EANPG PROGRAMME COORDINATING GROUP (COG) PERFORMANCE BASED NAVIGATION IMPLEMENTATION TASK FORCE (PBN TF)

EIGHTH MEETING

(Paris, France, 23-24 January 2013)

Agenda Item 3: Review the status of PBN implementation in the EUR (ICAO, Eurocontrol, States)

RESULTS OF A SURVEY OF IFR GA IN EUROPE ON SBAS

(Presented by Eurocontrol)

SUMMARY

This working paper presents the meeting with paper RAISG3-IP4 the results of a survey of IFR GA by GSA.

1. Action by the meeting

1.1 The PBN TF is invited to review and comment on the information provided in the attachment.

European GNSS Agency

Accelerating EGNOS adoption for General Aviation

Results of a Survey of IFR GA in Europe on SBAS

Source: Helios

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1 Introduction

With its 2011 and 2012 Work Programmes, the GSA aims at accelerating EGNOS adoption in key market segments. In addition, GSA supports the European Commission in the context of the Action Plan on GNSS Applications. Aviation has been highlighted as a priority market and it is therefore crucial to accelerate the pace of adoption by implementing the Aviation Adoption plan defined by GSA to this end.

One of the identified early adopters segments is General Aviation (GA). The general aviation sector is highly diverse and represents a significant number of flights, from recreational flying with non-powered aircraft to the complex operation of business jets and specialised aerial works. Major benefits in GA are related to safety, since EGNOS provides better precision than pure GPS or barometric readings, and increased situation awareness reducing the risk of CFIT (controlled flight into terrain) dramatically. IFR pilots (less than 10% of all general aviation pilots) can decide to install a stand-alone SBAS enabled receiver for a relatively small price.

The objective of this work is to determine the reasons why GA EGNOS users (IFR certified) have potentially delayed the installation of EGNOS receivers and the commencement of operations, and analyse options to foster adoption.

The report presents the results of a survey of Instrument Flight Rules (IFR) GA airspace users in Europe focusing on their types of operations and perception of Satellite Based Augmentation System (SBAS) costs and benefits. The survey was published online from April 2012 until June 2012 and this report presents the results of the analysis of data collected. The field study was performed with the support of HELIOS, who interviewed end users (i.e. individual pilots and operators) to gauge their attitudes towards EGNOS adoption in terms of:

- Total installation costs – including equipment and its certification, installation and operational approvals;
- Procedure availability;
- Perceived safety benefits;
- Perceived operational benefits – i.e. lower minima allowing access, or installation of Area Navigation (RNAV) compliant equipment opening access to new flight levels and airspace.

The organisations contacted included:

- International Aircraft Owners and Pilots Association (IAOPA) Europe, and through them individual national AOPAs;
- Private Pilot License – Instrument Rating (PPL-IR) Europe;
- European HEMS and Air Ambulance Committee (EHAC);
- European Helicopter Association (EHA).

2 Background

2.1 General

The GA community has been identified as one of the early adopters within aviation and through the Aircraft Owners and Pilots Association (AOPA) and Garmin, have expressed concerns about the costs for certification and resultant approvals borne by GA users. European Aviation Safety Agency (EASA) confirmed that the current process is indeed cumbersome and that they are revising this administrative process but that the proposed steps and fees are likely to remain intact.

Users not already equipped are required to undertake a number of steps to upgrade (or retrofit) their aircraft to be compatible with EGNOS, including:

- Installation (or upgrade) of on-board navigation equipment including SBAS-capable GNSS receiver and installation of any necessary auxiliary equipment (e.g. antenna, cabling, annunciation units, etc.);
- Certification of installation according to EASA AMCs;
- Operational approval of aircraft operators for Approach with Vertical Guidance (APV) SBAS procedures down to Localiser Performance with Vertical Guidance (LPV) minima by the national Civil Aviation Authority (CAA);
- Pilot training for APV SBAS procedures.

While the costs incurred by GA users to upgrade to SBAS are currently perceived by some as being prohibitive, the lack of APV SBAS procedures at aerodromes is perceived as a major barrier to adoption. To utilise EGNOS, owners/administrators of approach procedures at aerodromes need to design and publish APV SBAS procedures, down to LPV minima, to allow maximum benefits to GA users from EGNOS. Currently, there are few APV SBAS procedures with LPV minima published in Europe. In contrast, the United States has implemented more than 3,000 new SBAS (Wide Area Augmentation System - WAAS) procedures since 2003, giving pilots with Instrument Rating (IR) across the United States the benefit of access to aerodromes under low cloud conditions with increased safety.

Approximately 420,000 GA Instrument Flight Rules (IFR) flights involving different operations and actors took place in Europe during 2010. These ranged from less price sensitive business aviation owners and operators, through to helicopter operators and Sunday afternoon hobbyists. By better understanding the impact of certification fees and other barriers on the pace of uptake of EGNOS in the GA IFR community, GSA will be in a better position to foster EGNOS adoption within the community. The focus is on IFR users as the majority of GA users who fly according to Visual Flight Rules (VFR) will not make use of EGNOS procedures.

The GSA wants to understand the priorities of the various IFR airspace users. In particular, the GSA wants to investigate the interest of individual pilots and GA organisations to deploy new APV procedures at their local aerodromes, by finding out more about their operations and the perception of the benefits and costs.

GA operators are most likely to benefit from two types of SBAS approaches:

- APV (SBAS) LPV procedures;
- Point-In-Space procedure (PinS), specific to rotorcraft.

These are described in more detail in the sections below.

2.2 APV procedures

An APV is a continuous descent approach procedure with vertical and lateral guidance. There are two types of APV approach: APV SBAS and APV Baro.

APV SBAS

An APV SBAS approach is an SBAS-enabled approach similar to an Instrument Landing System (ILS) approach. It is flown in the same way as an ILS and has similar performance. The lateral accuracy is equivalent to an ILS localiser and the guidance is provided against a geometric path in space. Both vertical and lateral guidance is provided by SBAS-augmented GNSS. The approach is flown to a given Decision Height (DH) with the lowest possible DH 250 ft – a significantly lower minimum than that possible for Non-Precision Approaches (NPA). The specified minimum for DH is called LPV. The EGNOS Safety-of-Life service was made available in March 2011 and can now be used for LPV approaches almost anywhere in Europe. LPV procedures do not require any conventional ground-based navigation aids, such as ILS, VOR, DME or NDB, thus there is no need for aerodromes to maintain costly infrastructure.

There are future plans to reduce the APV SBAS DH to 200 ft, providing even more benefits to SBAS users.

APV Baro

APV Baro (or APV Baro-VNAV) is a straight-in approach procedure with vertical guidance provided from the on-board barometric altimeter and horizontal guidance via GNSS (which may include SBAS augmentation). The approach is conducted to the DH at which point visual contact with the runway is required. The navigation system presents the pilot with vertical guidance referenced to a specified vertical path angle (VPA), nominally 3˚, but steeper approaches are possible as well.

The APV Baro procedures do not have a FAF or a MAPt identified. The lowest possible DH is 300ft which is slightly more than for APV SBAS and marginally less than the minima available from an NPA when the OCA/OCH is calculated from the APV Obstacle Assessment Surfaces (OAS). The obstacle surfaces are similar to those for ILS but are based on the accuracy afforded by the GNSS horizontal guidance.

A disadvantage of APV Baro is that it requires a more sophisticated barometric altimeter system, coupled to the autopilot, which is expensive and not feasible for small non-complex aircraft. However, APV Baro procedures could be flown with SBAS equipment down to LNAV/VNAV minima[1] and are therefore potentially useful and beneficial for GA as well.

2.3 PinS procedure

The PinS approach procedure builds on existing RNAV criteria for GNSS approach procedures but modifies the design criteria to take into account helicopter specific parameters such as airspeed, fix tolerances, area widths and descent and climb gradients. Unlike an APV approach procedure, the waypoints

[1] It should be noted that EASA has not yet explicitly stated whether it is allowed to fly APV Baro procedures to LNAV/VNAV minima with SBAS equipment.

defining the PinS procedure do not have to allow a straight-in approach and at the missed approach point the runway / FATO may not be visible to the flight crew. Final manoeuvring is performed visually. In addition, the approach gradient supported by PinS may be much steeper - up to 9º compared to a maximum of approximately 6º with APV.

PinS (like APV approach procedures) provides instrument approach capabilities to locations where conventional navigation facilities are not available, such as helipads in mountainous areas or urban environments. The steeper approach allows the maintenance of obstacle separations not possible with other less steep instrument approach procedures enabling continued access to heliports in difficult to access areas during low cloud and reduced visibility conditions. Although specified for helicopter approaches, the PinS procedure can also be adapted for use by fixed-wing aircraft when supported by a specific aeronautical study as required by ICAO.

The route during the final segment between the MAP and the landing site is chosen by the pilot allowing some flexibility of the flight path depending on conditions.

2.4 Summary

The following table summarises the main characteristics of the approaches.

	APV	PinS
Type of aircraft	Fixed or rotary wing	Fixed or rotary wing
Possible vertical minima	Not lower than: - 250ft (using SBAS) - 300ft (using Baro)	Not lower than: - 250ft (using SBAS) - 300ft (using Baro)
Maximum descent angle	6˚	9˚
Typical uses	Runway straight in approaches	Cross runway approaches, medical heliports, high obstacle environments

Table 2-1: Summary of main characteristics of approach procedures

3 Methodology

3.1 General

To accelerate the adoption of EGNOS among GA airspace users in Europe a good understanding of the GA community is needed. However, data on GA community is not easily available publicly or when available has not been collected in a systematic way. Therefore, a standardised survey of GA users was undertaken to provide a robust baseline from and which comparable conclusions could be drawn.

The survey was designed to address the main questions, such as:

- What is the current user base?
- What is the likelihood for that user base increasing?
- What will be the utilisation of APV SBAS procedures by the GA community?
- Does the availability of APV SBAS procedures map to the user base aerodrome utilisation?
- What aircraft types are most frequently used?
- What proportion of GA aircraft are currently SBAS-capable?
- What are the perceived costs and benefits for those users not yet equipped?
- What is the willingness of GA users to pay to upgrade to fly APV SBAS procedures?

3.2 Approach

3.2.1 Target audience

The questionnaire was designed for European private pilots and general aviation organisations (such as air rescue, charter organisations, etc.) who conduct IFR flights, or intend to start operating such flights in the near future, and are interested in APV SBAS and PinS approach procedures.

3.2.2 Questionnaire design

The questionnaire was divided into three sections:

- **Section 1: About you** – collected basic data about users;
- **Section 2: Your views on SBAS costs and benefits** – covered the key questions on costs and benefits, identified barriers to adoption and divided users into those that were familiar and those not familiar with SBAS;
- **Section 3: About your current operations –** collected basic data on operations conducted by these users.

The final version of the questionnaire was produced and is presented in diagrammatic form in Appendix A. A complete list of aircraft types and helicopter types included as answer options in the survey is provided in Appendix B.

3.2.3 Methods of distribution and promotion

The survey was published online and was available from April 2012 through June 2012. The survey distribution was co-ordinated through the user representative bodies to ensure buy-in and the best possible response. The survey was designed as an electronic survey and all participants were asked to provide answers through the online portal. Links to the online questionnaire were distributed by:

- Direct email distribution to members of user organisations (IAOPA Europe, PPL/IR, EHAC);
- Promotion on IAOPA Europe website (homepage);
- Promotion on PPL/IR Europe website (forum);
- Promotion on Helios' website (news items and Helios blog);
- Promotion via Social Media: Linked in, Twitter and Facebook.

To increase interest in the survey and encourage participants to complete the whole questionnaire, participants were entered into a draw for a prize of a Kindle e-book reader when their details were provided. This information was used solely for the purposes of the prize draw.

4 Results of the survey

4.1 General

This section presents a high level analysis of the results of the survey. When the survey was closed for further responses on 29th June 2012, the total number of started responses was 392, of which 254 (65%) were completed with the remainder terminated at various points of the questionnaire. Since the population size is not known, statistical results must be considered carefully. If we assume the population is 25,000 IFR GA pilots in Europe, then the sample is on the edge of significance, since about 325 completed surveys would be required for statistical significance. More than this number started the survey, but less than it finished.

Given the narrow focus of the survey and relative length of the questionnaire, the number of completed responses compares well with other industry wide consultations undertaken by Helios. However, it is noted that the rate of response might have been better in some countries where the user base is significant (e.g. France, Italy and Spain). In addition, no responses were received from some Central and Eastern European countries (Bulgaria, Hungary or Romania).

The report is largely focused on IFR GA using aeroplanes as the number of responses from helicopter pilots/organisations was minimal.

4.2 User base

The following figure shows the geographical split of the survey participants

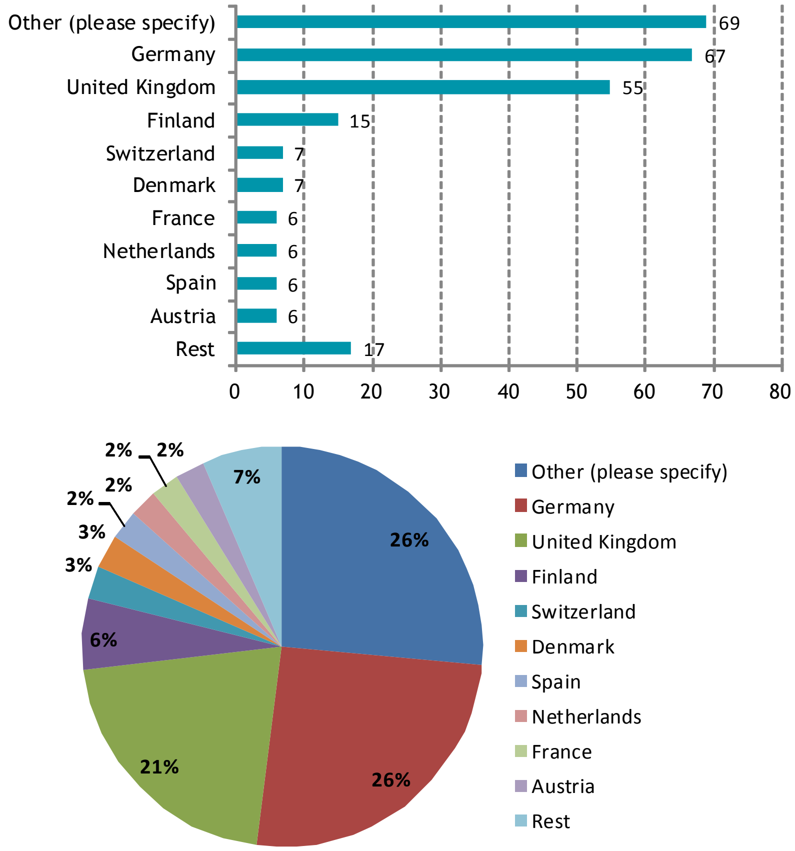


Figure 4-1: Geographical split of the survey participants

It has to be noted that the country of residence was not required, only the country of aircraft registration. Therefore a number of N-registered aircraft are included in the results (US) and classified as “Other”. These participants are spread across several countries Europe with majority of them are located in Germany, UK, France and Finland. In addition, there are a small number of respondents with aircraft registered in the Isle of Man, which maintains its own aircraft register. These are also classified as “Other”.

As the information on the total number of pilots with Instrument Rating (IR) in Europe is not easily available, we cannot compare it to the number of responses and determine approximate coverage that the survey achieved. However, a broad brush comparison can be done for the UK. The total number of responses from UK pilots was 55 (excluding those with N-registered aircraft). The estimated total number of UK pilots with IR flying as GA (aeroplanes and helicopters) is approximately 6,600. This was estimated from:

- the survey results, in particular the proportion of Air Transport Pilot Licence (ATPL) holders who responded to the survey (we assume these also fly as GA);
- the UK CAA statistics on the number of licences in 2008[2]; and
- the assumption that proportion of Private Pilot Licence (PPL) holders with IR is approximately 10%[3].

This means that the survey covered approximately 1% of all the UK GA pilots with Instrument Rating (IR). The coverage in Germany might be similar, however in other countries it is probably be less than 1%.

All the aerodromes that were identified by the survey participants as being candidates for SBAS installation or as their home aerodromes are identified in the following figure.

[2] UK CAA, Flight Crew Licence Age Profile as at 1 January 2008v2, http://www.caa.co.uk/docs/175/UK%20CAA%20Flight%20Crew%20Licnece%20Age%20Profile%20as%20at%201%20January%202008v2.pdf

[3] Helios estimate.

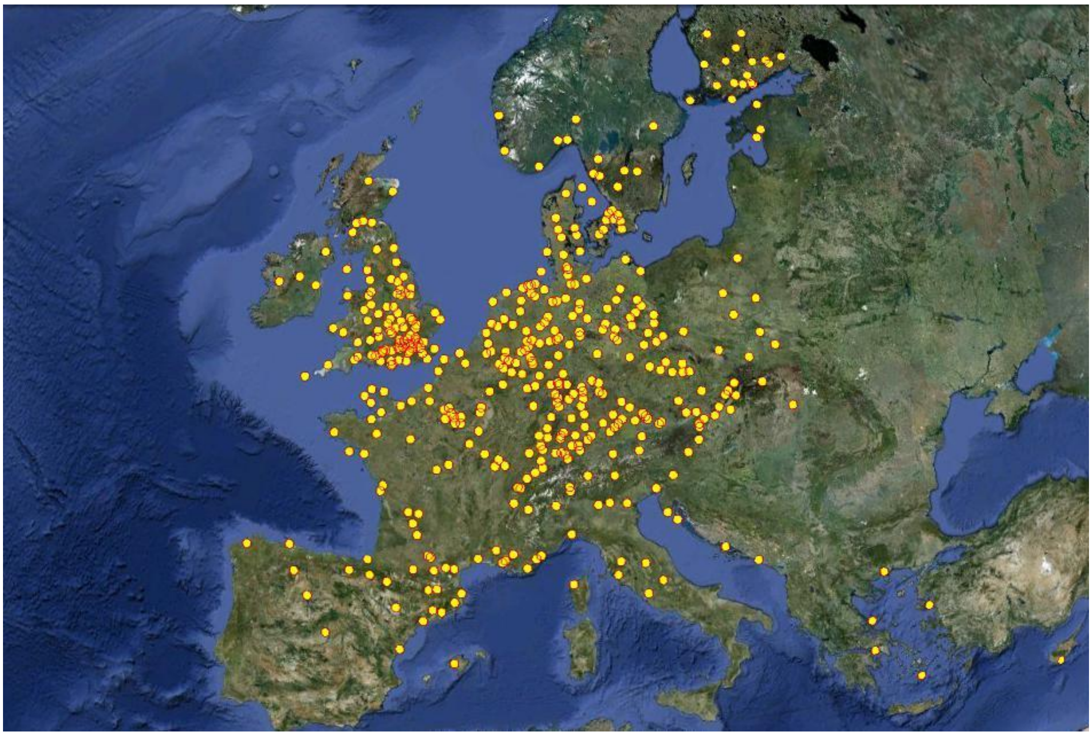


Figure 4-2: Distribution of aerodromes identified during survey

The largest group of participants was private pilots (PPL) with instrument rating, as expected. The second largest group were corporate pilots (CPL) followed by Flight Training Organisation (FTO) pilots, i.e. instructors. The other category contained a range of different answers, including, for example:

- Air Transport Pilot Licence (ATPL) and flying privately;
- Aerial work pilot;
- Self-flying business owner; or
- Production test pilot.

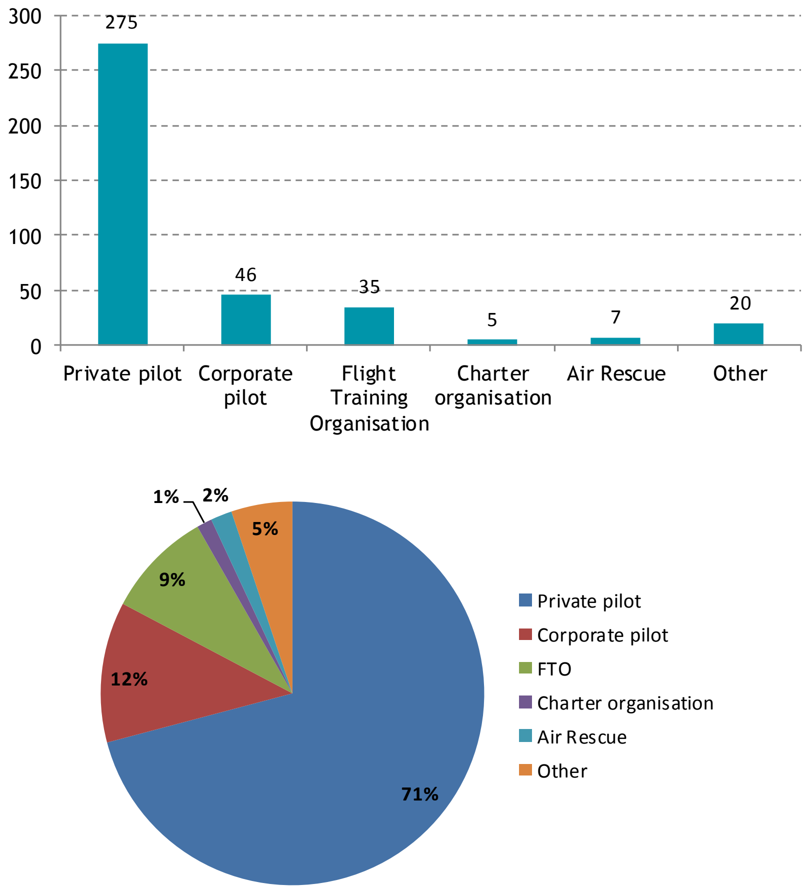


Figure 4-3: Types of respondents

The aeroplane types most frequently identified are presented in the figure below. It is evident that the GA market is relatively fragmented in terms of aeroplane types. While there were 120 aeroplane types in the list within this question, "other" was still the third most frequent answer. On the other hand, the survey results indicated that 50% of IFR GA pilots in Europe most frequently fly one of the following seven aircraft types in descending priority:

- Piper PA-28
- Cessna 172
- Diamond DA-40
- Cirrus SR22
- Socata - TB9/10/20/21/200
- Piper PA-46
- Piper PA-32.

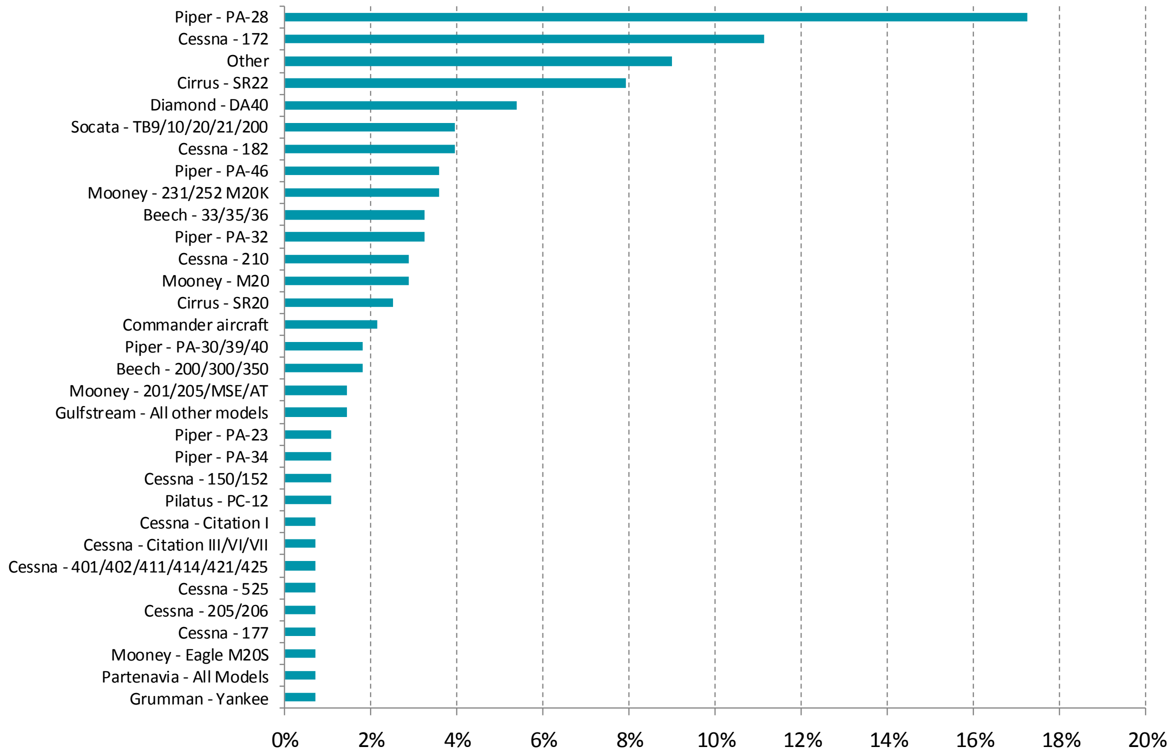


Figure 4-4: Most frequently used aeroplane types

The most frequently identified helicopter types are presented below. As the number of responses from helicopter pilots/operators was very low (7), the results cannot be considered as representative.

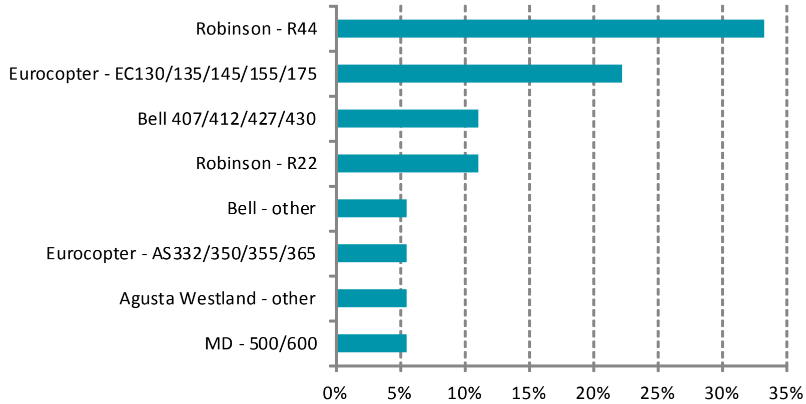
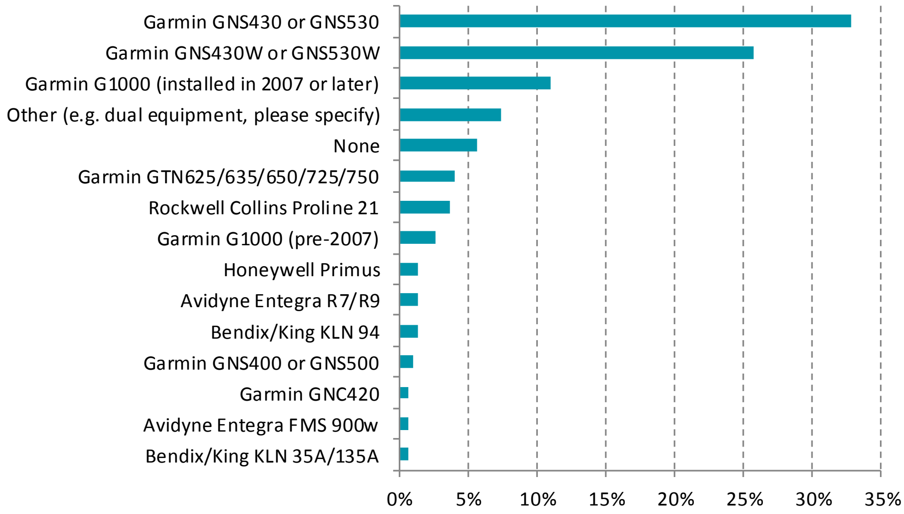


Figure 4-5: Most frequently used helicopter types

The navigation equipment installed in the aircraft is presented in the figure below.



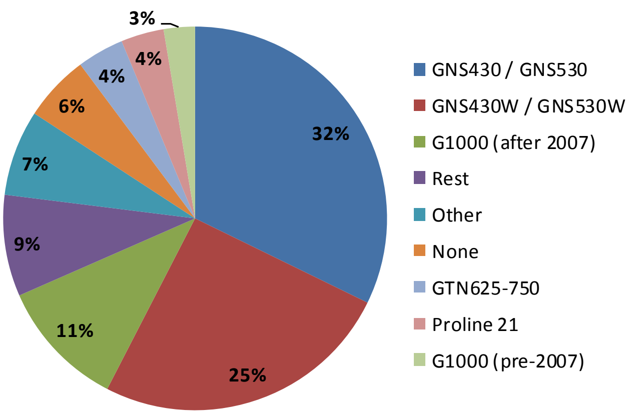


Figure 4-6: Equipage

Of note was the fact that approximately 48% of participants are already equipped with SBAS, although presumably not all of these are approved for vertically guided RNAV GNSS approaches (LNAV/VNAV, LPV).

Today, almost all new navigation equipment sold by GA manufacturers is SBAS-capable and certified for the use of SBAS. Given that the average lifecycle of such equipment is between 5 and 10 years, it is expected that IFR pilots will eventually install with SBAS avionics either as a retro-fit or forward-fit. Thus, SBAS penetration will increase over time naturally. However it is noted that the average GA aircraft lifespan is long and that the cost of an SBAS retrofit can be 30-50% of the value of the airframe and could discourage some users from installing as a retro-fit.

It is evident that pilots are relatively familiar with SBAS (WAAS/EGNOS) capabilities and only 17% of participants were not familiar with it. However, once the benefits of SBAS were explained to these 17%, 82% were immediately interested and could be included in the potential user base.

It is noteworthy to say that of all the participants, who completed section No 2 in the questionnaire, only 15% indicated that they are not interested in installing SBAS or have not considered it before. This confirms that large majority of the GA IFR community (85%) is interested in using SBAS.

4.3 Barriers of adoption

Several questions were included in the survey to investigate why users may not be willing to equip with SBAS or to use SBAS more frequently and how their decision could be influenced.

Those participants familiar with SBAS indicated that the primary reason for not equipping with SBAS was the unavailability of suitable procedures at their aerodromes/heliports (see figure below). The second most important factor was aircraft certification costs.

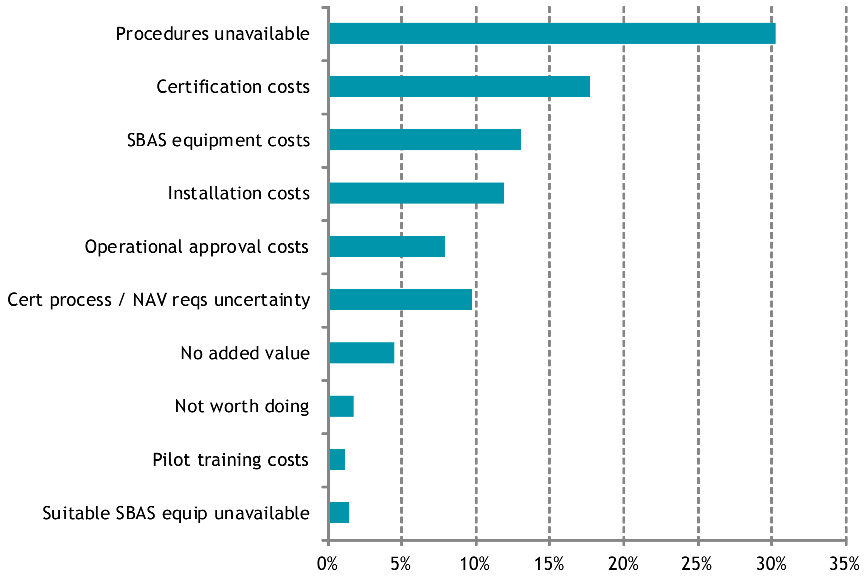


Figure 4-7: Reasons for not installing SBAS (participants familiar with SBAS)

Participants were also asked about the potential incentives for installing SBAS. The options included most of the previously identified reasons for not installing SBAS but included some additional items, such as availability of LPV minima of 200 ft or change in personal circumstances. The responses are presented in the figure below.

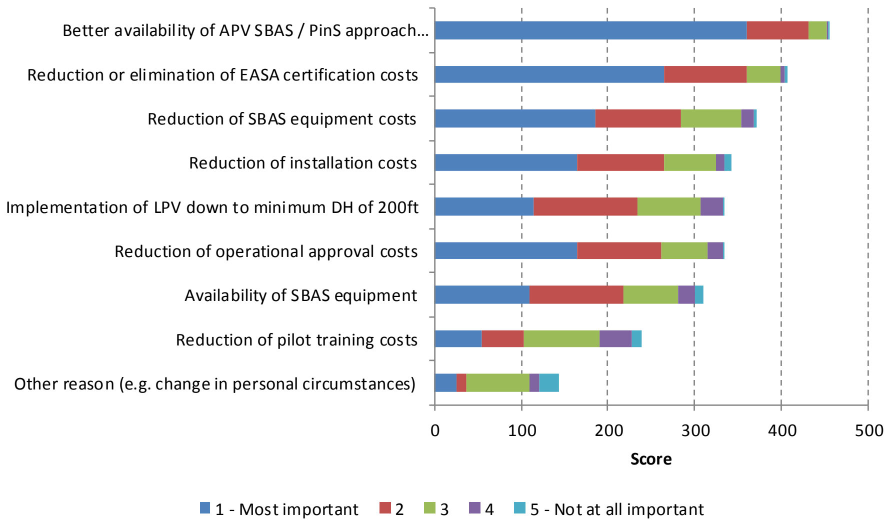


Figure 4-8: Incentives to upgrade in future (users familiar with SBAS)

To rank responses a score for each option was used where the number of selections of each option was multiplied according to its level of significance: for example, by 5 if it was selected as “1 – Most important” factor and by 1 if it was selected as “5 – Not at all important”.

The order of responses in Figure 4-8 is almost identical to that in Figure 4-7. Figure 4-8 suggests that the implementation of LPV down to a DH of 200 ft could be a significant factor to accelerate adoption. However this is less important than either the availability of procedures or installation/upgrade costs. On the other hand, the availability of LPV with a 200 ft DH could become more important factor when standard APV SBAS procedures are more commonly available.

Participants not familiar with SBAS indicated that the unavailability of APV SBAS and PinS procedures at their aerodromes/heliports was the most important factor when considering an SBAS upgrade (see Figure 4-9). Responses to this question were broadly similar regardless of whether the participant was familiar with SBAS or not.

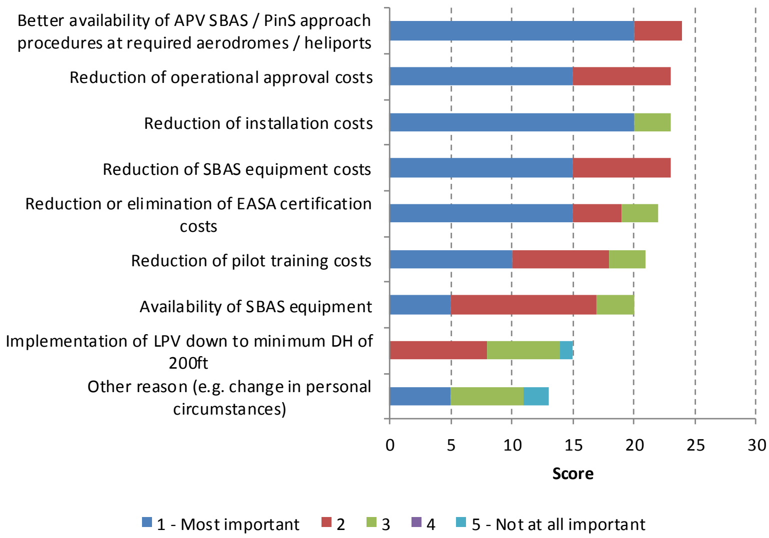


Figure 4-9: Incentives to upgrade in future (participants not familiar with SBAS)

The survey results highlighted a disparity between the current equipage rate (48%) and the real interest in using SBAS (85%). Since costs were reported as one barrier to equipage, there may be a risk that private pilots will use SBAS (once installed) without the necessary approvals to save costs. The survey did not attempt to investigate more closely and this risk should be considered by the relevant Safety Authorities. A discussion with Civil Aviation Authorities in Europe might provide further insight to determine whether this is a real safety issue that should be addressed.

In addition to the results presented in this section, several direct comments and suggestions were received from participants in relation to potential barriers not covered in the survey. These are summarised and described in section 4.6.

4.4 Perception of costs and benefits

One of the objectives of the survey was to identify the reasons that the GA community have not installed or applied for operational approval of SBAS procedures in a similar pattern to that observed in the United States with the implementation of WAAS. As has been shown in Section 4.3, the perception of cost ranked second on the list of perceived barriers to the adoption of SBAS technology by the GA IFR community.

Of particular note was the difference between what users were willing to pay for the upgrade and what the actual cost of implementation turned out to be. The evidence shown from Question 21 seems to indicate that the actual cost for the upgrade is approximately €17,000 on average. This compares to the responses from Question 24 where the average willingness to pay approximated to €5,600 and the expected benefits realised from the APV (SBAS) LPV of €5,000 (Question 27). This large difference in what responders would be willing to pay versus the actually experienced upgrade costs may be down to a lack of previous experience in upgrading aircraft to the capabilities that installation of these types of equipment will provide to the aircraft.

EASA have repeatedly noted to the GA community that in some case the implementation of SBAS equipment provides the aircraft with a capability that was not previously installed. This additional capability means that the aircraft needs to be reassessed in light of its operations and the flight crew qualification to fly it. Consequently it is classed as a major modification incurring additional implementation costs.

The influence of the different costs on the upgrade of the aircraft has been recognised in the responses to specific questions targeting users that had upgraded their aircraft and questions capturing perception. The difference in perception is graphically realised in the following figure.

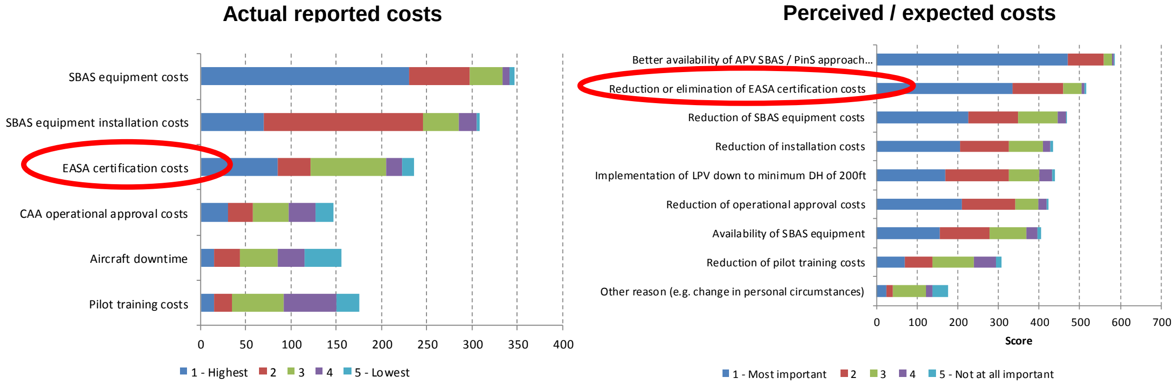


Figure 4-10: Comparison of actual and perceived/expected certification costs

Quite clearly these graphs show that although the perception is that the most significant cost that will be borne by the aircraft operators results from EASA certification fees, in reality the certification costs from EASA are outweighed by the costs from installation and the purchase of the equipment itself. The questionnaire did not ask responders about the numeric difference between the different cost components, but it is noted that difference between the 'paper costs' and the equipment costs are not so much different to be able to draw any definitive conclusions on whether those who have performed the upgrade had similar experiences with respect to implementation, certification and approval costs.

It is hard to estimate what the target price for aircraft certification should be to not to be a barrier for upgrade. However it is expected that if fees where reduced from those for "major modification" to "minor modification" (e.g. thanks to applying European Approved Model List – AML for certain type of equipment), this would persuade more GA users to equip and/or achieve LPV certification. This option would be attractive especially for those who are already equipped, but not LPV certified.

With respect to the benefits that users experienced, the questionnaire has confirmed that users rank the ability to gain access to aerodromes during periods of poor weather as the number one benefit (Question 26). This is followed closely by the perceived benefits of Safety of Life, e.g. avoided Controlled Flight Into Terrain (CFIT) and improved business resilience from a more reliable operation. Here users have a clear expectation of the level of benefit that should be derived from SBAS resulting from improved access to aerodromes and avoided diversions, delays or cancellations (DDCs). Question 28 shows that users expect to avoid on average a DDC 13 times per year. Correlation with the responses to Question 31 shows that the average operational cost per flight hour is € 295.

Assuming that the avoided DDC occurs 13 times a year and that average DDC lasts one extra flight hour on average (i.e. total cost of DDCs per year is roughly €3,800), this would indicate that either the level of benefits is overestimated by users (expected average benefits of €5,000 per annum – Question 27) or that the costs of disruption for some users are significant compared to others so as to distort the results.

4.5 Operations

The questionnaire targeted IFR pilots that would be able to fly implemented SBAS approach procedures. The users were asked about their usage pattern to determine what utilisation any implemented SBAS procedures might expect.

Utilisation per airframe followed a standard normal distribution with on average 197 flights per year. This, compared to the perceived benefits, would imply that each user expects on average that SBAS would be directly beneficial in reducing costs on approximately 7% of flights.

It is interesting to note however that there is no clear trend in the number of movements that are either flown on an IFR routing or terminate in an Instrument Approach Procedure (IAP). The responses to Question 33 show that for those aircraft flying predominantly IFR the top 50% of flights include IFR flight plan approximately 40% of the time, while the lowest 50% include IFR flight plan approximately 60% of the time demonstrating that most IFR aircraft do fly IFR. This is illustrated in the following figure.

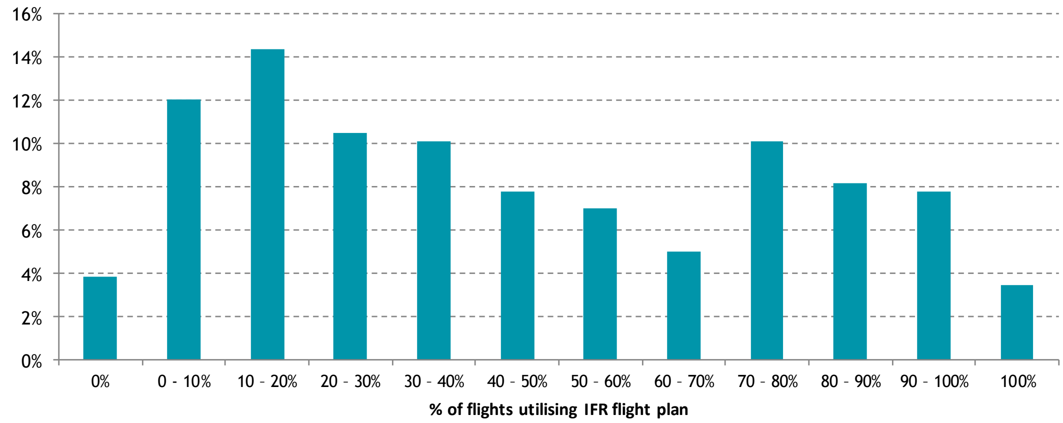


Figure 4-11: Proportion of flight utilising IFR flight plan

4.6 Additional potential barriers of adoption

Direct feedback in the form of comments and/or suggestions was sometimes provided by participants. Some comments appeared to provide further insight into the acceleration of EGNOS adoption, especially in relation to the identification of additional barriers. This section discusses the most important issues raised by respondents. The following barriers for the wider use of EGNOS in Europe were identified by participants:

- Uncertainty of future equipment mandates, especially navigation equipment mandates;
- Costs of navigation (NAV) database updates;

- Supporting IFR routes;
- Unavailability of instrument aerodromes.

4.6.1 Uncertainty of future equipment mandates

The upgrade of on-board avionics to SBAS-compatible equipment can be costly and GA users are especially cost-sensitive. Ideally, users would like to join such an upgrade with other useful upgrades related to different developments, e.g. to ensure compliance with emerging RNAV equipment mandates. Precision RNAV (P-RNAV) is currently being introduced in Europe. While no European Civil Aviation Conference (ECAC)-wide mandate for the carriage of P-RNAV is foreseen at the moment, some States may require P-RNAV certification for IFR operations in notified terminal airspace[4]. If a P-RNAV mandate will be approved in future, all GA IFR users flying in en-route airspace or in defined Terminal Areas (TMAs) would have to be equipped with P-RNAV compliant equipment[5]. As the majority of navigation equipment currently installed in typical GA aircraft or being offered by manufacturers is not compliant with P-RNAV, this is a potential threat to GA due to the cost of the new equipment and installation.

Some users expressed the opinion that the only SBAS upgrades that are worth doing are those which will deliver a P-RNAV solution at the same time. In case of a typical GA aircraft, this would mean that users would have to purchase Garmin GTN650 or 750 units which cost approximately €8,500 and €12,300 respectively (equipment only).

4.6.2 Costs of NAV database updates

To fly according to instrument rules, users have to keep aeronautical databases of NAV equipment current. Databases shall be updated every 28 days in accordance with the Aeronautical Information Regulation and Control (AIRAC) cycle. This usually requires a subscription with the provider of aeronautical information. Some respondents indicated that these costs can be prohibitive and can reach several thousand EUR per year. We have therefore further investigated this issue.

An overview of yearly subscriptions for different types of databases is provided in Table 4-1 below. As database update costs are borne by IFR users anyway, disregarding whether they want to use SBAS equipment or not, the only relevant element is the difference between costs for non-SBAS and SBAS equipment. We have compared costs for GNS 400 / 500 series.

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[4] Eurocontrol, http://www.eurocontrol.int/articles/requirements-civil-aircraft

[5] The requirement on equipment is +/- 1 NM navigation accuracy

NAV database coverage area	Yearly subscription costs		WAAS extra charge [%]
	Garmin GNS 400 / 500 Series - NON-WAAS	Garmin GNS 400 / 500 Series - WAAS	
Europe	€ 317	€ 347	9%
International (Europe, Africa, Asia, Australia)	€ 441	€ 474	7%
Worldwide	€ 567	€ 599	6%
Nav data card	€ 145	€ 174	20%

Table 4-1: Costs related to NAV database and its updates

The difference between NAV database yearly subscription costs for non-SBAS and SBAS equipment is approximately 5-10% and is not perceived by us as a potential barrier for adoption as it seems insignificant in comparison to other costs.

On the other hand, it has to be noted that NAV database yearly subscription costs can be exceptionally high for certain avionics, especially for those that are built-in by aircraft manufacturers, and for certain geographical areas (e.g. Eastern Europe).

Databases containing private procedures can also be costly to purchase and maintain. However this is not a problem for a regular IFR airspace user. In addition, this study focuses on public IFR procedures and therefore private procedures are outside the scope.

4.6.3 Supporting IFR routes

It was emphasised by some respondents that the existence of supporting IFR routes, which are connected to the APV SBAS final approach procedure, is as equally important as the final approach procedure itself. Indeed, users can benefit from SBAS approaches only if they are connected to IFR Standard Arrival Routes (STARs). The STARs should ideally be connected to IFR routes in upper airspace to allow users to complete the whole flight in IFR conditions.

For those aerodromes that are in proximity to large TMA serving international hubs, such as UK south east aerodromes close to the London TMA, it can be difficult to introduce dedicated STARs due to conflicts with existing routes in the larger TMA. This obstacle needs to be overcome by the procedure designer together with the Airspace Management Entity.

4.6.4 Unavailability of instrument aerodromes

Unavailability of instrument aerodromes has been raised as one of the key issues for wider roll-out of SBAS procedures. Requirements for instrument aerodromes can vary from country to country, however most EU countries require at least the following:

- Air Traffic Control (ATC) provided at the aerodrome;
- Local Meteorological (MET) information (either by manned MET station or Automatic Weather Observation System - AWOS).

These are described in more detail below.

Users expressed their opinion that requirements to turn non-instrument aerodromes into instrument aerodromes should be relaxed as most of them have been designed for commercial air traffic.

4.6.4.1 Requirement for ATC at instrument aerodromes

In some countries, ATC is required by law in order to implement and use any instrument procedure (e.g. UK). Many GA airfields cannot afford to pay for full ATC, which is usually an expensive service. Some respondents indicated that in the United States, this is sometimes solved by having a private ATC service (not from the main national Air Navigation Service Provider - ANSP) provided by remote Approach Controller. However, this is also relatively expensive and in many cases outside the budget of small GA airfields. The requirement for ATC can vary from country to country, but it can represent a significant barrier to adoption of SBAS procedures.

4.6.4.2 Unavailability of weather information

Unavailability of operational weather information is another potential barrier for adoption. Users in Europe have limited possibilities to get operational weather information during flight. In the US, many aerodromes are equipped with AWOS that constantly transmits the latest weather reports on Very High Frequency (VHF). In some countries however (e.g. in Sweden) AWOS stations are not permitted. The only alternative service is Automated Terminal Information Service (ATIS) that transmits weather reports on a dedicated VHF frequency. The limitation of ATIS is that it is transmitted only when the tower is manned and operational.

4.6.4.3 Lighting and PCL

It was stressed by some respondents that deployment of APV procedures shall be prioritised at aerodromes with lighting system and/or Pilot Controlled Lighting (PCL) system. At the moment, this is one of the main arguments of some national AOPAs, as PCL and conventional lighting would enable largest safety benefits (lower minima) to be realised.

PCL is a system that allows a pilot to control the lighting of an aerodrome (approach, runway and taxiway lights) via radio. It is most common at small GA aerodromes where it is neither economical to light the runways all night nor to provide ground staff to control the lighting according to pilots' requests. PCL is much more widespread in US than in Europe. In fact, the requirements imposed on PCL and ability to use it can vary in European countries.

While prioritisation of implementation of APV procedures at aerodromes equipped with lighting (either conventional or PCL) is a valid argument, it is also recognised that there are many GA aerodromes that lack such infrastructure. If the lighting system requires significant investment, this can be a barrier to the realisation of full benefits from SBAS procedures.

4.7 Limitations of the survey

While we designed the questionnaire with the aim to get the best data from the survey, there are several limitations which have to be taken into consideration when reading analysis of the results:

- **Uneven geographical distribution of responses:** the number of responses from some countries is significantly higher than from others and this affects the results, such as list of desired aerodromes. This was probably caused by a varying level of involvement of national AOPAs in questionnaire distribution and potentially also by a language barrier. The overall results expressing views of respondents may therefore be slightly skewed and represent views relevant to particular countries rather than Europe as a whole.

- **Probability of subjective responses:** we recognise that certain questions, especially those about costs (e.g. direct operating cost per flight hour) and benefits (e.g. how many times are participants likely to avoid flight diversion or cancellation per year), might have been difficult to answer and might have triggered subjective responses. The data therefore have to be treated carefully.

5 Conclusions

When closed for further responses on 29th June 2012, a total of 392 airspace users had responded to the survey with 254 (65%) actually completing the survey. The remainder terminated at various points of the questionnaire. Since the population size is not known, we do not know if the results are statistically significant. However, if the population is 25,000 IFR GA pilots in Europe, then the sample is on the edge of significance, since about 325 completed surveys would be required for statistical significance. More than this number started the survey, but less than it finished. However, the response was sufficient to support the study's overall conclusions.

The overall number of responses and proportion of completed responses can be considered successful given the narrow focus and length of the questionnaire. However, it is noted that the rate of response might have been better in some countries where the user base is significant (e.g. France, Italy and Spain). In addition, no responses were received from some Central and Eastern European countries.

The survey confirms that the vast majority of the European GA IFR community (85%) is interested in installing and using SBAS or have at least considered it before. Approximately 48% of participants indicated that their aircraft are already SBAS approved. However, this does not necessarily mean that all these participants have operational approval to fly LPV approach procedures – although this is highly likely.

Today, almost all new navigation equipment sold by GA manufacturers is SBAS-capable and certified for the use of SBAS. Given that the average lifecycle of such equipment is between 5 and 10 years, it is expected that IFR pilots will eventually install with SBAS avionics either as a retro-fit or forward-fit. Thus, SBAS penetration will increase over time naturally. GSA actions related to acceleration of the equipage rate should therefore be lower priority than ensuring procedure availability. However it is noted that the average GA aircraft lifespan is long and that the cost of an SBAS retrofit can be 30-50% of the value of the airframe and could discourage some users from installing as a retro-fit.

The three most important factors dissuading non-SBAS equipped GA users from upgrading are:

- Unavailability of APV SBAS and PinS approach procedures at those aerodromes/heliports they use - 28% of participants said this was one of the reasons for not equipping.
- Aircraft certification costs - 18% of participants indicated this was one of the reasons for not equipping.
- SBAS equipment costs - 14% of participants indicated this was one of the reasons for not equipping.

The survey results highlighted a disparity between the current equipage rate (48%) and the real interest in using SBAS (85%). Since costs were reported as one of the barriers to equipage, there may be a risk that private pilots will use SBAS (once installed) without the necessary approvals to save costs. The survey did not attempt to investigate more closely and this risk should be considered by the relevant Safety Authorities. A discussion with Civil Aviation Authorities in Europe might provide further insight to determine whether this is a real safety issue that should be addressed.

Questions investigating potential incentives to encourage the GA community to equip with SBAS revealed the implementation of LPV minima of 200 ft in Europe as being key. Although this factor seems to be less important than the availability of procedures and SBAS installation/upgrade costs, it could become more important with better availability of standard APV (SBAS) LPV procedures (250 ft DH).

Additional adoption barriers not fully covered in the design of the survey were identified by participants and included:

- Uncertainty over future equipment mandates, especially those related to the performance of navigation equipment (e.g. P-RNAV mandate);
- A lack of IFR routes and STARs supporting final APV SBAS approach procedures allowing airspace users to realise maximum benefits from the existence of APV SBAS procedures;
- A lack of instrument aerodromes and related issues that also affect the availability of APV SBAS procedures in Europe, namely:
  - the requirements for reclassifying non-instrument runways to instrument runways;
  - aerodrome lighting and PCL system;
  - availability of weather information at uncontrolled aerodromes (e.g. permit to use AWOS).

The survey did not obtain sufficient responses to create a priority list of countries or aerodromes. This was because not all the relevant national representative organisations were equally engaged in distributing the questionnaire and raising awareness resulting in reduced responses from some States. However, participants did identify a number of aerodromes where they would like to see APV SBAS procedures implemented.

A Questionnaire diagram

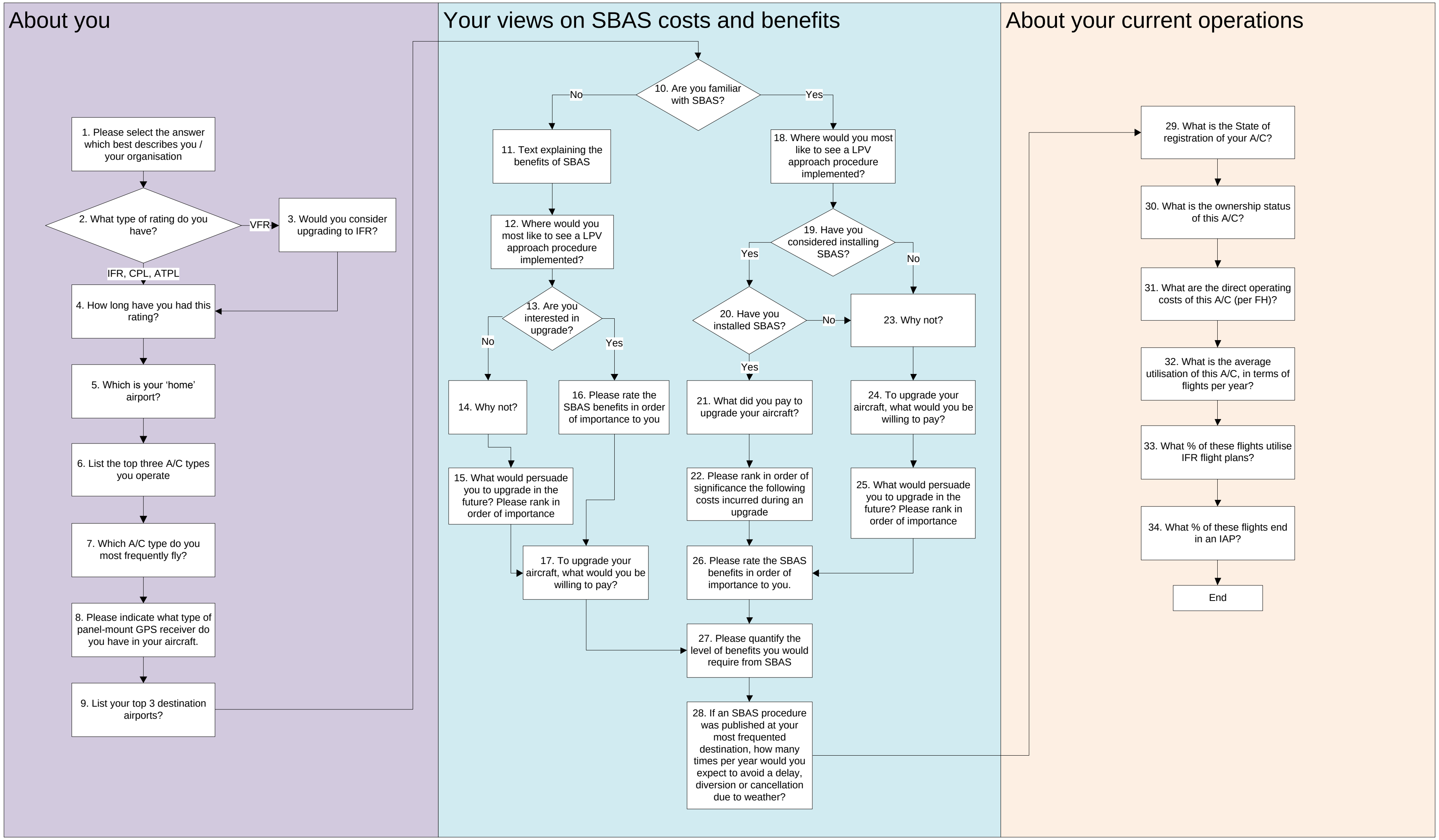

Figure 5-1: Questionnaire diagram

B List of all identified aerodromes

This appendix contains a list of all aerodromes identified as the top three aerodromes visited by survey participants (see Q9) ordered according to a score. The score was determined by the number of responses that mentioned the aerodrome and the order in which the aerodrome was selected. The number of appearances as a priority one aerodrome was multiplied by three and the number of appearances as a priority two aerodrome was multiplied by two. For example, Le Touquet Paris Plage airport was mentioned:

- 10 times as priority one;
- 6 times as priority two; and
- 6 times as priority three aerodrome;

hence the score 48.

No	ICAO code	Aerodrome title	Score	% of total score
1	LFAT	Le Touquet Paris Plage	48	3.0%
2	EDFE	Frankfurt-Egelsbach	44	2.7%
3	EDAZ	Schonhagen	30	1.8%
4	EFTP	Tampere-Pirkkala	26	1.6%
5	EGKA	Shoreham	23	1.4%
6	EGBJ	Gloucestershire	21	1.3%
7	EDFM	Mannheim City	20	1.2%
8	EDKB	Bonn-Hangelar	19	1.2%
9	EDMA	Augsburg	18	1.1%
10	EFTU	Turku	17	1.0%
11	EDNY	Friedrichshafen	16	1.0%
12	EGKB	Biggin Hill	15	0.9%
13	LFPN	Toussus Le Noble	15	0.9%
14	EFHF	Helsinki-Malmi	15	0.9%
15	EGMC	Southend	14	0.9%
16	EDML	Landshut	13	0.8%
17	LSZH	Zurich	13	0.8%
18	EDDP	Leipzig/Halle	13	0.8%
19	EDDS	Stuttgart	13	0.8%
20	EKRK	Koebenhavn/Roskilde	13	0.8%
21	EGHN	Isle Of Wight / Sandown	12	0.7%
22	EDRK	Koblenz-Winningen	12	0.7%
23	EGJB	Guernsey	12	0.7%
24	EHGG	Groningen/Eelde	12	0.7%
25	EDMS	Straubing	12	0.7%

No	ICAO code	Aerodrome title	Score	% of total score
26	EDFV	Worms	11	0.7%
27	LFMD	Cannes Mandelieu	11	0.7%
28	EDDK	Koln/Bonn	11	0.7%
29	EGSC	Cambridge	11	0.7%
30	LOAN	Wr. Neustadt / Ost	11	0.7%
31	LFAC	Calais Dunkerque	11	0.7%
32	EDLN	Monchengladbach	10	0.6%
33	EGBE	Coventry	10	0.6%
34	EDWJ	Juist	10	0.6%
35	EGNE	Retford/Gamston	9	0.6%
36	EPKA	Maslow K/Kielc	9	0.6%
37	EGJJ	Jersey	9	0.6%
38	EDLW	Dortmund	9	0.6%
39	LFRC	Cherbourg Maupertus	9	0.6%
40	LSZL	Locarno	9	0.6%
41	EGNC	Carlisle	9	0.6%
42	ESMS	Malmo	9	0.6%
43	EDGS	Siegerland	8	0.5%
44	EHLE	Lelystad/Lelystad	8	0.5%
45	EFSI	Seinajoki	8	0.5%
46	EGJA	Alderney	8	0.5%
47	EGCJ	Sherburn-In-Elmet	8	0.5%
48	EDDB	Berlin Brandenburg	8	0.5%
49	EFPO	Pori	8	0.5%
50	EGPK	Prestwick	8	0.5%
51	EETN	Lennart Meri Tallinn	8	0.5%
52	EDFH	Frankfurt-Hahn	8	0.5%
53	EDDG	Munster/Osnabruck	7	0.4%
54	EDDN	Nurnberg	7	0.4%
55	LOWW	Wien Schwechat	7	0.4%
56	EGTF	Fairoaks	7	0.4%
57	LFPL	Lognes Emerainville	7	0.4%
58	EGTK	Oxford/Kidlington	7	0.4%
59	LOWG	Graz International	7	0.4%
60	LSZR	St. Gallen-Altenrhein	7	0.4%
61	EFUT	Utti	7	0.4%
62	EDHL	Lubeck-Blankensee	7	0.4%
63	LSGL	Lausanne-La Blecherette	6	0.4%

No	ICAO code	Aerodrome title	Score	% of total score
64	EKOD	Odense	6	0.4%
65	EGHH	Bournemouth	6	0.4%
66	EDRY	Speyer	6	0.4%
67	EGTC	Cranfield	6	0.4%
68	EGTE	Exeter	6	0.4%
69	LFMN	Nice Cote D'Azur	6	0.4%
70	EGSH	Norwich	6	0.4%
71	EGCV	Sleap	6	0.4%
72	EDFZ	Mainz/Finthen	6	0.4%
73	LFRD	Dinard Pleurtuit Saint Malo	6	0.4%
74	EFOU	Oulu	6	0.4%
75	EDSB	Karlsruhe/Baden-Baden	6	0.4%
76	EBAW	Antwerpen/Deurne	6	0.4%
77	EGCK	Caernarfon	6	0.4%
78	EDAB	Bautzen	6	0.4%
79	EDDF	Frankfurt Main	6	0.4%
80	EKRS	Ringsted	6	0.4%
81	EDLE	Essen/Mulheim	6	0.4%
82	EFHV	Hyvinkaa	6	0.4%
83	EDDV	Hannover	6	0.4%
84	EPOD	Dajtki K/Olsztyna	6	0.4%
85	EDDM	Munchen	6	0.4%
86	EPWA	Warsaw Chopin Airport	6	0.4%
87	EDDW	Bremen	6	0.4%
88	ESME	Eslov	6	0.4%
89	LEGE	Girona	6	0.4%
90	EGGP	Liverpool	5	0.3%
91	LFSB	Bale-Mulhouse	5	0.3%
92	LFRQ	Quimper Pluguffan	5	0.3%
93	EGHS	Henstridge	5	0.3%
94	EGHJ	Bembridge	5	0.3%
95	EGLM	White Waltham	5	0.3%
96	EDJA	Memmingen	5	0.3%
97	EDDL	Dusseldorf	5	0.3%
98	EDBK	Kyritz	5	0.3%
99	EHTX	Texel/Texel	5	0.3%
100	LOAV	Voslau	5	0.3%
101	LFQB	Troyes Barberey	5	0.3%

No	ICAO code	Aerodrome title	Score	% of total score
102	EGNJ	Humberside	5	0.3%
103	EDVE	Braunschweig-Wolfsburg	5	0.3%
104	EDTL	Lahr	5	0.3%
105	EDTD	Donaueschingen-Villingen	5	0.3%
106	LERS	Reus	5	0.3%
107	LFBX	Perigueux Bassillac	4	0.2%
108	EGSX	North Weald	4	0.2%
109	EDAX	Rechlin-Larz	4	0.2%
110	EGPE	Inverness	4	0.2%
111	LGMG	Megara	4	0.2%
112	EGPG	Cumbernauld	4	0.2%
113	EDFC	Aschaffenburg	4	0.2%
114	EDLS	Stadtlohn-Vreden	4	0.2%
115	EHRD	Rotterdam/Rotterdam	4	0.2%
116	LFPB	Paris Le Bourget	4	0.2%
117	LFAI	Nangis Les Loges	4	0.2%
118	EGLD	Denham	4	0.2%
119	EGTB	Wycombe Air Park/Booker	4	0.2%
120	EGLK	Blackbushe	4	0.2%
121	LFGA	Colmar Houssen	4	0.2%
122	EDAD	Dessau	4	0.2%
123	LFLI	Annemasse	4	0.2%
124	EDTF	Freiburg I.Br.	4	0.2%
125	EGHA	Compton Abbas	4	0.2%
126	EEPU	Parnu	4	0.2%
127	EFLP	Lappeenranta	4	0.2%
128	EGCN	Doncaster Sheffield	4	0.2%
129	EDLM	Marl-Loemuhle	3	0.2%
130	LFLA	Auxerre Branches	3	0.2%
131	LIRZ	Perugia/S.Egidio	3	0.2%
132	EFHK	Helsinki-Vantaa	3	0.2%
133	LFMA	Aix Les Milles	3	0.2%
134	EGFE	Haverfordwest	3	0.2%
135	EDQH	Herzogenaurach	3	0.2%
136	LFQA	Reims Prunay	3	0.2%
137	EGKH	Lashenden/Headcorn	3	0.2%
138	EKYT	Aalborg	3	0.2%
139	EDME	Eggenfelden	3	0.2%

No	ICAO code	Aerodrome title	Score	% of total score
140	ENTO	Sandefjord/Torp	3	0.2%
141	EKBI	Billund	3	0.2%
142	EBSH	Saint-Hubert/Saint-Hubert	3	0.2%
143	EBLG	Liege/Liege	3	0.2%
144	LFRG	Deauville Normandie	3	0.2%
145	LFMT	Montpellier Mediterranee	3	0.2%
146	LFRK	Caen Carpiquet	3	0.2%
147	EDVC	Celle-Arloh	3	0.2%
148	EPKK	Krakow/Balice	3	0.2%
149	EHBK	Maastricht/Maastricht Aachen	3	0.2%
150	EGSF	Peterborough / Conington	3	0.2%
151	EDTY	Schwabisch Hall	3	0.2%
152	LGKV	Megas Alexandros	3	0.2%
153	ESGG	Goteborg/Landvetter	3	0.2%
154	EGLS	Old Sarum	3	0.2%
155	EGDM	Boscombe Down	3	0.2%
156	LGSK	Alexandros Papadiamantis	3	0.2%
157	LKKO	Kolin	3	0.2%
158	EDKL	Leverkusen	3	0.2%
159	EBSP	Spa/La Sauveniere	3	0.2%
160	EGLW	London Heliport	3	0.2%
161	LECJ	Castejon De Los Monegros	3	0.2%
162	ESML	Landskrona	3	0.2%
163	EGLG	Panshanger	3	0.2%
164	EDTM	Mengen-Hohentengen	3	0.2%
165	EHHO	Hoogeveen/Hoogeveen	3	0.2%
166	EGFF	Cardiff	3	0.2%
167	EGPH	Edinburgh	3	0.2%
169	EGTG	Bristol Filton	3	0.2%
170	LFTZ	La Mole	3	0.2%
171	EGUY	Wyton	3	0.2%
172	EGAA	Belfast/Aldergrove	3	0.2%
173	LFIK	Riberac Saint Aulaye	3	0.2%
174	LECD	La Cerdanya	3	0.2%
175	EDDC	Dresden	3	0.2%
176	LZDB	Dubnica	3	0.2%
177	LOWS	Salzburg - W. A. Mozart	3	0.2%
178	LZTT	Poprad-Tatry	3	0.2%

No	ICAO code	Aerodrome title	Score	% of total score
179	EGNR	Hawarden	3	0.2%
180	LZZI	Zilina	3	0.2%
181	EGNV	Durham Tees Valley	3	0.2%
183	EDXQ	Rotenburg(Wumme)	3	0.2%
184	LECU	Madrid/Cuatro Vientos	3	0.2%
185	EDTC	Bruchsal	3	0.2%
186	EGMD	Lydd	3	0.2%
187	EDXF	Flensburg-Schaferhaus	3	0.2%
188	LEIG	Igualada-Odena	3	0.2%
189	EDWF	Leer-Papenburg	3	0.2%
190	EGBP	Kemble	3	0.2%
191	EGBS	Shobdon	3	0.2%
192	EGCS	Sturgate	3	0.2%
193	EDXW	Sylt	3	0.2%
194	LEVD	Valladolid/Villanubla	3	0.2%
195	BIKF	Keflavik	3	0.2%
196	LEVT	Vitoria/Foronda	3	0.2%
197	LFLX	Chateauroux Deols	3	0.2%
198	EDWY	Norderney	3	0.2%
199	LSZK	Speck-Fehraltorf	3	0.2%
200	EBST	Sint-Truiden/Brustem	3	0.2%
201	EDDE	Erfurt-Weimar	3	0.2%
202	EDWC	Damme	3	0.2%
203	EDWL	Langeoog	3	0.2%
204	EDNX	Oberschleissheim	3	0.2%
205	ENKJ	Kjeller	3	0.2%
206	LKVM	Vysoke Myto	3	0.2%
207	LFRM	Le Mans Arnage	3	0.2%
208	ETHN	Niederstetten	3	0.2%
209	EDTH	Heubach	3	0.2%
210	LFMK	Carcassonne Salvaza	3	0.2%
211	EDNL	Leutkirch-Unterzeil	3	0.2%
212	ESTA	Angelholm	3	0.2%
213	EDAY	Strausberg	3	0.2%
214	LDLO	Losinj / Losinj I.	3	0.2%
215	LFGB	Mulhouse Habsheim	3	0.2%
216	LFSM	Montbeliard Courcelles	2	0.1%
217	LFPK	Coulommiers Voisins	2	0.1%

No	ICAO code	Aerodrome title	Score	% of total score
218	LIRS	Grosseto	2	0.1%
219	LEAS	Asturias	2	0.1%
220	EDTZ	Konstanz	2	0.1%
221	EFSE	Selanpaa	2	0.1%
222	LKTB	Brno/Turany	2	0.1%
223	EEKU	Kihnu	2	0.1%
224	EGTR	Elstree	2	0.1%
225	LFRN	Rennes Saint Jacques	2	0.1%
227	EDLZ	Soest/Bad Sassendorf	2	0.1%
228	ENBR	Bergen/Flesland	2	0.1%
229	EDCD	Cottbus-Drewitz	2	0.1%
230	LFIM	Saint Gaudens Montrejeau	2	0.1%
231	EGBG	Leicester	2	0.1%
232	LOLS	Scharding / Suben	2	0.1%
233	EFHN	Hanko	2	0.1%
234	LSZG	Grenchen	2	0.1%
235	LOAB	Dobersberg	2	0.1%
236	LFNF	Vinon	2	0.1%
237	EICM	Galway	2	0.1%
238	LKCR	Chrudim	2	0.1%
239	EDMF	Furstenzell	2	0.1%
240	EDWQ	Ganderkesee Atlas Airfield	2	0.1%
241	EHHV	Hilversum/Hilversum	2	0.1%
242	ETNH	Hohn	2	0.1%
243	EKEL	Endelave	2	0.1%
244	LELL	Sabadell	2	0.1%
245	EDWI	Wilhelmshaven Jadeweserairport	2	0.1%
246	ESGT	Trollhattan-Vanersborg	2	0.1%
247	EGSG	Stapleford	2	0.1%
248	LSZF	Birrfeld	2	0.1%
249	LIPO	Brescia/Montichiari	2	0.1%
250	EDMV	Vilshofen	2	0.1%
251	LOAG	Krems/Langenlois	2	0.1%
252	EDOD	Reinsdorf	2	0.1%
253	LFAB	Dieppe Saint Aubin	2	0.1%
254	LFPT	Pontoise Cormeilles En Vexin	2	0.1%
255	EGBM	Tatenhill	2	0.1%
256	LFML	Marseille Provence	2	0.1%

No	ICAO code	Aerodrome title	Score	% of total score
257	EGHO	Thruxton	2	0.1%
258	EGPF	Glasgow	2	0.1%
259	LOWI	Innsbruck	2	0.1%
260	EHAM	Amsterdam/Schiphol	2	0.1%
261	LOWL	Linz Intl	2	0.1%
262	ETEJ	Bamberg Aaf	2	0.1%
263	EKVD	Kolding/Vamdrup	2	0.1%
264	EDAQ	Halle-Oppin	2	0.1%
265	LSGE	Ecuvillens	2	0.1%
266	EDLI	Bielefeld	2	0.1%
267	LSGG	Geneve	2	0.1%
268	BIRK	Reykjavik	2	0.1%
269	EGNF	Netherthorpe	2	0.1%
270	EHAL	Ameland/Ameland	2	0.1%
272	LHNY	Nyiregyhaza	2	0.1%
273	LFDP	Saint Pierre D'Oleron	2	0.1%
274	LFBH	La Rochelle Ile De Re	2	0.1%
275	EGLF	Farnborough	2	0.1%
276	LIPQ	Trieste/Ronchi Dei Legionari	2	0.1%
277	EDLP	Paderborn/Lippstadt	2	0.1%
278	EDKA	Aachen-Merzbruck	2	0.1%
279	LFGQ	Semur En Auxois	2	0.1%
280	ETSI	Ingolstadt/Manching	2	0.1%
281	EGHR	Chichester/Goodwood	2	0.1%
282	EBZR	Zoersel/Oostmalle	2	0.1%
283	LZNI	Nitra	2	0.1%
284	LFBO	Toulouse Blagnac	2	0.1%
285	EGNT	Newcastle	2	0.1%
286	LSZB	Bern-Belp	2	0.1%
287	LFLB	Chambery Aix Les Bains	2	0.1%
288	EDMO	Oberpfaffenhofen	2	0.1%
290	LFEA	Belle Ile	2	0.1%
291	EPKN	Opole/Kamien Slaski	2	0.1%
292	LDDU	Dubrovnik / Cilipi	2	0.1%
293	EBOS	Oostende-Brugge/Oostende	2	0.1%
294	EDRT	Trier-Fohren	2	0.1%
295	EGLL	London Heathrow	2	0.1%
296	EFRH	Raahe-Pattijoki	2	0.1%

No	ICAO code	Aerodrome title	Score	% of total score
297	EGTN	Enstone	2	0.1%
298	LDSB	Brac / Brac I.	2	0.1%
299	ESMH	Hoganas	2	0.1%
300	LFLJ	Courchevel	2	0.1%
301	LIPB	Bolzano	1	0.1%
302	LFMZ	Lezignan Corbieres	1	0.1%
303	EDHE	Uetersen/Heist	1	0.1%
304	EGNH	Blackpool	1	0.1%
305	EDAE	Eisenhuttenstadt	1	0.1%
306	EFLA	Lahti-Vesivehmaa	1	0.1%
307	LFCL	Toulouse Lasbordes	1	0.1%
308	LESO	San Sebastian	1	0.1%
309	EFJY	Jyvaskyla	1	0.1%
311	EGKR	Redhill	1	0.1%
312	EGNS	Isle Of Man	1	0.1%
313	LDPL	Pula	1	0.1%
314	EGHQ	Newquay	1	0.1%
315	LILE	Biella/Cerrione	1	0.1%
316	EGBK	Northampton/Sywell	1	0.1%
317	LFPM	Melun Villaroche	1	0.1%
318	EGNX	East Midlands	1	0.1%
319	LCRA	Akrotiri	1	0.1%
320	EPLL	Lodz/Lublinek	1	0.1%
321	LFMV	Avignon Caumont	1	0.1%
322	LFBE	Bergerac Roumaniere	1	0.1%
323	EKHG	Herning	1	0.1%
324	EGPD	Aberdeen/Dyce	1	0.1%
325	EDAH	Heringsdorf	1	0.1%
326	LFDJ	Pamiers Les Pujols	1	0.1%
327	EDCJ	Chemnitz/Jahnsdorf	1	0.1%
328	LGMT	Odysseas Elytis	1	0.1%
329	EDLR	Paderborn-Haxterberg	1	0.1%
330	EGTU	Dunkeswell	1	0.1%
331	EDCG	Rugen	1	0.1%
332	LGSR	Santorini	1	0.1%
333	EDBC	Magdeburg/Cochstedt	1	0.1%
334	EPWK	Kruszyn K/Wloclawka	1	0.1%
335	LKLT	Letnany	1	0.1%

No	ICAO code	Aerodrome title	Score	% of total score
336	LJLJ	Ljubljana / Brnik	1	0.1%
337	EKAE	Aeroe	1	0.1%
338	LKHK	Hradec Kralove	1	0.1%
339	LEPA	Palma De Mallorca	1	0.1%
340	ESGP	Goteborg/Save	1	0.1%
341	EGMH	Manston	1	0.1%
342	LFGJ	Dole Tavaux	1	0.1%
343	EIWT	Weston	1	0.1%
344	EFMA	Mariehamn	1	0.1%
345	LZIB	Bratislava/M. R. Stefanik	1	0.1%
346	LOGP	Pinkafeld	1	0.1%
347	EGKK	London Gatwick	1	0.1%
348	EFNU	Nummela	1	0.1%
349	EGSU	Duxford	1	0.1%
350	LFKC	Calvi Sainte Catherine	1	0.1%
352	EHBD	Weert/Budel	1	0.1%
353	LFOP	Rouen Vallee De Seine	1	0.1%
354	EGFP	Pembrey	1	0.1%
355	LSZS	Samedan	1	0.1%
356	ESSU	Eskilstuna	1	0.1%
357	EDDR	Saarbrucken	1	0.1%
358	EGBW	Wellesbourne Mountford	1	0.1%
359	EHTE	Deventer/Teuge	1	0.1%
360	EDFW	Wurzburg-Schenkenturm	1	0.1%
361	LIQS	Siena/Ampugnano	1	0.1%
362	EFHA	Halli	1	0.1%
363	EDTS	Schwenningen Am Neckar	1	0.1%
364	EDXR	Rendsburg-Schachtholm	1	0.1%
365	LIPN	Verona/Boscomantico	1	0.1%
366	EDUY	Welzow-Sedlitzer See	1	0.1%
367	LIMJ	Genova/Sestri	1	0.1%
368	EDSZ	Rottweil-Zepfenhan	1	0.1%
369	BIAR	Akureyri	1	0.1%
370	LIPU	Padova	1	0.1%
371	LECI	Santa Cilia De Jaca	1	0.1%
372	EDQT	Hassfurt-Schweinfurt	1	0.1%
373	EDAV	Eberswalde-Finow	1	0.1%
374	EDHF	Itzehoe/Hungriger Wolf	1	0.1%

No	ICAO code	Aerodrome title	Score	% of total score
375	EDDH	Hamburg	1	0.1%
	Total		**1625**	**100%**