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

References: See para (i-iv) below

To: IGC GNSS web site under "IGC-approval Documents"
GFAC Chairman's web site
FR Manufacturer
Info to: igc-news@fai.org, newsgroup rec.aviation.soaring

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IGC-APPROVAL DOCUMENT FOR GNSS FLIGHT RECORDER

Maker - Recorder Name: **RC Electronics - Fenix Series (see para i-i below)**
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 in IGC/FAI claims. IGC reserves the right to alter this approval in the future.

(i-i) Document Versions. The initial IGC-approval for the original Fenix was dated 20 April 2021. This update adds the FenixN variant with changes to the screen display and location of the control knobs (see para 1.3.1.1).

(i-ii) IGC-approval Level. This is IGC Level 1 - all flights including world records. The Levels of IGC-approval are described in more detail in Annex B to the Sporting Code, para 1.1.4. 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> and the GFAC Chairman's web site <www.ukiws.uk/GFAC>. 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
RC Electronics d.o.o.,
Otemna 1c, 3201 Smartno v Rozni dolini, Celje, Slovenia

Web and email: www.rc-electronics.eu Andrej Vrečer, support@rc-electronics.eu

IGC manufacturer code : RCE DLL file : igc-rce.dll version 1.2A

1. HARDWARE

1.1 **Recorder Type and Model**. This document adds the FenixN variant to the original Fenix model. This is shown in the header record of IGC-format files in the form:
"HFFTYFRTYPE:RC Electronics, Fenix" or "HFFTYFRTYPE:RC Electronics, FenixN"

1.1.1 Serial Number. The IGC Serial Number (s/n) consists of three alphanumeric characters that are shown on the outside of the case and also on the start-up screen. The 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: ARCE002. The UTC date of flight is on the next line in the IGC file, prefixed "H"for a line in the Header record.

1.2 **Hardware Version**. Hardware Version 1 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 and Weight**

1.3.1 Dimensions. The main body of the case for the Fenix and FenixN is 82 x 82 x 26 mm in size. The FenixN includes a smaller secondary display unit 62 x 65 x 32 mm in size.

1.3.1.1 Extensions to the Main Case. On the front, two control knobs stand out a further 22 mm. In the original Fenix the knobs are to the right of the screen, whereas in the FenixN the knobs are under the screen. On the back, a screw connecter for the Antenna stands out a further 8 mm and three 5mm wide tubes for Pitot, Static and Total Energy connections stand out 14mm from the back of the case.

1.3.2 Weight. The main body of the case weighs about 220 grammes.

1.4 **GNSS receiver**. This is the MAX-8Q by Ublox AG of Switzerland (www.u-blox.com), shown in the header record of IGC files in the form HFGPSRECEIVER:uBLOX-MAX-8,72ch,max50000m. The last figure is the maximum altitude that is processed by the FR. The figure before is the maximum number of channels that the receiver is capable of processing. The reason for the large number of potential channels is that, as well as the US GPS system, this receiver is capable of processing signals from the European Galileo and the Russian GLONASS GNSS systems, although at this time signals only from the US GPS system are processed.

1.5 **Pressure altitude sensor.** This is the MS5607-02BA03 sensor by Measurement Specialities (ex-Intersema) of Switzerland (www.meas-spec.com/pressure-sensors.aspx). The pressure sensor is shown in the header record of IGC files in the form: HFPRSPRESSALTSENSOR:MEAS,MS5607,max25000m. The last figure is the maximum pressure altitude in metres that can be recorded in the IGC file, subject to a pressure altitude calibration to IGC standards, see B6.4.1.

1.6 **Display and Connectors**

1.6.1 Front of Case

1.6.1.1 Display and Control Knobs. A 80 mm diameter circular display is on the front face together with two control knobs. In a corner of the main display there are two small displays giving extra information. In the original Fenix model the small displays and two control knobs are on the right side of the main screen; in the FenixN the small displays and control knobs are under the main screen.

1.6.6.2 Micro-SD Card. A socket for a micro-SD card is between the two control knobs.

1.6.2 Back of Case

1.6.1 Power Source. DC power can be from 9 to 36 Volts and is supplied through a 12 x 7 mm green-coloured socket on the back of the case. An internal battery is not designed for continuous use and lasts for about 1 hour.

1.6.2 GPS Receiver Antenna. A 6mm diameter SMA screw connecter for connecting to the GPS receiver antenna is on the back of the case.

1.6.3 PEV button. A 7 mm RJ11 connector with 4 pins on the back of the case connects by cable to a number of functions described in the Fenix Operator's Manual. This includes a button for the Pilot Event (PEV) and fast-fix function, for which a button-press places the PEV symbol on the IGC file followed by fixes at one second intervals, the minimum number of fixes being 30 but more can be selected if required.

1.6.4 Data Connectors. Two 10 mm RJ45 connectors on the back of the case are labelled Data 1 and Data 2, and have 6 pins.

1.6.5 Pressure Connectors. Three 5 mm wide metal tubes project 16mm from the top of the back of the case and are for connecting to Pitot, Static and Total Energy.

1.6.6 Speaker Connector. A 4 mm diameter circular socket is for a plug that connects to an external speaker.

2. **FIRMWARE**. This refers to systems inside the FR. The IGC-approved standard is firmware Version 1.5 for the original Fenix, Version 1.6 for the FenixN. The version is given in the header record of IGC files in the form: HFRFWFIRMWAREVERSION:1.50. See also para 7.2 on updates.

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

3.1 Downloading Flight Data. Downloading is to a micro-SD card socket between the two control knobs on the front of the display. To download a flight, the FR should be turned off after the flight, powered up again and the appropriate Knob used to select "Logbook", in which stored IGC files are identified by date and time and can be selected for downloading to the SD card. In the original Fenix this is the lower knob, in the FenixN it is the knob on the left.

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 FR 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 IGC Shell program to work, the Dynamic Link Library (DLL) file from the FR 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 above.

4. **Engine Recording - ENL system**. A microphone and frequency filter system inside the FR automatically produces an ENL (Environmental Noise Level) value of acoustic (sound) noise that is added to each fix in the form of three numbers between 010 and 999. The system is intended to highlight any engine and propeller noise but to produce low ENL values in gliding flight.

4.1 ENL System.. The Environmental Noise Level (ENL) system is made by RCE 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 010 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 Motor Gliders that have engine and FR 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 under any positive forward thrust. This may apply to rear- mounted electric and jet engines unless the FR itself is mounted very close to the engine and/or propeller. In the case of jet engines this is because the noise is at higher frequencies than those for which the ENL system is designed. It may also apply to some 4-stroke engine/propeller combinations that are quiet. In these cases another type of FR must be used that clearly records any positive forward thrust.

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.

5 **Installation in the glider**. This type of Flight Recorder is designed to be fitted in an instrument panel so that the pilot can see the screen. For data recording, the unit may be fitted anywhere in the glider, subject to para 4 on engine recording, para 6 on security, and the Pilot Event (PEV) button must be in easy reach of the pilot. The position of displays and operating buttons and controls used in flight in single-seat gliders should not be remote from sight-lines used for pilot lookout and scan for other gliders and powered aircraft.

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 6.1 to 6.3 below on security seals. GFAC reserves the right to inspect production-standard equipment including for security, for compliance with the relevant IGC Specification and this Approval document, and the accuracy of figures in the IGC file from sensors such as for GPS 3D position, ENL and pressure altitude.

6.1 Physical Security. Tamper-evident seals with the Fenix logo are fitted over screws that hold the case together. In addition, an internal security system using microswitches activates if the case is opened, damaged, or interfered with.

6.2 Electronic Security. If the internal security mechanism has been 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, 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 the FR can be used again for flights to IGC standards, the FR 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 by the manufacturer 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 be certified 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. This includes changes to hardware and firmware including modules inside the recorder such as the GPS receiver, pressure altitude sensor, and so forth. If in doubt, GFAC should be notified.

Ian W Strachan
Chairman, IGC GFA Committee
ian@ukiws.uk

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

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 on pages 1-4.
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 and 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 of the FR 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)**. In accordance with IGC rules, this FR uses the WGS84 Ellipsoid Earth Model. In addition, pilots should ensure that lat/long figures for start, turn and finish points, are also entered with respect to the WGS84 Ellipsoid.

A3 **Setting the Fix Interval**. The basic fix interval for the flight is part of the menu that is selected by turning the appropriate button until the screen shows "Setup", clicking the button followed by scrolling down to "Logger" and pressing the button to select fix intervals between 1 and 20 seconds. In the original Fenix this is the lower button, in the Fenix N it is the button on the left. During flight, after the Event button is pressed the letters PEV (Pilot EVent) are recorded on the IGC file, and if the basic fix interval is longer than one second, a series of fixes at one second interval follow with a minimum of 30 fixes, and over 30 can be set through the set-up menu if required. There is therefore no need to set a very short fix interval for cruise flight because Turn Points and other points of interest can be marked by PEV events followed by 1-second fixing, and setting a short fix interval leads to IGC files of large size, particularly for long flights. Long flights with a short fix interval uses up more FR memory, causes downloading after flight to take a long time, increases the chance of data corruption within the IGC file, and may also cause problems with some analysis programs because of the large number of fixes that have to be processed.

A4 **Checking the Recorder before a Claim Flight**. Pilots should check and analyse a selection of IGC files before flights that will require Validation. It is the pilot's responsibility to ensure that the recorder is performing correctly and in accordance with this approval. This includes ensuring that GPS fixes, pressure altitude, ENL, date/time and other values critical to IGC-approval of the flight are recorded as expected. For gliders with any sort of engine, ENL values must be in accordance with the figures given in para B5. See also 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. Before making a flight that 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**. The recorder is switched on by pressing a button on the front of the recorder. In the original Fenix this is the lower button; in the FenixN it is the button on the left. Pilots are advised to switch on at least 5 minutes before takeoff and check that GPS lock-on to ensure that there is 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, see para B2.

A9 **Gliders with Engines**. This applies to gliders with any sort of power plant that could give forward thrust. A microphone inside the recorder automatically records the level of low-frequency acoustic noise, shown in the IGC file with each fix as three numbers under the ENL code.

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 show on IGC files as high ENL. This is magnified if sideslip is present and in particular at high airspeeds. Flight with cockpit panels open when climbing in a thermal or 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 Motor Gliders if the engine bay doors vibrate or move in and out. Flight near powered aircraft should also be avoided, except for aero-tow launches. See para B5 for ENL figures that are expected include those 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, see Para 4.1.3 on page 3. ENL figures for piston engines should be similar to those found in GFAC tests and listed in para B5, and this may be vital when a claim is made so that it is clear that the engine was not used during the soaring performance.

A10 **After Landing**. Until an OO has witnessed the FR installation in the glider, the pilot must not alter the installation or remove the FR from the glider. The pilot must ensure that there is evidence of the landing independent of the recorder, see A11 below. Pilots are advised not to switch off the FR for several minutes after landing, so that an adequate landing baseline is on the IGC file.

A10.1 After-flight calculation of security. When the FR is switched on again after switching off 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, 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 FR (see para B3.1).

A12 **Switching Off**. The FR is switched off by pressing and holding a button until the screen goes blank. In the original Fenix this is the lower button, in the FenixN it is the button on the left.

A13 **Downloading the Flight Data**. Downloading is to a micro-SD card in a socket between the two control buttons. In the original Fenix this is on the right of the screen, on the FenixN it is below the screen.

A13.1 OO's actions. For a flight to IGC standards of evidence, an OO must carry out the actions in para B3.3, and the OO's copy of the flight data will be 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 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 Pressure Altitude calibration that is valid 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 in IGC files from 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 on pages 1-4.
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 number of the Recorder, the glider type and registration, date and time. This type of recorder is designed to be fitted in an instrument panel, and if this is done, no special sealing is required.

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 FR 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 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 micro-SD card in the socket near the screen, between the two control buttons. To download flight data, the FR should be turned off after the flight and then opened up again and the appropriate knob used to select "Logbook" followed by selecting the latest IGC file, identified by its date and time.

B3.3.1 Files Produced. This process will produce an IGC flight data file with a file name in the format YYYY-MM-DD-RCE-XXX-N.IGC where Y = year, M = month, D = day, RCE = Manufacturer, XXX = Serial ID of the FR in numbers and/or letters, and N = flight number of the day.

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 PC. This file must be retained by the OO for later analysis under NAC procedures. The OO must be able to identify the flight 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 scoring, 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 in the competition, file names may be changed by the competition organisers, for instance to the glider competition number or the pilot's name, but integrity of the data in the file itself is preserved by the electronic security system and may be checked at any time by using the Validation process (B4 below).

B4 **Validation of 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 a current copy of the IGC Shell program and using the Validate function in the IGC Shell (see below). The Recorder manufacturer's 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 of 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 should 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 **Means of Propulsion Record - Gliders with Engines**. For recording engine noise, the Environmental Noise Level (ENL) system inside the FR is used. A microphone-based system produces three ENL numbers between 000 and 999 that are added to each lat/long fix in the IGC file and are based on noise centred on 150Hz. For engine and FR installations where ENL figures are low, making it difficult to distinguish between engine running and other noises (such as with rear-mounted electric engines, jet engines, and some rear-mounted four-strokes), another system or type of FR must be used.

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.

B5.1.1 Quiet period before flight. A low but positive ENL must be recorded when no noise is present, to indicate that the ENL system is working. For this type of Recorder, the base ENL in quiet conditions has been found to be between 010 and 025. Consistent ENL values of 000 indicate a fault in the ENL system.

B5.1.2 ENL during launching. During winch and aerotow launches, higher ENL values are to be expected than when soaring (B4.3). Typical ENL values are up to 350 for winch and 100 for aerotow, particularly if cockpit vents and direct vision 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 with a two-stroke engine running at full power. At power for level flight, ENL values of 700 have been recorded with a two-stroke engine, lower with a 4-stroke. During engine running, these figures are produced for a significant time. When altitude and speed are analysed it can be seen that substantial energy is being added, which can be attributed to energy not associated with climbing in a thermal. Previous tests with Wankel (Rotary) engines in other types of FR 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. 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. In this case, see para 4.1.3 on page 3.

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 up to 200 have been seen 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 450 have been seen. High ENL may also be due to 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 between 500 and 900 may be recorded, due to wheel rumble or tyre squeak. Unlike engine running these last only for a short time, showing a short "spike" on the noise 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 then 10 seconds) 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 powered aircraft, etc.

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 no major differences are seen that could indicate malpractice or manufactured (false) data. So that accurate pressure altitude is available, the FR is calibrated in an altitude chamber with respect to the values of the ICAO International Standard Atmosphere, in the same way as a barograph or aircraft altimeter. Before the calibration, the Recorder fix rate should be set to rapid fix interval such as a 1 or 2 seconds.

B6.1 Calibration method, making a calibration table. Recording should start 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 but significant pressure change so that recording commences before the calibration is started. The calibrator must record the pressure steps used, for later comparison with the IGC file. The stabilised pressure immediately before each 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 in the same way as flight data. 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 where a special High Altitude Flight Recorder (HAFR) is required, from which accurate GNSS altitudes 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 files. The original calibration file may have a nominal date/time (because GPS lock may not be present during the calibration), and the file can be copied and the file name changed to one that can be identified later. A text editor can be used to 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 GPS altitudes 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. Accuracy in lat/long is about twice that in Altitude because the angles of position lines from GPS satellites are more favourable for calculating horizontal position and less favourable for vertical 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. From GFAC tests, the lat/long error from a moving vehicle at a surveyed point in average reception conditions, shows an average error of between 5 and 10m for recent IGC-approved FR designs.

B6.3 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 with height, a small pressure step becomes a larger 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 this depends on 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. This type of FR is not an IGC HAFR.

B6.3.1 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 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 calibration is in accordance with IGC rules for pressure altitude calibrations.

B6.3.2 GNSS altitude. This FR is capable of recording up to 50 km, but see B6.3 above on IGC High Altitude Flight Recorders (HAFR).
