Ministry of Defence

# ACP-2021-078

# Enabling Remotely Piloted Aircraft Operations from RAF Fairford - HALE

## Stage 3 – CONSULT

## OPTIONS APPRAISAL (PHASE II – Full)

## Contents

# 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, the Sponsor conducted further engagement with stakeholders on the expected impacts of HALE Option 1 and 2. Much of this was focused on determining the impacts from the NATS West Airspace Deployment. In response to this feedback, the Sponsor met regularly with NATS to refine the HALE airspace options in a way that better aligned with the established Design Principles by further reducing impacts to civil traffic while retaining the minimum required volume for safe and efficient HALE RPA operations. The result of this engagement is a modification of the HALE options presented in Stage 2. This option is being presented in the Full Options Appraisal as HALE Option 3.

Based on engagement with stakeholders on expected impacts to civil traffic and the Sponsor's further analysis, it was determined that HALE Options 1 and 2 were no longer viable. HALE Option 3 is the sole design option that will be evaluated against the baseline "do nothing" option.

### 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.

### 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 |

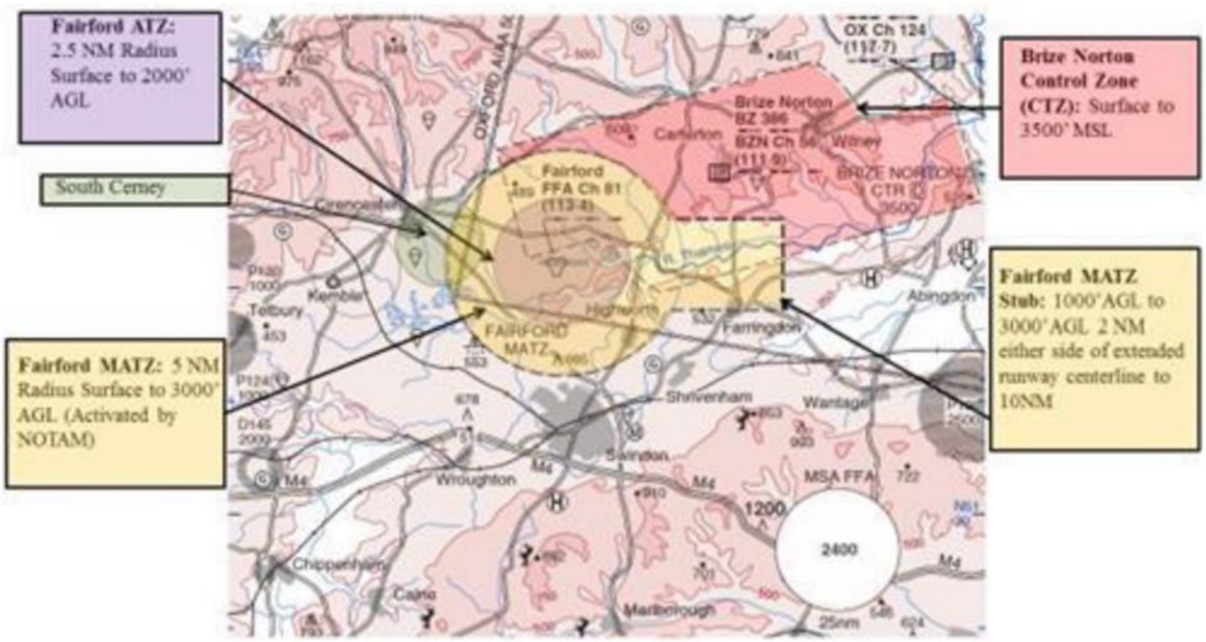
## Design Options

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[1], 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.

[1] 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, 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. With appropriate mitigations, this lateral buffer is expected to be deemed sufficient for policy dispensation as detailed in 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.

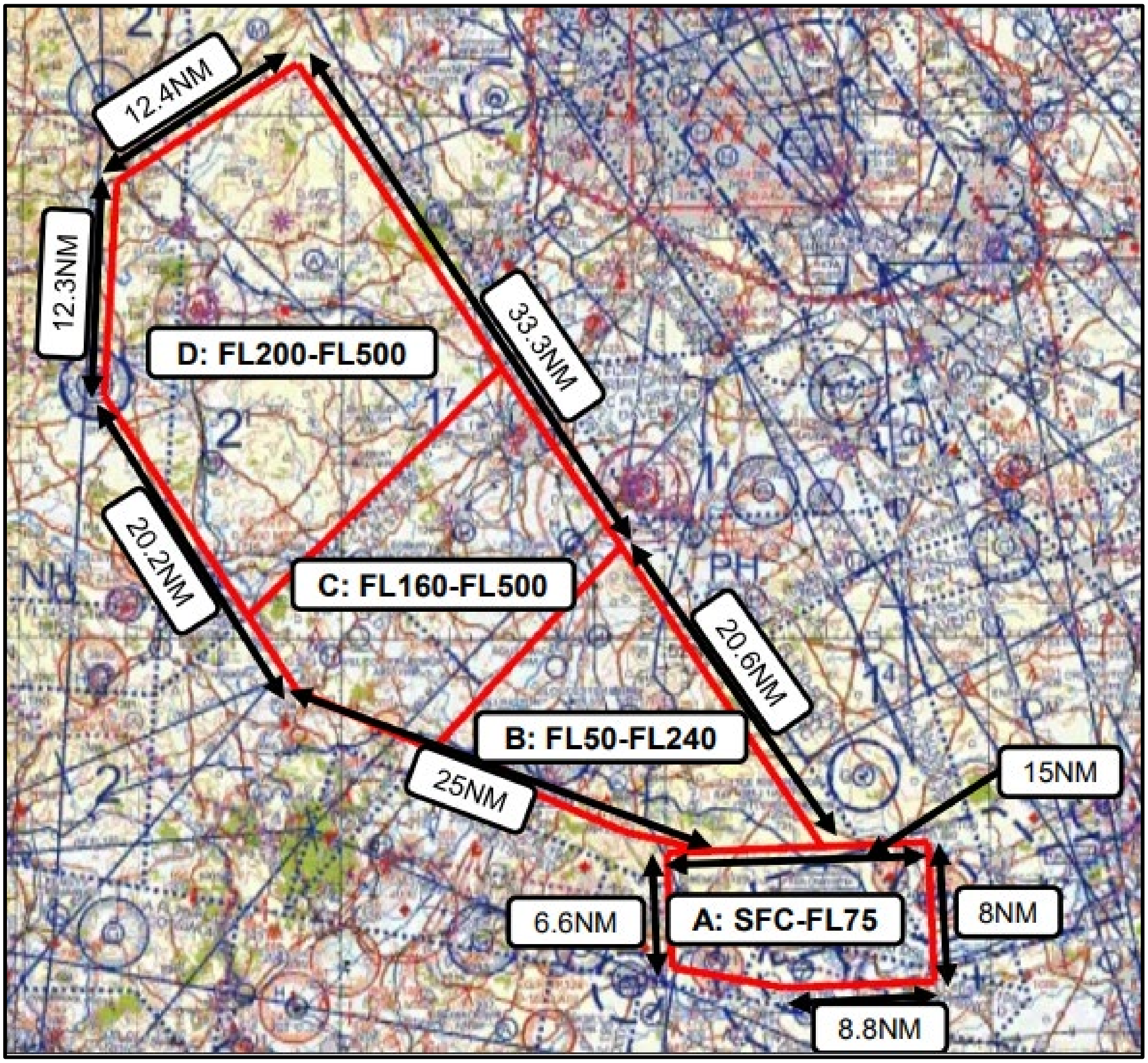
HALE Option 3 provides a volume of airspace that permits HALE RPA departure from RAF Fairford followed by a turn to the north within Segment A and transition to Segment B. After a climbing transition through Segment B, the HALE RPA continues its climb within Segments C and D to its high-level transition 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. 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, 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

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

required activations between 1 hour after sunset and 20:00 UTC or 05:30 UTC and 1 hour prior to sunrise will be in extremis and coordinated in advance.




HALE Option 3

## 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*<br>*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.<br><br>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. RPA will remain within segregated airspace at all times below FL500 until exiting UK airspace or landing at RAF Fairford. Based on engagement with the CAA, the Sponsor expects that HALE RPA transiting at or above FL500 will be assumed to be segregated by altitude. This will be formalised in an Operational Arrangement with the CAA.

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 significant. | Flight operations associated with the ACP would not be possible in a "do nothing" scenario and thus no capacity/resilience impacts would occur. |
| General Aviation | Access | Very minimal to no impacts to general aviation access are expected above the | Flight operations associated with the ACP would not be possible in a "do |

| | | | |
|---|---|---|---|
| | | 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. | 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 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 | Flight operations associated with the ACP would not be possible in a "do nothing" scenario and thus no change to fuel burn would occur. |

| | | | |
|---|---|---|---|
| | | around the proposed airspace, when active. | |
| Commercial airlines | Training costs | Not applicable | |
| Commercial airlines | Other costs | Not applicable | |
| Airport /ANSP | Infrastructure costs | Stakeholder 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 | Stakeholder 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 associated with this design. The Sponsor will share these costs as this information becomes available. | 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. |

**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 stakeholder engagement 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.

### 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 **9 Oct – 20 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 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.[5]
- 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.

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 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

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

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.[6]

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.

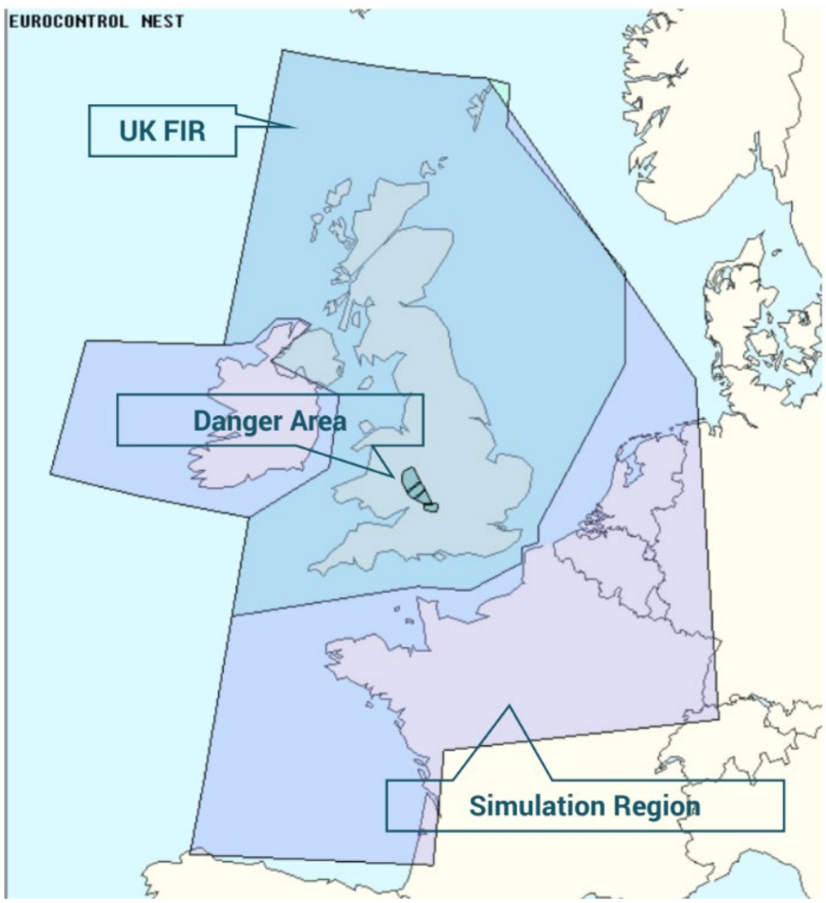



Fig 1 – Simulated Region

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

### 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.

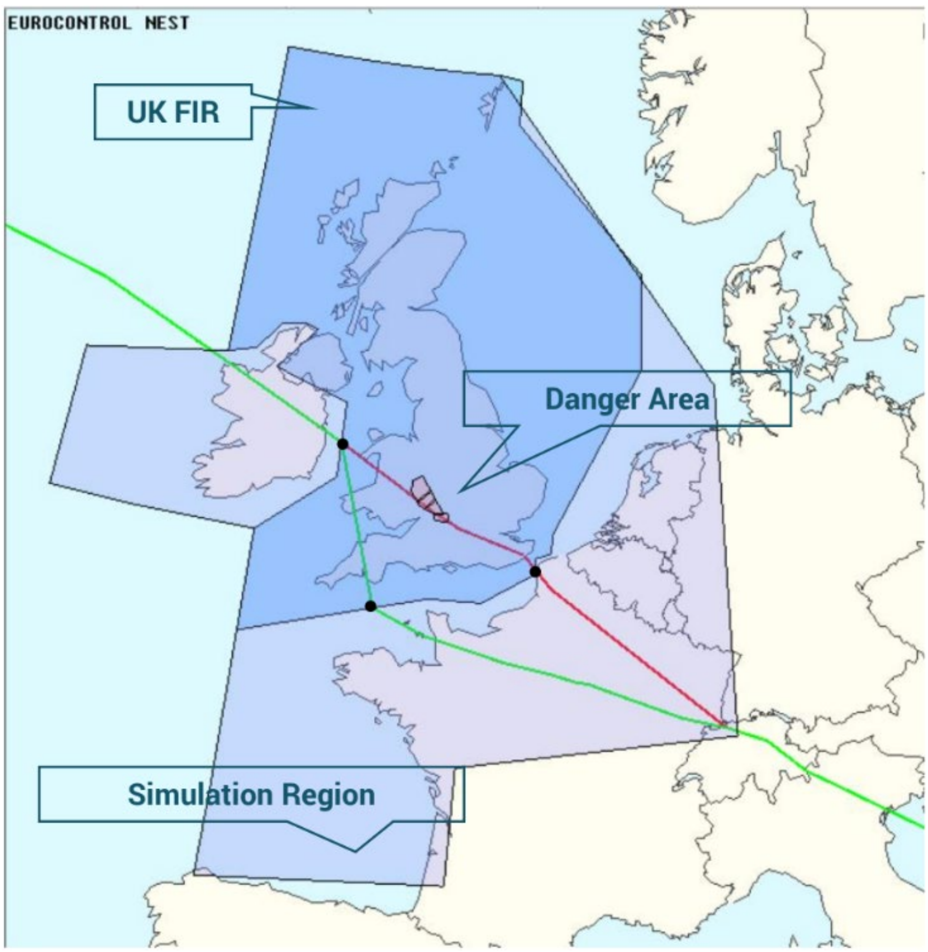



Fig 2 – Example Trajectory

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.

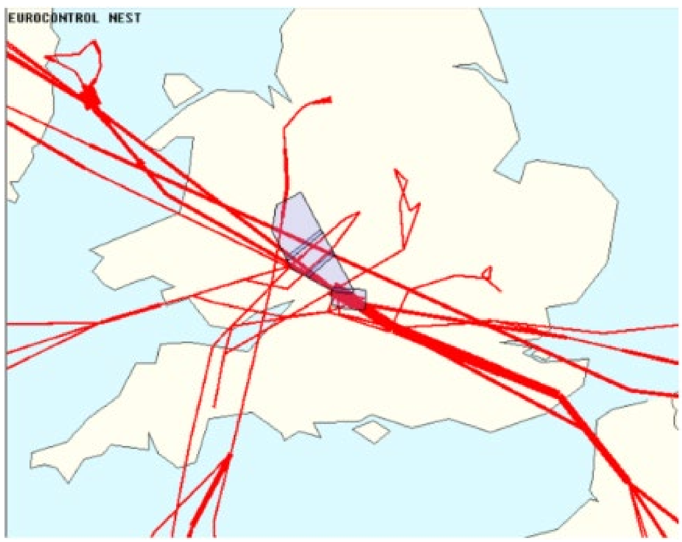



Fig 3 – Baseline Trajectories

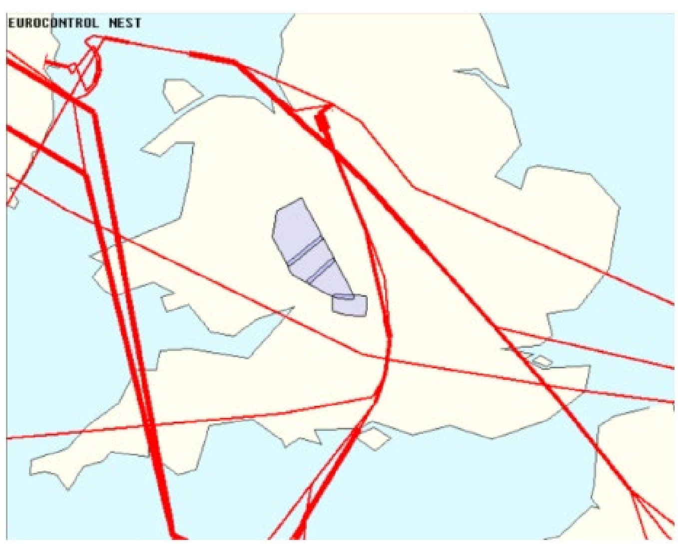



Fig 4 – Re-routed Trajectories when Danger Areas are active

### 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 distances, subsequently increasing the fuel burns and related emissions 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[7]. 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).

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

### 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 distances, subsequently increasing the fuel burns and related emissions 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 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 $CO_2$e emissions for years 2023 – 2034.

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 traffic forecasts are grown using the NATS March 2023 Base Case Forecast to estimate the maximum annual impacts from 2024 to 2034 (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) | $CO_2$e Emissions Impact (Tonnes) |
|---|---|---|---|---|---|---|---|---|
| 2023 | | 2,340 | 52,609 | 77,921 | 25,312 | 167,297 | 247,789 | 80,492 |
| 2024 | 5.7% | 2,473 | 55,599 | 82,349 | 26,750 | 176,805 | 261,870 | 85,065 |
| 2025 | 1.8% | 2,518 | 56,611 | 83,848 | 27,237 | 180,023 | 266,637 | 86,614 |
| 2026 | 1.4% | 2,553 | 57,398 | 85,013 | 27,615 | 182,526 | 270,341 | 87,815 |
| 2027 | 1.1% | 2,581 | 58,027 | 85,946 | 27,919 | 184,526 | 273,308 | 88,782 |
| 2028 | 1.2% | 2,612 | 58,724 | 86,978 | 28,254 | 186,742 | 276,590 | 89,848 |
| 2029 | 0.7% | 2,630 | 59,129 | 87,577 | 28,448 | 188,030 | 278,495 | 90,465 |
| 2030 | 0.7% | 2,648 | 59,533 | 88,177 | 28,644 | 189,315 | 280,403 | 91,088 |
| 2031 | 0.7% | 2,667 | 59,961 | 88,810 | 28,849 | 190,676 | 282,416 | 91,740 |
| 2032 | 0.7% | 2,686 | 60,388 | 89,442 | 29,054 | 192,034 | 284,426 | 92,392 |
| 2033 | 0.7% | 2,705 | 60,815 | 90,075 | 29,260 | 193,392 | 286,439 | 93,047 |
| 2034 | 0.7% | 2,724 | 61,242 | 90,708 | 29,466 | 194,750 | 288,451 | 93,701 |

## 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 2034 (10 years post deployment) and assumes a steady growth rate (GR) of 0.7% for 2029 and onwards.

| Year | Base Growth Flights | Base Growth Rate | Flights p/a in change area | Simulated Fuel Burn (T) | Simulated $CO_2$ (T) | Delta from baseline (fuel) | Delta from baseline ($CO_2$) | % flights $CO_2$ Traded | % flights non-traded | $CO_2$ traded (T) | $CO_2$ non traded (T) | Fuel Cost (GBP) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2023 | 2,340 | | 2,340 | 77,921 | 247,789 | 25,312 | 80,492 | 20% | 80% | 49,558 | 198,231 | £46,008,284 |
| 2024 | 2,473 | 5.7% | 2,473 | 82,349 | 261,870 | 26,750 | 85,065 | 20% | 80% | 52,416 | 209,454 | £48,622,787 |
| 2025 | 2,518 | 1.8% | 2,518 | 83,848 | 266,637 | 27,237 | 86,614 | 20% | 80% | 53,370 | 213,267 | £49,507,868 |
| 2026 | 2,553 | 1.4% | 2,553 | 85,013 | 270,341 | 27,615 | 87,815 | 20% | 80% | 54,111 | 216,230 | £50,195,740 |
| 2027 | 2,581 | 1.1% | 2,581 | 85,946 | 273,308 | 27,919 | 88,782 | 20% | 80% | 54,746 | 218,562 | £50,746,628 |
| 2028 | 2,612 | 1.2% | 2,612 | 86,978 | 276,590 | 28,254 | 89,848 | 20% | 80% | 55,382 | 221,208 | £51,355,970 |
| 2029 | 2,630 | 0.7% | 2,630 | 87,577 | 278,495 | 28,448 | 90,465 | 20% | 80% | 55,805 | 222,690 | £51,709,648 |
| 2030 | 2,648 | 0.7% | 2,648 | 88,177 | 280,403 | 28,644 | 91,088 | 20% | 80% | 56,229 | 224,174 | £52,063,917 |
| 2031 | 2,667 | 0.7% | 2,667 | 88,810 | 282,416 | 28,849 | 91,740 | 20% | 80% | 56,653 | 225,763 | £52,437,670 |
| 2032 | 2,686 | 0.7% | 2,686 | 89,442 | 284,426 | 29,054 | 92,392 | 20% | 80% | 57,076 | 227,350 | £52,810,833 |
| 2033 | 2,705 | 0.7% | 2,705 | 90,075 | 286,439 | 29,260 | 93,047 | 20% | 80% | 57,500 | 228,939 | £53,184,587 |
| 2034 | 2,724 | 0.7% | 2,724 | 90,708 | 288,451 | 29,466 | 93,701 | 20% | 80% | 57,923 | 230,528 | £53,558,340 |

| 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 | | |

## 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 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 Environmental Impact Assessment was completed, the Sponsor was able to agree to a stakeholder 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. The Sponsor intends to engage NATS to run another Environmental Assessment using the reduced activation window. This will be presented in Stage 4.

# 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 (£):** -£92,085,020

*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):** 990,557
(between 'with scheme' and 'without scheme' scenarios)

**Of which Traded** 198544.8155

**Change in carbon dioxide equivalent emissions in opening year (tonnes):** 85,065
(between 'with scheme' and 'without scheme' scenarios)

**Net Present Value of traded sector carbon dioxide equivalent emissions of proposal (£):** -£23,082,239
(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 | 69723.99552 |
| Non-traded sector | 0 | 0 | 0 | 278552.0045 |

**Qualitative Comments:**

**Sensitivity Analysis:**

Upper Estimate Net Present Value of Carbon dioxide Emissions of Proposal (£): -£138,127,530

Lower Estimate Net Present Value of Carbon dioxide Emissions of Proposal (£): -£46,042,510

**Data Sources:**