GNSS FLIGHT RECORDER APPROVAL COMMITTEE (GFAC)
FAI INTERNATIONAL GLIDING COMMISSION (IGC)

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www.fai.org/gliding under Technology, then under IGC-approved FRs
GFAC web site for FR data: www.ukiws.demon.co.uk/GFAC

To: IGC and GFAC Web sites
Notification to: IGC email mailing list <igc-discuss@fai.org>
Internet newsgroup rec.aviation.soaring
Copy: Manufacturer concerned

1 October 2013

IGC-APPROVAL FOR GNSS FLIGHT RECORDER

Recorder Name: LX Navigation LX20
Level of Approval: Badge flights up to and including Diamonds

(i) General. This document gives 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. IGC reserves the right to alter the terms of this approval in the future.

(i-i) Document Versions. Version 1 of the LX20 approval was dated 12 August 1996. Version 2 added the ENL function. Version 3 added the LX20-2000 model. Version 4 added the JRC/CCA-450 GPS receiver board and Versions 5 and 6 incorporated two IGC-approval levels. Version 7 changed the manufacturer name from Filser to LX Navigation and used wording used in recent IGC-approval documents. The 2011 paper on FR Security by the IGC ANDS and GFA Committees that was approved at the 2012 IGC Plenary meeting recommended a reduction to "Diamonds" and this was made in two stages, to "All Badges" on 1 October 2012 and to "Diamonds" on 1 October 2013.

(i-ii) IGC-approval Levels. The Levels of IGC-approval are listed in para 1.1.4 of Annex B to the Sporting Code for Gliding (SC3B), and cover the use of FRs in flights for FAI/IGC badges, diplomas, records and in competitions.

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

(ii) This IGC-approval 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 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.

MANUFACTURER

LX Navigation d.o.o. , Tkalska 10, SI-3000 Celje, Slovenia
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Email: support@lxnavigation.si ; Web: www.lxnavigation.si/avionics
Managing Director and contact: Crtomir Rojnik
Note: The company LXNAV d.o.o. that also manufactures FRs is a different Commercial Entity and has a different address

Note: This type of recorder was originally badged under the name Filser Electronic and IGC-approvals were also in the Filser name. Filser Electronic is now Funkwerk Avionics GmbH and this type of recorder is no longer supported. The original Design Authority for the recorder was LX Navigation and any correspondence should be with LXN using the contact details above.

EQUIPMENT

1. **HARDWARE.** IGC-approval applies to Hardware V3.0 and later which includes a security microswitch and RSA security (1998 or later). The Hardware version is shown in the IGC file header record in the form: HF RHW HARDWARE VERSION: 3.0

1.1 **Original LX20**

1.1.1 **Hardware Versions.** IGC-approval applies to Version 3 (V3.0) and later. The original 1996 hardware was Version 1.0 (V1.0). In 1997 V2.0 added Environmental Noise Level (ENL) recording and in 1998 V3.0 added a security microswitch and RSA security. The version is shown on the LCD on start up and in the IGC file header record after "HF RHW HARDWARE VERSION". For manufacturer notification of updates, see para 11.

1.1.2 **Dimensions.** The recorder unit has a rectangular metal case about 200 x 90 x 45mm and weighs about 500gm.

1.1.3 **Display, buttons, connectors.** A 62 x 44mm LCD is on the 200 x 90m face, and below it are 3 rows of 3 buttons with an Escape and Mark button below (total, 11 buttons). External connectors consist of an antenna bayonet fitting, a 9-pin RS232 and two circular data transfer connectors (see below under "permitted connections").

1.1.4 **GPS Receiver boards.** Early recorders were fitted with the 11-channel Koden (Japan) FDK-GSU/14 GPS board, later ones with a 6 channel Motorola Oncore or the 8 channel Motorola Oncore GT board. The GPS receiver type is shown in the header record of IGC-format flight files in the form "HFGPS:" followed by the type. This can be seen by using a text editor to view an IGC file.

1.1.5 **Pressure altitude sensor.** Sensym SDX15A2. The Recorder case is vented to atmosphere and records "cockpit static".

1.2 **LX20-2000** This model was introduced in year 2000.

1.2.1 **Hardware Version.** IGC-approval applies to Version 5 (V5.0) and later. The Version is shown on the LCD on start up and in the IGC file header record after "HF RHW HARDWARE VERSION". For manufacturer notification of updates, see para 11.

1.2.2 **Dimensions.** The recorder unit has rectangular metal case about 130 x 87 x 39mm., weight is about 390gm.

1.2.3 **Display, buttons, connectors.** A 62 x 44mm LCD is on the side of 130 x 87 dimension, and below it are 3 rows of 4 buttons. Three connectors are on the 87 x 39mm end, below the buttons; they are an antenna bayonet fitting and two telephone plug-type connectors (see below under "permitted connections").

1.2.4 **GPS Receiver boards.** Originally, either the Marconi (Canada) Superstar or the Ublox (Swizerland) GPS-MS1 GPS receiver was fitted. After September 2001, the Japan Radio Corporation JRC/CCA-450 may be fitted. These are all parallel receivers capable of receiving data from up to 12 satellites for any one fix. The receiver type is shown in the header record of IGC-format flight files in the form "HFGPS:" followed by the receiver type. This can be seen by using a text editor to view the start of the IGC file.

1.2.5 **Pressure altitude sensor.** A MS 5534A Pressure Altitude sensor by Intersema Sensoric SA of Switzerland (www.intersema.ch) is fitted. This 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.

1.3 **National and other regulations**. These may apply to electrical and electronic equipment. Compliance with such regulations is not the responsibility of FAI. It is understood that this equipment has the EU "CE" mark that implies compliance with EU directives on EMC and voltages.

1.4 **Other modules**. Other modules such as for cockpit in-flight displays may be connected but are not part of this IGC-approval and are a matter between the manufacturer and the customer.

2. **FIRMWARE**. IGC-approval applies to Firmware version 3.0 (V3.0) or later; the FR must have a security microswitch and RSA security. The Firmware version is shown in the IGC file header in the form: HF RFW FIRMWARE VERSION: 3.0. For manufacturer notification of updates, see para 11.

3. **SOFTWARE**. Program files for this recorder for Downloading, Conversion to the IGC format and Validating IGC flight data files, are available from the IGC GNSS web site: www.fai.org/gliding/gnss/freeware.asp
Look under the heading "LX Navigation download"

3.1 **Program file functions**.

3.1.1 DATA-LXN.EXE - this is for transferring flight data from the recorder to a PC and produces a *.FIL binary file and an *.IGC file for each flight.

3.1.2 CONV-LXN.EXE - this file is for conversion of a *.FIL flight data file to the IGC format, if this has not been done before.

3.1.3 VALI-LXN.EXE - this file is for validation by NACs and FAI of the security and integrity of the *.IGC files.

3.1.4 LXN LXEFAI and LXe programs. The above functions can also be carried out through the manufacturer's LXFAI software program version 5.0 or later releases and also the LXe program that is available from the company's web site.

3.2 **Latest versions**. The latest versions of the above programs must be used. The DATA, CONV and VALI files can be obtained from the IGC GNSS site for software given in para 3 above and at the beginning of this document, and are backward-compatible to previous versions.

3.3 **Free availability**. The DATA, CONV, and VALI files are freeware, copyright of the recorder manufacturer.

3.4 **Validity of Flight Data**. The IGC standard for electronic flight data is that the IGC file must pass the IGC VALIDATE check. That is, by using the VALI-LXN.exe program function with the IGC file in the same directory and interrogating the IGC file that is to be Validated. This checks that the IGC file has correctly originated from the recorder and that it is identical to when it was initially downloaded (that is, the data has not been changed later so that it is different). See B4.2 for more details.

CONDITIONS OF APPROVAL:

4 Permitted Connections to the main recorder module.

4.1 Original LX20 - Connections.

4.1.1 External antenna**.** This connects to a 9mm circular BNC bayonet connector on the upper left side of the case.
4.1.2 Multiple function connector**.** A 9-pin RS232 connector is on the bottom face below the keyboard, with connections for 12V external battery power, to a Pilot Event (PEV) button, a light indicating GNSS lock-on, and NMEA signal output to appropriate instruments.
4.1.3 Data transfer to PC**.** A PC is connected to a 4-pin circular data-transfer port on the top face above the LCD. However, a PC must not be connected between the takeoff of the claimed flight and the transfer of data after flight.
4.1.4 Second power connector**.** A 3-pin circular port on the top face above the LCD is for a 12V battery connection, for use if the 9pin RS232 connector is not used for this purpose.

4.2 LX20-2000 – Connections.

4.2.1 External antenna**.** This connects to a 9mm circular BNC bayonet connector on the case.
4.2.2 Data and Power**.** Data I/O and 12V power are through a 6-pin female 9.5 x 6.5 mm RJ12 socket on FR case, wired to the IGC standard for this type of socket.
4.2.3 Pilot Event (PEV) Button**.** A Pilot Event (PEV) button and green light GPS status indicator can be connected to a 4-pin female 7 x 6.5 mm RJ10 socket on the case.

5 **Security of the Equipment**. 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. GFAC reserves the right to inspect production-standard equipment from time to time for security, general compliance with the IGC Specification and the calibration of sensors such as for pressure altitude.

6 **Installation in a glider**. From the point of view of data recording, the unit may be fitted anywhere in the glider, subject to para 8.2 on sealing and that in Motor Gliders the position is suitable for recording Engine Noise Levels (ENL). If the GPS antenna is accessible to the crew in flight, no attempt must be made to inject false data. Any abuse of this may lead to a requirement to place the antenna out of reach of the flight crew.

6.1 Sight Lines. Particularly in single-seat gliders, the position of any displays concerned with 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**. When the Environmental Noise Level (ENL) system is fitted and enabled (see Annex A for the enabling method), acoustic noise levels at the recorder are recorded with each fix. This 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 system. A microphone and frequency filter and weighting system inside the recorder case automatically produces an ENL 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.

7.1.1 ENL Recording System . The ENL system in this FR is made by LX Navigation.

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

7.1.3 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 acoustic noise levels at the recorder, including when run at low power. For other types of engines, see para 7.2 below.

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

7.1.5 ENL test values. For details of typical ENL values found on GFAC tests, see para B.4.

7.2 Low-ENL Engine/Recorder combinations. This approval does not include cockpit mounting of the FR when used with engines that produce small ENL values 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 the FR position produces low-ENL values when the engine is run at low powers, there are two alternatives: (1) either the FR must be moved closer to the source of engine noise, or (2) another variable additional to ENL must 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. A copy of the current SC3B para 1.4.2.4.1 follows, and is particularly applicable to this type of recorder because it is very small and can easily be mounted near to the engine of a jet or the propeller of an electric motor glider.

7.2.1 Extract from SC3B para 1.4.2.4.1: FR mounting near the engine or propeller. Where cockpit or other mounting of an FR results in low ENL figures when the engine is run, an alternative to using an FR with an external MOP sensor is to mount an IGC-approved FR with ENL facilities in or near the engine-bay close to the engine and/or propeller. Such an installation of the FR in an individual motor glider must be inspected by an OO or NAC Official and documented for use in future claims. Flight testing must show substantially higher ENL figures when the engine is run at low power, compared to conditions met in engine-off soaring such as thermalling with cockpit panels and vents open. Claim documents must include evidence that the FR installation was as inspected, and that ENL figures in the IGC file are similar to those previously tested.

8. **Check of Installation in the Glider**. There must be incontrovertible evidence that the FR was in the glider for the flight concerned, and was installed in accordance with IGC procedures. This can be achieved either: by observation at takeoff or landing, or by sealing the FR to the glider at any time or date before takeoff and checking the seal after landing.

8.1 Observation of Installation before Takeoff or at Landing. If manual Observation is to be employed (instead of sealing, see 8.2 below), there are two ways to ensure that the installation is in accordance with the rules, and that another FR has not been substituted before the data is transferred to a PC. One of the following must be carried out:

8.1.1 A pre-flight check of the installation is made and the glider is under continuous observation by an OO until it takes off on the claimed flight,

8.1.2 An OO witnesses the landing and has the glider under continuous observation until the Recorder installation is checked.

8.2 Sealing to the Glider before Flight. If para 8.1 cannot be met, the FR 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 with the glider registration, the date, time and OO's name and signature. It should be possible for the OO to recognise the seal markings afterwards. The use of adhesive plastic tape is not satisfactory for IGC-approved sealing because it can be peeled off and re-fitted. Gummed paper tape is recommended, as used for sealing drum-type barographs. The OO must seal the FR 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 FR is sealed to such removable part, if such a part is transferred between gliders, any FR 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 European CE Mark and the manufacturer's name (which may appear as "Filser"), is fitted over at least one of the case securing screws. In addition, an internal security mechanism is included that activates if the case of the FR is opened. On switching on, the LCD screen shows the version, unit serial number, memory available and other details. If data is waiting to be downloaded the LCD shows "CHECKING SECURITY" for a short time before the menu is shown. If the FR case has been opened, breaching physical security, the message "SECRET KEY NOT VALID" will be shown on switching on and an audio alarm will sound which can be cancelled by pressing "ESC .

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 FR will be erased. Any flight data files produced after this will fail the IGC Validate test for electronic security. This test will also fail if the *.LXN or *.IGC file has been altered in any way after being transferred from the FR.

9.2.1. RSA or CRC security systems. For recorder units with RSA electronic security, the initials RSA will appear on screen when VALI-FIL is executed. For recorder units without RSA, the initials CRC will appear (Cyclic Redundancy Check). Units with CRC are for IGC badge and distance diploma flights only, see para (i.ii) and also under Hardware and Firmware above.

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.

9.3.1 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 to the IGC-approved standard.

10. **Analysis of Flight Data**. Analysis for flights to be validated to IGC criteria should be through the use of a program that complies with IGC rules and procedures, and is approved for this purpose by the relevant NAC. For a list of programs which are capable of reading and displaying flight data in the *.IGC file format, see the fai.org/gliding/gnss web site under the link to SOFTWARE (the full web reference is at the beginning of this document). 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 has not been altered after it was download from the Recorder to a PC. This is done by checking the IGC data file with an authorised copy of the VALI-LXN.EXE short program. The VALI program file must have originated from the current FAI/IGC web site for software listed at the beginning of this document. See Annex B for detail on how to use the validate systems.

11. **Manufacturer's Changes to 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 details of later versions of hardware, firmware and software, also any changes to modules such as the GPS receiver, pressure altitude transducer, the layout of the security microswitch and any other factor that could affect the security of the FR and the IGC files produced from it.

Ian W Strachan
Chairman, IGC GNSS Flight Recorder Approval Committee (GFAC)

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

Any questions to: Chairman IGC GFAC,
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Tel: +44 1420 564 195; Fax: +44 1420 563 140; email: ian@ukiws.demon.co.uk

------------ Annexes follow --------------

Annex A to IGC Approval - NOTES FOR OWNERS AND PILOTS

A(i) Status. This Annex should be read together with the main terms of approval earlier in this document.

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 equipment, for the use of pilots and OOs.

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

A1. **Antenna** - The antenna should be positioned in order to give sufficient signal strength for IGC purposes. No attempt must be made to inject false data via the antenna; any abuse of this may lead to a future requirement to position antennas out of reach of the flight crew.

A2 **Geodetic Datum (Earth Model)**. For IGC purposes, all latitudes and longitudes recorded by the Recorder must be to a Geodetic Datum (earth model) of WGS84. **In LX20 versions before V5.0, it is possible to modify the Geodetic Datum through a password system, and pilots must ensure that WGS84 is set**. Once set, or in V5.0 and later, 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).

A3 **Setting the Fix Interval**. The fast-fix facility operates when the Pilot Event (PEV) button is pressed and gives the number and interval of fixes that were set before flight by the pilot through the setup program under the heading "On event button". The fix interval for cruise flight between PEV events (such as between Waypoints) is set by the pilot before flight through the set-up program under the heading "Normal operation". 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 and take advantage of the fast fix facility. Setting a short fix interval for cruise flight leads to IGC files of large byte size, particularly for long flights. This uses up more memory, causes downloading after flight to take a long time, increases the chance of data corruption and may also cause problems with some analysis programs because of the large number of fixes that have to be processed.

A3.1 IGC rules. IGC rules on fix intervals for cruise flight are an absolute maximum of 60 seconds (SC3 para 4.3.1 and Annex C to SC3, para 7.1) and 10 seconds for competitions complying with 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 each Waypoint to ensure that a fix is recorded within its observation zone".

A4 **Checking Recorder operation before a Claim Flight**. Pilots should check and analyse a selection of IGC files from their recorder before attempting flights that will require Validation. This is to ensure that the recorder is performing correctly and in accordance with this approval. Particularly that GPS fixes, pressure altitude and ENL values are recorded as expected. In particular, ENL values should be in accordance with the figures given in para B5. See also A8 on ENL and A13 on pressure altitude calibration.

A5 **Recorder installation in the glider**. The pilot must ensure that an OO has checked the place of the equipment 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**. See para 8 in the Conditions of Approval. Regarding the position of displays concerned with the Recorder, see para 6 in the Conditions of Approval which refers to sight-lines and the need for pilot lookout and scan.

A6 **Check of Takeoff Independent of the Recorder**. The pilot must ensure that the time and point of takeoff has been witnessed and recorded in a way independent of the recorder, for comparison with takeoff data in the IGC file from the recorder, see para B2.

A7 **Connection to data Ports and connectors**. Although this approval does not presently require sealing of any ports or connectors in or on the recorder, no attempt must be made to pass unauthorised data into the Recorder, either on the ground or in flight. Para 9.1.1 in the Conditions of Approval, refers.

A8 **Use in Motor Gliders** (including self-sustainers): See para 7 of the main body of this document (before the annexes). The recorder must be placed so that engine-related noise is clearly received when the engine is giving any forward thrust and must not be covered or insulated (even so, automatic gain should continue to ensure high ENL readings under engine power).

A8.1 Cockpit Noise. Cockpit noises other than the engine will produce ENL figures on the IGC file, and should avoid those that could be mistaken for use of engine. **Flight with the cockpit Direct Vision (DV) and/or ventilation panel(s) open can produce a low-frequency sound (organ-pipe note) which will register as high ENL. This is magnified if sideslip is present and in particular at high airspeeds. High airspeeds with cockpit panels open 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 close to powered aircraft should also be avoided, except aero-tow launches. For ENL levels that have been recorded on GFAC tests, see B.4.2.

A8.2 Pilot check of ENL figures. Pilots should check that the ENL figures produced by their recorder show a clear differentiation 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, the recorder should be returned to the manufacturer for the ENL system to be re-set.

A8.3 Enabling the ENL system. Switch ENL to "Y" for yes in the I-Record screen. This screen is accessed by selecting "FAI LOGGER" and pressing Enter, 4 down strokes to access the I-Record screen, Enter. An IGC file from a short ground test will confirm that ENL is enabled.

A9 **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.

A9.1 After-flight calculation of security. After landing, the recorder calculates a digital signature for the IGC file for the flight, using either the RSA Public/Private Key (PPK) encryption system, or, for early models that have not been updated, the Cyclic Redundancy Check (CRC) system. This process places security codes at the end of each IGC file, 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 (see paras 9.2 and 10 before the Annexes).

A10 **Check of Landing Independent of the Recorder**. The pilot must ensure that the time and point of landing has been witnessed and recorded in a way independent of the recorder, for comparison with the IGC file data from the recorder (see para B3.1).

A11 **Switching Off**. This is by switching off the external power or disconnecting the RJ11 connector from the recorder.

A12 **Downloading the Flight Data**. This is by connecting a PC to the appropriate socket on the case of the recorder (para 4.2.for the original LX20 and 4.3for the LX20-2000). The OO will carry out the actions given in para B3.3, and the OO's copy of the transferred flight data is 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 takes or is given a copy on standard electronic storage media such as a memory stick, diskette or equivalents. 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.

A12.1 Use of Portable PC at the glider. The PC used may be owned by the pilot or any other person. The PC should be set up for ease of data transfer. Transfer of flight data is witnessed by the OO, and the flight files in IGC format must be given to the OO for safe keeping and analysis on standard electronic media such as a memory stick, diskette or equivalents.

A13 **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 B6. 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.

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

Annex B - **NOTES FOR OFFICIAL OBSERVERS AND NACs - PART OF IGC APPROVAL**

B(i) Status. This Annex should be read together with the main terms of approval earlier in this document.
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**. Due to the portability of this Recorder, it would be easy to transfer it from one glider to another, or from a powered aircraft to a glider. Therefore, an Official Observer (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. There are two ways of doing this, by manual observation at the time, or by sealing the recorder to the glider, see also para 8 in the main body of this document before the annexes:

B.1.1 Observation of Installation before Takeoff or at Landing. If manual Observation is to be employed (instead of sealing, see 8.2 below), one of the following must be carried out:

B1.1.1 A pre-flight check of the installation is made and the glider is under continuous observation by an OO until it takes off on the claimed flight, or,

B1.1.2 An OO witnesses the landing and has the glider under continuous observation until the Recorder installation is checked.

B1.2 Sealing. The OO shall seal the Recorder to the glider in a way acceptable to his NAC and to IGC, and such sealing may be at any time or date before flight. 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 8 of the Conditions of Approval.

B2 **Takeoff – Evidence independent of the Recorder**. The time and point of takeoff shall 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. This comparison is an important check on the integrity of the data in the IGC file and, combined with the IGC VALI check, indicates that it has not been made up before the flight.

B3 **Landing**

B3.1 Landing - Evidence independent of the Recorder. The time and point of landing shall 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 landing data from the Recorder. This comparison is an important check on the integrity of the data in the IGC file and, combined with the IGC VALI check, indicates that it has not been made up before the flight.

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 Transferring the Flight Data. If a portable PC is available, the flight data may be transferred at the glider without disturbing the installation of the Recorder. If a portable PC is not available, the OO shall check and break any sealing to the glider, and take the Recorder to a PC. 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 places a security record at the end of the IGC file that is then independently checked later at the NAC (and at FAI if the claim goes to them).

B3.3.1 Methods. Connect the PC to the data port on the recorder case using the cable supplied by the manufacturer or an equivalent. In the basic LX20, this is a 4-pin circular connector and in the LX20-2000 is a 6-pin RJ12 connector. For downloading, use either a current version of the short program file DATA-LXN.EXE, or use a current version of the LXN LXFAI program. The Recorder must be set to "Connect" mode in order to download data to the PC. This is done by pressing the WRITE button; the LCD then shows the Baud rate and a 10 sec countdown during which the data transfer may start.

B3.3.1.1 DATA-LXN file. The file DATA-LXN.exe is available free from the IGC GNSS web site for software given at the beginning of this document, or through a link from the main IGC/GNSS site. The file DATA-LXN.EXE can be executed on either a floppy diskette or on the PC hard disk. The software version is shown at the top of the menu (see under software on page 1, which gives the relevant versions). This program file executes in the normal way such as either by typing at a DOS prompt DATA-FIL, enter; or by to be changed, the help menu is accessed by typing the file name, space, hyphen, then the letter h.

B3.3.1.2 LXFAI Program. For the LXFAI program, follow the instructions given in the menu.

B3.4 Flight data files produced. This process will automatically produce both a binary-format file and an *.IGC-format flight data file. Both have the file name YMDCXXXF, where Y=year, M=month, D=day, C= manufacturer, XXX = Recorder Serial number/letters and F = flight number of the day. The full key to the file name is in Appendix 1 to the IGC GNSS FR Specification and is also listed in Annex C to the Sporting Code, SC3C. Because this recorder was originally under the Filser name, the intermediate binary file may have the suffix FIL and the manufacturer's single letter code may be F.

B3.5 OO's Copy. A copy of both the *.LXN or *.FIL and the *.IGC files shall be retained securely by the OO such as by immediately copying them to a separate PC memory stick or diskette, or by the use of the OO's own PC. These files shall be retained by the OO in safe keeping for later checking and analysis under NAC/IGC procedures.

B3.6 Competitions. Different rules may apply for competition flights, for which a central 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 IGC file validation system.

B4. **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 IGC GNSS web site under SOFTWARE). There are two aspects to data analysis, (1) checking the flight performance that is being claimed by looking at the fixes and other data in the IGC file, and (2) Validation of the integrity of the downloaded data itself.

B4.1 Validation of Flight Data. The IGC Validation system checks three elements. (1) That the flight data in the IGC file is identical to that originally downloaded from the Recorder That is, that data has not been changed after the initial download. (2) Checks the electronic security coding and general structure of the IGC file. (3) Checks that the Recorder has not been modified in an unauthorised way.

B4.2 Validation Method. Use the free VALI-LXN.exe program file that is available from the IGC GNSS web site. For more detail, see para B3.3.1. This system shall be used by the OO, the competition organisers, or the NAC as appropriate. Also by FAI if the data goes to them such as for a World Record.
Method: at the appropriate prompt or run function, type VALI-FIL.EXE followed by a space and the name of the file to be checked. The message "Integrity is OK" should appear, not "Integrity is NOT OK" (in the latter case the NAC or other validating authority must investigate the reason). Both the *.FIL and *.IGC flight files should be checked by this method. It should be noted that GFAC tests include ensuring that the change of a single character in an otherwise-correct IGC file, cause the VALI program to fail as indicated above. The type of electronic security (RSA or CRC) can be seen on screen when VALI is executed, see para 4.2.1 before the annexes.

B5. **Means of Propulsion (MoP) Record - Motor Gliders**. The MoP must either be sealed or inoperative, or the built-in Environmental Noise Level (ENL) system used. For the ENL system, see para 7 of the main body of this document before the annexes. ENL values recorded on GFAC tests on piston engines are given below, in the sequence of a flight.

B5.1 ENL during launching. During winch and aerotow launches, higher average ENL values are to be expected than when soaring (B5.3). On aerotow a reading of 279 has been recorded. During the ground roll, short-term higher values have been recorded, probably due to wheel rumble, and values of 400 have been seen for one or two fixes.

B5.2 ENL during engine running. On engine running at powers needed to climb, an increase to over 800 ENL is expected. Over 900 is typical for a two-stroke engine, over 800 for a 4-stroke. An ENL value of 999 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. The values quoted above are for 2- and 4-stroke engines. Wankel (rotary) and electric engines have not been tested with this recorder, but previous tests with Wankel engines indicate that they produce similar ENL values to 4-strokes.

B5.2.1 Quiet engines. This approval does not include use with Motor Gliders with electric, jet or other engines that produce low ENL values at the FR (see Para 7 in the Conditions of Approval).

B5.3 ENL during gliding flight. ENL readings of less than 060 indicate normal quiet gliding flight. Short periods of higher ENL while gliding may indicate aerodynamic noises. In a high-speed glide, or in a noisy glider, the ENL may increase to 200. Particularly, sideslip or high speeds with the cockpit Direct Vision panel open can produce low frequency noise ("organ-pipe" effect) and ENL readings of up to 350 have been recorded. High ENL may also be recorded during stalling and spinning, particularly if the engine doors flutter or vibrate (move slightly in and out due to stall buffet, producing a clattering noise). Finally, where the engine is mounted on a retractable pylon, a high ENL reading will be shown if flying with the pylon up and engine not running, due to the high aerodynamic noise.

B5.4 ENL during the approach to land. ENL values are 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.

B5.5 ENL during landing. During ground contact during takeoff and landing, short-duration ENL readings between 300 and 400 have been recorded, probably due to wheel rumble. Unlike engine running these last only for a short time, showing a short "spike" on the noise/time trace.

B5.6 ENL analysis. It is normally easy to see when an engine has been running and when it has not. Other data such as rates of climb and groundspeed, will indicate whether 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 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**. Flight data files will be analysed in accordance with Sporting Code procedures. Part of this is to compare the general shapes of the GNSS and pressure altitude fix records with time and to ensure that no major differences are seen that could indicate malpractice or manufactured (false) data. As part of this process, the FR can be calibrated in an altitude chamber in the same way as a drum barograph.

B6.1 Calibration method, making a calibration table. Unless the password system for early recorder models is used (see in 6.3.1 below), before a calibration, the normal fix rate should be set to a small time interval such as 2 seconds. Recording starts after a pressure change of about 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 (start) the recording of fixes, 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. 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 analyzed, compared to the calibration pressure steps, and a correction table produced and authenticated by an NAC-approved person (for instance an OO or GNSS FR 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 if pressure altitude is not available.

B6.2 GPS altitude figures recorded in the IGC file. Occasional short-duration differences in the shape of the GPS Altitude/time graph have been noted compared to the pressure altitude figures. This is not unusual with GPS receivers operating without a local differential beacon or regional augmentation system. The altitude accuracy from satellite-based systems will not be as good as accuracy in lat/long, because the geometry of the position-lines is not as favourable for altitude compared to horizontal position. This effect will be increased by poor antenna positioning. Data analysts 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 after 1 May 2000 when the GPS Selective Availability error was removed for civilian receivers, errors average between 11 and 12m. This is the average lat/long error taken from a sample of fixes from a moving vehicle at a number of surveyed points near 51N 001W for all recorders with 12 or more channels tested since that date.

B6.2.1 Koden (Japan) FDK/GSU 15D receiver. With the Koden board that is fitted to some early models, a time delay has been noted in the GPS altitude figures when compared to those for pressure altitude. In some flight files the shape of the GPS altitude trace differs from the shape of the pressure altitude trace. This was investigated with the GPS board manufacturer but no conclusion was reached. Lat/long fix accuracy is not affected and is typical of that for a 12 channel GPS system, but data analysts and NAC officials should allow for the above when comparing the GPS altitude and pressure altitude records.

B6.2.2 Other receivers. Occasional short-duration differences in the shape of the GPS Altitude/time graph have been noted compared to the pressure altitude figures. This is thought to be a combination of satellite geometry (poorer for altitude calculations) and different processing for GPS altitude within receivers compared to processing to horizontal position. These differences can be increased by poor antenna positioning in the glider or faults in the antenna cable or its connectors. Lat/long fix accuracy appears not to be affected and GFAC tests show typical accuracies in lat/long positions recorded in IGC files (average lat/long error about 11.4m). Data analysts and NAC officials should allow for the above when comparing the GPS altitude and pressure altitude records.

B6.3 LX20 Models and Versions

B6.3.1 Original LX20 model. From hardware Version 3.0, no password is needed (although the password system is not disabled and can still be used) because recording starts when a pressure change is detected of 1 m/sec for 5 sec. When the pressure-change system is used, a normal IGC file header record is produced and the pressure altitudes are recorded at whatever GPS fix rate has been set. If the password system is used, pressure altitudes are recorded at one second intervals but an abbreviated header record is produced which does not include the FR type, and the serial number is translated into numerals from the 3-character serial in the file name. If the password mode is used, the missing details must be included in the written record of the calibration.

B6.3.2. LX20-2000 model**.** No password is needed (although the password system is not disabled and can still be used) because recording starts when a pressure change is detected of 1 m/sec for 5 sec., and no GPS fixes are required for a pressure altitude trace to be produced. Pressure altitudes are recorded up to a pressure of 300 mb (30,030ft or 9153m). When the pressure-change system is used, a normal IGC file header record is produced and the pressure altitudes are recorded at whatever GPS fix rate has been set. If the password system is used, pressure altitudes are recorded at one second intervals but an abbreviated header record is produced which does not include the FR type, and the serial number is translated into numerals from the 3-character serial in the file name. If the password mode is used, the missing details must be included in the written record of the calibration.

B6.4 **Maximum Altitudes Recorded in the IGC file.** The pressure altitude sensor and the GPS system itself are capable of recording to almost unlimited altitudes, certainly up to 30km/100,000ft. However, the type of processor in the recorder and the need for good resolution (lack of large steps) across the altitude range, results in limitations in altitudes that can be recorded in the IGC file. The maximum altitudes for figures in IGC files that apply to this recorder are given below.

B6.4.1 Pressure Altitude. Pressure altitudes are recorded up to 13 km (42,651ft).

B6.4.2. GNSS altitude. All LX20 models record GPS altitude up to 60,000 ft (18,288m).

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