Ministry of Defence

ACP-2021-078

Enabling Remotely Piloted Aircraft Operations from RAF Fairford - HALE

Stage 3 – CONSULT

OPTIONS APPRAISAL (PHASE II – Full)

Version 2

Contents

ACP-2021-078 Revision History-Full Options Appraisal	
Page/Paragraph	Change
Pg. 5 Updated verbiage added	Added more context to the evolution of the design options, specified NATS was the stakeholder informing these designs.
Pg. 9 para. Airspace Utlisation	Deleted "in extremis" and substituted with "very rare". Further clarified with the following statement, "At this time, it is not possible to predict how "rare" these activations will be. As such, analysis has been completed on the worst-case scenario of between 1 hour after sunset and 1 hour before sunrise.
Pg. 10 Map Added	Map Title: HALE Option 3 in relation to adjacent ATS Routes
Pg. 11 Map Added	Map Title: HALE Option 3 in relation to adjacent CTAs
Pg. 15 para. 6	HALE RPA will remain within segregated airspace at all times below FL500 when operating within the London or Scottish FIR/UIR. This ACP is solely to allow the RPA to climb and descend in to and out of RAF Fairford from SFC to FL500. Based on ongoing engagement with the CAA and other stakeholders, the Sponsor anticipates that when operating in the London or Scottish UIR at FL500 and above, HALE RPA will operate as agreed in a type-specific Operational Arrangement with the CAA and MoD. The Operational Arrangement is in the process of being agreed and is not part of this ACP.
Pg. 23 Footnote Added	Added: Explanation of traded/non traded added as footnotes to the traded/nontraded assumptions.
Pg. 29 Added information, para. Annual Minimum Environmental Impact	Added: More information and explanation to the minimum impact from the assessment.
Pg. 31 Footnote Added	Added: Explanation of traded/non traded added as footnotes to the traded/nontraded assumptions.

Introduction

Scope

This document forms part of Stage 3 of ACP-2021-078. The purpose of this submission is to demonstrate that the Sponsor has followed each requirement as listed in CAP 1616, Airspace Change Process and forms part of the overall requirements for the Stage 3 CONSULT Gateway.

This Full Options Appraisal contains a qualitative and quantitative assessment of the remaining HALE option as compared to the "do nothing" option. The Sponsor utilised feedback gathered from stakeholders in Stage 2 as well as a rigorous analysis of the impacts in developing this appraisal.

Summary of Stage 2 Initial Options Appraisal

The Sponsor prepared a comprehensive range of airspace design options consisting of a "do nothing" option, two High Altitude Long Endurance (HALE) RPA options, and two Medium Altitude Long Endurance (MALE) RPA options. These were analysed in the Initial Options Appraisal in Stage 2. After Stage 2, it became apparent that the complexity introduced by the requirement for segregated transit corridors for MALE RPA could create delays to ACP-2021-078. For this reason, the MALE requirement of ACP-2021-078 was split into a separate ACP. ACP-2021-078 is now a HALE-only ACP.

Ten nights of ADS-B data were observed (five in summer and five in winter) and, during the 102 hours observed, two aircraft were observed within the proposed airspace below 7,000 feet. Due to the frequency of activation (two to three times per week), the duration of activation (up to three hours per activation), and the provision of a Danger Area Crossing Service (DACS), the Sponsor assessed that minimal to nil impacts were expected below 7,000 feet. This assessment was also validated by stakeholders.

Above 7,000 feet, additional impacts were expected as civil traffic would be required to reroute around the proposed airspace design. The estimated impact above 7,000 feet for the two HALE options, based on the same observation methodology, was an average of ~1.1 aircraft impacted per hour.

HALE Option 2 was identified as the preferred HALE option as it better aligned with the established design principles by accommodating mission requirements within a smaller volume of airspace.

Section 1 – Context

Engagement

After Stage 2, NATS identified significant expected impacts from HALE Options 1 and 2 prompting extensive engagement. Much of this engagement was focused on mitigating the impacts from the NATS West Airspace Deployment planned for March 2023. Specific concerns were raised by NATS about the impact of Segment A. NATS feedback indicated that the upper limit altitude of Segment A for both options would cause extensive impacts to flight planning for departures at adjacent airports. Additionally, the southern portion of Segment A for both options was identified as a major impact to civil traffic patterns.

The Sponsor also conducted further analysis[1] and determined that the volumes of Segment C in HALE Options 1 and 2 were not sufficient to enable safe and efficient RPAS transition between the ground and the operating altitude in all foreseeable contingency and emergency scenarios. A larger internal safety buffer was also deemed necessary to comply with the CAA's Safety Buffer Policy Letter.

Based on engagement with NATS on expected impacts to civil traffic and the Sponsor's analysis, it was determined that HALE Options 1 and 2 were no longer viable. The Sponsor then worked with NATS on modifications to those designs that better aligned with the established design principles. An interim design was considered that met the Sponsor's operational needs, but NATS feedback indicated that the interim design option would also cause significant impact to other users of the airspace. Through more engagement with NATS, the Sponsor was able to comply with some of the modification requests made by NATS to help to minimise impacts. HALE Option 3 is the result of this engagement and is the sole design option that will be evaluated against the baseline "do nothing" option. More details about this process can be found in the Consultation Document located on Citizen Space or the ACP Portal.

Environmental Assessment

The ACP Change sponsor is the MOD and is therefore only responsible for assessing the consequential impact on civil air traffic. The anticipated consequences of the proposed change are not expected to impact civil aviation traffic patterns below 7,000 feet. As a result, an Environmental Impact Assessment was conducted to concentrate on CO_2 emissions from the civil air traffic disruption during activation of the proposed danger areas. The Environmental Impact Assessment is based on a "worst-case" scenario for frequency and duration of activation of danger areas. The full assessment can be found in Annex A.

[1] Internal U.S. Air Force analysis. Due to operational security this is not provided in detail but can be requested by the CAA should more information be required.

Statement of Need

In order to support NATO's Agile Combat Employment concept, the US Air Force is making significant infrastructure investments on airbases in the UK and other allied nations. There is an emerging requirement for military aircraft, including Remotely Piloted Aircraft (RPA), to operate regularly from RAF Fairford. In accordance with CAP 722 – Unmanned Aircraft System Operations in UK Airspace – Guidance and Policy, beyond visual line of sight (BVLOS) operations require either a CAA-approved Detect and Avoid (DAA) capability or to remain within a block of airspace that is segregated from other airspace users. This ACP aims to establish suitable segregated airspace to enable RPA transition between RAF Fairford and high-altitude transit.

Design Principles

The Change Sponsor engaged with a wide range of potential stakeholders and sought their views on the initial proposed Design Principles in Stage 1. The feedback received was used to finalise the Design Principles below. These will now be used to analyse the design options.

Design Principle		Priority
a	Provide a safe environment for airspace users	1
b	Provide access to sufficient suitable airspace to enable efficient RPAS transition between the ground and high-level transit routes	2
c	Minimise the impact to other airspace users	3
d	Adhere to FUA principles and strategy	3
e	Where possible and practicable, accommodate the Airspace Modernisation Strategy	4
f	Endeavour to make the airspace as accessible as possible	5
g	Minimise the environmental impact of non-participating aircraft	6

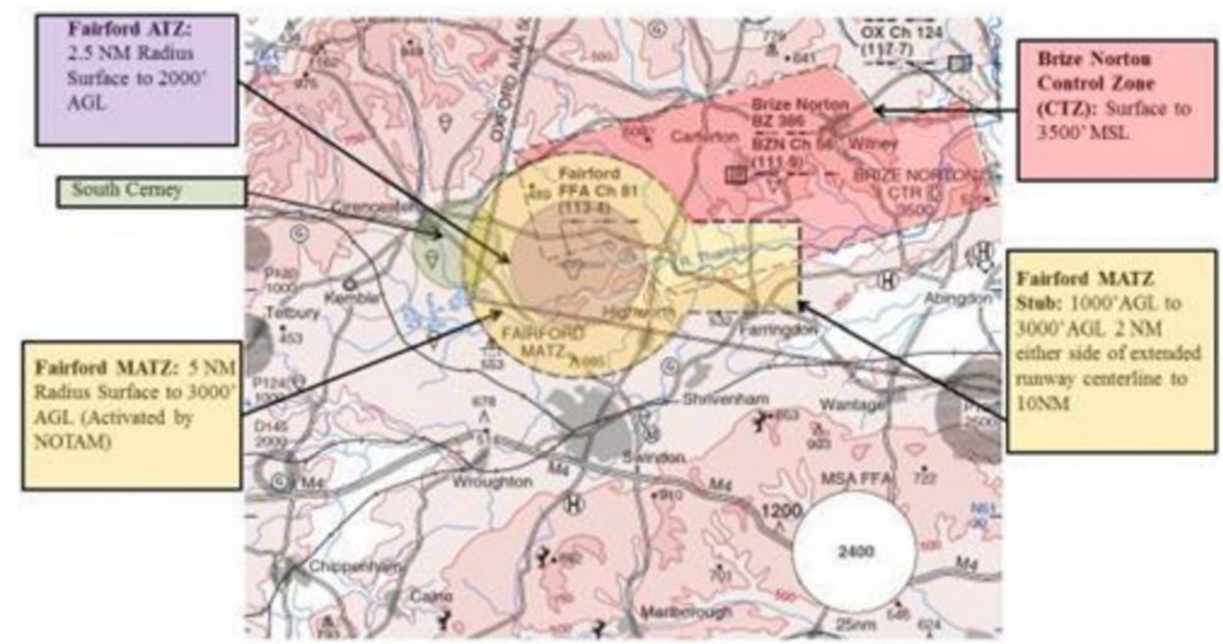
Design Options

The design options evaluated in this document are:

- Option 0 – Do Nothing
- Option 3 – Segmented Danger Areas

Options 1 and 2 have been discounted due to stakeholder feedback and further analysis by the Sponsor since Stage 2. A detailed explanation of this process and the engagement that led to the development of HALE Option 3 can be found in the Stage 3 Consultation Document.

Current Situation: Option 0 – Do Nothing



In accordance with CAP 722, Unmanned Aircraft System Operations in UK Airspace – Policy and Guidance[2], any unmanned aircraft operating BVLOS requires a technical capability which has been accepted as being at least equivalent to the ability of a pilot of a manned aircraft to "see and avoid" potential conflicts. U.S. military HALE RPA currently lack this detect and avoid capability and require a block of segregated airspace to operate in the current regulatory environment. As such, the "do nothing" scenario would mean that U.S. military HALE RPA operations would not be possible.

[2] CAP 722 Unmanned Aircraft System Operations in UK Airspace – Policy and Guidance

HALE Option 3

HALE Option 3 was developed after it was determined that HALE Options 1 and 2 were no longer viable. Through extensive engagement with stakeholders, primarily NATS, the Sponsor sought to develop an option that best met the design principles of this ACP

Safety was the primary consideration of this design. Significant work went into ensuring that the volume of the airspace was sufficient to fully contain the HALE RPA operation as well as all foreseeable contingency scenarios. This option was designed to allow for a minimum of a 3 NM lateral safety buffer. A 2 NM internal buffer is planned in Segments B, C, and D. An external Flight Plan Buffer Zone (FBZ) of 1 NM will be applied above FL245 and where the airspace abuts CTAs or has an interaction with an ATS Route. Segment A will not have a 2 NM internal buffer throughout, but departure and arrival procedures in Segment A will ensure that a lateral buffer of at least 3 NM is provided from adjacent controlled airspace. The Sponsor intends to seek out policy dispensation in accordance with the CAA Safety Buffer Policy Letter[3].

Preliminary data indicated that the majority of the impact to civil traffic would be at the higher levels. Because of this, extensive engagement was undertaken with NATS to understand traffic flows and determine how civil traffic could be least impacted while maintaining the minimum volume of airspace required for safe and efficient HALE RPA transition between the ground and high-level transit routes. The shape, location, and altitudes of the Segments of HALE Option 3 were informed by this engagement. The Sponsor was able to comply with many requested changes to reduce impacts. The major changes from previous HALE options included limiting the airspace footprint of Segment A south of RAF Fairford, significantly reducing the upper limit of Segment A, and adjusting the positioning of the higher-level airspace further to the north.

HALE Option 3 provides a volume of airspace that permits HALE RPA departure from RAF Fairford followed by a turn to the north within Segment A and transition to Segment B. After a climbing transition through Segment B, the HALE RPA continues its climb within Segments C and D to its high-level transition altitude of FL500 or above. The process is reversed on arrival to RAF Fairford. The aircraft begins descent in Segments C and B, then transitions to B and A for landing at RAF Fairford.

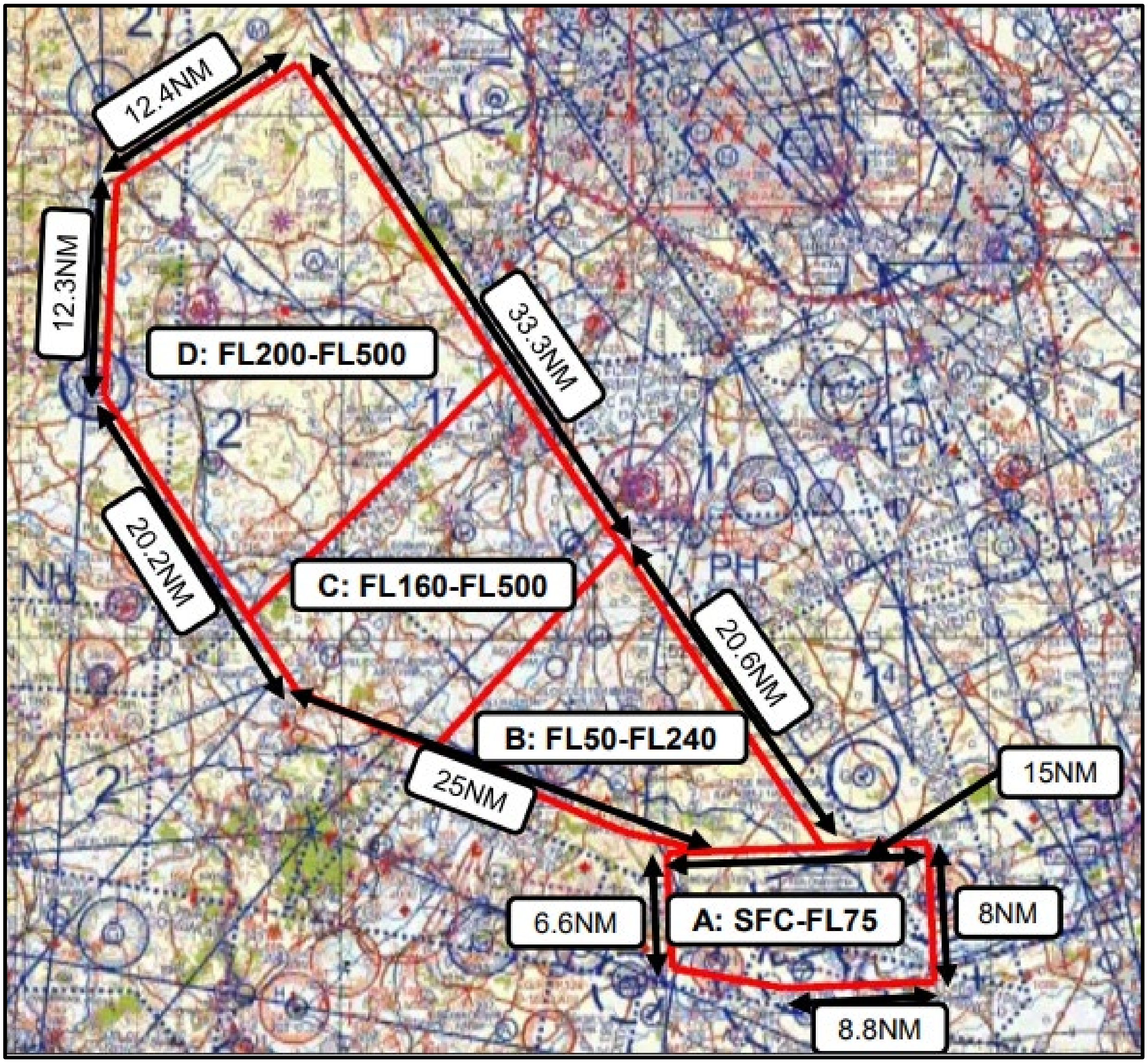
Airspace Utilisation

The proposed airspace is expected be activated 2-3 times per week for up to 3 hours per activation. This window of up to 3 hours is intended to not only accommodate arrivals and departures but to also ensure that the airspace is active for a sufficient time to account for emergency or contingency scenarios.

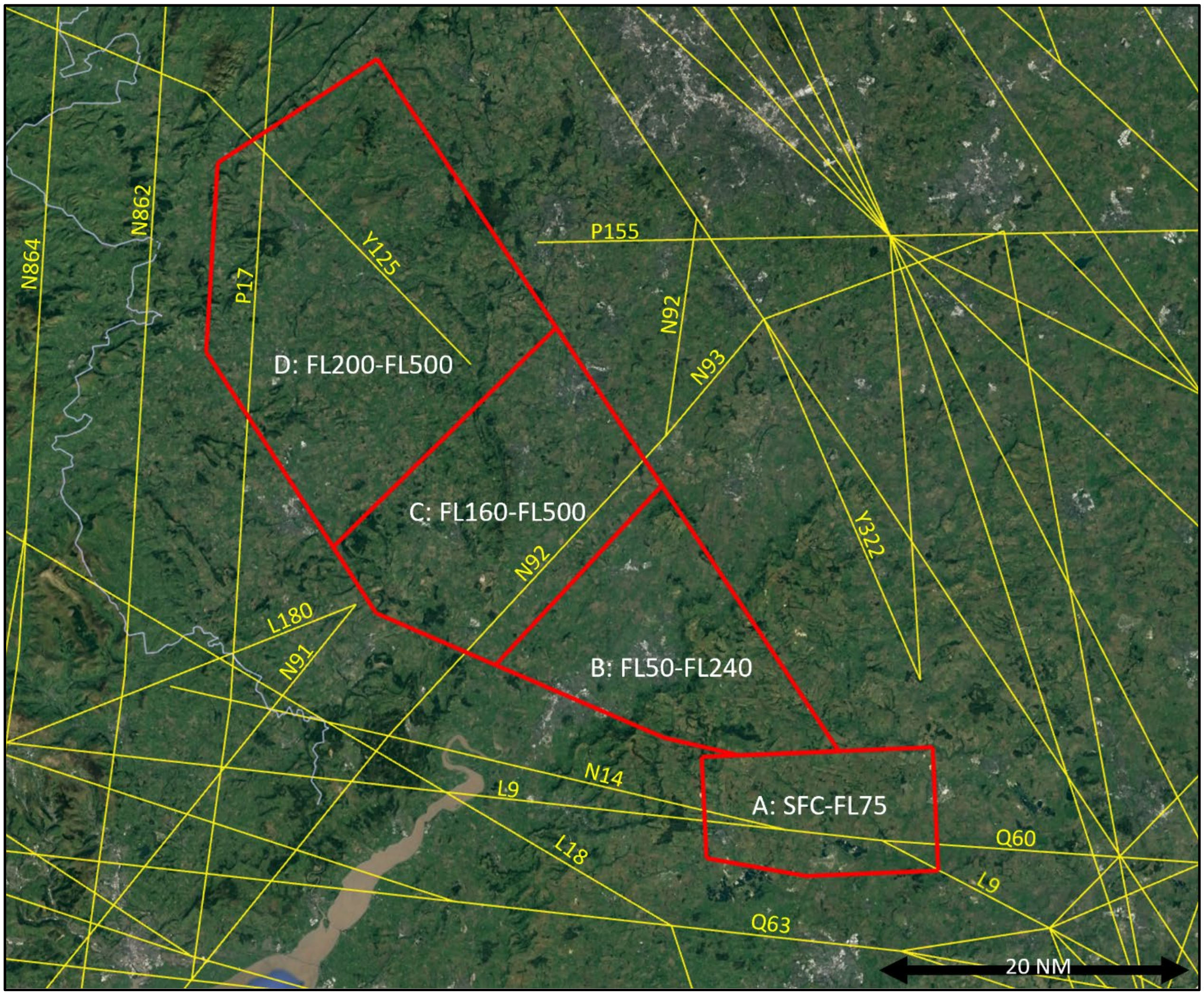
To minimise the impact to airspace users, the Sponsor initially limited the activation window to between 1 hour after sunset and 1 hour before sunrise. Stakeholder feedback and data gathered since Stage 2 identified significant impacts during this window,

[3] SPECIAL USE AIRSPACE - SAFETY BUFFER POLICY FOR AIRSPACE DESIGN PURPOSES, para 3.3

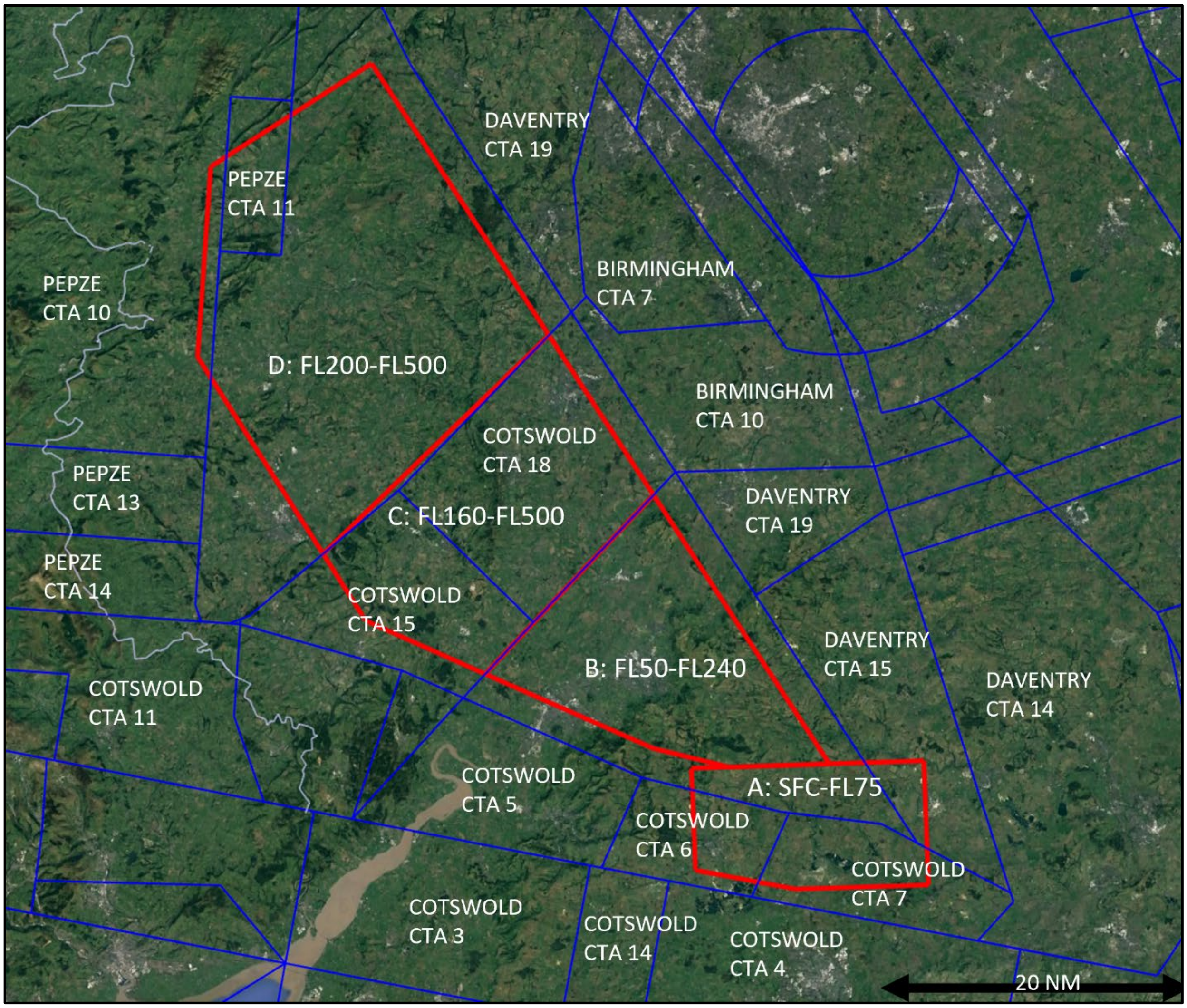
primarily in the winter months. Based on this data, the Sponsor has agreed to further restrict the activation window to 20:00 – 05:30 UTC for normal operations. Any required activations between 1 hour after sunset and 20:00 UTC or 05:30 UTC and 1 hour prior to sunrise are expected to be very rare and coordinated in advance. At this time, it is not possible to predict how "rare" these activations will be. As such, analysis has been completed on the larger 1 hour prior to sunset and 1 hour prior to sunrise window.



HALE Option 3 General Overview and Dimensions



HALE Option 3 in relation to adjacent ATS Routes



HALE Option 3 in relation to adjacent CTAs

Section 2 – Design Principle Evaluation

In Stage 2, the Sponsor evaluated the design options presented against the established design principles. Since Stage 2, a modified HALE Option 3 has emerged as the only viable airspace design. In this section, the Sponsor will evaluate this modified option against the design principles. The Sponsor welcomes stakeholder feedback on their assessment of how HALE Option 3 meets the design principles.

Design Principle Evaluation			**OPTION NO: 3**	
HALE Option 3 *Segmented Danger Areas*			ACCEPT / ~~REJECT~~	
Danger Areas are currently the primary method of achieving segregated airspace which is currently required in the UK for operations of BVLOS RPAS without a CAA-approved Detect and Avoid (DAA) capability. Danger Areas in the vicinity of RAF Fairford would be activated by NOTAM only when required in order to best meet the established Design Principles. Additionally, services such as a Danger Area Crossing Service (DACS) or Danger Area Activity Information Service (DAAIS) would be employed to ensure GA traffic would not be unnecessarily impeded.				
Design Principle A	Provide a safe environment for all airspace users.	**~~NOT MET~~**	**~~PARTIAL~~**	**MET**
This design option would facilitate a safe environment for BVLOS HALE RPAS operations in accordance with current regulation, which currently demands segregated airspace. It would also provide a safe environment for other airspace users through increased internal safety buffers and a volume of airspace that accommodates all foreseeable contingency scenarios.				
Design Principle B	Provide access to sufficient suitable airspace to enable efficient RPAS transition between the ground and high-level transit routes.	**~~NOT MET~~**	**~~PARTIAL~~**	**MET**
This option meets the minimum operational requirements of efficient USAF HALE RPA transit between the ground and high-level transit routes as well as the segregated airspace requirement of current regulations.				
Design Principle C	Minimise the impact to other airspace users.	**~~NOT MET~~**	**PARTIAL**	**~~MET~~**
Some impacts are expected to civil traffic with the majority of impacts expected above FL300. The proposed times, frequency of activation, and expectation of a DACS will reduce the overall impact to other airspace users but some impact can be expected.				

Design Principle D	Adhere to FUA principles and strategy.	~~NOT MET~~	~~PARTIAL~~	MET
As per the principles of FUA, the size, shape, and proposed times of use of the airspace were developed to minimise impacts to other airspace users. In accordance with CAP 740 Appendix A, the airspace will be activated when needed and returned when no longer needed. Additionally, the expected availability of a DACS will permit use of this airspace by other civil and military airspace users, where possible.				
Design Principle E	Where possible and practicable, accommodate the Airspace Modernisation Strategy	~~NOT MET~~	~~PARTIAL~~	MET
Accommodating RPAS is an aim of the Airspace Modernisation Strategy (AMS). The AMS is further required to support delivery of Defence and Security objectives. This option meets this objective. Due to the proposed times, frequency of activation, and expectation of a DACS, this option is expected to produce minimal impact to the other portions of the AMS. The Sponsor will continue to work closely with the CAA to ensure the AMS is accommodated where possible and practicable.				
Design Principle F	Endeavour to make the airspace as accessible as possible	~~NOT MET~~	~~PARTIAL~~	MET
Due to the proposed times, frequency of activation, and expectation of a DACS, this option should make the airspace as accessible as possible to other airspace users.				
Design Principle G	Minimise the environmental impact of non-participating aircraft	~~NOT MET~~	PARTIAL	~~MET~~
By selecting the minimum viable volume of airspace, limiting the activation window to times of lower traffic, limiting the frequency of activation to 2-3 times per week, and limiting the duration of activation no more than 3 hours, this option minimises the environmental impact of non-participating aircraft as much as possible while still permitting the required military activity. The provision of a DACS should further limit this impact.				

HALE Option 3 Summary

This design option was deemed to have met most, but not all, Design Principles. Some impacts to civil flight planning are expected but due to the proposed activation times, frequency of activation, and expectation of a DACS, the overall impact to other users of the airspace (and the subsequent increase in CO_2 emissions) will be minimised as much as possible while still permitting the required military activity.

This option will be further assessed later in this document.

Section 3 – Safety Assessment

Although there is no requirement for a safety assessment in Stage 3, an updated version of the safety assessment from Stage 2 is being included to account for the changes to the ACP since Stage 2. Specifically, the MALE options are being excluded and a single modified HALE Option 3 is being assessed. As described in Stage 2, the Summary of Preferred Options indicated the Sponsor's preference to establish segregated airspace in the form of Danger Areas. This also aligns with stakeholder feedback received throughout the ACP process. The Sponsor acknowledges that the establishment of the proposed Danger Areas may introduce the following hazards:

1. Should pilots be unable to accept DACS, the routing of traffic around the proposed airspace may create bottlenecks and increased traffic density in areas near the border of the proposed airspace. Due to the timing and duration of airspace activations and the identified lack of traffic operating in Class G, this is unlikely to have a significant impact. Based on stakeholder feedback, HALE Option 3 is expected to have fewer impacts than the discounted HALE Options 1 and 2.

2. A higher workload is expected to be imposed upon RAF Brize Norton and Swanwick Military ATC due to controlling the RPA, providing/managing DACS requests, and accomplishing tactical re-routing of network traffic. The latter would also increase workload for civil controllers.

3. Pilots of aircraft operating in Class G airspace may not be aware of the activity status of the airspace and inadvertently fly through the active Danger Area during RPA climb/descent. However, due to activity timings/duration and notification procedures, this is deemed to be a highly unlikely scenario.

If Danger Areas are implemented, the following will be in place to ensure safety is managed:

1. The proposed airspace will be activated by NOTAM at least 24 hours prior to USAF RPAS operations. Procedures will be adopted to ensure that the airspace is activated only when required and dynamically deactivated when not in use.

2. A 2 NM internal buffer is planned in Segments B, C, and D

3. An external FBZ of 1 NM will be applied above FL245 and where the airspace abuts CTAs or has an interaction with an ATS Route.

4. Procedures in Segment A will ensure that a lateral buffer of at least 3 NM is provided from adjacent controlled airspace.

5. To minimise the safety impacts of the proposed airspace, a DACS will be available for aircraft under a clearance from either RAF Brize Norton or 78 Sqn (Swanwick

Military). Procedures are being developed to allow for the dynamic real-time return of airspace to ATC when needed for higher priority flights or when not actively in use for RPA operations. This will maximise the availability of the DACS and minimise the need for routing around the proposed Danger Areas. RPA will not routinely loiter in the segregated airspace. All airspace design options are intended for egress from and ingress to RAF Fairford only. As such, the Sponsor expects that a crossing service will be available for the majority of the proposed activation window.

6. HALE RPA will remain within segregated airspace at all times below FL500 when operating within the London or Scottish FIR/UIR. This ACP is solely to allow the RPA to climb and descend in to and out of RAF Fairford from SFC to FL500. Based on ongoing engagement with the CAA and other stakeholders, the Sponsor anticipates that when operating in the London or Scottish UIR at FL500 and above, HALE RPA will operate as agreed in a type-specific Operational Arrangement with the CAA and MoD. The Operational Arrangement is in the process of being agreed and is not part of this ACP.

7. Specific emergency procedures are currently being developed. To minimise training requirements on ATC, every effort is being made to standardise lost link and other contingency and emergency procedures. If an emergency occurs within the Danger Area, HALE RPA will be programmed to remain within the Danger Area and hold or land at RAF Fairford.

Conclusion

Activations of airspace for up to 3 hours, 2-3 times per week, and during times of lower traffic density should minimise the impacts of the risks explained previously. The addition of procedures for real-time return of airspace not needed for RPA operations will further minimise these impacts as will the availability of a DACS.

The Sponsor will continue to engage with 78 Sqn and RAF Brize Norton ATC on procedures that will maximise safety and minimise risks to other users of the airspace and the public at large.

Section 4 – Full Options Appraisal

The following tables detail the appraisal of the remaining design option as evaluated against the “do-nothing” baseline.

HALE Option 3 Appraisal

Table 1 – Summary of Option Appraisal for HALE Option 3

Group	Impact	HALE Option 3	Do-Nothing
Communities	Noise impact on health and quality of life	As a Level M2 change, CAP1616 states that the prioritised environmental impact is CO_2 emissions, and an assessment of noise impacts is not normally required. This proposal is expected to have minimal to no impacts below 7,000 feet. Additionally, noise impacts were not a concern in any of the stakeholder engagement that was carried out prior to Stage 3A.	Flight operations associated with the ACP would not be possible in a “do nothing” scenario and thus no change in noise impacts on health and quality of life would occur.
Communities	Air Quality	In accordance with CAP 1616, this assessment is not required as the proposal will not affect emissions below 1,000 feet.	Flight operations associated with the ACP would not be possible in a “do nothing” scenario and thus no change in air quality would occur.

Wider society	Greenhouse gas impact	Activation of the proposed airspace will result in an increase of CO_2 emissions due to civil traffic being re-routed. Although tactical re-routing and a DACS will be available for the majority of the activation period, it is expected that some aircraft will need to circumnavigate the airspace. Network traffic will be required to flight plan around the proposed airspace, when active. A detailed quantitative analysis of the “worst case” scenario has been provided in Annex A.	Flight operations associated with the ACP would not be possible in a “do nothing” scenario and thus no greenhouse gas impact would occur.
Wider society	Capacity / resilience	The proposed airspace will be managed by the Military Airspace Management Cell to minimise disruption and activation will be via NOTAM. Due to the time window of activation and the limited frequency and duration of activation, this is not expected to be	Flight operations associated with the ACP would not be possible in a “do nothing” scenario and thus no capacity/resilience impacts would occur.

		significant.	
General Aviation	Access	Very minimal to no impacts to general aviation access are expected above the baseline “do nothing” option. This assessment is based upon stakeholder feedback and traffic data both demonstrating minimal to no expected impact to civil traffic below 7,000 feet. Access will be further enabled through the availability of a DACS.	Flight operations associated with the ACP would not be possible in a “do nothing” scenario and thus no general aviation impacts would occur.
General Aviation / commercial airlines	Economic impact from increased effective capacity	This option is not expected to have an impact to the number of air transport movements, estimated passenger numbers, or cargo tonnage carried.	Flight operations associated with the ACP would not be possible in a “do nothing” scenario and thus no change to economic impacts from increased effective capacity would occur.
General Aviation / commercial airlines	Fuel Burn	Projected fuel burn statistics can be found in Annex A. Due to the location of RAF Fairford, HALE Option 3 will have an inevitable impact on commercial airline routing. Although tactical rerouting	Flight operations associated with the ACP would not be possible in a “do nothing” scenario and thus no change to fuel burn would occur.

		and a DACS will be available for the majority of the activation period, it is expected that most network traffic will be required to flight plan around the proposed airspace, when active.	
Commercial airlines	Training costs	Not applicable	
Commercial airlines	Other costs	Not applicable	
Airport /ANSP	Infrastructure costs	NATS feedback has indicated that no infrastructure costs are expected with this design.	No infrastructure costs would be associated with a “do nothing” option.
Airport /ANSP	Operational costs	NATS feedback has indicated that operational costs will likely be nil or negligible with this design.	No operational costs would be associated with a “do nothing” option
Airport /ANSP	Deployment Costs	Costs would be incurred by NATS, RAF Brize Norton, and 78 Sqn through the briefing and training of air traffic controllers for RPA operations to include emergency and contingency situations. There will also be costs for ATM system updates. NATS is still conducting planning to determine the estimated deployment costs	Flight operations associated with the ACP would not be possible in a “do nothing” scenario and thus no change to Airport/ANSP deployment costs would occur.

		associated with this design. The Sponsor will share these costs as this information becomes available.	

Summary

Option 0 “do nothing” does not permit BVLOS RPAS operations and is only presented as a baseline for comparison.

HALE Option 3 has been developed to satisfy Design Principles A and B. It was also designed with extensive engagement with ATS providers and other stakeholders to satisfy Design Principles C-G to the maximum extent possible.

The Sponsor assesses that no impacts are expected below 7,000 feet when compared to the baseline “do nothing” option. This assessment was confirmed by stakeholders and validated through observed and simulated traffic data.

At or above 7,000 feet, impacts can be expected based on the need for network traffic to plan around the airspace during periods of activation. This option was designed with extensive engagement with NATS to avoid heavily used routes to the maximum extent possible. The worst-case scenario for fuel burn and CO_2 emissions (where no DACS is utilised) is presented in Annex A.

Section 5 – Stage 3 Environmental Impact Assessment Summary

As part of the Stage 3A Full Options Appraisal, CAP 1616 requires completion of an Environmental Impact Assessment. The environmental impact of military activity will not be considered during this ACP but the environmental impact from other air traffic as a result of the introduction of a new airspace structure must be considered.

HALE Option 3 was evaluated for impacts to civil traffic using a representative traffic sample provided by NATS Analytics. This sample confirmed that no impacts are expected below 7,000 feet for this design option, further validating the categorisation of this ACP as a Level M2 change. In accordance with CAP 1616, only CO_2 emissions are required to be assessed as a part of the Environmental Assessment of a Level M2 change.

CO_2 Emissions

An increase in CO_2 emissions is expected as a result of this change. The Sponsor will continue to engage with stakeholders on ways to mitigate the “worst case” scenario impact that is presented in Annex A of this document.

Noise, Local Air Quality, Tranquillity, and Biodiversity

Since no impacts are expected to civil traffic patterns below 7,000 feet, no adverse impacts related to noise, local air quality, tranquillity, or biodiversity are expected. While impacts to civil traffic patterns below 7,000 feet are highly unlikely, the Sponsor has planned impact mitigation efforts to include NOTAMs when proposed airspace would be active, activation during periods of low traffic density, and the utilisation of a DACS.

Section 6 - Next Steps

This document will be submitted to the CAA as evidence to support Stage 3A of ACP-2021-078. It is part of the documentary evidence for the Stage 3 Full Options Appraisal Gateway. The Sponsor is seeking feedback on Design Option 3 during the planned consultation period of **11 Oct – 21 Nov 2023**.

ACP Timeline

The agreed timeline for this ACP is as follows:

Stage	Submission	Gateway
DEFINE GATEWAY	11 Mar 22	25 Mar 22
DEVELOP AND ASSESS GATEWAY	15 Jul 22	29 Jul 22
CONSULT GATEWAY	15 Sep 23	29 Sep 23
UPDATE AND SUBMIT	8 Dec 23	
DECIDE GATEWAY		16 Feb 24
IMPLEMENT		Jun 24

Annex A – Environmental Impact Assessment

Overview and Methodology

NATS Analytics were engaged to produce an Environment Impact assessment. This assessment was produced in September 2023 and based on the following assumptions:

- A 1 NM flight plan buffer zone (FBZ) would occur above FL245 and where the ACP-2021-078 Danger Area abuts Control Areas (CTAs) and has an interaction with an Air Traffic Service (ATS) route.
- A 2,000ft vertical buffer was applied above and below the ACP-2021-078 Danger Area where it abuts/overlaps CTAs.
- In the scenario presented, the Danger Area can be activated 1 hour after sunset to 1 hour before sunrise. For the winter schedules, this equates to the longest night (~ 21st Dec) between 17:00 to 07:00 UTC hours. For the summer schedules, the danger area can be activated between 21:00 to 05:00 UTC. For summer, the night-time activation period is based on the traffic sample date 08/04/23 as opposed to the shortest day (~ 21st June) to model a worst-case scenario.[4]
- The Danger Area will be activated 2 to 3 times per week, in 3 hourly segments with a range of 6-9 hours activation per week. It may be activated on weekends as well as weekdays.
- No other special use airspace (SUA) volumes are active at the same time therefore the analysis relates only to the ACP-2021-078 Danger Area.
- The fuel impact of the change would happen at cruise. This is calculated by multiplying the difference in route length (NM) by the BADA 4.2 aircraft type cruising fuel burn rate at its Requested Flight Level (RFL).
- The traffic sample is representative and can be used to represent the impact of a 3-hour activation segment.
- The traffic forecasts are grown using the NATS March 2023 Base Case Forecast and assumes a steady growth rate of 0.7% for 2029 and onwards.
- The environmental results were filtered to only include those flights present in both simulations. No military or helicopter flights are modelled.
- 20% of emissions are traded, 80% are non-traded. For WebTAG submission, the carbon dioxide equivalent (CO_2e) emissions are reported as traded (flights whose origin and destination are within the EU) or non-traded.[5][6]

Simulated baseline air traffic models have been produced using tool NEST (V1.8) and Emissions figures have been produced using BADA 4.2 data. These products have been

[4] The current proposal is for activation between 20:00 and 05:30 UTC for normal operations.

[5] The % of flights CO2 Traded is defined as the % of UK domestic flights; flights between UK and Gibraltar, & flights departing the UK to EEA states within the dataset (% same for all years). The % of flights non-Traded is defined as all flights with destination outside of EEA states (% same for all years).

[6] CO2 Traded is calculated as the Simulated CO2 x % flights CO2 Traded, and CO2 non-Traded is calculated as the Simulated CO2 x % flights CO2 non-Traded.

made available by the European Organisation for the Safety of Air Navigation (EUROCONTROL).

The traffic sample is taken from the 2303 AIRAC from EUROCONTROL covering the period of 23/03/2023 to 19/04/2023. This AIRAC was chosen to give an up-to-date baseline set of traffic that was not considerably impacted by the Covid-19 pandemic and included the West Airspace Implementation.

The following 3 days were picked to simulate a typical winter schedule: 23/03/2023, 24/03/2023, and 25/03/2023. Another 3 days were picked to simulate a typical summer schedule: 30/03/2023, 03/04/23, and 08/04/23. These 6 days were picked to give a good overall representation of traffic, with the following factors considered: day of the week, traffic count, and city pair flows.

During winter, the ACP-2021-078 Danger Area may be activated between 17:00 - 07:00 UTC (based on the longest night ~ 21st Dec) and in summer, the Danger Area may be activated between 21:00 - 05:00 UTC. For summer, the night-time activation period is based on the traffic sample date 08/04/23 as opposed to the shortest day (~ 21st June) to model a worst-case scenario.

The traffic sample is defined as any flight whose simulated trajectory changed due to the activation of the Danger Area. Over the 6 sample days, 172 aircraft crossed the Danger Area.

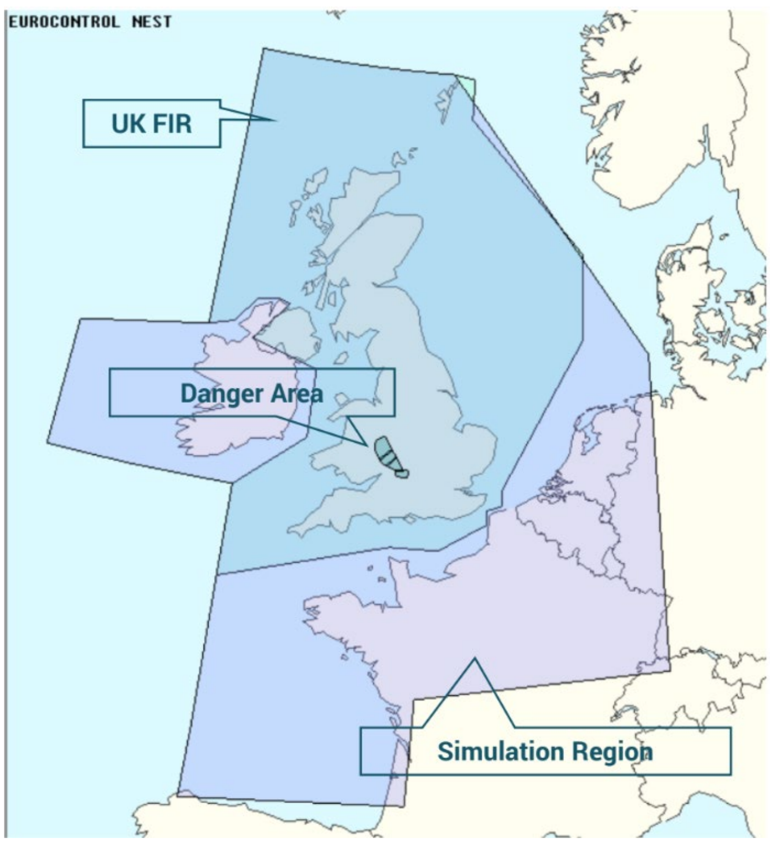


Fig 1 – Simulated Region

Effect on Aviation

Due to the proximity of the Danger Area to the southern edge of the UK FIR (London FIR), some flights need to change their UK entry/exit point between the Baseline and Scenario simulations in order to produce a valid flight plan. Therefore, a Simulation Region was created for this study, matching the UK FIR on the Atlantic boundary but expanding across European airspace. This fixes the Oceanic UK FIR entry/exit point for any transatlantic flights, ensuring that the North Atlantic Tracks are utilised in a realistic manner.

The Scenario trajectories were simulated within the Simulated Region, with the Oceanic entry and exit points matching those from the initial flight plan to replicate the North Atlantic Tracks on the chosen traffic sample days.

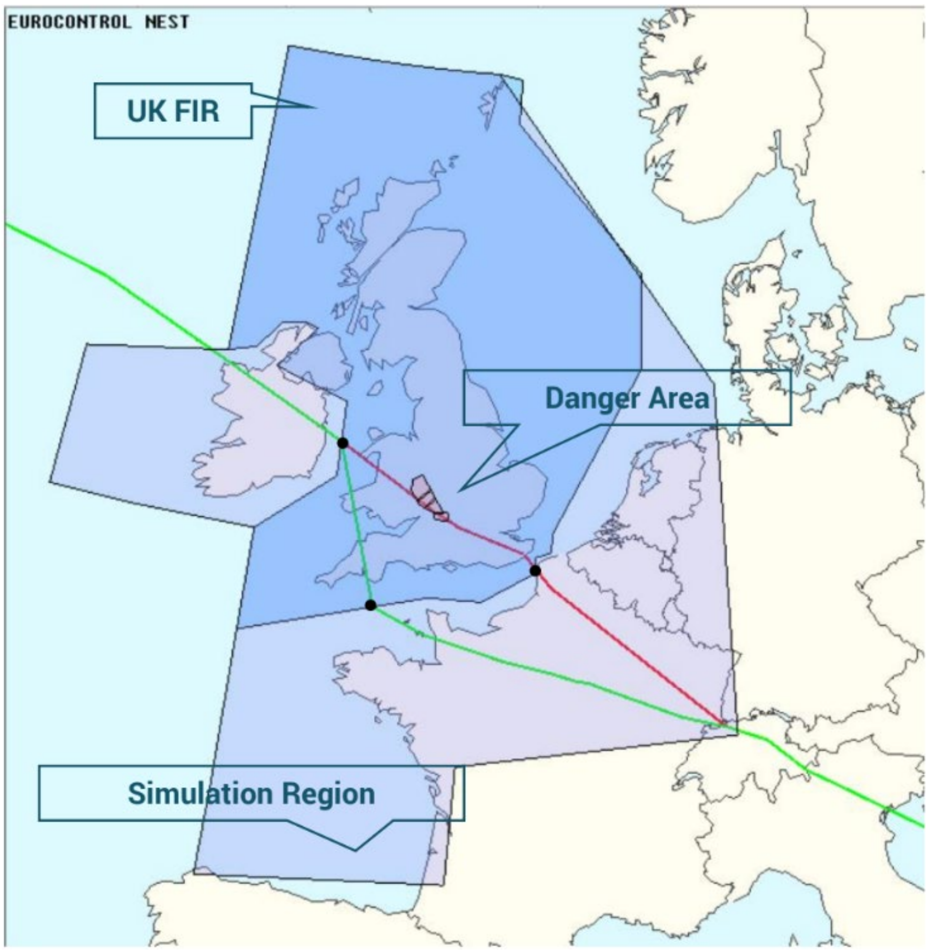


Fig 2 – Example Trajectory

The image above shows an example pair of Baseline (red) and Scenario (green) trajectories. The black dots mark the points where the flight enters or exits the UK FIR. In the Scenario, where the ACP-2021-078 Danger Area is active, the flight has to take a longer route across the UK FIR to avoid the Danger Area. For this particular flight, the route length has increased by 77 NM, therefore increasing its fuel burn and CO_2e emissions.

Environmental Impact

The track distance flown within the UK FIR (NM) was taken from the Baseline and Scenario models and used to calculate the change in distance flown. The fuel burn at cruise by aircraft type was then taken from the BADA 4.2 PTF tables and used to calculate the fuel burn change based on the change in distance flown.

The flights modelled were used to represent a typical 3-hour long activation segment of the ACP-2021-078 Danger Area. With a maximum of 9 hours of activation per week, this has been scaled up to represent a maximum annual impact (468 activation hours per year).

The figures below show baseline trajectories compared to the simulated trajectories of traffic routed around the activated Danger Areas.

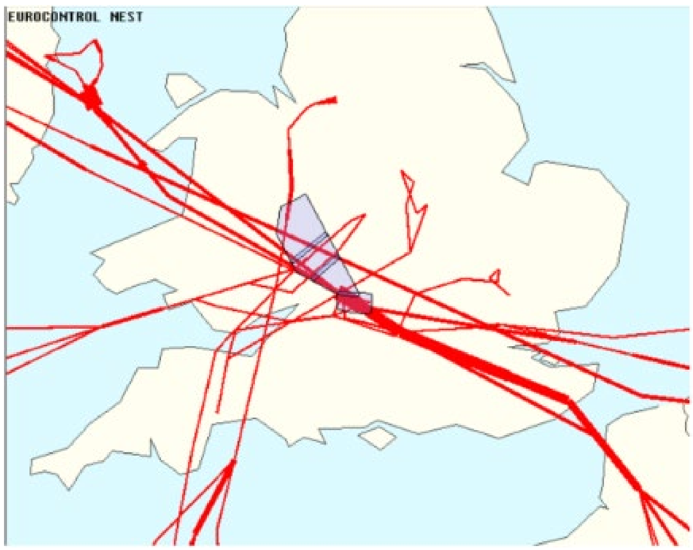


Fig 3 – Baseline Trajectories

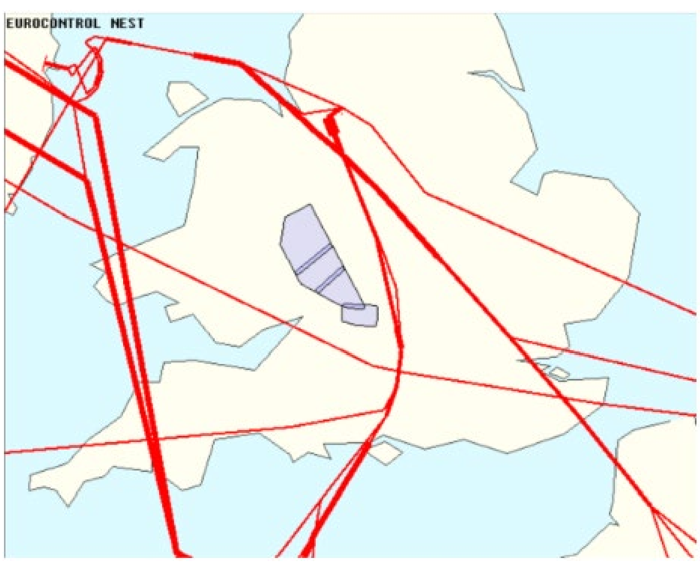


Fig 4 – Re-routed Trajectories when Danger Areas are active

Winter Environmental Impact – Average per flight

The average route length, fuel burn and carbon dioxide equivalent (CO_2e) emissions per impacted flight per hour during the winter hours (between 17:00 and 07:00 UTC) are given in the table below. The average flight has increased track distance of 41NM, increased fuel burn by 335kg and related emissions by 1,065kg when the ACP-2021-078 Danger Area is activated. The greatest number of flights would be impacted if activation occurred in the 3-hour period between 17:00-20:00. The greatest overall impact on fuel/CO_2e would occur if activation occurred between 22:00-01:00 or 02:00-05:00, affecting fewer but much heavier aircraft.

Winter schedules		Average Track Distance (NM)			Average Fuel Burn (Kg)			Average CO_2e Emissions (Kg)		
Hour	Flights	Baseline	Scenario	Difference	Baseline	Scenario	Difference	Baseline	Scenario	Difference
17:00-18:00	12	1,506	1,541	34	11,959	12,128	169	38,030	38,567	537
18:00-19:00	16	2,401	2,451	51	24,170	24,557	387	76,861	78,091	1,231
19:00-20:00	4	2,330	2,362	32	33,958	34,122	164	107,986	108,508	522
20:00-21:00	3	1,048	1,066	18	5,454	5,549	95	17,344	17,646	302
21:00-22:00	5	2,062	2,117	55	31,649	32,205	556	100,644	102,412	1,768
22:00-23:00	6	2,041	2,085	44	21,745	22,067	322	69,149	70,173	1,024
23:00-00:00	2	1,675	1,793	118	8,798	9,415	617	27,978	29,940	1,962
00:00-01:00	1	5,048	5,108	61	56,738	57,420	682	180,427	182,596	2,169
01:00-02:00	0	0	0	0	0	0	0	0	0	0
02:00-03:00	1	3,480	3,537	58	35,953	36,548	595	114,331	116,223	1,892
03:00-04:00	8	2,311	2,347	36	34,355	34,727	372	109,249	110,432	1,183
04:00-05:00	5	3,130	3,175	45	42,291	42,845	554	134,485	136,247	1,762
05:00-06:00	7	3,868	3,899	31	66,386	66,905	519	211,107	212,758	1,650
06:00-07:00	11	1,184	1,208	24	6,220	6,342	122	19,780	20,168	388
Average	**6**	**2,193**	**2,234**	**41**	**25,936**	**26,271**	**335**	**82,476**	**83,542**	**1,065**

- CO_2e is a standard measurement that considers the impact of all greenhouse gas emissions due to fuel burn as if they were all carbon dioxide. For aviation fuel, the conversion rate is 1kg fuel to 3.18kg of CO_2e.
- Numbers are presented rounded to nearest whole kg or NM. The data behind the scenes uses unrounded numbers. Positive numbers indicate additional contributions (penalty), negative numbers indicate lower contributions (benefit).

Summer Environmental Impact – Average per flight

The average route length, fuel burn and carbon dioxide equivalent (CO_2e) emissions per impacted flight per hour during the summer hours (between 21:00 and 05:00 UTC) are given in the table below. The average flight has increased track distance of 31 NM, increased fuel burn by 277 kg and related emissions by 881 kg when the ACP-2021-078 Danger Area is activated. The greatest number of flights would be impacted if activation occurred in the 3-hour period between 02:00-05:00. The greatest overall impact on fuel/CO_2e would occur if activation occurred between 00:00-03:00 or 01:00-04:00, affecting fewer but much heavier aircraft.

Summer schedules		Average Track Distance (NM)			Average Fuel Burn (Kg)			Average CO_2e Emissions (Kg)		
Hour	Flights	Baseline	Scenario	Difference	Baseline	Scenario	Difference	Baseline	Scenario	Difference
21:00-22:00	6	997	1,038	42	7,424	7,715	291	23,608	24,534	925
22:00-23:00	3	2,001	2,041	40	32,264	32,476	212	102,600	103,274	674
23:00-00:00	2	1,026	1,068	42	5,490	5,710	220	17,458	18,158	700
00:00-01:00	1	4,068	4,085	16	76,217	76,523	306	242,370	243,343	973
01:00-02:00	4	3,542	3,618	77	37,509	38,167	658	119,279	121,371	2,092
02:00-03:00	8	4,002	4,037	35	49,888	50,313	425	158,644	159,995	1,352
03:00-04:00	11	3,348	3,368	20	39,775	39,984	209	126,485	127,149	665
04:00-05:00	7	3,580	3,583	3	53,298	53,324	26	169,488	169,570	83
Average	**5**	**3,004**	**3,035**	**31**	**37,816**	**38,093**	**277**	**120,255**	**121,136**	**881**

- CO_2e is a standard measurement that considers the impact of all greenhouse gas emissions due to fuel burn as if they were all carbon dioxide. For aviation fuel, the conversion rate is 1kg fuel to 3.18kg of CO_2e.
- Numbers are presented rounded to nearest whole kg or NM. The data behind the scenes uses unrounded numbers. Positive numbers indicate additional contributions (penalty), negative numbers indicate lower contributions (benefit).

Annual Minimum Environmental Impact

The table below shows the annualised **minimum** impact (best case scenario) from activating the ACP-2021-078 Danger Area in terms of fuel burn and CO_2e emissions for years 2024 – 2033.

Overall, an average of 15 flights are impacted per typical 3-hour long activation segment. With a minimum of 2 activations per week, this equates to a minimum of 1,560 flights impacted per year based on 2023 traffic. The weighted average fuel burn per flight of 32,999 kg in the baseline and 33,299 kg in the simulated scenario for the whole flight trajectory have applied to the annual impacted traffic to obtain the total fuel burn (in tonnes) for each scenario.

The traffic forecasts are grown using the NATS March 2023 Base Case Forecast to estimate the average annual impacts from 2024 to 2033 (10 years post deployment) and assumes a steady growth rate (GR) of 0.7% for 2029 and onwards.

Year	GR%	Impacted Traffic	Baseline Fuel Burn (Tonnes)	Scenario Fuel Burn (Tonnes)	Fuel Impact (Tonnes)	Baseline CO2e Emissions (Tonnes)	Scenario CO2e Emissions (Tonnes)	CO_2e Emissions Impact (Tonnes)
2023		1,560	51,478	51,947		163,700	165,191	
2024	5.7%	1,649	54,415	54,911	496	173,040	174,617	1,577
2025	1.8%	1,679	55,405	55,910	505	176,188	177,794	1,606
2026	1.4%	1,703	56,197	56,709	512	178,706	180,335	1,629
2027	1.1%	1,722	56,824	57,342	518	180,700	182,348	1,648
2028	1.2%	1,743	57,517	58,041	524	182,904	184,570	1,666
2029	0.7%	1,755	57,913	58,440	527	184,163	185,839	1,676
2030	0.7%	1,767	58,309	58,840	531	185,423	187,111	1,688
2031	0.7%	1,779	58,705	59,240	535	186,682	188,383	1,701
2032	0.7%	1,791	59,101	59,639	538	187,941	189,652	1,711
2033	0.7%	1,804	59,530	60,072	542	189,305	191,029	1,724

* 2023 is used as a baseline to estimate future impacts. 2024-2033 serves as the 10-year period of expected impacts.

Annual Maximum Environmental Impact

The table below shows the annualised **maximum** impact (worst case scenario) from activating the ACP-2021-078 Danger Area in terms of fuel burn and CO_2e emissions for years 2024 – 2033.

With an estimated average of 15 flights impacted per typical 3-hour long activation segment and a maximum of 3 activations per week, this equates to an estimated maximum of 2,340 flights impacted per year based on 2023 traffic. The weighted average fuel burn per flight of 32,999 kg in the baseline and 33,299 kg in the simulated scenario for the whole flight trajectory have applied to the annual impacted traffic to obtain the total fuel burn (in tonnes) for each scenario.

The traffic forecasts are grown using the NATS March 2023 Base Case Forecast to estimate the maximum annual impacts from 2024 to 2033 (10 years post deployment) and assumes a steady growth rate (GR) of 0.7% for 2029 and onwards.

Year	GR%	Impacted Traffic	Baseline Fuel Burn (Tonnes)	Scenario Fuel Burn (Tonnes)	Fuel Impact (Tonnes)	Baseline CO2e Emissions (Tonnes)	Scenario CO2e Emissions (Tonnes)	CO_2e Emissions Impact (Tonnes)
2023 *		2,340	77,217	77,921		245,550	247,789	
2024	5.7%	2,473	81,606	82,349	743	259,507	261,870	2,363
2025	1.8%	2,518	83,091	83,848	757	264,229	266,637	2,408
2026	1.4%	2,553	84,246	85,013	767	267,902	270,341	2,439
2027	1.1%	2,581	85,170	85,946	776	270,841	273,308	2,467
2028	1.2%	2,612	86,193	86,978	785	274,094	276,590	2,496
2029	0.7%	2,630	86,787	87,577	790	275,983	278,495	2,512
2030	0.7%	2,648	87,381	88,177	796	277,872	280,403	2,531
2031	0.7%	2,667	88,008	88,810	802	279,865	282,416	2,551
2032	0.7%	2,686	88,635	89,442	807	281,859	284,426	2,567
2033	0.7%	2,705	89,262	90,075	813	283,853	286,439	2,586

* 2023 is used as a baseline to estimate future impacts. 2024-2033 serves as the 10-year period of expected impacts.

Associated Fuel Cost Data Based on Simulation

The traffic forecasts are grown using the NATS March 2023 Base Case Forecast to estimate the annual maximum impact (worst case scenario) from 2024 to 2033 (10 years post deployment) and assumes a steady growth rate (GR) of 0.7% for 2029 and onwards.

The table below provides details on the cumulative fuel burn and CO_2 emmisions of the aircraft that are simulated to be impacted along their normal route of flight. This serves as a baseline to analyse the delta between the additional expected impacts imposed by the ACP airspace in the worst-case scenario. This simulation shows that the increase to fuel burn, CO_2 emmisions, and the cost associated with fuel burn are simulated to be 0.9% in the worst-case scenario.

Year	Base Growth Flights	Base Growth Rate	Flights p/a in change area	Simulated Fuel Burn (T)	Simulated CO2 (T)	Delta from baseline (fuel)	Delta from baseline (CO2)	% flights CO2 Traded	% flights non-traded	CO2 traded (T)	CO2 non traded (T)	Fuel Cost (GBP)
2023	2,340		2,340	77,921	247,789	704	2,239	20%	80%	49,558	198,231	£46,008,284
2024	2,473	5.7%	2,473	82,349	261,870	743	2,363	20%	80%	52,416	209,454	£48,622,787
2025	2,518	1.8%	2,518	83,848	266,637	757	2,408	20%	80%	53,370	213,267	£49,507,868
2026	2,553	1.4%	2,553	85,013	270,341	767	2,439	20%	80%	54,111	216,230	£50,195,740
2027	2,581	1.1%	2,581	85,946	273,308	776	2,467	20%	80%	54,746	218,562	£50,746,628
2028	2,612	1.2%	2,612	86,978	276,590	785	2,496	20%	80%	55,382	221,208	£51,355,970
2029	2,630	0.7%	2,630	87,577	278,495	790	2,512	20%	80%	55,805	222,690	£51,709,648
2030	2,648	0.7%	2,648	88,177	280,403	796	2,531	20%	80%	56,229	224,174	£52,063,917
2031	2,667	0.7%	2,667	88,810	282,416	802	2,551	20%	80%	56,653	225,763	£52,437,670
2032	2,686	0.7%	2,686	89,442	284,426	807	2,567	20%	80%	57,076	227,350	£52,810,833
2033	2,705	0.7%	2,705	90,075	286,439	813	2,586	20%	80%	57,500	228,939	£53,184,587

Year	Delta from baseline (fuel in tonnes)	Increased Fuel Cost
2024	743	£ 438,704
2025	757	£ 446,971
2026	767	£ 452,875
2027	776	£ 458,189
2028	785	£ 463,503
2029	790	£ 466,456
2030	796	£ 469,998
2031	802	£ 473,541
2032	807	£ 476,493
2033	813	£ 480,036

Using the simulated delta in fuel burn and the fuel assumptions, the table to the left shows the estimated increase in cumulative annual fuel cost in a worst-case scenario. This equates to an average of ~ £178 in fuel cost per flight impacted[7]. The table below shows the jet fuel price figures used to derive these costs.

Fuel Assumptions (IATA jet fuel price)		Date Updated	Source
Fuel price USD/ tonne	$772.13	17/07/2023	https://www.iata.org/en/publications/economics/fuel-monitor/
USD/GBP conversion rate	0.76	17/07/2023	https://www.exchangerates.org.uk/Dollars-to-Pounds-currency-conversion-page.html
Fuel price GBP/ tonne	£590.45		

[7] (Additional annual fuel burn * £590.45)/ # of impacted flights annually

Note: The % of flights CO2 Traded is defined as the % of UK domestic flights; flights between UK and Gibraltar, & flights departing the UK to EEA states within the dataset (% same for all years). The % of flights non-Traded is defined as all flights with destination outside of EEA states (% same for all years).

Impact Mitigation

This Environmental Assessment is intended to show the worst-case scenario of environmental impacts. The Sponsor expects the actual impact to be lower due to the following mitigating measures.

DACS

Although network traffic will be required to flight plan around the airspace when active, a DACS is still expected to provide some mitigation of this impact. An activation window of up to 3 hours is required to provide flexibility in case the planned departure or arrival time is impacted by adverse weather or minor maintenance delays. This duration also ensures that the airspace is active in the event the aircraft needs to land shortly after takeoff in an emergency or contingency scenario. In normal operations, the airspace is only expected to be in use for 45-55 minutes per activation. When possible, the airspace will be made available to ATS providers, via a DACS, to minimize required re-routing of civil aircraft around the Danger Area.

Reduced Activation Window

Early in this ACP, it was evident that the volume of airspace required for HALE RPAS operations would have a significant impact to civil traffic. In an effort to minimise this impact, the Sponsor conceded to a reduced activation window of nighttime only activations. The sponsor further reduced this to 1 hour after sunset to 1 hour before sunrise to further reduce impacts to civil traffic.

After the NATS assessment was completed, the Sponsor was able to agree to a NATS request to further limit the activation window to 20:00 - 05:30 UTC to avoid peak traffic periods in the winter months. This equates to a 4.5-hour reduction in the activation window simulated in this assessment. Using the traffic samples from the winter hours scenario, this reduced window would drop the average number of aircraft impacted from 6 to 3.6 per hour. This reduction is due to an average of ~10 aircraft per hour no longer being impacted from 17:00 - 20:00 and 05:30 - 07:00.

While the Sponsor intends to operate only during this reduced window, flexibility is required for the rare occasion when operational necessity requires activation outside of this window (but still within 1 hour after sunset to 1 hour prior to sunrise). This expected to be very rare but cannot be accurately estimated at this time.

Annex B – Greenhouse Gases Workbook - Worksheet 1

Greenhouse Gases Workbook - Worksheet 1

Scheme Name:	Fairford RPAS ACP
Present Value Base Year	2010
Current Year	2023
Proposal Opening year:	2024
Project (Road/Rail or Road and Rail):	road

Overall Assessment Score:

Net Present Value of carbon dioxide equivalent emissions of proposal (£):	-£2,339,003 *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)	24,920
Of which Traded	4993.940843
Change in carbon dioxide equivalent emissions in opening year (tonnes): (between 'with scheme' and 'without scheme' scenarios)	2,363
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)	-£586,168 *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	1937.311537
Non-traded sector	0	0	0	7739.688463

Qualitative Comments:

Sensitivity Analysis:

Upper Estimate Net Present Value of Carbon dioxide Emissions of Proposal (£):	-£3,508,504
Lower Estimate Net Present Value of Carbon dioxide Emissions of Proposal (£):	-£1,169,501

Data Sources: