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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, newsgroup rec.aviation.soaring

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IGC-APPROVAL DOCUMENT FOR GNSS FLIGHT RECORDER

Manufacturer - Recorder Name: LX Navigation - LX MOP IGC
Level of Approval: IGC Level 1 - see para (i-ii) below

(i) General. This document gives formal approval from the above date for the Flight Recorder (FR) 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 for this type of FR was dated 16 November 2016. The reference to the FAI/IGC web site and some of 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 1 - all flights including world records. The Levels of IGC-approval are listed in Para 1.1.4 of Annex B to the IGC Sporting Code. Also see para 7 about future changes.

(i-iii) GNSS System. The Global Navigation Satellite System (GNSS) used 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 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 the latest 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 easily available for pilots and Official Observers.

MANUFACTURER

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IGC manufacturer codes & DLL file: Three letter LXN, single letter L ; IGC-LXN.dll

1. HARDWARE

1.1 **Recorder Name**. The LX MOP IGC is a small FR designed to be installed close to the source of maximum sound produced by the engine of a motor glider. MOP stands for Means of Propulsion and the MOP module inside the FR has a microphone and audio processing system. The type is shown in the header record of IGC files in the form: " HFFTYFRTYPE:LX MOP IGC".

1.1.1 Serial Identification (S/ID). The IGC Serial Identification (S/ID) (s/n) of an individual Recorder consists of three alphanumeric characters shown on the outside of the case. 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: A LXN OB2 FLIGHT:3, standing for LX Navigation FR s/n OB2, file 3 of the day.

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

1.3 **Dimensions, Weight, Power**. The case is 60 x 44 x 27 mm in size, and the GPS antenna connector projects a further 9mm. Weight is about 270 grammes. Power is from a 12V external supply through an RJ45 connector, and the internal battery will last for about 4 hours when fully charged if external supply fails.

1.4 **GNSS receiver**. This is the LEA-6S GPS receiver by Ublox AG of Switzerland, shown in the header record of IGC files in the form " HFGPS:uBLOX-LEA-6S,50ch50000 ". The last figure is the maximum altitude in metres that could be processed (see B6.3 for the IGC height limit). The figure before is the maximum number of channels available in the receiver.

1.5 **Pressure altitude sensor.** This is the MS5607 Pressure Altitude sensor by Measurement Specialities Switzerland sa (MEAS, ex-Intersema). This is shown in the header record in the form: "HFPRS PRESSALTSENSOR: MEAS, MS5607, max15000m". The last figure is the maximum altitude processed by the recorder to the 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 and Indicators**

1.6.1 GPS Receiver Antenna. A 6mm diameter SMA screw connection for the GPS receiver antenna is on the front of the case.

1.6.2 RJ45 Connector. An 8-pin RJ45 connector is on the front of the case and is used for DC power and other functions.

1.6.3 Light. A small light is on the front of the case between the antenna connector and the RJ45 socket. When the unit is recording or is ready to record, the light blinks in four different colours as follows:
red = no valid GPS; blue = internal battery charging; green = recording; white = under power, ready to record.

1.6.4 micro-SD Card. A socket for a micro SD card is on the back of the case. This is the primary storage for IGC file data, there is no IGC file storage in the recorder itself. This has implications for procedures after landing to ensure that downloaded IGC files will pass the IGC Shell validity check, see 3.2, A10 and A12.

2. FIRMWARE.

The IGC-approved standard for firmware inside the FR is Version 1.2 and higher. The version is listed in the header record of IGC files in the form: "HFRFWFIRMWAREVERSION:1.20"

3. SOFTWARE.

This refers to systems outside the FR.

3.1 Downloading Flight Data. IGC files are automatically downloaded to a micro-SD card in the socket on the back of the FR.

3.2 Validation of Flight Data. The IGC standard for electronic flight data is that the IGC file must pass the Validate check in 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. This checks that the IGC file has originated from a serviceable FR and that the flight data is identical to when it was first written to the micro SD card by the FR.

3.2.1 IGC Shell Files and FR Manufacturer's DLL file. These files are available from the IGC or the GFAC web pages through 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. For the Shell program to work, the recorder manufacturer's Dynamic Link Library (DLL) file must be in 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 from the IGC or GFAC web sites.

4. Engine Recording - ENL and MOP systems.

A microphone and frequency filter system inside the FR automatically produces an ENL (Environmental Noise Level) value of acoustic noise, with a maximum sensitivity at about 150 Hz. This is added to each fix (B-record line in the IGC file) as three ENL numbers, and is designed to produce low ENL values in gliding flight but high values when the engine is run. An additional MOP (Means of Propulsion) sensor is included inside the case to record the higher frequency noise that is produced by small jet engines used in some gliders. The MOP system has a maximum sensitivity at about 6000 Hz and records three MOP numbers in each fix in the IGC file in addition to the three ENL numbers.

4.1 ENL System.. The ENL system is made by LX Navigation. ENL figures are part of each fix in the IGC file and are between 000 and 999 in steps of 001.

4.1.1 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 recorder installations that give high ENL values in IGC files when the engine is producing any forward thrust. Such ENL values must clearly differentiate between forward thrust from the engine and soaring flight. For jet engines see 4.2. below.

4.1.2 Low-ENL Engine Installations. This small recorder is designed to be installed close to the maximum sound produced by an engine. This approval does not include other positions that produce small ENL numbers (except jets, see 4.2), particularly at low power when just producing positive forward thrust. This is particularly important in rear-mounted electric and 4 stroke engines.

4.2 Means of Propulsion (MOP) System for recording Jet Engines. The high frequency MOP sensor is made by LX Navigation and is inside the FR. It is designed for use with jet-powered gliders where the engine produces noise at frequencies above those at which the ENL system is sensitive. The FR should be mounted close to the jet pipe so that high MOP values are recorded whenever the engine is producing forward thrust.

4.2.1 MOP in the IGC file. Three MOP numbers are added to each fix (B-record lines) in the IGC file in addition to the three ENL numbers. The MOP numbers can be displayed by an analysis program with facilities for MOP as well as ENL. The type of MOP system is shown in an extra Header record line at the beginning of the IGC file in the form: HFMOPSENSOR:LX Navigation, Acoustic, LX MOP Type 3

5 **Installation in the glider**. This type of Flight Recorder is designed to be fitted close to the noise produced by the engine of a self-launching or self-sustaining motor glider.

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, 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 and this Approval, and the accuracy of outputs from sensors for GPS Position, ENL, MOP and pressure altitude.

6.1 Physical Security. Tamper-evident seals with the manufacturer's logo must be 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. This test will also fail if the IGC file is different from that originally downloaded from the Recorder, even by one character in the flight data. If corrupted firmware is detected, either IGC files will not be generated or if they are, will fail the IGC Validate test.

6.3 Recorder 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 re-sealed, 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 returned 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 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 unit, pressure altitude sensor, ENL and MOP systems, and so forth. If in doubt, GFAC should be notified.

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

Annex A 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(s), and no attempt must be made to pass unauthorised data into the Recorder including through the GPS antenna.

A2 **Geodetic Datum (Earth Model)**. This type of recorder is fixed on the WGS84 Geodetic Datum (earth model). Other lat/long data such as start, turn and finish points, must also be entered with reference to the WGS84 Geodetic Datum (IGC rule).

A3 **Fix Interval**. The fix interval is constant at 1 second, and can not be changed.

A4 **Checking the Recorder before a Claim Flight**. Pilots are recommended to check and analyse a selection of IGC files from their recorder before attempting flights that may 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 and GPS altitude, ENL, MOP, date/time and other values, are recorded as expected. For gliders with engines, ENL and MOP values should be in accordance with the figures given in para B5. See also A9 on ENL and MOP, 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 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 IGC 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 applying external power, following which the light (para 1.6.3) flashes. Pilots are advised to switch on at least 5 minutes before takeoff and check that it is ready to record (no flashing red light) so that there will be a baseline of fixes at takeoff.

A8.2 **Takeoff - Independent evidence**. The pilot must ensure that the time and point of takeoff has been independently witnessed and recorded for comparison with takeoff data in the IGC file from the recorder, see B1.2.

A9 **Gliders with Engines**. This applies to gliders with any sort of power plant that could give forward thrust. See para 4 on pages 2 and 3 about engine recording. The recorder must be placed so that engine noise is clearly received when the engine is giving any forward thrust and must not be covered or insulated (even so, automatic gain should ensure high ENL readings under engine power). Microphones inside the recorder automatically record the level of acoustic noise, shown in the IGC file with each fix as three numbers under the ENL code for low frequencies, and three numbers under the MOP code for high frequencies (for small jet engines). See para 4 on pages 2 and 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 will register as high ENL. This is magnified if sideslip is present and in particular at high airspeeds. Climbing with cockpit panels open should be avoided in case ENL is mistaken for use of engine***. High ENL may also be produced by stall buffet and spins, particularly in Motor Gliders if the engine bay doors flutter (vibrate or move in and out). Flight near powered aircraft should also be avoided, except for aero-tow launches. See B4.2 for ENL and MOP levels that have been recorded in GFAC tests.

A9.1.2 Pilot check of ENL and MOP figures. Pilots should check that the ENL and MOP figures produced by their recorder show a clear difference between engine-on and engine-off flight. ENL and MOP 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 and MOP figures are found to be significantly different to those in para B5, the recorder should be returned to the manufacturer or his authorised agent for the ENL and MOP systems to be re-set.

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 landing independent of flight recorder data, see

A11 below. *It is vital that the micro SD card is not removed for at least 5 minutes after the aircraft has been static after landing and that the GPS antenna is not disconnected during this time. This is so that the IGC file is not ended prematurely without a valid digital signature (in which case the flight data cannot be checked for integrity, see 10.1). This is because there is no large internal memory and the micro SD card is the source of IGC file data, requiring 5 minutes of fixes showing "no movement" before the file automatically completes with a digital security signature. The 5 minute period is primarily to allow for being static in wave or ridge lift and is so that the file does not complete whilst still airborne. It also ensures a good after-landing baseline.*

A10.1 After-flight calculation of security. A digital signature is calculated for each IGC file, placing security codes in the G-record at the end of the IGC file, which is then completed and stored on the micro SD card. 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 (see para 6.2 on page 3).

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**. External power can be switched off after landing and the FR will continue to run on its internal battery. After the IGC file has completed with a digital signature at the end (see A10 above) , the micro-SD card may be removed and if running on internal power the light will stop flashing. ***If the micro-SD card is removed too early, the file will not complete, there will be no digital signature at the end of the file, and although the file will include the flight data, it will be invalid for certification of the flight to IGC standards of evidence because it will fail the IGC Shell Validation check.*** If this happens, the light will continue to flash until either the microSD card is replaced or the internal battery runs down.

A13 **Downloading the Flight Data**. Downloading is automatic after the file has been completed with a digital signature (see A10 and A12 above) to the micro-SD card in the socket at the back of the recorder. See also B3.3.

A13.1 OO's actions. For a flight to IGC standards of evidence, an OO should then carry out the actions given in B3.3, and the OO's copy of the transferred flight data 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 should witness the transfer, and immediately takes or is given a copy on a storage device such as a memory stick or 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 media 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 must ensure that a pressure altitude calibration is carried out by an NAC-approved calibrator before any GNSS Recorder is used for a claimed flight performance. For the procedure, see para B6. A valid IGC file showing the pressure steps used in the calibration must be recorded and kept (Sporting Code rule). Altitude and height claims require a calibration for the flight performance concerned, 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 "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, its type and Serial Identification (S/ID), the glider type and registration, date and time. Before flight, the OO may seal the Recorder to the glider in a way acceptable to the NAC and to IGC, and such sealing may be at any time or date before flight. If sealing is not used, either a pre-flight check of the installation must be made after which the glider must be under continuous observation by an OO until it takes off on the claimed flight, or an OO must witness the landing and have the glider under continuous observation until the Recorder installation is checked. This is to ensure that the installation is in accordance with IGC rules, and that data transfer (B3.3) is from the correct Recorder.

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 takeoff data from the Recorder.

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 independent means such as an Air Traffic Control or official Club log of takeoffs and landings. After flight, this will be compared to the Recorder landing data.

B3.2 Checking the Installation. 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. IGC files are automatically downloaded to the micro-SD card in the socket at the back of the case. After this, the IGC file for the flight should be transferred to a PC under the control of the OO. Security of downloaded IGC files is maintained by coding at the end of the IGC file that enables files to be checked later for integrity by anyone including OOs or at the NAC. See para B4 for how this is done.

B3.3.1 Files Produced. This process will produce an IGC-format ASCII flight data file with the file name YMDFXXXN.IGC, where Y = year, M = month, D = day, F = recorder 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).

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

B3.3.3 Competitions. Different rules may apply for competitions, in which 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. Alternatively, a central competition data transfer facility may be used. For ease of identification within the competition, file names may be changed, for instance to the glider competition number or the pilot's name. Integrity of data within the file is preserved by the electronic security system and may be checked at any time by using the Validation process described in B3.3.1.

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 initially downloaded from the Recorder. This is done by using the Validate function of the latest version of the IGC Shell program to check the IGC data file (see below). The Shell program and the Recorder manufacturer's 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.

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. The IGCshell menu will appear in a grey rectangular box with 9 software buttons for selecting the recorder type, settings and flight logs.

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

B5 Gliders with Engines. For recording engine noise at the recorder, the Environmental Noise Level (ENL- low frequency) and Means of Propulsion (MOP - high frequency) systems inside the FR are used. See para 4 on pages 2 and 3.

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 a powered aircraft, etc. If in doubt, email the IGC file to the GFAC Chairman for further analysis and advice.

B5.1.1 Quiet period before flight. A low but positive ENL value is produced where no noise is present, to indicate that the ENL system is working. For this Recorder the base ENL in quiet conditions is 010. 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), typically up to 150 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 for two-stroke engines running at full power. At power for level flight, ENL values of 700 have been recorded in a two-stroke, lower in a 4-stroke. During engine running, these ENLs are produced for a significant time. 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. Tests with Wankel (Rotary) engines indicate that they have 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-stroke produce low ENL values unless the FR is positioned close to the engine and/or propeller. The additional MOP numbers in the IGC file are to record the use of jet engines, see para 4.2 on page 3 and B5.2 below.

B5.1.4 ENL during gliding flight. ENL readings between 010 and 050 indicate slow-speed gliding flight in a well-sealed cockpit. However, flight with the canopy panel(s) open produces substantial extra noise inside the cockpit. ENL values of up to 200 have been produced when thermalling with the cockpit panel (s) open. With sideslip or at higher speeds, a loud low frequency noise can be produced ("organ-pipe" effect) and ENL readings of up to 470 have been recorded. High ENL may also be recorded during stalling and spinning, particularly if the engine doors 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 from airbrakes, undercarriage, sideslip, turbulence, etc. Short-term peaks due to specific actions such as opening airbrakes, lowering undercarriage, etc., will be noted as well as a generally higher level of ENL because the glider is no longer aerodynamically clean.

B5.1.6 ENL during landing. During ground contact during landing, short-duration ENL readings of between 500 and 900 have been recorded due to wheel rumble or tyre squeak. Unlike engine running these last only for a short time, showing a short "spike" on the ENL 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, 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).

B5.2 MOP system. In addition to ENL, this recorder also produces three numbers under the MOP code from a high-frequency sensor with peak response at about 6000Hz (see para 4 on pages 2 & 3). The MOP system is designed to record the use of small jet engines that are fitted to some gliders, in which the Recorder should be fitted near the jet pipe. During post-flight analysis the ENL and MOP numbers in the IGC file during engine running should be compared, to check that they correspond in time and that numbers are as expected, particularly under high engine power, although the ENL readings will be much lower. This is easy to carry out and is a "double check" on the working of the ENL and MOP systems.

B5.2.1 Engine-on. MOP numbers recorded with each lat/long fix should be at least 500 when any forward thrust is generated, and over 900 at high power settings.

B5.2.2 Engine-off. In GFAC tests with engine off , MOP numbers in the IGC file were generally at its base value of 010, with occasional short-term "spikes".

B6 **Altitude analysis and calibration**. IGC files must be analysed using 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 a technical problem, malpractice or manufactured (false) data. So that accurate pressure altitude is available, the FR must be calibrated in an altitude chamber with respect to the ICAO International Standard Atmosphere (ISA) in the same way as a barograph or aircraft pressure altimeter.

B6.1 Calibration method. Recording starts after a pressure change of 1 metre per second for 5 seconds and no GPS fixes are required for a pressure altitude trace to be produced. The calibrator should be advised to make a short pressure change to trigger recording before starting the calibration itself. The calibrator must record the pressure steps used, for later comparison with the IGC file. The stabilised pressure immediately before the altitude is changed to the next level, will be taken as the appropriate value unless the calibrator certifies otherwise.

B6.1.1 After Calibration. After the calibration, the IGC file containing the pressure steps is transferred to a PC as if it was flight data (see B3.3). This may be done by an NAC-approved person other than the calibrator who may not have this knowledge. The 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 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 and GNSS altitude is used in accordance with Sporting Code procedures for HAFRs. If GPS lock-on has not occurred, the original IGC file may have a nominal date/time, in this case the file can be copied and the file name changed to one that can be identified as the calibration. A text editor can be used to 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.

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 systems operating without a local differential beacon or area augmentation system. The altitude accuracy from satellite-based systems will not be as good as accuracy in lat/long, because satellite geometry is not as favourable for obtaining accurate altitude compared to horizontal position. This effect may be increased by poor antenna positioning or losses in cables or connectors. Data analysts and NAC officials should allow for the above when comparing the GPS altitude and pressure altitude records. Lat/long fix accuracy is generally 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 about 11m for all recorders tested since the year 2000, with about 6m for good reception conditions and a high-gain antenna.

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 (49,213ft) an IGC-approved High Altitude Flight Recorder (HAFR) is required, and this FR is not IGC-approved as a HAFR.

B6.3.1 Pressure Altitude. Up to 15 km (49,213 ft).

B6.3.2 GNSS altitude. Up to 50 km (nominal), but see above about IGC High Altitude Flight Recorders (HAFRs)
