IGC-APPROVALS FOR GNSS FLIGHT RECORDERS - SUMMARY

Updated 25 May 2009

Contents

FAI & IGC WEB REFERENCES:

FAI web site: http://www.fai.org
IGC web site: http://www.fai.org/gliding
IGC GNSS web site: http://www.fai.org/gliding/gnss
Links to all approval documents: http://www.fai.org/gliding/gnss (go to end of the gliding/gnss page for links)
IGC table of approved Recorders: http://www.fai.org/gliding/system/files/igc_approved_frs.pdf
Sporting Code for Gliding (SC3) and its annexes (SC3A, SC3B, SC3C):
http://www.fai.org/gliding/sporting_code
Technical Specification for IGC-approved GNSS Flight Recorders:
http://www.fai.org/gliding/gnss/tech_spec_gnss.asp
Free software for IGC-approved Flight Recorders: http://www.fai.org/gliding/gnss/freeware.asp

TYPES OF IGC-APPROVED RECORDERS (45)

Types of IGC-approved Recorder in alphabetical order of Manufacturer.
Production status should be confirmed with manufacturer. See also the notes after the table.

	Manufacturer (alphabet order)	Type of Recorder	In Prod -uction	IGC-approval Level	MG engine recording System (where fitted)	Date of latest approval document
1	Aircotec	XC Profi (Gliders)	Yes	All Flights	Aircotec ENL	30 May 2006
2	Cambridge	CAI 10	No	Badges (all)	Cambridge ENL system 1	10 April 2005
3	Cambridge	CAI 20	No	Badges (all)	Cambridge ENL system 1	10 April 2005
4	Cambridge	CAI 25	No	Badges (all)	Cambridge ENL system 1	10 April 2005
5	Cambridge	CAI 302	Yes	All Flights	Cambridge ENL system 2	25 November 2003
6	Cambridge	CAI 302A (without display)	Yes	All Flights	Cambridge ENL system 2	25 November 2003
7	DSX	T-Advsor	Yes	All Flights	Not fitted (ENL in desugn)	12 April 2008
8	DSX	Tracer (T-advisor without Traffic Alert function)	Yes	All Flights	Not fitted (ENL in design)	12 April 2008
9	EDIATec	ECW100F	Yes	Up to Diamonds	Triadis ENL	14 June 2008
10	EW	EWFR A	No	Up to Diamonds	Microswitch and cable	10 April 2005
11	EW	EWFR B	No	Up to Diamonds	Microswitch and cable	10 April 2005
12	EW	EWFR C	No	Up to Diamonds	Microswitch and cable	10 April 2005
13	EW	EWFR D	No	Up to Diamonds	Microswitch and cable	10 April 2005
14	EW	MicroRecorder	Yes	All Flights	EW ENL	20 November 2008
15	Flarm	Flarm-IGC	Yes	Up to Diamonds	Triadis ENL	10 March 2008
16	Garrecht	Volkslogger VL1.0	Yes	All Flights	Garrecht ENL	20 January 2008
17	IMI	Erixx V1.0	Yes	All Flights	Nil	7 June 2008
18	LX Navigation	LX20 first batch 1997	No	Badges (all)	LXN ENL	20 February 2008

19	LX Navigation	LX20 with RSA security	No	All Flights	LXN ENL	20 February 2008
20	LX Navigation	LX20-2000	No	All Flights	LXN ENL	20 February 2008
21	LX Navigation	LX21	No	All Flights	LXN ENL	20 February 2008
22	LX Navigation	DX50	No	All Flights	Nil	20 February 2008
23	LX Navigation	LX5000IGC	No	All Flights	LXN ENL	20 February 2008
24	LX Navigation	Colibri V1.0	No	All Flights	LXN ENL	31 March 2007
25	LX Navigation	Colibri V4	Yes	All Flights	LXN ENL	31 March 2007
26	LX Navigation	Colibri 4F with Flarm	Yes	All Flights	LXN ENL	31 March 2007
27	LX Navigation	LX7000	No	All Flights	LXN ENL	17 March 2006
28	LX Navigation	LX7007	Yes	All Flights	LXN ENL	17 March 2006
29	LX Navigation	LX7007F with Flarm	Yes	All Flights	LXN ENL	17 March 2006
30	LX Navigation	LX8000	Yes	All Flights	LXN ENL	25 April 2008
31	LX Navigation	LX8007F with Flarm	Yes	All Flights	LXN ENL	25 April 2008
32	LX Navigation	Mini Box Flarm-IGC	Yes	Up to Diamonds	Not fitted	31 August 2008
33	LX Navigation	Red Box Flarm-IGC	Yes	Up to Diamonds	Not fitted	31 August 2008
34	New Technologies	NTE Easy	Yes	All Flights	NTE ENL	10 January 2007
35	New Technologies	NTE Easy Matchbox	Yes	All Flights	NTE ENL	8 August 2005
36	Nielsen Kellerman	ClearNav-IGC	Yes	All Flights	NKL ENL	25 May 2009
37	Peschges	VP8	No	Badges (all)	Cable to motor or microswitch	1 October 2004
38	Print Technik	GR1000	No	Badges (all)	Print Technik ENL	1 October 2004
39	Print Technik	GR1000A (with RSA security)	No	All Flights	Print Technik ENL	1 October 2004
40	Scheffel	Themi	Yes	Badges (all)	Not fitted	5 May 2003
41	Streamline Data Instruments (SDI)	PosiGraph V1.0	No	All Flights	LXN ENL	14 February 2003
42	Streamline Data Instruments (SDI)	PosiGraph V2	No	All Flights	LXN ENL	14 February 2003
43	Triadis	Altair V1.0	Yes	All Flights	Triadis ENL	14 February 2009
44	Zander	GP940	No	All Flights	Zander Vibration system	20 September 2004
45	Zander/SDI	GP941	Yes	All Flights	Zander ENL	20 August 2006

Notes to the table, next page

Notes to the table of Types of IGC-approved GNSS Recorders:

1. Motor Glider Means-of-Propulsion (MoP) recording method. Details on MoP recording are in the full version of the approval document. The Engine Noise Level (ENL) system is where the noise level at the recorder is recorded with each GNSS fix in the form of three numbers from 000 to 999. This is the IGC-preferred system for Motor Gliders with engines that produce significant noise in the cockpit, because it does not require wiring external to the recorder or any other actions by the pilot, and is self-checking because an ENL value is recorded with each fix, even during quiet flight. Motor Gliders that have engines that do not record sufficiently high ENL numbers must have another engine variable proportional to RPM recorded in the IGC file as well as ENL (see Annex B to the Sporting Code for Gliding, para 1.4.2.4).

2. Levels of Approval. IGC has established three levels of approval to which different types of flight apply. For details, see Annex B of the Sporting Code for Gliding, para 1.1.3.3.

2.1 All Flights approval. Type of recorders given IGC-approval for "all flights" must comply with all of the provisions of the IGC Technical Specification as it applies at the time that the approval is first given.

2.2 All Badges approval. This applies to types of Recorders that do not fulfil the Specification in some areas at the time of approval. However, it has been decided that they may be given an approval that excludes World Record flights but includes all IGC/FAI Badges and Distance Diplomas. Forevidence for competition flights, see para 3 below.

2.3 Diamonds-level approval. This is for FAI Silver, Gold and Diamond badge flights only, although for competitions see para 3 below. It is used for types of Recorders that have significant differences to the Specification at the time of approval but it is decided that a limited approval can be given rather than a refusal.

3. Competition Flights. Types of recorders that may be used for evidence in a competition are at the discretion of the competition organisers and may include one or more of the above IGC-approval levels if the organisers agree. The organisers may operate under other rules such as those in Annex A of the Sporting Code for Gliding which applies to World Championships and other competitions that also use Annex A rules. Annex A specifies the use of IGC-approved Recorders but does not (at the time or writing) specify the approval level so all approval levels may be used under Annex A rules, subject to any local rules. Outside Annex A, other rules and procedures for competitions may be made by the National Airsport Control (NAC) authority.

4. Grandfather Rights. This term describes a system where the level and other provisions of an IGC-approval are continued without alteration even though the Technical Specification is changed with time (generally, provisions are increased). For details, see Annex B of the Sporting Code for Gliding, para 1.1.3.3.5.

Manufacturers, next page

MANUFACTURERS OF IGC-APPROVED RECORDERS (18)

S/N	Name of Manufacturer (alphabetical order)	Country	Manufacturer's web page	IGC Codes for the Manufacturer	
				3 letters	1 letter (for IGC file name)
1	Aircotec Flight Instruments	Austria	www.aircotec.at	ACT	I
2	Cambridge Aero Instruments	USA	www.cambridge-aero.com	CAM	C
3	DSX Data Swan	Switzerland	www.d-s-x.com	DSX	D
4	EDIATec (with Flarm Firmware)	Switzerland	www.ediatec.ch	FLA	G
5	EW Avionics	UK	www.ewavionics.com	EWA	E
6	Filser (Now Funkwerk, IGC approvals transferred to LXN, see note at end)	Germany	Now Funkwerk, see note after this table	FIL	F
7	Flarm Technology GmbH	Germany	www.flarm.com	FLA	G
8	Garrecht Avionik GmbH	Germany	www.volkslogger.de	GCS	A
9	IMI Gliding Equipment	Czech Republic	www.imi-gliding.com	IMI	M
10	LX Navigation d.o.o.	Slovenia	www.lxnavigation.si	LXN	L
11	New Technologies s.r.l.	Italy	www.ntsrl.it	NTE	N
12	Nielsen Kellerman Company	USA	www.nkhome.com	NKL	K
13	Peschges Variometer GmbH	Germany	www.peschges-variometer.de	PES	P
14	Print Technik Ges.m.b.H	Austria	www.gps.at	PRT	R
15	Scheffel Automation	Germany	www.themi.de	SCH	H
16	Streamline Digital Instruments (SDI)	Germany	www.sdi-variometer.de	SDI	S
17	Triadis Engineering GmbH	Switzerland	www.triadis.ch	TRI	T
18	Zander Segelflugrechner	Germany	www.zander-variometer.de	ZAN	Z

Note on ex-Filser recorders: Four types of recorders were originally badged under the Filser name, but Filser were taken over by Funkwerk Avionics in 2006 and no longer support these recorders. Sine the original Design Authority for these recorders was LX Navigation, the IGC-approval documents were re-issued under the LXN name.

DATES OF ISSUE OF IGC-APPROVAL DOCUMENTS

The following approvals have been issued on behalf of IGC by the IGC GNSS Flight Recorder Approvals Committee (GFAC). This list is in reverse date order, the most recent approvals coming first.

25 May 2009 – Nielsen Kellerman ClearNav-IGC, Version 1 of IGC-approval document issued

14 February 2009 – Triadis Altair V1.0, Version 1 of IGC-approval document issued

20 November 2008 – EW microRecorder – update to allow for low ENL readings in quiet flight

31 August 2008 – LXN Mini Box Flarm-IGC, Version 1 of IGC-approval document issued, to "Diamonds" level.
31 August 2008 – LXN Red Box Flarm-IGC, Version 1 of IGC-approval document issued, to "Diamonds" level.

14 June 2008 – EDIATec ECW100F, Version 1 of IGC-approval document issued, to "Diamonds" level.
7 June 2008 – IMI Erixx V1.0, Version 1 of IGC-approval document issued

25 April 2008 – LXN LX8000 and LX8000F, Version 1 of IGC-approval document issued
12 April 2008 – DSX 7100 T-Advisor series and DSX 8000 Tracer series, Version 1 of IGC-approval document issued

10 March 2008 – Flarm-IGC V1.0, Version 1 of IGC-approval document issued, to "Diamonds" level.

20 February 2008 – LXN (ex Filser) DX50 update and change of name from Filser to LXN
20 February 2008 – LXN (ex Filser) LX20 update and change of name from Filser to LXN
20 February 2008 – LXN (ex Filser) LX21 update and change of name from Filser to LXN
20 February 2008 – LXN (ex Filser) LX5000IGC update and change of name from Filser to LXN
20 January 2008 – Garrecht Volks logger, update of wording

31 March 2007 – LXN Colibri 4F with Flarm, Version 1 of IGC-approval document issued
10 January 2007 – NT Easy, Version 1 of IGC-approval document issued

20 November 2006 – EW microRecorder, addition of EW engine noise recording system
20 August 2006 - Zander/SDI GP941, amendment with Firmware 2.11 on time recording
10 June 2006 - EW microRecorder, Version 1 of IGC-approval document issued
30 May 2006 - Aircotec XC Profi (Gliders), Version 1 of IGC-approval document issued
17 March 2006 - LXN 7007F with uBLOX board and internal FLARM module
24 February 2006 - LXN Colibri model 4 with uBLOX GPS receiver board

8 August 2005 - New Technologies (NTE) Easy Matchbox, Version 1 of IGC-approval document issued
20 July 2005 - LX Navigation LX7000 series, Version 2 with addition of LX7007
20 June 2005 - LX Navigation Colibri, addition of Colibri Version 4.
10 April 2005 - EW Models A-D, update of manufacturer details
10 April 2005 - Cambridge models 10, 20 & 25, update of manufacturer details and notice of change of IGC-approval level to take place 15 March 2006.

1 October 2004 - Prink Technik GR1000 and GR1000A Issue 3
1 October 2004 - Filser LX20 Issue 5
1 October 2004 - Peschges VP8 Edition 2A
20 September 2004 - Zander 940 Issue 2
12 September 2004 - Cambridge 10, 20 & 25, Issue 5
28 March 2004 - Cambridge 10, 20 & 25, Issue 4A
28 March 2004 - Filser LX20 Issue 5A
28 March 2004 - Peschges VP8 Edition 2
28 March 2004 - Prink Technik GR1000 Issue 2
1 February 2004 - LX Navigation LX20, "all badges" level for early standard without micro & RSA
1 January 2004 - Cambridge (Martinsville) 302 series withdrawn (company out of business)
1 January 2004 - Cambridge (Martinsville) 10/20/25 models withdrawn (company out of business)

25 November 2003 - Cambridge (Horn Lake) 302 series with Horn Lake address
25 November 2003 - Cambridge (Horn Lake) 10/20/25 models with Horn Lake address
25 November 2003 - Cambridge (Martinsville) 302 series with new manufacturer codes
25 November 2003 - Cambridge (Martinsville) 10/20/25 models with new manufacturer codes
25 August 2003 - Cambridge (Martinsville) 302 series, addition of simpler 302A model.
20 May 2003 - Cambridge (Martinsville) 10, 20 and 25, update to approval document

5 May 2003 - Scheffel Themi increased from Diamonds to "all badges" level
14 March 2003 - LX Navigation LX7000, new type of recorder, Version 1 of IGC-approval document issued
14 February 2003 - SDI Posigraph, introduction of Model 2
12 February 2003 - Zander/SDI GP941, introduction of A model with GPS15 board.
13 January 2003 - Cambridge (Martinsville) 302 series, introduction of ENL system

31 October 2002 - Scheffel Themi, Version 1 of IGC-approval document issued, to "Diamonds" level.
20 October 2002 - LX5000IGC, addition of 2002 model LX5000IGC-2 with higher resolution screen and extra button.

10 December 2001, updated approval documents issued for the following 5 types of recorder.
Filser DX50
Filser LX20
Filser LX5000IGC
LX Navigation Colibri
Streamline Digital Instruments (SDI) PosiGraph

30 October 2001 - Cambridge 302, Version 1 of IGC-approval document issued
30 October 2001 - Zander/SDI GP941, Version 1 of IGC-approval document issued

15 May 2000 - Filser LX5000IGC series, addition of LX5000IGC-2 and update of earlier approvals.
21 Mar 2000 - Filser LX20, Version 3 including the LX20-2000 and updated wording
10 Mar 2000 - Amendment 3 to EWFR approval to add 2 new Garmin GPS units

19 Nov 99 - Amendment 2 to EWFR approval to add 5 new Garmin GPS units.
21 Jun 99 - Cambridge Issue 3 Including Pilot Event (PEV) Function and the Palm-Nav Display.
10 May 99 - Garrecht Volkslogger Model Vl1.0, Issue 2 including Motor Glider ENL Function
8 Mar 99 - Streamline Digital Instruments (SDI, Germany) PosiGraph Model 1.0, Version 1 of IGC-approval document issued.
29 Jan 99 - Amendment 1 to EWFR approval to add new Model D with improved memory.

16 Nov 98 - Filser DX50, Amendment 1 to allow for three tube static pressure system.
26 Oct 98 - LX Navigation Colibri 1.0, Issue 2 with ENL recording
31 Aug 98 - LX Navigation Colibri 1.0 Version 1 of IGC-approval document issued (see above for later Versions)
24 Aug 98 - Issue 2 of EWFR approval to add model C, add some additional Garmin GPS units, and generally update the wording.
30 Jun 98 - Filser LX5000IGC, Version 1 of IGC-approval document issued
19 May 98 - Filser DX50, Version 1 of IGC-approval document issued (see above for later Versions)
24 Apr 98 - Filser LX21, Version 1 of IGC-approval document issued
3 Apr 98 - Garrecht Volkslogger VL1.0, Version 1 of IGC-approval document issued

20 Jul 97 - Cambridge 10, 20, 25; Version 2 Approval, adding the 12 channel board, variable time interval fixing, and updating wording to that used in other approvals.
13 May 97 - Amendment to EWFR A/B approval to add Garmin 12XL to list of approved stand-alone GPS units.
19 Apr 97 - EW "EWFR A & B" for badges up to and including Diamonds, when connected by cable to one of a list of approved GPS units, listed in the IGC-approval document (see above for later Versions).
25 Mar 97 - Filser LX20 Version 2 Approval, with the addition of motor glider engine recording
20 Mar 97 - Print Technik GR1000, Version 1 of IGC-approval document issued

10 Nov 96 - Zander GP940, Version 1 of IGC-approval document issued

12 Aug 96 - Filser LX20, Version 1 of IGC-approval document issued (see above for later Versions)

31 May 96 - Peschges VP8, Version 1 of IGC-approval document issued

16 Jan 96 - Cambridge Models 10, 20 and 22, Version 1 of IGC-approval document issued (see above for later Versions)

IGC-APPROVAL PROCEDURE AND DOCUMENTS

BRIEF HISTORY OF GNSS AND ITS USE IN GLIDERS

GNSS. This stands for Global Navigation Satellite System and is the generic term for the specific systems described below.

GPS/NAVSTAR. In 1973, the US Department of Defense (DoD) decided to develop the NAVSTAR system (Navigation System for Timing and Ranging), commonly referred to as GPS (Global Positioning System). From 1978, Block 1 GPS satellites were launched and the system first came on line in January 1980. It was initially for military use with receivers that had special codes to access the data. Later, civil GPS receivers were produced for general use but these were subject to a deliberate reduction in accuracy by the GPS controlling authority. The authority was originally the US Department of Defense (DoD) and later the US Department of Transportation (DoT) was added. The accuracy reduction was so that the military receivers would always have more accurate data and also that civilian receivers were less likely to be used for undesirable purposes such as disruption or terrorism. The accuracy-reduction system was called "Selective Availability" or SA and used a random short-term variation (wobble) of the timebase. Average error in lat/long for civilian receivers in these early days was measured by GFAC at about 50 metres for single fixes, reducing to about 40 metres as improved 12-channel receiver boards came on the market. Errors were recorded from a moving vehicle using several accurately-surveyed points on the ground at about 51N 001W and the overall average with SA was 44 m. When the SA system was withdrawn on 1 May 2000, GFAC accuracy results improved substantially, showing an average error at the end of 2000 of about 13m. Since then, average errors have improved to between 11 and 12m. The is probably due to improved processing within receiver boards, and the increased number of satellites whose data can be processed for each fix. The GPS system is updated as new satellites are put in orbit and old ones taken off-line.

> Accuracy enhancement systems. Enhancements to basic system accuracy are provided by regional Satellite-Based Augmentation Systems (SBAS). These increase accuracy by monitoring errors at ground stations in the area concerned and making corrections available to compatible receivers. Such systems in service include WAAS (North America) and EGNOS (Europe). Other SBAS systems include GAGAN (India) and MSAS (Japan). A Ground-Based Augmentation System (GBAS) is being developed in Australia. The GFAC accuracy tests do not use receivers with one of these enhancement systems.

GLONASS. The Russian GNSS system, the initials standing for GLObal'naya NAvigatsionnaya Sputnikovaya Sistema (GLObal NAvigation Satellite System). Unlike the US GPS system, GLONASS alters its system time on the date and time of every leap-second and is inoperative while doing so (see under GNSS, GPS, and UTC). Its system time is based on Moscow time rather than UTC. See www.glonass-ianc.rsa.ru

Galileo. In March 2002, the European Union (EU) and European Space Agency (ESA) agreed to produce a European GNSS system, and the Galileo project was formally launched in May 2002 under EU Council Regulation EC 876/2002. In June 2004, the European Union agreed with the USA that Galileo would use the BOC 1.1 signal modulation system, enabling the coexistence of GPS and Galileo on future receivers. In November 2007, the 27 EU transportation ministers agreed that Galileo should be operational by 2013. There are intended to be 30 satellites at an altitude of about 22,200 km and in three groups at an orbital plane of 56 degrees. Galileo will under civil control and is intended to be interoperable with the Russian GLONASS and US GPS systems. See http://ec.europa.eu/transport/galileo

Beidou/Compass. This is a Satellite Navigation System being developed by the Peoples Republic of China (PRC). In 2008, five satellites were in orbit and the full Beidou-2 system is planned to have 35 satellites. The existing satellites are geostationary and provide an area enhancement similar to EGNOS in Europe and WAAS in North America. See http://en.wikipedia.org/wiki/Beidou_navigation_system

Principle of operation – US GPS. Although this describes the US NAVSTAR/GPS system, other satellite navigation systems use similar principles although details such as frequencies will differ. A GPS receiver on the ground records the very small time-differences between low-powered transmissions at about 1500 MHz from the array of GPS satellites that are in view above the horizon at any one time. The satellites are in an orbit 55 degrees oblique to the equator at an altitude of about 20,200 km (12,552 Statute Miles). Today, 24 are normally active at any one time with some as in-orbit reserves (their transmission state is controlled from the ground). Each satellite has an atomic clock accurate to better than a nanosecond and its accuracy is monitored from the ground and updated as necessary. Due to earth shielding, a maximum of up to 12 transmitting satellites may be in view to a receiver at any one time. The exact number depends on where the receiver is placed on the earth's surface. Terrain shielding reduces the number of satellites in view, as does very high latitude. Satellite orbits are highly predictable, therefore, because a GPS receiver is constantly updated with GPS system information, it knows the exact position in space of each satellite at any one time. Each time-difference recorded by the receiver from a satellite provides a line-of-position which is used be the receiver's computer to construct the Most Probably Position (MPP) from the several available position lines for each fix. With modern 12-channel receivers operating in mid-latitudes, between 6 and 8 satellite position lines are typical for an individual fix. With sensitive receivers with good antenna layouts in clear horizon positions, 12 satellites have been observed to be locked on as far north as 51 degrees.

USE OF GNSS IN GLIDING CHAMPIONSHIPS

In 1987, discussions were held in the IGC Championships sub-committee on the potential use of GPS flight recorders for validation of flights and for display of position.

In 1991, Dr David Ellis of Cambridge Aero Instruments presented a paper on GPS recording at the OSTIV Conference in Uvalde, USA, the site of the World Gliding Championships. This paper was based on GPS flight recordings made in April 1991 using equipment loaned to Cambridge by a development engineer at Trimble Navigation. Flights were made from Palo Alto airport in California with a Cessna 172 and demonstrated the feasibility of GPS recordings for gliding.

Also at Uvalde were Alf Ingesson-Thoor and John Roake, the Directors of the future World Championships at Borlange, Sweden, in 1993 and at Omarama, New Zealand, in 1995. Bernald Smith, then a Vice-President of IGC, heard Ellis' paper and became an advocate of GPS recording. John and Alf then had meetings with Dave Ellis with a view to using GPS recording in future World Championships. At Uvalde, Bernald was responsible for photo evaluation and in a presentation described the work of his 15-person team. If GPS recording could succeed, such a large team would not be required. Also, Bernald Smith and John Roake were particularly concerned with the problems of photo evaluation from wave flights at altitudes such as 20,000ft at the future 1995 WGC in New Zealand. Following the Uvalde OSTIV conference, Cambridge Aero Instruments produced a recording system consisting of a Garmin GPS-10 engine and a HP-95 pocket calculator that was flown by John Good in a gliding competition at Matamata, New Zealand in February 1992.

In 1993, trials supervised by Bernald Smith on behalf of IGC were made during the World Championships in Borlange, Sweden, using prototypes of what became the Cambridge Model 10 recorder, supplied by Cambridge free of charge to IGC. For the next Worlds in New Zealand, Director John Roake sent specifications to a number of manufacturers for GPS recorders to be used for scoring the Championships. The equipment was to be rented to pilots, not sold to the organizers, and was to be tested first in the next New Zealand Nationals and the "Kiwiglide" Pre-world competition. Cambridge made a bid along these lines with a rental price of US$200 per recorder. This was accepted.

In 1994, IGC approved the use of the Cambridge design of recorder as the primary recording system for the World Championships in 1995. This was after the tests mentioned above of 15 pre-production Cambridge Model 10 recorders in the 1994 New Zealand Nationals and 30 in the later pre-worlds ("KiwiGlide"). This IGC decision for the first time gave primacy to GPS recording over photographic evidence. This recorder design, which became the Cambridge Model 10, included pressure altitude

recording, both physical and electronic security, and had the GPS receiver and memory units in one sealed case. IGC was particularly sensitive to security issues after a case of cheating on photographic evidence at Borlange had resulted in a pilot being sent home. The Cambridge system used a microswitch to show whether the (sealed) case had been opened and an electronic checksum system to check whether the output data file was valid for use for flight validation to IGC standards. Cambridge was to deliver the recorders for hire at Omarama in January 1995 to all championships pilots.

1992 - first GPS recorders on the gliding market. Independent of the Cambridge design, in 1992 a GPS recorder was developed by avionics supplier RD Aviation Ltd., of Oxford, UK. This was to a specification by its Managing Director Dickie Feakes who had been a glider pilot since the 1950s. This "RD Recorder" connected by cable to a stand-alone GPS receiver such as one of the Garmin range and was a simple memory module with no pressure altitude sensor or built-in security. The format of its data output was an ASCII file with the suffix "dat", short for data. The software compiler of this so-called "dot.dat" format was Vince May, the founder and owner of the UK company Skyforce, with inputs from Phil Jeffrey of the BGA Competitions Committee. The DAT format was later developed into the IGC data format that we use today. In the first year, the recorder was sold and badged by RD as the RD Recorder and in the second by Skyforce as the Skyforce Recorder; these were essentially the same design.

In 1993, two companies that had been producing electronic barographs, developed versions with larger memory that would connect to a GPS receiver unit and record GPS fixes as well as pressure altitude. These companies were EW Avionics (UK, MD Wayne Richards) and Borgelt Instruments (Australia, MD Mike Borgelt).

In 1994 Cambridge (USA, MD Dr David Ellis) produced early versions of the Model 10 recorder that was to be used at the Omarama World Championships in New Zealand in January 1995 (see above). The software writer was John Good. As well as built-in security, this design also had the ability to electronically store flight declarations. A separate display module gave range and steering information to a list of waypoints that were stored. Cambridge also developed the Environmental Noise Level (ENL) system for recording motor glider engine without needing wires external to the recorder case or requiring secure connections to glider structure as in earlier systems that used vibration-sensors.

1993-94 - Development of the IGC flight data standard. The IGC ASCII data format was developed during 1993 and 1994 from the BGA "dot.dat" format by a group of experts led by Bob Fletcher in the USA (then General Manager of Cambridge Aero Instruments) and Hans Trautenberg in Europe. The initial version of this data format was finalised by October 1994, used in the New Zealand world championships in January 1995 and was included in the new Annex B to the Sporting Code that was approved by IGC in March 1995. The original IGC file suffix was "GPS" but this was considered by the IGC GFA Committee to be too general and was changed to "IGC" later in 1995.

January 1995 - New Zealand World Gliding Championships. In January 1995 the World Gliding Championships were held at Omarama in New Zealand with John Roake as Director. Cambridge supplied all competitors with their model 10 recorder. This was the first time GPS recording had been used for scoring purposes in a World Championship. The Chairman of the IGC GNSS Committee, Bernald Smith, independently checked the GPS recorder results on behalf of IGC with a view to their future use for flights to IGC/FAI criteria.

Development of IGC procedures on GNSS recording. IGC officials at the New Zealand championships assessed the GPS recording in the championships as a success, and asked other IGC committees and technical experts to draft a definitive set of rules for more general use of GPS recorders in world gliding. The next IGC Plenary was only 6 weeks away on 17 and 18 March 1995 so this was a difficult task. The option of delaying until the next IGC Plenary was not really practical as this would have resulted in a delay of a further 12 months during which criticism would build up from those who wished to develop and use the new technology. Ian Strachan, then Sporting Code editor working for Tor Johannessen, had the task of making an initial draft and co-ordinating suggested changes. Fortunately he had some GPS knowledge, having previously tested some GPS recorders and was the author of an article on GPS recording in the UK

magazine "Sailplane and Gliding". Bernald Smith, then Chairman of the IGC GNSS Committee, also took a major part in this process and drafted chapter 1 of the new IGC document. Intensive international effort followed by these people and others. This involved the circulation of several drafts and a meeting on 15 March 1995 in Paris between IGC officials and potential recorder manufacturers. This resulted in a draft of a new Annex B to the Sporting Code for Gliding being produced in time to be approved by the IGC Plenary on 18 March 1995.

IGC GFA Committee. The IGC GNSS Flight Recorder Approval Committee (GFAC) was formed by IGC on 18 March 1995 at the same time that IGC approved the issue of the first edition of Annex B to the Sporting Code for Gliding. The first members of GFAC were Angel Casado (Spain), Arnie Hartley (Australia), Ian Strachan (UK), Kilian Grefen (Germany) and Mike Strang (USA). Shortly after, Ian Strachan was elected by the others as Chairman. Annex B to the Sporting Code for gliding gave GFAC the authority to test and evaluate GNSS Flight Recorders on behalf of IGC and to draft, finalise and issue documents giving IGC-approval for the use of such recorders for flights to IGC standards of evidence.

Testing, issue of IGC-approvals. The first type of recorder was submitted to GFAC for testing later in 1995 and the first IGC-approval documents were issued in January 1996 by FAI on behalf of IGC. The level of GFAC work over the years is indicated in the date list of approval documents and the various revisions that appear above.

Annual Reports on GNSS Recorder matters. The GFAC Chairman makes an annual report to IGC on GFAC and GNSS recorder matters. This is published in the Public Domain as part of the agenda for the annual IGC Plenary meeting. This is updated at the meeting itself and such updates are published in the minutes. These reports, when combined with the IGC-approval documents listed above, give an account of the work that has been carried out over the years since 1995.

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