GNSS FLIGHT RECORDER APPROVAL COMMITTEE (GFAC)
INTERNATIONAL GLIDING COMMISSION (IGC)
of the
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References: See para (i-iv) below

To: IGC GNSS web site under "IGC-approval Documents"
FR Manufacturer; info to igc-news@fai.org; fai.org, newsgroup rec.aviation.soaring Date of issue: 31 July 2023

IGC-APPROVAL DOCUMENT FOR GNSS FLIGHT RECORDER
Manufacturer - Recorder Name: LX Navigation - Flarm Eagle
Level of Approval: IGC level 3 - 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 in IGC/FAI claims. FAI and IGC reserve the right to alter this approval in the future.

(i-i) Document Versions. The initial IGC-approval was dated 15 November 2018. The reference to the FAI/IGC web site above 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 the page before the annexes. 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 3 - flights for IGC Silver and Gold badges, and the three Diamonds. This type of FR can also be used in gliding competitions in which the organisers allow this level of IGC-approval. The Levels of IGC-approval are listed in Para 1.1.4 of Annex B to the Sporting Code. Also see para 7 below 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.

MANUFACTURERS

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IGC-allocated manufacturer codes: This equipment consists of Flarm-IGC firmware in a case by LXN. The manufacturer codes for the firmware therefore apply and those for Flarm Technology are: three letter code FLA, single letter code G.

1. HARDWARE

1.1 **Recorder Type**. This is the Flarm Eagle series, shown in IGC file header record as HFFTYFRType:LXNavigation,FLARMEagle-IGC. See paras 1.3 and 1.6 for details.

1.1.1 Serial Identification (S/ID). The IGC Serial Identification (S/ID) (s/n) of an individual Recorder consists of three alphanumeric characters that are shown in the first line of each IGC file and also on the outside of the case. The first line of an IGC file starts with the letter A and the Firmware Manufacturer's three-letter IGC code, followed by the three-character IGC serial and then the flight number, in the form: A FLA Q8G FLIGHT:3, standing for Flarm FR, IGC serial Q8G, file 3 of the day. The UTC date of flight is on the next line in the IGC file.

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 " HFRHWHARDWAREVERSION:1.00 ".

1.3 **Dimensions, Weight, Power Source**.

1.3.1 Flarm Eagle. The case is 66 x 48 x 24 mm in size with three antenna connectors on one end projecting a further 10mm. Weight is about 95 grammes. A two-core cable at the opposite end to the antenna sockets is for DC electrical power and the voltage range is stated to be 9-36V.

1.3.2 Flarm Eagle Mobile. The name "mobile" is used because this unit is a Flarm Eagle module with an internal battery and can therefore be used without external power. It also has a Flarm screen at one end, see para 1.6.2 for more details. The case is 83 x 51 x 25 mm in size with two antenna connectors on one end projecting a further 10mm. Weight is about 120 grammes. The internal battery is charged through a micro-USB socket when connected to a 12V DC supply.

1.4 **GNSS receiver**. This is a u-blox 8 receiver by Ublox AG of Switzerland. This is shown in the header record of IGC files in the form " HFGPSType:u-blox u-blox 8 ".

1.5 **Pressure altitude sensor.** This is the MS5607 Pressure Altitude sensor by Measurement Specialities (MEAS) of Switzerland, a subsidiary of TE Connectivity also headquartered in Switzerland. This appears in the header record of IGC files in the form: "HFPRSPressAltSensor:TEC MS5607,15000". The last figure is the maximum pressure altitude in metres that can theoretically be recorded in the IGC file, subject to a pressure altitude calibration to IGC standards, see B6.4.1. The case is not pressure-sealed and "cockpit static" is recorded in the IGC file.

1.6 **Display, Antenna and Connectors**

1.6.1 Flarm Eagle. On one side of the case is a 12mm wide USB socket for uploading and downloading data via a USB stick or other USB device. On one end of the case there are three 5mm diameter SMA-type screw connectors for antenna cables . These are for GPS, Flarm, and the middle is a spare - the Flarm antenna is near the side on which the USB socket is mounted, the GPS antenna is on the other the side. At the opposite end to the antenna sockets is a 6-pin 10mm RJ12 socket for connecting an external Flarm unit, also a two-core cable for electrical power for which the voltage range is stated to be 9-36V DC.

1.6.2 Flarm Eagle Mobile. The unit is switched on and off by pressing the centre of the display at one end of the case. The Flarm display has four lights on the left in a vertical line, for Power (labelled PWR), GPS, Flarm Receive and Transmit (RX, TX). To the right a circle of lights indicates the direction of a Flarm target and on the right are five lights indicating the vertical position of the Flarm target. At the opposite end to the display are two 5mm diameter SMA-type screw connectors for antenna cables for GPS and Flarm, and a micro-USB socket for charging the internal battery. On one side of the case is a 12mm wide USB socket for uploading and downloading data via a USB stick or other USB device.

2. **FIRMWARE**. This refers to systems inside the FR and internal firmware is by Flarm Technology, see the top of this page for address and contact details. This approval is for Flarm firmware version 6.51 or later. The firmware version is shown in the header record of IGC files in the form: " HFRFWFirmwareFLARM,6.51" and can be seen by using a text editor to view the start of the IGC file.

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

3.1 Downloading Flight Data. Downloading is to a USB stick or other USB device inserted in the 12mm USB socket on the side of the case.

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 Firmware Manufacturer's DLL file. Note that the DLL file is that of the firmware manufacturer listed in para 2 above, not the

manufacturer of the case. Manufacturer's DLL 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 firmware manufacturer must first be copied to the IGC Shell directory.

3.2.2 Latest versions. The latest versions in igcdll.zip must be used, including the firmware manufacturer's DLL file igc-fla.dll, obtained as in 3.2.1.

4. **Engine Recording - ENL system**. A microphone and frequency filter system inside the FR automatically produces an Environmental Noise Level (ENL) value of acoustic noise which is added to each fix line in the IGC file in the form of three numbers between 000 and 999. This is intended to highlight any engine and propeller noise and to produce low ENL values in gliding flight.

4.1 ENL System Manufacturer. The ENL system in this recorder is designed by LXN but implemented through Flarm firmware. It is most sensitive to acoustic noise at about 150 Hz. For details of typical ENL values in flight, see para B.4.

4.2 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 with gliders that have engine and recorder installations that give high ENL values when the engine is producing forward thrust. ENL figures must clearly differentiate between forward thrust from the engine and ENL values in flight without engine power, see 4.3 below.

4.3 Low-ENL Engine/Recorder installations. This approval does not include use of the ENL system with engines that produce small ENL values at the Recorder when just producing positive forward thrust. Unless the FR is mounted very 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. If the FR position produces low-ENL values when the engine is producing positive thrust, there are two alternatives: (1) either the FR must be moved closer to the source of engine noise, or (2) another FR used that produces high enough values in the IGC file. Some other FRs have engine sensors external to the FR that can be connected to the FR by cable and in these cases, the IGC file includes an additional line under the MOP code that records three numbers in a similar way to ENL.

4.4. Unwanted High Engine-off ENL. Some installations may produce unwanted high noise and/or vibration in gliding flight which give high ENL figures that could be mistaken for use of engine. In these cases the mounting and/or installation of the FR must be changed to reduce ENL numbers in gliding flight.

5 **Installation in the glider**. The Flarm Eagle Mobile is designed to be fitted so that its screen with Flarm data is in view of the pilot. The basic Flarm Eagle has no screen but can be connected to a separate Flarm display unit by cable. From the point of view of data recording, both Flight Recorders may be fitted anywhere in the glider, subject to para 4 on 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, 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 , this Approval, and the accuracy of outputs from sensors such as for GPS Position, ENL and pressure altitude.

6.1 Physical Security. Tamper-evident seals with the manufacturer's logo are fitted over screws that hold the case together. In addition, an internal security mechanism activates if the case has been opened.

6.2 Electronic Security. If the internal security mechanism has activated, subsequent 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, 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 the Recorder can be used again for flights to the IGC standard, it 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 correctly. 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 unit, pressure altitude sensor, external MOP system, 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

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Annex A to IGC-approval document

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

A2 **Geodetic Datum (Earth Model)**. This 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 entered with respect to the WGS84 Geodetic Datum (IGC rule).

A3 **Setting the Fix Interval**. The basic fix interval is part of the set-up menu and the Instruction Manual gives the switching required.
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.

A4 **Checking the Recorder before a Claim Flight**. Pilots should 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, and that post-flight Validation of the integrity of the data in the file is successful using the DLL file of the firmware manufacturer (Flarm) as in para 3.2 on page 2. For gliders with engines, ENL values should be similar to the figures given in para B5, should be high with any use of engine and low in gliding flight. See also A5 on pre-flight declarations, 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 in accordance with the FR manufacturer's instructions, in this case through a FLARMCFG1.TXT file. Before making a flight that is to be claimed and requires a pre-flight declaration, pilots are advised to check that they can successfully 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.

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**. 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. As there are no lights on the Flarm Eagle that show that it is on and working, a USB stick can be used that has a light that indicates activity. This is not a consideration with the Flarm Eagle Mobile because it has a Flarm display on one end of the case.

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 type of power plant that could give forward thrust. A microphone inside the recorder automatically records the level of low-frequency acoustic noise which is shown in the IGC file as three numbers in each fix under the ENL code. For more information, see para 4 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 be recorded in IGC files as high ENL. This is magnified if sideslip is present and also at high airspeeds. Flight with cockpit panels open when climbing and at high airspeed should be avoided in case high ENL 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 (vibrate or move in and out). Flight near noisy powered aircraft should also be avoided, except for aero-tow launches. See B4.2 for ENL figures that have been recorded on GFAC tests.

A9.1.2 Pilot check of ENL figures. Pilots should check that the ENL figures produced by their recorder show a clear difference between engine-on and engine-off flight. More detail is in para 4 on page 3, particularly para 4.3 on low-ENL engine-on situations. Some installations may produce unwanted high noise and/or vibration in gliding flight which can give high ENL figures that could be mistaken for use of engine, and in these cases the mounting and/or installation of the FR must be changed to reduce ENL numbers in engine-off flight.

A10 **After Landing**. Until an OO has witnessed the Recorder installation in 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, see A11 below. Pilots are advised not to switch of the recorder for several minutes after landing, so that an adequate landing baseline can be established on the IGC file.

A10.1 After-flight calculation of security. When the recorder is switched on again after having been switched off, 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 can be downloaded via the USB socket. The security 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).

A12 **Switching Off**. The Flarm Eagle is switched off by turning power off, the Flarm Eagle Mobile by pressing the centre of the screen on the front of the FR until the lights on the screen go out.

A13 **Downloading the Flight Data**. Downloading is to a USB stick or other USB device when it is inserted in the USB socket on the side of the FR case. Download after flight is after first switching off and then on again with the USB stick in place. If a USB stick with a light indicator used, the light flickers during the download and then becomes steady with the download is complete.

A13.1 OO's actions. For a flight to IGC standards of evidence, an OO carrys 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 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 Pressure Altitude**. 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). Speed and distance claims need a calibration for calculating the altitude difference of the glider at the start and finish points, and altitude and gain-of-height claims require a calibration that includes the low and highest altitudes concerned. 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.

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 and landings. After flight, this will be compared to the Recorder takeoff data.

B3 **Landing**

B3.1 Independent Evidence. The time and point of landing 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 and 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 USB stick or other USB device fitted to the socket in the side of the FR. After this, the IGC file for the flight is transferred to a PC under the control of the OO. Security of downloaded IGC files is maintained because IGC-approved Recorders transfer coded security data to the end section of IGC files. This is then used to check the validity of the complete IGC file after flight using the IGC Shell Validation program. See para B4 below.

B3.3.1 Files Produced. This process will produce an IGC 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 (full key, Appendix 1 to the IGC GNSS Recorder Specification, copied 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, SD 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 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 competition flights, 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 SD 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 - however, data within the file must not be changed and integrity of data is preserved by the Validation process 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 file with the latest version of the IGC Shell program and using its Validate function in the IGC Shell menu (see B4.1 below) - for this to work, the FR Firmware manufacturer's DLL file must also be in the IGC Shell directory. The Shell program and DLL file must be the same as those on the current FAI/IGC of GFAC web sites given at the beginning of this document. A Data Analyst approved by the NAC shall carry out the IGC Validation check on the IGC file for the flight, and then check the flight data using an analysis program approved by the NAC.

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 firmware 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 firmware manufacturers, and the relevant one should be selected.

B4.1.1 Validation of IGC files. Select the firmware manufacturer's logo from the top menu box (as in 4.1 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 or even one digit in the flight data has been changed, the message is "Validation Failed" or equivalent. If a digit has been deliberately changed in order to check the system, if the correct digit is then restored, Validation will then once more be successful.

B5 Gliders with Engines. The Environmental Noise Level (ENL) system inside the FR uses a microphone most sensitive to low frequency sound between about 100 and 200 Hz. Processing in the recorder produces three ENL numbers between 000 and 999 that are included in each lat/long fix line in the IGC file. In this FR, the maximum sensitivity of the ENL system is at about 150Hz. For engine

and FR installations where ENL figures are low, making it difficult to distinguish between engine running and other noises, see para 4 on page 3, para A9 on page 4, and the rest of this para below. This may apply to rear-mounted electric and 4-stroke engines, jet engines, and installations where unwanted noise and/or vibration occurs in gliding flight. In the latter case, the mounting and/or installation of the FR must be changed so to reduce unwanted high ENL numbers during engine-off flight (see para A9.1.2).

B5.1 ENL Systems - General. With two-stroke piston engines it is normally easy to use ENL numbers 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 from 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), nearby noisy powered aircraft, etc.

B5.1.1 Quiet period before flight. A low but positive ENL should be seen 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. Consistent ENL values of 000 indicate a fault in the ENL system.

B5.1.2 ENL during launching. In winch and aerotow launches, higher ENL values are expected compared to soaring, ENL values up to 350 for winch launches, 100 for aero tow launches, higher if cockpit vents and direct vision (DV) 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 and forward-mounted four-stoke 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 is therefore 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 electric, jet, and some 4-strokes produce low ENL values unless the FR is positioned close to the engine and/or propeller. See para 4.3 on page 3 and para A9.1 on page 4.

B5.1.4 ENL during gliding flight. ENL readings up to 050 indicate low-speed glide 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 300 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 that can be confused with engine running and should be avoided. High ENL may also be recorded during stalling, particularly if the engine doors flutter or vibrate (move in and out due to stall buffet). Where the engine is mounted on a retractable pylon, a high ENL reading will be shown when flying with the pylon up and engine not running, due to the high aerodynamic noise. Some FR installations have shown high ENL in gliding flight, probably due to unwanted vibration or aerodynamic noise - if this could be confused with engine-running, such flights cannot be approved to IGC standards and the FR installation must be changed so that this effect is reduced.

B5.1.5 ENL during the approach to land. ENL values are normally higher on a landing approach due to aerodynamic noises due to use of airbrakes, undercarriage, sideslip, turbulence, wind shear, etc. Short-term peaks due to specific actions such as opening airbrakes, lowering undercarriage, etc., may 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. On landing, short-duration ENL readings ("spikes") of between 500 and 900 have been recorded on initial contact with the ground, probably due to wheel rumble or tyre squeak.

B5.1.7 ENL analysis. Viewing the ENL figures in an IGC file analysis program, 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 energy is being added in addition to pure soaring. Short term peaks in ENL (less then 10 seconds) may be due to factors mentioned above such as undercarriage and/or airbrake movement, sideslip, open DV panel/sideslip, a nearby noisy powered aircraft, etc.

B6 **Altitude analysis and calibration**. IGC files must be analysed in accordance with Sporting Code procedures. This includes comparing the general shapes of the GNSS and pressure altitude graphs against time, and ensuring that differences do not indicate problems with the FR, or could indicate malpractice or manufactured (false) data. There may be differences due to short-term GPS unlocks or low GPS signal strength due to poor Antenna positioning or characteristics, but for a flight to be Validated to IGC standards, enough valid data must always be present. So that pressure altitude is always available in the IGC file in addition to GPS data, IGC FRs are calibrated in an altitude chamber with respect to the International Standard (the "ICAO ISA"), in the same way as an aircraft pressure altimeter. Before the calibration, the Recorder fix rate should be set to a short interval such as 1 or 2 seconds so that high resolution data can be obtained.

B6.1 Making a calibration table. Recording should start after a pressure change of about 1 metre per second for 5 seconds, and no GPS fixes should be required for a pressure altitude trace to be produced in an IGCfile. The calibrator should be advised to make a short, large, pressure change to start recording before starting the calibration itself. The calibrator should 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.

B6.2 After Calibration. After the calibration, the IGC file containing the pressure steps must be 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, for instance if a non-IGC laboratory has made the calibration. The IGC-format calibration data file will then be analysed, compared to the calibration pressure steps recorded by the calibrator, and a correction table produced and authenticated by the calibrator and an NAC-approved person (for instance an OO or an NAC-approved specialist in pressure altitude calibration). The correction table will list true against altitudes in the IGC file. 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) claims above 15,000 metres in which a special High Altitude Flight Recorder (HAFR) is required, where GNSS altitude is used instead of Pressure Altitude in accordance with IGC Sporting Code procedures for Validation of altitudes over 15 km.

B6.2.1 IGC-format Files. The IGC calibration file must be kept for future reference. It may have a nominal date/time because GPS lock may not be present during the calibration, for instance if the pressure chamber is inside a building. The file name can be changed using a text editor to change to a current date and time in the IGC calibration file, although if any data in the file itself is changed, this will mean that the Validation check will fail and the original IGC file must be kept unaltered so that it can be Validated when required.

B6.3 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. Altitude accuracy is not as good as accuracy in lat/long, because satellite geometry is not as favourable for recording accurate altitude compared to horizontal position, and processing inside GPS recording systems tends to place more priority on lat/long rather than altitude. 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 recorders.

B6.4 Maximum Altitudes Recorded in the IGC file. 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 of the altitude sensor. Altitude resolution requirements are given in the IGC FR Specification, and for this type of FR the maximum altitudes in accordance with these requirements are given below. It should be noted that for validation of IGC altitude performances above 15km (49,213ft), evidence is required from an IGC-approved High Altitude Flight Recorder (HAFR), for which special requirements for both GNSS and pressure altitude are given in the IGC Sporting Code and the FR Specification, and this type of FR is not an IGC HAFR.

B6.4.1 Pressure Altitude. As part of the IGC-approval process, the manufacturer provided pressure altitude calibrations up to 8000 metres. For certification of performances to IGC standards, the individual FR to be used must have a current pressure altitude calibration from an NAC-approved calibration laboratory up to at least the altitude needed for the claim. This could be higher than 8000 metres as long as the data is in accordance with IGC rules for pressure altitude calibrations.

B6.4.2 GNSS altitude. Up to 50 km (nominal), but see the last sentence in B6.4 above on IGC High Altitude Flight Recorders.
