GNSS FLIGHT RECORDER APPROVAL COMMITTEE (GFAC)
INTERNATIONAL GLIDING COMMISSION (IGC)
of the
FÉDÉRATION AÉRONAUTIQUE INTERNATIONALE (FAI)
Maison du Sport International, Avenue de Rhodanie 54,
CH-1007 - Lausanne, Switzerland
www.fai.org sec@fai.org

References: See para (i-iv) below

To: FAI IGC website under "IGC-approval Documents"
        igc-news@fai.org , Newsgroup rec.aviation.soaring

Date of issue: 31 July 2023

IGC-APPROVAL FOR GNSS FLIGHT RECORDER
Recorder Name: Cambridge GPS NAV Models 10, 20 and 25
Level of Approval: See para (i-ii) below

 (i) <u>General.</u> *This document gives formal approval from the above date for the Recorder equipment described below to be used for the validation of flights under the FAI Sporting Code Section 3 (Gliders and Motor Gliders) and under the rules of the procedures of other FAI and other activities that use IGC-approved recorders, subject to the conditions and notes given later. This document replaces those with earlier dates. Only the terms of the IGC-approvals posted on the IGC web site are valid for use for IGC/FAI claims. IGC reserves the right to alter this approval.*

(i-i) <u>Document history</u>. *The original IGC-approval was issued on 16 January 1996. Updates adding various features were made in July 1997 and June 1999. Issue 4 dated November 2003 changed the Manufacturer's address from Vermont, USA, to the new management near Memphis, Tennessee, USA. Issue 5 dated September 2004 updated the wording and Issue 5A included reference to the R-Track Technologies company. In March 2006 the IGC-approval level was revised to All Badges and Distance Diplomas. In 2007 the manufacturer's address changed and the wording was updated to that used in other recent IGC-approval documents. In 2011 the wording was changed in accordance with the recommendations of the 2011 paper on FR Security by the IGC ANDS and GFA Committees that was approved at the 2012 IGC Plenary meeting. The Memphis operation closed in 2017 and Cambridge FRs were subsequently supported by Gary Kammerer, a former CAI Technician, however this support ceased in 2023 and these recorders are no longer supported by any IGC-approved organisation. In January 2020 some of the wording was updated, including the GFAC Chairman's new email address on page 4. and a new Annex C replacing a separate web document. This document changes the Chairman's name and contact e-mail address and removes references to the Chairman's website and other inactive website links.*

(i-ii) <u>IGC-approval Levels.</u> *This is IGC Level 3 (Badge Flights up to and including Diamonds). The Levels of IGC-approval are listed in para 1.1.4 of Annex B to the Sporting Code for Gliding (SC3B), and cover the use of FRs in flights for FAI/IGC badges, diplomas, records and in competitions.*

(i-iii) <u>GNSS System</u>. *The Global Navigation Satellite System used in this Recorder is the US NAVSTAR Global Positioning System (GPS).*

(i-iv) <u>Current web sites</u>. *References for the latest versions of documents relating to IGC-approval of FRs (including the latest version of this document) are given in para 2 on page 1 of the main table that lists all IGC-approvals. The latest version of the table is available through www.fai.org/igc-documents. The detailed references are placed in the main FR table rather than in each IGC-approval document, so that if the reference changes, only the main table has to be updated rather than all IGC-approval documents.*

(ii) <u>Equipment Functions.</u> *This document is concerned only with, and applies to, the functions of the equipment that record flight and related data. More specifically, with the accuracy and reliability of recorded data for the exclusive sole purpose of validation and certification of flight performances to the criteria of FAI and in particular, but not exclusively, IGC. FAI is the legal entity and Swiss law applies. FAI Commissions such as IGC and others are agents of FAI; GFAC and its advisors are agents of IGC. Tests made by GFAC on behalf of IGC and FAI primarily concern accuracy and security of data, transfer and conversion to and conformity of the output data with the specified IGC file format for the validation and certification purposes mentioned above. Other functions of the equipment are not part of this IGC-approval and the relevance of this document does not extend beyond the specific validation and certification purposes above. In particular this document does not give the approval of GFAC, IGC and/or FAI to any function linked with aspects that could be critical in any way to flight safety such as navigation, the avoidance of controlled or other restricted airspace, terrain avoidance and any aircraft proximity-warning and/or anti-collision functions. This document does not constitute any approval, guarantee and/or any statement by GFAC, IGC and/or FAI as to the reliability or accuracy of the equipment for operation in flight and any liability in connection therewith is hereby expressly excluded.*

(iii) <u>Intellectual Property.</u> *This approval is not concerned with, and FAI, IGC and GFAC have no responsibility for, matters related to: (a) Intellectual Property (IP) and Intellectual Property Rights (IPR) and/or, (b) the relations of the Manufacturer listed below with any other entities except with FAI and its agents, including IGC and GFAC, or as they affect FAI, its agents and this approval.*

(iv) <u>FAI Sporting Code Section 3</u>. *The attention of National Airsport Control (NAC) authorities, FAI National Members, 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 to the Code (SC3B) with equipment used in flight validation, Annex C to the Code (SC3C) deals with guidelines and procedures for Official Observers, pilots, and other officials involved in the flight validation process. Copies of all of these documents may be obtained from the FAI/IGC web sites listed above and links are provided from the IGC web site. A separate document published by FAI is entitled "Technical Specification for IGC-Approved Flight Recorders".*

(v) <u>Keep with the Equipment</u>. *It is recommended that a copy of this approval including its two annexes is kept with each unit of the equipment so that it is available for pilots and Official Observers when required.*

ORIGINAL MANUFACTURER AND CURRENT SERVICING

Manufacturer codes for Models 10/20/25: Three-letter, CAM; one letter, C. Binary file suffix, CAI

Since March 2023 these recorders no longer have any manufacturer support,

1. HARDWARE

1.1 <u>Type of Recorder.</u> This is a free-standing recorder unit with no display, to which other modules can be connected.

1.2 <u>Hardware Versions.</u> IGC-approval applies to all hardware versions. The version is shown in the IGC file header record after "H FR HW HARDWARE VERSION". See para 2 for Firmware versions and para 11 for notification of updates by the manufacturer or support agency.

1.3 <u>Dimensions, weight, connectors</u>

    1.3.1 <u>Model 10</u>. This has an L-shaped cross section and is about 160 x 160 x 80 mm overall. Weight is about 1640 gm with a 2 AH internal battery. It can be operated on external power without the battery and in this configuration the weight is 910 grammes.

    1.3.2 <u>Models 20 and 25</u>. The case is about 120 x 70 x 50 mm in size, and weight is about 360 grammes. Model 20 has an integral antenna and model 25 requires a remote antenna.

    1.3.3 <u>Connectors</u>. All models have 5 connectors fitted. Models 10 and 25 have another connector for an external antenna. Details of connectors are given below under Conditions of Approval.

1.4 <u>GPS receivers.</u> Recorders from late 1997 are fitted with the Garmin GPS25 12-channel parallel receiver board. Earlier model 10 units had the Garmin GPS10 receiver and earlier model 20/25 units had the Garmin GPS20, both of these being single-channel systems but for each fix receiving position lines from up to 8 satellites one after the other.

1.5 <u>Pressure altitude sensor</u>. This is the Semsyn SDX15A2 from the ex-Semsyn company of California, now part of the Honeywell Group. The pressure sensor is compensated for temperature variation and calibrated to the ICAO ISA. The recorder case is not pressure-sealed and "cockpit static" pressure is recorded in the IGC file.

1.6 <u>Other modules.</u> Other modules such as for cockpit in-flight displays may be connected, but are not part of this IGC approval and are a matter between the manufacturer and the customer. The recorder units themselves have no display, but a separate Cambridge 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 PDAs and the Cambridge L- and S-Nav units.

1.7 <u>National regulations.</u> 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.

2. FIRMWARE

2.1 <u>Firmware Version.</u> IGC-approval applies to Version 4.1 and later. The version number is shown on the LCD on start up, and in the header record of the IGC file after HFRFWFIRMWAREVERSION. For notification of updates by the manufacturer or support agency, see para 11.

2.2 <u>Later Firmware Versions</u>. 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. The 2007 version is V6.0.

3. SOFTWARE

3.1 <u>DOS-based short program files.</u> For computers with a DOS capability, the DOS program files DATA-CAM, CONV-CAM, and VALI-CAM are available on the IGC web pages. 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, see 3.4 and B4. The company's DATA, CONV and VALI programs are copyright of the Recorder manufacturer and are freeware.
See also: Annex C Procedure for validating secure files with no IGC Compliant DLL

    3.1.1 <u>CAI Binary file needed for Validation</u>. However, note that VALI-CAM only works with the CAI binary file. It does not work with the IGC ASCII format that is converted from the *.CAI file for the same flight. It is therefore essential to keep the CAI binary file for a flight as well as the IGC-format file.

3.2 <u>MS Windows-based Utilities program.</u> For computers with a MS Windows capability, a Cambridge Utilities program can be obtained from the FAI GFAC website. Downloading gives the CAIUtilsSetup.exe file which, when executed, creates a CaiUtil.exe and other files, also sub-directories for Flights and Sites.

3.3 <u>Cambridge full software program</u>. Release V5.882E dated 2000 may be used, 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.

3.4 <u>Validity of Flight Data.</u> Whatever program is used for downloading from the recorder and conversion to the IGC format, the criterion for validity of data is that the CAI binary must pass the IGC VALIDATE check. That is, by using the MS-Windows-based Cambridge Utilities program, or for DOS systems, by using the VALI-CAM.EXE file. The IGC Validate system checks that the CAI file has correctly originated from the recorder, that the recorder is still secure and has not been tampered with. It also checks that the data in the file is identical to when it was initially downloaded. See also B3.3.1.1.

CONDITIONS OF APPROVAL

4. **Connections to the recorder module**.

   4.1 <u>GPS Receiver Antenna</u>. A 9mm circular BNC bayonet connector is fitted, except for Model 20 that has an integral antenna.

   4.2 <u>External power.</u>   A specially-wired 7x7mm RJ-11 connector is for a 12 Volt DC input.

   4.3 <u>Display port.</u> A 10mm 6x6mm RJ-12 connector is for 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.

   4.4 <u>Datacom Port.</u> A 10mm 6x6 RJ-12 connector is for NMEA 0183 GPS data to cockpit instruments such as the Cambridge S- or L-Nav.

   4.5 <u>D-type 17mm RS232 9-pin</u>.

      4.5.1. <u>During flight</u>. The 9-pin RS232 is used in flight with optional mini-PCs (PDAs) such as Palm Nav, Compaq etc for moving map and other displays.

      4.5.2. <u>On the ground</u>. The 9-pin RS232 is connected to a PC for downloading flight data from the recorder. Also, through the manufacturer's full software program, to set up the Recorder before flight.

5. **Security of the Equipment**. GFAC is presently satisfied with the physical and electronic security of this equipment in terms of the integrity   of the recorded flight data and the level of this approval for the types of flights concerned. See paras 9.1 and 9.2 on security seals. GFAC reserves the right to inspect production-standard equipment from time to time for security, general compliance with the IGC Specification and the calibration of sensors such as for pressure altitude.

6. **Installation in a glider**. From the point of view of data recording, the unit may be fitted anywhere in the glider, subject to para 9 on sealing and that in Motor Gliders the position is suitable for recording Engine Noise Levels (ENL). If the GPS antenna is accessible to the crew in flight, no attempt must be made to inject false data and any abuse of this may lead to a future requirement to place the antenna out of reach of the flight crew.

   6.1 <u>Cockpit Sight Lines</u>. Particularly in single-seat gliders, the position of any displays concerned with the recorder should not be remote from sight lines used for pilot lookout and scan for other aircraft and gliders.

7. **Motor Glider Engine Recording**. An ENL (Environmental Noise Level) recording system is fitted and when enabled (see Annex A   for method), acoustic noise levels at the recorder are recorded with each fix. This is essential for Motor Gliders in order to show that the engine was not run during the part of the flight that contains the claimed glide performance. ENL data has also been shown to be useful for non-motor gliders in the case of accidents and incidents.

   7.1 <u>ENL Recording System Manufacturer</u>. The ENL system in this recorder is made by Cambridge Aero Instruments and is the company's 1995 ENL system, the first for an IGC FR (a later ENL system was produced for the CAI 300 Series FR).

   7.2 <u>ENL figures</u>. ENL figures in each fix in the IGC file are between 000 and 195 in steps of 001. To obtain figures out of the more normal IGC maximum of 999, multiply the recorded ENL numbers by 5.12.

   7.3 <u>ENL IGC-approval - Engine Types</u>. This document gives IGC-approval for the use of the above system for the validation of glide (non-powered) performances to IGC standards of evidence when flown with Motor Gliders that have piston engines that give substantial acoustic noise levels at the FR, including when run at low power. For other types of engines, see para 7.6 below.

   7.4 <u>ENL System and Cockpit Positioning</u>. The recorder must be positioned in the glider so that it can receive a high level of engine-related noise whenever forward thrust is being generated (but see 7.5 below).

   7.5 <u>Low-ENL Engine/Recorder combinations</u>. This approval does not include cockpit mounting of the FR when used with engines that produce small ENL values at the Recorder, particularly at low power when just producing positive forward thrust. Such engines include those that are electrically or jet powered, the latter because the noise is at higher frequencies than those for which the ENL system is designed. It may also apply to some 4-stroke engine/propeller combinations that are particularly quiet. If the FR position produces low ENL values when the engine is run at low powers, there are two alternatives: (1) either the FR must be moved closer to the source of engine noise, or (2) another variable additional to ENL must be recorded in the IGC file under the MOP code, in accordance with Annex B to the Sporting Code for Gliding, para 1.4.2, particularly 1.4.2.4. A copy of the current SC3B para 1.4.2.4.1 follows, and is particularly applicable to models 20 and 25 because they are small and can be mounted near to the engine of a jet or the propeller of an electric motor glider.

      7.5.1 <u>Extract from SC3B</u>. <u>FR mounting near the engine or propeller</u>. Where cockpit or other mounting of an FR results in low ENL figures when the engine is run, an alternative to using an FR with an external MOP sensor is to mount an IGC-approved FR with ENL facilities in or near the engine-bay close to the engine and/or propeller. Such an installation of the FR in an individual motor glider must be inspected by an OO or NAC Official and documented for use in future claims. Flight testing must show substantially higher ENL figures when the engine is run at low power, compared to conditions met in engine-off soaring such as thermalling with cockpit panels and vents open. Claim documents must include evidence that the FR installation was as inspected, and that ENL figures in the IGC file are similar to those previously tested.

   7.6 <u>ENL testing</u>. For details of typical ENL values found on GFAC tests, see para B.4.

8. **Check of Installation**. There must be incontrovertible evidence that the recorder was in the glider for the flight concerned, and was installed in accordance with IGC procedures. This can be achieved either by observation at takeoff or landing, or by sealing the Recorder to the glider at any time or date before takeoff and checking the seal after landing.

8.1 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 Recorder installation is checked. This is to ensure that the installation is in accordance with the rules, and that another Recorder has not been substituted before the data is transferred to a PC after flight.

8.2 Sealing to the Glider before Flight. If para 8.1 cannot be met, the Recorder 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. It must be possible for the OO to recognise the seal markings afterwards. 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 Recorder 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 Recorder is sealed to such removable part, if such a part is transferred between gliders, any Recorder seal for the previous glider must be removed.

9 **Security Seals, Physical and Electronic**.

9.1 Physical Security. An internal security mechanism is included that activates if the case of the Recorder is opened. If the Recorder case has been opened, breaching physical security, on switching on, the LCD screen (if fitted) will show the unit serial identity and "GPS Recorder Un-Sealed" for a short time.

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

9.2. Electronic Security. If the internal security mechanism has been activated (such as by opening the case), any data in the memory will be lost, settings will revert to defaults, and the electronic security algorithms in the Recorder will be erased. Any flight data files subsequently produced will fail the IGC Validate test for electronic security. The Validate test will also fail if the CAI binary file is different to that initially downloaded from the Recorder.

9.3 Recorder found to be unsealed. If either physical or electronic security is found to have failed, the Recorder must be returned to the manufacturer or his appointed agent for investigation and resealing. A statement should be included on how the unit became unsealed.

9.3.1 Checks before re-sealing. Whenever any unit is resealed, the manufacturer or agent must carry out positive checks on the internal programs 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.

10. **Analysis of Flight Data**. Analysis for flights to be validated to IGC criteria should be through the use of a program that complies with IGC rules and procedures and is approved for this purpose by the relevant National Airsport Control authority (NAC.) For a list of programs which are capable of reading and displaying flight data in the *.IGC file format, see the fai.org/gliding/gnss web site under the link to SOFTWARE (the full web reference is at the beginning of this document). Before a Flight Performance is officially validated, the authority responsible for validation must check that the data in the CAI binary file has originated from the Recorder concerned, and is identical to when it was download from the Recorder to a PC. This is done by checking the CAI binary data file with an authorised copy of the VALI-CAM.EXE short program or by using the Cambridge Utilities program (for software programs, see para 3 above). See Annex B for detail on how to use the validate systems.

11. **Changes to Hardware, Firmware and Software**. Notification of any intended change to hardware, firmware or software must be made by the manufacturer or support agency to the Chairman of GFAC so that a decision can be made on any further testing which may be required to retain IGC-approval for the change. This includes details of later versions of hardware, firmware and software, also any changes to modules such as the GPS receiver, pressure altitude transducer, the layout of the security microswitch and any other factor that could affect the security of the FR and the IGC files produced from it.

Peter G H Purdie
Chairman, IGC GFA Committee
gfac@fai.org

Annexes:

A. Notes for owners and pilots.
B. Notes for Official Observers and NACs
C. Procedure for validating secure files with no IGC Compliant DLL

Annex A to IGC Approval Document - **NOTES FOR OWNERS AND PILOTS**

A(i) *Status.* *This is to be read together with the main terms of approval to which this is an Annex*
A(ii) *IGC-Approval level. See Page 1, para (i-ii).*
A(iii) *Copy of this document. It is recommended that a copy of this approval document is kept with the FR, for the use of pilots and OOs.*

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

A1. **Antenna**. The antenna should be positioned in order to give sufficient signal strength for IGC purposes. No attempt must be made to inject false 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 (Earth Model)**. For IGC purposes, all latitudes and longitudes recorded by the Recorder must be to a Geodetic Datum (earth model) of WGS84. For WGS84, the LCD must read "GPS Map Datum 100" on start-up. Flights where other Datums are set are not valid for IGC purposes. It should be ensured that other lat/long data such as for start, turn and finish points, is entered also to the WGS84 Geodetic Datum (IGC rule).

A3 **Setting the Fix Interval**. The fast-fix facility operates when the ON button is pressed and gives fixes at 2 second intervals for 30 seconds. The fix interval for cruise flight between PEV events (such as between Waypoints) is set by the pilot before flight through the set-up program. There is therefore no need to set a very short fix interval for cruise flight because points of interest can be marked by PEV events and take advantage of the fast fix facility. Setting a short fix interval for cruise flight leads to IGC files of large byte size, particularly for long flights. This uses up more of the recorder's memory, causes downloading after flight to take a long time, increases the chance of data corruption and may also cause problems with some analysis programs because of the large number of fixes that have to be processed.

> A3.1 <u>IGC rules</u>. IGC rules on fix intervals for cruise flight are an absolute maximum of 60 seconds (SC3 para 4.3.1 and Annex C to SC3, para 7.1) and 10 seconds for competitions complying with Annex A to SC3 (SC3A para 5.4C). SC3C para 7.1 says: "10 to 20 seconds has been found to be suitable, and does not use up as much memory as a more frequent setting for the whole flight. A more frequent fix interval is recommended near a Waypoint to ensure that a fix is recorded within its observation zone".

A4 **Checking the Recorder before a Claim Flight**. Pilots should check and analyse a selection of IGC files from their recorder before attempting flights that will require Validation. This is to ensure that the recorder is performing correctly and in accordance with this approval. Particularly that GPS fixes, pressure altitude and ENL values are recorded as expected. In particular, ENL values should be in accordance with the figures given in para B5. See also A8 on ENL and A13 on pressure altitude calibration.

A5 **Observing the Recorder 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, an OO should be asked to seal the Recorder to the glider, and this can be done at any time or date before flight. See para 8 in the conditions of approval. Regarding the position of displays concerned with the Recorder, see para 6 in the Conditions of Approval which refers to sight-lines and the need for pilot lookout and scan.

A6 **Independent Check of Takeoff**. The pilot must ensure that the time and point of takeoff has been independently witnessed and recorded for comparison with takeoff data in the IGC file from this recorder, see para B1.2.

A7 **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 Recorder. See para 9.1.1 in the Conditions of Approval.

A8 **Use in Motor Gliders**. See para 7 of the main body of this document before the annexes. The ENL system automatically records the level of acoustic noise at the recorder. The recorder must be placed so that engine noise is clearly received when the engine is giving any forward thrust and must not be covered or insulated (even so, automatic gain should continue to ensure high ENL readings under engine power).

> A8.1 <u>Cockpit Noise</u>. Pilots should note that cockpit noises other than the engine will produce ENL figures on the IGC file, and should avoid those that could be mistaken for use of engine. 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. This is magnified if sideslip is present and in particular at high airspeeds. High airspeeds with cockpit panels open should therefore be avoided in case the ENL recorded is mistaken for use of engine. High ENL may also be produced by stall buffet and spins, 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.

> A8.2 <u>Pilot check of ENL figures</u>. Pilots should check that the ENL figures produced by their recorder show a clear differentiation between engine-on and engine-off flight. ENL figures should be in accordance with those found in GFAC tests and listed in para B5. This may be vital on a later flight when a claim is made. If ENL figures are found to be significantly different to those in para B5, the recorder should be returned for the ENL system to be re-set.

A9 **After Landing**. Until an OO has witnessed the Recorder installation to the glider, the pilot must not alter the installation or remove the Recorder from the glider. The pilot must ensure that there is evidence of the landing independent of the FR data.

A9.1 After-flight calculation of security. After landing, the recorder calculates a digital signature for the IGC file for the flight. This places security codes at the end of the IGC file. These codes are used to verify the integrity of the whole file at any later time by using the Validate function.

A9.2 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-based 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 file. Both files must be sent to the agency responsible for validating the flight, such as the National Airsport Control Official Observer. If the CAI file is lost, so will 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, through the free CONV-CAM.exe program.

A10 **Independent Check of Landing** - The pilot must ensure that the time and point of landing has been witnessed and recorded for comparison with IGC file data from the recorder (see para B2.1).

A11 **Switching Off.** This is by switching off the external power or disconnecting the RJ11 connector from the recorder.

A12 **Downloading the Flight Data**. This is by connecting a PC to the RS232 socket on the recorder. The OO will carry out the actions given in para B3.3, and the OO's copy of the transferred flight data is sent to the organisation that will validate the flight, such as the National Airsport Control authority (NAC). The OO does not personally have to transfer the data from the Recorder, but witnesses the transfer and takes or is given a copy on standard electronic media such as a memory stick, diskette or equivalents. Different rules may apply for competition flights, for which a central data transfer facility may be used, but for a flight to the rules for IGC records and badges, the above continues to apply.

A12.1 Use of Portable PC at the glider. Transfer of flight data is witnessed by the OO, and the flight files in IGC format must be given to the OO for safe keeping and analysis on standard electronic media such as a memory stick, diskette or equivalents.

A13 **Calibration of Barograph Function**. Pilots are advised to have a barograph (pressure altitude) calibration carried out either by the manufacturer or by an NAC-approved calibrator before any GNSS Recorder is used for a claimed flight performance. For the procedure, see para B6. A valid IGC-format file showing the pressure steps used in the calibration must be recorded and kept (Sporting Code rule). Altitude and height claims require a calibration for the flight performance concerned, and speed and distance claims need a calibration for calculating the altitude difference of the glider at the start and finish points. Also, the NAC may wish to compare recorded pressure altitudes for takeoff and at landing, with QNH pressures for the appropriate times recorded by a local meteorological office.

A14 **Warnings**. In the course of GFAC testing, some features have been found which users should note.

A14.1. 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. For these recorders, which were designed before the current IGC Specification for Flight Recorders was published, 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.

A14.2. 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 Recorder 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.

A14.3 Warning on fitting the power plug. 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 Recorder 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 follows ---------

Annex B to IGC-approval document - **NOTES FOR OFFICIAL OBSERVERS AND NACs**

B(i)   *Status. This is to be read together with the main terms of approval to which this is an Annex.*
B(ii)   *IGC-Approval level. See Page 1, para (i-ii).*
B(iii)   *Copy of this document. It is recommended that a copy of this approval document is kept with the FR, for the use of pilots and OOs.*

B1 **Installation in the Glider**. It should be noted that, due to the portability of these FRs, particularly Models 20 and 25,, it would be possible to transfer the FR unit from one glider to another, or to a powered aircraft. Therefore, an OO shall witness and record the position of the Recorder in the glider, the type and Serial Identification (S/ID) of the Recorder, the glider type and registration, date and time. Before flight, if requested, the OO shall then seal the Recorder to the glider in a way acceptable to his NAC and to IGC, and such sealing may be at any time or date before flight. If sealing is not used, either a preflight check of the installation must be made after which the glider must be under continuous observation by an OO until it takes off on the claimed flight. Alternatively, an OO must witness the landing and have the glider under continuous observation until the Recorder installation is checked. This is to ensure that the installation is correct, and another Recorder has not been substituted in the glider before the data transfer (B3.3). See para 8 of the Conditions of Approval. Regarding the position of displays concerned with the Recorder, see para 6 in the Conditions of Approval which refers to sight-lines and the need for pilot lookout and scan.

B2 **Takeoff - Independent Evidence**. 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. After flight, this will be compared to the takeoff data from the Recorder.

B3 **Landing**

B3.1 Independent Evidence of 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. After flight, this will be compared to the landing data from the Recorder.

B3.2 Checking the Installation of the Recorder. As soon as practicable after landing, an OO shall inspect the installation of the Recorder in the glider (including any sealing to the glider), so that this can be compared to the check described in para B1 above. The transfer of flight data shall then take place in accordance with B3.3.

B3.3 Downloading the Flight Data. If a portable PC is available, the flight data may be transferred at the glider without disturbing the installation of the Recorder. If a portable PC is not available, the OO shall check and break any sealing to the glider, and take the Recorder 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 Recorder and IGC file which is then independently checked later by the body validating the flight (such as the Competition organization or the NAC).

B3.3.1 Method Either follow the menu in the MS Windows-based Cambridge Utilities program or execute the DOS file DATA-CAM.EXE. For his program and the DOS file, see para 3 on page 2 about software.

B3.3.1.1 DATA-CAM file. This can be executed on either a floppy diskette (which can be self-booting) or on the PC hard disk. The version of DATA-CAM is shown at the top of the menu (see under "Software" on page 1). 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.

B3.3.1.2 Latest versions. The latest versions of the CAI programs and files must be used. See para 3 on page 2 about software.

B3.3.2 Files produced. This process will automatically produce both a CAI binary format file and an IGC-format flight data file both with the file name YMDCXXXF, where Y=year, M=month, D=day, C= manufacturer, XXX = Recorder Serial Identification (S/ID)/letters and F = flight number of the day. The full key to the file name is in Appendix 1 to the IGC GNSS Recorder Specification and is also listed in Annex C to the Sporting Code, SC3C.

B3.3.3 OO's Copy. A copy of both the CAI and IGC files shall be retained securely by the OO such as by immediately copying them to a separate PC memory stick or card, or by the use of the OO's own PC. These files shall be retained by the OO in safe keeping for later checking and analysis under NAC/IGC procedures. Retaining the CAI file is of more importance because the IGC file can be generated from it at any time, for instance by using the free CONV-CAM program or the MS Windows equivalents.

B3.3.4 Competitions. Different rules may apply for competition flights, for which a central data transfer facility may be used. For ease of identification within the competition, file names may be changed, for instance to the glider competition number or the pilot's name. Integrity of data within the file is preserved by the electronic security system and may be checked at any time by using the IGC file validation system.

B4. **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 (list, see the IGC GNSS web site under SOFTWARE).   There are two aspects to data analysis, (1) checking the flight performance that is being claimed by using the fixes and other data in the IGC file, and (2) Validation of the integrity of the downloaded data itself. **With these recorders, only the CAI binary file can be validated, the manufacturer's software does not validate the IGC format file.** The IGC file can be generated from the CAI binary at any time. After the CAI file has been validated, flight analysis should be made on the IGC file that is then generated from it, not an older version of the IGC file (which could have been changed).

B4.1 Validation of Flight Data. The IGC Validation system checks three elements. (1) That the flight data in the IGC file is identical to that originally downloaded from the Recorder. (2) Checks the electronic security coding and general structure of the CAI

binary file. (3) Checks that the Recorder has not been modified in an unauthorised way.

B4.2 _Validation Method_. Either follow the menu in the MS Windows-based Cambridge Utilities program or execute the DOS file VALI-CAM.EXE with the CAI binary file for the flight. For this program and the DOS file see para 3 on page 2 about software. The program or DOS file that are used by the organisation validating the flight performance shall be the latest version. This shall be used by the OO, competition organisers, or the NAC as appropriate.

B4.2.1 _Validation indications_. 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 Recorder 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 Recorder.

B4.3 _Flight Analysis_. The CAI file that has just been Validated shall then be converted to IGC format by using an approved program, see para 3 on page 2 about software. 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.

B5. **Means of Propulsion (MoP) Record - Motor Gliders**. The MoP must either be sealed or inoperative, or the FR ENL system used. For the ENL system, see para 7 of the main body of this document before the annexes. For these FRs, ENL values in the ENL file are recorded up to a maximum of 195. For comparison with later recorders that use the full ENL range from 000 to 999, the figures from these 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. Adding a zero to the percentage gives a figure similar to those in IGC files from later types of Recorders.

B5.1. _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.

B5.2. _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 with this recorder, but previous tests with Wankel engines indicate that they produce similar ENL values to 4-strokes. 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.

B5.2.1 _Electric, Jet and other types of engines_. This approval does not include use with Motor Gliders with electric, jet or other engines that produce small ENL values at the FR, for these see Para 7 in the Conditions of Approval.

B5.3. _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.

B5.4. _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.

B5.5. _ENL during landing_. During ground contact during takeoff and landing, short-duration ENL readings up to 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.

B5.6. _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 (for address, see before the Annexes).

B6 **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 Recorder must be calibrated in an altitude chamber in the same way as a drum barograph.

B6.1 Calibration method, making a calibration table. Before a calibration, owners are advised to set the normal fix rate to a small time interval such as 2 seconds. Recording starts after a pressure change of 1 metre per second for 5 seconds, and no GPS fixes are required for a pressure altitude trace to be produced. The calibrator should be advised to make a short pressure change to trigger (start) the recording of fixes, before starting the calibration itself. The calibrator will record the pressure steps used, for later comparison with the flight file. 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.

B6.1.1 After the calibration – the data file containing the pressure steps is transferred to a PC as if it was flight data (see B3.3 above); this may be done by an NAC-approved person other than the calibrator who may not have this knowledge. The IGC format calibration data file will then be analyzed, compared to the calibration pressure steps, and a correction table produced and authenticated by an NAC-approved person (for instance an OO or GNSS Recorder 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 if pressure altitude is not available.

B6.2 GPS altitude figures recorded in the IGC file. Occasional short-duration differences in the shape of the GPS Altitude/time graph have been noted compared to the pressure altitude figures. This is not unusual with GPS receivers operating without a local differential beacon or regional augmentation system such as WAAS for North America, EGNOS for Europe and similar systems elsewhere (for details see the web or the Glossary to the IGC GNSS Recorder Specification). Errors in altitude from satellite-based systems will be about twice those for lat/long because the geometry of the position-lines is not as favourable for altitude compared to horizontal position. This effect will be increased by poor antenna positioning. 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 on this recorder 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 for civilian receivers, errors average between 11 and 12m. This is the average lat/long error taken from a sample of fixes from a moving vehicle at a number of surveyed points near 51N 001W for all recorders with 12 or more channels. OOs, data analysts and NAC officials should allow for the above when comparing the values of GPS altitude and pressure altitude.

B6.3 Maximum Altitudes Recorded in the IGC file. The pressure altitude sensor and the GPS system itself are capable of recording to almost unlimited altitudes, certainly up to 30km/100,000ft. However, the type of processor in the recorder and the need for good resolution (small steps) across the altitude range, results in limitations in altitudes that can be recorded in the IGC file. The maximum altitudes for figures in IGC files that apply to this recorder are given below.

B6.3.1 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.

B6.3.2 GNSS altitude. This is recorded up to 65,000ft (19,812m) above the WGS84 ellipsoid, but is not used for the precise measurement of IGC altitudes, for which pressure altitude to the ICAO ISA is required.

-----------Annex C follows----------

Annex C to IGC-approval document – VALIDATING SECURE FLIGHT RECORDER WITH NO IGC COMPLIANT DLL

C(i)   Status. This is to be read together with the main terms of approval to which this is an Annex.
C(ii)   IGC-Approval level. See Page 1, para (i-ii).
C(iii) Copy of this document. It is recommended that a copy of this approval document is kept with the FR, for the use of pilots and OOs.

C1.   This Annex is intended for Official Observers reviewing Performance Claims by Flight Recorders where no IGC-Compliant DLL has been provided by the Manufacturer.

C2.   Downloading of Flight Recorders is the Pilot's responsibility and is outside the scope of this Annex.

C3.   The older DOS programs provided by manufacturers are 16-bit programs, which will not run on modern 64-bit PC Operating Systems. This problem does not affect 32-bit Operating Systems.

C4   There is in fact more than one solution, but this is a solution that should resolve the problem in all cases. The solution recommended by GFAC is to validate claims in the DOS environment provided by DOSBOX, an X86 emulator. DOSBOX can be downloaded from https://www.dosbox.com/ where you will also find Tutorials and a Manual. The installation is very simple and does not need further explanation here.

C5   Having Installed DOSBOX, there is a configuration file:
       C:\Users*myusername*\AppData\Local\DOSBox\dosbox-0.74-2.conf
There should be no need to alter the configuration, but you may find it useful to add actions to be taken every time the environment is created in the [autoexec] section.   For instance, you may find it useful to put all the DOS programs into a single folder and then edit the config file [autoexec] section as follows:

```
[autoexec]
# Lines in this section will be run at startup.
# You can put your MOUNT lines here.:
mount C: C:\Users\myusername\Documents\myfolder
mount D: C:\Users\myusername\Documents\LIB
C:
PATH=D:\;Z:\
```

Use a simple text editor for this (such as notepad) and not a Word Processor (such as Word) to edit the Windows file

```
C:\Users\myusername\AppData\Local\DOSBox\dosbox-0.74-2.conf
```

(or whatever it is called in your version of Windows). Do not attempt to edit in DOSBOX.

In the above example, in DOSBOX; C: is your working folder and D: is your library folder. Note that when a drive is MOUNTed, it is in fact a windows folder. It is bad practice to mount a physical drive.
An alternative, simpler approach would be to put programs and data files in the same location.

```
[autoexec]
# Lines in this section will be run at startup.
# You can put your MOUNT lines here.:
mount C: C:\Users\myusername\Documents\myfolder
C:
```

Where myfolder contains both.

For more information on the MOUNT command please refer to the DOSBOX manual. You are now ready to validate your first claim.

C6   Validating an IGC file.
       Proceed as follows:
       C6.1. Load DOSBOX.
       C6.2. Copy the IGC file to be validated to c:\Users\myusername\Documents\myfolder
       C6.3. In DOSBOX use the command RESCAN to update the drive contents lists. THIS IS MOST IMPORTANT.
       C6.4. Use the command VALI-xxx filename.igc where xxx is the three-letter-code of the manufacturer and filename.igc is the name of the file to be validated. If you need to convert a Flight Recorder binary file (such as filename.ZAN) to an IGC file, this can be done in the DOSBOX environment using CONV-xxx instead of VALI-xxx.

C7.   Exceptions. It has been found that it may be necessary to copy VALI-ZAN.EXE from D: to C: for correct operation. The reason for this is not clear.

C8   Comments. Any comments should be addressed to gfac@fai.org