Free Route Airspace Deployment 2

(Part of NATS West Airspace Modernisation Project)

Gateway documentation:
Stage 3 Consult

Step 3A Options Appraisal
(Phase II - Full)
including Safety Assessment

Roles

Action	Role	Date
Produced	**Airspace Change Specialist** Airspace & Future Operations	03/08/2021
Reviewed Approved	**Airspace Implementation Manager** Airspace and Future Operations	04/08/2021
Reviewed Approved	**Manager Airspace Delivery** Airspace and Future Operations	04/08/2021
Reviewed Approved	**FRA Project Manager** Operations & Airspace Programme Delivery	04/08/2021

Drafting and Publication History

Issue	Month/Year	Changes this issue
1.0	August 2021	Submitted to CAA
1.1	August 2021	WebTAG data revised and updated

Contents

1. Introduction

This document forms part of the document set in required for the CAP1616 airspace change process.

This document aims to provide adequate evidence to satisfy Stage 3 Consult; Step 3A Consultation Preparation: Options Appraisal (Phase II Full), including a Safety Assessment and a full analysis of shortlist options.

Its purpose is to provide a more detailed quantitative assessment on the defined shortlist of design options which have progressed through the Step 2B Initial Options Appraisal, which was based around a qualitative assessment. This document will include a quantitative assessment of all reasonable costs and benefits of the design options, other costs and benefits described qualitatively and reasons why they could not be quantified. A preferred design option will also be provided, including reasons for the preference.

2. Link with LD1.1

The FRA D2 consultation is being run in parallel with that of London Airspace Modernisation Programme 2, Deployment 1.1 (LD1.1, ACP-2017-70). The two consultations will have the same start and end dates, the same stakeholders and a common geographical area. The changes for LD1.1 and FRA D2 will be implemented simultaneously on the same date. This is because there are dependencies between the two ACPs[1], these are outlined clearly in the consultation material and an FAQ document. If there is a delay to either ACP this will also delay the other. By consulting on these two related ACPs at the same time it will reduce the burden on stakeholders, it will assist stakeholder understanding of how the overall airspace system will operate, cumulative impacts can be more easily explained/understood, and stakeholder fatigue should be avoided.

3. Change Level

The changes proposed in this ACP impact flights above FL245. Hence in accordance with the Levels as defined in CAP1616, this proposal is categorised as a Level 2B change.

In line with the requirements for a Level 2B change the environmental impact assessment has been conducted on the basis of CO_2e emissions. There would be no perceptible change to noise impacts to stakeholders on the ground, so no noise analysis has been conducted.

4. Options Appraisal (Phase II Full)

There are three design options in this document which are compared to the baseline do-nothing scenario. The options to have progressed to this stage are:

- FRA Option 1. In which all ATS routes are removed, and RAD restrictions are introduced in order to manage the flow of traffic transitioning into and out of FRA.
- FRA Option 2. In which the ATS route structure is partially maintained, for instance in areas of high complexity where systemisation of the flows is required such as the London TMA.
- FRA Option 3. In which the entire ATS route structure is maintained, but aircraft are not constrained to flight plan the ATS routes within the FRA.

[1] LD1.1 cannot be implemented independent of FRA because there are no routes proposed above FL245/305 and no routes in sector 9. Existing routes in sector 9 do not align to the route structure proposed in the LD1.1 ACP. FRA D2 cannot be implemented independent of the LD1.1 ACP because the structural limitation, FRA significant points etc are based on the LD1.1 ACP design options.

The baseline do-nothing option would not deliver any benefit or meet the mandated legal requirement to introduce FRA in the UK UIR, so was discounted at Stage 2 as a viable option. It should be noted that the implementation of Free Route Airspace (FRA) was mandated in EU law via the SESAR PCP Implementing Regulation EU716/2014[2], and as such is not benefits driven.

The mandate stipulates FRA be implemented from FL305 and above as the minimum requirement. Within the D2 airspace, it is NATS' preference to implement FRA from FL245, which is in line with the preferred option of the LD1.1 ACP consultation. Due to the interdependency with the LD1.1 design, the actual implementation level(s) will be determined post consultation during Stage 4 of both ACPs. Due to this interdependency we have assessed the benefits for FRA D2 against a DFL of FL305 (FL245 in Swanwick AC Sector 9) (LD1.1 Option 4) and a DFL of FL245 throughout the region (LD1.1 Option 6).

This document presents the benefits for deployment both at FL305 and FL245 for each FRA Option.

The detailed makeup of the above three options is described in Doc 2a(ii) Table 2.

There is a fixed correlation between fuel burnt and greenhouse gases emitted. For every 1kg of fuel that is burnt 3.18kg of CO2 equivalent (CO2e) is emitted.

Methodological Note

There is a significant degree of uncertainty in predicting how aircraft operators will use FRA. This has an impact on the relative magnitude of the benefit apportioned to each option. The justification for the allocation of benefits is described below:

Option 1 – All Routes Removed (100% benefit): with no route structure it is assumed that aircraft operators would flight plan direct great-circle routes where able, subject to RAD restrictions. This was the basis of the computer simulations and hence 100% benefit is apportioned.
Option 2 – Partial Routes (75% benefit): with an ATS route structure partially maintained, aircraft operators would be required to use these routes subject to RAD restrictions, where necessary and hence would not be able to flight plan direct great-circle routes in all cases. This would dilute the benefit of FRA. Using ATC expertise and experience, it was considered that the 75% benefit calculated for Full FRA would be likely realised by this option.
Option 3 – All routes retained (40% benefit): with the existing ATS route structure fully maintained, aircraft operators could flight plan via the existing routes or via direct great-circle routes, subject to RAD restrictions. Using ATC experience and experience, it was considered that many flights would not utilise the FRA and as such that 40% of the benefit calculated for Full FRA would be likely to be realised by this option.

[2] EU716/2014 has been superseded by EU2021/116 (Common Project 1) within the EU. This change to the regulation occurred post-UK withdrawal from the EU and the DfT have consulted on if and how to incorporate this into UK law, at the time of writing, a decision has not been published. EU716/2014 is retained (and amended in UK domestic law) under the European Union (Withdrawal) Act 2018[2] (referred to as 'the mandate' throughout this document). Due to wider commitments (e.g. Borealis Alliance and the CAA AMS) and consistency of operation, NATS' intention is to introduce FRA throughout UK airspace regardless of the withdrawal of the United Kingdom from the European Union (EU). FRA implementation will align with the requirements[2] of EU716/2014 until such time that it is superseded in UK law.

4.1 FRA Option 1 – ATS Routes Removed

FRA Option 1 would implement FRA across the Deployment 2 area with all ATS routes removed and RAD restrictions introduced in order to manage the flow of traffic in complex areas and transitioning into and out of FRA.

The CAP1616 Full Options Appraisal analysis is given below.

<table>
<tr><th>Group</th><th>Impact</th><th>Level of Analysis</th><th>Description</th></tr>
<tr><td>Communities</td><td>Noise impact on health and quality of life</td><td>Qualitative</td><td>The proposed changes to air traffic patterns are all above FL245 (circa 24,500ft). This is well above the 7,000ft threshold below which noise impacts are considered significant and analysis is required.
The potential noise impacts are neither measurable nor describable.</td></tr>
<tr><td>Communities</td><td>Air quality</td><td>N/A</td><td>Government guidance (ANG 2017) says that aircraft flying higher than 1,000ft are unlikely to have a significant impact on local air quality. This option does not propose changes below 1,000ft</td></tr>
<tr><td>Wider society</td><td>Greenhouse gas impact</td><td>Monetise and quantify</td><td>The impact assessment indicates that c.422,069 flights per year would be impacted by the change in 2023, rising to 587,073 in 2033.

The flight level at which FRA is implemented impacts the enabled benefits. Due to the interdependency with the LD1.1 ACP, the actual implementation level of FRA will be determined post-consultation during Stage 4. For transparency, the benefits for FRA D2 Option 1 with a DFL of FL305 (FL245 in Swanwick AC Sector 9) (LD1.1 Option 4) and a DFL of FL245 throughout the region (LD1.1 Option 6) are presented.

The forecast reduction of CO_2e emissions in the opening year, and 10 years post-implementation are shown below
<table>
<tr><td></td><td colspan="2">FRA at FL305 (FL245 in Sector 9) (LD1.1 Op4)</td><td colspan="2">FRA implemented at FL245 (LD1.1 Op6)</td></tr>
<tr><td>FRA Option</td><td>2023 CO_2e (T) saving</td><td>2033 CO_2e (T) saving</td><td>2023 CO_2e (T) saving</td><td>2033 CO_2e (T) saving</td></tr>
<tr><td>Option 1 – All routes removed</td><td>1,208</td><td>1,680</td><td>1,530</td><td>2,128</td></tr>
<tr><td>NPV Benefit</td><td colspan="2">£323,512</td><td colspan="2">£409,863</td></tr>
</table>
WebTAG was used to assess the greenhouse gas impact over 10 years after the proposed changes. 49.3% of flights have origin and destination within the EU (traded), and 50.7% originate or destined for airports outside of the EU (non-traded[3]).

The monetised NPV benefit calculated by WebTAG due to the reduction in per flight GHG emissions is £323,512 if implemented at FL305; or £409,863 if implemented at FL245.

The benefit is the result of shorter average routes due to direct great circle routes in the D2 free route airspace. The additional benefit of reduced fuel uplift and reduced CO_2e emissions due to the corresponding weight reduction have not been included. It must be noted that FRA will only enable this benefit. Actual trajectories planned within FRA will be determined by airspace users.

The WebTAG GHG worksheet outputs are shown in Appendix A.
The NATS May 21 STATFOR extended forecast was used and traffic figures grown year-on-year for the WebTAG input.</td></tr>
<tr><td>Wider society</td><td>Capacity/ resilience</td><td>Qualitative</td><td>Increased flight planning flexibility would allow aircraft operators to flight plan more efficiently and would give them the option of avoiding capacity constrained areas.
As forecast traffic levels grow, the ability to avoid restrictions by utilising alternative flight plan trajectories would reduce the likelihood of delay, thus improving the resilience of the wider network.</td></tr>
</table>

[3] In accordance with CAA guidance, CO_2e emissions for flights within the EU are accounted for in WebTAG as traded, and flights whose origin or destination are outside of the EU are non-traded. Proportions of flights are derived from analysis of traffic by NATS.

<table>
<tr><td>General Aviation</td><td>Access</td><td>Qualitative</td><td>GA access to the higher-level airspace above FL245 would be unchanged.</td></tr>
<tr><td>General Aviation/ commercial airlines</td><td>Economic impact from increased effective capacity</td><td>Qualitative</td><td>N/A – The introduction of FRA would not increase air transport movements, passenger numbers or cargo carried as an outcome of this proposal.
The flight plan options this proposal would introduce could allow airlines to avoid capacity constrained areas and avoid consequential delay and cost.
However, this is not quantifiable, and no specific capacity increase is assumed or claimed by this proposal.</td></tr>
<tr><td>General Aviation/ commercial airlines</td><td>Fuel burn</td><td>Qualitative and quantitative</td><td>Analysis predicts an enabled decrease in fuel burn. The predicted figures are dependent on the outcome of the LD1.1 consultation and the flight level at which FRA is implemented, so both potential figures are presented here.
<table>
<tr><th></th><th colspan="2">FRA at FL305 (FL245 in Sector 9) (LD1.1 Op4)</th><th colspan="2">FRA implemented at FL245 (LD1.1 Op6)</th></tr>
<tr><th>FRA Option 1 – All routes removed</th><th>2023</th><th>2033</th><th>2023</th><th>2033</th></tr>
<tr><td>Fuel burn saving (T)</td><td>380</td><td>528</td><td>481</td><td>669</td></tr>
<tr><td>Average fuel burn saving per flight</td><td colspan="2">0.9kg</td><td colspan="2">1.14kg</td></tr>
<tr><td>Enabled Fuel Saving (£)</td><td>£173,877</td><td>£241,598</td><td>£220,092</td><td>£306,115</td></tr>
</table>
The average calculated network fuel burn saving per flights is 1.14kg if FRA is implemented at FL245; and 0.9kg if implemented at FL305. This small benefit would lead to noticeable per annum savings due to the annual traffic in this part of UK airspace. Predicted fuel cost savings (based on current fuel costs) are shown in the table above.

These figures are based on the IATA jet fuel price of 9 July 2021, at $634US per tonne and converted to GBP at 0.72£/$1 and presumes a constant fuel price and exchange rate. The forecast used was NATS May 21 STATFOR extended forecast.
Note that improvements in predictability leading to improved flight planning and reduced delay and holding could further improve upon this saving.</td></tr>
<tr><td>Commercial airlines</td><td>Training cost</td><td>Qualitative</td><td>There is not expected to be any airline training cost associated with FRA implementation.</td></tr>
<tr><td>Commercial airlines</td><td>Other costs</td><td>Qualitative</td><td>Updates to FMS and flight planning systems will be by the routine AIRAC updates. There are no other known costs which would be imposed on commercial aviation.</td></tr>
<tr><td>Airport/ Air navigation service provider</td><td>Infrastructure costs</td><td>Qualitative and quantitative</td><td>This proposal would not lead to any supporting infrastructure costs.</td></tr>
<tr><td>Airport/ Air navigation service provider</td><td>Operational costs</td><td>Qualitative</td><td>This proposal would not lead to changes in operational costs.</td></tr>
<tr><td>Airport/ Air navigation service provider</td><td>Deployment costs</td><td>Qualitative and quantitative</td><td>This proposal is expected to require air traffic controller familiarisation training, in the order of 120-150 controllers and c.50 assistants at NATS Swanwick, including extensive use of the NATS simulator facility.
Support staff are required to run the simulator – planning, training staff, data preparation and testing, pseudo pilots, safety analysts, outputs to be recorded and reported etc. Some staff may only require briefings. There may be occasions where the reduced availability of operational controllers during their conversion training could mean operational rostering becomes a factor when considering continuous service delivery.

The Military ANSP may also require briefing prior to deployment. This requirement will be clarified as designs mature through on-going engagement.</td></tr>
</table>

4.2 FRA Option 2 – ATS Routes Structure is Partially Maintained

FRA Option 2 comprises an FRA implementation across the Deployment 2 area where ATS routes are partially maintained in order to systemise traffic flows in complex areas. For this implementation option the majority of the impacts are the same as for option 1.

The benefits due to fuel savings and reduction in CO_2e emissions have been assessed to be 75% of those for Option 1 because it is likely that some flights will flight plan the partially retained ATS route structure.

<table>
<tr><th>Group</th><th>Impact</th><th>Level of Analysis</th><th>Evidence</th></tr>
<tr><td>Communities</td><td>Noise impact on health and quality of life</td><td>Qualitative</td><td>(Same as FRA Option 1) The proposed changes to air traffic patterns are all above FL245 (circa 24,500ft). This is well above the 7,000ft threshold below which noise impacts are considered significant and analysis is required.
The potential noise impacts are neither measurable nor describable.</td></tr>
<tr><td>Communities</td><td>Air quality</td><td>N/A</td><td>(Same as FRA Option 1) No changes below 1,000ft</td></tr>
<tr><td>Wider society</td><td>Greenhouse gas impact</td><td>Qualitative and quantitative</td><td>The impact assessment indicates that c.422,069 flights per year would be impacted by the change in 2023, rising to 587,073 in 2033.

The flight level at which FRA is implemented impacts the enabled benefits. Due to the interdependency with the LD1.1 ACP, the actual implementation level of FRA will be determined post-consultation during Stage 4. For transparency, the benefits for FRA D2 Option 1 with a DFL of FL305 (FL245 in Swanwick AC Sector 9) (LD1.1 Option 4) and a DFL of FL245 throughout the region (LD1.1 Option 6) are presented.

The forecast reduction of CO_2e emissions in the opening year, and 10 years post-implementation are shown below
<table>
<tr><td></td><td colspan="2">FRA at FL305 (FL245 in Sector 9) (LD1.1 Op4)</td><td colspan="2">FRA implemented at FL245 (LD1.1 Op6)</td></tr>
<tr><td>FRA Option</td><td>2023 CO_2e (T) saving</td><td>2033 CO_2e (T) saving</td><td>2023 CO_2e (T) saving</td><td>2033 CO_2e (T) saving</td></tr>
<tr><td>Option 2 – Partial routes</td><td>906</td><td>1,260</td><td>1,148</td><td>1,596</td></tr>
<tr><td>NPV Benefit</td><td colspan="2">£242,634</td><td colspan="2">£307,397</td></tr>
</table>
WebTAG was used to assess the greenhouse gas impact over 10 years after the proposed changes. 49.3% of flights have origin and destination within the EU (traded), and 50.7% originate or destined for airports outside of the EU (non-traded[4]).

The monetised NPV benefit calculated by WebTAG due to the reduction in per flight GHG emissions is £242,634 if implemented at FL305; or £307,397 if implemented at FL245.

The benefit is the result of shorter average routes due to direct great circle routes in the D2 free route airspace. The additional benefit of reduced fuel uplift and reduced CO_2e emissions due to the corresponding weight reduction have not been included. It must be noted that FRA will only enable this benefit. Actual trajectories planned within FRA will be determined by airspace users.

The WebTAG GHG worksheet outputs are shown in Appendix A.
The NATS May 21 STATFOR extended forecast was used and traffic figures grown year-on-year for the WebTAG input.</td></tr>
<tr><td>Wider society</td><td>Capacity/ resilience</td><td>Qualitative</td><td>The same evidence statement as Option 1 applies.
The retention of some of the ATS route structure would assist in network resilience.</td></tr>
<tr><td>General Aviation</td><td>Access</td><td>Qualitative</td><td>(Same as FRA Option 1) GA access to the higher-level airspace above FL245 would be unchanged.</td></tr>
<tr><td>General Aviation/</td><td>Economic impact from</td><td>Quantitative</td><td>(Same as FRA Option 1) N/A - the introduction of FRA would not increase air transport movements, passenger numbers or cargo carried as an outcome of this proposal.</td></tr>
</table>

[4] In accordance with CAA guidance, CO_2e emissions for flights within the EU are accounted for in WebTAG as traded, and flights whose origin or destination are outside of the EU are non-traded. Proportions of flights are derived from analysis of traffic by NATS.

<table>
<tr><td>commercial airlines</td><td>increased effective capacity</td><td></td><td>The flight plan options this proposal would introduce could allow airlines to avoid capacity constrained areas and avoid consequential delay and cost.
However, this is not quantifiable, and no specific capacity increase is assumed or claimed by this proposal.</td></tr>
<tr><td>General Aviation/ commercial airlines</td><td>Fuel burn</td><td>Qualitative and quantitative</td><td>Analysis predicts an enabled decrease in fuel burn. The predicted figures are dependent on the outcome of the LD1.1 consultation and the flight level at which FRA is implemented, so both potential figures are presented here.
<table>
<tr><td></td><td colspan="2">FRA at FL305 (FL245 in Sector 9) (LD1.1 Op4)</td><td colspan="2">FRA implemented at FL245 (LD1.1 Op6)</td></tr>
<tr><td>FRA Option 2 – Partial routes</td><td>2023</td><td>2033</td><td>2023</td><td>2033</td></tr>
<tr><td>Fuel burn saving (T)</td><td>285</td><td>396</td><td>361</td><td>502</td></tr>
<tr><td>Average fuel burn saving per flight</td><td colspan="2">0.68kg</td><td colspan="2">0.85kg</td></tr>
<tr><td>Enabled Fuel Saving (£)</td><td>£130,408</td><td>£181,198</td><td>£165,069</td><td>£229,586</td></tr>
</table>
The average calculated network fuel burn saving per flights is 0.85kg if FRA is implemented at FL245; and 0.68kg if implemented at FL305. This small benefit would lead to noticeable per annum savings due to the annual traffic in this part of UK airspace. Predicted fuel cost savings (based on current fuel costs) are shown in the table above.

These figures are based on the IATA jet fuel price of 9 July 2021, at $634US per tonne and converted to GBP at 0.72£/$1 and presumes a constant fuel price and exchange rate. The forecast used was NATS May 21 STATFOR extended forecast.
Note that improvements in predictability leading to improved flight planning and reduced delay and holding could further improve upon this saving.</td></tr>
<tr><td>Commercial airlines</td><td>Training cost</td><td>Qualitative</td><td>(Same as FRA Option 1) There is not expected to be any airline training cost associated with FRA implementation.</td></tr>
<tr><td>Commercial airlines</td><td>Other costs</td><td>Qualitative</td><td>(Same as FRA Option 1) Updates to FMS and flight planning systems will be by the routine AIRAC updates. There are no other known costs which would be imposed on commercial aviation.</td></tr>
<tr><td>Airport/ Air navigation service provider</td><td>Infrastructure costs</td><td>Qualitative and quantitative</td><td>(Same as FRA Option 1) This proposal would not lead to any supporting infrastructure costs.</td></tr>
<tr><td>Airport/ Air navigation service provider</td><td>Operational costs</td><td>Qualitative</td><td>(Same as FRA Option 1) This proposal would not lead to changes in operational costs.</td></tr>
<tr><td>Airport/ Air navigation service provider</td><td>Deployment costs</td><td>Qualitative and quantitative</td><td>(Same as FRA Option 1 This proposal is expected to require air traffic controller familiarisation training, in the order of 120-150 controllers and c.50 assistants at NATS Swanwick, including extensive use of the NATS simulator facility.
Support staff are required to run the simulator – planning, training staff, data preparation and testing, pseudo pilots, safety analysts, outputs to be recorded and reported etc. Some staff may only require briefings. There may be occasions where the reduced availability of operational controllers during their conversion training could mean operational rostering becomes a factor when considering continuous service delivery.

The Military ANSP may also require briefing prior to deployment. This requirement will be clarified as designs mature through on-going engagement.</td></tr>
</table>

4.3 FRA Option 3 – ATS Routes Structure is Wholly Retained

FRA Option 3 comprises an FRA implementation across the Deployment 2 area where ATS routes are wholly retained. This gives aircraft operators the option of flying the routes if desired (or not). It also gives ATC the option of using the systemisation afforded by the ATS routes in areas where high traffic densities could impact capacity without systemisation of flows.

For this implementation option, the benefits are assessed to be 40% of those for Option 1 because it is likely that some flights will flight plan the retained ATS route structure.

<table>
<tr><th>Group</th><th>Impact</th><th>Level of Analysis</th><th>Evidence</th></tr>
<tr><td>Communities</td><td>Noise impact on health and quality of life</td><td>Qualitative</td><td>(Same as FRA Option 1) The proposed changes to air traffic patterns are all above FL245 (circa 24,500ft). This is well above the 7,000ft threshold below which noise impacts are considered significant and analysis is required.
The potential noise impacts are neither measurable nor describable.</td></tr>
<tr><td>Communities</td><td>Air quality</td><td>N/A</td><td>(Same as FRA Option 1) No changes below 1,000ft</td></tr>
<tr><td>Wider society</td><td>Greenhouse gas impact</td><td>Qualitative and quantitative</td><td>The impact assessment indicates that c.422,069 flights per year would be impacted by the change in 2023, rising to 587,073 in 2033.

The flight level at which FRA is implemented impacts the enabled benefits. Due to the interdependency with the LD1.1 ACP, the actual implementation level of FRA will be determined post-consultation during Stage 4. For transparency, the benefits for FRA D2 Option 1 with a DFL of FL305 (FL245 in Swanwick AC Sector 9) (LD1.1 Option 4) and a DFL of FL245 throughout the region (LD1.1 Option 6) are presented.

The forecast reduction of CO_2e emissions in the opening year, and 10 years post-implementation are shown below
<table>
<tr><th></th><th colspan="2">FRA at FL305 (FL245 in Sector 9) (LD1.1 Op4)</th><th colspan="2">FRA implemented at FL245 (LD1.1 Op6)</th></tr>
<tr><th>FRA Option</th><th>2023 CO_2e (T) saving</th><th>2033 CO_2e (T) saving</th><th>2023 CO_2e (T) saving</th><th>2033 CO_2e (T) saving</th></tr>
<tr><td>Option 3 – All routes remain</td><td>483</td><td>672</td><td>612</td><td>851</td></tr>
<tr><td>NPV Benefit</td><td colspan="2">£131,191</td><td colspan="2">£163,945</td></tr>
</table>
WebTAG was used to assess the greenhouse gas impact over 10 years after the proposed changes. 49.3% of flights have origin and destination within the EU (traded), and 50.7% originate or destined for airports outside of the EU (non-traded[5]).

The monetised NPV benefit calculated by WebTAG due to the reduction in per flight GHG emissions is £131,191 if implemented at FL305; or £163,945 if implemented at FL245.

The benefit is the result of shorter average routes due to direct great circle routes in the D2 free route airspace. The additional benefit of reduced fuel uplift and reduced CO_2e emissions due to the corresponding weight reduction have not been included. It must be noted that FRA will only enable this benefit. Actual trajectories planned within FRA will be determined by airspace users.

The WebTAG GHG worksheet outputs are shown in Appendix A.
The NATS May 21 STATFOR extended forecast was used and traffic figures grown year-on-year for the WebTAG input.</td></tr>
<tr><td>Wider society</td><td>Capacity/ resilience</td><td>Qualitative</td><td>The same evidence statement as Option 1 applies.
The retention of the structure would assist in network resilience.</td></tr>
<tr><td>General Aviation</td><td>Access</td><td>Qualitative</td><td>(Same as FRA Option 1) GA access to the higher level airspace above FL245 would be unchanged.</td></tr>
<tr><td>General</td><td>Economic</td><td>Qualitative</td><td>(Same as FRA Option 1) The introduction of FRA would not increase air transport</td></tr>
</table>

[5] In accordance with CAA guidance, CO_2e emissions for flights within the EU are accounted for in WebTAG as traded, and flights whose origin or destination are outside of the EU are non-traded. Proportions of flights are derived from analysis of traffic by NATS.

<table>
<tr><td>Aviation/ commercial airlines</td><td>impact from increased effective capacity</td><td></td><td>movements, passenger numbers or cargo carried as an outcome of this proposal.
The flight-plan options this proposal would introduce could allow airlines to avoid capacity constrained areas and avoid consequential delay and cost.
However, this is not quantifiable, and no specific capacity increase is assumed or claimed by this proposal.</td></tr>
<tr><td>General Aviation/ commercial airlines</td><td>Fuel burn</td><td>Qualitative and quantitative</td><td>Analysis predicts an enabled decrease in fuel burn. The predicted figures are dependent on the outcome of the LD1.1 consultation and the flight level at which FRA is implemented, so both potential figures are presented here.
<table>
<tr><td></td><td colspan="2">FRA at FL305 (FL245 in Sector 9) (LD1.1 Op4)</td><td colspan="2">FRA implemented at FL245 (LD1.1 Op6)</td></tr>
<tr><td>FRA Option 3- - All routes retained</td><td>2023</td><td>2033</td><td>2023</td><td>2033</td></tr>
<tr><td>Fuel burn saving (T)</td><td>152</td><td>211</td><td>192</td><td>268</td></tr>
<tr><td>Average fuel burn saving per flight</td><td colspan="2">0.36kg</td><td colspan="2">0.46kg</td></tr>
<tr><td>Enabled Fuel Saving (£)</td><td>£69,551</td><td>£96,639</td><td>£88,037</td><td>£122,446</td></tr>
</table>
The average calculated network fuel burn saving per flights is 0.46kg if FRA is implemented at FL245; and 0.36kg if implemented at FL305. This small benefit would lead to a per annum savings due to the annual traffic in this part of UK airspace. Predicted fuel cost savings (based on current fuel costs) are shown in the table above.

These figures are based on the IATA jet fuel price of 9 July 2021, at $634US per tonne and converted to GBP at 0.72£/$1 and presumes a constant fuel price and exchange rate. The forecast used was NATS May 21 STATFOR extended forecast.
Note that improvements in predictability leading to improved flight planning and reduced delay and holding could further improve upon this saving.</td></tr>
<tr><td>Commercial airlines</td><td>Training cost</td><td>N/A</td><td>(Same as FRA Option 1) There is not expected to be any airline training cost associated with FRA implementation.</td></tr>
<tr><td>Commercial airlines</td><td>Other costs</td><td>N/A</td><td>(Same as FRA Option 1) Updates to FMS and flight planning systems will by the routine AIRAC updates. There are no other known costs which would be imposed on commercial aviation.</td></tr>
<tr><td>Airport/ Air navigation service provider</td><td>Infrastructure costs</td><td>Qualitative and quantitative</td><td>(Same as FRA Option 1) This proposal would not lead to any supporting infrastructure costs.</td></tr>
<tr><td>Airport/ Air navigation service provider</td><td>Operational costs</td><td>N/A</td><td>(Same as FRA Option 1) This proposal would not lead to changes in operational costs.</td></tr>
<tr><td>Airport/ Air navigation service provider</td><td>Deployment costs</td><td>Qualitative and quantitative</td><td>(Same as FRA Option 1) This proposal is expected to require air traffic controller familiarisation training, in the order of 120-150 controllers and c.50 assistants at NATS Swanwick, including extensive use of the NATS simulator facility.
Support staff are required to run the simulator – planning, training staff, data preparation and testing, pseudo pilots, safety analysts, outputs to be recorded and reported etc.
Some staff may only require briefings. There may be occasions where the reduced availability of operational controllers during their conversion training could mean operational rostering becomes a factor when considering continuous service delivery.

The Military ANSP may also require briefing prior to deployment. This requirement will be clarified as designs mature through on-going engagement.</td></tr>
</table>

Cost Benefit Comparison

The monetised benefits of all three options have been totalled in analysis below (Note, with 2 years before implementation, project and deployment costs have not been quantified at this stage[6]. There are no significant differences in the cost of implementation of the options).

For the three FRA options, a benefit assessment is provided for both implementation at FL305 (LD1.1 Opt 4) or FL245 (LD1.1 Op 6). as well as the combined results for each FRA option with LD1.1 Option 4 and 6. (The discount rate of 3.5% has been applied as per the standard rate given in the Treasury Green Book Annex A6[7]).

Tables 1 and 2 show the cost/benefit calculations for FRA Option 1:

Table 1 CAP1616 cost-benefit example - FRA Option 1 implemented at FL305 (LD1 Op4)

Year	2023 0	2024 1	2025 2	2026 3	2027 4	2028 5	2029 6	2030 7	2031 8	2032 9	2033 10	NPV
Discount factor	1	0.965	0.931	0.899	0.867	0.837	0.808	0.779	0.752	0.726	0.700	
Option 1 - Full FRA (100% benefit)												
Net community benefit (CO2)	£36,062	£42,442	£46,250	£49,112	£51,002	£53,065	£54,605	£56,460	£60,564	£64,774	£68,121	
Net airspace users benefit (Fuel)	£173,877	£197,213	£210,025	£216,431	£219,634	£223,295	£225,583	£229,701	£234,734	£238,395	£241,598	
Net sponsor benefit	£0	£0	£0	£0	£0	£0	£0	£0	£0	£0	£0	
Present value	£209,939	£232,753	£241,830	£243,604	£241,464	£239,925	£236,772	£235,460	£237,084	£237,773	£237,307	£2,593,912
LD1.1 Option 4												
Net community benefit (CO2)	£44,821	£52,680	£57,448	£61,022	£63,342	£65,847	£67,831	£70,142	£75,260	£80,538	£84,705	
Net airspace users benefit (Fuel)	£215,974	£244,914	£260,833	£269,180	£272,679	£277,588	£280,641	£285,693	£291,978	£296,358	£300,803	
Net sponsor benefit		£0	£0	£0	£0	£0	£0	£0	£0	£0	£0	
Present value	£260,794	£289,022	£300,343	£302,916	£299,804	£298,141	£294,460	£292,776	£294,828	£295,599	£295,352	£3,224,035
Combined: FRA Op1/LD1.1 Op4)												
Net community benefit (CO2)	£80,883	£95,123	£103,698	£110,135	£114,344	£118,913	£122,436	£126,602	£135,824	£145,312	£152,825	
Net airspace users benefit (Fuel)	£389,851	£426,653	£438,475	£436,386	£426,924	£419,153	£408,796	£401,634	£396,088	£388,060	£379,833	
Net sponsor benefit	£0	£0	£0	£0	£0	£0	£0	£0	£0	£0	£0	
Present value	£470,733	£521,775	£542,173	£546,520	£541,269	£538,065	£531,232	£528,236	£531,912	£533,372	£532,659	£5,817,946

Table 2 CAP1616 cost-benefit example - FRA Option 1 implemented at FL245 (LD1 Op6)

Year	2023 0	2024 1	2025 2	2026 3	2027 4	2028 5	2029 6	2030 7	2031 8	2032 9	2033 10	NPV
Discount factor	1	0.965	0.931	0.899	0.867	0.837	0.808	0.779	0.752	0.726	0.700	
Option 1 - Full FRA (100% benefit)												
Net community benefit (CO2)	£45,693	£53,769	£58,587	£62,233	£64,619	£67,213	£69,189	£71,521	£76,707	£82,024	£86,286	
Net airspace users benefit (Fuel)	£220,092	£249,376	£265,849	£274,543	£278,203	£282,779	£285,982	£291,015	£297,421	£301,539	£306,115	
Net sponsor benefit	£0	£0	£0	£0	£0	£0	£0	£0	£0	£0	£0	
Present value	£265,785	£294,417	£306,152	£308,945	£305,871	£303,850	£300,131	£298,302	£300,368	£300,846	£300,653	£3,285,320
LD1.1 Option 6												
Net community benefit (CO2)	£35,765	£42,094	£45,909	£48,721	£50,601	£52,624	£54,154	£56,001	£60,082	£64,266	£67,675	
Net airspace users benefit (Fuel)	£172,504	£195,620	£208,335	£215,002	£217,797	£221,717	£224,156	£228,191	£233,211	£236,709	£240,260	
Net sponsor benefit	£0	£0	£0	£0	£0	£0	£0	£0	£0	£0	£0	
Present value	£208,269	£230,867	£239,916	£241,929	£239,470	£238,164	£235,169	£233,824	£235,457	£236,041	£235,924	£2,575,031
Combined: FRA Op1/LD1.1 Op6)												
Net community benefit (CO2)	£81,458	£95,863	£104,496	£110,954	£115,220	£119,837	£123,344	£127,522	£136,789	£146,290	£153,961	
Net airspace users benefit (Fuel)	£392,596	£429,421	£441,572	£439,920	£430,121	£422,177	£411,957	£404,605	£399,036	£390,597	£382,617	
Net sponsor benefit	£0	£0	£0	£0	£0	£0	£0	£0	£0	£0	£0	
Present value	£474,054	£525,284	£546,068	£550,874	£545,341	£542,014	£535,300	£532,127	£535,825	£536,887	£536,577	£5,860,352

The results in the tables above show that the monetised benefit over ten years for FRA Option 1 implemented with LD1.1 Option 6 (£5,860,352) is marginally greater than that with LD1.1 Option 4 (£5,817,946).

[6] FRA D2 Stage 2 Initial Options Appraisal provided an estimated implementation cost of £3.5million. Prior to the COVID-19 pandemic the LD1.1 and FRA D2 projects were being progressed independently. As a result of the pandemic a thorough review was undertaken by NATS of these projects. This concluded that by implementing these two projects simultaneously significant costs could be saved whilst delivering the benefits to the aviation industry earlier. The cost for FRA D2 is not currently accurately quantifiable given the timescales and dependencies across the projects. This will be provided in the Final Options Appraisal post consultation.

[7] The Net community benefit (CO_2e) is already discounted through the WebTAG workbook.

Tables 3 and 4 show the cost/benefit calculations for FRA Option 2:

Table 3 CAP1616 cost-benefit example - FRA Option 2 implemented at FL305 (LD1 Op4)

	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	
Year	0	1	2	3	4	5	6	7	8	9	10	NPV
Discount factor	1	0.965	0.931	0.899	0.867	0.837	0.808	0.779	0.752	0.726	0.700	
Option 2 - Partial Routes (75% benefit)												
Net community benefit (CO2)	£27,046	£31,832	£34,687	£36,834	£38,251	£39,799	£40,954	£42,345	£45,423	£48,581	£51,090	
Net airspace users benefit (Fuel)	£130,408	£147,910	£157,519	£162,323	£164,726	£167,471	£169,187	£172,276	£176,050	£178,796	£181,198	
Net sponsor benefit	£0	£0	£0	£0	£0	£0	£0	£0	£0	£0	£0	
Present value	£157,454	£174,565	£181,373	£182,703	£181,098	£179,944	£177,579	£176,595	£177,813	£178,330	£177,980	£1,945,434
LD1.1 Option 4												
Net community benefit (CO2)	£44,821	£52,680	£57,448	£61,022	£63,342	£65,847	£67,831	£70,142	£75,260	£80,538	£84,705	
Net airspace users benefit (Fuel)	£215,974	£244,914	£260,833	£269,180	£272,679	£277,588	£280,641	£285,693	£291,978	£296,358	£300,803	
Net sponsor benefit		£0	£0	£0	£0	£0	£0	£0	£0	£0	£0	
Present value	£260,794	£289,022	£300,343	£302,916	£299,804	£298,141	£294,460	£292,776	£294,828	£295,599	£295,352	£3,224,035
Combined: FRA Op2/LD1.1 Op4)												
Net community benefit (CO2)	£71,867	£84,512	£92,135	£97,857	£101,594	£105,646	£108,785	£112,487	£120,683	£129,119	£135,795	
Net airspace users benefit (Fuel)	£346,381	£379,075	£389,580	£387,763	£379,309	£372,438	£363,254	£356,884	£351,958	£344,810	£337,537	
Net sponsor benefit	£0	£0	£0	£0	£0	£0	£0	£0	£0	£0	£0	
Present value	£418,248	£463,587	£481,715	£485,619	£480,903	£478,084	£472,039	£469,371	£472,641	£473,929	£473,332	£5,169,469

Table 4 CAP1616 cost-benefit example - FRA Option 2 implemented at FL245 (LD1 Op6)

	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	
Year	0	1	2	3	4	5	6	7	8	9	10	NPV
Discount factor	1	0.965	0.931	0.899	0.867	0.837	0.808	0.779	0.752	0.726	0.700	
Option 2 - Partial Routes (75% benefit)												
Net community benefit (CO2)	£34,270	£40,327	£43,940	£46,674	£48,464	£50,409	£51,892	£53,641	£57,530	£61,518	£64,715	
Net airspace users benefit (Fuel)	£165,069	£187,032	£199,387	£205,907	£208,652	£212,084	£214,486	£218,261	£223,066	£226,155	£229,586	
Net sponsor benefit	£0	£0	£0	£0	£0	£0	£0	£0	£0	£0	£0	
Present value	£199,339	£220,813	£229,614	£231,709	£229,403	£227,888	£225,098	£223,727	£225,276	£225,634	£225,490	£2,463,990
LD1.1 Option 6												
Net community benefit (CO2)	£35,765	£42,094	£45,909	£48,721	£50,601	£52,624	£54,154	£56,001	£60,082	£64,266	£67,675	
Net airspace users benefit (Fuel)	£172,504	£195,620	£208,335	£215,002	£217,797	£221,717	£224,156	£228,191	£233,211	£236,709	£240,260	
Net sponsor benefit	£0	£0	£0	£0	£0	£0	£0	£0	£0	£0	£0	
Present value	£208,269	£230,867	£239,916	£241,929	£239,470	£238,164	£235,169	£233,824	£235,457	£236,041	£235,924	£2,575,031
Combined: FRA Op2/LD1.1 Op6)												
Net community benefit (CO2)	£70,035	£82,421	£89,849	£95,396	£99,065	£103,034	£106,046	£109,641	£117,612	£125,784	£132,389	
Net airspace users benefit (Fuel)	£337,573	£369,259	£379,681	£378,242	£369,808	£363,018	£354,221	£347,910	£343,121	£335,892	£329,025	
Net sponsor benefit	£0	£0	£0	£0	£0	£0	£0	£0	£0	£0	£0	
Present value	£407,608	£451,680	£469,530	£473,638	£468,874	£466,051	£460,268	£457,551	£460,733	£461,676	£461,414	£5,039,022

The results in Tables 3 and 4 above show that the monetised benefit over ten years for FRA Option 2 implemented with LD1.1 Option 4 or 6 realises lesser benefits that that offered by Option 1 (£5,169,469/ £5,039,022).

Tables 5 and 6 show the cost/benefit calculations for FRA Option 3:

Table 5 CAP1616 cost-benefit example - FRA Option 3 implemented at FL305 (LD1 Op4)

	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	
Year	0	1	2	3	4	5	6	7	8	9	10	NPV
Discount factor	1	0.965	0.931	0.899	0.867	0.837	0.808	0.779	0.752	0.726	0.700	
Option 3 - Routes remain (40% benefit)												
Net community benefit (CO2)	£14,425	£16,977	£18,500	£19,645	£20,401	£21,226	£21,842	£22,584	£24,226	£25,910	£27,248	
Net airspace users benefit (Fuel)	£69,551	£78,885	£84,010	£86,572	£87,854	£89,318	£90,233	£91,880	£93,894	£95,358	£96,639	
Net sponsor benefit	£0	£0	£0	£0	£0	£0	£0	£0	£0	£0	£0	
Present value	£83,976	£93,101	£96,732	£97,442	£96,586	£95,970	£94,709	£94,184	£94,834	£95,109	£94,923	£1,037,565
LD1.1 Option 4												
Net community benefit (CO2)	£44,821	£52,680	£57,448	£61,022	£63,342	£65,847	£67,831	£70,142	£75,260	£80,538	£84,705	
Net airspace users benefit (Fuel)	£215,974	£244,914	£260,833	£269,180	£272,679	£277,588	£280,641	£285,693	£291,978	£296,358	£300,803	
Net sponsor benefit		£0	£0	£0	£0	£0	£0	£0	£0	£0	£0	
Present value	£260,794	£289,022	£300,343	£302,916	£299,804	£298,141	£294,460	£292,776	£294,828	£295,599	£295,352	£3,224,035
Combined: FRA Op3/LD1.1 Op4)												
Net community benefit (CO2)	£59,245	£69,657	£75,948	£80,667	£83,743	£87,073	£89,673	£92,726	£99,485	£106,448	£111,953	
Net airspace users benefit (Fuel)	£285,524	£312,466	£321,127	£319,691	£312,647	£307,037	£299,496	£294,233	£290,176	£284,260	£278,322	
Net sponsor benefit	£0	£0	£0	£0	£0	£0	£0	£0	£0	£0	£0	
Present value	£344,770	£382,124	£397,075	£400,358	£396,390	£394,111	£389,169	£386,960	£389,661	£390,708	£390,274	£4,261,600

Table 6 CAP1616 cost-benefit example - FRA Option 3 implemented at FL245 (LD1 Op6)

	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	
Year	0	1	2	3	4	5	6	7	8	9	10	NPV
Discount factor	1	0.965	0.931	0.899	0.867	0.837	0.808	0.779	0.752	0.726	0.700	
Option 3 - Routes remain (40% benefit)												
Net community benefit (CO2)	£18,277	£21,508	£23,435	£24,893	£25,848	£26,885	£27,676	£28,608	£30,683	£32,810	£34,514	
Net airspace users benefit (Fuel)	£88,037	£99,751	£106,340	£109,817	£111,281	£113,112	£114,393	£116,406	£118,968	£120,616	£122,446	
Net sponsor benefit	£0	£0	£0	£0	£0	£0	£0	£0	£0	£0	£0	
Present value	£106,314	£117,767	£122,461	£123,578	£122,348	£121,540	£120,052	£119,321	£120,147	£120,338	£120,261	£1,314,128
LD1.1 Option 6												
Net community benefit (CO2)	£35,765	£42,094	£45,909	£48,721	£50,601	£52,624	£54,154	£56,001	£60,082	£64,266	£67,675	
Net airspace users benefit (Fuel)	£172,504	£195,620	£208,335	£215,002	£217,797	£221,717	£224,156	£228,191	£233,211	£236,709	£240,260	
Net sponsor benefit	£0	£0	£0	£0	£0	£0	£0	£0	£0	£0	£0	
Present value	£208,269	£230,867	£239,916	£241,929	£239,470	£238,164	£235,169	£233,824	£235,457	£236,041	£235,924	£2,575,031
Combined: FRA Op3/LD1.1 Op6)												
Net community benefit (CO2)	£54,042	£63,602	£69,344	£73,614	£76,449	£79,509	£81,830	£84,609	£90,765	£97,076	£102,189	
Net airspace users benefit (Fuel)	£260,541	£285,032	£293,033	£291,893	£285,370	£280,194	£273,392	£268,536	£264,840	£259,304	£253,997	
Net sponsor benefit	£0	£0	£0	£0	£0	£0	£0	£0	£0	£0	£0	
Present value	£314,583	£348,634	£362,377	£365,507	£361,819	£359,704	£355,222	£353,145	£355,604	£356,380	£356,186	£3,889,159

The results in Tables 5 and 6 above show that the monetised benefit over ten years for FRA Option 3 implemented with LD1.1 Option 4 or 6 realises the least benefits of the three Options (£4,261,600 / £3,889,159).

In summary, Option 1 is preferred option for FRA deployment, showing higher NPV benefits than with Option 2 or Option 3, regardless of implementing flight level; and when combined with the benefits of the LD1.1 proposed changes, shows that FRA Option 1 and LD1.1 Option 6 would enabled the greatest benefit.

	FRA NPV Benefit (saving)	LD1.1 NPV Benefit (saving)	Combined NPV Benefit (saving)
FRA Option 1 / LD1.1 Option 4	£2,593,912	£3,224,035	£5,817,946
FRA Option 1 / LD1.1 Option 6	£3,285,320	£2,575,031	£5,860,352
FRA Option 2 / LD1.1 Option 4	£1,945,434	£3,224,035	£5,169,469
FRA Option 2 / LD1.1 Option 6	£2,463,990	£2,575,031	£5,039,022
FRA Option 3 / LD1.1 Option 4	£1,037,565	£3,224,035	£4,261,600
FRA Option 3 / LD1.1 Option 6	1,314,128	£2,575,031	£3,889,159

5. Safety Assessment

5.1 Options Appraisal Safety Assessment - Baseline

The current operation uses a published route structure and airline operators flight-plan to follow available ATS routes or flight plannable Directs (DCT) as published in the Route Availability Document (RAD). The published routes are supportive of strategic de-confliction between flights against active Special Use Airspace volumes (such as Danger Areas) and airspace with constrained radiotelephony or surveillance coverage. The routes also provide an operational framework that is conducive to Air Traffic Controllers' familiarity with traffic patterns, potential conflict points and practices for conflict avoidance/resolution. Flights into and out of the airspace volume (i.e. across boundaries with other Sectors and Air Traffic Control Units) are nominally managed via published waypoints.

In addition to flights following routes, some may be instructed to take a more direct path through the airspace. This is done in a tactical manner by Air Traffic Controllers based on their judgement that a different path can be followed safely.

Air Traffic Controllers are supported in their task by equipment functionality (tools) that includes prediction of the trajectories that aircraft will follow. Predicted trajectories can be viewed by Controllers, and the tools use the former to identify potential areas of conflict between aircraft for Controllers' attention. The tools also monitor the conformance of aircraft to their expected trajectories and highlight deviations. The tools support the Controllers in ensuring that the aircraft pass through the airspace safely separated from other aircraft, Danger Areas etc.

5.2 Options Appraisal Safety Assessment – Current Position

Project activities so far have included a Real Time Development Simulation and associated Safety and Human Factors workshops.

The initial work[8] that has been done has indicated that the Air Traffic Controllers regard the FRA mode of operation as being similar to that experienced today. Key factors underlying this are that direct routings that are (tactically) provided today are expected to be reflected in flight plans and that the tools will continue to support Controllers in foreseeing and resolving potential conflicts. Although reduced familiarity as to where conflicts may occur is a possibility (due to the ability to flight plan user-preferred trajectories) the tools are designed to provide adequate support in discerning and managing changes in this aspect.

A qualitative high-level safety appraisal for the three proposed options for FRA indicates that the existing level of safety performance undertaken within the current operation would be maintained.

[8] It has not yet been possible to fully involve all ATC parties (such as the Military) or to exercise the final form of equipment functionality.

6. Conclusion and Next Steps

6.1 This proposal has been developed following the submission of the following Statement of Need to the CAA Airspace Regulation:

> In response to SESAR PCP Implementing Regulation EU716/2014, NATS intends to implement Free Route Airspace (FRA) in a phased manner across UK airspace. The SESAR PCP ATM Functionality 3 (AF3) states that Free Route shall be provided and operated in the airspace for which the Member States are responsible at and above flight level 310 in the ICAO EUR region by 1st January 2022. This ACP proposes the introduction of the second deployment of FRA across the Swanwick West Sector Group (which covers most of Wales and southwest England) in order to comply with this Implementing Regulation within the required timescale.

(Note the timeline for this second deployment is aiming to implement by not before 23 March 2023).

6.2 This document describes options which address the Statement of Need by the proposed introduction of Free Route Airspace across the southwest London UIR. This will meet PCP mandated requirements and Borealis Alliance commitments regarding the implementation of FRA.

6.3 Additionally, the options have been developed thus far with assistance, input, feedback and effort from senior MoD staff, senior representatives of all bordering ANSPs, representatives from airlines and flight planning service providers. NATS thanks all these stakeholders and looks forward to continuing the development of this proposal.

6.4 Three options have been appraised and feedback on these will be requested from stakeholders during consultation.

6.5 Option 1 is preferred option for FRA deployment, showing higher NPV benefits than with Option 2 or Option 3, regardless of implementing flight level; and when combined with the benefits of the LD1.1 proposed changes, shows that FRA Option 1 and LD1.1 Option 6 would enable the greatest benefit.

6.6 Subject to CAA approval at the Stage 3 Gateway Assessment, this proposal will then move on to Stage 3C - Consultation.

7. Appendix A: WebTAG Calculations for FRA Deployment 2

The data used for the inputs to WebTAG are given below:

7.1 Traffic forecasts:

Year	Base Growth Flights (000's)	Base Growth Rate
2023	2,132	
2024	2,418	13.40%
2025	2,574	6.50%
2026	2,657	3.20%
2027	2,691	1.30%
2028	2,740	1.80%
2029	2,769	1.10%
2030	2,818	1.80%
2031	2,879	2.20%
2032	2,922	1.50%
2033	2,965	1.50%

Table 1: Base Case forecast traffic growth 2023-2031 (NATS May 21 STATFOR extended forecast)

Computer Modelling Results:

Table 2 shows the computer simulation results for FRA with a deployment level of FL305 (FL245 in S9)

Year	Flights per year in FRA D2 Area	Simulated Fuel Saving (T)	Simulated CO2 saving (T)	CO2 Traded (49.3%)	CO2 non-traded (50.7%)	Fuel Cost (USD)	Fuel Cost (GBP)
2023	422,069	380	1,208	596	612	240,920	173,877
2024	478,695	431	1,370	675	695	273,254	197,213
2025	509,584	459	1,458	719	739	291,006	210,025
2026	525,997	473	1,505	742	763	299,882	216,431
2027	532,905	480	1,525	752	773	304,320	219,634
2028	542,534	488	1,553	766	787	309,392	223,295
2029	548,232	493	1,569	774	795	312,562	225,583
2030	557,967	502	1,597	787	810	318,268	229,701
2031	570,108	513	1,632	805	827	325,242	234,734
2032	578,528	521	1,656	816	840	330,314	238,395
2033	587,073	528	1,680	828	852	334,752	241,598

The results calculated by NATS Analytics for the fuel saving and CO_2e savings (with 100% of the benefit realised) are given in Columns 3 and 4.

Table 3 shows the computer simulation results for FRA with a deployment level of FL245

Year	Flights per year in FRA D2 Area	Simulated Fuel Saving (T)	Simulated CO2 saving (T)	CO2 Traded 49.3%	CO2 non-traded 50.7%	Fuel Cost (USD)	Fuel Cost (GBP)
2023	422,069	481	1,530	754	776	304,954	220,092
2024	478,695	545	1,736	856	880	345,530	249,376
2025	509,584	581	1,847	911	936	368,354	265,849
2026	525,997	600	1,907	940	967	380,400	274,543
2027	532,905	608	1,932	952	980	385,472	278,203
2028	542,534	618	1,967	970	997	391,812	282,779
2029	548,232	625	1,988	980	1,008	396,250	285,982
2030	557,967	636	2,023	997	1,026	403,224	291,015
2031	570,108	650	2,067	1,019	1,048	412,100	297,421
2032	578,528	659	2,097	1,034	1,063	417,806	301,539
2033	587,073	669	2,128	1,049	1,079	424,146	306,115

The results calculated by NATS Analytics for the fuel saving and CO_2e savings (with 100% of the benefit realised) are given in Columns 3 and 4.

7.2 WebTAG GHG Workbook Output: FRA Option 1 deployed at FL305(FL245 S9) as per LD1.1 Op4

Greenhouse Gases Workbook - Worksheet 1

Scheme Name: NATS FRA Deployment 2 (LD1_Op4)

Present Value Base Year	2010
Current Year	2021
Proposal Opening year:	2023
Project (Road/Rail or Road and Rail):	road

Overall Assessment Score:

Net Present Value of carbon dioxide equivalent emissions of proposal (£): £323,512

*positive value reflects a **net benefit** (i.e.CO2E emissions reduction)

Quantitative Assessment:

Change in carbon dioxide equivalent emissions over 60 year appraisal period (tonnes): (between 'with scheme' and 'without scheme' scenarios)	-16,753
Of which Traded	-8260
Change in carbon dioxide equivalent emissions in opening year (tonnes): (between 'with scheme' and 'without scheme' scenarios)	-1,208
Net Present Value of traded sector carbon dioxide equivalent emissions of proposal (£): (N.B. this is not additional to the appraisal value in cell I17, as the cost of traded sector emissions is assumed to be internalised into market prices. See TAG Unit A3 for further details)	£258,945

*positive value reflects a **net benefit** (i.e.CO2E emissions reduction)

Change in carbon dioxide equivalent emissions by carbon budget period:

	Carbon Budget 1	Carbon Budget 2	Carbon Budget 3	Carbon Budget 4
Traded sector	0	0	0	-3484
Non-traded sector	0	0	0	-3582

Qualitative Comments:

Sensitivity Analysis:

Upper Estimate Net Present Value of Carbon dioxide Emissions of Proposal (£):	£485,284
Lower Estimate Net Present Value of Carbon dioxide Emissions of Proposal (£):	£161,772

Data Sources:

7.3 WebTAG GHG Workbook Output: FRA Option 1 deployed at FL245 as per LD1.1 Op6

Greenhouse Gases Workbook - Worksheet 1

Scheme Name: NATS FRA Deployment 2 (LD1_Op6)

Present Value Base Year	2010
Current Year	2021
Proposal Opening year:	2023
Project (Road/Rail or Road and Rail):	road

Overall Assessment Score:

Net Present Value of carbon dioxide equivalent emissions of proposal (£): £409,863

*positive value reflects a **net benefit** (i.e. CO2E emissions reduction)

Quantitative Assessment:

Change in carbon dioxide equivalent emissions over 60 year appraisal period (tonnes): -21,222
(between 'with scheme' and 'without scheme' scenarios)

Of which Traded -10462

Change in carbon dioxide equivalent emissions in opening year (tonnes): -1,530
(between 'with scheme' and 'without scheme' scenarios)

Net Present Value of traded sector carbon dioxide equivalent emissions of proposal (£): £327,978
(N.B. this is not additional to the appraisal value in cell I17, as the cost of traded sector emissions is assumed to be internalised into market prices. See TAG Unit A3 for further details)

*positive value reflects a **net benefit** (i.e. CO2E emissions reduction)

Change in carbon dioxide equivalent emissions by carbon budget period:

	Carbon Budget 1	Carbon Budget 2	Carbon Budget 3	Carbon Budget 4
Traded sector	0	0	0	-4413
Non-traded sector	0	0	0	-4539

Qualitative Comments:

Sensitivity Analysis:

Upper Estimate Net Present Value of Carbon dioxide Emissions of Proposal (£): £614,814

Lower Estimate Net Present Value of Carbon dioxide Emissions of Proposal (£): £204,951

Data Sources:

8. Appendix B: Combined benefits for LD1.1 and FRA D2

It is important to note the interdependency of LD1.1 with the FRA D2 ACP, and to recognise the cumulative impact of both ACPs when considering the potential benefits. Due to the interdependency with this ACP and the FRA D2 ACP, the actual implementation level of FRA in this airspace will be determined post-consultation during Stage 4. The flight level at which FRA is implemented impacts the enabled benefits for FRA.

In order to give the complete (combined) picture, the benefits for each FRA D2 Option with LD1.1 Option 4 (FRA DFL of FL305 (FL245 in Swanwick AC Sector 9)) and with LD1.1 Option 6 (FRA DFL of FL245 throughout the region) are presented, with the summed overall impacts for each option summarised below:

	Combined Impacts: FRA / LD1.1 Option 4	2023 CO_2e (T) saving	2033 CO_2e (T) saving	2023 Fuel Burn (T)	2033 Fuel Burn (T)
FRA Option 1	Option 1 – All routes removed	1,208	1,680	380	528
	LD1.1 Option 4	1,500	2,089	472	657
	Combined Impacts	**2,708**	**3,769**	**852**	**1,185**
FRA Option 2	Option 2 - Partial Routes	906	1,260	285	396
	LD1.1 Option 4	1,500	2,089	472	657
	Combined Impacts	**2,406**	**3,349**	**757**	**1,053**
FRA Option 3	Option 3 - All routes retained	483	672	152	211
	LD1.1 Option 4	1,500	2,089	472	657
	Combined Impacts	**1,983**	**2,761**	**624**	**869**

Table B1 Combined CO2e emissions/fuel burn reductions for each FRA Option and LD1.1 Option 4

	Combined Impacts: FRA / LD1.1 Option 6	2023 CO_2e (T) saving	2033 CO_2e (T) saving	2023 Fuel Burn (T)	2033 Fuel Burn (T)
FRA Option 1	Option 1 - All routes removed	1,530	2,128	481	669
	LD1.1 Option 6	1,198	1,669	377	525
	Combined Impacts	**2,728**	**3,797**	**858**	**1,194**
FRA Option 2	Option 2 - Partial Routes	1,148	1,596	361	502
	LD1.1 Option 6	1,198	1,669	377	525
	Combined Impacts	**2,346**	**3,265**	**738**	**1,027**
FRA Option 3	Option 3 - All routes retained	612	851	192	268
	LD1.1 Option 6	1,198	1,669	377	525
	Combined Impacts	**1,810**	**2,520**	**569**	**793**

Table B2 Combined CO2e emissions/fuel burn reductions for each FRA Option and LD1.1 Option 6

The tables above show that FRA Option 1 provide the greater CO_2e and fuel burn benefit. When combined with the proposed LD1.1 changes in the airspace below, Option 6 provides the greatest overall benefit as shown in the red circles (Table B2). Therefore, to optimise the largest environmental benefit from both ACPs, NATS advocates LD1.1 Option 6 as the preferred option, given the holistic overview.

Modelling assumptions

- The AirTOP ATC computer simulation software was utilised plus RALPH pre-processor v1.3.17, and NEMo post processorv2.6
- Traffic levels were grown as per the May 21 STATFOR extended forecast.

- Trajectory profiles are calculated using NATS business intelligence (BI) data statistics on observed climb/descend rates, speeds and turn rates for BADA aircraft groups.
- No “go-arounds” were simulated.
- The current airspace was been connected to the proposed designs inside West Airspace where possible.
- Validation of the model was conducted by the LD1.1 ATC design team and Analytics, this task was completed to a level acceptable with the design team.
- The baseline model includes SAIP AD4/5 and Farnborough ACP.
- Unconstrained demand was modelled, thereby excluding the naturally occurring influence of flow restrictions (i.e. no regulations were applied to the traffic sample).
- A “blue sky” weather scenario, where no wind effects are present, was assumed.
- No conflict resolution was applied en-route.
- No network effects are simulated (i.e. no holding, vectoring, AMAN, runway arrival and departure separations).
- No randomisation of flight plan departure times was utilised.
- Fuel burn was calculated using NATS NEMO tool which uses BADA 4.2 data. Aircraft types not in BADA 4.2 use BADA 3.13 data.
- Controller tasks were completed instantaneously with each controller able to control multiple aircraft simultaneously (i.e. no workload or response time constraints).
- Sectorisation has been based on the Eurocontrol sector definitions.
- The following updates were made to the traffic sample as requested by the project team:
- B744 and A380 aircraft types for BAW were replaced with 60% B772 and 40% B788
- A318 aircraft types for BAW were removed from our sample
- A340 aircraft types for VIR were replaced with B789
- As the level restrictions on the scenario ATS Routes were still being developed, these have not been included in the fast-time simulations to avoid unrealistic flight profiles.