities set out in the DfT’s Guidance (2014, paragraphs 4.1 & 4.2). Consultation and proposal documentation **must** therefore demonstrate how each priority for each of the altitude bands has been considered and addressed
- B.28 The environmental assessment **must** include a high quality paper diagram of the airspace change in its entirety as well as supplementary diagrams illustrating different parts of the change. This diagram **must** show the extent of the airspace change in relation to known geographical features and centres of population.

- B.29 The Proposal **should** consider and assess more than one option then demonstrate why the selected option meets safety and operational requirements and will generate an overall environmental benefit or, if not, why it is being proposed.
- B.30 The DfT's Guidance (2014, paragraphs 7.9 to 7.12) also outlines the need for Change Sponsors to consider options for respite when designing Airspace Changes. Consideration of local circumstances is important when making decisions about respite options, but the introduction of respite should be consistent with the objective of "limiting the number of people affected by aircraft noise, whilst providing an opportunity for some communities to benefit from relief of aircraft noise for an agreed time."
- B.31 The Change Sponsor **must** provide SARG with a complete set of coordinates describing the proposed change in electronic format using World Geodetic System 1984 (WGS 84). In addition, the Change Sponsor **must** supply these locations in the form of Ordnance Survey (OS) national grid coordinates. This will give non-aviation stakeholders an accurate geographical description of the proposed arrangements. This electronic version **must** provide a full description of the horizontal and vertical extent of the zones and areas contained within the airspace change. It **must** also include coordinates in both WGS 84 and OS national grid formats that define the centre lines of routes including airways, standard instrument departures (SID), standard arrival routes (STAR), noise preferential routes (NPR) or any other arrangement that has the effect of concentrating traffic over a particular geographical area. Coordinates for current airspace and airport arrangements can be found in the UK Air Pilot (NATS, 2007) and its associated web site. Details of WGS 84 Latitude/Longitude and the OS national grid coordinate system can be found on the Ordnance Survey web site (OS, 2006) – this contains software that will facilitate conversion between Latitude/Longitude and OS national grid.
- B.32 Change Sponsors **should** provide indications of the likely lateral dispersion of traffic about the centre line of each route. This **should** take the form of a statistical measure of variation such as the standard deviation of lateral

distance from the centre line for given distances along track in circumstances where the dispersion is variable. Change Sponsors **may** supply the outputs from simulation to demonstrate the lateral dispersion of traffic within the proposed airspace change or bring forward evidence based on actual performance on a similar kind of route. It may be appropriate for Change Sponsors to explain different aspects of dispersion, e.g. dispersion within NPRs when following a departure routeing and when vectoring – where the aircraft will go and their likely frequency.

- B.33 Change Sponsors **must** provide a description of the vertical distribution of traffic in airways, SIDs, STARs, NPRs and other arrangements that have the effect of concentrating traffic over a particular geographical area. For departing traffic, Change Sponsors **should** produce profiles of the most frequent type(s) of aircraft operating within the airspace. They **should** show vertical profiles for the maximum, typical and minimum climb rates achievable by those aircraft. A vertical profile for the slowest climbing aircraft likely to use the airspace **should** also be produced. All profiles **should** be shown graphically and the underlying data provided in a spreadsheet with all planning assumptions clearly documented.
- B.34 The DfT guidance ([DfT, 2014 – paragraph 4.12](#)) requires [SARG](#) to ‘ensure that consideration should therefore be given to how the use of [CDO](#) and Low Power/Low Drag (LPLD) procedures can be promoted in the course of developing new procedures and when considering proposals for changes to existing airspace arrangements’. A description of [CDO](#) and LPLD is provided in Annex 5. Change Sponsors **should** explain how such consideration is taken into account within their Proposals.

Traffic Forecasts

- B.35 The amount of air traffic is an important consideration in the assessment of airspace changes and their environmental impact. Change Sponsors will have made a comprehensive assessment of traffic forecasts before reaching the conclusion that an airspace change should be considered. Forecasting is not an exact science and no one pretends that the future will turn out exactly as predicted. There are many factors outside the control of

the Change Sponsor and it would not be reasonable to hold the Change Sponsor to account for deviating from forecasts unless traffic levels breach binding constraints (e.g. planning agreements, environmental legislation or limits imposed by Government policy). Nonetheless, forecasts are essential to the Airspace Change Process, not only providing justification for changes, but also enabling the impact of changes to be properly considered. In planning changes to airspace arrangements, Change Sponsors **may** have conducted real and/or fast time simulations of air traffic for a number of options. Such simulations will help to establish whether options will provide the required airspace capacity.

- B.36 Change Sponsors **must** include traffic forecasts in their environmental assessment. Information on air traffic **must** include the current level of traffic using the present airspace arrangement and a forecast. The forecast will need to indicate the traffic growth on the different routes contained within the airspace change volume. The sources used for the forecast **must** be documented.
- B.37 Typically, forecasts **should** be for five years from the planned implementation date of the airspace change. There **may** be good reasons for varying this – for example, to use data that has already been made available to the general public at planning inquiries, in airport master plans or other business plans. It **may** also be appropriate to provide forecasts further into the future than five years; for example, extensive airspace changes or where traffic is forecast to grow slowly in the five-year period but faster thereafter.
- B.38 There are considerable uncertainties in forecasting growth in air traffic. Traffic forecasts will be affected by consumer demand, industry confidence and a range of social, technological and environmental considerations. It may be appropriate for Change Sponsors to outline the key factors and their likely impact. In these circumstances, Change Sponsors **should** consider generating a range of forecasts based on several scenarios that reflect those uncertainties – this would help prevent iterations in the assessment process.

B.39 Traffic forecasts **should** contain not only numbers but also types of aircraft. Change Sponsors **should** provide this information by runway (for arrivals/departures) and/or by route with information on vertical distribution by height/altitude/flight level as appropriate. Types of aircraft **may** be given by aircraft type/engine fit using ICAO type designators. If this is not a straightforward exercise, then designation by the UK Aircraft Noise Contour Model (ANCON) types (shown in Table 1) or by seat size categories (as shown in Table 2) would be acceptable.

Table 1: Current ANCON database aircraft type listing

ANCON type	Type description	Engine description
B717	Boeing 717-200	BR715
B727C3	Boeing 727-100/200 with hush kit	PW JT8D-15/17
B732C3	Boeing 737-200 with hush kit	PW JT8D-15A/17A
B733	Boeing 737-300/400/500	CFM56-3
B736	Boeing 737-600/700	CFM56-7
B738	Boeing 737-800/900	CFM56-7
B741C3	Boeing 747-100 Chapter 3	PW JT9D-7A/F
B742C3	Boeing 747-200 Chapter 3	GE CF6/PW JT9D-7Q/RR RB211-524
B747SP	Boeing 747SP	GE CF6/PW JT9D-7Q/RR RB211-524
B744G	Boeing 747-400	GE CF6-80
B744P	Boeing 747-400	PW4000
B744R	Boeing 747-400	RR RB211-524G/H
B752C	Boeing 757-200	RR RB211-535C/PW2037/2040
B752E	Boeing 757-200	RR RB211-535E4/E4B
B753	Boeing 757-300	RR RB211-535E4B
B762	Boeing 767-200/ER	GE CF6/PW4000/RR RB211
B763G	Boeing 767-300/ER	GE CF6-80
B763P	Boeing 767-300/ER	PW4000
B763R	Boeing 767-300/ER	RR RB211-524G/H
B764	Boeing 767-400	GE CF6/PW4000
B772G	Boeing 777-200/ER/LR	GE GE90

B772P	Boeing 777-200/ER/LR	PW4000
B772R	Boeing 777-200/ER/LR	RR Trent 800
B773G	Boeing 777-300ER	GE GE90
B773R	Boeing 777-300	RR Trent 800
B787	Boeing 787-300/800	GE GENX/RR Trent 1000
BA46	AVRO 146-RJ	LF507-1F
CRJ	Canadair Regional Jet	GE CF34-3A1
CRJ700	Canadair Regional Jet 700	GE CF34-8C
CRJ900	Canadair Regional Jet 900	GE CF34-10C
DC87	Boeing (McDonnell Douglas) DC8-70	CFM56-2C
DC9C3	Boeing (McDonnell Douglas) DC9-10/20/30/40 with hush kit	PW JT8D-9/11/17
DC10	Boeing (McDonnell Douglas) DC10-10/30/40	GE CF6/PW JT9D
EA30	Airbus A300-B4/600/R	GE CF6/PW4000
EA31	Airbus A310-200/300	GE CF6/PW4000
EA318	Airbus A318	CFM56-5
EA319C	Airbus A319	CFM56-5
EA319V	Airbus A319	IAE V2500
EA320C	Airbus A320	CFM56-5
EA320V	Airbus A320	IAE V2500
EA321C	Airbus A321	CFM56-5
EA321V	Airbus A321	IAE V2500
EA33	Airbus A330-200/300	GE CF6/PW4000/RR Trent 700
EA34	Airbus A340-200/300	CFM56-5C
EA346	Airbus A340-500/600	RR Trent 556
EA350	Airbus A350-800/900	GE GENX/RR Trent
EA380	Airbus A380-800	GP700/RR Trent 900
EMB145	Embraer EMB 135/145	RR AE3007A
E170	Embraer EMB 170	GE CF34-8E
E190	Embraer EMB 190	GE CF34-10E
EXE2	Chapter 2 Executive Jet	-
EXE3	Chapter 3 Executive Jet	-
FK10	Fokker 70/100	RR Tay 650
L4P	Large 4-propeller	-

LTT	Large twin turboprop	-
L101	Lockheed L1011 TriStar all series	RR RB211-524
IL62	Ilyushin IL62M/MK	D-30KU
MD11	Boeing (McDonnell Douglas) MD11	GE CF6/PW4000
MD80	Boeing (McDonnell Douglas) MD80) all series	PW JT8D-200
MD90	Boeing (McDonnell Douglas) MD90	IAE V2525/8
SP	Single piston-propeller	-
STP	Small twin piston-propeller	-
STT	Small twin turboprop	-
TU54	Tupolev TU154M	D-30KU-154

Table 2: Passenger and freighter aircraft classes by seat size and freight load

Passenger aircraft classes		Freighter aircraft classes	
Class 1	<70 seats	Class A small	<30 tonnes
Class 2	70-150 seats	Class B medium narrow	30-50 tonnes
Class 3	151-250 seats	Class C medium wide	>50-65 tonnes
Class 4	251-350 seats	Class D large	>65-100 tonnes
Class 5	351-500 seats	Class E very large	>100 tonnes
Class 6	>500 seats		

Section 4 – Noise: Standard Techniques

B.40 Noise is a complex phenomenon. Background information on the subject can be found within the appendices listed below.

- References and Selected Bibliography
- Noise Measurement
- Noise Modelling
- Effects of Noise
- Continuous Descent Approaches and Low Power/Low Drag Procedures
- Guidance on the Use of the Integrated Noise Model (INM)

- B.41 The references also include a selected bibliography covering important noise documents.

L_{eq} Contours

- B.42 The most commonly used method of portraying aircraft noise impact in the UK is the L_{eq} noise exposure contour. Noise exposure contours show a set of closed curves on a map. Each contour shows places where people get the same amounts of noise energy – L_{eq} – from aircraft (the ‘eq’ subscript is an abbreviation of the word equivalent i.e. L_{eq} is the equivalent continuous sound level). They are analogous to the contours on an ordinary map showing places at the same height. Noise exposure is generally used to indicate the noise environment averaged over a time interval.
- B.43 Research has indicated that L_{eq} is a good predictor of a community’s disturbance from aircraft noise. L_{eq} is measured in a unit called dBA, where dB means ‘decibel’ and the A suffix means A-weighted (which matches the frequency response of the human ear).
- B.44 Conventional noise exposure contours, which are produced regularly for major airports, are calculated for an average summer day over the period from 16 June to 15 September inclusive, for traffic in the busiest 16 hours of the day, between 0700 and 2300 local time. These are known as L_{eq}, 16 hours contours. This calculation produces a cautious estimate (i.e. tends to over-estimate) noise exposure. This is mainly because airports are generally busier during the summer and a higher number of movements is likely to produce higher L_{eq} values. Aircraft tend to climb less well in higher temperatures, so because they are closer to the ground, L_{eq} values will tend to be higher than in colder weather.
- B.45 Change Sponsors **must** produce L_{eq}, 16 hours noise exposure contours for airports where the proposed option **entails changes to departure and arrival routes for traffic below 4,000 feet agl based on the published minimum departure and arrival gradients**. Under these circumstances, at least three sets of contours **must** be produced:

- Current situation – these may already be available as part of the airport's regular environmental reporting or as part of the airport master plan;
 - Situation immediately following the airspace change; and
 - Situation after traffic has increased under the new arrangements (typically five years after implementation although this **should** be discussed with the SARG Project Leader).
- B.46 The height of 4,000 feet agl was selected as the criteria for Leq contours because aircraft operating above this altitude are unlikely to affect the size or shape of L_{eq} contours.
- B.47 The contours **should** be produced using either the UK Aircraft Noise Contour Model (ANCON) or the US Integrated Noise Model (INM) but ANCON must be used when it is currently in use at the airport for other purposes.
- B.48 Terrain adjustments **should** be included in the calculation process (i.e. the height of the air routes relative to the ground are accounted for). These corrections are limited to geometrical corrections for aircraft-receiver distances and elevation angles. It is not necessary to include consideration of other more complex effects, such as lateral attenuation from uneven ground surfaces and noise screening or reflections from topographical features or buildings.
- B.49 Contours **must** be portrayed from 57 dBA Leq, 16 hours at 3 dB intervals. DfT policy is that 57 dBA Leq, 16 hours represents the onset of significant community annoyance. Change Sponsors **may** include the 54 dBA Leq, 16 hours contour as a sensitivity analysis but this level has no particular relevance in policy making. Contours **should not** be produced at levels below 54 dBA Leq, 16 hours because this corresponds to generally low disturbance to most people, and indeed aircraft noise modelling at such levels is unlikely to generate accurate and reliable results.
- B.50 A table **should** be produced showing the following data for each 3 dB contour interval:

- Area (km²); and
- Population (thousands) – rounded to the nearest hundred.

B.51 It is sometimes useful to include the number of households within each contour, especially if issues of mitigation and compensation are relevant:

- This table **should** show cumulative totals for areas/populations/households. For example, the population for 57 dBA will include residents living in all higher contours;
- The source and date of population data used **should** be noted adjacent to the table. Population data **should** be based on the latest available national census as a minimum but more recent updated population data is preferred;
- The areas calculated should be cumulative and specify total area within each contour including that within the airport perimeter;
- Where Change Sponsors wish to exclude parts of the area within contours, for example, excluding the portion of a contour falling over sea – this **may** be shown additionally and separately from the main table of data; and
- Change Sponsors may include a count of the number of schools, hospitals and other special buildings within the noise exposure contours.

B.52 Contours for assessment **should** be provided to SARG in **both** of the following formats:

- Electronic files in the form of a comma delimited ASCII text file containing three fields as an ordered set (i.e. coordinates should be in the order that describes the closed curve) defining the contours in Ordnance Survey National Grid in metres:

Field	Field name	Units
1	Level	dB
2	Easting	six figure easting OS national grid reference (metres)
3	Northing	six figure northing OS national grid reference (metres)

- Paper version overlaid on a good quality 1:50 000 Ordnance Survey map. However, it **may** be more appropriate to present contours on 1:25 000 or 1:10 000 Ordnance Survey maps.
- B.53 Ordnance Survey national grid coordinates are required because they are the common standard for noise exposure contours population/household databases in the UK. Change Sponsors should ensure that they are familiar with conversion from latitude and longitude to Ordnance Survey national grid coordinates. Guidance is available from the Ordnance Survey (OS, 2006) and a conversion tool is available on its web site.
- B.54 Contours for a general audience **may** be provided overlaid on a more convenient map (e.g. an ordinary road map with a more suitable scale for publication in documents). The underlying map and contours **should** be sufficiently clear for an affected resident to be able to identify the extent of the contours in relation to their home and other geographical features. As such, the underlying map **must** show key geographical features, e.g. streets, rail lines and rivers.

Sound Exposure Level (SEL) Footprints

- B.55 SEL footprints show the extent of noise energy generated from a single aircraft event, for example, an aircraft either taking off or landing (in contrast to the summing of events in noise exposure). This footprint shows a contour of equal SEL values. Thus, a 90 dBA SEL footprint shows the area in which SEL values are greater than (or equal to) 90 dBA. These footprints are useful in evaluating options by identifying the relative contribution of different aircraft types, routes and operating procedures on the total noise impact.
- B.56 Footprints are particularly useful in portraying the impact of aircraft movements at night on sleep disturbance. Research has shown that residents tend to be awoken by the noise levels in a single noise event, as measured by SEL, rather than by an aggregation of noise events, as measured by Leq (DoT, 1992). One of the key findings of this research is that for outdoor aircraft noise events below 90 dBA SEL, the average

person's sleep is unlikely to be disturbed. At higher levels, between 90 and 100 dBA SEL, the chance of an average person being awoken by that aircraft noise event was found to be about 1 in 75. Thus, it is possible to calculate the approximate number of awakenings by combining knowledge of the population count within 90 dBA SEL footprints, the number of movements of different aircraft types and the probability of being awoken.

B.57 SEL footprints **must** be used when the proposed airspace includes changes to the distribution of flights at night below 7,000 feet agl and within 25 km of a runway. Night is defined here as the period between 2300 and 0700 local time. If the noisiest and most frequent night operations are different, then footprints **should** be calculated for both of them. A separate footprint for each of these types **should** be calculated for each arrival and departure route. SEL footprints **may** be used when the airspace change is relevant to daytime only operations. If SEL footprints are provided, they **should** be calculated at both 90 dBA SEL and 80 dBA SEL.

B.58 Footprints for assessment **should** be provided to SARG in **both** of the following formats:

- Electronic files in the form of a comma delimited ASCII text file containing three fields as an ordered set (i.e. coordinates should be in the order that describes the closed curve) defining the footprints in Ordnance Survey National Grid in metres:

Field	Field name	Units
1	Level	dB
2	Easting	six figure easting OS national grid reference (metres)
3	Northing	six figure northing OS national grid reference (metres)

- Paper version overlaid on a good quality 1:50 000 Ordnance Survey map. However, it **may** be more appropriate to present footprints on 1:25 000 or 1:10 000 Ordnance Survey maps.

B.59 As with contours, footprints for a general audience **may** be provided overlaid on a more convenient map (e.g. an ordinary road map with a more

suitable scale for publication in documents). The underlying map and footprints **should** be sufficiently clear for an affected resident to identify the extent of the footprints in relation to their home or other geographical features. Hence, this underlying map **must** show key geographical features, e.g. streets, rail lines and rivers. Calculations **should** include terrain adjustments as described in the section on L_{eq} contours.

- B.60 It should be noted that a footprint is employed in assessing a single noise event: a contour is for noise exposure from many noise events.

Number of ‘highly annoyed’ people

- B.61 It is possible to calculate the numbers of people who would be ‘highly annoyed’ by particular levels of aircraft noise exposure by using L_{eq} contours and a well established response relationship known as the Schultz curve (Schultz, 1978). The Schultz curve is S-shaped in form and shows aircraft noise level on the horizontal axis and the percentage of highly annoyed people as described by social survey on the vertical axis. It shows that the incidence of highly annoyed people is low at low levels of aircraft noise and the curve is relatively flat at these levels. At progressively higher noise levels, the proportion of highly annoyed people grows steadily, so the slope of the curve increases. At higher levels of aircraft noise the curve begins to flatten, until at very high levels of aircraft noise the curve is nearly flat at 100% i.e. at these levels, everyone is said to be highly annoyed by aircraft noise.
- B.62 The Schultz curve is well supported by scientific research (Fidell, 2003). A suitable equation to calculate the proportion described as highly annoyed people is:

$$\% \text{ highly annoyed} = \frac{100}{1 + e^{(13.2 - 0.19 L_{eq, 16 \text{ hours}})}}$$

- B.63 This expression provides an estimate of the percentage of highly annoyed people as a function of aircraft noise measured in dBA $L_{eq, 16 \text{ hours}}$. For the mid points of 3 dB intervals from 54 dBA $L_{eq, 16 \text{ hours}}$ to 75 dBA $L_{eq, 16 \text{ hours}}$ the results from the expression are shown in Table 3.

Table 3: Percentage of highly annoyed people as a function of L_{eq} , 16 hours

Mid points of L_{eq} 3 dB intervals	% highly annoyed
55.5	6.6
58.5	11.1
61.5	18.0
64.5	28.0
67.5	40.7
70.5	54.9
73.5	68.2

- B.64 The calculation of the total number of people said to be highly annoyed is achieved by multiplying the number of people within each 3 dB contour band and the appropriate percentage in Table 3 then summing the totals over all contour bands.
- B.65 An advantage of this methodology is that it is possible to take into account areas outside the standard 57 dBA L_{eq} contour but above the 54 dBA L_{eq} , 16 hours, where the percentage of highly annoyed people will be small but the number of those people might be significant. But note that this method considers all highly annoyed individuals as equivalent, even when they may be getting very different levels of noise exposure. Thus, it equates an ‘average’ person at high L_{eq} value with a ‘sensitive’ person at a low L_{eq} value.
- B.66 Change Sponsors **may** use the percentage highly annoyed measure in the assessment of options in terminal airspace to supplement L_{eq} . If they choose to use this method, then the guidance on population data for noise exposure contours set out above **should** be followed. Change Sponsors **should** use the above expression and associated results in Table 3 in calculating the number of those highly annoyed. If they wish to use a variant method, then this would need to be supported by appropriate research references.

L_{DEN} Contours

- B.67 European Directive 2002/49/EC relating to the assessment and management of environmental noise requires the production of noise maps for airports and other transport and industrial sources at five-yearly intervals beginning in 2006. This Directive requires the use of the L_{DEN} metric which measures noise on a L_{eq} basis over an annual average 24-hour period, but which applies weightings for the evening and night periods. It essentially does this by calculating L_{eq} for evening and night operations as if those noise events were 5 dB and 10 dB noisier than actually measured.
- B.68 Change Sponsors **may** use the L_{DEN} metric but, if they choose to do so, they **must** still produce the standard L_{eq}, 16 hours contours as previously described. L_{DEN} contours will generally be larger than the standard L_{eq}, 16 hours contours, and hence contain a higher population/household count. There are two main reasons for this. First, the evening and night weightings will cause higher modelled noise levels than actually observed. Second, the outer contours are set at 55 dBA L_{DEN} rather than 57 dBA L_{eq}.
- B.69 As people become familiar with the application of L_{DEN} contours following publication of the 2006 contours in June 2007, it is possible that Change Sponsors will be expected to produce L_{DEN} contours in circumstances where it is appropriate to produce L_{eq} contours. However, it **should** be noted that L_{DEN} is supplementary to L_{eq}, 16 hours and not a replacement for it.
- B.70 If Change Sponsors wish to use the L_{DEN} metric they **must** do so in a way that is compliant with the technical aspects of the Directive and any supplementary instructions issued by DEFRA. Change Sponsors **should** note the requirement for noise levels to be calculated as received at 4 metres agl. In particular, the guidance on how contours are to be portrayed, as described in the section dealing with L_{eq} contours, applies. Calculations **should** include terrain adjustments as described in the section on L_{eq} contours.

- B.71 An exception regarding L_{DEN} contours is the production of a table showing numerical data on area, population and households which should be presented by band (e.g. 55 dBA to 60 dBA) rather than cumulatively as for UK L_{eq} contours (e.g. >55 dBA). This is a Directive requirement. It means, for example, that, if the total number of people exposed to a given level of noise or higher is required, then the reader has to add the data for that band to all higher bands to form a cumulative total. There is potential for confusion between the application of long standing current practice with L_{eq} contours and implementation of the Directive requirements. Change Sponsors should make it clear where areas/counts are by band or cumulative.
- B.72 The CAA conducted a study into the production of L_{DEN} contours for DEFRA. Change Sponsors considering the application of L_{DEN} contours are advised to consult the study report (CAA, 2004).

L_{Night}

- B.73 European Directive 2002/49/EC also requires the production of L_{Night} contours. The principles outlined for the production of L_{DEN} contours are applicable to the production of L_{Night} contours. Although the European Commission intends that L_{Night} contours are to be used for the assessment of sleep disturbance, there is little scientific evidence on the relationship between the amount of noise exposure, as measured by L_{Night} , and the degree of sleep disturbance. The CAA and DfT, therefore, place more reliance on the use of SEL footprints, which are an indicator of awakenings from sleep.
- B.74 Change Sponsors **may** use the L_{Night} metric within their environmental assessment and consultation. If they do so, SEL footprints **must** also be produced. Calculations should include terrain adjustments as described in the section on L_{eq} contours.

Difference Contours

- B.75 Indicators such as those described so far are important in measuring and portraying the total noise impact, but can be complemented by showing

how an airspace change redistributes noise burdens. In effect, other indicators can be used to show the changes in noise exposure over an area.

B.76 One way of portraying changes in noise exposure is the difference contour. These contours show the relative increase or decrease in noise exposure, typically in L_{eq} , on a base scenario, which is normally chosen to be the current situation. The increases/decreases are shown in bands:

- Increase/decrease (\pm) of 1 – 2 dB;
- \pm 2 – 3 dB;
- \pm 3 – 6 dB;
- \pm 6 – 9 dB; and
- \pm > 9dB.

B.77 Because the contours show increases and decreases, some form of colour shading is required to show whether a particular area will experience an increase or decrease in noise exposure. It is recommended that red is used for increases in noise exposure and blue is used for decreases in noise exposure.

B.78 Population/household counts can be used to compare the numbers of people that may experience increased noise exposure with those who will gain from the proposal.

B.79 Difference contours are particularly applicable where the redistribution of noise impact is significant, e.g. revising arrival and departure routes or in adapting the mode of runway operation. Change Sponsors **may** use difference contours if it is considered that redistribution of noise impact is a potentially important issue. One caveat is that where aircraft noise is relatively low, aircraft noise may well not be the dominant noise source. As such, the benefits and disbenefits shown by difference contours may or may not be realised in practice.

Section 5 – Noise: Supplementary Methods

B.80 The following metrics should be regarded as additional to the standard methods for the assessment of noise. It is not intended that Change Sponsors should feel obliged to use these techniques. Rather, this section gives Change Sponsors the opportunity to use additional metrics if they think it would be helpful. However, Change Sponsors should be aware that use of too many metrics might serve to confuse rather than enlighten. The environmental information presented to support an airspace change should be proportionate as outlined in Section 2.

N70 Contours

B.81 A common objection to L_{eq} type metrics is that they are not easy for a non-technical audience to interpret. For this reason, the Australian Department of Transport devised a set of metrics that might be more easily understood by the public (Australian Department of Transport and Regional Services, 2000). Note, however, that the report describing the metrics stresses that the proposed metrics do **not** replace the Australian ANEF system (their version of L_{eq}). The ANEF system, like L_{eq} , was based on social survey and noise measurement work and remains the metric for use in Australian policy making. Hence, the Australian position is that N70 contours are a supplementary method. This is also the CAA's position.

B.82 N70 contours show the locations where the number of events exceeds 70 dBA L_{max} . The level of 70 dBA L_{max} was selected because it was considered to represent the level indoors that would be likely to interfere with conversation or listening to the radio or television (approximately 60 dBA L_{max}). This allows for about 10 dB attenuation (i.e. noise reduction) through the fabric of a house with its windows open. In this instance, attenuation of 10 dB is based on typical Australian housing, much of which is pre-fabricated and predominantly wooden construction. The corresponding attenuation is likely to be somewhat higher for typical UK housing. Rationale for the selection of 70 dBA is subjective in its assumptions about interference with communication and the sound

insulation properties of dwellings. Typically, contours ranging from 10 events to 500 events over 70 dBA L_{max} are plotted. N80 or any other level can be selected for plotting but the level selected is largely arbitrary.

- B.83 By showing the distribution of noise events under different circumstances, N70 contours may be used to address the common criticism that L_{eq} contours only show the impact on an average day. N70 contours could be used to demonstrate different methods of runway usage or show how movements vary at different times of day. Unfortunately, with so much data being presented, the public may be faced with too much information. Nevertheless, N70 contours are an attractive aid to the public because if the number of movements doubles, then the N70 doubles, all other things being equal. L_{eq} type metrics are logarithmic in nature, which translates to an increase by 3 dB for a doubling of traffic: less dramatic, but it does have the advantage of being representative of people's actual responses to increased traffic.

Person-Event Index (PEI)

- B.84 A further supplementary method developed by the Australian Department of Transport and Regional Services is the Person-Event Index (PEI). The particular problem it addresses is that comparing options by counting the population within standard L_{eq} type contours gives little indication of the number of aircraft noise events that might be expected. The PEI combines information on single event levels with the number of aircraft movements.
- B.85 The PEI is based upon the N70 (or similar) metric and so suffers from all the limitations of this method previously described above. The PEI attempts to measure the total noise load generated by an airport to be computed by multiplying the number of people exposed by the number of events to which they are exposed. PEI can be expressed by the mathematical expression:

$$PEI(x) = \sum_{N=N_{min}}^{N_{max}} P_N N$$

Where x = the single event threshold noise level expressed in dBA L_{max}

P_N = the number of persons exposed to N events > x dBA L_{max}

N_{min} = the lowest number of noise events > x dBA L_{max} (a defined cut-off level)

N_{max} = the highest number of noise events > x dBA L_{max} (a defined cut-off maximum)

B.86 Change Sponsors **may** use PEI as a supplementary assessment metric.

Average Individual Exposure (AIE)

B.87 The PEI does not indicate the extent to which aircraft noise is distributed across the exposed population. A given PEI could indicate that a small number of people are exposed to high numbers of aircraft noise events but could equally well result from a high number of people being exposed to a low number of events. The average individual exposure (AIE) is an indicator of the mean number of aircraft noise events experienced over a given time period. AIE is described by the following expression:

$$AIE = \frac{PEI(X)}{\text{Total exposed population}}$$

Where $PEI(x)$ = the person-event index for events > x dBA L_{max} .

B.88 Change Sponsors **may** use the AIE metric as a supplementary assessment metric. If the Change Sponsor uses PEI as a supplementary metric then AIE **should** also be calculated as both metrics are complementary.

Operations Diagrams

B.89 Operations diagrams portray a representation of how the airspace is to be used. A feature of operations diagrams is that they do not use or contain any information about noise levels. This can be advantageous when it is difficult or impossible to measure aircraft noise accurately and reliably, for example, when aircraft noise levels are relatively low. It is a disadvantage when aircraft noise levels can be accurately determined. The omission of noise information might result in a misleading presentation. For each route, a box with information about the distribution of air traffic is shown on a

diagram of the airspace overlaid on a map showing recognisable geographical features. Each box can include the following information (Change Sponsors **may** vary the information displayed providing that the diagram is a fair and accurate representation of the situation portrayed):

- Average number of daily movements;
- Percentage of all aircraft movements at the airport using that route;
- Daily range of movements – minimum and maximum; and
- Percentage of days with no movements.

B.90 Operations diagrams are typically used to show daily traffic movements but can be used to portray other time periods where air traffic varies considerably over time.

B.91 Change Sponsors should always bear in mind that the production of a large number of operations diagrams covering every eventuality in great detail has the potential for confusion. The challenge is to present information on aircraft noise in ways that are clear and accurate, without omitting essential detail, but which can be readily understood by a non-technical audience. N70 contours, PEI, AIE and operations diagrams should be considered as communication tools with limited applicability in the assessment process. There is a professional balance to be struck between the amount of data produced and the degree to which this information actually helps the audience to understand the key issues. Thus, N70 contours, PEI, AIE and operations diagrams should only be considered as supplementary communication tools.

Population Count Methodology

B.92 One method of portraying noise impact, which has been employed in recent airspace changes, is a simple count of either the population residing or the residential area beneath the proposed affected airspace. The attraction for both Change Sponsors and residents alike is that this concept is easy to understand. The inherent problem is in the term ‘affected’.

B.93 The methodological limitations of population counts and the calculation of residential areas overflowed are:

- The areas considered for population counts or built-up area calculations are largely arbitrary.
 - Some Change Sponsors define the swathe for departure routes as extending 1.5 km either side of the departure track. This arbitrary definition has been used for many years at a number of UK airports as a threshold for compliance with noise preferential routes (NPR) prior to ATC being able to vector aircraft for safety or to follow a more expeditious route. This enables airports to measure and monitor track adherence. The width of the swathe is a function of the aircraft's ability to navigate accurately along the NPR track and does not necessarily have any relationship with noise impact experienced on the ground.
 - For arrivals, Change Sponsors sometimes show broad swathes that encompass the areas likely to be over-flown by arriving aircraft. These broad swathes necessarily include a wider area than departure swathes. This is because ATC vector aircraft to organise a stream of arrivals at the required separation distances along the final approach path to the runway. The probability of being over-flown within an arrival swathe is therefore less than that within a departure swathe because the arrival swathe will be larger.
- Not all individuals within the swathe are affected to the same extent. For example, a resident living 15 nm along track from the airport with aircraft operating at 5,000 feet will experience less impact than a resident at 5 nm from the runway threshold with aircraft at 1,500 feet. However, the population count method considers both residents to be somehow equivalent.
- The population count method takes no account of the usage patterns of particular routes. Because of the prevailing wind conditions, westerly arrivals and departures at most UK airports are more prevalent. Thus, swathes for westerly operations will occur more frequently than those for easterly operations.
- Since any definition of a built-up area is largely arbitrary, the identification of such areas can be inconsistent. The same

considerations outlined in the previous three paragraphs would apply to the calculation of built-up areas.

- B.94 A possible way of addressing some (but not all) of these problems is to divide the arrival/departure track into 1 km segments and then to count the population for each segment separately. This then allows some account to be taken of the varying impact on the populations affected.
- B.95 Nevertheless, even given all these limitations, the population count and built-up area methods do provide an indication of the population and areas over flown. They enable an assessment of whether a proposed route structure accords with the Government policy that the best environmental outcome is derived from the concentration of departures on the least number of practical routes designed specifically to minimise the number of people over-flown at low levels (DfT, 2014 – paragraph 7.2). The warning from the above is that these are coarse tools, and so caution **should** be applied in their interpretation for environmental assessment.

L_{max} Footprints

- B.96 Change Sponsors **may** use maximum sound levels (L_{max}) in presenting aircraft noise footprints for public consumption if they think that this would be helpful. This does not replace the obligation to comply with the requirement to produce sound exposure level (SEL) footprints, where applicable, described in Section 4.

L_{max} Spot Point Levels

- B.97 Change Sponsors **may** produce diagrams portraying maximum sound event levels (L_{max}) for specific aircraft types at a number of locations at ground level beneath the airspace under consideration. This may be helpful in describing the impact on individuals. It is usual to include a table showing the sound levels of typical phenomenon, e.g. a motor vehicle travelling at 30 mph at a distance of 50 metres.

Section 6 – Climate Change

- B.98 The Guidance to the CAA on environmental objectives (DfT, 2014) recognises that aviation is a growing contributor to greenhouse gas emissions that cause climate change and states that the Government’s strategy on aviation is to ensure that the aviation sector makes a significant and cost effective contribution towards reducing global emissions. It states that ‘the CAA has the opportunity to contribute to the Government’s aim of reducing CO₂ emissions by prioritising the most efficient use of airspace including procedures that enable aircraft to climb efficiently, allow direct routings, reduce holding times and facilitate the consistent use of continuous descent and low power/low drag procedures’.
- B.99 The Government’s sustainable development strategy (DEFRA, 2005) states that the effects on climate change can already be seen. It describes the effects of temperatures, sea levels and ice/snow cover. It states that the UK needs to make a profound change in its use of energy and other activities that release greenhouse gases.
- B.100 The Government white papers ‘The Future of Aviation’ (DfT, 2003) and the ‘Energy White Paper: Our energy future – creating a low carbon economy’ (DTI, 2003) state that ‘we should ensure that the aviation industry is encouraged to take account of, and where appropriate reduce, its contribution to global warming’. It suggests that the aviation sector needs to take its share of responsibility for tackling this problem. However, the white paper (DfT, 2003) then states that reduction in greenhouse gas emissions across the economy does not mean that every sector is expected to follow the same path. The Government’s intention is to apply a comprehensive approach, using economic instruments to ensure that growing industries are catered for within a reducing total. The Government intends that the use of emissions trading allows coverage of environmental costs through a mixture of emissions reduction within the sector and purchase of reductions that can be produced more cheaply by other sectors. The Government’s intention is to include intra EU air services in a European emissions trading

scheme as soon as possible. The subject of emissions trading schemes is beyond the scope of this document.

- B.101 The DfT states the potential to maximise CO₂ efficiency is primarily above 7,000 feet (amsl) where local impacts are not a priority. CO₂ efficiency is also a consideration below 7,000 feet (amsl), although at these altitudes it must be balanced with other local impacts (DfT, 2014 – paragraph 2.3). The Intergovernmental Panel on Climate Change has estimated that air traffic management and associated operating procedures have the potential to reduce fuel burn by 6% and 12% over the next 20 years (IPCC, 1999). More recently, the European Commissioner for Transport claimed that the Single European Sky (SES) initiative would enable reductions of emissions from aircraft by 4-6% per flight through the use of more efficient trajectories (Flight International, 22 November 2005). This aim is repeated in the EC communication proposing a regulation for the establishment of the SESAR project (European Commission, 2005).
- B.102 There is a commercial incentive for aircraft operators to select the most fuel-efficient route available but also a requirement for air navigation service providers to propose airspace changes that will facilitate these. However, the need to provide additional airspace capacity, reduce delays and mitigate other environmental impacts complicates the issue.
- B.103 Change Sponsors **must** demonstrate how the design and operation of airspace will impact on emissions. The kinds of questions that need to be answered by the Change Sponsor are:
- Are there options which reduce fuel burn in the vertical dimension, particularly when fuel burn is high e.g. initial climb?
 - Are there options that produce more direct routing of aircraft, so that fuel burn is minimised?
 - Are there arrangements that ensure that aircraft in cruise operate at their most fuel-efficient altitude, possibly varying altitude during this phase of flight?

- B.104 It must of course be recognised that airspace design and operation is only one element in determining the quantity of aircraft emissions. The design of aircraft and engines, growth of air traffic, capacity and load factors of aircraft, airline operating procedures and other factors will all have an influence on aircraft emissions although these factors are outside the scope of the Airspace Change Process.
- B.105 For the purposes of the assessment of Airspace Change Proposals, it is deemed sufficient to estimate the mass of carbon dioxide emitted for different options considered. This can be calculated by multiplying the mass of kerosene burned during flight by a factor of 3.18. Determining the quantities of other emissions is considered to be too complex and scientific understanding of the impact too poor for inclusion in environmental assessment of Airspace Change Proposals. This guidance will be reviewed as understanding of the measurement of emissions and their impact improves.
- B.106 The mass of fuel burned and, therefore, carbon dioxide emitted can be derived from a range of aircraft performance models and simulators. An example is the EUROCONTROL Base of Aircraft Data (BADA) model (EUROCONTROL, 2004).
- B.107 Change Sponsors **should** estimate the total annual fuel burn/mass of carbon dioxide in metric tonnes emitted for the current situation, the situation immediately following the airspace change and the situation after traffic has increased under the new arrangements – typically five years after implementation. This set of scenarios needs to be discussed with the SARG Project Leader. Change Sponsors **should** produce estimates for each airspace option considered.
- B.108 Change Sponsors **should** provide the input data for their calculations including any modelling assumptions made. They **should** state details of the aircraft performance model used including the version numbers of software employed.

- B.109 Where the need to provide additional airspace capacity, reduce delays or mitigate other environmental impact results in an increase in the total annual fuel burn/mass of carbon dioxide in metric tonnes between the current situation and the situation following the airspace change, Change Sponsors **should** provide justification. It is possible that the circumstances of individual airspace changes may prevent Change Sponsors from achieving climate change benefits but section [2.3](#) of the environmental objectives (DfT, 2014) establishes that [SARG](#) is in a position to contribute to reducing aircraft emissions generally. It suggests mechanisms for achieving this e.g. direct routes, reduced holding and procedures that will reduce fuel costs.
- B.110 A short description of the science of climate change is presented at Annex 7.

Section 7 – Local Air Quality

- B.111 The DfT's guidance on the environmental objectives issued to the CAA (DfT, 2014 [paragraph 2.7](#)) states while the CAA should prioritise noise below 4,000 feet (amsl), there could be circumstances where local air quality may be a consideration because emissions from aircraft taking off, landing or whilst they are on the ground have the potential to contribute to overall pollution levels in the area. This could lead to a situation where prioritising noise creates unacceptable costs in terms of local air quality or might risk breaching legal limits. The CAA should therefore take such issues into account when it considers they are relevant. The white paper 'The Future of Air Transport' (DfT, 2003) reveals that there is a risk that development of Heathrow might breach mandatory limits on nitrogen dioxide. Since then, much work has taken place on further investigation of local air quality issues. These include a supplementary report (DfT, 2003d) on air quality assessments that was issued shortly after publication of the white paper.
- B.112 This was followed by a report of the air quality technical panels (DfT, 2006) which makes recommendations on how best to assess air quality at

Heathrow in future years, including modelling tools and assumptions to be used. Although produced in the context of Heathrow, many of the models and methods are probably more generally applicable. This report states that future year modelling and generation of the relevant emissions inventories was outside the terms of reference. It is, therefore, silent on whether Heathrow will be able to develop and remain within the mandatory limits.

- B.113 The European Union strategy is set out in Directive 96/62/EC on ambient air quality (EC, 1996 and 2003). It defines several thresholds – limit values that should not be exceeded, target goals that will avoid impact on human health and alert thresholds where a breach of the threshold requires some action. This strategy subsequently generated further Directives which specified the levels appropriate for different pollutants. The first ‘daughter’ Directive (Directive 99/30/EC), which specifies values for NO₂ and PM₁₀, among others, is the most relevant to aviation. It is unlikely that these limit values will be approached or breached for any but the largest UK airports. The recent EC ‘thematic strategy’ (EC, 2005) does not significantly affect these criteria. The European Union ambient air quality strategy (EC, 1996 and 2003) was transposed into UK law in the form of the Air Quality Limit Values Regulations 2003. This has since been superseded on 15 February 2007 by The Air Quality Standards Regulations 2007. This legislation sets limit values with a margin of tolerance. So, for example, the annual mean limit value for NO₂ is set at 40 µg.m⁻³ with a margin of tolerance of 6 µg.m⁻³, reducing on 1 January 2008 to a margin of 4 µg.m⁻³ and on 1 January 2009 to a margin of 2 µg.m⁻³. The Regulations also set alert thresholds and assessment thresholds.
- B.114 Since 1997, local government is required to review and assess air quality in its geographical area. The aim of such reviews is to ensure that the national air quality objectives, which are based on European legislation, will be achieved. If a local authority finds any places where the objectives are not likely to be achieved, it must declare an Air Quality Management Area (AQMA). The extent of declared AQMA can be ascertained from local

authorities, which are obliged to publish this information. Government policy on AQMAs is set out in substantial documents (DEFRA, 2000 and 2003).

- B.115 The DfT Project for Sustainable Development of Heathrow (PSDH) Report of the Airport Air Quality Technical Panels (DfT, 2006) recommends the Atmospheric Dispersion Modelling System – Airport (ADMS-Airport) for use of the main modelling work at Heathrow. It recommends two other models for specialist purposes. Although the panels' work was carried out in the context of Heathrow, it is thought that the ADMS model is appropriate for other airports. A description of the model can be found on the European Environmental Agency web site (EEA, 2006). It is understood that the model is not yet ready or available for use by Change Sponsors.
- B.116 Change Sponsors **must** produce information on local air quality **only** where there is the possibility of pollutants breaching legal limits following the implementation of an airspace change. The requirement for local air quality modelling will be determined on a case-by-case basis as discussed with the SARG Project Leader and ERCD. This discussion will include recommendations of the appropriate local air quality model to be used. Concentrations **should** be portrayed in microgrammes per cubic metre ($\mu\text{g}\cdot\text{m}^{-3}$). They **should** include concentrations from all sources whether related to aviation and the airport or not. Three sets of concentration contours **should** be produced:
- Current situation – these may already be available as part of the airport's regular environmental reporting or as part of the airport master plan;
 - Situation immediately following the airspace change; and
 - Situation after traffic has increased under the new arrangements – typically five years after implementation although this **should** be discussed with the SARG Project Leader.
- B.117 Contours for assessment **should** be provided to SARG in similar formats to those used for noise exposure contours. Where Change Sponsors are required to produce concentration contours they should also produce a table showing the following data for concentrations at $10\ \mu\cdot\text{m}^{-3}$ intervals:

- Area (km²); and
 - Population (thousands) – rounded to the nearest hundred.
- B.118 The source and date of population data used **should** be noted adjacent to the table. Population data **should** be based on the latest available national census as a minimum but more recent updated population data is preferred.
- B.119 A short description of the science of local air quality is presented in Annex 8.

Section 8 – Tranquillity and Visual Intrusion

- B.120 Tranquillity can be defined as ‘a state of calm or quietude’. The DfT’s guidance to the CAA (DfT, 2014 – paragraph 8.4) requires CAA whenever practicable and in line with the altitude-based priorities in the Guidance, to take into account the concept of tranquillity when making decisions regarding airspace below 7,000 feet (amsl). This guidance takes into account the relevant parts of the Rural White Paper (DETR, 2000) which states that the countryside has a unique character which includes less tangible features such as tranquillity and lack of noise. The white paper goes on to state that protecting the countryside from further intrusion of noise is not a luxury.
- B.121 It should also be noted that Areas of Outstanding Natural Beauty (AONB) and national parks are afforded certain statutory protection, but this does not extend to precluding overflight by aircraft. The DfT guidance (2014 – paragraph 8.2) explains that flights over National Parks and AONB are not prohibited by legislation as a general prohibition against over-flights would be impractical. Government policy will continue to focus on minimising the over-flight of more densely populated areas below 7,000 feet (amsl), but balanced with emissions between 4,000 and 7,000 feet (amsl), as set out in the altitude-based priorities in the Guidance. However, where it is practical to avoid over-flight of National Parks and AONB below 7,000 feet (amsl), the CAA should encourage this.

- B.122 The measurement of tranquillity is not well developed. There is no universally accepted metric by which tranquillity can be measured, although several interesting ideas have been suggested. For example, CPRE has presented a set of tranquillity maps for England in October 2006. However, it is not obvious how such a methodology could be reliably adapted for aircraft noise. Indeed, discussions with the researchers who produced the maps indicated the difficulties in applying such maps for the purposes of assessing the environmental impact of an airspace change. There is very little published material on the subject of visual intrusion with respect to aircraft. There is some literature on the subject of visual intrusion related to wind farms but there is not an obvious way of applying this method to aircraft.
- B.123 SARG will maintain a careful watch on research and ideas about the definition and measurement of tranquillity and visual intrusion. No formal guidance can be issued at present. Change Sponsors may use the techniques described under operations diagrams to communicate to consultees how the airspace will be used. Assessment by SARG of these aspects will be on a case-by-case basis until methodologies are well established.
- B.124 Change Sponsors and others should be aware of the interdependency between aspects of tranquillity and visual intrusion and climate change.

Section 9 – Economic Valuation of Environmental Impact

- B.125 Change Sponsors **may** wish to conduct an economic appraisal of the environmental impact of the airspace change, assessing the economic benefits generated by the change. If undertaken, this **should** be conducted in accordance with the guidance from HM Treasury in the Green Book (HM Treasury, 2003). The Green Book contains specific guidance on the subject of the valuation of environmental impact including climate change, noise and local air quality. It discusses a number of techniques used in financial appraisal. It recognises that valuing environmental impacts is difficult and constantly evolving and may not be possible for some types of impact. The

implication is that an economic valuation of environmental impact may not capture all impacts. Also, economic valuation of the environment is controversial and ethical objections are often raised against making the environment appear as saleable as a supermarket good (Helm, 2003).

Calculation of Net Present Value (NPV)

- B.126 Net Present Value (NPV) is a well-established technique used in financial appraisal, which focuses on the positive and negative cash flows generated by a change. Projects would normally be accepted as worthwhile if the NPV is positive. In the present context the benefits would be economic gains and the costs might include estimates of some environmental costs, to the extent that estimation of these is possible. The technique is the subject of a number of technical and philosophical criticisms when used for environmental assessment. Business and economics textbooks cover NPV in detail (e.g. Brealey and Myers, 2003). There are several reviews of environmental assessment in relation to aviation (e.g. Dings et al, 2002).
- B.127 If Change Sponsors include a calculation of NPV then they **must** show financial discount rates, cash flows and their timings and any other assumptions employed. The discount rate **must** include that recommended in the Green Book currently set at 3.5%. Additionally, other discount rates **may** be used in a sensitivity analysis or because they are representative of realistic commercial considerations. The reader is referred to a standard textbook on this subject for further details (Brealey and Myers, 2003).

Environmental Economic Assessment Techniques

- B.128 The benefits and costs of environmental impact are typically difficult to value because there is no overt market for such things and, therefore, costs cannot be readily ascertained. Two categories of techniques are available – revealed and stated preference. Both techniques have limitations.
- B.129 Revealed preference techniques are used to observe real world financial transactions and from these deduce the underlying value of environmental impact. A typical revealed preference technique relevant to the valuation of aircraft noise is the use of property values and characteristics to estimate a

value for noise. This technique is known as hedonic pricing and is comparatively well established with many studies providing estimates for the value of aircraft noise (e.g. Nelson, 2004).

- B.130 Stated preference techniques involve asking respondents for their preferences in order to extract a value for environmental impact from their responses (Schipper, 2004). These techniques have the advantage of collecting data that is not available in the real world. For example, attributes and costs of an option that does not currently exist may be presented to a respondent and the environmental costs of the postulated option can be derived from their responses.
- B.131 If Change Sponsors wish to use either of these techniques, they **should** seek specialist advice from environmental economists with expertise in assessing aircraft noise.

Appendix B annex 1

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Appendix B annex 2

Noise Measurement

Sound

B.132 Sound is energy propagating through the air by the mechanism of the wave motion of its particles. It causes small fluctuations in air pressure, which are detected by the ear or other receiving instrument such as a noise monitor. The audible quality and quantity of the sound depends upon the amplitude and frequency of these fluctuations. Most sounds consist of a mix of different frequencies. Frequency refers to the number of vibrations per second of the wave motion and is measured in Hertz (Hz). 'Noise' is generally used to denote unwanted sound.

Sound Power and Intensity

B.133 The strength of a noise source is usually quantified in decibels (dB). Sound quantities described in decibels are referred to as sound levels. Decibels are used because sound powers and intensities cover a wide range of values. Using the decibel, which is a logarithmic unit, avoids the problems caused by having to manipulate numbers with many digits. Decibels relate one quantity to another. In effect, they are ratio measures. In sound measurement, the reference level is taken to be the threshold of human audibility – this is 20 μPa (micro Pascals) or 2×10^{-5} Pascals (where one Pascal equals 1 Newton per square metre). Decibels are subject to the usual rules applying to the manipulation of logarithms. This means that increasing the sound energy by a factor of k , i.e. k times as much, increases the dB value by $10 \log_{10} k$. Thus, doubling the sound energy results in an increase of 3 dB. Similarly, halving the sound energy results in a decrease of 3 dB.

Loudness and Intensity

- B.134 The extent of the unacceptability of sound depends at least on three physical characteristics:
- Intensity;
 - Duration; and
 - Frequency.
- B.135 Intensity is the rate of flow of sound energy through a unit area normal to the direction of propagation. It is a physical quantity measured in Watts per square metre ($W.m^{-2}$). Loudness is the perceived or subjective magnitude of sound. Other things being equal, the approximate relationship between intensity and loudness is that a tenfold change in intensity produces a twofold change in loudness. It must be stressed that this is an approximate relationship; it varies between individuals and with the characteristics of the sound. It is not the same as the relationship between sound energy and sound level. Loudness is a subjective measure which varies between individuals and is, therefore, not easy to measure.

Noise Measurement Scales

- B.136 Noise is inherently complex. A number of different noise measurement scales have been devised. Each of them captures some, but not all, of the different aspects of this complexity.

A-weighted sound level – L_A

- B.137 Frequency affects how sound is perceived. The normal human ear responds to sound over a wide range of frequencies but with different sensitivities. A variety of frequency weightings have been developed to match these response characteristics – the most common being A-weighting. This broadly matches the frequency response of the human ear. It is widely used for the measurement of noise from all modes of transport. Decibel levels measured on this scale, abbreviated as L_A , are written as

dB(A) or dBA. References to sound levels within this document imply the use of A-weighting unless stated otherwise.

Maximum sound level – L_{\max}

B.138 The simplest measure of a noise event such as the over-flight of an aircraft is L_{\max} , the maximum sound level recorded. It is usual to measure L_{\max} using the sound level meter's slow response, which damps down the very rapid, largely random fluctuations of level.

Sound Exposure Level – SEL

B.139 The sound exposure level (SEL) of an aircraft noise event is the sound level, in dBA, of a one second burst of steady noise that contains the same total A-weighted sound energy as the whole event. In other words, it is the dBA value that would be measured if the entire event energy were compressed into a constant sound level for one second. Mathematically, SEL is defined as:

$$SEL = 10 \log_{10} \left[\frac{1}{T_{Ref}} \int_0^T 10^{\frac{L(t)}{10}} dt \right]$$

Where $T_{Ref} = 1$ second (the 'reference period');

$L(t)$ = the instantaneous sound level L at time t ; and

T = duration of the sound event in seconds.

B.140 Most of the sound energy recorded from an aircraft is concentrated in the highest sound levels. This means that SEL values can usually be accurately estimated (to better than 0.25 dB by including only those sounds that lie within 10 dB of L_{\max}). This may be impractical when measuring the noise of quieter aircraft at locations where the background noise level from other sources is relatively high. To reduce this kind of background interference, it is standard practice for airport noise monitoring systems to incorporate fixed threshold levels at which measuring instruments are triggered.

- B.141 SEL increases by 3 dB if the duration of a sound is doubled, because the energy is doubled (assuming the pattern of rise and fall remains the same). Because most aircraft noise events have durations significantly greater than the reference time of 1 second, their SEL values are usually numerically greater than L_{\max} – typically by around 10 dB.

Perceived Noise Level – PNL

- B.142 Different types of aircraft – jets, propeller and helicopters – have distinctive noise characteristics. These arise from particular combinations of sound from different noise sources having different frequency ranges, intensities and temporal features. The annoyance characteristics from an aircraft noise event are not fully matched by simple A-weighted sound level. Researchers concluded that a more complete measure of the complex signature of aircraft noise required a special scale. This is Perceived Noise Level (PNL), measured in PNdB units.
- B.143 PNL is defined as how unwanted, objectionable, disturbing or unpleasant is the sound. Like LA, the PNL scale allows for the sensitivity of the human ear to different frequencies but it is much more complicated to calculate. PNL is determined by a combination of measurement and mathematical calculation involving frequency analysis. Each frequency band in the spectrum is converted to its noisiness value and these are then summed in a special way to obtain the total noisiness of the sound. As originally used, a single value of PNL for an event was recorded – the instantaneous maximum value – PNL_{\max} .

Effective Perceived Noise Level – EPNL

- B.144 The noise made by a passing aircraft is complicated by its motion which causes its intensity and frequency to change with time. Research into the human perception of aircraft noise led to the conclusion that PNL did not completely reflect the true noisiness of a complete aircraft noise event. The missing ingredients were the effects of tones and duration. For example, sounds that exhibit distinct whistles and whines and/or have longer durations are generally more annoying than a simple PNL measure would

indicate. EPNL is a measure that takes account of both tones and duration. It is currently used for aircraft certification and night noise quota schemes.

- B.145 EPNL measurements for certification purposes are taken under very specific circumstances, which do not necessarily reflect sound levels measured on the ground from that aircraft during normal operations. Recent research has revealed that under certain circumstances some aircraft can be responsible for significantly greater noise impact than would be anticipated from certification data measured in EPNL (CAA, 2003).

Long-term noise exposure and Equivalent Continuous Sound Level

– L_{eq}

- B.146 The levels of individual noise events are useful for many purposes including aircraft certification. However, in order to assess environmental noise exposure, it is necessary to consider and take into account the impact of many events over longer periods – days, months, years – living near an airport. These events will generally differ in magnitude; there will be different numbers in each hour or day; and they will occur at different times of day. Most indices for these assessments are L_{eq} -based.
- B.147 Equivalent continuous sound level or L_{eq} is defined as the level of hypothetical steady sound which, over the measurement period, would contain the same (frequency-weighted) sound energy as the actual variable sound. L_{eq} can be measured over any scale in practice, but L_A is the most widely used. The corresponding L_{eq} is sometimes abbreviated L_{Aeq} .
- B.148 L_{eq} can be measured or calculated in several ways. The total noise exposure can be measured if the sound meter runs continuously during the measurement period. If the requirement is to monitor the contribution of aircraft noise only to the total, the meter can be programmed to calculate the exposure due to noise events above a pre-determined threshold. Additional information on aircraft operations can subsequently be used to identify those noise events likely to have been caused by aircraft.
- B.149 When noise comprises a sequence of discrete events, as with aircraft noise, L_{eq} can be expressed in terms of the number of events that occur

during the measurement period and their average sound exposure level (SEL) using the following equation:

$$L_{eq} = \overline{SEL} + 10\log_{10}N - 10\log_{10}T$$

Where \overline{SEL} = logarithmic average of individual noise events with sound exposure level SEL_i ;

$$\text{in mathematical terms } \overline{SEL} = 10\log_{10} \left[\frac{1}{N} \sum_{i=1}^N 10^{\frac{SEL_i}{10}} \right]$$

N = number of aircraft noise events;

SEL_i = the sound exposure level of the i th event; and

T = measurement period in seconds.

B.150 The above equation is particularly useful because it quantifies the relative contributions of the noise levels and number of events to the total noise exposure, and embodies the equal energy principle.

B.151 For continuously varying sound levels, where it is not possible to employ the discrete formula for L_{eq} , a more rigorous mathematical description is shown by this formula:

$$L_{eq} = 10\log_{10} \left[\frac{1}{T} \int_0^T 10^{\frac{L(t)}{10}} dt \right]$$

Where $L(t)$ = the instantaneous sound level L at time t ; and

T = duration of the sound event in seconds.

B.152 This expression is the one used in noise monitors and models for the calculation of L_{eq} .

L_{DEN}

B.153 The day-evening-night level (L_{DEN}) is a variant of L_{eq} . It essentially adds an extra artificial number of decibels to aircraft noise levels occurring in the evening and at night. These weightings are 5 dB and 10 dB for the evening and night periods respectively. It has three component parts: L_{Day}

measured over a 12 hour day period from 0700 to 1900 (the same as L_{eq} for that period), $L_{Evening}$ measured over a 4 hour evening period from 1900 to 2300, and L_{Night} measured over an 8 hour night period from 2300 to 0700 (all times local). Mathematically, L_{DEN} is defined by:

$$L_{DEN} = 10 \log_{10} \frac{1}{24} \left(12 \times 10^{\frac{L_{Day}}{10}} + 4 \times 10^{\frac{L_{Evening}+5}{10}} + 8 \times 10^{\frac{L_{Night}+10}{10}} \right)$$

Appendix B annex 3

Noise Modelling

Levels, Footprints and Contours

- B.154 Event levels such as L_{max} or SEL describe the noise of individual aircraft flights observed at particular points. To describe the noise impact over an area, footprints and contours are used. These are lines on a map or diagram joining points with the same value of the noise metric. The area inside this line shows all places where the noise impact is equal to or greater than some value. A footprint is for a single event; a contour is for noise exposure from many events.
- B.155 Footprints are used to compare the noise characteristics of different aircraft. They help to illustrate the effects of different operating procedures. Thus, they show how these modify footprint shapes and areas. They are also helpful in depicting the relative contributions of different aircraft types to noise exposure.
- B.156 Long-term noise exposure is usually measured by an index, such as equivalent continuous sound level or L_{eq} , spanning a suitable period of time (such as an average day or night). The extent of total noise exposure is illustrated by noise exposure contours. Contours (lines of equal L_{eq}) are effectively aggregations of SEL noise footprints of all the individual aircraft movements. Contours help to quantify the extent of aircraft noise exposure. As a start, they serve to illustrate its geographical distribution. The total impact is normally summarised in terms of the areas and numbers of people/households enclosed by the contours. Contours can be used to compare situations at different times, different places and under different circumstances.
- B.157 Event levels, footprints and contours are relatively simple concepts, but their determination is complicated. They are subject to both measurement and statistical uncertainty. The areas of both contours and footprints are

very sensitive to changes in noise emissions. Typically, the total area increases by approximately 20% for a 1 dB increase in average source levels.

Noise Monitoring

- B.158 For particular points, noise event levels and exposure levels can be readily measured using sound level meters. These meters may be portable (used for research studies) or fixed (used by airport operators). Modern noise monitors are robust and reliable. They function for long periods, in most weather conditions and with minimal attention – they are also increasingly sophisticated, and can be linked together to form noise monitoring systems. They can be further enhanced with radar data and flight operations data to provide noise and track keeping systems such as those installed at major airports.
- B.159 The analysis and interpretation of noise measurements is complicated by inherent variability. A particular aircraft type can produce a wide range of noise levels at any particular point on the ground. This occurs even when the aircraft's ground tracks are very similar. The principal causes are differences in aircraft weights, flight operating procedures and atmospheric conditions. The weather affects the performance of aircraft, especially their climb rates. This is especially important for departures, as the climb rate affects the distance the sound travels through the air. The meteorological conditions also affect the way in which sound propagates between aircraft and the ground. Atmospheric variation – of wind speed, temperature, humidity and turbulence – can itself cause significant differences in event levels, of up to 10 dB or more. Noise data must therefore be expressed in statistical terms, as averages – which are susceptible to a degree of uncertainty.
- B.160 A further complication for the automated monitoring of aircraft noise is how to distinguish the noise of aircraft from background noise, mainly from road vehicles and other human activity. This is an increasingly difficult problem. Levels of aircraft noise generally continue to diminish in relation to noise

from other sources, thus accurate aircraft noise exposure level estimation requires considerable scrutiny of environmental data. This is essential to ensure both reliable identification of aircraft events and exclusion of non-aircraft sources of noise.

- B.161 Noise exposure patterns around airports are normally determined, in large part, by computer modelling. The methods used need to be theoretically sound, but they must incorporate real measured data on aircraft performance and noise characteristics. To ensure public confidence, the results of this modelling must be regularly validated, hence there must be regular checking through exposure measurement programmes.

Noise Modelling

- B.162 The requirements to determine noise exposure levels have led to the development of various aircraft noise exposure models. These are computer programs that calculate noise contours as functions of information describing the aircraft traffic and the way in which aircraft are operated.
- B.163 Modelling means calculating noise exposure rather than measuring it. Calculating some aircraft noise characteristics from purely theoretical scientific principles is feasible, but it would be far too complex and computationally intensive for application in the production of noise contours. Instead, relatively simple mathematical tools combined with data about the generation and propagation of aircraft noise from a large body of measured data are used. The first step is to gather a large body of representative measured noise data for a range of aircraft types under different flight conditions. The next step is to create robust mathematical tools to estimate how noise will propagate from these noise sources. Modelling aircraft noise involves combining the noise from many individual aircraft movements. All the different types of aircraft and operations have to be taken fully into account, including their specific noise and performance characteristics following different flight paths during both arrivals and

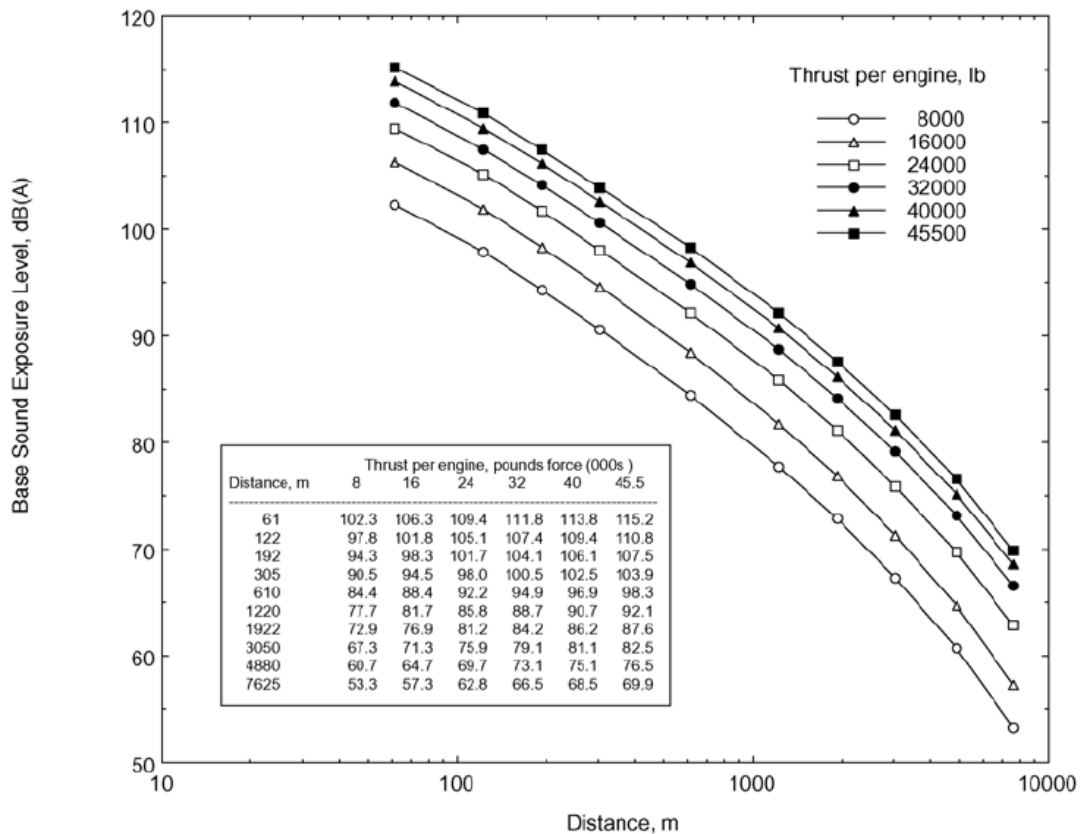
departures. It is essential to have reliable ways of estimating how sound attenuates with distance along the propagation path.

- B.164 Models must sum the diverse sound energy inputs from the individual events over a time period that is sufficiently long (usually months rather than days). This ensures that the results are statistically reliable enough to identify differences between one situation and another. Most models calculate noise exposure levels over an array of grid points around the airports. Contours are then fitted to these point levels by mathematical interpolation.
- B.165 These models need input information on aircraft performance and noise characteristics. Direct measurements of noise and flight paths are made. An important source of data is that collected by manufacturers as part of the certification process. Sufficient data are required to allow the model to represent all operations of importance. The data on aircraft flight paths must adequately represent actual operational air traffic patterns. This includes the way aircraft adhere to Noise Preferential Routes (NPRs) and Standard Instrument Departures (SIDs). But it must also cover the way that traffic is dispersed by air traffic control intervention (known as radar vectoring) and is sequenced on arrival.

Noise-Power-Distance (NPD) Curves

- B.166 Noise-power-distance (NPD) curves are vital to noise modelling. These show the noise received on the ground as a function of distance from the sound source and engine power settings. NPD curves account for both noise emissions as well as atmospheric sound propagation effects. Different curves represent different specific power settings applied to the aircraft engines as illustrated by the example in Figure 1. Producing a set of NPD curves for a specific aircraft/engine configuration requires very detailed analysis of large volumes of data. Assembling an adequate family of NPD curves is a very slow and painstaking process.

Figure 1: Sample noise-power-distance (NPD) curves (CAA, 1998)



UK Noise Modelling – ANCON 2

- B.167 A full technical description of the aircraft noise exposure model used by the CAA is contained in DORA Report 9120 – The CAA Aircraft Noise Contour Model: ANCON1 (CAA, 1992), updated by R&D Report 9842 – The UK Civil Aircraft Noise Model ANCON – Improvements in Version 2 (CAA, 1998).
- B.168 The CAA produces noise exposure contours each year for Heathrow, Gatwick and Stansted on behalf of the DfT. The CAA also produces forecast noise exposure contours, in particular for the new runway/airport options considered in the Government consultation that led to its White Paper on the Future of Air Transport (DfT, 2003).

Appendix B annex 4

Effects of Noise

B.169 The two previous Annexes have largely been concerned with well-specified technical issues concerning noise. The effects of noise, particularly aircraft noise, have straightforward technical aspects, but also raise much more complex issues about human response. This Annex is no more than a survey of some of the more important effects. The aim is to highlight, with a few paragraphs on each topic, some of the important issues. Annexes 2 and 3 are essential precursors to the more research-orientated material in this Annex.

B.170 The paragraphs in the following text are grouped under a series of main and sub-headings:

- General Background;
 - Cause-effect Relationships:
 - Noise-induced hearing loss;
 - Detection and distraction;
 - Interference with communication; and
 - Impairment of task performance;
 - Annoyance:
 - Annoyance as an indicator of aircraft noise community impact;
 - Attributes of a noise index;
 - Relationship between noise exposure and community annoyance ;
 - Aircraft Noise Index Study (ANIS);
 - Recent Continental European studies ;
 - Sleep Disturbance:
 - Aircraft Noise and Sleep Disturbance Field Study; and
 - World Health Organization (WHO) Guidelines.

General Background

B.171 Noise is defined by WHO as unwanted sound. Physically, there is no difference between sound and noise. The difference is one of human perception and is subject to individual variability. A number of possible distinct adverse effects have been identified by WHO:

- Noise-induced hearing impairment;
- Interference with speech communication;
- Disturbance of rest and sleep;
- Psycho-physiological, mental health and performance effects;
- Effects on residential behaviour and annoyance; and
- Interference with intended activities.

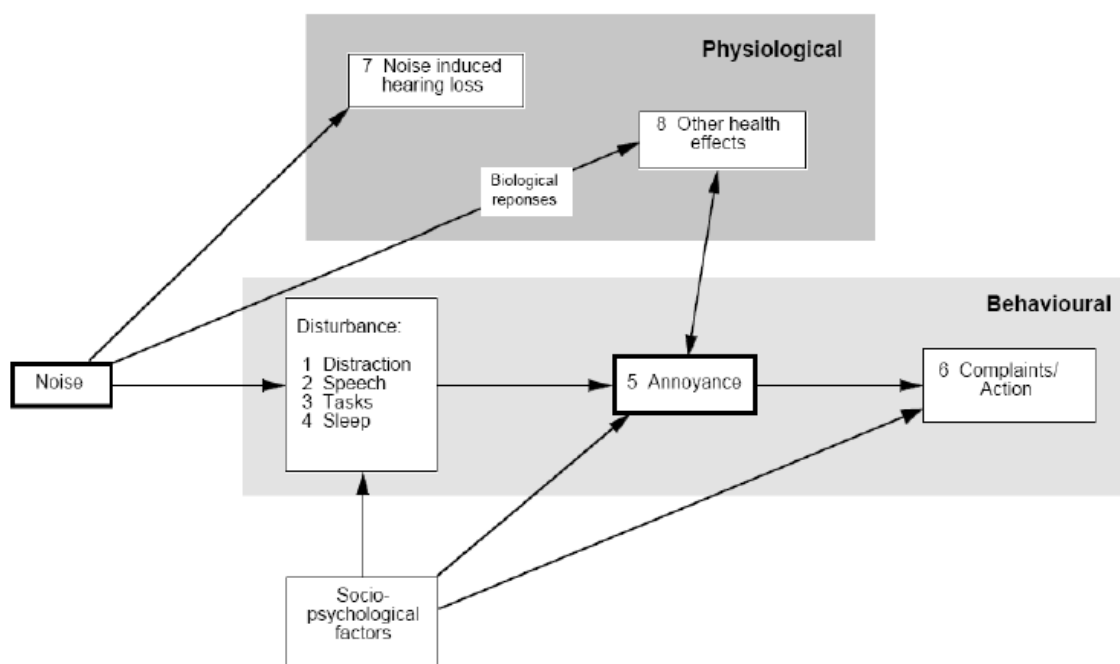
B.172 Noise can have a variety of possible effects on individuals. Hearing loss is the most extreme but others including direct disturbance to speech and tasks as well as less specific annoyance reactions. However, to reiterate, reactions vary between individuals. Even for a specific person, where he or she is and what activity is in progress will have an effect on how that person reacts to noise. For these reasons, community annoyance – averaged over a large group of people or the proportion showing ‘high’ reactions – is widely used as a way of measuring the impact of noise on populations exposed to aircraft noise.

Cause-Effect Relationships

B.173 Many different effects of noise can be identified. Individuals experience each of them to different degrees. For the practical assessment of any particular effect, it is necessary to define an appropriate indicator of reaction which can then be correlated with a noise exposure measure. Although there is no standard classification of effects, it is possible to divide them into (a) behavioural indicators of well-being, showing how noise may interfere with normal living, and (b) physiological/medical indicators of chronic health such as (in the extreme) noise-induced hearing loss or other symptoms that may be caused by noise.

- B.174 The essential conclusions from aircraft noise effects research are that community annoyance is the most useful general criterion of overall, long-term aircraft noise impact, and that it can be correlated with long-term average noise exposure.

Figure 2: Noise-cause and effect relationships



- B.175 At the primary level of behavioural reaction, noise disturbs human activities – by causing distraction or physically interfering with them. Four effects can be grouped together under the general heading of disturbance:

- detection/distraction;
- speech interference;
- disruption of work/mental activity and
- sleep disturbance.

- B.176 At the secondary level of behavioural reaction, which can be viewed as an indirect or cumulative response to disturbance of different kinds, is:

- annoyance.

- B.177 A third level response would be:

- overt reaction including the act of complaining.
- B.178 There are two principal physiological effects. These are:
- noise-induced hearing loss (although this is not likely to be caused by the noise of aircraft at locations that are beyond airport boundaries);
and
 - stress and other health effects.
- B.179 Noise-induced hearing loss is a widely recognised and well-documented industrial problem. The nature of stress and health effects is much more complex. It is known that noise can cause a variety of biological reflexes and responses, which are referred to as stress reactions, but it is unclear whether these could lead to clinically recognisable disease following a period of exposure.
- B.180 Some effects have been measured objectively and quantitatively, and correlate with noise exposure indicators. These include speech disturbance and noise induced levels of hearing loss. However, some behavioural indicators, including annoyance, are essentially subjective. Although quantifiable, people's responses are very sensitive to non-acoustic socio-psychological factors such as location, activity, state of well-being, familiarity with the noise, environmental expectations, and attitudes to noise makers. The effects of such modifying factors can dramatically weaken correlations between noise and response indicators by masking or confounding their dependency on noise. Such relationships are further obscured by variations in the actual noise exposure over time and space, because individuals move around and engage in different activities.
- B.181 Obvious physical factors governing intrusion into activities include time and situation – sleep disturbance occurs primarily at home during the night, speech interference during the day and so on. Equally important are those factors that control attitudes and sensibilities: whether or not a particular sound annoys may depend very much on the message that it conveys. Concerns about the source of noise can influence annoyance even more strongly than the physical noise exposure itself.

- B.182 Because of the combined influences of acoustical and non-acoustical factors, it is increasingly difficult to isolate the underlying noise-response relationship for the higher-level responses. Thus, the probability of speech disturbance is strongly dependent on acoustical factors – the characteristics of the speech and the background noise. Whether or not this would result in annoyance depends on a set of modifying socio-psychological factors. Finally, the possibility of consequent overt reaction depends on the annoyance felt, but also on yet further modifying factors.
- B.183 The information in the research and policy literature on relationships between noise exposure and its potential adverse effects on people is of variable quality. Some proffered relationships stem from extensive research and are reasonably well corroborated and widely used: others are too fragmentary and insufficiently supported to offer reliable criteria. Practical noise assessment methodology has to be consistent with the understanding of the factors involved. Because effects on the community as a whole can only be described in broad statistical terms, noise exposures are commonly defined through long-term averages at representative locations.

Noise-Induced Hearing Loss

- B.184 Noise-induced hearing loss has long been recognised as an industrial hazard. Recently, there has been increasing concern that many leisure activities such as discotheque music, noise from loudspeakers and headphones, shooting and motor sports have associated hearing risks. In combination with natural ageing effects, which reduce hearing acuity (presbycusis), damage caused by excessive noise can lead to severe impairment in later life.
- B.185 Although agreement is not universal, the assumption that cumulative damage is proportional to total noise energy emission (i.e. the summed product of intensity and time) has led to the common practice of defining workplace noise exposures in terms of average noise levels during working

hours. It is generally believed that, even for working lives of up to 40 years, damage risk is negligible for Leq, 8 hours of less than 75 dBA.

- B.186 Such levels of noise exposure from aircraft are largely confined to people exposed within aerodrome boundaries who must wear protective equipment. The risks of consequent hearing damage to wider communities have not been a significant cause for concern.

Detection and Distraction

- B.187 Human hearing is extremely acute: the ear and the brain can extract a great deal of information from sound, even at very low levels. Total silence is essentially a theoretical concept: in reality, some sound is always present – but background sound often remains unnoticed because it is unremarkable (in information terms) and hence of no concern. Sounds attract attention when they change or convey information, especially recognisable warnings of danger.
- B.188 For the moment, disregarding most of the perceptual complexities involved, a key question is whether a potentially offending noise is actually audible. It is only when it is sufficiently loud or intense to be detectable amid inoffensive background sound that it is likely to be audible. If an aircraft is heard, it may cause disturbance, depending on its level and the listener's activity. A loud aircraft will be detected by most people – whether or not it disturbs them. Some people may not be able to detect less noisy events: the quieter the aircraft noise events, the fewer people will notice them. In general, aircraft noise will nearly always be audible if its noise level is somewhat above that of the masking background noise. If the noise contains irregularities such as whistles or thumps it may be quite audible at levels 10 dB below the background noise. Thus, close to aircraft flight paths near airports, where aircraft L_{max} is likely to exceed background levels by 20 dB or more, it will be highly audible. Only at very distant locations or in areas of high background noise will aircraft be inaudible.

Interference with Communication

- B.189 Interference with speech communication is a common type of noise disturbance: the intelligibility of speech is impaired by masking noise. For listeners with normal hearing, the intelligibility of normal conversation is 100% in steady masking noise levels of 45 dBA or less, about 99% at 55 dBA and 95% at 65 dBA. At higher background levels intelligibility falls rapidly, reaching zero at about 75 dBA (Berglund and Lindvall, 1995). The WHO guidelines state that speech in relaxed conversation is 100% intelligible in background levels of about 35 dBA. The research reported by Stockholm University indicates that a satisfactory conversation can be conducted outdoors with a normal voice up to a distance of 2 metres under a steady masking level of 60 dBA. Voice levels obviously tend to be raised to overcome background masking: the research indicates that satisfactory conversation with raised voice can be achieved up to 4 metres under a steady masking sound of 60 dBA.
- B.190 Indoor noise levels are governed by a variety of factors, including the size, shape and furnishings of the room, the activity inside it and the transmission of sound from adjacent areas. Inside homes, human voices, domestic appliances and entertainment systems are significant sources of noise, as can be that from road and rail traffic if there are busy roads or railway lines nearby. Outdoor sound is attenuated as it passes into the building, mainly through windows. If the windows are wide open, the attenuation is around 15 dB (i.e. noise levels heard in the room are reduced by 15 dB from the outdoor level). If windows are closed, this rises to between 20 dB and 30 dB depending on the weight of the glass, whether the glazing is single or double, and on the quality of the seals. Special windows designed to minimise the transmission of noise can increase attenuation to between 30 and 40 dB. Indoor noise levels span a very wide range, from perhaps 20 dBA inside quiet homes at night, through 40 dB to 60 dBA in homes and offices during daytime, to 70 dBA in noisier working situations and in homes with music playing.

- B.191 It must be remembered that, like most noise criteria, these reflect normal conditions. In specific situations, the degree of speech disturbance will be influenced by attention and motivation, clarity of speech, room acoustics and the listener's hearing acuity.

Impairment of Task Performance

- B.192 Any work that depends upon aural communication is sensitive to noise disturbance. If that communication is speech, the criteria outlined in the preceding paragraphs apply.
- B.193 A quiet environment is a frequently postulated requirement for mental concentration and creative activity. Very high levels of noise can affect a variety of tasks but the effects are complex. Intellectually simple tasks that do not involve aural communication are generally not degraded by noise, but this is less true of more challenging ones. Thus, because variations depend on the task being performed, research results cannot be expressed as generalised criteria.

Annoyance

- B.194 Noise annoyance is a feeling of resentment, displeasure, discomfort, dissatisfaction or offence, which occurs when noise interferes with thoughts, feelings or activities. There are both short-term and long-term impacts. A single noisy event may be described as annoying: equally, a resident might describe the level of ambient noise as an annoying feature of local living conditions in general. The former annoyance is related to the loudness, duration and setting of the specific event: the latter may be thought of as the consequence of repeated disturbances of various kinds.
- B.195 Annoyance can result from different causes. Some noises, like unpleasant odours, are simply disliked because of their intrinsically disagreeable character, e.g. harsh sounds imbued with high frequency tones. Others are disliked because of their consequences – noises that startle, awaken or interfere with conversation, for example. Yet again, others may simply

emanate from sources that are considered unwelcome for other reasons. Thus, road traffic might be perceived to cause congestion or air pollution; people might worry that aircraft could crash on them; and commercial premises might be considered inappropriate in residential areas.

- B.196 From a noise control perspective, the cause of the annoyance is important. If it is the very existence of the noise that produces direct and immediate annoyance, then reduction of its level might do little to diminish the adverse reaction. The same could be true if the specific type of noise source aggravates. In such cases, mere 'detectability' might be the criterion of annoyance. In contrast, if annoyance is related to intensity, so that the character of the noise itself is disagreeable or because of the severity of the resulting disturbance, then it will help matters to abate the noise.
- B.197 The capacity of a given sound to annoy depends on its physical characteristics including sound level, spectral characteristics and variations with time. These variables are characterised by onset times, durations and repetition rates. However, as already indicated, annoyance also depends on non-acoustical, cognitive factors, such as wider concerns over (personal) safety or indeed a conviction that the noise exposure could be reduced by third parties 'if they did their job properly'. Other cognitive factors are individual noise sensitivity, the degree to which the individual feels able to control the noise, whether the noise stems from a new situation or technology, or if it results from an important economic activity providing local employment.

Annoyance as an Indicator of Aircraft Noise Community Impact

- B.198 Noise disturbance and short-term annoyance have been studied extensively in research laboratories. Such experiments can be performed with great accuracy and have provided a wealth of knowledge about the fundamental characteristics of human hearing and perception of sound. However, a detailed understanding of specific disturbance criteria is not particularly helpful in the assessment of the day-by-day impact of

environmental noise on communities. The noise experienced by individuals depends on where they live and work and upon their lifestyles – aspects that cannot be addressed within the confines of a research laboratory. No two people experience exactly the same noise exposure patterns over a period of time; nor do they experience the same interference with their activities. Different people react differently to the same noise: some are a great deal more sensitive and others are much less sensitive than the average person. Coupled with the multiplicity of potential disturbance effects, these variations make studies in the community intrinsically more complex than laboratory work. Yet it is only in the real world that relationships between cause and long-term annoyance – arising from total long-term noise exposure from all sources – can be investigated.

- B.199 Community annoyance has been adopted as a general indicator for all of the possible impacts of environmental noise. In social surveys, individual annoyance has been measured in a variety of ways – quantifying it on simple numerical or category scales or via elaborate multi-question procedures.

Attributes of a Noise Index

- B.200 A noise index should be simple, practical, unambiguous, and capable of accurate measurement (using conventional, standard instrumentation). It must also be suitable for estimation by calculation from underlying source variables and robust – not over-sensitive to small changes in input variables.
- B.201 The family of A-weighted metrics is now in widespread use around the world for quantifying environmental noise for both single events and longer-term exposure. This includes L_A , L_{max} , SEL and L_{eq} – where L_A , alternatively denoted by $L_{A(t)}$, is the instantaneous level at any time (t). Of these, L_{max} and SEL describe the level of an individual noise event. Theoretically, SEL is generally preferable because it accounts for the duration of the event as well as its intensity and is the building block of L_{eq} . Many non-specialists often find the SEL concept difficult to grasp,

especially because (for the same event) SEL usually exceeds L_{\max} numerically. Thus, L_{\max} is sometimes favoured as a metric for day-to-day noise monitoring and indeed it is used to regulate noise limits for departing aircraft at Heathrow, Gatwick and Stansted.

- B.202 L_{eq} fully meets the requirements of an indicator of long-term environmental noise exposure. It is a simple, logical and convenient measure of average sound energy which is at least as good as any alternative index as a predictor of adverse effects and community annoyance. It takes account of the sound levels within each event, the duration of those events and the number of events. These features are explained in later sections of this Annex.

Relationship between Noise Exposure and Community Annoyance

- B.203 The search for annoyance indices has revealed that average long-term annoyance can readily be determined. One simple way, which has many merits, is to ask social survey respondents to rate their individual annoyance on a numerical or categorical scale such as 'not at all, a little, moderately, very much'. However, the individual responses are only weakly governed by the magnitude of the noise exposure. In statistical terms, only about one quarter of the inter-individual variance in annoyance can be attributed to the average level of noise exposure (however defined). This low correlation reflects the very large differences between individual reactions to the same amount of noise (due to non-acoustic factors). Uncertainty also arises because of inevitable measurement and prediction inaccuracies in the estimates of both noise exposure and annoyance.
- B.204 Researchers have tried to identify and quantify the sources of this human variation because it masks the true nature of any underlying noise effect. This research demonstrated that noise annoyance is very sensitive to people's views on: a) the importance of the noise generating activity; and b) the noisemakers' concerns about any nuisance they might cause. Composite annoyance predictors accounting for socio-psychological factors

in addition to noise exposure have been found to account for as much as 50% of the variance in annoyance. But these are of little more practical value than 'noise-only' indices because, in most circumstances, the non-acoustical factors are themselves unknown.

- B.205 Attempts have been made to substantiate 'multi-dimensional' noise rating indices that make suitable allowance for some of the more obvious influences. Among these influences are:
- Situational factors – environmental expectations are greater at home than at work, for example;
 - Time of day – probably linked to (a) but, for example, assuming noise is less tolerable by evening and night than day; and
 - Source of noise – it has been found that, dB for dB, people are more tolerant of railway trains than road vehicles and that aircraft can be judged as more annoying than either (Miedema and Oudshoorn, 2001).
- B.206 There is little scientific basis for any specific adjustments or weightings: the statistical evidence is too weak. The main justification for applying them as part of the decision-making process is to address public concern that their perceived importance has not been overlooked. The precise manner of application is left to common sense and judgement. Generalised noise-annoyance relationships provide guidance to planners and policy makers but they are likely to be less reliable than the results of properly designed and executed studies.
- B.207 Some authorities have introduced weightings into L_{eq} , i.e. adjustment to L_{eq} values, to recognise the view – strong in some environmental organisations – that sensitivities vary across the day. Belief that noise is 'less tolerable' at night than during the day is reflected in a modified version of L_{eq} , which is used in some countries for aircraft noise exposure. One measure that is widely used in the USA is known as Day-Night Level, DNL or L_{DN} . DNL includes a 10 dB weighting for a 9-hour night period. All noise events occurring during the night are artificially increased by 10 dB before the

noise energy level is averaged over the full 24 hours. This means that one night flight contributes as much to DNL as do ten identical daytime flights.

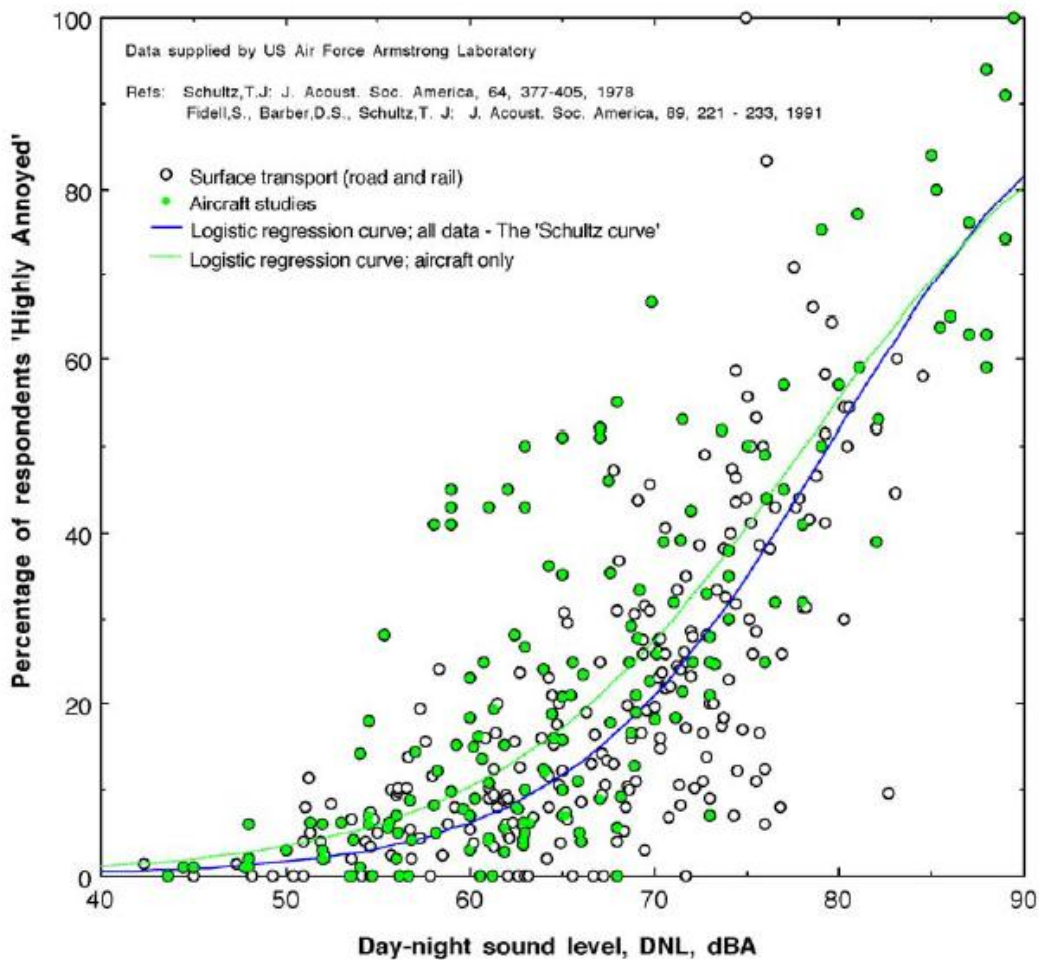
- B.208 The European Commission has introduced a directive (European Commission, 2002b) that requires member States to produce noise exposure contours using a variant of L_{eq} known as L_{DEN} or DENL. This includes a 10 dB weighting for noise events at night and a 5 dB weighting for events during the evening, with special definitions for what are night and evening periods. As in the case of LDN, the night weighting has the effect that one night flight contributes as much to L_{DEN} as ten identical daytime flights. The evening weighting of 5 dB has the effect that one evening flight contributes as much to L_{DEN} as just over three identical daytime events – (because $10^5/10 = 3.162$). There is little scientific evidence supporting the use of time-of-day weightings. Indeed, UK research has indicated that there is no need for such weightings (CAA, 1985). However, one Dutch study has lent support for the inclusion of a night-time 10 dB penalty (Miedema, 2000).
- B.209 In general, there is no direct relationship between L_{eq} , 16 hours and LDN or L_{DEN} . Without any aircraft noise events during the night period, L_{DN} is identical to L_{eq} , 24 hours. In the absence of night flights, L_{eq} , 16 hours will be approximately 1.8 dB higher than L_{DN} other things being equal.

Schultz Curve

- B.210 There is now substantial acceptance by researchers and noise policy makers that L_{eq} , or simple variants of L_{eq} , are appropriate noise exposure indicators. L_{eq} is at least as good as any other noise-based indicator for predicting average noise annoyance or the likely percentage incidence of high noise annoyance. A widely quoted relationship is the Schultz curve. This curve is a graph of 'percentage highly annoyed' against noise exposure level. It was originally based on data from numerous social survey studies of public reactions to transport noise (aircraft, road and rail traffic) carried out in different countries.

B.211 This analysis (Schultz, 1978) provided much of the evidence for two far-reaching conclusions: first, that daytime noise exposure levels less than 50 dBA L_{DN} cause little or no serious annoyance in the community; and second that 55 dBA L_{DN} might be considered as a general environmental health goal for outdoor noise levels in residential areas. The latter conclusion, in fact, assumes that transport would continue to dominate outdoor ambient noise levels in most inhabited areas. This analysis, which was updated in 1991 (Fidell et al, 1991), is illustrated in Figure 3. Each point in the diagram represents the response of a sample of respondents exposed to a particular level of noise. The different symbols are used to distinguish between results for aircraft noise and surface transport.

Figure 3: Schultz curve



B.212 The Schultz curve is a 'best fit' to all the data in the diagram. It is a statistical estimate of the underlying trend between annoyance and the

noise exposure level, expressed as Day-Night Level, L_{DN} . It is given by the mathematical expression:

$$\% \text{ highly annoyed} = \frac{100}{1 + e^{(11.13 - 0.14L_{DN})}}$$

B.213 The form of the Schultz curve is a so-called ‘logistic regression’ curve. It is used to depict an underlying trend in proportional data, i.e. where values cannot lie outside the range 0 -100%. The curve is asymptotic to 0% at low noise exposure levels and to 100% at high noise levels.

B.214 However, it is evident that there is much scatter in Schultz’s data – many individual points deviate considerably from the trend line. It is suggested that there are at least three reasons for this scatter:

- Substantial variations in individual reactions attributable to the many modifying non-acoustical factors. One such factor, that is apparent from Figure 3, is that aircraft causes a generally higher incidence of annoyance than surface transport noise. This means that the dose-response relationship, which applies to general transportation noise, is likely to underestimate reactions to aircraft noise alone.
- The group responses, as statistical estimates of population characteristics, are subject to marked sampling errors due to limited sample sizes.
- Merging data from different studies is invariably confounded to some extent by differences in the definitions of annoyance (especially where different languages are involved), thresholds of high annoyance and noise exposure variables.

B.215 Despite these limitations, the Schultz curve illustrates the probable form of the relationship between noise exposure and community annoyance.

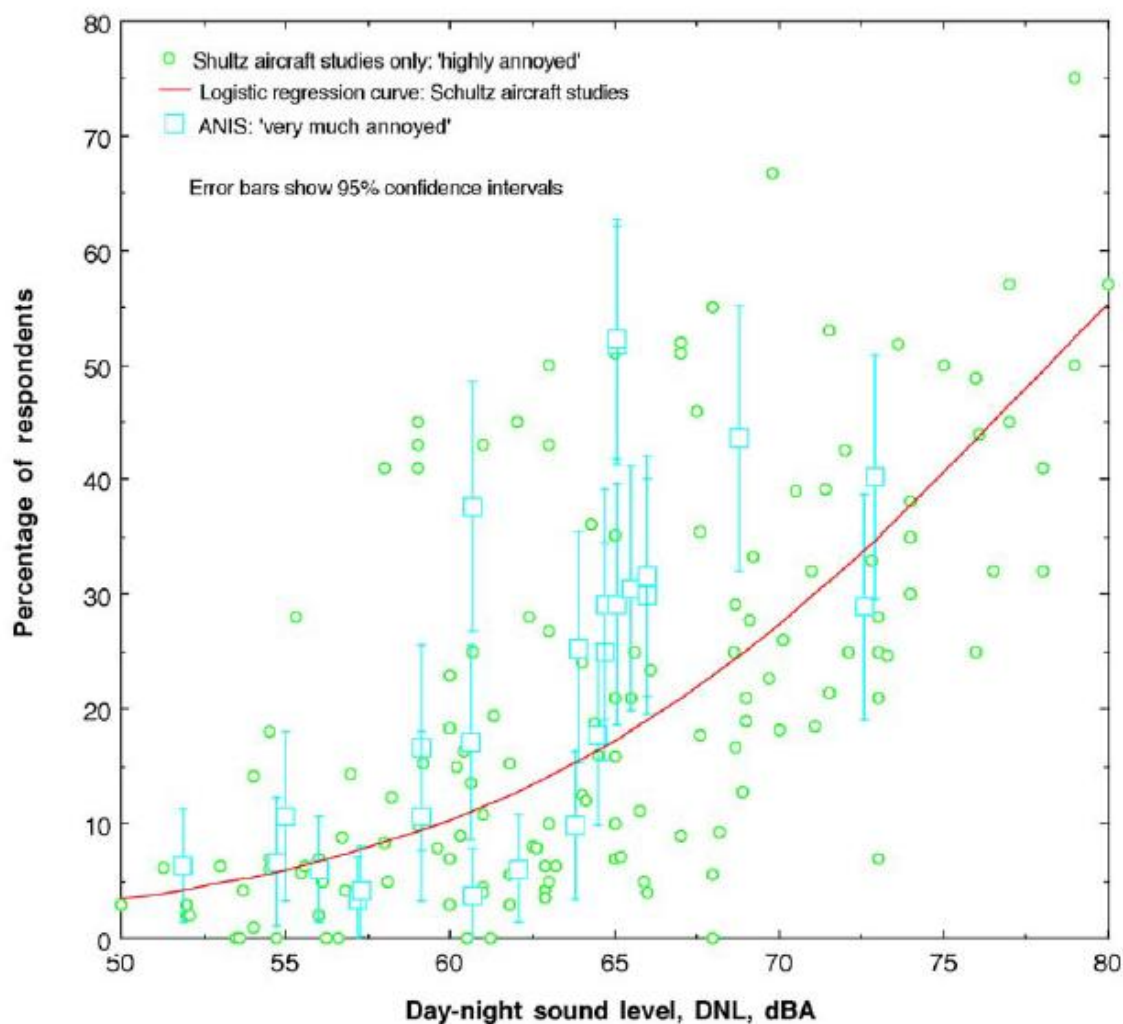
Aircraft Noise Index Study (ANIS)

B.216 In 1980 the CAA began an extensive programme of social survey and noise measurements (CAA, 1985) commissioned by the Civil Aviation Policy Division of the Department of Transport. The aim of this study was either to

substantiate the Noise and Number Index (NNI) – the previous UK noise index – or, if necessary, devise a new index of annoyance due to aircraft noise. A review of ANIS and subsequent UK developments is Brooker (2004).

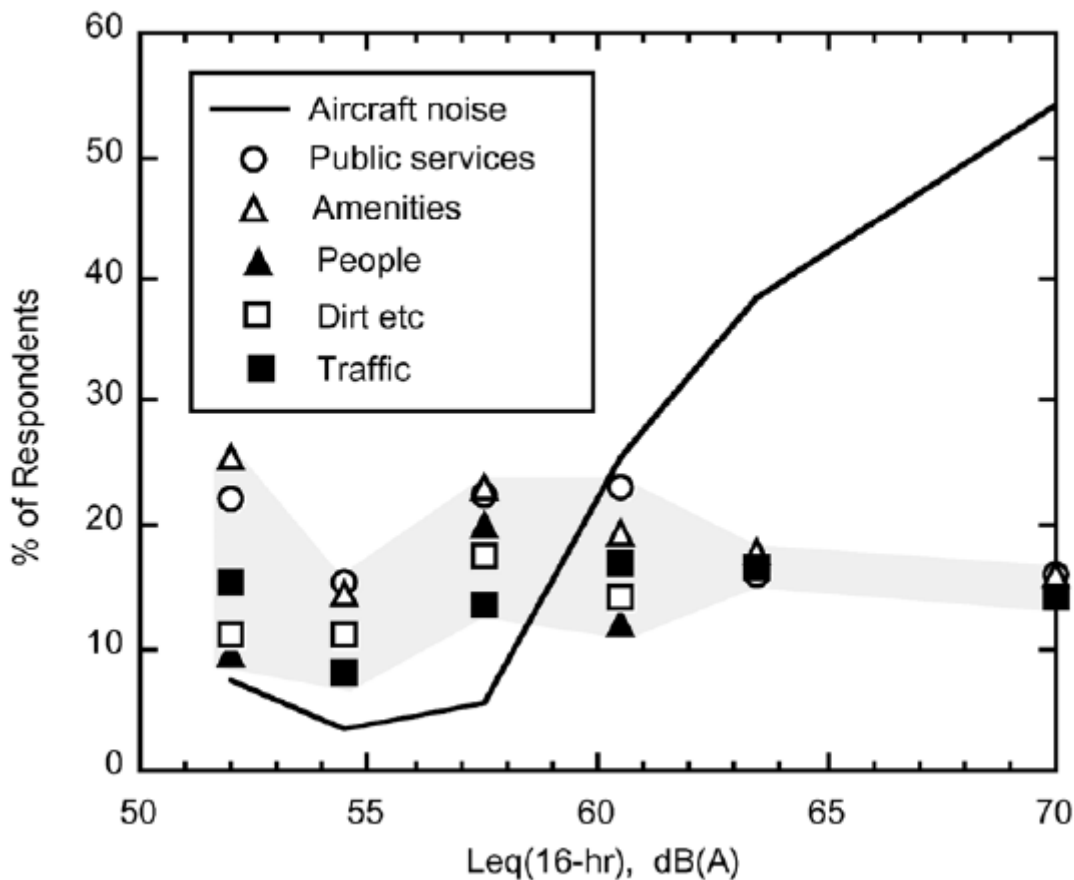
- B.217 The surveys were carried out using a questionnaire in summer 1980. Each respondent was given an introductory letter from the Department of Trade and Industry which introduced the survey as one that was examining people's attitudes towards the area in which they live. No specific mention was made of aircraft noise in this letter. Out of 3,140 addresses selected for interview, 2,097 people were successfully interviewed.
- B.218 The sample design used was one in which several small geographical areas, approximately 1 km² (known as 'common noise areas'), were intensively sampled. These areas were chosen to provide the greatest independent variation between sound level and number. This was because an important aspect of the study was to separate the effects of noise and number in order to provide evidence to support NNI or assist in the design of its replacement.
- B.219 The electoral register was used to select households randomly for the survey. The sampling method was designed to give equal probability of selection for all adults over the age of 18 living within that common noise area. The numbers of areas surveyed during the study were Heathrow (20), Gatwick (2), Luton (2), Manchester (1) and Aberdeen (1).

Figure 4: Comparison of ANIS and Schultz aircraft data



B.220 Figure 4 shows a comparison between aircraft data used in the Schultz curve and data from ANIS. The percentages on the vertical axis show residents who reported that they were 'very much bothered or annoyed by aircraft noise'. In order to achieve this comparison, LDN values for the ANIS cases have been estimated. The logistic curve is that fitted to the aircraft data in Figure 4. The error bars attached to the ANIS points represent estimated 95% confidence intervals – the range in which the bulk of true reaction values are likely to fall. These show that sampling errors may explain a substantial part of the data scatter. It is clear that the ANIS results exhibit the same general trends as the aircraft studies included in the Schultz analysis.

Figure 5: Dislikes spontaneously mentioned by ANIS respondents



B.221 Figure 5 shows L_{eq} , 16 hours on the horizontal axis and the percentage of respondents reporting 'a spontaneous dislike of various aspects of life' on the vertical axis. It gives a clear indication of how aircraft noise changes from a minor feature of the environment below about 57 dBA L_{eq} , 16 hours to a significant one above 60 dBA L_{eq} , 16 hours.

B.222 The study was successful in disentangling the effects of aircraft sound level and number of noise events. The trade-off implicit in NNI was not substantiated – the study suggested that NNI placed too much weight on the number of aircraft (it applied a coefficient 15 before $\log_{10} N$ rather than the coefficient of 10 implicit in L_{eq}). The study found no evidence to support the inclusion of time-of-day weightings. It found that a good fit to disturbance responses is given by L_{eq} , 24 hours. Also, the averaging of L_{eq} was found to be statistically preferable to L_{eq} calculated on a worst mode basis, that is, assuming that the runway is operated solely in the worst

direction in noise terms for each respondent. A major confounding factor affecting responses is the proportion of people who work at the airport or who have business at the airport. Data from the five airports did not reveal any marked 'airport-specific' effects.

- B.223 Following the publication of the ANIS report, the Department of Transport undertook a substantial formal consultation on a proposal to change from NNI to L_{eq} as the index for monitoring aircraft noise. The results of the consultation (CAA, 1990) showed substantial support for the adoption of L_{eq} with many advantages being recognised. However, many consultees expressed reservations about the details – in particular, the time-of-day factor.
- B.224 ANIS revealed no better predictor of annoyance than L_{eq} , 24 hours. But the consultation indicated that the adoption of a 24-hour index was seen to be too radical a change from the 12-hour period specified for NNI and, without special weightings for evening and night-time periods, would not recognise the somewhat different considerations applying to evaluation of noise outside the 'working day' period. Consultees were, in general, against moving to a 24-hour L_{eq} index.
- B.225 ANIS had shown that, as a predictor of annoyance, L_{eq} , 16 hours is statistically indistinguishable from L_{eq} , 24 hours, while most aircraft movements occur between the hours of 0700 and 2300. The conclusion was to adopt L_{eq} , 16 hours for the period 0700 to 2300 as the aircraft noise index. Furthermore, the Government decided that 57 dBA L_{eq} , 16 hours should mark the approximate onset of significant community annoyance.

Sleep Disturbance

- B.226 Everyday experience indicates that noise interferes with sleep. Most people have been awakened by sudden, unusual sounds and regularly use alarm clocks to awaken themselves, but they also get used to high levels of noise and sleep through it, especially when it is steady – as inside trains and planes, for example. It is possible that noise only disturbs sleep when it is

- unfamiliar or conveys a special message – for example, a parent is awakened by the stirring of a child but may sleep through a thunderstorm.
- B.227 Sleep is, in fact, a complicated series of states, not a single uniform one. Sleep is essential for general well-being, even though the reasons remain obscure. People feel strong resentment when they perceive their sleep to be disturbed: indeed this is a major cause of annoyance. Disturbance at night can take many forms – prevention from falling asleep, physiological arousals and changes of sleep state, and awakenings. Serious sleep deprivation could lead to day-time tiredness and have consequences on a person's ability to function normally. Thus, there is little disagreement that extensive noise-induced awakenings could have a definitive adverse effect. It is less clear whether and to what extent noise can cause harmful loss of sleep, or whether lesser reactions, which do not involve awakening, can affect general well-being in similar ways.
- B.228 It is difficult to measure the effects of noise on sleep without the measurement process affecting sleep itself. Many studies have been carried out. Some of these are in the laboratory, where physiological responses to specially presented sounds can be readily measured. Others are field studies, mainly using social survey methods but sometimes by physical measurement. Different kinds of studies lead to different conclusions, with consequent variability in the measured cause-effect relationships. Some laboratory studies have associated awakenings with noise events as low as 40 dBA L_{max}, while some field studies show very few awakenings at indoor levels of 60 dBA L_{max}. These differences are believed to reflect important effects of familiarity and habituation: people sleep more soundly at home in their normal surroundings.
- B.229 These uncertainties mean that it is difficult to derive definitive noise exposure criteria governing sleep disturbance. Given that some effects have been measured in the laboratory at levels from about 30 dBA L_{eq}, it has been argued that to avoid any negative effects, exposure levels inside the bedroom should not exceed this threshold. However, if the noise is steady and familiar, for example, from a ventilator or air conditioning

system, higher levels might be judged to be tolerable. The same may be true of less steady but unexceptional, non-threatening noise – for example, the sound of ocean waves on a beach. The more intermittent and unfamiliar the noise, then, in general, the more likely it is to disturb. In particular, if noise exposure (e.g. as measured by L_{eq}) is governed by a few very noisy events, then the level of those individual events might well be the major concern.

- B.230 It is generally agreed that, in the home, the effects of familiar events would be small when below indoor event levels of about 45 dBA L_{max} . Awakenings would be infrequent below 55 dBA L_{max} . All these levels apply to indoor conditions. If sleep effects are being related to outdoor sound levels, then about 15 dB should be added in the case of partially open windows and about 25 dB for closed windows.
- B.231 A fuller exposition of the adverse effects of night-time noise was published by the CAA in 2000 (CAA, 2000).

Report on a Field Study of Aircraft Noise and Sleep Disturbance

- B.232 In 1990 the Department of Transport commissioned the CAA to carry out research into aircraft noise and sleep disturbance (DoT, 1992) in preparation for a review of the London airports night restrictions scheme. The objectives of the study were to determine (a) the relationships between outdoor noise levels and the probability of sleep disturbance, and (b) the variation of these relationships with time of night.
- B.233 It was necessary to investigate the influence of non-acoustical factors upon disturbance of people's sleep including their age, sex and personal characteristics, their general views about the neighbourhood, their perceptions about sleep quality and the ways in which this might be affected by aircraft noise.
- B.234 The CAA managed this research programme which was undertaken by research teams from Loughborough University Sleep Laboratory, the

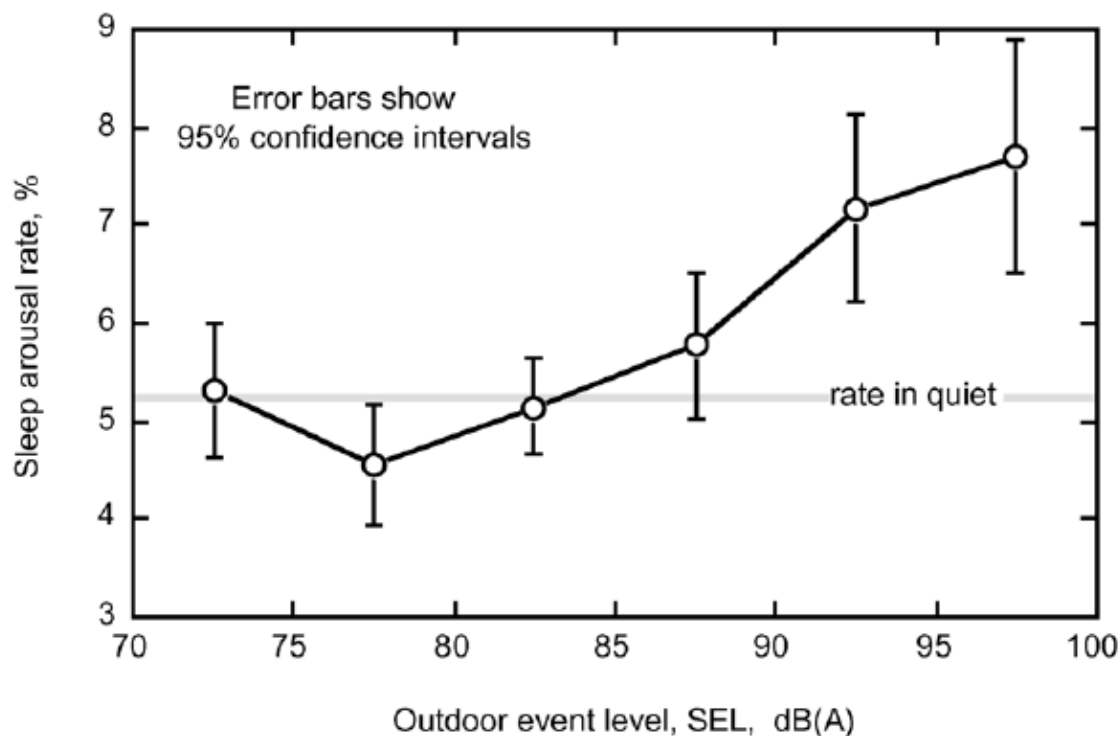
Department of Biological Sciences of Manchester Metropolitan University and the Department of Social Statistics of Southampton University. The research team was advised by a steering group chaired by the DfT including representation from airlines, airports and local people. The study drew on the views of a panel of leading experts in the field of sleep research.

- B.235 The traditional method of monitoring sleep is electroencephalography or 'sleep EEG', in which brain waves are measured by electrodes attached to the scalp. A hypnogram is a record of sleep stages during the night obtained from EEG data. Sleep stages in the hypnogram include light, deep and Rapid Eye Movement (REM – indicative of dreaming) as well as wakefulness. However, the method is complex and expensive and, partly for these reasons, most EEG work has been carried out in laboratory situations. In order to avoid the statistical constraints of such limited studies and because of the strong possibility that laboratory studies are not truly representative of the way people react in their homes, this study made use of actimeters to gather a large quantity of field data. Actimeters are small, relatively inexpensive devices that measure movement (motility) – worn like a wristwatch, they are easily used in the home without supervision. They log and store data for many nights which are subsequently transferred to a computer for conversion to actigrams, the graphical record of limb movements.
- B.236 Actimetry is widely used in sleep research but an important part of this study was to validate its use for measuring the effects of aircraft noise on sleep. This was done by a direct comparison of EEG and actimetry measured disturbance for a sub sample within the study.
- B.237 The main study involved field measurements at 8 sites, 2 each around Heathrow, Gatwick, Stansted and Manchester airports. The sites chosen provided a range of noise exposure levels – their selection was guided by needs for sufficient local population with similar noise exposures within the site and avoidance of confounding noise sources such as busy roads and railways. Fieldwork was conducted between February and October of 1991,

commencing with social surveys to identify a pool of subjects from which to select participants for the actimetry work. The selected subjects (50 per site) wore actimeters for 15 nights and also completed 'sleep diaries' covering both the night and any daytime sleepiness. In addition, 6 of the 50 subjects were monitored using EEG for 4 of their actimetry nights – the EEG data were required to calibrate the actimetry results. Throughout the survey period, a concurrent programme of outdoor noise measurement provided aircraft noise data for correlation with measured sleep disturbance.

- B.238 For the EEG sample, agreement between actimetrically determined arousals (onsets of limb movement) and EEG measured awakenings was high – 88% of all awakenings coincided with actimetric arousals. The agreement in the case of undisturbed 'epochs' (30 second measurement periods) was even higher, 97% overall. This was seen as important support for the actimetry method, given that undisturbed epochs were 95% of the total.
- B.239 From the actimetry data it was estimated that per subject, for all causes, all nights and all epochs during the average sleeping period of 7 hours, there were about 18 awakenings per night lasting for 10-15 seconds or more. Most of these were not remembered the morning after. On 57% of measurement nights, no awakenings were reported. In the remaining 43% of cases, subjects recalled an average of three awakenings, from all causes, during the previous night. Aircraft noise was given as a relatively minor cause (less than 4% of reported awakenings). About one quarter of all actimetry subjects specifically reported being disturbed by aircraft noise during the study – on average by these subjects, once every five nights. The incidence of aircraft noise events ranged between averages of 3 and 48 events per night.

Figure 6: Relation between actimetrically measured sleep disturbance and noise



B.240 Figure 6 shows the estimated average disturbance rate (based on actimetric arousals) as a function of outdoor aircraft noise event level (SEL). The results indicated that, below 90 dBA SEL (approximately 80 dBA L_{max}), aircraft noise events are unlikely to cause any measurable increase in overall rates of sleep disturbance experienced during normal sleep: in the range 85-90 dBA SEL, the arousal rate associated with aircraft noise events was not significantly different from the rate during the absence of aircraft noise events, shown as a line marked 'rate in quiet' on the diagram.

B.241 It is only above 90 dBA SEL (approximately 80 dBA L_{max}) that the differences between sleep arousal rates with and without aircraft noise are statistically significant at the 95% level. This means that there is a one in twenty probability that the results were obtained as the result of pure chance. At higher noise levels, between 90 and 100 dBA SEL (approximately 80 and 90 dBA L_{max}), the chance of the average person being awakened by an aircraft noise event was about 1 in 75. This risk of arousal due to aircraft noise must be compared with an average of 18

nightly awakenings from all causes. Thus, even large numbers of night movements would be likely to cause very little increase in the average person's nightly awakenings. Susceptibility to sleep disturbance varied markedly. For aircraft noise related disturbance, the 2-3% most sensitive people could be over twice as likely to be disturbed as the average person and the 2-3% least sensitive less than half as likely.

- B.242 The actimetry results related only to disturbance from sleep: they did not answer the questions of whether aircraft noise delays sleep onset (either at the beginning of the night or after awakening during the night) or causes premature awakening at the end of a night's sleep.
- B.243 Statistically, time of night and time from sleep onset were found to be significant factors affecting arousal from sleep. The data indicated that people appear to be most resistant to disturbance, from any cause, after first falling asleep. Then, starting with a pronounced fluctuation having a cycle time of about 90 minutes, the overall disturbance rate increases steadily, from the equivalent of about two awakenings an hour at the beginning of the night to about three per hour at the end of the night.

World Health Organization (WHO) Guidelines

- B.244 The World Health Organization published a set of guidelines for community noise (WHO, 1999). These guidelines are essentially values for the onset of health effects. These are levels that would produce no significant health effects for the population at large. The WHO considers that the extent of the community noise problem is large. It notes that:

'When all transportation noise is considered, about half of all European Union citizens live in zones that do not ensure acoustical comfort to residents. At night, it is estimated that more than 30% is exposed to equivalent sound pressure levels exceeding 55 dBA, which are disturbing to sleep.'

- B.245 The UK Government considers that the guideline values are very low, i.e. extremely cautious (DfT, 2004a). It has stated that it would be difficult to

achieve them in the short to medium term without draconian measures, but that is not what the WHO proposed. The recommendation was that the Guidelines for Community Noise should be adopted as long term targets for improving human health which the Government has stated that it will take into account.

B.246 The WHO guidelines (WHO, 1999) relevant to aircraft noise and residential areas are shown in Table 4.

B.247 The WHO guideline targets and the Government definition of significant community annoyance are not incompatible. The WHO values are set at the level below which there is no impact from annoyance on human health – the Government value is set at the level where the effect in terms of community annoyance becomes significant.

Table 4: WHO guidelines relevant to aircraft noise and residential areas

Specific environment	Critical health effect(s)	LAeq (dB)	Time base (hours)	LAm _{ax} , fast (dB)
Outdoor living area	Serious annoyance, daytime and evening	55	16	-
	Moderate annoyance, daytime and evening	50	16	-
Dwelling indoors	Speech intelligibility and moderate annoyance, daytime and evening	35	16	-
	Sleep disturbance, night time	30	8	45
Outside bedrooms	Sleep disturbance, window open (outdoor values)	45	8	60
Outdoors in parkland and conservation areas	Disruption of tranquillity	See note		
Notes:				
a) Existing quiet outdoor areas should be preserved and the ratio of intruding noise to natural background sound should be kept low.				

- b) There are additional guidelines for schools, hospitals, industrial areas and ceremonies/entertainment.
- c) Sound meters can be set to a slow or fast setting. This determines how closely the measured value tracks very short-term rapid fluctuations of sound level. A slow setting damps down these short-term fluctuations.

Continuous Descent Operations and Low Power/Low Drag Procedures

Introduction

B.248 A continuous descent operation (CDO) is defined (DfT et al, 2006a; NATS, 2006) as ‘a noise abatement technique for arriving aircraft in which the pilot, when given descent clearance below Transition Altitude by ATC, will descend at the rate best suited to the achievement of continuous descent, whilst meeting the ATC speed control requirements, the objective being to join the glide-path at the appropriate height for the distance without recourse to level flight’. The theoretical ‘ideal’ profile for Heathrow, Gatwick and Stansted is a descent at 3 degrees from 6,000 feet. The industry code of practice (DfT et al, 2006a) recommends that an arrival is classed as a CDO if it contains, at or below 6,000 feet:

- no level flight; or
- one phase of level flight not longer than 2.5 nm.

B.249 Level flight is defined as any segment of flight having a height change of not more than 50 feet over a track distance of 2 nm or more, as recorded in the airport noise and track-keeping system.

B.250 A low power/low drag procedure is defined as ‘a noise abatement technique for arriving aircraft in which the pilot delays the extension of wing flaps and undercarriage until the final stages of the approach, subject to ATC speed control requirements and the safe operation of the aircraft’.

Implementation

B.251 On being instructed to leave the holding facility (stack), headings and flight levels/altitudes will be passed to the aircraft by ATC. Descent clearance will include an estimate of the track distance to touchdown. Pilots are expected

to use this information to manage their rate of descent to achieve a continuous descent to touchdown. Guidance, in the form of graphs and tables, is published in the code of practice (DfT et al, 2006a) with advice on the use of flight management systems. Additional distance information will be passed by ATC, normally on first contact with the final director, before intercept heading for the ILS.

- B.252 Performance of a CDO relies on a combination of factors and cooperation between individuals and organisations. In order to carry out a CDO, the pilot needs accurate information on distance to touchdown from ATC. ATC requires knowledge of the planned track to be followed by the aircraft. The planned track will take into account separation and sequencing between aircraft and it is possible that 'path stretching' will be required in order to maintain minimum separation between aircraft and achieve an efficient flow of aircraft to the runway.

Costs

- B.253 CDO procedures involve some additional radio traffic in the form of distance to touchdown estimates and the associated cognitive effort by the air traffic controller in making this prediction. It will also involve the pilot in additional workload in determining the optimal descent position having been given descent clearance and a protracted period of descent during a busy phase of flight. Other workload factors will include monitoring busy radio circuits, manoeuvres required for separation and sequencing, surveillance of proximate traffic including the possibility of TCAS alerts, establishment on the ILS localiser and pre-landing cockpit checks.

Benefits

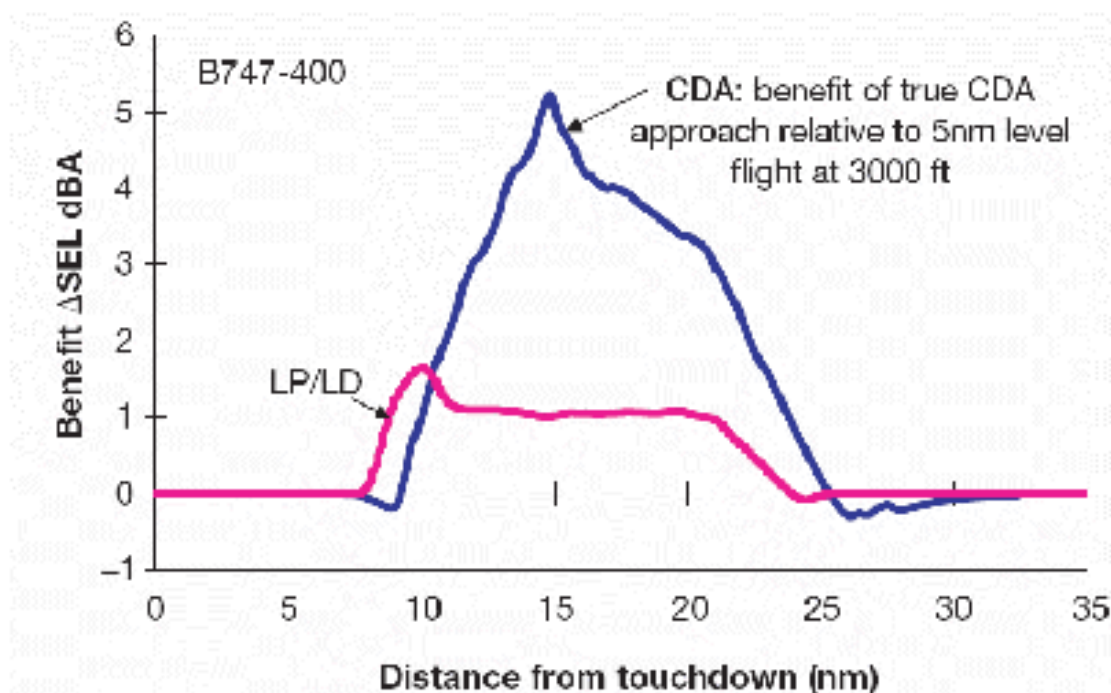
- B.254 CDO achievement generates a number of benefits. It reduces the amount of fuel burned by approaching aircraft – this was the reason for its original implementation during the fuel crisis of the 1970s (Morris, 2004). This will reduce aircraft engine emissions – both carbon dioxide and oxides of

nitrogen. Aircraft flying a CDO procedure will also produce lower noise levels experienced on the ground than an aircraft flying the approach with significant periods of level flight. This reduction in noise impact is due to:

- Lower power settings on the engines required for descent as opposed to level flight; and
- Aircraft maintaining a higher altitude than would otherwise be the case with greater attenuation between the source and the ground.

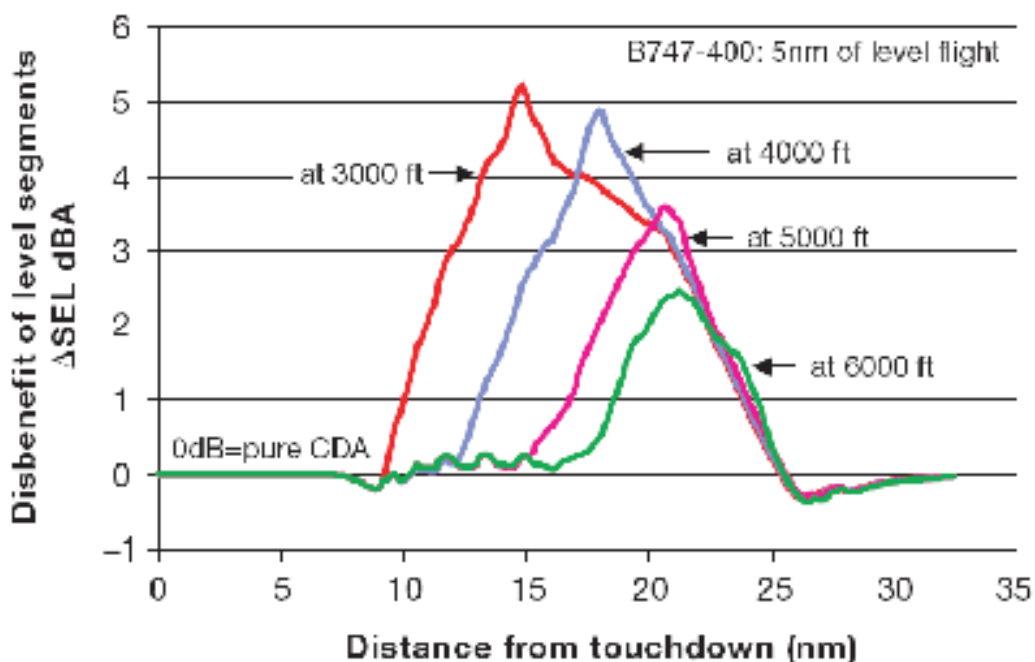
B.255 Figure 7 shows the sound exposure level (SEL) benefits in dBA at different distances from touchdown of CDO and LPLD relative to an approach containing a 5 nm level segment at 3,000 ft. SEL of an aircraft noise event is the sound level of a one second event that contains the same total A-weighted sound energy as the whole event – in other words, the sound level that would be measured if all the noise energy were to be compressed into a reference time of one second.

Figure 7: B747-400 under flight path - CDO and LPLD benefits



- B.256 Figure 8 shows the difference between a CDO profile and the approaches with level segments described in the previous paragraph. The CDO profile is the 0 dBA line in this diagram.

Figure 8: Disbenefit of level flight intercept relative to 'pure' CDO approach



Conclusion

- B.257 Both diagrams demonstrate that there is a significant benefit in noise terms deriving from CDO and LPLD achievements with CDO generating greater benefits. These benefits occur between 25 and 8 nm from touchdown and can be as much as 5 dBA. It should be recognised that for most airports the benefits will not have any significant impact on the size or shape of noise exposure contours because aircraft are normally established on the 3 degree glide slope before 8 nm from touchdown irrespective of whether a CDO has been achieved.

Appendix B annex 6

Guidance on Use of the Integrated Noise Model (INM)

Introduction

- B.258 This Annex offers guidance on the use of the Integrated Noise Model (INM)⁵. The latest version of INM was version 7.0, which was released in October 2013.
- B.259 INM is a widely used aircraft noise model that is produced by the US Federal Aviation Administration (FAA). It is one of the few aircraft noise models commercially available to airports and their noise consultants. Other models in common use have been developed by governments and aviation authorities and are not normally available to external agencies.
- B.260 INM is a very comprehensive aircraft noise model but the accuracy of its outputs is dependent on the quality of input data and the way in which the model is used. The default settings for the model may not be appropriate under particular circumstances and therefore use of those default settings may generate inaccurate results.

Aircraft

- B.261 INM contains data on the aerodynamic performance and noise characteristics of a large number of aircraft types. However, aircraft types included within the model are predominantly those operating in the USA. A substitution list is provided for those aircraft types that do not feature within the INM database. Noise data, used by INM, are based on measurements carried out during the certification process and these may not be representative of aircraft noise measurements taken under realistic operational conditions.

⁵ The Integrated Noise Model has been replaced by the FAA's Aviation Environmental Design Tool (AEDT) as of May 2015.

- B.262 For nearly all aircraft types, the INM default departure profile uses maximum thrust generating the maximum climb rate. This default profile generates lower levels of noise, other things being equal, because the aircraft will be at greater altitude although generating more noise. The attenuation due to greater propagation path length tends to offset the additional noise due to increased thrust. Use of maximum thrust on take-off is not a typical mode of operation for most civil jet aircraft. Engine maintenance considerations dictate a lower thrust setting on take-off than that typically assumed by INM.
- B.263 INM includes provision for noise modellers to provide their own aircraft performance data. Where this is not possible, for whatever reason, an alternative is to adjust the stage length of the profile. The stage length defines the distance between departure airport and destination. In effect, the climb gradient for departures can be adjusted to more realistic conditions by increasing the fuel load. The noise modeller needs to use judgement in order to assess whether this approach is appropriate and, if so, the relevant stage length to apply.
- B.264 Aircraft in flight are subject to variability in their navigational performance. This should be taken into account during noise modelling using the dispersed track function available within INM. This enables the noise model to account for the lateral dispersion of aircraft tracks about the mean track. This can be achieved by using data from a noise and track keeping system or radar data. If neither of these is available, a noise modeller can use subjective judgement combined with knowledge of operations by aircraft at similar airports as an input to the INM dispersed track function.

Contour Calculation

- B.265 INM gives the noise modeller the ability to adjust the way in which noise contours are calculated. This, in turn, affects the accuracy and validity of contours produced. The INM default values can result in noise exposure contours that contain artefacts or unwanted by-products of the calculation

process. These artefacts are manifest as asymmetries and irregularities in contours.

- B.266 The best way of avoiding calculation artefacts is to use a finely spaced calculation grid. This can be achieved in INM by setting the refinement and tolerance appropriately. INM changes grid spacing dependent on these settings and the rate at which the noise exposure values change across the grid. It is recommended that refinement is set at 9 and tolerance is set at 0.1 dB. This will help to optimise the accuracy of the resulting output but will increase calculation times and the amount of data generated.
- B.267 INM offers the facility for rotating the axis of the calculation grid to align with the runway axis in order to avoid spurious asymmetry in the calculated contour. Noise modellers should consider using the option of grid rotation if unexplained asymmetry about the runway axis is evident. If using the facility of rotating the axis, care should be taken to ensure that the process of rotating input data to the calculation grid and then rotating the output contour in the opposite direction does not induce errors of itself.

Conclusions

- B.268 It is recommended that noise modellers give careful consideration to INM settings before producing noise exposure contours. Use of the INM default settings can result in inaccurate outputs.
- B.269 The following INM settings are recommended:
- Stage length: as appropriate to achieve realistic climb gradients.
 - Dispersed track: to model measured or estimated lateral dispersion about mean tracks.
 - Refinement: 9.
 - Tolerance: 0.1 dB.
 - Grid rotation: as necessary to avoid spurious asymmetry about runway axis.

Appendix B annex 7

Climate Change

- B.270 Numerous research papers and policy documents have been published about climate change. The main problem is that burning fossil fuels causes the surface temperature of the earth to heat up – global warming. Aviation mainly contributes to global warming because of the fuel burned by aircraft in flight. A set of important documents on the topic is: DfT (2003a, 2003b, 2003c), ICAO (2001), POST (2003) and RCEP (2001, 2002). DfT (2004) is the most recent UK Government technical statement specifically concerned with aviation and global warming.
- B.271 The problems arise because ‘greenhouse’ gases, including water vapour, carbon dioxide (CO₂) and methane (CH₄), absorb infrared radiation and thus trap heat near to the earth’s surface. The impact of aviation on climate change is increased over that of CO₂ alone by the range of secondary emissions released and their specific effects at altitude, plus other effects e.g. contrail formation and associated cirrus clouds. The impact is measured using a concept called radiative forcing. The radiative forcing index (RFI) measures the magnitude of a potential climate change mechanism. It expresses the change in the energy balance of the earth-atmosphere system measured in watts per square metre (W.m⁻²). Positive values of radiative forcing imply warming, and negative values imply cooling. The RCEP and other credible authorities state that the total radiative forcing due to aviation is probably some 3 times that due to aviation’s carbon dioxide emissions alone. It should be noted that there is uncertainty about the impact of some of the emissions from aviation, particularly contrails and associated cirrus clouds.

B.272 DfT (2003a) states that:

‘For 2000, estimates show that UK civil passenger aviation produced 30 million tonnes of CO₂, which corresponds to 18% of all UK transport CO₂ emissions and 5% of UK CO₂ emissions from all sectors.

[In] 2020 aviation might produce ... about 10 – 12 % of total UK CO₂ emissions from all sectors. For the reasons given in the section on radiative forcing ... aviation’s share of total climate effects is higher than its share of CO₂ alone.’

B.273 Thus, even over 20 years, aviation is projected to increase its global warming effects markedly.

Appendix B annex 8

Local Air Quality

- B.274 Air is mainly nitrogen and oxygen, with smaller proportions of inert gases and carbon dioxide. Human activity has added other components to the atmosphere, which are less benign to people's health and result in 'air pollution' or degraded 'air quality'. This has mainly occurred through industrial processes and the burning of fossil fuels in vehicles and power plants. Aviation, in combination with road traffic, contributes to the total emissions of air pollutants near to airports. The most important emissions for aviation are nitrogen dioxide (NO₂) and particulates or small particles (PM₁₀).
- B.275 Damage to human health from air pollution can potentially be of many kinds (COMEAP, 2000):
- Death within a short time to normally healthy people (highly unlikely as a consequence of aviation alone);
 - Death within a short time to susceptible people (highly unlikely as a consequence of aviation alone);
 - Reduced life span through cumulative pollution effects;
 - Statistically reduced life span through possibility of carcinogenic effects; and
 - Reduced quality of life, e.g. asthma symptoms.
- B.276 ICAO deals with the environmental effects of aviation through its Committee on Aviation Environmental Protection (CAEP). Its resolution A35-5 (ICAO, 2004) addresses inter alia the problem of limiting exhaust pollution from aircraft. ICAO has set engine certification standards in the convention on International Aviation (Annex 16 Volume 2). These limit the emissions of unburned hydrocarbons, NO_x, CO and smoke during the landing and take-off (LTO) cycle, up to an altitude of 3,000 feet agl. The LTO cycle includes idle, taxi, take-off, climb out, descent and approach.

Local air quality at ground level remains largely unaffected by aircraft emissions that take place above 3,000 feet agl because dispersion reduces concentration levels for these emissions. In 2005, ICAO mandated a further reduction of 12% in NO_x for all aircraft jet engines certificated after December 2008 (ICAO, 2005).

Appendix C

Airspace Change Proposal – Consultation Report

Introduction

- C.1 As part of the formal Airspace Change Proposal submission to SARG, the Change Sponsor must be able to demonstrate that the consultation feedback has been considered and, where appropriate, integrated into the Formal Airspace Change Proposal.
- C.2 In order to ensure that the various areas for assessment by SARG are addressed, Change Sponsors should submit the documentation with clearly defined sections as per the following headings:
- Executive Summary
 - Overview of Responses
 - Modifications to the Proposal
 - Supporting Documentation

Executive Summary

- C.3 The Executive Summary should bring the key information to the front of the Consultation Report in order to help readers have visibility of key issues.

Overview of Responses

- C.4 The purpose of this section is to summarise the analysis of the individual comments and feedback from the consultation exercise and to highlight recurrent themes.

Modifications to the Proposal

C.5 The purpose of this section is to demonstrate how the Change Sponsor has modified the Proposal in light of stakeholder feedback and responses to the consultation exercise.

Supporting Documentation

C.6 The Change Sponsor must provide the following supporting documentation:

- A copy of the original Proposal (or any subsequent Proposals) upon which consultation was conducted;
- Consultation Record Sheets (refer to Template below);
- A copy of all correspondence sent by the Change Sponsor to consultees during the consultation exercise;
- A copy of all correspondence received by the Change Sponsor from consultees during consultation;
- A tabular summary record of consultation actions;
- A map (no smaller than A3 size) showing the location(s) of complainants in relation to proposed airspace boundaries, arrival and departure routes, noise contours, etc.;
- Details of and reasons for any modification to the original Proposal as a result of consultation;
- Details of further consultation (written and verbal) conducted on any revised Proposal;
- A record of all the actions taken with all consultees, be it through meetings or verbal contacts, must be maintained. The need to close correspondence is important, especially where objections are dealt through mitigation or agreement; and
- A copy of the feedback documentation to all consultees.

Consultation Record Sheet (Template)

Serial	1	2	3	4	5	6	7	8	9	10
Name/organisation										
Date hastening letter sent										
Date response received										
Further correspondence (ref no/date)										
Date of meetings										
For neutral/against proposal										
Key issues/themes										
Impact of issues/themes on the design options										

Appendix D

Airspace Change Proposal – Methods of Consultation

Introduction

D.1 Consultation is the only way to ensure that the Proposal has taken account of the interests of all airspace users and the society. There is no right method for any given circumstance. All sorts of conditions influence which method will provide useful information and there are no guarantees that just because one method worked well once it will do so again. Therefore, this part of the guidance is designed to help the Change Sponsor get started. It does not set out to debate the philosophy behind consultation, but gives general 'good practice' advice about consultation, introduces some of the commonly used ways of consulting, sets out some of the issues to think about when considering each method, and summarises the pros and cons of the different methods of consultation.

D.2 Benefits of consultation:

- Enables user and other stakeholder requirements to be identified by the Change Sponsor, thus ensuring the airspace arrangements are, wherever possible, able to meet all stakeholder requirements;
- Fosters a working partnership between the airspace users, the Change Sponsor and those affected by its operations; and
- Identifies problems quickly, offering an opportunity to put things right before they escalate.

Consultation Methods

D.3 The following are examples of methods for consultation:

- Questions in Written/Electronic Consultation Documents;
- Consultation Questionnaires;

- Questionnaire-based Surveys;
- Using Representative Groups;
- Focus Groups; and
- Open/Public Meetings.

Questions in Written Consultation Documents

D.4 Asking the right questions will:

- Make it easier for stakeholders to reply to the consultation;
- Collect evidence to test the Change Sponsor's assumptions on the change Proposal;
- Help to unearth anything that had not been anticipated;
- Persuade stakeholders that the consultation is genuine and that their views and experience are valued;
- Increase the likelihood of quality and quantity of responses; and
- Make the task of analysing responses easier.

D.5 Do not start drafting the questions until after the proposal due to be consulted upon has been written. From the outset, keep a note of any issues that are unclear or uncertain and for which further evidence and opinion is needed.

D.6 There are different types of questions. The type of questions asked depends on what stage of the proposal is being consulted upon:

- Open questions:
 - Provide qualitative responses – ideas, opinions and comments.
 - Provide range and depth.
 - Respondents can qualify their answers.
 - Are not easy to quantify numerically, unless a coding frame has been drawn up.
 - Answers can be misinterpreted.
 - Answers may not be analysed impartially.
- Closed questions:
 - Provide specific data.

- Easy to complete, especially for people with little time to spare.
- Easy to analyse and report.
- Provides clear information on the level of support.
- Because percentages of responses can easily be obtained, this should only be interpreted to give an indication of the weight of views and of course should not be interpreted as representing the level of support within the total population.
- Can draw misleading conclusions from a limited range of options.
- Do not capture qualifications to answers, e.g. “Yes, but...” or “It depends...”.
- May discourage a stakeholder from giving information about any unanticipated implications not covered in the consultation document.
- General questions:
 - Convey that the Change Sponsor is open to receiving a wide range of views.
 - Can mislead stakeholders about the extent to which the Airspace Change Proposal can be influenced and so changed.
- Detailed questions:
 - Convey the impression that the Change Sponsor really is interested in the views of stakeholders.
 - Help provide feedback on the specific areas of uncertainty.

D.7 How to use Questions in a Consultation Document:

- Use a mix of open and closed questions;
- Use a mix of general and detailed questions;
- Keep the number of questions to a minimum;
- Allow adequate space for answers without leaving too much space;
- Avoid double- barrelled questions “Do you understand and support...”;
- Ask respondents to comment on any unintended consequences; and
- Include a final question asking for any relevant comments.

Consultation Questionnaires

- D.8 Instead of including questions in the consultation document, a Change Sponsor could consider producing a separate questionnaire.
- D.9 Questionnaires are a useful tool to provide structure to a consultation exercise as they:
- Can draw together questions already contained within the document;
 - Can include both open and closed questions;
 - Should include paragraph references to the relevant section in the consultation document;
 - Can be included with a document or separately;
 - Can be easily integrated with answers from online consultations;
 - Are easier for stakeholders to respond;
 - Increase the likelihood that all questions are answered;
 - Are easier to analyse; and
 - Should never be compulsory; be clear that respondents can submit their comments in any format.

Questionnaire-based Surveys

- D.10 Quantitative research gives statistics in response to set questions. For instance, it could tell a Change Sponsor what proportion of those affected by its operations would like to see start times put back an hour later each day. It also allows the Change Sponsor to get views from a widely representative group, and can give statistically reliable information. It is, therefore, essential to engage expert advice in the development of questionnaires.
- D.11 Quantitative research will tell the Change Sponsor what proportion of people think something but, unless it is planned carefully, it won't provide the reasons why. It can also fail to pick up on what are viewed as being the significant problems as these were not considered when drafting the questions.

D.12 Points to think about:

- **Preparation:** Read other surveys, its results, the questionnaires and the evaluation of the process.
- **Questions:** The usefulness of the survey will depend on the questions. It is only too easy to carry out surveys that ignore the issues that are important to others. Discussion groups can help find out what questions should be asked.
- **Testing:** Pilot the questionnaire on a small group. Can they understand the questions? Does it produce meaningful results? Will the results help? Avoid leading questions, and only ask one question at a time.
- **Relevance:** Do not ask a question if the results cannot be acted upon.
- **Design:** Pay attention to the design and layout of survey forms. A large print size, plenty of space for people to write, clear instructions and questions, putting everything in a logical order and asking for personal information at the end rather than the beginning will all increase the chances that people will fill in the form. People may be put off by a very long questionnaire.
- **Expertise:** If complex questions need to be asked, it might be better employing someone to conduct interviews rather rely on a self-completion questionnaire.
- **Confidentiality:** Allow people to make their comments anonymously. Make it clear that opinions will not be published in such a way that individuals can be identified, unless there will be a need to quote responses, in which case permission must be sought.
- **Responses:** Sample sizes and response rates will vary according to the sort of survey method being used, who is being asked and what is being asked. Response rates to postal surveys can be as low as 5-10% if they are sent cold. A Change Sponsor can improve results by sending out a 'warning letter', designing the survey carefully, include pre-paid envelopes, personalised letters and a 'reminder letter' when

nearing the closing date (but allowing time for responses to be sent), however, never expect a 100% response.

D.13 Advantages of using Questionnaire-based Surveys:

- A very good method of obtaining reliable statistical information;
- Requires relatively low level of interaction;
- Provides the ability to analyse large samples quickly;
- Can be low-cost; and
- Are a good method of getting views of non-user groups.

D.14 Disadvantages of using Questionnaire-based Surveys:

- A poorly designed survey, with poorly drafted questions, can give misleading results;
- If only a small number of people respond, results will be unreliable;
- A lot of time and money can be involved in analysing results;
- Difficult to obtain qualitative information; and
- Can be costly.

D.15 Costs can vary depending on how the survey is done and how large the sample is. An in-house produced questionnaire can be relatively cheap.

D.16 Questionnaire-based surveys are best used to discuss general issues, as they can be targeted at particular groups and focussed on specific issues.

Using Representative Groups

D.17 Many, mainly voluntary, organisations know what is happening within their groups, and are in a good position to give an indication of what people will think about the proposals and the specific problems people will have with it. Representative Groups may be made up of people who have a particular interest in a subject and have strong views, and this needs to be taken into account. They should not be used as the only means of consultation, but will be a useful source of qualitative information about the effects of the Proposal. They can also help find out where more in-depth research is needed.

D.18 Representative Groups are a ready-made source of information. They may carry out their own research or be able to provide feedback on their experiences. Involving them during the development of the Proposal before going to wider consultation can be invaluable.

D.19 Points to think about:

- **Finding groups:** A Change Sponsor may already have had dealings with, and knowledge of these groups. Local councils usually maintain databases of the groups in their areas or they may be recorded in various regional directories.
- **What they do:** Find out what the group does, who it represents, its priorities, what are its specific interests, how it carries out its work and so on.
- **Involving them:** Discuss how best to work together – meet individual groups, or hold forums where several groups get together.
- **How they can help:** Think about whether organisations could help by carrying out research. But don't always expect them to do it for nothing; they may be cheaper than a commercial organisation, but running voluntary organisations costs money.
- **Timing:** Give voluntary bodies time to respond, they are busy and have limited resources.

D.20 Advantages of using Representative Groups:

- Numbers to be dealt with are more manageable;
- Provides an ability to tap into information being collected by independent organisations;
- Can provide quantitative and qualitative information;
- Can help get views of particular groups;
- Relatively quick and cheap;
- Provides a chance to explore views in depth; and
- Allows for the ability to discuss detailed solutions with people with some technical knowledge.

D.21 Disadvantages of using Representative Groups:

- Depending on type of organisation, the group may contain particularly motivated people who are not fully representative of the users or those affected;
- May not provide statistical information;
- Finding the right group and maintaining records of existing groups can be very time consuming; and
- Groups may require a considerable amount of time to respond.

D.22 Costs are relatively cheap.

D.23 Representative Groups are best used to discuss general and specific issues of relevance to the proposed airspace change.

Focus Groups

D.24 Focus groups are usually made up of around 8-10 people led by a trained facilitator in a one-off discussion on a particular topic. Like individual interviews, focus groups can explore issues in considerable depth, and have the advantage that people can bounce ideas off others.

D.25 Focus groups are particularly useful for finding out what specific groups of people think of the proposed change.

D.26 Points to think about:

- **Composition:** Although it is tempting to try to get a group to be fully representative of all users or the public, experience has shown that the smaller group leads to more effective communication. It may require more than one discussion group to investigate views of more than one part of the community. The timing of the focus group meetings will need to fit in with the needs of all its members.
- **Expertise:** It is important to use a skilled facilitator to run the groups. They will make sure that everyone has a chance to speak and move the discussion along without imposing their views.
- **Focus:** Start with something relatively simple with real boundaries.

- **Valuing participants:** Show participants that their contributions are valued by making sure that they have clear information about what their role is, and that all practical arrangements run smoothly. It is often the little things that are important – such as giving participants clear directions to the venue or how long the discussion is likely to take.
- **Incentives:** It is often a good idea to follow up an invitation with a telephone call the day before the focus group, and it may be appropriate to offer to pay for travel expenses.
- **Preparation:** It is important to prepare for the focus group carefully, such as drawing up a list of questions or areas that wish to be covered. Although the groups should be fairly flexible and informal, a structure that makes sure that the significant areas are covered, and that other issues do not take over the conversation, is important.
- **Recording:** Consider tape recording sessions to allow for more detailed analysis afterwards. But normal notes are also important because, for example, the use of visual aids would be difficult to record on tape.

D.27 Advantages of using Focus Groups:

- Identification of what is considered important;
- Individuals may feel more confident in groups and say things they would not say on their own;
- Groups allow people to spark ideas off one another;
- Provides information about what people think and why; and
- Can help get any messages across better.

D.28 Disadvantages of using Focus Groups:

- Must use experienced facilitator (cost);
- Group views can tend to the norm (although a good facilitator will help avoid this);
- Difficult to prioritise issues;
- Does not provide statistical information – gives the ‘why’, not the ‘how many’;

- Feedback will not be typical of the views of users or those affected; and
- Lack of confidentiality in the group may inhibit some participants.

Open/Public Meetings

- D.29 Open meetings are meetings arranged for members of the public to find out and express their views on a particular issue. Attendance is open to any interested member of the public. Meetings are usually held at a public place (school, church hall, sports centre) convenient for people to get to. The issue to be discussed is usually publicised in advanced through posters leaflets, letters, invitations, etc.
- D.30 Public meetings often have a low attendance, and those people who do attend often have a particular concern or viewpoint, which is not necessarily representative of the population as a whole.
- D.31 Open meetings can, however, be a good way of encouraging dialogue and keeping members of the public informed. Used carefully, they can complement other forms of consultation.
- D.32 Points to think about:
- **Issue:** The Proposal will clearly have an impact on attendance. More people will attend if they are directly affected by or concerned about the issue, or where their interest is attracted. Try to make the material advertising the meeting as interesting as possible and make sure it makes clear the content of the meeting. Have clear objectives for what needs to be achieved from the meeting and how this will contribute to taking forward the Proposal.
 - **Target audience:** Open meetings are unlikely to attract an audience that is representative of the local population, and may contain more retired and middle-aged people than young people, so do not use them as the only method of consultation. Think about the target audience, and organise a meeting at an appropriate time and location.

- **Collecting information:** Think about why people might want to attend an open meeting. As well as an interest in a particular issue, people might be motivated to attend by a sense of community spirit or support. A short questionnaire for people who attend could provide this information.
- **Publicity:** Publicise the meeting as widely as possible to reach the intended audience. As well as posters, leaflets, etc., word of mouth is an effective means of advertising. Speak to informal networks, parish councils, community and interest groups.
- **Practicalities:** Planning the practical side of a meeting can be difficult if the number of people likely to attend is unknown, so the organiser might want to invite people to let them know if they are going to come so there is an indication of numbers.
- **Meeting structure:** Think about how the meeting will be structured. Make sure that any speakers know what is expected of them (i.e. how long they should speak) and that the Chair is well briefed and is able to control any more vocal members of the audience and limit repetitive discussion. If appropriate, it may be beneficial to break the meeting up into smaller workshop/discussion groups to give more people the chance to participate.
- **Reporting:** Recording views and reporting back can be difficult in open meetings, particularly if there are large numbers of attendees. Make sure someone takes a note of the points raised. People can vote on the main issues, but be careful not to place too much weight on these statistics. It must be made clear to participants how their opinions will be taken forward.

D.33 Advantages of using Open/Public Meetings:

- Provides local opportunities for people to comment on matters that affect them directly or indirectly;
- Offers a convenient and transparent way to demonstrate public consultation/build up good relationships; and
- Can be used to inform the public at the same time as getting views.

D.34 Disadvantages of using Open/Public Meetings:

- People who attend are unlikely to be representative of the local population;
- Attendees' ability to contribute to a discussion can be limited due to lack of knowledge and possibly lack of interest; and
- Contributions will mainly be about local, topical or personal concerns.

D.35 Costs can be relatively cheap depending on how it is done.

D.36 Open/public meetings are best used to get a feel for public opinion on a particular topic/issue and inform the public.