



References: See para (i-iv) below

To: IGC GNSS web site under "IGC-approval Documents"
FR Manufacturer; info to igc-news@fai.org, newsgroup rec.aviation.soaing

Date of issue: 31 July 2023

IGC-APPROVAL DOCUMENT FOR GNSS FLIGHT RECORDER
Manufacturer - Recorder Name: LX Navigation - Colibri X
Level of Approval: IGC Level 1 - see para (i-ii) below

(i) General. This document gives formal approval from the above date for the Recorder equipment described below to be used for validation of flights under the FAI Sporting Code Section 3 (Gliders and Motor Gliders), subject to the conditions and notes given later. Only the terms of the latest IGC-approval documents currently posted on the IGC web site are valid for use for IGC/FAI claims. IGC reserves the right to alter this approval in the future.

(i-i) Document Versions. The initial IGC-approval was dated 31 August 2018. The reference to the FAI/IGC web site and the Manufacturer details at the top of page 2 were updated on 1 February 2020. A version dated 24 May 2020 included 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 3. This document changes the Chairman's address 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 1 (all flights including world records). The Levels of IGC-approval are listed in Para 1.1.4 of Annex B to the Sporting Code. Also see para 7 on page 4 about future changes.

(i-iii) GNSS System. The Global Navigation Satellite System (GNSS) used 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 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) Data Recording. This document is concerned with the functions of the equipment that record 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 IGC and FAI. FAI is the legal entity and Swiss law applies. FAI Commissions such as IGC are agents of FAI; GFAC members and its advisors are agents of IGC. Tests made by GFAC on behalf of IGC and FAI concern accuracy and security of data, transfer and conversion to and conformity of the output data with the standard IGC file format in relation to 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 mentioned above. In particular this applies to any function linked with aspects that could be critical to flight safety such as navigation, airspace avoidance, terrain avoidance and any aircraft traffic alert, 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 has no responsibility for, matters related to: (a) Intellectual Property (IP), Intellectual Property Rights (IPR) and/or, (b) the relations of the Manufacturer listed below with any other entities except with FAI and its agents or as they affect FAI, its agents and this approval.

(iv) National and other Regulations. These Regulations may apply to electrical and electronic equipment and compliance with such regulations is not the responsibility of FAI or IGC.

(v) Sporting Code. The attention of National Airsport Control (NAC) authorities, 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) with guidelines and procedures for Official Observers, pilots, and other officials involved in the flight validation process; Annex D (SC3D) with the Official IGC Pilot Ranking List. Copies of all of these documents may be obtained from the IGC web site listed above and those particularly relevant to IGC Flight Recorders are also on the GFAC web site. A separate IGC document "Technical Specification for IGC-Approved Flight Recorders" is available on the IGC and GFAC web sites listed above, together with links to up-to-date IGC-approval documents for all IGC-approved Flight Recorders.

(vi) Copy of this Document. 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.

MANUFACTURER

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IGC Manufacturer Codes: Single letter: L, three letters: LXN

1.1 **Recorder Type, Model, Serial.** The recorder type and model is the Colibri X. The IGC Serial Identification (S/ID) (s/n) of an individual Recorder consists of three alphanumeric characters that are marked on the case and also shown by selecting the screen display that includes icons for Pilot, Glider, etc (see 1.6.1 below) and tapping the "Info" icon at the bottom of the screen under the "Transfer" icon. The IGC s/n is also in the first line of an IGC file prefixed by the letter A and the Manufacturer's three-letter IGC code, in the form: A LXN TBY FLIGHT:2, standing for LX Navigation FR s/n TBY, IGC file 2 of the day.

1.2 **Hardware Version.** Hardware Version 1 and higher is the IGC-approved standard, but see para 7.2 on updates. The Version number is shown in the header record of IGC files in the form "H FRHW HARDWARE VERSION:1.00".

1.3 **Dimensions and Weight.** The Colibri X is 102 x 70 x 14mm in size and weighs about 150 grammes.

1.4 **GNSS receiver.** The GNSS receiver is the ORG 1410 by Origin GPS Ltd of Israel and signals from the US GPS system are processed in this FR. The receiver is shown in IGC file header record in the form "HFGPS:ORIGIN ORG1410,48ch,max24000m". The last figure is the maximum GPS altitude that is processed by the FR (but see B6.3 on altitude limits). The figure before the altitude is the maximum number of channels that the receiver is capable of processing, although only a maximum of 12 live GPS satellites will be in view at any one time.

1.5 **Pressure altitude sensor.** This is the MS5607 Pressure Altitude sensor by Measurement Specialities of Switzerland, owned by TE Connectivity). The pressure sensor is shown in the header record of IGC files in the form: "HFPRSPRESSALTSENSOR:MEAS,MS5607,max31000m".

The last figure is the maximum altitude processed by the recorder to the pressure altitude resolution required by the IGC FR Specification.

1.6 **Display, Connectors, GPS Antenna.** The FR is turned on by pressing the power button at the top of the left side of the case for about 2 seconds. For turning off, see para A12 on page 6.

1.6.1 **Display.** A 53 x 71mm touch-screen display is on the front face. Different screens are selected by swiping the display left or right with a finger and then up or down to view other features. Various icons and instructions are then selected by pressing them on the screen.

1.6.2 **Power Connection.** The internal battery is charged through a 7mm wide Micro USB B connector on the bottom of the case. The Colibri X User Guide says that a fully charged battery can power the unit for 15 hours.

1.6.3 **micro-SD Card.** A socket for a micro SD card is on the left side of the case. IGC files are downloaded to the micro SD card, and the card is also used to upload programs to the FR. For details of available selections, see the manufacturers User Guide.

1.6.4 **GPS Receiver Antenna.** The antenna is inside the case and no external connection is required.

2. **FIRMWARE.** This refers to systems inside the FR. The IGC-approved standard is firmware Version 1.0 and higher, see para 7.2 on updates. The version is listed in the header record of each IGC file in the form:

"HFRFWFIRMWAREVERSION:1.00"

3. **SOFTWARE.** This refers to systems outside the FR.

3.1 **Downloading Flight Data.** Downloading of IGC files is to the micro-SD card on the left side of the case. Press the "Logbook" icon on the screen, select the flight to be downloaded and then press "Transfer to SD card".

3.2 **Validation of Flight Data.** The IGC standard for electronic flight data is that the IGC file must pass the IGC Validate check that is part of the IGC Shell program. See below for how to obtain the Shell program and B3.4 for how to carry out the IGC Validation check. The Validate procedure checks that the IGC file has originated correctly from a serviceable recorder and that the flight data is identical to when it was initially downloaded.

3.2.1 **IGC Shell Files and FR Manufacturer's DLL file.** These files are available from either the IGC or the GFAC web pages, see the web references at the top of page 1. The file igcdll.zip should be downloaded into the directory in the PC to be used for IGC file validation (the name IGCshell is recommended). For the shell program to work, the Dynamic Link Library (DLL) file from the recorder manufacturer must first be copied to the IGC Shell directory. For the DLL file name, see the Manufacturer's data at the top of page 2.

3.2.2 **Latest versions.** The latest versions of the files in igcdll.zip and the manufacturer's DLL files must be used, obtained as in 3.2.1.

4. **Engine Recording - the ENL system.** A microphone and frequency filter system inside the FR automatically produces an ENL (Environmental Noise Level) value of acoustic noise which is added to each fix. This is intended to highlight any engine and propeller noise but to produce low ENL values in gliding flight.

4.1 **ENL System inside the FR.** The ENL system is made by LX Navigation and is most sensitive to noise at about 150 Hz.

4.1.2 **ENL figures.** ENL figures in each fix in the IGC file are between 000 and 999 in steps of 001.

4.1.3 **ENL IGC approval - Engine Types.** This document gives IGC-approval for the use of the ENL system for the validation of glide performances to IGC standards of evidence with gliders that have engine and recorder installations that give high ENL values in IGC files when the engine is producing any forward thrust. Such ENL values must clearly differentiate between forward thrust from the engine and soaring flight.

4.1.3.1 **Low-ENL Engine/Recorder combinations** This approval does not include use of the ENL system with engines that produce small ENL values at the Recorder when just producing forward thrust. Unless the FR is mounted close to the engine and/or propeller, this includes rear-mounted electrical and jet engines, in the case of the jet because the noise is at higher frequencies than those for which the ENL system is designed. It may also apply to some rear-mounted 4-stroke engine/propeller combinations that produce low noise in the cockpit.

4.1.4 ENL System and Cockpit Positioning. The recorder must be positioned in the glider so that it can receive a high level of engine and/or propeller noise when any forward thrust is being generated, but see para 5.

4.1.5 ENL testing. For details of typical ENL values, see para B.4.

5 **Installation in the glider.** This type of Flight Recorder is designed to be fitted so that the pilot can see the screen and use the touch facility to change displays. From the point of view of data recording, the unit may be fitted anywhere in the glider, subject to para 4 on ENL for engine recording and para 6 on security.

5.1. **Check of Installation.** There must be incontrovertible evidence that the recorder was in the glider for the flight concerned, and was installed and operated in accordance with IGC procedures. Unless the recorder is part of a permanent installation in the Instrument Panel, this can be achieved either by independent 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, see para B1 later.

6. **Security - Physical and Electronic.** 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 below on security seals. GFAC reserves the right to inspect production-standard equipment for security, compliance with the current IGC Specification, compliance with this Approval, and the accuracy of outputs from sensors such as for GPS Position, ENL and pressure altitude.

6.1 **Physical Security.** The case is sealed and the only mode of entry would be using a drill or saw. In addition, an internal microswitch activates if the case has been interfered with, after which any future IGC files are marked as insecure, see 6.2 below.

6.2 **Electronic Security.** If the internal security mechanism has been activated, later IGC files will fail the IGC Validation test for electronic security. This test will also fail if the IGC file being analysed is different from that originally downloaded from the Recorder, even by one character in the flight data. If corrupted firmware is detected, depending on the nature of the problem, either IGC files will not be generated or if they are, they will fail the IGC Validate test.

6.3 Recorder found to be unsealed. If either physical or electronic security is found to have failed, before it can be used again for flights to the IGC standard, 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.

6.3.1 **Checks before re-sealing.** Whenever any unit is resealed, the manufacturer or his 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.

7 **Updates and Changes**

7.1 **Updates to IGC-approval Documents.** The latest IGC-approval documents are posted on the GFAC and IGC FR web sites given at the top of page 1, and for flights to IGC standards the latest document is the only one that is valid. These sites also have a table of all IGC-approvals together with approval levels and links to the latest IGC-approval documents for each type of FR. Pilots are advised to check the latest IGC-approval document(s) for the FR(s) to be used before making a flight that is to be claimed, so that they are aware of any changes.

7.2 **Manufacturer's Changes including later versions of Hardware, Firmware and Software.** Notification of any intended change that might affect the recording function, the structure and security of IGC files, or the physical and electronic security of the FR, must be made by the manufacturer to the Chairman of GFAC so that a decision can be made on any further testing which may be required to retain IGC-approval. It includes changes to hardware and firmware including modules inside the recorder such as the GPS receiver, pressure altitude sensor, ENL figures, and so forth. If in doubt, GFAC should be notified.

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

Annex A - NOTES FOR OWNERS AND PILOTS - PART OF IGC APPROVAL

A(i) Status. To be read together with the main terms of approval to which this is an Annex.

A(ii) IGC-Approval level. See page 1 heading "Level of Approval".

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 **Connectors**. This approval does not presently require sealing of any connectors, ports or plugs, or stowage out of reach of the pilot(s), and no attempt must be made to pass unauthorised data into the Recorder including through the GPS antenna.

A2 **Geodetic Datum (Earth Model)**. This type of recorder is fixed on the WGS84 Geodetic Datum (earth model). It should be ensured that other lat/long data such as for start, turn and finish points, is also with respect to the WGS84 Geodetic Datum (IGC rule).

A3 **Setting the Fix Interval**. The basic fix interval is set using the "Logger" icon in the screen that has 10 other icons such as Pilot, Glider, etc., and is obtained by swiping right on the screen until the icon screen is shown. In addition to the basic fix interval, a series of fast-fixes at one second interval occur after the Event button is pressed, recording the letters PEV (Pilot EVent) on the first of the fast-fixes in the IGC file. Fast fix is at one second interval but the number of fixes over a minimum of 30 can be set through the Logger icon menu. There is no need to set a very short fix interval for cruise flight because points of interest can be marked by PEV events followed by fast fixing. Setting a short fix interval for *cruise flight* leads to IGC files of large 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 are a maximum setting of 60 seconds, and a 10 second maximum for competitions under the rules of Annex A to SC3 (SC3A).

A4 **Checking the Recorder before a Claim Flight**. Pilots are recommended to check and analyse a selection of IGC files before making flights that require Validation. It is the pilot's responsibility to ensure that the recorder is performing correctly and in accordance with this approval - for instance ensuring that GPS fixes, pressure altitude, ENL, date/time and other values are recorded as expected. In particular, for gliders with any type of engine, ENL values must be high enough to clearly record any production of forward thrust, be approximately in accordance with the figures given in para B5, and in gliding flight ENL values must be low enough to distinguish from any use of engine. See para 4.1(ENL) on page 3, para A9 on ENL and A13 on pressure altitude calibration.

A5 **Pre-flight Declaration in the IGC file**. Electronic pre-flight declarations of Waypoints are made by putting Start, Finish and Turn Points into the recorder after selecting the TSK (Task) screen by swiping the screen to the right, then swiping up to reveal the "Edit Task" icon. Before this, a list of Waypoints must be uploaded from the micro-SD card using the "Transfer" icon on the Icon Screen, and then selecting "Turnpoints". Before making a flight that is to be claimed and requires a pre-flight declaration, pilots are advised to check that they can carry this out, and that an IGC file is produced that satisfies the Sporting Code on pre-flight declarations.

A6 **Observing the 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, which should be either in or near the instrument panel so that it is easy to see the screen.

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.

A8 **Takeoff**

A8.1 **Switch On**. The recorder is switched on by a press of the button on the left side. Pilots are advised to switch on at least 5 minutes before takeoff and check that GPS lock-on has occurred in time to establish a baseline of fixes before the start of the takeoff roll.

A8.2 **Takeoff - Independent evidence**. 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 the recorder, see B1.2.

A9 **Gliders with Engines**. This applies to gliders with any sort of power plant that could give forward thrust. See para 4 of the main body of this document on recording the use of engine. The recorder must be placed so that engine noise is clearly received when the engine is giving power and it must not be covered or insulated. A microphone inside the recorder automatically records low-frequency acoustic noise under the ENL code with a peak frequency of about 150Hz. This is shown in the IGC file as three ENL numbers on each fix line. See para 4.1 on page 3.

A9.1 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 can register as high ENL. This can be magnified if sideslip is present and also at high airspeeds. Flight with cockpit panels open when climbing and also at high airspeed should 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 gliders with engines if the engine bay doors flutter (move in and out). Flight near powered aircraft should also be avoided, except for aero-tow launches. See B5 for levels that have been recorded on GFAC tests by the ENL system inside the recorder.

A9.1.2 Pilot check of ENL figures. Pilots must check that the ENL figures produced by their recorder show a clear difference between engine-on and engine-off flight. ENL figures should be close 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 engine-on ENL figures are found to be significantly different to those in para B5 when using piston engines, the recorder should be returned to the manufacturer for the ENL system to be re-set. Pilots must also ensure that ENL in gliding flight is not high enough to be confused with engine running, for instance avoiding conditions that produce noise levels that could be recorded as high ENL and be mistaken for use of engine, such as flight with canopy panels open if this produces high noise levels. See also para 4 on page 3, also para B5, particularly B5.1.3 on flight with engine and 5.1.4 on gliding flight.

A10 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. ***This recorder is small and portable. Pilots are advised to make sure that its installation in the cockpit is independently witnessed before removing the recorder from the glider, to avoid questions later.***

A10.1 Independent Evidence. The pilot must ensure that there is evidence of the landing independent of the flight recorder data, see A11 below. Pilots are advised not to switch off the recorder for several minutes after landing, so that an adequate landing baseline is on the IGC file.

A10.2 After-flight calculation of security. If the pilot ends the IGC flight file by pressing the main button, or when the recorder is switched on again after having been switched off (for instance after landing), a digital signature is calculated for the IGC file for the flight. This process places security codes at the end of the IGC file for the last flight, which is then completed 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 of the IGC Shell program.

A11 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).

A12 Switching Off. The recorder is switched off by pressing the power button at the top of the left side of the case, after which a screen appears with "Power off" and "Cancel" options. To switch off, press the "Power off" box at the top of the screen.

A13 Downloading the Flight Data. Downloading is to the micro-SD card in the socket on the left side of the case. The flight to be downloaded is selected by pressing the "Logbook" icon on the screen, selecting the flight and pressing "Transfer to SD card". The type and specification of the micro-SD card must be compatible with this FR and users should note that some types of micro-SD card are not compatible. See the User Guide for the specification of micro-SD cards that can be used.

A13.1 OO's actions. For a flight to IGC standards of evidence, an OO should carry out the actions given in para B3.3, and the OO's copy of the transferred flight data will be sent to the Organisation that will validate the flight, such as the National Airspace Control authority (NAC). The OO does not personally have to transfer the data from the Recorder, but witnesses the transfer, and immediately afterwards takes, or is given, a copy on a storage device such as a memory stick or SD card.

A13.2 Competitions. Different rules may apply for competition flights, for which pilots may be allowed to bring their own flight data on portable storage data to competition control, or a central data transfer facility may be used. However, for a flight to IGC rules such as for records and badges, OO monitoring as in A13.1 continues to apply.

A14 Calibration of Barograph Function. Pilots are advised to have a pressure altitude calibration carried out 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. Speed and distance claims need a calibration for calculating the altitude difference of the glider at the start and finish points. Also, the NAC or FAI may wish to compare pressure altitudes recorded on the Recorder for takeoff and at landing, with QNH pressures for the appropriate times recorded by a local meteorological office.

Annex B - NOTES FOR OFFICIAL OBSERVERS AND NACs - PART OF IGC APPROVAL

B(i) Status. To be read together with the main terms of approval to which this is an

Annex. B(ii) IGC-Approval level. See page 1 heading "Level of Approval".

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. 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. The IGC Serial Identification (S/ID) (s/n) of an individual Recorder consists of three alphanumeric characters that are marked on the case and also shown by selecting the screen display that includes icons for Pilot, Glider, etc., and tapping the "Info" icon at the bottom of the screen, under the "Transfer" icon.

B2 Takeoff - Independent Evidence. The time and point of takeoff must 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. After flight, this will be compared to the Recorder's takeoff data.

B3 Landing

B3.1 Independent Evidence. The time and point of landing must also be recorded, either by an OO, other reliable witnesses, or by other means such as an Air Traffic Control or official Club log of landings. After flight, this will be compared to the Recorder's landing data.

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, so that this can be compared to the check described in para B1.

B3.3 Downloading the Flight Data. Downloading is to a micro-SD card in the socket on the left of the screen, see para A13 earlier. After this, the IGC file for the flight must be transferred from the micro-SD card to a PC under the control of the OO. Security of downloaded IGC files is maintained by electronic coding specific to the Recorder which is then independently checked later at the NAC (and at FAI if the claim goes to them). See para B4 below for how this is done.

B3.3.1 Files Produced. This process will produce an IGC-format ASCII flight data file with the file name YMDFXXXN.IGC, where Y = year, M = month, D = day, F = firmware manufacturer, XXX = Recorder Serial Identification (S/ID)/letters and N = flight number of the day. For the full key, see Appendix 1 to the IGC GNSS Recorder Specification, also in Annex C to the Sporting Code (SC3C).

B3.3.2 OO's Copy. A copy of the IGC file must be retained securely by the OO such as by immediately copying it to storage media such as a memory stick, data card, or the hard disk of the OO's own PC. This IGC file must be retained by the OO for later checking and analysis under NAC procedures. The OO must be able to positively identify the flight data file as being from the flight concerned. Takeoff and landing data independent of the IGC file must also be available, see above in B2 and B3.1.

B3.3.3 Competitions. Different rules may apply for competitions, but for validation of performances for IGC badges and records, the rules in the IGC Sporting Code and this Approval document continue to apply. For competition purposes only, pilots may be allowed to download their own flight data and take it to Competition Control on portable storage media such as a USB stick or memory card, or a central competition 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 Validation process described in B4 below.

B4 Validation and Analysis of Flight Data Files. 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 the file that was downloaded from the Recorder to the PC. This is done by checking the IGC data file with an authorised copy of the IGC Shell program and using the Validate function in the IGC Shell menu (see below). The Recorder manufacturer's latest DLL file will also be needed in the IGC Shell directory. The Shell program and DLL file must be the same as those on the current FAI/IGC or GFAC web sites given at the beginning of this document. A Data Analyst approved by the NAC shall carry out this IGC Validation check on the IGC file and then evaluate the flight data using an analysis program approved by the NAC concerned.

B4.1 IGC Shell Program. Download the file igcshell.zip from the IGC or GFAC web pages, un-zip and place all the files in one directory (the name IGC Shell is recommended). For the shell program to work, the appropriate Dynamic Link Library (DLL) file from the recorder manufacturer must be copied to the IGC Shell directory. After copying it to the directory that contains the IGC Shell files, execute IGCshell.EXE. Set the path to the IGCshell directory using the "Set Directories" button on the screen. The IGCshell menu will now appear in a grey rectangular box with 9 software buttons for selecting the recorder type, recorder settings and flight logs. The recorder software box at the top has a list of FR manufacturers, and the appropriate one should be selected.

B4.1.1 Validation of IGC files. Select the FR manufacturer's logo from the top menu box (as above), press the "Validate" button and select the IGC file to be checked. If successful, the message "File has been successfully validated" appears. If there is a security problem, the message "Integrity Bad" appears, together with a likely reason.

B5 Gliders with Engines. For recording engine noise at the recorder, the Environmental Noise Level (ENL) system is used, see para 4 on page 3. In the IGC file, on each fix line, three ENL numbers are added after the lat/long data. The ENL numbers

record low-frequency noise with maximum sensitivity about 150Hz. Other detail on ENL is given below.

B5.1 ENL - General. With piston engines it is normally easy to see when the engine has been running and when it has not. Other data such as rates of climb and groundspeed, will indicate whether or not energy is being added other than during soaring. Short term peaks in ENL (10 seconds or less) may be due to other factors such as undercarriage and/or airbrake movement, sideslip, open DV panels (particularly with sideslip), the nearby transit of powered aircraft, etc. If in doubt, email the IGC file to the GFAC Chairman for further analysis and advice (see page 5 for email address).

B5.1.1 Quiet period before flight. A low but positive ENL is used when no noise is present, to indicate that the ENL system is working. For this Recorder the base ENL in quiet conditions is between 010 and 025.

B5.1.2 ENL during launching. During winch and aerotow launches, higher ENL values are to be expected than when soaring (B4.3), typically up to 350 for winch and 100 for aerotow, particularly if cockpit panels are open. During the ground roll, short-term higher values may be recorded due to wheel rumble or tyre squeak.

B5.1.3 ENL during engine running. An ENL value of 999 has been produced by this type of recorder with two-stroke engines running at full power. At power for level flight, ENL values of 700 have been recorded in a two-stroke, lower in a 4-stroke. During engine running, these 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. Previous tests with Wankel (Rotary) engines indicate that they produce similar ENL values to 4-strokes.

B5.1.3.1 Engines producing low ENL signatures. This approval does not include FR/engine installations with low ENL values when the engine is producing forward thrust and could be mistaken for soaring flight (such as with cockpit panels open). Engines such as rear-mounted electric, jet, and some 4-strokes produce low ENL values unless the FR is positioned close to the engine and/or propeller or jet pipe. In these cases, another IGC-approved FR must be used that produces high numbers when the engine is run.

B5.1.4 ENL during gliding flight. ENL readings up to 050 indicate low-speed gliding flight in a well-sealed cockpit. However, flight with the canopy panel(s) open produces extra noise inside the cockpit and ENL values of up to 200 have been produced when thermalling with cockpit panels open. With sideslip or at higher speeds, a loud low frequency noise can be produced ("organ-pipe" effect) and ENL readings of up to 470 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.

B5.1.5 ENL during the approach to land. ENL values are normally 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.

B5.1.6 ENL during landing. During ground contact during landing, short-duration ENL readings of between 500 and 900 have been recorded, probably due to wheel rumble or tyre squeak. These last only for a short time, showing a short "spike" on the noise/time trace.

B5.1.7 ENL analysis. It is normally easy to see when an engine has been running and when it has not. Other FR data such as rates of climb and groundspeed, will indicate whether or not non-atmospheric energy is being added. Short term peaks in ENL (less than 10 seconds) may be due 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 in doubt, email the IGC file to the GFAC Chairman for further analysis and advice (see earlier for email address).

B6 Altitude analysis and calibration. IGC 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 there are no major differences that could indicate malpractice or manufactured (false) data. So that accurate pressure altitude is available, the FR must be calibrated in an altitude chamber with respect to the International Standard (the ICAO ISA), in the same way as a barograph or aircraft altimeter. Before the calibration, the Recorder fix rate should be set to a 1 or 2 second interval.

B6.1 Calibration method, making a calibration table. Recording starts after a pressure change of 1 metre per second for 5 seconds. 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 recording before starting the calibration itself. The calibrator will record the pressure steps used, for later comparison with the IGC 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 Calibration. After the calibration, the IGC file containing the pressure steps is transferred to a PC as if it was flight data (see B3.3). This may be done by an NAC-approved person if the calibrator does not have this knowledge. The IGC-format calibration data file will then be analysed, compared to the calibration pressure steps, and a correction table produced and authenticated by an NAC-approved person (for instance an OO or GNSS 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 for gain-of-height and altitude claims. Only pressure altitude is valid for IGC altitude purposes except for (1) proof of flight continuity (no intermediate landing) or (2) above 15,000 metres used with a special High Altitude Flight Recorder (HAFR), where GNSS altitude may be used in accordance with Sporting Code procedures. The IGC file should be kept with the calibration paperwork so that it is not confused with other calibration files. The original IGC file may have a nominal date/time (because GPS lock may not be present during the calibration run), and the file can be copied and the file name changed to one that can be identified as the calibration. A text editor can be used to change add a realistic date and time in the file itself, although this will mean that the Validation check will fail and the original IGC file must also be kept unaltered so that it can be Validated when required.

B6.2 Altitude figures recorded in IGC files. Occasional short-duration differences in the shape of the GPS Altitude/time graph have been noted compared to pressure altitude figures. GPS altitude accuracy is not as good as accuracy in lat/long, because satellite geometry is not as favourable for obtaining accurate altitude compared to horizontal position. This effect may be increased by less-than ideal antenna positioning in some gliders. 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 multi-channel GPS system. From GFAC tests, the lat/long error taken from a moving vehicle at a surveyed point in average reception conditions, shows an average error of between 11 and 12m for all recorders tested since the year 2000, and between 5 and 10m for more recent recorder designs. The GPS system is capable of recording to almost unlimited altitudes, certainly up to 30km/100,000ft. Pressure altitude sensors have good altitude resolution at low altitudes, but as air density reduces at height, a small pressure step becomes a large altitude difference. The capability for fine resolution (small steps) in altitudes in IGC files also depends on how altitude figures are processed within the FR, and for pressure altitude the resolution capability of the altitude sensor.

B6.3 IGC Rules for Maximum Altitudes. For this type of FR the maximum altitude that can be validated in accordance with IGC rules is 15km. In this FR, GPS altitude is recorded up to 31km and pressure altitude up to 24km, but IGC rules state that for validation of IGC altitude performances above 15km (49,213ft), evidence is required from an IGC-approved High Altitude Flight Recorder (HAFR). ***This type of FR is not certified as an IGC HAFR.*** For IGC-approval as a HAFR, special requirements for recording GNSS and pressure altitude are given in the IGC Sporting Code and the FR Specification.
