“EASA over-regulation of light aircraft GPS installations denies safety benefits to General Aviation pilots”

Executive Summary

European pilots and flight schools want to be able to cost-effectively upgrade old navigation radios with modern GPS units. They want to fly safer modern GPS procedures instead of using methods that date back to the 1930s. They want EASA to adopt a simple airworthiness process based on Approved Model Lists, like the one used in the USA and validated, since the 1990s, by tens of thousands of aircraft installations and millions of flight hours. The want practical approval for GPS operations, suited to the needs of GA. They want to access to the benefits of the EU-funded EGNOS satellite infrastructure and the future benefits of the Galileo system.

“Why is one EU agency (the GSA) promoting EGNOS on the basis that it can prevent 74% of ‘Controlled Flight into Terrain’ accidents, whilst another agency (EASA) is erecting paperwork and regulatory barriers to make these benefits onerously expensive for light aircraft?”

“Why do European light aircraft and some scheduled airline flights still use 1930s instrument approach methods?”

“Why can it cost up to €20,000 in paperwork to get EASA approvals for GPS units of which over 100,000 have been fitted to light aircraft worldwide since the 90s?”

“Is it a surprise that many European light training aircraft lack GPS navigation equipment (such as the aircraft on the right, which crashed during an instructional flight in March 2011 due to a navigation error at night) when a full set of EASA paperwork approvals can cost up to 50% of the value of the aircraft?”

“Tens of thousands of US aircraft have millions of flight hours experience flying GPS approaches. What information does EASA have to justify its vastly more expensive and complex airworthiness approvals, given the successful experience of the USA?”

1. Briefing and Case Examples

Until GPS technology became suitable for aviation use, "Instrument Approaches" (to land aircraft in bad weather), used only ground-based radio aids. The first such technology involved simple non-directional beacons (NDBs) at an airport and "radio compass" equipment in aircraft.

Popular Science magazine, April 1931

BROADCAST STATION CAN GUIDE FLYER

Lost flyers soon may find their way in fog by following the strains of a jazz orchestra back home. In parts of the country where official radio beacon stations for aircraft do not yet exist, any broadcast station can guide a plane by means of a new "radio compass" recently tested by the U. S. Army Air Corps at Washington, D. C. The pilot in the above photo is demonstrating it.

This device sets a flyer's course in any desired direction with reference to a selected broadcasting station within 100 miles or more. The broadcast program, received through a set much like any standard aircraft radio, actuates a needle on a round dial beside the pilot. When the needle swings to the right or left of the center of the dial, it shows the pilot he is off his course.

Capt. Elrey Jeppesen

Douglas DC3, 1930s

The Radio Compass is essentially a needle which points to the direction of the radio beacon relative to the nose of the aircraft. An exact position fix is possible when overhead the beacon.

In the early 1930s, pilots would use the radio compass to help navigate to an airport and then descend to the runway using whatever method they thought appropriate, aided by maps designed for motorists. In 1934, a US pilot called Elrey Jeppesen began to publish the notes and instrument procedures he had designed for himself for the use of other pilots. Jeppesen's charts quickly became a standard used in civil and military aviation in the USA.

Radio aids more advanced than the NDB became common in the years after World War 2. The "VOR-DME" system provides a much more accurate bearing and distance. In particular, the

Instrument Landing System (ILS) provides a very accurate 3-dimensional path (a “precision approach”) to guide an aircraft onto a runway.

However, VOR-DME and ILS installations are very expensive, and suitable only for larger airports with a higher volume of airline traffic. Airports used mainly by general aviation and regional or commuter airlines often cannot afford hundreds of thousands of pounds for advanced radio aids. As a result, until the 1990s, NDB Instrument Approaches were still common. Since the late 90s, GPS has rendered inaccurate and unreliable NDB technology completely obsolete. However, in Europe, lighter aircraft (both private and in scheduled airline services) still depend upon NDBs – often in locations serving communities that might depend upon air transport. The island of Alderney is an example in the chart on the bottom right below.

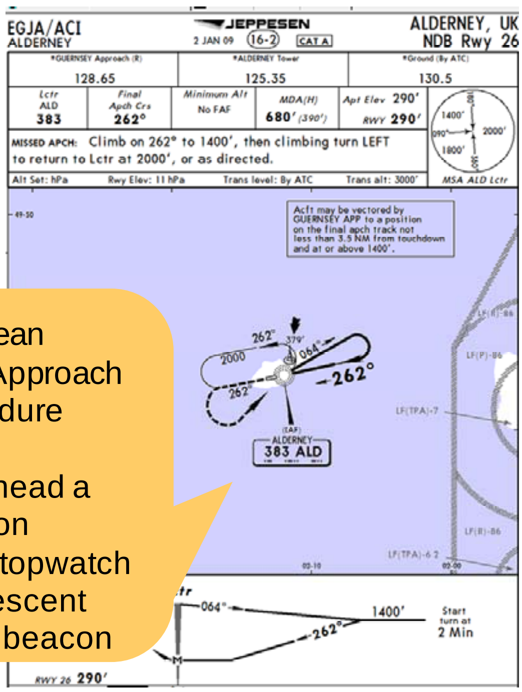
USA: 1930s

Europe: 2011

Vintage radio compass

2011 model radio compass

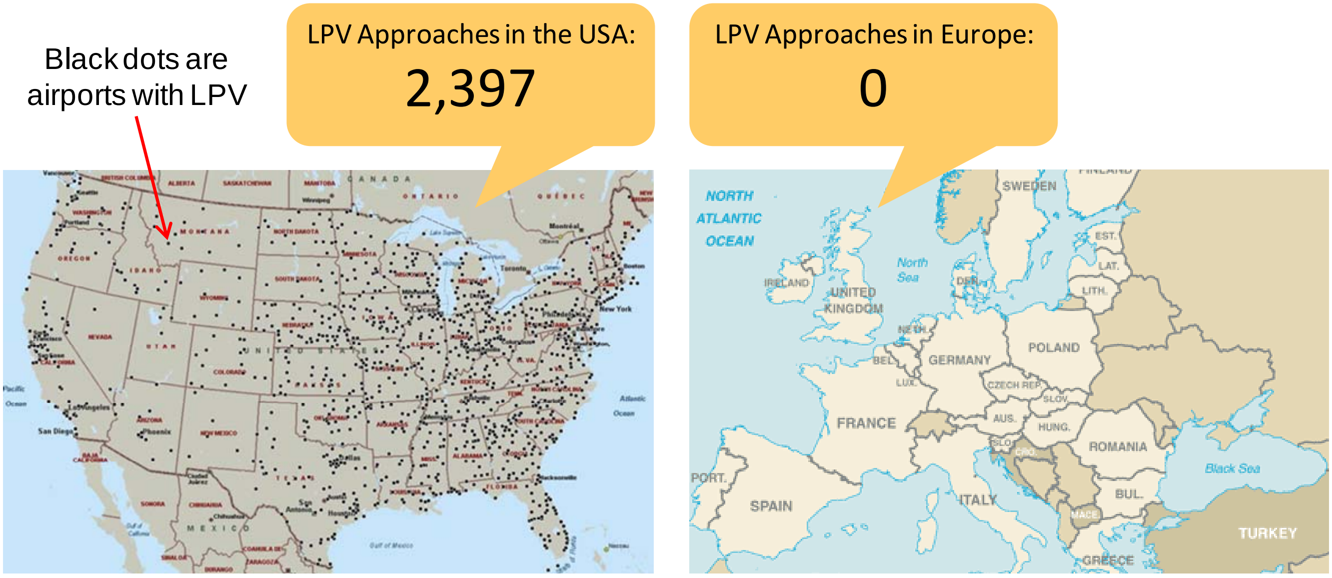
Original 1934 Captain Jeppesen Instrument Approach Plate: procedure based on
- flying overhead a radio beacon
- starting a stopwatch
- turn and descent back to the beacon



2011 European Instrument Approach Plate: procedure based on
- flying overhead a radio beacon
- starting a stopwatch
- turn and descent back to the beacon

The most recent GPS development is a technology which allows “LPV” approaches to achieve accuracy and reliability similar to the precision ILS used at major airports.
This technology has been available in the USA since 2004, where tens of thousands of light aircraft have GPS navigation units fitted and approved for LPVs. In Europe, the satellite

technology (EGNOS) has only been operational since early 2011, and, as a result, Europe lags the USA in the availability of LPV approaches:



However, many European aircraft have LPV-capable GPS units fitted; they have been the industry standard since 2006. Given that Europe now also has the satellite technology working and certified for aviation use, and given the vast and successful experience of the USA, one might imagine that LPV use will grow rapidly in Europe.

It should. However, there is a major obstacle.

EASA, the European Aviation Safety Agency, is responsible for the Certification and Airworthiness Approval of European aircraft. The main body of this paper argues that EASA's costly, complex and duplicative approvals process detracts from aviation safety by making the installation of (elaborately certified) modern technology by (elaborately regulated) maintenance organisations a bureaucratic nightmare for aircraft operators.

By "aircraft operators" we don't only mean a group of pilots sharing a light single-engine airplane or a small flying club with 2 or 3 training aircraft.

In one European country, the largest provider of air traffic control and air navigation services has been running a trial to test LPV approaches as a replacement for a current NDB approach - the sole procedure available at the trial airport, which serves both scheduled airline traffic and light aircraft. A leading commercial Flight Training Organisation (FTO), has been trying to participate with a 'representative' aircraft: a light twin-engine Beech Duchess, used for training future airline pilots. The FTO, in turn, has engaged the countries' leading EASA-approved Design Organisation for light aircraft avionics. Despite having an "industry standard" installation, validated in millions of flight hours and millions of LPV approaches in the USA, after many months, the FTO and Design Organisation are still struggling with EASA to get LPV approval for their aircraft – for an existing LPV-capable installation which has already gone through the entire Airworthiness Approval process. They are simply looking for a paperwork change to permit LPV approaches. What hope is there for the 'ordinary' pilots and flying clubs?

2. Question in the European Parliament on EASA over-regulation: Sep. 2010

(our bold, highlight emphasis)

Parliamentary questions

28 September 2010 E-7689/2010

Question for written answer
to the Commission
Rule 117
Morten Messerschmidt (EFD)

Subject: EASA and intensive regulation Answer(s)

In recent years, EASA has adopted a practice that involves the intensive regulation of aviation rules, to the great inconvenience of individual flying enthusiasts. The Commission's own EU Barometer surveys show that a high level of regulation increases discontent with the EU.

Martin Robinson, the Vice-President of IAOPA (The International Council of Aircraft Owner and Pilot Associations) recently stated that over-regulation by EASA is the greatest threat to air safety in Europe. In the same breath, he also criticises EASA for issuing endless detailed rules without being able to base these on trustworthy data.

Can the Commission therefore say whether all this rule-tightening is really necessary, if the rules absolutely have to cover more or less everything to do with flying, and which data are used as the basis for this intensive regulation?

Answer given by Mr Kallas on behalf of the Commission

The adoption of a number of harmonised rules at EU level has been decided by the Europan legislators due to the need of making some standards mandatory, ensuring homogeneous enforcement, facilitating freedom of movement and guaranteeing a level playing field at EU level.

The European Aviation Safety Agency (EASA) assists the Commission in the preparation of such rules. In doing so, the Agency follows the mandates laid down in Regulation (EC) No 216/2008[(1)] for every area under consideration, which include considering existing international standards (those set by the International Civil Aviation Organisation — ICAO) and national rules, proposing proportionate and cost effective rules after having consulted widely all stakeholders concerned.

EASA concentrates its regulatory tasks on issues which have been considered essential for ensuring and maintaining a high level of safety by the referred Regulation or are requested by Member States or by stakeholders represented in its consultative and advisory bodies[(2)]. These bodies include representatives from IAOPA.

The final deliverables prepared by EASA are the result of a long and sound consultation process and are accompanied by a Regulatory Impact Assessment. The consultation process as such is set out in a decision of the Management Board of the Agency based on the principles and criteria set out in Regulation (EC) No 216/2008. These deliverables can take the form of draft binding rules or voluntary standards. EASA proposals for draft binding rules are addressed to the Commission, which decides on their adoption after consultation of a committee of experts and of the European legislators.

The Commission wishes to underline that, in the course of the legislative process, due regard is paid to the need to ensure that any new binding rule is simple, proportionate, cost–effective and reflecting the complexity of the activity in question as well as the risk involved. Also, particular attention is paid to the potential impact of any such rule on small and medium-sized enterprises and general aviation as presented in the communication of the Commission of 11 January 2008, 'An Agenda for Sustainable Future in General and Business Aviation'[(3)].

Extract from the Written Answer E-7689/2010: (our underline emphasis)

"...due regard is paid to the need to ensure that any new binding rule is simple, proportionate, cost–effective and reflecting the complexity of the activity in question as well as the risk involved. Also, particular attention is paid to the potential impact of any such rule on small and medium-sized enterprises and general aviation...."

3. Is EASA's airworthiness process "simple, proportionate and cost-effective"?

All mainstream production aircraft are certified by regulatory authorities. The original design has a "Type Certificate", and alterations to the design require a "Supplemental Type Certificate" (STC). Any part fitted to an aircraft, from the engine down to a replacement nut or bolt, needs to be approved by a regulatory process. Equipment which serves a particular required function (eg. a VHF radio for air traffic control communications) needs approval under a "Technical Standards Order" (TSO) specific to that function.

The diagram above illustrates a typical light aircraft installation of industry-standard integrated GPS and Radio units replacing the aircraft's original communication and navigation equipment. Such installations have been validated in tens of thousands of light aircraft and millions of flight hours since the 1990s. The table below describes the rather different interpretation of “simple, proportionate and cost effective” in Europe compared to the USA.

USA	**Europe**
Installation of dual GPS units certified to common (E)TSO-C146a standard	
FAA publishes “Approved Model List” of 980 aircraft types	EASA does not accept the Approved Model List method; insists on a “Supplemental Type Certificate” for each individual aircraft type at a cost to GA of ~€10,000 per type
A new installation needs a 2 page “Form 337” signed by an FAA authorised engineer and approved by an FAA inspector. ➢ **Cost of “approval paperwork” in addition to equipment and installation: <u>practically zero</u>**	A new installation needs to be conducted by an EASA approved Part M Engineer or Part-145 Maintenance Organisation, who must contract an EASA-approved Part-21 Design Organisation. The Design Organisation must prepare ~100 pages of drawings, data and diagrams for each installation (at a cost of ~€5000) and submit them as a “Major Modification” to EASA, with a fee of €1200-€2400 ➢ **Cost of “approval paperwork” in addition to equipment and installation: <u>€7000-€10,0000</u>**
Operator requires an airworthiness approval for LPV approaches for an existing installation: No regulatory work needed. Approval included in the original installation’s Flight Manual Supplement, available since 2006. ➢ **Cost of approval for LPV approaches in an existing installation: <u>Not applicable, original installation already approved</u>**	Operator requires an airworthiness approval for LPV approaches for an existing installation: EASA require a further Major Modification, with a further fee of €1200-2400 and further costs from a Design Organisation to prepare the paperwork (eg. €5000). EASA also require additional equipment to be fitted (at a cost of €5000-€10,000) in accordance with their AMC20-28, unless an investigation by EASA deems this unnecessary (further cost) ➢ **Cost of approval for LPV approaches in an existing installation: <u>€5000-€10,0000</u>**
Total Cost of Approvals: near zero	**Total Cost of Approvals: €10,000-€20,000**
Cost as % of value of a typical light aircraft: **0%**	Cost as % of value of a typical light aircraft: **25-50%**

No evidence that this extra cost mitigates any meaningful risk or has any safety benefit, given the vast experience of the US methods. Plenty of evidence that it is a barrier to European pilots moving from 1930s navigation methods to modern GPS procedures

4. Comments on EGNOS and LPV approaches from the European GNSS Agency (an agency of the European Union)

"Helicopters, business aviation, regional airlines and the large general aviation aircraft flying into small and medium-sized airports – where the traffic does not justify expensive investment into ground-based navigation infrastructure – will benefit from the considerable reduction in the decision height provided by EGNOS

When the decision height is lowered, the uncertainty of landing in adverse weather conditions is equally reduced. This translates into a substantial drop in delays, diversions and flight cancellations, allowing operators to achieve reductions in unnecessary flying hours (and thus cuts in costs for staff, fuel and CO_2 emissions)."

"Safety is also improved. By being able to fly the same approach procedure regardless of the weather, the pilot has more situational awareness, resulting in an estimated reduction by 74% of so-called 'Controlled Flight into Terrain', where the plane is lined up properly with the runway, but hits the ground too soon."

Controlled Flight Into Terrain (CFIT) and Non-Precision Approaches (NPA)

Graphical support

Context description

- CFIT occurs when an airworthy aircraft under the control of the flight crew is flown unintentionally into terrain, obstacles or water, usually with no prior awareness by the crew
- This type of accident can occur during most phases of flight, but CFIT is more common during the approach-and-landing phase
- Non-Precision Approaches are at the basis of CFIT occurrence

EGNOS benefits

- Offering Approaches with Vertical Guidance procedures and enabling Continuous Descent Approaches, EGNOS can lead to a decrease in the number of CFIT occurrences

Source: http://egnos-portal.gsa.europa.eu/users/general-information/cost-benefits-analysis
and LEK study http://egnos-portal.gsa.europa.eu/files/dmfile/study_cost_benefit_analysis_Aviation.pdf

APPENDIX

DISCUSSION PAPER: AIRWORTHINESS APPROVAL OF GNSS RNAV EQUIPMENT IN NON-COMPLEX EASA AIRCRAFT

Vasa Babic   **May 2011, v2.1**

Summary

This is a discussion and advocacy paper to encourage debate amongst PPL/IR Europe members and other stakeholders. It is not a formal submission to EASA or any third party. It addresses the EASA airworthiness requirements for typical IFR GPS installations in "non-complex" aircraft (ie. piston and single-engine turbine GA types).

Sections 1-3 review the functional requirements for LPV Approach and PRNAV approval, and argue that three specific requirements are unnecessarily imposing disproportionate barriers in the approvals process. These sections are unavoidably dense in their use of technical references; a reader may wish to refer to the summary paragraph at the end of section 3.

Sections 4 and 5 review the 'bigger picture' of EASA Minor and Major Modification approvals for RNAV equipment and applications. It is argued that these processes are unnecessarily costly, duplicative and onerous, given the commonality of the non-complex aircraft fleet, and disproportionate, given the safety benefits of approved RNAV equipment and the safety record of lighter regulatory models.

Section 6 describes some draft recommendations. Firstly, for better and clearer functional requirements in respect of typical non-complex aircraft RNAV installations. Secondly, for a more proportionate airworthiness approval model, based on Approved Model Lists (AMLs) and simpler Minor modification processes.

1. Introduction and references

There are 6 main documents relevant to the topics covered in this paper
EASA AMC20-4: BRNAV
EASA AMC20-5: GPS approval
EASA AMC20-27: RNP Approach Operations including APV BARO-VNAV
EASA AMC20-28: RNAV GNSS Approach Operations to LPV minima using SBAS
EASA (JAA) TGL10 Rev 1: PRNAV
FAA AC20-138A: the basis of much of the content in AMC 20-27 and 28; see also the Sep 2010 revision: AC20-138B

Many of the RNAV concepts referred to in this paper are detailed in the author's "PPL/IR Europe RNAV Training Manual" which can be downloaded from this link: www.pplir.org/rnavmanual

This paper will not consider BRNAV and AMC20-4 and -5; these are mature applications well understood by all stakeholders. It will also not consider APV BARO-VNAV, since no Non-Complex aircraft can support this application. It is important to clarify that the Baro input, Baro aiding and VNAV features of (E)TSO C129 and C146 GNSS units are not APV BARO-VNAV functions, and any reference or requirements in AMC20-27 specific to APV BARO-VNAV may be ignored for the purpose of this paper.

In this paper, for brevity, the terms “RNAV NPA approach” will be used to refer to non-precision RNAV Approaches based on GNSS using LNAV minima, and “LPV approach” to refer to RNAV APV approaches using SBAS to LNAV/VNAV or LPV minima.

It is worth noting that no SBAS approach is a “precision approach” in the formal ICAO sense. Although an LPV approach has much in common with a CAT 1 ILS precision approach, it is formally classified as an APV (Approach with Vertical Guidance).

It should also be noted that EASA’s AMC 20-27 and 28 have an apparent omission: no reference is made to LNAV/VNAV approaches using SBAS-VNAV rather than Baro-VNAV. This is a less demanding application than LPV minima, so one can assume that if LPV airworthiness requirements are met, an installation will also be deemed LNAV/VNAV compliant, although a formal statement to this effect would be useful.

Finally, for the sake of brevity, we shall use the phrase “GA aircraft” to refer to Non-Complex EASA general aviation aircraft approved for IFR, and all reference to airworthiness criteria and approvals shall relate to Non-CAT operation.

In summary, the focus of this paper is

A. AMC20-27 and the requirements for RNAV NPA approaches
B. AMC20-28 and the requirements for LPV approaches
C. TGL10 Rev1 and the requirements for PRNAV

in EASA Non-Complex Non-CAT aircraft.

2. The “Reference Installation”

Although there is a wide variety of avionics and instruments in GA aircraft, for the purposes of RNAV approval, the homogeneity of the fleet is high, because essentially two products account for a very great majority of the relevant installations. These are the Garmin GNS430/530 (and variants, including the SBSAS “W” series) and Garmin G1000 (in SBAS and non-SBAS variants).

For the purpose of this paper, we shall consider one **“Reference” class of installation**, illustrated in Fig.1 below. The properties of this class of installation are as follows:

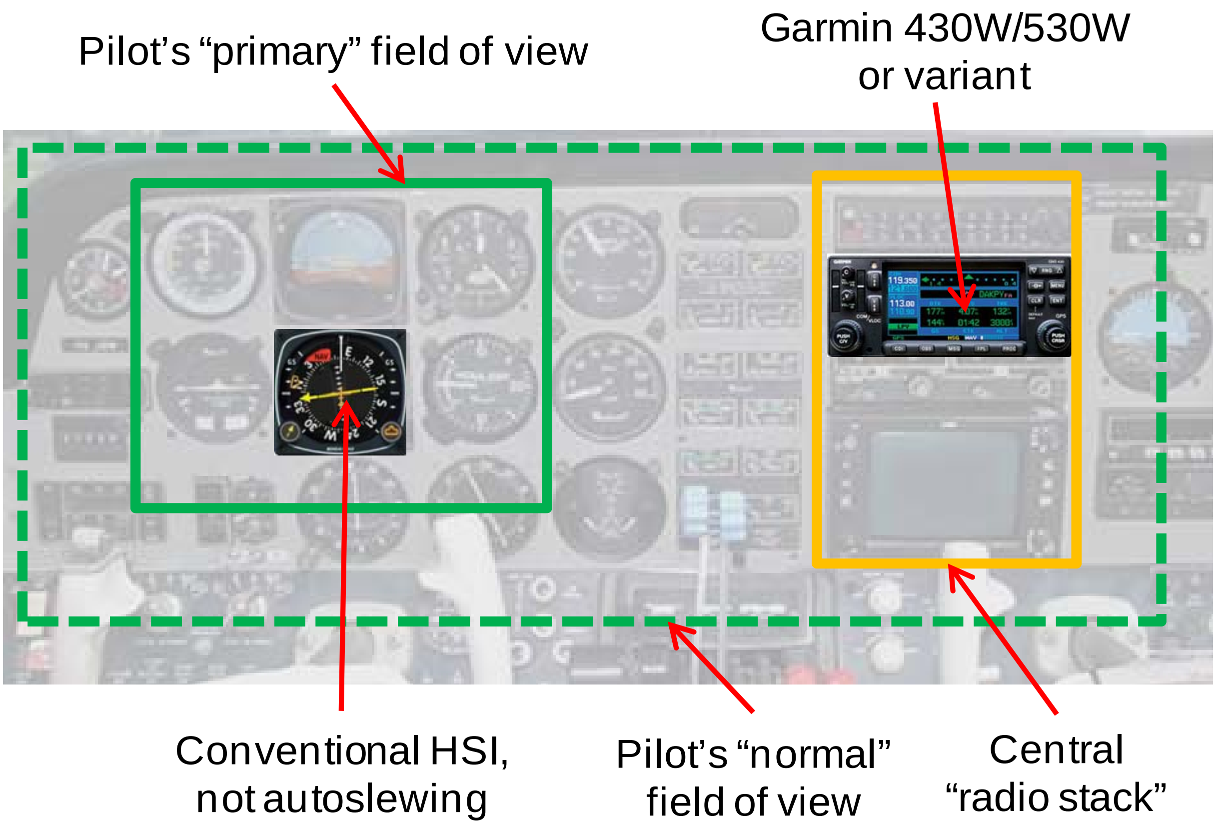
1. At least one (E)TSO-C146a Garmin 430W or 530W (or Garmin 400W/500W series variants without the VHF Com and Nav radio functions) fitted in the centre radio stack (ie. not on the co-pilot panel or in a pedestal) with an installation approved for IFR under (E)TSO-C146a and other airworthiness requirements (eg. AMC20-5, AMC20-4)

2. A mechanical, non-autoslewing HSI in the pilot’s primary field of view

3. No additional mode annunciators or distance repeaters, other than the annunciation and distance information provided on the Garmin display and, in some cases, a Nav Source annunciator of the GPS vs VOR/ILS type.

4. An autopilot may or may not be installed. If installed, it may or may not provide NAV and/or GS coupling from the Garmin GPS. However, if it does, the installation shall be compliant with the STC requirements for such an installation.

Fig. 1 Illustrative example of "Reference Installation"



The reason to consider this Reference installation is that it effectively encompasses all non-EFIS GA aircraft that may be seeking AMC20-28 and TGL10 approval. We shall consider some other types of installation at the end of this paper, but initially it is useful and convenient to consider only this "Reference Class".

3. Airworthiness compliance of the "Reference Installation"

A. <u>AMC20-27 and the requirements for RNAV NPA approaches</u>

It is our understanding that the Reference installation is compliant with the requirements of AMC20-27 for the purpose of RNAV NPA approaches

B. <u>AMC20-28 and the requirements for LPV approaches</u>

AMC20-28's formal status is that of a Notice of Proposed Amendment (NPA) rather than an amendment finally incorporated into EASA AMC20. However, it is the basis, at present, for LPV approach approvals and we need to consider it as such. AMC20-28 is derived from the FAA's AC 20-138A, to which it refers as follows:

In section 3: *"Since this AMC has been harmonised with other implementation and operational criteria outside of Europe, i.e. USA/FAA, it is expected to facilitate interoperability and ease the effort in obtaining operational authorisation by operators"*

In section 6.1: *"This AMC is consistent with FAA Advisory Circular AC 20-138A (LPV approach operation airworthiness approval section)."*

Compliance with the FAA’s AC20-138A (revised to AC20-138B since Sep 2010) for operators of N-register aircraft is not a trivial matter; for example, the requirements include a detailed flight test report. However, from a functional point of view, not only is the “Reference Installation” fully compliant with AC20-138A&B, but this compliance has been validated by thousands of aircraft flying the thousands of LPV approaches available in the USA. In fact, the accumulated experience of the US fleet probably exceeds the number of LPV approaches that will be flown by GA aircraft in Europe in the next 20 or 30 years. Therefore, in the case of LPV approaches, our observations are that

- The US experience is vast and the European experience is zero
- The intention of AMC20-28 is to be “consistent” and “harmonised” with AC20-138A
- The “Reference Installation” is compliant with the functional requirements of AC20-138A

However, the functional requirements in Section 7.1 of AMC20-28 differ from AC20-138A in two important respects:

In 7.1 item 2 (our emphasis in bold):

Capability to display the GNSS Approach mode (e.g. LPV, LNAV/VNAV, LNAV ...) in the **primary** field of view.

In 7.1 item 3 (our emphasis in bold):

Capability to continuously display the distance to the Landing Threshold Point/Fictitious Threshold Point (LTP/FTP). Note: The display must be visible to the flight crew and located in the **primary** field of view (± 15 degrees from the normal line of sight) when looking forward along the flight path.

Contrast these two requirements with their equivalent in AC20-138A Para 18 section d(2) (our emphasis in bold):

“Displays used for loss of integrity monitoring, waypoint sequencing, start of a turn, turn anticipation, active waypoint, distance to active waypoint, desired track and actual track (track angle error), TO/FROM indication, approach mode annunciation, and automatic mode switching should be located within the pilot’s ***normal field of view****. The normal field of view is such that the pilot would notice an annunciation during normal aircraft operation.* ***Guidelines for the normal field of view include****: the lateral normal field of view is from the center of the airspeed indicator to and including the* ***equipment if installed in the center radio stack****”*

In summary, AC20-28 substitutes the AC20-138A requirement for Mode Annunciation and Distance to Threshold to be in the “Normal” field of view with a requirement for the “Primary” field of view.

A Garmin 430W or 530W includes the Mode Annunciations and Distance display of AMC20-28 in its main display, see Fig 2 below.

Fig 2

Distance to Threshold display

GNSS Approach mode

GNSS Approach Mode Annunciation (re: AMC20-28 7.1 Item 2)

In the early days of IFR GPS, various remote annunciators were often required in the pilot's primary field of view. However, with the arrival of units that integrated VOR/ILS receivers and GPS receivers, the requirement for annunciators changed. This development is described in the following quote from Transport Canada's Policy Letter #523-008 (our bold emphasis):

"Technical Standard Orders ((E)TSOs) are based on standards produced by RTCA Inc; DO-229 is the standard for GPS/WAAS Airborne Equipment. The original wording of DO-229.....(suggested) remote annunciators were required in the pilot's primary field of view. However, in 1998, RTCA published DO-229A and introduced the concept of a "normal field of view", making it clear that many annunciations previously required in the pilot's primary field of view did not have to be so prominent. In essence, ***those annunciations not normally provided on the CDI/HSI, could, per DO-229A, be provided anywhere between the airspeed indicator on the left, and the center radio stack on the right.*** *Identical wording was incorporated into AC 20-138A in December 2003."*

Hence, we do not see any basis for the requirement in AC20-28, contrary to DO229 and AC20-138A, for approach mode annunciators other than those integrated into the GPS unit in the centre radio stack in the case of the "Reference Installation".

Distance Display to Threshold (re: AMC20-28 7.1 Item 3)

The requirement in AC20-28 for a display in the pilot's "primary" field of view is contrary to "normal" field of view requirement in DO229 and AC20-138A. We do not believe there is a justification for the extra requirement in AC20-28, on three grounds.

- Firstly, the experience of the US fleet flying LPV approaches, mentioned above.
- Secondly, the experience of the entire global fleet of GA aircraft that have been flying Precision ILS approaches to Cat I minima for decades, without a requirement for DME display in the primary field of view. In fact, almost all piston aircraft equipped with DME have a display integral to a receiver fitted in the centre radio stack.
- Thirdly, the disproportionate cost to most GA aircraft for a Distance Display near the primary flight instruments, for which the only practical solution is either an EFIS installation (circa €10,000) or a remote distance repeater (see Fig 3) at a cost of €7000. Whilst many aircraft owners, flying clubs and training organisations may be able to afford to upgrade an older non-SBAS GPS to the "Reference Installation" standard (about €5000-€10,000), it will be a stretch for many. It is absurd to expect operators to spend *another* €7000-€10,000 to meet the otherwise unnecessary Distance Display requirement. This extra sum represents 10%-20% of the capital value of many piston aircraft.

Fig 3.
Honeywell KDI 572 remote distance annunciator. Cost of unit plus interface, installation and approval: approx €7000

The question of how the field of view is defined has also been helpfully addressed in the FAA's most recent (Sep 2010) version of AC20-138, version B (extract from page 78, our emphasis):

"(2) Traditionally, 14 CFR part 23 airplanes with "classic" analog instrumentation in the "basic T" arrangement have included the center radio stack within the allowable field of view to satisfy this guidance. There is no intent for this AC to change that long-standing guidance.

Note: *Primary field of view is being incorporated as a standardized term across all documents. The primary field of view definition should be broad enough to include the center radio stack on 14 CFR part 23 airplanes with "classic", basic 'T' instrumentation."*

A simple way for EASA to resolve the issues described in this section would be to amend AC20-28 to make it consistent with the highlighted extract, above, from AC20-138B.

C. TGL10 Rev 1 and the requirements for PRNAV

Although the benefits of PRNAV are primarily in enabling continuous descent approaches for turbine aircraft, there should be no misunderstanding that PRNAV is somehow exclusive to large, multipilot aircraft flying 200KIAS arrivals. PRNAV is an application with a lateral RNP of 1nm. It fits between the BRNAV RNP of 5nm and the much more demanding RNAV NPA requirement of 0.3nm. A light, single pilot aircraft without an autopilot is perfectly capable of complying with PRNAV.

From an Airworthiness perspective, TGL10 contains only one potential difficulty for the "Reference Installation". The critical para is 7.1.1, which refers to the need for an autoslewing primary flight display. However, the final sentence of 7.1.1 says *"An acceptable alternative is a navigation map display, readily visible to the flight crew, with appropriate map scales and giving equivalent functionality to the lateral deviation display, except that scaling may be set manually by the pilot"*

To us, it is self-evident that the map display on a Garmin 400/500 is acceptable as "*a navigation map display...with appropriate map scales and giving equivalent functionality to the lateral deviation display"* and that, in the Reference Installation, a centre radio stack mounted instrument is "*readily visible to the flight crew*".

However, despite several years of effort, we have been unable to get a consistent and satisfactory answer on this subject within Europe. Issuing a PRNAV LoA is a matter for the State of Registry, rather than EASA, but flight manual supplements, which may be required for such an LoA, are an EASA airworthiness responsibility. We have, on various occasions, had conflicting and contradictory feedback from EASA and NAAs.

One example of such feedback is the claim that a Garmin 400/500 series unit cannot meet the "acceptable alternative" criteria in 7.1.1, because the Garmin manual has a disclaimer that the moving map may not be used for navigation. The "Garmin manual disclaimer" is reproduced in Fig.4 below. This disclaimer means that the moving map's topographical and airspace information is not a substitute for paper charts but we believe it is clear that the map leg track and deviation display is acceptable as an aid to navigation, and that this 'issue' is a spurious one.

> ***CAUTION:** The electronic chart is an aid to navigation and is designed to facilitate the use of authorized government charts, not replace them. Land and water data is provided only as a general reference to your surroundings. The positional accuracy of the land and water data is not of a precision suitable for use in navigation and it should not be used for navigation. Only official government charts and notices contain all information needed for safe navigation – and, as always, the user is responsible for their prudent use.*

Fig. 4
Extract from Garmin GNS530W Pilot's Guide, page i "Introduction: Cautions"

TGL10 was written in the 1990s, and needed to deal with a very heterogeneous airliner fleet that included many aircraft with mechanical primary flight displays and pedestal-mounted legacy FMS units. IFR GPS units in light aircraft were relatively new. The question of compliance with PRNAV requirements was necessarily a complex one. However, in 2011, the situation is very different. The Garmin 400/500 series was introduced 13 years ago. The technology is very mature and the worldwide operating experience of GA aircraft in RNAV enroute, terminal and approach operations is vast. The GA community deserves a simple and clear means of gaining PRNAV approval, and, in particular, unambiguous guidance from EASA that the "Reference" class of installation is compliant with TGL10. The history of conflicting and inconsistent interpretations of TGL10 amongst individual staff within NAAs and EASA is a long and unnecessary one. There is absolutely zero value, we believe, in every individual installation and application being debated from "first principles" by the stakeholders involved, as it is at present.

Compliance issues: Summary

In summary, the GA community urgently needs 3 items clarified in respect of the "Reference Installation"
(i) that a centre radio stack installed (E)TSO-C146a GPS unit may be accepted as an alternative means of compliance with AMC20-28 7.1 items 2 and 3
(ii) that a centre radio stack installed (E)TSO-C146a or (E)TSO-C129a GPS navigation map display meets the "alternative" requirement at the end of TGL10 7.1 Para 1
(iii) overall guidance that greatly simplifies the airworthiness approval process for the "Reference Installation", such that it may be deemed compliant with AMC20-27, 20-28 and TGL10 subject only to inspection and testing for specific problems (eg. unusual panel layout, incorrect functioning in-flight) and not a lengthy, expensive and confusing "quasi-certification investigation" which tests the principles of whether this class of installation can be acceptable.

4. The Airworthiness Approval Process

In addition to the functional requirements detailed in section 3, above, it is also important to review the overall EASA airworthiness approval process for the installation of GPS RNAV equipment and the process by which additional applications are approved through Flight Manual Supplements.

The installation of a single GPS RNAV unit is generally an EASA Minor modification, and approval for BRNAV is generally included in the approval package. The approval cost (in addition to the equipment and physical installation) is €280 for the EASA fee and typically €500-€1000 for the paperwork an avionics installer needs to supply with the mod application. Taking the UK as an example, the paperwork required for a single GPS installation has increased from 2 pages to 30 pages since EASA took over responsibility for minor mods from the CAA, and dual installations under a minor mod are no longer permitted.

The installation of dual GPS RNAV units is now an EASA Major modification, requiring an STC. The EASA fee is €1200-€2400, and the cost of paperwork required from an applicant is typically several thousand euros. An existing, approved installation which requires a Flight Manual amendment to show PRNAV or RNAV Approach capability requires an additional Major mod STC, with additional costs of thousands of euros. EASA do not accept "Approved Model Lists" (AMLs) for a GPS unit, and require an individual STC for each aircraft Type, increasing the approval cost by up to 10x compared to the AML method used in the USA.

The present approvals burden also needs to be put in a historical context. All of the equipment and applications referred to in this paper have existed since at least 2004/05 (when the first TSO-C146a units became available). However, because RNAV applications in Europe have lagged the availability of technology and equipment elsewhere by 5 years or more, the ability to get European RNAV approvals has lagged the actual installation of capable equipment by many years. This means that the same installation in a European aircraft may have needed multiple Minor and/or Major modifications over the years, as the application approvals became available. This is undesirable in of itself, but, we believe, completely unacceptable given how onerous the modification requirements are. Of course, history is behind us, but it is relevant context for why stakeholders want better regulation now and in the future.

It is our view, and the long-held view of most industry stakeholders, that EASA approval process for RNAV GPS (both installations and airworthiness approval for specific RNAV applications) is excessively onerous, complex, duplicative and expensive. Not only is a vast amount of work conducted without any material safety benefit (certainly no benefit proportional to the costs involved), but the process and its costs, we are convinced, have a negative impact on safety.

It should be recognised that this is not a plea for *a lowering of standards*. High safety standards for IFR GPS are essential and inherent in the requirements of (E)TSO'd equipment and compliant, professional installations completed by approved organisations. It is a plea for *the recognition of commonality* in non-complex aircraft, which is somehow absent in the depth and complexity of EASA approvals required for individual aircraft types and individual installations.

Approved, (E)TSO'd GPS units bring an obvious safety benefit to enroute navigation, both under VFR and IFR. For non-precision approach operations, the alternative to GPS approaches is either 1930s radio beacon technology or 1960s VOR/DME aids. The fact that in Europe in 2011 there are still many GA aircraft, and some scheduled public transport flights, using NDB approaches could seem almost incredible to a 3rd party observer. The benefits of using an ILS-like LPV instead of non-precision radio aids are so obvious and manifest, they do not need detailing further. All modern (E)TSO GPS units also provide Terrain Awareness capabilities which we think are as critical to mitigating CFIT risks in general aviation as EGPWS has proven in CAT.

The image in Fig.5 below is that of a G-registered Cessna which collided with terrain in the UK during a night cross-country training flight in late March 2011, during the period this paper was being drafted. It is believed the aircraft had been navigated using visual references and VOR cross-cuts, and that a pilot error in position fixing led to descent into unlit terrain obscured by ground fog. The aircraft was equipped only with radio navigation receivers – this is common amongst light aircraft used in Europe for private pilot training and rental.

Fig 5. March 2011

It was very fortunate that the instructor and student survived this CFIT accident. This scenario is typically a fatal one.

We believe the installation of modern IFR GPS units with Terrain Awareness is a major factor in reducing the risk of CFIT in light aircraft.

In our opinion, over-regulation always has the potential to adversely impact safety, by diverting resources unproductively and making safety-enhancing operations more inaccessible. However, we believe RNAV airworthiness is an extreme case:

- The safety benefits of (E)TSO'd equipment are so great and so obvious
- The safety record of "lighter" approval regimes (namely the FAA) is so vast and successful
- The cost of EASA over-regulation is so material that it can exceed the value of the avionics installed and be a very meaningful proportion of the hull value of a light aircraft

We have a concern that, overall, EASA is making European GA less safe than it could be through the excessive cost and complexity of RNAV airworthiness approval.

5. Comments on EASA policy in respect of RNAV equipment

EASA is a Safety agency and not just a Regulatory agency. In public, EASA leadership regularly makes commitments to working in partnership with Industry and to pursuing good, proportionate regulation.

The problem arises in the practical experience of stakeholders. EASA teams and individual staff members develop policies and interpretations based, professionally and in good faith, on their understanding of the constraints and context in which they work. There is always a justifiable source, reference or rationale for any individual element of rules or policy. The "inputs" which build the overall regulatory model are assembled in this way. However, there does not appear to be any feedback in respect of the overall output of the model. Is the regulatory outcome a good one? Does it benefit safety? Is it proportionate, transparent and consistent?

The GA community depends on EASA being responsible for good regulatory outcomes and not merely "justifiable" regulations and interpretations. Where the two are in conflict, we believe EASA should use its powers and discretion to change the regulations and interpretations, and achieve the right outcome. The present outcome is not satisfactory, and it compromises the real safety improvements available to GA through RNAV. In particular, the completion of the EGNOS project and the availability of LPV approaches is a very great, albeit long overdue, opportunity for GA. That such an opportunity should be delayed and dissipated through over-regulation is not an outcome EASA or its stakeholders should accept.

6. Initial Recommendations for discussion

1. EASA should publish material (AMC amendments or GMs) which clarifies that a Non-complex EASA aircraft installation in the “Reference Class” is compliant with the requirements of AMC20-4, AMC20-27, AMC20-28 and TGL10 subject to appropriate inspection and testing.

This material should include clarification which gives proportionate guidance on more capable installations (eg. with EFIS or a full Glass Cockpit) and less capable common variants (eg. a CDI instead of an HSI and/or a non-SBAS GPS capable of RNAV NPA and PRNAV but not LPVs)

2. EASA should review the Airworthiness approval process for Non-Complex aircraft RNAV equipment installation and flight manual supplements and

i. Accept Approved Model Lists for RNAV and EFIS equipment installations
ii. Permit Flight Manual Supplements and Changes as minor modifications for all RNAV applications in non-complex aircraft
iii. Simplify the minor modification process in this respect, to recognise that the Flight Manual amendments are generic, with only minor variation (if any) across individual installations

3. AMC 20-28 should be amended to include the following definition, consistent with AC20-138B:

> *“The primary field of view definition should be broad enough to include the center radio stack on Part 23 airplanes with “classic”, basic ‘T’ instrumentation.”*