Snowdonia Aerospace Airspace Change Proposal
Initial Design Options Appraisal (Stage 2B), ACP-2019-58
Llanbedr Danger Area (DA)

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Document Details

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Second reviewer and release authorisation		Chief Executive

Issue	Amendment Details	Date
1.0	First formal release	10th July 2020

Executive Summary

This report documents the "Stage 2B Options Appraisal" element of the Snowdonia Aerospace LLP submission for an Airspace Change Proposal, Reference: ACP-2019-58, Llanbedr Danger Area (DA, under the Civil Aviation Authority (CAA) CAP1616 Airspace Change Process.

Snowdonia Aerospace LLP is continuing to progress and further develop a number of complementary business opportunities at Llanbedr Aerodrome relating to aerospace Research, Development, Test and Evaluation (RDT&E) and military aircraft training. To support these operations (and others) action is required to upgrade and formalise the current airspace around the Aerodrome as the present provision is insufficient to meet the identified future need and risks restricting opportunities that are in the strategic economic interest of the UK and Welsh governments and required to sustain long term employment in the region. Snowdonia Aerospace LLP (hereafter also referred to as the Change Sponsor) is therefore developing two Airspace Change Proposals (ACPs) to underpin these activities:

- ACP-2019-58, Llanbedr Danger Area (DA), which can be accessed online via: https://airspacechange.caa.co.uk/PublicProposalArea?pID=193
- ACP-2020-02, Llanbedr Aerodrome Traffic Zone (ATZ), which can be accessed online via: https://airspacechange.caa.co.uk/PublicProposalArea?pID=211

This document relates to the former application, ACP-2019-58, with a view to creating a permanent Danger Area that will enable Llanbedr Aerodrome to increase support to the RDT&E for next-generation UK aerospace - *e.g.* drones (particularly non-military drones for good), electric aircraft, urban/regional air mobility vehicles, balloons, airships, near-space testing *etc*.

The CAA Civil Aviation Publication CAP1616 defines a six-stage process through to implementation of a permanent airspace change, some of which have more than one step. This document addresses the requirements for Stage 2B: Options Appraisal.

Stage 2B requires the Change Sponsor to carry out an initial appraisal of the impacts of each of the airspace design options identified in Step 2A and should, as a minimum, contain qualitative assessments of the different options. This highlights to change sponsors, stakeholders and the CAA the relative differences between the impacts, both positive and negative, of each option. The Change Sponsor assesses each option against a "do nothing" scenario (the "counterfactual"), even where there is only a single change option to understand these impacts.

The following primary conclusions have been made for Stage 2B:

1. Snowdonia Aerospace has assessed the impacts of the permanent Danger Area (DA) Design Options #1 and #2 proposed at Stage 2A against a "do nothing" option (continuing under a Temporary Danger Area) using the design criteria against which the options are being assessed;
2. In both cases, the permanent DA design provides an area of segregated airspace local to Llanbedr Aerodrome for the research, development, test and evaluation (RDT&E) of novel aerospace systems and an air corridor that will link Llanbedr Aerodrome with the existing Danger Area D201 over Cardigan Bay;
3. The methodology applied a simple qualitative assessment of the different options, both positive and negative, against the CAP1616, Appendix E, Table E2: "Guide to expected approach to key analysis for a typical airspace change". This approach has been applied previously in other Airspace Change Proposals of similar scale/proportionality and it has been deemed compliant both with the spirit of CAP1616 and the Government Green Book;

4. The assessment has highlighted a strong economic case for implementation of a permanent Danger Area on the basis that it will (a) significantly enhance the UK RDT&E capability in environmentally-friendly aircraft and electric technologies in accordance with the 2018 Aerospace Industrial Strategy, and (b) generate jobs and related economic benefit in local communities;
5. The number of novel aerospace system flight movements is expected to double, but the numbers are relatively small (~100 days of Danger Area activation per annum and <200 flights per annum), the vast majority of operations (~90%) will be over the aerodrome or out over the sea and the vehicle size (the majority <150kg) and propulsion type (50%+ electric) mean that the noise and environmental impact is expected to be negligible;
6. Despite a predicted increase in both novel aerospace RDT&E flying and RAF/MOD training, there is still considered to be sufficient capacity to accommodate all activities safely, including additional General Aviation. The estimate of approximately 100 days of Danger Area activation per annum translates to 2 days per week and with operations above 2000ft likely only 33% of the time. Appropriate air traffic management principles have already been identified to ensure spatial and temporal deconfliction across all elements of the Danger Area;
7. On the basis of the safety, operational, environmental and economic considerations, the Change Sponsor strongly recommends that the CAA consider the Llanbedr DA airspace change proposal favourably.

The initial design option appraisal stated here will be taken forward into Stage 3A of the CAP1616 process where the Change Sponsor plans its stakeholder consultation and engagement strategy, and prepares consultation documents, including the second-phase full options appraisal with more rigorous evidence for its chosen option.

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1. Introduction

1.1. Background

Llanbedr Aerodrome (EGFD), Gwynedd (Figures 1a-1d), is sited on a coastal promontory at the northerly end of Cardigan Bay[1] with bi-directional over-water approaches to the 2000m+ main runway (17/35), which is at an elevation of 8m above mean sea level. There are two additional cross runways 05/23 and 15/33. Under upcoming aerodrome licensing proposals it is currently intended the runways will be 2,188m, 1,199 and 799m respectively. The local geography is predominantly coastal lowland and farmland within Snowdonia National Park that is bounded to the east by the Rhinog mountains, which rise to 756m at a distance of 9500m (approx.) from the main runway. The village of Llanbedr (population 645, 2011 census) is 2000m (approx.) to the north-east of the northern threshold and there's also a transitory population during summer months at the Shell Island campsite (approx. 1000m to the north-west of the main runway northern threshold) and the Dyffryn caravan park (approx. 500m to the south of the main runway southern threshold). The overall population density is consistent with that for Gwynedd as a whole - *i.e.* <50 people per square km[2,3].

Fig. 1a *- aerial view looking west*

Fig. 1b *- aerial view looking east*

Fig. 1c *- aerial view looking north*

Fig. 1d *- aerial view looking south*

Llanbedr Airfield has a long history and established use for the research, development, test and evaluation (RDT&E) flying activities, particularly associated with the use of target drones, and also as a secondary/tertiary operating site for RAF Valley (EGOV, approx. 58km north/north-west). An Aerodrome Traffic Zone (ATZ)[4] and the original Danger Area D202 supported these activities prior to QinetiQ/MOD vacating the site in 2004, along with extant Danger Area D201, the closest edge of which is 25km (approx.) south-west of Llanbedr[5].

1 View on Google Maps
2 Ref: National Statistics Wales, June 2018
3 Ref: Annual Lower Super Output Area (LSOA) Population Estimates, 2018
4 Aerodrome Traffic Zone (ATZ) as detailed in Article 5 of the Air Navigation Order, 2016, Ref: Air Navigation Order, 2016
5 Ref: https://www.aurora.nats.co.uk/htmlAIP/Publications/2018-08-02/html/eAIC/EG-eAIC-2018-087-Y-en-GB.html

The airfield currently supports an increasing mix of small (<20kg) and light (<150kg) drone RDT&E and General Aviation (GA) operations together with visiting military aircraft (fixed wing and rotary) and others including the search and rescue (SAR) helicopter from Caernarfon (EGCK, approx. 35km north/north-west), Police helicopter and Air Ambulance. The airspace is currently Class G. A local Flight Information Service (FIS) has been provided to support day-to-day operations and a Temporary Danger Area (TDA)[6] has previously been consulted on and implemented as and when required, either as a whole or in part, to support RDT&E activities and provide a safe corridor to D201. There are GA aircraft operations most flyable days with an average of 100 to 200 movements per month. The airfield has also been designated as one of the candidate sites for a UK Spaceport by the Department for Transport (DFT) and Snowdonia Aerospace LLP has recently received a grant award from the UK Space Agency to generate a Horizontal Spaceport Development Plan.

1.2. Opportunity to be addressed and Statement of Need

Snowdonia Aerospace LLP is continuing to progress and further develop a number of complementary business opportunities at Llanbedr Aerodrome relating to aerospace RDT&E and military aircraft training. To support these operations (and others) action is required to upgrade and formalise the current airspace around the Aerodrome as the present provision is insufficient to meet the identified future need and risks restricting opportunities that are in the strategic economic interest of the UK and Welsh governments and required to sustain long term employment in the region. Snowdonia Aerospace LLP (hereafter also referred to as the Change Sponsor) is therefore developing two Airspace Change Proposals (ACPs) to underpin these activities:

- ACP-2019-58, Llanbedr Danger Area (DA), which can be accessed online via: https://airspacechange.caa.co.uk/PublicProposalArea?pID=193
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This document relates to the former application, ACP-2019-58, with a view to creating a permanent Danger Area that will enable Llanbedr Aerodrome to increase support to the RDT&E for next-generation UK aerospace - *e.g.* drones (particularly non-military drones for good), electric aircraft, urban/regional air mobility vehicles, balloons, airships, near-space testing *etc*. The Statement of Need for the application is declared as follows:

- *To provide an environment for safe operation of all ongoing aerospace-related Research, Development, Test and Evaluation (RDT&E) activities in the vicinity of Llanbedr Airfield (EGFD) and the ability for associated aircraft to transit safely to/from Danger Area D201 to undertake extended range/endurance/altitude testing (in accordance with extant D201 procedures) without concern for other air traffic.*

The proposal explicitly supports the Airspace Modernisation Strategy (CAP1711) by creating a permanent test zone in which to explore the airspace integration issues associated with new airspace users such as drones that are currently identified as “unknowns” in Chapter 5 of CAP1711.

1.3. The cause of the opportunity and associated factors or requirements

The preface to the UK Government Aerospace Industrial Strategy, 2018, states that:

- *‘Environmentally-friendly aircraft will increasingly incorporate electric technologies, and we anticipate more aircraft operating autonomously in the future. New markets for drones and Urban Air Mobility vehicles will be developed. We want the UK to be at the cutting edge of these exciting developments much as we were when Sir Frank Whittle developed the world’s first jet engine’.*

Llanbedr has long been a UK national asset for aerospace RDT&E and there has been increased demand in recent years given its ideal location for Beyond Visual Line-of-Sight (BVLOS) drone testing.

[6] Ref: “Request for TDA “Approval in Principle” For UAS operations at Llanbedr Aerodrome”, QINETIQ/MS/AD/LET1404197, Sept 2014

These activities have been satisfied to date by use of a Temporary Danger Area, but both customer demand and the need for confidence and reliance are now such that an application for a Permanent Airspace Change is warranted. The combination of safety, operational, technical and environmental factors already pertaining to low volume RDT&E activities is not expected to change. Moving to a permanent Danger Area will allow an increase in throughput to satisfy the market need and provide UK businesses in these sectors with a surety of being able to operate in the UK on a reactive basis. Many UK businesses have chosen to undertake their testing abroad due to the uncertainties around availability of adequate and appropriate commercial trials environments. Figures 2a – 2f below gives an indication of some of the wide variety of novel aerospace systems and applications that have previously been tested at Llanbedr Aerodrome and which would benefit from a permanent Danger Area to help accelerate development and commercial exploitation.

***Fig. 2a** – Penguin B used to explore the potential for aeromedical delivery drones*

***Fig. 2b** – Vertical Aerospace electric Urban Air Mobility (UAM) vehicle*

***Fig. 2c** – Scheibel S100 Camcopter used to explore the potential for search/rescue drones*

***Fig. 2d** – Astigan solar-powered high altitude, long endurance (HALE) vehicle*

***Fig. 2e** – C-Astral Bramor used to explore the potential for mapping and surveying drones*

***Fig. 2f** – The view of Cardigan Bay from the B2Space near-space testing balloon*

2. Design Options and Design Principle Evaluation

2.1. CAP1616 requirements and document scope

The CAA Civil Aviation Publication CAP1616[7] provides guidance on the regulatory process for changing the notified airspace design and planned and permanent redistribution of air traffic, and on providing airspace information.

CAP1616 defines a six-stage process through to implementation of a permanent airspace change, some of which have more than one step. However, it is recognised that requested airspace changes can vary hugely in size, scale and complexity and this variation has led the CAA to scale the process accordingly (CAP1616, Para. 50). Furthermore, the CAA will consider requests from the Change Sponsor for additional scaling of the process when there is a good reason and it is proportionate to do so.

On the 23rd January 2020 the CAA Airspace Regulation team met with Snowdonia Aerospace LLP to discuss an appropriately scaled submission for ACP-2019-58, Llanbedr Danger Area. Subsequent to this meeting, the CAA agreed to a scaled CAP1616 submission with a combined Define, Develop and Assess Gateway in July 2020. To meet this combined Gateway, Snowdonia Aerospace as the Change Sponsor is required to submit the following documents:

- Stage 1A: Assess Requirements - Statement of Need (previously submitted)
- Stage 1B: Design Principles;
- Stage 2A Options Development;
- Stage 2B Options Appraisal.

This document addresses the requirements for Stage 2B: Options Appraisal.

Stage 2B requires the Change Sponsor to carry out an initial appraisal of the impacts of each of the airspace design options identified in Step 2A and should, as a minimum, contain qualitative assessments of the different options. This highlights to change sponsors, stakeholders and the CAA the relative differences between the impacts, both positive and negative, of each option. The Change Sponsor assesses each option against a “do nothing” scenario (the “counterfactual”), even where there is only a single change option to understand these impacts.

The remainder of this section summarises the design principles from Stage 1B, the design options from Stage 2A, further history on the airspace use around Llanbedr, and an assessment of potential future use as context for the full options appraisal in Section 3.

2.2. Summary of design principles

Based upon responses received from stakeholder engagement and associated discussions and analysis, the final technical, safety, environmental and operational design principles for ACP-2019-58, Llanbedr Danger Area are as defined in Table 1 below:

[7] Ref: https://publicapps.caa.co.uk/docs/33/CAP1616_Airspace%20Change_Ed_3_Jan2020_interactive.pdf

ID	Category	Design Principle
1	Technical	The design will provide an area of segregated airspace local to Llanbedr Aerodrome for the research, development, test and evaluation (RDT&E) of novel aerospace systems
2	Technical	The design will also provide an air corridor that will link Llanbedr Aerodrome with the existing Danger Area D201
3	Technical / Operational	The design will consist of multiple segments that should, where possible, allow the area of segregated airspace to be kept to a minimum in line with Flexible Use of Airspace principles while still meeting operational requirements
4	Technical / Operational	The Danger Area (DA) design will be consistent with the operation of the Aerodrome Traffic Zone (ATZ) (assuming successful conclusion of ACP-2020-02)
5	Safety	The design will not adversely affect the safety of operations at other nearby aerodromes
6	Safety / Operational	Operating hours of the Flight Information Service (FIS) and DA will be linked to ensure consistent traffic procedures and radio calls, and demand for changes in operating hours of the FIS will require a corresponding change in the operating hours of the DA and vice-versa
7	Environmental / Operational	Any impact on the environment and associated leisure activities should, where possible, be minimised via operating procedures and should, where possible, take account of any local development projects or noise sensitive areas that are highlighted as a result of stakeholder engagement
8	Environmental	The design should, where possible, take account of local planning policy including that of the Snowdonia National Park Authority and the aerodrome registered Safeguarding Map
9	Operational	Impact on military aircraft training should, where possible, be minimised via operating procedures in line with Flexible Use of Airspace principles
10	Operational	Impact on General Aviation (GA), gliding, microlight flying, hang gliding, paragliding or model flying should, where possible, be minimised via operating procedures in line with Flexible Use of Airspace principles

Table 1 *- Final design principles for ACP-2019-58, Llanbedr Danger Area*

2.3. Summary of design options

SAC has prepared two design options for the Danger Area (DA) and a side-by-side comparison of is shown in Figure 3a and 3b below. In both cases, the design provides an area of segregated airspace local to Llanbedr Aerodrome for the RDT&E of novel aerospace systems and an air corridor that will link Llanbedr Aerodrome with the existing Danger Area D201. As far as possible, the shape of both DA options has been designed to be easy to interpret and implement and the size has been designed to accommodate a range of different novel aerospace systems. Outline Air Traffic Management principles have also been identified for both options.

Option #1 describes a baseline for the DA airspace change based on the Temporary Danger Area (TDA) that was originally consulted on, approved and promulgated in 2014. Option #2 is a further refinement based on feedback received as part of the two-way engagement process on the Design Principles. Feedback from stakeholders and interested parties indicated that Option #1 was considered to be easier to interpret and to provide greater flexibility for operators using the DA, whereas Option #2 was considered to be more complex but offered more advantages in terms of flexible use of airspace.

Other local airspace users, both military and general aviation, identified possible potential airspace access conflicts, but SAC is sympathetic to the needs of other airspace users and we believe a mutually satisfactory compromise is very easily achievable. An action was identified for continued engagement to further refine the details and operating procedures that will inform the Letters of Agreement with these other airspace users. Notwithstanding this action, we believe the Design Principles and Design Options that have been developed to date are fundamentally sound and suitable for taking forward into the next stages of the airspace change process.

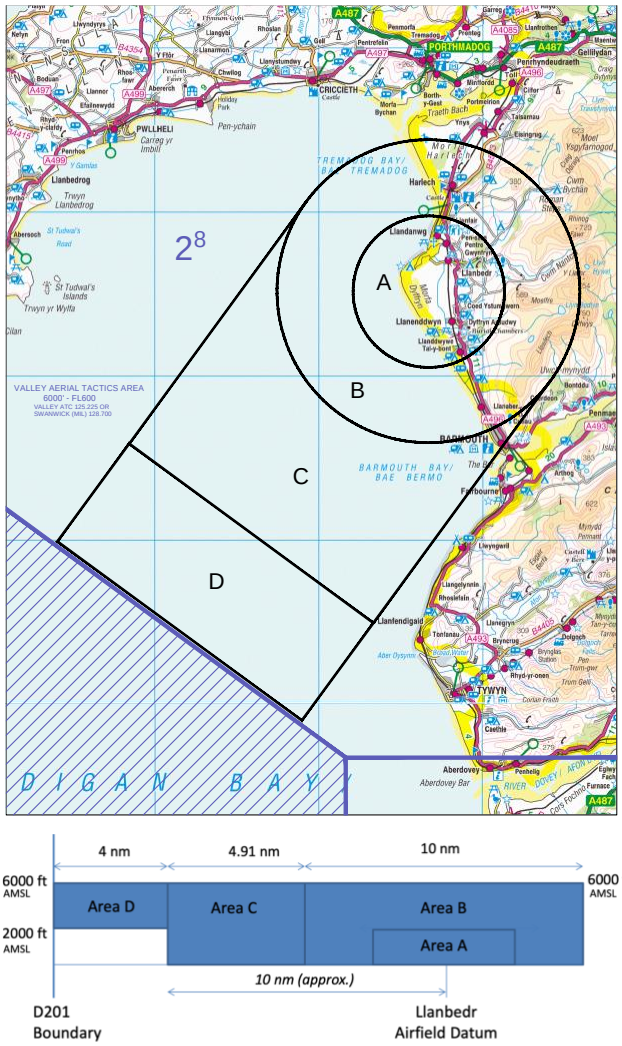

Fig. 3a *– Airspace Design Option #1 for ACP-2019-58, Llanbedr Danger Area*

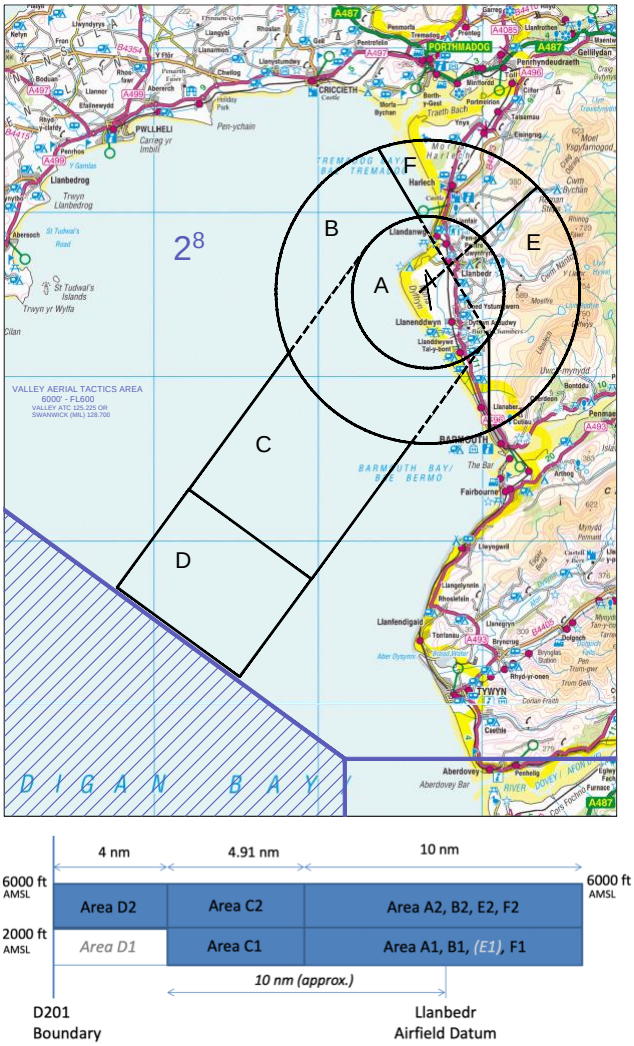

Fig. 3b *– Airspace Design Option #2 for ACP-2019-58, Llanbedr Danger Area*

2.4. Summary of historical airspace use

Llanbedr Aerodrome opened in 1941 as part of RAF Fighter Command's 12 Group and pre-dates the creation of Snowdonia National Park by 10 years. From 1942 it was an operational base for towed targets and later became part of the Royal Aircraft Establishment, Defence Evaluation & Research Agency and QinetiQ, providing target drone services to the UK Armed Forces through to October 2004.

In terms of airspace, these activities (and those highlighted below) were previously supported by an Aerodrome Traffic Zone and Danger Area (D202) as illustrated in Figure 4 (from 2002). These airspace constructs lapsed when QinetiQ/MOD vacated the site in 2004.

Figure 4 *- UK aviation chart from 2002 showing the ATZ and Danger Area (D202) at and around Llanbedr Aerodrome prior to QinetiQ/MOD vacating the site in 2004*

As well as target drone operations, Llanbedr also supported training activities from RAF Valley, a range of other military operations, General Aviation and a variety of other novel aviation during this period and "Target Rolling: A History of Llanbedr Airfield"[8] provides a detailed record of activity. A further article in Target Magazine[9] by the Senior Air Traffic Control Officer at Llanbedr notes that over 67,000 aircraft movements were recorded in the period from 1998 through to QinetiQ/MOD vacating the site in 2004, an average of approximately 9500 movements per annum.

From the transfer of the aerodrome into private ownership in 2012, Snowdonia Aerospace LLP has and continues to develop the aerodrome to create a multi-use aerospace centre. This was much welcomed by the GA community, as noted in Pilot Magazine[10].

As detailed in Section 1, Snowdonia Aerospace LLP is further progressing and further developing a number of complementary business opportunities at Llanbedr Aerodrome relating to aerospace RDT&E and military aircraft training, while also continuing to support a mix of other aerospace uses including general aviation. To safely sustain these activities, action is required to upgrade and formalise the current airspace around the Aerodrome as per Airspace Change Proposal, Reference: ACP-2019-58, Llanbedr Danger Area.

2.5. Assessment of future airspace use

With regard current novel aerospace RDT&E activity at Llanbedr Aerodrome, we've seen on-site occupancy increase from 30 days in 2017/18 to 40 days in 2018/19 and to 80 days in 2019/20. We have now reached the point where a request for activation of a Temporary Danger Area is a schedule limitation and is not providing UK businesses with the surety of being able to operate in the UK on a reactive basis.

[8] Wendy Mills, "Target Rolling: A History of Llanbedr Airfield", Midland Publishing. pp. 128. ISBN 1-85780-136-9
[9] Target, Souvenir Edition No. 10, Autumn 2004
[10] https://www.pilotweb.aero/airfieldsfurther /welcome-to-llanbedr-1-3656415

Looking ahead to the immediate future, we can foresee that support to the UK Research and Innovation Future Flight Challenge[11] is, as a minimum, going to double on-site occupancy to 160 days/annum in the period 2020 to 2024 and that growth in the novel aerospace industry is likely to sustain this figure into the longer term.

Translating this forecast of on-site occupancy into the demand for activation of the permanent Danger Area is not straightforward because of the wide variation in types of novel aerospace systems (examples of which are illustrated in Figure 2a – 2f) and the associated type-specific flight test and evaluation requirements. Furthermore, it would be useful to have an estimate of the breakdown for the probable utilisation of the sub-areas identified in Design Options #1 and #2 to determine the potential impact on other airspace users, the local community and the surrounding environment.

Any estimate we make is obviously going to have a degree of error, but for the purposes of the CAP1616 Stage 2B Design Options Appraisal, we believe a reasonable approach is to apply a simple multiplicative cascade - *i.e.* we would expect the sub-areas further away from the aerodrome to be used less - and that the respective probabilities associated with each step have been determined based on a mix of prior experience and market knowledge:

- We expect there to be a 66.6% probability (*i.e.* twice as likely as not) that we will need to activate the DA on any day when the airfield is supporting a novel aerospace system activity;
- We then expect there to be a similar 66.6% probability that we would need to activate more than one sub-area (Area A + Area B/C/D *etc*.);
- We further expect there to be a 66.6% probability that the additional sub-areas will be adjacent to Area A - *i.e.* Area B for Option 1 or Area B/E/F for Option 2 - and a corresponding 33.3% probability that the novel aircraft system would need to enter the Area C/D corridor;
- For Option #2 we would also expect there to be a 75% probability (*i.e.* three time as likely as not) that Area B would be activated in preference to Areas E or F;
- Again, for Option #2, if over-land sub-areas of the DA need to be activated, there is expected to be a 50% probability that it will be Area E or F;
- Finally, regardless of Design Option or sub-area, we expect there to be a 66.6% probability that the maximum altitude required will be 2000ft and a corresponding 33.3% probability that the maximum altitude required will be 6000ft.

Assuming a minimum target of 160 days occupancy per year, this gives the following predicted number of days Danger Area activation per year for each the various sub-areas:

	Design Option #1	**Design Option #2**
Area A (over the aerodrome)	107	107
Area B* (inshore+)	47	35
Area C/D (offshore corridor to D201)	24	24
Area E (coastal lowland/Harlech)		6
Area F (toward Rhinog mountains)		6
Max. altitude <2000ft	71	71
Max. altitude <6000ft	36	36

***Table 2** - Estimate of future permanent Danger Area annual daily usage (*Note - Option #1, Area B is equivalent to Option #2, Area B+E+F)*

[11] https://www.ukri.org/innovation/industrial-strategy-challenge-fund/future-flight1/

To complete the forecast, it would also be reasonable to estimate that it's again twice as likely as not (66.6%) that the novel aerospace systems operating at Llanbedr Aerodrome will have a maximum take-off weight less than 150kg (i.*e.* small/light drones) and that the split between internal combustion engine/jet-powered aircraft and electric-powered aircraft will be roughly 50:50, but with an increasing bias toward electric-powered aircraft over time.

Please note that these estimates are indicative only and intended primarily to show the usage of the various sub-areas relative to each other and to allow the potential impact on other airspace users, the local community and the surrounding environment to be determined. We have quoted daily occupation as the key metric as this is easier to predict and there are historical records for the past three years to back this up, but in terms of actual flights/aircraft movements, it would be reasonable to assume two flights on any given day as a guide.

This estimate is also based primarily on a forecast of drone and electric aircraft operations in the period up to 2024. Beyond this period, we would expect a small but increasing number of space-related activities to increase the proportion of operations using the air corridor to connect to the D201 Cardigan Bay Range.

3. Design Options Appraisal

3.1. Methodology

Stage 2B requires an initial appraisal of the impacts of the design options presented in Section 2.3 against a "do nothing" option using the design criteria against which the options are being assessed (from Section 2.2).

The chosen methodology is to conduct a simple qualitative assessment of the different options, both positive and negative, against the headings identified in CAP1616, Appendix E, Table E2: "Guide to expected approach to key analysis for a typical airspace change". This approach has been applied previously in other Airspace Change Proposals of similar scale/proportionality that have successfully passed the Stage 2 Gateway and it has been deemed compliant both with the spirit of CAP1616 and the Government Green Book[12]. There are no commercial airline operations in the vicinity of Llanbedr, but there is a significant amount of military aircraft training. The options appraisal has therefore been conducted in this context and references to "commercial airline" within CAP1616 have been interpreted as "RAF/MOD".

3.2. The "do nothing" option

In the context of novel aerospace operations at Llanbedr Aerodrome and demand for a permanent Danger Area, the "do nothing" option would be to try and persist with a series of Temporary Danger Area requests with the consequent impact on schedule limitation and business uncertainty. This also makes the assumption that a TDA can be renewed and/or revised indefinitely.

3.3. Options appraisal

Table 2 detail the appraisal of the Llanbedr Danger Area options and the "do nothing" options against the high-level objectives and assessment criteria laid out in CAP1616, Appendix E, Table E2. The immediate pre-2004 position at Llanbedr (Section 2.4) and estimated post-2020 position (Section 2.5) are also valuable additional baselines.

Group	Impact	DA Option #1	DA Option #2	"Do nothing"
Communities	Noise impact on health and quality of life	• The number of novel aerospace system movements is expected to double, but numbers are relatively small (~100 DA days/annum, <200 flights/annum), and vehicle size (majority <150kg) and propulsion type (50%+ electric) means the noise impact is likely to be negligible. The vast majority of operations (~90%) will also be over the aerodrome or out to sea. Systems that deviate notably from the norm can be managed by Letter of Agreement with the local communities		• There would be little or no change from present
Communities	Air quality	• As above, there is expected to be little impact on air quality		• There would be little or no change from present
Wider society	Greenhouse gas impact	• As above, there is expected to be little direct impact and a strong element of the RDT&E activities will be focussed on reducing greenhouse gases in aviation		• There would be little or no change from present
Wider society	Capacity / resilience	• A permanent DA will significantly enhance the UK RDT&E capability in environmentally friendly aircraft and electric technologies and allow UK Govt. to move closer to the goal stated in the Aerospace Industrial Strategy, 2018 for "the UK to be at the cutting edge of these exciting developments". A permanent DA also supports the Airspace Modernisation Strategy by creating a test zone in which to explore the airspace integration issues associated with new airspace users such as drones that are identified as "unknowns" in Chapter 5 of CAP1711.		• Similar to the permanent DA, but at much reduced capacity, and makes the assumption that the TDA can be renewed indefinitely

[12] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/685903/The_Green_Book.pdf

General Aviation	Access	• The current level of GA traffic (789 movements in 2019)[13] is unlikely to be unduly impacted by the DA, which is estimated will be active 2 days / week on average. Related operational issues could be managed via Letters of Agreement.	• As per Option #1, but with the potential for increased flexible use of airspace via greater DA segmentation and with mechanisms in place for safe transit to west, east or above the DA (above 2000ft) depending on which sub-areas are active.	• There would be little or no change on General Aviation operations in the vicinity of Llanbedr from the present position
RAF	Access	• Despite a predicted increase in both RDT&E flying and RAF/MOD training, there is still considered to be sufficient capacity to accommodate all activities safely with appropriate mechanisms identified for spatial and temporal deconfliction. It is estimated the DA will be active 2 days / week on average and with operations above 2000ft likely only 33% of the time. Related operational issues could be managed via Letters of Agreement.	• As per Option #1, but with the potential for increased flexible use of airspace via greater DA segmentation and with mechanisms in place for safe transit to west, east or above the DA (above 2000ft) depending on which sub-areas are active.	• There would be little or no change on RAF/MOD operations in the vicinity of Llanbedr from the present position
General Aviation / RAF	Economic impact from increased effective capacity	• There is not expected to be any economic impact on General Aviation or RAF/MOD		• There would be little or no change from present
General Aviation / RAF	Fuel burn	• General aviation and RAF/MOD fuel burn is not expected to change		• There would be little or no change from present
RAF	Training cost	• *Not applicable*		• *Not applicable*
RAF	Other costs	• *Not applicable*		• *Not applicable*
Airport / ANSP	Infrastructure costs	• There will be a need for further investment into the Aerodrome facilities to implement a UTM system. These costs are being borne by Snowdonia Aerospace LLP as part of its ongoing investment programme at the Aerodrome		• As per Option #1
Airport / ANSP	Operational costs	• There may be a need for increased Flight Information Service (FIS) and Rescue & Fire-Fighting Services (RFFS), but this cost will be borne by Snowdonia Aerospace LLP • *See also economic impact*		• As per Option #1
Airport / ANSP	Deployment costs	• There may be a need for additional FIS and RFFS training, but this cost will be borne by Snowdonia Aerospace LLP • *See also economic impact*		• As per Option #1

[13] Snowdonia Aerospace, Llanbedr Aerodrome Movement Record 2019

Airport / ANSP	Economic impact from increased effective capacity	• A recent economic impact assessment[14] suggested a multi-use aerospace site at Llanbedr (with aerodrome licencing, ATZ and DA implementation as fundamental building blocks) could contribute 515 jobs and £19.5m/annum of GVA at the local level and 765 jobs and £34m/annum of additional GVA in Wales over the next 10 years	• Not having a permanent DA will remove one of the fundamental building blocks associated with development of Llanbedr as a multi-use aerospace site and jeopardise the predicted economic benefit to the local community

***Table 2** – Summary of the options appraisal for Llanbedr Danger Area and "do nothing" options*

3.4. Safety assessment

By definition and design a Danger Area (or Temporary Danger Area) is intended to enhance the safety of aviation operations by creating a small volume of segregated airspace that gives protection to experimental aircraft that are not "able to comply with the current requirements of the Air Navigation Order (ANO), including the Rules of the Air" as per CAA CAP722 Unmanned Aircraft System Operations in UK Airspace – Guidance & Policy.

None of the areas of the proposed DA will be permanently active and will only be activated by Notice to Airmen (NOTAM) when novel aerospace flying activities are due to take place. There is a safety advantage in having a permanent Danger Area as opposed to a Temporary Danger Area as it will be published in standard Aeronautical Information Regulation and Control (AIRAC) documentation as well as being promulgated via NOTAM ahead of activation. Snowdonia Aerospace will work actively with other local airspace users – *e.g.* via the regular RAF Valley Airspace Users Symposium – to raise awareness of Danger Area activities at Llanbedr.

Once active, the following outline Air Traffic Management principles are expected to apply for both Danger Area Design Options #1 and #2 to ensure safe operation with regard (a) novel aerospace systems remaining within the DA, (b) other air traffic is kept out of the DA, and (c) any transfer between the Llanbedr DA and D201 is managed safely:

- A Flight Information Service (FIS) will be provided by Snowdonia Aerospace from take-off to landing for all novel aerospace operations within the proposed DA. The core FIS will be augmented with an Unmanned Traffic Management (UTM) system with a minimum ADS-B Out monitoring capability. Llanbedr FIS will also provide a Danger Area Activity Information Service (DAAIS) for all airspace users in the vicinity of the DA;
- It is anticipated that the novel aerospace system will be equipped with an ADS-B Out transponder as a minimum electronic conspicuity capability when operating outside of Area A for both Options #1 and #2;
- QinetiQ/MOD Aberporth Air Traffic Control (ATC) will be notified of all novel aerospace operations and their services will be engaged via Letter of Agreement (LOA) for operations that intend to transit through Area D for both Options #1 and #2 to operate in D201 or further into D202;
- The novel aerospace system crew is responsible for monitoring flight systems and communicating directly with Llanbedr FIS or MOD Aberporth ATC;
- In addition, the novel aerospace system crew is to ensure that the aircraft remains within the confines of the segregated airspace during both normal operation and in the event of any routine emergency. The novel aerospace system will be expected to "geo-fence" and maintain a buffer to prevent inadvertent departure from the DA.

[14] Wavehill Ltd, "Economic Impact Assessment for the Masterplan Development Proposals for the Snowdonia Aerospace Centre incorporating Spaceport Snowdonia at Llanbedr Airfield", 12th March 2020

With regard unmanned aircraft/drone operations, it should be noted that a Danger Area is only one element of a multi-faceted Operating Safety Case (OSC) that will determine where, when and how a drone can operate and will be subject to review and approval by the CAA before operation within the DA will be allowed.

A permanent DA will also warrant closer attention from the CAA Innovation Hub with regard their "Regulatory Sandbox" activities and is likely to see a case officer nominated to support RDT&E activities at Llanbedr and provide advice to individual operators on an appropriate approach to safety management (independent of the subsequent OSC review).

A permanent Danger Area at Llanbedr is therefore considered to be most appropriate mechanism to address safety in the face of increasing demand for novel aerospace test and evaluation capability in the UK.

3.5. Discussion of options appraisal

Taking the analysis in Sections 3.3 and 3.4 together, there is an exceptionally strong argument that implementation of a permanent Danger Area at Llanbedr provides a solution that not only satisfies safety and operational requirements, but also minimises the broader environmental impact, whilst meeting a need that is in the strategic economic interest of both the UK and Welsh governments in terms of accelerating novel aerospace development in the UK and creating jobs in south Gwynedd, respectively.

The primary difference between the "do nothing" option of continuing with a Temporary Danger Area or implementing a permanent Danger Area is that a permanent DA will take away the schedule limitation on RDT&E operations at Llanbedr and provide UK aerospace businesses with a surety of being able to conduct developmental testing in the UK on a reactive basis. There is a growing demand for such a capability, as witnessed by the doubling of activity at Llanbedr over the past two years and the forecast for it to double again in the next two years, particularly to support the upcoming UK Future Flight Challenge (see Section 2.5). UK Research & Innovation has already highlighted a paucity of aviation innovation or development environments in the UK that will allow real-life demonstration and evaluation of next-generation system-of-system issues as part of its Future Flight Challenge[11] problem statements. A permanent DA will significantly enhance the UK RDT&E capability in environmentally-friendly aircraft and electric technologies and allow UK Government to move closer to the goal stated in the Aerospace Industrial Strategy, 2018 for "the UK to be at the cutting edge of these exciting developments". A permanent DA also supports the CAA Airspace Modernisation Strategy (CAP1711) by creating a test zone in which to explore the airspace integration issues associated with new airspace users such as drones that are currently identified as "unknowns" in Chapter 5 of CAP1711.

As well as supporting the development of environmentally-friendly aerospace and aviation in the UK and supporting regeneration of a greener UK economy following Covid-19, there is also a strong local economic benefit to a permanent DA. A recent economic impact assessment[14] suggested a multi-use aerospace site at Llanbedr (with aerodrome licencing, ATZ and DA implementation as fundamental building blocks) could contribute 515 jobs and £19.5m/annum of GVA at the local level and 765 jobs and £34m/annum of additional GVA in Wales over the next 10 years.

The overarching economic benefit obviously has to be set against the potential noise/non-economic quality-of-life impact on the local community and the surrounding environment and the potential impact on airspace access for the RAF/MOD and other General Aviation operators.

With regard the potential noise and non-economic quality-of-life impact on the local community and the surrounding environment, the number of novel aerospace system movements is obviously expected to double, but the numbers are relatively small (~100 days of Danger Area activation/annum and <200 flights/annum), and the vehicle size (the majority <150kg) and propulsion type (50%+ electric) mean that the noise and environmental impact is likely to be negligible. The vast majority of operations (~90%) will also be over the aerodrome or out over the sea (see Section 2.5).

It is worth noting that no noise issues have been raised by the local community concerning previous novel aerospace RDT&E activities over the past five years under the Temporary Danger Area. Indeed, many of the smaller, electric systems are near-silent and near-invisible to the naked eye when at their operating altitude and will probably have gone completely unnoticed by the public. Any larger systems that may deviate notably from the norm will be discussed with the local community and can be managed by Letter of Agreement.

The remaining area of concern therefore relates to the potential impact on airspace access for the RAF/MOD and other General Aviation operators in the vicinity of Llanbedr Aerodrome. Despite a predicted increase in both novel aerospace RDT&E flying and RAF/MOD training, there is still considered to be sufficient capacity to accommodate all activities safely. The estimate of approximately 100 days of Danger Area activation at Llanbedr per year translates to 2 days per week and with operations above 2000ft likely only 33% of the time, relative to a base level of 4000ft for Texan T1 and 5000ft for Hawk T2. Similarly, activation of the DA sub-areas creating a corridor to D201 is likely only 33% of the time and engagement with the MOD Danger Area Airspace Manager has identified no fundamental issues other than a need to provide sufficient notice to allow coordination with MOD test activities. Appropriate air traffic management principles have already been identified to ensure spatial and temporal deconfliction across all elements of the Danger Area and a permanent DA will also provide Snowdonia Aerospace with the confidence to invest further in Unmanned Traffic Management (UTM) technology and airspace coverage. On this basis, it is considered that RDT&E flying and RAF/MOD training can safely co-exist (as it did very successfully pre-2004 with much higher numbers of aircraft movements) and that any related operational integration issues could be managed via Letters of Agreement.

Likewise, there is also considered to be more than sufficient capacity to safely accommodate all General Aviation (GA) activities. The current level of GA traffic is only 789 movements per year (2019), averaging roughly 2 movements per day, including weekends, and is unlikely to be unduly impacted by the Danger Area, which will be active an estimated 2 days per week on average, and is less likely to include weekends when GA traffic is more prevalent. Furthermore, DA Option #2 features greater segmentation of the Danger Area that will also allow GA aircraft to safely transit an active DA to the west, east or above (>2000ft) depending on which sub-areas are activated. On this basis, it is believed that RDT&E flying and GA traffic can safely co-exist and that any related operational integration issues could be managed via Letters of Agreement.

Considering the safety, operational, environmental and economic considerations presented above, the Change Sponsor strongly recommends that the CAA consider the Llanbedr Danger Area airspace change proposal favourably.

4. Conclusions and Next Steps

4.1. Conclusions

The following conclusions have been drawn from the "Stage 2B Options Appraisal" element of the Snowdonia Aerospace LLP submission for an Airspace Change Proposal, Reference: ACP-2019-58, Llanbedr Danger Area (DA), under the Civil Aviation Authority (CAA) CAP1616 Airspace Change Process:

1. Snowdonia Aerospace has assessed the impacts of the permanent Danger Area (DA) Design Options #1 and #2 proposed at Stage 2A against a "do nothing" option (continuing under a Temporary Danger Area) using the design criteria against which the options are being assessed;
2. In both cases, the permanent DA design provides an area of segregated airspace local to Llanbedr Aerodrome for the research, development, test and evaluation (RDT&E) of novel aerospace systems and an air corridor that will link Llanbedr Aerodrome with the existing Danger Area D201 over Cardigan Bay;
3. The methodology applied a simple qualitative assessment of the different options, both positive and negative, against the CAP1616, Appendix E, Table E2: "Guide to expected approach to key analysis for a typical airspace change". This approach has been applied previously in other Airspace Change Proposals of similar scale/proportionality and it has been deemed compliant both with the spirit of CAP1616 and the Government Green Book;
4. The assessment has highlighted a strong economic case for implementation of a permanent Danger Area on the basis that it will (a) significantly enhance the UK RDT&E capability in environmentally-friendly aircraft and electric technologies in accordance with the 2018 Aerospace Industrial Strategy, and (b) generate jobs and related economic benefit in local communities;
5. The number of novel aerospace system flight movements is expected to double, but the numbers are relatively small (~100 days of Danger Area activation per annum and <200 flights per annum), the vast majority of operations (~90%) will be over the aerodrome or out over the sea and the vehicle size (the majority <150kg) and propulsion type (50%+ electric) mean that the noise and environmental impact is expected to be negligible;
6. Despite a predicted increase in both novel aerospace RDT&E flying and RAF/MOD training, there is still considered to be sufficient capacity to accommodate all activities safely, including additional General Aviation. The estimate of approximately 100 days of Danger Area activation per annum translates to 2 days per week and with operations above 2000ft likely only 33% of the time. Appropriate air traffic management principles have already been identified to ensure spatial and temporal deconfliction across all elements of the Danger Area;
7. On the basis of the safety, operational, environmental and economic considerations, the Change Sponsor strongly recommends that the CAA consider the Llanbedr DA airspace change proposal favourably.

4.2. Next steps

The initial design option appraisal stated here will be taken forward into Stage 3A of the CAP1616 process where the Change Sponsor plans its stakeholder consultation and engagement, and prepares consultation documents, including the second-phase full options appraisal with more rigorous evidence for its chosen option.

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