Fédération
Aéronautique
Internationale

Section 3 – Gliding

Annex C
Official Observer & Pilot Guide

Maison du Sport International
Av. de Rhodanie 54
CH-1007 Lausanne
Switzerland
Tél. +41 (0)21 345 10 70
Fax +41 (0)21 345 10 77
E-mail: info@fai.org
Web: www.fai.org

2017 Edition

valid from 1 October 2017

FEDERATION AERONAUTIQUE INTERNATIONALE
MSI - Avenue de Rhodanie 54 – CH-1007 Lausanne – Switzerland

Rights to FAI international sporting events

All international sporting events organised wholly or partly under the rules of the Fédération Aéronautique Internationale (FAI) Sporting Code[1] are termed *FAI International Sporting Events*[2]. Under the FAI Statutes[3], FAI owns and controls all rights relating to FAI International Sporting Events. FAI Members[4] shall, within their national territories[5], enforce FAI ownership of FAI International Sporting Events and require them to be registered in the FAI Sporting Calendar[6].

An event organiser who wishes to exploit rights to any commercial activity at such events shall seek prior agreement with FAI. The rights owned by FAI which may, by agreement, be transferred to event organisers include, but are not limited to advertising at or for FAI events, use of the event name or logo for merchandising purposes and use of any sound, image, program and/or data, whether recorded electronically or otherwise or transmitted in real time. This includes specifically all rights to the use of any material, electronic or other, including software that forms part of any method or system for judging, scoring, performance evaluation or information utilised in any FAI International Sporting Event[7].

Each FAI Air Sport Commission[8] may negotiate agreements, with FAI Members or other entities authorised by the appropriate FAI Member, for the transfer of all or parts of the rights to any FAI International Sporting Event (except World Air Games events[9]) in the discipline[10], for which it is responsible[11] or waive the rights. Any such agreement or waiver, after approval by the appropriate Air Sport Commission President, shall be signed by FAI Officers[12].

Any person or legal entity that accepts responsibility for organising an FAI Sporting Event, whether or not by written agreement, in doing so also accepts the proprietary rights of FAI as stated above. Where no transfer of rights has been agreed in writing, FAI shall retain all rights to the event. Regardless of any agreement or transfer of rights, FAI shall have, free of charge for its own archival and/or promotional use, full access to any sound and/or visual images of any FAI Sporting Event. The FAI also reserves the right to arrange at its own expense for any and all parts of any event to be recorded.

1 FAI Statutes, ... Chapter 1, ... para. 1.6
2 FAI Sporting Code, Gen. Section, ... Chapter 4, ... para 4.1.2
3 FAI Statutes, ... Chapter 1, ... para 1.8.1
4 FAI Statutes, ... Chapter 2, ... para 2.1.1; 2.4.2; 2.5.2 and 2.7.2
5 FAI By-Laws, ... Chapter 1, ... para 1.2.1
6 FAI Statutes, ... Chapter 2, ... para 2.4.2.2.5
7 FAI By-Laws, ... Chapter 1, ... paras 1.2.2 to 1.2.5
8 FAI Statutes, ... Chapter 5, ... paras 5.1.1, 5.2, 5.2.3 and 5..2.3.3
9 FAI Sporting Code, Gen. Section, ... Chapter 4, ... para 4.1.5
10 FAI Sporting Code, Gen. Section, ... Chapter 2, ... para 2.2.
11 FAI Statutes, ... Chapter 5, ... para 5.2.3.3.7
12 FAI Statutes, ... Chapter 6, ... para 6.1.2.1.3

TABLE of CONTENTS


FIRST
X-COUNTRY

Official Observer & Pilot Guide

GENERAL

1.1 Purpose of this Annex The Annex has been prepared to assist pilots and Official Observers (OOs) to interpret the rules of the Sporting Code, gives guidance on how to comply with them, and recommends procedures for the operation of equipment used to provide evidence for flights. Changes to this Annex do not require formal IGC approval.

Although clarity and simplicity is the goal of the Sporting Code, how one is to respond to the requirements may be confusing. If you think that any part of the Code is capable of more than one interpretation, pass your concern to the IGC Sporting Code committee chairman at *igc-sporting-code@fai.org*. Suggested improvements to the text will always be given consideration.

A vertical line to the right of any paragraph indicates a notable change in the text from the previous Annex. The text may also contain minor changes to the wording that are not so marked.

1.2 The National Airsport Control (NAC) A NAC administers FAI air sports in its country. It may delegate to another organisation such as its national gliding association that part of its sporting powers. In the Code and this Annex, "NAC" means the NAC or its delegated organisation. Its responsibilities are to:

a. maintain control of its national Claims Officer, OOs, data analysts, and FR pressure calibration labs,

b. have final responsibility for the flight analysis process, integrity, and accuracy of data that it ratifies.

c. issue and maintain a list of position recorders (PRs) that it accepts or has tested (see A5-1.6), may hold a national turn point list, may modify IGC record forms to incorporate national-only record types, and maintain a badge claim form.

d. maintain registers of national badge leg, badge, record, and FAI diploma flight achievement.

e. transmit to the FAI data on completed Diamond badges and Diploma flights.

1.3 NAC recommended practices

a. *OO appointment and training* NACs should establish requirements for becoming an OO, such as holding a badge leg or having an association with the sport for some minimum time. It is useful to maintain guidance material, self-help tests, etc. to assist new OOs gain knowledge of the Code and allow experienced OOs to stay current on changes to the rules.

b. *OO control and tracking* As a minimum, each NAC should maintain a list of its current OOs and their contact information, enabling the distribution of information on changes to badge and record procedures or national factors that will influence badge and record flights.

c. *Preliminary review of claim* In the interest of efficient processing of record and badge claims, a NAC may allow specified persons to perform a "first look" review of e-mailed flight data and pertinent scanned documents, if any, such as a paper declaration. This preliminary review can be performed at the level of the Claims Officer or a NAC-appointed data analyst. Badge claims may also be pre-screened at the club level by an experienced OO, which can reduce a Claims Officer's workload by correcting errors in a claim form or not forwarding clearly invalid ones.

   A "first look" .igc file may be submitted soon after landing since an obvious problem may then be noted that could shorten or eliminate processing time and effort. However, this in no way substitutes for the submission of a complete claim package including the original of all recorded data, a completed application form, and each applicable certificate (see SC3-4.4.1).

d. *NAC jurisdiction* The relationship between an "organizing NAC" and a "controlling NAC" is given in SC3-4.1. A claim by a foreign pilot must be certified by the OO who has been approved in writing by the host country (controlling) NAC. The OO shall send the completed claim to the controlling NAC

for a check for compliance with national aeronautical rules who, in turn, will forward the claim to the organizing NAC.

A foreign OO wishing to ratify badge claims must apply to the host NAC for permission to act within its jurisdiction. Simple e-mail communication between the host NAC's National Claims Officer and the foreign OO is suggested. The host NAC may require some minimum level of local knowledge for approval.

e. *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.

1.4 Official Observer duties An Official Observer has the responsibility of being the FAI's "field representative". An OO ensures that the flight is controlled in accordance with Code requirements, and that the required evidence is gathered and prepared in such a manner that later study of it by a disinterested examiner (usually the national Claims Officer), will leave no doubt that the claimed achievement was met. The function of the OO is first, to verify that a pilot has completed what is claimed, and second, to certify that the claim satisfies the Code requirements for a given badge, diploma, or record.

The OO must act independently and without favour, and be familiar with the definitions in Chapter 1 of the Sporting Code. The ability to correctly interpret the Code is important – it is even more important for the OO to pay careful attention to detail and have the integrity to never approve a claim unless satisfied it is correct and complete. The OO can refer a claim to higher authority if there is some question that the flight does not fulfill the rules. The Code standards are the foundation of soaring achievement, so a rejected badge or record claim is a cautionary learning experience for the pilot.

***Note**: Even though references in this Annex are to "the OO", any number of OOs may be involved in the control of a given badge or record claim.*

1.5 A word on processing claims National Claims Officers and OO are encouraged to take the position that, while ensuring the Code rules are met, their goal is to award achievements, not reject claims for correctable errors that do not otherwise affect the proof of the soaring performance. However, such corrections only apply to Silver or Gold badge claims – pilot-input data in flight recorders is an example (see 6.5).

1.6 National records (SC3-3.0c) With the exception of a Continental record or a multi-place record claim, a World record must first be ratified as a national record. A NAC may have additional record types or classes and accept different forms of evidence for them; but a national record that leads to a claim for a world record must conform fully to the Code.

1.7 Measurement accuracy and precision

a. *Precision errors* Do not introduce more precision to a calculated value than the recording devices used can detect. A FR may record altitude values to the nearest metre, but its pressure sensor is not capable of resolving height to that precision, especially at high altitude. The reverse case is a sensor or processor that is more precise than its data readout; for example, a digital clock that displays time to the nearest minute while its internal counter is operating to the microsecond.

b. *Measurement accuracy* Badge claims are certified for performances that *exceed* a specified minimum, so the distance calculated by common flight analysis software is normally sufficient. If there is any question as to the distance meeting a badge requirement, then use the FAI World Distance Calculator below.

c. *Badge distance calculation* First, find the course distance by using evaluation software set to the WGS84 earth model or by calculating the sum of course "leg" distances, each determined by the FAI World Distance Calculator set to the WGS 84 earth model. This calculator may be used online or downloaded from *http://www.fai.org/how-to-set-a-record/121-cia/34839-world-distance-calculator*. Next, determine if a loss-of-height (LoH) and/or cylinder correction applies; if so, find their sum. Last, calculate the official distance = course distance – (LoH + cylinder corrections).

d. *Conversion factor misuse* Recorded values should be used in all intermediate calculations, but the final result must be rounded down to the precision of the *least accurate* data. A distance of "about 1100 feet" infers that it could be anywhere between 1050 and 1150 feet. Only the first three figures

are significant, therefore the phrase “about 1100 feet (335.3 metres)” is nonsensical. Such misuse is often seen on altitude gain claims. A conversion cannot add precision, so the example should be rounded off to 335m.

e. *Altitude accuracy* Dynamic pressure errors, errors associated with reading FR barograms, producing an air pressure calibration trace, and (if necessary) drawing a calibration graph – all these introduce uncertainty in the precise height achieved. This height *cannot* be accurate to the metre, regardless of the calculations. The resulting gain or absolute altitude value should be rounded down to the nearest 10 metres. If a second set of air pressure data was recorded, the worse case height reading is to be taken as the performance.

1.8 Responsibility for following flight regulations (SC3-4.4.2a) The pilot-in-command has the sole responsibility to follow general and local regulations as well as the glider’s technical limitations, and shall certify this for each claimed performance. A willful violation of air regulations is unsportsmanlike conduct. The OO must refuse to certify a claim that was performed illegally. The OO’s knowledge of local regulations is required to do this, and this is particularly important for OOs acting in a foreign country for pilots attempting records. The legal definition of “local sunset” is an example for record distance flights, for example. It is for this reason that the local NAC must approve OOs acting in their jurisdiction and process record claims from them (SC3-4.1b).

TASK CONSIDERATIONS

2.1 Pilot preparation The most valuable thing you can do to meet the requirements of a task is to carefully *prepare* for the intended flight. Lack of preparation may seriously delay or even cancel your planned flight, may result in the missing evidence that accounts for most rejected claims, and demonstrates a less than professional attitude towards your flying. Your preparation of *impeccable* evidence requires some care and time. Time is always in short supply on the morning of the big flight, so anticipate the day and plan for it during the off-season – this will go a long way towards your success.

a. Study the *current* Sporting Code to understand the requirements for the task (the Chapter 1 task table is particularly useful), and discuss your planned flight with the OO. On-Line-Contest rules *do not* apply. For example, a flight in which the OLC scores one of its legs as being over 50 km doesn‘t necessarily qualify as a Silver distance flight. Refer to the Appendix 2 documentation checklist also.

b. Be completely familiar with your flight recorder and the loading of the way point data. Practice with the recorder on local flights before trusting yourself to use it correctly for a badge flight.

c. Have only the *current* badge, record, and other flight forms on hand. Store all tyour task-planning documents in a separate folder and keep it handy. World record forms are available on the IGC site.

d. Plan several tasks for different meteorological conditions and have them loaded in your FR or available on your computer. Finally, prepare and *use* a task checklist – see Appendix 7.

2.2 The Silver distance flight The Silver distance is the “leaving the nest” adventure, intended to get you away from your home airfield, to navigate, and to plan for a potential landout. The “no-help-or-guidance” note in SC3-2.2.1a applies, meaning even help from other Silver distance hopefuls that day, or team flying. Historically, the Silver distance required a landing 50 km or more away from the home airfield, later a photograph of a turn point at least 50 km away was possible. Now, any finish fix at least 50 km from your release point or MoP stop satisfies the requirement, *regardless of any other turn points that may be declared, or the success or not of a greater task.* If the Loss of Height between release and the selected finish fix is excessive (see SC3-2.4.4b), then choose another fix that is within limits.

2.3 The Silver duration flight The duration flight does not require a release certificate signed by the tow pilot or winch operator, and there is no longer a loss of height restriction either. If you are planning a duration flight and there is no FR/PR on board, make sure that your OO is aware of this so that the flight can be regularly observed.

The large problems associated with the Silver duration flight are:

a. *Boredom* Boredom causes loss of concentration and thermalling skills. Set a series of “mini-tasks” for yourself: an efficient climb, using every bit of some weak lift, a series of 10 km goal flights, etc.

b. *Reluctance to fly away from the field* You cannot stay up if you don't go to the lift. Fly 10 km from the field – your glider can go that far. Then get high and stay high.

c. *A full bladder or dehydration* This is *not* a choice; do not allow yourself to become dehydrated to avoid the distraction of a full bladder. If you feel thirsty, you have waited too long to drink and are already dehydrated. Drink an excess of fluid first thing in the morning to become fully hydrated then empty your bladder shortly before take-off. Fully hydrating before flight will delay the need for fluids. Carry sufficient water for the temperature conditions and have and use a workable method of urine disposal.

2.4 The 3TP distance task This task allows several options in both the declaration of the way points and how they may be used during your flight. This is a good task for a Silver or Gold attempt – using either one of two turn points more than 50 km away is a popular option, with start and finish being the home airfield. You can then choose the better turn point to go to during the flight. If all the TPs are flown in the declared sequence and the start and finish points are identical, a triangle distance or speed task can also be claimed. See 3.2 for an example on how the loss-of-height limit applies to a Silver distance flight. A maximum of five way points may be declared:

a. A start point and a finish point. The start point may also be used as a turn point if it is declared as such. The release or MoP stop may also be the start point if the task is undeclared.

b. One, two, or three turn points, achievable in any order, allowing up to four legs to be summed for total distance. A TP may be repeated but it must be listed a second time on the declaration (a double O&R task, for example, although this is not allowed for a Diamond Goal task). A single TP might be claimed for a "dog-leg" course, or for a failed out-and-return course that was not correctly closed. At least one TP must be achieved otherwise only Straight Distance can be claimed.

2.5 Loss of height & cylinder OZ considerations

a. When planning a task course, always be aware of the max LoH you can incur before it nullifies the badge or record attempt. More detail is given in 4.5.

b. Even though you achieve a declared turn point, there is no requirement to claim it. You may ignore the last TP and claim the best finish fix instead if the landing is within the cylinder.

c. If cylinder corrections and any LoH adjustment amount to more than the last leg distance achieved, the pilot may still do better to ignore the last TP and claim the best finish fix instead.)

d. If the pilot exits the cylinder and proceeds 90 degrees or more from the declared last leg heading: *the radically changed outbound course line at the last TP changes sector orientation there.* In this case, the pilot may find that a cylinder penalty no longer applies at the last declared TP when claiming the best finish fix.

e. Do not assume that the loss of height value calculated by common flight analysis software is accurate. (Other software analysis problems are described in 10.8.) If an excessive LoH is indicated, examine closely the waypoint fixes selected by the software. *Manual selection of waypoint(s) for a free distance task claim could eliminate a LoH problem.*

2.6 Common badge flight errors OOs reject many claims as a result of common errors on badge flights. Here are some flight preparation or execution factors that can result in your claim failing:

a. You flew it with no planning, and then expected that the OO would find a way after the flight to make it fit the badge requirements.

b. You did not get a briefing on the usual task pitfalls *before* you attempted a specific task.

c. You did not complete an Internet or paper declaration when using a PR for a distance flight.

d. You did not know the maximum height you could be towed to on an under-100 km distance task. This is particularly important if the landing may be at a lower elevation than your take-off point.

e. You are a beginner in the use of the FR and did not practice using it to make sure you got into the OZ of your intended TP, or your FR was configured to sound a TP entry alert for a cylinder OZ, so you turned away on course before you entered the sector OZ that was needed for your task distance.

f. You did not confirm that the FR(s) being used on your flight had your name and the correct glider information stored. Refer to 6.5 for problems in changing this data.

g. The OO was not available on landing so you took the FR out of the glider and gave it to him later that day. (See para 9.1 – the OO *must* have control of the FR after landing until the flight data is downloaded.) This mistake is easy to make if the glider is a club ship that is to be used for another task.

h. Your OO did not keep a copy of the flight file and the original was contaminated in the process of converting it to an .igc file using *SeeYou*, for example. (A file stored on the OLC site will *not* validate.)

2.7 Notes on declarations If you are new to flight recorders in general or to a particular FR or linked device, make some practice flights before a badge attempt; it is the best way to avoid declaration problems. Even if you have no intention to claim a task, enter a declaration each time you fly, and check it carefully post-flight to make sure the correct data appears where it belongs in the .igc file. However, if there is an error in the pilot-entered data, the instruction in 6.5 can be applied. The structure of FR declarations is described in 6.4. Consider the following:

a. A declaration is not required for duration or height claims when the OO certifies basic pilot and glider data (SC3-4.4.1c), and a declaration does not need to be witnessed by the OO (see 6.4).

b. It is now common for more than one device capable of acting as an FR to be installed in the glider, even though it may not be its primary use, a FLARM for example. It is also possible that a pilot may not be aware of what devices in a club ship can act as FRs. Therefore, prior to a flight for a badge or record claim, the pilot must specify to the OO what units are to be used and contain the flight declaration. *Only these unit(s) inspected (controlled) by the OO before the flight are used in the claim (SC3-2.2.6 or 3.2.2)*.

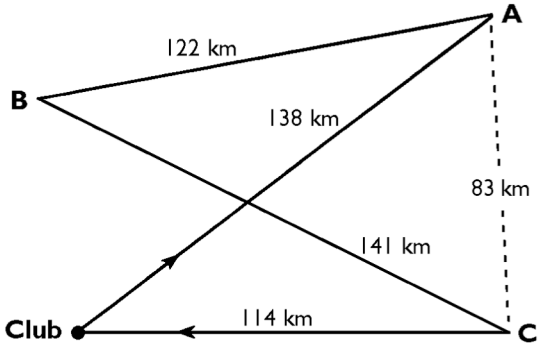
c. When more than one FR/PR installed in the glider is to be used, the task declaration (except for the recorded time of declaration) must be identical in each. Any difference in the declaration between FRs could be grounds for refusing the claim.

d. A pilot using an FR/flight computer system may be rushed before take-off and confuse its "declaration" and "navigation" functions. If you wish to make a last minute change to a badge task, writing a new Internet or paper declaration will avoid possible FR data input errors. Note the timing warning in para 6.4a. An Internet or paper declaration is always required when using a PR, but an FR is the *only* acceptable means of data entry for record attempts.

e. Compatibility problems can arise between an FR linked to a third-party PDA or flight computer. The end result may be a flawed declaration, and it could be difficult or impossible to determine whether the FR, the software, or user procedures are responsible. If a flawed declaration appears to be due to a fault or anomaly in the FR, report it promptly to the GFAC chairman at ian@ukiws.demon.co.uk.

2.8 Internet declarations (SC3-2.3.1) An internet declaration is an alternative to a paper declaration for badges. The NAC may accept declarations sent via internet, either by e-mail or to a NAC-approved website. The OO must be satisfied that the declaration is valid by inspecting its time stamp. The time stamping added by servers can be checked in e-mail headers or server logs. Any solution chosen by the NAC or OO should clearly show the declaration time stamp. Note that e-mail headers contain several time stamps from each server accessed; they should be checked to select the correct one. Date and time shown next to the sender/subject in e-mail readers is not to be trusted.

2.9 Claiming more than one soaring performance A flight may satisfy the requirements for more than one badge leg or record, and claiming a declared task does not prevent the pilot from also claiming straight distance from release to a finish fix. Planning a task begins with the selection of turn points that accomplish your chief objective but also provides for an alternate or additional claim. This may also allow you to make very useful in-flight decisions on course selection. Examine the course shown here (club/A/B/C/club). If this declared flight is completed, the following badge tasks can be claimed:



a. *Silver distance* – 138 km (club/A)
If the pilot abandoned this flight more than 50 km from the club, Silver distance is still achieved by claiming straight distance from release to a finish fix at the furthest point from the club.

b. *Diamond Goal distance* – 346 km (A/B/C/A)
Note that the A-club-C legs indirectly complete the A-C leg of the ABC triangle. If the task is flown in the reverse direction, it would meet the 3TP distance requirements, but not the Diamond Goal.

c. *Diamond distance* – 515 km (club/A/B/C/club)

2.10 Abandoned turn points and other declared task problems A failed declared task might still fulfill the requirements of another soaring performance – so rather than focusing on the failure, look for what might have been achieved. For example, a free record may be possible if any declared way point had been missed. A flawed Goal Distance record attempt can be evaluated as Straight Distance for badge or Diploma purposes. A 3TP Distance flight is a viable task in its own right or when claimed as a result of a declared closed course being marred by one or more of the following problems:

a. any number of the declared turn points were achieved, but not in declared order.

b. the start and/or finish for an intended closed course was not achieved as required by SC3-1.3.1a or 1.3.2b.

c. the declared start and finish points were achieved, but yield a disqualifying loss of height correction (a start at release and/or a finish at a finish fix will often solve this problem).

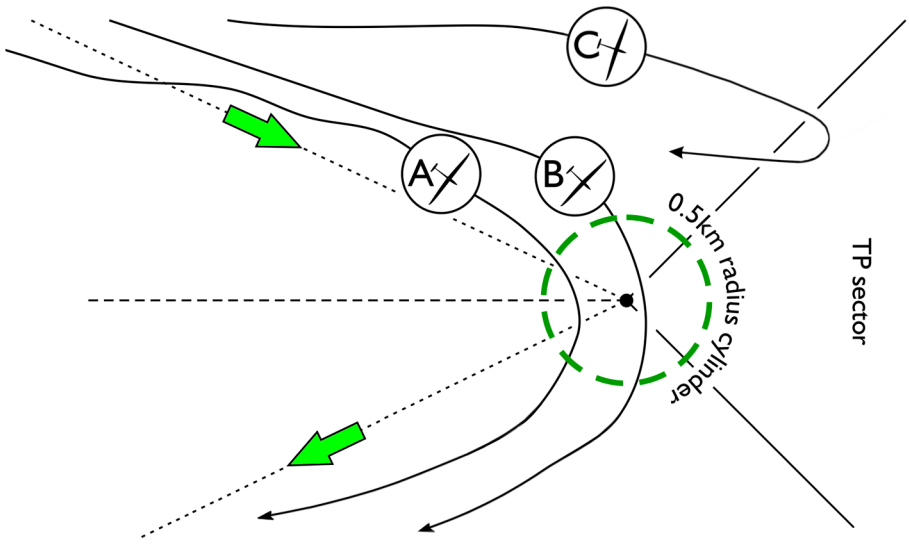
2.11 Limit on declared TPs You cannot have more TPs declared than the claimed task requires. For example, an Out-and-Return task must have only one declared TP, and a Goal Distance task must have none – and neither task can be claimed from a portion of a triangle or 3TP course. The Task Table at the end of Chapter 1 of the Code will assist your planning.

2.12 Turn point observation zones A TP is achieved only when the pilot enters its observation zone. You can use either the cylinder or the FAI sector OZ at each declared TP as the flight situation warrants, OZ type is not a declaration input. Remember that the FAI sector OZ has an unlimited radius, so it is important to check for entry if you are far from the declared location of the TP. The cylinder OZ may have some advantages over the sector given that only distance from the turn point is a factor (not bearing or direction also) – but this OZ could severely limit a pilot's opportunity to achieve a TP if it were under poor weather, for example. Consider the three tracks into a turn point in the below diagram:

a. Pilot A enters the cylinder OZ and must accept a 1 km distance correction at this turn point.

b. Pilot B also records points within the sector OZ so there is no reduction to the leg length.

c. Pilot C makes a quick turn just after entering the sector OZ. Remember, you can fly into a sector OZ without actually going around the TP; this is very useful feature of the sector OZ if the weather is not soarable near the TP.



2.13 Free record flights (SC3-3.1.5) Declared waypoints are not required for these distance tasks, but are not excluded either. A normal declaration is still made before the flight that includes the pilot's name and glider information. The pilot is free to fly anywhere between take-off and landing and, after the flight, select fixes from the position data to be the way points claimed for the soaring performance. However, it is a common tactic to claim fixes just past the turn points of a suitable declared task, and claim two records for the same flight. See 4.5 for details on selecting fixes.

HEIGHT FACTORS

3.1 Height correction – distance flights over 100 km (SC3-2.4.4a) For these flights, an adjustment to the claimed distance is applied if the LoH exceeds 1000 metres in order that there is no benefit to starting a task with excess height. A correction of 100 times the excess LoH must be subtracted from the achieved course distance. If the LoH on your flight was 1157m, then the distance flown is reduced by 100 times 157m or 15.7 km. Note that the official distance for the course might also have a cylinder OZ correction(s) applied per SC3-1.3.6.

3.2 The 1% rule – height loss for tasks less than 100 km (SC3-2.4.4b) For distance flights less than 100 km, the maximum LoH using pressure data cannot be more than 1**%** of the distance flown or [1% of the distance less 100m] using GPS height data. *No margin is allowed* – any excess will invalidate the flight. Be especially aware of this when the finish point or the possibility of landing is at a lower elevation than the start. A Silver badge distance flight that is exactly 50 km from the release can have a LoH of no more than 500m and so on up to 1000m for a 100 km flight. For pilots using altimeters that display altitude in feet, Table A will assist in determining the maximum LoH allowed.

TABLE A Maximum barometric height losses for distances less than 100 km

km	*ft*	*km*	*ft*	*km*	*ft*	*km*	*ft*	*km*	*ft*
50	1640	60	1968	70	2296	80	2624	90	2952
52	1706	62	2034	72	2362	82	2690	92	3018
54	1771	64	2099	74	2427	84	2755	94	3083
56	1837	66	2165	76	2493	86	2821	96	3149
58	1902	68	2230	78	2559	88	2887	98	3215

3.3 Height measurement using PR evidence Some GPS units can record both pressure and GPS altitude. If pressure altitude is not recorded, GPS height from a PR is sufficient for Silver and Gold badge claims provided that there is a margin of 100m over the required gain of height for Silver and Gold altitude, and 100m under the LoH for Silver and Gold distance and duration claims. A Gold altitude claim would require a GPS height gain of at least 3100m, and a 65 km flight would require a loss of GPS height of no more than ([65 km x 1**%**] – 100m) or 550m. For pilots using altimeters that display altitude in feet, refer to Table A and subtract an additional 328 feet to determine the maximum LoH when GPS height evidence is used.

Note: even if a PR does have a pressure sensor incorporated, it is not required to be used for altitude evidence – GPS height may be used with the added 100m margin included. This allows a PR to be used if it is equipped with a pressure sensor for which there is no valid calibration, or an FR if it is out of calibration.

3.4 Correcting altitude data for instrument error When FR calibration is done numerically, linear interpolation may be used to correct for instrument error and the result is "calibrated pressure altitude." In the example below, 492 feet (150m) was recorded by the FR before take-off where the site elevation is actually 798 feet msl (243m).

Metric units

Lab altitude	FR altitude
0	30
X	**150**
609	641

X = 609 – (641-150) • ((609-0)/(641-30))
= 120 metres

English units

Lab altitude	FR altitude
0	98
X	**492**
2000	2100

X = 2000 – (2100-492) • ((2000-0)/(2100-98))
= 394 feet

The same method can be applied to FR-recorded altitudes at release, start, low point, high point, and finish, but if the pre- and post-flight baseline data points differ from actual field elevation(s) by more than 30m (100 feet), it would be preferable to calculate absolute altitudes following the guidance in 3.5 below.

3.5 Measurement of altitude – the pressure correction formula (SC3-3.4.3)

This correction is required to determine the specific altitude for a fix. FRs record altitude values referenced to the standard ISA pressure of 1013.25 hPa (29.92 "Hg). You need to find reference pressure at your selected flight fix, but as pressure changes constantly over time and distance, this is practically impossible, so the closest possible approximation shall be used. If the fix is close to takeoff or landing, values from respective ground baselines are good choice. In other cases, an “educated guess” should be performed using all data available, especially synoptic maps and pressure logs from nearby stations. This information should be copied right after the flight was performed, as it might be difficult to obtain it weeks later.

Establishing the correction value is easier when using the atmospheric pressure ground baseline at a known elevation – no conversion from height to pressure is required. First, apply the instrument error correction to the baseline value (see 3.5). Then calculate the correction:

pressure correction [m] = known elevation [m] – calibrated pressure baseline altitude from FR [m]

If raw pressure values are used, convert them to height units. A pressure lapse rate of 1 hPa per 9m is acceptable for elevations up to 1000m (or 1"Hg / 1000 ft). So, if the QNH is 1020, the correction would then be:

(1020 – 1013.25) x 9 = 61m (and the value is negative if the QNH is less than standard ISA pressure). However, it’s better to use official ISA calculators or tables:

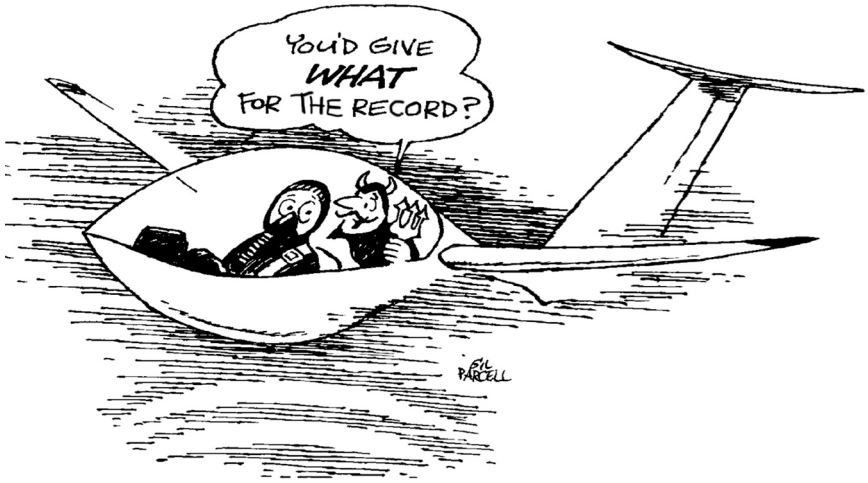
pressure correction [m] = known ground pressure reduced to sea level (QNH) in hPa – (1013.25 x ISA pressure lapse rate)

Finally, to calculate corrected altitude for the fix in question, apply both the instrument error correction as in 3.5 above and the pressure correction to the raw altitude value from the FR:

altitude [m] = calibrated pressure altitude from FR [m] + pressure correction [m]

3.6 Checking FR file output Pilots should check the .igc files from their flight recorders before making a flight for which a claim might be made to ensure that they comply with IGC rules and procedures and that file recording is not flawed. For example, there have been cases where, due to poor antenna position or performance, altitude dropout has occurred while Lat/long recording continued. A high-gain GPS antenna should be used and its position in the cockpit and cabling to recorders should be checked (see 7.2). Pilots are advised to carry more than one fully tested FR when making record attempts.

3.7 High altitude flight recorders (HAFRs) HAFRs are special FRs designed for use above 15,000 metres where GPS altitude evidence is used rather than pressure altitude, which has progressively lower resolution at such high altitudes. The use of HAFRs and data handling is described in Appendix 6.



START and FINISH CONSIDERATIONS

4.1 Start and finish parameters The start and finish each have three associated parameters:

The start position is where the release or stopping the MoP took place or is the declared start point. It is used in calculating the task distance.	*The finish position* is where the landing or restarting the MoP took place, the declared finish line is crossed, or a virtual finish point fix is selected. It is used in calculating the task distance.
The start time is the actual time of release or MoP shut down, or on crossing the start line, or the time at a fix selected as a start.	*The finish time* is the actual time of landing or MoP restart, crossing the finish line, or the time of a claimed finish fix.
The start height is measured at the same place as the start time.	*The finish height* is measured at the same place as the finish time.

4.2 Start and finish options The start and finish of a badge or record flight are the places where mistakes may occur because of the several alternatives available. The start holds much potential for error or miscalculation of position or height that could negate the remainder of the flight. The Code gives several choices for starting (SC3-1.3.1) and finishing (SC3-1.3.2). See also the Task Table at the end of SC3 Chapter 1.

a. The lack of a clear low point following the launch could result in a claim being denied or heavily penalized due to uncertainty in determining a Loss of Height (LoH) for the task. This is usually not a problem with a winch launch or stopping an engine. For an aerotow, make a brisk turn immediately after release. For a tow to wave, make a rapid turn or a quick descent for a time long enough for it to register on your FR/PR (at least 2 or 3 data points).

b. Start and finish line crossings are required for a distance to a goal flight, or at the single start/finish point declared for a closed course including Diamond goal, an out & return, and a triangle speed or distance record flight. Note that the finish line is perpendicular to the finish leg so it may be rotated with respect to the start line. When any of the above courses is declared but no turn point is rounded, straight distance may be claimed using a start at release, followed by any type of finish.

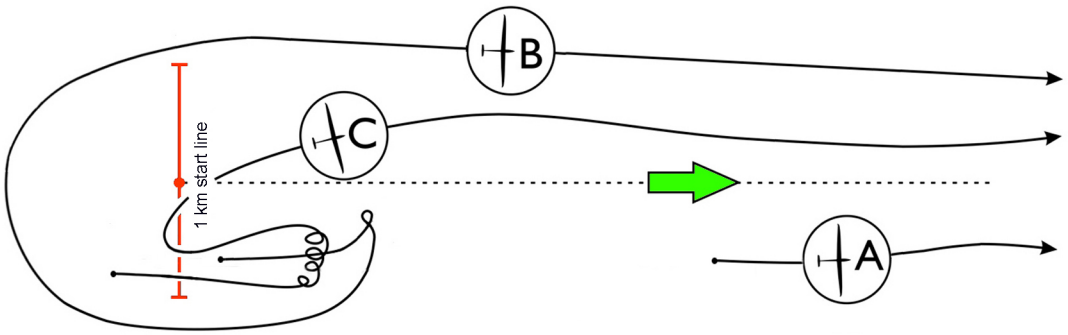
c. You *must* be aware of how much LoH between start and finish you can have before your planned task fails due to an LoH correction. Review the 1% rule at 3.2 when the task is less than 100 km.

4.3 Starting examples

a. Pilot A is towed about 2 km down track and releases. Straight distance for a badge or any free distance for a record can be claimed.

b. Pilot B releases, climbs and then goes back behind the start line but does not cross it when heading out on course. The declared start point cannot be claimed, therefore only straight distance or free distance tasks can be claimed from the release point.

c. Pilot C releases and crosses the start line, but decides his height is insufficient, so climbs then starts again. He can claim any task completed, and claims the last crossing as the start time.



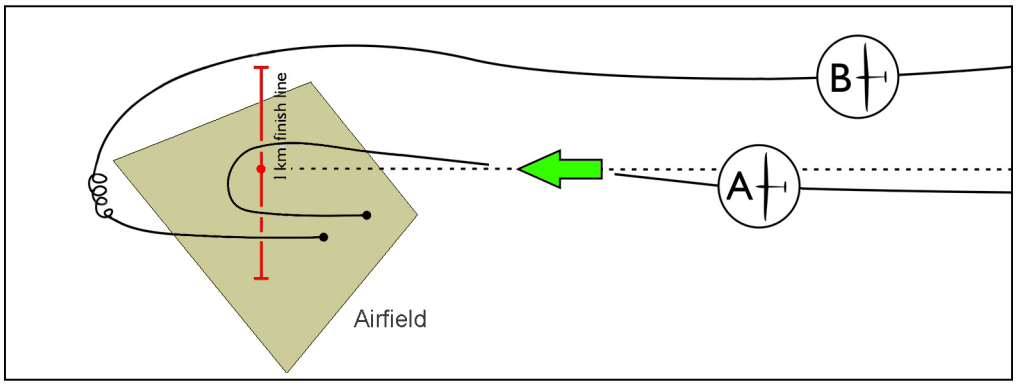
4.4 Finishing examples

The finish line can be crossed more than once. Cross again if you were low the first time and would suffer an unacceptable loss of height correction for a distance task or invalidate a speed task. It is useful to have

a finish point at the approach end of your planned landing field or at the intersection of two runways so that the line can be crossed on a straight-in landing if that became necessary. In the diagram below:

a. Pilot A crosses the finish line correctly. The point he crosses the line is his finish position and height.

b. Pilot B crosses to the right of the finish line, thermalled (see virtual finish below), then crosses the finish line again to land, but from the wrong direction. Pilot B has not completed his declared finish, but the finish point could be a fix selected at some point behind the finish line.



4.5 Virtual finish A fix may be selected post-flight from the FR data as an in-flight finish point. A virtual finish allows the pilot to:

a. use the same loss-of-height calculation for a distance flight in a pure glider as a motor glider that re-starts its MoP (then the pure glider is not constrained to land in order to finish).

b. claim a finish fix that will minimize or eliminate a LoH correction.

c. attain a valid finish then, for safety or convenience, land elsewhere.

To use a virtual finish effectively, you must plan that it may be needed. For example, you may climb to any height before starting to allow for a safe height for an early departure on a task, but you will then need to determine the lowest finish altitude that will incur no penalty. Similarly, if you are too low at the finish of a task that allows for little or no LoH correction to be required, you may climb after crossing the finish line until the LoH from the start drops to an acceptable value and then cross the finish line again.

PRESSURE ALTITUDE EVIDENCE

5.1 Pressure data The pressure altitude function of an FR records air pressure against time and is required for all badge and record flights except for duration flights under observation. All FRs record air pressure (Appendix 5, para 1.5 refers) as well as some PRs. It can provide the following data:

a. *Altitude* The air pressure data can be used to establish height, subject to the inherent errors noted in 1.7e and corrections described in 3.5, calibrated to the ICAO International Standard Atmosphere (ISA) – see chapter 11. However, calibration traces are usually recorded directly in height, making this conversion unnecessary.

b. *Continuity* The pressure data will show that the recorded task is a single flight.

c. *Duration* The pressure data may be used to determine the duration of a flight when no OO has witnessed the landing.

5.2 Calibration requirements Altitude and height gain claims require calibration data to the ICAO ISA to be applied to the critical altitudes in the soaring performance concerned. Speed or distance claims need calibration data for calculating the altitude difference of the glider at the start and finish points. Also, the NAC or FAI may wish to compare pressure altitudes recorded on the FR at take-off and landing with atmospheric pressures (QNH) recorded by a local meteorological office at the time of the flight. Pilots are advised to have a calibration carried out as given by the manufacturer or a NAC-approved calibrator before an FR is used on a record or badge flight. The .igc file of the calibration must be retained.

a. *Pressure units* The metric unit used in measuring atmospheric pressure is the hectopascal (hPa), and is numerically the same in millibars (mb). Inches of mercury ("Hg) are also used. Calibrations

must be to the ISA standard (15°C and 760 mm (29.92 "Hg) or 1013.25 hPa/mb at sea level; above sea level, a constant temperature lapse rate of 6.5°C per 1000m (2°C / 3.6°F per 1000 feet) to an altitude of 11,000m, above which the ISA assumes a constant temperature of -56.5°C).

b. *Equipment accuracy* Calibration equipment must be capable of holding the pressure in a vacuum chamber steady within 0.35 hPa for about 2 minutes, and overall accuracy of the pressure measureing equipment should be within 0.70 hPa after taking temperature and other corrections into account.

c. *Calibration period* The required calibration period is given in SC3-2.5.2 or 3.4.2. If pressure data is being used only to prove flight continuity (such as for a distance or duration claim), the FR pressure function does not have to be in calibration. Calibration *is* required if the start height or release height has to be verified.

POSITION RECORDERS and IGC-APPROVED FLIGHT RECORDERS

6.1 Flight Recorder and Position Recorder documents All official documents related to FR or PRs are on the IGC Flight Recorder Approval Committee (GFAC) website, *www.ukiws.demon.co.uk/GFAC/*

6.2 Position Recorders (PRs) This type of recorder may be used for height and position evidence for Silver and Gold badges in accordance with the SC3-2.6. Each type of PR must be individually approved by a NAC through a PR-approval document. A NAC must be satisfied that a PR complies with the Code before accepting a model for use based on another NAC's approval. A method for testing a PR by a NAC for its approval is given in Appendix 5-1.6. Approval documents shall include any operating limitations needed to enable a given unit to conform to the Code. See other items on the IGC web page for PRs such as a specimen PR approval document.

a. *OO procedures* As PRs are not as secure as FRs, OOs should do all procedures and checks carefully. Study the PR's approval document, which gives advice on pre- and after-flight procedures, downloading, and general security. Follow as much as possible the security checking steps pertaining to FRs given in 10.2. 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 the OO, or an official Air Traffic Controller, or club flight operations log. These positions should closely compare with the positions 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 a further file download is still possible if the OO has concerns about the flight. Pilots should also ensure that independent evidence of take-off and landing is available.

6.3 Flight recorders (FRs) The principles and technology related to the GPS system on which flight recorders operate is outlined in Appendix 5. Full details of the IGC-approval process for FRs is in Chapter 1 of Annex B to the Sporting Code on the IGC GFAC web site.

a. *IGC-approval documents* An FR must be operated in accordance with its IGC-approval (Appendix 5, para 1.3). Pilots should obtain a copy for the FR they use, and study it and any user manual from the manufacturer before flights that will need to be officially validated. Notice of initial issue or amendments to existing IGC-approvals is posted on the <*rec.aviation.soaring*> newsgroup and on the e-mail mailing list *igc-discuss@fai.org*.

b. *IGC flight data file* Data is in a file with a ".igc" suffix. The .igc file format is in Appendix 1 to the FAI/IGC document, *Technical Specification for IGC-approved GNSS Flight Recorders* on the IGC GFAC web site. An .igc file uses ASCII text characters and can be viewed with any text editor, for instance to check the data that was input for the declaration.

c. *Downloading* Transferring data after a flight is either to a computer or, with some FRs, direct to a storage device such as a memory stick or card. Downloading to a computer should use the FR manufacturer's IGC-XXX.DLL file together with the IGC Shell program (XXX is the 3-letter code for the FR manufacturer). Both files are freeware and available from the IGC GFAC web site, as is the FR manufacturer's short program files for older recorders that have no DLL file. Use the file *data-xxx.exe* for downloading, or for some recorders that download initially in binary format, *conv-xxx.exe* for converting from binary to the .igc format.

d. *Validation of .igc files* The IGC electronic validation system ("Vali") checks .igc files for integrity. The Vali check ensures that the .igc file has originated from a serviceable and sealed FR and that it is *exactly* the same as downloaded – if just one data character is changed, the check will fail. The check is made by using the Vali function of the IGC Shell program together with the FR manufacturer's IGC-XXX.DLL file in the same directory (see c above). For older recorders where there is no DLL file, the FR short program file *vali-xxx.exe* carries out the Vali function.

6.4 Flight recorder declarations (SC3-2.3 & 3.2) Flight recorders have the facility to enter the data required for a flight declaration; this appears in the .igc file. Since FRs have both physical and electronic security (Appendix 5, para 1.4) and an accurate real-time clock, the declaration does not need to be witnessed by the OO. An FR declaration can be updated by a later one, or by a subsequent paper / internet declaration for badge flights.

a. *Way point declaration* An .igc file stores waypoint location on lines that start with the letter C (the C-record). Where the FR has this capability and the pilot has entered such data, the date/time that the way points were declared is shown in the first line of the C-record.

WARNING *Some older types of FRs store the latest turn-on time as the waypoint declaration time. If these FRs are switched on after a paper/internet declaration has been made, the declaration in the FR becomes the "latest" one again – nullifying the written one. If you are making a last minute paper/internet declaration and you are unsure how the FR acts, ensure that the FR is ON at the time.*

b. *The "A" record* The first line of an IGC file begins with an "A", followed by a three-character code for the recorder manufacturer, followed by the recorder's serial number. The A-record in its entirety can be seen when the IGC file is viewed in text format.

WARNING *When the "A" is followed immediately by an "X", this indicates either:*
- *FR recorded data was amended and saved using software not subject to IGC approval, or*
- *a PR was used, in which case a written declaration is required (SC3-2.3.1a).*

c. *The header record* The remainder of the declaration data is in the H (Header) record that starts on the second line of the .igc file. H-record lines that list information on components within the FR begin with "HF" and cannot be altered. The line beginning with "HFPLT" lists the pilot name; in newer FRs a line beginning with "HFCM2" is provided for the name of a crew member. The lines beginning with "HFGTY" and "HFGID" are for glider type and identification, respectively. If two pilots are aboard for a record claim, but an FR provides only one line for both names, enter the name of both pilots, shortening each as necessary.

A few older recorders allow H-record pilot and aircraft data to be entered *after* the flight. These lines start with the letters HO (for OO entries) or HP (for pilot entries) and will not cause the data file to fail the Vali check (6.3d above). Therefore, all data files must be reviewed by analysis software and in text format, all H-record data required for declarations must appear in lines that start with the letters HF (*not* with any that start HO or HP), and the .igc file must pass the Vali check.

WARNING *The HO and HP issue described above can result from transferring declaration data to an FR using a device and/or software not subject to IGC approval. Test as needed to make sure any such device and software are compatible with the FR in use.*

6.5 Pilot and glider data Pilot and glider data *must* be correct in all certificates and FRs used for a record claim. Pilot and glider data stored in a PR or FR is not definitive until confirmed by the OO from independent evidence taken at take-off and landing. Pilot name and/or glider information input errors are made even by experienced pilots with their own gliders and FRs.

WARNING *Many FR manufacturers provide for entering pilot name(s) and aircraft data using "set-up" procedures that are completely separate from those used to declare the task … and in many cases, accessing the "set up" menu is not at all intuitive.*

If indisputable evidence for the actual pilot and the glider flown is available, the correct data may be certified by the OO per SC3-4.4.1. Such correction is limited to Silver and Gold badge claims. Such certification is expected to be of an exceptional nature; it should not become "standard practice" for pilots by OOs. The OO is not *required* to certify such a claim.

6.6 Sampling rate (SC3-2.5.3a & 3.5.5a) The GPS sampling rate is set in the set-up menu of the FR. As modern FRs have abundant memory, using a setting of 4-5 seconds allows a good presentation of the track for analysis purposes. As a normal thermal turn takes about 20 seconds, setting the sampling rate to 4 or 5 seconds will have turns appearing square to pentagonal in the graphical output of a flight, making turns reasonably clear and allow examining them for consistent thermalling technique.

Most FRs also provide for the selection of a short interval for use near waypoints. This is done automatically in some FRs, or after pressing the Pilot Event (PEV). A fast-fix interval of 1 or 2 seconds is recommended to ensure that a fix is recorded within an OZ.

6.7 Missed fixes Some fixes may be missed or be assessed as spurious (see 10.7 for a description of anomalies). Where valid position data does not appear in the recording, the fixes must show pressure altitude to prove flight continuity. Missed fixes from an otherwise continuous trace that lowers the actual sampling rate to less than once per minute (for example, because of short term attitude or GPS system anomalies) is normally acceptable provided that an intermediate landing and take-off was not possible.

FLIGHT RECORDERS – INSTALLATION

7.1 Installing the FR in the glider Following the installation guidelines should avoid the more common problems, but there is no substitute for testing your installation before attempting a flight that might have to be claimed and validated to IGC standards. Any limitations or conditions for a FR or PR installation will be given in its approval document. For flight safety, the position of displays and operating buttons and controls (including switching by touch screens) used in single seat gliders should be close to sight lines used for pilot lookout and scan for other aircraft.

a. *Connection to ports and antenna* Approval documents generally do not require the sealing of any ports, plugs, or cable connections. If the FR is connected to the static port tubing (where allowed by its IGC approval) the OO should ensure that there are no connections in the tubing that could allow alteration of the static pressure and thereby give a false air pressure reading.

b. *FRs using Environmental Noise Level (ENL) or MoP equipment* The FR must be so placed that engine noise or, for MoP recorders, other data indicating engine use, is clearly received when the engine is producing thrust. The FR should not be covered or insulated, even if automatic gain would continue to ensure high ENL or MoP readings under power.

7.2 Antenna placement Look carefully at the instructions for fitting and placing the antenna in the specification for the flight recorder and, if necessary, the specification for the type of antenna used. The following general advice applies, unless the specification for your equipment says something else.

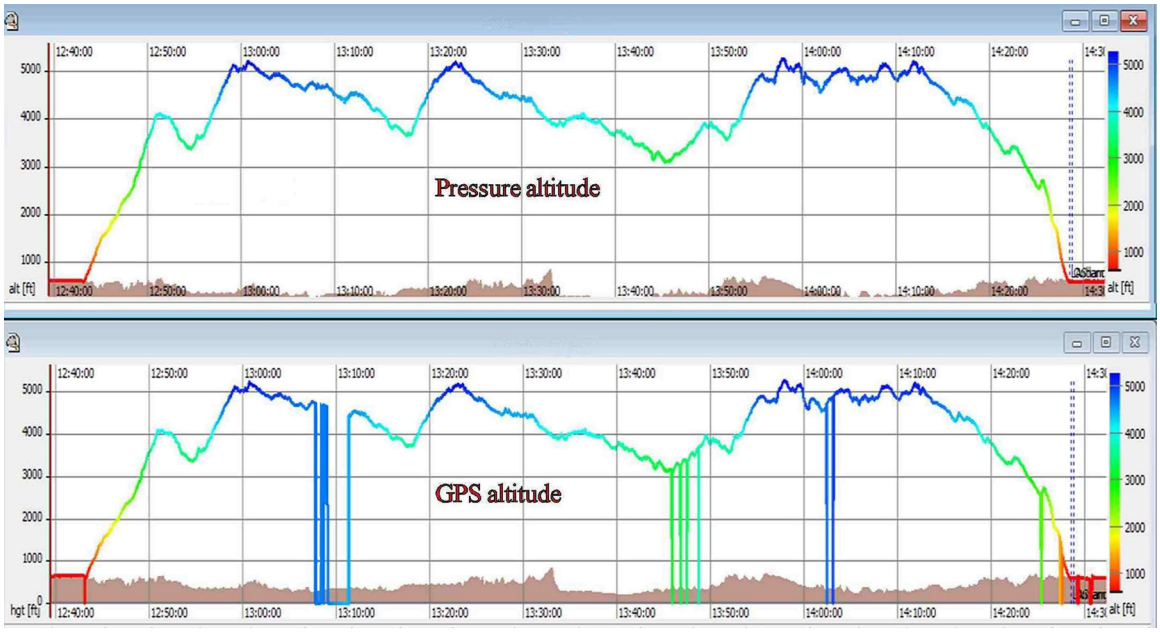
a. *General* The antenna should be clear of any object except attachments that are part of its design, and the antenna itself should not touch anything. In particular, metal or carbon fibre objects should not be between the antenna and a clear horizon (glass fibre and Kevlar do not reduce signal by very much). For FRs mounted in instrument panels, the antenna should be placed on top of the panel rather than inside or underneath it, but may be covered to prevent overheating in the sun (check that the cover and any paint used do not reduce the GPS signal). Antennas should not be mounted on conductive material (metal, carbon fibre) unless the signal is improved by or requires a "ground plane" (see the antenna's specification). The distance to other antennas such as for a second FR or radio should be over 25 cm (about 10 inches) if possible, to reduce the possibility of mutual interference.

> ***Safety note*** *When an antenna is mounted on a canopy, a connector should be used that will separate under tension (such as an SMB design) if the canopy must be jettisoned.*

b. *Antenna cable and connectors* The cable and connectors between the antenna and the FR should be matched to the characteristics of the antenna and FR. In general, the cable should be no longer than necessary and be of high quality (however, some cables may be of a specific length matched to the system and should not be shortened). Extra connectors should be avoided because each connector causes a loss in signal strength.

c. *Graphs of GPS altitude* This pair of graphs from an actual .igc file shows what can happen if these precautions are not taken. They show where signal strength was low at the recorder and

GPS altitude recording was lost for part of the trace. This can be seen where the GPS altitude in the .igc file falls to zero (in accordance with the FR specification for loss of signal). In these cases there may be a 2D fix (if Lat/ Long recording continues) or no fix at all; in either case pressure altitude recording will continue. In the case of no fix, a turn point could be lost, so if a pilot sees a GPS altitude graph like this, corrective action should be taken starting with checking the antenna position and performance.



Example of GPS altitude dropout due to poor antenna positioning or performance.

7.3 Installation checks by the OO There must be unambiguous evidence that every FR or PR present in the glider for the flight concerned was correctly installed as in 7.1 above with either of two provisions described in the FR's IGC approval document. In summary, those provisions are:

a. *Sealing* At any date and time before the flight, the OO may seal the FR to the glider structure in a manner acceptable to the NAC if it is possible that no OO will be present when the launch takes place. The seal must be applied and marked by the OO with initials or a symbol that provides unambiguous proof after the flight that the seal has not been compromised, and the seal must be able to be identified afterwards.

b. *Pre- or post-flight installation check* On the date of flight, the OO performs either:
   - a preflight check of the FR installation, noting the date and time it was performed. The glider must then be under continual observation by the OO until it takes off on the claimed flight, or
   - witnesses the landing and has the glider under continual observation until the installation of the FR is checked. This is not only to ensure that the installation is in accordance with the rules, but also to ensure that another FR has not been substituted before the data is transferred to a computer following the flight.

FLIGHT RECORDERS – PILOT ACTION

8.1 Independent evidence of take-off and landing The pilot must ensure that the time and point of take-off and the landing has been witnessed and recorded for comparison with the FR or PR data. If not witnessed by the OO, times may be confirmed by checking the official log of take-offs and landings, or by evidence from a reliable witness that is countersigned later by the OO.

8.2 Observation zone considerations OZ type is *not* part of a flight declaration, even though the pilot can select the OZ type to set into the FR. If the sector OZ was set into the FR and the pilot missed entering it at a turn point, the soaring performance will still have been completed if the pilot was within the cylinder OZ. In this case the leg distance must be reduced by 500 metres. Be aware that this could negate a badge flight that was within 1 or 2 km of the minimum distance for that badge leg.

Between 5 and 10 valid fixes on both sides of the fix or fixes used for verifying presence in the OZ should be at the time interval setting used for the OZ (the fast rate in FRs that have this facility). Some FRs mark OZ entry with a tone, but only post-flight analysis of the .igc file can prove your presence in the OZ. Fly into the OZ for several fixes before turning for the next leg. As GPS fixes may be lost at high bank angles, depending on the antenna mounting, extreme maneuvers should be delayed until valid fixes have been recorded in the OZ.

8.3 After flight The pilot *must not* alter the installation of or remove the FR (or any other flight data recording equipment) until it is witnessed by the OO. This is an easy mistake for a pilot new to their use for badge flights. Doing so compromises the OO's control of the flight, which invalidates the claim. Control of the FR is not compromised if the pilot enters a new declaration prior to the flight or for a subsequent flight.

FLIGHT RECORDERS & POSITION RECORDERS – OO ACTION

9.1 Prior to flight OO's should work with the pilot to ensure that the declaration loaded into the FR is correct in all aspects for the planned task. As good practice, the OO should review with the pilot the common errors given in 2.6 that are likely to spoil a claim.

9.2 Transferring the flight data file The OO must be able to identify the .igc flight data file as being from the flight concerned. The OO shall transfer the 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 transfers data directly to storage media such as a memory stick, the data may be transferred without disturbing the installation of the FR. If this cannot be done, the OO shall check and break any seal to the glider, then take the FR to a computer to transfer the flight data. If 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 procedure required, the pilot or another person may download the data while that OO witnesses the process. Security is maintained by the coding embedded in the FR and in downloaded .igc files that can be checked later through the IGC Vali program (see 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/igc-documents*, then look for "IGC-approval Documents for all IGC-approved Flight Recorders". The FR types, their manufacturers, IGC approval dates and a history of the use of GPS in IGC, are listed in *www.ukiws.demon.co.uk/GFAC/igc_approved_frs.pdf*.

b. *IGC file name* The original .igc file name format is "YMDCSSSF.IGC", where Y=year, M=month, D=day, C=manufacturer, SSS=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. For numbers over 9 such as in months and days, 10 is coded as A, 11 as B, etc. For new FR manufacturers and types of FR, the IGC long file name is used with data in the same sequence, for example, 2009-05-21-XXX-SSS-01.IGC.

9.3 Data transfer problems Some programs other than the IGC download utilities are able to transfer 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.

9.4 OO's copy of flight data The .igc file(s) for the flight may be saved on any storage media that the pilot cannot access. A copy of the file(s) – both the binary (if produced) and the .igc file(s) – shall be retained by the OO for later checking and analysis under the procedures of the authority validating the flight. 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.

FLIGHT RECORDERS & POSITION RECORDERS – DATA ANALYSIS

10.1 Validation and downloading of IGC files No brand of evaluation software is approved or preferred by the FAI, but the link to the IGC Shell program and a list of available programs and links to the websites of manufacturers is posted on the GFAC website: *www.ukiws.demon.co.uk/GFAC/index.htm*. Evaluation software is popular for its scalable view of the flight track, 3-D animation features, and detailed flight statistics, but note that they are not always completely accurate (see 10.8). They provide a variety of user settings in support of "what if" analysis, task planning functions and claim review for OLC, other online forums, and FAI badges and records as well. Some companies offer optional PDA and/or smart phone apps that provide navigation support in flight. As of mid-2017, several freeware evaluation options exist.

In any flight evaluation software, both pressure and GPS altitude, and MoP operation for motor gliders, 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.

10.2 Security checking The flight data transferred by or under the supervision of the OO becomes the master file to be retained by that OO on memory media. *Checking the security of the file is the first step in data analysis*. This requires the appropriate software, preferably the FR manufacturer's current "freeware" on the IGC website. With a successful security check, copies of the master file can be made for evaluation (keep them in a location separate from the master file.) A data file can fail security for a number of reasons:

a. a power surge during download,

b. a download using software other than the IGC-approved freeware,

c. the FR's internal security switch has been breached, or

d. the data file was amended during or after flight.

In most cases, as long as the original file is still in the FR, a fresh data transfer can solve the problem, enabling claim review to proceed. If a fresh transfer is not possible or it also fails security, the data file may be sent as an e-mail attachment to the GFAC chairman at *ian@ukiws.demon.co.uk* or to the National Claims Officer. 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 evaluated for other purposes, no badge or record can be claimed if a data file doesn't pass the required security.

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.

10.3 Assistance to OO After the OO has checked data file security and verified that the data file is complete, the OO may receive assistance if needed from another OO or from a NAC-appointed Data Analyst for help with common problems encountered during flight evaluation. The DA does not need to be the OO or approve badge or record claims, but his or her expertise can be important for a detailed evaluation.

10.4 Basic evaluation of flight data using graphic software Use an overhead view of the entire flight to see the general shape of the course and use graphs of altitude and MoP data to verify continuity of flight. Toggle between these views and zoom in as needed to check for:

a. clear evidence of release or MoP stop. Make note of time, altitude and location
b. airspace concerns, if any
c. valid start and finish procedures
d. time and altitude at start and finish points and at fixes yielding the best gain of height
e. proof of presence in turn point OZ (see 8.2 for free record fixes)
f. similarity of GPS and pressure altitude traces with time, course distance, and speed.

When more than one FR has 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 Altitude loss or gain evaluation When a gain or loss of altitude is to be evaluated, the same pressure reference should be used to establish the maximum and minimum values. It means that only instrument error (see 3.5) needs to be corrected. Correction for non-standard pressure is not critical and not required, as it is applied in the same way to both extremities. Diurnal or geographical changes of pressure should be ignored; they may work in favor or against the final result.

10.6 Absolute altitude evaluation The pressure-corrected altitude value for a fix is only needed for absolute altitude records. If a corrected altitude is to be established, reference pressure data should be taken from the take-off or landing baselines, whichever is closer to the tested fix. Be prudent when using take-off/landing site elevations for reference as most airfields are not perfectly flat and one end of the runway may be several metres higher than the other. If quality meteorological data is available (especially QNH reports from nearby stations), an interpolation of reference pressure data can be performed to obtain even more accurate results (see 3.6).

Altitude records exceeding 15,000 metres must use GPS altitude as the data source (SC3-3.5.3). Great accuracy in the FR barometric reading is not required since it is only supporting the GPS data.

10.7 Data anomalies In the event of any inconsistency 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. As a first step, contact the GFAC chairman, sending the IGC and other files concerned. If in doubt, the original file transferred from the FR should be used and the analysis process 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 examine 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. Without such evidence, validation should not be given when data interruption 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.

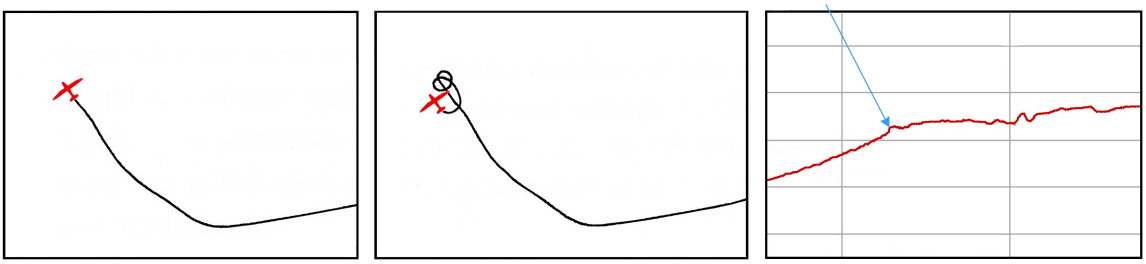
b. *Breaks in fixes and missed fixes* Fix breaks or sidesteps should be investigated; one must judge if the evidence of flight continuity remains incontrovertible. Analyse the time, altitude and position of the last and next valid data. Lack of any data for 5 minutes would not normally invalidate a flight, 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 will prove flight continuity, although evidence of presence in an OZ could be lost.

10.8 Evaluation software problems There are several ways in which evaluation software can incorrectly evaluate a flight. Check user settings during each new evaluation. Some settings, such as units of measure, map display, etc. are retained until changed; but many others revert to the pro-gram default when another flight data file is loaded. The data analyst must be familiar with both the Sporting Code and the software being used, particularly for distance claims. The following areas should be carefully checked:

a. *Confirm or correct the software-calculated release time* For aerotows in particular, this may be calculated incorrectly. Check the overhead view and altitude data for changes in rate of climb, turn radius and speed. A combination of these will typically reveal where – in light winds – the pilot released, slowed to minimum sink speed and began thermalling.

In ridge or wave lift, the pilot may release and simply bear to the left or right. On or off tow, speed will decrease with any turn into the wind and towing through rotor turbulence can easily be mistaken for the release. In these cases, familiarity with local procedures and displaying the flight over a satellite map can help clarify where release occurred.

Ground track on aerotow *Turn radius while thermalling* *Thermalling turn begins here*

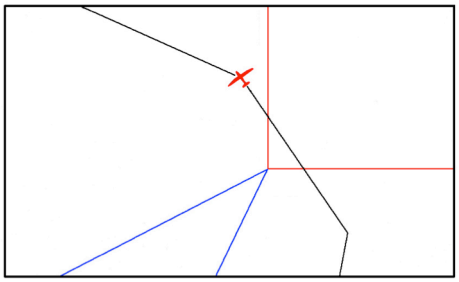


b. *Flight track details/problems to consider:*
- a declared start or finish point is not achieved,
- release or MoP stop is a viable alternative to the declared start point,
- a turn point is skipped or used out of declared order, or
- a finish fix is a viable alternative to the declared finish point.

Accessing the declaration screen displayed by software and amending the task or using the "map edit" function as needed may remedy a problem.

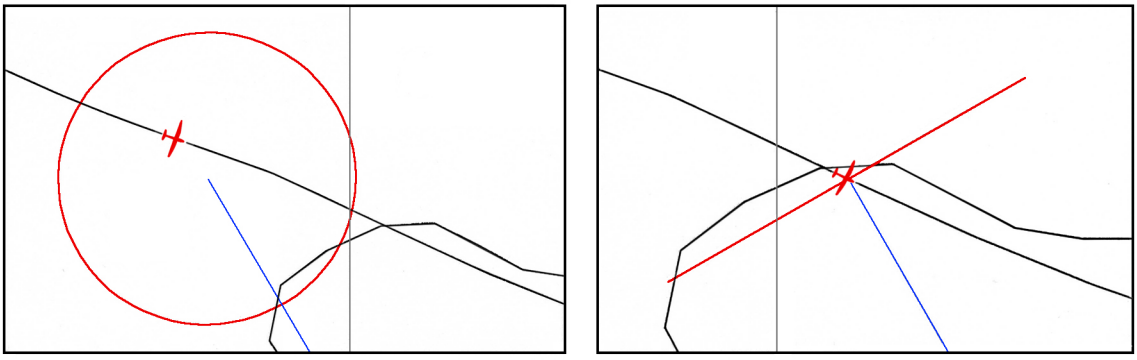
c. *Some software will not reliably credit TPs achieved by ground track only.*

The Code does allow a TP when a straight line drawn between consecutive fixes passes *through* the OZ. This is uncommon, but it's wise to take a close look at TPs to make sure each is credited properly. Software statistics will report the turn point illustrated as "not rounded" but the user can see it was achieved.



d. *Claim problems associated with free records.*
Some software "optimizes" closed courses for free records using a calculated start/ finish location rather than a start fix. Examine the track for a start fix that also yields a viable finish. In most cases such a fix is within 5 km of the software-calculated location.

Default display uses a no longer valid start OZ *Manual editing and a start fix solves the problem*



e. *Some software does NOT by default display altitudes as actually recorded in flight* When gain or loss of height is a critical factor of the flight, adjust user settings as needed to make sure altitude is displayed as "QNE" at a sea-level pressure ("hPa") of 1013.25 mb *or* consult the .igc file to determine the altitudes recorded at the start and finish times. Convert metres to feet if necessary and proceed as in 10.6.

f. *An "optimized" flight involving a loss-of-height correction* This problem is corrected by finding a lower start fix. A more rigorous technique (e.g. finding the best *pair* of start and finish fixes within 30 minutes of those selected by software) can yield better distance, but can be time consuming to find.

FR PRESSURE ALTITUDE CALIBRATION

11.1 Initial setup These calibration procedures also apply to PRs that can record pressure altitude. The FR manufacturer is expected to set the pressure altitude sensor within the FR to the criteria in SC3B-2.6.1. Large corrections should not apply after initial calibrations, because outputs of electronic barographs are converted directly to metres or feet. On set-up and calibration before or immediately after initial sale, it is expected that the sea level setting will correspond to the required 1013.2 hPa within 1.0 hPa, up to an altitude of 2000 metres within 3.0 hPa, and within 1% of altitude above 2000 metres.

11.2 Preparation If possible, the calibrator should be familiar with the type of FR being calibrated, but it is appreciated that technicians in civil aviation organizations will usually follow their normal calibration procedures and expect that the FR will record appropriately once it is switched on. Given this, it is up to the pilot to set up the FR beforehand. Details on calibrations are at the end of Annex B in the IGC approval document for the type of recorder concerned. The recording interval should be set to 1 or 2 seconds. If the FR has no internal battery to run it during the calibration, use an external battery placed in the altitude chamber with the FR.

11.3 Calibration

a. Place the FR in the calibration chamber. Increase the pressure altitude about 300 metres or 1000 feet, hold for 1 minute, then return to ambient. This is to ensure that the FR begins recording. Most FRs will start to record either just after being switched on, or when a pressure change is detected (typically a change in pressure altitude of 1 m/sec for 5 seconds).

b. The actual calibration begins now. Adjust the chamber pressure to the ISA msl value of 1013.2 hPa. Given the actual ambient pressure, it may be necessary to hold a positive pressure in the chamber.

c. If a metric calibration is being made, use intervals of 500 metres for the first 2000 metres and 1000 metre steps thereafter. If using feet, use altitude steps of 1000 feet for the first 6000 feet and 2000-foot steps thereafter. Hold each step for at least one minute. All calibration points, including the 1013.2 hPa sea level datum, should be approached from the same direction. After the maximum altitude has been reached, slowly reduce the chamber pressure to ambient.

d. Download the .igc file of the calibration and use the data to produce a calibration table of altitudes against corrections. A calibration table (such as shown on the next page) will show the following information: recorder model and serial number, place and date of calibration, type and serial number of the reference calibration equipment, name and signature of the calibrating officer. Keep the .igc file for record purposes and supply it with the calibration table when sent to other people.

11.4 Recording of calibration data

a. After the calibration, the data file containing the pressure steps shall be transferred to a computer as if it were flight data (SC3B-2.6.1). The stabilised pressure immediately before the altitude is changed shall be taken as the appropriate value unless the calibrator certifies otherwise. The IGC-format calibration data file will then be analysed, compared to the calibration pressure steps, and a correction table produced and authenticated by a NAC-approved person, preferably the calibrator. The data file must be analysed and authenticated by a NAC-approved person if the calibrator is not NAC-approved.

b. The correction table will list true ISA against indicated altitudes. The table can then be used to adjust critical pressure altitudes recorded during a soaring performance such as take-off, start and landing altitudes for altitude differences, for comparison with independently recorded air pressure (QNH) readings, and low and high points on gain-of-height and altitude claims.

c. Some FRs can display pressure altitude directly on a screen, but it is unlikely that the figures will be the same as those recorded in the .igc file. Only the .igc file data can be used in analysing altitudes on flights.

d. OOs responsible for validating later flights may wish to see the calibration file when assessing any claim that is made with the instrument being calibrated. Therefore, a copy of the calibration .igc file must be retained at least until the calibration becomes out of date. Retain the calibration at the calibration organisation or, where calibration is at civil aviation and military instrument sections, the supervising OO should retain the .igc file and the calibration table.

Pressure altitude calibration table (sample)

Flight recorder type / model / serial no. .....

Name / place of calibration facility .....

Flight recorder calibrated against:

Reference manometer type / model / serial no. .....

on ..... [date] in accordance with

FAI Sporting Code Section 3, Gliding, Annex C, Flight Recorder Calibration Procedure

QFE = 1010.1 HPa T = 14°C

The manometer readings have been corrected for temperature. As this is a FAI/IGC-approved FR, the .igc calibration file is held on record at this facility.

Manometer (ft ref to 1013.2 HPa)	*FR reads (ft)*	*Correction (ft)*
0	10	-10
1000	1005	-5
2000	2000	0
3000	2975	+25
4000	3950	+50
5000	4950	+50
6000	5920	+80
8000	7910	+90
10000	9910	+90
12000	11910	+90
14000	13890	+110
16000	15865	+135
18000	17860	+140
20000	19865	+135
22000	21885	+115
24000	23880	+120
26000	25925	+75
28000	27890	+110
30000	29875	+125
32000	31875	+125
34000	33925	+75

[Name/Signature] ..... [date] .....

Authorised calibrator for the National Aero Club of [country]

MOTOR GLIDERS

12.1 Means of Propulsion (MoP) record for motor gliders Unless the MoP is either sealed or certified as inoperative, an approved MoP recording system must be used. This system will be described in the approval document (6.3a) for the particular type of flight recorder. For motor gliders in which the MoP produces substantial acoustic noise when producing forward thrust, the Environmental Noise Level (ENL) system is used.

ENL systems are within the FR and need no external connections. An ENL value is recorded with each fix in the form of three numbers. Using a system that analyses the data in .igc files, the environmental noise level at the FR can be seen across the whole flight. ENL systems in new types of FRs are tested by GFAC and only given IGC-approval when it can be shown that the system differentiates between MoP operation and other noises produced in gliding flight.

For engines that produce lower noise levels, sensors external to the FR and connected to it, can be positioned close to the engine and produce values that are recorded in the .igc file under the MOP code. Details on interpreting them should be taken from IGC-approval documents.

12.2 MoP recording systems

a. *Environmental Noise Level (ENL) system* These systems produce ENL values between 000 and 999 for each fix in the .igc file. Analysis of ENL values enable the OO to determine whether the MoP was operated at positive forward thrust. The system is designed to emphasize engine noise while producing positive but low ENL values in normal quiet gliding flight. More exact figures for the type of FR concerned are given in-its approval document.

b. *Low noise engines – electric and others* Some engine/propeller/jet combinations do not produce enough acoustic noise at a cockpit-mounted FR for ENL systems to differentiate between engine running and soaring flight. This includes rear-mounted electric and jet engines, particularly when the FR is at the front of the cockpit. The provisions of SC3 Annex B-1.4.2.4 then apply, either requiring an extra sensor external to the FR and designed for these engines, or installation of the FR with its ENL sensor closer to the source of engine noise. Values from sensors external to the FR are stored in fixes in the .igc file as three numbers under the MOP code in addition to the three numbers under the ENL code.

12.3 ENL figures – engine off ENL figures between 000 and 999, found during GFAC testing before IGC approval, are listed in the approval document of the FR concerned. Others given below are a general indication of what to expect. Pilots should ensure that the FR to be used produces similar figures to those in its IGC-approval document; if not, the FR should be returned to its manufacturer to have the ENL system re-set.

a. *Winch and aerotow launches* ENL values are typically up to 300 for winch and 200 for aerotow may be seen, depending on speed, whether canopy panel(s) are open, and any sideslip present.

b. *In flight* Values under about 100 indicate normal gliding flight. In a high-speed glide or in an aerodynamically noisy glider, ENL may rise to 250. After launch, flight near powered aircraft should be avoided. Spins and stall buffet produce higher ENL values, particularly if the engine doors vibrate due to disturbed airflow at the stall – 500 has been recorded in a spin. If the engine is on a retractable pylon, a high ENL reading will be shown when flying with the pylon up and engine off due to the high aerodynamic noise.

   Flight with canopy side vent(s) open can produce a low frequency “organ pipe” note, particularly at high speed or with sideslip, where ENL figures us high as 600 have been recorded. If the glider is climbing, this can be mistaken for engine running. Pilots should avoid these conditions, and if loud cockpit noise is experienced during soaring flight, change conditions to reduce it so that it only lasts for a short time.

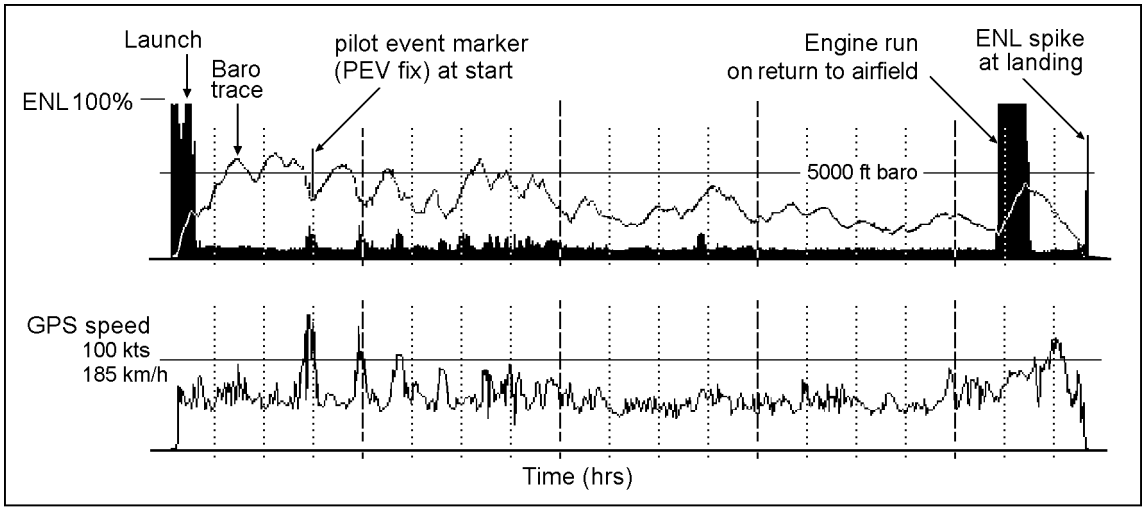
c. *Landing approach* ENL values are higher on an approach from noise due to undercarriage, sideslip, etc. because the glider is no longer aerodynamically clean. Short-term peaks due to specific actions such as opening air brakes will be noted as well. ENL values of up to 400 have been recorded, although 200 is more typical in an aerodynamically noisy glider, and 50 in a quiet machine.

d. *Take-off and landing* During ground contact at take-off and landing, short duration ENL "spikes" up to about 600 have been recorded from wheel noise or, on landing, initial contact with the ground.

12.4 ENL figures – engine on An ENL of over 700 is expected when the engine is running at climb power. Over 900 is typical for a two-stroke engine, and over 700 for a 4-stroke. Values over 900 have been recorded with a two-stroke engine running at full power. During engine running, these high ENLs are produced for a significant time during climbing flight and can therefore be attributed to engine running rather than soaring.

12.5 ENL analysis It is normally easy to see when an engine has been running. Other data, such as rates of climb and ground speed, will indicate whether or not non-atmospheric energy is being added. Short term peaks in ENL (10 seconds or so) may be due to the other factors mentioned above such as undercarriage and/or air brake movement, sideslip, open direct vision panel, the nearby passage of a powered aircraft, etc. If in doubt, e-mail the .igc file to the GFAC chairman at ian@ukiws.demon.co.uk for further analysis and advice.

12.6 Sample ENL data ENL data is shown below, using the presentation from one of the many analysis programs designed for the IGC file format. Here, the ENL values are highlighted as solid black bars whose height corresponds to the ENL values at each fix. They are shown on the same axis as the trace from the FR pressure altitude sensor. A separate graph of speed with time is included, and this is helpful in identifying why ENL values have varied during normal gliding flight, such as explaining higher ENL values at higher speeds.



ENL levels are shown in black, overlaid on the altitude trace with GPS-derived groundspeed below.

Appendix 1

COMMON CONVERSION FACTORS

DISTANCE	1	inch	=	25.4	millimetre (exactly)
		foot	=	0.3048	metre
		mile (nautical)	=	1852	metre (exactly)
		kilometre	=	3280.84	feet
		mile (statute)	=	5280	feet (exactly)
		mile (statute)	=	1.6093	kilometres
		mile (nautical)	=	1.1508	miles (statute)
SPEED	1	foot/second	=	0.3048	metres/second
		metre/sec	=	3.6	kilometres/hour
		metre/sec	=	1.9438	knots
		metre/sec	=	2.2369	miles/hour
		mile/hour	=	1.6093	kilometres/hour
		knot	=	1.8520	kilometres/hour
		knot	=	1.1508	miles/hour
		knot	=	101.2686	feet/minute
		mile/hour	=	1.4667	feet/second
PRESSURE	1	atü	=	15	psi (for tire pressure)
		psi	=	6.8948	kilopascals (kPa)
		atmosphere	=	101.3325	kilopascals
		atmosphere	=	1013.325	hectopascals (hPa) or millibars
		atmosphere	=	29.9213	inches Hg (0°C)
		inch Hg (0°C)	=	33.8639	millibars (mb)
		millibar	=	0.7501	millimetres Hg
VOLUME	1	gallon (Imp)	=	1.2009	gallons (US)
		gallon (US)	=	3.7854	litres
		gallon (Imp)	=	4.5459	litres
MISC.	1	gallon (Imp)	=	10	lbs water (15°C)

as a rough approximation:
100 ft/min = 1 knot = 0.5 metre/sec

Appendix 2

FAI BADGE DOCUMENTATION

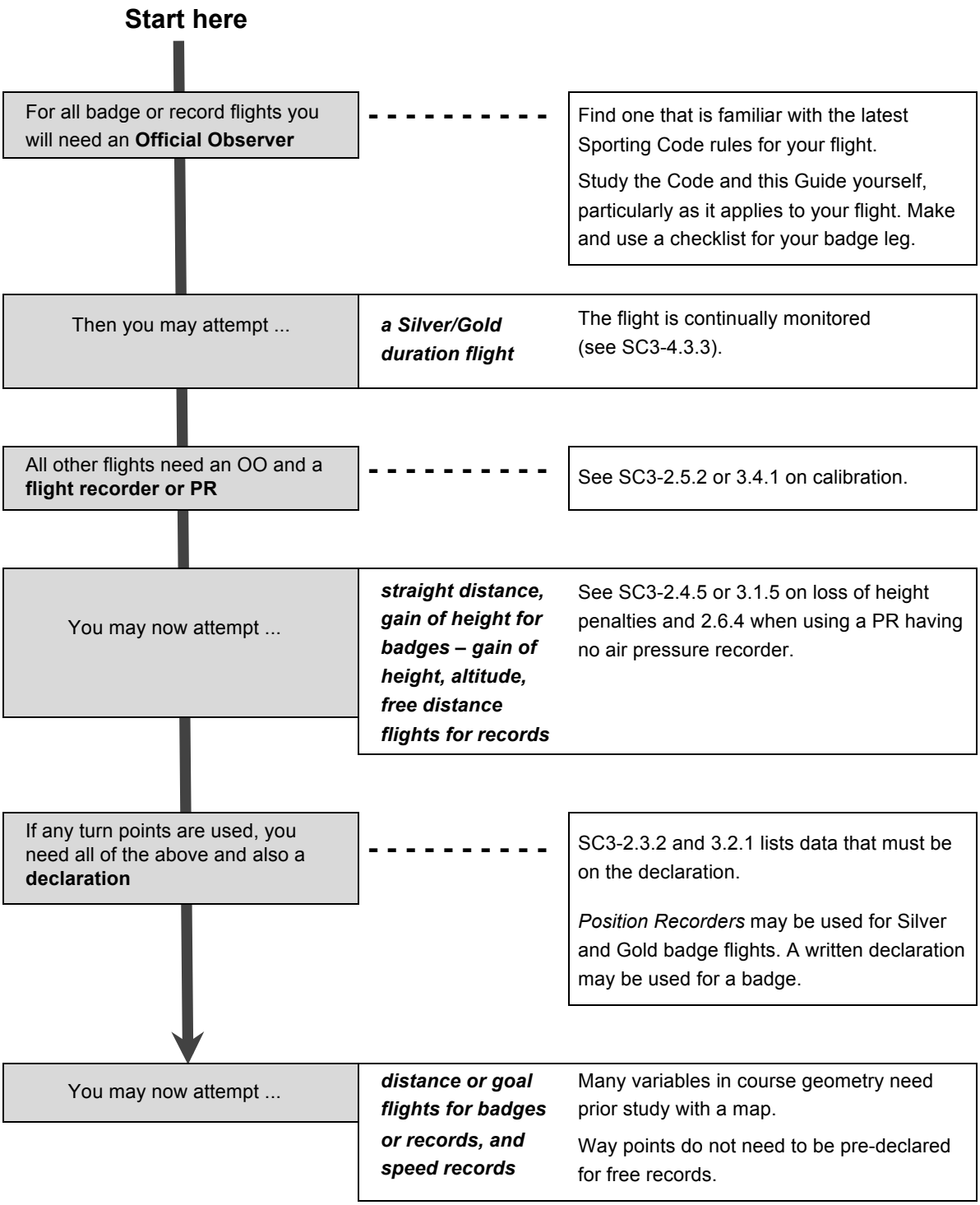
Documentation required is indicated by an asterisk *	Flight recorder barogram	Baro. calibration certificate	Difference of height certificate	Flight declaration	Landing certificate	Position evidence
Silver Height	*	*				
Silver/Gold Duration	*1				*2	
Silver Distance	*	5	*	*3	*	*3
Gold/Diamond Height	*	*				
Gold/Diamond Distance	*	5	*	*4	*	*4
Diamond Goal	*	5	*	*	*	*
Diploma Flights	*	5	*	*4	*	*4

Notes:

1. Not required if continually observed.
2. Required if landing not witnessed by OO.
3. Required if a declared start or finish point is used.
4. Not required for straight distance.
5. May be required if an accurate loss of height calculation is critical to the claim.

Appendix 3

BADGE or RECORD FLIGHT PROCEDURES FLOWCHART



Get a landing certificate signed by the OO or two witnesses.

Appendix 4

FLIGHT DECLARATION

This declaration or an equivalent is required if a Position Recorder is being used (SC3-2.3).

The last declaration made before takeoff is the only one valid for a given flight. Warning: some IGC-approved FRs make turn-on time of the FR the declaration time. To avoid problems, turn on the FR *before* the OO signs below.

Flight date ....

Pilot ..... **Name(s) (print)**

Glider ..... **Type & Registration**

FR/PR .... **Type & Serial no.**
(main) **(backup – if any)**

Start PT ....
Describe way points with a NAC-designated code name or with coordinates

TP 1 .....

TP 2 .....

TP 3 .....

Finish PT .....

.....
Signature of Pilot in Command

I hereby certify that I received and reviewed this form at the date and time below.

O.O. ..... **Name (print)**

..... **Date/ time**

Appendix 5

IGC-approved GNSS flight recorders and Global Navigation Satellite Systems

References: IGC web site: <*www.fai.org/gliding*>
IGC GNSS document site: <*www.fai.org/igc-documents*> then look for Flight Recorders
Chairman, IGC GNSS Flight Recorder Approval Committee (GFAC): <*ian@ukiws.demon.co.uk*>
Extensive information on GNSS systems is on the web:
for instance: *https://en.wikipedia.org/wiki/Satellite_navigation*

1.1 Terminology The title Global Navigation Satellite System (GNSS) is a generic term for any satellite-based system that enables receivers on or near to the Earth's surface to display accurate position data such as latitude, longitude and altitude. GNS Systems include the USA GPS, Russian GLONASS, European Galileo, Chinese Beidou 2, and future systems. IGC-approved flight recorders (FRs) and NAC-approved position recorders (PRs) currently use the USA GPS system. An IGC-approved FR is a specially sealed unit with a GPS receiver, capable of recording 3D fixes, time and other data, that can be downloaded after flight to a PC in the IGC file format. The lower level PR may lack some features and is restricted in the types of flights for which it can be used (see XXX). The words "logger" or "data logger" may be confusing when translated into other languages, so the term "flight recorder" (FR) is the official term used by IGC and FAI.

1.2 Position, height, and timing accuracy Overall average horizontal position error measured to date by GFAC is about 11 metres based on thousands of samples, although more recent IGC FR designs have averaged between 6 and 7 metres in good reception conditions. Tests are done by carrying the FR in a vehicle, driving over several accurately-surveyed points, and recording the difference.

a. Vertical (altitude) accuracy is less than horizontal accuracy because of the shallower angles of the position lines needed for an altitude fix, and GPS altitude errors are generally about twice those for horizontal position. GFAC tests have also shown that it is possible to have accurate fixes in lat/long, but poor accuracy in GPS altitude, an obvious GPS altitude anomaly, or even complete altitude unlock. These are indicated in an IGC file either by a zero GPS altitude figure, or an obvious "spike" in GPS altitude, when lat/long positions continue to show a smooth track.

b. FRs have an internal clock powered by a small sustainer battery inside the FR that maintains continuous date and time even when the FR is switched off. The internal clock also gives accurate time in .igc files when the FR is operating in pure pressure altitude mode if there is a failure to receive or process GPS data.

c. GNSS systems have very accurate digital clocks so that the time differences between signals from different satellites can be used to calculate position on the surface of the earth.

1.3 Rules for the use of FRs and levels of IGC approval Current rules are in the Sporting Code (SC3), its annexes (SC3A, B, and C), in the IGC *Specification for IGC-approved GNSS Flight Recorders*, and in other IGC documents and information. All are available on the IGC web pages. Annex B (SC3B) contains the rules and procedures for the use of GNSS recorders. Each flight recorder is given IGC-approval as listed below:

a. *IGC approval for all flights* Flight recorders that comply with all provisions of the FR specification at the time the approval document is issued, may be used for all record, diploma, and badge flights.

b. *IGC approval for badge and diploma flights* Flight recorders that do not fully comply with some of the provisions of the IGC specification. These may not be used for world records.

c. *IGC approval for badge flights up to Diamond only* Flight recorders with less rigorous standards than either a or b.

d. Use of FRs in IGC competitions and championships is covered in Annex A to the Code (SC3A)

e. *A list of all IGC-approved FRs* This is published on the IGC gliding documents web page, with links to the IGC-approval documents for each FR. Each document has an introductory section, manufacturer contact details, description of the hardware, firmware and software, followed by "Conditions of Approval", connections to the FR, security (physical and electronic), installation in the glider, motor glider aspects, sealing requirements (if any), and methods for downloading and analysis of flight data. Two annexes follow, Annex A with notes for pilots and FR owners, Annex B with notes for OOs and other people concerned with validating a flight, including barograph calibrators.

1.4 Physical and electronic security

a. *Physical security* An internal security mechanism activates if the FR case is opened. A silver coloured tamper-evident manufacturer's seal is normally fitted over one or more of the case securing screws.

b. *Electronic security* If the FR has been tampered with (such as by unauthorised opening of the case or attempting to do so), the internal security mechanism will erase the electronic key used to validate the integrity of subsequent IGC files. These files will continue to be produced, but will be marked as "unsecure" and will fail the IGC Vali test (6.2.d). Individual Vali programs originate from the FR manufacturers, are checked by GFAC for Sporting Code compliance and are coded to recognise the correct digital signature from each FR.

c. *Other flight data checks* Detection of alteration or artificial manufacture of data can also be helped by analysing features that can be checked from independent sources. These include wind drift in thermals, independent evidence of the ground level pressure for the time and places of take-off and landing, exact positions at takeoff and landing, comparison with other flight records from the day and locality concerned, etc. The nearest meteorological office will have past records of ground level pressures and the wind structure with altitude. This independent data can be used for checking against the FR flight data that is being investigated.

d. *Flight recorder found to be unsealed* If either physical or electronic security is found to have failed, the FR must be returned to the manufacturer or his appointed agent for investigation and resealing. A statement by the owner of the FR should be included on how the unit became unsealed.

1.5 Altitude sensing and recording

a. *GPS altitude* The GPS altitude computed and recorded in an FR is the vertical distance above the WGS84 ellipsoid. Because of the difference to pressure altitude, GPS altitude figures must not be used for gain/ loss of height or absolute altitude calculations (except above 15,000 metres in the case of an IGC-approved High Altitude Flight Recorder), but may be used for evidence of flight continuity if the pressure altitude trace has failed.

b. Position Recorders Where the lower technical standard PRs record altitude at all, they may record altitude above an approximate sea level surface known as the WGS84 Geoid, an approximate sea level surface. Some Prs with a pressure altitude sensor may mix GPS altitude and pressure altitude data, for instance, to produce approximate height above ground.

c. *Pressure altitude* Pressure altitude is with reference to the International Standard Atmosphere (ISA) having a sea level datum of 1013.25 HectoPascals (HPa – the same as millibars (mb)). As this is the IGC standard for measurement of altitude, a pressure altitude sensor is required in IGC-approved FRs. This enables pressure altitude recording to continue in the event of GPS failure or short-term unlock. The pressure altitude sensor in a FR is temperature compensated and is set by the sensor and FR manufacturer to the ISA. A sea level baseline setting and a setting for gain with altitude are usually available for adjustment and IGC procedures require the FR manufacturer to adjust these settings for minimum error before sale (see para 11.1).

1.6 Position Recorders – IGC file format and testing Because PRs are simpler than flight recorders, some data fields may not be present. Pressure altitude in the .igc file is recorded as zero unless it is derived from a pressure sensor (from which a calibration must be made following IGC procedures).

a. *Analysis*. The .igc file produced by the device should be capable of analysis by a recognised and publically or commercially available analysis program. The analysis program should be specified in the NAC's approval document.

b. *Validation* The method of ensuring the integrity of the .igc file should be specified in the approval document, including details of the validation system that will identify any changes to the .igc file made after

the initial download. Any changes detected after this transfer will invalidate the data. In this event, a further transfer should take place under close OO supervision and the .igc file analysed again.

c. *Testing* The recommended testing process for an NAC's PR is to make several test flights, comparing the device against an FR having IGC approval to see that there is no material difference in the results between them.

d. *Predicted fixes* The GFAC test for "predicted" fixes should be carried out to ensure that the PR only records fixes using real satellite data and doesn't generate them (SC3-2.6.2 refers). A vehicle containing a PR is driven over a well-marked 90° 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 complete PR is covered so that GPS signals are blocked (for instance by aluminum foil). 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.

e. *Flight tests* 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.

f. *Information for GFAC* Before issuing an approval for a PR, NACs must send the GFAC chairman the following information (current email ian@ukiws.demon.co.uk):
   - the Internet link to the PR's operating manual,
   - the proposed operating limitations,
   - a copy of the download and .igc file validation systems,
   - 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. If the PR can be shown to comply with IGC rules and procedures for PRs, the final approval will be posted on the IGC web site.

Appendix 6

High altitude flight recorders (HAFR)

1.1 An IGC HAFR is a special type of flight recorder designed, tested, and having an IGC-approval document that includes altitude performances above 15,000 metres as well as normal FR functions at lower altitudes. As part of the initial IGC-approval process, GPS altitudes in .igc files from a HAFR recorder type are checked for anomalies. After IGC-approval as a HAFR, where the top height is above 15,000 metres, GPS altitude from the HAFR's .igc file is used for absolute altitude and gain-of-height records instead of pressure altitude, subject to other IGC procedures for HAFRs. Other references on HAFRs include: SC3-3.5.3b, SC3B-2.1.2.2, and the IGC FR Specification document.

1.2 Checks of altitude data

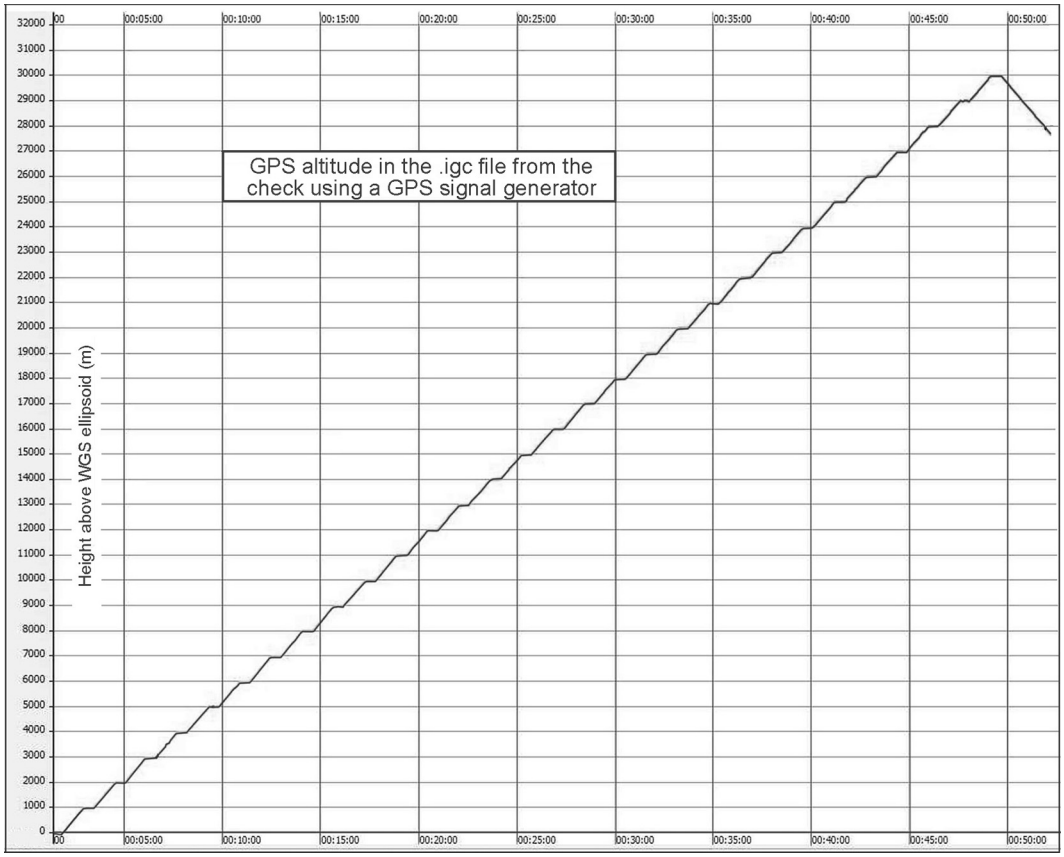
a. *Pressure altitude calibrations* For distance and speed records, the pressure altitude function of a HAFR must be calibrated in a similar way to other FRs (within 5 years before the flight and 2 months after). For altitude records below 15,000 metres, both calibrations are required, with the less favourable of the two used for the calculations. For altitude records above 15,000 metres, the 5-year pre-flight calibration is required, but there is no requirement for a post-flight pressure altitude calibration because GPS altitude will be used for the claim.

b. *Checking GPS altitudes in the .igc file* For claims above 15,000 metres, an independent check of the GPS altitude figures in the IGC file from the HAFR used for the claim must be carried out using a high quality GPS signal generator at an NAC-approved organisation, within similar timescales to pressure altitude calibrations. This is to check that no fault has developed in the way GPS altitude is processed by the HAFR before the figures are placed in the .igc file. The preflight check must be within 5 years of the claim flight, but where a claim flight is at a location remote from facilities for checking GPS altitude, the 2-month period for after-flight checks begins when the HAFR is returned to a location at which these facilities are available.

c. *Independent check of GPS altitude figures in the .igc file* At an NAC-approved organisation, a high quality GPS signal generator must be used to input a series of exact GPS altitudes to the antenna connector of the HAFR being tested, in a series of steps similar to those used for pressure altitude calibrations. At a minimum, the steps must cover either side of any low and high point that is to be claimed and the height of these steps must not exceed 1000 metres. The type of signal generator, its specification or other document showing its accuracy and performance, the identity of the tester and head of the testing team shall be recorded. The GPS conditions modelled should be appropriate to the region of the altitude record flight using factors such as latitude, number of satellites likely to be in view, and predicted ionospheric conditions. Examples of tables and graphs from such tests are shown for a specimen HAFR type ABC, serial number XYZ.

1.3 Signal generator output The input of the exact GPS altitudes in the steps in the graph are compared to the GPS altitude figures in the .igc file, using one of the analysis programs for .igc files. The signal generator should be set to give exact figures at each step (such as each 1000 metres), so that it easy for the figures in the .igc file to show any differences. The graph of altitude steps is then turned into a table of corrections to GPS altitudes in the .igc file to obtain the exact altitudes that were produced by the GPS signal generator. This table is then used to correct absolute altitude and gain-of-height figures from the claim flight in a similar way to the corrections applied to pressure altitude after a calibration in a pressure chamber.

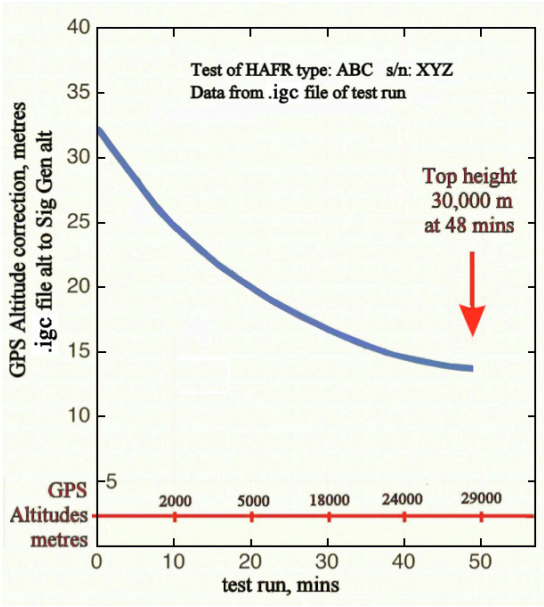
Differences between GPS altitudes in the .igc file and the exact altitudes from the signal generator are due to the processing of the GPS signal within the GPS receiver in the HAFR, followed by further processing within the recorder to place GPS altitude figures in the .igc file. This results in a corrected GPS altitude that must be used for altitude performances above 15,000 metres. The differences in the table shown are from a real HAFR test and are small, but with other types of HAFR the differences could be larger. There is also the possibility that the figures could differ from tests made several years before, due to processing being affected by updates to the HAFR or the development of faults in the FR. Since the corrected figures will be used directly for world or national records, these pre-flight and after-flight GPS altitude checks ensure as far as possible that there are no anomalies in the figures to be validated as an absolute altitude or gain-of-height record.



Sample HAFR check on GPS altitude – HAFR type ABC, Serial no. XYZ

Test organization:		
Date of test:		
Name of tester or Head of Test Team:		
Signal generator type:		
SigGenSpecification/Certificate of performance:		
HAFR type: ABC	Serial # (from IGC file name): XYZ	
Signal generator above WGS ellipsoid (metres)	.igc file (metres)	Correction in metres to be applied to .igc file value
0	-32	32
1000	972	28
2000	1975	25
3000	2977	23
4000	3978	22
5000	4979	21
6000	5979	21
7000	6980	20
8000	7980	20
9000	8980	20
10000	9981	19
11000	10981	19
12000	11981	19
13000	12982	18
14000	13982	18
15000	14982	18
16000	15983	17
17000	16983	17
18000	17983	17
19000	18984	16
20000	19984	16
21000	20984	16
22000	21984	16
23000	22985	15
24000	23985	15
25000	24985	15
26000	25985	15
27000	26986	14
28000	27986	14
29000	28986	14
30000	29986	14

Table of GPS altitudes from test of IGC HAFR with GPS signal generator



Appendix 7

Planning for FAI flight claims

Pre-flight preparations

PILOT 1 Verify each FR or PR being used is properly approved and running current "firmware".

2 Arrange for the OO or any other person monitoring flights to observe your takeoff and make note of the specific aircraft you are flying.

3 Refer as needed to SC3-2.3.2 for badges and 3.2.1 for records to make sure your declaration includes all required information.

OO 1 For each FR/PR, follow its Approval Document (AD) procedures for checking the device installation before take-off. The OO may be required to perform a pre-flight installation check *and* maintain a continual watch of the aircraft until takeoff.

2 If a written declaration is being used for a badge claim, you must sign it and add the date and time of signing. Retain the original for submission with claim materials.

Post-flight actions performed as soon as possible after landing

PILOT 1 If the OO or any other person monitoring flights did not witness your landing, you must obtain names, signatures and contact information from two witnesses who arrive at the landing location soon after landing.

OO 1 Perform a post-flight installation check of each FR/PR, as directed in its AD. Depending on AD provisions, the OO may be required to be present at landing *and* maintain a continual watch of the aircraft until a post-flight installation check is performed.

2 Download the FR/PR data or supervise as the pilot does it. Using the manufacturer's IGC-approved software is recommended.

3 Take charge of the data file and perform the required security check as soon as possible and retain for evaluation. Make copies of the original file for the pilot. If the data file does not pass security, perform or supervise a fresh download, following AD procedures and making sure the device running the download software is connected to a reliable power source.

4 Determine if FR calibration is current and if the claim requires a current calibration.

5 Refer to SC3-4.3 and 4.4 as needed to verify all required OO procedures were followed.

INDEX