NATS

Performance
through Innovation

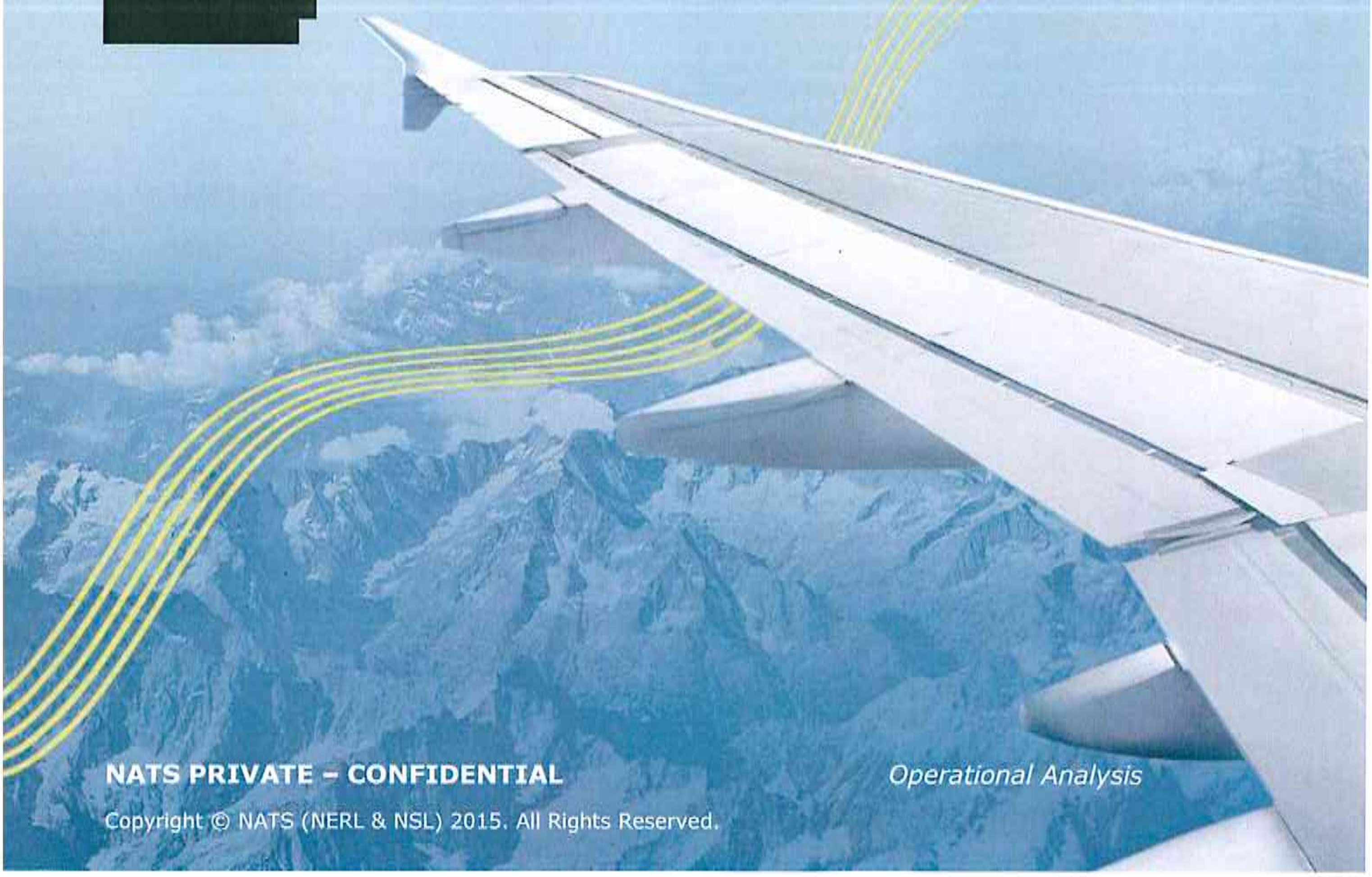
LAMP Phase1a: ACP Environmental Benefits Report

Fast Time Simulation Airspace Comparison

Version 1.2
MRI #4165/RPT/144
March 2015

Prepared by

[redacted]



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Operational Analysis

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LAMP Phase 1a: ACP Environmental Benefits Report

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Acceptance

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Author	Senior Research Analyst	[redacted]	January 2015
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Referenced Documents

List of documents referenced in this publication:

Ref	Title	Report Reference
(1)	Manual of Air Traffic Services, Part II. *NATS En-Route Plc, 2008.*	Operational Information, Swanwick
(2)	UK AIP AIRAC 05/2009	Aeronautical Information Service, NATS
(3)	NATS Fuel Burn and Related Emissions Model (KERMIT)	N/A

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1. Executive Summary

A Fast Time Simulation study has been undertaken to assess the environmental impact of the proposed LAMP Phase1a airspace.

The results of the Fast Time study conclude that the proposed LAMP Phase 1a airspace changes will enable benefits in fuel burn savings and the associated reduction in CO_2 emissions overall. For 2020, the high-case forecast scenario estimates the enabled savings at 19,675 tonnes of fuel burn, estimated to equate to approximately 49,659 tonnes of CO_2 (adjusted).

2. Introduction

A Fast Time Simulation study was requested by the NATS LAMP project team to estimate future enabled and actual operational and environmental benefits in support of the LAMP Phase 1a Airspace Change Proposal. Enabled benefits consider the impact of the changes to the procedures that dictate fuel uplift requirements and are therefore most relevant to airline operators as they are a factor in the economic efficiency of a route.

Actual benefits also take into account the effect of tactical intervention on overall fuel burn and therefore relate to the actual CO2 impact of the proposed changes. As tactical intervention is, by nature, impossible to accurately replicate in a Fast Time Simulation model, a methodology has been developed to translate the enabled results into actual results using a comparison with actual flown trajectories derived from radar data. This is referred to as the 'Adjusted CO2' methodology and is detailed further in Section 6.

This Fast Time study (undertaken using specialist fast time simulation software called AirTOp) considered a Baseline airspace model against which the proposed change was compared using the same traffic sample in order to identify the effects of the LAMP Phase 1a airspace. This impact was determined using the KERMIT tool to assess track mileage, fuel burn and 3Di score.

This document provides a summary of the Fast Time Simulation and the requested outputs of the study.

3. Methodology

3.1. Modelling Assumptions

During modelling and the analysis of results, the following assumptions were made:

- Results were required for 2016 as the first year of operation and 2020 as a future case.
- The number of flights modelled is sufficient to enable valid conclusions are drawn. Where this may not be the case, it has been highlighted in the report.
- Aircraft linking (the linkage between inbound and outbound flights made by the same aircraft) was not modelled.
- Airfield ground movement was not modelled. All runway movements were free from taxiing: departing aircraft entered the simulation by appearing on the departure runway aligned ready for take off, and arriving aircraft were removed from the simulation once their speed on the runway had reduced to their normal taxiing speed.
- Standard inbound/outbound separations were modelled for all airfields. Details of these parameters were obtained from MATS Part 2(1) and the AIP(2) respectively.
- A "blue sky" weather picture with no wind was assumed for the Baseline and all comparative analysis between the Baseline scenarios and proposed designs.
- The airspace designs did not include flow restrictions or slot compliance such that unconstrained demand profiles were modelled. This ensured that ineffecienies inherent within the airspace were not masked by the utilisation of these tactical measures.
- The traffic growth was based on NATS November 2012 grid forecasts and grown on a city-pair basis for UK flights and a region-pair basis for overflights (2012 is the latest grid forecast available).
- When undertaking comparative analysis between the designs, the traffic samples used were common to analysis of both baseline and the proposed designs. This was to ensure any observed differences were due to the airspace design, not due to changes in the traffic samples.
- Conflict resolution was not used, ie aircraft flew their flight planned route.
- Simulated controller tasks were completed instantaneously with each controller able to control multiple aircraft simultaneously.
- Metric outputs were largely based on procedural and standing agreement altitudes and flight level restrictions on SIDs, STARs, Holds and transitions. The exception was where the procedural levels were felt to be so different to what is actually flown, or to the profiles which are expected to be achieved and accounted for in airline fuel planning calculations, as to promote invalid conclusions, in these cases 'pessimistic typical' levels were used. These were based on expert controller validation; any difference from procedural level restrictions is detailed in Appendix A of this report.
- Runway changes were not modelled.
- All fuel burn and 3Di analysis is based on the output of the KERMIT environmental model(3).

3.2. Traffic Samples

For each sample day all flights which flight-planned to;

- arrive or depart London City
- arrive at Gatwick from the north-east or south-east
- depart Stansted, Luton or Northolt on a DVR SID
- arrive at Bournemouth or Southampton from the south-east
- depart Bournemouth or Southampton routing to DVR
- arrive at Southend
- arrive at Farnborough from the south-east, south or south-west
- depart Farnborough routing to DVR

were simulated with the exception of positioning flights to or from Heathrow, Stansted, Luton, London City, Northolt, Southampton, Bournemouth, Biggin Hill, Farnborough, Manston, Southend or Cambridge which were removed as these are tactically managed in reality.

3.2.1. Base-year Traffic Samples

The dates used to create the traffic samples for this analysis were selected to represent typically busy periods of LTMA traffic in 2013.
The analysis has been in progress assessing design iterations throughout 2014, hence 2013 samples were used. The sample has not been updated for the final report as the 2013 samples were deemed to remain representative of the traffic mix and distribution.

CFMU data on the number of arrivals and departures from AIRAC 1307 (27/06/2013-24/07/2013) as a typical summer month was used to identify days of average, busy and unusually high traffic demand.

Dates with traffic delays and regulations were discarded from the initial sample to avoid this biasing the results. Traffic varies by the day of the week with weekdays being busier than weekends and the direction of the Oceanic tracks (Northabout/Southabout). Therefore, it was decided that the sample days should be taken from different weekdays and include at least one Northabout and one Southabout day.

The chosen sample days were Friday (05/07/2013- Northabout) with two Mondays (27/06/2013- Northabout and 22/07/2013-Southabout) and a Thursday (18/07/2013- Middleabout).

The last-filed flight-plans for these dates were then obtained from CFMU, via EUROCONTROL's Network Strategic Tool (NEST). This captures what the traffic requested to fly in adherence to the procedures and avoids the inclusion of any tactical or capacity management effects upon the traffic routings.

Of the 4 traffic samples listed above, all were simulated for the 2013 base year (for the purposes of the adjusted CO2 analysis – see section 6), while only 05/07/2013 and 22/07/2013 were used for the comparative analysis of the baseline airspace versus the proposed design. The comparative analysis was limited to two day-long traffic samples because the time/resource involved with running additional samples was considered disproportionate to the additional value they would bring (the two sample days were deemed to be representative of normal busy operation covering northabout and southabout days).

3.2.2. Grown Traffic Samples

Growth has been applied in two ways within this analysis;

1. Growing modelled sample days to 2016 and 2020: the base-year traffic samples detailed in 3.2.1 were grown to reflect predicted traffic demand using high-case NATS 2012 Grid Forecasts. As one set of traffic samples was used to assess all the Phase 1a airspace changes, the high-case forecasts were chosen as the base-case forecasts are known to have underestimated the demand at London City in 2013 (London City movements represent the largest number of flights affected by the LAMP Phase1a changes).

2. Growing average results to 2016 and 2020: the analysis of the sample days produced average fuel change per flight for each route. To calculate the estimated annual saving this figure was multiplied by the forecasted (grown) number of airport movements and the proportion of flights for that airfield which used the relevant route in 2014. This proportion was calculated using radar data and CFMU flight-planned data contained within the NATS Business Intelligence data warehouse. The forecast (grown) airport movements were taken from the NATS 2012 grid forecast.

3.3. Simulation

Two simulations were run for each day sample- once assuming easterly operations and once assuming westerly operations. Where environmental benefits are not quoted as being specifically easterly or westerly, they are calculated as an average of the two methods of operation.

A total of 22 scenarios were modelled as described in Table 1- Simulation scenarios.

Design	Sample Year/Day	Easterly				Westerly			
		27/06	05/07	18/07	22/07	27/06	05/07	18/07	22/07
Baseline	2013	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6	Run 7	Run 8
	2016		Run 7		Run 8		Run 9		Run 10
	2020		Run 11		Run 12		Run 13		Run 14
Phase1a	2016		Run 15		Run 16		Run 17		Run 18
	2020		Run 19		Run 20		Run 21		Run 22

Table 1- Simulation scenarios

Continued feedback from the customer and operational staff was obtained to validate the AirTOp modelling. This was to ensure the metrics were appropriate for assessing the viability of the project objectives.

The versions of the airspace modelling used to obtain the results quoted in this report are LAMP Baseline v6.5 and LAMP Phase1a v1.86.

3.4. Software Versions

Fast Time Simulation was undertaken using AirTOp version 2.3.15B5.

Fuel burn and emissions analysis of the trajectories was conducted using KERMIT version 6.3.

Both of the above tools used BADA 3.11 data to model aircraft performance characteristics.

4. Design Overview

The following airspace designs have been modelled for this analysis;

4.1. Baseline Airspace

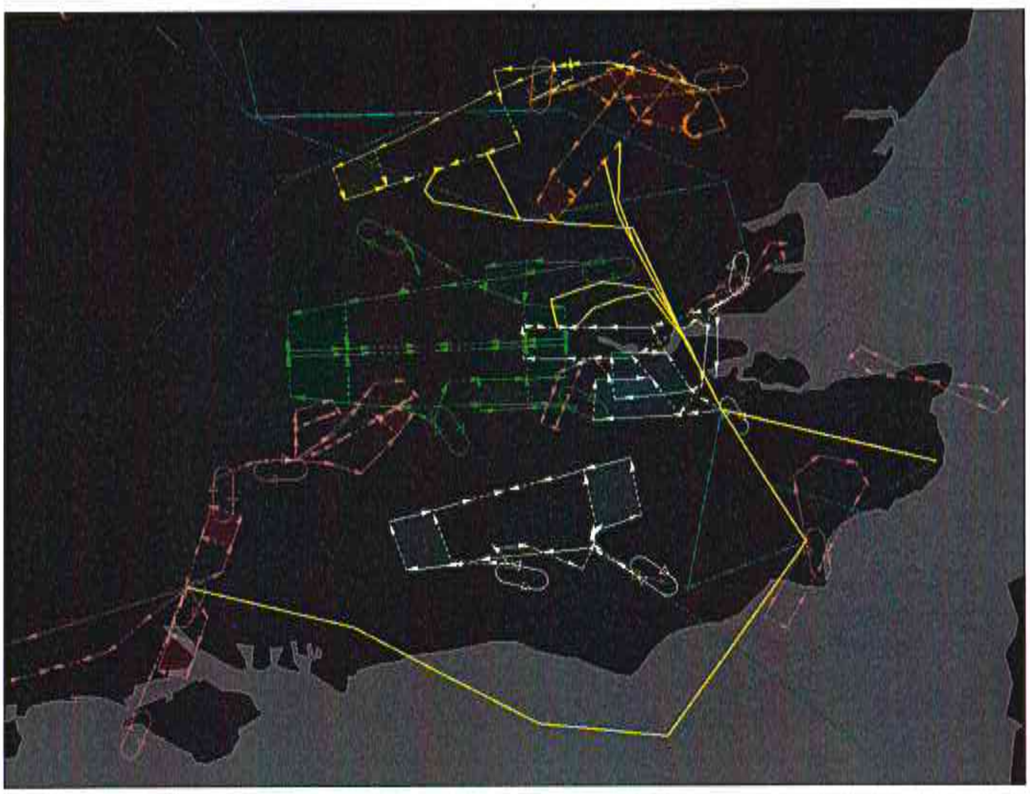

Figure 1- Baseline airspace modelled in AirTOp with LC, KK, SS and GW STARs and SIDs highlighted

The baseline model was originally based on the information contained in AIRAC [3] cycle April 2009. This has been subsequently updated and validated by operational controllers to represent todays airspace structure, with the additional modification that level restrictions on the London City DVR, LYD and SAM SIDs and the Luton, Stansted and Northolt DVR SIDs. This is so that flights modelled on these SIDs follow a profile expected given standing agreements rather than the procedural levels on the SID plate. This is because the SID levels are never flown, being primarily intended for radio-fail situations, whereas the standing agreement levels represent the procedures applied in normal operations. These level modifications are detailed in Appendix A and were arrived at using expert controller validation.

4.2. Phase 1a Airspace

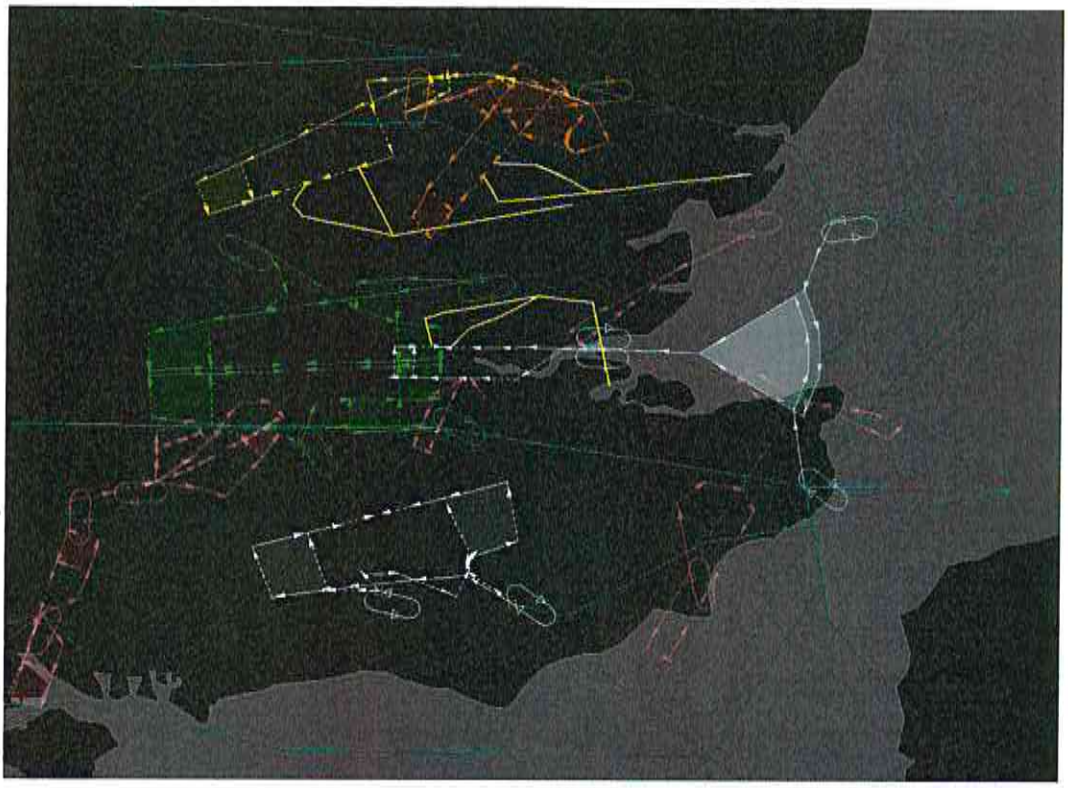

Figure 2- LAMP Phase1a airspace modelled in AirTOp with LC, KK, SS and GW airports' STARs and SIDs highlighted

The following differences from the baseline procedures have been modelled;

- STARs, holds, a new point merge approach structure and RNAV downwind transitions for London City
- London City SAM, DVR and LYD SIDs have been replaced by the EKNIV SID.
- STARs into the Gatwick TIMBA hold from the north-east or south-east.
- Stansted DVR departures now use the existing CLN SID, Luton and Northolt DVR departures now use the existing MATCH SID, with all then following new airways.
- The SAM1D STAR for Bournemouth and Southampton (from the south-east) has been replaced by the SAM2D STAR.
- Farnborough, Bournemouth and Southampton departure routes via DVR.
- STARs have been introduced for Southend arrivals from the South and East.
- Arrival routes for Farnborough inbounds from the south-east, south or south-west.

5. Enabled Environmental Benefits Analysis

Track distance and enabled fuel savings are reported for each affected flightpath for comparison between the Baseline airspace and LAMP Phase1a airspace. The London City analysis also includes 3Di score and flight time as a full traffic sample was simulated for this airfield.

Some simulation results are notably different for easterly and westerly operations. Hence, they are given separately in addition to the overall averages quoted in the tables below.

All positive results shown in the following tables (shaded green) represent an average benefit from the Phase 1a airspace compared to the baseline. Negative results (red shading) represent a comparative average disbenefit.

5.1. London City

London City was the only airfield at which all traffic was modelled, even the unaffected departure routes. This was so that the full runway throughput was modelled, allowing for comparison of holding between the two scenarios. The fuel results for the affected departures are given both as an average over *all* departures (in Table 4 and Table 5) and as an average over the affected routings (in Table 8 below).

5.1.1. Track Distance

Table 2 and Table 3 show the average track distance comparison (including a variable element for holding) to the nearest Nm. A positive figure denotes a lower average track mileage in the Phase1a airspace simulations than in the baseline, and vice versa for negative values.

	Baseline minus Phase1a	
	2016	2020
Average over all movements	-7Nm	-6Nm
Average over all arrivals	-11Nm	-10Nm
Average over all departures	-2Nm	-2Nm

Table 2

	Baseline minus Phase1a			
	Easterly Simulations		Westerly Simulations	
	2016	2020	2016	2020
Average over all movements	-5Nm	-4Nm	-9Nm	-8Nm
Average over all arrivals	-7Nm	-6Nm	-15Nm	-14Nm
Average over all departures	-3Nm	-3Nm	-2Nm	-2Nm

Table 3

5.1.2. Enabled fuel

Table 4 and Table 5 show enabled fuel comparisons to the nearest 5kg. A fuel burn difference of less than 10kg is quoted as negligible.

	Baseline minus Phase1a	
	2016	2020
Average over all movements	65kg	75kg
Average over all arrivals	85kg	95kg
Average over all departures	45kg	50kg

Table 4

	Baseline minus Phase1a			
	Easterly Simulations		Westerly Simulations	
	2016	2020	2016	2020
Average over all movements	80kg	90kg	45kg	55kg
Average over all arrivals	120kg	135kg	45kg	60kg
Average over all departures	40kg	45kg	50kg	50kg

Table 5

Estimated annual enabled fuel benefit

Table 6 and Table 7 show estimated annual enabled fuel comparisons in tonnes for affected departures and arrivals at London City repectively. Forecasted movements are quoted from the NATS November 2012 Grid forecasts.

	2016	2020
Basecase forecasted DVR and LYD departures from London City	19,051	23,193
Annual enabled fuel benefit (tonnes)	1,606	2,003
Highcase forecasted DVR and LYD departures from London City	21,959	24,688
Annual enabled fuel benefit (tonnes)	1,851	2,132

Table 6

	2016	2020
Basecase forecasted arrivals to London City	35,186	42,835
Annual enabled fuel benefit (tonnes)	2,948	4,143
Highcase forecasted arrivals to London City	40,557	45,596
Annual enabled fuel benefit (tonnes)	3,398	4,410

Table 7

Aircraft type and route combinations

Table 8 and Table 9 show a breakdown of the above metrics by route and, within that, by aircraft type. Where this reduces the sample size to less than 10 aircraft the results are not reported. The number of aircraft is taken from all 4 simulations combined and the 'Baseline minus Phase1a' results are reported as an average of the aircraft in that group.

Departures:

	2016		2020	
	Number of aircraft	Baseline minus Phase 1a	Number of aircraft	Baseline minus Phase 1a
EGLC-DVR	158	115kg	190	115kg
2 Engine Small Jet	46	165kg	62	165kg
4 Engine Medium	40	200kg	44	200kg
Heavy Turboprop	58	35kg	68	35kg
EGLC-LYD	122	45kg	126	45kg
2 Engine Small Jet	32	45kg	32	50kg
4 Engine Medium	22	140kg	22	140kg
Heavy Turboprop	38	20kg	38	20kg
Small Jets	22	negligible	26	negligible

Table 8

Arrivals by STAR:

The difference in enabled fuel benefits quoted in Table 9 include the difference in fuel burn resulting from the changes to the individual STARs, and also differences due to changes in the amount of arrival delay between the two scenarios. This second element relates to the amount of delay each individual aircraft had to absorb in each scenario and is a reflection of the traffic situation at that time as well as the airspace structure itself.

	2016		2020	
	Number of aircraft in sample	Baseline minus Phase 1a	Number of aircraft in sample	Baseline minus Phase 1a
ALKIN3D	136	40kg	144	60kg
2 Engine Small Jet	34	75kg	34	90kg
4 Engine Medium	48	65kg	52	100kg
Heavy Turboprop	30	negligible	30	negligible
Small Jets	16	negligible	18	negligible
ALKIN3F	44	125kg	44	120kg
2 Engine Small Jet	22	200kg	22	190kg
Heavy Turboprop	10	30kg	10	35kg
SPEAR1A	24	-90kg	20	-100kg
Medium Airbus	24	-90kg	20	-100kg
SPEAR1B	212	110kg	246	125kg
2 Engine Small Jet	54	175kg	66	190kg
4 Engine Medium	42	205kg	46	235kg
Heavy Turboprop	88	45kg	100	45kg
Medium Turboprop	12	40kg	14	55kg
Small Jets	12	35kg	16	50kg
SPEAR1L	48	35kg	52	70kg
4 Engine Medium	22	90kg	28	140kg
Medium Turboprop	26	-10kg	24	negligible
SPEAR1M	78	140kg	78	135kg
2 Engine Small Jet	52	215kg	54	195kg
Medium Turboprop	20	-30kg	20	-30kg

Table 9

5.1.3. 3Di score

Table 10 and Table 11 show the average 3Di score comparison given to the nearest 3Di point.

	Baseline minus Phase1a	
	2016	2020
Average over all movements	9	9
Average over all arrivals	16	16
Average over all departures	2	2

Table 10

	Baseline minus Phase1a			
	Easterly Simulations		Westerly Simulations	
	2016	2020	2016	2020
Average over all movements	11	11	7	7
Average over all arrivals	20	20	12	12
Average over all departures	1	1	2	2

Table 11

5.1.4. Average time in holding and total flight time per arrival

Table 12 and Table 13 show the average time in holding and total flight time comparisons, given to the nearest half minute. They show that in westerly operations the arrivals spent more time in flight in the Phase 1a scenario than in the baseline, some of which was spent in holding. This is because there is longer distance to fly in the Phase 1a approach structure and the westerly low-level vectoring area can absorb more delay than the point merge arc. The fuel burn results nevertheless show a saving as the profile of the approach via point merge arc is better than via low-level vectoring.

	Baseline minus Phase1a	
	2016	2020
Average time in holding (minutes)	0	0
Average flight time (minutes)	-0.5	0

Table 12

	Baseline minus Phase1a			
	Easterly Simulations		Westerly Simulations	
	2016	2020	2016	2020
Average time in holding (minutes)	0	0	-0.5	-0.5
Average flight time (minutes)	1.5	2	-2.5	-2

Table 13

5.2. Stansted, Luton and Northolt DVR SIDs

5.2.1. Track Distance

Table 14 and Table 15 show the average track distance comparison to the nearest Nm. A positive figure denotes a lower average track mileage in the Phase1a airspace simulations than in the baseline, and vice versa for negative values.

	Baseline minus Phase1a	
	2016	2020
Stansted DVR departures	2Nm	2Nm
Luton DVR departures	-8Nm	-8Nm
Northolt DVR departures	-10Nm	-10Nm

Table 14

	Baseline minus Phase1a			
	Easterly Simulations		Westerly Simulations	
	2016	2020	2016	2020
Stansted DVR departures	6Nm	7Nm	-2Nm	-2Nm
Luton DVR departures	-8Nm	-8Nm	-8Nm	-8Nm
Northolt DVR departures	-10Nm	-10Nm	-10Nm	-10Nm

Table 15

5.2.2. Enabled fuel

Table 16 and Table 17 show enabled fuel comparisons to the nearest 5kg. A fuel burn difference of less than 10kg is quoted as negligible.

	Baseline minus Phase1a	
	2016	2020
Stansted DVR departures	205kg	215kg
Luton DVR departures	180kg	190kg
Northolt DVR departures	50kg	50kg

Table 16

	Baseline minus Phase1a			
	Easterly Simulations		Westerly Simulations	
	2016	2020	2016	2020
Stansted DVR departures	290kg	300kg	120kg	125kg
Luton DVR departures	185kg	195kg	175kg	185kg
Northolt DVR departures	50kg	50kg	50kg	50kg

Table 17

Estimated annual enabled fuel benefit

Table 18, Table 19 and Table 20 show estimated annual enabled fuel comparisons for Stansted, Luton and Northolt respectively in tonnes. Forecasted DVR departures are calculated from the NATS November 2012 Grid forecasted movements multiplied by the proportion of flights for each airfield which were DVR departures in 2014.

	2016	2020
Basecase forecasted DVR departures from Stansted	25,135	27,867
Annual enabled fuel benefit (tonnes)	5,131	5,941
Highcase forecasted DVR departures from Stansted	27,874	30,226
Annual enabled fuel benefit (tonnes)	5,690	6,445

Table 18

	2016	2020
Basecase forecasted DVR departures from Luton	9,955	11,276
Annual enabled fuel benefit (tonnes)	1,810	2,126
Highcase forecasted DVR departures from Luton	10,292	11,691
Annual enabled fuel benefit (tonnes)	1,871	2,205

Table 19

	2016	2020
Basecase forecasted DVR departures from Northolt	868	1,004
Annual enabled fuel benefit (tonnes)	44	51
Highcase forecasted DVR departures from Northolt	899	1,052
Annual enabled fuel benefit (tonnes)	46	54

Table 20

Aircraft type and route combinations

Table 21 shows a breakdown of the above metrics by route and, within that, by aircraft type. Where this reduces the sample size to less than 10 aircraft the results are not reported. The number of aircraft is taken from all 4 simulations combined and the 'Baseline minus Phase1a' results are reported as an average of the aircraft in that group.

	2016		2020	
	Number of aircraft in sample	Baseline minus Phase 1a	Number of aircraft in sample	Baseline minus Phase 1a
EGGW				
3 Engine Small	12	55kg	10	60kg
Medium Airbus	36	220kg	48	225kg
Medium Boeing	24	205kg	24	185kg
Small Heavy	10	470kg	16	485kg
Small Jets	24	15kg	34	10kg
EGSS				
Medium Airbus	68	190kg	82	195kg
Medium Boeing	178	175kg	194	175kg
Small Heavy	16	485kg	20	485kg
EGWU				
Small Jets	16	40kg	16	40kg

Table 21

5.3. Gatwick TIMBA arrivals from the north-east and south-east

As the Phase 1a airspace changes to Gatwick arrivals do not differ between easterly and westerly operations they have not been reported separately in this section.

5.3.1. Track Distance

Table 22 shows the average track distance comparison to the nearest Nm. A positive figure denotes a lower average track mileage in the Phase1a airspace simulations than in the baseline, and vice versa for negative values.

	Baseline minus Phase1a	
	2016	2020
Average of TIMBA3E arrivals	5Nm	5Nm
Average of TIMBA3B arrivals	0Nm	0Nm

Table 22

5.3.2. Enabled fuel

Table 23 shows enabled fuel comparisons to the nearest 5kg. A fuel burn difference of less than 10kg is quoted as negligible.

	Baseline minus Phase1a	
	2016	2020
Average of TIMBA3E arrivals	140kg	140kg
Average of TIMBA3B arrivals	15kg	15kg

Table 23

Estimated annual enabled fuel benefit

Table 24 shows estimated annual enabled fuel comparisons for Gatwick in tonnes. Forecasted affected arrivals are calculated from the NATS November 2012 Grid forecasted movements multiplied by the proportion of Gatwick movements which arrived via DET or KUNAV in 2014.

	2016	2020
Basecase forecasted N-E or S-E arrivals to Gatwick	66,447	72,070
Annual enabled fuel benefit (tonnes)	4,437	4,463
Highcase forecasted N-E or S-E arrivals to Gatwick	74,838	80,063
Annual enabled fuel benefit (tonnes)	4,929	4,958

Table 24

Aircraft type and route combinations

	2016		2020	
	Number of aircraft	Baseline minus Phase 1a	Number of aircraft	Baseline minus Phase 1a
TIMBA2E				
2 Engine Boeing Heavy	14	345kg	14	345kg
Medium Airbus	146	95kg	162	95kg
Medium Boeing	140	165kg	136	165kg

TIMBA3B				
Medium Airbus	432	15kg	438	15kg
Medium Boeing	150	15kg	158	15kg
Upper Medium	48	20kg	46	20kg

Table 25 shows a breakdown of the above metrics by route and, within that, by aircraft type. Where this reduces the sample size to less than 10 aircraft the results are not reported. The number of aircraft is taken from all 4 simulations combined and the 'Baseline minus Phase1a' results are reported as an average of the aircraft in that group.

	2016		2020	
	Number of aircraft	Baseline minus Phase 1a	Number of aircraft	Baseline minus Phase 1a
TIMBA2E				
2 Engine Boeing Heavy	14	345kg	14	345kg
Medium Airbus	146	95kg	162	95kg
Medium Boeing	140	165kg	136	165kg
TIMBA3B				
Medium Airbus	432	15kg	438	15kg
Medium Boeing	150	15kg	158	15kg
Upper Medium	48	20kg	46	20kg

Table 25

5.4. Farnborough arrivals from the south-east, south and south-west

As the Phase 1a airspace changes to Farnborough arrivals do not differ between easterly and westerly operations they have not been reported separately in this section.

5.4.1. Track Distance

Table 26 shows the average track distance comparison to the nearest Nm. A positive figure denotes a lower average track mileage in the Phase1a airspace simulations than in the baseline, and vice versa for negative values.

	Baseline minus Phase1a	
	2016	2020
Arrivals via GIBSO	-20Nm	-21Nm
Arrivals via KATHY	-6Nm	-8Nm
Arrivals via KUNAV	10Nm	9Nm

Table 26

5.4.2. Enabled fuel

Table 27 shows enabled fuel comparisons to the nearest 5kg. A fuel burn difference of less than 10kg is quoted as negligible.

	Baseline minus Phase1a	
	2016	2020
Average over arrivals via GIBSO	-100kg	-125kg
Average over arrivals via KATHY	-60kg	-85kg
Average over arrivals via KUNAV	40kg	35kg

Table 27

Table 26 shows that Farnborough arrivals via GIBSO and KATHY incur a disbenefit in the Phase 1a airspace. Conversely, the changes to the arrival routes via KUNAV resulted in a fuel burn saving and as this is the by far the most popular of the three affected arrival routes, the impact on the affected Farnborough arrivals overall was negligible.

Aircraft type and route combinations

Table 28 shows a breakdown of the above metrics by route and, within that, by aircraft type. Where this reduces the sample size to less than 10 aircraft the results are not reported, hence only a subset of arrivals via KUNAV (and none via KATHY or GIBSO) are shown in the table. The number of aircraft is taken from all 4 simulations combined and the 'Baseline minus Phase1a' results are reported as an average of the aircraft in that group.

	2016		2020	
	Number of aircraft	Baseline minus Phase 1a	Number of aircraft	Baseline minus Phase 1a
Arrivals via KUNAV				
3 Engine Small	12	75kg	10	65kg
Small Jets	40	35kg	44	30kg

Table 28

5.5. Bournemouth and Southampton arrivals from the south-east

As the Phase 1a airspace changes to Bournemouth and Southampton arrivals do not differ between easterly and westerly operations they have not been reported separately in this section.

5.5.1. Track Distance

Table 29 shows the average track distance comparison to the nearest Nm. A positive figure denotes a lower average track mileage in the Phase1a airspace simulations than in the baseline, and vice versa for negative values.

	Baseline minus Phase1a	
	2016	2020
Southampton arrivals from the south-east	-7Nm	-7Nm
Bournemouth arrivals from the south-east	-6Nm	-6Nm

Table 29

5.5.2. Enabled fuel

Table 30 shows enabled fuel comparisons to the nearest 5kg. A fuel burn difference of less than 10kg is quoted as negligible.

	Baseline minus Phase1a	
	2016	2020
Southampton arrivals from the south-east	-70kg	-65kg
Bournemouth arrivals from the south-east	-50kg	-60kg

Table 30

Estimated annual enabled fuel benefit

Table 31 and Table 32 show estimated annual enabled fuel comparisons for Southampton and Bournemouth respectively in tonnes. Forecasted south-east arrivals are calculated from the NATS November 2012 Grid forecasted movements multiplied by the proportion of Southampton or Bournemouth movements which arrived via GWC in 2014.

	2016	2020
Basecase forecasted S-E arrivals to Southampton	1,720	2,093
Annual enabled fuel benefit (tonnes)	-119	-135
Highcase forecasted S-E arrivals to Southampton	1,882	2,262
Annual enabled fuel benefit (tonnes)	-130	-146

Table 31

	2016	2020
Basecase forecasted S-E arrivals to Bournemouth	1,057	1,213
Annual enabled fuel benefit (tonnes)	-54	-75
Highcase forecasted S-E arrivals to Bournemouth	1,111	1,280
Annual enabled fuel benefit (tonnes)	-56	-79

Table 32

Aircraft type and route combinations

Table 33 shows a breakdown of the above metrics by route and, within that, by aircraft type. Where this reduces the sample size to less than 10 aircraft the results are not reported, hence only a subset of arrivals to Southampton (and none to Bournemouth) are shown in the table. The number of aircraft is taken from all 4 simulations combined and the 'Baseline minus Phase1a' results are reported as an average of the aircraft in that group.

	2016		2020	
	Number of aircraft	Baseline minus Phase 1a	Number of aircraft	Baseline minus Phase 1a
EGHI				
Heavy Turboprop	18	-70kg	24	-70kg

Table 33

5.6. Farnborough, Bournemouth and Southampton departures via DVR

5.6.1. Track Distance

Table 34 and Table 35 show the average track distance comparison to the nearest Nm. A positive figure denotes a lower average track mileage in the Phase1a airspace simulations than in the baseline, and vice versa for negative values.

	Baseline minus Phase1a	
	2016	2020
Farnborough DVR departures	-18Nm	-18Nm
Bournemouth DVR departures	-5Nm	-5Nm
Southampton DVR departures	-5Nm	-5Nm

Table 34

	Baseline minus Phase1a			
	Easterly Simulations		Westerly Simulations	
	2016	2020	2016	2020
Farnborough DVR departures	-18Nm	-19Nm	-17Nm	-16Nm
Bournemouth DVR departures	-5Nm	-5Nm	-5Nm	-5Nm
Southampton DVR departures	-5Nm	-5Nm	-5Nm	-5Nm

Table 35

5.6.2. Enabled fuel

Table 36 and Table 37 show enabled fuel comparisons to the nearest 5kg. A fuel burn difference of less than 10kg is quoted as negligible.

	Baseline minus Phase1a	
	2016	2020
Farnborough DVR departures	-90kg	-95kg
Bournemouth DVR departures	-20kg	-20kg
Southampton DVR departures	-150kg	-150kg

Table 36

	Baseline minus Phase1a			
	Easterly Simulations		Westerly Simulations	
	2016	2020	2016	2020
Farnborough DVR departures	-95kg	-105kg	-90kg	-80kg
Bournemouth DVR departures	-150kg	-150kg	-145kg	-145kg
Southampton DVR departures	-20kg	-20kg	-20kg	-20kg

Table 37

Estimated annual enabled fuel benefit

Table 38, Table 39 and Table 40 show estimated annual enabled fuel comparisons for Farnborough, Bournemouth and Southampton respectively in tonnes. Forecasted DVR departures are calculated from the NATS November 2012 Grid forecasted movements multiplied by the proportion of flights for each airfield which were DVR departures in 2014.

	2016	2020
Basecase forecasted DVR departures from Farnborough	1,446	1,672
Annual enabled fuel benefit (tonnes)	-132	-155
Highcase forecasted DVR departures from Farnborough	1,497	1,752
Annual enabled fuel benefit (tonnes)	-137	-162

Table 38

	2016	2020
Basecase forecasted DVR departures from Bournemouth	242	278
Annual enabled fuel benefit (tonnes)	-36	-41
Highcase forecasted DVR departures from Bournemouth	254	293
Annual enabled fuel benefit (tonnes)	-38	-43

Table 39

	2016	2020
Basecase forecasted DVR departures from Southampton	142	172
Annual enabled fuel benefit (tonnes)	-3	-3
Highcase forecasted DVR departures from Southampton	155	186
Annual enabled fuel benefit (tonnes)	-3	-4

Table 40

Aircraft type and route combinations

Table 41 shows a breakdown of the above metrics by route and, within that, by aircraft type. Where this reduces the sample size to less than 10 aircraft the results are not reported, hence only DVR departures from Southampton and Bournemouth (and none from Farnborough) are shown in the table. The number of aircraft is taken from all 4 simulations combined and the 'Baseline minus Phase1a' results are reported as an average of the aircraft in that group.

	2016		2020	
	Number of aircraft	Baseline minus Phase 1a	Number of aircraft	Baseline minus Phase 1a
Bournemouth DVR departures				
Medium Boeing	18	-150kg	18	-150kg
Southampton DVR departures				
Small Jets	18	-20kg	22	-20kg

Table 41

5.7. Southend arrivals

5.7.1. Track Distance

Table 42 and Table 43 show the average track distance comparison to the nearest Nm. A positive figure denotes a lower average track mileage in the Phase1a airspace simulations than in the baseline, and vice versa for negative values.

	Baseline minus Phase1a	
	2016	2020
Arrivals via NEVIL	-21Nm	-21Nm
Arrivals via RATUK	-15Nm	-17Nm
Arrivals via SUMUM	4Nm	1Nm
Arrivals via XAMAN	6Nm	6Nm

Table 42

	Baseline minus Phase1a			
	Easterly Simulations		Westerly Simulations	
	2016	2020	2016	2020
Arrivals via NEVIL	-29Nm	-29Nm	-13Nm	-12Nm
Arrivals via RATUK	-24Nm	-24Nm	-7Nm	-9Nm
Arrivals via SUMUM	0Nm	-4Nm	8Nm	6Nm
Arrivals via XAMAN	0Nm	0Nm	12Nm	11Nm

Table 43

5.7.2. Enabled fuel

Table 44 and Table 45 show enabled fuel comparisons to the nearest 5kg. A fuel burn difference of less than 10kg is quoted as negligible.

	Baseline minus Phase1a	
	2016	2020
Average over all Southend arrivals	-10kg	-10kg
Arrivals via NEVIL	-120kg	-115kg
Arrivals via RATUK	-30kg	-30kg
Arrivals via SUMUM	25kg	20kg
Arrivals via XAMAN	45kg	50kg

Table 44

	Baseline minus Phase1a			
	Easterly Simulations		Westerly Simulations	
	2016	2020	2016	2020
Average over all Southend arrivals	-40kg	-40kg	15kg	20kg
Arrivals via NEVIL	-235kg	-235kg	negligible	negligible
Arrivals via RATUK	-40kg	-40kg	-20kg	-20kg
Arrivals via SUMUM	-50kg	-65kg	100kg	110kg
Arrivals via XAMAN	-35kg	-30kg	125kg	125kg

Table 45

Estimated annual enabled fuel benefit

Table 46 shows estimated annual enabled fuel comparisons for Southend in tonnes. Forecasted arrivals are calculated from the NATS November 2012 Grid forecasted movements, reported to the nearest 1,000.

	2016	2020
Basecase forecasted arrivals to Southend	5,518	6,382
Annual enabled fuel benefit (tonnes)	-208	-211
Highcase forecasted arrivals to Southend	5,714	6,686
Annual enabled fuel benefit (tonnes)	-215	-221

Table 46

Aircraft type and route combinations

Table 47 shows a breakdown of the above metrics by route and, within that, by aircraft type. Where this reduces the sample size to less than 10 aircraft the results are not reported. The number of aircraft is taken from all 4 simulations combined and the 'Baseline minus Phase1a' results are reported as an average of the aircraft in that group.

	2016		2020	
	Number of aircraft	Baseline minus Phase 1a	Number of aircraft	Baseline minus Phase 1a
Arrival via NEVIL				
Medium Airbus	18	-120kg	22	-115kg
Arrival via XAMAN				
Medium Airbus	12	50kg	16	50kg

Table 47

5.8. Overall estimated annual fuel benefit

Table 48 and Table 49 show the estimated annual enabled fuel saving and the equivalent carbon dioxide emissions savings respectively (in tonnes) for all the LAMP Phase 1a changes.

Estimated enabled fuel saving (Tonnes)	2016	2020
Base case forecasts	15,597	18,227
High case forecasts	17,394	19,675

Table 48

Estimated CO_2 saving based on enabled fuel saving (Tonnes)	2016	2020
Base case forecasts	49,600	57,962
High case forecasts	55,314	62,566

Table 49

6. Adjusted CO_2 Analysis

CAP 725 requires an estimate of the overall CO2 reduction. The modelling process necessarily considers a principally procedural environment, in which all aircraft follow similar profiles defined by a set of rigid modelling rules. This provides what we refer to as *enabled* fuel benefit, which is a proxy for the difference that the proposal will make to the trip fuel that airlines will account for. As such this is a measure of the financial benefit to airlines when considering the efficiency of a particular route.

In reality aircraft are tactically vectored for reasons of safety and efficiency. This occurs in today's airspace and would also occur in the future (the amount of vectoring expected in the future is discussed later).

This vectoring means that not all trip fuel that airlines load onto a flight is spent. As CO_2 is only generated from spent fuel this can mean that the enabled fuel benefit may overestimate the CO_2 benefit if a straight conversion is undertaken.

Therefore whilst the enabled fuel benefit may be an appropriate basis for reporting a financial benefit to airlines, this section describes and applies a method for adjusting the results in an attempt to avoid overestimating actual fuel burn and therefore CO2.

In order to provide an indication of the difference between the *enabled fuel* benefit estimates, as derived from the Fast Time Simulations and estimates of *actual* fuel burn benefit, a comparative assessment was conducted using radar data. This assessment used the same base-year traffic sample as the Fast Time Simulations, cut to the UK FIR and using the same environmental assessment software, KERMIT, for the emissions estimates. The use of radar data captured any tactical intervention experienced by the aircraft, as well as other changes to that occurred in the operation, for example, runway usage, effects of weather or airline SOPs.

The fuel burn estimates derived from the radar data could then be compared against the fuel burn estimates derived from the Fast Time Simulation Procedural Baseline to identify the relative difference.

Whilst this methodology attempted to use the same set of flights, for the same period of time, the tactical nature of the radar environment meant that some exceptions were made. This involved the exclusion of 4 flights (total sample size 2205) for which radar data was incomplete or the traffic experienced extended delays, diversions or cancellations; in these instances the associated fuel burn estimates derived from the fast time simulations were also excluded.

6.1. Traffic Sample

In order to estimate the actual fuel burn difference for the network affected by LAMP Phase 1a the following flights were compared;

- London City arrivals and departures
- Stansted DVR departures
- Luton DVR departures
- Gatwick arrivals via TIMBA

6.2. Results

The comparison of the mean fuel burn from radar data less the mean fuel burn estimated from the Fast Time Simulations was **-255** Kg.

The statistical technique of Boot Strapping[1] was applied to the comparison of each flight's estimated fuel burn (between Radar and Fast Time Simulation) to produce the 2.5th and 97.5th percentile over a cycle of 100,000 steps.

This found that the mean difference had a variability of +/- **10** Kg,
i.e.

The Fast Time Simulation 'Procedural' Baseline used to show enabled benefits, resulted in a greater fuel burn than the Typical Baseline, with a mean difference of 255 Kg +/- 10 Kg. This relates to a 21% differential (ie the Typical Baseline has 21% less fuel burn than procedural baseline).

This difference represents:

- The fuel burn currently saved through tactical intervention.

and

- The fuel burn resulting from the modelling assumptions and simulation parameters employed.

Applying the mean difference as a percentage of the procedural baseline to the average fuel burn saving in the future traffic scenarios provided an upper estimate of the actual fuel burn and carbon dioxide savings respectively. This is shown in Table 50 below.

This assumes that the percentage adjustment applied to the procedural baseline to obtain the actual fuel burn remains the same, regardless of changes to the airspace design and traffic demand

i.e.

- That the amount of tactical intervention remains consistent with the current day operation.

Estimated actual fuel burn saving (Tonnes)	2016	2020
Base case forecasts	12,380	14,467
High case forecasts	13,806	15,616

Table 50

Estimated actual CO_2 saving (Tonnes)	2016	2020
Base case forecasts	39,368	46,006
High case forecasts	43,903	49,659

Table 51

In reality there are two main factors that could result in changes to the amount of tactical intervention:

Increasing traffic will reduce tactical intervention with current airspace

Tactical intervention is possible in today's airspace in part because the traffic volume is such that controllers have the space to be flexible. For example, routes may be designed with kinks or level caps to avoid neighbouring traffic flows, however if there is no traffic on the neighbouring route then the controllers may tactically offer a direct route that bypasses the kink, or climbs flights through a procedural restriction. As the volume of traffic increases there would be less opportunity for such tactical intervention.

This would have the effect of reducing the difference between the procedural modelled fuel burn and the actual measured fuel burn, and would potentially increase the benefits in Table 51 (bringing the benefits closer to the figures in Table 49).

Introduction of PBN will reduce tactical intervention in the proposed airspace

An aim of a PBN environment is to introduce more systemisation and predictability of aircraft tracks. This would mean less tactical intervention i.e. that whilst 21% may be an appropriate

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[1] Boot strapping is a statistical technique which allows estimation of the sample distribution of a statistic using random sampling methods.

reduction for the actual fuel burn for today's airspace; it may be an overestimate for the proposed PBN design. This effect therefore has the potential to decrease the benefits stated in Table 51.

It should be noted that while the PBN ideal is for complete systemisation, the real time simulations for LAMP clearly show a significant amount of tactical intervention would still be a significant part of the day to day operation of PBN airspace (see the LAMP 1A bridging ACP for real time simulation results).

It is not possible to reliably estimate either the potential increase in benefit as a result of less opportunity for tactical intervention in a conventional airspace environment as traffic grows, or the potential decrease in benefits from less tactical intervention in a PBN airspace environment. Neither effect has therefore been taken into account in Table 51 (estimated actual CO_2 savings).

Additional Notes

In order to draw a like-for-like comparison with the Typical Baseline, these estimates relied upon data cut to the UK FIR due to the lack of reliable radar data outside this region. The relative changes found between each Fast Time Simulation, as reported in Section 5, were cut to common 3-dimensional locations outside of the UKFIR to ensure benefits or dis-benefits due to differences in profile affecting trajectories outside the UK FIR were captured (i.e. earlier climb within the UK FIR allowing an aircraft to reach its' cruising altitude earlier outside the UK FIR).

Additionally, it should be noted that these results are based on a limited sample of traffic data from 2013. Application of forecast traffic growth, together with extrapolation to annualised figures, increases uncertainty within the results with an assumption that the average fuel burn on the busy sample dates is representative of the whole year.

Summary

Neither the positive effect on the results of increasing traffic levels on vectoring in today's environment, nor the negative effect of PBN on vectoring in the proposed PBN environment can be quantified with any certainty.

Whilst it is not possible to determine with certainty the carbon dioxide emissions that will occur in the future, this methodology nonetheless provides an indication of the potential scale in variation between the enabled fuel benefits derived from these Fast Time Simulations and those of real-world operations. NATS is not aware of any other methodology to reliably capture this variation. This methodology therefore represents the best estimate of the overall CO_2 saving from the proposed changes.

7. Summary of Results

The results of the Fast Time study conclude that the proposed LAMP Phase 1a airspace changes will enable benefits in fuel burn savings and the associated reduction in CO_2 emissions overall. For 2020, the base-case forecast scenario estimates the enabled savings at over **18,200 tonnes of fuel burn** estimated to equate to c. **46,000 tonnes of CO_2** (adjusted).

Most of the savings come from changes to London City departures and arrivals. Both departures and arrivals had increased track mileage but this was outweighed by the benefits from their improved profiles. This was particularly evident in the case of the arrivals in westerly operations which spent more time in flight and in holding but were still calculated to incur a fuel saving. This is because there is longer distance to fly in the Phase 1a London City approach structure and the baseline westerly low-level vectoring area can absorb more delay than the point merge arc, but the profile of the approach via point merge arc is significantly better avoiding fuel inefficient low-level vectoring.

Changes to Stansted, Luton and Northolt DVR departures also contribute fuel burn savings with Stansted departures estimated to save the most as they benefit from a slight reduction in track mileage overall as well as an improved profile.

Gatwick TIMBA arrivals from the north-east and south-east see a reduction in enabled fuel in the Phase 1a airspace with the arrivals from the north-east experiencing a reduction in track mileage as well.

Farnborough arrivals via GIBSO and KATHY incurred a disbenefit in the Phase 1a airspace. Conversely, the changes to the arrival routes via KUNAV resulted in a fuel burn saving and as this is the by far the most utilised of the three affected arrival routes, the impact on the affected Farnborough arrivals overall was negligible. Farnborough departures via DVR also incur a disbenefit however, resulting in an estimated disbenefit of 145 tonnes of fuel to Farnborough overall in 2020 (base-case forecast).

Southampton and Bournemouth arrivals from the south-east and departures via DVR were calculated to have increased track mileage and fuel burn in the Phase 1a airspace, resulting in a combined estimated disbenefit of 138 and 116 tonnes of fuel for affected Southampton and Bournemouth movements in 2020 respectively (base-case forecast).

While not all Southend arrivals incurred a disbenefit from the Phase 1a airspace changes, the overall impact was an estimated disbenefit of 211 tonnes of fuel in 2020 (base-case forecast).

	Arrivals			Departures			
	Saving per affected flight	Number of affected flights	Total saving for all arrivals (T)	Saving per affected flight	Number of affected flights	Total saving for all arrivals (T)	Overall airport saving (T)
EGLC	85kg	36,119	3,026	85kg	19,051	1,606	4,632
EGSS	[redacted]	[redacted]	[redacted]	205kg	25,135	5,131	5,131
EGGW	[redacted]	[redacted]	[redacted]	180kg	9,955	1,810	1,810
EGWU	[redacted]	[redacted]	[redacted]	50kg	868	44	44
EGKK	60kg	66,447	4,437	[redacted]	[redacted]	[redacted]	4,437
EGHI	-65kg	1,720	-119	-20kg	142	-3	-121
EGHH	-60kg	1,057	-54	-150kg	242	-36	-89
EGLF	15kg	5,881	94	-90kg	1,446	-132	-38
EGMC	-35kg	5,518	-208	[redacted]	[redacted]	[redacted]	-208

Table 52 and

	Arrivals			Departures			
	Saving per affected flight	Number of affected flights	Total saving for all arrivals (T)	Saving per affected flight	Number of affected flights	Total saving for all arrivals (T)	Overall airport saving (T)
EGLC	95kg	43,970	4,253	85kg	23,193	2,003	6,255
EGSS	[redacted]	[redacted]	[redacted]	215kg	27,867	5,941	5,941

EGGW				190kg	11,276	2,126	2,126
EGWU				50kg	1,004	51	51
EGKK	60kg	72,070	4,463				4,463
EGHI	-65kg	2,093	-135	-20kg	172	-3	-138
EGHH	-60kg	1,213	-75	-150kg	278	-41	-116
EGLF	<10kg	6,801	10	-95kg	1,672	-155	-145
EGMC	-35kg	6,382	-211				-211

Table 53 below show summaries of the enabled fuel benefits estimated using the 2016 and 2020 base-case forecasts respectively. The saving per affected flights is rounded to the nearest 5 kg and the total saving for all arrivals to the nearest tonne. The base-case estimated overall enabled fuel saving for 2016 is 15,597 tonnes and for 2020 is 18,228 tonnes.

	Arrivals			Departures			
	Saving per affected flight	Number of affected flights	Total saving for all arrivals (T)	Saving per affected flight	Number of affected flights	Total saving for all arrivals (T)	Overall airport saving (T)
EGLC	85kg	36,119	3,026	85kg	19,051	1,606	4,632
EGSS				205kg	25,135	5,131	5,131
EGGW				180kg	9,955	1,810	1,810
EGWU				50kg	868	44	44
EGKK	60kg	66,447	4,437				4,437
EGHI	-65kg	1,720	-119	-20kg	142	-3	-121
EGHH	-60kg	1,057	-54	-150kg	242	-36	-89
EGLF	15kg	5,881	94	-90kg	1,446	-132	-38
EGMC	-35kg	5,518	-208				-208

Table 52 2016 Base-case forecast

	Arrivals			Departures			
	Saving per affected flight	Number of affected flights	Total saving for all arrivals (T)	Saving per affected flight	Number of affected flights	Total saving for all arrivals (T)	Overall airport saving (T)
EGLC	95kg	43,970	4,253	85kg	23,193	2,003	6,255
EGSS	[redacted]	[redacted]	[redacted]	215kg	27,867	5,941	5,941
EGGW	[redacted]	[redacted]	[redacted]	190kg	11,276	2,126	2,126
EGWU	[redacted]	[redacted]	[redacted]	50kg	1,004	51	51
EGKK	60kg	72,070	4,463	[redacted]	[redacted]	[redacted]	4,463
EGHI	-65kg	2,093	-135	-20kg	172	-3	-138
EGHH	-60kg	1,213	-75	-150kg	278	-41	-116
EGLF	<10kg	6,801	10	-95kg	1,672	-155	-145
EGMC	-35kg	6,382	-211	[redacted]	[redacted]	[redacted]	-211

Table 53 2020 Base-case forecast

8. Appendix A

8.1. Existing SIDs Modelled Profiles

8.1.1. Stansted DVR SIDs

DVR 7R EGSS_23

Waypoints	radio fail levels		pessimistic typical levels	
	Min	Max	Min	Max
I-SX-D1.2	-	-	-	-
DET-D30-R336	3000ft	5000ft	3000ft	5000ft
DET-D25-R336	5000ft	5000ft	5000ft	5000ft
DET-D10-R336	5000ft	5000ft	-	8000ft
DET	5000ft	5000ft	-	-
DVR	5000ft	5000ft	-	-

DVR 5S EGSS_05

Waypoints	radio fail levels		pessimistic typical levels	
	Min	Max	Min	Max
I-SED-D2	-	-	-	-
LAM-D9-R027	3000ft	5000ft	3000ft	5000ft
DET-D25-R336	5000ft	5000ft	5000ft	5000ft
DET-D10-R336	5000ft	5000ft	-	8000ft
DET	5000ft	5000ft	-	-
DVR	5000ft	5000ft	-	-

8.1.2. Stansted CLN SIDs

CLN 4S EGSS_05

Waypoints	radio fail levels		pessimistic typical levels	
	Min	Max	Min	Max
I-SED-D1	-	-	-	-
BKY-D14-R117	2500ft	4000ft	2500ft	4000ft
BKY-D17-R117	3000ft	4000ft	3000ft	4000ft
CLN-D21-R268	4000ft	4000ft	4000ft	4000ft
CLN-D20-R268	-	-	-	-
CLN-D16-R268	5000ft	5000ft	-	-
CLN-D13-R268	6000ft	6000ft	-	-
CLN	6000ft	6000ft	-	FL150

CLN 8R EGSS_23

Waypoints	radio fail levels		pessimistic typical levels	
	Min	Max	Min	Max
I-SX-D1.2			-	-
XIGAR			-	-
CLN-D28-R268	3000ft	4000ft	3000ft	4000ft
CLN-D20-R268	4000ft	4000ft	-	-
CLN-D16-R268	5000ft	5000ft	-	-
CLN-D13-R268	6000ft	6000ft	-	-
CLN	6000ft	6000ft	-	FL150

8.1.3. Luton DVR SIDs

DVR 7B EGGW_26

Waypoints	radio fail levels		pessimistic typical levels	
	Min	Max	Min	Max
BNN-D10.2-R035	-	-	-	-
BNN-D9-R035	-	-	-	4000ft
BNN-D7-R035	-	-	-	4000ft
BPK-D12-R286	-	-	-	4000ft
BPK-D10-R286	3000ft	4000ft	3000ft	4000ft
BPK-D3-R286	5000ft	5000ft	4000ft	4000ft
BPK	5000ft	5000ft	4000ft	4000ft
BPK-D7-R99	5000ft	5000ft	5000ft	5000ft
BPK-D15.5-R099	5000ft	5000ft	-	8000ft
DET-D10-R336	5000ft	5000ft	-	8000ft
DET	5000ft	5000ft	-	-
DVR	5000ft	5000ft	-	-

DVR 7C EGGW_08

Waypoints	radio fail levels		pessimistic typical levels	
	Min	Max	Min	Max
LUT	-	-	-	-
BPK-D10-R337	-	-	-	-
BPK-D5-R337	4000ft	-	3000ft	4000ft
BPK-D3-R337	5000ft	5000ft	3000ft	4000ft
BPK	5000ft	5000ft	4000ft	4000ft
BPK-D7-R99	5000ft	5000ft	5000ft	5000ft
BPK-D15.5-R099	5000ft	5000ft	-	8000ft
DET-D10-R336	5000ft	5000ft	-	8000ft
DET	5000ft	5000ft	-	-
DVR	5000ft	5000ft	-	-

8.1.4. Luton MATCH SIDs

MATCH 1C EGGW_08

Waypoints	radio fail levels		pessimistic typical levels	
	Min	Max	Min	Max
LUT	-	-	-	-
BPK-D10-R337	-	-	-	-
BPK-D6-R337	4000ft	-	3000ft	4000ft
BPK-D3-R337	5000ft	5000ft	3000ft	4000ft
BPK	5000ft	5000ft	4000ft	4000ft
MATCH	5000ft	5000ft	-	FL170

MATCH 1B EGGW_26

Waypoints	radio fail levels		pessimistic typical levels	
	Min	Max	Min	Max
BNN-D10.2-R035	-	-	-	-
BNN-D7-R035	-	-	-	4000ft
BPK-D12-R286	-	-	-	4000ft
BPK-D10-R286	-	-	3000ft	4000ft
BPK-D6-R286	4000ft	-	3000ft	4000ft
BPK-D3-R286	5000ft	5000ft	4000ft	4000ft
BPK	5000ft	5000ft	4000ft	4000ft
MATCH	5000ft	5000ft	-	FL170

8.1.5. Northolt DVR SIDs

DVR 5Y EGWU_25

Waypoints	radio fail levels		pessimistic typical levels	
	Min	Max	Min	Max
EGWU_25_SID_WP1	700ft	700ft	700ft	3000ft
CHT	3000ft	3000ft	3000ft	3000ft
WATFO	4000ft	4000ft	-	-
BPK-D6-R245	4000ft	4000ft	-	-
BPK-D3-R246	5000ft	5000ft	4000ft	4000ft
BPK	5000ft	5000ft	-	5000ft
BPK-D7-R99	5000ft	5000ft	5000ft	5000ft
BPK-D15.5-R099	-	-	-	8000ft
DET-D10-R336	-	-	-	8000ft
DET	-	-	-	-
DVR	-	-	-	-

DVR 5X EGWU_07

Waypoints	radio fail levels		pessimistic typical levels	
	Min	Max	Min	Max
EGWU_07_SID_WP1	700ft	700ft	700ft	3000ft
OCK-D18-R011	3000ft	3000ft	-	-
WATFO	4000ft	4000ft	3000ft	3000ft
BPK-D6-R245	4000ft	4000ft	-	-
BPK-D3-R246	5000ft	5000ft	4000ft	4000ft
BPK	5000ft	5000ft		5000ft
BPK-D7-R99	5000ft	5000ft	5000ft	5000ft
BPK-D15.5-R099	-	-	-	8000ft
DET-D10-R336	-	-	-	8000ft
DET	-	-	-	-
DVR	-	-	-	-

8.1.6. Northolt MATCH SIDs

MATCH 1Y EGWU_25

waypoints	radio fail levels		pessimistic typical levels	
	Min	Max	Min	Max
EGWU_25_SID_WP1	700ft	-	700ft	-
CHT	3000ft	3000ft	3000ft	3000ft
WATFO	4000ft	4000ft	4000ft	4000ft
BPK-D3-R246	5000ft	5000ft	4000ft	4000ft
BPK	5000ft	5000ft	-	5000ft
MATCH	5000ft	5000ft	-	FL170

MATCH 1X EGWU_07

waypoints	radio fail levels		pessimistic typical levels	
	Min	Max	Min	Max
EGWU_07_SID_WP1	700ft	-	700ft	-
OCK-D18-R011	3000ft	3000ft	-	-
WATFO	4000ft	4000ft	3000ft	3000ft
BPK-D3-R246	5000ft	5000ft	4000ft	4000ft
BPK	5000ft	5000ft	-	5000ft
MATCH	5000ft	5000ft	-	FL170

8.1.7. London City SAM SIDs

SAM 5T EGLC_27

Waypoints	radio fail levels		pessimistic typical levels	
	Min	Max	Min	Max
I-LSR-D1.5	-	-	-	-
LON-D18-R076	3000ft	3000ft	3000ft	3000ft
LON-D25.5-R076	3000ft	3000ft	3000ft	3000ft
GINTI	4000ft	4000ft	4000ft	4000ft
DET-D10-R337	4000ft	4000ft	4000ft	4000ft
DET-D6-R337	4000ft	4000ft	-	5000ft
DET	4000ft	4000ft	-	5000ft
DET-D3-R151	-	-	-	5000ft
LYD	-	-	-	-
WAFFU	-	-	-	-
CAMRA	-	-	-	-
GWC	-	-	-	-
SAM	-	-	-	-

SAM 5U EGLC_09

Waypoints	radio fail levels		pessimistic typical levels	
	Min	Max	Min	Max
I-LST-D1	-	-	-	-
BIG-D13.5-R021	3000ft	3000ft	3000ft	3000ft
LON-D27-R082	3000ft	3000ft	3000ft	3000ft
BEMID	4000ft	4000ft	4000ft	4000ft
DET-D10-R337	4000ft	4000ft	4000ft	4000ft
DET-D6-R337	4000ft	4000ft	-	5000ft
DET	4000ft	4000ft	-	5000ft
DET-D3-R151	-	-	-	5000ft
LYD	-	-	-	-
WAFFU	-	-	-	-
CAMRA	-	-	-	-
GWC	-	-	-	-
SAM	-	-	-	-

8.1.8. London City DVR SIDs

DVR 4T EGLC_27

Waypoints	radio fail levels		pessimistic typical levels	
	Min	Max	Min	Max
I-LSR-D1.5	-	3000ft	-	-
LON-D18-R076	3000ft	3000ft	3000ft	3000ft
LON-D25.5-R076	3000ft	4000ft	3000ft	3000ft
GINTI	4000ft	4000ft	4000ft	4000ft
DET-D10-R337	4000ft	4000ft	4000ft	4000ft
DET-D6-R337	4000ft	4000ft	-	5000ft
DET	4000ft	4000ft	-	5000ft
DET-D3-R108	-	-	-	5000ft
DVR	-	-	-	-

DVR 4U EGLC_09

Waypoints	radio fail levels		pessimistic typical levels	
	Min	Max	Min	Max
I-LST-D1	-	-	-	-
BIG-D13.5-R021	3000ft	3000ft	3000ft	3000ft
LON-D27-R082	3000ft	3000ft	3000ft	3000ft
BEMID	4000ft	4000ft	4000ft	4000ft
DET-D10-R337	4000ft	4000ft	4000ft	4000ft
DET-D6-R337	4000ft	4000ft	-	5000ft
DET	4000ft	4000ft	-	5000ft
DET-D3-R108	-	-	-	5000ft
DVR	-	-	-	-

8.1.9. London City LYD SIDs

LYD 4T EGLC_27

Waypoints	radio fail levels		pessimistic typical levels	
	Min	Max	Min	Max
I-LSR-D1.5	-	3000ft	-	-
LON-D18-R076	3000ft	3000ft	3000ft	3000ft
LON-D25.5-R076	3000ft	4000ft	3000ft	3000ft
GINTI	4000ft	4000ft	4000ft	4000ft
DET-D10-R337	4000ft	4000ft	4000ft	4000ft
DET-D6-R337	4000ft	4000ft	-	5000ft
DET	4000ft	4000ft	-	5000ft
DET-D3-R151	-	-	-	5000ft
LYD	-	-	-	-

LYD 4U EGLC_09

Waypoints	radio fail levels		pessimistic typical levels	
	Min	Max	Min	Max
I-LST-D1	-	-	-	-
BIG-D13.5-R021	3000ft	3000ft	3000ft	3000ft
LON-D27-R082	3000ft	3000ft	3000ft	3000ft
BEMID	4000ft	4000ft	4000ft	4000ft
DET-D10-R337	4000ft	4000ft	4000ft	4000ft
DET-D6-R337	4000ft	4000ft	-	5000ft
DET	4000ft	4000ft	-	5000ft
DET-D3-R151	-	-	-	5000ft
LYD	-	-	-	-

8.2. New SIDs Modelled Profiles

8.2.1. London City EKNIV SIDs

EKNIV 1W EGLC_10

waypoints	radio fail levels		pessimistic typical levels	
	Min	Max	Min	Max
LCE01	-	-	-	-
LCE02	3000ft	3000ft	3000ft	3000ft
LCW03	3000ft	3000ft	3000ft	3000ft
KW038	4000ft	4000ft	-	-
SODVU	4000ft	4000ft	FL70	FL70
EKNIV	4000ft	4000ft	-	-

EKNIV 1V EGLC_28

waypoints	radio fail levels		pessimistic typical levels	
	Min	Max	Min	Max
LCW01	-	-	-	-
LCN02	3000ft	3000ft	3000ft	3000ft
LCN06	3000ft	3000ft	3000ft	3000ft
KW038	4000ft	4000ft	-	-
SODVU	4000ft	4000ft	FL70	FL70
EKNIV	4000ft	4000ft	-	-