THE FAI INTERNATIONAL GLIDING COMMISSION (IGC)

GLOBAL NAVIGATION SATELLITE SYSTEM (GNSS)
FLIGHT RECORDER (FR) APPROVAL COMMITTEE (GFAC)

FAI web site: http://www.fai.org
IGC web site: http://www.fai.org/gliding
IGC GNSS web site: http://www.fai.org/gliding/gnss
Free software: http://www.fai.org/gliding/gnss/freeware.asp

To: FAI internet IGC-discuss group
Internet newsgroup rec.aviation.soaring
IGC GNSS web site under "List of Approvals"
Copy: Manufacturer concerned

10 April 2005

IGC-APPROVAL FOR GNSS FLIGHT RECORDER
CAMBRIDGE GNSS FLIGHT RECORDER MODELS 10, 20 and 25
ISSUE 5A WITH IGC-APPROVAL LEVEL CHANGE ON 15 MARCH 2006

(i) Status. This document gives formal approval for these models of GNSS Flight Recorders to be used for the validation of certain flights under the rules and procedures of the FAI Sporting Code Section 3 (Gliders and Motor Gliders), subject to the conditions and notes given later. It replaces those documents with earlier dates. Only the contents of the document posted on the IGC web site are valid for use for IGC/FAI claims. IGC and FAI reserve the right to alter the terms of this approval in the future.

(i-i) Approval history. The original IGC-approval for these types of recorders was issued on 16 January 1996. Updates adding various features were dated 20 July 1997 and 29 June 1999. These were issued for the original Cambridge operation in Vermont. Issue 4 dated 25 November 2003 changed the Manufacturer's address from Vermont to the new site at Horn Lake, Mississippi. Issue 5 dated 12 September 2004 brought wording into line with other IGC-approval documents and Issue 5A includes reference to R-Track Technologies and the revised IGC-approval level that applies from 15 March 2006.

(ii) IGC-approval levels. "All flights" IGC-approval applies until 14 March 2006. On 15 March 2006 the IGC-approval level becomes "all IGC/FAI badge and distance Diploma flights", that is, excluding evidence for World Record flights. This is in accordance with a decision of the IGC Plenary meeting on 5 March 2005 on types of recorders without public/private key security systems such as RSA and equivalents. Approval levels are listed in para 1.1.3.3 of Annex B to the Sporting Code for gliding (SC3B).

(ii-i) Other flights including competitions. Use in competitions and for flights other than record, badge and diploma flights to IGC Sporting Code rules is at the discretion the body responsible for validating the types of flight concerned. Annex A to the Sporting Code for Gliding covers World Gliding Competitions and others that may use Annex A rules and procedures.

(iii) GFAC tests. These are concerned primarily with the data from this recorder that is included in the IGC data format. Particular concerns are its accuracy and security, ease of transfer from the recorder to a PC, and conformity of the IGC file and the recorder design generally with the IGC Technical Specification for such recorders. Other aspects of the recorder system may not be tested and are a matter between the FR manufacturer and customers.

(iv) References. The attention of NACs, officials and pilots is drawn to the latest edition of the FAI Sporting Code Section 3 (Gliding) including its annexes and amendments. Annex A to this code (SC3A) deals with competition matters. Annex B (SC3B) deals with equipment used in flight validation (Chapter 1, GNSS Flight Recorders). Annex C (SC3C) is entitled "Official Observer and Pilot Guide" and consists of guidelines and procedures for the flight validation process. A separate document published by FAI is entitled "Technical Specification for IGC-Approved Flight Recorders" Copies of all of these documents may be obtained from the FAI/IGC web sites listed above and links are provided from the main IGC web site.

(v) Exclusions. This approval is not concerned with, and FAI has no responsibility for, matters related to: (a) Intellectual Property (IP) and Intellectual Property Rights (IPR) or, (b) the relations of the Organisation with any others except with FAI and its agents or as they affect FAI, its agents and this approval.

(vi) Standards and Procedures. This approval document is concerned solely with the standards of, and procedures relating to, the hardware, firmware and software for the type(s) of recorder described below and manufactured, updated or serviced by the Organisation listed below under "Manufacturer" and updated or serviced by such Organisation or its agents authorised by it to carry out such work.

(vii) Keep with recorder. It is recommended that a copy of this approval including its two annexes is kept with each unit of the equipment.

MANUFACTURER:

Cambridge Aero Instruments (CAI) brand products
manufactured by:
R-Track Technologies, Inc., 1565 Dancy Boulevard,
Horn Lake, Mississippi 38637 USA.
Tel: (+1 662) 280 7610
Fax: (+1 662) 280 7609
Web: http://www.cambridge-aero.com
Email: cai@cambridge-aero.com
Manufacturer codes: Three-letter, CAM; one letter, C. Binary file *.CAI
General Manager, R-Track Technologies: Arthur Chapman

HARDWARE

Model Numbers, power source. Model 10 - has space for a 2AH internal battery and a remote antenna, although it can be operated on external power without the internal battery.
Models 20 and 25 - require external power, model 20 having an integral antenna and model 25 a remote antenna.
Description, size, weight. Model 10 has an L-shaped cross section and is about 160 x 160 x 80 mm overall. Weight is about 1640 gm with the 2 AH internal battery and 910 gm without.
The later Models 20 and 25 consist of a rectangular metal case about 120 x 70 x 50 mm in size, and weigh about 360 grammes.
All models have 5 connectors fitted to the case and the models 10 and 25 have an additional connector for an external antenna, model 20 having an integral antenna. Details of connectors are given below under Conditions of Approval.

GPS receiver boards. Recorders from late 1997 are fitted with the Garmin GPS25 12-channel parallel receiver board. Earlier model 10 units had the Garmin GPS10 and earlier model 20/25 units had the Garmin GPS20, these both being single channel systems but capable of receiving a series of up to 8 satellites for individual fixes.
Other modules. The recorder units themselves have no display, but a separate LCD module can be connected to display information in flight. Another connection can be used to feed NMEA data to other cockpit instruments such as the Cambridge L- and S-Nav units.
National regulations. These may apply to electrical and electronic equipment, such as the EC "CE" mark for compliance with EC directives on EMC and voltages. Compliance with such regulations is not the responsibility of FAI. This equipment is understood to have the EU CE mark.

FIRMWARE
The version number of the firmware in the recorder is shown on the LCD on start up, the 2003 version being V6.0. IGC-approval applies to Version 4.1 and later. Version 5.4 firmware introduced the Pilot Event (PEV) marker function, fast fixing on pressing the ON button on the LCD unit, and the Palm-NAV multifunction display.

SOFTWARE
Short program files. The DOS versions have file names DATA-CAM, CONV-CAM, and VALI-CAM and MS Windows-based programs are being prepared that fulfil the same functions. The DATA program is for transferring flight data from a recorder to a PC and also converts the downloaded binary *.CAI file to the *.IGC file format if the CONV file is in the same directory. The CONV program may also be used on its own to convert a CAI file to the *.IGC ASCII format. The VALI program is for validation of the security and integrity of *.CAI files at any time after initial downloading from the recorder. However, note that VALI-CAM only works with the CAI binary file and not with the IGC ASCII format that is converted from the *.CAI file for the same flight, it is therefore essential to keep the CAI file for a flight as well as the IGC data file. The company's DATA, CONV and VALI programs are copyright of the FR manufacturer but are freeware. The latest versions may be obtained from the FAI site for free software given at the beginning of this document.
Cambridge full software program. Release V5.882E dated 2000, or later releases. This includes recorder setup including programming for variable rate fixing and the Pilot Event (PEV) function, also the Cambridge flight data analysis system.
Other programs. For downloading data after flight from the recorder to a computing device, any program or sub-routine originating from the recorder manufacturer may be used. Such a program may be embedded in a larger program, such as in software that is designed so that Official Observers and others can download many different types of recorder. The criterion for valid flight data is that the resulting flight data file passes the VALI check that is described above.

CONDITIONS OF APPROVAL:

1. **Permitted Connections to the recorder module**.

1.1 GPS Antenna. To 9mm BNC antenna port (not applicable to model 20 with integral antenna).

1.2 External power. 12V battery connections to either the 7x7mm RJ-11 connector or the 5mm circular connector on the recorder case.

1.3 Display port - 10mm 6x6mm RJ-12 connector. To the optional CAI cockpit display unit (LCD), or, where an LCD is not available, to a cable with a press-button for initiating the PEV event and a series of fast fixes.

1.4 NMEA 0183 Datacom Port - 10mm 6x6 RJ-12 connector. This is a GPS data feed to cockpit instruments for use with computing and variometer units, such as the Cambridge S- or L-Nav.

1.5 Data-transfer port - 9-pin 17mm RS232.

1.5.1. During flight. To the optional Cambridge Palm-NAV PC and moving map display, when operated in accordance with the Cambridge manual for this equipment. Between the takeoff of the claimed flight and the transfer of data after flight witnessed by an OO, no other type of equipment including any other type of PC must be connected. Other types of display may be approved by IGC and added later.

1.5.2. On the ground. To a PC for downloading flight data from the recorder. Also, through the manufacturer's full software program, to set up the FR before flight.

2. **Security of the Equipment**. IGC is presently satisfied with the physical and electronic security of this equipment. See para 4 on security seals.

2.1. **Installation in a glider**. The FR may be fitted anywhere in the glider, subject to paras 2.2 and 3.2 and that the position of any displays in single-seat gliders is not remote from sight lines used for pilot lookout and scan for other aircraft and gliders. If the GPS antenna is accessible to the crew in flight, no attempt must be made to inject data; any abuse of this may lead to a future requirement to place the antenna out of reach of the flight crew.

2.2. **Motor gliders**. A microphone and frequency filter and weighting system automatically produces an ENL (Engine Noise Level) value with each fix up to a maximum ENL value of 195 (note that the IGC standard is a maximum of 999). This system is always enabled and cannot be turned off. It is designed to emphasise engine noise but at the same time produce positive but low ENL values in normal gliding flight. The FR must be positioned in the glider so that it can receive a high level of engine noise when forward thrust is being generated. GFAC has tested the FR in motor gliders with two-stroke and 4-stroke engines, but not with Wankel or electric power sources. The ENL figures produced by these recorders should be multiplied by 5.1 (giving a maximum of 995) before comparing them with the ENL figures from later IGC-approved recorders that have a maximum ENL of 999. For details of ENL figures expected, see para B.4.

2.3. **Sealing of data ports and plugs**: no present requirement, but no attempt must be made to pass unauthorised data into the FR.

3. **Check of Installation in the Glider**. There must be incontrovertible evidence that the FR was in the glider for the flight concerned. This can be achieved either by observation at takeoff or landing or by an OO sealing the FR to the glider at any time or date before takeoff and the seal being checked after landing.

3.1. **Observation of Installation before Takeoff or at Landing**. For observation, either a preflight check of the installation must be made and the glider must be under continuous observation by an OO until it takes off on the claimed flight, or an OO must witness the landing and have the glider under continuous observation until the FR installation is checked. This is to ensure that the installation is in accordance with the rules, and that another FR has not been substituted before the data is transferred to a PC after flight.

3.2. **Sealing to the Glider**. If para 3.1 cannot be met, the FR must be sealed to the glider by an OO at any time or date before flight so that it cannot be removed without breaking the seal. The sealing method must be acceptable to the NAC and IGC. Paper seals must be marked in a manner such that there is incontrovertible proof after the flight that seals have not been tampered with, such as by marking with the glider registration, the date, time and OO's name and signature. The use of adhesive plastic tape is not satisfactory for IGC-approved sealing because it can be peeled off and re-fitted. Gummed paper tape is recommended, as used for sealing drum-type barographs. The OO must seal the FR unit to glider parts that are part of the minimum standard for flight. It is accepted that such parts can be removed for purposes such as servicing; such parts include the canopy frame, instrument panel, and centre-section bulkhead fittings. If the FR is sealed to such removable part, if such a part is transferred between gliders, any FR seal for the previous glider must be removed.

4. **Security Seals, Physical and Electronic**. An internal electronic security mechanism is included and the electronic security check will no longer produce a valid *.CAI file if the case has been opened. On switching on, the LCD screen shows the unit serial number, and then shows "GPS Recorder Sealed" for a short time. If the FR is found to be unsealed either physically or electronically, it must be returned to the manufacturer or his appointed agent for investigation and resealing, with a statement of how the unit became unsealed. Whenever any unit is resealed, the manufacturer or agent must carry out positive checks on the internal programmes and wiring, and ensure that they work normally. If any evidence is found of tampering or unauthorised modification, a report must be made by the manufacturer or agent to the Chairman of GFAC and to the NAC of the owner. The IGC approval of that individual unit will be withdrawn until the unit is re-set and certified to be to the IGC-approved standard.

5. **Analysis of Flight Data**. This may be through any analysis programme that is approved by the relevant NAC. For a list of those which use the *.IGC file format, see the IGC GNSS web site under SOFTWARE). The validating agency must check that the *.CAI file is valid and unaltered, by the use of the latest version of the VALI-CAM.EXE short program file (VALI-CAM only works with the CAI file, not with the IGC file that was converted from it for that flight). See Annex B for how to use.

6. **Manufacturer's Changes**. Notification of any intended change to hardware, firmware or software must be made by the manufacturer to the Chairman of GFAC so that a decision can be made on any further testing which may be required.

Ian Strachan
Chairman, IGC GFAC

Annexes:
A. Notes for owners and pilots
B. Notes for Official Observers and NACs

Any Queries to:
Chairman IGC GFAC, Bentworth Hall West, Alton,
Hampshire GU34 5LA, England
Tel: +44 1420 564 195; Fax: +44 1420 563 140;
email: ian@ukiws.demon.co.uk

Annex A to IGC-approval document

NOTES FOR OWNERS AND PILOTS -
PART OF IGC APPROVAL FOR CAMBRIDGE GNSS FRs MODELS 10, 20 & 25

To be read together with the main terms of approval to which this is an Annex. It is recommended that a copy of this approval document including annexes is kept with the equipment concerned, for the use of pilots and Official Observers.

Pilot's Responsibility. It is the responsibility of the pilot to ensure or to note the following:

A1. **Antenna** - That the antenna is positioned in order to give sufficient signal strength for IGC purposes. No deliberate attempt must be made to inject data via the antenna. Any abuse of this may lead to a future requirement to position antennas out of reach of the flight crew.

A2. **Geodetic Datum**. That the WGS84 Geodetic Datum is set (IGC Sporting Code rule) For WGS84, the LCD should read "GPS Map Datum 100" on start-up. Flights where other Datums are set are not valid for IGC purposes.

A3. **Observing the FR installation in the glider**. The pilot must ensure that an OO has checked the place of the equipment in the glider and how it is fixed to the glider. If it may be difficult to obtain an OO immediately before takeoff, or to witness the landing, you should ask an OO to seal the FR to the glider, and this can be done at any time or date before flight. See para 3 in the conditions of approval.

A4. **Takeoff**. The pilot must ensure that the time and point of takeoff has been witnessed and recorded for comparison with that recorded by the GNSS FR, see para B1.2.

A5. **Connection to Ports**. Although this approval does not presently require sealing of any ports or plugs, no attempt must be made to pass unauthorised data into the FR. See paras 2.3 and 3 in the conditions of approval.

A6. **Use in Motor Gliders** (including self-sustainers): The internal microphone and associated circuitry automatically records an ENL (Engine Noise Level) value between 000 and 195 with each fix. The ENL system is automatically enabled and no pilot action is required. The FR should not be covered or insulated, although even so, automatic gain should continue to ensure high ENL readings under power.

A6.2.1 Cockpit noise. Pilots should note that cockpit noises other than the engine will produce ENL readings, and should avoid those that could be mistaken for use of engine. Generally the frequency filtering built in to `the FR will avoid any problems, but it should be noted that **flight with the cockpit Direct Vision (DV) and/or ventilation panel(s) open can produce a low-frequency sound (organ pipe note) which will register as high ENL, particularly if sideslip is present**, as will spins and stall buffet, particularly in Motor Gliders if the engine bay doors flutter (vibrate or move in and out). Flight close to powered aircraft should also be avoided, except for normal aero-tow launches. For ENL levels that have been recorded on GFAC tests, see B.4.2. Pilots should analyse their flights and ensure that their recorder produces ENL values similar to those given in B4.2. If not, the recorder should be returned to the manufacturer or agent for re-calibration to B4 values.

A7. **After Flight** - The pilot must ensure that the time and point of landing has been witnessed and recorded for comparison with that recorded by the GNSS FR (see para B2.1). Until an OO has witnessed the FR installation to the glider, the pilot must not alter the installation or remove the FR from the glider. The OO will carry out the actions given in para B2.3, and the OO's copy of the transferred flight data will be sent to the NAC. The OO does not personally have to transfer the data from the FR, but witnesses the transfer and is given a copy on electronic media. Different rules may apply for competition flights, for which a central data transfer facility may be used, but for a flight to IGC record and badge rules, the above continues to apply.

A7.1 Retaining both the CAI and IGC files. Downloading from the recorder to a PC is initially in the binary *.CAI format. This is then converted to the ASCI *.IGC format. However, the validation program VALI-CAM.exe only operates with the CAI format, not with the IGC format. It is therefore essential to retain the CAI format file for the flight concerned as well as the IGC format. Both files must be sent to the agency responsible for validating the flight, such as the National Airsport Control body, and, for world records, eventually to FAI. If the CAI file is lost, so may be official validation for the flight. The IGC file is less important because it can be re-generated at any time from the CAI binary, such as through the free CONV-CAM.exe program.

A8. **Calibration of Barograph Function**. Pilots are advised to have a barograph calibration carried out either by the manufacturer or by an NAC-approved calibrator before any GNSS FR is used for a claimed flight performance. An IGC-format file showing the pressure steps used in the calibration must be recorded and kept. Altitude and height claims obviously require a calibration, but speed and distance claims also need a calibration for calculating the accurate altitude difference of the glider between the start and finish points. Also, the NAC or FAI may wish to compare pressure altitudes recorded on the FR for takeoff and at landing, with QNH pressures for the appropriate times recorded by a local meteorological office.

A9. **Warnings**. In the course of GFAC testing, some features have been found which it is considered worthwhile to specifically mention to users.

A9.1. Warning to retain the binary *.CAI file for a claimed flight. It is essential that the binary *.CAI file for the flight is not deleted. It must be retained for the final stages of the flight validation process, for instance at the NAC or, for world records, at FAI. The VALI-CAM check can only be carried out on the CAI file and does not work with the IGC format file that is created from it. If the CAI file is lost, the flight cannot be validated. See also A7.1.

A9.2. Warning on possible over-writing of task declaration. The last electronic task declaration made will appear on ALL flight data files in the next batch downloaded from the FR to a PC. This will include files for flights made before the last declaration was made. This means that unless flight data is transferred before the next task declaration is made, a later declaration, timed and dated for the time at which it was executed, will appear on flight data from earlier flights, and any original electronic declaration will be lost. Pilots are advised to transfer data from any flight using an electronic declaration immediately after flight, and certainly before another electronic declaration is made.

A9.3 Warning on fitting the power plug. The RJ11 external power plug is a smaller size than the other RJ45 external plugs, and it is possible to push it into one of the other female connectors on the FR by mistake. The RJ-11 external power plug is a smaller size than the other external plugs. It is therefore possible to inadvertently push it into one of the other female connectors on the FR case. Although the RJ-11, being smaller, will not latch in, contact can be made with metal pins in the recorder connector and this can cause damage. Users are advised to be careful only to present the power plug to its proper connector. Colour coding of plugs and connectors may help and red is conventionally used for power connectors.

Annex B to IGC-approval document

NOTES FOR OFFICIAL OBSERVERS AND NACs -
PART OF IGC APPROVAL FOR CAMBRIDGE GNSS FRs MODELS 10, 20 & 25

To be read together with the main terms of approval to which this is an Annex. It is recommended that a copy of this approval document is kept with the equipment concerned, for the use of pilots and Official Observers.

B1. **Installation and Takeoff Records**

B1.1. **Installation in the Glider**. An OO shall witness and record the position of the FR in the glider, the type and serial number of the FR, the glider type and registration, date and time. The procedures in this paragraph and the sub-paras below are to ensure that the installation is correct, and that another FR has not been substituted in the glider before the transfer of flight data (B2.3). See paras 2 and 3 of the Conditions of Approval.

B1.1.1. Sealing to the glider. At any time or date before flight, if requested, the OO may seal the FR to the glider structure in a way acceptable to his NAC and to IGC. This is the preferred option because it makes it easier for the pilot on the day of flight.

B1.1.2. If sealing is not used. Either a pre-flight check of the installation must be made on the day of flight or an OO must witness the landing, but see the qualifications that follow. After the pre-flight check on the day, the glider must be under continuous observation by an OO until it takes off on the flight concerned. Where an OO witnesses the landing, the glider must be under continuous observation until the FR installation is checked.

B1.2. **At Takeoff**. The time and point of takeoff shall be recorded, either by an OO, other reliable witnesses, or by other means such as an Air Traffic Control or official Club log of takeoffs and landings. This shall be compared to the FR takeoff data.

B2. **Landing**.

B2.1. **At Landing**. The time and point of landing shall be recorded, either by an OO, other reliable witnesses, or by other means such as an Air Traffic Control or official Club log of takeoffs and landings. This shall be compared to the FR landing data.

B2.2. **Checking the Installation of the FR**. As soon as practicable after landing, an OO shall inspect the installation of the FR in the glider (including any sealing to the glider), so that this can be compared to the check described in para B1.1 above. The transfer of flight data shall then take place in accordance with B2.3.

B2.3. **Transferring the Flight Data**. If a portable PC is available, the flight data may be transferred at the glider without disturbing the installation of the FR. If a portable PC is not available, the OO shall check and break any sealing to the glider, and take the FR to a PC. If the OO is not familiar with the actions required, the pilot or another person may transfer the data while the OO witnesses the process. Security is maintained by electronic coding embedded in the FR and in the downloaded file. This is then independently checked later at the NAC (and at FAI if the claim goes to them).

Method: Either follow the menus in the Cambridge full software program CAIXX or other approved downloading program, or use the freeware short program files by executing the file DATA-CAM.EXE or its MS Windows-based equivalent. DATA-CAM can be executed on either a floppy diskette (which can be self-booting) or on the PC hard disk. The software version is shown at the top of the menu (see under "Software" on page 1, which gives the relevant versions). It executes in the normal way such as by typing "DATA-CAM, enter", at a DOS prompt, or by double-clicking "DATA-CAM" in a file list (File Manager/Windows Explorer, etc), and then following the menu actions in the DATA-CAM file. The DATA file will produce a binary *.CAI file for the flight, and if the CONV-CAM.EXE file is in the same directory, an *.IGC file will also be produced automatically at the same time.

This process will produce both CAI-binary and IGC-format flight data files with the file names YMDCXXXF.CAI and YMDCXXXF.IGC, where Y=year, M=month, D=day, C= manufacturer, XXX = FR Serial Number and F = flight number of the day (full key, Appendix 1 to the IGC GNSS FR Specification).

A copy of both the CAI and IGC-format files shall be retained securely by the OO such as by immediately copying them to a separate diskette or PC card, or by the use of a PC independent of the pilot. The *.CAI and *.IGC files for the flight shall be retained by the OO in safe keeping for later checking and analysis under NAC procedures. Retaining the CAI file is of more importance because the IGC file can be re-generated from it at any time, for instance using the free CONV-CAM program.

Competitions: Different rules may apply for competition flights, for which a central data transfer facility may be used, but for flights to IGC record and badge rules the above must be followed, and allowed for in competition procedures.

B.3. **Analysis of Flight Data Files**. A Data Analyst approved by the NAC will then evaluate the flight using an analysis program approved by the NAC concerned. For a list of programs that analyse the IGC flight data file format, see the IGC GNSS web site under SOFTWARE. First, an authenticated version of the program VALI-CAM.EXE or its MS Windows equivalent shall be used by the organisation validating the flight (for instance, the NAC and later FAI for data sent to FAI for checking) to check the integrity of the *.CAI binary file for the flight. This checks the electronic security coding in the file, that the FR from which it was downloaded has not been interfered with, and that the flight data in the *.CAI file is identical to when it was initially downloaded. Note that this check cannot be made with the IGC file for the flight, the CAI binary format file for the flight is needed (an IGC format file can be produced at any time from the CAI file). The latest version of VALI-CAM must be used and is available from the IGC GNSS site for software.

Method: at the appropriate prompt or run function, type VALI-CAM.EXE followed by a space and the full name of the *.CAI file to be checked (which must be in the same directory as the VALI program file). If the file data integrity is good, the following message should appear: "Seal intact, data integrity check pass, security check pass". The message "Seal not intact" indicates that the FR internal physical security seal has been broken, and the message "Security check FAIL" indicates that the CAI file is not the same as it was when it was transferred from the FR.

This checked CAI file shall then be converted to IGC format by using an approved program (for instance the free CONV-CAM program from the IGC web pages or one known to originate from the manufacturer). This IGC file shall be used for flight validation checking. Other IGC files created earlier have no guarantee of data integrity whereas the one created from a CAI binary that has just been checked by the VALI program may be used for flight validation to IGC/FAI standards.

B4. **Means of Propulsion (MoP) Record - Motor Gliders**. The MoP must either be sealed or inoperative, or the built-in microphone system used (Hardware versions 3.3 or later). The microphone and filtering system records an ENL value with each fix up to a maximum of 195. For comparison with later recorders that use the full ENL range from 000 to 999, the figures from Cambridge 10, 20 and 25 recorders should be multiplied by 5.1 (this gives a maximum of 995). ENL values recorded on GFAC tests are given below, in the sequence of a flight. So that these can more easily be related to those produce by other types of recorders, a percentage figure is also given in brackets, out of the maximum of 195.

B4.1. **ENL during launching**. During winch and aerotow launches, higher ENL values are to be expected than when soaring (B4.3), typically up to 80 (41%) for winch and 40 (21%) for aerotow.

B4.2. **ENL during engine running**. On engine running, an increase to over 150 (77%) ENL is expected with over 180 (92%) being typical. The value of 195 (100%) has been recorded with a two-stroke engine running at full power. During engine running these high ENLs are produced for a significant time, and when altitude and speed are analysed it can be seen that substantial energy is being added, which can therefore be attributed to energy not associated with soaring. The values quoted above are for 2- and 4-stroke engines, Wankel (rotary) and electric engines have not been tested. There is no reason to believe that Wankel engines will not give similar values to 4-strokes, but if an electric engine is encountered, please contact GFAC as soon as possible so that tests can be carried out. Note that with prolonged running under high noise conditions, the ENL readings may reduce from an initial high value to slightly lower figures, this is not unusual and is thought to be a function of gain circuits in this ENL system.

B4.3. **ENL during gliding flight**. ENL readings of less than 020 (10%) indicate normal gliding flight in a quiet cockpit environment. In a high-speed glide or in an aerodynamically-noisy glider, ENL may increase to about 50 (26%). Short periods of higher ENL while gliding (up to about 80 (41% ENL) may indicate aerodynamic noises such as due to airbrakes, lowering the undercarriage, sideslip, etc, and are normal before landing. Particularly, sideslip or high airspeeds with the cockpit panel(s) open often produces low frequency noise that registers as high ENL readings (up to 80 (41%) has been recorded), and these conditions should be avoided because, particularly if climbing, it could be taken as use of engine power. High ENL can also be recorded during stalling, particularly if the engine doors pant (move slightly in and out due to stall buffet, producing a clattering noise). Finally, where the engine is mounted on a retractable pylon, a high ENL reading will be shown if flying with the pylon up and engine not running, due to the high aerodynamic noise.

B4.4. **ENL during the approach to land**. ENL values are always higher on a landing approach due to aerodynamic noises such as due to airbrakes, undercarriage, sideslip, etc. Short-term peaks due to specific actions such as opening airbrakes, lowering undercarriage, etc., will be noted as well as a generally higher level of ENL because the glider is no longer aerodynamically "clean". ENL values of up to 90 (46%) have been recorded, although 60 (31%) is more typical.

B4.5. **ENL during landing**. During ground contact during takeoff and landing, short-duration ENL readings up to about 150 (77%) have been recorded due to wheel rumble; unlike engine running these last only for a short time, showing a short "spike" on the noise/time trace.

B4.6. **ENL analysis**. It is normally easy to see when an engine has been running and when it has not. Other data from analysis programs such as rates of climb and groundspeed, 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 airbrake movement, sideslip, open DV panel/sideslip, the nearby passage of a powered aircraft, etc. If any anomalies are detected, email the CAI and IGC files to the GFAC chairman for further analysis and advice.

B.5 **Altitude analysis and calibration**. Flight data files shall be analysed in accordance with Sporting Code procedures. Part of this is to compare the general shapes of the GNSS altitude and pressure altitude records with time and to ensure that no major differences are seen that could indicate a problem in recording or even artificially-manufactured (false) data. As part of this process, the FR must be calibrated in an altitude chamber in the same way as a drum barograph.

B.5.1 **Calibration method, making a calibration table**. No GPS fixes are required for a pressure altitude trace to be produced. However, before a calibration, you are advised to set the normal (cruise) fix rate to a small time interval such as 5 seconds or less. Recording at the pre-set fix interval starts when power is connected to the recorder and the pressure altitude change threshold is exceeded (about 1 m/sec for 5 sec). The calibrator should be asked to cycle the pressure briefly up and down before starting the calibration itself, so that recording will start. The calibrator should be asked to record the pressure steps used, for later comparison with the IGC file for the calibration. The stabilised pressure immediately before the altitude is changed to the next level, will be taken as the appropriate value unless the calibrator certifies otherwise. After the calibration, the data file containing the pressure steps is transferred to a PC as if it was flight data (see B2.3 above); this may be done by an NAC-approved person other than the calibrator who, at a non-gliding calibration centre, may not have this knowledge. The IGC format calibration data file will then be analysed, compared to the calibration pressure steps, and a correction table produced and authenticated by an NAC-approved person (for instance an OO or GNSS FR Data Analyst). The correction table will list true against indicated altitudes. This table can then be used to adjust pressure altitudes which are recorded during flight performances and which require correction before validation to IGC criteria. These include takeoff, start and landing altitudes for altitude difference and for comparison with independently-recorded QNH readings, and low and high points on gain-of-height and altitude claims. Only pressure altitude is valid for IGC altitude purposes except for proof of flight continuity (no intermediate landing) where GNSS altitude may also be used.

B.5.2 **GPS altitude figures recorded in the IGC file**. Occasional short-duration differences in the shape of the GPS altitude/time graph have been noted when compared to the pressure altitude figures. This is not unusual with GPS receivers operating without a local differential beacon or other accuracy-enhancing systems. The altitude accuracy from satellite-based systems will not be as good as accuracy in lat/long, because satellite geometry is not as favourable for obtaining accurate altitude fixes compared to fixes of horizontal position. This effect will be increased by poor antenna positioning in the glider. Data analysts and NAC officials should allow for the above when comparing the GPS altitude and pressure altitude records. Lat/long fix accuracy is not affected and tests with these recorders with the 12 Channel Garmin GPS25 GPS receiver board show it to be typical of that for a 12 channel GPS system. From GFAC tests after 1 May 2000 when the GPS Selective Availability error was removed, the lat/long error taken from a moving vehicle at a surveyed point, averages between 11 and 12m for all 12 channel recorders tested since that date.

B.5.3 **Maximum Altitudes Recorded in the IGC file**. The maximum altitudes in IGC files that apply to this recorder are given below.

B.5.3.1 **Pressure Altitude**. This is recorded up to 36,000 ft (10,973m) on the ICAO ISA. The reason that this is not higher is because of the balance between altitude resolution (size of altitude steps processed in a digital recording system) and the overall range of altitudes recorded. Pressure altitude resolution in these models is about 8 metres (25ft) at sea level and if the altitude range was increased this resolution figure would also increase. The maximum pressure altitude tested by GFAC was 36,000 ft.

B.5.3.2 **GNSS altitude**. This is recorded up to 65,000ft (19,812m) above the WGS84 ellipsoid, but is not used for IGC altitude measurement purposes, for which pressure altitude to the ICAO ISA is required.

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