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STEP 3A OPTIONS APPRAISAL (PHASE II - FULL)

5 March 2024

78 pages

SPACE PORT 1

Administration Page

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Executive Summary

The main business demand for the Spaceport-1 (SP-1) facility is for the operation of sub-orbital sounding rockets. This Airspace Change Proposal (ACP) was de-scoped in September 2022 to remove the requirement for airspace to support orbital launch.

Under the terms of Civil Aviation Publication (CAP) 1616, the airspace change Sponsor is required to conduct an 'Options Appraisal Phase II – Full' as part of the ACP process Stage 3 Step 3A. During Stage 2, three airspace options were taken forward for the initial options appraisal and were rated in order of preference as follows:

- Option 3 - New fillet of airspace around launch site and use of existing Danger Areas D701;
- Option 5 in conjunction with Option 3[1] - Applying sub-divisions/reconfiguration of D701; and,
- Option 4 - Creation of a whole new bespoke modular airspace structure from the SP-1 site.

During stage 2 it was established that all three options had the same impact on local communities from a noise, environmental and biodiversity perspective, and similarly there was no difference between the options regarding the impact on other aviation activity below 7000ft. The main difference between options was the influence on transatlantic air traffic when routing westbound from UK airspace into the North Atlantic (NAT) oceanic airspace. With all three options having some impact on the NAT traffic, further evidence was required to establish the variance of the impact from each option to ascertain if there was any significant difference. This would then be tested against the expected cost of implementing each option, considering the magnitude of changes to air traffic control and Ministry of Defence (MOD) Range systems and procedures as well as aeronautical and navigation charts. Moreover, further investigation was needed to establish the frequency of flights affected over a 12 month period; this would be balanced against the frequency of expected launches (10) and associated 'backup days' per annum. This additional work and testing forms the basis for the full options appraisal contained within this document.

It is established that the benefits of Options 4 and 5 (associated with using less airspace for short-range rocket launch) are negligible. The EUROCONTROL provided data and analysis shows that despite Option 3 requiring more airspace and affecting more flights for short-range rocket launch when compared to Option 4 or 5, the additional 'affected' flights do not necessarily burn extra fuel. Moreover, the EUROCONTROL analysis further indicates that for long-range rocket launch the difference between the three Options, in terms of number of flights affected, is insignificant. Both of these findings are primarily due to the configuration of the D701 Danger Areas – the wider the north-south expansion of areas activated, the greater the impact on NAT traffic; expansion to the west has far less consequence. Furthermore, with pre-planned airspace closures, airline operators and air traffic service providers are often able to offer minor route changes many miles ahead of the affected area, potentially enabling the aircraft to re-route without flying any extra track miles.

Despite being unable to conduct a quantitative assessment of associated costs each change would induce (with regard to equipment and chart changes/associated training), it is concluded (through a simple qualitative assessment) that Option 3 is the most cost effective solution when all facets are taken into account. Option 5 is considered the next best option and Option 4 the least suitable option

[1] Option 5 in conjunction with Option 3 is hereafter referred to simply as 'Option 5' throughout this document for ease of understanding.

based on cost effectiveness and the potential to induce additional safety risk associated with two similar complex, yet separate, airspace designs being in the same volume of airspace.

When considering the impact Option 3 has on the transatlantic air traffic for a worst case long-range rocket launch scenario, 10 months of Automatic Dependent Surveillance – Broadcast (ADS-B) data for the region has been examined. It is evident from the analysis that there are significant variations in the daily number of flights potentially affected by the activation of the D701 areas; this daily variation is determined by the position of the Jetstream[2] and time of day. It can be determined that in a single year, the Jetstream favours the transatlantic air traffic to track westbound[3] over southern UK and Ireland more often than over Scotland and the D701 Danger Areas in the summer months, with this trend reversing in the winter months. More rocket launches are expected in the summer months due to weather factors. This means the westbound flow of air traffic routes through the D701 areas on average about once every two to three days. When this is factored against the maximum number of the days the D701 areas are likely to be activated in support of SP-1 rocket launch (circa 20 per year), it is evaluated that SP-1 rocket launches will only impact on the transatlantic traffic about 8-9 times a year. This impact is further reduced when short-range rockets are considered and fewer D701 areas are used thereby lessening the impact on transatlantic traffic.

Averaging the number of affected flights over the anticipated combination of short and long-range rocket launches, with an afternoon launch window, the total worst-case environmental impact is assessed to be circa 704.4 tonnes of extra CO_2 emissions over a 12-month period, based on 2019 traffic levels. When this figure is measured against the total CO_2 emission of a typical long haul flight across the Atlantic, it equates to an increase in CO_2 emissions of about 0.17%.

[2] The Jetstream are strong upper winds blowing from west to east that airline operators use to their advantage by flying along the direction of the Jetstream eastbound and avoiding flying onto the Jetstream when flying westbound. The NAT organised track structure is positioned to maximise the benefits and minimise the impact of the Jetstream.

[3] Eastbound flights are generally discounted as they predominantly occur after 0100-0900 UTC; this is a period when SP-1 will not be launching.

1. Introduction

1.1 Background

1.1.1 The document forms part of Stage 3 of the Airspace Change Proposal ACP-2021-12, which was commenced in July 2021 in order to establish segregated airspace to facilitate sub-orbital rocket launch from the Spaceport 1 (SP-1) launch site on the Outer Hebrides as shown in Figure 1. The SP-1 project, led by the local council Comhairle nan Eilean Siar (CnES), seeks to develop a vertical launch spaceport at Scolpaig, North Uist. The project is being pursued in support of key local economic development priorities and is strategically aligned with the UK Government's National Space Strategy which seeks to capture a greater share of the growing global space market and create additional jobs in the sector over the next decade. The provision of sub-orbital launch capability is a key component. QinetiQ is the airspace change Sponsor for this proposal, which seeks to secure suitable segregated airspace from surface level (SFC) to unlimited (UNLTD) for the safe operation (from launch to splashdown) of sub-orbital sounding rockets operating from the SP-1 launch site.

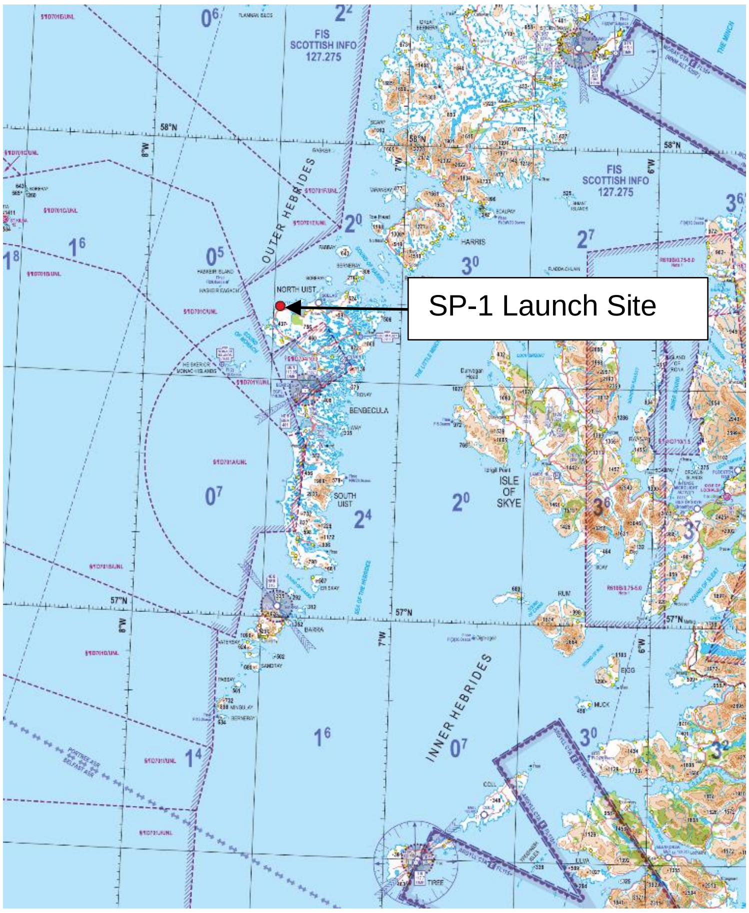

Figure 1: SP-1 Launch site location. (Source: CAA 1:500000 Chart)

1.2 CAP 1616 Full Options Appraisal Process Requirements

1.2.1 CAP 1616 Stage 3 Step 3A stipulates that the change Sponsor should carry out the second phase of the required three-phased options appraisal; namely 'Options Appraisal Phase II (Full)'. Following on from Phase I (Initial), in which several airspace options were developed and evaluated against the Design Principles (DP), the baseline 'do nothing option' and original Statement of Need (SoN), Phase II requires the Sponsor to develop more rigorous evidence for the options carried forward.

1.3 Aim

1.3.1 The aim of this document is to provide evidence to the CAA that the change Sponsor has adhered to the process laid out in CAP 1616 for Stage 3 prior to the 'Consult Gateway'. It builds upon the work undertaken during the Initial Options Appraisal in Stage 2 and forms part of the information required for the Stage 3 Consult.

2. Summary of Stage 2 Options Appraisal (Phase I – Initial)

2.1 Stage 2 Options Methodology

2.1.1 The Sponsor prepared a number of airspace design options upon which it invited feedback and comment from a wide range of stakeholders; this feedback incorporated a request to consider how each option was aligned to the DPs.

2.1.2 Six airspace options were presented including the baseline 'Do-Nothing' Option 0; this option was not considered viable for rocket launch as it does not provide any segregation – a critical element of the DPs and SoN. It is strongly argued that segregation of rockets is categorically essential in ensuring safety as these rockets are unable to comply with the Rules of The Air (RoTA), thereby increasing the risk of mid-air collision and, following catastrophic failure or flight termination, create a debris hazard to other aircraft. This Option remains the 'baseline' current day operation for the airspace. However, this option prevents the socio-economic benefits that SP-1 will provide as summarised at paragraph 3.10.1.

2.1.3 Option 1 required that temporary airspace be designed for each launch necessitating a unique bespoke airspace design driven by the individual rocket safety assessment and safety trace[4] analysis. Although this option utilised a smaller volume of airspace than the other options, it would require individual Notice To Aviation (NOTAM) and associated Aeronautical Information Publication (AIP) Supplement (SUPP) information to be created and published for each launch to enable segregation. Such one-off NOTAMs would not be fully integrated into the UK Airspace Management Cell (AMC) or EUROCONTROL Network Manager (ENM) Airspace Management (ASM) systems that enable the harmonised and dynamic planning of the ATM network. Furthermore, temporary airspace is not featured on navigation charts nor in Air Traffic Control (ATC) and Ministry of Defence (MOD) Hebrides Range surveillance systems. Instead, temporary airspace reservations have to be plotted using

[4] Safety Trace is the term given to the volume of airspace needed to contain all credible hazards, including the debris field created by any failure or subsequent destruction of the rocket that may pose a risk to third parties. This includes the failure of any of the vehicles' systems or components, as well as catastrophic system failure planned (in the case of a flight termination system) or unplanned.

dynamic mapping tools, inducing a higher probability of plotting error. This option was therefore discounted as it failed to meet several of the DPs based on these issues.

2.1.4 Option 2, (using EG D701[5], but with a bespoke temporary airspace design around the launch site), was similarly discounted on the same grounds, based on the fact that a temporary airspace solution around the launch site would be needed for each launch and, unlike Option 1, the volume of airspace utilised was no less than the other options presented. A summary of the proposed Options is contained in the table below [Table 1]

Option	Description	Notes
0 - Do nothing	No change to current airspace	Not viable for rocket launch.
1 - Do Minimum	Design and publish unique airspace design NOTAM & AIP SUPP information for every individual launch	Temporary NOTAMs not integrated into ASM systems.
2 - Do Minimum & Utilise D701	Design and publish unique airspace design NOTAM & AIP SUPP information for airspace around launch site	Temporary NOTAMs not integrated into ASM systems.
3 - New Fillet of Segregated Airspace around Launch Site and Utilise D701	New fillet would be an extension of D701 and activated in a similar fashion	Fully integrated into ASM systems; Utilise existing ASM processes and procedures.
4 - Construct New Bespoke Segregated Airspace Blocks From Launch Site	Design a new bespoke airspace complex from the launch site extending out over D701	Require new ASM processes and procedures; Area delineation may be an issue.
5 - Adding Sub-division of D701B, C, D, E, & F	Use in conjunction with either Options 2 & 3 – sub-divisions reduce the overall airspace volume in use within D701	May need additional ACP to change D701; Additional airspace made available would have limited use.

Table 1: Summary of airspace options presented during Stage 2

2.1.5 The feedback received during Stage 2 was limited to the main stakeholders namely, MOD, NATS and Highlands & Islands Airports Ltd (HIAL). The feedback included their view on whether the design option met the DPs; this information was used to help inform the DP evaluation and decision to consider three options in Step 2B. Two of the respondents, HIAL and MOD, suggested Option 3 as their preferred option based on the fact that this option largely uses an existing segregated airspace structure with well-established ASM processes and procedures. MOD proffered that they would support Option 5 (modification of the D701 areas) providing it was cost neutral to them and the benefits of such changes could be shown to be cost effective when all aspects were considered. All options require the new airspace 'fillet' of segregated airspace to connect the launch site to the existing D701 and D704 Danger Areas or bespoke airspace structure (for Option 4). NATS suggested Option 4 as the preferred option and challenged the fact several of the DPs made reference to the use of D701. The Sponsor acknowledged this observation and agreed that, by removing the reference to D701, at

[5] EG is the International Civil Aviation Organisation (ICAO) designator for the UK and D specifies Danger Area – EG D701 is abbreviated to D701 throughout this document.

least three of the DPs would enable Option 4 to meet the DP requirements. Option 4 was therefore considered along with the Option 3 and 5 and were taken forward to the Options Appraisal Phase I - Initial. All stakeholders agreed that the first three options (Option 0, 1 & 2) should be discounted as not meeting the DPs and/or SoN.

2.2 Shortlisted Options – Description and Rational for Order of Preference

2.2.1 All three options taken forward during the Options Appraisal at Step 2B of Stage 2 necessitate the same design and volume of airspace around the launch site (known herein as the ‘airspace fillet’) in addition to a small segregated area around the launch pad necessary to protect SP-1 ground personnel; see Figure 2. The dimensions of the fillet of airspace have been determined by safety analysis conducted by MOD Hebrides QinetiQ Range safety staff using exemplar modelling of worst case scenarios combined with their unique knowledge and experience of operating similar sub-orbital rocket systems on the MOD Hebrides Range (see Section 4.1). Such systems have been operated extensively in support of military exercises such as the At Sea Demonstration (ASD) and Formidable Shield (FS) large scale International ballistic missile training events.

2.2.2 It was during these exercises, when launching similar sub-orbital rockets from the MOD Hebrides Range, it was discovered that there was a risk to ground personnel conducting critical pre-launch activities, (such as arming/refuelling) from the sudden appearance of low flying aircraft, overhead. To prevent an unexpected distraction to such ground personnel, or potential High Frequency radio interference from low flying aircraft on the rocket systems, it is deemed necessary to have a small protection zone around the launch pad in the form of a Danger Area. This small additional Danger Area is centred on the launch pad and extends 1000m laterally from surface level to 3000ft above ground level (agl), (see Figure 2). This small Danger Area may be activated several days prior to the rocket launch to enable ground personnel to conduct ‘dry’ launch runs. The area may also need to be active for extended time periods (several hours) before launch. Feedback from stakeholders during Stage 2 of the ACP process indicated that this small additional Danger Area would have no impact on local aviation activities.

2.2.3 Beyond the immediate launch area (outside the fillet) the airspace requirements differ for each type of rocket being launched, associated payload and test requirements. As such no single block of airspace was considered appropriate and a modular design is promoted that enables different segments of airspace to be activated to provide the required protection from hazards arising from different individual sounding rockets. This is where the three Options differ.

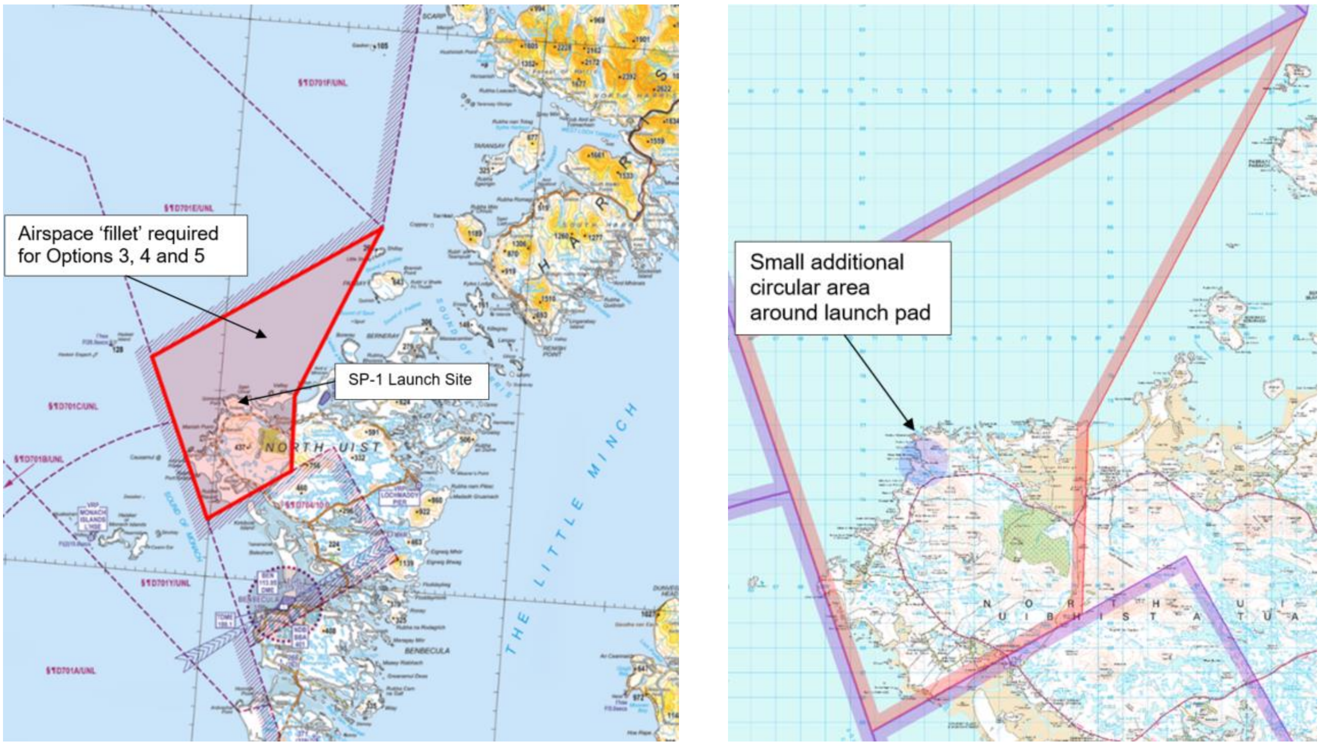

Figure 2: Airspace fillet around launch site and small additional segregated airspace volume around launch pad, both required for all three airspace options. (Source: CAA 1:250000 Chart and Ordnance Survey 1:50000 Map)

2.2.4 **Option 3 – New Fillet of Segregated Airspace around Launch Site and Utilise D701 (Preferred Option)** – This option includes the use of a new fillet of airspace around the launch site between D701 and D704 that could be activated by NOTAM in the same manner as D701 see Figure 3. This would provide a permanent airspace solution over the launch site and provide connectivity to the D701 Danger Areas. The D701 areas could be activated in the normal manner using only those areas necessary to contain the safety trace of the rocket being launched. Both the fillet of airspace and D701 would be fully integrated into the systems and processes employed by the UK AMC and the ENM, enabling the harmonised and dynamic planning of the ATM network. Furthermore, this option provides the most straightforward operation for Range staff as each different sounding rocket launch would be treated in exactly the same manner as any MOD weapon firing or test and evaluation event. The new fillet of airspace would be treated as an extension of D701 for ASM purposes, and the associated D701 areas would be activated as needed to meet the safety trace requirements of the vehicle being launched. Notification, activation and deactivation would follow existing procedures and Letters of Agreement (LoAs).

SPACE PORT 1

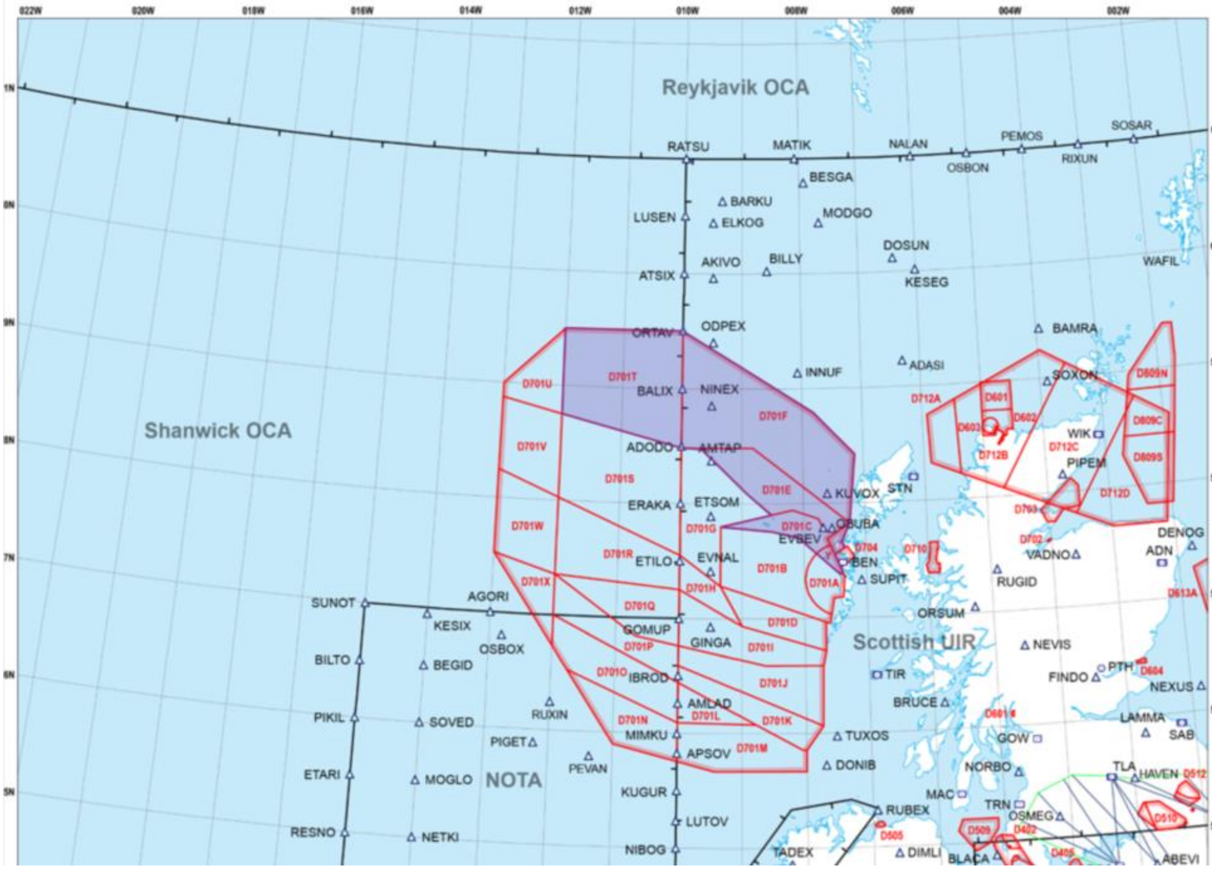

Figure 3: Option 3 - New airspace fillet and use of existing airspace structure D701 MOD Hebrides Range. D701 shaded areas shows an example of D701 areas need for an exemplar long-range sounding rocket. (Source: QinetiQ)

2.2.5 **Option 3 was considered the preferred option for the following reasons:**

- it meets the SoN;
- it meets the majority of the DPs and those it does not meet are partially met;
- it is the least costly option;
- it is the simplest to understand and implement; and,
- it is considered the safest option.

2.2.6 It is recognised that this option will, on occasions, result in more airspace being used than is absolutely necessary to contain the safety trace of the sounding rocket. However, this is not unusual when testing/operating embryonic systems within a modular airspace structure. It is considered that the benefits of utilising an existing airspace structure and associated operating procedures and processes, far outweigh the reduction in overall airspace the other two options may make available. This is particularly pertinent when considering the limited use of the airspace (10 launches[6] per year that probably equates (accounting for contingency days) to less than four airspace activations per month). Through careful planning and adoption of best practice currently in operation at the MOD Hebrides Range, the impact of these contingency days can be greatly reduced (as demonstrated in the ASD/FS exercises). Furthermore, the current airspace structure is well known to MOD Hebrides Range and ANSP staffs alike and is already fully integrated into the UK AMC and ENM ASM and flight planning systems (including Local And sub-Regional Airspace management support system (LARA)) – these will only require minor modifications to include the fillet of airspace around the launch site and rocket launch operations.

2.2.7 It is not possible to quantify these costs due to the number of different elements that will need to be changed and the different organisations responsible for those changes; furthermore, there are commercial sensitivities associated with revealing certain costs. The Sponsor has therefore been unable to gain any meaningful data to provide a quantitative assessment or monetise the costs associated with the changes detailed below (see also paragraph 3.11), thus a qualitative assessment is provided. Option 3 is considered the least costly option due to the following qualitative assessment:

- there is no requirement for 5 Letter Name Codes (5LNCs) being reserved with International Code And Route Designators (ICARD) – new reporting points – to allow circumnavigation the new airspace structure, as these are already in place and feature in existing flight planning system; so no updates[7] required;
- Flight Planning Buffer Zones (FBZs) are already in place for the D701 areas and any new FBZs will only be required for the small airspace 'fillet';
- only two reference points (associated with the 'fillet') will need to be ADQ validated;
- special instructions and associated training costs for ANSP and MOD Hebrides Range staff will be less than those for the other two options where significant airspace changes are made;
- only the small airspace 'fillet' will require integrating into LARA as all other areas already exist;
- ATC and MOD Hebrides Range system mapping will only require minor modifications to include the airspace 'fillet';
- only very minor updates to aeronautical and maritime charts; and,
- it is expected to be possible to make minor amendments to current LoAs, ASM processes or procedures rather than producing new standalone documents.

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[6] The conditions of the SP-1 site planning consent limited the number of launches to 10 per year.

[7] It is recognised that the new 'fillet' of airspace will need to be included in an update to systems but the change is very small in comparison with other options and it is considered no new 5LNCs will be required.

This option is considered the safest based on the fact it induces the minimum of change and adds little additional complexity to the existing airspace structure, unlike Option 4 and, to a lesser degree, Option 5.

2.2.8 **Option 5 (in Conjunction with Option 3) – Adding Sub-divisions to Selected D701 Areas (An Alternative to the Preferred Option)** – This option introduces a series of sub-divisions and/ or minor re-profiling of the existing D701 areas in order to reduce the overall volume of airspace unavailable to other airspace users when short-range rockets are launched. However, due to the immaturity of the sounding rocket systems it is not possible to determine the 'down range[8]' safety traces, therefore the optimum positioning of any sub-divisions are not yet known – this information is unlikely to be available until a rocket provider has committed to a launch and full collaboration with Range staff is exercised. Using the limited current knowledge and expectation of the smaller sounding rocket systems, the two solutions for Option 5 are depicted at Figure 4 below have been developed. The left hand diagram adds sub-divisions of the existing areas while the right hand diagram shows a modification to the internal boundaries of the inner areas. All three airspace options are further evaluated later on in this document; see paragraph 3.3.

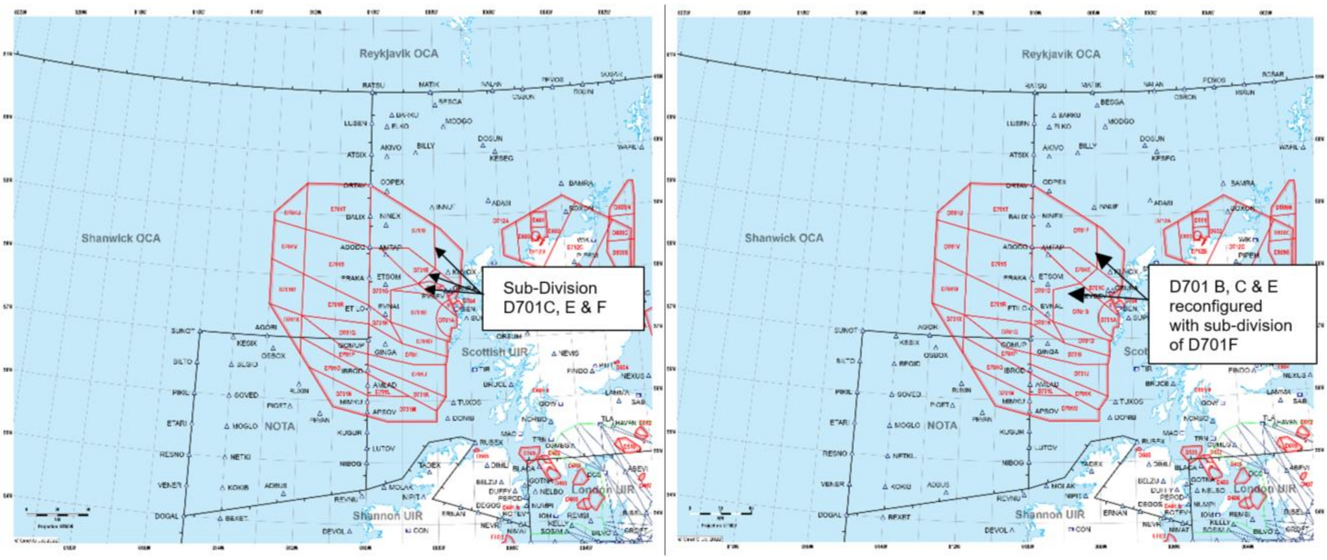

Figure 4: Option 5 adding sub-divisions/re-profiling selected D701 areas. (Source: QinetiQ)

[8] Down range is considered to be post launch when the rocket is in successful flight away from the spaceport.

2.2.9 Option 5 retains the external boundaries of D701 thereby removing the requirement for new additional reporting points and FBZs (other than around the airspace fillet). Furthermore, this option could use extant ASM processes and procedures, LoAs and other orders/instructions with minor modifications.

2.2.10 The main benefit of this option would be to reduce the overall volume of airspace that would need to be activated to contain the hazards associated with sub-orbital rocket launch where these are short-range; however, this reduction in volume of airspace needs to be balanced against expected use of available airspace when considering the number of launches each year and expected activation of airspace.

2.2.11 There will be a greater operational cost associated with this option compared to Option 3 although, this cost should be lower than for Option 4. It is not possible to quantify these costs due to the number of different elements that will need to be changed and the different organisations responsible for those changes; furthermore, there are commercial sensitivities associated with revealing certain costs. The Sponsor has therefore been unable to gain any meaningful data to provide a quantitative assessment or monetise the costs associated with the changes detailed below:

- additional FBZs around the new airspace fillet;
- several new reference points that determine the origin of each new line drawn to subdivide or reconfigure D701 will need to be ADQ validated;
- special instructions and associated training costs for ANSP and MOD Hebrides Range staff are increased slightly when compared with Option 3; however, these will be limited if extant ASM processes and procedures are utilised and amended to include SP-1 activities;
- minor changes to airspace mapping in LARA;
- minor changes and updates to ATC and MOD Hebrides Range systems mapping; and,
- minor updates to aeronautical and maritime charts.

2.2.12 **Option 4 – Construct New Bespoke Segregated Airspace Blocks from Launch Site (Least Preferred Option)** – As many of the sounding rockets have very limited pedigree, endeavouring to accurately predict the launch profiles, and, critically, the safety traces, is not feasible at this stage (so far in advance of the launch). Therefore, any attempt to design new airspace blocks introduces risk unless a large bespoke modular design is created. Any such large bespoke modular design for sounding rockets would have to extend in excess of 250km (135 NM) west north-west from the launch site and be constructed of several different airspace blocks to enable a process of tailored activation (similar to that currently used for D701) to be adopted. With experience gained from the ACP pertaining to the redesign of the D701 areas in 2014, it is expected any such modular design would have to be largely aligned to the existing boundaries of D701 to enable minimum disruption to traffic routing to/from the Oceanic Entry Points (OEPs) at 10° west. The modular design and alignment of the D701 Danger Areas may not always occupy the absolute minimum volume of airspace (with more airspace sometimes being activated than is absolutely necessary) however its alignment enables Commercial Air Traffic (CAT) to fly the shortest routes to/from the OEPs. Therefore, any additional unused airspace becomes largely irrelevant especially as this airspace is rarely used by anything other than CAT. For this reason, it is considered that any modular bespoke design would have to follow similar alignments to that of D701. The airspace would be fully integrated with the systems and processes employed by the UK AMC and the ENM enabling the harmonised and dynamic planning of the ATM network.

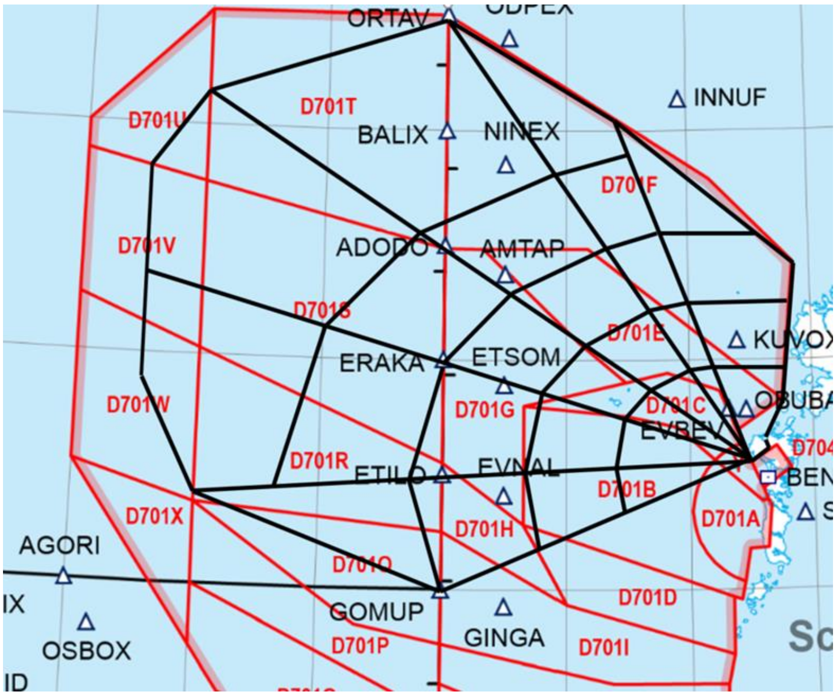

Figure 5: Option 4 shown in black outline[9] modular design overlaid with existing EG D701 Danger Areas. (Source: QinetiQ)

[9] The black line between GOMUP and AGORI is not part of the airspace design, this line depicts the northern edge of the airspace ceded to the Irish authorities.

2.2.13 Option 4 introduces an extremely complex airspace structure due to the presence of the existing D701 areas (see Figure 5) and there is concern the two could easily be confused as they are managed by the same organisations (MOD Hebrides Range staff and ANSPs). This would be particularly pertinent where new standalone ASM processes and procedures are developed and are operated in conjunction with existing procedures. Furthermore, both aeronautical and maritime charts would become complex; similarly the radar maps used by MOD Hebrides Range and ATC staff would need to be capable of displaying both structures clearly.

2.2.14 Option 4 is considered the most costly option due to the number and magnitude of the changes that would be required. However, it is not possible to quantify these costs due to the number of different elements that will need to be changed and the different organisations responsible for those changes; furthermore, there are commercial sensitivities associated with revealing certain costs. The Sponsor has therefore been unable to gain any meaningful data to provide a quantitative assessment or monetise the costs associated with the changes detailed below:

- requirement for 5LNCs being reserved with ICARD (new reporting points) to allow circumnavigation of the new airspace structure;
- introduction of a number FBZs around the new airspace structure depending upon which elements are activated;
- all new reference points for the origin of each line associated with this modular structure will need to be ADQ validated;
- special instructions and associated training costs for ANSP and MOD Hebrides Range staff are increased significantly when compared against the other two options due to the size of the airspace change and associated standalone new ASM processes and procedures;
- major update to mapping in LARA;
- significant updates to ATC and MOD Hebrides Range systems mapping;
- significant updates to aeronautical and maritime charts; and,
- development and agreement of wholly new LoAs along with the development of SP-1 specific ASM processes and procedures including orders/instructions to MOD Hebrides Range and ATC staff together with associated training costs.

3. Evidence to Support Options Appraisal Phase II (Full)

3.1 Local Air Traffic Analysis

3.1.1 To gain an understanding of the ‘current day’ operation in the local area of the proposed airspace fillet for SP-1, detailed traffic analysis was conducted during Stage 2 of the ACP process to ascertain the local traffic levels, in particular the number of flights below 7000ft. The summary findings indicate that the ‘baseline’ ‘current day’ volume of air traffic below 7000ft is extremely low, with the majority of flights being conducted by Loganair on their two to three daily scheduled operations to Benbecula Airport. Given the low traffic levels and small volume of airspace change, it is judged that this baseline will not change as a result of this ACP; further details and evidence to support this claim can be found at Section 3.9 and at Reference C.

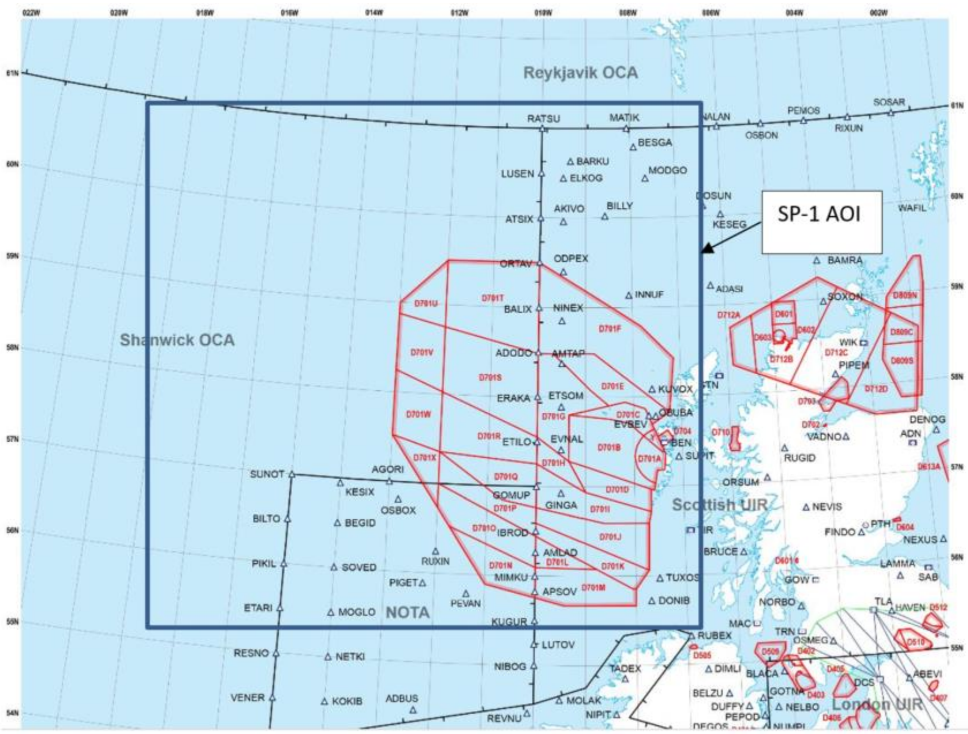

Figure 6: SP-1 AOI marked in dark blue outline. (Source: QinetiQ)

3.1.2 Considering aircraft operating above 7000ft, there is little or no activity to assess until the transatlantic traffic operating circa FL250 and above. Here the current day baseline has been assessed using Automatic Dependent Surveillance – Broadcast (ADS-B) data[10] for a 10 month period (Mar 2019 – Dec 2019), pre-COVID-19, for aircraft flying through the Area Of Interest (AOI)[11], see Figure 6. This was considered the most appropriate year to use where traffic levels were recorded at their highest, a figure the EUROCONTROL predictions suggest will not be reached again until the end of 2024/beginning of 2025. The vast majority[12] of air traffic operating in the North Atlantic (NAT) airspace is equipped with ADS-B, therefore it is considered that this data provides the most accurate assessment of aircraft movements to and from the oceanic areas.

3.2 NAT Air Traffic Analysis

3.2.1 The NAT Traffic analysis is divided into two distinct elements using different methods of assessment: the first element explores the different 'Traffic Impact Assessment' [3.3] the three options have on transatlantic air traffic. The main focus here is on the impact a short-range rocket launch may

[10] Provided by Spire Aviation September 2023.

[11] Air traffic data was evaluated for the prescribed AOI however, in order to provide a quantative assessment of the impact specific D701 Danger Area activation had on flight, the AOI was reduced to an area described in 3.5.1 (bounded by 56N, 60.5N, 14W and 6.5W).

[12] "Over 95 percent of the North Atlantic traffic is already ADS-B equipped" (Source: NATS press release: '*Aireon system goes live – trial operations begin over the North Atlantic marking new chapter in aviation history* ', dated 02 Apr 2019.

have when comparing Option 3 with Options 4 and 5, both of which use less airspace than Option 3 for short-range rocket launches (see paragraph 3.3). It is considered vital to understand whether the additional airspace made available by these two options actually provides any benefit in terms of reducing the additional track miles flown by aircraft needing to deviate off route (to avoid the activated areas), as both these options are more costly and complex to implement than Option 3. A similar comparison is also made between Option 3 and Option 4[13] with regard to a long-range rocket launch. This analysis has been conducted by EUROCONTROL using their sophisticated flight modelling and prediction tools for a single 'typical busy' day for flights[14] over Scotland. This assessment is purely used to understand if there are any differences in impact on NAT traffic between the three airspace options. It should be noted that the metrics used by EUROCONTROL may differ from those used by the UK CAA (the CAA prescribed metrics are used during the second element of the analysis, described below). Furthermore, the number of D701 areas activated differs between the two elements of analysis as does the start point for any flight deviation.

3.2.2 The second element of the analysis firstly ascertains the seasonal variation in NAT track position[15] [3.4] and then evidences the baseline current-day transatlantic air traffic flow in the SP-1 AOI. A 'Baseline Traffic Analysis – Worst Case Scenario Impact Assessment' [3.5] is made to understand the maximum number of potentially affected flights and extra track miles flown over a 12 month period. From this the indirect environmental impact assessment can be calculated; this is covered in paragraph 3.7. This second element of the analysis was conducted through the study of a vast amount of data where all flights crossing the AOI within specified time periods were considered over a 10 month period during 2019[16], as explained further in paragraph 3.6. Using this data and averaged for a 12 month period, the extra track miles flown was calculated through QinetiQ modelling. From this, using the most common single aircraft type crossing the AOI, the extra fuel burnt and associated CO_2 emissions has been calculated and this <u>forms the full options appraisal assessment of the indirect environmental impact presented in 3.7.</u>

3.3 Traffic Impact Assessment – Options Comparison EUROCONTROL Analysis

3.3.1 Using two different exemplar rocket profiles (short-range and long-range) EUROCONTROL were tasked with providing air traffic network impact data on the shortlisted options.

3.3.2 **Task aim:**

- to ascertain whether Option 5 (sub-dividing/re-profiling existing D701 areas) had any significant benefit (i.e. lower impact on NAT tracks) than using the existing D701 areas for short-range rocket launch. For completeness, Option 4 (bespoke new areas) was also tested; and,
- to ascertain whether there was any difference in the impact on NAT tracks when using Option 3 when compared with Option 4.

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[13] Option 5 is not considered for long-range rocket launch as it provides no additional benefit.

[14] These were actual flights with realistic fuel burn for each different aircraft type on the selected day.

[15] Comparison between the frequency of NAT westbound tracks over Scotland and southern UK/Ireland.

[16] 2019 is considered the peak period for air travel.

3.3.3 **Task method** – EUROCONTROL were provided with five different airspace scenarios against which to test the impact on NAT tracks; see Figure 8

3.3.4 Three of the scenarios used the airspace requirements for an exemplar short-range rocket launch while two scenarios used the airspace for an exemplar long-range rocket launch. EUROCONTROL considered a single day traffic sample on 11th January 2023 where there was a high level of westbound transatlantic air traffic routing through the Scottish Prestwick (EGPX[17]) airspace where the SP-1 AOI sits; this constitutes a worst case scenario. Two three hour time periods (potential launch windows 1000-1300 UTC and 1300-1600 UTC) were studied with the morning scenarios labelled ‘a’ and the afternoon scenarios labelled ‘b’:

- Scenario 1 – uses Option 5 (sub-division/re-profiling D701) for short-range rocket; Figure 9;
- Scenario 2 – uses Option 3 (utilisation of existing D701 areas) for short-range rocket; Figure 10;
- Scenario 3 – uses Option 4 (new bespoke design) for short-range rocket; Figure 11;
- Scenario 4 – uses Option 3 for long-range rocket; Figure 12 ;and,
- Scenario 5 – uses Option 4 for long-range rocket; Figure 13.

Note: Option 5 uses less airspace than Option 3 only in the case of short-range rocket launches therefore the traffic impact assessment for long-range rockets only compares Option 3 with Option 4.

3.3.5 The assessment objective, test criteria, and assumptions are summarised in Figure 7. The findings are contained in Table 2 and Figure 14.

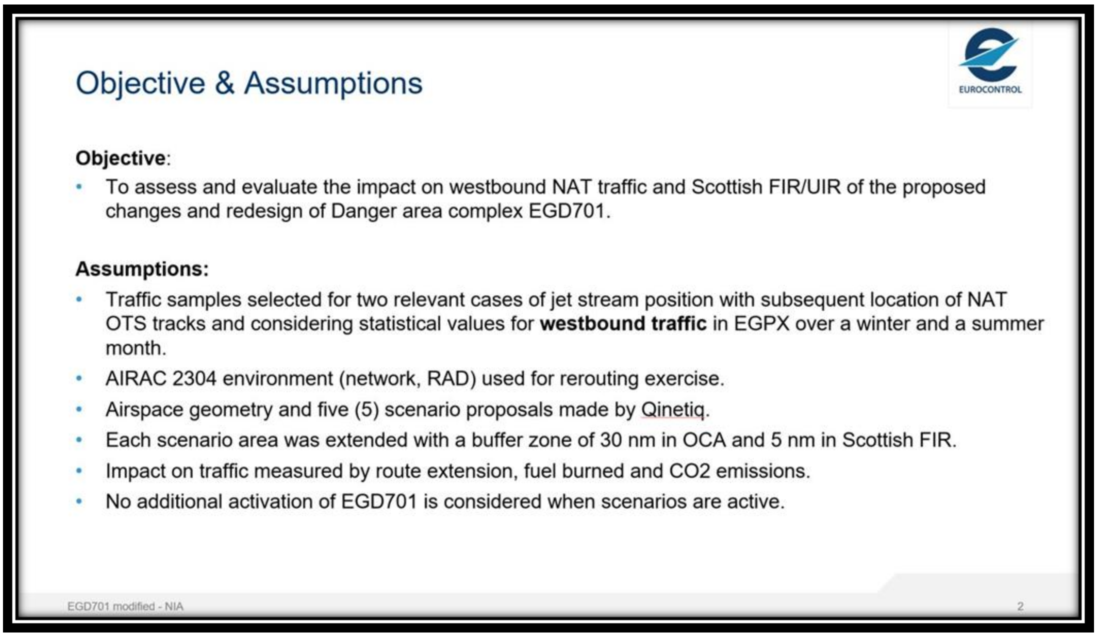

Figure 7: EUROCONTROL objectives and assumptions criteria used in their traffic impact analysis. (Source: EUROCONTROL)

[17] EGPX is the ICAO designator where ‘EG’ is the UK designator and PX the designator for Prestwick.

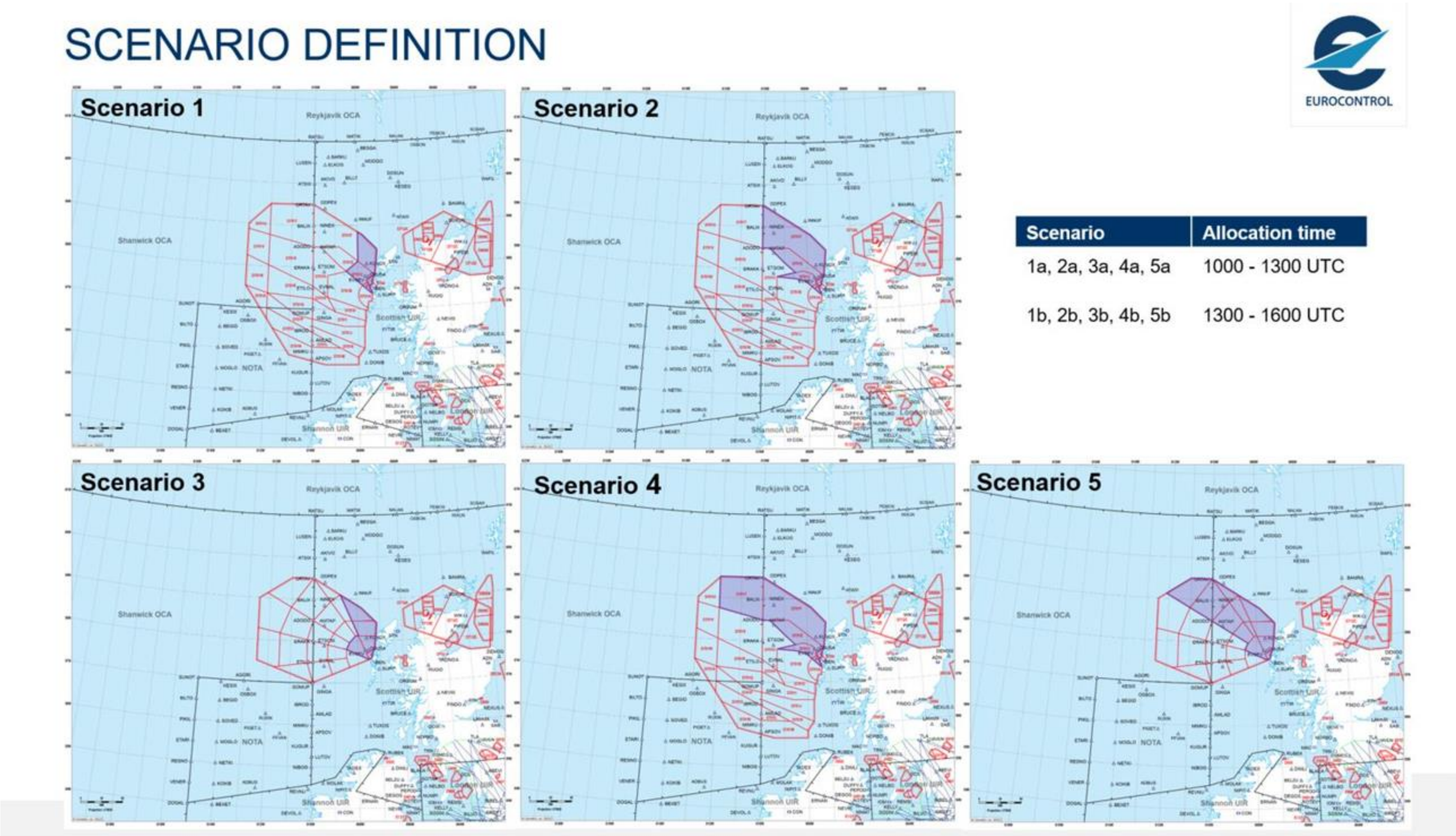

Figure 8: Five scenarios EUROCONTROL were tasked to evaluate for the two time periods indicated, where Scenario 1 is Option 5, Scenario 2 & 4 are Option 3 (for short and long-range rocket respectively) and Scenario 3 & 5 are Option 4 (for short and long-range rockets respectively). (Source: EUROCONTROL)

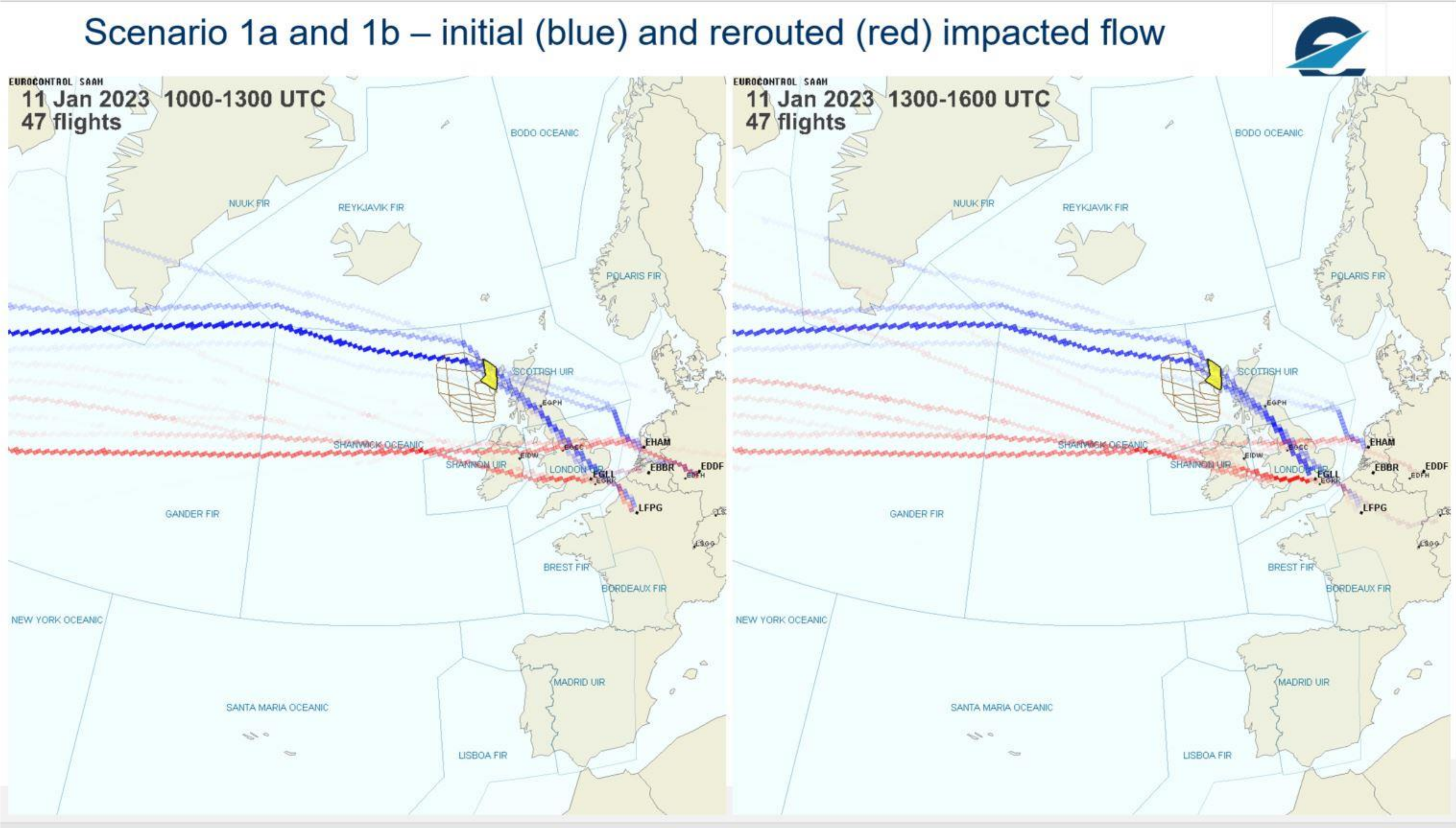

Figure 9: Scenario 1 (a & b) showing Option 5 (sub-divisions/re-profiling D701) traffic impact for short-range rocket launch. (Source EUROCONTROL)

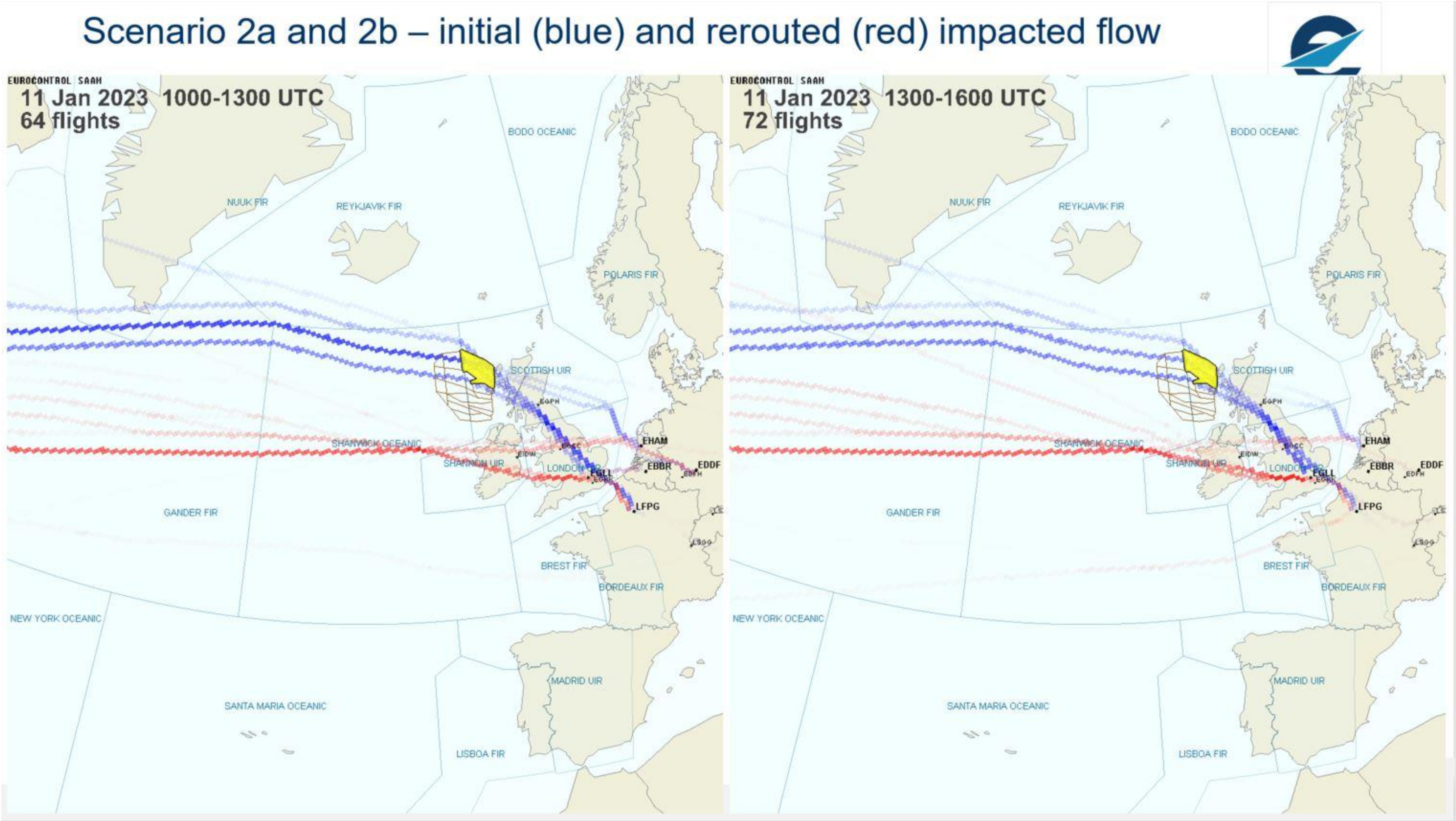

Figure 10: Scenario 2 (a & b) showing Option 3 (utilising existing D701 structure) traffic impact for short-range rocket launch. (Source: EUROCONTROL)

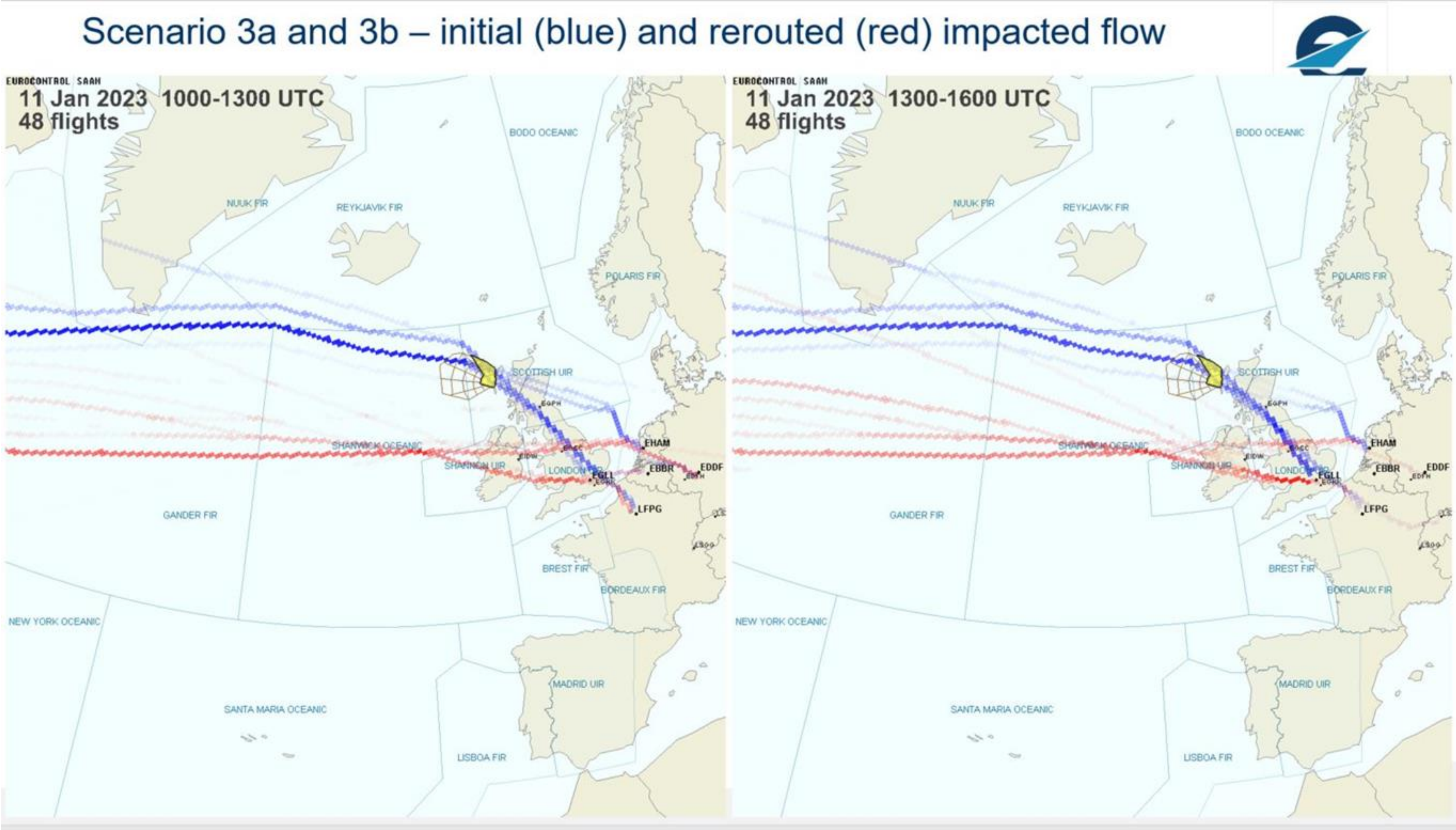

Figure 11: Scenario 1 (a & b) showing Option 4 (new bespoke design) traffic impact for short-range rocket launch. (Source: EUROCONTROL)

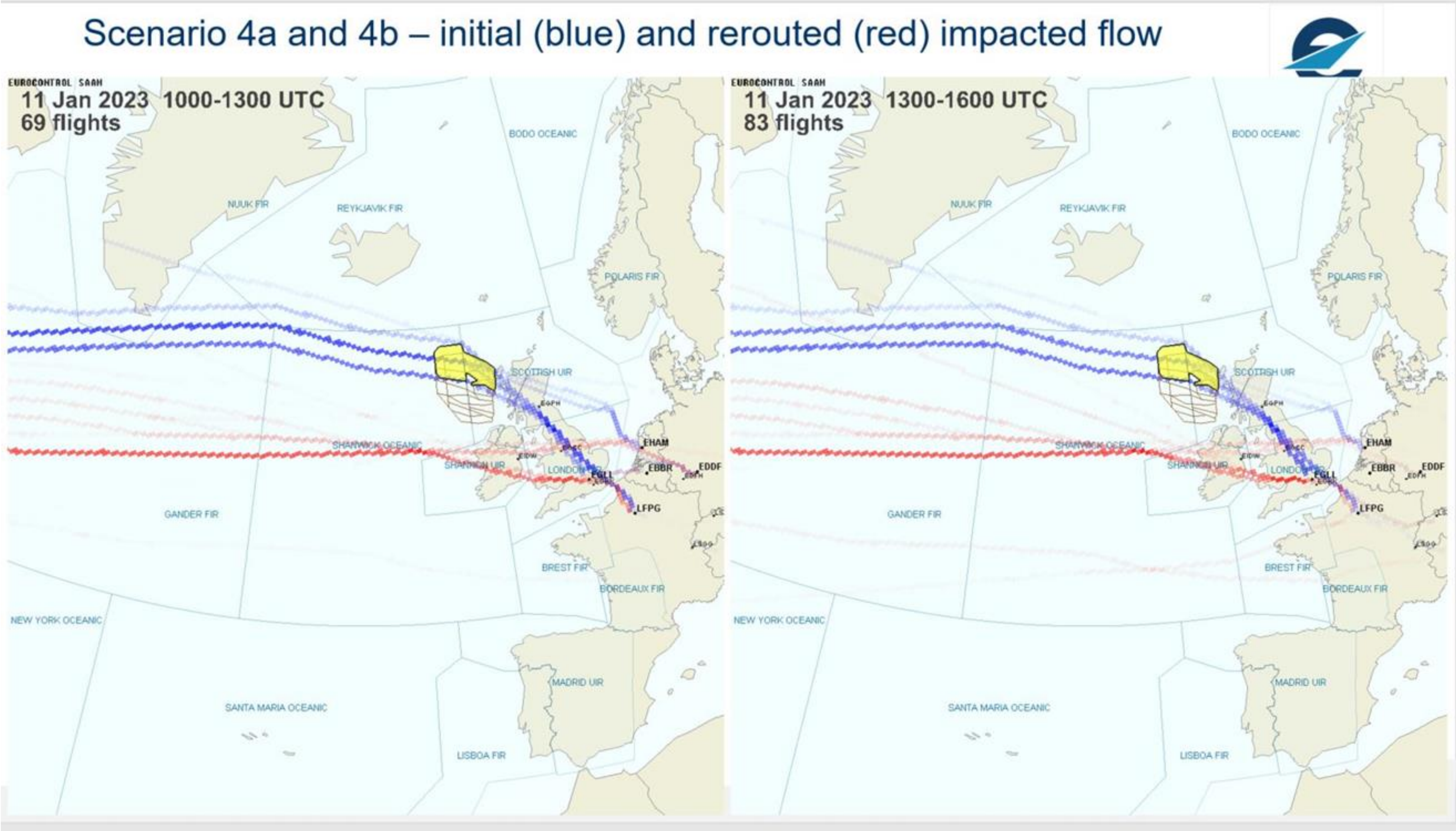

Figure 12: Scenario 4 (a & b) showing Option 3 traffic impact for long-range rocket launch. (Source: EUROCONTROL)

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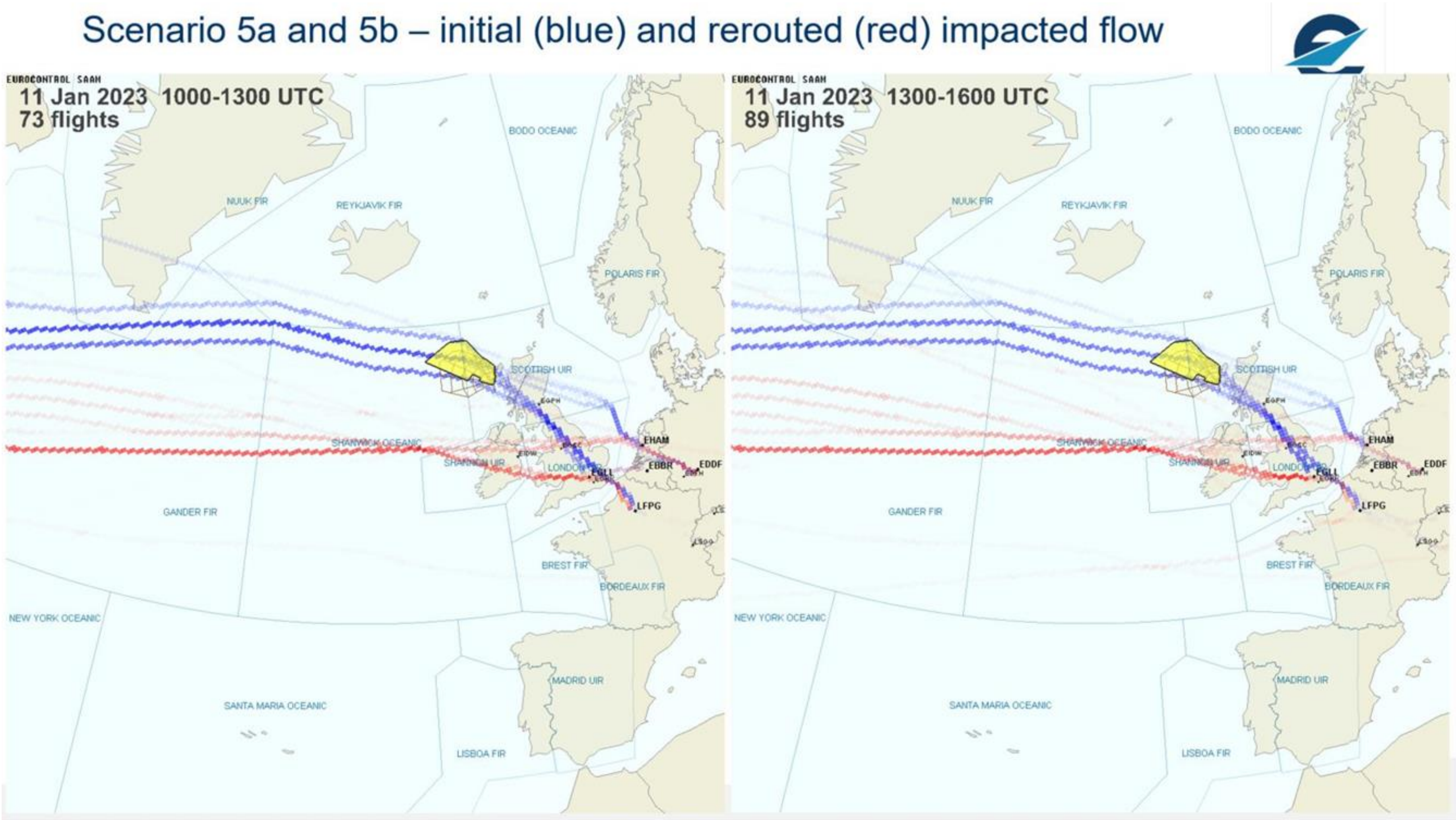

Figure 13: Scenario 5 (a & b) showing Option 4 traffic impact for a long-range rocket launch. (Source: EUROCONTROL)

3.3.6 EUROCONTROL findings – are contained in Table 2 below and show, against each scenario:

- the total number of flight passing through the AOI;
- the number of flights deviated around the SP-1 airspace activations and the total length of the deviations in NM; and,
- the actual number of flights that have to fly extra track miles with associated total extra fuel burn.

Scenario	Total number of flights	Length (NM)		Fuel (kg)	
		Nb flights	Total	Nb flights	Total
1a	**47**	45	1751.921	20	9992.51
1b	**47**	37	1007.908	12	6023.64
2a	**64**	45	1784.305	20	9992.51
2b	**72**	37	1007.908	12	6023.64
3a	**48**	46	1786.479	20	9992.51
3b	**48**	37	1007.908	12	6023.64
4a	**69**	45	1784.305	20	9992.51
4b	**83**	42	1435.055	16	8968.93
5a	**73**	49	2027.348	23	12401.91
5b	**89**	52	1880.241	19	11346.03

Table 2: Options comparison where Scenario 1 is Option 5 (for short-range rockets); Scenarios 2 & 4 are Option 3 (for short- and long-range rockets respectively) and Scenarios 3 & 5 are Option 4 (for short- and long-range rockets respectively). The 'a' against the scenario indicates time frame 1000-1300 & the 'b' indicates 1300-1600; all times UTC. (Source: EUROCONTROL)

3.3.7 Findings Evaluation – When comparing the scenarios for afternoon short-range rocket launches[18] – shown by the rows outlined in purple in Table 2 – it is evident that there is no difference in impact of the three Options. This verifies that, despite more flights being affected by utilisation of the

[18] The majority of rocket launches are expected to take place in the afternoon so they do not impact on the maximum number of OEPs that may be closed before 1400 UTC (one hour earlier in the summer) per annum, as agreed in MOD Hebrides Range LoA [E]. Furthermore, the time needed to complete all set up activities and procedures will normally preclude a morning launch.

existing D701 areas under Option 3 when compared to Option 4 and Option 5 as shown in Figure 9, Figure 10 & Figure 11, the extra track miles flown by those additional affected flights is insignificant in terms of extra fuel burn (in particular for the afternoon[19] time period). This is further reinforced by the EUROCONTROL findings shown in Figure 14. It is also evident that due to the configuration of the D701 Danger Areas – the wider the north-south expansion of areas activated, the greater the impact on NAT traffic; expansion to the west has far less consequence. This appears to be a significant factor as to why the three airspace options have a very similar impact on NAT traffic despite using dissimilar volumes of airspace.

3.3.8 For long-range afternoon rocket launches, it seems that Option 4 (in Scenario 5) gives a slightly greater impact than Option 3 (In Scenario 4).

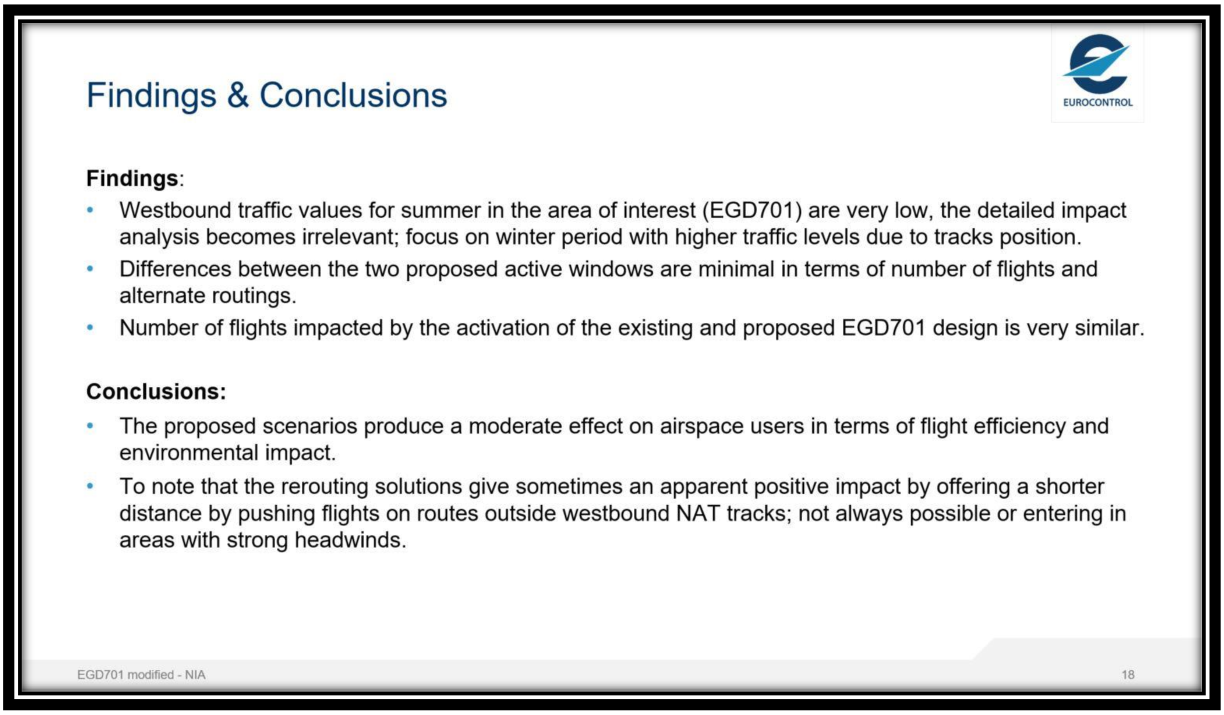

Figure 14: EUROCONTROL task, summary of findings and conclusions. (Source: EUROCONTROL)

3.4 Understanding Daily Variations in NAT Organised Track Structure

3.4.1 In order to evaluate the potential impact SP-1 rocket launch is likely to have on the ATM network it is important to note that activation of D701 may, on some days, have little or no impact on the NAT

[19] It is considered unlikely that there will be any morning long-range rocket launches pre-1300 UTC; short-range rockets may be launched prior to 1300 UTC but only where the D701 areas used do not impact on the OEPs.

air traffic. This is due to the positioning of the NAT Organised Track Structure (OTS) that determines[20] the routes for aircraft crossing the NAT and is influenced by the position of the Jetstream. Two examples of the NAT OTS are shown in Figure 15 where the Jetstream is favouring a westbound[21] flow out over Scotland and Figure 16 where the westbound flow is now out over Ireland and southern UK.

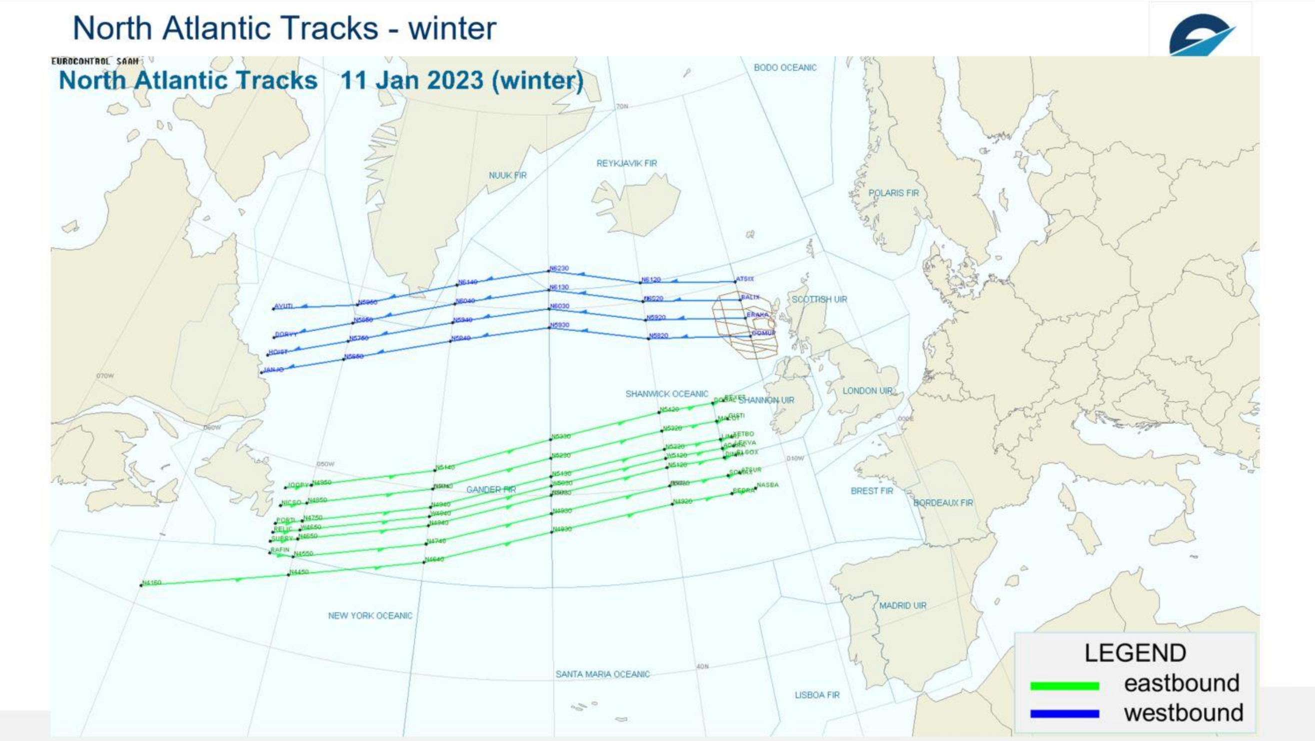

Figure 15: NAT OTS where the Jetstream favours the westbound flow of air traffic out over Scotland with the eastbound flow routing over Ireland and the southern UK. (Source: EUROCONTROL)

[20] It is recognised that the NAT OTS may be removed in the future as technology improves and aircraft are able to route more directly point to point. However, there is insufficient data currently available to accurately predict what impact the D701 areas will have on air traffic flying point to point across the NAT.

[21] The eastbound flow of air traffic is not considered in the analysis as it occurs during the night, generally during the period 0100-0800 UTC; a period where there will not be any rocket launches.

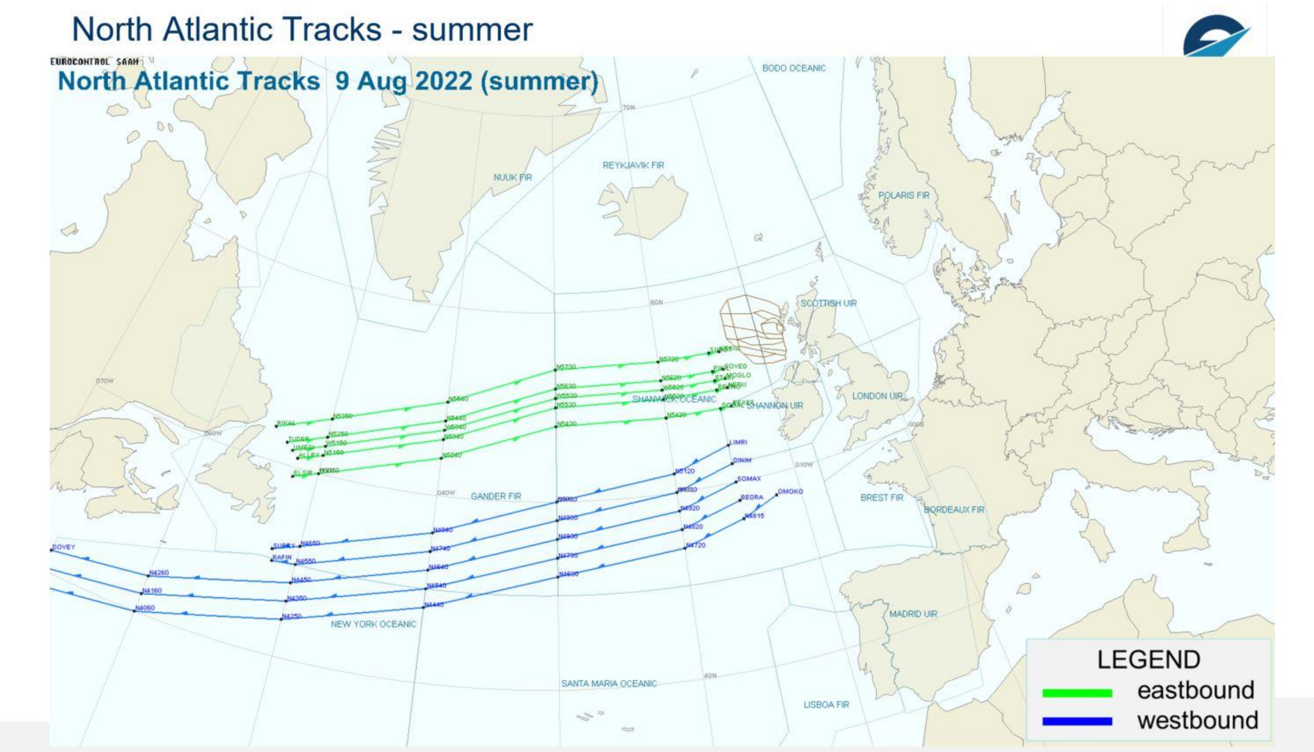

Figure 16: NAT OTS where the Jetstream favours a westbound flow out over southern UK and Ireland. (Source: EUROCONTROL)

3.4.2 It is considered important to understand how often the Jetstream favours westbound transatlantic traffic through the SP-1 AOI and any seasonal variations. QinetiQ previously captured 12 month's published data for the NAT OTS for 2018 and this was used to identify trends. Although the loading of individual tracks is not known, it is evident that the more tracks created, the higher was the demand.

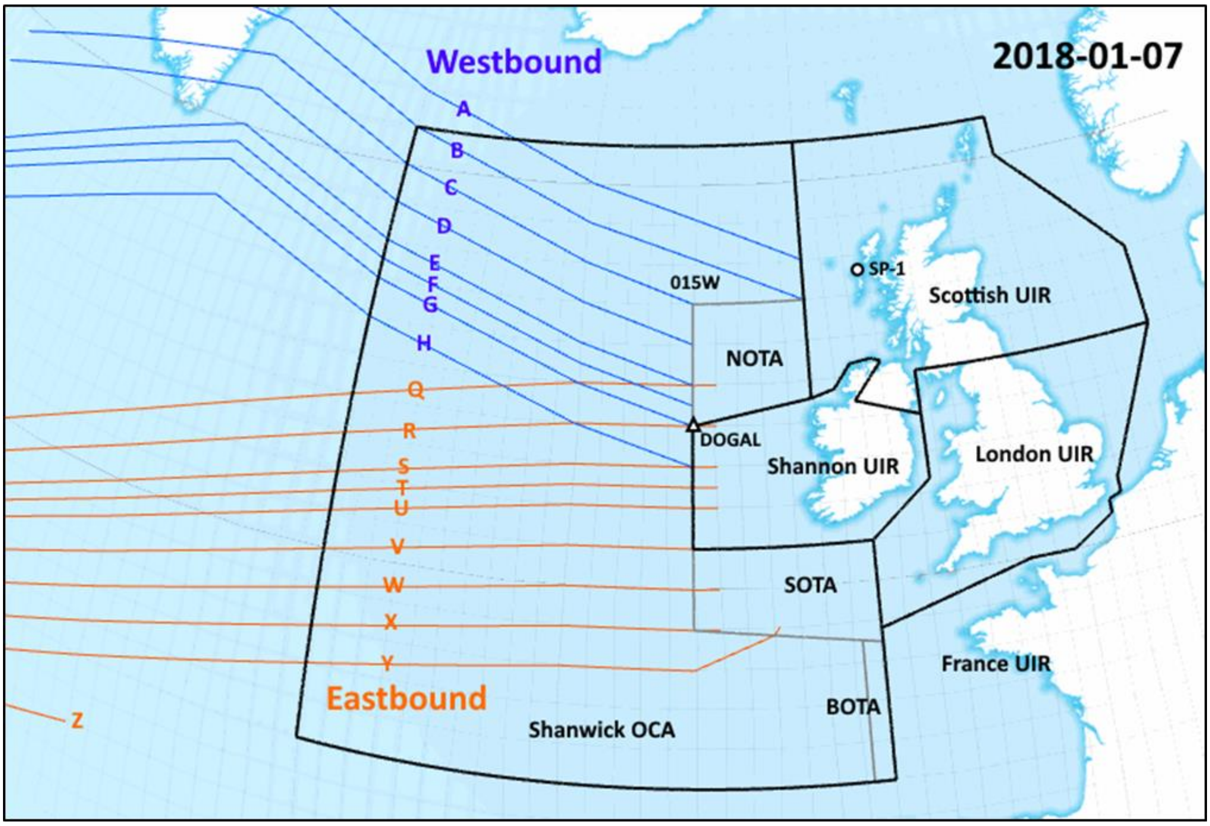

Figure 17: Example of NAT OTS 17 Jan 2018 – Westbound tendency is 6 – 2 = +4, for eastbound tendency is 1 – 8 = -7. (Source: QinetiQ)

3.4.3 For each track on each day, it was determined where it intersected the 15º west meridian and the latitude was noted (tracks whose east most extremity was west of this meridian were excluded from the analysis). Tracks which pass 015º west, north of OEP DOGAL ('north gate'), were classified as 'northerly tracks'; tracks which pass 015º west at DOGAL or further south ('south gate'), were classified as 'southerly tracks'. Separately for each day's set of eastbound and westbound tracks the 'tendency' was determined as the number of northerly tracks minus the number of southerly tracks (see the example day in Figure 17) . This measure is shown through the year: for westbound tracks in Figure 18; and for eastbound tracks in Figure 19.

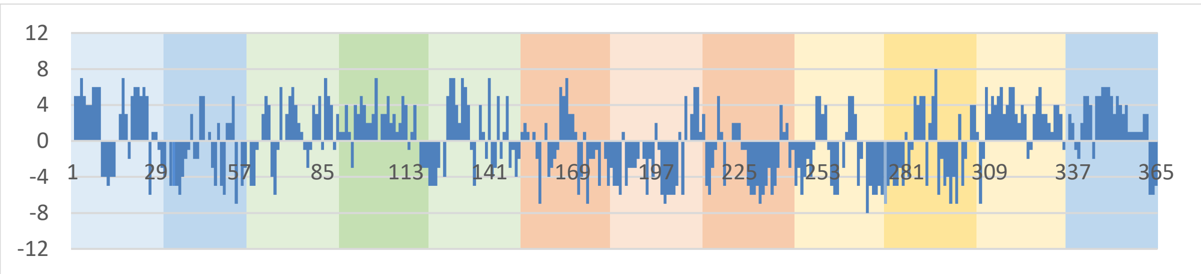

Figure 18: Tendency' of westbound tracks for each day of 2018.

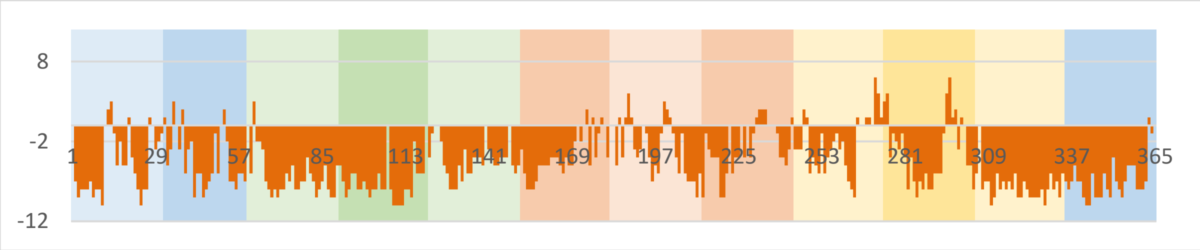

Figure 19: Tendency' of eastbound tracks for each day of 2018.

Key to Figure 18 and Figure 19:

- where the histogram is above the horizontal axis, this indicates that more of those tracks pass through the north-gate than the south-gate – for the purpose of study this was designated a 'northerly disposition';
- where the histogram is below the horizontal axis, this indicates that more of those tracks pass through the south-gate than the north-gate – this was designated a 'southerly disposition'; and,
- where the histogram is zero, this indicates that as many tracks pass through the north-gate as through the south-gate – this was designated an 'indeterminate disposition'.

To analyse seasonal trends, May–Oct was considered as 'summer' and Jan–Apr & Nov–Dec as 'winter'. The seasonal disposition of the westbound and eastbound tracks is tabulated below:

	Westbound						Eastbound					
disposition	summer		winter		annual		summer		winter		annual	
northerly	62	(34%)	117	(65%)	179	(49%)	30	(16%)	10	(6%)	40	(11%)
indeterminate	11	(6%)	9	(5%)	20	(6%)	90	(10%)	8	(4%)	27	(7%)
southerly	110	(60%)	53	(30%)	163	(45%)	134	(73%)	161	(90%)	295	(81%)
total	183	(100%)	179	(100%)	362	(100%)	183	(100%)	179	(100%)	362	(100%)

Table 3: Seasonal disposition of westbound and eastbound tracks in 2018.

3.4.4 Analysis findings

Eastbound – During 2018 eastbound tracks had a northerly disposition on only 40 days. There was a slight tendency for northerly disposition to be more common in the summer but this has a low statistical significance (i.e. could easily be no more than a fluctuation resulting from chance). Over the year, the ratio of southerly to northerly disposition was 7.4 to 1.

Westbound – During 2018 the split between northerly disposition and southerly disposition shows strong seasonal variation (with a high level of statistical significance), and actually switches between summer and winter:

- on a summer day a southerly disposition was 1.8× more likely than a northerly disposition;
- on a winter day a northerly disposition was 2.2× more likely than a southerly disposition.

3.4.5 While considering these findings, it is concluded that during the summer months the probability of a rocket launch airspace activation occurring when the Jetstream favours a northerly NAT OTS is circa 37% of the time (using the summer % number and half the indeterminate figure of 6%). If it is assumed that there will be more launches in the summer months than winter month due to weather limitations, meaning circa 6 launches in the summer vs. circa 4 launches in the winter; when combined with backup days and airspace activations, this equates to 12 activations in the summer and 8 activations in the winter. 37% of 12 airspace activations equates to 4.5 activations impacting on the NAT OTS. For the winter months the 6 activations will impact the NAT OTS 68% of the time that equates to circa 4 days. Therefore, the analysis to determine the environmental impact caused by aircraft re-routing from their optimum NAT OTS will consider **a total of 9 days of airspace activations per annum** (rounded up to present a slightly more worst case scenario).

3.5 Baseline Traffic Analysis – Worst Case Scenario Impact Assessment

3.5.1 In order to provide a more quantitative assessment of the effect of D701 Danger Area activations on NAT traffic, ADS-B data for 2019[22] was procured[23]; this is considered **the baseline**. To facilitate the processing of large quantities of data a more constrained AOI was defined (bounded by 56º north, 60.5º north, 14º west and 6.5º west) and a time window of 1000–2000 UTC was imposed on each day.

3.5.2 The typical form of the data is illustrated in Figure 20 which shows all the plots collected in March 2019. Points to note are that the tracks pass through ‘choke points’ at 10º west corresponding to the OEPs at whole number (and to a lesser extent half-number) degrees of latitude. For the purpose of analysis each individual flight can be characterised as two great-circle segments, with a change of heading as the aircraft crosses 10º west.

3.5.3 Inspection of the data revealed that coverage was incomplete (i.e. did not fully extend to 10º west) for the first seven weeks of the year and that there was no data for two days in March – this left good coverage for 310 days which were used in the analysis.

3.5.4 Individual plots were formed into tracks for each day on the basis of ICAO 24-bit aircraft address and timing (the latter used to form two separate tracks for those individual aircraft that crossed the AOI in both directions on a given day). Tracks were filtered to provide a ‘clean’ dataset of transatlantic flights – the dataset consisted of those tracks: that were above FL195 and crossed 10º west within the time window; and were more than 5 minutes duration (anomalously short tracks – less than 5 minutes duration or shorter than 10NM – were removed).

3.5.5 The numbers of the various aircraft types in the dataset (310 days) are summarised as aggregated types in Table 4. Note that two-thirds of Atlantic traffic is accounted for by the top four aggregated types: Boeing 777 (B777) variants, Boeing 787 (B787) variants, Airbus 330 (A330) variants, and Boeing 767 (B767) variants; the B777 was the most common aircraft type.

3.5.6 These numbers are considered the ‘baseline’ current day situation because, following the impact of the COVID-19 pandemic, today’s traffic volume (2023/24) is still only just recovering to 2019 level (see paragraph 3.8).

[22] 2019 air traffic data was used as a reasonable comparison of air traffic levels expected in 2024 using EUROCONTROL data (see para 3.8)

[23] Provided by Spire Aviation, see https://aviation-docs.spire.com/api/tracking-history/output/

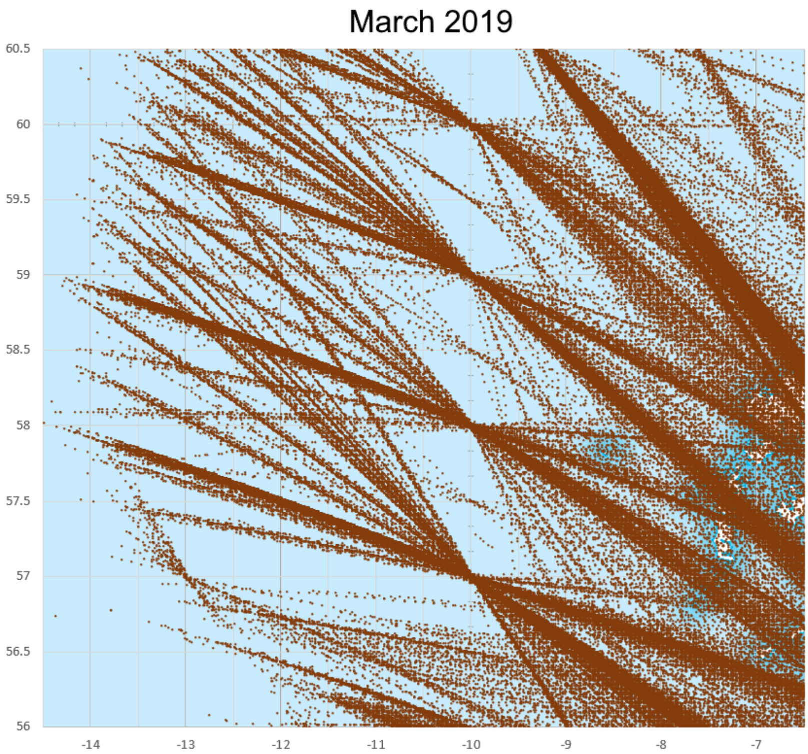

Figure 20: Chart of ADS-B plots within the constrained AOI for all days in March 2019. (Source: Spire Aviation)

Aggregated type	*ICAO type designators[24]*	*no. of flights*	*propn.*
Boeing B777	*B772, B773, B77L, B77W*	*9741*	*20.8%*
Boeing B787	*B788, B789, B78X*	*7948*	*17.0%*
Airbus A330	*A332, A333*	*7433*	*15.9%*
Boeing B767	*B762, B763, B764*	*6145*	*13.1%*
Boeing B747	*B744, B748, B74S, BLCF*	*4737*	*10.1%*
Boeing B757	*B752, B753*	*3220*	*6.9%*
Airbus A380	*A388*	*1489*	*3.2%*
Airbus A340	*A342, A343, A345, A346*	*1458*	*3.1%*
Airbus A350	*A359, A35K*	*921*	*2.0%*
Gulfstream	*ASTR, G150, G280, GA5C, GA6C, GALX, GLF3, GLF4, GLF5, GLF6*	*735*	*1.6%*
Airbus A320	*A20N, A21N, A318, A319, A320, A321*	*684*	*1.5%*
Boeing B737	*B38M, B733, B734, B735, B737, B738, B739, P8*	*517*	*1.1%*
Bombardier	*GL5T, GL7T, GLEX*	*504*	*1.1%*
Dassault Falcon	*F2TH, F900, FA20, FA50, FA7X, FA8X*	*325*	*0.7%*
	subtotal	*45857*	*97.7%*
other		*1086*	*2.3%*
	total	*46943*	*100%*

Table 4: Most frequent aircraft, by type, crossing the NAT.

[24] See www.icao.int/publications/DOC8643/Pages/Search.aspx

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3.5.7 To understand the impact Option 3 (preferred Option) will have on the ATM network, it is necessary to establish the actual number of aircraft crossing the D701 Danger Areas when considering both long-range and short-range rocket launch. This is achieved by observing the number of flights that cross the AOI during the period 1300 UTC to 1600 UTC on one of the busiest periods of the year. This figure is then multiplied by 9 (see paragraph 3.4.5 above) to provide the total number of flights potentially affected in a 12 month period. A summary of assumptions used during the analysis is as follows:

- rocket launch will occur 1300-1600 UTC;
- traffic analysis considers the maximum number of flights affected (using the busiest day of the year in the SP-1 AOI);
- there will be a maximum of 9 airspace activations per year that impact on the NAT OTS;
- long-range rocket launch will account for 6 activations and short-range rockets 3 activations per year;
- D701 areas A, B, C, E, F, G, S, T & Y are activated for long-range rockets;
- D701 Areas Y, C, E & F activated for short-range rocket launches;
- ANSP applies a 30 NM buffer (separation criteria) to D701 areas west of 10º west and 5 NM to areas east of 10º west;
- assessment of additional track miles flown (due to D701 activation) assume the deviation does not commence before the Scottish Flight Information Region (FIR) and takes no account of pre-tactical[25] rerouting (the modelling of the tracks affected by the activation of the Danger Areas and the rerouted tracks is illustrated in Figure 21 and Figure 22 respectively);
- average flight deviation 22.8 km per flight[26]; and,
- fuel consumption is based on the average fuel burn of the most frequent[27] aircraft types crossing the North Atlantic (B777 all variants).

[25] Pre-tactical routing is where flight plans are adjusted more than a day in advance to take account of the D701 airspace restrictions, such pre-tactical planning can often prevent any additional track miles being flown.

[26] The traffic analysis of the 2019 data sample (described in paragraph 3.6 below) found a total of 8309 flights crossed the AOI between 1300 and 1600 UTC. The average modelled deviation was 12.3 NM = 22.8 km.

[27] Analysis presented in Table 4 above shows the B777 accounted for over 20% of NAT traffic.

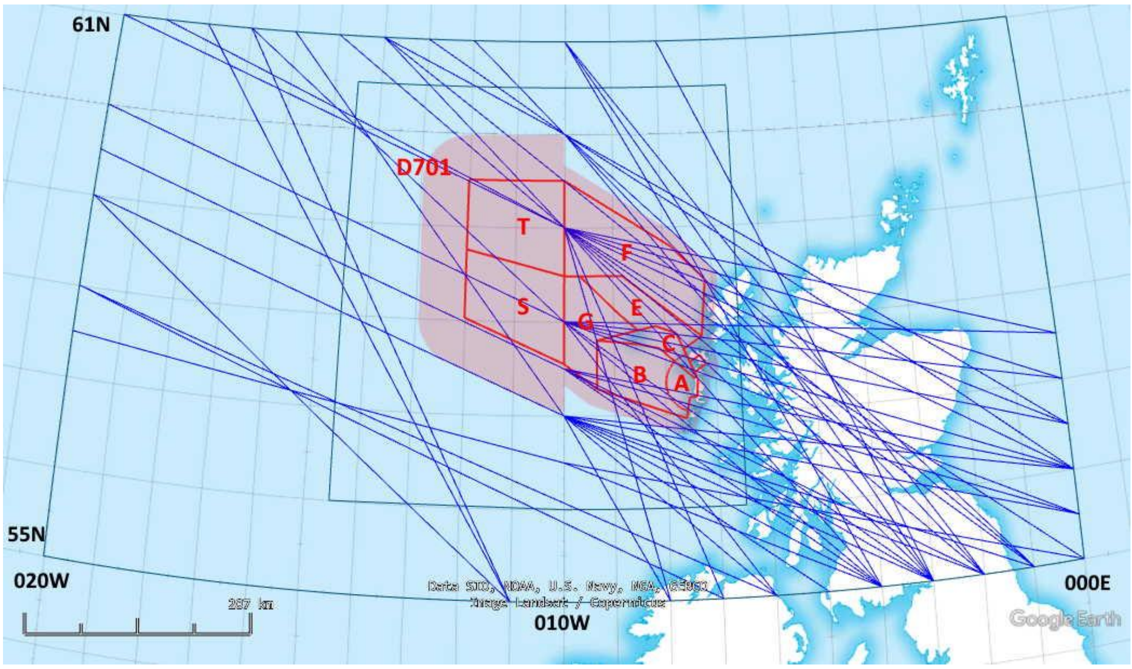

Figure 21: Chart of modelled tracks affected by activation of danger areas 1300-1600 UTC on 29 Sep 2019. (Source QinetiQ)

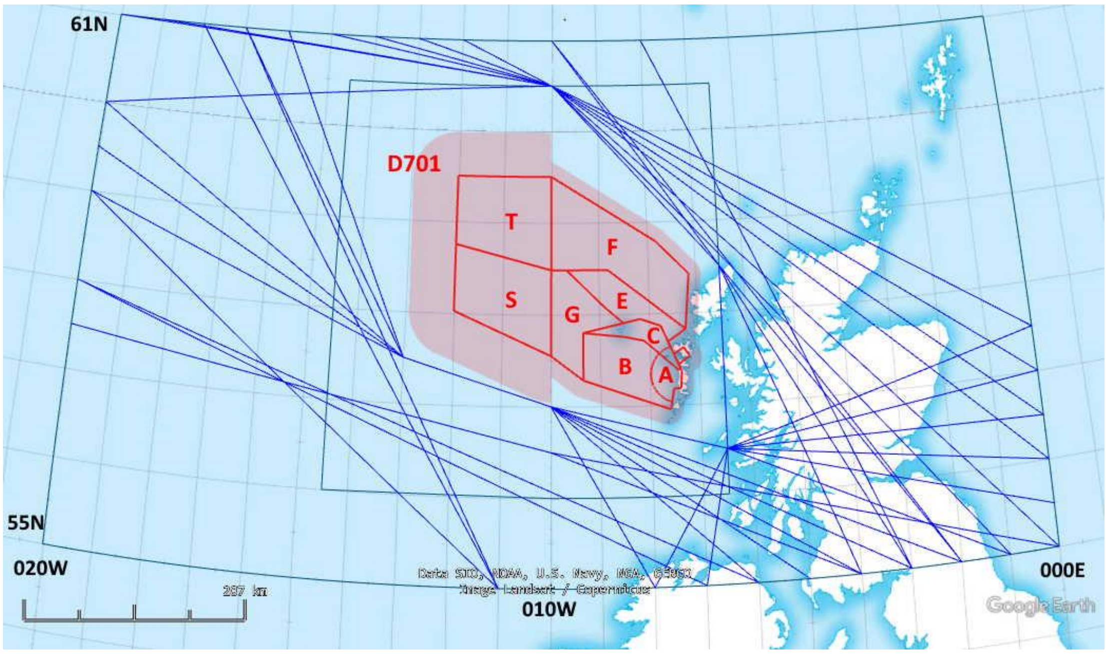

Figure 22: Chart of rerouted tracks (Note: more than one aircraft may have flown each of the routes shown). (Source: QinetiQ)

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3.6 Traffic Analysis – Data Sample

3.6.1 During 2019 a total of 8309 flights were observed to cross the SP-1 AOI during the period 1300-1600 UTC. The busiest day was 29th September that saw 380 flights cross the AOI during 1000-2000 UTC (main westbound flow). For the period 1300-1600 UTC the D701[28] areas needed for a long-range rocket launch would affect 133 flights resulting in a total of 1635.9 NM (3029.7 km[29]) extra flown. For the same period the D701 areas required for a short-range rocket would affected 71 flights resulting in a total of 873.3 NM (1617.4 km) extra flown. From the data analysis the following conclusions are made:

- using the assumption that from the 9 airspace activations per year, 6 are for long-range rockets and 3 are for short-range rockets; this equates to a total of 1011 flights[30] affected per year;
- if the affected flights make their track deviation at the Scottish FIR boundary, the extra distance flown by each flight is circa 22.8 km [31];
- in a year 23,051 km[32] extra will be flown as a result of D701 activation for SP-1 rocket launch; and,
- analysis of the main aircraft types crossing the NAT (see Table 4) shows that the B777 is the most common aircraft and using ICAOs Carbon Emissions Calculator[33] the average fuel burn is at a rate of 9.61kg per km flown.

3.7 Annual Re-route, Fuel Burn and CO_2 Impact Calculations

3.7.1 The Department for Transport's Transport Analysis Guidance (TAG) was identified in the Stage 2 'Initial Options Appraisal' as evidence to be collected for the 'Full Options Appraisal' at Stage 3. However, the Sponsor elected to use the detailed analysis obtained from QinetiQ modelling to establish the potential extra fuel burn and expected additional CO_2 emissions for a 12 month period. It is considered that this analysis provides sufficient detail to satisfy the CAP 1616 requirements and the use of TAG is therefore not necessary.

3.7.2 Using the total annual extra track distance of 23,051 km flown to deviate around the active D701 areas, it can be seen that when multiplied by the average fuel burnt by a B777 per km flown, the extra fuel burnt in a year is circa 221,520kg (221.5 tonnes).

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[28] This includes the ANSP buffers as prescribed in paragraph 3.5.7.

[29] Using the metric that 1 NM = 1.852 km.

[30] Calculation (6×133) + (3×71) = 1011 flights affected.

[31] This figure is derived from the modelling illustrated in Figures 21 and 22 above. For simplicity the assumption is made that the same deviation in track miles is required for both long and short-range rockets.

[32] 1011 flights × 22.8 km.

[33] ICAO Carbon Emissions Calculator (ICEC).

3.7.3 Using the metric[34] that one tonne of aviation fuel burnt produces 3.18 tonnes of CO_2 emissions means the total increase in CO_2 emissions is circa 704.4 tonnes per year. While this figure may appear high, it should be read in conjunction with the fuel burnt for a 'typical' long haul transatlantic flight. Examination of a single actual flight that crossed the AOI, a B777-300ER operating as Emirates flight EK211 (Dubai to Houston) on 2nd May 2019, the flight track is circa 13,243 km. This means the flight burns 127,265.2 kg of fuel or 127.3 tonnes; this results in 404.8 tonnes of CO_2. Therefore the extra fuel burnt and CO_2 emissions caused by the flight deviating around the active D701 areas (22.8 km) equates to about 0.17%[35] of the flight's total fuel burn and emissions. This could be considered as insignificant.

3.8 10-Year Forecast Traffic Levels – CAT

3.8.1 This forecast is based on the EUROCONTROL traffic forecast update for Europe 2023-2029, as shown in Figure 23, and extrapolating the 'Base scenario' shown in blue out to 2035 (10 years post expected airspace implementation). On that basis, it is forecast that the percentage growth in traffic is circa +2% until 2027, thereafter it reduces to +1% annually; this is considered to be the most accurate assessment of future traffic levels available.

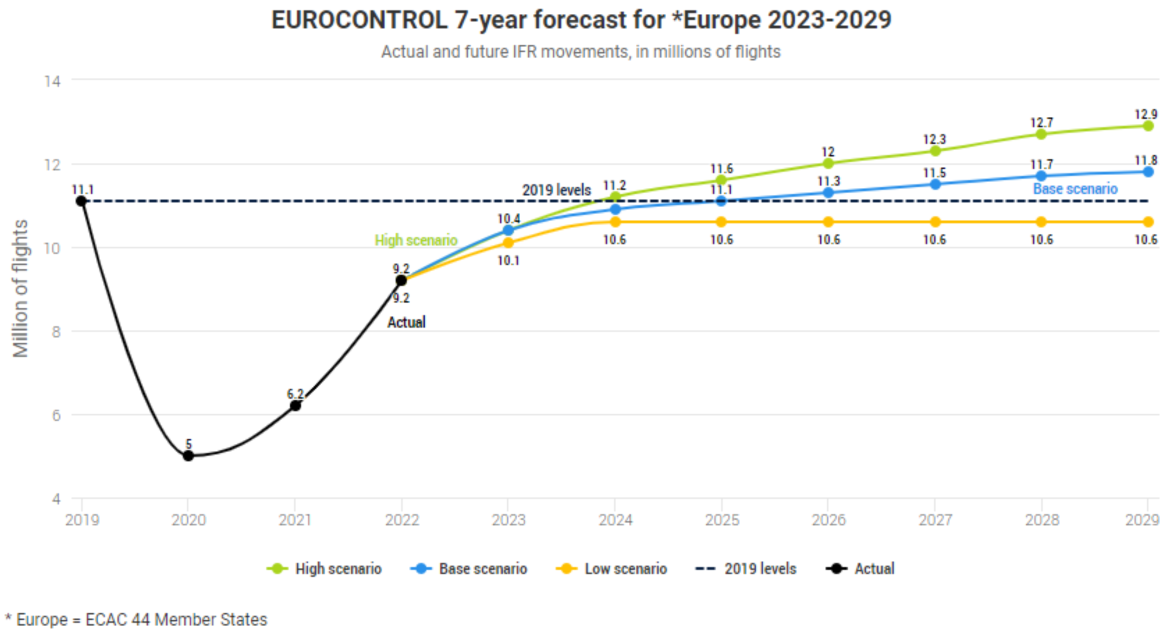

Figure 23: EUROCONTROL 7-year forecast for traffic levels. (Source: EUROCONTROL)

3.8.2 Using the EUROCONTROL predictions, it is reasonable to assume that the number of affected flights as a result of this airspace change could increase from 1011 (as derived in paragraph 3.6.1) to 1152 flights (using the above growth rate) in 10 years' time[36]. Assuming a proportionate increase in

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[34] American Society for Testing and Materials (ASTM) D1655, ASTM, 2015.

[35] 22.8(km) x 9.61(kg/km) = 219.11 kg extra fuel burnt which equates to 0.1722% of the 127,265.2 kg burnt for the total flight.

[36] Assuming ACP implemented in 2025.

fuel burn and CO_2 emissions, this suggests that the additional annual CO_2 emissions arising from this ACP would have risen to 802.7 tonnes[37] by 2035. However, this does not take into account the development and introduction of more environmentally friendly aero engines and the use of bio-fuels, both of which will reduce the carbon footprint for aviation.

3.9 Estimated Impact on Flights Below 7000ft

3.9.1 From the evidence gained during Stage 2 of the ACP process, the number of local (i.e. lower altitude) flights in the vicinity of the SP-1 site and the area covered by this airspace change is very low compared to most other parts of the UK. It has been determined that the daily scheduled flights to/from Benbecula (not normally more than three arrivals per day) will only be impacted by the subsequent activation of the D701 areas (namely D701A and D701Y) when runway 05 is in operation. On the rare occasions where these D701 areas are activated during a scheduled flight, current procedures enable that flight to access the Danger Areas, when safe to do so, even when active. Experience launching similar rockets from the MOD Hebrides Range has shown that the launch can be delayed by unpredictable events such as changeable weather conditions, the Range safety area being fouled by a 3rd party, or minor technical issues. To accommodate these variable occurrences it is necessary to provide a sufficiently extensive time period within which to conduct the launch (circa 2-3 hours). Therefore, during these delayed launch periods it is possible to allow aircraft safe access to the Danger Areas, in particular any scheduled flights. Furthermore, immediately after launch when the rocket has cleared the airspace fillet and D701A and Y areas, access may again be permitted as the rocket will no longer pose a hazard to aircraft in those areas. In all cases, the airspace will be de-activated as soon as ‘splash down’ has been confirmed and/or all hazards, including debris hazards, are known to have ceased. It is concluded that the commercial flights operating to/from Benbecula and Barra will rarely have to fly any additional track miles due to the airspace activations in support of SP-1. This means there will be little or no increase in CO_2 emissions or changes to normal noise patterns created by these flights[38].

3.9.2 Other flights potentially affected by activation of the airspace fillet and associated D701 areas are primarily: helicopters supporting the local lighthouses, fisheries protection aircraft and those supporting the emergency services – see Table 5. All will receive prior notification of the airspace activations (as is current practice for the D701 areas); this will enable them to plan and coordinate their sorties in advance, thus avoiding any additional fuel burn due to the airspace restrictions being in place. Emergency flights[39] will normally be afforded priority to enter the active airspace where it is safe to do so; this could mean delaying the rocket launch until the emergency aircraft are clear.

3.9.3 It is therefore concluded that the airspace fillet, small Danger Area around the launch pad and any associated activation of D701 areas will not alter the current baseline environmental impact or noise created by flights in the local area operating below 7000ft. More detailed evidence to support

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[37] In 10 years number of flights increased to 1152, (1152–1011) = 141 additional aircraft/flights affected
Extra distance is 141 × 22.8 km = 3,215 km
Extra fuel burnt is 3215 km x 9.61kg/km = 30,896 kg (circa 30.9 tonnes)
CO_2 emissions is 30.9 tonnes x 3.18 = 98.3 tonnes of CO_2. 98.3 + 704.4 = 802.7 tonnes CO_2 by 2035.

[38] Traffic patterns for Benbecula airport and the beach landing site at Sollas are reproduced in the Stage 2B initial Options Appraisal (Phase I) at [C].

[39] These are often referred to as Category A flights.

this conclusion is contained in 'Version 3 Stage 2B Options Appraisal (Phase I) Initial' available at: Airspace change proposal public view (caa.co.uk).

3.10 10-Year Forecast Local Traffic Levels and SP-1 Usage

3.10.1 **SP-1 usage** - It is extremely difficult to predict at this juncture the demand for the Spaceport over the next 10 years. It is anticipated that the first two to three years will see fewer annual launches (maybe 6 during the first year and 8 in the second year) with a gradual build-up to 10 thereafter. The market remains too immature to forecast the requirement beyond this early period although there is an expectation that there will be approximately 10 sub-orbital launches per year, based on the limit imposed in the SP-1 planning application. It is therefore not possible to conduct a full cost benefit analysis other than what has already been exposed in the Socio-Economic Impact Assessment 2023/24-2025/26 produced by MKA Economics dated November 2022 [F], where the net direct, indirect, and induced economic impacts, at the Outer Hebrides level, of the operational SP-1 in 2025/26 are estimated to be:

- Employment – 23.26 Full Time Employees (FTEs);
- Turnover - £6.45 million;
- Gross Value Added (GVA) - £2.73 million; and,
- Income - £1.18 million.

It should be noted that the socioeconomic impact assessment scale of assessment was limited to 3 years based on 6 launches in 2023/24, 8 launches in 2024/25 and 10 in 2025/26. If the maximum launch cadence of 10 is assessed in 25/26 it is expected the monetised figures will continue to grow in line with inflation from 2025/26 until 2035.

3.10.2 **Local aviation activity** - It is thought that demand for passengers and cargo flying to Benbecula may increase slightly with the advent of the Spaceport, as personnel transit to/from the mainland and rocket equipment/support items are brought in. Local businesses (hotels and shops) should also benefit from the increase in personnel living on the islands, this will also increase supply chains. There may be a slight increase in helicopter support traffic where these are needed to recover any elements of the sounding rockets, although the details remain imprecise at this stage and it is too early to monetise any of these effects. Furthermore, there is insufficient data available to predict what if any increase there will be in commercial flights or other helicopter support flights. It is considered that it is likely the aircraft flights in the local area (below 7000ft) will remain largely unchanged from those detailed in Table 5 below. Scrutiny of the CAA published aircraft movement figures for Benbecula Airport over the past 10 years would indicate a steady decline in aircraft movements from a peak in 2018 of 3650 movements to a trough in 2022 of 2772 movements. It is evident that from 2012 to 2019 annual aircraft movements were averaging at circa 3500 movements per annum, with a steady decline thereafter. It is therefore determined that even with a slight increase in aircraft movement as a result of the SP-1 facility, it is unlikely these will surpass the 2012-1019 annual average as there is no evidence to suggest any increase in aircraft movements over the next 10-11 years.

Operator – Provider of Statistical Evidence	Approximate annual flights in region	Monthly Average	Comments
2Excel Aviation	30	<3	Fisheries protection & UK SAR
Northern Lighthouse Board	24	2	Conducted inclusively by PDG Aviation; figures include short

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			transits to and from support ships operating in close proximity to 2 lighthouse stations (Haskeir & Ushenish).
Bristow Helicopters	60	5	Coastguard Stornoway – Difficult to predict but stated nil flights some months with up to 10 in a busy month; numbers include all flights, tasking & training flights
PDG Aviation	20	<2	Figure includes all NLB support flights.
Sollas beach site	>24	<2	Annual figure based on busiest year annual fly in event. Monthly figure based on general enquires to use landing site as provide by Sollas Fly In coordinator.
Babcock Aviation	104	<9	Operating Air Ambulance and Police helicopters; the former averaging 8 flights per month in the local area and the latter one flight every 6 months.
Gamma Aviation	>24	>2	Survey and air ambulance flights considered to be less frequent than SAR flights, estimated to be circa >2 per month – no formal response received, estimate based on local knowledge from MOD Hebrides Range staff.
Loganair	2256	188	CAT cargo & passenger operator to Benbecula.
Military – Low Flying Booking	24	>2	Assumed to be less than 2 per month based on night flying statistics and infringement data.
Danger Area Infringements (NATS)	1	>1	Data obtained from QinetiQ contracted civil air traffic Range controllers (NATS)
AIRPROX Reports	0	0	UK AIRPROX board data
Total Number	2546	212	
Total Number Excluding Scheduled Flights	290	24	Circa 24 ‘other[40]’ flights per month

Table 5: Summary table of local area aviation operators - annual and average monthly flights.

[40] Where ‘other’ flights include SAR, Air Ambulance, Air Taxi, NLB support, military, General Aviation (GA) and any non-commercial aircraft flights.

3.11 Rough Order of Magnitude (ROM) Costs Associated with Equipment & Chart Updates

3.11.1 Option 3 creates the smallest change out of all three Options assessed during stage 2, with only two new lines being drawn on radar mapping systems (for both the Range and ANSPs) for the airspace fillet. Furthermore, there is no requirement to create any extra 5LNCs, or draw FBZs other than around the new airspace fillet. Similarly, aeronautical and navigational charts will require the minimum of alteration as will aeronautical information publications. Option 5 is somewhat more complex as, in addition to the changes required for Option 3, it also requires modifications to several of the D701 areas – this also necessitates amending all LoAs and ASM procedures associated with these existing areas to reflect the change. Option 4 requires the most significant change, not only in terms of substantial changes to radar mapping, charts and publications, but also with regard to procedures, processes – bringing associated training costs.

3.11.2 The Sponsor had intended to gain the ROM costs for each of the three Options presented in order to conduct a cost comparison; however, this has proved unattainable. The Sponsor made several requests to NATS (the most impacted ANSP) for their ROM costs associated with the three Options but the response from NATS suggested that: *'NATS internal policy will limit future responses to confirming whether or not the cost to deploy identified options are materially different to each other, or whether they are, materially, cost agnostic. It is unlikely that NERL[41] will choose to release commercially sensitive material to sponsors around the cost to implement'*. The MOD Hebrides Range also declined to provide any detailed ROM costs associated with any of the changes due commercial sensitivities. However, it was acknowledged by the MOD Hebrides Range that Option 3 would be significantly cheaper to implement than the other two options as the changes to publications, Range orders and equipment were so much smaller; furthermore Option 3 would induce minimum training costs. It is assumed that NATS would agree this position given the overall airspace change is much smaller. Moreover, as the EUROCONTROL traffic impact analysis strongly suggests that there would be little or no benefit to adopting Option 4 or Option 5 in preference to Option 3, it is considered that any further investigation to ascertain these costs would be disproportionate to the scale of the airspace change. Therefore, the Sponsor proposes that the qualitative assessment that Option 3 will be significantly cheaper to implement than Option 4 or Option 5 is sufficient for the purposes of the full Options Appraisal.

4. Safety Assessment

4.1 Safety Analysis[42] – Factors Affecting Determination of Airspace Fillet Parameters

4.1.1 There are two generic risks to other airspace users from launch activities:

- collision with a sounding rocket during a nominal flight profile – this is where the sounding rocket flight is following the intended path; and,

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[41] NERL is the abbreviation for 'NATS En Route Ltd'.

[42] Note: This safety analysis section is supported by a detailed document that was produced by QinetiQ and will be delivered to the CAA Space Team during Stage 4. This supporting document contains commercially sensitive information that cannot be contained in this report but provides the regulators with supplementary information to verify the safety arguments and statements made herein.

- collision with all or parts of a sounding rocket that has failed – this is where a sounding rocket fails to follow the intended flight path and/or fails explosively on the launch pad or in flight.

4.1.2 In both cases, it is vital that risk is managed such that other airspace users are not exposed to additional hazards associated with the activities, and the most effective way to achieve this is to segregate the sounding rockets from other airspace users through the establishment of SUA.

4.1.3 When designing the dimensions of the SUA herein referred to as the airspace 'fillet', both generic risks are considered. The shape of the fillet is determined by these risks but also by the proximity of the existing Danger Areas, D701 and D704. The aim of the fillet is to provide segregated airspace connectivity to the D701 complex to the north and west. Any hazards existing beyond the western or northern boundary of the fillet can be safely segregated by activating the appropriate D701 areas. It is not intended to use D704 to the south but the boundary of D704 provides a convenient demarcation line for the southern boundary of the fillet; this boundary line is more than adequate to contain all credible hazards as depicted in Figure 2. Therefore, the line of most significant interest is the eastern boundary of the fillet.

4.1.4 The following safety analysis is based upon the experience of QinetiQ in supporting numerous large area weapons firings on the MOD Hebrides Range, including the 12 suborbital rocket launches conducted there since 2015. This allows an assessment of what safety areas are achievable in practice. For the purpose of this assessment, QinetiQ are considering the maximum fillet that might reasonably be required for a launch.

4.1.5 **Collision with a sounding rocket during a nominal flight profile** – Nominal flight profiles include all of the numerous possible minor variations to the intended flight profile, all of which would be considered to meet the mission parameters:

- **Unguided Sounding Rockets** - Unguided sounding rockets adopt an initial flight path determined by the launch tower arrangement. In all cases, the launch tower will have an elevation (from horizontal) of 88° or less. Depending on the sounding rocket boost phase characteristics, it may remain essentially on the initial elevation angle for a short period of time but will be progressively and increasingly affected by gravity, having the effect of continuously reducing the elevation angle during the flight. Therefore, as all launch azimuths are west or northwest, no point on a nominal flight path can be further east than the position of the launch pad.

- **Guided Sounding Rockets** – For a guided sounding rocket, the launch may be canted to the west as for the unguided rockets; however, it is expected that in the majority of cases, the sounding rocket will be launched vertically (e.g. an elevation from horizontal of 90°).

4.1.6 The guided sounding rocket will assess its current flight parameters, compare these to the planned flight parameters and apply corrections in order to achieve the planned flight profile.

4.1.7 **Wind drift effects for nominal launch flight profiles –** During flight of non-exo-atmospheric projectiles, both powered and unpowered, it is possible for the trajectory to be affected by the presence of wind. A controlled projectile will be designed to compensate for deviations in planned trajectories caused by external influences, but it would be possible for wind effects to cause an uncontrolled projectile to exit from the airspace fillet in certain wind conditions.

4.1.8 The effect of wind on projectile trajectories is likely to be most significant when its forward speed is at its lowest, such as at ballistic apogee with a broadside wind, or during a near vertical launch. The amount of deviation caused will be dependent on, amongst other things:

- the projectile's incident airflow direction and speed (a combination of projectile airspeed and direction and wind speed and direction);
- air pressure; and,
- a coefficient, or aerodynamic derivative, known as the Longitudinal Moment (also known as Yaw Moment), which depends on the projectile's physical configuration.

Furthermore, if the speed of final descent is controlled by parachute, then once again the trajectory of that descent will be significantly affected by wind speed and direction.

4.1.9 The effects of wind on all phases of flight will be considered during the mission safety analysis for each launch. The analysis may show that under certain wind conditions, there will be an unacceptable probability of the projectile exiting the airspace fillet. Wind conditions would be assessed on the day of launch and the launch delayed or aborted if the calculated safety limits were exceeded. Therefore, for any launch, the probability of wind related excursion from the airspace fillet will be reduced to be as low as reasonably practicable to ensure that airspace users outside the airspace fillet will not be exposed to any unacceptable risk.

4.1.10 **Conclusion for nominal launches –** The main risk to other airspace users is therefore determined to be downrange, which is a sector from the southwest to the northwest of the launch pad location. The airspace fillet, by connecting to the D701 Danger Areas, ensures adequate segregated airspace to contain all credible hazards. As the trajectory of the rockets will always be in this westerly sector, the airspace to the east of the launch pad does not need to be as big and only needs to be of sufficient volume to contain a rocket vehicle failure as described in 4.1.11 below.

4.1.11 **Collision with all or parts of a sounding rocket that has failed** – A failed or "off-nominal" sounding rocket is any one where the rocket fails to complete a full nominal flight profile. There are several possible failure scenarios, each of which could cause a hazard to an airspace users. Considering these in turn we have:

- a sounding rocket exploding on the launch pad;
- a sounding rocket exploding during an otherwise nominal flight;
- a sounding rocket deviating from the nominal flightpath and exploding; and,
- a sounding rocket deviating from the nominal flightpath and remaining in one piece.

Explosions may be due to a failure or due to flight termination; however, the cause is not critical to this assessment.

Scenario 1: Sounding rocket exploding on the launch pad – To examine the risk associated with a sounding rocket exploding on the launch pad, the largest sounding rocket anticipated to be launched from SP-1 may be considered as the worst case. This rocket is an 11 metre guided vehicle with a propellant mass of circa 1.5 tons. Utilising the United States (US) Federal Aviation Authority (FAA) and US Department of Defence (DoD) methodologies for calculating Hazardous Fragment Distances

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(HFD), this sounding rocket attracts a safety zone of approximately 426m radius from the pad as depicted in Figure 24.

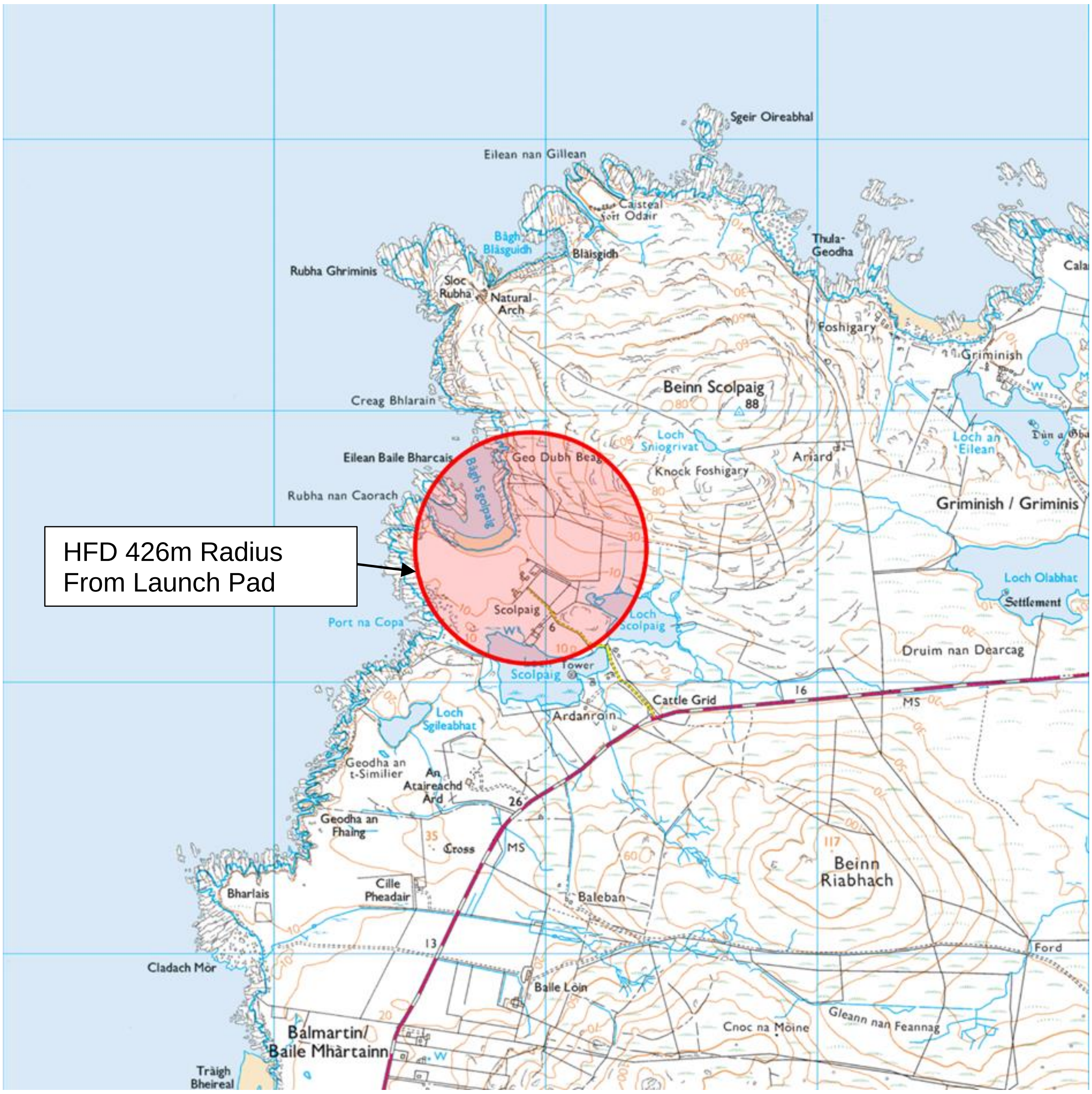

Figure 24: Diagram Depicting Indicative HFD Following Catastrophic Sounding Rocket Failure on the Launch Pad. (Source: Ordnance Survey 1:25000 map)

4.1.12 **Scenario 2: Sounding rocket exploding during the ascent phase** – When considering a sounding rocket exploding during the ascent phase the normal safety approach is to model the dispersion of fragments for a rocket exploding at a series of points during the boost phase, for a variety of wind/atmospheric conditions. The analysis used for this scenario is the same worst case rocket identified above, on the planned flightpath, which has been modelled for explosive failure at 10, 20 and 30 seconds after launch during the 'worst case wind conditions' (considered to be the maximum wind velocity that any rocket can be launched in). This debris field analysis was then cross referenced with the sounding rocket safety data provided for use on the MOD Hebrides Range; both were similar. The comparison of data provided confidence that the maximum dispersion of debris following catastrophic failure after launch would be wholly contained within the airspace fillet. It should be noted that the ground safety footprint might preclude rockets being launched in certain wind conditions where this causes debris to fall over the land areas.

4.1.13 **Scenario 3: Sounding rocket deviating from the planned flightpath due to a failure, and exploding either due to a failure or due to flight termination** - This situation combines two types of failure, namely the sounding rocket deviating from its nominal flightpath and either breaking up (due to a sudden dynamic deviation causing structural failure), or being flight terminated (explosively) having deviated from the planned flight path by a predetermined distance and/or for a predetermined time.

4.1.14 These distances and times will be launcher specific and all the relevant data will be evaluated for each launch on a case-by-case basis. However, discussions with operators and the experience gathered on the MOD Hebrides Range supports using a time of 5 seconds between deviation beginning and the initiation of flight termination.

4.1.15 Due to the nature of sub-orbital launches, the rockets used are either unguided or, for guided systems, are capable of course correction but should not be considered manoeuvrable. The effect is that while the deviation flightpath may, over time, result in a significant positional change from that planned, in 5 seconds the deviation from the nominal flightpath will be relatively small.

4.1.16 Sounding rockets, even guided versions, are designed to withstand thrust along the axis of the rocket. Note that despite the name, guided sounding rockets are only capable of gentle course correction (low g manoeuvers). While there is some inherent capability to withstand off-axis thrust, the drive to minimise vehicle weight and their pencil-like shape makes manoeuvrability very limited. Sudden changes of direction will therefore cause structural failure of the vehicle and it will break up rather than achieving a significant deviation.

4.1.17 Low g deviations at very low speed, close to launch, may result in a more significant change of direction in a short time; however, the distance travelled will be small due to the low speed. As the speed rises, low g manoeuvers will inherently move the rocket less and less distance off its flightpath within the flight termination time allowed. This is one reason why unguided sounding rockets use launch rails – lateral deviation is constrained until speed has risen significantly.

4.1.18 The result is that this scenario does not change the proposed airspace fillet as the debris would still be contained within the same area from the launch pad or, will be sufficient distance down range from the launch pad that the debris will be contained in the D701 Danger Areas (over the sea).

4.1.19 **Scenario 4: Sounding rocket deviating from the planned flightpath, due to a failure, and remaining unitary** – Unguided sounding rockets all launch from rails pointing downrange. Barring catastrophic failure early in flight, covered in scenarios 1 and 2, all of their hazards are inherently constrained to a downrange footprint. Even in failure cases such as the loss of a fin, the rocket will break up downrange. There is therefore, no credible risk from an unguided sounding rocket to airspace users outside the airspace fillet and associated D701 areas.

4.1.20 It is expected that guided rockets will always be fitted with flight termination systems to mitigate the hazard created by their inherent capability to achieve a slow and steady deviation from their nominal trajectory (given that they enter an appropriate failure mode). Therefore, the flight termination system becomes an integral part of the overall safety analysis process associated with guided rockets. Each guided rocket system will also be extensively tested before use and will need to meet specific legislative requirements associated with the rocket operator's licence so the risk of failure is reduced. Similarly, the flight termination system will undergo extensive testing and pre-flight checks; based on experience of utilising such systems at QinetiQ managed Ranges, failure of these systems is considered a low probability event. The flight termination system may be initiated by the guidance system and/or by personnel controlling the rocket system. While there might be a trigger from the flight control computer to the flight termination system, these are required to be separate systems and therefore the failure of both will require independent simultaneous failures to prevent operation. The chance of these failures occurring at the same time reduces the probability of an unterminated deviating rocket leaving segregated airspace, to 'incredibly low[43]'.

4.1.21 The safety assessment to establish the size of the additional small Danger Area around the launch pad (to protect SP-1 ground personnel) is briefly described in paragraph 2.2.2; this will be expanded further during Stage 4.

5. Operating Principles

5.1 Type of Airspace

5.1.1 The Sponsor intends to establish SUA in the form of a Danger Area around the SP-1 launch site as this is considered the most efficient use of airspace; evidence supporting this statement is contained in: 'Version 3 Stage 2B Options Appraisal (Phase I) Initial' paragraph 3.14 available at: Airspace change proposal public view (caa.co.uk). In summary, a Danger Area is only activated when required and the airspace reverts to its normal background classification at all other times (Class G and Class C). This is judged to be the least restrictive solution for all aviation stakeholders.

5.2 Activation Periods

5.2.1 It is intended that the airspace will be activated by NOTAM using existing notification procedures and protocols as used for the MOD Hebrides Range D701 Danger Areas [E]. This means the timings of the airspace activation and the exact D701 requirements will be determined at least 21 days in advance (referred to as D-21); this notification will be submitted as an airspace booking request to Prestwick Centre (PC) reservations cell who in turn may negotiate changes with MOD Hebrides Range to minimise the impact on civil operations. At D-5, the final agreed airspace request will be submitted and if the request has an adverse impact on the UK and Irish network, AMC UK will negotiate a solution with MOD Hebrides Range – any subsequent approval will be issued at D-5. NOTAMs are then published by the responsible agencies at D-1.

5.2.2 It is not anticipated that the NOTAM period will exceed three hours and the launch times are expected to occur after 1400 UTC (one hour earlier in the summer) so that the agreed (Reference [E] refers at paragraph C.2.2) maximum number of OEP closures in a year is not affected. Launches prior to 1400 UTC (one hour earlier in the summer) will normally be contained within the D701 areas that do not impact on OEPs. The small Danger Area around the launch pad may be activated several days prior to the rocket launch to enable ground personnel to conduct 'dry' launch runs. The area may also need to be active for extended time periods (several hours) before launch – these timings will be largely driven by the rocket provider and determined by their safety requirements.

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[43] Incredibly low is a safety term used where the probability of such an occurrence happening is so small that it is considered acceptable by International safety bodies and the UK Health & Safety Executive (HSE)

5.2.3 Planned SP-1 launch activities will also be promulgated using 'notices to mariners' and notification processes used by the local Council as further detailed in Appendix 13.1 of the 2021 EIA report [D]. Additionally, the status of airspace activations may be obtained from the MOD Hebrides Range using the promulgated means of contact.

5.3 Access to Airspace

5.3.1 As described in paragraph 3.9, where safe to do so, aircraft will be allowed to enter the activated NOTAM airspace under certain circumstances with permission from MOD Hebrides Range – in particular those flights supporting emergency services or scheduled flights into Benbecula where D701A and Y are active but no hazard is present at the time.

5.3.2 Other aircraft may also obtain updates on Range activity by calling on the notified aviation frequency where a SUA Activity Information Service (formally known as a Danger Area Activity Information Service (DAAIS)) is provided.

5.4 Management of Airspace

5.4.1 It is proposed that the management of the new airspace fillet and associated D701 Danger Areas activated to support SP-1 rocket launch, is managed in exactly the same fashion as the D701 Danger Areas are currently managed. In essence, the airspace fillet will become an extension of the D701 Danger Areas for ASM purposes. The airspace will be activated by NOTAM by MOD Hebrides range staff, who will ensure the Range is 'clear' before issuing any approval for rocket launch. No rocket launches will take place without the express authorisation of MOD Hebrides Range.

5.4.2 Utilising extant ASM process and procedures for SP-1 launches ensures best practice (using tried and tested procedures that have been successfully in place for 10 years). These processes and procedures are understood by all staff (both Range and ANSPs). It is acknowledged that current LoAs will need to be slightly modified to include reference to SP-1 operations; however, these adjustments should not be significant. It is further recognised that NATS have concerns with the use of current LoAs for SP-1 use because of the commercial aspects of the launches imply that these could not be classed as MOD activity. There are no charging mechanisms in place for ANSPs with regard to commercial Spaceport activities, unlike military sponsored events. The Sponsor would argue that these issues are out with the bounds of the ACP process and are part of broader governmental discussions. It is strongly suggested that the ASM process and procedures should not be influenced by these 'political' issues and it is in everyone's interest to use the extant procedures, for reasons of both safety and efficiency. It is similarly recognised that the AMC UK do not currently have a process or agreements by which 'new entrants' such as Spaceport operators can engage and input their airspace requirements. This could similarly prove a challenge in developing the ASM processes; again it could be argued this sits outside the ACP process as it will require regulatory input and guidance.

6. Environmental Assessment

6.1 Direct Impact

6.1.1 The direct environmental impact caused by SP-1 is largely captured in the EIA [D] and Supplementary Environmental Information (SEI) for SP-1. However, at the CAA pre-Stage 3 meeting it was highlighted to the Sponsor that there were certain details that needed to be added to facilitate the CAP 1616 requirements; these additional elements are as follows:

- identification of all tranquillity receptors on LASmax[44] contours;
- structural damage assessment in Lmax[45];
- sonic boom assessment in pound per square foot (psf);
- identification of all Noise Sensitive Receptors (NSRs) exposed above 1 psf;
- probability of awakening; and,
- longer term exposure to repeated noise events along exemplar trajectories and, consideration of alternative fuels.

6.1.2 In December 2021, CnES ('the Developer'), submitted a planning application under the Town and Country Planning (Scotland) Act 1997 (as amended) for permission to construct and operate a sub-orbital sounding or research rocket launch facility in North Uist Outer Hebrides, Spaceport 1 ('the Project') (Ref: 21/00646/PPD)1. An EIA Report ('2021 EIA Report') [D] was prepared in accordance with the Town and Country Planning (EIA) (Scotland) Regulations 2017 (the 'EIA Regulations') to support the planning application for the development. Following examination of the 2021 EIA Report by CnES Planning, which also considered externally commissioned reviews and representations by the public, a request for a SEI was issued to the Developer on 1 September 2022. The SEI [G] was submitted to CnES in January 2023. The SEI updates and modifies aspects of the 2021 EIA Report (and supporting information), and stakeholder and public responses to the planning application (Ref: 21/00646/PPD). Following the CAA gateway review 25 January 2024 further modelling was commissioned to address the CAA feedback, outputs of the modelling (mapping of LZmax contours) and accompanying technical note/methodology can be found at Appendix A.

6.1.3 Information to inform the ACP draws on both the original EIA submission, the SEI submission and in response to specific requests for representing spatial data, includes a small number of additional figures as well as the following response to specific areas bulleted above at paragraph 6.1.1.

- **Identification of all tranquillity receptors on LAmax contours** - EIA Technical Appendix 19.1: 'Noise Technical Report' illustrates 'tranquillity receptors' on LASmax contours against human receptors, cultural heritage receptors, and ecological designations. These are subsequently assessed in more detail within other chapters of the EIA/SEI as referenced. The CAA additionally defines statutory landscape designation features as 'Tranquillity Receptors'. Impacts arising from noise on the setting of landscape designations are captured in a separate assessment which formed part of the updated SEI submission[46] (SEI Section 8 and supporting SEI Technical Appendix 8.1). Maps illustrating the original (LASmax) noise contours against the NSA designations are presented in Figure 25 and Figure 26, these were not originally presented in the EIA or SEI. The Technical Note (see Appendix A) provides detail on the re-run of the RUMBLE model with the new output showing the LZmax(slow) contours illustrated in Figure 27 below.

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[44] LASmax is the maximum time-weighted and A-weighted sound pressure level with SLOW time constant.

[45] Lmax is the single highest sampled level of sound.

[46] This is a broader level assessment of the impacts on noise/visual change of the special qualities of the landscape National Scenic Area (NSA) feature.

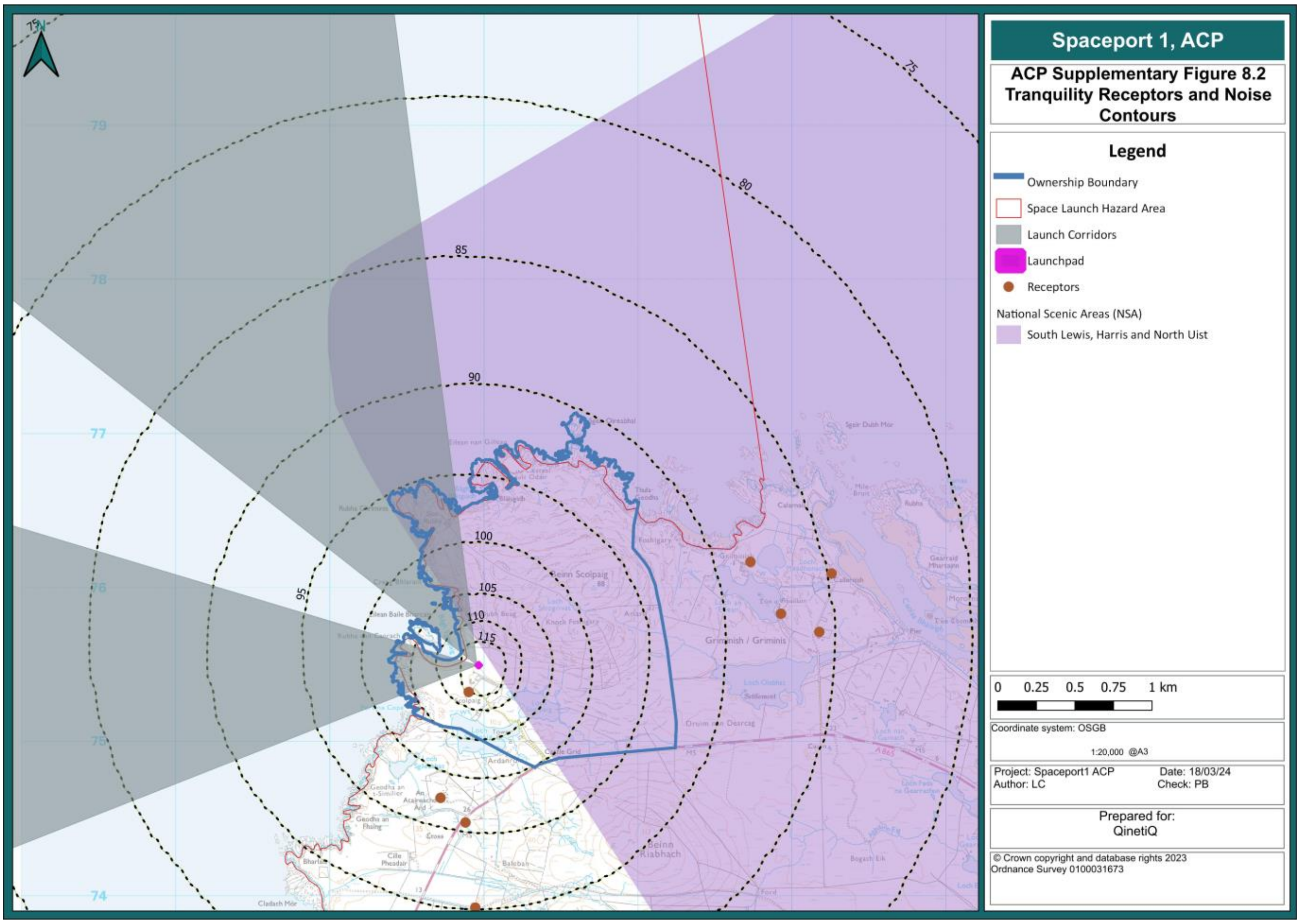

Figure 25: Diagram showing tranquillity receptors, NSA and LASmax noise contours together with expected launch corridors with trajectory between 225º and 315º. (Source: Atlantic58)

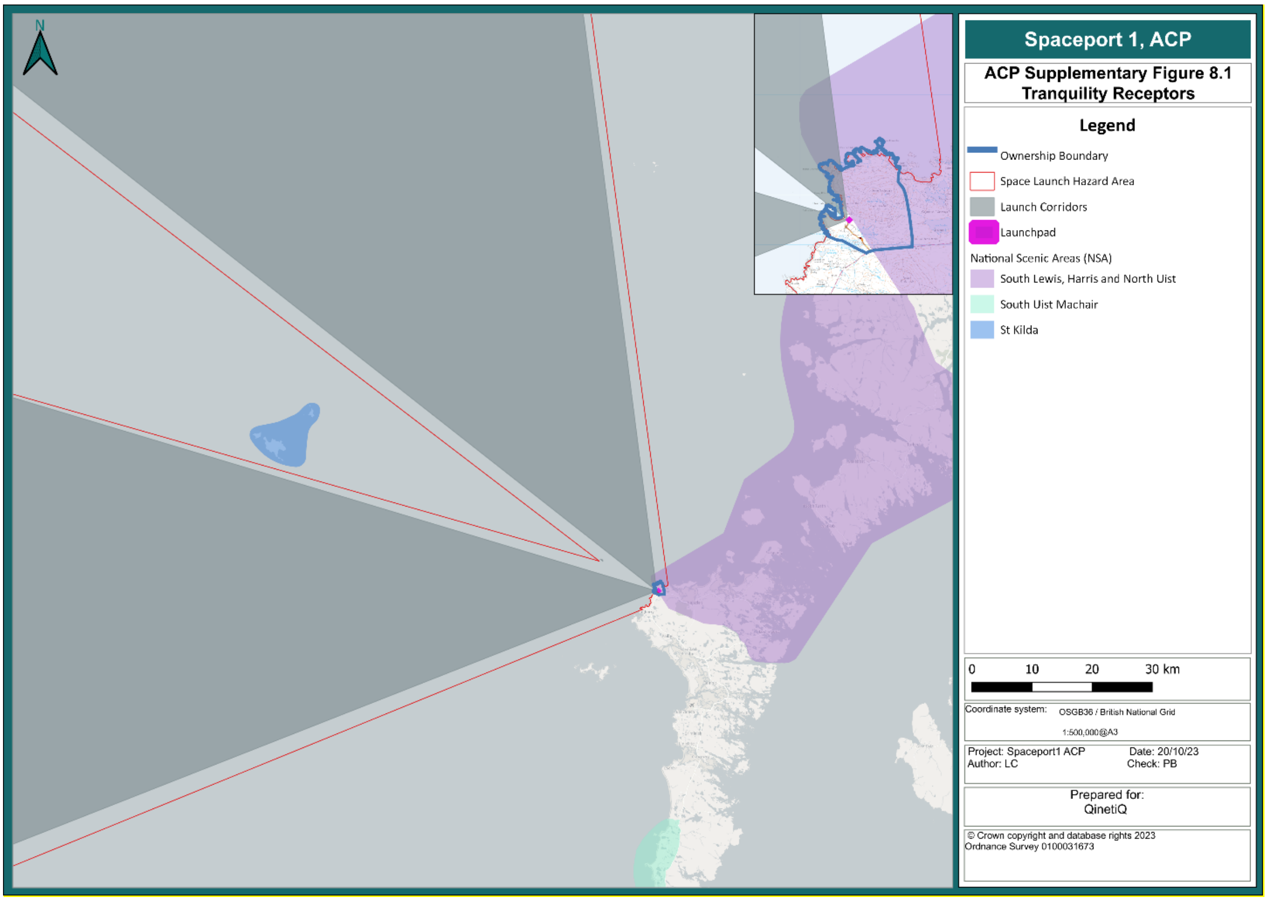

Figure 26: Diagram showing tranquillity receptors and expected launch corridors with trajectories between 225º and 315º. (Source: Atlantic58)

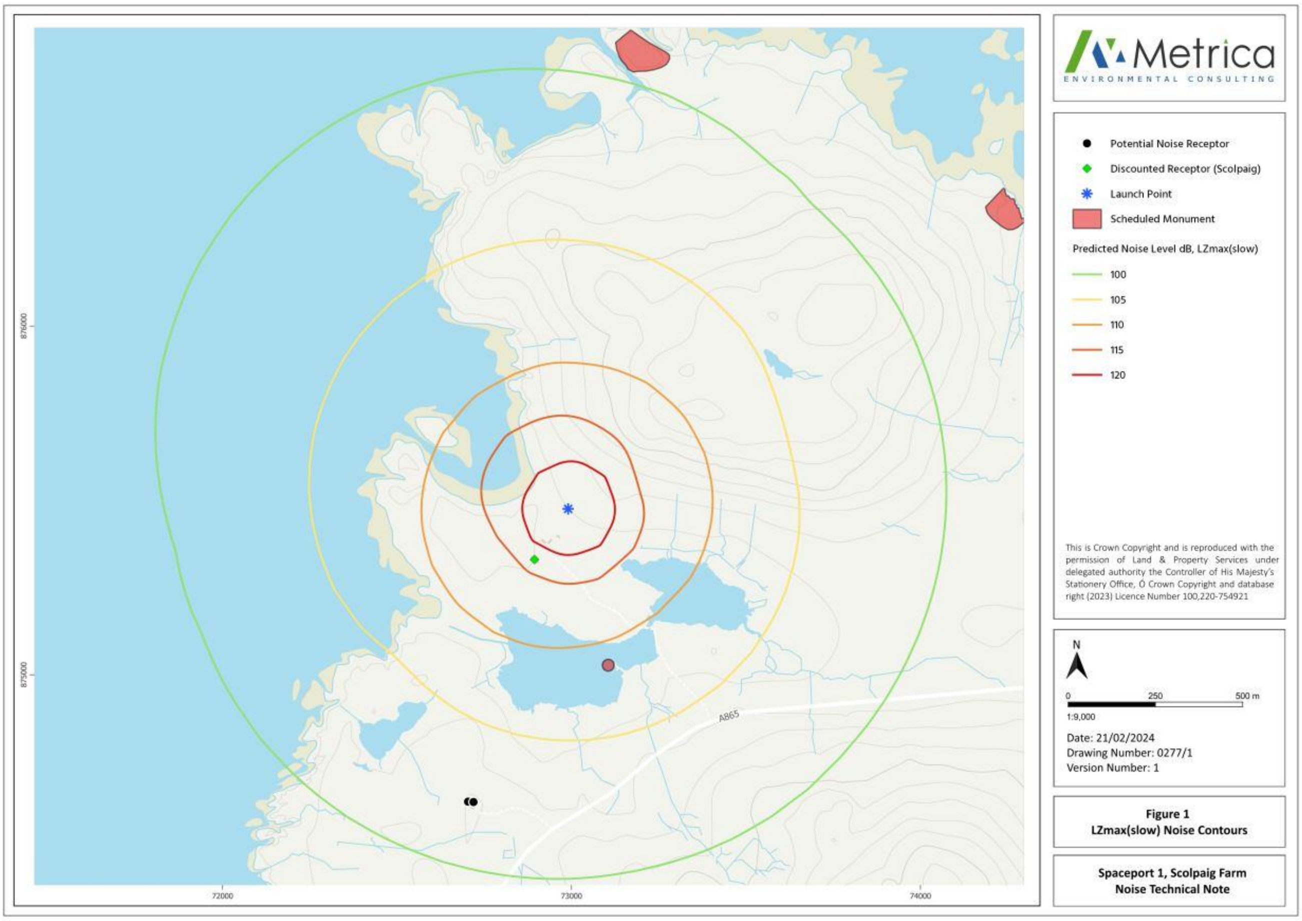

Figure 27: LZmax (slow) noise contours obtained from RUMBLE modelling. (Source: Metrica technical note Feb 24)

- **The LASmax metric** – The CAA guidance in CAP 1616 specifies the requirement for assessment against LASmax metric. The predictions presented are derived from the EIA and are based on the output of the RUMBLE software[47] which uses the LASmax metric. When assessing distinct and infrequent noise, such as rocket noise, measures of single events such as the maximum noise level (LAmax) and the Sound Exposure Level (SEL) or LAE[48] are most appropriate. Unweighted maximum noise level (Lmax – also denoted as LZmax) may also be appropriate for assessing risk of structural damage to surrounding buildings and properties. To avoid acute damage to the human inner ear resulting from impulsive sounds, World Health Organisation (WHO) noise guidelines suggest that the maximum sound level (LAmax) should never exceed 110 dB LASmax[49]. To avoid and minimise the risk of structural damage the

[47] Airport Cooperative Research Program, (2018) User Guides for Noise Modelling of Commercial Space Operations – RUMBLE and PCBoom, Research Report 183.

[48] LEA is the sound exposure expressed as a logarithm divided by time.

[49] LASmax is the maximum time-weighted and A-weighted sound pressure level with SLOW time constant.

maximum unweighted noise level (LASmax) should not exceed 120 dB (unweighted). It is recognised that the difference between A-weighted and Z-weighted levels does vary with the distance from the source due to the frequency spectrum becoming gradually weighted toward lower frequencies with increasing distance, due to air and ground absorption effects. To better understand these differences the data was re-run in the RUMBLE model in order to produce LZmax(slow) contours as shown in Figure 27. This figure also shows any/all residential dwellings and scheduled monuments that are predicted to experience noise levels above 100 dB, LZmax(slow). As stated in the EIA Report, Scolpaig Farmhouse is currently in a dilapidated state and will not be reinstated as a residential dwelling, instead being integrated and redeveloped as part of the SP-1 Development; it is therefore not considered a noise-sensitive receptor for the purposes of this assessment.

- As can be seen in Figure 27, there are a total of three receptors (two dwellings, and one scheduled monument) that are predicted to experience levels above 100 dB LZmax(slow), none of which are predicted to experience levels of 120 dB LZmax(slow), or above (i.e. the criterion for risk of structural damage given in the Space Industry Act 2018[50]).

- **Structural damage assessment in Lmax** - The technical report provided as EIA Appendix 19.1: 'Noise Technical Report' confirms that LAmax and Lmax are the same values for rocket noise due to frequency weightings. Structural damage to cultural heritage receptors (agreed as the highest-risk receptor) was assessed in the SEI submission SEI Appendix 19.2: 'Vibration Technical Note'. The closest human occupied building is located approximately 890 m from the launch pad. Operational (launch) phase vibration impacts are possible on heritage assets up to 100m from the proposed launch pad, however the only scheduled monument recorded on the site (Scolpaig Tower) lies 470 m from the launch pad and will not be impacted by launches. Other (none designated) archaeology may be impacted by vibration and dedicated mitigation has been developed, converted into planning conditions to protect these features (namely the development of a Preservation Strategy, Habitat Amenity Management Plan).

- **Sonic boom assessment in pound per square foot (psf) –** CAP 1616 guidance indicates that no receptor should experience a maximum overpressure above 1 psf. The maximum overpressure was calculated and reported in EIA Chapter 19: 'Noise and Vibration'; this model[51] indicates that the psf for sonic boom ranges from 0.01 to 0.54 psf. The sonic boom footprint across the range of trajectories for the worst case scenario launch vehicle proposed at SP-1 is presented in EIA Technical Appendix 19.1. No further modelling is proposed.

- **Sonic boom Identification of all Noise Sensitive Receptors (NSRs) exposed above 1 psf -** As described in the EIA Chapter 19, there is no exposure to noise above 1 psf.

- **Probability of awakening** – Planning conditions limit the execution of launch activities between the hours 0700 – 2000 (Monday to Friday) and 0700 – 1800 (Saturday) with no Sunday working (see Condition 15 of the CnES Decision Notice); therefore the probability of awakening is not considered as launch activities will be during the 'day time' metric described in CAP 1616 paragraph B51.

[50] Guidance to the regulator on environmental objectives relating to the exercise of its functions under the Space Industry Act 2018, Department for Transport, UK Government, 2021

[51] PCBoom software.

- **Longer term exposure to repeated noise events along exemplar trajectories** - Section 4 of the SEI updates the original project description provided in the EIA and describes the range of trajectories, frequency, duration and timing of launches. The EIA Chapter 19 'Noise and Vibration', supported by the EIA Technical Appendix 19.1, provides greater detail.

- **Consideration of alternative fuels** - Although SP-1 will not have direct control over the fuels used by the rocket providers they will strongly encourage the providers to adopt cleaner fuels and technologies which minimise the contribution of this sector to climate change and ozone depletion. Rocket providers will be advised to ensure that any such cleaner fuels or technologies adopted, do not introduce their own significant environmental effects.

6.1.4 CAA draft document: *'Environmental Assessment Requirements for Vertical Spaceflight Airspace Change Proposal (ACPs)',* calls for the following additional detail:

- **A description of activities including launch trajectories, frequency of activations, duration, timings and how these might change over the 10-year forecast period** – Section 4 of the SEI [G] provides significant detail pertaining to launch activities. The trajectories will be between 225º and 315º, with 10 launches per year, timings will generally be after 1300 UTC (other than for short-range rockets that do not impact on OEPs – see paragraph 5.2.2). 10-year forecast details are contained at paragraph 3.10.1.

- **Consideration of single noise events** – Noise exposure footprints and structural damage assessment are captured at paragraph 6.1.3 above. Furthermore, a dedicated assessment of vibration was undertaken as part of the SEI Appendix 19.1 for single noise events, this was focused primarily on heritage features which were assessed as being at the greatest risk of structural damage from launch activities.

- **Exposure to repeated noise events – Human Receptors**: Exposure to repeated noise events is considered in the context of the maximum launch budget of 10 launches/year and assessed in EIA Chapter 19: 'Noise and Vibration', supported by EIA Technical Appendix 19.1. In addition to the noise assessment outlined above, SEI Appendix 8.1: 'Landscape and Visual Assessment' considers the wider setting elements, including acoustic disturbance. Cumulative and in-combination impacts are considered in SEI Section 23: 'Cumulative and In Combination Effects'.

- **Wildlife receptors** – Separate assessments are provided in the EIA relating to the impacts of noise on:
  - Ornithology – EIA Chapter 14;
  - Terrestrial Ecology – EIA Chapter 15;
  - Marine Ecology – EIA Chapter 16.

  One assessment was updated and expanded in the SEI (see SEI Section 14: 'Ornithology', supported by SEI Figure 14.4) in relation to specific queries relating to noise disturbance (including ongoing launch noise/sonic boom disturbance).

- A Habitats Regulations Appraisal (HRA) was also undertaken to determine whether the project has the potential to affect any Special Areas of Conservation (SACs) and Special Areas of Protection (SPAs) within the UK-wide network of protected sites, including impacts associated with noise; EIA Annex Bi: 'Information to Inform HRA (SPAs)' refers.

- **Meteorological conditions** – Meteorological conditions adopted for modelling are provided in EIA Appendix 19.1: 'Noise Technical Report' and use the following models:

    - RUMBLE – the results are for a neutral wind vector velocity. Launches could occur at surface wind speeds of up to 10 ms-1 therefore, worst case assumptions are made.
    - PC BOOM – for simplicity, the model assumes wind at zero velocity. The US Standard Atmosphere, determined by NASA in 1976, has been assumed for atmospheric temperature.

- **Fuel burn and CO_2 emissions** – EIA Chapter 20: 'Climate Change', provides a basic analysis of the potential contribution of the project to climate change which does not consider the indirect impact such as the rerouting of flights.

- **Statuary air quality limits, designated air quality area and national objectives for pollutants** – EIA Chapter 18: 'Air Quality and Heat', describes the potential impacts that may arise from changes in air quality and heat emissions associated with up to 10 sub-orbital launch events introduced as a result of the Project. The assessment includes a summary of relevant air quality legislation and policy drivers, baseline air quality conditions, and the potential impact from foreseeable launch scenarios. Cumulative impacts are assessed in the supporting technical appendix EIA Appendix 18.1: 'Detailed Dispersion Modelling'.

- **Primary pollutants** - Detailed dispersion modelling was undertaken for the range of potential air emissions anticipated from an analysis of multiple launch operators, and is contained within EIA Appendix 18.1: 'Detailed Dispersion Modelling'. Indirect or secondary pollutants are considered in Section 4.7 of that Appendix.

- **Consideration of overflight of any tranquil areas** – One NSA is located within the overflight area (Space Launch Hazard Area). The setting (including noise) impacts on the NSA are assessed as part of the expanded SEI Submission in SEI Section 8 and supporting SEI Appendix 8.1: 'Landscape and Visual Assessment'. Figure 26 has been created to meet the requirements of the ACP process illustrating the Space Launch Hazard Area and the NSA.

- **Consideration of overflight of any biodiversity areas** – Separate assessments are provided in the EIA/SEI relating to the biodiversity of various wildlife receptors:

    - EIA Chapter 14 Ornithology
    - EIA Chapter 15 Terrestrial Ecology
    - EIA Chapter 16 Marine Ecology

  Each chapter is accompanied by Figures setting out maps of each of the key biodiversity designations and other relevant receptors.

6.1.5 It is important to note that in addition to the EIA/SEI that was developed in support of the planning process for SP-1 and the environmental requirements of CAP 1616, the Spaceport operator or Launch operator will need to deliver an Assessment of Environmental Effects (AEE) as part of the Space Industry Act (SIA) 2018 licensing activities – this work remains ongoing.

6.2 Indirect Impact

6.2.1 The indirect impact is considered to be two main elements, namely SP-1 affecting local area flights nominally below 7000ft, and aircraft transiting over the northern UK into Oceanic airspace of the NAT. These indirect impacts are quantified in paragraph 3.9 and paragraph 3.5 respectively.

6.3 ACP-2021-12 CAP 1616 TABLE E2 – Airspace Design Options Appraisal Analysis

6.3.1 CAP 1616 Appendix E provides a guide to the expected approach to key analysis for a typical airspace change with further guidance provided in the draft 'environmental assessment requirements for vertical launch spaceflight ACPs', where the environmental assessment requirements of the SIA 2018 and CAP 1616 are summarised. It is suggested that Sponsors should seek opportunities to obtain the relevant information from an applicant's AEE. As the AEE for SP-1 has not yet been completed the Sponsor has used information from the EIA and SEI produced for SP-1 as part of the planning application process; extracts from the EIA have been previously reproduced in documents supporting Stage 2 of this ACP process and are available to view on line at: 21/00646/PPD. The Sponsor has addressed the guidance requirements utilising the Table E2 from CAP 1616 Appendix E.

Group	Impact	Level of analysis	Option 3 - New Fillet of Segregated Airspace around Launch Site and Utilise D701
Communities	Noise impact on health and quality of life	Monetise* & quantify * 'Additional guidance under s70(2)(ca) Transport Act 2000: Carrying out air navigation functions for the purpose of spaceflight activities'; **removes the requirement to monetise noise**.	**DIRECT** - It is recognised that the nature of sounding rocket launch will create noise at the time of launch albeit for only a short period of 1-2 minutes. There are only a small number of dwellings in the immediate vicinity of the launch site that are likely to be affected meaning the number of individuals disturbed will be low. Furthermore, the launch site is restricted to 10 launches per year so it is considered that the noise impact will be low. Details of noise profiling can be found in the EIA/SEI and at paragraphs 6.1.3 and 6.1.4. **INDIRECT** - The location of the airspace around the launch site should not cause any deviation of the scheduled flights operating to Benbecula or divert any GA or helicopter traffic in the local area such that there should not be any noticeable difference in local flying activity that would induce noise in areas not normally affected by aircraft noise. Evidence to support this is detailed in paragraphs 3.9 and 3.10 above.

Group	Impact	Level of analysis	Option 3 - New Fillet of Segregated Airspace around Launch Site and Utilise D701
Communities	Air Quality		With no expected impact on GA or CAT aircraft operating below 7000ft in the local area, the air quality associated with this activity will remain unchanged. It is anticipated that the air quality in the immediate vicinity of the launch site may be affected for a short period (a few seconds) during the actual launch but this should quickly disperse and, given the prevailing wind is from the south-west, be experienced largely over the sea. This is evidenced in greater detail in Section 6 of this report and further amplified in the SP-1 EIA/SEI. It is not anticipated that the air quality for communities would be affected by any re-routing of CAT in the upper air (above FL195) caused by activation of D701 or the fillet of airspace around the launch site.
Wider society	Greenhouse gas emissions	Monetise & quantify	**Direct Impact** - The nature of sounding rockets, engine design and fuel used will result in greenhouse gas emissions, which will vary between different rocket types and so is difficult to quantify at this stage. It is thought that the impact should be negligible given the number of actual launches will average at less than one per month (a maximum of 10 per year). More information can be found in the EIA Appendix 18.1 'Detailed Dispersion Modelling'. **Indirect Impact** – It has been identified that there will be little or no disruption to air traffic flying below 7000ft therefore greenhouse gas emissions associated with local air traffic will not change. Of more significance is the greenhouse gas impact caused by CAT having to fly extended track miles to route around the active elements of D701; this is covered in detail at paragraph 3.7 in this document. It is estimated that in a single year a worst case maximum of 704.4 tonnes of CO_2 could be created. Using the metric that 1 tonne of CO_2 costs $93.93, 704.4 tonnes costs $66,164. The 10 year estimate based on EUROCONTROL predictions could see the CO_2 emissions rise to 802.7 tonnes in a year with an associated cost of $75,397.6 by 2035.
Wider society	Capacity / resilience	Monetise & quantify	Where a large number of D701 areas are active this could potentially induce a capacity issue on the NAT track structure where other adjacent airspace reservations are also active. This can be partly mitigated by using the same extant airspace protocols and ASM procedures in place for D701, for SP-1 operations. This would mean certain adjacent Danger Areas would not be active at the same time as D701. Moreover, by adhering to the limitations posed on the time of day when specific D701 areas are activated, the impact on the ATM network is further reduced. It is not possible to monetise this impact as there are too many variables associated with sub-orbital rockets with regard to the number and location of the D701 areas that will be required. These are determined by the

Group	Impact	Level of analysis	Option 3 - New Fillet of Segregated Airspace around Launch Site and Utilise D701
			safety trace of the individual rocket being launched, the environmental conditions and rocket payload. The information will not be known until the rocket provider commits to a SP-1 launch and the preliminary planning commences. It is also not possible to predict what other airspace reservations may be in place at the time of a SP-1 launch and what the combined impact on the ATM network will be; this simply cannot be quantified at this stage of the process.
General Aviation	Access	Monetise & quantify	There may be a very small impact on GA when the airspace around the launch site is activated, especially on non-radio fitted aircraft. It is anticipated that access for radio fitted aircraft will be possible during periods where the airspace is activated but launches are delayed or awaiting full range clearance (see paragraph 5.3). As is current practice for the D701 areas, MOD Hebrides Range staff are able to permit aircraft to enter active Danger Areas when considered safe to do so. Given the extremely light levels of GA activity and the infrequent use of the segregated airspace around the launch site, any impact on GA is considered negligible.
General Aviation / commercial airlines	Economic impact from increased effective capacity	Quantify	Not Applicable
General Aviation / commercial airlines	Fuel burn	Monetise & quantify	Activation of the fillet of airspace around the launch site is unlikely to invoke any increase in fuel burn for either GA or CAT; however, activation of D701 can lead to increase in fuel burn for CAT where they are forced to fly additional track miles around active Danger Areas. The worst case scenario for an increase in fuel burn is detailed at paragraph 3.7 where the total additional fuel burn for a year is calculated as 221.5 tonnes. Using the metric that 1 tonne of aviation fuel costs $104.39[52] then the total additional fuel costs are $23,122.4. Extant ASM processes and procedures detailed in current LoAs associated with the MOD Hebrides Range are an important facet in reducing the impact D701 has on CAT and their subsequent additional fuel burn. In particular, the limitations posed on the time of day when certain D701 areas are activated is crucial in reducing the impact on the ATM network. Utilising these same procedures

[52] International Air Transport Association (IATA) (2023), “Jet Fuel Price Monitor”. Accessed 9 Jan 24, available online at: IATA - Fuel Price Monitor. Price point: 5 Jan 24.

Group	Impact	Level of analysis	Option 3 - New Fillet of Segregated Airspace around Launch Site and Utilise D701
			and LoAs for rocket launch and use of D701 as proposed under this option, means that ‘best practice’ is being followed and consequential impact on CAT is minimised.
Commercial airlines	Training costs	Monetise & quantify	Not Applicable
Commercial airlines	Other costs	Qualitative	Not Applicable
Airport /ANSP	Infrastructure costs	Monetise & quantify	Not Applicable
Airport /ANSP	Operational costs	Monetise & quantify	The operational cost should be minimal for Option 3, consisting only of the cost of capturing the small fillet of airspace around the launch site into the ATC training system and any additional training associated with the minor amendments to extant LoAs and SOPs. By using D701 in its current form, the cost to ANSPs is minimised as ASM processes and procedures remain largely unchanged. Despite the Sponsor attempting to obtain rough order of magnitude costs for each of the three Options, this information was not forthcoming for commercial reasons therefore it has not been possible to quantify or monetise the operational costs; paragraph 3.11 refers. A similar argument applies for Benbecula airport where utilisation of existing LoAs, modified to include SP-1 and the fillet of airspace around the launch site, minimises the cost especially when compared to the creation of a new bespoke set of Danger Areas or, to a lesser degree, modification of the existing D701 areas.
Airport /ANSP	Deployment costs	Monetise & quantify	The deployment cost should be minimal, consisting only of the cost of introducing the small airspace fillet around the launch site into the ATC and ASM systems, applying a new FBZs where appropriate; making minor amendments to extant LoAs and SOPs; and minor amendments to aeronautical charts including two new Aeronautical Data Quality (ADQ) points to be validated for the airspace fillet.

Group	Impact	Level of analysis	Option 3 - New Fillet of Segregated Airspace around Launch Site and Utilise D701
			Using D701 in its current form means the costs to ANSPs are minimised as there would be no requirement to: • Introduce new additional reporting points (5LNCs). • Make large changes to ATC and MOD Hebrides Range systems mapping. • Introduce wholly new LoAs, ASM processes or procedures (and associated training costs). A similar argument applies for Benbecula airport where utilisation of existing LoAs, modified to include SP-1 and the airspace fillet around the launch site, reduces the cost especially when compared to the creation of a new bespoke set of Danger Areas or, to a lesser degree, modification of the existing D701 areas. The Sponsor has been unable to gain sufficient evidence to provide a quantitative assessment and as such these costs have not been monetised. The Sponsor offers a simple qualitative assessment as detailed in paragraph 3.11 of this document.

Group	Impact	Level of analysis	Option 4 - Construct New Bespoke Segregated Airspace Blocks from Launch Site
Communities	Noise impact on health and quality of life	Monetise* & quantify * 'Additional guidance under s70(2)(ca) Transport Act 2000: Carrying out air navigation functions for the purpose of spaceflight activities'; **removes the requirement to monetise noise**.	**DIRECT** - It is recognised that the nature of sounding rocket launch will create noise at the time of launch albeit for only a short period of 1-2 minutes. There are only a small number of dwellings in the immediate vicinity of the launch site that are likely to be affected meaning the number of individuals disturbed will be low. Furthermore, the launch site is restricted to 10 launches per year so it is considered that the noise impact will be low. Details of noise profiling can be found in the EIA/SEI and at paragraphs 6.1.3 and 6.1.4. **INDIRECT** - The location of the airspace around the launch site should not cause any deviation of the scheduled flights operating to Benbecula or divert any GA or helicopter traffic in the local area such that there should not be any noticeable difference in local flying activity that would induce noise in areas not normally affected by aircraft noise. Evidence to support this is detailed in paragraphs 3.9 and 3.10 above.

Group	Impact	Level of analysis	Option 4 - Construct New Bespoke Segregated Airspace Blocks from Launch Site
Communities	Air Quality		With no expected impact on GA or CAT aircraft operating below 7000ft in the local area, the air quality associated with this activity will remain unchanged. It is anticipated that the air quality in the immediate vicinity of the launch site may be affected for a short period (a few seconds) during the actual launch but this should quickly disperse and, given the prevailing wind is from the south-west, be experienced largely over the sea. This is evidenced in greater detail in Section 6 of this report and further amplified in the SP-1 EIA/SEI. It is not anticipated that the air quality for communities would be affected by any re-routing of CAT in the upper air (above FL195) caused by activation of a new bespoke modular airspace design or the fillet of airspace around the launch site.
Wider society	Greenhouse gas emissions	Monetise & quantify	**Direct Impact** - The nature of sounding rockets, engine design and fuel used will result in greenhouse gas emissions, which will vary between different rocket types and so is difficult to quantify at this stage. It is thought that the impact should be negligible given the number of actual launches will average at less than one per month (a maximum of 10 per year). More information can be found in the EIA Appendix 18.1 'Detailed Dispersion Modelling'. **Indirect Impact** – It has been identified that there will be little or no disruption to air traffic flying below 7000ft therefore greenhouse gas emissions associated with local air traffic will not change. Of more significance is the greenhouse gas impact caused by CAT having to fly extended track miles to route around the active elements of new bespoke areas (*it is assumed the impact on CAT will be the same as for Option 3 (utilising the existing D701 areas) as evidenced in the EUROCONTROL analysis in paragraph 3.3*); this is covered in detail at paragraph 3.7 in this document. It is estimated that the worst case scenario for a single year an additional 704.4 tonnes of CO_2 could be created. Using the metric that 1 tonne of CO_2 costs $93.93, 704.4 tonnes costs $66,164. The 10 year estimate based on EUROCONTROL predictions could see the CO_2 emissions rise to 802.7 tonnes in a year with an associated cost of $75,397.6 by 2035.
Wider society	Capacity / resilience	Monetise & quantify	Where a large number of bespoke areas are active this could potentially induce a capacity issue on the NAT track structure where other adjacent airspace reservations are also active. This can be partly mitigated by using the same extant airspace protocols and ASM procedures in place for D701, for SP-1 operations. This would mean certain adjacent Danger Areas would not be active at the same time as the bespoke areas. Moreover, by adhering to the limitations posed on the time of day when specific D701 areas are activated for the bespoke areas too, the impact on the ATM network is further reduced. It is not possible to monetise this impact as there are too many

Group	Impact	Level of analysis	Option 4 - Construct New Bespoke Segregated Airspace Blocks from Launch Site
			variables associated with sub-orbital rockets with regard to the number and location of the bespoke areas that will be required. These are determined by the safety trace of the individual rocket being launched, the environmental conditions and rocket payload. The information will not be known until the rocket provider commits to a SP-1 launch and the preliminary planning commences. It is also not possible to predict what other airspace reservations may be in place at the time of a SP-1 launch and what the combined impact on the ATM network will be; this simply cannot be quantified at this stage of the process.
General Aviation	Access	Monetise & quantify	There may be a very small impact on GA when the airspace around the launch site is activated, especially on non-radio fitted aircraft. It is anticipated that access for radio fitted aircraft will be possible during periods where the airspace is activated but launches are delayed or awaiting full range clearance (see paragraph 5.3). As is current practice for the D701 areas, MOD Hebrides Range staff are able to permit aircraft to enter active Danger Areas when considered safe to do so. Given the extremely light levels of GA activity and the infrequent use of the segregated airspace around the launch site, any impact on GA is considered negligible.
General Aviation / commercial airlines	Economic impact from increased effective capacity	Quantify	Not Applicable
General Aviation / commercial airlines	Fuel burn	Monetise & quantify	Activation of the fillet of airspace around the launch site is unlikely to invoke any increase in fuel burn for either GA or CAT; however, activation of any large bespoke areas can lead to increase in fuel burn for CAT where they are forced to fly additional track miles around active Danger Areas (*it is assumed the impact on CAT will be the same as for Option 3 (utilising the existing D701 areas) as evidenced in the EUROCONTROL analysis in paragraph 3.3)*. The worst case scenario for an increase in fuel burn is detailed at paragraph 3.7 where the total additional fuel burn for a year is calculated as 221.5 tonnes. Using the metric that 1 tonne of aviation fuel costs $104.39[53] then the total additional fuel costs are $23,122.4. Extant ASM processes and procedures detailed in current LoAs associated with the MOD Hebrides Range are an important facet in reducing the impact D701 has on CAT and their subsequent

[53] IATA (2023), "Jet Fuel Price Monitor". Accessed 9 Jan 24, available online at: IATA - Fuel Price Monitor. Price point: 5 Jan 24.

Group	Impact	Level of analysis	Option 4 - Construct New Bespoke Segregated Airspace Blocks from Launch Site
			additional fuel burn. In particular, the limitations posed on the time of day when certain D701 areas are activated is crucial in reducing the impact on the ATM network. Mapping across these procedures and LoAs for any new bespoke areas, where practicable, should provide similar benefits in reducing the overall impact on CAT.
Commercial airlines	Training costs	Monetise & quantify	Not Applicable
Commercial airlines	Other costs	Qualitative	Not Applicable
Airport /ANSP	Infrastructure costs	Monetise & quantify	Not Applicable
Airport /ANSP	Operational costs	Monetise & quantify	It is considered that this Option (out of the three Options proposed) would induce the highest operational cost to ANSPs and MOD Hebrides Range staff with regard to training. Staff would need to learn and understand the new processes and procedures associated with operating this wholly new airspace structure in addition to performing similar but discreetly different tasks operating the existing D701 areas. Measures would have to be put in place to ensure staff (both ANSP and Range staff) were not confused by operating two distinctly similar but different airspace structures in the same volume of airspace. A similar argument applies for Benbecula airport where training would be required in relation to any new processes and procedures pertaining to the new standalone airspace. Despite the Sponsor attempting to obtain rough order of magnitude costs for each of the three Options, this information was not forthcoming for commercial reasons therefore it has not been possible to quantify or monetise the operational costs. Paragraph 3.11 refers where a simple qualitative assessment is made.
Airport /ANSP	Deployment costs	Monetise & quantify	The deployment costs for this Option would be significantly more than for the other two proposed Options for the following reasons: • the requirement for 5LNCs being reserved with ICARD (new reporting points) to allow circumnavigation of the new airspace structure; • introduction of a number FBZs around the new airspace structure depending upon which elements are activated;

SPACE PORT 1

Group	Impact	Level of analysis	Option 4 - Construct New Bespoke Segregated Airspace Blocks from Launch Site
			• all new reference points for the origin of each line associated with this modular structure will need to be ADQ validated; • special instructions and associated training costs for ANSP and MOD Hebrides Range staff are increased significantly when compared against the other two options due to the size of the airspace change and associated standalone new ASM processes and procedures; • major update to mapping in LARA; • significant updates to ATC and MOD Hebrides Range systems mapping; • significant updates to aeronautical and maritime charts; and, • development and agreement of wholly new LoAs along with the development of SP-1 specific ASM processes and procedures including orders/instructions to MOD Hebrides Range and ATC staff. A similar argument applies for Benbecula airport where new LoAs, instructions and orders would have to be created for the new bespoke areas and agreements negotiated regarding access to active areas for specific airport approaches; these are likely to be different from the extant agreements due to the shape of any new areas. The Sponsor has been unable to gain sufficient evidence to provide a quantitative assessment and as such these costs have not been monetised. The Sponsor offers a simple qualitative assessment as detailed in paragraph 3.11 of this document.

Group	Impact	Level of analysis	Option 5 - Use in Conjunction with Option 3 Adding Sub-division of D701C, E, & F or reconfiguration of D701
Communities	Noise impact on health and quality of life	Monetise* & quantify * 'Additional guidance under s70(2)(ca) Transport Act 2000: Carrying out air navigation	**DIRECT** - It is recognised that the nature of sounding rocket launch will create noise at the time of launch albeit for only a short period of 1-2 minutes. There are only a small number of dwellings in the immediate vicinity of the launch site that are likely to be affected meaning the number of individuals disturbed will be low. Furthermore, the launch site is restricted to 10 launches per year so it is considered that the noise impact will be low. Details of noise profiling can be found in the EIA/SEI and at paragraphs 6.1.3 and 6.1.4. **INDIRECT** - The location of the airspace around the launch site should not cause any deviation of the scheduled flights operating to Benbecula or divert any GA or helicopter traffic in the local area such that there should not be any noticeable difference in local flying activity that would induce

Group	Impact	Level of analysis	Option 5 - Use in Conjunction with Option 3 Adding Sub-division of D701C, E, & F or reconfiguration of D701
		functions for the purpose of spaceflight activities'; **removes the requirement to monetise noise**.	noise in areas not normally affected by aircraft noise. Evidence to support this is detailed in paragraphs 3.9 and 3.10 above.
Communities	Air Quality		With no expected impact on GA or CAT aircraft operating below 7000ft in the local area, the air quality associated with this activity will remain unchanged. It is anticipated that the air quality in the immediate vicinity of the launch site may be affected for a short period (a few seconds) during the actual launch but this should quickly disperse and, given the prevailing wind is from the south-west, be experienced largely over the sea. This is evidenced in greater detail in Section 6 of this report and further amplified in the SP-1 EIA/SEI. It is not anticipated that the air quality for communities would be affected by any re-routing of CAT in the upper air (above FL195) caused by activation of D701 or the fillet of airspace around the launch site.
Wider society	Greenhouse gas emissions	Monetise & quantify	**Direct Impact** - The nature of sounding rockets, engine design and fuel used will result in greenhouse gas emissions, which will vary between different rocket types and so is difficult to quantify at this stage. It is thought that the impact should be negligible given the number of actual launches will average at less than one per month (a maximum of 10 per year). More information can be found in the EIA Appendix 18.1 'Detailed Dispersion Modelling'. **Indirect Impact** – It has been identified that there will be little or no disruption to air traffic flying below 7000ft therefore greenhouse gas emissions associated with local air traffic will not change. Of more significance is the greenhouse gas impact caused by CAT having to fly extended track miles to route around the active elements of new bespoke areas (*it is assumed the impact on CAT will be the same as for Option 3 (utilising the existing D701 areas) as evidenced in the EUROCONTROL analysis in paragraph 3.3*); this is covered in detail at paragraph 3.7 in this document. It is estimated that the worst case scenario for a single year could create an increase of 704.4 tonnes of CO_2. Using the metric that 1 tonne of CO_2 costs $93.93, 704.4 tonnes costs

Group	Impact	Level of analysis	Option 5 - Use in Conjunction with Option 3 Adding Sub-division of D701C, E, & F or reconfiguration of D701
			$66,164. The 10 year estimate based on EUROCONTROL predictions could see the CO_2 emissions rise to 802.7 tonnes in a year with an associated cost of $75,393.6 by 2034.
Wider society	Capacity / resilience	Monetise & quantify	Where a large number of D701 areas are active this could potentially induce a capacity issue on the NAT track structure where other adjacent airspace reservations are also active. This can be partly mitigated by using the same extant airspace protocols and ASM procedures in place for D701, for SP-1 operations. This would mean certain adjacent Danger Areas would not be active at the same time as the D701 areas. Moreover, by adhering to the limitations posed on the time of day when specific D701 areas are activated, the impact on the ATM network is further reduced. It is not possible to monetise this impact as there are too many variables associated with sub-orbital rockets with regard to the number and location of the D701 areas that will be required. These are determined by the safety trace of the individual rocket being launched, the environmental conditions and rocket payload. The information will not be known until the rocket provider commits to a SP-1 launch and the preliminary planning commences – this also means it is difficult to determine the most effective position of any sub-divisions. Furthermore, it is not possible to predict what other airspace reservations may be in place at the time of a SP-1 launch and what the combined impact on the ATM network will be; this simply cannot be quantified at this stage of the process.
General Aviation	Access	Monetise & quantify	There may be a very small impact on GA when the airspace around the launch site is activated, especially on non-radio fitted aircraft. It is anticipated that access for radio fitted aircraft will be possible during periods where the airspace is activated but launches are delayed or awaiting full range clearance (see paragraph 5.3). As is current practice for the D701 areas, MOD Hebrides Range staff are able to permit aircraft to enter active Danger Areas when considered safe to do so. Given the extremely light levels of GA activity and the infrequent use of the segregated airspace around the launch site, any impact on GA is considered negligible.
General Aviation / commercial airlines	Economic impact from increased effective capacity	Quantify	Not Applicable

Group	Impact	Level of analysis	Option 5 - Use in Conjunction with Option 3 Adding Sub-division of D701C, E, & F or reconfiguration of D701
General Aviation / commercial airlines	Fuel burn	Monetise & quantify	Activation of the fillet of airspace around the launch site is unlikely to invoke any increase in fuel burn for either GA or CAT; however, activation of a large number of D701 areas can lead to increase in fuel burn for CAT where they are forced to fly additional track miles around active Danger Areas (*it is assumed the impact on CAT will be the same as for Option 3 (utilising the existing D701 areas) as evidenced in the EUROCONTROL analysis in paragraph 3.3)*. The worst case scenario for an increase in fuel burn is detailed at paragraph 3.7 where the total additional fuel burn for a year is calculated as 221.5 tonnes. Using the metric that 1 tonne of aviation fuel costs $104.39[54] then the total additional fuel costs are $23,122.4. Extant ASM processes and procedures detailed in current LoAs associated with the MOD Hebrides Range are an important facet in reducing the impact D701 has on CAT and their subsequent additional fuel burn. In particular, the limitations posed on the time of day when certain D701 areas are activated is crucial in reducing the impact on the ATM network.
Commercial airlines	Training costs	Monetise & quantify	Not Applicable
Commercial airlines	Other costs	Qualitative	Not Applicable
Airport /ANSP	Infrastructure costs	Monetise & quantify	Not Applicable
Airport /ANSP	Operational costs	Monetise & quantify	It is considered that this Option would induce higher operational costs to ANSPs and MOD Hebrides Range staff (with regard to training), than Option 3 but less costs than Option 4. Staff would need to learn and understand the new processes and procedures associated with operating the reconfigured D701 Areas. A similar argument applies for Benbecula airport where training would be required in relation to any new processes and procedures pertaining to the new standalone airspace.

[54] IATA (2023), "Jet Fuel Price Monitor". Accessed 9 Jan 24, available online at: IATA - Fuel Price Monitor. Price point: 5 Jan 24.

Group	Impact	Level of analysis	Option 5 - Use in Conjunction with Option 3 Adding Sub-division of D701C, E, & F or reconfiguration of D701
			Despite the Sponsor attempting to obtain rough order of magnitude costs for each of the three Options, this information was not forthcoming for commercial reasons therefore it has not been possible to quantify or monetise the operational costs. Paragraph 3.11 refers where a qualitative assessment is made.
Airport /ANSP	Deployment costs	Monetise & quantify	The deployment costs for this Option would be more than for Option 3 due to the reconfiguration of the D701 areas, however it is likely the deployment costs would be less than for Option 4. Deployment costs are likely to include but are not limited to: • validating all reference points in the new structure to ensure ADQ standards are met; • special instructions and associated training costs for ANSP and MOD Hebrides Range staff; • integration of new areas into LARA and automated flight planning systems; • minor amendment to aeronautical and maritime charts; and, • amending current LoAs, ASM processes or procedures (with associated training costs). It is anticipated that deployment costs for Benbecula airport would be more than for Option 3 but less than for Option 4 in line with the qualitative assessment at 3.11. The Sponsor has been unable to gain sufficient evidence to provide a quantitative assessment and as such these costs have not been monetised. The Sponsor offers a simple qualitative assessment as detailed in paragraph 3.11 of this document.

Table 6: ACP-2021-12 CAP 1616 TABLE E2 – Airspace Design Options Appraisal Analysis

7. Next Steps

7.1 Next Steps in This ACP

This document, together with the Consultation Strategy and Consultation Document are submitted to the CAA for assessment at the CONSULT Gateway 15th March 2024. On successful completion of Stage 3 Step 3B, the process will move to Stage 3 Step 3C formal consultation phase. The following timeline is predicted:

CAP 1616 Descriptor	Planned Date
Stage 3 – Consult	15 March 2024
Stage 4 – Update & Submit	8 August 2024
Stage 5 – Decide	5 December 2024
Stage 6 – Implement	17 April 2025
Stage 7 – Post implementation review	To be determined (circa April 2026)

SPACE PORT 1

8. Glossary

Acronym	Meaning
5LNC	5 Letter Name Code
A330	Airbus 330
ACP	Airspace Change Proposal
ADQ	Aeronautical Data Quality
ADS-B	Automatic Dependent Surveillance - Broadcast
AGL	Above Ground Level
AIP	Aeronautical Information Publication
AIRPROX	Air Proximity
AMC	Airspace Management Cell
ANSP	Air Navigation Service Provider
AOI	Area Of Interest
ASD/FS 21	At Sea Demonstration/Formidable Shield 2021
ASM	Airspace Management
ASTM	American Society for Testing and Materials
ATC	Air Traffic Control
ATS	Air Traffic Service
B757	Boeing 757
B767	Boeing 767
B777	Boeing 777
CAA	Civil Aviation Authority
CAP	Civil Aviation Publication
CAT	Commercial Air Transport
CnES	Comhairle nan Eilean Siar
CNS	Communication Navigation & Surveillance
CO_2	Carbon Dioxide
D-1	Day minus 1
D-5	Day minus 5
D-21	Day minus 21
DAAIS	Danger Area Activity Information Service
dB	Decibel
DoD	Department of Defence
DPs	Design Principles
EG D	UK Segregated Airspace Designator and Danger Area
EGPX	Prestwick (ICAO designator)
EIA	Environmental Impact Assessment
ENM	EUROCONTROL Network Manager
FAA	Federal Aviation Authority
FBZ	Flight planning Buffer Zone
FIR	Flight Information Region
FL	Flight Level
FRA	Free Route Airspace
FTE	Full Time Employees
FUA	Flexible Use of Airspace
GA	General Aviation
GVA	Gross Value Added

HFD	Hazardous Fragmentation Distances
HIAL	Highlands & Islands Airports Ltd
HIE	Highlands & Islands Enterprises
HRA	Habitats Regulations Approval
IAA	Irish Aviation Authority
IATA	International Air Transport Association
ICAO	International Civil Aviation Organisation
ICEC	ICAO Carbon Emissions Calculator
ICARD	International Codes And Route Designators
km	Kilometre
LARA	Local and sub-regional airspace management support system
LoA	Letter of Agreement
MNPS	Minimum Navigation Performance Specification
MOD	Ministry of Defence
NAT	North Atlantic
NLB	Northern Lighthouse Board
NM	Nautical Mile
NOTA	Northern Oceanic Transition Area
NOTAM	Notice To Aviation
NOx	Nitrogen Oxides
NSA	National Scenic Areas
NSR	Noise Sensitive Receptors
OEPs	Oceanic Entry Points
OTS	Organised Track Structure
PC	Prestwick Centre
psf	Pounds per Square Foot
RF	Radio Frequency
ROM	Rough Order of Magnitude
RoTA	Rules of The Air
SAC	Special Areas of Conservation
SAR	Search And Rescue
SEL	Sound Exposure Level
SFC	Surface Level
SIA	Space Industry Act
SoN	Statement of Need
SP-1	Spaceport 1
SPA	Special Protection Areas
SUA	Special Use Airspace
SUPP	Supplement
TDA	Temporary Danger Area
UCT	Coordinated Universal Time
UNLTD	Unlimited
US	United States
VFR	Visual Flight Rules
WHO	World Health Organisation

9. References

A. **CAP 1616 Fourth Edition published March 2021; online, available at:** http://publicapps.caa.co.uk/modalapplication.aspx?catid=1&pagetype=65&appid=11&mode=detail&id=8127

B. ACP-2021-12 Stage 2 Step 2A Airspace Design Options and Design Principle Evaluation Report Version 2 dated 17th March 2023, online, available at: Airspace change proposal public view (caa.co.uk)

C. ACP-2021-12 Stage 2 Step 2B Options Appraisal (Phase 1) Initial Version 3 dated 11th May 2023, online available at: Airspace change proposal public view (caa.co.uk)

D. Environmental Impact Assessment Spaceport-1 Scolpaig, online, available at: https://cne-siar.gov.uk/home/busines/spaceport-1/

E. Letter of Agreement between NATS (en Route) plc, MOD DE&S, AMC UK, QinetiQ Ltd, UK CAA, IAA and Shannon V1.0 effective 1st May 2023.

F. MKA Economics 'Spaceport 1 Socio-Economic Impact Assessment 2023/24 – 2025/26' Final Report dated November 2022, online, available at: https://cne-siar.gov.uk/home/busines/spaceport-1/

G. Spaceport 1 EIA Report - Supplementary Environmental Information SEI Addendum Report dated January 2023, online, available at: https://cne-siar.gov.uk/home/busines/spaceport-1/

A Appendix A - Technical Note SP-1 Scolpaig V1.1 Dated February 2024

TECHNICAL NOTE

SPACEPORT 1, SCOLPAIG

VERSION 1.1

February 2024

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1 INTRODUCTION

Metrica Environmental Consulting Ltd ('Metrica') has been commissioned by Atlantic58 ('the Client') to provide support during the Airspace Change Proposal (ACP) process associated with Spaceport 1 ('the Development'), a new spaceport to be built and operated at Scolpaig, North Uist.

As part of this process, Metrica has been responding to comments relating to noise from the Civil Aviation Authority (CAA) following submission of the Development's EIA Report[1]. This Technical Note provides a formal response to the most recent comments from the CAA.

2 LAUNCH VEHICLE NOISE MODELLING AND FREQUENCY SPECTRUM

The CAA provided the following comment[2] with regard to the 1/3 octave band frequency spectrum shown in Chart 1 of Section 3.1 of the EIA Technical Assessment[3]:

"Rocket launches generate a lot of low frequency noise, however, the sponsor's 1/3 octave band spectrum exhibits very little low frequency noise, as if it is already A-weighted"

The method for determining the sound power level and associated frequency spectrum for launch noise is described in NASA 1971[4]. This is the method employed by the RUMBLE 2.0 launch noise modelling software, and has been validated by the software authors through measurement.

As the method relies on the physical characteristics of the launch vehicle, the resulting frequency spectrum is specific to the launch vehicle used. The values presented in the EIA Technical Assessment have been checked as requested; we can confirm that they are correct and are unweighted dB(Z) values.

It is important to note that the bandwidth of each 1/3 octave band is substantially smaller at lower frequencies (i.e., in the order or 10 Hz), than at higher frequencies (i.e. in the order of 1000 Hz). As such, the levels in low-frequency bands will intrinsically appear lower than those at higher frequencies, even where the level of energy at each frequency is the same, (e.g. white noise). This gives an impression form the chart that the launch vehicle emits 'very little' low-frequency noise when that is not the case in practice.

3 PREDICTED SOUND LEVELS: dB(Z)

With regard to predicted sound levels, the CAA queried the relationship between LAmax(slow) and LZmax(slow) levels, and stated that the assessment is required to *"remodel and map all areas exposed to spaceflight noise exceeding 100, 105, 110, 115 and 120 dB LZmax. The maps must illustrate any structures in the area impacted above 100 dB LZmax."*

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[1] Spaceport 1 EIA Report, Chapter 19: Noise and Vibration, Aquatera Ltd and Western Isles Marine and Environment Ltd, 2021

[2] Received by email from Client, dated 30/01.2024

[3] Spaceport 1 EIA Report, Appendix 19.1: Technical Appendix: Noise, Aquatera Ltd and Western Isles Marine and Environment Ltd, 2021

[4] NASA SP-8072 Acoustics Loads Generated by the Propulsion System, National Aeronautics and Space Administration, 1971

With regard to the difference between A-weighted and Z-weighted levels, whilst the difference does not change with level in its pure sense, it does vary with distance from the source, due to the frequency spectrum becoming gradually weighted toward lower frequencies with increasing distance, due to air and ground absorption effects.

Therefore, and as requested, the RUMBLE model has been re-run using the same input parameters as those used in the EIA; and the resulting LZmax(slow) contours shown in Figure 1. In addition, the figure shows any / all residential dwellings and scheduled monuments that are predicted to experience noise levels above 100 dB, LZmax(slow). As stated in the EIA Report, Scolpaig Farmhouse will not be reinstated as a residential dwelling, instead being integrated and redeveloped as part of the Development; it is therefore not a noise-sensitive receptor for the purposes of this assessment.

As can be seen, there are a total of three receptors (two dwellings, and one scheduled monument) that are predicted to experience levels above 100 dB LZmax(slow), none of which are predicted to experience levels of 120 dB LZmax(slow), or above (i.e. the criterion for risk of structural damage given in the Space Industry Act 2018[5]).

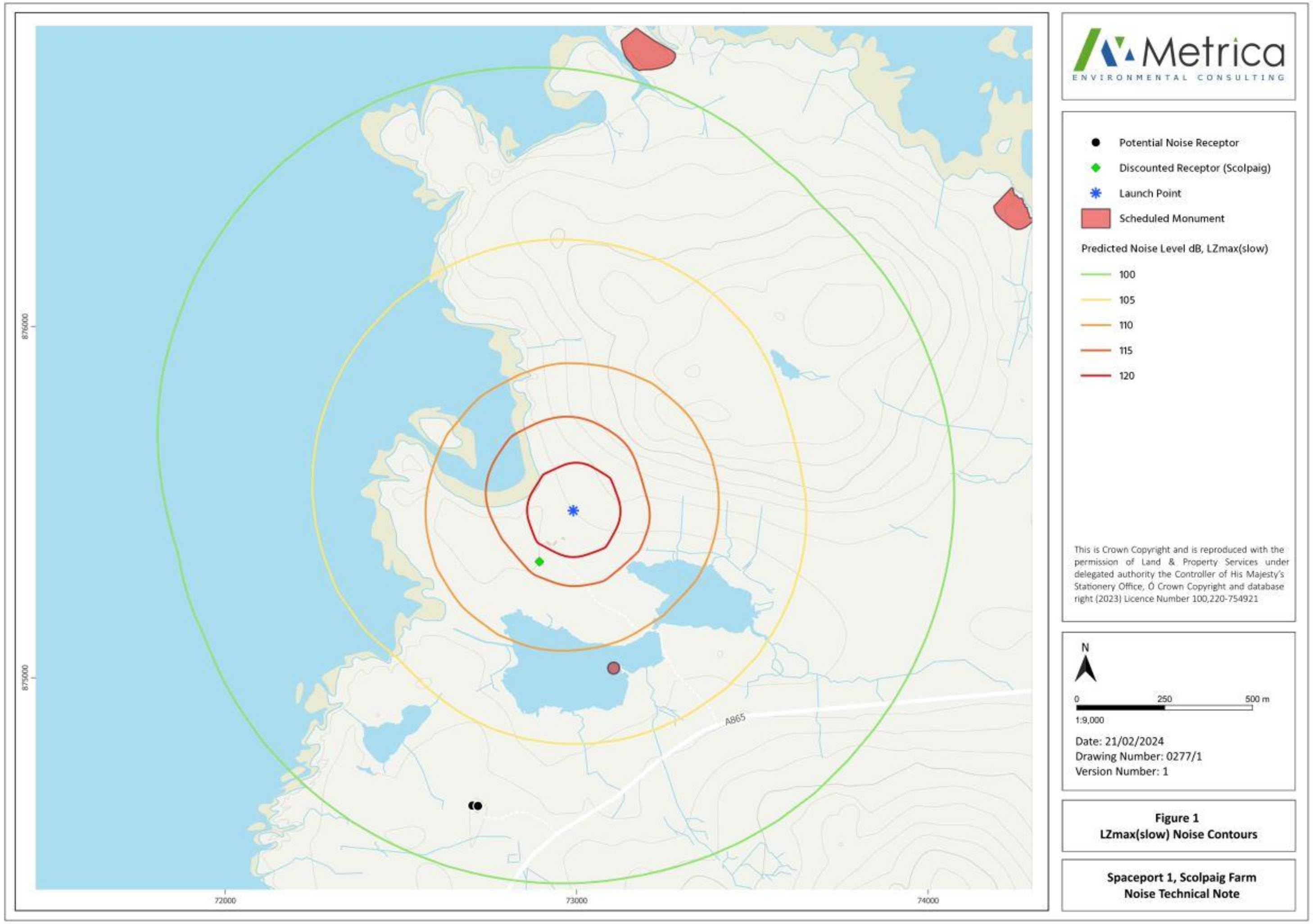
4 CONCLUSION

As requested by the CAA, this technical note has provided responses to the queries surrounding the launch vehicle frequency spectrum, and the difference between A-weighted and Z-weighted Lmax(slow) levels.

Regarding the frequency spectrum, the values presented in the EIA Technical Assessment have been checked as requested, and it is confirmed that they are correct.

With regard to the difference between A-weighted and Z-weighted levels, whilst the difference is relatively modest at distances relating to the identified receptors, it is acknowledged that the levels differ increasingly with distance from the launch site due to air and ground absorption (by up to 5 dB at distances of approximately 2 km). As requested, noise levels arising from operation of launch vehicles have been recalculated in terms of LZmax(slow); levels all receptors have been found to remain within the relevant criteria, and the outcome of the EIA therefore remains unchanged.

[5] Guidance to the regulator on environmental objectives relating to the exercise of its functions under the Space Industry Act 2018, Department for Transport, UK Government, 2021



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