Annex __ to the agenda for the IGC plenary meeting 6 March 2009

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

CHAIRMAN'S REPORT - IGC GNSS FLIGHT RECORDER APPROVAL COMMITTEE (GFAC)

This report on GFAC activities is dated 10 January 2009 and any updates will be presented to the IGC Plenum

1. **GNSS Recorder IGC-approvals**. A total of 43 types of recorders from 16 manufacturers have been approved since the IGC-approval system started in March 1995. This is a large increase from what was reported last year and has involved a large amount of work during 2008.

1.1 New IGC-approvals. Nine new types of recorder have been tested and approved since the last IGC plenary agenda report dated 10 January 2008. These included recorders from four manufacturers new to IGC.

1.1.1 Full IGC-approvals. These were issued for the DSX 7100 T-Advisor and DSX 8000 Tracer with effect from 12 April 2008, the LXN LX8000 and LX8000F (with embedded Flarm) with effect from 25 April 2008, and the IMI Erixx V1.0 with effect from 7 June 2008.

1.1.2 Limited IGC-approvals. The following types of recorder have limited electronic and physical security and have been given IGC-approval for badge flights up to and including the three Diamonds (and competitions that use this level of approval). The Flarm-IGC V1.0 was IGC-approved with effect from 10 March 2008, the EDIATec ECW100F with effect from 14 June 2008, the LXN Mini Box Flarm-IGC and the LXN Red Box Flarm-IGC with effect from 31 August 2008. Note that, for the recorders with the IGC suffix, earlier models without the suffix are not IGC-approved.

1.2 Updated IGC-approvals. The wording in the approval for the Garrecht Volkslogger was updated with effect from 20 January 2008. Also, the wording for the EW microRecorder was updated to allow for low ENL readings in quiet flight, with effect from 20 November 2008.

1.2.1 Filser/Funkwerk/LXN. The Filser company is now part of Funkwerk GmbH and the Filser range of IGC-approved recorders are no longer supported by Funkwerk. However, LX Navigation was the original designer of these recorders and, after negotiations with GFAC, Funkwerk agreed that the names could be transferred from Filser to LXN. At the same time, LXN agreed to take over the IGC-approvals of these recorders. These were re-issued on 20 February 2008 under the LXN name. At the same time, the wording was updated to the current standard. The recorders concerned were the LXN (ex Filser) DX50, LX20, LX21 and LX5000IGC.

1.3 Scope of IGC-approvals. IGC-approval is concerned with recording and security of data in the recorder and in the post-flight IGC file data. IGC and FAI take no responsibility for the consequences of the use of IGC-approved Flight Recorders for purposes other than validation and certification of flights to FAI/IGC procedures. Such other purposes include, but are not limited to: in-flight navigation, airspace avoidance, terrain avoidance, traffic alert, or other matters concerning flight safety. See Annex B to the Sporting Code (SC3B), para 1.1.1.

2. **Future IGC-approvals**. Recorders from Nielsen Kellerman (USA) and Triadis (Switzerland) are being tested. The DSX recorder, approved on 12 April 2008, is being tested for the addition of an Environmental Noise Level (ENL) system that was not available at the time of the original approval. Correspondence has also taken place with the FlyMaster company of Portugal.

3. **Analysis Programs for Flight Data**. 27 programs have been notified to GFAC that can analyse data in the IGC file format. These are listed on the IGC GNSS web site.

4. **Technical Specification**. Amendment 11 to the IGC Flight Recorder Specification was issued on 20 May 2008 after circulation of drafts to the IGC ANDS and GFA committees, technical advisors, bureau representatives, recorder manufacturers and potential manufacturers. This amendment included details of electronic flight declarations, calibrations, connectors, sealing, various records in the IGC file, and some other updates.

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 flight recorder aspects of claims for badges and records. Particularly, analysis of ENL records for motor gliders has been a major part of this work.

6. **GPS Lat/Long Accuracy**. At the date of this report, GFAC tests show an average error of 11.47m for lat/long fixes recorded in IGC data files from a sample of about 2000 test points. These tests are made from a moving ground vehicle at accurately-surveyed points at about 51N 001W. These points include several with a clear horizontal horizon, one with terrain masking of about 5 degrees above the horizontal and some with nearby low-rise buildings. The average error figure using this method has been between 11 and 13m since the Selective Availability (SA) error was removed from civil GPS systems by the US Government on 1 May 2000. The overall results indicate a 99% probability of being within 26m, 95% of being within 20m, 90% within 18m, 80% within 16m, 70% within 14m, 60%within 13m and 50%within 11.5m. If only points with a clear horizon are taken, the average figure falls to 6.84m with a 99% probability of being within 19m, 95% of being within 16m, 90% within 12m, 80% within 10m, 70% within 8m, 60%within 7m and 50%within 6.8m.

7. **Drafting of Documents and Amendments**. No amendment to Annex B of the Sporting Code (SC3B) was made in 2008.

8. **Amendments to the Sporting Code**. The report of the Sporting Code Committee mentions the possible use of Commercial Off The Shelf (COTS) GPS units for position evidence instead of cameras for Silver and Gold badge flights. The reason for not including diamonds is that the IGC-approval system that has been in place since 1995 already applies to Diamond flights up to World Records in three levels of approval (listed in Annex B to the Code). Some of the implications of using non-IGC-approved COTS units are at Appendix 1 to this report. GFAC is concerned that whatever is decided on COTS GPS does not devalue the existing IGC-approval system for Secure Flight Recorders or in the future discourage manufacturers from designing GNSS recorders to the IGC Specification that covers all flights from Silver up to world records. Several GFAC members are not in favour of allowing COTS recorders to be used for flights under IGC rules, because of inferior security of data and the possibility of devaluing the existing IGC-approval system that has worked well since 1995. One GFAC member suggests that allowing COTS recorders with little built-in security, is not far from allowing a pilot to self-certify a flight performance.

9. **ENL – Noise Level figures in the IGC file**

9.1 ENL wording. It is intended to change the wording for ENL from "Engine Noise Level" to "Environmental Noise Level". This is a more accurate description and results from correspondence with an NAC that thought that the ENL figures in the IGC file were recordings of engine noise only.

9.2 Motor Gliders with low ENL readings. GFAC makes comprehensive tests of new ENL systems as part of the IGC-approval process, using gliders, motor gliders and light aircraft. IGC-approvals for ENL systems

only apply to types of Motor Glider which have engines that produce enough noise at the Flight Recorder for the ENL figures quoted in Annex B to the IGC-approval document to be achieved. Generally this applies to internal-combustion engines such as two- and four-strokes and rotary (Wankel) engines.

9.2.1 Electric engines. Tests on Motor Gliders with electric engines (such as the Lange Antares electric-powered models) have shown insufficient ENL readings and the provisions of para 1.4.2.4 of Annex B to the Sporting Code on low noise Motor Gliders, apply. This states that where the engine system produces low ENL values that make it difficult to differentiate between power-on and power-off flight, an additional system shall be provided in the motor glider concerned. This system "must produce a signal that is shown in the IGC file under the three-letter code "RPM" (as defined in the Technical Specification for Flight Recorders), as a more direct indication of forward thrust. This will be subject to GFAC evaluation on the type of motor glider concerned".

10. **Waypoint data format**. Although there is an IGC-recommended format for Waypoint data, it has been hardly ever used by any of the recorder manufacturers or other bodies that publish WP lists. This is probably because it was produced too late. That is, after manufacturers and other bodies had already decided on their own formats. It is therefore proposed that the current IGC WP format be withdrawn. GFAC notes that the Worldwide Soaring Turnpoint Exchange, widely used by the soaring community, uses the "STX" Waypoint format which is defined in http://soaringweb.org/TP/stx.html, and the attention of recorder manufacturers should be drawn to this format, without making it mandatory.

11. **GFAC Work Load**. The workload during the year in dealing with the above has been at its usual high level and with new IGC-approval applications expected, is not likely to reduce.

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Appendix: Sporting Code - considerations for COTS GPS units

References:

All IGC-approval documents: www.fai.org/gliding/system/files/igc_approved_frs.pdf This web page 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: 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 the same as 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 will not work with some modern PCs and their Operating Systems.

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

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

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Appendix to Report to IGC Plenary by GFAC Chairman - Sporting Code matters

This adds to proposals by the Sporting Code committee 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 gives some of the implications if IGC were to accept this concept and is similar to what was put to the 2008 IGC Plenary.

Considerations on the possible use of evidence from COTS GPS units for Silver and Gold badge performances

1 **Existing IGC Procedures for Diamonds and Above**. IGC procedures and standards for GNSS recorders have been in place for 14 years. They are embedded in the Sporting Code for Gliding (SC3) and its annexes, particularly Annex B to the Code and also in the document "Technical Specification for IGC-approved GNSS Flight Recorders" that also contains the protocols for the IGC data file format. These standards involve a number of levels of security, procedures and rules that apply to the validation of flights in the IGC environment. The lowest level of IGC-approval is for badge flights up to and including the three diamonds and the highest is for all flights including for World Records. It is proposed that these existing and well-proven rules and procedures should not be altered by introducing different standards of security, procedures, accuracy and integrity of altitude and position data into the types of flights already covered by the IGC-approval system. It follows that such COTS units could be considered for evidence for flights below the three Diamonds, that is, for Silver and Gold flights. For the reasons given in para 6, it is strongly recommended that pressure altitude to the ICAO ISA must also be available for the flight. In principle, the COTS GNSS unit would replace the camera for evidence of horizontal position.

1.1 Status of GNSS Units. Any COTS GNSS unit used for evidence of Silver and Gold flights must not be regarded as an IGC-approved unit, for which the much more rigorous IGC Specification applies. Such COTS units are not part of the existing IGC-approval system. The use of IGC-approved recorders for all flights from Silver to World Records should continue under the existing system. Any new procedures for COTS GPS units should apply only to flights below Diamond level, that is, for Silver and Gold badge legs. Some features known to be present in some COTS units must be taken into account so that the fix data used in evidence is accurate and to a consistent datum for latitude, longitude and GNSS altitude figures.

1.2 Pressure Altitude. Independent of the COTS GNSS unit, pressure altitude data to normal IGC standards is needed for the purposes below:

1.2.1 Measurement. For accurate gain-of-height and altitude loss calculations in accordance with IGC Sporting Code rules and procedures that have been in place for many decades.

1.2.2 Comparison. So that the altitude profile of the flight from the GNSS unit can be compared to data from the independent pressure altitude source as a check on the integrity of the overall COTS GNSS data. GNSS altitude and Pressure altitude data use different zero datums and different altitude scales, but the general shapes of the two altitude graphs with time should be very similar.

2 **Evidence of Position**. It must be ensured that the Lat/Long figures that are downloaded are derived from GNSS position lines (rather than predictions) and that all data uses the same Earth Model (Geodetic Datum).

2.1 Predicted Data and Averaging. Any GNSS unit that can produce lat/long fixes that are not derived directly from real-time GNSS satellite lines-of-position, should not be used for flight validation purposes. This includes predicted data based on past fixes, used in some COTS units designed for ground use when signal is temporarily lost due to ground obstructions, and units with excessive "averaging" that results in alteration of precise lat/long positions.

2.2 Changes of Earth Model. It is preferred that the GNSS unit will not allow the Earth Model (Geodetic Datum) to be changed when the unit is operating in flight, but can only be changed during the initial set-up process. However, if a GNSS unit permits change of the Earth Model in flight, such units should either be positioned out of reach of the crew in flight, or must be sealed by an OO before flight in such a way that the Earth Model cannot be changed in flight.

3. **Downloading from the COTS unit**. So that one of the existing analysis programs can be used, the downloaded data should be converted to the IGC format, as far as possible (allowing for the limitations of data available from the unit concerned). Additional data required by the Sporting Code should be manually recorded by the OO and pilot in the usual way. It is desirable that the program used for downloading and conversion to IGC format should include a system such that any unauthorised changes to the electronic data, can be detected later. This is a similar principle to the IGC Validation system but would apply to the data after downloading rather than being integral with the recorder itself as in IGC-approved recorders.

4. **Supervision**. Supervisors of COTS GPS evidence should be aware that the security of the unit itself and of the data initially downloaded from it does not conform to IGC standards for flights other than Silver and Gold. Also that COTS units do not have the physical or electronic security that is built in to IGC-approved GNSS recorders. GNSS recorders with IGC-approvals can also be used for Silver and Gold flights and can be used for higher badges, diplomas, records and championships. Their characteristics are covered in the Technical Specification for IGC-approved GNSS Flight Recorders.

5 **Altitude Evidence**. In the Sporting Code for Gliding (FAI SC3), where accurate measurement of altitude is concerned, pressure altitude has always been required. Such pressure altitude figures must be calibrated to the International Standard Atmosphere of the International Civil Aviation Organisation (the ICAO ISA). Any change to this long-term IGC policy would require major amendments in many places in the Sporting Code and its three annexes. For the reasons given below, it is suggested that such a change is not justified. Every IGC-approved Flight Recorder has a pressure transducer system, calibrated to the ICAO ISA, in accordance with the IGC Specification for such recorders.

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

6.2 GPS altitude. Pressure Altitude and GPS altitude are to different scales. GPS altitude is vertical height above the ellipsoidal world model (Geodetic Datum) that is used for the Latitude and Longitude figures. This is not the same as the ICAO ISA. In some COTS GPS units, a conversion is available that gives an approximate altitude above local sea level. However, heights Above Sea Level (ASL) on maps are often taken from a Mean Sea Level (MSL) datum that is a good average for the area in question, and this may not correspond to exact MSL at any given point. For the WGS84 system, an approximate local sea level figure can be obtained through the use of look-up tables that convert between the WGS84 ellipsoid and the WGS84 Geoid, an equipotential surface approximately equivalent to local sea level. Such look-up tables can be stored in the GNSS unit in electronic form and often form the basis of ASL selections mentioned in equipment manuals. GPS altitude figures can be converted to pressure altitude to the ICAO ISA but this is not easy and requires accurate data on the actual atmospheric temperature and pressure structure at the altitudes and positions of the glider concerned during the flight. For accurate conversions, these need meteorological "soundings" derived from radio-sonde ascents or observations from aircraft with appropriate instruments.

6.2.1 Anomalies in IGC fileGPS Altitude. Even if the above was practical, errors in GPS altitude need to be considered. In ideal conditions, GPS altitude errors should be about twice those of lat/long due to the different geometry of the position lines. Unfortunately, analysis of several thousands of IGC files has shown a significant number of cases where GPS altitude figures show examples of electronic noise, that is, random variations of GPS altitude with time. They also show occasional more major anomalies including obvious GPS-altitude errors and altitude unlocks, while lat/long fixes remain unaffected. Examples include GPS altitude overshoots over pressure altitude at high points and undershoots at low points, giving an exaggerated gain-of-height. These anomalies are not a feature of the GPS system itself but of the way GPS altitude fixes are processed within the GPS boards concerned. Fortunately, GPS lat/long figures are processed separately using different algorithms, for instance using noise reduction techniques, and are not subject to the same anomalies as GPS altitude. In comparison, pressure altitude figures in IGC files derived from a separate transducer, have been shown to be very reliable and free of electronic noise.

6.3 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 the existing use of GPS altitude to prove continuity of flight if pressure altitude recording fails, because for this purpose, accuracy is not as important as demonstrating continuity of flight.

6.4 Altitude in COTS GPS units. The track records of many COTS GPS units do not include altitude. However, some COTS units do record GPS altitude with each lat/long fix in their track records, but, as described above, such GPS altitude figures are not to the ICAO ISA. Such GPS altitude figures should therefore not be used for accurate altitude measurement to IGC standards.

6.4.1 Pressure Altitude. A few COTS units include a pressure altitude capability that may or may not be recorded in the track record. It may not be possible to calibrate this pressure altitude to the ICAO ISA because some units are designed to re-set the pressure datum automatically with time in an effort to obtain a continuous 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.

7. **Changes to the Sporting Code**. The Sporting Code Committee has put forward amendments to the Sporting Code Section 3 and these appear elsewhere in the Plenary agenda. It is suggested that, if IGC agree the use of COTS recorders for Silver and Gold badge flights, the above considerations should be taken into account and the Sporting Code should make it very clear where IGC-approved Flight Recorders are required and where COTS Flight Recorders are allowed.

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