GNSS FLIGHT RECORDER APPROVAL COMMITTEE (GFAC)
FAI 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: IGC GNSS web site under https://www.fai.org/page/igc-approved-flight-recorders
        FR Manufacturer, igc-news@fai.org , Newsgroup: rec.aviation.soaring   Date of issue: 31 July 2023

IGC-APPROVAL FOR GNSS FLIGHT RECORDER
Recorder name: Cambridge 302 series
Level of Approval: See para (i-ii) below

(i) General. This document gives formal approval from the above date for the Flight Recorder (FR) 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 and 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-approval documents currently posted on the IGC web site are valid for use for IGC/FAI claims, and IGC reserves the right to alter this approval in the future.

(i-i) Document history. The first IGC-approval for the 302 Series was issued on 30 October 2001 to the Cambridge operation, then based in Vermont, USA. An update adding a noise recording (ENL) system for motor gliders was issued in January 2003. Another update adding the simpler 302A model was issued in August 2003. An update in November 2003 changed the Manufacturer's address from Vermont to the new management near Memphis, Tennessee, USA, and an update dated 12 April 2007 updated the wording to that used in other IGC-approval documents. A change of IGC-approval level was notified in this document dated 20 October 2019, and the change was made on 1 January 2020, see (i-ii) below. 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 a new para (i-iv) with directions to the current web sites for documents related to the FR IGC-approval process, and the GFAC Chairman's new email address on page 4. 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) IGC-approval Level. This is IGC Level 2 (all IGC badges and distance diplomas). The Levels of IGC-approval are listed in the Sporting Code for Gliding, Annex B para 1.1.4. This type of FR may also be used in gliding and FAI competitions and events to which the IGC Level 2 recorder standard applies. The rules and procedures for World Gliding Championships (and other Competitions that use the same rules) are given in Annex A to the Sporting Code for Gliding (SC3A). Until the end of 2019 the IGC-approval level was Level 1 (all flights including world records), but this was changed due to increases in IGC Specification conditions for Level 1 that are not met by this type of FR.

(i-iii) GNSS System. The Global Navigation Satellite System (GNSS) in this Recorder is the US NAVSTAR Global Positioning System (GPS).

(i-iv) Current web sites. 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 https://www.fai.org/page/igc-approved-flight-recorders 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) Equipment Functions. 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) Intellectual Property. 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) FAI Sporting Code Section 3. 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" and is also available through the IGC GNSS web site shown above.

(v) Keep with the Equipment. 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.

MANUFACTURER

Three-letter manufacturer IDs in IGC-format files, CAM;   one letter, C.

The original manufacturer was Cambridge Aero Instruments (CAI) Inc, which no longer exists as a Registered Company. Since March 2023 these recorders no longer have any manufacturer support.

1. HARDWARE

1.1 <u>Type of Recorder</u>. This recorder is designed for mounting in an instrument panel with a 57mm (2.2 inch) cut-out, but can also be mounted elsewhere in the cockpit.

1.2 <u>Hardware Versions</u>. This approval applies to Version 2.0 or later. The version is shown in the header record of IGC-format flight files in the form "HF RHW Hardware version: 300 Series 2.0". Further hardware details are in the Logbook (L-) record in the IGC file.

1.3 <u>Models - 302 and 302A</u>. The description below refers to the 302 model with LCD. In the simpler 302A model, the front face has a green GPS status light and a Pilot Event (PEV)/fast fix button instead of the LCD and changes from the main 302 model are shown below between [square] brackets.

1.4 <u>Dimensions, weight, connectors</u>.

    1.4.1 <u>Dimensions</u>. The metal case of the recorder is about 138 mm long with 62 x 62 mm ends. It is designed for mounting in an instrument panel with a 57mm (2.2 inch) circular cut-out.

    1.4.2 <u>Weight</u>. Weight with LCD is about 400 grammes and 350gm for the 302A model without LCD.

    1.4.3 <u>Connections</u>. Three pressure tube connections project about 17mm at the back and a control knob projects about 15mm at the front [302A model, no pressure tube connections or front control knob]. Electrical connectors are at the back at the opposite end to the 50mm diameter circular display [except in the 302A that has no display]. Connectors are described in more detail below.

    1.4.4 <u>Display</u>. The instrument display, where fitted, includes an analogue variometer needle and an outer scale, with a 35mm diameter LCD inset in the middle and a knob on the bottom left corner that can be pushed and rotated. In the 302A model, the LCD is replaced by a green GPS status light and a button that when pressed gives a Pilot Event (PEV) and a series of fast fixes.

    1.4.5 <u>Serial Identification (S/ID)</u>. The unique three-character Serial Identification (S/ID) for each individual recorder is inscribed on the variometer scale at about the 4 o'clock position [for the 302A on the front face].

1.5 <u>GPS receiver</u>. A Garmin GPS25-LVC parallel receiver is fitted, capable of receiving data from up to 12 satellites for any one fix.

1.6 <u>Pressure altitude sensor</u>. A MS 5534-AP pressure sensor by Intersema Sensoric SA of Switzerland, now owned by TE Connectivity is fitted. This is compensated for temperature variation and calibrated to the ICAO ISA. The recorder case is not pressure-sealed and "cockpit static" pressure is recorded on the IGC file. The type of sensor is shown in the header record of IGC-format flight files in the form "HFPRSPRESSALTSENSOR:INTERSEMA,MS5534A" which can be seen by using a text editor to view the start of the IGC file.

1.7 <u>Other modules</u>. Other modules such as for cockpit Personal Digital Assistants (PDAs) may be connected, but are not part of this IGCapproval and are a matter between the manufacturer and the customer.

1.8 <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

This approval is for firmware Version 2.0 or later, where the later versions are IGC-approved. V2.0 was for the original models without the motor glider noise recording (ENL) system. Version 2.6 or later is for recorders with the ENL system. The version is shown in the header record of IGC-format flight files in the form "HF RFW Firmware Version: 2.6". Further firmware details are in the L (Logbook) record in the IGC file.

3. SOFTWARE

3.1 <u>MS Windows program</u>. A Utilities Program for the Cambridge 302 (3 UTP C) can be obtained from the Manufacturer contact at the top of page 2. This uses the file 3UTPC257.zip or later versions (the numbers are the version, in this case 257). When un-zipped, this produces the file 3UTPC257.exe that enables downloading from the recorder and validation of Cambridge 302 IGC files. For downloading, see B3.3.1.1 and for file validation see B4.

3.2 <u>DOS-based short program files</u>. For computers with a DOS capability, the short program files DATA2CAM and VALI2CAM are available on the IGC web pages and also from the Manufacturer contact at the top of page 2. DATACAM2.EXE is for transferring flight data from the FR to a PC and automatically produces an IGC file for the last flight, leaving a menu on screen for transfer of other flight data. The file VALICAM2.EXE checks the security of the IGC file and ensures that the IGC file is identical to that initially downloaded. These program files are not backward compatible with the earlier Cambridge models 10, 20 and 25 for which the short program file names are DATA-CAM.EXE and VALI-CAM.EXE. DATACAM2 Version 1.0.0 or later can be used with units without the ENL function. DATACAM2.EXE Version 1.0.2 or later is for units with the noise recording (ENL) system.

3.3 <u>Validity of Flight Data</u>. Whatever program is used for downloading the IGC file from the recorder, the criterion for validity of data is that the IGC file must pass the IGC Validate check. That is, by using the "Verify Files" function in the Utilities Program for the Cambridge 302 (3 UTP C) Utilities Program for the Cambridge 302 (3.1 above), or for DOS systems, by using the VALI-CAM2.EXE file (3.2 above). The IGC Validate system checks that the CAI file has correctly originated from the recorder, that the recorder is still secure, has not been tampered with, and that data in the file is identical to when it was initially downloaded. See also B3.3.1.1.

CONDITIONS OF APPROVAL

4. **Connections**. All connectors are at the opposite end of the case to the instrument face.

4.1 <u>GPS Antenna</u>. The recorder case has a screw type SMC (Sub-Miniature Type C) coaxial cable connector with a 4mm diameter thread. This connects to a 3.5mm screw fitting on the end of the antenna cable.

4.2 <u>Power and other functions</u>. A custom-wired plug-in PCB (Printed Circuit Board) Mounting terminal block (type Weidmuller BL3 5/10) has 10 pins at 3.5mm pitch. This is for power (auxiliary battery and glider power), Ground Hold/Gear/Spoiler switches, External Speaker, and Pilot Event (PEV marker).

4.3 <u>Data Download</u>. Male 9-pin RS232 connector to the 9-pin female RS232 connector on the case, for transfer of flight and other data to and from a PC, including to a PDA during flight.

4.4 <u>Extra Display</u>. Female 6 pin RJ-11 connector. Mainly for connection of the company's GPS-Nav LCD. This connector uses IIC protocols.

4.5 <u>Pressure Connectors</u>. Three 6mm diameter pressure connectors from top to bottom when mounted in the panel at the correct orientation: static, pitot (airspeed), and total energy static (not fitted to 302A model).

4.6 <u>Other Modules</u>. Other modules and functions external to the 302 recorder/display movement have not been tested as part of this IGC-approval and are a matter between the manufacturer and customers. These include the switches for glider functions, PDA and external LCD that are mentioned above.

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**. This type of recorder is designed for mounting in an instrument panel, but from the point of view of data recording, the unit may be fitted anywhere in the glider, subject to para 9 on sealing and in Motor Gliders that 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. **Cockpit Noise Level Recording - ENL system**. Other than early models of this recorder, an ENL (Engine Noise Level) system is fitted that records acoustic noise levels at the recorder 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 and is optimised for this type of recorder. It is different to the ENL system fitted to earlier Cambridge recorders.

7.2 <u>ENL figures</u>. ENL figures in each fix in the IGC file are between 000 and 996 in steps of 004.

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 internal-combustion engines that give substantial acoustic noise levels in the cockpit.

7.3.1 <u>Electric or other Quiet Engines</u>. This approval does not include use with Motor Gliders with electric or other engines that produce little noise in the cockpit, particularly under reduced power such as for level flight. If an electric or other quiet engine is to be used, GFAC should be notified beforehand so that tests can be carried out.

7.4 <u>ENL System and Cockpit Positioning</u>. A microphone and frequency filter and weighting system automatically produces an ENL (Engine Noise Level) value with each fix. The system is designed to highlight any engine noise but to produce low ENL values in gliding flight. The recorder must be positioned in the glider so that it can receive a high level of engine and propeller noise when forward thrust is being generated.

7.5 <u>ENL testing</u>. GFAC has tested the Recorder in motor gliders with different types of internal-combustion engines, but not with electric or other power sources that produce little noise in the cockpit. Typical ENL values are in para B.4.

8. **<u>Check of Installation in the Glider</u>**. There must be incontrovertible evidence that the particular recorder was present in the glider for the flight concerned. As this system is designed primarily for panel mounting, this should be straightforward. For recorders that are not part of a fixed panel-mounted installation, 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. A signed and dated Official Observer' (OO's) seal applied to the recorder at an appropriate place will fulfil this requirement until the seal may require replacement due to damage or wear.

8.1 <u>Observation of Installation before Takeoff or at Landing</u>. For recorders that are not part of a fixed panel-mounted installation, the recorder may be sealed to the glider in accordance with 8.2. Otherwise, either a pre-flight check of the installation must be made and the glider must be under continuous observation by an Official Observer (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. This is less critical with a panel-mounted instrument compared to one that is mounted elsewhere in the cockpit, but nevertheless the possibility still exists that the installation could be changed in an unauthorised way unless independent checks are made.

8.2 <u>Sealing to the Glider before Flight</u>. For recorders that are not part of a fixed panel-mounted installation, if direct observation under para 8.1 cannot be achieved, 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 across the join in the seal 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 FR unit to glider parts which 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.

9 <u>**Security Seals, Physical and Electronic**</u>.

9.1 <u>Physical Security</u>. A silver-coloured tamper-evident seal with the manufacturer's name is fitted over at least one of the case securing screws. In addition, an internal security mechanism is included that activates if the case of the FR is opened. If the FR case has been opened, breaching physical security, a message indicating that the unit is insecure appears on the LCD on switch-on, and subsequent IGC files will fail the VALI check (see 3.3 above and para B3).

9.1.1 <u>Sealing of data ports and plugs</u>: no present requirement, but no attempt must be made to pass unauthorised data into the FR.

9.2. <u>Electronic Security</u>. 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 FR will be deleted. Any flight data files subsequently produced will fail the IGC Validate test for electronic security. This test will also fail if the IGC file is not identical to that initially downloaded.

9.3 <u>Recorder found to be unsealed</u>. 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 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 IGC file has originated from the Recorder concerned, and is identical to that initially download from the Recorder to a PC. This is done by checking the IGC data file with the IGC Validation program system (see 3.3 above and B3).

11 **Manufacturer's Changes, later Versions of Hardware, Firmware and Software**. Notification of any intended change to hardware, firmware or software or to the manufacturer's status or details must be made by the manufacturer to the Chairman of GFAC. This is so that a decision can be made on any update of this IGC-approval or on further testing which may be required to retain IGC-approval for the change. This includes changes of any sort, large or small. It includes details of later Versions of hardware, firmware and software, also any changes to modules such as GPS receiver boards, pressure altitude transducers and the layout of the security microswitch and its shielding from possible interference. If in doubt, GFAC should be notified so that the responsibility for any possible action passes from the manufacturer to GFAC.

Peter G H Purdie
Chairman, IGC GNSS Flight Recorder Approval Committee (GFAC)
gfac@fai.org

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

NOTES FOR OWNERS AND PILOTS
PART OF IGC APPROVAL FOR CAMBRIDGE 302 GPS RECORDER

A(i)   *Status*. *This Annex should be read together with the main terms of approval to which this is an integral part.*

A(ii)   *IGC-Approval level*. *See para (i-ii) on page 1*

A(iii)   *Copy of this document*. *It is recommended that a copy of this approval document 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:

A.1 **Antenna** - That the antenna is positioned in order to give sufficient signal strength for IGC purposes, and that the connector is firmly screwed and lightly fixed with locking agent so that it cannot be loosened or become detached due to vibration or turbulence in flight. The locking agent used should prevent it from inadvertent un-screwing but enable it to be unscrewed later if required. No deliberate attempt must be made to inject data via the antenna, and any abuse of this may lead to a future requirement to position antennas out of reach of the flight crew.

A.2 **Geodetic Datum**. Latitudes and longitudes recorded by the FR must be to the WGS84 Geodetic Datum, or the flight data will be invalid for IGC purposes. This recorder is fixed on the WGS84 Datum. No pilot action is required except to ensure that other lat/long data such as for start, turn and finish points, is also entered to the WGS84 Geodetic Datum (IGC rule).

A3 **Setting the Fix Interval**. The fast-fix and Pilot Event (PEV) facility 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 *IGC rules*. 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 recorder 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 6 in the Conditions of Approval in this document .

    A5.1 *External View and Sight Lines*. On the position of any visual displays connected to the FR, see para 6.1 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. 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**. The internal microphone and associated circuitry automatically records the level of acoustic noise at the recorder. This is recorded in the IGC file with each fix. The recorder must be placed so that engine noise is clearly received when the engine is giving power and must not be covered or insulated (even so, automatic gain should continue to ensure high ENL readings under engine power).

   A8.1 Cockpit Noise. 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 Pilot check of ENL figures. 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 similar to 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 to the manufacturer 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 flight recorder data.

   A9.1 After-flight calculation of security. After landing, the recorder calculates a digital signature for the IGC file for the flight, using a public/private key encryption system. This process places security codes at the end of the IGC file for the last flight, which is then complete and stored in the memory ready for downloading. These codes are used to verify the integrity of the whole file at any later time by using the Validate function (see paras 9.2 and 10 in the main section).

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 external power.

A12 **Downloading the Flight Data**. This is by connecting a PC to the RS232 socket on the recorder. For Software, see para 3 before the Conditions of Approval earlier in this document. 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. The PC used may be owned by the pilot or any other person. The PC should be set up for ease of data transfer. 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 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.

NOTES FOR OFFICIAL OBSERVERS AND NACs -
PART OF IGC APPROVAL FOR CAMBRIDGE 302 GPS RECORDER

B(i)   *Status*. *This Annex should be read together with the main terms of approval to which this is an integral part.*

B(ii)   *IGC-Approval level*. *See para (i-ii) on page 1*

B(iii)   *Copy of this document*. *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 in the Glider**. An OO shall record the position of the FR in the glider, the type and Serial Identification (S/ID) of the particular FR, the glider type and registration, date and time. The Serial Identification (S/ID) of each individual recorder consists of three characters made up of letters and/or numbers and is shown on the outside of the variometer scale at about the 4 o'clock position. Regarding the position of any ancillary displays connected to the FR, see para 6.1 in the Conditions of Approval which refers to sight-lines and the need for pilot lookout and scan.

B1.1. Recorder not in Instrument Panel. If the recorder is not in the instrument panel, before flight the glider shall either be observed or the recorder sealed to the glider. If sealing is to be used, the OO shall seal the FR to the glider in a way acceptable to the 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, 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 correct, and that another FR has not been substituted in the glider before the data transfer (B2.3).

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. As this recorder is normally in a fixed mounting in the instrument panel, this should be straightforward. The transfer of flight data shall then take place in accordance with B3.3.

B3.3   Downloading the Flight Data.   Where the recorder is in a fixed mounting in the instrument panel, the flight data should be downloaded to a PC at the glider without disturbing the installation of the Recorder. 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 organisation validating the flight (such as the Competition organization or the NAC). If the recorder is not panel-mounted, the data can still be downloaded at the glider but 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.

B3.3.1   Method. Use a connector cable that has a 9-pin RS232 male connector for the plug at the back of the recorder and a RS232 female connector for the PC, or an appropriate connector to a PDA.   If the back of the instrument panel is difficult to access, this cable should be fixed to the recorder and the other end placed in an accessible position. Then, for a PC either follow the menu in the MS Windows-based Cambridge 302 Utilities Program or execute the DOS file DATACAM2.EXE; for a PDA use the Pocket PC based Cambridge 302 utility program. These programs and the DOS file are available on the IGC GNSS web pages (see the list of web references at the front of this document).

B3.3.1.1   Cambridge 302 Utilities Program. For software programs, see para 3 on page 3. The menu for the Utilities Program for the Cambridge 302 is obtained by executing the file 3UTPC257.exe on a PC or 3UTIQ257 on a PDA. This enables downloading from the recorder and also validation of Cambridge 302 IGC files on initial download and at any later time. For downloading, call up the menu and use the button "Transfer Flight Logs" followed by "Transfer". The Utilities Programs are in the file 3UTxx257.zip. When un-zipped, this produces the files 3UTPC257.exe (to run directly on a PC) and.3UTIQ257.exe (to transfer to a PDA).

B3.3.1.2 <u>DATACAM2 file</u>. This file can be executed on the PC hard disk, on portable storage media such a memory card or stick, or on a floppy diskette (which can be self-booting).. The version of DATACAM2 is shown at the top of the menu (see under "Software" on page 1). It executes in the normal way such as by typing "DATACAM2, enter", at a DOS prompt, or by double-clicking "DATACAM2" in a file list (File Manager/Windows Explorer, etc), and then following the menu actions in the DATACAM2 file. This will produce the IGC file for the flight concerned. In the event of any problems in getting DATACAM2 to work through the hard disk of a PC, try installing it on a self-booting floppy diskette, re-boot to the diskette and type "DATACAM2".

B3.3.1.3 <u>Latest versions</u>. The latest versions of the CAI programs and files must be used, for these, see para 3 at the top of page 3 about software.

B3.3.4 <u>Files produced</u>. This process will produce an IGC-format flight data file 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.

B3.3.5 <u>OO's Copy</u>. A copy of the IGC file shall be retained securely by the OO such as by immediately copying it 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.

B3.3.6 <u>Competitions</u>. Different rules may apply for competition flights, for which a central data transfer facility may be used. However, as this model is designed for panel mounting, arrangements should be made with the organisers for data transfer at the glider. 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.   <u>Analysis of Flight Data Files</u>. 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, checking the flight performance that is being claimed by using the fixes and other data in the IGC file, and Validation of the integrity of the downloaded data itself.

B4.1 <u>Validation of Flight Data</u>. The IGC Validation system checks three elements: (1) That the flight data in the IGC file is identical to that originally downloaded from the FR. (2) Checks the electronic security coding and general structure of the IGC file. (3) Checks that the Recorder has not been opened or modified in an unauthorised way.

B4.2 <u>Validation Method</u>. 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. This program and the DOS file are available on the IGC GNSS web pages (see the list of web references at the front of this document). The program or DOS file that are used by the organisation validating the flight performance shall be identical to those available on the current IGC GNSS web pages. This system shall be used by the OO, the competition organisers, or the NAC as appropriate.

B4.2.1 <u>Latest versions</u>. The latest versions of the CAI programs and files must be used, see para 3 on page 3 about software.

B4.2.2 <u>Cambridge 302 Utilities Program</u>. The menu for the Utilities Program for the Cambridge 302 (3 UTP C) is obtained by executing the file 3UTPC257.exe. This enables the validation of Cambridge 302 IGC files on initial download and at any later time. For downloading, call up the menu and use the button "Transfer Flight Logs" followed by "Transfer". After the file is downloaded its validation status is shown on screen. For validation of an existing IGC file, select "Transfer Flight Logs", ignore any message about Com ports (a Com port is not needed to Validate a file already in the PC) then select "Verify Files" and go to the file that is to be validated. The Utilities Program is in the file 3UTPC256.zip. When un-zipped, this produces the file 3UTPC256.exe.

B4.2.3 <u>DOS File VALICAM2.EXE</u>. This file can be executed on the PC hard disk, on portable storage media such a memory card or stick, or on a floppy diskette (which can be self-booting).. The version of VALICAM2 is shown at the top of the menu (see under "Software" on page 1). At the appropriate prompt or run function, type VALICAM2 followed by a space and the name of the file to be checked. In the event of any problems in getting VALICAM2 to work through the hard disk of a PC, try installing it on a self-booting floppy diskette together with the files to be checked. Re-boot to the diskette and type "VALICAM2" followed by the file name of the IGC file to be checked.

B4.2.4 <u>Validation indications</u>. For the CAI Utilities program and the VALICAM2.exe program file described above, if the file data integrity is good, the following message will appear: "Log Data Integrity OK, Signature Data Integrity OK, Security OK". For the IGC file to be used as evidence to IGC standards, all three elements must be shown as "OK".

B4.2.4.1 <u>Log Data Integrity and Signature Data Integrity</u> - indicate to a high probability whether the data in the file is the same as the data that was supposed to be transferred. The purpose of these is to indicate any errors during the transfer of data from the recorder to the PC.

B4.2.4.1.1 <u>Log Data Integrity</u> - refers to a 32 bit CRC check sum of all of the data in the file except the Security Signature (G-Record). This check sum is calculated on the data as it was transferred from the recorder. It does not indicate whether the recorder itself was secure.

B4.2.4.1.2 <u>Signature Data Integrity</u> - refers to a 32 bit CRC check sum of the Security Signature (the G Record at the end of the IGC file). This check sum is calculated on the signature data as it was transferred from the recorder. It does not indicate whether the recorder itself was secure.

B4.2.4.2 <u>Security OK</u> - indicates that the IGC file contents passed the electronic security check, using the DSA system with a large length of private key.

B4.2.4.3 <u>Validation problems</u>. If there is a problem, OK in the headings above will be replaced by "Fail". In this case the NAC or other validating authority must investigate the reason.

B4.2.4.4 <u>GFAC tests</u>. GFAC tests include ensuring that the change of a single character in the flight data of an otherwise-correct IGC file, cause the VALI program to fail as indicated above.

B5 **Means of Propulsion (MoP) Record - Motor Gliders**. The MoP must either be sealed or inoperative, or the recorder's built-in microphone system used. This records noise level at the recorder and appears in the IGC file as three numbers between 000 and 999 with each fix on the IGC file, under the Three-Letter Code ENL (Engine Noise Level). See para 7 (before the annexes) for more details on the ENL system. ENL values recorded on GFAC tests are given below, in the sequence of a flight.

B5.1 <u>ENL during launching</u>. During winch and aerotow launches, higher average ENL values are to be expected than when soaring (B5.3). Up to ENL 200 for winch and 150 for aerotow have been recorded. During the ground roll, short-term higher values up to 400 have been seen, probably due to wheel rumble, particularly on hard surfaces.

B5.2 <u>ENL during engine running</u>. On engine running at powers needed to climb, an increase to an average of over 700 ENL is expected. Over 850 is typical for a two-stroke engine, over 700 for a 4-stroke. An ENL value of 996 has been recorded with both two- and four-stroke engines 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. Wankel (rotary) and electric engines have not been tested. In other tests, Wankel engines have produced similar ENL values to 4-strokes.

B5.2.1 <u>Low-ENL engines</u>. This approval does not include use with Motor Gliders with electric or other engines that produce low ENL at the recorder (see Para 7.3 in the Conditions of Approval). If a low-ENL engine is to be used, GFAC must be contacted as soon as possible so that tests can be carried out.

B5.3 <u>ENL during gliding flight</u>. ENL readings of less than 050 indicate normal gliding flight in a quiet cockpit in a well-sealed glider. In a high-speed glide or in an aerodynamically-noisy glider, ENL may increase to about 200. Short periods of higher ENL while gliding (up to about 300 ENL) may indicate aerodynamic noises such as due to airbrakes, lowering the undercarriage, sideslip, etc, and are normal before landing. Particularly, sideslip or high speed with the cockpit Direct Vision (DV) or ventilation panel(s) open can produce low frequency noise ("organ-pipe" effect) and ENL readings of up to 450 have been recorded. High ENL may also be recorded during stalling and spinning, particularly if the engine doors flutter or vibrate (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. <u>ENL during the approach to land</u>. ENL values are always higher on a landing approach due to aerodynamic noises such as due to airbrakes, undercarriage, sideslip, turbulence, 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 300 have been recorded, although 200 is more typical in an aerodynamically noisy glider, and 100 in a quiet machine.

B5.5 <u>ENL during landing</u>. During ground contact during landing, short-duration ENL values up to 500 have been recorded, probably due to wheel squeak and rumble, particularly on hard surfaces. Unlike engine running, these last only for a short time, showing a short spike on the noise/time record.

B5.6. <u>ENL analysis</u>. 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 will be analysed in accordance with Sporting Code procedures. Part of this is to compare the general shapes of the GNSS and pressure altitude fix records with time and to ensure that no major differences are seen that could indicate malpractice or manufactured (false) data. As part of this process, the FR is calibrated in an altitude chamber.

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 1 or 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 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 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. GFAC tests show average errors between 11 and 12m. This is based on lat/long errors measured from a sample of fixes from a moving vehicle at a number of surveyed points near 51N 001W. 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 (lack of large 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. Recorded up to 20km (65,617ft).

B6.3.2 GNSS altitude. Recorded between minus 1.5km up to 18km (-4,921 to 59,066ft), as specified by the GPS receiver board manufacturer.