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THE FAI INTERNATIONAL GLIDING COMMISSION (IGC)
GLOBAL NAVIGATION SATELLITE SYSTEM (GNSS)
FLIGHT RECORDER APPROVAL COMMITTEE (GFAC)

References:
FAI web site: www.fai.org
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 web site under "List of Approvals"
Notification to: IGC email mailing list <igc-discuss@fai.org>
Internet newsgroup rec.aviation.soaring
Copy: Manufacturer concerned

12 February 2017

IGC-APPROVAL FOR GNSS FLIGHT RECORDER

Level of Approval: **All flights (see para i-ii)**
Recorder Name: **LXNAV Nano 4**

(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. FAI and IGC reserve the right to alter this approval in the future.

(i-i) Document Versions. This is the initial IGC-approval for this type of FR.

(i-ii) IGC-approval Level. At the date of this document, 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, also see para 7 on page 3 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).

*(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 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) 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. Copies of all of these documents may be obtained from the FAI/IGC web sites listed above and links are provided from the IGC web site. 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 approval including its two annexes is kept with each unit of the equipment so that it is available for pilots and Official Observers.

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Manufacturer Codes: Single letter: V, three letters: LXV

1. HARDWARE

1.1 **Recorder Type and Serial Number**. The recorder type is the LXNAV Nano 4, shown in the header record of IGC files in the form: "HFFTYFRTYPE:LXNAV,NANO4".

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 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: "ALXV2BCFLIGHT:2", standing for LXNAV FR s/n 2BC, IGC file 2 of the day (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 and higher is the IGC-approved standard for Nano versions, but see para 7.2 on updates. The Version number is shown in the header record of IGC files in the form "HFRHWHARDWAREVERSION:1.0".

1.3 **Dimensions, Weight, Power Source**. The Nano 4 is 68 x 105 x 18 mm in size and weighs about 140 gm. External power is from an 11mm wide USB connector plugged in to the power source, connecting by cable to a male fitting for the USB micro-B socket described in 1.6.2 below. There is also an internal battery, capable of running the recorder for about 10 hours when fully charged.

1.4 **GNSS receiver**. This is the NEO7 GPS receiver by Ublox AG of Switzerland (www.u-blox.com), shown in the header record of IGC files in the form HFGPSMANUFACTURERSNAME:UBLOX,NEO7,56,max50000m . The last figure is the maximum altitude in metres that could theoretically be processed, but see B6.3 for the IGC height limit. The figure before is the maximum number of channels available

1.5 **Pressure altitude sensor.** This is the MS5611 Pressure Altitude sensor by Measurement SpecialitiesSwitzerland sa (MEAS, ex-Intersema - www.meas-spec.com). This is shown in the header record in the form: "HFPRS PRESSALTSENSOR: MEAS, MS5611, max16000m". 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 **Antenna , Connectors and Display.**

1.6.1 GPS Receiver Antenna. The GPS receiver antenna is inside the recorder near the micro-USB socket and no external connection is required.

1.6.2 micro-USB. A socket for a 6 pin 7mm wide micro-B USB plug is on the top face. This is for powering the recorder, charging the internal battery, uploading data into the recorder and downloading IGC files.

1.6.3. Display and Buttons. The display is 70 x 52mm in size. There are four buttons under the display and two on the right side of the case. An on/off button is next to the micro-USB socket on the top of the recorder. Their functions are described in the manufacturer's instructional Manual for this FR.

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

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

3.1 Downloading Flight Data. Downloading is through the micro-USB socket direct to a PC.

3.2 Validation of Flight Data. The IGC standard 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 the flight data is identical to when it was initially downloaded.

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

3.2.2 Latest versions. The latest versions of the files must be used, obtained from the IGC or GFAC web sites.

4. **Engine Recording - ENL and MOP systems**. A microphone and frequency filter and weighting system automatically produces an ENL (Environmental Noise Level) value with each fix, 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 that records the higher frequency noise that is produced by small jet engines used in some gliders. The MOP system has a maximum sensitivity at about 8000 Hz and records three MOP numbers in each fix in the IGC file in addition to the three ENL numbers. The FR must be positioned so that either high ENL or MOP figures are produced with any forward engine thrust, and does not record other noise in gliding flight that could be confused with use of engine.

4.1 ENL System. The ENL system in this FR is made by LXNAV. ENL figures in each fix in the IGC file 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 when flown in gliders with that engines that give high ENL values in IGC files when producing any forward thrust. For details of typical ENL values found on GFAC tests, see para B.4. For jet engines see 4.2. below.

4.1.2 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, particularly at low power when just producing positive forward thrust (unless the MOP system satisfactorily records use of such engines, see below). Such 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 in jet engines the noise is at higher frequencies than those for which the ENL system is designed (see 4.2 on jets). It may also apply to some 4-stroke engine/propeller combinations. If the FR position produces low-ENL values when the engine is run at low but positive thrust, there are two alternatives: either (1) this FR must be moved closer to the source of engine noise, or (2) another FR used that can be positioned closer to the source of engine noise, or (3) a type of cockpit-mounted FR used that has in addition to internal ENL, a remote sensor that can be placed close to the engine and creates an additional record in the IGC file under the Means of Propulsion (MOP) code.

4.2 Means of Propulsion (MOP) System. The MOP sensor is made by LXNAV and is inside the FR. The type of MOP sensor is described in the header record of IGC files, see 4.2.1 below. This type of sensor records high frequency acoustic noise and is designed for use with jet-powered gliders where the engine produces noise at frequencies above those to which the ENL system is sensitive. Where this FR is used for recording the running of jet engines, it must be securely mounted in a position from which it can be shown that high MOP values are recorded whenever the engine is producing forward thrust and low MOP figures are produced in gliding flight. ***This may mean that the recorder screen cannot be seen by the pilot in flight***.

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. A brief description of the MOP system is in the header record of each IGC file in the form: HFMOPSENSOR:LXNAV,ON,Internal Acoustic - Peak 8 KHz

5 Installation in the glider.

This type of recorder is small and portable. It is easy to transfer from one glider to another, and an OO must be able to positively certify in which glider it was fitted for the flight to be claimed, and where it was fitted. For recording of GPS fixes, the unit may be fitted anywhere in the glider, but see para 4 on ENL and MOP, and para 6 on security. For jet engines, see para 4.2 above.

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.

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 joints in the case. 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, later IGC files will fail the IGC Validation test for electronic security. This test will also fail if the IGC file being analysed is different from that originally downloaded, even by one character in the flight data. If the firmware becomes corrupt, 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 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. The latest document is the only one that is valid. These sites also have a table of all IGC-approvals with links to the latest 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 claim flight, so that they are aware of any changes.

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

Questions to: Chairman IGC GFA Committee (GFAC),
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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, main heading and para (i-ii).
A(iii) Copy of this document. It is recommended that a copy of this 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 integral GPS antenna. The GPS antenna is near the micro-USB port, and the unit should be placed so that the antenna is on top.

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

A3 **Setting the Fix Interval**. The fast-fix facility gives 30 fixes at one second intervals and occurs after a Pilot Event (PEV) is recorded on the IGC file. This is done by pressing the box marked "Event" at the bottom of the touch-sensitive screen when the map is displayed. The fix interval for *cruise flight* between PEV events (such as between Waypoints) is set by the pilot before flight. There is therefore no need to set a very short fix interval for cruise flight because points of interest can be marked by PEV events followed by fast fixing. Setting a short fix interval for *cruise flight* leads to IGC files of large byte size, particularly for long flights. This uses up more of the recorder's memory, causes downloading after flight to take a long time, increases the chance of data corruption, and may also cause problems with some analysis programs because of the large number of fixes that have to be processed.

A3.1 IGC rules. Rules on fix intervals are a maximum setting of 60 seconds, and a 10 second setting for competitions under the rules of 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 are recommended to 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/MOP 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 below on ENL and MOP and A13 on pressure altitude calibration.

A4.1 **Gliders with Engines - ENL and MOP numbers in the IGC file**. This applies to gliders with any type of engine, see para 4 on pages 2 & 3. Low frequency acoustic noise is measured by a internal microphone and recorded in the IGC file with each fix as three numbers under the Environmental Noise Level (ENL) code. An additional microphone and processing system inside the recorder is sensitive to the high frequency noise produced by small jet engines that are fitted to some gliders, and this is recorded as three additional numbers with each fix under the Means of Propulsion (MOP) code.

A4.1.1 Pilot’s Responsibility to check Engine Recording before Making a Claim. Unless another IGC-approved FR or method is used for recording the use of engine, the recorder must be placed so that either the ENL or MOP systems produce high values when the engine gives any forward thrust, and low figures are recorded in gliding flight so that they can be clearly distinguished from any engine running. Note that this may mean that the recorder has to be fitted close to the source of engine noise rather than in the cockpit with the screen in view. ***** If this is not done, there may be doubt on whether the engine was used during the glide performance, in which case the performance can not be Validated to IGC standards *****

A4.1.2 Other Noises. Pilots should note that noises other than from the engine will produce ENL or MOP figures on the IGC file, and should avoid those that could be mistaken for use of engine. Flight with the 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 at high airspeeds. Flight with cockpit panels open at high airspeeds and climbing 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. In some jet engine installations close to the engine bay, high MOP in gliding flight has been recorded due to high frequency aerodynamic noise in the engine bay, and the FR must be mounted so that this is avoided. Flight near powered aircraft should also be avoided (except aero-tows). For ENL and MOP levels recorded in IGC files, see B.4.2.

A4.1.3 Pilot check of ENL and MOP numbers. Pilots should check that the ENL and MOP numbers on the IGC file show a clear difference between engine-on and engine-off flight. Numbers 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 these numbers 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/or MOP systems to be re-set.

A5 **Pre-flight Declaration in the IGC file**. Pre-flight declarations of Waypoints are made by putting Start, Turn and Finish Points into the recorder from a PC connected to the micro-USB socket on the FR case 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 declarations.

A6 **Observing the installation in the glider**. This type of recorder is portable and is easy to transfer from one glider to another, see para 5 on page 3. The pilot must ensure that an OO has checked the place of the recorder and how it is fixed to the glider. 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.

A7 **Connection to Ports**. This approval does not presently require sealing of any ports or plugs, but no attempt must be made to pass unauthorised data into the Recorder.

A8 **Takeoff**.

A8.1 Switch On. The recorder is switched on by a press of the button near the mini-USB port on the top of the recorder. 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.

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.

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 recorder data, see A11 below. Pilots are advised not to switch off the recorder for several minutes after landing, so that an adequate after-landing baseline can be established on the IGC file.

A10.1 After-flight calculation of security. A digital signature is calculated for the IGC file either when the pilot ends the IGC flight file by pressing the main button, or automatically when the recorder detects "no movement" for over 5 minutes. 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, see para 6.2 on page 3 and para B4 later.

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 pressing the main button on the top of the case for longer than 2 seconds.

A13 **Downloading the Flight Data**. Downloading is via the micro-USB socket on the top of the case, direct to a PC.

A13.1 OO's actions. For a flight to IGC standards of evidence, an OO will then carry out the actions given in para B3.3, and the OO's copy of the transferred flight data will be sent to the organisation that will validate the flight, such as the National Airsport Control authority (NAC). The OO does not personally have to transfer the data from the Recorder, but witnesses 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 A13.1continues to apply.

A14 **Calibration of Barograph Function**. Pilots are advised to have a pressure altitude calibration carried out by an NAC-approved calibrator before the recorder is used for a claim. 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 gain-of-height claims require a calibration for the low and high points of a claim. Speed and distance claims need a calibration for calculating the altitude difference between the start and finish points. Also, the OO or NAC 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.

------------------- end of Annex A --------------------

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, main heading and para (i-ii).*
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**. This recorder is small and the OO should ensure that checks and precautions are taken so that it cannot be removed and flown in another glider and, for gliders with any type of engine, is in a suitable place for recording engine noise when any forward thrust is being generated (see para 4 on pages 2 & 3, and para A4 on page 4). An OO shall witness and record the recorder type and serial number, its position in the glider, the glider type and registration, date and time. Before flight, if requested, the OO shall then 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 correct, and another Recorder has not been substituted in the glider before the data transfer described in B3.3.

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 of Landing. The time and point of landing must be recorded, either by an OO, other reliable witnesses, or by other means such as an Air Traffic Control or official Club log of takeoffs and landings. After flight, this will be compared to the recorder 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 (including any sealing to the glider), so that this can be compared to the check described in para B1 above. The transfer of flight data shall then take place in accordance with B3.3.

B3.3 Downloading the Flight Data. Downloading is via the micro-USB socket on the top of the case, direct to a PC. The PC should recognise the Nano as an extra drive with the IGC files in the Nano memory listed ready for copying the latest ones to the PC. Security of downloaded IGC files is maintained by electronic coding embedded in the Recorder which can then be checked at any time later. See para B4 below for how this is done.

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

B3.3.2 OO's Copy. A copy of the IGC file must be retained securely by the OO such as by immediately copying it to storage media such as a memory stick, 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, and 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, for 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, or a central competition data transfer facility may be used. For ease of identification within the competition, file names may be changed, for instance to the glider competition number or the pilot's name. Integrity of data within the file is preserved by the electronic security system and may be checked at any time by using the Validation process of the IGC Shell program, see B4.1.

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 downloaded from the Recorder to the PC. This is done by checking the IGC data file with an authorised copy of the IGC Shell program and using the Validate function in the IGC Shell menu. 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 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 detailed 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 Dynamic Link Library (DLL) file from the recorder manufacturer must be copied to the IGC Shell directory. Then, execute IGCshell.EXE and set the path 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 include the line "LXNAV V3.0, Nano, ..." (or later). This should be selected.

B4.1.1 Validation of IGC files. Select the LXV 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.

B5. **Gliders with Engines**. This applies to gliders with any type of engine including self-sustainers, see para 4 on pages 2 & 3, and para A4 on page 4. The OO must ensure that the place of installation is suitable for receiving engine and/or propeller noise, and is not subject to other noise in gliding flight that could be confused with use of engine, so that it can be shown that the engine was not producing any forward thrust during the claimed glide performance. The Environmental Noise Level (ENL) low frequency system adds three ENL numbers to each fix line in the IGC file. High frequency sound is recorded under the Means of Propulsion (MOP) code by a sensor inside the recorder and three MOP numbers are added to each fix line in addition to the three ENL numbers.

B5.1 ENL System. The ENL system is most sensitive around 150 Hz and works well with 2-stroke engines that produce high levels of low frequency noise. Where the FR is in the cockpit and used with electric, jet and some 4-stroke engines, ENL readings with engine may not be high enough to record use of engine at low but positive thrust. In such cases, either another FR should be used or this FR moved closer to the engine and/or propeller. ENL values recorded on GFAC tests are given below, in the sequence of a flight.

B5.1.1 ENL during launching. During winch and aerotow launches, higher ENL values are to be expected than when soaring , typically up to 250 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.

B5.1.2 ENL during engine running. An ENL value of 999 has been produced with a two-stroke engine running at full power and 850 with a 4-stroke engine at high 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 figures are produced for a significant time, and when altitude and speed are analysed it can be seen that substantial energy is being added that is not associated with soaring. Previous tests with Wankel (Rotary) engines indicate that they produce similar ENL values to 4-strokes.

B5.1.2.1 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. With the FR in the cockpit, engines such as electric, jet, and some 4-stroke produce low ENL values unless the FR is re-positioned close to the engine and/or propeller, or another FR is positioned close to the source of engine noise, or an FR is used that has an external MOP sensor that can be positioned close to the source of maximum engine noise.

B5.1.3 ENL during gliding flight. ENL readings between 010 and 040 indicate slow-speed gliding flight in a well-sealed cockpit. Fight 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 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.

B5.1.4 ENL during the approach to land. ENL values are normally higher on a landing approach due to aerodynamic noises 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.

B5.1.5 ENL during landing. During ground contact during landing, short-duration ENL readings of between 500 and 700 have been recorded, probably due to wheel rumble or tyre squeak. Unlike engine running these last only for a short time, showing a short "spike" on the noise/time trace.

B5.1.6 ENL analysis. If ENL readings during engine running are high (such as with a 2-stroke engine), it is 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 factors mentioned above such as undercarriage, airbrakes, 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 page 3 for email address).

B5.2 MOP System. In addition to ENL, three numbers under the MOP code are produced from a high-frequency sensor with peak response at about 8000Hz (see para 4 on pages 2 & 3 and para A4 on page 4). 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 in a good position to sense the high frequency noise from 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 - Jet engines. MOP numbers in each lat/long fix should be at least 500 when any forward thrust is generated, and over 900 at high power.

B5.2.2 Engine-off. In GFAC tests with engine off , MOP numbers in the IGC file were between 000 and 050 with occasional higher short-term "spikes" due to random high frequency noises not related to jet engine running, which will produce high MOP values over longer time periods. In some jet installations, if the FR is fitted in the jet engine bay, high noise has been recorded in gliding flight that could be confused with use of engine. In this case the position of the FR must be changed so that noise in gliding flight is reduced while preserving high MOP with any forward thrust.

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 International Standard (the ICAO ISA), in the same way as a barograph or aircraft 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 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 used 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 IGC 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 accurate ICAO altitudes against those in the IGC file for each step. This table can then be used to adjust pressure altitudes in IGC files for flight performances 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 on gain-of-height and altitude claims. Up to an altitude of 15,000 metres, only pressure altitude is valid for IGC altitude purposes except for proof of flight continuity (no intermediate landing) where GNSS altitude may also be used. The IGC file for the calibration should be kept with the calibration paperwork so that it is not confused with other calibration files. The original IGC file for the calibration may have a nominal date/time (if no GPS lock occurred during the calibration). In this case, the file may 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’s header record,, although this will mean that the IGC Shell 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. 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 will be increased by poor antenna positioning and antenna performance. Lat/long fix accuracy is generally not affected . 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 recently tested, and between 6 and 7 metres for tests with a clear horizon and good antenna performance and placing.

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. Processing is up to 16 km (52.493 ft), although above 15km an IGC-approved HAFR is required, see above.

B6.3.2 GNSS altitude. Processing is theoretically up to 50 km, although above 15km an IGC-approved HAFR is required, see above.
