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Sporting Code Section 3 - Gliders and Motor Gliders

Proposed Year 1 draft changes to incorporate evidence from COTS GPS units for the verification of Silver and Gold badge performances

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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 and in particular it must not be possible to change the Geodetic Datum (earth model) in flight 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 equipotential 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. **Proposed Changes to the Sporting Code**. In accordance with the above, the following amendments to Sporting Code Section 3 are proposed:

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 exact 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 way points 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).
