**GNSS FLIGHT RECORDER APPROVAL COMMITTEE (GFAC)**
**FAI INTERNATIONAL GLIDING COMMISSION (IGC)**
**of the**
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**References:**
FAI web site: www.fai.org
IGC web site: www.fai.org/gliding
GFAC Chairman's web site for FR data: www.ukiws.demon.co.uk/GFAC
FAI/IGC GNSS FR web site: www.fai.org/igc-our-sport/gnss-recording-devices
FAI/IGC GNSS FR software web site: www.fai.org/gnss-recording-devices/free-software

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

22 January 2012

## IGC-APPROVAL FOR GNSS FLIGHT RECORDER

**Level of Approval:** **All flights (see para i-ii)**
**Recorder Name:** **LX Navigation LX7000 Series (See Page 2 para 1.1 for model numbers)**

*(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 and Scope. The original IGC-approval document for the LX 7000 recorder was dated 14 March 2003. On 20 July 2005 the LX7007 model was added with a faster microprocessor and additional connectors. On 17 March 2006 the LX7007F was added with the uBLOX TIM-LP GPS receiver and a FLARM module inside the recorder case. This document adds the LX7007FC with a colour display and a different microcontroller.*

*(i-ii) IGC-approval Level. This approval is for all flights including world records. The Levels of IGC-approval are listed in Annex B to the Sporting Code for Gliding, para 1.1.3.3.*

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

*(ii) 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) 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) 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 document published by FAI is entitled "Technical Specification for IGC-Approved Flight Recorders" and is also available through the IGC/GNSS web site shown above.*

*(v) 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**


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| IGC manufacturer codes: | Three letter LXN, single letter L |


**EQUIPMENT**:

## 1. HARDWARE

### 1.1 Model Numbers.

1.1.1 LX7000. This was the original model first IGC-approved in 2003.

1.1.2 LX7007. This was introduced in July 2005, with a faster microprocessor and extra connectors on the rear of the FR module. The extra connectors were a female 9-pin sub D connector for use with a PDA, a female RJ-45 8 pin IGC-standard connector for transfer of data and a 6-pin RJ11 user port.

1.1.3 LX7007F. This was introduced in February 2006. The letter F indicates the FLARM air-to-air proximity warning system by Flarm Technology of Zurich, Switzerland (www.flarm.com). In the LX7007F, a FLARM module is incorporated inside the LX7007 recorder case in addition to the LX recorder. See para (ii) above on the status of FLARM with respect to IGC and FAI and the manufacturer and operator of this recorder.

1.1.4 LX7007FC. This was introduced in January 2012 and is based on the LX7007F with the addition of a colour display, a different microcontroller and enhanced electronic security.

1.2 **Hardware Version**. Version 1.0 (V1.0) was for the original LX7000. V2.0 is for the LX7007 and V3.0 for the LX7007FC. Later versions may be used if they are IGC-approved, see para 10. The Version is shown in the header record of IGC-format flight files in the form "HF RHW HARDWARE VERSION: 3.0" which can be seen by using a text editor to view the IGC file.

1.3 **Dimensions and Controls**. The recorder is designed for mounting in an instrument panel with a 79 mm (3.11 inch) cut-out. The recorder case is of square cross section about 81 x 81mm and is about 86 mm long. Three electrical connectors are on the back and project up to a further 13 mm. The front contains a 59 x 41mm LCD, six buttons and four control knobs. The knobs project about 23 mm from the metal case. Weight is about 550 grammes and connectors are described later.

1.4 **GPS receiver board**. Early models had the JRC/CCA-450 12-channel receiver by Japan Radio Corporation (www.jrc.co.jp/eng). From 2006 the 16 channel uBLOX (Switzerland) TIM-LP board is fitted (www.u-blox.com).

1.5 **Pressure altitude sensor**. This is the MS 5534-A pressure sensor by Measurement Specialities (ex-Intersema) of Switzerland (www.meas-spec.com/pressure-sensors.aspx). It is compensated for temperature variation and calibrated to the ICAO ISA. The recorder case is not pressure-sealed and "cockpit static" pressure is recorded on the IGC file.

1.6 **National regulations**. These may apply to electrical and electronic equipment although compliance with such regulations is not the responsibility of FAI. However, this recorder has the European Union (EU) "CE" mark that indicates compliance with EU directives on EMC and voltages.

1.7 **Other modules**. The LX7000 system is modular and includes other units and connections. These include functions such as pitot and static pressures, variometer and glider performance information. This approval is for the Display Unit (DU) that contains all of the elements of an IGC-approved the GNSS Flight Recorder (FR).

## 2. FIRMWARE

Version 1.0 was the IGC-approved firmware standard for the original LX7000, Version 2 for the LX7007 and Version 3 for the LX7007FC. Later versions may be used if they are IGC-approved, see para 10. The firmware version is in the header record of IGC-format flight files in the form "HF RHW FIRMWARE VERSION: 3.0", which can be seen by using a text editor to view the IGC file.

## 3. SOFTWARE

External software can be used by connecting a cable from a PC port (USB or RS232) to the15-pin connector on the back of the recorder. For the 7007 series, the RJ45 connector may also be used. For early models, the recorder must be set to its "Transfer" mode before data can be downloaded or uploaded. The LX7007FC has a micro-SD receptacle above the screen and IGC files can be downloaded to it using a menu on the screen.

3.1 Windows-based IGC Shell and DLL system. For all except the LX7007FC, downloading is through the Microsoft Windows-based IGC Shell system that is available from the IGC GNSS web in the file igcdll.zip. Download these IGC Shell files into a specific directory that you have named in advance, for instance "IGCshell". For the shell program to work, the Dynamic Link Library (DLL) file from the FR manufacturer must be copied to the IGC Shell directory. For this recorder, the file IGC-LXN.DLL (version 1.2b) is available from the web sites listed at the start of this document..

3.2 Manufacturer's Programs. The manufacturer's programs (LX-FAI and LXe) and other programs may also be used for downloading IGC files, *subject to Validating the integrity of the IGC file as in 3.3 below*.

3.3 Validity of Flight Data. Whatever program is used for downloading from the Recorder and conversion to the IGC format, the criterion for validity of data is that the IGC-format file must pass the IGC VALIDATE check. The IGC Shell program must be used with the latest IGC-LXN.DLL file in the same directory, using the menus from the IGC Shell screen to select the IGC file to be checked.

3.4 Use of Latest Files - Free Availability. The DLL file is copyright of the Recorder manufacturer but is freeware. The IGC Shell program is freeware and can be used with all FR manufacturers' DLL files though a single menu. The latest versions of these programs must be used and are available from the web sites listed at the start of this document.

**CONDITIONS OF APPROVAL**

4. **Connections**. All connectors are at the opposite end of the case to the instrument face which has the LCD, buttons and control knobs. This FR is designed to be panel-mounted and cable connectors, once installed, may be difficult to access unless the design of the instrument panel allows easy access.

4.1 GPS antenna. The connector is a BNC 9mm diameter bayonet type (push and twist fitting).

4.2 Connector for power and other units. A 26 x 9 mm 15 pin D type male connector is for power and connections to other units such as the LX Analogue Unit (AU) that gives variometer, airspeed and speed-to-fly information. These other units are not part of this IGC-approval, which only applies to the FR functions.

4.3 Data transfer to a PC. Data transfer connectors are listed below and are all on the back of the FR case, except the LX7007FC which uses a micro-SD card. If the type of panel mounting makes access to the connectors on the back of the recorder case difficult, an extension lead should be provided from the transfer connector at the back of the recorder case for connecting to a PC for downloading flight data.

4.3.1 7000 model. An 8 x 8mm 6 pin RJ-11 connector is on the back of the case, wired to the IGC standard.

4.3.2 7007 and 7007F. A 11 x 8mm RJ45 8 pin connector is on the back of the case, wired to the IGC standard. The RJ45 also supplies power and can be used to run the recorder as an alternative to the 15-pin D-type connector. The 15-pin connector can also be used for data transfer using an LXN-proprietary cable.

4.3.3 7007FC model. A micro-SD card receptacle is above the screen on the front of the case. Downloading to the card is through the "Logbook" menu on the screen and pressing the "Enter" button on the bottom right of the screen.

5. **Security of the Equipment**. GFAC is presently satisfied with the physical and electronic security of this equipment. See para 8 on installation and para 9 on security and seals. GFAC reserves the right to inspect production equipment from time to time for security and general compliance with the IGC Specification.

6. **Installation in a glider**. The recorder is designed for mounting in an instrument panel, but may be fitted anywhere in the glider, subject to para 8 on sealing and, for Motor Gliders, that the position is suitable for recording high enough ENL values (see para 7). If the GPS antenna is accessible to the crew in flight, no attempt must be made to inject false data. Particularly in single-seat gliders, the position of any other displays connected to the recorder should not be remote from sight lines used for pilot lookout and scan for other aircraft and gliders.

7 **Motor Glider Engine Recording**. A microphone and frequency filter and weighting system inside the recorder case automatically produces an ENL (Environmental Noise Level) value with each fix. The system is designed to highlight any engine-related noise but to produce low ENL values in gliding flight. The ENL system is essential for Motor Gliders in order to show that the engine was not used to produce forward thrust during the part of the flight that contains the claimed glide performance. ENL data has also been shown to be useful for non-motor gliders in the case of accidents and incidents.

7.1 ENL Recording System . The ENL system in this recorder is made by FR manufacturer LX Navigation.

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

7.3 Engine Types. This document gives IGC-approval for the use of the above ENL system for the validation of glide performances to IGC standards when flown in Motor Gliders that have piston engines that give high enough ENL values to distinguish engine running from conditions met in soaring flight.

7.3.1 Low-ENL Engine/Recorder combinations. This approval does not include use with engines that produce small ENL values at the Recorder, particularly at low power when just producing positive forward thrust. Such engines include those that are electrically or jet powered, the latter because the noise is at higher frequencies than those for which the ENL system is designed. It may also apply to some 4-stroke engine/propeller combinations that are particularly quiet. If a low-ENL engine and recorder layout is to be used for flights to IGC standards of evidence, another variable additional to ENL is required to be recorded in the IGC file under the MOP code, in accordance with Annex B to the Sporting Code for Gliding, para 1.4.2, particularly 1.4.2.4.

7.4 ENL System and Cockpit Positioning. The recorder must be positioned in the glider so that it can receive a high level of engine and propeller noise whenever forward thrust is being generated.

7.5 ENL test values. For typical ENL values found on GFAC tests with piston engines, see para B.4.

8. **Check of Installation in the Glider**. There must be incontrovertible evidence that the particular recorder was present in the glider for the flight concerned. This can be achieved either by 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. As this system is designed primarily for panel mounting, a signed and dated OO's seal applied to the recorder at an appropriate place on or behind the instrument panel, will fulfil this requirement until the seal may require replacement due to damage or wear.

8.1 Observation of Installation before Takeoff or at Landing. The recorder may be sealed to the glider in accordance with 8.2. As it is designed to be mounted in the instrument panel, this should be straightforward. Otherwise, either a pre-flight check of the installation must be made and the glider must be under continuous observation by an Official Observer (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 and the flight data is downloaded. This is less critical with a panel-mounted instrument compared to one that is mounted elsewhere in the cockpit, but nevertheless the possibility still exists that the installation could be changed in an unauthorised way unless independent checks are made.

8.2 Sealing to the Glider before Flight. If direct observation under para 8.1 cannot be achieved, the recorder must be sealed to the glider by an OO at any time or date before flight so that it cannot be removed without breaking the seal. The sealing method must be acceptable to the NAC and IGC. Paper seals must be marked in a manner such that there is incontrovertible proof after the flight that seals have not been tampered with, such as by marking across the join in the seal with the glider registration, the date, time and OO's name and signature. It must be possible for the OO to recognise the seal markings afterwards. The OO must seal the Recorder unit to glider parts which are part of the minimum standard for flight. It is accepted that such parts can be removed for purposes such as servicing; such parts include the canopy frame, instrument panel, and centre-section bulkhead fittings. If the Recorder is sealed to such removable part, if such a part is transferred between gliders, any Recorder seal for the previous glider must be removed.

9. **Security Seals, Physical and Electronic**.

9.1 Physical Security. A silver-coloured tamper-evident seal with the manufacturer's name, is fitted over two of the case-securing screws above the maker's label on the back of the recorder case. In addition, an internal security mechanism is included that activates if the case of the Recorder is opened. If the Recorder case has been opened, breaching physical security, a message indicating that the unit is insecure appears on the LCD on switch-on, and subsequent IGC files will fail the VALI check (see B3).

9.1.1 Sealing of data ports and plugs. No present requirement, but no attempt must be made to pass unauthorised data into the Recorder.

9.2 Electronic Security. If the internal security mechanism has been activated (such as by opening the case), any data in the memory will be lost, settings will revert to defaults, and the electronic security algorithms in the Recorder will be trashed. Any flight data files subsequently produced will fail the IGC VALI DATION test for electronic security. The system uses RSA with a private key of 512 bits except the LX7007FC which is 1536 bits. The VALI test will also fail if the IGC file being checked differs in any way from that initially downloaded from the Recorder.

9.3 Recorder found to be unsealed. If either physical or electronic security is found to have failed, 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.

9.4 Checks before re-sealing. Whenever any unit is resealed, the manufacturer or 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.

10 **Manufacturer's Changes, later Versions of Hardware, Firmware and Software**. Notification of any intended change to hardware, firmware or software 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 for the change. This includes changes of any sort, large or small. It includes details of later versions of hardware, firmware and software, also any changes to modules inside the recorder such as GPS receivers, pressure altitude transducers and anything related to either physical or electronic security. If in doubt, GFAC should be notified so that the responsibility for any possible action passes from the manufacturer to GFAC.

Ian W Strachan
Chairman, IGC GFA Committee

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

Any Queries to:
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Tel: +44 1420 564 195; Fax: +44 1420 563 140; email: ian@ukiws.demon.co.uk

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Annex A to IGC Approval - **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. These recorders are IGC-approved for all flights including world records.*
*A(iii)* *Copy of this document. It is recommended that a copy of this approval document is kept with the equipment, for the use of pilots and OOs.*

**Pilot's Responsibility**. It is the responsibility of the pilot to ensure or to note the following:

A.1 **Antenna** - The antenna should be positioned to give sufficient signal strength for IGC purposes. No attempt must be made to inject false data via the antenna.

A.2 **Geodetic Datum**. Latitudes and longitudes recorded by the Recorder must be to the WGS84 Geodetic Datum, or the flight data will be invalid for IGC purposes. This recorder is fixed on the WGS84 Datum. No pilot action is required except to ensure that other lat/long data such as for start, turn and finish points, is also entered to the WGS84 Geodetic Datum (IGC rule).

A.3 **Recorder installation in the glider**. The pilot must ensure that an OO has checked the place of the Recorder module in the glider and how it is fixed to the glider. If it may be difficult to find an OO immediately before takeoff, or to witness the landing, you are advised to ask an OO to seal the Recorder to the glider, and **this can be done at any time or date before flight**. See para 8 in the conditions of approval. On the position of any other displays connected to the Recorder, see para 6 in the Conditions of Approval which refers to sight-lines and the need for pilot lookout and scan.

A.4 **Independent Check of Takeoff** - The pilot must ensure that the time and point of takeoff has been independently witnessed and recorded for comparison with that recorded by the GNSS Recorder, see para B1.2.

A.5 **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. See paras 8 and 9 in the Conditions of Approval in the main part of ths document.

A.6 **Use in Motor Gliders** (including self-sustainers). The internal microphone and associated circuitry automatically records an ENL (Engine Noise Level) value between 000 and 996 with each fix. The ENL system should be enabled on delivery but pilots are advised to check that it is by following the procedures in the manual for the recorder. The Recorder must not be covered or insulated, although even so, the "automatic gain" function should continue to ensure high ENL readings under engine power.

A6.1 Cockpit noise. Cockpit noises other than the engine will produce ENL figures on the IGC file. Pilots should avoid those that could be mistaken for use of engine. The frequency filtering built in to the Recorder should avoid any problems, but **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, particularly if sideslip is present**. High ENL may also be produced by stall buffet, particularly in Motor Gliders if the engine bay doors vibrate or move in and out. Flight close to powered aircraft should also be avoided, except for aero-tow launches. For ENL levels that have been recorded on GFAC tests, see B.4.2.

A.7 **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 date from the recorder (see para B2.1).

A.8 **After Landing**. Until an OO has witnessed the Recorder installation to the glider, the pilot must not alter the installation or any sealing. The OO will carry out the actions given in para B2.3, and the OO's copy of the transferred flight data will be sent to the organisation that will validate the flight, normally the National Airsport Control authority (NAC). The OO does not personally have to transfer the data from the Recorder, but witnesses the transfer and takes or is given a copy on electronic media. Different rules may apply for competition flights, for which a central data transfer facility may be used, but for a flight to the rules for IGC records and badges, the above continues to apply. As this recorder is designed to be mounted in the instrument panel, data transfer should be at the glider to avoid disturbing the mounting.

A8.1 After-flight calculation of security. On switching off and then switching on again, the recorder calculates a digital signature for the previous flight, using the RSA system of Private Key encryption. Power must be off for 5 minutes or longer for the flight file to be ended and the security calculation to take place (the 5 minute "power-off protocol" is to allow for events such as changing the battery in flight). The security calculation takes about a minute and the screen displays a message such as "Calculating Security". This process places security codes at the end of the IGC file for the last flight, which is then complete and stored in the memory ready for downloading. These codes are used to verify the integrity of the whole file at any later time by using the Validate function of the IGC Shell program.

A8.2 Use of Portable PC at the glider. Except for the LX7007FC which has a Micro-SD card system, if the type of panel mounting makes access to the connectors on the back of the recorder difficult, an extension lead should be provided for downloading using an IGC standard connector to a PC. The LX7000/7007 Display and recorder Unit (DU) can be switched on using glider power and the PC used may be owned by the pilot or any other person. The PC should be set up for ease of transferring the data, such as by easy access to the IGC Shell program with the IGC-LXN.DLL file or an equivalent program that carries out the same function. For early models, the FR must be in "Transfer" mode which is available for about 20 seconds after switching on. Alternatively, select the special TRANSFER function that is provided as part of the Setup menu. Transfer of flight data is witnessed by the OO, and the flight files in IGC and binary (*.LXN) format must be given to the OO for safe keeping and analysis.

A.9 **Calibration of Barograph Function**. Pilots are advised to have a barograph (pressure altitude) calibration carried out either by the manufacturer or by an NAC-approved calibrator before any GNSS Recorder is used for a claimed flight performance. For the procedure, see para B5. A valid IGC-format 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.

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*B(i) Status. To be read together with the main terms of approval to which this is an Annex.*
*B(ii) IGC-Approval level. These recorders are IGC-approved for all flights including world records.*
*B(iii) Copy of this document. It is recommended that a copy of this approval document is kept with the equipment, for the use of pilots and OOs.*

## B.1 Installation and Takeoff Recording

B.1.1 **Installation in the Glider**. An OO shall witness and record the position of the Recorder in the glider, the type and serial number (s/n) of the particular Recorder, the glider type and registration, date and time. The s/n of each individual recorder consists of three characters made up of letters and/or numbers. It is recommended that, before flight, the OO should seal the Recorder to the glider in a way acceptable to his NAC and to IGC, and such sealing may be at any time or date before flight. If sealing is not used, either a 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 FR installation is checked. This is to ensure that the installation is correct, and that another FR has not been substituted in the glider before the data transfer (B2.3). See paras 5 and 6 of the Conditions of Approval. On the position of any other displays connected to the Recorder, see para 6 in the Conditions of Approval which refers to sight-lines and the need for pilot lookout and scan.

B.1.2 **At Takeoff**. The time and point of takeoff shall be recorded by sources independent of the Recorder, 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. This will then be compared to the takeoff data recorded on the IGC file.

## B.2 Landing

B.2.1 **At Landing**. The time and point of landing shall be recorded by sources independent of the Recorder, 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. This will be compared to the landing data recorded on the IGC file.

B.2.2 **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 in para B1.1 above. The transfer of flight data shall then take place in accordance with B2.3.

B.2.3 **Transferring the Flight Data**. The flight data should be transferred at the glider, without disturbing the installation of the Recorder (see para A7). If the OO is not familiar with the actions required, the pilot or another person may transfer the data while the OO witnesses the process. Security is maintained by electronic coding embedded in the Recorder which is then independently checked by the organisation validating the flight (such as the NAC) by using the IGC VALIDATE software program for the recorder.

B2.3.1 Methods. The LX7007FC uses a micro-SD card mounted above the screen and downloading to the card is through the "Logbook" menu on the screen and pressing the "Enter" button on the bottom right of the screen. If the connectors at the back of the recorder are accessible, for the original LX7000 model use a cable with a 6-pin RJ-11 male connector for the Recorder wired to the IGC-standard for RJ11 connectors. For the LX7007, use a cable with an 8-pin RJ45 male connector wired to the IGC-standard for RJ45 connectors. For the LX7007, download can also be through the LXN 15-pin D-type connector on the Recorder case. If the rear of the recorder is not accessible, the pilot must provide a connected extension cable so that an IGC-standard connector can be used from the recorder end to the PC. On the PC, an appropriate download program is needed such as a current version of the IGC Shell Program with the file IGC-LXN.DLL in the same directory, a FR manufacturer's program such as LXFAI or Lxe),or another program that downloads from tghese recorders. The DATA-LXN and IGC Shell programs and the IGC-LXN.DLL file are available free from the web sites listed at the start of this document. For early models, a special TRANSFER mode is needed, see the Manual for the particular FR model.

2.3.1.1 IGC Shell. Download the free IGC Shell program and place all the files in one directory (the name IGC Shell is recommended). These files are available on the IGC GNSS web pages through the file igcdll.zip. For the shell program to work with a Recorder, the appropriate Data Link Library (DLL) file from the recorder manufacturer must be copied to the IGC Shell directory. For this Recorder, the file IGC-LXN.DLL (version V1.2b) is available on the IGC GNSS web site and on the manufacturer's CD-ROM. After copying it to the directory that contains the IGC Shell files, execute IGC-SHELL.EXE. Set the path to the IGCshell directory using the "Set Directories" button. The IGCshell menu will now appear in a grey rectangular box with 9 software buttons for selecting the recorder type, recorder settings and flight logs. The recorder software box at the top should now include the line "LX Navigation v1.1, Colibri, LX7000DU" or a later equivalent. This should be selected. With the recorder connected to the PC and the correct Com Port selected on the IGCshell screen, selections for data Download, file Conversion to IGC format and Validation can now be made using the screen buttons provided.

B2.3.1.2 Latest versions. The latest versions of the free IGC shell and DLL files must be used. These can be obtained from the web sites listed at the start of this document.

B2.3.1.3 Other Programs. Downloading of flight data can be made using other programs, subject to the downloaded IGC file passing the IGC VALIDATE electronic security check. The FR manufacturer's LXFAI and LXe programs include other functions such as set-up, insertion of turning points, tasks, etc. Programs capable of downloading these recorders are also available from other sources such as software for analysis of IGC files.

B2.3.2 Files produced. One of the processes above will produce an *.IGC-format flight data file with the file name YMDLXXXF, where Y=year, M=month, D=day, L= manufacturer, XXX = Recorder Serial Number/letters and F = flight number of the day (full key, Appendix 1 to the IGC GNSS Recorder Specification, also listed in Annex C to the Sporting Code, SC3C). Early models produce a binary format file with the suffix LXN that is converted to the IGC file through either the IGC Shell program or a program from the manufacturer of the FR or of analysis software.

B2.3.3 Integrity of Flight Data. Integrity of flight data is preserved by comparing checks on takeoff and/or landing from sources different to the recorder, and by the VALIDATE check that can be carried out at any time on any individual IGC file.

B2.3.4 OO's Copy. A copy of the IGC file (and the binary LXN file from early models) shall be retained securely by the OO such as by immediately copying them to industry-standard storage media, copies being sent to the body that is to Validate the flight. The OO must keep the files at least until the flight is Validated by the appropriate organisation in accordance with IGC rules.

B2.3.5 Competitions. Different rules may apply for competition flights, for which a central download facility may be used. However, as this model or recorder is designed for panel mounting, arrangements should be made with the organisers for data transfer at the glider rather than having to remove the recorder after each flight. For ease of identification within the competition, IGC file names may be changed, for instance to the glider competition number or the pilot's name. The data in the original IGC file name is repeated in the IGC file header and is protected by the IGC security system (VALI check), and can be read at any time by using a text editor.

B.3 **Analysis of Flight Data Files**. A Data Analyst approved by the NAC will then evaluate the flight using an analysis program approved by the NAC concerned (list, see the web sites listed at the start of this document). In addition to checking flight data, the latest version of the IGC Shell VALIDATION program shall be used by the organisation Validating the flight, together with the latest DLL file from the FR manufacturer. The IGC Validation program and manufacturer's DLL checks the electronic security coding in the file, that the Recorder has not been damaged or modified in an unauthorised way, and that the flight data in the file is identical to when it was originally downloaded.

B.4 **Means of Propulsion (MoP) Record - Motor Gliders**. The MoP must either be sealed or inoperative, or the built-in microphone system used that records a three-number Engine Noise Level (ENL) with each fix on the IGC file. See para 7 in the main body of this document for more details on the ENL system. ENL values recorded on GFAC tests are given below, in the sequence of a flight.

B.4.1 ENL during launching. During winch and aerotow launches, higher average ENL values are to be expected than when soaring (B4.3). On aerotow a reading of 279 has been recorded. During the ground roll, short-term higher values up to 400 have been seen, probably due to wheel noise.

B.4.2 ENL during engine running. On engine running at powers needed to climb, an increase to over 800 ENL is expected. Over 900 is typical for a two-stroke engine, over 800 for a 4-stroke. An ENL value of 996 has been recorded with a two-stroke engine running at full power. During engine running, these high ENLs are produced for a significant time, and when altitude and speed are analysed it can be seen that substantial energy is being added, which can therefore be attributed to energy not associated with soaring. Wankel (rotary) and electric engines have not been tested, but there is no reason to believe that Wankel engines will not produce similar values to 4-strokes.

B4.2.1 Electric or Jet Power. Either the FR must be fitted near the engine or a type of recorder with an external MOP function must be fitted. Annex B to the Sporting Code (SC3B) para 1.4.2.4 applies.

B.4.3 ENL during gliding flight. ENL readings of less than 060 indicate normal quiet gliding flight. In a high-speed glide, or in a glider with more cockpit noise, the ENL may increase to 200. Sideslip or high speeds with the cockpit panel(s) open can produce low frequency noise ("organ-pipe" effect) and ENL readings of up to 350 have been recorded under these conditions. High ENL may also be recorded during stalling and spinning, particularly if the engine doors flutter or move sin-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.

B.4.4. ENL during the approach to land. ENL values are always 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. ENL values of up to 300 have been recorded, although 240 is more typical in an aerodynamically noisy glider, and 120 in a quieter machine.

B.4.5 ENL during landing. During ground contact during landing, short-duration ENL values up to 400 have been recorded, probably due to wheel squeak and rumble, particularly on hard surfaces. Unlike engine running these last only for a short time, showing a short spike on the noise/time record.

B.4.6 ENL analysis. It is normally easy to see when an engine has been running and when it has not. Other data such as rates of climb/descent and groundspeed, will indicate whether or not non-atmospheric energy is being added. Short term peaks in ENL (10 seconds or so) may be due to the other factors mentioned above such as undercarriage and/or airbrake movement, sideslip, open cockpit panel combined with sideslip and /or high airspeed, 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).

B.5 **Altitude analysis and calibration**. IGC files will be analysed to 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. As part of this process, the Recorder can be calibrated in an altitude chamber in the same way as a drum barograph.

B.5.1 Calibration method, making a calibration table. No GPS fixes are required for a pressure altitude trace to be produced. However, before a calibration, you are advised to set the normal (cruise) fix rate to a small time interval such as 5 seconds or less. Recording at the pre-set fix interval starts when power is connected to the recorder and the pressure altitude change threshold is exceeded (about 1 m/sec for 5 sec). The calibrator should be asked to cycle the pressure briefly up and down before starting the calibration itself, so that recording will start. 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. After the calibration, the data file containing the pressure steps is transferred to a PC as if it was flight data (see B2.3 above); this may be done by an NAC-approved person other than the calibrator who may not have this knowledge. The IGC format calibration data file will then be analysed, compared to the calibration pressure steps, and a correction table produced and authenticated by 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.

B.5.2 GPS altitude figures recorded in the IGC file. Occasional short-duration differences in the shape of the GPS altitude/time graph have been noted when compared to the pressure altitude figures. This is not unusual with GPS receivers operating without a local differential beacon or other accuracy-enhancing systems such as RAIM or SBAS. 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 fixes compared to horizontal position. This effect will be increased by poor antenna positioning in the glider. 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. GFAC tests awhiw the lat/long error taken from a moving vehicle at a surveyed point, averages between 11 and 12m for all 12 channel recorders tested since that date.

B.5.3 Maximum Altitudes Recorded in the IGC file. The maximum altitudes in IGC files that apply to this recorder are given below.

B.5.3.1 Pressure Altitude. This is recorded up to 8 km (26,247 ft) on the ICAO ISA.

B.5.3.2 GNSS altitude. This is recorded up to 9 km (29,528 ft) above the WGS84 ellipsoid.

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