Report from Chairman of the GNSS Flight Recorder Approval Committee (GFAC)

for the agenda of the 2014 IGC Plenary

10 January 2013

1 **GNSS Flight Recorder IGC-approvals**. A total of 45 types of GNSS Flight Recorders (FRs) from 17 different manufacturers are currently IGC-approved.

1.1 This is a reduction compared to previous years because the IGC-approval of 7 types of FR was withdrawn on 1 October 2012 after a security review by ANDS & GFAC, their paper being approved by the IGC Bureau and Plenary. Meanwhile, two manufacturers no longer make FRs, reducing the manufacturer total from 19 to 17. One of the withdrawn types of FRs has been approved by an NAC as an IGC Position Recorder (PR) although it does not comply with Sporting Code rules and procedures for PRs. The IGC Bureau is aware, and this is being treated as a special case under "Grandfather Rights" in view of its previous history as an early IGC-approved FR.

2 **GFAC Approval activity in 2013**

2.1 January 2013 - Testing PowerFlarm Core and Portable models for Diamond level IGC-approval
2.2 January 2013 - Testing new electronic security system for IGC file validation of Flarm-IGC files.
2.3 14 February 2013 – Update to FLARM-IGC recorder and others using it as the main recorder module. These are:
Ediatec ECW100F,
LX Navigation Mini-Box Flarm,
LX Navigation Red Box Flarm
2.4 28 February 2013 – Flarm, Flight Recorder aspects of powerFlarm-IGC, initial approval
2.5 31 March 2013 – Triadis Recorder Unit 3 (RU3), initial approval
2.6 5 May 2013 – Triadis Recorder Unit 2, initial approval.
2.7 5 May 2013 - Update to LXNAV FRs with the external MOP box for low ENL situations
2.8 31 July 2013 – LXNAV FlarmMouse with Flarm-IGC firmware, initial approval.
2.9 31 August 2013 – Notice of IGC-approval level changes to take place on 1 October 2013
2.10 1 October 2013 – Changes of Approval level for the LX Navigation DX50, LX20, LX21, LX5000; SDI Posigraph; & Zander 940, the final phase of the ANDS/GFAC FR Security paper approved by the IGC Bureau and Plenary
2.11 10 October 2013 – LXNAV LX9000 series, addition of LX9070

3. **Ongoing Work in early 2014**. The following FRs have been put forward for IGC-approval:
3.1 Glider Computer Advanced (GCA), made by PressFinish GmbH of Munich, Germany
3.2 LX Navigation LX5000R.
3.3 LX Navigation Flarm Mobile.

4 **GPS Lat/Long**. Results of accuracy tests in Lat/Long position are similar to last year, see Appendix 1.

5 **IGC File Analysis**. Many IGC files have been analysed including those from FRs being tested, and those sent to GFAC by a number of organisations. Advice has been given to NACs, competition organisers, pilots and OOs. This also applies to IGC files from IGC Position Recorders that have a lower level of security but use the same IGC file structure.

6 **Amendments - Annex B to the Sporting Code, and the FR Specification**. No amendment to Annex B was made in 2013 but one is required in 2014. This is because in the last few months of 2013, the IGC ANDS and GFA Committees carried out a considerable amount of work to update the IGC FR Specification document because it had not been revised since May 2011. This work resulted in amendment 2 dated 31 December 2013 which can be viewed on the FAI/IGC and GFAC web pages together with the full FR Specification. This process revealed areas of the Specification that need further ANDS/GFAC discussion and it is intended that Amendment 3 will be published in 2014. Inputs for Amendment 3 are invited from any party with an interest, to be sent to the GFAC Chairman.

6.1 Chapter 1. Chapter 1 of the FR Specification is the basis for Chapter 1 of Annex B to the Sporting Code, and it is intended to update chapter 1 of Annex B to match the FR Specification.

6.2 High Altitude Flight Recorders (HAFRs). For flights above 15,000 metres (49,213ft), para 4.5.3 of the main volume of SC3 refers to HAFRs and states that more detail will be in Annex B to the Code and also in the FR Specification. The latest amendment to the FR Specification adds para 2.2.4.1 with the necessary detail. This leaves Annex B and it is intended to amend it to be in line with the HAFR paras in SC3 and the FR Specification. Finally, doubts have been expressed about SC3 para 4.5.3d which prevents IGC flight validation using GPS altitude under conditions of high "solar flux radiation"; this is covered in more detail in para 3 of Appendix 2.

7 **IGC Position Recorders (PRs)**. These do not have the integrity and security of IGC-approved FRs and are for validation of Silver and Gold badge flights only. Small changes to wording in SC3 and SC3C are proposed in Appendix 2, mainly referring to the NAC PR-approval document that applies to each type of PR.

8 **Earth Models**. The main volume of SC3, para 4.4.2a, states that for distance calculations "the WGS84 earth model shall be used". However, in October 2011 Annex A to the Code was changed to make a spherical earth model mandatory for championships, without this major change being brought to the attention of the IGC Plenary or other IGC experts such as those on the ANDS and GFA Committees, several of whom then objected to the replacement of the WGS84 ellipsoid by a sphere. Despite this, Annex A still says that: "the Earth Model to be used for all calculations specified in this Annex shall be a sphere of radius 6371.0 kilometers". In addition to the inconsistency between two parts of SC3, it is not clear how, using a sphere, airspace proximity calculations showing airspace compliance can be carried out when international airspace is defined with respect to the WGS84 Geodetic Datum. In addition, if an IGC record, badge or distance diploma appears to have been achieved in an Annex A championship, the achievement may fail when the distance is re-calculated from sphere to ellipsoid, as required by the main volume of SC3. It is therefore proposed that for accurate distance calculations, IGC should have one standard and not two, which should be that in the main volume of SC3, to which Annex A is an annex and not a stand-alone document. More detail is in Appendix 3.

9 **Conclusion**. It has been another busy year for GFAC and an update will be given to the Plenary.

Ian W Strachan
Chairman IGC GFA Committee
ian@ukiws.demon.co.uk

Appendix 1: IGC FR accuracy results
Appendix 2: SC3 proposed changes
Appendix 3: IGC Earth Models

Web references:

GFAC web site: www.ukiws.demon.co.uk/GFAC
This is easier to navigate than the FAI/IGC web site, and includes tables of IGC-approvals for FRs, details of manufacturers, links to all IGC-approval documents, free software, the FR Technical Specification, Sporting Code Annexes B and C with FR Rules and Procedures, the 2011 FR Security Paper, and IGC Position Recorder approval documents where they comply with the Sporting Code..

FAI/IGC web site: www.fai.org/gliding For FRs, scroll down to "Technology",
then IGC-approved Flight Recorders, Free Software, or Position Recorders
further menus follow such as Approval Documents, Technical Specification, etc

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GFAC Flight Recorder Accuracy Tests

Tests are made from a moving ground vehicle at a number of accurately-surveyed points at about 51N 001W. These points include several with a clear horizon, one with terrain masking of about 5 degrees above the horizontal and some with nearby low-rise buildings.

For FRs mounted in gliders, this represents a case where the FR antenna is mounted in less-than-optimal conditions or where the antenna or its cable has been damaged or is less than ideal.

The average error figure using this method has been between 11 and 13m since the year 2000.

The overall results give an average (50% probability) of 11.47m, with:

99% probability of being within 26m,

95% of being within 20m,

90% within 18m,

80% within 16m,

70% within 14m,

60% within 13m

50% within 11.5m.

For points with a clear horizon, the average (50% probability) figure falls to 6.84m, with:

99% probability of being within 19m,

95% of being within 16m,

90% within 12m,

80% within 10m,

70% within 8m,

60%within 7m,

50%within 6.8m.

IGC Position Recorders

1 SC3 main volume.

Page 2, wording on "Fix" to read: " ... from an IGC-approved Flight Recorder, pressure and GPS altitude, or from a Position Recorder, GPS altitude only". Reason, factual correction.

Chapter 4 Appendix A1, add reference to the Specimen PR-approval document that has been on the IGC web pages since IGC PRs were first introduced. The second para of A1 to read: "A1.1 Each NAC is to approve each type of PR for use within their area of responsibility, and a Specimen PR-approval document is on the IGC web pages which should be modified with the characteristics of the type of PR concerned. A1.2 Guidance on PR operation ... ". Reason, use of the Specimen PR-approval document will reduce work for NACs and be easier for pilots and OOs compared to the use of different formats.

2 SC3 Annex C.

1.3c to start: "To issue and maintain a PR-approval document for each type of position recorder (PR) that it accepts;". Reason, the previous wording simply said "to maintain a list", without mentioning the PR-approval documents that show pilots and OOs how to use the type of PR concerned.

6.1 second sentence change from: "PRs must be approved individually by each NAC. Approvals ...", to: "Each type of PR must be approved by the NAC through a PR-approval document. Approval documents ... ". Reason, showing the way that PRs are approved for use rather than just saying that they must be approved.

6.1a, add at the end of the first sentence: "and study the PR-approval document for the type of PR concerned which gives advice on pre- and after-flight procedures, downloading and security generally." Reason: Calling attention to the PR-approval document.

6.2 The text in this para refers to PRs but the title does not show this. Add "PRs - " at the start of the title, or re-number to 6.1c.

6.2d, last para to start: "This will enable GFAC to provide the NAC with expert advice ... ". Reason, shorter.

6.2d, last sentence about posting PR-approval documents on the IGC web pages. This is an important statement, add it to SC3 main volume Annex to Chapter 4.

High Altitude Flight Recorders (HAFRs)

3 SC3 4.5.3d This states: "Claims using altitude data from a HAFR must include evidence that there was no solar flux radiation during the flight that exceeded the high of the 96 hours preceding the flight. Note: A source of solar data is the NOAA Space Weather Prediction Center at <www.swpc.noaa.gov/today> or <www.n3kl.org/sun>."

3.1 General. Doubt has been expressed about the need for the above and its practicality in a World Record situation. It is understood that high Solar Flux Radiation (SFR) is mainly associated with the 11 year sunspot cycle, currently near its peak with little evidence of anomalies in GPS fixes. Also, the GPS-based ADS-B system depends on accurate fixes, is used in Australia, by the US FAA's "NextGen" Air Traffic Management (ATM) system, and elsewhere in the world, and there is no evidence that it is failing in such conditions.

3.2 IGC Aspects. The wording needs to be changed because in a low radiation period, a small increase in Solar Flux Radiation (SFR) during a record flight, although still of low strength and having no impact on GPS accuracy, would invalidate a new record. Also, the first web reference is no longer valid. More important, closer definition of SFR is required together with its units, from where and how it is to be measured. What if a new world altitude record is achieved by the Perlan project, but SFR is above the SC3 limit? Is the record to fail? IGC already has the requirement to record both pressure and GPS altitude in the FR IGC file, so that the general shape of the two curves can be compared and any anomalies in one or the other curve shown. Because of this it may be better to delete sub-para (d) completely in case it negates a perfectly viable world record. However, correspondence is taking place on the effect of high SFR on GPS with experts in the US FAA, EASA, and the Navigation Bureau of ICAO, and a report will be made to the plenary.

Appendix 3

Earth Models in IGC Documents

1. General. The WGS84 Ellipsoid earth model has an Equatorial radius of 6378.137 km and a Polar radius of 6356.7523 km, a "flattening" of 21.3847 km. This compares to the "FAI Sphere" with a radius of 6371 km, and is an approximation of the earth's shape, compared to the WGS84 ellipsoid which is very close to the real shape of the earth. As long ago as 1989 ICAO adopted, quote: "the World Geodetic System 1984 as the standard geodetic reference system for future international air navigation" (including the boundaries of Controlled and other airspace), and Civil and Military Aviation Regulatory Authorities followed. The ellipsoid is also used by the US GPS system, other GNSS, and other systems such as Google Earth. All Lat/Longs in IGC files are referenced to WGS84. The General Section (GS) of the current Sporting Code says, para 7.2.2: "If not otherwise specified by the Air Sport Commissions, the earth model to be used for geometric calculations shall be the WGS84 ellipsoid". The GS also says that: "for FAI purposes, WGS84 (World Geodetic System 1984) is the standard Geodetic Datum".

2 IGC Earth Models. In gliding, since 2001 the main volume of our Sporting Code (SC3) has specified the use of WGS84 for accurate distance measurement. However, Annex A to the Sporting Code (SC3A) was changed in October 2011 to use a sphere of radius 6371km for "all calculations specified in this Annex" (that is, for World Championships and other competitions using Annex A rules). This continued in the 2012 and 2013 editions of Annex A despite questions raised by individual members of ANDS, GFAC and ex-IGC President Professor Peter Ryder. The change from ellipsoid to sphere is a major change that has not previously been brought to the attention of the IGC Plenary, either for approval as a change to Annex A or in the form of the usual Year 1 / Year 2 system for major Sporting Code changes.

3 Calculations. Although distance calculations are simpler using a sphere, programs such as those using the Vincenty algorithm exist for distance calculations on the surface of the WGS84 Ellipsoid, many of them free including one on the FAI web site. Vincenty is endorsed by ICAO and the US GPS operating authority for distance calculations, and is specifically mentioned in the General Section of the FAI Sporting Code.

4 *The Annex A Committee is invited to justify why it is necessary to mandate a calculation system that differs from that used for other IGC performances such as Records, Badges and Diplomas, and, using a spherical Earth Model, how accurate separation (or otherwise) from Airspace can be calculated for flights, as required by Air Law and the FAI GS.*
