Report from GFAC Chairman,
IGC GNSS Flight Recorder Approval Committee (GFAC)

to the 2013 IGC Plenary

General: This has been a very busy year for GFAC which has had to deal with several important policy issues as well as the routine of testing FRs and processing IGC-approval documents

Reference A: ANDS/GFAC paper on FR security dated 19 July 2011,
approved by the IGC Bureau on 9 October 2011 and by the 2012 IGC Plenary on 3 March 2012.
See: www.ukiws.demon.co.uk/GFAC/securitypaper.htm

1 **GNSS Flight Recorder IGC-approvals**. A total of 51 types of GNSS Flight Recorders (FRs) from 19 different manufacturers have been IGC-approved since GFAC was formed in March 1995.

1.1 Approval withdrawals. On 1 October 2012, IGC-approval of seven types of FR was withdrawn as a result of the security issues raised in the Reference A paper. These were the EW Models A-D (the recorder has no GPS receiver and needs a separate unit which has no security protection), LX Navigation LX20 first batch (no microswitch or RSA-level security) and the Print Technik GR 1000 and GR 1000A (security keys revealed).

1.2 Current IGC-approvals. The result of the above is that IGC-approvals now exist for 44 types of FR from 17 different manufacturers (Filser FRs are now dealt with by LX Navigation and Print Technik is no longer in the business). For links to approval documents, see either the IGC or the GFAC web sites. The GFAC web site was created in 2011 as a backup to the IGC site due to difficulties with the IGC site in 2011 and 2012.
See: www.ukiws.demon.co.uk/GFAC/igc_approved_frs.pdf
or: www.fai.org/gliding then look for "Technology", then "IGC-approved Flight Recorders".

2 **Approval activity in 2012 and 2013**

2.1 10 January 2012 – LXNAV LX9000, addition of MOP box for jet-engined motor gliders
2.2 22 January 2012 – LX Navigation LX7007FC, initial approval
2.3 31 January 2012 - LXNAV LX8000 and 8000F, addition of MOP box for jet-engined motor gliders
2.4 15 May 2012 - Flarm-IGC security update
2.5 29 May 2012 – Security update to EDIATEC ECW100F, LX Navigation Mini Box and Red Box Flarm
2.6 1 October 2012 - Changes as a result of the Reference A Security paper: Reductions in IGC-approval levels for: Cambridge 10, 20, 25, Filser/LXN DX50, Filser/LXN LX20 (with RSA192), Filser/LXN LX21, Filser/LXN LX5000 IGC, LXN Colibri 1, SDI/LXN Posigraph, Zander GP940. Plus withdrawal of IGC-approvals as in 1.1 above.
2.7 5 October 2012 - LX Navigaton Colibri approval now specifies the Hardware and Firmware versions for Models 1 & 4.
2.8 October/November 2012 - Initial testing LXNAV nanoFlarm, now returned for final design decisions
2.9 December 2013 and January 2013 - Testing PowerFlarm Core and Portable models for Diamond level IGC-approval
2.10 January 2013 - testing new electronic security system for IGC file validation of Flarm-IGC files.

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

3 **Anomalies found during the year**. 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 the same IGC file structure.

3.1 Security Breach. During April 2012, software appeared on the web from an unknown source that enables false Flarm-IGC files to be produced that pass the IGC electronic validation check. The IGC-approval level for this recorder is

"Diamonds", the lowest of the three approval levels. In view of the low approval level and the many thousands of Flarm-IGC in service, it was decided not to withdraw the IGC-approval but to warn users pending a security update. Flarm-IGC firmware with improved security to protect Flarm IGC files has now been developed, and is being made available. It is intended that IGC-approval will continue to apply to un-modified units until 1 October 2013.

4 **Annex B to the Sporting Code**. Amendment 8 dated 1 October 2012 contains a revised procedure for IGC-approval level changes between IGC Plenaries, the wording being part of the GFAC report that was approved by the 2012 IGC Plenary.

5 **FR Security Review 2011 - Completion**. The IGC-approval reductions of 1 October 2012 were part of a two-stage process, to allow time for owners to adjust. On 1 October 2013, the full provisions of Reference A will take place. After this date, the types of FR listed in 2.2 above will be at "Diamonds" IGC-approval level. It should be noted that the LX Navigation company has confirmed that the security of their Colibri 4 model is the same as the earlier Colibri 1. It will therefore be treated in the same way. However, a security upgrade is available (Firmware Version 10) that will retain "All Flights" approval, unmodified Colibri 1 and 4 units reverting to Diamonds level from 1 Oct 2013.

6 **IGC Position Recorders**. The Sporting Code wording on IGC Position Recorders was updated in 2012 as a result of the Plenary decision to allow GPS altitude to be used instead of Pressure altitude with an increment of 100m to allow for the different scales and the increased "noise" in GPS altitude figures from low-cost receivers.

6.1 GPS Altitude. GFAC tests and previous reports to IGC have shown that GPS altitude figures many IGC files have short-term variations ("noise") and, in some files, larger differences compared to Pressure altitude that cannot be explained by the different scales used for GPS and Pressure altitude (GPS is height above the WGS84 ellipsoid, pressure uses the ICAO ISA scale). This is probably because, in low-cost receivers, after the receipt of the raw signal, GPS altitude is not "smoothed", unlike Lat/Long figures that are processed to reduce short-term variations and "outlyers".

6.1.1 NACs validating claims where GPS altitude is being used, are advised to analyse the whole GPS altitude graph as well as the exact points used for the badge claim, and to ensure that the points used for calculation are part of an altitude graph that is similar to what is expected.

6.2 Sporting Code Compliance. An NAC approval document has been issued in the Nation concerned for a PR in which the recorder unit does not have its own GPS receiver but depends on a cable connection to a Garmin-type GPS receiver. This does not comply with the Sporting Code for PRs in three respects.

6.2.1 Such GPS receivers are designed mainly for road use, and record "predicted" fixes when GPS signal strength is low. *Predicted "fixes" carry forward the previous track, are not based on current GPS signals, and do not reflect actual positions. They can be used to deliberately throw forward what appear to be "fixes", for instance into an Observation Zone when the glider was not there. This was seen in early GFAC tests, which is why Predicted Fixes have always been excluded in the Specification for IGC Flight Recorders, similarly in Sporting Code wording on Position Recorders.*

6.2.2 The cable connection to the Position Recorder unit has essentially no security and allows many types of GPS receivers to be connected, with many different characteristics. *IGC PRs may have reduced security compared to an IGC-approved FR, but not no security at all.*

6.2.3 The NAC issued their PR approval document without sending it first to GFAC for comment and advice, and had been told earlier by a GFAC Technical Advisor that the Recorder unit did not comply with the Sporting Code for PRs. *The Sporting Code requires NACs to consult GFAC before issuing a PR approval because GFAC is IGC's advisor on security, IGC file structure, and GNSS Recorder matters generally.*

6.2.4 The NAC has been informed of the above but as this report is written, is unwilling to withdraw the document. It is emphasised that this for an IGC Position Recorder for the purpose of validating claims for IGC Badges (note "IGC", not "NAC"). *IGC is asked to confirm that the Sporting Code must be followed in approval documents for IGC Position Recorders.*

7 **Earth Models**. The U.S. GPS system uses the WGS84 Ellipsoid earth model, with slightly different radii for the equator and the poles (for figures, see SC3B page vii). As long ago as 1989 ICAO adopted, quote: "the World Geodetic System1984 as the standard geodetic reference system for future international air navigation", and Civil Aviation Regulatory Authorities followed. The WGS84 Ellipsoid is also used by future GNSS systems (and other system such as Google Earth), and all Lat/Longs in IGC files are referenced to it. The General Section (GS) of the current Sporting Code (para 7.3.1.1) says that for distance measurement "the earth model for FAI purposes is the WGS84 ellipsoid", and the option of a constant-radius sphere was deleted from the GS in 2012.

7.1 In gliding, the main volume of our Sporting Code (SC3) specifies the use of WGS84 for accurate distance measurement. However, Annex A to the Sporting Code (SC3A) was changed in October 2011 to a sphere, for the purpose of "all calculations specified in this Annex" (that is, World Championships and others using Annex A rules). This continues in the 2012 edition of Annex A despite questions raised by individual members of ANDS, GFAC and 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 the 2011/12 editions of Annex A or as a "Year 1" proposal for Sporting Code change.

7.2 Although 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. The main volume of our Gliding Sporting Code has not specified a spherical Earth Model we adopted the Ellipsoid in 2001, at the same time as its inclusion in the Sporting Code General Section (GS). Vincenty is endorsed by ICAO and the GPS operating authority for distance calculations, and this was checked before using it in 2001 for the FAI web-based distance calculator.

7.3 *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.*

8 **Conclusion**. It has been another busy year for GFAC, and as this report is written, three new types of GNSS FR are being tested (paras 2.8-2.10 refer). An update on GFAC activities will be given to the Plenary.

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Appendix 1: IGC FR accuracy results

Web references: GFAC web site: www.ukiws.demon.co.uk/GFAC
This 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, look for "Technology", then "IGC-approved Flight Recorders".

Low-ENL Motor Gliders (electric or jet): See Annex B to the Sporting Code (SC3B):
General: para 1.4.2. Critical ENL: para 1.4.2.2. Low ENL Motor Gliders: para 1.4.2.4.

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 Selective Availability (SA) error was removed from civil GPS systems by the US Government on 1 May 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.
