To: Recipients of IGC Agenda
From: Chairman IGC GNSS Flight Recorder Approval Committee (GFAC)

GFAC CHAIRMAN'S REPORT

This report is dated 8 January 2006 and an update will be given at the IGC plenary

1. **GNSS FR Approvals**. A total of 29 types of recorders from 11 manufacturers have been approved since the IGC-approval system started in March 1995.

1.1 Types of recorders. Three new types of recorder have been tested and approved since the last IGC plenary agenda report dated 9 January 2005. These are as follows, with the dates of the IGC-approval document:

LX Navigation Colibri Version 4, approved on 20 June 2005.

LX Navigation LX7007, approved on 20 July 2005.

New Technologies (NTE) Easy Matchbox, approved on 8 August 2005. New Technologies s.r.l. is a company based near Milan in Italy and the Easy Matchbox design is their first to gain IGC-approval.

1.2 Revised approval documents. Since the last IGC plenary agenda the following approval documents have been revised:

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.

20 July 2005 - LX Navigation LX7000 series, Version 2.

2. **Applications for IGC-approval**. New designs from companies in Austria, Slovenia and the UK are being evaluated and another from Italy is expected shortly. One of these designs has a FLARM proximity warning module inside the recorder box and is being checked to ensure that the FLARM system does not interfere with recorder functions.

3. **Analysis Programs for Flight Data**. 27 programs have been notified to GFAC that are capable of analysing data in the IGC file format. For details, see the web addresses at the end under "References".

4. **Technical Specification**. Amendment 8 to the IGC Flight Recorder Specification was issued on 15 December 2005 after circulation of drafts to the IGC ANDS (ex-GNSS) and GFA committees, technical advisors, bureau representatives and recorder manufacturers and potential manufacturers. This amendment consisted of some clarifications of existing procedures and some new three-letter codes to allow for additional data that might be recorded in the IGC file. Meanwhile GFAC is working with the FLARM team on the possibility that extra codes might be added for the recording of proximity data on the IGC file.

5. **Anomalies found during the year**. Many IGC files have been analysed including those for recorders being tested and those forwarded by a number of organisations for comment and analysis. Advice has been given to a number of NACs on claims for badges and records and to FAI on world record claims. Anomalies in GPS altitude figures continue to be seen in IGC files. These vary from complete loss of GPS altitude for parts of flights, to electronic noise in GPS altitude recording, and overshoots and undershoots in GPS altitude when compared to pressure altitude. Fortunately, lat/long data for these flights generally showed few obvious anomalies and a combination of this and a good pressure altitude record, allowed most of these flights to be validated.

6. **GPS Lat/Long Accuracy**. At the time of this report, GFAC tests show an average error of 11.52m for lat/long fixes recorded in IGC data files from a sample of over 1300 test points. These tests are made from a moving ground vehicle at various accurately-surveyed points at about 51N 001W. The average accuracy figure has been between 11 and 12m since the deliberate Selective Availability (SA) error was removed from civil GPS systems on 1 May 2000. The overall results indicate a 99% probability of being within 27m, 95% of being within 20m, 90% within 18m, 80% within 16m, 70% within 15m, 60%within 13m and 50%within 11m.

7. **Drafting of Documents**. Amendment 3 to Annex B to the Code (SC3B) took effect on 1 October 2005 and consisted of a few factual corrections that were listed in the appendix to the GFAC Chairman's report to the 2005 Plenary.

8. **Amendments to the Sporting Code.** In the case of the main body of the code (SC3) the Sporting Code Specialist has made a Year 1 proposal on the possible use of Commercial Off The Shelf (COTS) GPS units for position evidence instead of cameras, for Silver and Gold badge flights. The IGC-approval system and its different levels of approval, covers Diamond flights and above, through to World Records. A paper amplifying some of the consequences of accepting COTS units for position evidence for Silver and Gold flights is at Appendix 1 to this report.

9. **IGC-standard programs for Downloading**. As reported last year, GFAC formulated protocols in 2001 for free standard MS Windows-based programs for download of data from recorders and for Validation of IGC flight data files. These were to replace the older DOS programs which do not work on some modern PCs. The Windows-based protocols were made mandatory in April 2003 with a deadline date of 1 July 2004 for implementation by all manufacturers of IGC-approved recorders. In the last GFAC report to the Plenary dated January 2005, only two out of the 10 current manufacturers had produced the required programs. The situation now is that there are 11 manufacturers of IGC-approved recorders of which 6 have produced the required programs. Those who have not include Cambridge, EW Avionics, Print Technik, Scheffel and Zander.

10. **GFAC Work Load**. The work load during the year in dealing with the above has been at its usual high level. There has not, for instance, been enough time to make progress on the concept of "server-based security" that has been raised at previous IGC Plenaries. However, no manufacturer so far has wanted to use this system and new recorders are all using the traditional system based on freely-available VALI files for checking the integrity of data in the IGC file.

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Appendix 1: Sporting Code matters, some consequences of accepting COTS recorders

References:

All IGC-approval documents: http://www.fai.org/gliding/gnss/approved_gnss_flight_recorders.asp This also has a brief history of the US GPS system and early developments of recorders for gliding. New or revised approvals are also announced on newsgroup r.a.s. and on the IGC-discuss list.

Free programs for all IGC-approved Recorders: http://www.fai.org/gliding/gnss/freeware.asp These are for downloading data from a recorder to a PC, and checking the IGC file as being valid and un-altered from that downloaded from the recorder. They include the appropriate IGC-XXX.dll file (XXX is the IGC code for the particular manufacturer) that works with the standard IGC Shell program for download and validation functions. For manufacturers who have not produced the *.dll file, the older DATA, CONV and VALI functions in DOS format are available but may not work with some modern PCs.

Analysis software for IGC files: http://www.fai.org/gliding/gnss/gnss_analysis_software.pdf

Technical Specification for IGC-approved Recorders: http://www.fai.org/gliding/gnss/tech_spec_gnss.asp

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Appendix 1 - Sporting Code matters - Some consequences of accepting COTS recorders

This adds to the Year 1 proposal by the Sporting Code committee (see elsewhere in this agenda) on the possible use of Commercial Off the Shelf (COTS) GPS units to replace camera position evidence for Silver and Gold badge flights. What follows shows some of the implications if IGC were to accept this concept.

Sporting Code Section 3 - Gliders and Motor Gliders

Consequences of incorporation of evidence from COTS GPS units
for the verification of Silver and Gold badge performances

by Ian Strachan, GFAC Chairman

1. **Background and principles**

1.1 Existing IGC Procedures for Diamonds and Above. Since 1995, rules and procedures have been in place using GPS recorders for flights up to world records. These standards are embedded in the Sporting Code and its annexes, particularly Annex B to the Code and also in the stand-alone Technical Specification for IGC-approved GNSS Flight Recorders. They involve a number of levels of security and many specific rules and procedures matched to the IGC environment. The lowest level of IGC-approval is for badge flights up to and including the three diamonds. It is therefore suggested that these existing rules and procedures should not be de-valued by allowing a lower standard of security and procedures into the area already covered by IGC-approved types of recorder. Therefore, the use of IGC-approved recorders for flights for Diamond legs up to World Records should continue and any new procedures for COTS GPS units should be for flights below Diamond level, that is, for Silver and Gold badge legs.

1.2 Procedures for Gold and Silver. Evidence from non-IGC approved recorders could be used for Gold and Silver flights under rules agreed by IGC but simpler than those already in place for IGC-approved types of recorders.

1.2.1 COTS GPS equivalent to Camera evidence for Lat/Long. IGC could accept that evidence of horizontal position (Latitude and Longitude) from the internal Track Records of a COTS GPS unit downloaded after flight, is at least equivalent to that from camera evidence of position. With the qualifications that there are procedures for control and Official Observation of such recorders. In particular it must not be possible to change the Geodetic Datum (earth model) in flight without this change being recorded by such a recorder, because that would alter the basis for the recorded Lat/Long positions.

1.2.2 Altitude Evidence. All altitude evidence in the existing Sporting Code where accurate measurement is concerned is required as pressure altitude calibrated to the ICAO ISA (the International Standard Atmosphere of the International Civil Aviation Organisation). All IGC-approved Flight Recorders have a pressure transducer system. This can be calibrated as above and is more accurate and stable with time than the traditional aneroid-based barographs that record on a drum or a roll of paper. Such pressure altitude figures are an integral part of all fixes recorded in an IGC flight data file.

1.2.2.1 Pressure Altitude and Controlled Airspace. Worldwide, the vertical boundaries of all controlled airspace are defined to a pressure altitude datum. This includes airways bases and control zone levels.

1.2.2.2 GPS altitude. GPS altitude is to a different scale and is geometric height above the ellipsoidal world model (Geodetic Datum) that is used in defining the Latitude and Longitude figures. In many GPS units, a conversion is available that gives an approximate altitude above local sea level. This is through the use of look-up tables stored I the unit and convert between the WGS84 ellipsoid and the WGS84 Geoid, an equal-potential (gravitational) surface approximately equivalent to local sea level. Conversion of GPS altitude figures to pressure altitude to the ICAO ISA is possible but difficult and requires a knowledge of the actual atmospheric temperature and pressure structure at the altitudes and positions of the glider concerned during the flight. Ideally, these need meteorological "soundings" derived from radio sonde ascents and aircraft observations. Even if this was practical, a crucial difficulty is that analysis of IGC files since the first IGC-approvals were given in 1996 has shown that GPS altitude figures in a significant number of IGC files show examples of electronic noise, that is, random variations of GPS altitude with time. They also show occasional major anomalies including obvious GPS-altitude errors and altitude unlocks. Examples have been seen where GPS altitude overshoots pressure altitude at high points and undershoots at low points, thus giving an exaggerated gain-of-height if GPS altitude was used

compared to pressure altitude. This is not a feature of the GPS system itself but of the way raw GPS altitude fixes are processed within the low-cost GPS boards concerned. Fortunately, GPS lat/long figures are processed separately using different algorithms including a certain amount of averaging to reduce "noise" and do not appear to be subject to such errors. In comparison to GPS altitude, pressure altitude figures in IGC files are very reliable and free of electronic noise and other anomalies.

1.2.2.3 Conclusion on Altitude Figures. For the above reasons, it cannot be recommended to IGC that GPS altitude should replace pressure altitude in the Sporting Code for accurate altitude measurement. However, there is no difficulty with its existing use to prove continuity of flight if pressure altitude recording fails.

1.2.2.4 Altitude in COTS GPS units. Some COTS GPS units record GPS altitude with each lat/long fix in their track records. However, such GPS altitude figures are subject to the different scale and the errors that are described above and the conclusions in 1.2.2.3 and should not be used for accurate altitude measurement. A few COTS units present pressure altitude as well, which may or may not be recorded in the track record. Generally this pressure altitude cannot be calibrated to the ICAO ISA because the unit is designed to re-set the pressure datum automatically to the GPS altitude datum in an effort to obtain an approximate "above sea level" reading. Such pressure altitude figures if recorded in the track record will not be to the ICAO ISA and therefore not to the IGC measurement standard.

2. **Changes to the Sporting Code**. In accordance with the above, the following amendments to Sporting Code Section 3 could follow:

SC3 para Amendment

4.6.4 Revised para 4.6.4 and its sub-paras to read as follows. In other parts of the code the term "Flight Recorder" to be changed to "IGC-approved Flight Recorder" where applicable, to distinguish between Recorders that are tested and approved and those that are not.

4.6.4 **GNSS Flight Recorder position and other evidence**

4.6.4.1 IGC-approved Flight Recorders. Types of FAI/IGC-approved recorder for which an official IGC-approval document is posted on the IGC GNSS web site may be used for the validation of types of flights that are described in the approval document. See Annex B para 1.1.3.3 for the different approval levels for various types of flight up to "all flights" approval that includes world records. For validation of a flight using such evidence, the conditions and procedures in the IGC-approval must be followed and OOs involved shall familiarise themselves with the terms of the IGC-approval. The approval document will specify procedures to be used, advice to pilots, OOs and NACs and any limitations (see Annex B Chapter 1).

4.6.4.2 Silver and Gold badge flights - Position Evidence. GPS receiver units that are not IGC-approved in accordance with 4.6.4.1 but after flight are capable of producing a track record of the flight in both lat/long and altitude, may be used for evidence of horizontal position (Latitude and longitude) for Silver and Gold badge flights only. The track record must be capable of being downloaded after flight and converted to the IGC data file format for analysis. The type of GPS unit must be subject to NAC approval for this purpose, Official Observer supervision of the unit concerned before and after flight and the following IGC procedures that apply to all Flight Recorders. A record of pressure altitude to the ICAO ISA to the normal IGC rules and procedures for pressure altitude is also required for the flight, such as by the use of a separate barograph. This is to comply with IGC standards of altitude measurement for any gain of height, start and finish altitudes and for comparison with any nearby controlled airspace. It must also be compared with GPS altitude recorded on the same flight and must show a similar general shape of altitude against time for the flight. This is an integrity check on the data in the IGC file that is not as secure as that from IGC-approved recorders.

4.6.4.3 General Procedures for all GNSS Flight Recorders

4.6.4.3.1 Geodetic Datum (Earth model). The WGS84 Geodetic Datum shall be used for all Lat/Long data that is recorded and used after flight for analysis. It must be shown that the downloaded lat/long data was fixed on the WGS84 datum for the whole flight. A recorder must be used in which the recorded data: either is permanently fixed on the WGS84 Datum, or it must not be possible to change the datum from WGS84 in flight, or if such a change is made the change must be recorded on the IGC file (although if a change from WGS84 is shown, the flight data shall be invalid for IGC purposes).

4.6.4.3.2 Presence of the recorder in the Glider. There must be incontrovertible evidence, independent of the Recorder data, that the Recorder from which the data was taken was in the glider flown by the pilot during the claimed soaring performance. This is particularly important with small and portable types of Recorder that can easily be transferred between gliders.

4.6.4.3.3. Before the flight. For recorders capable of storing a pre-flight declaration to IGC standards, this shall be stored electronically in the flight recorder (1.3.2) together with the time of declaration, or, where a written pre-flight declaration is allowed, the OO shall sign it. The flight recorder system shall be placed, configured or sealed in such a way that it will be impossible to operate any controls or connect other devices other than those specifically allowed for use in flight, for instance in accordance with the IGC approval for the equipment.

4.6.4.3.4 Takeoff and landing evidence independent of the Recorder. An OO shall ensure that there is separate evidence for the times and points of takeoff and landing, pilot(s) names, glider type and registration, and the type and serial number of the Recorder used for the flight evidence. This evidence shall be independent of the data produced by the Recorder. This is used as an independent integrity check on the flight recorder data which can then be used for more detailed analysis (Annex C para 11.3).

4.6.4.3.5 After flight. As soon as possible after landing, the flight data shall be transferred under OO observation from the Recorder to standard storage media via a PC or other device. The OO shall check any seals that were applied before the flight. The flight data shall then be sent either by email or by sending the storage device, to a person approved by the NAC to make the analysis.

4.6.4.4 Data Analysis. Analysis of the flight data shall be performed by a qualified person approved by the NAC, whose duty is to ensure that the appropriate evidence is present to verify the reaching of way points, heights, times and position, as required. The GPS altitude record with time must approximately match the pressure altitude record in terms of general shape. Detailed guidelines for analysis are in Annex C. Where there is more than one Recorder in the glider, the one holding the last pre-flight declaration shall normally be used for analysis. However, in the case of a failure or partial failure of this Recorder, data from another may be used provided it is approved for the type of flight performance claimed. If the soaring performance qualifies for a badge or record, the following shall be forwarded to the NAC:

4.6.4.4.1 Original Data. The download process from the Recorder immediately after landing must include the production of data in the IGC file format. If the type of recorder downloads into an intermediate format such as manufacturer's binary, the file in this format must be kept as well as the IGC format to which it has been converted and sent for analysis together with the IGC format file. Storage of data between download and analysis of flight data may be on any standard media such as diskette, hard disk or memory stick but such media must be protected from the possibility of data corruption or interference.

4.5.4.4.2 Claim form. The appropriate claim form(s) must include evidence of times and exact locations of events (such as takeoff and landing) independent of Recorder data. This must agree with the equivalent data from the Recorder and gives confidence that the rest of the detailed recorder data can be used as evidence for the flight.

4.6.4.4.3 Free (not pre-declared) Flights. For free record flights, the achieved waypoints shall be determined after flight from valid fixes in the flight recorder evidence.

4.6.4.4.4 Other Data. This includes any other measured data and/or auxiliary material required by a NAC to support the mandatory evidence (examples, Annex B, Appendix 1).

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