



GNSS FLIGHT RECORDER APPROVAL COMMITTEE (GFAC)
FAI INTERNATIONAL GLIDING COMMISSION (IGC)
of the
FÉDÉRATION AÉRONAUTIQUE INTERNATIONALE (FAI)
Maison du Sport International, Avenue de Rhodanie 54
CH-1007 - Lausanne, Switzerland
Tel +41 21 345 1070; Fax +41 21 345 1077; sec@fai.org

References:

IGC web site: www.fai.org/gliding
GFAC web site: www.ukiws.demon.co.uk/GFAC
IGC FR web site: www.fai.org/igc-our-sport/gnss-recording-devices

To: IGC GNSS and GFAC Chairman's web sites
Notification to: IGC email mailing list <igc-discuss@fai.org>
Internet newsgroup rec.aviation.soaring
Copy: FR Manufacturer

10 April 2014

IGC-APPROVAL FOR GNSS FLIGHT RECORDER

Level of Approval: All flights (see para i-ii)
Maker, Recorder Name: ClearNav Instruments, CNv-IGC

(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 given later. IGC reserves the right to alter this approval in the future.

(i-i) Document Version and Scope. This is the initial IGC-approval for this type of Flight Recorder (FR). This approval only applies to the recorder function. Other modules and functions of the recorder and external units that may be linked to it are a matter between owners and the manufacturer.

(i-ii) IGC-approval Level. This type of Recorder is approved for all IGC flights including world records. The Levels of IGC-approval are listed in Para 1.1.4 of Annex B to the Sporting Code.

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

(ii) Data Recording. This IGC-approval document is concerned with the functions of the equipment that record flight 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 and its advisors are agents of IGC. Tests made by GFAC on behalf of IGC and FAI concern accuracy and security of data, download 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) and Intellectual Property Rights (IPR) and/or, (b) the relations of the Manufacturer listed below with any other entities except with FAI and its agents 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. A separate IGC document is entitled "Technical Specification for IGC-Approved Flight Recorders". These documents and current approvals for all IGC-approved Flight Recorders are available on the FAI/IGC and GFAC web sites listed above.

(vi) Copy of this Document. It is recommended that a copy of this document including its two annexes is kept with each unit of the equipment so that it is available for pilots and Official Observers.

MANUFACTURER ClearNav Instruments
Address: 779 Rosedale Rd, Kennett Square, PA19348, USA
+1 610 388 0456 <http://clearnav.net>
Contact: Gary Kammerer gary@clearnav.net
IGC Manufacturer Code: CNI

1. HARDWARE

1.1 **Recorder Type and Serial Number.** The recorder type is the ClearNav CNv-IGC (abbreviated CNv-IGC). The suffix "IGC" is significant because there were earlier versions or the ClearNav CNv system that are not IGC-approved. This IGC-approval is for the Flight Recorder element of the CNv-IGC variometer and air data computer system. The recorder type is shown on the start-up screens, and in the header record of IGC files in the form: "HFFTYFRTYPE:ClearNav Instruments, CNv-IGC"

1.1.1 **Serial Number.** The IGC Serial Number (s/n) of an individual Recorder consists of three alphanumeric characters that are shown on the outside of the case and on the second screen after start-up, after the manufacturer's name and the Recorder type. The s/n is also in the first line of an IGC file after the letter A and the Manufacturer's three letter IGC code, in the form: "A CNI V75 FLIGHT:2", standing for ClearNav Instruments FR s/n V75, flight 2 of the day (the 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 3 and higher is the IGC-approved standard, but see para 7 on updates. The Version number is shown on the second screen after start-up in the form: "HW: 3". It is also in the header record of IGC files in the form "H FR HW HARDWAREVERSION: CNv-IGC ADC 3". The initials "ADC" are because the FR hardware is inside the unit that also houses the Air Data Computer (ADC).

1.3 **Dimensions, Weight, Power Source.** The unit that houses the recorder hardware is 110 x 65 x 20 mm in size, weight is 150 grammes and the power source is 12V DC. The recorder will work normally in the voltage range 8-16 VDC.

1.4 **GPS receiver.** The GPS receiver module is the Ublox NEO-6G by Ublox AG of Switzerland (www.ublox.com). This is shown in the header record of IGC files in the form "HFGPS:UBLOX,NEO-6G,16Ch,50000". The last figure is the maximum altitude in metres processed by the recorder to the altitude resolution requirements of the IGC FR Specification. The figure before is the maximum number of channels available in the receiver.

1.5 **Pressure altitude sensor.** This is the MS 5607 Pressure Altitude sensor from Measurement Specialities (ex-Intersema) of Switzerland (www.meas-spec.com/pressure-sensors.aspx). This is shown in the header record of IGC files in the form "HFPRSPRESSALTSENSOR:Intersema,MS5607-BP,9160". The last figure is the maximum altitude in metres processed by the recorder to the altitude resolution requirements of the IGC Specification. The recorder case is not pressure-sealed and "cockpit static" pressure is recorded in the IGC file.

1.6 **Connectors.** These are all on the main 110 x 65mm face of the Recorder Unit.

1.6.1 **10-way Connector.** Two connections are for 12V DC power and two for the Audio Unit speaker.

1.6.2 **3 RJ Connectors.** Two RJ10 4p4c CANbus connectors are for external devices such as Vario Display and MOP sensor, and 1 RJ11 6p6c for output of serial data to third party devices.

1.6.3 **Antenna Connector.** This is a 5mm diameter screw-in fitting.

1.6.4 **USB socket.** A 15mm wide USB socket is for a memory stick for downloading and uploading data into the RU.

1.6.5 **Pressure Connectors.** Three connectors for 4mm OD tubing are for Pitot, Static and Total Energy inputs.

2. **FIRMWARE.** This refers to systems inside the hardware unit that contains the recorder elements (para 1.2 above). Firmware Version 2.6.2321 and higher is the IGC-approved standard, but see para 7 on updates. The Version number is shown on the second screen after start-up in the form: "FW: 2.6.2321". It is also listed in the header record of IGC files in the form: "HFRWFIRMWAREVERSION: ClearNav CNv-IGC ADC 2.6.2321 2014-04-10". For the initials ADC see para 1.2 above. The date of release follows the firmware numbers.

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

3.1 **Downloading Flight Data.** Downloading is to a USB memory stick and is selected through the Display Unit.

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 Validation check. The Validate procedure checks that the IGC file has originated correctly from a serviceable recorder and that it 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.

3.2.2 **Latest versions.** The latest versions of the files in igcdll.zip and the manufacturer's DLL files must be used, obtained from the IGC or GFAC web sites.

4. **Engine Recording - ENL system.** A microphone and frequency filter and weighting system automatically produces an ENL (Environmental Noise Level) value with each fix. This is intended to highlight any engine and propeller noise but to produce low ENL values in gliding flight. The ENL system is mandatory for Validation of glide performances by gliders with any sort of motor, to show that forward thrust was not produced during the part of the flight that contains the glide performance to be claimed. ENL data has also been shown to be useful for non-motor gliders in the case of accidents and incidents.

4.1 **ENL Recording System Manufacturer.** The ENL system is made by the ClearNav company.

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

4.3 **ENL IGC-approval - Engine Types.** This document gives IGC-approval for the use of the above ENL system for the validation of glide performances to IGC standards of evidence when flown with Motor Gliders that have piston engines that give high ENL values in IGC files from this type of recorder when producing forward thrust.

4.3.1 **Low-ENL Engine/Recorder combinations** This approval does not include cockpit mounting of the FR when used with engines that produce small ENL values in IGC files from this type of recorder, particularly at low power when just producing forward thrust. Low-ENL engines include those that are electrically or jet powered where the FR is not mounted close to the engine and/or propeller. This is because electric engines produce small amounts of noise and jet engines produce higher noise frequencies than those for which the ENL system is designed. This may also apply to some 4-stroke engine/propeller combinations that are particularly quiet. If the FR position produces low-ENL values when the engine is run at low but positive thrust, there are two alternatives: (1) either the FR must be moved closer to the source of engine or propeller noise, or (2) another variable additional to ENL must be recorded in the IGC file under the MOP (Means of Propulsion) code, which uses a sensor remote from the FR that can be placed close to the engine (see Annex B to the Sporting Code for Gliding, para 1.4.2, particularly 1.4.2.4).

4.4 **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.

4.5 **ENL testing.** For details of typical ENL values found on GFAC tests with piston engines, see para B.4.

5 **Installation in the glider.** From the point of view of data recording, the unit may be fitted anywhere in the glider, subject to para 4 on ENL and para 6 on security. However, 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. 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. For how this is to be done, see para B1 later in this document.

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 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 been activated, subsequent IGC files will fail the IGC Validation test for electronic security and a message will be added to the Header record of IGC files in the form HF FRS SECURITY SUSPECT USE VAL1 PROGRAM:03; IsNotSealed. The Validation 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 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 **Manufacturer's Changes, 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, and so forth. If in doubt, GFAC should be notified.

Ian W Strachan
Chairman, IGC GFA Committee

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

Any questions to: Chairman IGC GFAC,
Bentworth Hall West, Alton, Hampshire GU34 5LA, UK
Tel: +44 1420 564 195; Fax: +44 1420 563 140; email: ian@ukiws.demon.co.uk

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 and para (i-ii).

A(iii) Copy of this document. It is recommended that a copy of this document is kept with the equipment, 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**. The antenna should be positioned to give sufficient signal strength for recording IGC files without dropped fixes. No attempt must be made to inject false data via the antenna.

A2 **WGS84 Earth Model**. This type of recorder is fixed on the WGS84 ellipsoid earth model and no selection or switching is required. However, it should be ensured that other lat/long data such as for start, turn and finish points, also use the WGS84 ellipsoid earth model (IGC rule).

A3 **Setting the Fix Interval**. The fast-fix facility operates when Pilot Event (PEV) is selected on the Display Unit (DU) and the appropriate button on the DU is pressed. The next fix in the IGC file is marked with the PEV code, followed by 30 fixes at one second intervals. The fix interval for cruise flight is set up through the DU. There is therefore no need to set the cruise fix interval to a very short value, because Observation Zones and other points of interest can be marked by PEV events followed by fast fixes. Setting a short fix interval would lead to IGC files of an unnecessarily large byte size being created for long flights. This uses up more memory, causes downloading after flight to take a long time, increases the chance of data corruption, and may also cause problems with some analysis programs because of the large number of fixes that have to be processed.

A3.1 **IGC rules**. IGC rules on fix intervals for cruise flight are a maximum of 60 seconds and 10 seconds for competitions using Annex A to SC3. SC3C para 7.1 says: "10 to 20 seconds has been found to be suitable, and does not use up as much memory as a more frequent setting for the whole flight. A more frequent fix interval is recommended near a Waypoint to ensure that a fix is recorded within its observation zone".

A4 **Checking the Recorder before a Claim Flight**. Pilots should check and analyse a selection of IGC files from their recorder before attempting flights that will require Validation. 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 and other values are recorded as expected. In particular, for gliders with engines, ENL values should be in accordance with the figures given in para B5. See also A9 on ENL and A14 on pressure altitude calibration.

A5 **Pre-flight Declaration in the IGC file**. Electronic pre-flight declarations are made by following the instructions in the Manufacturer's manual. 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. Also, that an IGC file is produced that satisfies the Sporting Code on pre-flight declarations (for instance after an OO who is familiar with SC3 rules has checked the IGC file).

A6 **Observing the installation in the glider**. The pilot must ensure that the OO has checked the place of the FR in the glider and how it is fixed. If it may be difficult to obtain an OO immediately before takeoff, or to witness the landing, an OO should be asked to seal the Recorder to the glider, and **this can be done at any time or date before flight**. See para 5 earlier in this document that deals with installation, including positioning so that pilot lookout and scan is not impeded.

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 takeoff starts.

A8.2 **Independent evidence of Takeoff**. The pilot must ensure that the time and point of takeoff has been independently witnessed and recorded for comparison with takeoff data in the IGC file from this recorder.

A9 **Use in Gliders with Engines** (including self-sustainers). This applies to gliders with any sort of engine. 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 must not be covered or insulated (even so, automatic gain should continue to ensure high ENL readings under engine power). An internal microphone and associated circuitry automatically records the level of acoustic noise at the recorder. This is recorded in the IGC file with each fix 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 will register as high ENL. This is magnified if sideslip is present and in particular at high airspeeds. High airspeeds with cockpit panels open and climbing with cockpit*

panels open should therefore be avoided in case the ENL recorded is mistaken for use of engine. Flight close to powered aircraft should also be avoided, except for aero-tow launches. For ENL levels recorded on GFAC tests, see B.4.2.

A9.2 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. ENL figures should be in accordance with those found in GFAC tests and listed in para B5. This may be vital on a later flight when a claim is made. If ENL figures are found to be significantly different to those in para B5 when using piston engines, the recorder should be returned to the manufacturer for the ENL system to be re-set.

A9.3 Low-ENL installations. For installations of engine and FR that produce low ENL figures in the IGC file when the engine is running (such as electric, jet and some 4-strokes), see para 4.3.1 earlier in this document.

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. The pilot must ensure that there is evidence of the landing independent of the flight recorder, see A11. Pilots are advised not to switch off the recorder for at least one minute after landing.

A10.1 After-flight calculation of security. After landing, the recorder calculates a digital signature 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 complete and stored in the memory ready for downloading. These codes are used to verify the integrity of the whole file at any later time by using the Validate function of the IGC Shell program with the manufacturer's DLL file in the same directory.

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.** This is by disconnecting the DC supply.

A13 **Downloading the Flight Data.** Downloading is to a USB memory stick and is selected through the Display Unit.

A13.1 OO's actions. An OO will then carry out the actions given in para B3.3, and the OO's copy of the downloaded flight data will be sent to the organisation that will validate the flight, such as the National Airsport Control body (the NAC). The OO does not personally have to download the data from the Recorder, but witnesses the download and immediately after the OO takes or is given a copy on electronic media such as a memory stick.

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 media to competition control, or a central data download 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 Function.** Pilots are advised to have a pressure altitude calibration carried out by an NAC-approved calibrator before any Recorder is used for a claimed flight performance. For the procedure, see para B6. An IGC file showing the pressure steps used in the calibration must be recorded and kept (Sporting Code rule). Altitude and height claims require a calibration for the flight performance concerned, and speed and distance claims need a calibration for calculating the altitude difference of the glider at the start and finish points. Also, the NAC 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 and para (i-ii).

B(iii) Copy of this document. It is recommended that a copy of this document is kept with the equipment, for the use of pilots and OOs.

B1 Installation in the Glider. An OO shall witness and record the position of the Flight Recorder (FR) in the glider, the type of FR, its three-character IGC serial number, the FR hardware and firmware numbers, the glider type and registration, date and time. The FR type, serial number and hardware/firmware numbers are shown on the second screen after startup; for more detail, see paras 1.1.1, 1.2 and 2 on page 2 of this document. Before flight, if requested, the OO shall seal the Recorder to the glider in a way acceptable to his NAC and to IGC, and such sealing may be at any time or date before flight. If sealing is not used, either a preflight check of the installation must be made after which the glider must be under continuous observation by an OO until it takes off on the claimed flight. Alternatively, an OO must witness the landing and have the glider under continuous observation until the Recorder installation is checked. This is to ensure that the installation is correct, and another Recorder has not been substituted in the glider before the flight file is downloaded (B3.3); see para 5 before the Annexes, which also refers to the position of the FR display which should be placed so that pilot lookout and scan is not compromised.

B2 Takeoff - Independent Evidence. The time and point of takeoff shall be recorded independently from the FR, either by an OO, other reliable witnesses, or by other means such as an Air Traffic Control or official Club log of takeoffs and landings. After flight, this will be compared to the takeoff data from the FR.

B3 Landing

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

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

B3.3 Downloading the Flight Data. Downloading is through the USB socket on the recorder and is selected through the Display Unit.

B3.3.1 Files Produced. This process will automatically produce an IGC-format flight file with the file name YYYY-MM-DD-CCC-XXX-NN.IGC, where Y=year, M=month, D=day, CCC=IGC Manufacturer Code, XXX = Recorder Serial Number/letters and NN = flight number of the day.

B3.3.2 OO's Copy. A copy of the IGC file for the flight to be claimed shall be retained securely by the OO such as by immediately copying it to storage media such as a memory stick or the hard disk of the OO's own PC. The IGC file shall be retained by the OO in safe keeping for later checking and analysis under NAC/IGC procedures. The hard disk of another PC may also be used but 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 procedures may apply to competitions. 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 download 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 (but the correct details will always be in the Header record of the IGC file). However, where a claim is to be made to IGC standards, an OO must supervise the download in the normal way.

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 originated from the Recorder concerned, and is identical to the file that was originally downloaded from the Recorder. This is by using the Validate function of the IGC Shell program (see B4.1 below). The FR manufacturer's DLL file is needed in the IGC Shell directory for Validation to work, and the Shell program and the manufacturer's DLL file must be the same as those on the current FAI/IGC or GFAC web sites listed 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 system 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 FR Manufacturer's Dynamic Link Library (DLL) file must be copied to the IGC Shell directory. After copying it to the directory that contains the IGC Shell files, execute IGC-SHELL.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 should now include the line for the manufacturer of this FR, which should be selected.

B4.1.1 Validation of IGC files. With the recorder connected to the PC and the IGC Shell program selected, highlight the recorder manufacturer from the top menu box, press the "Validate" button and select the IGC file that is to be checked. If successful, the message "File has been successfully validated" appears. If there is a security problem, the message "Validation check failed" appears, together with a reason.

B4.1.2 Latest File Versions. The latest versions of the IGC shell and DLL files must be used. These can be obtained from the IGC or the GFAC web sites listed at the beginning of this document.

B5. Engines - ENL figures in the IGC file. This applies to gliders with engines of any sort including small self-sustainers. It must be proved that the MoP (engine) was not used to produce any forward thrust during the claimed glide performance. To show this, the engine must either be sealed or inoperative, or the built-in Environmental Noise Level (ENL) system used. The ENL system uses a microphone in the recorder and acoustic noise is transformed into three numbers under the ENL code that are added to each fix in the IGC file. For more information, see para 4 before the Annexes. ENL values recorded on GFAC tests are given below, in the sequence of a flight.

B5.1 ENL during launching. During winch and aerotow launches, higher ENL values are to be expected than when soaring (B4.3), typically up to 180 for winch and 150 for aerotow. During the ground roll, short-term higher values have been recorded, probably due to wheel rumble or tyre squeak, and values of 300 have been seen for one or two fixes.

B5.2 ENL during engine running. On engine running at powers needed to climb, an increase to over 700 ENL is expected. Over 900 is typical for a two-stroke engine, over 700 for a 4-stroke. An ENL value of 999 has been recorded at full power with a 2-stroke engine. During engine running, these high ENLs are produced for a significant time, and when altitude and speed are analysed it can be seen that substantial energy is being added, which can therefore be attributed to energy not associated with soaring. The values quoted above are for 2- and 4-stroke engines. Previous tests with Wankel (Rotary) engines indicate that they produce similar ENL values to 4-strokes.

B5.2.1 Engines producing low ENL signatures. This approval does not include installations of the FR and engine where only low ENL values are produced when the engine is producing forward thrust. Engines such as electric, jet, or a well-silenced 4-stroke produce low ENL values unless the FR is positioned close to the engine and/or propeller. Such a low-ENL installation will require, in addition to ENL, an RPM-related variable under the MOP code to be recorded by a sensor close to the engine and/or propeller. See para 4.3.1 before the Annexes.

B5.3 ENL during gliding flight. ENL readings of less than 030 indicate normal quiet gliding flight. Short periods of higher ENL while gliding may indicate aerodynamic noises. In a high-speed glide, or in a noisy glider, ENL may increase to 150. Particularly, sideslip or high speeds with the cockpit Direct Vision (DV) panel open can produce low frequency noise ("organ-pipe" effect) and ENL readings of up to 350 have been recorded. High ENL may also be recorded during stalling and spinning, particularly if the engine doors flutter or vibrate (move slightly in and out due to stall buffet, producing a clattering noise). Finally, where the engine is mounted on a retractable pylon, a high ENL reading will be shown if flying with the pylon up and engine not running, due to the high aerodynamic noise.

B5.4 ENL during the approach to land. ENL values are higher on a landing approach due to aerodynamic noises from airbrakes, undercarriage, sideslip, turbulence, etc. Short-term peaks due to specific actions such as opening airbrakes, lowering undercarriage, etc., may be seen as well as a generally higher level of ENL because the glider is no longer aerodynamically clean. ENL values of up to 150 have been recorded on the approach to land.

B5.5 ENL during landing. During ground contact during takeoff and landing, short-duration ENL readings of up to 550 have been recorded, probably due to wheel rumble or tyre squeak, particularly on hard surfaces. Unlike engine running these last only for a short time, showing a short "spike" on the noise/time trace.

B5.6 ENL analysis. It is normally easy to see when an engine has been running and when it has not. Other data such as rates of climb and groundspeed will indicate whether energy is being added other than through thermal or other source of lift. Short term peaks in ENL (1-5 seconds or so) may be due to other factors mentioned above such as undercarriage and/or airbrake movement, sideslip, open DV panel (particularly with sideslip), a nearby 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. Flight data files will be analysed in accordance with Sporting Code procedures. Part of this is to compare the general shapes of the GNSS and pressure altitude fix records with time and to ensure that no major differences are seen that could indicate unreliable or false data. As part of this process, the pressure altitude system in the FR must be calibrated in an altitude chamber in the same way as a mechanical barograph.

B6.1 Calibration method, making a calibration table. For a pressure altitude calibration, first change the fix interval to 1 or 2 seconds and put the FR in the pressure chamber. Recording starts after a pressure change of 1 metre per second for 5 seconds, and no GPS fixes are required for a pressure altitude trace to be produced. Date/time will be provided by the Real-Time Clock in the Recorder Unit (powered by a small sustainer battery when external power is off) and this will be recorded in the IGC file and in the file name. The calibrator should be advised to make a short pressure change to trigger recording before starting the calibration itself, which must be with respect to the ICAO International Standard Atmosphere (ICAO ISA). 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 downloaded to a PC as if it was flight data (see B3.3 above); this may be done by an NAC-approved person if the calibrator does not have this knowledge. The IGC file is then analysed 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 altitude to the ICAO ISA compared to the pressure altitudes recorded in the IGC file. This table can then be used to adjust pressure altitudes which are recorded during flight performances and which require correction to the ICAO ISA before validation of the flight. These include takeoff, start and landing altitudes for altitude difference and for comparison with independently-recorded QNH readings, and low and high points on gain-of-height and altitude claims. Below altitudes of 15,000m, only pressure altitude is valid for accurate altitude measurement purposes to IGC standards, except for proof of flight continuity (no intermediate landing) where GNSS altitude may also be used.

B6.2 GPS altitude figures recorded in the IGC file. Occasional short-duration differences in the shape of the GPS Altitude/time graph have been noted compared to the pressure altitude figures. This is not unusual with GPS receivers operating without a local differential beacon. The altitude accuracy from GNSS will not be as good as accuracy in lat/long because the geometry of position-lines is not as favourable for altitude compared to horizontal position. This effect may be increased by poor antenna positioning. Data analysts and NAC officials should allow for the above when comparing the GPS altitude and pressure altitude records. Lat/long fix accuracy is not affected and tests on this recorder show it to be typical of that for a multi-channel GPS system. From GFAC tests over many years, the average lat/long error measured from ground vehicles at a selection of surveyed points in average reception conditions, is between 11 and 12m for all recorders tested.

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 discrimination at low altitudes but as air density reduces at height, a small pressure step becomes a large altitude difference. The type of processor in the FR and the need for good resolution (small steps) across the altitude range, results in limitations in altitudes recorded in the IGC file. The maximum altitudes in the IGC file to the resolution requirements of the IGC FR Specification for this type of FR are given below (although for flights above 15km, see special IGC rules for High Altitude Flight Recorders (HAFR) in the Sporting Code).

B6.3.1 Pressure Altitude. Up to 9160 metres (30,052 ft)

B6.3.2. GPS altitude. Up to 50 km. Note that above 15km (49,213ft) an IGC-approved High Altitude Flight Recorder (HAFR) is required, and this FR is not IGC-approved as a HAFR.
