# Sporting Code rules on IGC Position Recorders - 1 October 2014

*What follows are the current Sporting Code rules and procedures for IGC Position Recorders, copied from the appropriate paragraphs in the main volume of SC3 and its Annex B (Equipment for Validation of flights) and Annex C (Guide for Official Observers and Pilots). The wording below is from the documents dated 1 October 2014), starting with the Annex B Glossary entry for Position Recorder, a useful introduction for what follows.*

Position Recorder (PR) - a stand-alone GPS recorder unit, data from which may be used under IGC rules for the validation of types of badge flights that are listed in the main volume of the Sporting Code (SC3). The IGC flight data file format is used, but an IGC PR has a lower technical and security standard compared to an IGC-approved Flight Recorder (FR), and the IGC Technical Specification for GNSS FRs is advisory rather than a requirement. Rules and procedures for IGC Position Recorders are given in the main volume of SC3, including para 1.1.5 and the appendix to Chapter 4. More detail is in Annex C (SC3C) including para 6 on Recorders, para 11 on Calibration, Appendix 3 on Badge procedures, and Appendix 5 on GNSS recording. A specimen approval document for IGC Position Recorders is available on the IGC and GFAC web pages, together with guidance notes.

*(Source - Glossary, Annex B to the Sporting Code).*

## SC3 Main Volume

1.1.5 Position Recorder. A "PR" is an electronic device approved by NACs to record GPS data for Silver and Gold badge claims only. See the Chapter 4 Appendix for restrictions in PR use.

1.2.7 Fix. A single data point selected from recorded flight data giving latitude, longitude, time, and ... from a Position Recorder that does not record pressure altitude, GPS altitude only.

1.4.2 Duration, gain of height and absolute altitude performances. A Declaration is not required for duration and gain of height badge flights that use only a Position Recorder (per the Chapter 4 Appendix)

Chapter 4 Appendix - The use of Position Recorders for Silver and Gold badge flights

A-1 General. Many GPS devices can record the coordinates of their position at intervals. If this data can be downloaded in the same format as an .igc file, NACs may allow these “position recorders” (PRs) to be used to validate the horizontal position of the glider. Altitude evidence may also be used in accordance with A-7 below. Each NAC is to approve each type of PR for use within their area of responsibility and to maintain a current list of them. A specimen PR-approval document is on the IGC web site and should be used as a basis, modified with the characteristics of the type of PR concerned. GFAC will post PR approval documents that comply with the Sporting Code on the IGC web site. Guidance on PR operation and the approval process is given in Annex C-6.1 and 6.2, but NACs should consult GFAC for advice prior to beginning the approval process for a given type of PR as there may be known problems with it or it may have been found to not comply with IGC rules and procedures. Types of recorder which have lost their approval as IGC FRs may be suitable to use as PRs if the requirements in this appendix are met.

A-2 Earth Model. PRs must use the WGS84 Ellipsoid Earth Model and it must not be possible to change it during the flight.

A-3 Averaging and predicted positions. Any PR that can produce estimated fixes through averaging or predicting based on past fixes is acceptable only if the estimation functions are disabled. The OO must supervise the disabling process or verify that it was completed before flight and certify that this was done.

A-4 Frequency of fixes. Fix frequency must be at least once per minute.

A-5 Declaration. A written declaration (either internet-based or on paper) including all appropriate items listed in SC3-4.2.1 is the only acceptable form.

A-6 Downloading and verification. Downloaded data must be converted as closely as possible to the .igc format. Any download and conversion program must be approved by the NAC and include a validation system that will identify any changes to the .igc file made after the initial download.

A-7 Altitude. Where the type of PR does not record pressure altitude, GPS altitude evidence may be used for a flight provided that a 100 metre error margin is applied to all pressure height requirements of the Code (example: the gain of height is at least 1100 metres for Silver altitude) and it can be shown that the GPS altitude figures are reliable to be used for measurement purposes. See Annex C-2.4 and 6.2c.

A-8 Presence of position recorder in the glider. There must be proof, independent of the recorded data, that the PR was in the glider flown by the pilot claiming the soaring performance.

A-9 Before flight. The OO must ensure the PR is installed, configured, or sealed in such a way that switches and buttons cannot be used in a manner that could affect the downloaded flight data or allow connection to devices that could alter the data.

A-10 Takeoff and landing. The OO must ensure that there is evidence of the position and time of take-off and landing. This evidence must be independent of the data produced by the PR.

A-11 After flight. As soon as possible, the OO shall check any seals applied before the flight, supervise the download of data from the PR and perform a preliminary analysis of the flight claim. Both the .igc format data file and any other data file (if applicable) from the PR shall then be sent, using NAC-specified methods, to a NAC-approved person to analyse the data.

A-12 Analysis. The analysis of the data must be done in the same manner as the data from an IGC-approved FR.

5.5.2 Badge Performances ... if a position recorder was used, the original data file (the first copy) in the format produced by the position recorder should be used. Where any conversion to .igc format is done during download or afterward, both the original and the .igc files must be submitted.

## SC3 Annex B - Equipment

Glossary: Position Recorder. See the first para on page 1 of this document.

Validation, VALI check. ... A less rigorous form of file validation applies to IGC Position Recorders (PRs, see above) where Validation of the file at any time later may be provided either by part of the program that downloads the data or by another method accepted by the NAC and GFAC. When a flight data file from a IGC PR is checked later by the appropriate Validation function, it must show that the file is identical to when it was originally downloaded. This differs from IGC-approved FRs, where the signature generation and Validation program originates from the FR manufacturer and the serviceability and sealing of the FR itself is part of the Validation process.

1.7.1 IGC File Format. In the case of ... some types of IGC Position Recorder, there may be some differences compared to the current IGC file format, but for a performance to be validated to IGC standards, in all cases the file must pass the IGC electronic Validation check (see para 1.1.10.1).

2.1.2 GNSS altitude.

2.1.2.1 IGC Position Recorders (PRs). In an IGC PR, if pressure altitude is not recorded in its IGC-format flight data file, GNSS altitude may be used for measurement purposes with an increment over the appropriate SC3 altitude requirements, in accordance with SC3 procedures for IGC PRs. This is because of the different scales used in deriving altitude from pressure and GPS sensors, and short-term variations of GPS altitude figures seen in IGC files where low-cost GPS receivers are used (also see 2.4.1 below). At the date of publication of this amendment, the increment is 100 metres (328 ft). SC3 references are listed above in the Glossary entry for Position Recorders.

2.2.1 Flight Recorders. The pressure altitude recording system fitted to all IGC-approved Flight Recorders and some IGC Position Recorders is a barograph system in its own right. Such systems must comply with other rules in the Sporting Code for Gliding (SC3 and its Annexes) for barographs and their calibration.

2.4 Flight Recorder Altitude Evidence. This applies to GNSS altitude and pressure altitude evidence from IGC-approved Flight Recorders and IGC Position Recorders. *(See the rest of 2.4 in Annex B for the detail)*

## SC3 Annex C - OO Guide

1.3 The National Airsport Control (NAC)
1.3c ... to issue and maintain a list of position recorders (PRs) that it accepts, ...

1.4e. Position Recorder approval. If a PR has been used, its status should be checked by both the host and controlling NACs. Clearly, the claim may be approved if both NACs have approved the device and the conditions of approval are similar. In any other case, the NACs should confer and the controlling NAC may proceed as it sees fit.

6.1 Position Recorders (PRs). This type of recorder may be used for height and position evidence for Silver and Gold badges in accordance with the SC3 Chapter 4 Appendix. PRs must be approved individually by each NAC. Each type of PR must be approved by the NAC through a PR-approval document. Approval docu-ments shall include any operating limitations needed to enable a given unit to conform to the Sporting Code. NACs may approve a PR based on another NAC's approval after checking that it complies with the current Code. A NAC must be satisfied that the rules given in the above Appendix can be complied with before accepting a model for use. See other items on the IGC web page for PRs such as a specimen PR approval document.

a. OO procedures. Because PRs are not as secure as FRs, OOs should do all procedures and checks carefully. Study the PR-approval document for the type of PR concerned, which gives advice on pre- and after-flight procedures, downloading, and general security. Follow as much as possible the security check-ing steps pertaining to FRs given in para 10.1. The data should be checked to see that general conditions for the flight such as soaring altitudes reached, wind drift in thermals and speeds achieved, are similar to the known conditions of the flight. Independent data for the positions of take-off and landing is required either from an OO, or official Air Traffic or club log. These positions should closely compare with those recorded for take-off and landing in the .igc file.

b. Pilot procedures. Pilots are advised to retain the flight data in the PR memory as long as possible, so that in the event the OO has concerns about the flight, a further file download from the PR is still possible. They are also advised to ensure that independent evidence of take-off and landing is available.

6.2 PR .igc file format and testing. Because PRs are simpler than flight recorders, some non-vital data fields may not be present. Pressure altitude in the .igc file is to be recorded as zero unless it is derived from a pressure sensor (from which a calibration must be made following IGC procedures). The tests below should be shown in the PR files, and files from an FR should be included for comparison.

a. Analysis. The .igc file produced by the device should be capable of analysis by a recognised and public-ally or commercially available analysis program. The files sent to GFAC must be able to demonstrate this. The analysis program should be specified in the approval document.

b. Validation. The method of ensuring the integrity of the .igc file should be specified in the approval docu-ment, including details of the validation system that will identify any changes to the .igc format file made after the initial download. Any changes detected after initial download will invalidate the data. In this event, a further download should take place under close OO supervision and the .igc file analysed again.

c. Testing. The recommended testing process is to conduct a number of test runs to compare the device against an FR having "all flights" approval to see that there is no material difference in the results between them.

The GFAC test for "predicted" fixes should be carried out to ensure that the PR only records fixes and doesn't generate them (A3 of the Chap 4 Appendix refers). Drive a vehicle containing a PR over a well-marked 90 degree feature such as a road junction, to mark the feature on the .igc file. Where fix rate can be changed, a fast fix rate such as one per second should be used. The feature is then approached again at a high but safe speed. When nearly at the feature, the GPS antenna is disconnected or, for units with internal antennas, the PR antenna is covered so that GPS signals are blocked (for instance by metal foil used in cooking).

The .igc file must show that on the second run, no fixes were projected beyond the feature. In addition, the GPS fixes at the right angle (the drive with the antenna connected can be repeated several times) should be compared with the lat/long of the feature from Google Earth of the road or other junction, to demonstrate fix accuracy and that the WGS84 datum is used by the PR system.

The PR should be flown together with an FR and the data from the two .igc files compared. In particular, the shape of the GPS altitude graph with time should be relatively smooth with no "spikes" or other short-term variations.

d. Information for the GFAC. Before issuing an approval for a PR, NACs must send the GFAC chairman <ian@ukiws.demon.co.uk> the following information:

- the Internet link to the GPS unit operating manual,
- the proposed operating limitations,
- a copy of the download and .igc file validation,
- sample .igc files.

This will enable GFAC to provide the NAC with expert advice including information on the PR's IGC file structure and any SC3 requirement that may have been missed. The final approval data will be posted on the IGC GNSS web page for PRs.

**Flight Recorders & Position Recorders – OO Action**

9.1 Downloading the flight data file. The OO shall download the flight data file as soon as practicable after landing, especially if the pilot, glider, or task is to change for the next flight. If a laptop computer is available or the FR downloads directly to portable storage media such as a memory stick, the flight data may be down-loaded at the glider without disturbing the installation of the FR. If this cannot be done, the OO shall check and break any seal to the glider, and take the FR to a computer to download the flight data. When more than one FR is carried, each must be checked to ensure that the last declaration, either in the FR or written, applies to the flight. If the OO is not familiar with the actions required, the pilot or another person may download the data while the OO witnesses the process. Security is maintained by the coding embedded in the FR and in downloaded .igc files that can be independently checked later through the IGC Vali program (see para 6.3d).

a. Data download method. The method for each type of FR is given in its IGC approval document (6.3a) that is available at <www.fai.org/gliding/gnss>. The FR types, their manufacturers, IGC approval dates and a history of the use of GPS in IGC, are listed in:
< http://www.fai.org/gnss-recording-devices/igc-approved-flight-recorders >

b. IGC file name. An .igc file has the format "YMDCXXXF.IGC", where Y=year, M=month, D=day, C=manu-facturer, XXX=FR serial number, and F = flight number of the day (full key, Appendix 1 to the IGC Flight Recorder specification). Where an intermediate manufacturer's binary file is also produced, it will have the name YMDCSSSF.XXX, where XXX is the IGC 3-letter code for the FR manufacturer. Where numbers over 9 apply, such as in months and days, 10 is coded as A, 11 as B, etc. There is also a long file format with data in the same sequence, such as 2009-05-21-XXX-SSS-01.IGC.

9.2 Potential data download problems. Some programs other than the IGC download utilities are able to download data from FRs. but they might not produce files that will pass the Vali check. Also, some older FRs do not store separate .igc file header data for each flight but use the last data entered for previous .igc files in the FR memory. To minimise the possibility of corrupt or inaccurate files, use the IGC utilities. After downloading the .igc file, immediately check it with the Vali program. If there is a problem, go back to the FR and download again.

9.3 OO's copy of the data. A copy of the file(s) for the flight data – both the binary (if produced) and the .igc file(s) – shall be retained by the OO. The OO may keep the data files for the flight on any storage media that the pilot cannot access. The OO must be able to positively identify the flight data files as being from the flight concerned. These files shall be retained by the OO for later checking and analysis under the procedures of the authority validating the flight. Copies of all files must be forwarded by the OO to the validating authority, the OO keeping the original files. If the FR produces a binary file, a valid .igc file can be re-created from the binary – this can be critical if there is any difficulty with the .igc file first sent to the validating authority. The copies must be kept by the OO at least until the flight has been validated.

9.4 FR manufacturer's codes. The GFAC allocates both one- and three-letter codes to manufacturers of FRs. The current codes are in the table below. The one-letter code is used in the short .igc file name after the three characters for the date (ex: 967L is 2009, June, 7, LX Navigation). The 3-letter code is used in the long version of the file name above and also in the first line of the file itself. The definitive list is in the FR Specification document, App 1, para 2.5.6, see < http://www.fai.org/gnss-recording-devices/igc-approved-flight-recorders >

**Flight Recorders & Position Recorders - Data Analysis**

10.1 Security checking. The flight data downloaded by or under the supervision of an OO is the master file to be retained by the OO on memory media. Checking the security of the file is the first step in data analysis. This requires the appropriate software, available as "freeware" at the IGC website. With a successful security check, copies of the master file can be created for evaluation, and - to avoid confusion - saved in a location separate from the master file.

When a data file fails security, the cause could be a power surge during download, a download using software other than the IGC-approved freeware, the FR's internal security switch has been breached, or the data file was amended during or after flight. In most cases, as long as the original data file is still resident in FR memory, a fresh download can solve the problem, enabling claim review to proceed.

If a fresh download is not possible or it, too, fails security, the data file may be sent as an e-mail attachment to the National Claims Officer or the GFAC chairman at < ian@ukiws.demon.co.uk >. If the cause of the failure can be determined, the problem can in all likelihood be remedied for future flights. Although the flight can be evalu-ated, no badge or record can be claimed without a data file that passes the required security.

Note: badge or record evaluation must use an exact copy of the OO's master file, unchanged by any means. Using common analysis software, it is possible to change and save task information in an amended data file that will pass security. This can fool the casual reviewer, but is clearly shown in "L" records appearing at the end of the data file, after the "G" record.

10.2 OO support. At any time after the OO has checked data file security and verified that the data file is complete, the OO may request and receive help if needed to evaluate the flight. Specifically:

a. the OO may turn to another OO for help with common problems encountered during flight evaluation, or

b. the OO may seek help from a NAC-appointed Data Analyst. The DA need not be an OO or approve badge or record claims, but his or her technical expertise can be important for a detailed evaluation. In either case, see SC3-4.5.6d and 6e for details.

10.3 Flight evaluation software. In any flight evaluation software, a barograph presentation must be available showing both pressure and GPS altitude and, for motor gliders, MoP operation must be shown as part of the vertical data displayed. The automatic functions of evaluation programs (such as waypoint OZ presence and engine on/off thresholds) should be checked manually, inspecting the relevant data if there is any doubt whether the particular automatic function positively identifies the threshold concerned.

10.4 Evaluation of flight data. A GPS fix always has some uncertainty as described in Appendix 5 para 1.2 of this Annex. This uncertainty shall not be used for adjusting the likely place of a position fix for OZ validation purposes. A valid fix shall always be taken to be at the center of any such circle of uncertainty.

Flight data is to be examined as a whole, and all fixes (valid or otherwise) must be taken into account, particularly those in or near OZs. The data analyst approved by the NAC will then evaluate the flight. Analysis for flight vali-dation will be through a program approved by the relevant NAC - see the gliding/GNSS web site under "Software". A check of the rules and procedures by the OO include:

a. evidence of flight continuity and the shape of the flight course,
b. valid start and finish,
c. proof of presence in OZ (para 8.2 for fixes,
d. similarity of GPS and pressure altitude traces with time,
e. altitude difference and/or altitude penalty,
f. course distance and speed (SC3 rules),
g. electronic security (use of the Vali program).

When two FRs have recorded the flight, their ground tracks will appear nearly identical in analysis software, but the fixes recorded will not be absolutely identical since the antennas of the two FRs are not in the same location, they are not typically recording at exactly the same times, they may be accessing different satellites, and different model FRs may be using different algorithms to process data.

10.5 Data anomalies. In the event of an inconsistency, anomaly, or gap in the data, the NAC shall consult specialists in the field to determine if there is a satisfactory explanation, and whether the flight performance may be validated despite the anomaly. In the first instance, contact the chairman of GFAC and send the IGC and other files concerned. If in doubt, the original file downloaded from the FR should be used and the analysis pro-cess repeated. Try using a different program to analyse the .igc file, and also examine it in text format.

a. Complete loss of data. The OO or analyst should approach all interruptions of FR recordings with skeptical caution. If all FR data is lost for a period of time, other evidence must conclusively show that flight continuity was maintained and, in the case of a motor glider, that the MoP was not operated during the loss. The altitudes at beginning and end of the loss must be considered, together with other evidence such as a second FR or barograph. Without such evidence, validation should not be given when data inter-ruption is in excess of 5 minutes, and for motor gliders this period should not exceed 1 minute for pylon-mounted MoPs and 20 seconds for non-pylon mounted MoPs.

b. Breaks in fixes and missed fixes. Fix breaks or sidesteps should be investigated. Missed fixes are assessed in the same way as a break in the trace of a mechanical barograph; one must judge if the evidence of flight continuity remains incontrovertible. Analyse the time, altitude and position of the last and next valid data. Lack of any data for 5 minutes would not normally invalidate a flight, but lack of any data over 10 minutes would be questionable. In the case of an FR, pressure altitude data should continue to be recorded and prove flight continuity, although without fixes the evidence of presence in an OZ will be lost.

c. Spurious fixes. Spurious fixes may occur that show anomalous positions in a fix sequence, and must be ignored in OZ validation. The indication that a fix is spurious is a large change of position that cannot be explained by a likely change of ground speed. The diagram *(see page 17 of Annex C)* shows that they are easy to see, and reject for the purposes of flight validation. Possible factors are reduction of signal due to turning flight (when antenna alignment is off vertical), or errors induced by RF energy transmissions from the glider resulting from poor RF shielding in the cockpit.

**Barograph Calibration Procedure**

11.1 Initial setup. These calibration procedures also apply to PRs that can record pressure altitude.
*(If the PR concerned records Pressure Altitude, see the rest of para 11 in Annex C to the Code)*

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