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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

30 April 2014

## IGC-APPROVAL FOR GNSS FLIGHT RECORDER

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

*(i) General. This document gives formal approval from the above date for the Recorder equipment described below to be used for validation of flights under the FAI Sporting Code Section 3 (Gliders and Motor Gliders), subject to the conditions and notes given later. FAI and IGC reserve the right to alter this approval in the future.*

*(i-i) Document Versions. The initial IGC-approval for the original version of the Nano was dated 31 August 2010 and on 1 October 2012 the wording on hardware and firmware was updated. This version adds the Nano 3 with a screen.*

*(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, and see para 7 below about future changes to this document.*

*(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** LXNAV d.o.o. Kidriceva 24a, 3000 Celje, Slovenia

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Contact: Erazem Polutnik, Uroš Krašovic

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

## 1. HARDWARE

1.1 **Recorder Type and Serial Number**. The recorder type is LXNAV Nano, the original version first IGC-approved in 2010, and the Nano 3 with a screen, added in 2014. This is shown in the header record of IGC-format files in the form: "HFFTYFRTYPE:LXNAV,NANO" for the original version or, for the Nano 3 "HFFTYFRTYPE:LXNAV,NANO3".

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, for the Nano 3, 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 both 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".

1.3 **Dimensions, Weight, Power Source**. The original Nano is 65 x 42 x 22mm in size (less the button on one side), and weighs about 70 grammes. The Nano 3 is 65 x 42 x 27mm in size and weighs about 80 gm. Power is from a long-life internal battery, recharged via a 8mm wide mini-USB socket.

1.4 **GNSS receiver**. The original Nano has a FGPMMOPA6 GPS receiver by GlobalTop Tech Inc of Taiwan (www.gtop-tech.com) and the Nano 3 has a NEO7 GPS receiver by Ublox AG of Switzerland (www.u-blox.com). This is shown in the header record of IGC files in the form HFGPS:GLOBALTOP,FGPMMOPA6,66,max18000m for the original Nano and HFGPS:HFGPS:UBLOX,NEO7,56,max50000m for the Nano 3. The last figure is the maximum altitude in metres processed by the recorder to the altitude resolution requirements of para 2.2 of the IGC Specification. The figure before is the maximum number of channels available in the receiver.

1.5 **Pressure altitude sensor.** For most units this is the MS5611 Pressure Altitude sensor by Measurement Specialities (ex-Intersema) of Switzerland (www.meas-spec.com/pressure-sensors.aspx). For some early units the MS5561C pressure sensor was fitted. The pressure sensor is shown in the header record of IGC files in the form "HFPRSPRESSALTSENSOR:INTERSEMA,MS5611,max16000m". The last figure is the maximum altitude processed by the recorder to the altitude resolution requirements of para 2.2 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 and no external connection is required.

1.6.2 Main Rocker Button. A three-way rocker button on the side of the case next to the five lights can be pressed and also pushed left or right to select different functions. When the unit is off, a short press will switch it on. When the unit is running, a press of less than 2 seconds gives a Pilot Event (PEV), a press of longer than 2 seconds switches the unit off.. The button can also be pushed left and right, but these functions are not used at present.

1.6.3 Lights. Four green lights and a red light are to the right of the button. The first green light flashes when power is on, the second green light flashes when GPS status is good, the third green light flashes when recording is being made, the fourth green light flashes if the bluetooth module is switched on, the fifth light is red and after initial switch-on, indicates a fault.

1.6.4 mini-USB. An 8mm wide mini-USB D-connector socket is on an end face. This is for charging the internal battery and also for uploading data into the recorder and for downloading IGC files

1.6.5 micro-SD. In the original Nano, a socket for a micro-SD card is to the right of the main button and is for uploading and downloading as an alternative to the mini-USB connector above. This was the original upload/download method but now the mini-USB socket can be used as well.

1.6.6. Display and Buttons. The Nano 3 has a 60 x 38mm display and four buttons for making selections indicated by the display.

## 2. FIRMWARE.

This refers to systems inside the FR. The IGC-approved standard for the original Nano is firmware Version 1 and higher, and for the Nano 3 firmware Vesion 1.12 and higher, but see para 7.2 on updates. The version is listed in the header record of IGC files in the form: "HFRFWFIRMWAREVERSION:1" for the original Nano and "HFRFWFIRMWAREVERSION:1.12" for the Nano 3.

## 3. SOFTWARE.

This refers to systems outside the FR.

3.1 Downloading Flight Data. Downloading is through the mini-USB socket direct to a PC or equivalent. In the original Nano an alternative is to use the micro-SD card socket, see 1.6.5 above, and in this case download of IGC files is automatic if a card is in the holder during flight.

3.2 Validation of Flight Data. The IGC standard for electronic flight data is that the IGC file must pass the IGC Validate check that is part of the IGC Shell program. See below for how to obtain the Shell program and B3.4 for how to carry out the IGC Validation check. The Validate procedure checks that the IGC file has originated correctly from a serviceable recorder and that the flight data is identical to when it was first written into the FR memory and then, if correct procedures are followed, as 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 motors, 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 in this FR is made by LXNAV.

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 positive forward thrust. 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. 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) the FR must be moved closer to the source of engine or propeller noise, or (2) a type of FR must be used that has, in addition to ENL, a sensor remote from the FR that can be placed close to the engine and creates an additional record in the IGC file under the MOP (Means of Propulsion) code; 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.

This type of recorder is very 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. From the point of view of data recording, the unit may be fitted anywhere in the glider, subject to para 4 on ENL, para 6 on security, and the position of the Pilot Event (PEV) button should be in easy reach of the pilot. The position of displays and operating buttons and controls used in flight in single-seat gliders should not be remote from sight-lines used for pilot lookout and scan for other gliders and powered aircraft. The Nano 3 display is very small and pilots should take care not be distracted from lookout and scan while trying to read data on the display.

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. This test will also fail if the IGC file being analysed is different from that originally downloaded from the Recorder, even by one character in the flight data. If corrupted firmware is detected, depending on the nature of the problem, either IGC files will not be generated or if they are, they will fail the IGC Validate test.

6.3 Recorder found to be unsealed. If either physical or electronic security is found to have failed, before 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 Updates and Changes

7.1 Updates to IGC-approval Documents. The latest IGC-approval documents are posted on the GFAC and IGC FR web sites given at the top of page 1, and for flights to IGC standards the latest document is the only valid one. These sites also have a table of all IGC-approvals together with approval levels and links to the latest IGC-approval documents for each type of FR. Pilots are advised to check the latest IGC-approval document(s) for the FR(s) to be used before making a flight that is to be claimed, so that they are aware of any changes.

7.2 Manufacturer's Changes including later versions of Hardware, Firmware and Software. Notification of any intended change that might affect the recording function, the structure and security of IGC files, or the physical and electronic security of the FR, must be made by the manufacturer to the Chairman of GFAC so that a decision can be made on any further testing which may be required to retain IGC-approval. It includes changes to hardware and firmware including modules inside the recorder such as the GPS receiver unit, pressure altitude sensor, 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 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 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 integral GPS antenna. The GPS antenna is on the top of the recorder module that also has the button, lights and mini-USB receptacle. Underneath is the battery unit. The unit should be placed so that the antenna is on the top.

A2 **Geodetic Datum (Earth Model)**. This type of recorder is fixed on the WGS84 Geodetic Datum (earth model). It should be ensured that other lat/long data such as for start, turn and finish points, is also entered 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. A short press of the button on the side of the case records a PEV event and starts fast fixing; in the Nano 3 a notice to this effect appears at the top of the screen. ***Caution: do not press for longer than about 2 seconds or the unit will start the switch-off sequence.*** Also, fast fixing is automatic near waypoints for the task entered for the flight. 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. IGC rules on fix intervals are a maximum setting of 60 seconds, and a 10 second setting for competitions that are under te rules of Annex A to SC3 (SC3A para 5.4C). 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 and other values are recorded as expected. In particular, for motor gliders, ENL values should be in accordance with the figures given in para B5. See also A9 on ENL and A13 on pressure altitude calibration.

A5 **Pre-flight Declaration in the IGC file**. Electronic pre-flight declarations of Waypoints are made by putting Start, Finish and Turn Points into the recorder from a PC connected to the micro-USB socket on the FR case in accordance with the FR manufacturer's instructions. In the original Nano the mico-SD card can also be used but it will probably be found more convenient to use the mini-USB connector as above. Before making a flight that is to be claimed and requires a pre-flight declaration, pilots are advised to check that they can successfully carry this out, and that an IGC file is produced that satisfies the Sporting Code on electronic pre-flight 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 before the Annexes on "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. 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**. On the position of the display in the Nano 3, see para 5 above which refers to sight-lines and the need for pilot lookout and scan.

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 a short press of the button on the side of the recorder. The five lights then flash, indicating that the recorder is 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. For the function of the five lights, see para 1.6 before the annexes.

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 **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 and climbing with cockpit panels open should therefore be avoided in case the ENL recorded is mistaken for use of engine***. High ENL may also be produced by stall buffet and spins, particularly in Motor Gliders if the engine bay doors flutter (vibrate or move in and out). Flight near 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 data, see A11 below. Pilots are advised not to switch of the recorder for at least one minute after landing, so that an adequate landing baseline can be established on the IGC file.

A10.1 After-flight calculation of security. If the pilot ends the IGC flight file by pressing the main button, or when the recorder is switched on again after having been switched off (for instance after landing), a digital signature is calculated for the IGC file for the flight. This process places security codes at the end of the IGC file for the last flight, which is then completed and stored in the memory ready for downloading. These codes are used to verify the integrity of the whole file at any later time by using the Validate function of the IGC Shell program.

A11 **Independent Check of Landing** - The pilot must ensure that the time and point of landing has been witnessed and recorded for comparison with IGC file data from the recorder (see para B2.1).

A12 **Switching Off**. This is by switching off the recorder by pressing the main rocker button on the side of the case for longer than 2 seconds.

A13 **Downloading the Flight Data**. Downloading is via the mini-USB socket on the case, direct to a PC or equivalent . In the original Nano the micro-SD card socket (para 1.6.5 above) may also be used for downloading. For more details, see B3.3.

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 after takes or is given a copy on a storage device such as a memory stick or SD card.

A13.2 Competitions. Different rules may apply for competition flights, for which pilots may be allowed to bring their own flight data on portable storage data to competition control, or a central data transfer facility may be used. However, for a flight to IGC rules such as for records and badges, OO monitoring as in A13.1continues to apply.

A14 **Calibration of Barograph Function**. Pilots are advised to have a pressure altitude calibration carried out by an NAC-approved calibrator before 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.

------------------- 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 very 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 motor gliders, is in a suitable place for engine noise recording.*** An OO shall witness and record the position of the Recorder in the glider, the type and serial number of the Recorder, the glider type and registration, date and time. 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 (B3.3), see para 5 before the annexes. On the position of the display in Version 3, see para 5 before the annexes which refers to sight-lines and the need for pilot lookout and scan.

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 case, direct to a PC. The PC should recognise the Nano as an extra drive and the IGC files in the Nano memory are listed ready for copying to the PC. If the most recent file is not there, disconnect from the PC and switch the Nano on and off again, then connect to a PC once more. For the original Nano, downloading may also be to the micro-SD card socket (para 1.6.5 on page 2) and is automatic if an SD card is in the holder during flight, otherwise, downloading occurs by putting a card in and switching the FR on again. Security of downloaded IGC files is maintained by electronic coding embedded in the Recorder which is then independently checked later at the NAC (and at FAI if the claim goes to them). 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 described in B3.3.1 above.

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 (see below). The Recorder manufacturer's DLL file will also be needed in the IGC Shell directory. The shell program and DLL file must be the same as those on the current FAI/IGC of GFAC web sites given at the beginning of this document. A Data Analyst approved by the NAC shall carry out this IGC Validation check on the IGC file and then evaluate the 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 name IGC Shell is recommended). For the shell program to work, the appropriate Dynamic Link Library (DLL) file from the recorder manufacturer must be copied to the IGC Shell directory. After copying it to the directory that contains the IGC Shell files, execute IGCshell.EXE. Set the path to the IGCshell directory using the "Set Directories" button on the screen. The IGCshell menu 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 V1.0*" (or later version). 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, together with a likely reason.

B5. **Engines - ENL figures in the IGC file**. This applies to gliders with engines of any sort including self-sustainers. This recorder is very small and could be mounted in a number of places. For gliders with any sort of engine, the OO must ensure that the place of installation is suitable for receiving engine and/or propeller noise, so that it can be proved that the engine was not used to produce any forward thrust during the claimed glide performance. The IGC ENL system in this FR uses a microphone in the recorder to transform acoustic noise into three numbers under the ENL code, the numbers being added to each fix in the IGC file. 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 the FR must be moved closer to the engine and/or propeller, or a type of FR used which has a remote sensor that can be mounted near the engine and records three extra numbers on the IGC file under the MOP code. For more information, see para 4.3 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 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.

B5.2 ENL during engine running. An ENL value of 999 has been produced by this type of recorder 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 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. 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, and some 4-stroke produce low ENL values unless the FR is positioned close to the engine and/or propeller. In this case, see B5 above and para 4.3.1 before the Annexes.

B5.3 ENL during gliding flight. ENL readings between 002 and 040 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 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 normally higher on a landing approach due to aerodynamic noises such as due to airbrakes, undercarriage, sideslip, turbulence, etc. Short-term peaks due to specific actions such as opening airbrakes, lowering undercarriage, etc., will be noted as well as a generally higher level of ENL because the glider is no longer aerodynamically clean.

B5.5 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.

B5.6 ENL analysis. It is normally easy to see when an engine has been running and when it has not. Other FR data such as rates of climb and groundspeed, will indicate whether or not non-atmospheric energy is being added. Short term peaks in ENL (less then 10 seconds) may be due to the other factors mentioned above such as undercarriage and/or airbrake movement, sideslip, open DV panel/sideslip, the nearby passage of a 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**. 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, making a calibration table. 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 flight 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. Downloading should be at the 1 second interval that can be selected through the screen display and the menu button on the keypad. The IGC-format calibration data file will then be analysed, compared to the calibration pressure steps, and a correction table produced and authenticated by an NAC-approved person (for instance an OO or GNSS Recorder Data Analyst). The correction table will list true against indicated altitudes. This table can then be used to adjust pressure altitudes which are recorded during flight performances and which require correction before validation to IGC criteria. These include takeoff, start and landing altitudes for altitude difference and for comparison with independently-recorded QNH readings, and low and high points on gain-of-height and altitude claims. 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. and the file should be kept with the calibration paperwork so that it is not confused with other calibration files. As the original IGC file will have a nominal date/time, 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 change add a realistic date and time, 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. 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 less-than ideal antenna positioning in some gliders. Data analysts and NAC officials should allow for the above when comparing the GPS altitude and pressure altitude records. Lat/long fix accuracy is not affected and tests on this recorder show it to be typical of that for a 12 channel GPS system. From GFAC tests, the lat/long error taken from a moving vehicle at a surveyed point in average reception conditions, shows an average error of between 11 and 12m for all recorders tested since that date.

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

B6.3.2 GNSS altitude. For the original Nano, up to 18 km (59,055 ft), for the Nano 3, up to 50 km, although above 15km an IGC-approved HAFR is required, see above.

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