Civil Aviation Authority

Heathrow Airport Operational Freedoms Trial

CAP 1117

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Heathrow Airport Operational Freedoms Trial

The Civil Aviation Authority's supplementary views on Heathrow Airport's end-of-trial report

www.caa.co.uk

October 2013

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Key points

The hypothesis being tested by the trial, as proposed by the South-East Airports Taskforce, was that granting additional operational freedoms at Heathrow could potentially deliver:

- significant benefits for passengers by improving the resilience and reliability of the airport, and
- environmental benefits, with fewer unscheduled night flights, lower emissions and less stacking.

However, the data from the trial is inconclusive.

The CAA would agree with Heathrow Airport Ltd (HAL) that it is possible that the freedoms trialled did benefit airport operations. Intuitively, greater operational flexibility should help air traffic controllers to get the airport back on schedule. But the benefits claimed in the HAL report have not been statistically proven.

Any operational benefits of operational freedoms are offset by some redistribution of aircraft noise among local communities, and preliminary work suggests some detrimental impact. Communities below the westerly approach paths have their respite period interrupted by aircraft arriving on the runway usually used for departures, while others are affected by vectoring off the established departure routes.

Developing earlier work by HAL, the CAA sought to estimate the monetary value of the costs and benefits of the measures trialled:

- The CAA estimates that operational benefit from the operational freedoms trialled in Phase 2 is likely to lie somewhere between –£7.7 million and +£10.6 million a year, with a mean estimate of around +£1.8 million. However, there are substantial uncertainties around such calculations.
- The CAA developed a methodology that could form the basis for future work to calculate the lost value associated with the erosion of respite from noise. However, the available data is currently insufficient to allow us to make such a calculation.

A lot was learnt from the trial, which the CAA believes:

- could be joined up with the wider package of ongoing change to enhance operations at Heathrow, and
- has led to HAL adopting a more inclusive approach to engaging with the community about the impact that the airport has on them.

HAL's engagement programme was largely successful in publicising the trial and bringing together technical experts to discuss data issues. However, it was less obvious that much progress was made in improving its relationship with the wider community.

Before taking a decision on any more permanent application of the freedoms, the Government has undertaken to hold a public consultation. The CAA has set out a number of 'insights' built up during the trial and recommends that the Government consults stakeholders on these insights as well as the overall value of the freedoms to Heathrow.

Should the Government agree to any future deployment of the 'early vector' operational freedom, an essential enabler would be to re-design the Standard Instrument Departure routes.

Glossary

A glossary also appears in Annex M of the HAL report.

A-CDM	Airport Collaborative Decision Making.
ACL	Airport Coordination Ltd, the independent body which allocates airport slots at Heathrow.
ADC	Alternation Decibel Correction
ANIS	Aircraft Noise Index Study.
ANSP	Air Navigation Service Provider, which in the context of Heathrow is either NERL or NSL, subsidiaries of NATS (formerly National Air Traffic Services). www.nats.co.uk/
APFG	Airport Performance Facilitation Group. APFG was set up to oversee progress with the SEAT recommendations on improving punctuality and resilience and reducing delay. www.caa.co.uk/apfg
ATC	Air traffic control.
ATFM	Air traffic flow management – a function established with the objective of contributing to a safe, orderly and expeditious flow of air traffic, by ensuring that ATC capacity is utilised to the maximum extent possible and that the traffic volume is compatible with the capacities declared by the appropriate air navigation service providers.
Cranford Agreement	An informal but long-standing agreement not to use the northern runway for easterly departures. The Government has ended the agreement. www.publications.parliament.uk/pa/cm201011/cmhansrd/cm100907/wmstext/100907m0001.htm
De-alternation	Landing on the runway designated for departures, or taking off on the runway designated for arrivals. The runway alternation programme is published at www.heathrowairport.com/noise.
Delay	The time lost through an aircraft holding in queues while it is waiting to access infrastructure and/or airspace safely. These queues take various forms, including airborne holding stacks, taxiway queues and being held on stand awaiting ATC clearance.

DfT	Department for Transport.
Dual arrivals	The use of both Heathrow's runways at the same time for arriving flights.
Dual departures	The use of both Heathrow's runways at the same time for departing flights.
Easterly operations	Landing from the west towards the east, and taking off towards the east.
ECS	Education and Consultancy Services Ltd unit of the University of Cambridge Institute for Manufacturing.
ERCD	Environmental Research and Consultancy Department of the CAA.
EUROCONTROL	The European Organisation for the Safety of Air Navigation. www.eurocontrol.int/
FAS	Future Airspace Strategy, a collaborative initiative between a range of stakeholders which sets out a plan to modernise airspace by 2020. www.caa.co.uk/default.aspx?catid=2408&pagetype=90
HACAN	Heathrow Association for the Control of Aircraft Noise. www.hacan.org.uk/
HAL	Heathrow Airport Ltd. www.heathrowairport.com
Heathrow Airport Consultative Committee	An advisory body constituted by HAL in accordance with Section 35 of the Civil Aviation Act 1982 (as amended by the Airports Act 1986) which provides a forum for representatives of airport users, local authorities and other bodies concerned with the locality to discuss matters concerning the development or operation of the airport affecting users and people living and working locally. www.lhr-acc.org/
KPI	Key performance indicator.
LAMP	London Airspace Management Programme, forming part of FAS.
NATS, NERL, NSL	See ANSP.

Noise and Track-Keeping Working Group (NTKWG)	A group chaired by HAL comprising local community representatives, ATC and airport personnel, active on noise and track-keeping and other environmental issues and reporting on these to the Heathrow Airport Consultative Committee.
Noise-preferential routes	Aircraft departing from Heathrow follow set departure routes agreed by Government. The NPR followed usually depends on the destination of the flight.
Operational freedom	The use of an air traffic management procedure connected to the Operational Freedoms Trial in accordance with the trigger conditions detailed at www.heathrowairport.com/noise. These procedures were used from 07.00 until the last departure.
Out of alternation	See De-alternation.
Proactive measure	The use of an air traffic management procedure to test proactively specific procedures connected to the Operational Freedoms Trial. Proactive tests were the landing of A380s or small/light aircraft out of alternation, and the use of the southern runway for Terminal 4 movements. Proactive tests were run during specific periods.
Punctuality	The difference between the *planned* off- or on-blocks time as defined in the schedule (i.e. the scheduled time) and the *actual* off- or on-blocks time.
Resilience	The ability to anticipate, withstand and recover from disruptions caused by adverse conditions.
Segregated mode	The usual mode of runway operation at Heathrow: the use of one runway for arrivals and one for departures.
SEAT	South-East Airports Taskforce.
SID	Standard Instrument Departure. Published flight procedures that are followed by aircraft on an Instrument Flight Rules flightplan immediately after take-off.
Stackholding time	The time from which the aircraft enters a 'holding stack' (a fixed circling pattern which aircraft fly while waiting to land) until the time at which they leave. Heathrow uses four such stacks.

Taxi-in time	The time taken from touchdown to docking at the arrival gate.
Taxi-out time	The time taken from pushback until the aircraft reaches the holding point to queue for the runway.
TEAM	Tactically Enhanced Arrivals Measures. The procedure of landing aircraft on the runway designated for departing aircraft – a dual-arrival runway operation. TEAM is triggered: – where there is a forecast delay of 10 minutes or more between 06.00 and 06.29, or 5 minutes forecast delay or more between 06.30 and 07.00; or – after 07.00, when severe inbound congestion occurs, or is anticipated to occur, involving delays of 20 minutes or more.
TEAM*	The same as TEAM, except that for TEAM*, which was specific to the Operational Freedoms Trial, the 20-minute threshold trigger is reduced to 10 minutes delay; or the headwind on approach to Heathrow is forecast to be greater than 20 knots at 3000 feet; or the arrival or departure flight schedule is anticipated to run later than 30 minutes or 30 per cent of flights are running outside of the 15-minute punctuality target.
TED	Tactically Enhanced Departures. The procedure of departing aircraft using the runway designated for arriving aircraft – a dual-departure runway operation.
Vectoring/ Early vectoring	Air traffic control re-directing aircraft (early) from their normal routes of departure.
Westerly operations	Landing from the east towards the west, and taking off towards the west.

CHAPTER 1

Introduction

Heathrow's Operational Freedoms Trial

1.1 The Heathrow Operational Freedoms Trial was designed to test whether additional operational flexibility would benefit operational resilience at Heathrow, and to quantify both the benefits and costs of possible changes to existing operating procedures. The Government made clear that the trial would not increase the number of flights at Heathrow, which is currently subject to a cap of 480,000 air transport movements a year.

1.2 The trial was run by Heathrow Airport Ltd (HAL).[1] It was in two phases. Phase 1 of the trial ran from 1 November 2011 to 29 February 2012 and Phase 2 of the trial ran from 1 July 2012 until 28 February 2013.

The purpose of this report

1.3 HAL has produced a report of the findings of the Operational Freedoms Trial.[2] (We refer to this as 'the HAL report'.) This report sets out the CAA's views on the HAL report.

1.4 Our report is being submitted to the Department for Transport (DfT) and Airports Commission as part of the CAA's role in providing oversight of the trial and separate and independent analysis on the conduct of the trial and HAL's conclusions.

1.5 The report is aimed at providing a readily accessible and evidence-based summary of HAL's findings from the trial. It supplements the HAL report and therefore, in order to avoid duplication, offers only a summary of the significant quantities of detailed information provided in the HAL report. We cross-refer to the HAL report and appendices where we have seen it appropriate to comment.

1.6 In the final chapter we draw some conclusions about the findings of the trial to influence the Government's thinking on whether some or all of the measures trialled should be deployed on a more permanent basis.

1 On 15 October 2012, BAA announced that it was changing its name and that Heathrow and other BAA airports would operate solely under their own stand-alone brand. This report therefore refers to HAL throughout, but any quotes from material pre-dating October 2012 may refer to BAA.

2 The two reports will be published on the CAA's and HAL's respective websites.

Structure of this report

1.7 This report sets out:

- the background to the trial;
- the CAA's approach to overseeing the trial;
- an overview of how the trial was designed;
- a summary of reports on the trial, including the recommendations the CAA made for Phase 2 in the light of Phase 1;
- the safety impacts of the trial;
- the CAA's views on HAL's data collection, publication and analysis methodology;
- the extent to which operational freedoms were used in the trial;
- the CAA's views on HAL's analysis of the effects of the measures trialled, both operational and environmental, and our estimation of the monetary value of the costs and benefits;
- a commentary on the involvement of other stakeholders, in particular HAL's engagement with the local community; and
- the CAA's conclusions about the outcome of the trial, to inform the Government's thinking on whether the operational freedoms should be deployed on a more permanent basis.

CHAPTER 2

Trial Oversight

Chapter summary

The aim of the trial was to see whether enhanced arrival and departure flow rates could improve Heathrow's ability to recover from or avoid disruption by maintaining performance against the planned schedule.

The CAA was asked by the Government to provide independent oversight of the trial, consistent with its objective of enhancing aviation safety and with its advisory role to Government.

The CAA is generally satisfied with HAL's conduct of the trial.

The CAA's overwhelming priority has been the continued safety of Heathrow's operations. Our main involvement was in overseeing the trial's design and data analysis. The CAA's reports from Phase 1 informed HAL's design and handling of Phase 2.

The CAA monitored HAL's engagement programme with local communities and maintained its own, separate dialogue with relevant local authorities. Our Environmental Research and Consultancy Department (ERCD) participated in work to assess the value to communities of respite from aircraft noise.

HAL commissioned University of Cambridge Institute for Manufacturing to audit its methodologies and processes.

Background to the trial

2.1 The report of the South East Airports Taskforce (SEAT), published on 14 July 2011, recommended a package of proposals to address punctuality, delay and resilience issues, to be taken forward at an airport level, but overseen by the CAA.[3] The report recommended exploring the scope for establishing a set of operational freedoms at Heathrow. These freedoms would enable the greater use of tactical measures – in the form of enhanced arrival and departure flow rates – to prevent or mitigate disruption and to facilitate recovery, in defined and limited circumstances.

3 www.gov.uk/government/uploads/system/uploads/attachment_data/file/4354/south-east-airports-taskforce-report.pdf

2.2 The Minister of State for Aviation announced a two-phase trial of operational freedoms by HAL to generate evidence on the impacts and benefits and to provide a basis for consultation with local communities.[4] This would inform the Government's decision on whether these measures should be adopted on a permanent basis, and what safeguards should apply in relation to their use, given that the anticipated operational benefits would be offset by some redistribution of aircraft noise among local communities. HAL was required to engage fully and transparently with relevant local authorities, communities and other stakeholders throughout the process, particularly on the monitoring of noise impacts.

2.3 The hypothesis in the SEAT report[5] was that the granting of additional freedoms could potentially deliver:

- significant benefits for passengers by improving the resilience and reliability of the airport; and
- environmental benefits, with fewer unscheduled night flights, lower emissions and less stacking.

2.4 SEAT recognised that the occasional and limited redistribution of noise when measures were applied would mean that there would be a mix of positive and negative impacts for different parts of the community, and that some people would have existing periods of respite from aircraft noise interrupted.

2.5 SEAT accepted that well-defined safeguards would need to be placed on this additional operational flexibility to ensure that it could only be used on a limited number of occasions in order to strengthen resilience and to prevent or recover from disruption, and that it did not become a routine part of airport operations.

CAA oversight role

2.6 The CAA was asked to provide independent oversight of the trial, consistent with our objective of enhancing aviation safety performance by pursuing targeted and continuous improvements in systems, culture, processes and capability, and consistent with our advisory role to Government.

2.7 The CAA agreed its role with the DfT in advance of the trial. This was summarised in a CAA press notice published at the end of October

4 www.gov.uk/government/speeches/south-east-airports-taskforce

5 SEAT Report, July 2011, paragraphs 5.10 and 5.12.

2011.[6] The CAA also chaired the Airport Performance Facilitation Group (APFG), which was set up to oversee progress with the SEAT recommendations referred to above.[7]

2.8 The CAA's reporting on Phase 1 informed the design and handling of Phase 2. This end-of-trial report is intended to inform the Government when it considers whether some or all of the operational freedoms measures trialled are deployed on a more permanent basis. We understand that before making such a decision the Government would first seek views through a public consultation.

CAA's safety oversight

2.9 In areas of safety, the CAA's role is to ensure that those organisations charged with delivery of safety-significant services (for example air traffic services, aerodrome operators, airlines, maintenance etc) do so in a safe and compliant manner. Many specific disciplines within the aviation industry are subject to regulatory oversight, but in general terms, oversight of each technical discipline will involve audit and acceptance (or approval where appropriate) of services, training and equipment delivered in accordance with service providers' Safety Management Systems, and in accordance with UK and international rules and regulations.

2.10 In respect of the Operational Freedoms Trial specifically, safety oversight fell broadly into two categories. First, review and acceptance of the safety assurance developed to enable the trials to be enacted, and second, ongoing review and monitoring of the conduct of the trials during their enactment. In both cases the CAA has maintained its statutory obligation to intervene if necessary to assure safety.

2.11 Prior to enactment of the trial elements (in both phases), the CAA reviewed the proposed Air Traffic Control (ATC) operational and procedural changes in response to submission of Supplementary Instructions (SIs) or Temporary Operating Instructions (TOIs) by the Air Navigation Service Providers (ANSPs), in this case NATS En Route plc (NERL) for Terminal Control and NATS Services Ltd (NSL) for Heathrow

6 www.caa.co.uk/application.aspx?catid=14&pagetype=65&appid=7&newstype=n&mode=detail&nid=2050

7 APFG included representatives from Government, airports, airlines, NATS, Airport Coordination Ltd, London First and Aviation Environment Federation. APFG met five times between September 2011 and November 2012. www.caa.co.uk/apfg

Tower. For a trial of this sort, the CAA also audits the safety assurance which supports the introduction of the SI or TOI.

2.12 The CAA received regular updates on safety from the ANSP during the trial, and participated in weekly telephone conferences to assure appropriate visibility of trial conduct.

CAA role as adviser to Government

2.13 The CAA was heavily involved in the preparations for the trial, including chairing the SEAT sub-group on punctuality, delay and resilience, whose work informed the final SEAT recommendations agreed by the DfT. The CAA also contributed to the more detailed discussions on trial design and implementation, so as to help Government in deciding the most appropriate scope and triggers. However, the CAA did not have powers to direct changes to the content of the trial, other than where the design or conduct of the trial was likely to have an impact on the airport's safe operation.

2.14 Therefore, safety apart, the CAA's role in overseeing the trial should be seen principally in the context of its advisory role to Government. In this context, the CAA has focused on ensuring that the trial is run within the broad parameters agreed by Government. This includes ensuring that the trial was conducted in a way that produced grounded, objective data that could be shared with others to scrutinise.

2.15 The aim has been to engender a more open, evidence-based assessment by policy-makers, the community and the airport based on a better and more objective understanding of the trade-offs between operational benefit and community harm. In this way we sought to facilitate the creation of a robust information base on which Government could ultimately base decisions. This emphasis on the generation of objective information and its transparency is consistent with the approach that the CAA proposes on the exercise of its new information powers.[8]

8 Under the Civil Aviation Act 2012, the CAA has new duties and powers to provide information to users of air transport to assist them in comparing services and facilities, and to the general public about the environmental impact of aviation. In May 2013 the CAA consulted on its proposed Statement of Policy for the use of these powers.
www.caa.co.uk/default.aspx?catid=2608&pagetype=90&pageid=14745

CAA oversight of HAL engagement

2.16 The CAA saw HAL's engagement with local communities as key to ensuring both the legitimacy of the trial and a proper understanding of its impacts. The CAA therefore monitored HAL's engagement through a weekly teleconference and regular meetings with HAL and DfT. This gave the CAA an overview of HAL feedback on its ongoing engagement and on the complaints it was receiving.

2.17 The CAA also initiated its own channels of communication with stakeholders through observing at numerous HAL meetings with stakeholders, as well as hosting our own regular bilateral meetings with local authorities, in particular the 2M Group.[9] We met Populus, the polling company commissioned by HAL to undertake focus groups and opinion polls about the trial. We had representation on the working group looking at the value of respite and on the data group which agreed the best approach to collecting and analysing trial data. We also produced a news release at the start of the trial, briefed local journalists, and commented on printed and website briefing material.

CAA oversight of data collection and analysis

2.18 One of the CAA's principal high-level objectives was to ensure that the trial was conducted in a way that produced grounded, objective data that could be shared openly with all stakeholders for proper, evidence-based scrutiny. The aim was to bring a better and more objective understanding of the trade-offs between operational benefit and community harm.

2.19 HAL involved stakeholders in specifying the type of information that they would find helpful, and the data generated has been made publically available to third parties such as local authorities and local communities, facilitated by the CAA. As a result there has been more frequent and deeper liaison between the airport and community stakeholders during the 16-month period spanning the trial than might otherwise have been the case.

2.20 The CAA's Environmental Research and Consultancy Department (ERCD) participated in work to assess the value to communities of respite from aircraft noise. As noted in Chapter 8, the CAA's ERCD was commissioned by HAL to carry out the noise assessment for the trial, completely separate from the CAA's oversight role, and briefed

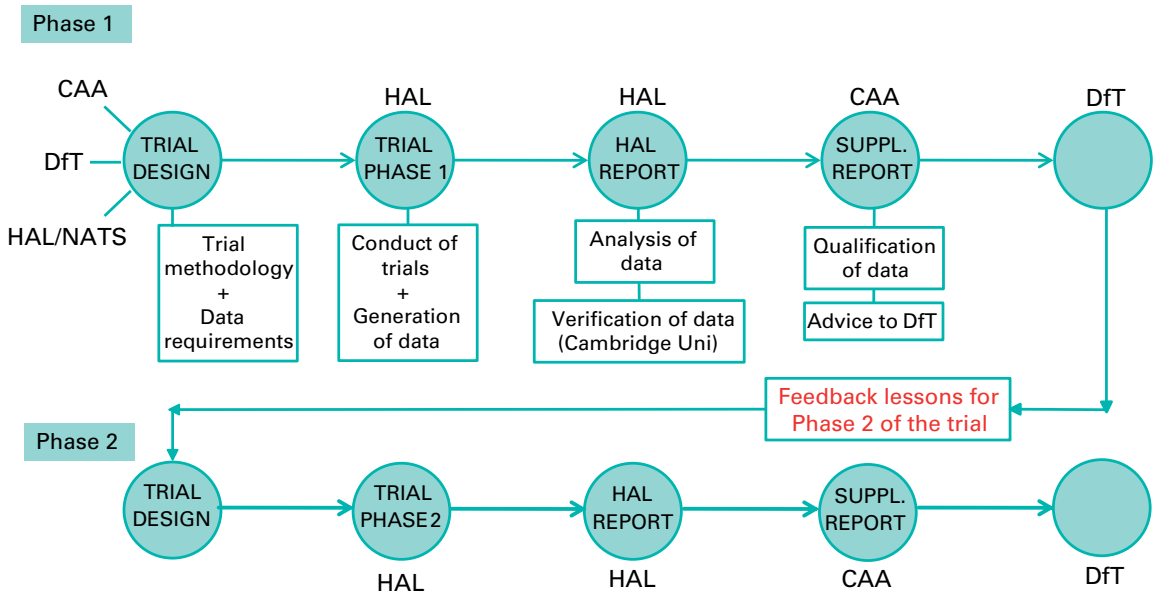
9 The 2M Group is an all-party alliance of local authorities concerned about the environmental impact of Heathrow operations on their communities. www.2mgroup.org.uk/

stakeholders on its methodology through the Noise and Track-Keeping Working Group (NTKWG).[10]

Oversight and reporting process

2.21 The oversight and reporting process is set out in Figure 1 below.

Figure 1: Reporting on the trials – generation of data and production of reports



Audit of the trial by University of Cambridge Institute for Manufacturing

2.22 HAL commissioned Education and Consultancy Services Ltd of Cambridge University's Institute for Manufacturing (ECS) to provide an independent audit to ensure that the trial was conducted and reported on in a manner consistent with the objectives. This included providing a methodology for the adequate assessment of the trial and ensuring appropriate scientific rigour; highlighting potential strengths and weaknesses of trial activities; monitoring progress with the trial, ensuring robust data collection methods; and preparing an overall report that describes assessment methods and the results of the trial.

10 NTKWG is a group chaired by HAL comprising local community representatives, air traffic control and airport personnel. It is active on noise and track-keeping and other environmental issues and reports on these to the Heathrow Airport Consultative Committee.

CAA conclusions on HAL's conduct of the trial

2.23 HAL's conduct of the trial has generally been good, with thought and resources committed to addressing the principal issues faced by the trial, and proper review of lessons learned after Phase 1 to inform the way Phase 2 was designed and run.

2.24 HAL, CAA and ECS have dedicated significant resources to generating, validating, and interpreting data from the trial, and to agreeing a common approach. From this we have achieved reasonably close consensus on the optimum analytical approach and what the results from the trial tell us. Nevertheless, as could be expected, differences of interpretation remain.

2.25 Further CAA commentary on the way the trial was run and analysed appears under each of the chapter headings of this report.

CHAPTER 3

Design of the trial

Chapter summary

The trial was in two phases, with the outcome of Phase 1 influencing the design of Phase 2.

Heathrow's runways are usually subject to a strict alternation pattern, with one used for take-offs and one for landings. The aim of the trial was to test greater flexibility in this alternation. Phase 2 also tested the early vectoring of aircraft from their normal departure routes.

The trial consisted of a set of reactive measures, which could be used only when certain trigger criteria were met, and proactive measures used during defined periods.

Two of the planned measures could not be trialled, one because the necessary safety assurance was not in place and one because airlines were unable to comply with the schedule changes that were required.

The SEAT recommendations

3.1 As explained in Chapter 2, the SEAT report recommended exploring the idea of making Heathrow's operating restrictions more flexible to enable the greater use of tactical measures, in defined and limited circumstances, to help improve the airport's resilience to disruption.

SEAT punctuality, delay and resilience sub-group

3.2 The SEAT recommendation stemmed from the punctuality, delay and resilience sub-group of SEAT. The sub-group produced a report[11] in May 2011 which categorised Heathrow operations over the course of a year as approximately 300 'green' days of normal operations, 50 'amber' days of moderate disruption, and 15 'red' days of severe disruption where on-the-day recovery is not possible. The report noted that in some circumstances the availability of greater tactical headroom at

11 http://assets.dft.gov.uk/publications/south-east-airports-taskforce-report/south-east-airports-taskforce-sub-group-report.pdf

Gatwick and Stansted (where in each case the runway is used for both landings and take-offs) could facilitate recovery at these airports during amber days, where in general they recover more quickly than Heathrow.

3.3 The sub-group proposed introducing short-term, tactical measures, known as operational freedoms, to handle peaks in demand or to off-set potential reductions in operational capacity on a temporary basis as required. This would largely be in the form of additional flexibility for ATC in operating the runways and related airspace. The sub-group envisaged the measures being triggered by the onset or anticipation of disruption, and being applied solely on days of disruption and only against clear, pre-determined criteria.

Implementing the SEAT recommendations

3.4 The SEAT report largely adopted this recommendation by the sub-group, and announced the Operational Freedoms Trial at Heathrow under the CAA's oversight. The aim of the trial was to see whether the measures would enhance arrival and departure flow rates and thus improve Heathrow's ability to recover from disruption and get the schedule back on track.

3.5 The SEAT report stated that the trial measures would be deployed on an occasional and limited basis and in prescribed circumstances, with safeguards to ensure that they could only be used to improve resilience and deal with disruption and did not become a routine part of airport operations. The specification for the trial, including the trigger points used, was agreed between HAL and the Government, informed by advice from the CAA.

3.6 The inherently untested nature of the measures meant it was difficult to predict the degree to which they would be used, hence the requirement for a trial to collect evidence on the impacts. An overly restrictive trial would limit the data generated to provide that evidence, on which the Government would ultimately base its decision on any more permanent deployment of the freedoms. Consistent with the SEAT report, the design of the trial therefore did not limit the trial to so-called amber or red days. Instead, specific criteria were agreed that had to be met before the measures could be used, including anticipated poor punctuality or delay performance, and a limit on the number of landings out of alternation in any one hour. In addition, some measures were also trialled proactively without trigger conditions, but for set periods only.

Reactive and proactive measures

3.7 The 'reactive' measures in the trial reduced the trigger for deploying the 'dual-arrivals' freedom (defined below), from the standard 20-minute expected-time-in-stack delay to 10 minutes. This gave Heathrow's air traffic controllers greater flexibility to try to pre-empt instances of worsening build-up in delay. The reactive measures also tested the effect of increasing the departure rate through controllers re-directing aircraft from their normal departure route.

3.8 A separate part of the trial ('proactive' measures) also explored the potential benefits to resilience of removing from the arrival stream aircraft types with particular wake-vortex separation requirements, and allowing Terminal 4 movements to use the nearer southern runway.

3.9 Some freedoms which HAL planned to include as part of the trial did not prove feasible. This was a source of frustration for some parties, where significant preparation time was expended to no avail. However, the experience gained is likely to be useful for HAL's future planning.

Pre-existing freedoms

3.10 Normally the airport operates in 'segregated' mode whereby one runway is used for arrivals and one for departures. Some freedom to depart from this arrangement already existed before the trial began.[12] Subject to certain criteria, this allows dual arrivals in the early morning between 06.00 and 07.00, or when there is severe inbound congestion, or when aircraft are on easterly operations, i.e. arriving from the west and departing towards the east.[13] Dual arrivals and dual departures are also permitted in exceptional circumstances, for example recovery from snowfall.

3.11 Thus it has been necessary to untangle the existing freedoms – which were not an 'operational freedom' for the purposes of the trial – from those introduced by the trial.

12 At the beginning of the trial HAL was receiving so many questions about these existing freedoms that it published an explanatory document (in December 2011). This was subsequently adapted to explain the freedoms being trialled in Phase 2. www.heathrowairport.com/static/Heathrow_Noise/Downloads/PDF/LHR_noise-Operational_Freedoms_trial-Phase_2-explanatory_document.pdf

13 Air traffic control selects the runway depending on wind direction, on the basis that aircraft have to land and take off into wind. Around 30 per cent of operations are 'easterlies' on average. On easterly operations there is no runway alternation, a legacy of the 'Cranford Agreement' that the northern runway would not be used for easterly departures.

3.12 The trial did not increase the cap on overall movements, the scheduled hourly capacity, or scheduled night flights, and it did not involve 'mixed-mode' operations, i.e. the scheduling of the runway to operate arrivals and departures at the same time.

Design of Phase 1

Safety considerations

3.13 The development and acceptance of suitable robust safety assurance was required before Phase 1 of the trial could commence. Air traffic control at Heathrow and Terminal Control developed a Concept of Operations, and from this developed operational and procedural changes to their systems. The Concept of Operations, together with Temporary Operating Instructions (TOIs) with associated safety assurance, were submitted to the CAA for review and acceptance. Acceptance of the material pertaining to design of Phase 1 was achieved before the trial commenced.

3.14 The design of Phase 1 of the trial incorporated provision for regular reporting on safety performance, predominantly the absence of safety-related events, via a (nominally weekly) telephone conference.

Reactive measures

3.15 Phase 1 of the trial investigated the impacts of the following measures after 07.00. These measures could be applied reactively when, on the day, certain trigger criteria were met relating to anticipated poor punctuality or delay performance.

Dual arrivals

3.16 The first was Tactically Enhanced Arrivals Measures (TEAM), whereby some arriving aircraft on westerly operations were able to use the runway designated for departing aircraft – a dual-arrival runway operation. When forming part of the trial this measure was referred to as TEAM* to distinguish it from the existing dual-arrivals freedom, mentioned above, which was already known as TEAM.

Dual departures

3.17 The second was Tactically Enhanced Departures measures (TED), whereby some departing aircraft on westerly operations were able to use the runway designated for arriving aircraft – a 'dual-departure'

runway operation. Such departures from the designated arrivals runway were restricted in terms of their need to be individually coordinated with departures from the departures runway. This amounted to a single stream of departures, with normal departure separation, but using both runways. This freedom was rarely used – 38 times on eight individual days in Phase 1 – because it gave little operational advantage and was perceived to hinder the overall operation.[14]

Proactive measures

3.18 Operational freedoms were also applied proactively, for two four-week periods (28 November to 25 December 2011 and 16 January to 12 February 2012). These proactive measures tested the effect of landing A380 (i.e. very large) or small aircraft on the runway normally used for departures, and the use of the southern runway for Terminal 4 movements that would otherwise have used the northern runway.

Design of Phase 2

3.19 In the light of Phase 1, HAL incorporated some variations in the design of Phase 2.[15]

Trial duration

3.20 The duration of Phase 2 was extended by six months, so as to end on 31 March 2013 rather than 30 September 2012, the date given by the Minister when the trial was first announced in July 2011. The end of the trial was subsequently advanced to 28 February 2013, because the discrete month planned for trialling the proposed early-morning arrivals measure was not in the event needed, as explained below.[16]

Safety considerations

3.21 The process followed for reviewing the safety of the design of Phase 2 of the trial mirrored Phase 1. Although the specific freedoms and associated triggers were different, the process of identifying and documenting a Concept of Operations, TOIs and safety assurance was followed. However, in the case of the planned trial of dual departures (see below), the ANSP was unable to produce suitably robust safety assurance in the time available, and as such this element of the trial was not incorporated

14 Section 7.5 of the HAL report.

15 www.gov.uk/government/speeches/operational-freedoms-at-heathrow-airport

16 www.gov.uk/government/speeches/early-completion-to-operational-freedoms-trial-at-heathrow

in Phase 2. Acceptance of the material pertaining to all other elements of the design of Phase 2 was achieved before this phase of the trial commenced.

3.22 The design of Phase 2 of the trial also incorporated provision for regular reporting on safety performance, predominantly the absence of safety-related events, via a (nominally weekly) telephone conference.

Reactive measures

Dual arrivals

3.23 This part of the trial continued as in Phase 1, with two exceptions. First, an existing hourly cap on the more flexible use of dual arrivals allowed as part of the trial was raised from six to 12. Second, from late October 2012, HAL changed the criteria for deploying TEAM after 07.00, such that TEAM would not be used if there was any forecast or actual departure delay after 07.00. This change was made as a result of agreement between HAL and airlines to facilitate the airlines' desire for on-time departures.

Early vectoring

3.24 A new measure was added, whereby during 'segregated' operations certain departing aircraft were radar vectored (i.e. re-directed) early by air traffic control from their normal departure routes, mostly remaining within the lateral swathe of the established noise preferential routes (NPRs). This tested whether increasing the departure rate from a single runway improved the reliability of the schedule and reduced the number of unscheduled night flights. It was deployed subject to delay or punctuality triggers being met, as with the dual-arrivals measure, and was the only measure deployed in the month of January 2013.

Dual departures (not implemented)

3.25 Dual departures proposed for inclusion in Phase 2 involved early vectoring to provide an azimuth separation of departing streams of aircraft to allow the two runways to be used independently for simultaneous departures. However, limitations associated with operating dual departures on Heathrow's runways, compounded by existing airspace and route structures (i.e. established NPRs, adjacent airfields, missed approach tracks etc) were all factors which affected the production of suitable safety assurance.

3.26 HAL (in collaboration with the ANSP, and with the agreement of the CAA) identified that developing the necessary safety assurance was not achievable in the time available for the Operation Freedoms Trial. Therefore this measure did not, in the event, form part of the trial.

Early-morning arrivals (not implemented)

3.27 HAL planned to explore whether airport resilience and noise disturbance to local communities could be improved by re-ordering the timing of early-morning arrivals. Specifically the plan was to allow a maximum of 12 aircraft scheduled to arrive after 06.00 to land between 05.30 and 06.00 (i.e. in the restricted night period) to relieve any arrivals backlog at the start of the day, provided that the same number of flights scheduled to arrive between 04.30 and 05.00 were rescheduled to arrive after 05.00. However, in discussion with airlines it became clear that for operational reasons they were unable to reschedule flights in this way, and this measure also did not, in the event, form part of the trial.

Proactive measures

3.28 The proactive measures tested in Phase 1 were refined and continued in Phase 2, and were tested for three one-month periods (16 July to 15 August 2012, October 2012 and February 2013). The main change was that the proactive use of the departures runway for landing an A380 aircraft was extended to include potentially the aircraft in front of or behind an A380. The other proactive measures in Phase 2 were to land 'small and light' wake-vortex category aircraft on the runway normally used for departures, and to land aircraft destined for Terminal 4 on the southern runway when the northern runway was designated for landings.

CHAPTER 4

Reports on the trial

Chapter summary

This chapter summarises the reports by HAL and CAA published during the course of the trial, and the independent audit by the University of Cambridge Institute for Manufacturing ECS Unit.

The reporting on Phase 1 helped to inform HAL's design of and general approach to Phase 2.

The main conclusion from Phase 1 was that insufficient evidence had been generated because of its short duration, and that Phase 2 duration should be extended significantly to enable more robust analysis of the costs and benefits.

ECS supports the findings of the HAL report, but acknowledges that the design of the trial could be improved.

Detailed findings from the HAL report are discussed in Chapters 8 and 9.

HAL reporting

4.1 HAL has published significant detail on the background, design, use and effects of the operational freedoms used, accompanied by independent reports from Cambridge University's Institute for Manufacturing ECS Unit and the CAA's ERCD.

4.2 Over the course of the trial, HAL has produced:[17]

- The end-of-trial report which is the subject of this CAA report, covering the whole of the trial.
- An explanatory document setting out what freedom to depart from 'normal' segregated-mode operations already existed prior to the trial.
- A report at the end of Phase 1 covering the period 1 November 2011 to 29 February 2012.
- A mid-phase report at the end of the first half of Phase 2, covering the summer period 1 July to 31 October 2012.

17 All this material was published on the HAL website at www.heathrowairport.com/noise and www.heathrowoperationaldata.com/

- Monthly factual data reports highlighting key performance parameters.
- Daily data on key performance parameters.
- A website dashboard of information at a glance covering key data on movements, cancellations, punctuality, night flights, runway use, airborne performance and complaints.

HAL findings from Phase 1

4.3 HAL's report on Phase 1 analysed the outcomes from operational, environmental, economic and community perspectives. The report concluded that there had been valuable learnings from Phase 1 which were used to inform Phase 2 and which would be used to assess future progress with the development of operational freedoms.

4.4 In Phase 1, operational freedoms were used almost solely to de-alternate arrivals under westerly operations. On average, just over three per cent of westerly arrivals were affected by operational freedoms. HAL analysis suggested that the trial recorded improvements in ATFM arrival delay, stackholding (under specific circumstances), on-time arrival punctuality, and taxi-in times; a reduction in the average respite hours with no de-alternated flights; a small increase in the noise exposure during respite; a large increase in complaints; generally low awareness and, where explained, some support for the trial among the local community; no detriment to safety; and only very minor increases in airport/airline/ATC workload.

HAL findings from Phase 2

4.5 As noted above, HAL published a report during the first half of Phase 2 covering the summer 2012 season only, which reached some preliminary conclusions, including an estimation of the economic effects where there was a statistically demonstrable link between change in a KPI and the use of operational freedoms. These amounted to a net benefit of £4.3 million for arrivals and net cost of £0.8 million for departures (for a seven-month summer season).

4.6 HAL did not produce a separate report on the second half of Phase 2, and so the findings from the winter 2012 season have been incorporated in its report on the whole trial.

4.7 Detailed findings from this final HAL report are discussed in later chapters, in particular Chapter 8. The headline HAL findings (in section

7 of the HAL report) are that the operational freedoms trialled often had only a small impact and could be swamped by other factors, confirming the inherent complexity of Heathrow operations. HAL concludes that operational freedoms deliver some useful operational performance improvements in some limited areas, and should be retained for future use at Heathrow. However, HAL concludes that they would not provide wholesale significant benefits that would facilitate recovery from major disruption if they were to be implemented in isolation and without further enhancement.

4.8 The HAL report does not include an estimation of the economic effects. The CAA has therefore carried out its own estimations of the economic effects (Chapter 9).

CAA reporting

4.9 The CAA produced two earlier reports on the trial for the Minister of State for Transport, both concerning Phase 1. The first was a mid-trial interim report.[18] The second was a report at the end of Phase 1, which supplemented HAL's own report on Phase 1 and made recommendations for Phase 2.[19]

CAA interim report on Phase 1 (February 2012)

4.10 The CAA was asked by the Minister of State to produce an interim report on the first phase of the trial before it ended on 29 February 2012. This interim report was based on data collected in November and December 2011. It set out the background to the trial; the CAA's approach in overseeing it; how the trial operated; how the airport engaged with local communities about it; how often the freedoms were used; the measurable outcomes so far; and the main issues it faced. However, it did not offer conclusions as to the trial's impact.

4.11 The report concluded that HAL's conduct of the trial had generally been good, with thought and resources committed to addressing the principal issues faced by the trial. It identified areas where improvements could be made. These included trial design and methodology; data production, capture and validation; and engagement with local communities.

18 http://www.caa.co.uk/application.aspx?catid=14&pagetype=65&appid=7&newstype=n&mode=detail&nid=2050

19 www.caa.co.uk/default.aspx?catid=589&pagetype=90&pageid=13392

CAA supplementary views on the HAL report on Phase 1 (May 2012)

4.12 This CAA report supplemented the HAL report on Phase 1 by providing an independent view on the conduct and effects of the trial.

4.13 The report concluded that HAL had run Phase 1 of the trial within the parameters agreed with Government and had generally collected and published data for analysing the trial in an appropriate and transparent manner. It noted that successful engagement with local communities had presented a challenge because of the broad spectrum of interested parties and the technical nature of the measures trialled.

4.14 The report suggested that insufficient evidence had been generated because of the relatively short duration of the trial and that more detailed data and analysis would be required from Phase 2 to draw definite conclusions on those benefits, and on the impacts on local communities. It recommended that the duration of Phase 2 be extended from three to nine months to increase the amount of data generated, enabling a more robust analysis of the benefits and impacts.

4.15 The majority of the report's recommendations had a direct bearing on the approach to be adopted in Phase 2 beginning 1 July 2012, building on the CAA's recommendations in our earlier interim report on Phase 1. HAL sets out these recommendations and how it responded to them in Table 1 of its report. We repeat this table in Appendix A and add our further comments.

4.16 The recommendations concerned:

- trial design and duration, including allowing enough time to agree and consult on them;
- data content, accuracy, validation and regression analysis, and involving local authority technical experts where appropriate in the process;
- awareness-raising with the local community, including clarifying how the trial differed from existing operational procedures;
- better analysis of whether noise complaints were linked specifically to the trial, and assessing the value placed on noise respite by local residents; and
- the resource impact of the trial on the airport, NATS and airlines.

Views of University of Cambridge Institute for Manufacturing

ECS role

4.17 As noted in Chapter 2, HAL employed Education and Consultancy Services Ltd of Cambridge University's Institute for Manufacturing (ECS) to provide independent assurance for the data and trial methodology. ECS's comments related only to the statistical analysis and methodology and did not cover the analysis of customer complaints or of noise and emissions.

Phase 1

4.18 After Phase 1, ECS concluded that data was extracted accurately from HAL's systems, and that the statistical tests undertaken, and the conclusions drawn, were correct. It also examined the nature of the measures trialled and concluded that the analysis strategy was correct.

4.19 However, ECS also noted that the analysis did not provide clear and explicit cause-and-effect links between the measures trialled and most of the performance measures of interest. ECS recommended that an experimental design be developed jointly by NATS and HAL, validated by the CAA with the support of ECS. The CAA agreed that a more robust experimental design should be put in place before Phase 2 commenced.

Phase 2

4.20 An informal working group comprising representatives from HAL and its consultants, the CAA and ECS was formed prior to the start of Phase 2 to discuss the trial design and how best to collect and analyse the trial data. This is discussed in more detail in the section on regression analysis methodology in Chapter 6.

ECS conclusions

4.21 A summary of the audit by ECS appears at section 2.11 of the HAL report. This records that "The independent analysis of the trial data performed by Cambridge, using the same [regression] analysis approaches, supports the report findings", but also acknowledges that "Future trials would benefit from having a narrower scope and greater control of operating conditions, helping to make cause-and-effect relationships associated with operational freedoms easier to observe".

4.22 Apart from auditing the operational and complaints data collected over the trial, ECS also conducted an independent check and analysis of the performance measures of interest in terms of traffic flow and time-sensitive performance indicators.

4.23 ECS thought that the regression analysis adopted by HAL in Phase 2 was a reasonable approach, given the limitations in trial design and data availability. However, ECS regarded the selection of the independent variables for the regressions guided by root-cause charts for both arrival and departure flows as highly arbitrary.[20]

4.24 ECS also performed random checks of some of the regression results and concluded that they were technically correct. Although the results from regression analyses suggested very modest improvements in some measured KPIs, the results are associated with a high degree of uncertainty and sometimes with a very low value of 'goodness of fit' to the data.

4.25 ECS concluded that the lack of clear evidence of performance improvement is mostly because of the complexity of the operational environment and the inability to control many aspects of the trial, thus making it difficult to base any case for more permanent adoption of the freedoms at the airport on the results from the data analysis.

20 This is because the final set of chosen variables is determined through a rather subjective trial-and-error selection process.

CHAPTER 5

Safety impacts

Chapter summary

The safety of Heathrow's operations – the CAA's overwhelming priority – was not prejudiced by the trial.

There were four safety-related events or actions arising from the trial, none causing ongoing significant safety concerns. They arose as a result of the temporary nature of the trial, and the CAA's view is that any future deployment or adaptation of operational freedoms must therefore be accompanied by 'permanent' enabling arrangements, including re-design of departure routes.

Safety oversight

5.1 As explained in more detail in Chapter 2, the CAA was charged with ongoing review and monitoring of the conduct of the trials during their enactment. In this context (in common with its involvement in the design process) the CAA has maintained its statutory obligation to intervene if necessary to assure safety, and received regular safety updates during the trial.

5.2 In the case of the dual-departures freedom originally proposed, the lack of a sufficiently robust safety assurance case was one of the reasons why the freedom was not taken forward to the trial stage (see Chapter 3).

Safety occurrences

5.3 There was a single safety-related occurrence in Phase 1. This related to work permits issued to operate in the runway undershoot, and was addressed immediately by HAL. Safety of aircraft was not compromised and the CAA does not believe that the occurrence was directly attributable to the trial.

5.4 There were three safety-related actions arising in Phase 2. These are properly and fully described in section 4 of the HAL report, and can be summarised as follows:

- withdrawal of the revised TANGO Standard Instrument Departure (SID),[21] subsequently reintroduced in 'un-revised' format;

21 Published flight procedures that are followed by aircraft immediately after taking-off.

- inappropriate departure clearance issued allowing a four-engined 'heavy' aircraft to use the westerly early vector; and
- error in track-keeping during easterly early vectoring.

5.5 The CAA was promptly advised of all four safety-related events or actions by HAL and the ANSP in accordance with the design criteria for ongoing safety oversight of the trial.

5.6 None of the above events or actions caused ongoing significant safety concerns. They were, however, in part reflective of safety issues arising from the 'trial nature' of the deployment of freedoms, rather than the technical content of the freedoms themselves.

5.7 The HAL report (paragraph 1.74) comments that from an air traffic controller's perspective, it was felt that use of the proactive freedom also had a safety benefit as it reduced runway crossings. Intuitively, this would be expected from landing aircraft bound for Terminal 4 on the southern runway out of alternation. However, while trial data did suggest a reduction in runway crossings during the proactive periods (Table 43 in the HAL report), the statistical 'goodness of fit' relating this reduction to use of the proactive freedom was very poor, so it is difficult to conclude that this was as a result of the trial.[22]

Conclusions

5.8 The CAA's overwhelming priority has been to ensure that what has been trialled has not prejudiced the safety of Heathrow's operations. The CAA's conclusion in this respect is that the trial has taken place without any trial-related safety incidents.

5.9 However, we note that the safety events or actions that have occurred have all related to the temporary variation of established, published processes which are familiar to pilots and air traffic controllers, in particular the SIDs. With suitable mitigations in place, such as increased safety oversight, this was acceptable for a trial. However, it would not be appropriate for permanent adoption. The CAA therefore expects (and would require) any permanent adoption of operational freedoms to be preceded by appropriate re-design, safety assessment and publication of amended procedures (including the Heathrow SIDs).

22 The benefit gained from this proactive freedom would be dependent on aircraft vacating the runway efficiently, i.e. at the appropriate exit taxiway for Terminal 4. Any benefit is potentially lost where aircraft are unable to do this.

CHAPTER 6

HAL data collection, publication and analysis methodology

Chapter summary

The CAA sought to ensure that the trial was conducted in a way that produced grounded, objective data that could be shared with us and with others to scrutinise. This approach has been relatively successful.

The CAA worked closely with HAL and ECS to agree a common methodology for statistical analysis of the trial (although some differences remain in the interpretation of the results).

HAL has adhered to its commitment to involve community stakeholders in specifying the type of information they would find helpful, and to publish the data generated.

Data collection and publication

6.1 As noted in Chapter 2, HAL discussed the data to be collected for the trial with the CAA, DfT and other stakeholders in advance of the commencement of Phase 1. In particular, HAL liaised with local authorities about the kind of data they would find useful; their views on data provision are summarised in Chapter 10.

6.2 HAL published daily data on its website three days in arrears and more detailed monthly reports about four weeks after month-end (or longer if it coincided with the preparation and publication of an end-of-phase or end-of-season report).

6.3 Following the publication of its Phase 1 report, HAL adhered to its commitment to the Noise and Track-Keeping Working Group (NTKWG) to provide lower-level flight details, circulating this data to NTKWG members in November 2012 after excising any information that it considered to be commercially confidential. This allowed some external scrutiny of HAL's analysis and operation of the trial.

6.4 For Phase 2, HAL published daily data on its website, including, for the inter-phase period (March to June 2012), spreadsheets with the collated data for a whole month, and charts which tracked the development of key performance indicators (KPIs).

6.5 Section 2.9 of the HAL report sets out the various data sources required to collate all the information used in the analysis of the trial. Some of the data in the Phase 1 monthly reports had been collated from the wrong source and was inaccurate. The CAA recommended that such issues were resolved for Phase 2 and, where published data was identified to be in error, that it was corrected promptly. The improvements to the data website, clarity over the appropriate data sources to use and reasonably swift amendment by HAL of any data in error demonstrated good progress by HAL on this recommendation.

Challenges of data analysis

Factors affecting operational performance

6.6 Heathrow's performance is affected by a wide range of factors – for example, the weather, both local and elsewhere; how closely operators comply with the schedule; operational incidents like a birdstrike or technical failure; traffic mix; ANSP performance; strikes; innovations being applied in the system; other airports' performance; and so on. The main challenge in analysing the impact of the trialled freedoms on performance is to separate out, as far as possible, the effect of the freedoms from these other factors that could have a bearing on performance.

6.7 However, this is not straightforward, because Heathrow operates in a complex, finely tuned, capacity-constrained 'closed system' with efficient and intensive use of its segregated runways. As explained in the HAL report, there are strong interconnections between all operational processes and actors such that the impact from any disturbance to one part of the airport operating system could propagate both upstream and downstream of the system.

Methodology

6.8 The CAA has worked closely with HAL, its consultants and ECS in order to agree a methodology for analysing the trial. In particular, the CAA has worked hard to agree a common approach. From this we have achieved reasonably close consensus on what the data demonstrates by way of benefits from the trial.

6.9 The aim was to separate out the elements of the airport's performance that could be attributed to the trial, through statistical analysis. This analysis focused on the strength of any relationship between key

indicators for operational performance and actual utilisation of the freedoms, isolating the effect of the former from other variables that could have a bearing on performance.

6.10 The task of attributing operational improvement to the trialled freedoms was, however, hindered by the imperfect design of the trial[23] – better design would have enabled greater control of other external factors and separate application of the individual freedoms. The potential influence of other factors that did not form part of the trial (set out below) also made it difficult to separate out the effects of the trial from the effects of other extraneous factors.

Other factors potentially influencing but not forming part of the trial

6.11 Among the weather and other events that affected Heathrow during the trial period, Section 1.5 of the HAL report highlights two major events in particular – the London Olympics in July–August 2012 and the Farnborough Air Show in July 2012. HAL also sets out a number of operational initiatives which were not part of the trial but were in progress during the trial period.

6.12 The CAA recognises that these events and initiatives may have had specific impacts of their own. However, both HAL and the CAA found no evidence to suggest that these events had any significant impact on the outcome of the trial.

6.13 The operational initiatives were:

- Airport Collaborative Decision Making (A-CDM),[24] active in the first part of July 2012 and in monitoring mode for the remainder of the trial. A-CDM is a joint initiative between airlines, ground handlers, EUROCONTROL, NATS and HAL to share the latest and most accurate information about the status of inbound and outbound flights, enabling better-informed, more consistent decision making.

23 As acknowledged in the penultimate paragraph of Section 2.11 of the HAL report.

24 http://mediacentre.heathrowairport.com/Press-releases/Heathrow-announces-measures-to-further-improve-operations-1c7.aspx

- Future Airspace Strategy (FAS),[25] a collaborative initiative between a range of stakeholders which sets out a plan to modernise airspace by 2020. Elements of the Operational Freedoms Trial, in particular the use of early vectors, will influence the designs and requirements being produced as part of the London Airspace Management Programme (LAMP) in support of FAS.
- On-time Departure Trial conducted by NATS for one month from 5 November 2012 under the auspices of the FAS Queue Management and Airport Integration Sub-Group, using the flow-regulation process to restrict aircraft to their scheduled 15-minute departure windows and to assess the impact of early departures (thus early arrivals) on stackholding.
- Criteria for deploying TEAM after 07.00: from late October 2012, HAL changed the criteria such that TEAM would not be used if there was any forecast or actual departure delay after 07.00. This change was made as a result of agreement between HAL and airlines to facilitate better the airlines' desire for on-time departures.
- Early-morning noise respite trial,[26] from 5 November 2012 to 31 March 2013, developed in conjunction with the noise pressure group Heathrow Association for the Control of Aircraft Noise (HACAN), NATS and British Airways to explore whether creating 'noise relief zones' for communities living under the flight path could ease disturbance for residents at one of the most sensitive times of day.

Analysis of Phase 1 data

6.14 The application of reactive and proactive operational freedoms was hypothesised by HAL to have certain impact on a number of KPIs such as punctuality, runway throughput, stackholding delay, taxi-in time etc.

6.15 The approach taken by HAL to test these hypotheses in Phase 1 involved using data from an appropriate baseline period (the winter months of November–February 2008/09, 2009/10 and 2010/11), using regression analysis to test whether some external drivers (such as traffic volume and weather conditions) influenced operational performance of each KPI. HAL then compared trial KPIs with the baseline KPIs – while controlling for each of the significant external drivers individually – by means of standard statistical tests.

25 www.caa.co.uk/default.aspx?catid=2408&pagetype=90

26 www.heathrowairport.com/noise/noise-in-your-area/early-morning-trial

6.16 Although these statistical tests could give an indication of whether or not any differences in the average and variance of the KPIs between the trial and base periods were systemic,[27] they were unable to confirm any cause and effect between implementation of the freedoms and the monitored KPIs during the trial. The main reason for this was because these tests only allow the control of one external factor at a time and so could not take into account the fact that some or all of these external factors may interact with each other and have a joint influence on the operational performance.

6.17 A different approach was therefore called for in Phase 2, as recommended in the CAA report at the end of Phase 1.

Regression analysis methodology used for Phase 2

6.18 While in Phase 1 HAL used partial comparison analysis to determine if there were any significant differences in the KPIs between the base and trial periods, in Phase 2 HAL adopted a multivariate regression approach to analyse the potential impacts of the operational freedoms.

6.19 In collaboration with HAL and its consultants, the CAA and ECS were actively involved both in the trial design prior to the beginning of Phase 2 and in developing a robust methodology and regression models throughout Phase 2. An informal working group comprising representatives from the three parties was formed prior to the start of Phase 2 to discuss the trial design and how to collect and analyse the trial data. The aim was to find the best way to isolate the impact of the operational freedoms on the KPIs from any influence exerted by other external factors such as weather, traffic mix and traffic volume.

6.20 This required identification of all the potential influencing external drivers (both upstream and downstream from the KPI measuring points)[28] that may have had impacts on the KPIs. There was consensus among members of the working group that it was also necessary to take account of any effects on the KPIs that might have taken time to develop or dissipate.[29]

27 That is, unlikely to be caused solely by random variations.

28 This is due to the feedback in some of the operational processes (see Section 2.7 and Figures 25 and 26 of the HAL report).

29 The detailed regression approach adopted for Phase 2 was not possible for Phase 1 because the level of detail and granularity of data (down to half-hourly resolution) used for Phase 2 was not available in Phase 1.

6.21 The set of independent drivers and their corresponding lags selected by HAL in its regression models[30] were based on its understanding of the arrival and departure processes at Heathrow, which, as pointed out by ECS (see paragraph 4.23 above), inevitably, were to some extent arbitrary. HAL tested three different functional forms (linear, exponential and square root) to model the relationship between the KPIs and the independent variables. HAL concluded that the linear approach was the most appropriate for all the KPIs except stackholding delay, where a square-root function was used.[31]

6.22 The CAA carried out regression analysis of its own as a cross-check of the robustness of HAL's models and result findings. The two regression modelling approaches are very similar to each other. However, we used a more flexible, functional-form approach, and adopted a more systematic way of selecting the potentially influencing variables and their corresponding time lags,[32] in the search for a more robust model to assess the extent to which the improvement (or degradation) of the KPIs can be attributed to the use of the operational freedoms.

6.23 For the most part, the results of the CAA analysis appeared broadly to agree with those of HAL. However, there were a few cases where there were noticeable differences between them. These results are summarised in Chapter 8 (Tables 3 to 5).

30 These are summarised in Tables 5 and 6 of the HAL report.

31 Preliminary estimations in the HAL Phase 2 summer season report were based on log linear regression models which were subsequently found to be highly sensitive to the value of the constant used to convert any zero-valued KPI to a positive number before the log transformation. As a result, HAL has resorted to using either linear or square-root regression models in its final report instead of the log transformation approach in its summer season report.

32 The CAA used a data transformation technique, called Box-Cox transformation, which is a method of generalising the linear model by applying a power transformation to the data in order to stabilise the variance and make the data more 'normal distribution'-like. Selection of model variables and their corresponding lags are based on the Akaike Information Criterion and Bayesian Information Criterion which are measures of the trade-off between the complexity of the model and the goodness of fit of the model.

CHAPTER 7

Extent to which operational freedoms were used in the trial

Chapter summary

In Phase 1 and the first half of Phase 2, the number of de-alternated flights after 07.00 rose significantly as a result of the trial. TEAM*, the dual-arrivals freedom, was used for around two to three per cent of arrivals, averaging around 19 a day.

In the second half of Phase 2, TEAM* was used less often, averaging around 10 a day, following a change by HAL in the trigger criteria.

When the airport was on westerly operations, the trial freedoms were used for one or more movements virtually every day throughout both phases of the trial. During Phase 2, there were only very few days when the trigger criteria were not met.

In Phase 1, proactive freedoms were used for around three flights a day (less than half a per cent of arrivals in the periods when they were being tested). In Phase 2, this increased significantly, to around six flights a day in July and October 2012 (one per cent of arrivals), and around 18 flights a day in February 2013 (three per cent of arrivals).

In Phase 2, the early-vectoring freedom was used for around 43 flights a day (six to seven percent of departures in the period when the freedom was being tested).

Introduction

7.1 The use of the operational freedoms was hypothesised by HAL to have certain impacts on the KPIs. Table 1 compares the average values of some of the measured KPIs during the trial and baseline periods.

Table 1: Comparison of KPIs observed during the trial and baseline periods

	Winter baseline 2008/09 to 2010/11 (Nov–Feb)		Winter Phase 1 2011/12 (Nov–Feb)		Winter Phase 2 2012/13 (Nov–Feb)		Summer baseline 2009 to 2012 (May–Oct)		Summer Phase 2 2012 (Jul–Oct)	
	East	West	East	West	East	West	East	West	East	West
Arrival de-alternation/ day	25.0	23.1	31.3*	34.4*	22.9	14.8*	17.8	15.0	20.1	37.1*
Runway arrivals/ hour	34.9	37.7	38.4*	37.7	36.7	36.1*	39.6	39.6	38.6	39.6
Runway departures/ hour	36.3	39.3	40.0*	39.6	36.3	38.2*	40.6	42.5	39.3	40.5*
Stackholding (min.)	2.8	4.8	3.6*	5.1*	4.2*	4.6*	3.8	4.4	4.5	3.8*

Source: HAL.

Notes: The daily de-alternation figures show the total of all de-alternated flights, irrespective of the reason for de-alternation, including emergencies, issues with infrastructure or adverse wind conditions etc.

Runway arrival and departure rates per hour apply to the hours between 07.00 and 20.00 only.

* indicates that the observed KPI during the trial period was statistically different (at five per cent significance level) from the corresponding baseline period.

7.2 Table 1 shows that the number of post-07.00 de-alternated flights was significantly higher for both westerly and easterly arrivals in Phase 1 and for westerly arrivals in the Phase 2 summer period when compared with their respective baselines.

7.3 However, the arrival de-alternation rate was low on westerly operations in the Phase 2 winter period because of the change in TEAM procedures from late October 2012 whereby TEAM* was not deployed after 07.00 whenever departure delays were building up.[33]

7.4 There was a statistically significant difference from the respective baselines in average runway arrival and departure rates for easterly operations in Phase 1 and for westerly operations in the Phase 2 winter period.

33 See paragraphs 3.23 and 6.13 – HAL found evidence (section 7.2 of the HAL report) to suggest that for every increase in TEAM* utilisation of two flights, a reduction of three departures was incurred as a result.

7.5 There was an increase in the average stackholding delay for both westerly and easterly operations in Phase 1 compared with the baseline. However, the decrease in stackholding delay for westerly operations for both the winter and summer periods for Phase 2 was statistically significant compared with their respective baselines.

7.6 As explained in Chapter 6, these simple statistical comparisons could only give a qualitative indication of whether or not any differences in the KPIs between the trial and base periods were systemic. No conclusions on the performance impact of the freedoms could be drawn from such comparisons since no account was taken of other external factors that could also have a bearing on performance (for example, differences in demand level, weather conditions etc).

Traffic volume and direction of operation (easterly or westerly)

7.7 The extent to which operational freedoms were actually used is set out in Sections 1.3 to 1.6 of the HAL report, along with the traffic volumes during the trial. Table 2 below is a summary of the data during the two phases of the trial and their corresponding baseline periods.

7.8 The table shows that daily traffic in Phase 1 was higher than the winter baseline period, while daily traffic in the Phase 2 winter and summer periods was similar to the corresponding baseline periods.

7.9 In terms of direction of operations, Phase 1 was close to the long-term average east-west ratio of 25:75. Phase 2 was more westerly biased than normal, although the whole summer 2012 season (April to October) was similar to the summer baseline average.

Table 2: Traffic volume and use of the operational freedoms

	Winter baseline 2008/09 to 2010/11 (Nov–Feb)	Winter Phase 1 2011/12 (Nov–Feb)	Winter Phase 2 2012/13 (Nov–Jan)	Summer baseline 2009 to 2012 (May–Oct)	Summer Phase 2 2012 (Jul–Oct)
Average daily arrivals	616	634	615	660	664
Average daily departures	617	634	615	660	663
Easterly operations as % of total	29%	27%	23%	26%	18%
TEAM* as % of arrivals	-	2.3%	1.5%	-	2.9%
Proactive as % of arrivals	-	0.4%	*[5]*	-	0.8%
Early vectoring as % of departures *[1]*	-	-	5.5%	-	6.5%
Availability of TEAM* trigger *[2]*	-	-	54%	-	41%
Utilisation of TEAM* trigger *[3]*	-	-	39%	-	69%
Availability of departure trigger *[2]*	-	-	73%	-	69%
Utilisation of departure trigger *[3] [4]*	-	-	43%	-	51%

Source: HAL and CAA calculations.

Notes: Figures for use of operational freedoms are based on westerly operations only.

[1] The early-vectoring freedom on departures was not trialled in Phase 1. Detailed trigger information on arrivals and departures freedoms was also not available during Phase 1.

[2] The triggers are classified as 10-minute anticipated delay or 20-knot headwind at 3000 feet between 07.00 and 23.30.

[3] Trigger utilisation is defined as the number of hours that the triggers were used (for one or more TEAM* movements) per day divided by the number of hours that they were available.

[4] Based on CAA calculation.

[5] In the Phase 2 winter period, proactive de-alternations were trialled in February 2013, when they made up 2.9% of arrivals.

Use of operational freedoms

7.10 When the airport was on westerly operations, the trial freedoms were used for one or more movements virtually every day throughout both phases of the trial. There were only very few days when triggers were not available during Phase 2. The TEAM* trigger utilisation rate was significantly higher during the summer period of Phase 2 (69 per cent) than the winter period (39 per cent).

7.11 Although the trigger utilisation rate was high, the number of TEAM* movements on average was actually relatively low.[34] The average number of TEAM* movements in Phase 1 was around 19 per day, and the summer 2012 period of Phase 2 was similar at 19.3 TEAM* movements per day, representing around two to three per cent of arrivals during the periods that the measures were active. In the Phase 2 winter period (November and December 2012), TEAM* movements almost halved to 9.7 per day, mainly as a result of the change in TEAM procedures in late October 2012. This is also reflected in the lower TEAM* utilisation rate in the Phase 2 winter 2012 period than in summer 2012, even though the availability of the trigger was higher in the winter.

7.12 In Phase 1, proactive freedoms were used for around three flights a day (less than half a per cent of arrivals in the periods when they were being tested). In Phase 2, this increased significantly, to around six flights a day in July and October 2012 (one per cent of arrivals), and around 18 flights a day in February 2013 (three per cent of arrivals).

7.13 In Phase 2, the early-vectoring freedom was used for around 43 flights a day (six to seven percent of departures in the period when the freedom was being tested).

7.14 Reactive freedoms were trialled on the same days as proactive freedoms.

7.15 The use of TEDs (dual departures) is not shown in the table, because they were hardly used in Phase 1 (38 departures), and not used at all in Phase 2.

34 This could be so if the number of flights being 'TEAMed' during any half-hourly period was actually low even though the trigger condition had been met (see also Note 3 to Table 2).

CHAPTER 8

HAL analysis of the effects of the trial

Chapter summary

This chapter explains the CAA's views on HAL's analysis of the outcomes that can be measured from the trial. The analysis is confined to Phase 2, as insufficiently detailed data was collected from Phase 1.

HAL and the CAA have been unable to establish a significant positive cause-and-effect relationship between the use of operational freedoms and an improvement in the KPIs being monitored.

Therefore any operational benefit claimed in the HAL report has not been statistically proven. It should therefore be regarded more as the expert opinion of HAL and NATS, based on their experience from the trial. Other unmodelled factors may have had more influence on the KPIs than the deployment of the freedoms.

One explanation is that the intensive dual runway operation is so highly interconnected that focusing too heavily on arrivals causes departure delay and vice versa.

Complaints regarding noise rose significantly during the trial. However, it is difficult to distinguish those that relate to a flight affected by operational freedoms from those which have arisen from a greater public awareness of noise issues.

HAL's preliminary work on the erosion of respite to local communities suggests some detrimental impact.

While a reduction in late-running night-time departures was observed, it was not clear from the trial how much of this can genuinely be attributed to use of operational freedoms.

Analysis of the impact on operational performance

8.1 As explained in Chapter 6, Phase 1 demonstrated that a different approach to statistical analysis was required for Phase 2. The HAL analysis is therefore confined to data from Phase 2 of the trial.

Results of regression analysis from Phase 2

8.2 Section 3 of the HAL report sets out the impact of operational freedoms in Phase 2 on arrivals and departures performance. Tables 3 to 5 below compare these Phase 2 findings with the corresponding findings by the CAA. These results are based on the regression analyses described in paragraphs 6.18 to 6.22 above. Appendix B sets out HAL's findings in more detail, with the CAA's comments alongside.

TEAM* (Table 3)

8.3 Table 3 shows that the HAL and CAA findings on the impact of TEAM* are broadly similar, apart from Air Traffic Flow Management (ATFM) and stackholding delay performance. HAL found that over the summer period application of TEAM* tended to reduce ATFM delay, albeit its model has a very low explanatory power (R-square = 0.25), but to increase stackholding time.[35] In contrast, the CAA found some tentative evidence to suggest that TEAM* tended to be associated with an increase in ATFM delay and had no significant statistical relationship with stackholding time.

8.4 Both HAL and CAA found that application of TEAM* tended to increase holding point delay during the trial. As one might expect, the use of TEAM* is associated with an improvement in departure punctuality in the winter period (but not in summer), because controllers were refraining from using TEAM* whenever actual or anticipated departure delay was occurring and utilisation of TEAM* was relatively low (see paragraph 7.3).

35 R-square is defined in Note 2 of Table 3.

Table 3: Impact of TEAM* on operational performance in Phase 2

		HAL		CAA	
KPI	**Season**	**Impact**	**R-square**	**Impact**	**R-square**
ATFM delay	Summer	Reduction (5%)	0.25	Increase (10%)	0.76
	Winter	No association	0.30	No association	0.76
Stackholding time	Summer	Increase (5%)	0.64	No association	0.82
	Winter	Increase (5%)	0.69	Reduction (5%)	0.82
Start-up delay	Summer	No association	0.86	No association	0.48
	Winter	No association	0.80	No association	0.28
Holding point delay	Summer	Increase (5%)	0.56	Increase (5%)	0.62
	Winter	Increase (5%)	0.52	Increase (5%)	0.56
Taxi-in time (T4)	Summer	Reduction (5%)	0.22	Reduction (5%)	0.17
	Winter	Reduction (5%)	0.38	Reduction (5%)	0.15
Taxi-out time	Summer	No association	0.36	No association	0.2
	Winter	No association	0.60	Reduction (10%)	0.18
Arrival punctuality	Summer	Increase (5%)	0.54	Increase (10%)	0.68
	Winter	No association	0.55	Increase (10%)	0.71
Departure punctuality	Summer	No association	0.62	No association	0.68
	Winter	Increase (5%)	0.63	Increase (5%)	0.53

Source: HAL and CAA.

Notes: The percentages in brackets indicate the level of significance of the freedom in explaining the movement of the measured KPI. A significance level of five per cent or less suggests that there is strong evidence to reject the hypothesis that the applied freedom has no effect on the KPI. A significance level of more than 10 per cent is considered as no statistically significant relationship between the freedom and the KPI.

R-square is a measure of the goodness of fit of a model. A high R-square value indicates that the set of included independent variables is capable of explaining a large proportion of the observed variation in the dependent variable, suggesting that the model has a good explanatory power.

See overleaf for colour key.

Key to Table 3:

The association between the freedom and the measured KPI is significantly different from zero with a certainty of at least 90 per cent.

The association between the freedom and the measured KPI is significantly different from zero with a certainty of at least 95 per cent.

The association between the freedom and the measured KPI is significantly different from zero with a certainty of at least 95 per cent, but its direction is contrary to the trial hypothesis.

The association between the freedom and the measured KPI is significantly different from zero with a certainty of at least 90 per cent, but its direction is contrary to the trial hypothesis.

No fill means no statistically significant association between the freedom and the measured KPI.

Not applicable.

Proactive measures (Table 4)

8.5 Table 4 shows that HAL linked the use of proactive freedoms to improvement in taxi-in time and deterioration in arrival punctuality, but there was no significant effect on ATFM delay and stackholding. The CAA, in contrast, found that use of proactive freedoms was associated with a reduction in stackholding time and start-up delay, and an increase in holding point delay; but we found no strong evidence to suggest that proactive freedoms reduced taxi-in time (very low R-square) and arrival punctuality (no statistically significant association).

Table 4: Impact of proactive freedoms on operational performance in Phase 2

		HAL		CAA	
KPI	**Season**	**Impact**	**R-square**	**Impact**	**R-square**
ATFM delay	Summer	No association	0.14	No association	0.76
Stackholding time	Summer	No association	0.62	Reduction (5%)	0.82
Start-up delay	Summer			Reduction (5%)	0.48
Holding point delay	Summer			Increase (5%)	0.62
Taxi-in time (T4)	Summer	Reduction (5%)	0.68	Reduction (5%)	0.17
Taxi-out time	Summer			Reduction (5%)	0.20
Arrival punctuality	Summer	Reduction (5%)	0.42	No association	0.68
Departure punctuality	Summer			No association	0.68

Source: HAL and CAA.

Notes/colour key: see Table 3.

Early vectoring (Table 5)

8.6 HAL found early vectoring to have the counter-intuitive results of increasing start-up delay[36] and reducing departure punctuality in the summer period, but no statistically significant relationship was evident in the winter season or for holding point delay and taxi-out time (Table 5). The CAA found some evidence that the use of early vectoring was associated with a reduction in holding point delay, but no evidence of improvement in the other departure performance indicators.

Table 5: Impact of early vectoring on departures performance in Phase 2

		HAL		CAA	
KPI	**Season**	**Impact**	**R-square**	**Impact**	**R-square**
Start-up delay	Summer	Increase (5%)	0.86	No association	0.48
	Winter	No association	0.80	No association	0.28
Holding point delay	Summer	No association	0.56	Reduction (5%)	0.62
	Winter	No association	0.51	Reduction (10%)	0.56
Taxi-out time	Summer	No association	0.20	No association	0.20
	Winter	No association	0.60	No association	0.18
Departure punctuality	Summer	Reduction (5%)	0.62	Reduction (10%)	0.68
	Winter	No association	0.63	No association	0.53

Source: HAL and CAA.

Notes/colour key: see Table 3.

36 Although HAL found some evidence of a significant and negative association between early vectoring and start-up delay with a time lag of 60 minutes.

Conclusions on regression analysis results

8.7 Detailed regression analysis was undertaken by both HAL and the CAA on the Phase 2 data to determine the effects of the trial on a number of arrival and departure performance indicators. The main objective of the analysis was to assess the extent to which the application of the operational freedoms helped improve the KPIs while controlling the potential impacts from other external factors such as weather, traffic mix and traffic volume.

8.8 There was close collaboration and discussion between HAL, the CAA and ECS prior to and during Phase 2 about the trial design and how to best collect and analyse trial data. This led to separate but similar modelling approaches by HAL and the CAA based on a common set of consolidated data, and there was broad agreement on the findings.

8.9 However, given the exceedingly complex and capacity constrained environment in which Heathrow operates, and given that there are interdependencies between separate KPIs (both upstream and downstream) and their interactions at different times, it is almost impossible to isolate fully all of the effects due to the trialled freedoms.

8.10 This is reflected in the large standard errors associated with some estimated model parameters and in general the relatively low values of R-square obtained from the regression analysis. These suggest that only a relatively small proportion of the KPI variations is being explained by the selected independent variables and that other unknown (or un-modelled) factors, which are not being captured by the models, may have more influence on the KPIs than the application of the freedoms.

8.11 Furthermore, significant but counter-intuitive results have also been observed in some cases which cast some doubt on the robustness of the results, and add further uncertainties to the direction and extent of the operational impact.[37]

8.12 In summary, the findings overall are that HAL and the CAA have been unable to establish a significant positive cause-and-effect relationship between the use of operational freedoms and an improvement in the KPIs being monitored.

37 It was also found that many of the probability plots of residuals from HAL's regression models do not conform to a normal distribution, which raises further questions about the robustness of the models.

TEAM*

8.13 The claims by HAL that the application of TEAM* could lead to performance enhancement in terms of stackholding delays, ATFM delays and taxi-in time are not unequivocally borne out by the analysis, as the regressions have either a very low R-square value or results that are contrary to HAL's original hypotheses. On the other hand, HAL found that application of TEAM* had a negative impact on departures – an increase in TEAM* utilisation of two flights led to a reduction of three departures (see paragraph 8.39).

Proactive tests

8.14 The proactive tests, as well as increasing the arrival rate (albeit at the expense of decreasing the departure rate), were found to be associated with a decrease in taxi-in time, especially for Terminal 4 arrivals. However, again the overall R-square values are so low that any suggestion of positive impact needs to be treated with great caution.

Early vectoring

8.15 Likewise, no demonstrable benefits for departure performance could be found from the application of early vectoring. This was partly because the freedom was only applied to a limited number of departing flights using certain SID routes.

Analysis of environmental impacts

Introduction

8.16 Alongside the operational results, the HAL report (section 5) also analysed data on community impact in terms of the noise impact and the number of complaints (section 6). The CAA has also considered the impact on emissions.

Noise

8.17 The CAA's ERCD was commissioned by HAL to carry out the noise assessment for the trial, completely separate from the CAA's oversight role.

8.18 With an existing planning cap on Heathrow's annual air transport movements of 480,000, the trial was never intended to increase the airport's capacity (the absolute number of flights using Heathrow). However, the trial has redistributed some existing flights (and noise)

in the vicinity of the airport. This has had an effect on respite periods for communities below the westerly approach paths and on those affected by vectoring from the established departure routes (SIDs) and associated Noise Preferential Routes (NPRs). To better understand the effect of the redistribution of noise, HAL carried out a study using social survey techniques. To supplement this, the CAA developed a methodology dependent on social survey data and noise contour results that could be used to investigate the effect of aircraft arriving on the designated departure runway.

CAA independent noise assessment

8.19 The trial did not change the total number of flights operating at Heathrow, and therefore there was no net increase in noise. However, that noise was redistributed in a way that may have impacted some residents more than others.

8.20 The independent CAA assessment commissioned by HAL is summarised in section 5.2 of the HAL report and is reproduced as Annex J of the HAL report. The assessment presents facts but does not comment on the significance of effects. The CAA briefed stakeholders on its methodology through the NTKWG.

Commentary on complaints data

8.21 During both Phase 1 and Phase 2 of the trial, the number of noise complaints handled by HAL was significantly higher than in the periods before the trial or in the same months in previous years.[38] During the trial, complaints averaged approximately 25 per day in Winter 2011/12, 78 per day[39] in Summer 2012 and 91 per day in Winter 2012/13. We note that assessing the significance of these complaints figures is difficult as it is very likely that many of the extra complaints were due to publicity surrounding the trial and residents' extra sensitivity to noise (or propensity to register a complaint) as a consequence. For example, in Phase 1, high numbers of complaints were recorded when the airport was under easterly operations, even though none of the operational freedoms were being used.

8.22 In HAL's Phase 1 report, overall complaints were simply compared with the historic average and mapped alongside the change in noise contours

38 See, for example, Figure 62 in the HAL report relating to Phase 2.

39 Nearly a quarter of all the complaints in Summer 2012 were registered in the three days 22 to 24 October following a leaflet campaign by the MP for Richmond Park.

produced by operational freedoms. The CAA recommended that a more sophisticated analysis could attempt to identify which complaints could and could not have arisen as a result of changes to operations caused by the trial. For Phase 2, where possible, the HAL report examined the date and location of each complaint to assess whether it coincided with a use of operational freedoms (irrespective of whether the complainant realised this or not).[40] The report indicates that more than 80 per cent of complaints quoting a specific date and time are unlikely to have arisen because of a flight affected by the trial. The remainder (fewer than 20 per cent) may have arisen as a result of such flights, but undoubtedly a proportion of them did not. Similarly, those residents that experienced a reduction in noise as a consequence of the trial are unlikely to have recorded that fact. By definition, the results are therefore heavily biased towards registering negative effects.

8.23 Therefore, while we would not wish to dismiss the relevance of complaints data to assessing community nuisance, we believe that the information is a poor proxy for harm, and that it is best used for informing further work on community impact.

Evaluation of noise respite

8.24 Given the sensitivity of noise issues around Heathrow and the risks of placing more weight on the complaints data than they can bear, the CAA sought other approaches to evaluate the impact on the community.

8.25 In its report on Phase 1, the CAA recommended that HAL give consideration to whether Phase 2 of the trial would benefit from further work to understand the value placed on respite by residents. To address this, HAL appointed consultants Ian Flindell & Associates and MVA Consultancy to undertake a study, with representatives from HAL, CAA and DfT engaged to provide oversight.

8.26 The scope of the study included defining terms (namely the technical meanings of relief and respite for use in the study), preparing and refining survey questionnaire methodologies, deploying these at focus groups and in-home interviews held in areas subjected to overflights from departing or arriving aircraft, analysing the responses and further refining the methodologies in light of the responses. Section 6.3 of the HAL report outlines the results from this survey of 75 participants overall.

40 Not all complaints give precise time or location information, so it is not always possible to assess whether a flight affected by operational freedoms was the cause of the complaint.

8.27 While the findings from the surveys provide some initial indications as to the views of a sample of local residents on certain issues relating to respite and relief, it would be unwise to place too much weight on the work undertaken to date given the limited sample size. It was considered, however, that by using the techniques developed for this research, it would be possible to produce a survey which, if widely deployed, would enable statistically robust quantitative results to be obtained of the views of local residents on respite.

Impacts on late-running night-time departures and other KPIs

8.28 One of the potential benefits of the freedoms trialled was that they would allow greater conformity with the schedule of operations at Heathrow and that this would assist in avoiding late-running night-time departures. As the community is disproportionately impacted upon by such departures, this was seen as a key potential benefit of the trial and was registered as one of the KPIs to be monitored during the trial.

8.29 Using a partial comparison analysis as in Phase 1, HAL's results show that there is a statistically significant reduction in the average late-running night-time departures (post-23.00) per day in Phase 1 and in the summer part of Phase 2, compared with the baselines.[41] However, as HAL noted in section 5.3 of its report, it is not clear how much of this reduction can be attributed to operational freedoms, since other external potential drivers are not properly accounted for in the simple comparison analysis. We note that the largest improvement occurred during Phase 1 of the trial, when there were effectively no departure freedoms in operation.

8.30 Likewise, there was no evidence to suggest that operational freedoms would have a significant impact on continuous descent approach compliance, although a significant degradation in track-keeping compliance was found on the SIDs to which early vectoring was applied (except for the Dover SID during the winter part of the trial).

Emissions

8.31 The HAL report does not include any calculation of the impact of the trial on aircraft emissions.[42]

41 HAL found no statistically significant reduction in late-running departures in the Phase 2 winter season.

42 HAL included estimates in its Phase 2 summer season report but not in its final report.

8.32 Reductions in delays, such as less time spent by aircraft holding in the stack or at the departure runway holding point, would reduce the amount of fuel burnt, which in turn would lead to a reduction in carbon emissions. Estimates of the potential reduction in carbon emissions can be obtained as an intermediary output in the CAA's calculation of the costs and benefits of each individual freedom (described in Chapter 9 and in Appendix C).

8.33 Results from the CAA analysis, notwithstanding the uncertainties associated with the estimates, indicate potential carbon savings of around 1670 tonnes over a summer season and 920 tonnes over a winter season as a result of application of the freedoms in Phase 2 (Table 6).

Table 6: CAA estimate of carbon savings (tonnes) based on Phase 2 results

	Summer	Winter
TEAM*	–404	327
Proactive tests	765	0.0
Early vectoring	1,310	594
Total	**1,670**	**920**

Source: CAA calculation.

Note: All figures are rounded to the nearest tonne. Results have been scaled up to full IATA seasons.

CAA conclusions on HAL analysis of the effects of the trial

Operational impact

8.34 The statistical analysis of the trial discussed in the first part of this chapter has been unable to demonstrate that, on their own, these operational freedoms make any significant difference to airport resilience – the results show no significant positive cause-effect relationship between the use of the freedoms and an improvement to the KPIs that were monitored. This is the conclusion of HAL, ECS and the CAA.

8.35 The CAA's conclusion is that at an operational level, the freedoms trialled were not a clear success.

8.36 What this means in practice is that any claimed benefit by the HAL report for operational benefits from the trialled operational freedoms has not been statistically proven. It should therefore be regarded more as the expert opinion of HAL and NATS, based on their experience from the trial.

8.37 If there are operational benefits, then these are lost in the 'noise' of the many other perturbations to the schedule that occur daily at a seriously congested airport like Heathrow operating for most of the day virtually to the limits of its capacity.

8.38 One explanation for this is that, as noted in Chapter 6, the airport is a relatively finely tuned, 'closed system' with efficient and intensive use of its segregated runways to enable simultaneous arrivals and departures. Focusing too heavily on one temporarily forfeits the ability to do the other – on-time arrival is replaced by departure delay and vice versa.

8.39 Indeed, HAL acknowledges in its report (section 7.2) that for every increase in TEAM* utilisation (i.e. dual arrivals) of two flights, the departure rate is decreased by around three departures per hour, and TEAM* increases the queue for the departure runway, requiring the judicious application of TEAM* taking departure demand into account.[43]

8.40 Another plausible explanation for not finding statistical evidence of benefits is that operational freedoms have not been uniformly beneficial when they have been used. If, say, only half of the uses contributed to benefits, then this may not be picked up in the regression analysis.

Community impact

8.41 The freedoms have changed how some aircraft arrive at, and depart from, Heathrow. Therefore even though the overall amount of noise generated by aircraft using the airport has not been affected by the trial, there has been a resulting redistribution of noise around the airport.

8.42 The analysis of complaints indicates that, although complaints were much higher during the trial than at the same period in previous years, a significant proportion (more than 80 per cent) of those complaints are unlikely to be due to a flight affected by the trial. They may, therefore, be attributable to the greater awareness of noise issues brought about by related publicity. Of the remainder (fewer than 20 per cent), it is not possible to say with any accuracy how many were due to operational freedoms, but undoubtedly some were (equally, there were undoubtedly many residents that were affected by such flights who did not register a complaint to HAL, or not on every occasion they were so affected).

43 The CAA notes that normal operational procedures impose a cap of six TEAM arrivals per hour, whereas Phase 2 of the trial increased this cap to 12, as explained in paragraph 3.23; it may be that the usual cap was imposed for a reason.

8.43 HAL's preliminary work on the erosion of respite to local communities suggests some detrimental impact, although we note that this social survey work was of limited scope and further work would be needed to provide a statistically significant sample of residents' views.

8.44 Although there is a statistically significant reduction in late-running night-time departures compared with the baseline, it is not clear how much of this reduction can be attributed to operational freedoms, since the largest improvement occurred during Phase 1 of the trial when there were effectively no departure freedoms in operation.

CHAPTER 9

CAA valuation of the impact of the trial using basic costs and benefits calculations

Chapter summary

A discussion of the benefits or disbenefits of the operational freedoms trialled can be made more meaningful by estimating their monetary value, in terms of both operational and environmental impacts.

The HAL report does not estimate the monetary value of the operational impact of the trial, even though its Phase 1 and Phase 2 (summer) reports did so.

The CAA has therefore sought to estimate the monetary value of operational impact, and also of the value communities place on respite and how this was impacted by runway de-alternation through the use of TEAM*.

- The CAA estimates that operational benefit through use of operational freedoms trialled in Phase 2 is likely to lie somewhere between –£7.7m and +£10.6m a year, with a mean estimate of around +£1.8m. However, there are substantial uncertainties around such calculations.
- The CAA developed a methodology that could form the basis for future work to calculate the overall value of respite from noise through runway alternation and the lost value associated with the erosion of respite from the trial. However, the available data is currently insufficient to allow us to make such a calculation.

Introduction

9.1 A discussion of the benefits or disbenefits of the measures trialled can be made more meaningful by estimating their monetary value.

9.2 In its earlier Phase 1 and Phase 2 summer season reports, HAL included calculations of potential economic costs and benefits from the operational impact of operational freedoms.[44] HAL has not, however, included such calculations in its final report. The CAA has therefore itself sought to estimate the monetary value of the operational impact using HAL's earlier methodology. It should however be stressed that

44 Chapter 10 of the Phase 1 report and Chapter 4 of the Phase 2 summer season report, each with a related appendix showing the analysis.

there are substantial uncertainties around such estimates, given the wide range of potential benefits that the analysis by HAL and ourselves suggests could be associated with the trialled freedoms.

9.3 At the outset, the CAA did not think that it would be in a position to carry out a traditional cost/benefit analysis of *all* of the trial impacts: without sufficient work to understand the value to local communities of respite from noise, we would not be able to place an accurate value on the disbenefits.

9.4 With the aim of gaining as complete a picture as possible of the trial impact, the CAA did seek to generate comparable monetary estimates for the environmental impact of the freedoms. In terms of the noise impact on the local community, the CAA undertook some work to develop a methodology which would at least allow us to produce a range within which benefits may exist, but in the event there was insufficient evidence to allow us to calculate a monetary estimate. This chapter therefore begins by setting out an estimate of the potential economic costs and benefits of applying operational freedoms based on analysis of data from the summer and winter seasons during Phase 2. It then goes on to consider the impact on local communities and an approach for estimating the monetary value of the loss of noise respite from the runway de-alternation of westerly operations as a result of operational freedoms.

Valuing impact on operational performance

9.5 The analysis in this section only includes the potential economic and environmental (i.e. reduction in CO_2 emissions due to less fuel usage) impacts associated with the airport, airlines and their passengers. External impacts, specifically those on the nearby community associated with changes in noise respite, are considered in paragraphs 9.23 to 9.27 below. Extra resource costs on air traffic controllers, the airport and airlines as a result of implementing operational freedoms during the trial are also not included in the calculation, although these are not expected to be significant.

9.6 The results are based on the estimated coefficients of both the reactive and proactive operational freedoms in the regression models. The calculated costs and benefits are therefore subject to the same limitations and assumptions as the regression analysis and are intended to provide indicative orders of magnitude only.

9.7 The methodology and assumptions used by the CAA to convert predicted time savings (costs) into monetary value are similar to those used by HAL, as detailed in its Phase 2 summer season report, and in Appendix C of this report. However, the methodology used by HAL to calculate the lower and upper bounds of the predicted time savings (costs) and the baseline of a KPI used to calculate the impact of TEAM* appear to differ from those used by the CAA.

9.8 While HAL used the 95 per cent confidence interval of each significant coefficient in the regressions to derive the lower and upper bounds of the predicted time savings, the CAA considers that it is more appropriate to use the 95 per cent confidence interval of the predicted KPI itself to derive the lower and upper bounds for the predicted change in a monitored KPI.

9.9 Furthermore, HAL's calculation of the benefits (costs) of applying TEAM* is based on the change in a KPI with and without the freedom being applied, while the CAA sought to measure the marginal impact of TEAM* against the pre-existing freedom of TEAM, as explained below.

9.10 As explained in the HAL Phase 2 summer season report, impacts associated with operational freedoms occur at different stages of a flight. Therefore costs and benefits need to be calculated for each stage of the flight for which operational freedoms have been found to have statistically significant impact on a KPI as indicated by the regression analysis.[45]

9.11 From the regression parameters it is possible to estimate the value of the costs and benefits of applying operational freedoms (reactive and proactive) by calculating the difference in the predicted values of the KPI with and without the freedoms being applied for a specific time period.[46]

9.12 The dual-arrivals operational freedom (TEAM*) was based on the extension of a pre-existing dual-arrivals freedom (TEAM), which has a stricter delay trigger of 20 minutes. The CAA therefore considers that the benefits (or costs) calculation should only reflect the additional benefits (or costs) from applying TEAM* compared with the use of TEAM.

9.13 However, the application of TEAM* altered how delays would build up during the day, so there is no way of identifying which of the out-of-alternation arrivals would have occurred anyway through TEAM.

45 A significance level of more than five per cent is considered as no statistically significant relationship between the freedom and a KPI, thus it will not be included in the cost/benefit calculation.

46 HAL's time savings (costs) calculation is based on this approach.

9.14 In order to estimate the number of additional dual arrivals due to TEAM*, the CAA has assumed that the factors contributing to de-alternation for reasons other than TEAM* (i.e. due to TEAM and for safety/emergency reasons) have remained constant throughout the baseline and the trial periods.[47] Consequently, the difference in the daily average number of de-alternated westerly arrivals between the trial period and the corresponding baseline is attributable to TEAM*, as shown in Table 7.

Table 7: Average number of daily out-of-alternation westerly arrivals

	Phase 1 Winter (Nov 2011–Feb 2012)	Phase 2 Summer (Jul–Oct 2012)	Phase 2 Winter (Nov–Dec 2012)
Baseline	11.5	11.4	11.2
Trial	22.4	21.3	8.5
TEAM* (trial minus baseline)	10.9	9.9	-2.7

Source: Tables 1 to 3, Annex J of the HAL report, 'London Heathrow Operational Freedoms Trial: Effect on Noise'.

9.15 Thus, for the Phase 2 summer period, we have estimated the number of out-of-alternation arrivals that would have been classified as TEAM by multiplying the ratio of TEAM movements in the baseline to trial period (i.e. 11.4/21.3 = 0.54) from Table 7 above with the number of total out-of-alternation movements observed in each half-hourly period. The additional benefit (cost) due to TEAM* is then calculated as the difference between the predicted KPI for total out-of-alternations and the predicted KPI for the estimated TEAM movements.

9.16 Table 7 shows that in the Phase 2 winter period, the number of out-of-alternation arrivals was actually lower than that of the baseline, as a result of the change in procedure described earlier that prioritised departure punctuality over the use of TEAM*. However, since both the number of TEAM* and TEAM movements were recorded during Phase 2, we have assumed that the number of recorded TEAM* movements in the data were indeed attributable to TEAM*.[48]

47 See Section 2.1 of Annex J of the HAL report, 'London Heathrow Operational Freedoms Trial: Effect on Noise'.

48 It is likely that this has over-estimated the number of attributable TEAM* movements as some of these out-of-alternations would have been classified as TEAM if the pre-trial 20-minute trigger condition were applied during the trial period. Consequently, our calculation of additional benefits due to TEAM* in the Phase 2 winter period is likely to be overestimated.

9.17 The time saving (or delay) per flight (Table 9) is then aggregated over the entire period of the trial to obtain the overall additional saving (or cost) due to the operational freedoms.

9.18 Table 8 below is a summary of the overall result based on the CAA methodology and regression analysis. The wide range of values (based on the 95 per cent confidence intervals of the projected KPIs which encompass the zero value within the range) reflected in the results is due to the high level of uncertainties arising from the regression analysis.

Table 8: CAA estimate of costs/benefits from Phase 2 of the trial (£m)

Period	Lower	Mean	Upper
Summer season	-5.73	1.94	8.85
Winter season	-1.91	-0.15	1.72
Total year	**-7.65**	**1.79**	**10.58**

Source: CAA calculation.

Note: The benefit/cost calculation is only applied to those cases where a statistically significant relationship (i.e. p-value < five per cent) is found between the freedom and a KPI.

9.19 Although there are substantial uncertainties around the estimated costs and benefits from the trial, operational benefit due to the use of the freedoms is likely to sit somewhere in the range of –£7.7 million and +£10.6 million a year, with a mean estimate of around +£1.8 million. Significantly, the CAA assessment indicates a similar picture for each of the individual freedoms, with none of the freedoms suggesting a wholly positive range of benefit. These results suggest that the overall benefit (cost) due to operational freedoms is therefore unlikely to be significantly different from zero.

9.20 Appendix C gives a full breakdown of the costs and benefits calculated by the CAA from the application of the operational freedoms during Phase 2, along with the key assumptions used.

9.21 In order to facilitate a like-for-like comparison in view of the different approaches by HAL and the CAA, Tables 9 to 11 present a breakdown of the estimated marginal impacts of operational freedoms on the KPIs in terms of time savings (costs) which are based on the methodology outlined in paragraphs 9.7 to 9.17 above and in Appendix C.

Table 9a: Estimates of arrivals and departures time savings (costs) from use of TEAM* in Phase 2 of the trial (summer)

	Saving during trial (min.)				Average saving per flight (min.)			
Summer	**HAL**		**CAA**		**HAL**		**CAA**	
KPI	**Lower**	**Upper**	**Lower**	**Upper**	**Lower**	**Upper**	**Lower**	**Upper**
ATFM	-12,502	13,900	-	-	-0.173	0.192	-	-
Stackholding	-11,570	3,937	-	-	-0.16	0.054	-	-
Holding point delay	-43,735	31,711	-10,969	3,265	-0.570	0.410	-0.142	0.042
Taxi-in (T4)	-1,018	1,698	-3,829	5,423	-0.112	0.186	-0.053	0.075

Source: HAL and CAA calculation.

Table 9b: Estimates of arrivals and departures time savings (costs) from use of TEAM* in Phase 2 of the trial (winter)

	Saving during trial (min.)				Average saving per flight (min.)			
Winter	**HAL**		**CAA**		**HAL**		**CAA**	
KPI	**Lower**	**Upper**	**Lower**	**Upper**	**Lower**	**Upper**	**Lower**	**Upper**
Stackholding	-4,299	776	-2,067	3,982	-0.126	0.023	-0.06	0.116
Holding point delay	-20,041	9,741	-4,856	-269	-0.542	0.263	-0.131	-0.007
Taxi-in (T4)	-408	736	-1,518	3,115	-0.060	0.108	-0.044	0.091

Source: HAL and CAA calculation.

Table 10: Estimates of arrivals and departures time savings (costs) from use of proactive freedom in Phase 2 of the trial (summer)

	Saving during trial (min.)				Average saving per flight (min.)			
Summer	**HAL**		**CAA**		**HAL**		**CAA**	
KPI	**Lower**	**Upper**	**Lower**	**Upper**	**Lower**	**Upper**	**Lower**	**Upper**
Stackholding	-	-	-957	2,460	-	-	-0.027	0.069
Start-up	-	-	-524	1,413	-	-	-0.014	0.038
Holding point delay	-	-	-3,542	857	-	-	-0.096	0.023
Taxi-in (T4)	-51	1,186	-207	2,971	-0.006	0.130	-0.006	0.083
Taxi-out	-	-	-410	1,994	-	-	-0.011	0.054

Source: HAL and CAA calculation.

Table 11: Estimates of arrivals and departures time savings (costs) from use of early vectoring in Phase 2 of the trial (summer)

	Saving during trial (min.)				Average saving per flight (min.)			
Summer	**HAL**		**CAA**		**HAL**		**CAA**	
KPI	**Lower**	**Upper**	**Lower**	**Upper**	**Lower**	**Upper**	**Lower**	**Upper**
Start-up delay	-11,022	22,986	-	-	-0.298	0.621	-	-
Holding point delay	-	-	-9,521	24,353	-	-	-0.123	0.315

Source: HAL and CAA calculation.

9.22 Table 12 shows that the CAA's estimate of the overall potential time savings (costs) from the use of operational freedoms is likely to be in a range between -38,400 and 49,564 minutes over the summer and winter seasons, which has a much narrower band than HAL's. The lower and upper values (which encompass the zero value within the range) reflect the level of uncertainties arising from the regression analysis.

Table 12: Overall estimates of arrivals and departures time savings (costs) in minutes during Phase 2 of the trial

	HAL		CAA	
	Lower	**Upper**	**Lower**	**Upper**
Summer	-79,898	75,418	-29,959	42,736
Winter	-24,748	11,253	-8,441	6,828
Total	**-104,646**	**86,671**	**-38,400**	**49,564**

Source: HAL and CAA calculation.

Valuing impact on respite from noise

9.23 As explained in paragraph 8.25 above, a study was undertaken by Ian Flindell & Associates and MVA Consultancy to evaluate noise respite. This study adopted a bottom-up approach using social survey techniques.

9.24 To complement this approach, the CAA undertook a parallel exercise, again to evaluate noise respite, but adopting a top-down approach using pre-existing social survey results and noise modelling. This work was relatively innovative in seeking to combine data from previously published social survey results with established noise valuation metrics to provide an estimate of the monetary value of respite to communities, and, from that, to derive a monetary value for the loss of social amenity that might

be experienced from the trial measures. The CAA study, including the assumptions and methodology used, is documented in Appendix D.

9.25 More specifically, the CAA sought to calculate a monetary value for the overall value of respite through the alternation of the runway designated for westerly arrivals at Heathrow. Using this, we devised an approach that could be used to calculate monetary values (possible upper and lower bounds) for the respite that was lost due to the use of the TEAM* freedom during the trial. The monetary costs per household per decibel change in transportation noise according to the DfT's WebTAG were used, as were the findings from a study[49] into respite using the Aircraft Noise Index Study.[50]

9.26 However, this methodology requires statistically robust value for the benefit of respite, which may be calculated from noise attitude survey data. We found that a statistically significant value for this input did not currently exist based on available data. Without further evidence, we could therefore not provide a quantitative indication as to the monetary value of respite due to alternation of the runway used for westerly arrivals, or of the loss of respite due to the Operational Freedoms Trial.

9.27 The methodology developed could nevertheless form the basis for future work.

Conclusions on valuing the impacts of the trial

Operational benefits

9.28 The analysis in this chapter seeks to make the benefits or disbenefits of the measures trialled more meaningful by estimating their monetary value, although it stops well short of a traditional cost/benefit analysis. It must also be recognised that there are substantial uncertainties around such estimates.

9.29 The analysis finds that the operational benefit of the measures trialled in Phase 2 could actually be negative – we estimate that it is likely to sit somewhere in the range of between –£7.7 million and +£10.6 million, with a mean estimate of around +£1.8 million. The analysis indicates a similar picture for each of the individual freedoms, with none of the freedoms giving a range that is wholly positive.

49 Aircraft noise annoyance estimation: UK time-pattern effects, Peter Brooker. Applied Acoustics 71, 2010 (661-667).

50 DR Report 8402, United Kingdom, Aircraft Noise Index Study: main report. CAA 1985.

9.30 The wide range of uncertainty that has arisen from this analysis demonstrates the profound difficulties HAL, ECS and the CAA have faced in evaluating the operational impact of the freedoms. In summarising these results, the CAA notes that the mid-point in the range is positive although relatively low, which indicates that the mean estimate suggests some minor benefits were achieved from the introduction of the freedoms. However, the existence of such a wide range arising from uncertainty around the trial's effects, including a potentially significant negative range, suggests that the results should be treated with caution. The CAA therefore believes that, ideally, further evidence should be sought before taking a decision on whether or not to make the freedoms permanent.

Community impact

9.31 The CAA developed a methodology for approximating changing levels of respite at Heathrow by combining social survey information on the value of respite with the DfT's own WebTAG approach to estimating the monetary value of noise nuisance.

9.32 However, there was insufficient evidence on which to base a calculation for the lost value associated with the erosion of respite from noise. The methodology that the CAA developed could nevertheless form the basis for future work.

CHAPTER 10

Stakeholder views

Chapter summary

The CAA discussed the trial with representatives of airlines, NATS and local authorities, and monitored HAL's engagement with local communities, seeing this as a key aspect of the trial.

Industry regarded the trial as well run and as useful learning in the context of the ongoing wider dialogue around airport capacity. However, while the added flexibility provided by operational freedoms was seen as useful, the trial had revealed no 'silver bullet' solution to improving Heathrow's resilience.

Industry noted the need for careful management of the Heathrow 'closed system' to prevent imbalances in arrival and departure delay, and air traffic controller workload issues from tactical application of non-standard procedures.

Industry saw some potential for enhancing the impact of the freedoms in the context of taking a more proactive approach to keeping the airport 'on schedule'.

It was difficult for the CAA to judge whether the engagement process could have worked any better against a backdrop of the ongoing debate around airport expansion in the South East. HAL committed considerable time and resources to the engagement process, including explaining the trial to residents, involving local authorities in specifying the type of information that they would find helpful, and sharing the data analysis with them.

Local authorities expressed concerns about the trial from several perspectives: timescales had been too short; explanations and data from the trial lacked clarity or granularity; it was less easy to value the negative impact on the community than the operational benefits; and they had not seen the rationale for HAL's post-trial proposal that the Airports Commission consider operational freedoms as a means of making best use of airport capacity in the short to medium term.

The CAA observed a distinct lack of trust by local communities in HAL's statements and motivations, and their sensitivity to any change in operating procedures, reflecting the widely differing views of each side.

Introduction

10.1 This chapter summarises the involvement of other stakeholders in the trial and their views on its merits.

10.2 The Government has undertaken to consult formally on any more permanent deployment of operational freedoms, giving all stakeholders the opportunity to express their views.

Industry stakeholder views

10.3 The CAA discussed the trial with British Airways, Virgin Atlantic, the Board of Airline Representatives in the UK (BAR UK, representing airlines serving the UK) and NATS.[51]

Airlines

General comments

10.4 In general, airlines thought the trial had been a good idea and that it had gone as well as could have been expected. They felt that the trial had not revealed any 'silver bullets' in terms of improving resilience to disruption, reinforcing what was known already, that the airport was completely full and the system was already being worked very hard. That said, this conclusion would not have been possible without the trial.

10.5 Airlines observed that the trial had sought to push the boundaries of what could be achieved to improve the airport's ability to recover from and avoid disruption. They felt that the trial had generally been well managed in building on the learning from Phase 1 by extending the duration of Phase 2 and incorporating appropriate modifications to the trial design and data collection. Airport stakeholders had participated in the trial in a positive way and it had proved useful to bring relevant people together and to share their learning, although some foreign airlines had shown some unfamiliarity with the trial.

51 As noted in Chapter 2, the CAA also chaired the Airport Performance Facilitation Group, which was set up to oversee progress with the initiatives for improving punctuality, delay and resilience recommended by the South-East Airports Taskforce, including operational freedoms. The Group included representatives from Government, airports, airlines, NATS, Airport Coordination Ltd, London First and Aviation Environment Federation.

10.6 There was no firm airline view on whether the measures trialled had been the best ones or had represented the full range of what could be done; the sample of flights affected was relatively small, particularly from the perspective of an airline which served Heathrow only a few times a day. There was a general feeling that there remained a need to enforce a stricter adherence to the schedule.

10.7 Airlines believed that the trial had to be viewed as part of the wider dialogue around airport capacity – including submissions to the Airports Commission, the Government's night noise consultation, and the Sustainable Aviation strategy.

Comments on specific freedoms trialled

10.8 In terms of the specific freedoms trialled, airlines had not at first fully appreciated that the way they were deployed tended to favour arrivals rather than departures, potentially creating an imbalance.
It was also suggested that it had taken time for NATS to adapt to the new procedures the trial required. While favouring arrivals might seem to be a reasonable pro-consumer approach, it had caused a problem where there were stand constraints, such as at T5, where even a slight perturbation could quickly lead to recently landed aircraft being unable to disembark passengers because the aircraft was waiting for a stand.
It was suggested that TEAM may have been used too routinely by the NATS London Terminal Control Centre sequencing arrivals before handing over to Heathrow Tower. Following discussion between airlines, NATS and HAL a more tactical approach to the use of TEAM* had successfully been adopted in Phase 2. Careful management of the Heathrow 'closed system' was needed to monitor landing and take-off rates, start up delay, holding delay etc, to prevent any imbalance developing.

10.9 Airlines seemed generally supportive of the added flexibility demonstrated by the proactive trials. There was a strong feeling that the increased wake-vortex separation required by growing A380 operations was going to further pressurise the airport. Intuitively, therefore, giving the tower the flexibility to land A380s out of alternation or aircraft bound for Terminal 4 on the southern runway may have helped in the short term. However, going forward, this was not seen as a viable solution to the A380 issue in the longer term.

10.10 Airlines noted that TEAM was already being used to improve the arrivals rate, but that the trial had shown that improving the departure rate was also possible. The trial had demonstrated that there did seem to be some flexibility to fine-tune the existing departure routeings within the existing airspace framework so as to achieve a higher rate of departures off a single runway allowing the airport to recover better from disruption. Airlines questioned whether progress could be made along these lines more permanently pending a full redesign of the airspace through the longer-term LAMP programme.

NATS

10.11 Section 1.7 of the HAL report gives an air traffic controller's perspective on deploying the freedoms.

10.12 In our own discussion with NATS the CAA concluded that, overall, NATS controllers found that the trial generated useful insights. However, the tactical application of non-standard procedures at a heavily congested airport like Heathrow created controller workload issues and was not acceptable in the long-term. (NATS also mentioned pilot workload, although in our discussions airlines seemed less convinced that this was an issue.)

10.13 As HAL noted, use of TEAM* for arrivals had created unwelcome departure delay, often because decisions on TEAM* sequencing had to be taken up to 30 minutes ahead of landing. Decisions on departure flexibility, mainly early vectoring, could be done just a few minutes ahead. Therefore if a window in the departure stream presented itself at short notice, it might not be possible to make use of it. NATS also felt that better information tools could have improved the decisions being made on tactical application of the freedoms. All these factors reduced the ability to make best use of the freedoms, and the TEDs freedom in Phase 1 had simply proved unworkable under current procedures.

10.14 NATS suggested that possible solutions to this are greater flexibility in when the freedoms could be deployed; trialling new departure routes; implementation of Airport-Collaborative Decision Making (see paragraph 6.13), developing the concept of the runway manager, as well as better schedule adherence; essentially taking a more proactive approach to scheduling rather than relying on reactive responses.

Engagement with local communities

Introduction

10.15 The Operational Freedoms Trial altered the respite periods created by runway alternation, and therefore inevitably involved some redistribution of aircraft noise among local communities. HAL recognised that it was expected by the Government and the CAA to engage fully and transparently with relevant local authorities, communities and other stakeholders throughout the trial, particularly on the monitoring of noise impacts.

CAA oversight

10.16 As explained in Chapter 2, the CAA monitored HAL's engagement programme with local communities and maintained its own, separate dialogue with relevant local authorities. The CAA has ensured that stakeholders have been involved in specifying the type of information that they would find helpful, and that the data generated has been made publicly available to third parties such as local authorities and local communities. The CAA participated in work to assess the value to communities of respite from aircraft noise.

Engagement between HAL and local communities

10.17 HAL's communications and engagement strategy is set out in section 6.2 of its report.

10.18 As we explained in our report on Phase 1, the CAA appreciates the complexities associated with engaging with local communities, including the number of people and audiences involved, the recent history of Heathrow development, and the technical nature of some of the operational issues associated with the trial. These audiences have different requirements – for example, specialists requiring detailed data and residents needing plain-language explanation.

10.19 HAL has committed considerable time and resources to the engagement process. In general, the company has been responsive to stakeholders' appetite to engage in the trial and has organised the right meetings – covering local communities and residents' associations, MPs, London Assembly members and local authorities – before and during the trial. HAL produced considerable publicity through extensive leafleting, advertising and 'advertorials' in the local press, briefing local journalists, and participating in radio interviews, with an

email and telephone enquiry hotline. HAL's website has a number of pages dedicated to the trial,[52] including the design of the trial, a video animation, and data downloads.[53]

10.20 HAL commissioned opinion polls and focus groups from Populus Ltd, and a social survey. The results from Populus for Phase 1 helped HAL to devise a more effective communication strategy in Phase 2 including further polling on attitudes to the trial and to the airport more generally. In Phase 2 HAL also commissioned some limited qualitative research on the impact of the trial through in-depth interviews with local residents (section 6.2.3 of the HAL report).

10.21 On more technical issues HAL has used the existing vehicle of the NTKWG (see paragraph 6.3) to hold monthly meetings to brief local authority and industry representatives about the design of the trial and to discuss data collection issues. Comments from NTKWG members helped to inform the data analysis, data presentation and polling work in Phase 2, and findings were presented to NTKWG.

CAA observations on community relations

10.22 The CAA report after Phase 1 observed that in some of our engagement with local stakeholder groups (and reflected by the Populus findings) there was a general sensitivity to any change in operating procedures affecting local residents. Just as important, we also observed how this was exacerbated by the lack of trust in HAL's statements and motivations.

10.23 We have seen some success in bringing the technical experts together to discuss data issues, but in terms of the relationship with the wider community it was less obvious that much progress has been made. As noted in Chapter 8, the number of complaints in Phase 2 was significantly higher than normal, but for the most part could not be directly related to flights making use of the operational freedoms being trialled. This has to be viewed in the context of the ongoing debate around airport expansion in the South East.

10.24 There remains a question as to how effective any engagement about the trial would be in these circumstances, in light of the sometimes widely differing views and interests of the airport and local community.

52 www.heathrowairport.com/noise/noise-in-your-area/operational-freedoms-trial

53 http://heathrowoperationaldata.com/

Concerns expressed by local authorities regarding the trial

Communication about the trial design and reporting

10.25 Some local authorities expressed concern to Government and the CAA about the little notice they had been given to inform or respond to local residents before the trial – timescales which the CAA accepts were largely outside HAL's control. They also expressed a wish to be more involved in the trial design. HAL made a commitment to local authorities that if the Minister considered any components of the trial were creating unacceptable disturbance to residents, then those components would be discontinued.

10.26 Following Phase 1, it took time for HAL to assess what had been learnt and to build that into the design of Phase 2 and gain approval from the CAA and Government. As Phase 2 approached, local authorities were again raising the same issue about being given insufficient time to engage properly about the trial, despite the recommendations in the CAA report regarding more engagement with stakeholders and through the NTKWG. In some cases local authorities felt that they needed more information to understand properly how some of the new measures would be implemented, for example where they interacted with the existing night flights regime.

10.27 When HAL produced its report on the summer season of Phase 2 in December 2012, local authorities again complained that they were given insufficient time to digest and comment on the draft. Local authorities then expressed frustration that the early-morning arrivals measure proposed for Phase 2 – which brought the prospect of reducing the number of flights arriving before 05.00 – was not proceeded with, after it had been trailed to residents. Local authorities questioned why it had not been established earlier that airlines were unable to meet the operational requirements.

Data

10.28 Local authorities made numerous requests for clarification of the monitoring of the trial, including greater granularity and earlier release of data. There was perhaps a greater public expectation for information to be disclosed than HAL was anticipating.

10.29 Although some resource issues were initially apparent, HAL was generally responsive in accommodating these requests: as recommended by the CAA, there was greater involvement of local authority experts in the detail of the data collection and analysis for Phase 2. The main forum

for these requests has been the pre-existing NTKWG which includes representatives from the local authorities in the vicinity of the airport.

10.30 However, the provision of data was still not without its problems. There was a delay in local authorities receiving very detailed data from Phase 1 for technical analysis. While welcoming the detailed material published by HAL on its website, some local authorities felt that a more digestible summary of the information was needed to make residents aware of the trial's impacts.

10.31 Local authorities stressed to the CAA that they understood the objectives behind the trial and sought wherever possible to explain these to residents. However, they felt that if changes to established operating patterns were to be accepted by local residents, they needed open explanation, preferably in advance. The form of the data made it more difficult for them to explain to a complainant why there had been a particularly noisy aircraft a few days previously, and whether the flight was part of the trial. They suggested that data could have been made more accessible (such as a weekly narrative or a daily log listing flights that landed out of alternation and the reason why), and that this would have improved the understanding and trust of the local community.

10.32 A lack of explanation and transparency was felt to be a source of frustration for residents and contributing to a climate of distrust. It was suggested that it was of little comfort for local residents to be told that the flight that had disrupted their sleep had been nothing to do with the trial. These views reflect continuing issues around the wider HAL-community relationship, rather than being specific to the trial itself.

Complaints handling

10.33 Local authorities expressed concern about the effectiveness of HAL's complaints process and related monitoring arrangements, and suggested that there was some merit in an independent audit of the complaints system. HAL acknowledged that at certain points during the trial a backlog of complaints had developed. As noted earlier, the number of complaints rose significantly during the trial.

10.34 The CAA encouraged local authorities to discuss and resolve these issues with HAL through the NTKWG. As a result, HAL invited local authority members to visit their complaints-handling facility.

Estimating the monetary value of environmental impact

10.35 Local authorities expressed concern that while a methodology could be developed to quantify the impact of the trial in terms of operational improvements and passenger time, and thus to estimate their monetary value, there was no equivalent means of valuing respite or the loss of it for the local community. There was little underpinning social survey or science to assess the impact of the annoyance to the communities overflown of allowing aircraft to land out of alternation. They were concerned that the HAL report would be unable to assess the potential damage to communities who would have experienced some consequential erosion of the respite provided by westerly runway alternation. They questioned how the monetary value estimated for operational benefits would be weighed against the community disbenefits. Because the total amount of noise was unchanged by the trial, the relatively minor change in noise contours might suggest little impact. In reality, the impact on particular communities might be significant due to temporal and geographical changes to some aircraft operations.

10.36 The CAA's independent assessment (Annex J of the HAL report) includes statistics showing changes in the distribution of flights across the day as well as the contours.

10.37 In response to the concerns expressed above, Heathrow commissioned a study (from Ian Flindell & Associates and MVA Consulting) on valuing the loss of noise respite through qualitative social survey research, overseen by the DfT and the CAA, as explained in paragraphs 8.25–8.27 above. Since the extent of the social survey work was not envisaged to quantify the value of respite by the end of Phase 2, the CAA also undertook the study explained in paragraph 9.25 above.

HAL submission to Airports Commission

10.38 Local authorities expressed concern regarding HAL's proposal to the Airports Commission of May 2013 that the Commission should consider the use of operational freedoms for making the best use of existing capacity in the short and medium terms. They had not seen the underlying rationale, and they had not agreed to the trial findings as stated in the document.

Conclusions on stakeholder views

Industry

10.39 The representatives from NATS and airlines who we spoke to after the trial generally regarded it as having been well run. They thought that it had provided useful learning in the context of the ongoing wider dialogue around airport capacity, and that operational freedoms provided useful additional operational flexibility. However, they recognised that the trial had revealed no 'silver bullet' solution to improving Heathrow's resilience.

10.40 Airlines referred to the need for careful management of the Heathrow 'closed system' to prevent imbalances in arrival and departure delay. NATS referred to air traffic controller workload issues from tactical application of non-standard procedures. Overall, they saw some potential for enhancing the impact of the freedoms in the context of taking a more proactive approach to keeping the airport 'on schedule'.

Local communities

10.41 The CAA spent some time overseeing the process of engagement with local communities. However, we were not driving the process, and it was difficult at times to judge whether engagement could have worked better, or whether HAL had done all that could reasonably have been expected. It is possible that some problems may have stemmed from HAL initially underestimating the resourcing that responding to data requests would require. We certainly observed a need for clearer explanation of how the airport operations worked prior to the trial to allow a proper comparison. HAL rose to the challenge and produced documentation that helped residents' understanding.

10.42 We have seen some success in bringing the technical experts together to discuss data issues, but there was less obvious success at the airport-community relationship level, reflecting the widely differing views and interests of the airport and local community. It is fair to say that substantial efforts have been made by HAL to explain the trial, and by local authorities to become involved in specifying what trial data they would find useful. The CAA has acted as facilitator for this more frequent and deeper liaison during the 18 months or so that HAL designed and ran the trial.

10.43 The CAA has followed much of the discussion. We have dedicated considerable resources to advising on the design of the trial, data collection, reporting and engagement, as well as deploying our own environmental expertise to look at noise issues – including specific work with HAL, DfT and other noise experts on the design of a survey to understand communities' value of respite.

10.44 The CAA is generally satisfied that HAL did all that could reasonably have been expected to meet the requests of local authorities and residents, although this did require some encouragement at times. Where timescales were too short this was sometimes out of HAL's control because of the need to seek CAA and Government agreement, or because of the sheer volumes of data that needed to be processed, requiring specialist help from consultants.

CHAPTER 11

CAA conclusions

Chapter summary

The hypothesis being tested by the trial, as proposed by SEAT, was that the granting of additional freedoms could potentially deliver:

- significant benefits for passengers by improving the resilience and reliability of the airport, and
- environmental benefits, with fewer unscheduled night flights, lower emissions and less stacking.

However, the data from the trial is inconclusive.

The CAA would agree with HAL that it is possible that the freedoms trialled did benefit airport operations. Intuitively, greater operational flexibility should help air traffic controllers to get the airport back on schedule. But the benefits claimed in the HAL report have not been statistically proven.

Any operational benefits of operational freedoms are offset by some redistribution of aircraft noise among local communities, and preliminary work suggests some detrimental impact. Communities below the westerly approach paths have their respite period interrupted by aircraft arriving on the runway usually used for departures, while others are affected by vectoring off the established departure routes.

Developing earlier work by HAL, the CAA sought to estimate the monetary value of the costs and benefits of the measures trialled:

- The CAA estimates that operational benefit from the operational freedoms trialled in Phase 2 is likely to lie somewhere between –£7.7m and +£10.6m a year, with a mean estimate of around +£1.8m. However, there are substantial uncertainties around such calculations.
- The CAA developed a methodology that could form the basis for future work to calculate the lost value associated with the erosion of respite from noise. However, the available data is currently insufficient to allow us to make such a calculation.

Summary continued overleaf

A lot was learnt from the trial, which the CAA believes:

- could be joined up with the wider package of ongoing change to enhance operations at Heathrow
- has led to HAL adopting a more inclusive approach to engaging with the community about the impact that the airport has on them.

HAL's engagement programme was largely successful in publicising the trial and bringing together technical experts to discuss data issues. However, it was less obvious that much progress was made in improving its relationship with the wider community.

Before taking a decision on any more permanent application of the freedoms, the Government has undertaken to hold a public consultation. The CAA has set out a number of 'insights' built up during the trial and recommends that the Government consults stakeholders on these insights as well as the overall value of the freedoms to Heathrow.

Should the Government agree to any future deployment of the 'early vector' operational freedom, an essential enabler would be to re-design the Standard Instrument Departure routes.

Trial purpose, oversight and design (Chapters 2 to 4)

11.1 The Operational Freedoms Trial explored the effect of making Heathrow's operating restrictions more flexible to enable the greater use of tactical measures in defined and limited circumstances. **The aim was to see whether enhanced arrival and departure flow rates could improve the airport's ability to recover from or avoid disruption by maintaining performance against the planned schedule.**

11.2 The CAA was asked by the Government to oversee the conduct of the trial. **HAL's conduct of the trial has generally been good**, with thought and resources committed to addressing the principal issues faced by the trial, and with proper review of lessons learned after Phase 1 to inform the way Phase 2 was designed and run.

11.3 Some freedoms which HAL planned to include as part of the trial did not prove feasible. In the case of early-morning arrivals, this was a source of frustration for local authorities in particular, but the experience gained is likely to have been useful.

Safety (Chapter 5)

11.4 The CAA's overwhelming priority has been to ensure that what has been trialled has not prejudiced the safety of Heathrow's operations. A small number of safety-related events and actions have taken place during the trial. However, temporary additional mitigations, including safety oversight and monitoring processes put in place for the duration of the trial, have ensured that **genuine trial-related safety incidents have been avoided**.

11.5 The safety-related events and actions which took place during the course of the two phases of the trial were not of immediate concern in terms of aircraft safety. They were however reflective of the 'trial nature' of the deployment of freedoms, rather than the technical content of the freedoms themselves. **Therefore, should any future deployment or adaptation of the operational freedoms be proposed, normal 'permanent' arrangements such as Standard Instrument Departure (SID) re-design would be an essential enabler.**

Data collection, publication and analysis methodology (Chapter 6)

11.6 The CAA's other main objective has been to ensure that HAL conducted the trial in a way that produced grounded, objective data that could be shared with us and with others to scrutinise. With some facilitation by the CAA, **HAL has generally adhered to its commitment to involve community stakeholders in specifying the type of information that they would find helpful. HAL has published significant quantities of data generated by the trial.** ECS provided an independent audit of the trial conduct and reporting.

11.7 HAL and the CAA have dedicated significant resources to the interpretation of trial data. The aim was to separate out the elements of the airport's performance that could be attributed to the trial, through statistical analysis. **As a result, we have achieved reasonably close consensus on the optimum analytical approach and what the results from the trial tell us,** although some differences of interpretation remain.

Analysis of the operational benefits (Chapters 7 to 9)

11.8 There were inherent difficulties in trying to separate out the direct effects of the freedoms from other factors that might impact on Heathrow's operational performance. This is evidenced in the low level of confidence associated with the trial results and the regression analysis carried out separately by HAL and the CAA, with help from ECS.

11.9 **These uncertainties mean that, in the absence of further evidence, it is extremely difficult to reach any strong conclusions on the benefit or otherwise of the trial. In particular, we note that the benefit for operational freedoms claimed in the HAL report has not been statistically proven and that those results should therefore be regarded more as the operator's expert opinion based on its and NATS' own experience from the trial.**

11.10 The CAA's own analysis has estimated the monetary value of the operational benefits. There are substantial uncertainties around such a calculation, but **we estimate the monetary value from the measures trialled in Phase 2 as being somewhere in the range of between –£7.7 million and +£10.6 million a year, with a mean estimate of around +£1.8 million.**

11.11 Thus while the mid-point in the range is positive, it is relatively low in monetary terms, and the span of the range means that the operational benefit could actually be negative. This is also the case for the impact of each of the freedoms assessed individually. The uncertainties in the estimate giving rise to the broad span, including a potentially significant negative range, indicate that the results should be treated with caution.

11.12 **One explanation for the data results is that the airport is a relatively finely tuned, 'closed system'** – in other words the system is highly interconnected **with efficient and intensive use of its segregated runways to enable simultaneous arrivals and departures. Focusing too heavily on one temporarily forfeits the ability to do the other** – on-time arrival is replaced by departure delay and vice versa. If there are benefits from the trialled freedoms, then the evidence from the trial data was lost among the many other perturbations to the schedule that occur daily at a congested airport like Heathrow.

Community impacts (Chapters 7 to 9)

11.13 The trial was never intended to increase the number of flights using Heathrow. However, it has redistributed existing flights (and noise) affecting nearby communities. This has had an impact on respite periods from noise for communities below the twin runways' flight paths and on those affected by vectoring from the established departure routes and associated Noise Preferential Routes.

11.14 **Complaints regarding noise have risen significantly during the trial.** However, there are drawbacks in assessing community impacts through complaints. In particular, it is difficult to distinguish complaints that can be attributed to the use of operational freedoms from those which have arisen from a greater public awareness of noise issues and how to complain about noise, brought about by related publicity. **We would therefore caution against placing too much weight on complaints data as a reliable proxy for community disturbance.**

11.15 During the trial, HAL commissioned polling by Populus Ltd to undertake qualitative and quantitative research into residents' attitudes to the trial.

11.16 In order to better understand the value placed on respite by residents, HAL commissioned a study to investigate this using survey techniques. It was considered that by using the techniques developed for this research, it would be possible to produce a survey which, if widely deployed, would enable statistically robust quantitative results to be obtained of the views of local residents on respite.

11.17 In addition, the CAA, supported by the DfT, developed a methodology for approximating changing levels of respite at Heathrow. This was achieved by combining social survey information on the value of respite with the DfT's own WebTAG approach to estimating the monetary value of noise nuisance. There was insufficient evidence on which to base a calculation for the lost value associated with the erosion of respite by the measures trialled, but the CAA methodology could form the basis for future work.

11.18 The trial tested the hypothesis that the use of the freedoms could reduce the number of late-running night-time departures by ensuring that there was greater conformity with the operating schedule. **While a reduction in late-running night-time departures was observed, it was not clear from the trial how much of this can genuinely be attributed to use of operational freedoms**.

Engagement process (Chapter 10)

11.19 HAL acknowledged that it needed to engage fully and transparently with local communities throughout the trial. There were different audiences for engagement. **HAL successfully brought technical experts together to discuss detailed data issues, but it was less obvious that much progress was made in improving the relationship with the wider community**. The CAA is generally satisfied that HAL did all it could to meet the requests of local authorities and residents, although this did require some facilitation at times. For example, HAL was responsive to community demands for plain-language explanations of the trial and how the airport operations worked prior to the trial, to allow a proper comparison.

11.20 Although local authorities felt that some timescales were too short, these were sometimes out of HAL's control because of the need to seek CAA and Government agreement, or because of the sheer volumes of data that needed to be processed, requiring specialist help from consultants.

11.21 It was difficult at times for the CAA to judge whether the engagement process could have worked any better against a backdrop of the ongoing debate around airport expansion in the South East. Very obvious was the lack of trust in HAL's statements and motivations, and the sensitivity to any change in operating procedures, reflecting the sometimes widely differing views and interests of the airport and the local community.

Deploying operational freedoms more permanently

HAL conclusions

11.22 The HAL report (section 7.8) draws the following conclusions about the operational freedoms trialled:

- It has proved difficult to quantify benefits or draw definitive conclusions from the trial due to its artificial nature and the complex operational environment of Heathrow.
- There is considerable uncertainty associated with the results and these will be open to different interpretations.

- The operational freedoms trialled delivered perceptible and useful operational improvements in limited areas, but not all were at the level or significance that was originally envisaged. The freedoms would not, therefore, provide the wholesale significant benefits that could be required to facilitate recovery from major disruption if they were to be implemented in isolation and without further enhancement.
- The application of the departure freedoms was constrained by the structure of Heathrow's airspace and the wider London Terminal Manoeuvring Area, and the benefits would be increased by enhancing the design of early vectoring (section 7.3.1).
- Application of all the operational freedoms had perceived negative impacts on the local communities, particularly those involving de-alternation of arrivals and degraded track-keeping for departures.

11.23 In view of these conclusions, HAL recommends that the following operational freedoms should be retained for permanent use at Heathrow:

- TEAM* with a limit of 12 per hour. Broadening the trigger criteria for use of this freedom (from anticipated arrival or departure delays of 10 minutes or more to any delay likely to impact operations).[54]
- Early vectoring of enhanced design, with more departure routes in both directions and broadened trigger criteria. These early vectors would form a key input to the design of any new SIDs, which may in turn support the outcome of the LAMP programme.
- Proactive freedoms as trialled in Phase 2.

Government consultation

11.24 The Government has made clear that, following submission of this report and the HAL report to the Airports Commission, it intends to consult on any proposal to deploy operational freedoms more permanently. Both reports have been published.[55] The Government's Aviation Policy Framework[56] noted that Heathrow, Gatwick and Stansted will continue to be designated for noise purposes.[57]

54 HAL notes that it is minded to replicate the current runway-use arrangements on westerly operations on easterly operations also (assuming approval is given for the necessary enabling works).

55 This CAA report at www.caa.co.uk/CAP1117 and the HAL report at www.heathrowairport.com/noise/noise-in-your-area/operational-freedoms-trial

56 www.gov.uk/government/publications/aviation-policy-framework

57 The Civil Aviation Act 1982 gives the Secretary of State powers to put in place certain noise mitigation measures at designated airports.

CAA overall conclusions

SEAT expectations

11.25 The hypothesis in the 2011 SEAT report being tested by the trial[58] was that the granting of additional freedoms could enable the airport to respond to severe weather or other disruptions by the flexible deployment of measures which temporarily increase the number of take-offs and/or landings in a given period of time. This would have been expected to potentially deliver:

- significant benefits for passengers by improving the resilience and reliability of the airport; and
- environmental benefits, with fewer unscheduled night flights, lower emissions and less stacking.

11.26 SEAT recognised that the occasional and limited redistribution of noise when measures were applied would mean that there would be a mix of positive and negative impacts for different parts of the community, and that some people would have their existing periods of respite from aircraft noise interrupted.

HAL trial conclusions

11.27 The CAA recognises that, intuitively, greater operational flexibility for air traffic controllers at times of disruption would appear to be preferable than denying them that flexibility. For example, landing an aircraft destined for Terminal 4 on the southern runway so that it does not need to cross the southern runway, or vectoring aircraft early from their departure tracks to increase the rate of departures and thus allow a backlog to be cleared more quickly.

11.28 The CAA also accepts HAL's assertion that because Heathrow has historically been configured to operate in 'segregated mode' and is already operating close to its maximum capacity, the benefits were always expected to be marginal (although potentially significant, given the scale of Heathrow's operations).

11.29 However, the detailed operational experience built up during the 12 months that the two phases of the trial were in operation, together with the feedback from those responsible for delivery (HAL and NATS), suggests that the effect is more balanced than was anticipated at the outset of the trial.

58 SEAT Report, July 2011, paragraphs 5.10 and 5.12.

11.30 While a huge quantity of data has been collected, it has proven impossible to establish a strong, empirically tested and objective relationship between the use of the freedoms and operational benefit at Heathrow. This means that the evidence on operational benefit from the trial is essentially inconclusive.

11.31 The CAA accepts that this uncertainty arises from the limitations of the trial design, coupled with the complex nature of Heathrow's operations. The CAA recognises that HAL made considerable efforts to improve the trial design in close cooperation with the CAA, DfT and ECS. HAL could not reasonably have been expected to do more on the data collection and analysis.

11.32 The CAA would agree that it is possible that the freedoms trialled have demonstrated operational improvements. But it is difficult to infer this from the data produced, because of the 'noise' surrounding the data.

Community impacts

11.33 In addition to the data amassed on the operational benefit of the freedoms, the trial has provided an opportunity to develop a better understanding of the effects of changes in operations on the communities surrounding Heathrow. There has been a redistribution of noise in the area surrounding the airport as a consequence of the trial. The preliminary work on the erosion of respite to local communities suggests some detrimental impact, although we were unable to quantify this, and we believe this work would benefit from further scrutiny, possibly using the consultation process to achieve this. Unfortunately, evidence that the trial caused any reduction in the number of late-running night-time departures is inconclusive.

Scope for further trials

11.34 From our experience of overseeing the trial during both phases, the CAA regards it as unlikely that much would be gained from seeking to gather more evidence by further extending the trial. It seems likely that the same problems associated with identifying causes and effects would be experienced, even if the trial design were further refined.

Next steps

11.35 Although the trial has in some respects delivered inconclusive results, a number of learnings have been generated that the CAA believes could lead both to better operations at Heathrow and to a more inclusive approach towards community engagement and community effects by the airport. We believe that stakeholders, including representatives of local community interests, should be given a further opportunity to take stock and comment on the research and data analysis associated with the trial.

11.36 CAA therefore welcomes the Government's stated intention to launch a public consultation on any decision as to whether operational freedoms should be adopted more permanently. In the current absence of a compelling case for or against the freedoms, we recommend that the Government should use any consultation to seek further evidence from interested parties, before weighing this up in making its decision.

11.37 The following section specifies a number of insights built up during the trial. The CAA would recommend that, as part of any consultation phase, the Government seek the views of stakeholders both on the overall value of the freedoms to Heathrow and on the insights below before taking a decision on the permanent application of the freedoms.

Safety Insights

11.38 **Insight No. 1: While the freedoms have been trialled safely, the CAA has identified operational and procedural changes that would need to be introduced to provide the highest level of safety assurance before the freedoms were made permanent.**

11.39 Part of the trial involved early vectoring, allowing aircraft to deviate earlier from the published SID routings to help accommodate better departure rates. The trial revealed realisable benefits from this practice, in reducing the time interval required between certain departing aircraft pairs. During the 'trial' environment these benefits were reduced by the additional voice-communications workload required to implement the revised departure routings.

11.40 Permanent deployment would, by necessity, involve SID re-design and publication,[59] and this would increase the realised benefit of the early vectoring indicated within the trial. Evidence gained from this operational freedom helps to inform the design of new Heathrow SIDs

59 The CAA's Airspace Change Process applies to all proposals for changes to the status of UK airspace. www.caa.co.uk/default.aspx?catid=7&pagetype=90&pageid=9129

that will be an integral part of the wider LAMP redesign mentioned under paragraph 6.13.

Operational Insights

11.41 **Insight No. 2: The CAA suggests that whatever decision is taken on operational freedoms, what has been learnt can and should be joined up with other collaborative initiatives, including better optimisation of the airport's schedules, as part of a process of continuous improvement.**

11.42 In the wider context of improving the airport's performance, the trial has provided useful experience and given a better understanding of the system and its limitations, including its reliance on different elements of the airport and airspace system.

11.43 For example, one possible explanation for the trialled freedoms apparently being less successful than SEAT expected is that air traffic controllers may not always have been able to make the best use of the additional flexibility. This could be because the trigger criteria for deploying the freedoms were too blunt, or because the tools available to controllers (in the form of information systems) did not give them a sufficiently accurate prediction for when runway capacity was going to be available.

11.44 There is inevitably a degree of speculation here. But it has been suggested by the airport and NATS that improvements based on better information sharing, such as A-CDM and the appointment by the airport of an arrivals manager, should improve the airport's ability to gain performance advantages from the freedoms. This would particularly apply as controllers become more used to the freedoms being deployed routinely.

11.45 There is a strong case for implementing the above measures to further improve information flows across the airport community. We suggest that it would be useful to seek stakeholder views on whether these changes would help the airport's ability to make better use of the flexibility afforded by the operational freedoms.

11.46 **Insight No. 3: A continued focus on performance is needed as Heathrow faces operational challenges.**

11.47 A full airport faces a difficult tension between squeezing out more capacity and maintaining an acceptable level of performance. It could be argued that HAL, the airlines, the slot coordinator and regulators have until now allowed or even encouraged Heathrow to be scheduled to the

maximum, at the expense of performance, in a ratcheting effect that is difficult to reverse.[60]

11.48 With the airport operating at close to its cap of 480,000 air transport movements a year, HAL's focus has been on improving its performance in terms of punctuality, resilience and delay. However, maintaining performance in the face of the forecast changing traffic mix is likely to introduce further challenges to this position as the average aircraft size using Heathrow (and the separation distances between aircraft) increases, in particular through the growing A380 fleet.

11.49 Should further operational flexibility be given to the airport, it would be important to ensure that the benefits are captured in terms of operational performance.

Community Insights

11.50 **Insight No. 4: The impact on communities of operational freedoms is uncertain but could be significant. Further consideration should be given to how these impacts are measured and how they might be mitigated.**

11.51 As with any decision on operational changes at Heathrow, it is important to weigh up the potential benefits to passengers and the airport from improving performance with the potentially significant environmental effects on the local communities affected by such changes. Efforts have been put into better understanding the impact of the freedoms on the community, including developing modelling for what the marginal loss of respite would mean for residents, although we appreciate that there are significant difficulties in assigning objective costs to what is an inherently subjective issue. We would suggest that stakeholder views are sought on the work done so far and where more could be done to understand these effects better and how to mitigate them.

11.52 **Insight No. 5: The trial has been a good platform to test enhanced information sharing and a more open dialogue between community groups and Heathrow. The benefits of this approach should not be lost going forward.**

11.53 The CAA notes that considerable efforts were made by both HAL and representative groups in sharing data and views on the broader environmental impact of the trial on local communities. While the relationship between the airport and parts of the community continues

60 The trade-offs between capacity and reliability were recognised in the 2011 SEAT report (page 38).

to lack trust, we believe the increased transparency and dialogue between the parties has been helpful in improving understanding of the issues on both sides and ultimately improving decision-making.

11.54 Furthermore, the added scrutiny to which Heathrow's current operations have been exposed has also helped to identify a number of operational practices which require clear, transparent explanation, and in some cases simplification, so that all parties understand better how the airport is designed to function. It is important that this transparency is maintained beyond the trial period. For example, HAL has been asked to reinstate to its website some key material relating to the trial which it had removed. We would welcome views from all stakeholders on how the experience of the trial could be built upon to create a more open, consultative relationship between HAL and its local communities.

APPENDIX A

CAA recommendations from Phase 1 of the trial for Phase 2

A1 The majority of the CAA's recommendations from Phase 1 had a direct bearing on the approach to be adopted in Phase 2. These recommendations are set out below, together with HAL's comments on how it responded (set out in Table 1 of its report) and the CAA's further comments.

A2 For ease of reference, the recommendations are grouped according to theme. For completeness we have included the recommendations from the CAA's interim report on Phase 1, although HAL has not commented on these specifically in its report.

Table A1: Outcome of CAA recommendations from Phase 1

CAA Recommendation from Phase 1	HAL action (HAL report, Table 1)	CAA comments
Engagement		
CAA interim recommendation: Any adjustments to the trial design and trial methodology should be agreed between the DfT, CAA and BAA further in advance of the planned commencement of the second phase of the trial to enable better preparation and greater transparency.	No comment.	Discussions began soon after Phase 1 was complete. The design of Phase 2 was announced by Written Ministerial Statement on 15 May 2012, and stakeholder engagement began earlier than for Phase 1.
CAA interim recommendation: We note that the timing of the first phase of the trial allowed only limited opportunity for prior engagement with local communities. We recommend that BAA considers how best to engage with communities about the trial ahead of the commencement of the second phase, including seeking agreement with the DfT and CAA on what successful engagement looks like.	No comment.	HAL reconsidered and modified its engagement strategy in the light of experience with Phase 1 and Populus surveys. Its strategy and the aims were discussed with the DfT and CAA.
CAA interim recommendation: Local authority technical experts should have more, and earlier, opportunity to be engaged in the data verification and analysis.	No comment.	See CAA recommendation 1 below.
CAA interim recommendation: The publication of existing runway operating procedures in mid-December helped to answer a number of the questions raised about the distinction between pre-existing procedures and the operational freedoms in the trial. We recommend that the differences between existing flexibility and the freedoms being tested by the trial are clearly explained at an earlier stage for the second phase of the trial.	No comment.	HAL published an explanatory document in July 2012.

CAA Recommendation from Phase 1	HAL action (HAL report, Table 1)	CAA comments
Engagement		
CAA recommendation 1: That the technical discussions on the impact of the trial continue to be facilitated through Heathrow's existing Noise and Track-Keeping Working Group and that there is greater involvement of local authority experts in the detail of the data collection and analysis at an earlier stage for Phase 2. This should help to reduce the number of queries from various parties around different data sources and conflicting information, which it has taken considerable effort and time to resolve.	The Noise and Track-Keeping Working Group (NTKWG) has been closely involved throughout Phase 2 of the trial providing review and feedback on all aspects of the trial, in particular relating to data presentation and the format and contents of reporting on the trial. The number of queries on data fell considerably compared to Phase 1.	There was much greater collaboration in Phase 2. There was an issue of late provision of low-level Phase 1 data to NTKWG members, and some lack of clarity over opportunities for NTKWG to comment on draft reports, but in general these were resolved.
CAA recommendation 2: The CAA agrees with BAA that a different approach to awareness-raising should be adopted ahead of and during Phase 2. In particular, more effort should be given to informing local communities affected by the trial through appropriate local media (for example, radio, local newspapers).	An extensive awareness campaign was adopted prior to Phase 2 and community engagement activities have been undertaken throughout Phase 2. See [Section 6 of HAL report].	The CAA is content that this recommendation was complied with.
Data		
CAA interim recommendation: A key step in the data validation process for the final report will be ensuring that the two principal sources of data used in measuring use of the trial freedoms (i.e. the Noise and Track-Keeping System and NATS operations logs) are reconciled accurately and consistently so as to provide a robust and reliable picture of the flights that have benefited from the application of the operational freedoms. We would recommend that Cambridge University look specifically at this aspect of data generation as part of their validation role.	No comment.	In the latter part of Phase 1, HAL worked closely with Cambridge University to identify the appropriate sources for all the data needed for analysis of the trial. This work is summarised in Section 2.9 of the HAL report. The CAA is therefore content that this recommendation was complied with.

CAA Recommendation from Phase 1	HAL action (HAL report, Table 1)	CAA comments
Data		
CAA recommendation 3: Fewer issues with data accuracy are expected in Phase 2, but we believe it would be of help to those with an interest in the operation of the trial if BAA can correct or at least notify users of inaccuracies in published information as soon as possible throughout the period of Phase 2.	A data steering group has been established to oversee data collection and integrity, including the main stakeholders. Data issues are raised through this steering group and are also reported to the NTKWG. There have been far fewer data accuracy issues in Phase 2 than in Phase 1.	The CAA is content that this recommendation was complied with.
Use of the operational freedoms		
CAA recommendation 4: We would suggest that BAA seeks to establish a way of capturing how often the trigger conditions are being met but the freedoms are not being used. This would be useful information to add to that collected in Phase 2 of the trial.	Trigger conditions, when they are used and when they are not used even if available are captured and reported in monthly reports. These are summarized in [the HAL report].	The CAA is content that this recommendation was complied with.
CAA recommendation 5: We agree with the view expressed by Cambridge University that BAA should engage with them and the CAA to establish a more robust experimental design for Phase 2 ahead of commencement.	The CAA and Cambridge University ECS Unit were actively involved in the Phase 2 trial design.	The CAA is content that this recommendation was complied with.
Effects of the trial – analysis methodology		
CAA recommendation 6: Given that operating conditions during Phase 2 of the trial are likely to be heavily affected by the Olympics and in light of the difficulties faced during Phase 1 in terms of drawing robust conclusions from the data generated, we recommend that the duration of Phase 2 be extended to encompass the 2012/13 winter scheduling season.	Phase 2 of the trial runs to end of February 2013.	The CAA is content that this recommendation was complied with. Phase 2 originally ran until the end of March 2013, but because it was not possible to trial the planned early-morning arrivals measure, by agreement this was advanced to the end of February 2013.

CAA Recommendation from Phase 1	HAL action (HAL report, Table 1)	CAA comments
Effects of the trial – analysis methodology		
CAA recommendation 7: We would recommend that more detailed regression analysis is undertaken on the Phase 1 data as well as the future Phase 2 results so as to provide a better foundation for any future decisions on the application of the operational freedoms tested.	Phase 2 was analysed using a detailed regression analysis (see [the HAL report]). It was not, however, possible to re-analyse the Phase 1 data using the same techniques because data were not captured with sufficient granularity in Phase 1 to apply the techniques developed for and during Phase 2, specifically trigger data, flight-by-flight cataloguing of aircraft to which operational freedoms were applied and weather data.	The CAA is content that this recommendation was complied with. The Phase 1 regressions were based on daily data, whereas those used for Phase 2 were based on half-hourly data, an approach which proved more successful. The CAA accepts that it was not practical for HAL to re-cast the Phase 1 data at a half-hourly level, and CAA attempts to produce more robust regressions from the daily Phase 1 data did not yield markedly better results than HAL's initial analysis.
Effects of the trial – environment		
CAA recommendation 8: That BAA gives consideration to whether Phase 2 of the trial would benefit from further work to understand the value placed on respite by residents.	The work on value of respite is described in section 6 of [the HAL report].	Heathrow has run small focus groups within communities affected by aircraft overflights. A survey methodology has been developed which, if widely deployed, may enable statistically robust results to be obtained of the views of local residents on respite. While the findings from the surveys may provide some initial indications as to the views of a sample of local residents on certain issues relating to respite and relief, the survey work would need to be developed and implemented on a larger and quantitative scale if a statistically definitive value of respite is to be obtained.

CAA Recommendation from Phase 1	HAL action (HAL report, Table 1)	CAA comments
Effects of the trial – community		
CAA recommendation 9: As the findings from the analysis undertaken so far leave unanswered the question of how many of the complaints generated relate specifically to direct experience of nuisance generated by flights utilising operational freedoms, we recommend that further analysis of complaints data, from both Phase 1 and 2 of the trial, should be undertaken to clarify the nature of the relationship.	More comprehensive analysis of complaints data has been undertaken. This is described in Section 6 of [the HAL report].	Following discussion and suggestions from the CAA, HAL has tried to separate complaints data from Phase 2 of the trial into those that could be related to a movement affected by operational freedoms and those that could not. Given that there are different levels of detail associated with different complaints, the CAA believes there would be little more to be gained from extending this analysis beyond that which HAL has undertaken. Therefore, the CAA is content that this recommendation was complied with.
Effects of the trial – resources		
CAA recommendation 10: The report on Phase 2 of the trial should include greater consideration of the resource impact on the airport, NATS and airlines.	The resource implications of the trial itself as it was executed were minimal.	The HAL report does not give any detail underlying this assertion, but the CAA's interviews with stakeholders did not suggest any significant impact. HAL expended considerable staff resources in design of the trial and engaging with local communities.

APPENDIX B

Impact of operational freedoms on KPIs (Phase 2)

Key Performance Indicator	HAL findings	CAA comments
Runway arrival and departure rate	Both TEAM* and proactive tests increase the arrival rate while early vectoring increases the departure rate; however, application of TEAM* arrivals will also have a negative impact on departure rates.	The CAA agrees with these findings which are not unexpected.
ATFM delay	Some evidence of a negative association between ATFM delays and TEAM* (but not proactive tests) in the summer period, while no evidence of a similar association in the winter period of the trial.	HAL's summer model has a very low explanatory power (R-square=0.25) which suggests that other unknown external factors may have far more influence on the KPI than TEAM* has. The CAA's own modelling suggests a positive rather than a negative association over the summer period with a relatively high R-square value of 0.76.
Stackholding delay	No evidence to support the hypothesis of the association of TEAM* and proactive tests with a reduction in stackholding delays. However, there is some tentative evidence that TEAM* results in a significant and negative rate of change in stackholding time.	HAL's results actually indicate a significant and positive (which is counter-intuitive) association between TEAM* and stackholding. On the other hand, HAL's finding of a negative rate of change of stackholding is based on a model with a very low R-square value (0.09) such that no meaningful conclusion can be drawn from it. The CAA results show no statistically significant association between stackholding delay and TEAM*, but there is evidence of a significant negative association with proactive tests in the summer period.
Start-up delay	No evidence to suggest that start-up delays would be reduced by the application of early vectoring.	The CAA results concur with HAL's findings, although there is some tentative evidence in the summer period that the application of a proactive test may help reduce start-up delay.

continued overleaf

Key Performance Indicator	HAL findings	CAA comments
Holding point delays	There is evidence of a positive association between TEAM* and holding point delays, but no evidence to support the hypothesis that holding point delays would be reduced by the application of early vectoring.	The CAA analysis finds that both TEAM* and proactive tests have positive association with the KPI, and some evidence to suggest that application of early vectoring would reduce holding point delays.
Taxi-in time	Some limited evidence of a reduction in taxi-in time, particularly for Terminal 4 arrivals, with the application of TEAM*.	The low R-square values throughout suggest that only a small proportion of the variation of the KPI is explained by the regression models.
Taxi-out time	No evidence of an association between early vectoring and taxi-out times.	Analysis by the CAA corroborates these findings.
Arrival punctuality	Some evidence to suggest that an increase in arrival punctuality is associated with TEAM* during the summer period but not during the winter period.	The CAA finds only limited evidence of a small improvement in the KPI associated with application of TEAM*.
Departure punctuality	There is evidence to suggest that departure punctuality is improved by the application of early vectoring in the summer but not winter period.	Analysis by the CAA corroborates these findings.
Arrival and departure cancellations (#)	No evidence to suggest that arrival/ departure cancellations are impacted by the application of operational freedoms.	Analysis by the CAA corroborates these findings.

Notes: A negative (positive) association means that the application of the freedom tends to be associated with a decrease (increase) in the measured KPI.

R-square is a measure of the goodness of fit of a model. A high R-square value indicates that the set of included independent variables is capable of explaining most of the observed variation in the dependent variable, suggesting that the model has a good explanatory power.

(#) Because data was available on a daily rather than half-hourly basis, the analyses on cancellations were based on simple statistical comparisons of the sample averages and standard deviations between the trial and baseline periods.

Source: HAL report and CAA analysis.

APPENDIX C

CAA estimates of costs and benefits (Phase 2)

C1 The purpose of the costs and benefits calculation is to use passenger value of time and fuel savings and other methods to seek to attribute a monetary value to the identifiable impacts of the trialled operational freedoms on the performance of the monitored KPIs. This generates a common currency for comparison between the different freedoms.

C2 The methodology used by the CAA to calculate the costs and benefits is largely based on that proposed and detailed by HAL in its report on the summer season of Phase 2.

C3 This involves assigning costs to the different phases of individual flights as the operational freedom may have a significant impact at different stages of a flight. The costs and benefits will be calculated separately for each time sensitive KPI for which a statistically significant impact has been identified. To avoid the possibility of double-counting, benefits from improvement in punctuality have not been included in the overall benefits calculation.

C4 For each KPI and for each operational freedom (if a statistically significant relationship between them has been established), the potential time savings are estimated by taking the difference between the fitted KPI values with and without the application of the freedom.

C5 However, in lieu of the fact that the dual-arrivals operational freedom (i.e. TEAM*) was built on a pre-existing freedom of dual arrivals (i.e. TEAM) which has a higher delay trigger of 20 minutes, the CAA considers that the benefits (or costs) calculation should only reflect the additional benefits (or costs) of applying TEAM* against the use of TEAM.

C6 However, since the application of TEAM* altered how delays would build up during the day, there is no simple way of identifying which of the out-of-alternation arrivals would have occurred due to TEAM. Thus further assumptions on the proportion of out-of-alternations that can be attributed to TEAM* as opposed to TEAM have to be made and these are described in detail in paragraphs 9.10–9.16 in the main document.

C7 Next, the time saving is divided by the number of flights over the season to obtain the average time saving per flight. Only those flights on westerly operation from 07.00 and onward have been taken into

account – the time when the trial effectively started each day. And only the proactive period is considered to calculate the average time saved per flight by the proactive operational freedom.

C8 The costs/benefits based on the time saving per flight are calculated for the following:

- Potential fuel costs/savings per flight.
- Potential costs/benefits on implied cost delay per flight.
- Potential costs/benefits on passenger value per flight.
- Potential costs/benefits per flight.
- The key assumptions used in the calculation of potential benefits/costs are exactly the same as those presented in Section 4 and Annex F of HAL's summer season Phase 2 report. These include fuel burn and carbon dioxide emissions, price of aviation fuel, value of carbon, implied cost per minute of delay and passenger value of time etc, and are listed in Tables C1 to C3 below.
- The total benefit/cost per flight is a summation of the individual benefits/costs per flight listed above. This total benefits/costs is then multiplied by the total number of flights over the season to obtain a potential saving/cost for the whole season (only those flights after 07.00 on westerly operation have been taken into account).

Table C1: Parameters used by HAL to calculate potential summer season fuel cost savings

Parameter	Value	Source
CO_2 emissions (stack) (tonnes per minute)	0.206	Emissions analysis
CO_2 emissions (taxi-in) (tonnes per minute)	0.078	Emissions analysis
CO_2 emissions (holding point) (tonnes per minute)	0.073	Emissions analysis
Price of aviation fuel ($ per tonne)	$992.79	Average aviation fuel prices 1 July–31 October 2012 from US Energy Information Administration statistics converted at 362 US gallons of aviation fuel = 1 metric tonne (UN Energy Statistics Yearbook)
Price of aviation fuel (£ per tonne)	£625.48	Converted at average exchange rate 1 July–31 October 2012 ($1.587 to £1) (www.exchangerates.org.uk)
Value of carbon (€ per tonne)	€7.71	Average of daily price of carbon 1 July–31 October 2012 (www.forexpros.com)
Value of carbon (£ per tonne)	£6.13	Converted at average exchange rate 1 July–31 October 2012 (€1.257 to £1) (www.exchangerates.org.uk)
Jet fuel to CO_2 conversion factor	3.149	Standard Inputs for EUROCONTROL Cost Benefit Analyses, edition 5.0, December 2011

Source: HAL Phase 2 summer season report.

Table C2: Implied cost per minute of delay based upon 2008 Runway Resilience Study costs

	ATFM	Stack	Ground	Stand
Implied cost per minute of delay (£ per minute)	£21.1	£31.7	£31.3	£21.1

Source: HAL Phase 2 summer season report.

Table C3: Parameters used by HAL to calculate potential summer season passenger value of time savings

Parameter	Value	Source
Average passengers per aircraft	146	CAA and BAA statistics for Heathrow (2011)
Percentage of business passengers	31%	CAA Passenger Survey Report (2011)
Percentage of leisure passengers	69%	CAA Passenger Survey Report (2011)
Business passenger value of time (£ per minute)	£0.91	2008 Runway Resilience Study
Leisure passenger value of time (£ per minute)	£0.14	2008 Runway Resilience Study

Source: HAL Phase 2 summer season report.

C9 The following tables give a breakdown of the CAA's estimates for the incremental costs and benefits from the use of reactive and proactive freedoms during Phase 2. These estimates only apply to those cases where a statistically demonstrable link between changes in the KPI during the trial and operational freedoms was found from the regression analysis (i.e. where the level of significance of the freedom in explaining the movement of the measured KPI is five per cent or less).

Table C4: Potential savings over the summer season

TEAM*	Time saving (min)			Potential saving (£/flight)			Potential saving, summer (£)		
KPI	Lower	Mean	Upper	Lower	Mean	Upper	Lower	Mean	Upper
Taxi-in	-3829	797	5,423	-5.43	1.13	7.69	-594,005	123,641	841,287
Holding point	-10,969	-4,676	3,265	-14.41	-6.14	4.29	-1,625,404	-692,897	483,813
					Total TEAM* =		**-£2,219,409**	**-£569,256**	**£1,325,100**

Proactive	Time saving (min)			Potential savings			Potential savings, summer (£)		
KPI	Lower	Mean	Upper	Lower	Mean	Upper	Lower	Mean	Upper
Stackholding	-957	964	2,460	-3.46	3.48	8.89	-378,303	381,070	972,441
Taxi-in	-207	1,474	2,971	-0.59	4.23	8.53	-64,657	462,643	932,505
Start-up	-524	569	1,413	-1.09	1.18	2.93	-122,505	133,025	330,342
Holding point	-3,542	-1,718	857	-9.76	-4.73	2.36	-1,100,674	-533,867	266,312
Taxi-out	-410	792	1,994	-1.14	2.20	5.55	-128,692	248,595	625,882
					Total proactive =		**-£1,794,831**	**£691,466**	**£3,127,482**

Source: CAA calculation

Key to Tables:

The association between the freedom and the measured KPI is significantly different from zero with a certainty of at least 95 per cent.

The association between the freedom and the measured KPI is significantly different from zero with a certainty of at least 95 per cent, but its direction is contrary to the trial hypothesis.

Table C4: Potential savings over the summer season (continued)

Early vectoring KPI	Time saving (min)			Potential saving (£/flight)			Potential saving, summer (£)		
	Lower	Mean	Upper	Lower	Mean	Upper	Lower	Mean	Upper
Holding point	-9,521	10,080	24,353	-12.50	13.24	31.99	-1,720,533	1,821,550	4,400,814
					Total early vectoring =		**-£1,720,533**	**£1,821,550**	**£4,400,814**
					Total summer season =		**-£5,734,773**	**£1,943,760**	**£8,853,396**

Source: CAA calculation

Table C5: Potential savings over the winter season

TEAM* KPI	TIme saving (min)			Potential saving (£/flight)			Potential saving, winter (£)		
	Lower	Mean	Upper	Lower	Mean	Upper	Lower	Mean	Upper
Stackholding	-2,067	1,469	3,982	-7.8	5.54	15.02	-571,199	405,947	1,100,394
Taxi-in	-1,518	813	3,115	-4.55	2.43	9.33	-333,073	178,385	683,480
Holding point	-4,856	-3,537	-269	-13.33	-9.71	6.33	-1,009,314	-735,161	-61,523
					Total TEAM* =		**-£1,913,586**	**-£150,829**	**£1,722,351**
					Total winter season =		**-£1,913,586**	**-£150,829**	**£1,722,351**

Source: CAA calculation

APPENDIX D

CAA evaluation of respite

Objective

D1 To calculate a monetary value for the respite obtained at Heathrow Airport through the alternation of the runway designated for westerly arrivals.

D2 Following this, to calculate a value for the respite that was lost due to the use of operational freedoms during the Operational Freedoms Trial.

Rationale

D3 In his retrospective analysis[61] of the data gathered during the Aircraft Noise Index Study (ANIS),[62] Peter Brooker identified a shift in annoyance levels between people living in areas which were, and were not, exposed to runway alternation and any resulting relief/respite. This shift in annoyance (termed the 'alternation decibel correction', ADC) was calculated to be worth 2 dB in overall LAeq16h noise level terms.

D4 The DfT's WebTAG[63] defines monetary costs per household per decibel change in transportation[64] noise level upwards of 45 dB LAeq18h.

D5 The rationale for applying the WebTAG methodology to the Brooker result is the assertion that monetary cost is proportional to annoyance.

Approach

D6 Adopting this rationale, it is conceivable that a value for the monetary value of respite due to alternation of the runway designated for westerly arrivals at Heathrow could be obtained. The following approach was devised:

- Consider regions of west London located beneath the westerly arrival routes which are subject to runway alternation.

61 Aircraft noise annoyance estimation: UK time-pattern effects, Peter Brooker. Applied Acoustics 71, 2010 (661-667).

62 DR Report 8402, United Kingdom, Aircraft Noise Index Study: main report. CAA 1985.

63 TAG Unit 3.3.2: The Noise Sub-Objective.

64 Road and railway.

- Calculate the numbers of households exposed to different levels of westerly arrival noise using Heathrow average summer daytime 16 hour Leq noise contours plotted for westerly arrivals only.
- Multiply the numbers of households exposed to the modelled noise levels by the respective monetary values (WebTAG) such to evaluate the annoyance shifts (ADCs) from each of the contour band levels (Brooker).
- Sum the monetary values obtained for the shift at each noise level to yield an annual monetary value of respite due to alternation of the runway designated for westerly arrivals.

D7 Having calculated an overall monetary value for respite, use the results of the Operational Freedoms Trial to factor the value calculated for overall respite accordingly to represent the amount of respite that was lost due to the freedoms.

Annoyance shift, considerations

D8 The ANIS study was conducted in 1982; runway alternation had been in operation for the preceding nine years. It is conceivable that a gradual introduction of TEAM since then would have potentially eroded some of the benefits of alternation indicated through annoyance scores in the ANIS survey. The ADC may therefore have reduced between 1982 and today.

D9 The airport is currently operating with an average of 2 per cent of westerly arrival movements out of alternation. Despite changes in total operations from a peak of 479,000 ATMs in 2008 to 455,000 in 2010, the baseline data from the analysis of the trial show the percentage of out-of-alternation arrivals remaining fairly constant throughout this period.

D10 Looking back through available data, the DfT's evidence to the Terminal 5 Inquiry in 1997 reported that "The numbers are consistently low, and usually in the region of 1 to 3 per cent of westerly landings…". The 2 per cent average proportion of out-of-alternation arrivals observed for the trial baseline is thus consistent with use in 1995–1997. During the trial, the average proportion of out-of-alternation arrivals observed was 3.5 per cent.

D11 The Department's T5 Inquiry evidence also stated that "Since the introduction of runway alternation in 1972, NATS has also been given the discretion to suspend its application temporarily in order to reduce delays to arriving aircraft. Operations at Heathrow require use of the full

capacity of the landing runway for significant periods of the day, and an excess of demand over the capacity of one runway may occur for a variety of reasons."

D12 The inference is that the current proportion of TEAM operations has remained constant for quite some time and there was almost certainly some level of de-alternation during the period of the 1982 ANIS annoyance surveys. If the proportion of de-alternation was broadly similar at the time of ANIS as it is today, there are grounds to suggest that the ADC may have changed little between 1982 and today.

D13 Traffic levels have increased by 90 per cent since the 1982 survey. Since the proportion of out-of-alternation arrival is considered to have remained about the same, the net increase in out-of-alternation arrivals has increased. There is a case to say that the ADC may have reduced as a result.

D14 While individual noise event levels have reduced with the introduction of quieter aircraft, the 90 per cent increase in traffic levels has led to a 90 per cent increase in arrival noise events. There is a case to say that residents may now place greater value on respite as a result of the traffic increase, despite an increase in net out-of-alternation arrivals, such that the ADC calculated from the 1982 results may have increased.

Review of the result found by Brooker

D15 When undertaking his analysis, Brooker selected sites from the ANIS study results which experienced both relief and respite from departing and arriving aircraft. Since we are investigating the effects of out-of-alternation westerly arrivals occurring due to operational freedoms, we are only interested in respite for sites specifically under the westerly approach paths. There was therefore a need to repeat the analysis but including only the sites affected by westerly arrival alternation in order to obtain an ADC relevant to this particular investigation.

D16 Exclusion of all sites except those affected by westerly arrival alternation left us with three respite sites under the westerly approach: Hounslow, Isleworth and Chiswick. Upon re-analysis, it was found that these data points were insufficient to identify a statistically significant effect. Consequently, we do not consider it appropriate to draw conclusions on the value of respite due to westerly arrival alternation based on an ADC derived from the available data.

D17 We do, however, believe that if a statistically significant ADC could be calculated from the results of robust survey work, this monetisation

approach could be useful in estimating the value of respite due to westerly arrival alternation at Heathrow, and also the value lost due to out-of-alternation westerly arrivals. We have therefore set out our proposed methodology in the following sections.

Calculating an overall value of respite

Methodology

D18 Plot the Heathrow Leq noise contours for the relevant year/period for westerly arrivals (76/24 westerly/easterly standard modal split) in 1 dB steps.

D19 Calculate the number of households in each contour band. Include contours down to the level where the most commonly used arrival routes join the extended runway centre-lines.

D20 Multiply the number of households in each contour band by the respective monetary value associated with increasing noise levels by the ADC using the Value of a Change in Transport-Related Noise from WebTAG Unit 3.3.2.

D21 Sum the results for each contour band to obtain a value for respite.

D22 For sensitivity testing, repeat steps D20 and D21 but for different ADCs as appropriate.

Assumptions

D23 The summer average contour with a long-term westerly/easterly modal split is used as it takes into account the number of days during a summer period that people are exposed to westerly arrivals. The 2011 summer noise contour is the most recent which was not affected by the Operational Freedoms Trial.

D24 The monetary values are based on road and rail noise. TAG Unit 3.18, Aviation Appraisal states in paragraph 3.3.1 that "The principles of Unit 3.3.2 also apply to aviation. In the absence of any aviation specific values, aviation appraisal should use the values set out in that Unit."

D25 The methodology assumes that current attitudes to aviation noise are similar to those identified in the survey work from which the ADC is derived.

D26 The WebTAG monetary values are currently based on 2010 values and prices. WebTAG assumes an average household size of 2.36 people per household.

D27 Although the WebTAG values are based on LAeq18h noise levels, it is reasonable to apply the methodology to aviation noise levels evaluated in terms of the LAeq16h metric. This is because alternation of the designated westerly arrival runway at Heathrow occurs during the 16-hour daytime period from 07.00–23.00, which falls within the 18-hour period.

Calculating a value of respite lost due to operational freedoms

Methodology

D28 To obtain values for the loss of respite due to the Operational Freedoms Trial, the calculated overall values of respite may be factored to represent the amount of respite lost as measured in terms of out-of-alternation westerly arrivals (TEAM*).[65]

D29 Any reasonable and justifiable factoring methodologies may be used. Two different methodologies are offered here to produce lower and upper bounds on the calculated value. The factors are based on:

a) Additional duration of noise exposure above a threshold of 70 dBA Lmax due to TEAM* during the trial, compared with the duration of noise exposure during the baseline, i.e. with extant levels of TEAM in the absence of TEAM* (lower bound); and

b) Reduction of the number of clock-hours with no de-alternated westerly arrivals, comparing use of TEAM* in the trial period to the baseline with extant levels of TEAM in the absence of TEAM* (upper bound).

D30 Clearly there is a case for a), for example interference of speech which lasts only for the duration of the noise event, hence this sets a lower bound.

D31 In the case of b), there is consistent anecdotal evidence that people plan noise-sensitive activities around the 15.00 alternation change and therefore it is plausible to assume the adverse effects last for up to an hour.

65 TEAM* is one of the operational freedoms that was trialled. It is similar to TEAM, but has different trigger criteria.

D32 In summary the lower and upper bounds represent values if respite is defined in periods of around a minute or an hour. Accepting this methodology, the value may be somewhere between these two extremes. Without undertaking further research on attitudes to noise, respite and the value placed on both elements, we are unable to provide any indication as to where the value may lie within this range.

Conclusion

D33 A methodology has been conceived to calculate:

- a monetary value for the overall value for respite due to alternation of westerly arrivals at Heathrow; and
- monetary values (possible upper and lower bounds) for the loss of respite due to the TEAM* operational freedom.

D34 This methodology requires statistically robust value for the benefit of respite, which may be calculated from noise attitude survey data. This investigation has identified that a statistically significant value for this input does not currently exist based on available data. Without further evidence, we cannot provide a quantitative indication as to the monetary value of respite due to alternation of the runway used for westerly arrivals, or of the loss of respite due to the Operational Freedoms Trial.