**GNSS FLIGHT RECORDER APPROVAL COMMITTEE (GFAC)**
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**of the**
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**References:**
FAI web site: www.fai.org
GC web site: www.fai.org/gliding
GFAC Chairman's web site: 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 November 2015

# IGC-APPROVAL FOR GNSS FLIGHT RECORDER

**Level of Approval:** **All flights (see para i-ii)**
**Recorder Names:** **Logstream FR-1**

*(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 initial approval for this type of recorder was dated 22 November 2015.*

*(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 1.1.4.*

*(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 document 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

Logstream Sp z o.o. Ul. Przylep-Zrodlana 1, 66-015 Zielona Gora, Poland
Email, Web, Contact: office@logstream.eu & www.logstream.eu Contact: Tomasz Dzikuc
IGC FR Manufacturer Code: LGS (no single-letter code is needed because the long file name is used for IGC files)

## EQUIPMENT

### 1 HARDWARE

1.1 Recorder Name. Logstream FR-1.

1.2 Hardware Version. The original IGC-approved hardware standard was Version 1.0. Later versions may be used if they are IGC-approved, see para 7 below. The Version number is shown in the header record of IGC files in the form "HFRHWHARDWAREVERSION:1.0".

1.3 Size, Weight, Power Source. The FR-1 is a small free-standing unit 87 x 80 x 30mmin size and weighing about 180 grammes. It can be powered either through the RJ45 socket by a 12V DC source or through the mini USB socket by a stable 5VDC source such as a PC USB output. When the RJ45 is used, it performs normally between 11 and 16 Volts and continues to work down to about 10 volts. When no external power is supplied, a small sustainer battery maintains the Real-Time Clock (RTC) and security functions.

1.4 GPS receiver. This is by Global Top of Taiwan (www.gtop-tech.com), model FGPMMOPA6H is fitted and is capable of processing up to 66 GNSS channels. This is shown in the header record of IGC files in the form "HFGPSRECEIVER:GLOBALTOP,FGPMMOPA6,66,max18000m".

1.5 Pressure altitude sensor. This is the MS 5540-CM Pressure Altitude sensor by Measurement Specialities (ex-Intersema) of Switzerland (www.meas-spec.com/pressure-sensors.aspx). This is shown in the header record of IGC files in the form "HFPRSPRESSALTSENSOR:MEASPEC,MS5540-CM,max15000m.". The last figure is the maximum altitude processed to the resolution requirements of para 2.2 of the IGC Specification. The pressure altitude system is compensated for temperature variation and set to the ICAO ISA, subject to later calibration under IGC procedures. The recorder case is not sealed and "cockpit static" pressure is recorded on the IGC file.

1.6 Connectors.

1.6.1 Front Face.

1.6.1.1 USB socket. This a 14mm wide USB-A fitting at the centre of the front face for download and upload of data via a USB stick. Further details are in A5, A13 and the Operating Manual.

1.6.1.2 PEV Button. When this is pressed, a fix with a PEV code is added to the IGC file, followed by 30 fixes at 1 second intervals. Before flight recording, if pressed for over 3 seconds it changes Task A to Task B and vice versa.

1.6.1.3 Lights. There is a red Power light, a green light for GPS lock, and lights for Task A (orange) and Task B (yellow).

1.6.2 Rear Face.

1.6.2.1 GPS Antenna. This is a 6mm diameter SMA circular screw-fitting. There is another GPS antenna inside the case and the external antenna fitting is so that a good signal can still be received if the position of the FR inside the glider gives a low signal at the internal antenna.

1.6.2.2 RJ-45 Socket. This supplies 12 volts to power the recorder and is used for other functions listed in the Operating Manual.

1.6.2.3 Mini USB Socket. This is a 6mm wide Mini B USB fitting and is used to connect the recorder to a PC's USB socket for download and upload of data (as an alternative to using the full size USB socket on the front face), on which the recorder is recognised as two drives named LGS_nnn_IGC and LGS_nnn_CFG where nnn is the individual FR's three character identification. The Mini USB socket can also be used to power the recorder instead of the RJ45, supplying a stable 5V input from a USB socket such as on a PC or the USB socket on the other end of some 12V vehicle lighter plugs.

1.7 National and other regulations. These regulations may apply to electrical and electronic equipment and compliance with such regulations is not the responsibility of FAI . See the caveat on page 1, para (ii) .

2. **FIRMWARE** Version 1.0 was the original IGC-approved firmware standard. Later versions may be used if they are IGC-approved, see para 7 below for IGC-approval of updates. The firmware version is listed in the header record of IGC files in the form "HFRFWFIRMWAREVERSION:1.0" .

### 3. SOFTWARE

3.1 Downloading of Flight Data. Downloading is either through the USB socket on the front face or through the mini-USB socket on the rear face, in accordance with procedures given in the Operators Manual.

3.2 Validation of Flight Data. Validation of the data in the downloaded IGC file is by the Validation function of the Microsoft Windows-based IGC Shell system that is available without charge from the IGC GNSS web site in the file igcdll.zip.

3.2.1 IGC Shell Files. The IGC Shell files should be downloaded into a specific directory that is named in advance (the name IGCshell is recommended). For the shell program to work with a recorder, the appropriate Dynamic Link Library (DLL) file from the recorder manufacturer must be copied to the IGC Shell directory.

3.2.2 Latest versions. The latest versions of IGC Shell and the manufacturer's DLL files must be used, obtained from the IGC and GFAC web site given at the beginning of this document.

3.2.3 IGC Standard for Flight Data Validity. The IGC standard for electronic flight data is that the IGC file must pass the IGC Validate check. The Validate function of the IGC Shell program is used to interrogate the IGC file that is to be Validated. The IGC Validate procedure checks that the IGC file has correctly originated from a specific recorder and that it is identical to when it was initially downloaded. See B3.3.1.1 for more details.

4 **Engine Recording - ENL system**. A microphone-based system inside the FR automatically produces three Environmental Noise Level (ENL) numbers that are included with each fix. This is designed to highlight engine noise but to produce low ENL values in soaring flight. For flights in gliders with an engine capable of producing forward thrust, the ENL figures in the IGC file must be analysed to show that no forward thrust was produced during the claimed soaring performance.

4.1 ENL System . The ENL system in this recorder is made by Logstream and has peak sensitivity at about 200 Hz. ENL figures in each fix in the IGC file are between 010 and 999 in steps of 001 (note the Zero Noise level of 010, figures below this indicating a fault in the ENL system). For details of typical ENL values found in GFAC tests, see para B.4.

4.2 IGC-approval - Engine Types and Recorder Mounting. This document gives IGC-approval for validation of soaring performances where the engine and recorder mounting has been shown to produce high ENL values when any forward thrust is produced.

4.2.1 Cockpit Mounting. If the recorder is mounted in the cockpit this Approval applies to piston engines that give n high acoustic noise levels at the recorder, and to nose-mounted engines where the recorder is positioned close to the recorder and propeller.

4.2.2 Low-ENL Engine/Recorder installations. This approval does not include use of the ENL system with engines that produce small ENL values at the Recorder when the engine is just producing positive forward thrust. Unless the FR is mounted very close to the engine, this applies to rear-mounted electrical and jet engines, in the case of the jet 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. There are two solutions: (1) Mount the recorder close to the engine and/or propeller, or (2) If a low-ENL engine /recorder layout is to be used for flights to IGC standards of evidence, the Sporting Code provides for the use of a type of recorder with an external sensor in addition to ENL. The external sensor records in the IGC file under the MOP code and can be placed to receive a strong engine signal in low forward thrust conditions. Rules for external MOP sensors are in Annex B to the Sporting Code and the FR Technical Specification.

5 **Installation in the glider**. From the point of view of fix recording, the FR may be fitted anywhere in the glider, subject to para 4 on ENL and para 6 on security. Unless the FR has to be fitted close to the engine in order to comply with para 4.2.2, the Pilot Event (PEV) button should be within easy reach of the pilot.

5.1. **Check of Installation**. This recorder is small and light, and could easily be removed and flown in another glider or powered aircraft. There must be incontrovertible evidence that the IGC file for the Claim came from the recorder in the glider for the flight concerned, and that the FR was installed and operated in accordance with IGC procedures. This can be achieved either by independent Observation at takeoff or landing, or by sealing the Recorder to the glider at any time or date before takeoff and checking the seal after landing, see Annex B para B1.

6 **Security - Physical and Electronic**.

6.1 Physical Security. Tamper-evident seals with the recorder manufacturer's name are fitted over screws that hold the case of the recorder unit together. In addition, an internal security mechanism operates if the case is opened.

6.2 Electronic Security. If the internal security mechanism has been activated, the security record (G-record) will be altered and a line placed in the IGC file header record that includes the words "SECURITY CHECK FAILED". Also, such files will fail the IGC Validation test for electronic security. The IGC Validation test will also fail if the IGC file being analysed is different from that originally downloaded from the Recorder, even by one character in the flight data. This recorder uses RSA with a private key of 1600 bits. Firmware updates for the recorder are encrypted and the encryption key is known only to the manufacturer. The firmware state of the recorder is checked during power-up, and if corrupted or tampered firmware is detected, IGC files will still be generated but will fail the IGC Validate test (see 3.2 above and B3.3.1.1).

6.3 Recorder found to be unsealed. If either physical or electronic security is found to have failed, before it can be used again for flights to IGC standards, the Recorder must be returned to the manufacturer or his appointed agent for investigation and resealing. A statement should be included on how it became unsealed.

6.3.1 Checks before re-sealing. Whenever any unit is resealed, the manufacturer or his agent must carry out positive checks on the internal programs and wiring, and ensure that they work normally. If any evidence is found of tampering or unauthorised modification, a report must be made by the manufacturer or agent to the Chairman of GFAC and to the National Airsport Control authority (NAC) of the owner (the NAC is the National body that validates flights to IGC criteria and will normally be the National Gliding Association). The IGC approval of the individual unit will be withdrawn until the unit is re-set and certified to be returned to the IGC-approved standard.

7 **Updates and Changes**.

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

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

Ian W Strachan
Chairman, IGC 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, Email: ian@ukiws.demon.co.uk

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**NOTES FOR OWNERS AND PILOTS - PART OF IGC APPROVAL**

*A(i) Status. To be read together with the main terms of approval to which this is an Annex.*
*A(ii) IGC-Approval level. All flights including world records, see para (i-ii).*
*A(iii) Document Copy. It is recommended that a copy of this approval document is kept with the equipment concerned, for the use of pilots and OOs.*

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

A1 **GPS Antenna and other connectors**. This approval does not presently require sealing of any connectors, ports or plugs, or require stowage out of reach of the pilot(s), and no attempt must be made to pass unauthorised data into the Recorder including through the GPS antenna.

A2 **Geodetic Datum (Earth Model)**. For IGC purposes, all latitudes and longitudes must be referenced to the WGS84 ellipsoid. This type of recorder is fixed on the WGS84 datum and no selection or switching is required except to ensure that other lat/longs such as for start, turn and finish points, are also referenced to the WGS84 ellipsoid (IGC rule).

A3 **Setting the Fix Interval**. The fast-fix facility operates when the Pilot Event button on the display unit is pressed, giving 30 fixes at one second intervals. The fix interval for cruise flight between PEV events (such as between Waypoints) is set by the pilot before flight through the manufacturer's set-up program that allows fix intervals up to 60 seconds. There is therefore no need to set a very short fix interval for cruise flight because points of interest can be marked by PEV events followed by fast fixing. Setting a short fix interval for the complete flight leads to IGC files of large byte size, particularly for long flights. This uses up more of the recorder's memory, causes downloading after flight to take a long time, increases the chance of data corruption and may also cause problems with some analysis programs because of the large number of fixes that have to be processed.

A3.1 IGC rules on Fix Interval Settings. IGC rules include maximum fix interval setting of 60 seconds, 10 seconds for competitions that use the rules of Annex A to SC3. Annex C to SC3 (the OO guide) says: "10 to 20 seconds has been found to be suitable, and does not use up as much memory as a more frequent setting for the whole flight. A more frequent fix interval is recommended near a Waypoint to ensure that a fix is recorded within its observation zone".

A4 **Checking the Recorder before a Claim Flight**. Pilots are recommended to analyse IGC files from their recorder before attempting flights that will be claimed under IGC rules. It is the pilot's responsibility to ensure that the recorder is performing correctly and in accordance with this approval. For instance ensuring that GPS fixes, pressure altitude, ENL, pre-flight declarations, pilot and glider data, and other values are recorded as expected. For motor gliders, ENL values should be similar to the figures given in para B5. See also A9 on ENL and A13 on pressure altitude calibration.

A5 **Pre-flight Settings**. Electronic pre-flight declarations of Waypoints are made by uploading Start, Finish and Turn Points from Waypoint data. Before making a flight that is to be claimed and requires a pre-flight declaration, pilots are advised to check that they can successfully carry this out, and that an IGC file is produced that satisfies the Sporting Code on pre-flight declarations. During start-up, firmware checks if a USB stick is in the socket on the front face and if it contains files with declaration and other settings. If it has, the files are checked and loaded. This process can also be completed via a PC connection to the mini USB connector on the back face, through which the FR is recognised as two drives named LGS_nnn_IGC and LGS_nnn_CFG where nnn is the FR's three character identification. Files with declarations and other FR settings generated by LGSConnect application should be copied to the LGS_nnn_CFG drive. For further details, see the Operating Manual.

A6 **Observing the Recorder installation in the glider**. The pilot must ensure that an OO has checked the place of the recorder in the glider and how it is fixed to the glider.

A7 **Switch on.** Pilots are advised to switch on at least 5 minutes before takeoff and check that GPS lock-on has occurred in time to establish a baseline of fixes before takeoff. GPS lock-on is shown by the green light on the recorder.

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

A9 **Gliders with an Engine** (including self-sustainers). An microphone system inside the recorder records the level of acoustic noise at the recorder, shown in the IGC file as three ENL numbers attached to each lat/long fix. The recorder must be placed so that engine noise is clearly received when forward thrust is being produced. This recorder is small and there is the option of fitting the recorder close to the engine. The recorder must not be covered so that noise at the recorder is reduced. See also para 4 on page 3.

A9.1 Cockpit Noise. Pilots should note that cockpit noises other than the engine will produce ENL figures on the IGC file, and should avoid those that could be mistaken for use of engine. **Flight with the cockpit Direct Vision (DV) and/or ventilation panel(s) open can produce a low-frequency sound (organ-pipe note) that will register as high ENL. This is magnified if sideslip is present and at high airspeeds. Opening cockpit panels at high airspeeds and climbing with cockpit panels open should be avoided in case the ENL recorded is mistaken**

**for use of engine**. High ENL may also be produced by stall buffet and spins, particularly in Motor Gliders if the engine bay doors flutter (vibrate or move in and out). Flight near powered aircraft should also be avoided, except for normal aero-tow launches. See B4.2 for levels that have been recorded on GFAC tests by the internal FR ENL system and by external MOP systems.

A9.1.2 Pilot check of ENL figures. Pilots should check that the ENL figures produced by their recorder show a clear difference between engine-on and engine-off flight. ENL figures should be in accordance with those found in GFAC tests and listed in para B5. This may be vital on a claim flight. If ENL figures are found to be significantly different to those in para B5 when using internal combustion engines, the recorder should be returned to the manufacturer for the ENL system to be re-set.

A9.2 Low-ENL Installations. This recorder is small and if ENL with engine running is found to be too low, the recorder should be re-positioned close to the engine and/or propeller. This applies to rear-mounted electric, jet and some 4-stroke installations. In the case of Front-mounted Electric Systems (FES) the recorder should be mounted close behind the engine and it must be shown to produce high ENL when any forward thrust is generated. Otherwise, for engine and FR installations that produce low ENL figures, a recorder with a separate external MOP system is required, see para 4.2 on page 3.

A10 **After Landing**. Until an OO has witnessed the Recorder installation to the glider, the pilot must not alter the installation or remove the Recorder from the glider. The pilot must ensure that there is evidence of the landing independent of the flight recorder data, see A11 below. **Pilots are advised not to switch off the recorder for 5 minutes after landing because data needed to certify the flight may be lost if the recorder is switched off too early.**

A10.1 After-flight calculation of security. A digital signature is calculated for each IGC file. This places security codes at the end of the IGC file, which is then completed and stored in the memory ready for downloading. These codes are used to verify the integrity of the whole file at any later time by using the Validate function of the IGC Shell program.

A11 **Independent Check of Landing**. The pilot must ensure that the time and point of landing has been witnessed and recorded for comparison with IGC file data from the recorder (see para B3.1).

A12 **Switching Off**. This is by disconnecting external power.

A13 **Downloading the Flight Data**. Downloading is via either the USB socket on the front face of the recorder, or via the mini-USB socket on the back. When recording stops, firmware checks if a USB stick is present in the socket on the front face, and if it is, the last IGC files are copied to the Stick. This also happens when the FR is powered up. Downloading can also be through the mini-USB socket when it is connected to a PC, on which the recorder is recognised as two drives named LGS_nnn_IGC and LGS_nnn_CFG where nnn is the FR's three character identification. IGC files can be transferred to the PC from the LGS_nnn_IGC file. For further details, see the Operating Manual, also B3.3 for how the IGC file is handled.

A13.1 OO's actions. For a flight to IGC standards, an OO will then carry out the actions given in para B3.3.1, and the OO's copy of the IGC file will be sent to the organisation that will validate the flight, such as the National Airsport Control authority (NAC) for gliding. The OO does not personally have to transfer the data from the Recorder, but witnesses the transfer, and immediately takes or is given a copy from the USB memory stick or PC.

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

A14 **Pressure Altitude Calibration**. Pilots are advised to have a pressure altitude calibration carried out by an NAC-approved calibrator before any GNSS Recorder is used for a claimed flight performance. For the procedure, see para B6. A valid IGC file showing the pressure steps used in the calibration must be recorded and kept (Sporting Code rule). Altitude and height claims require a calibration for the flight performance concerned, and speed and distance claims need a calibration for calculating the altitude difference of the glider at the start and finish points. Also, the NAC 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 to IGC-approval document

## NOTES FOR OFFICIAL OBSERVERS AND NACs - PART OF IGC APPROVAL

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

B1 **Installation in the Glider**. This FR is small and light and could easily be removed and flown in another glider or powered aircraft, so there must be incontrovertible evidence that the FR was in the glider for the flight to be claimed. The FR can be fitted anywhere in the cockpit but should be within reach of the pilot if the PEV button is to be used. An OO shall witness and record the position of the Recorder in the glider, its type and three-character identification, the glider type and registration, date and time. Before flight, if requested, the OO shall then seal the Recorder to the glider in a way acceptable to the NAC and to IGC, and such sealing may be at any time or date before flight. If sealing is not used, either a pre-flight check of the installation must be made after which the glider must be under continuous observation by an OO until it takes off on the claimed flight, or an OO must witness the landing and have the glider under continuous observation until the Recorder installation is checked. This is to ensure that the installation is as previously inspected, and that the data transfer (B3.3) is from the correct Recorder.

B2 **Takeoff - Independent Evidence**. 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.

B3 **Landing**

B3.1 Independent Evidence of Landing. 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 data from the FR.

B3.2 Checking the Installation. As soon as practicable after landing, an OO shall inspect the installation of the Recorder in the glider including any sealing to the glider of the Recorder, so that this can be compared to the check described in para B1 above.

B3.3 Downloading the Flight Data. The IGC file for the flight is downloaded either to a USB stick or a PC. Security of downloaded IGC files is maintained by electronic coding placed by the FR on the file which can then be checked at any time later. See para B4 for how this is done.

B3.3.1 Files Produced. This will produce an IGC file with the name style 2015-10-27-LGS-XY4-03.IGC, for 27 October 2015, Logstream, FR serial XY4, flight 3 of the day. The full description is in Appendix A to the IGC FR Specification.

B3.3.2 OO's Copy. A copy of the IGC file must be retained securely by the OO such as by immediately copying it to a separate memory stick or the OO's own PC. The IGC file must be retained by the OO for later checking and analysis under NAC procedures. The OO must be able to positively identify the flight data file as being from the flight concerned, and takeoff and landing data independent of the IGC file must also be available, see B2 for takeoff and B3.2 for landing.

B3.3.3 Competitions. Different rules may apply for competitions, for which pilots may be allowed to download their own flight data and take it to Competition Control on portable storage media such as a USB stick or memory card, or a central competition data transfer facility may be used. For ease of identification within the competition, file names may be changed, for instance to the glider competition number or the pilot's name. Data within the file is till secure and may be checked at any time by using the Validation process described in B4. However, for flights that are to be Validated to IGC rules, normal IGC procedures continue to apply including OO supervision of download after flight and secure storage of flight data independent of the pilot until the flight is Validated by the appropriate organisation.

B4 **Validation of and Analysis of Flight Data Files**. Before a Flight Performance is officially validated, the authority responsible for validation must check that the data in the IGC file has originated from the Recorder concerned, and is identical to the file that was downloaded from the Recorder to the PC. This is done by checking the IGC file with an current copy of the IGC Shell program and using the Validate function in the menu (see below). The Recorder manufacturer's DLL file is needed in the IGC Shell directory. The shell program and DLL file must be the same as those on the current GFAC or IGC web site at the beginning of this document. A Data Analyst approved by the NAC shall carry out the IGC Validation check on the IGC file and then evaluate the flight data using an analysis program approved by the NAC concerned.

B4.1 IGC Shell Program. Download the IGC Shell program from the GFACor IGC web pages and place all the files in one directory. For the shell program to work with a particular Recorder, the appropriate Dynamic Link Library (DLL) file from the recorder manufacturer must be copied to the IGC Shell directory. After copying it to the directory that contains the IGC Shell files, execute IGCshell.EXE. Set the path to the IGCshell directory using the "Set Directories" button on the screen. The IGCshell menu will now appear in a grey rectangular box with 9 software buttons for selecting the recorder type, recorder settings and flight logs. The recorder software box at the top should include the line "*Logstream 1.0*" (or a later version), and this should be selected.

B4.1.1 Validation of IGC files. Select the FR Manufacturer's logo from the top menu box (as above), press the "Validate" button and select the IGC file to be checked. If successful, the message "File has been successfully validated" appears. If there is a security problem, the message "Integrity Bad" or "Validation check failed" appears, together with a likely reason.

B4.1.2 Latest File Versions. The latest versions of the IGC shell and DLL files must be used. These can be obtained from the GFAC or IGC web sites for listed on the first page of this document.

B5 **Means of Propulsion Record - Gliders with Engines**. For recording engine noise at the recorder, the Environmental Noise Level (ENL) system inside the FR is used, see para 4 on page 3 of this document. A microphone-based system produces three ENL numbers between 010 and 999 that are added to each lat/long fix in the IGC file. For engine and FR installations where ENL figures are too low to distinguish between engine running and other noises (such as with rear-mounted electric and jet engines), either the FR should be installed close to the engine or a type of FR used that has an external sensor operating under the MOP code and connected by cable to the FR so that it can be positioned to receive a strong signal whenever the engine produces forward thrust.

B5.1 ENL - General. With piston engines it is normally easy to see when the engine has been running and when it has not. Other data such as rates of climb and groundspeed, will indicate whether energy is being added other than during soaring. Short term peaks in ENL (10 seconds or so) may be due to factors such as undercarriage and/or airbrake movement, sideslip, open DV panels (particularly with sideslip), the nearby transit of a powered aircraft, etc. If in doubt, email the IGC file to the GFAC Chairman for further analysis and advice (see page 3 for email address).

B5.1.1 ENL during Launching. During winch and aerotow, higher ENL values are expected than when soaring, and 250 has been recorded for winch and 400 for aerotow. During the initial ground roll, short-term higher values may be recorded due to wheel rumble or tyre squeak.

B5.1.2 ENL during Engine Running. An ENL value of 999 has been produced with a two-stroke engine running at full power and 800 with a 4-stroke engine at high power. At power for level flight, ENL values of 700 have been recorded. During engine running, these figures are produced for a significant time, and when altitude and speed are analysed it can be seen that energy is being added that is not associated with soaring. Tests with Wankel (Rotary) engines indicate that they produce similar ENL values to 4-strokes.

B5.1.3 Engine and FR Installations producing Low ENL Values. See para 4.2 2 on page 3. . However, this FR is small and can be fitted close to the source of engine and propeller noise (although this could men that the PEV button cannot be used and a faster cruise fix rate should therefore be set).

B5.1.4 ENL during Gliding Flight. ENL readings between 010 and 050 indicate slow-speed gliding flight in a well-sealed cockpit. However, flight with the canopy panel(s) open produces extra noise inside the cockpit. ENL values up to 200 have been produced when thermalling with cockpit panels open. With sideslip or at higher speeds, a loud low frequency noise can be produced ("organ-pipe" effect) and ENL readings of up to 400 have been recorded. High ENL may also be recorded during stalling and spinning, particularly if the engine doors flutter or vibrate (move slightly in and out due to stall buffet, producing a clattering noise). Finally, where the engine is mounted on a retractable pylon, a high ENL reading will be shown if flying with the pylon up and engine not running, due to the high aerodynamic noise.

B5.1.5 ENL during the Approach to Land. ENL values are always higher on a landing approach due to aerodynamic noises due to airbrakes, undercarriage, sideslip, turbulence, etc. Short-term peaks due to specific actions such as opening airbrakes, lowering undercarriage, etc., will be noted as well as a generally higher level of ENL because the glider is no longer aerodynamically clean. With this type of recorder, ENL values up to 450 have been recorded on approach with cockpit panels open.

B5.1.6 ENL during landing. During ground contact during landing, short-duration ENL readings of up to 700 have been recorded, probably due to wheel rumble, or tyre squeak on landing on a hard surface.

B6 **Altitude analysis and calibration**. IGC files must be analysed using Sporting Code procedures. Part of this is to compare the general shapes of the GNSS and pressure altitude fix records with time, to ensure that no major differences are seen that could indicate malpractice or manufactured (false) data. As part of this process, the Recorder must be calibrated in an altitude chamber in accordance with Annex C to the Sporting Code.

B6.1 Calibration Method and Producing a Calibration Table. The FR should first be set to a fast fix rate. No GPS fixes are required for a pressure altitude trace to be produced, and recording starts after a pressure change of 1 metre per second for 5 seconds. The calibrator should therefore make a short pressure change to trigger recording before starting the calibration itself. The calibrator will record the pressure steps used for later comparison with the IGC file. The stabilised pressure immediately before the altitude is changed to the next level, will be used for the calibration table unless the calibrator certifies otherwise.

B6.1.1 After Calibration. After the calibration, the IGC file containing the pressure steps is transferred to a PC; this may be done by an NAC-approved person other than the calibrator if the calibrator does not have this knowledge. The calibration IGC file will then be analysed and a correction table produced and authenticated by an NAC-approved person (for instance an OO or FR Data Analyst). The correction table will list true ICAO altitudes against those recorded. This table can then be used to adjust pressure altitudes recorded during flights that require correction before validation to IGC criteria. Altitudes that need correcting to true ICAO figures include takeoff, start and landing altitudes so that "altitude difference" can be calculated and compared with independently-recorded QNH readings, also low and high points for gain-of-height and altitude claims. Up to an altitude of 15,000 metres, pressure altitude figures must be used for IGC altitudes, although proof of flight continuity (no intermediate landing) can use GNSS altitude if pressure altitude is not available. The IGC file for the calibration must be kept with the calibration paperwork. If the IGC file has a nominal date/time (because of the absence of GPS lock), the file name can be changed to one that can be identified as the calibration. Also, a text editor can be used to add a realistic date and time in the file itself, although this will mean that the Validation check will fail and the original IGC file must also be kept unaltered so that it can be Validated later if required.

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 regional Enhancement Systems such as EGNOS for Europe or WAAS for North America. Altitude accuracy will not be as good as accuracy in lat/long, because satellite geometry is not as favourable for recording altitude compared to horizontal position. This effect may be increased by poor antenna positioning or interference from other glider systems. Data analysts should allow for the above when comparing the GPS altitude and pressure altitude records. Lat/long fix accuracy is generally not affected. From GFAC tests over many years the average lat/long error from a moving vehicle at a number of accurately-surveyed ground points in average reception conditions is between 11 and 12m, better in good reception conditions.

B6.3 Maximum Altitudes Recorded in the IGC file. The GPS system is capable of recording to almost unlimited altitudes, certainly up to 30km/100,000ft. The pressure altitude sensor is also capable or recording to high altitudes, although as air density reduces at height, a small pressure step becomes a large altitude difference. However, the type of processor in the recorder and the need for good resolution (small 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.

B6.3.1 Pressure Altitude. Pressure altitude is recorded up to 15 km (49,213 ft).

B6.3.2 GNSS Altitude. GPS altitude is recorded up to 18 km (59,055 ft).

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