GNSS FLIGHT RECORDER APPROVAL COMMITTEE (GFAC)
FAI INTERNATIONAL GLIDING COMMISSION (IGC)
of the
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References: See para (i-iv) below

To: IGC GNSS web site under "IGC-approval Documents"
 GFAC Chairman's web site
 FR Manufacturer, info to igc-news@fai.org, newsgroup rec.aviation.soaring   Date of issue: 27 October 2020

IGC-APPROVAL FOR GNSS FLIGHT RECORDER
Recorder Name: FLARM-IGC V1.0
Level of Approval: IGC Level 3 - see para (i-ii) below

(i) General. This document gives formal approval from the above date for the Flight Recorder(FR) equipment described below to be used for validation of flights under the FAI Sporting Code Section 3 (Gliders and Motor Gliders), subject to the conditions and notes given later. IGC reserves the right to alter this approval in the future. Only the terms of the latest IGC-approval documents currently posted on the IGC web site are valid for use for IGC/FAI claims. IGC reserves the right to alter this approval in the future.

(i-i) Document Versions and Scope. The initial IGC-approval document was dated 10 March 2008 and an update dated 15 May 2012 notified that a program had appeared on the web that enabled false Flarm-IGC flight files to pass the IGC electronic Validation check. This was corrected in the update of 14 February 2013 (see para 3 below). Reference to the FAI/IGC web site and manufacturer details at the top of page 2 were updated on 1 February 2020. The version dated 20 May 2020 included a new para (i-iv) with directions to the current web sites for documents related to the FR IGC-approval process, and the GFAC Chairman's new email address on page 4. This version updates the Flarm DLL file used to Validate IGC files.

(i-ii) IGC-approval Level. This is IGC level 3 - flights for IGC Silver and Gold badges, and the three Diamonds. This type of recorder can also be used in gliding competitions in which the organisers allow this level of IGC-approval. 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 FR is the US NAVSTAR Global Positioning System (GPS).

(i-iv) Current web sites. References for the latest versions of documents relating to IGC-approval of FRs (including the latest version of this document) are given in para 2 on page 1 of the main table that lists all IGC-approvals. The latest version of the table is available through <www.fai.org/igc-documents> and the GFAC Chairman's web site <www.ukiws.uk/GFAC>. The detailed references are placed in the main FR table rather than in each IGC-approval document, so that if the reference changes, only the main table has to be updated rather than all IGC-approval documents.

(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 traffic alert, proximity-warning and/or anti-collision functions. This document does not constitute any approval, guarantee and/or any statement by GFAC, IGC and/or FAI as to the reliability or accuracy of the equipment for operation in flight and any liability in connection therewith is hereby expressly excluded.

(iii) This approval is not concerned with, and FAI has no responsibility for, matters related to: (a) Intellectual Property (IP) and Intellectual Property Rights (IPR) and/or, (b) the relations of the Manufacturer listed below with any other entities except with FAI and its agents or as they affect FAI, its agents and this approval.

(iv) The attention of National Airsport Control (NAC) authorities, officials and pilots is drawn to the latest edition of the FAI Sporting Code Section 3 (Gliding) including its annexes and amendments. Annex A to this code (SC3A) deals with competition matters, annex B to the Code (SC3B) with equipment used in flight validation, Annex C to the Code (SC3C) with guidelines and procedures for Official Observers, pilots, and other officials involved in the flight validation process. Copies of all of these documents may be obtained from the FAI/IGC web sites listed above and links are provided from the IGC web site. A separate document published by FAI is entitled "Technical Specification for IGC-Approved Flight Recorders" and is also available through the IGC/GNSS web site shown above.

(v) It is recommended that a copy of this approval including its two annexes is kept with each unit of the equipment so that it is available for pilots and Official Observers.

MANUFACTURER

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IGC-allocated manufacturer codes: Three letter FLA, single letter G

Note: This IGC-approval only refers to Flarm units from the above company and that conform to the terms of this document. For other Flarm units including those produced under license by other companies or fitted as modules in equipment from other companies, separate IGC-approval documents apply where such units have been tested and confirmed to be to the IGC standard.

1. **HARDWARE**

1.1 **Recorder Name**. FLARM-IGC V1.0. In the header record of IGC files, given as: "HF FTY FRType: Flarm-IGC"

1.2 **Hardware Version**. Version 06 was the original IGC-approved hardware standard. Earlier versions refer to previous standards of FLARM recorders before IGC-approval. Hardware Version 05 may also be used if firmware has been updated to the IGC standard (see under Firmware below). The Hardware Version number is shown in the header record of IGC-format flight files in the form "HF RHW HARDWARE VERSION: Flarm-IGC06 " which can be seen by using a text editor to view the start of the IGC file. See para 11 below for later Versions.

> 1.2.1 Fabrication Numbers. Before an IGC-approved standard was agreed, several thousand Flarm units were made and operated. A modification programme allows these to be updated to the IGC-standard described in this document. The original Fabrication number that refers to the original factory production, is prefixed "F", is marked on the case and is retained after any update. This is NOT the IGC Serial for the recorder, which is a unique three-character group that appears on the case and in the name and header record of the IGC file. In the Fabrication number, the first number after the letter F shows the original production status as follows: F5xxxx = vertical bar display and TIM-LP GPS; F6xxxx = round two-colour LED display and TIM-LP GPS; F7xxxx = round two-colour LED display and LEA-4P GPS.

1.3 **Dimensions, Weight, Power Source**. The recorder unit is in a hard black plastic case 110 x 75 x 24mm in size and weighs about 135 grammes without external cables. It is powered from an external DC source between 12 and 24 Volts and has no internal battery.   When power is off, data is stored in flash memory and is retrieved when power is re-applied.

1.4 **Connectors and lights.**   One of the 75 x 24mm end faces has a connector for the GPS Receiver (RX) antenna (AE) and two multi-pin sockets, described in more detail later in para 4. On the other end face is a button and a series of lights designed to show the direction of other aircraft from which signals are received and are also equipped with Flarm. In hardware V06 and later a micro-SD card slot is on the end face and the lights include four vertical status lights and 12 others arranged in a circle. In V05 hardware 10 lights are arranged in a horizontal bar. A connector to a transmit and receive (TX/RX) AE is on the 110 x 75mm top face. This AE transmits 3D position and other information to other compatible units that are in range and receives their GPS position and other information so that relative position can be calculated.

1.5 **GPS receiver**. A 16-channel GPS receiver by u-blox of Switzerland (www.u-blox.com) is fitted and hardware version 7 has the LEA-4P receiver, earlier versions have the TIM-LP. The type of receiver is shown in the header record of IGC files in the form "HFGPS: u-blox LEA-4P" which can be seen by using a text editor to view the start of the IGC file.

1.6 **Pressure altitude sensor.**   A MS 5534A or MS 5534B Pressure Altitude sensor by MEAS Switzerland SA, formerly Intersema Sensoric SA (www.meas-spec.com) is fitted. This is compensated for temperature variation and calibrated to the ICAO ISA. ICAO ISA. It is shown in the header record of IGC files in the form: "HF PRS PressAltSensor: Intersema MS5534". The recorder case is not pressure-sealed and "cockpit static" pressure is recorded on the IGC file.

1.7 **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.

> 1.7.1 Flarm Traffic Alert function. The Flarm Traffic Alert (Proximity Warning) function is not part of this IGC-approval, which concerns only the recording function. Users of the Traffic Alert function are advised to check their National regulations before using it. FAI, IGC and GFAC have no responsibility or liability for such use.

1.8 **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.** This approval refers to firmware version 5.08 or later. The version is listed in the header record of IGC files in the form: "HF RFW FIRMWARE VERSION:Flarm-IGC5.08". This can be seen by using a text editor to view the start of the IGC file. Version 4.0 was the original firmware standard but IGC-approval was withdrawn in March 2013 from firmware versions less than v5.08.

3. **SOFTWARE.** Downloading of flight data is either through the micro-SD card fitting on the case, through the IGC Shell system (available from the IGC GNSS web site, see B3.1.1), or through the latest version of the FR Manufacturer's flarmTool software (the latter two methods are for early FRs without the micro-SD card receptacle). In April 2012, software appeared on the web from an unknown source that enabled false Flarm-IGC files to be produced that passed the IGC electronic validation check (para 3.3 below). Flarm-IGC firmware with improved security was made available through a web-based download, see para 2 above. Pilots are advised not to delete the flight data from the FR memory until the IGC file validation process is complete, so that in the event of a query a further download can be made from the FR by an OO.

3.1 **Latest IGC Shell versions**. The latest versions of the files in IGC Shell.zip and the manufacturer's DLL files must be used, obtained from the IGC GNSS site for software given at the beginning of this document.

3.2 **Free availability**. The IGC Shell program is free and the manufacturer's DLL file is freeware. 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 Data Link Library (DLL) file from the recorder manufacturer must be copied to the IGC Shell directory. For this recorder, the file IGC-FLA.DLL is available on the IGC GNSS web site.

3.3 **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 Validate function of the IGC Shell program together with the IGC-FLA.DLL 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 B3.3.1.1 for more details. Particularly until the security update (para 3 above) is made, because of the possibility that a false IGC file could be produced and continue to pass the Validate check it is essential that downloading of IGC files is under strict OO and/or NAC control and such files are kept securely at all times so that unauthorized persons cannot gain access to them. It must be able to be shown that the IGC file that is used to Validate the flight was securely kept between initial download and Validation. Independent evidence on takeoff and landing data (8.1 below) is even more important than before, and the equivalent data in the IGC file used for flight Validation must agree with the independent evidence.

4 **Connections to the Recorder.**

4.1 GPS Receiver Antenna.   A circular MCX push-pull female connector of 3mm diameter is on the end face of the recorder opposite the display lights. The antenna cable has a MCX male connector of 5mm diameter, narrowing to 3mm where it fits into the recorder unit.

4.2 RJ-45 connector. An 8-pin RJ-45 socket is on the same face as the antenna connector. This is used with a manufacturer's cable with IGC-standard wiring. This cable includes connections for 12-24V external power and may also have a connector for upload and download of data to and from the recorder or for connecting to other modules such as remote displays and PDAs.

4.3 6-pin RJ-11 connector. A 6-pin RJ-11 socket on the recorder case is between the antenna and RJ45 connectors and is for connecting other modules such as remote displays. Such modules are outside the scope of this document and are a matter between the manufacturer and the customer.

4.4 Micro-SD Card. In Hardware versions 06 and later, a 11 x 14mm micro-SD (Secure Digital) card slot is next to the Flarm circular display lights on an end face of the unit. This is used for downloading flight data and other functions such as making pre-flight declarations, updating the obstacle database and traffic alert firmware. In the case of pre-flight declarations the date/time stamp in the IGC file is applied when the recorder is next switched on and locked to a GPS signal.

4.5 Traffic alert function - transmit/receive antenna. A 6mm diameter SMA screw fitting is for the Flarm traffic alert transmit and receive (TX/RX) antenna.

5 **Security of the Equipment**. When Firmware V5.8 is fitted (see para 2 above) and the IGC file downloaded from the FR passes the IGC electronic Validation test (para 3 above), GFAC is presently satisfied with the electronic security of the recorded flight data at the "diamond" level of IGC-approval (para (i-ii) on page 1 for IGC-approval levels). Also see paras 8.1 and 8.2 on security seals. 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 7.4 on ENL and para 8 on sealing. However, the position of any displays, lights and operating buttons and controls used in flight in single-seat gliders should not be remote from sight-lines used for pilot lookout and scan for other aircraft and gliders.

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

   7.1 ENL Recording System Manufacturer. The ENL system in this recorder is made by Triadis Engineering (Switzerland), see www.triadis.ch.

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

   7.3 ENL IGC-approval - Engine Types. This document gives IGC-approval for the use of the above system for the validation of glide performances to IGC standards of evidence when flown with Motor Gliders that have piston engines that give substantial ENL values from the Recorder.

      7.3.1 Low-ENL Engine/Recorder combinations. This approval does not include cockpit mounting of the FR when used with engines that produce small ENL values 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 (Means of Propulsion) code, in accordance with Annex B to the Sporting Code for Gliding, para 1.4.2, particularly 1.4.2.4.

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

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

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

   8.1 Observation of Installation before Takeoff or at Landing. For independent Observation, either a preflight check of the installation must be made by an IGC Official Observer (OO) and 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 within the rules, and that another Recorder has not been substituted before the data is transferred to a PC after flight. Takeoff and landing data in the IGC file used to Validate the flight must be compatible with independent evidence of takeoff and landing.

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

9 **Security - Physical and Electronic**.

9.1 Physical Security. A tamper-evident seal with the manufacturer's name is fitted over one or more of the case securing screws. In addition, an internal security mechanism detects if the internal modules inside the case have been tampered with.

9.1.1 Sealing of data ports and connectors: 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, the security record (G-record) will be removed from subsequent IGC files 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 (see para 3 above). This test will also fail if the IGC file being analysed is different from that originally downloaded from the Recorder, even by one character in the flight data area. Firmware updates are encrypted and the encryption key is known only to the manufacturer. Firmware updates are either for the recorder function or the traffic alert function, and only the recorder function is part of this IGC-approval. The firmware state is checked during power-up. If corrupted or tampered firmware is detected, an error code (0x066) is displayed on any PDA that is connected and the recorder or traffic alert function (as appropriate) will not operate.

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

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

10 **Manufacturer's Changes, later Versions of Hardware, Firmware and Software**. Notification of any intended change to hardware, firmware or software must be made by the manufacturer to the Chairman of GFAC so that a decision can be made on any further testing which may be required to retain IGC-approval for the change. This includes changes of any sort, large or small. It includes details of later Versions of hardware, firmware and software, also any changes to modules such as GPS receiver boards, pressure altitude transducers and anything related to either physical or electronic security. If in doubt, GFAC should be notified so that the responsibility for any possible action passes from the manufacturer to GFAC.

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

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NOTES FOR OWNERS AND PILOTS - PART OF IGC APPROVAL

A(i)   Status. To be read together with the main terms of approval to which this is an Annex.
A(ii)   IGC-Approval level. See page 1 heading "Level of Approval".
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.

Security of IGC flight data files: See para 3 in the main part of this document.

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

A1 **Antenna**.   The MCX fitting is removed with a straight pull and there is no screw or bayonet fitting to undo. Care should therefore be taken not to put the fitting under tension so that it could pull off accidentally.

> A1.1 Reception. The antenna should be positioned to give sufficient signal strength for fix recording. No deliberate attempt must be made to inject data via the antenna.

A2 **Geodetic Datum (Earth Model)**. This type of recorder is fixed on the WGS84 Earth Model and no selection or switching is required except to ensure that other lat/long data such as for start, turn and finish points, is entered also to the WGS84 Geodetic Datum (IGC rule).

A3 **Setting the Fix Interval**. The fast-fix facility operates when the button on the end face with the display lights, is pressed. This gives 60 fixes at one second intervals after the PEV event. 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 provided by the manufacturer. 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 of the recorder's memory, causes downloading after flight to take a long time, increases the chance of data corruption and may also cause problems with some analysis programs because of the large number of fixes that have to be processed.

> A3.1 IGC rules. IGC rules on fix intervals 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 a Waypoint to ensure that a fix is recorded within its observation zone".

A4 **Checking the Recorder 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. It should be ensured that Pre-flight declarations (their content and the recorded time of declaration), GPS fixes, pressure altitude and ENL values are recorded as expected. Also, 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 **Observing the 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 **Takeoff**.

> A6.1 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 starts.

> A6.2 Independent evidence of Takeoff. 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 this recorder, see para B1.2.

A7 **Connection to Ports**. Although this approval does not presently require sealing of any ports or plugs, no attempt must be made to pass unauthorised data into the Recorder. See para 9.1.1 in the Conditions of Approval.

A8 **Use in Motor Gliders** (including self-sustainers): The internal microphone and associated circuitry automatically records the level of acoustic noise at the recorder. This is recorded in the IGC file with each fix. The recorder must be placed so that high ENL values are recorded when the engine is giving power and must not be covered or insulated (even so, automatic gain should continue to ensure high ENL readings under engine power). See also para 7 in the main body of this document, particularly 7.3 on low ENL figures for some combinations of engine and recorder position.

> A8.1 Cockpit Noise. Pilots should note that cockpit noises other than the engine will produce ENL figures on the IGC file, and should avoid those that could be mistaken for use of engine. **Flight with the cockpit Direct Vision (DV) and/or ventilation panel(s) open can produce a low-frequency sound (organ-pipe note) which will register as high ENL. This is magnified if sideslip is present and in particular at high airspeeds. High airspeeds 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 for normal 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.

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, see A9 below. **Pilots are advised not to switch of the recorder for 5 minutes after landing, otherwise flight data may be lost if the recorder is switched off too early.**

> A9.1 After-flight calculation of security. After landing, the recorder calculates a digital signature for the IGC file for the flight. This process places security codes at the end of the IGC file for the last flight, which is then complete and stored in the memory ready for downloading. These codes are used to verify the integrity of the whole file at any later time by using the Validate function of the IGC Shell program with the IGC-FLA.DLL file in the same directory.

A10 **Independent Check of Landing** - The pilot must ensure that the time and point of landing has been witnessed and recorded for comparison with IGC file data from the recorder (see para B2.1).

A11 **Switching Off**. This is by switching off the external power or disconnecting the RJ45 connector from the recorder.

A12 **Downloading the Flight Data**. See para 3 in the main body of this document. The OO will carry out the actions given in para B3.3, and the OO's copy of the transferred flight data will be sent to the organisation that will validate the flight, such as the National Airsport Control authority (NAC). The OO does not personally have to transfer the data from the Recorder, but witnesses the transfer and takes or is given a copy on electronic media. Different rules may apply for competition flights, for which a central data transfer facility may be used, but for a flight to the rules for IGC records and badges, the above continues to apply.

> 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, such as by easy access to the IGC Shell program with the IGC DLL file for this recorder in the same directory. 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, such as on portable media such as a USB memory stick, diskette or equivalents.

A13 **Calibration of Barograph Function**. Pilots are advised to have a barograph 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-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.

A14 **Caution – microSD Card**. The microSD card is very small (11 x 15 x 1 mm) and light (0.4 grammes). It is very easy to lose. If it is removed from the recorder by pressing lightly on it and then releasing it, the card can spring out from the recorder and travel up to 2 metres. The card could then be very difficult to find, particularly if this occurs on a grass airfield.

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.*   *See page 1 heading "Level of Approval".*
B(iii)   *Copy of this document.*   *It is recommended that a copy of this approval document is kept with the equipment, for the use of pilots and OOs.*

General: Security of the FR and data in IGC files: See para 3 in the main part of this document. Also, OOs and other persons validating flight performances should bear in mind that no security system or design is completely proof against malpractice or even attempts to produce false data, and should carefully cross-check the data in the IGC file for which there is also independent evidence from other reliable sources (examples, B2, B3.1). In the past, false files have been artificially manufactured for several types of IGC-approved FRs, and flight validators should be alert to this possibility. Any anomalies in data or cross-checks should be reported to the NAC and the GFAC Chairman.

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 OO shall witness and record the position of the Recorder in the glider, the type and serial number of the Recorder, the glider type and registration, date and time. Before flight, if requested, the OO shall then seal the Recorder to the glider in a way acceptable to his NAC and to IGC, and such sealing may be at any time or date before flight. If sealing is not used, either a preflight 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. Alternatively, an OO must witness the landing and have the glider under continuous observation until the Recorder installation is checked. This is to ensure that the installation is correct, and another Recorder has not been substituted in the glider before the data transfer (B3.3). See para 8 of 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.

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 landing data from the Recorder.

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. See para 3 of the main body of this document and use either the micro-SD card (if fitted) or a PC. The flight data may be transferred at the glider without disturbing the installation of the Recorder. In the case of the SD-card, the last IGC files are automatically transferred to it by the recorder and a card reader can then be used to copy them to a PC, before re-fitting the SD card to the recorder. If neither the micro-SD card nor a portable PC is 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 is then independently checked later at the NAC (and at FAI if the claim goes to them), see also para 3 of the main part of this document on security of IGC files.

B3.3.1   Method: Use either the micro-SD card or the RJ45 connector with a cable wired to the IGC RJ45 standard. The IGC RJ45 wiring standard branches to a female 9-pin RS232 plug for connecting to a PC and 12–24 volt power connections to power the recorder. The micro-SD card is in the end of the recorder that also has the button and lights. If the manufacturer's instructions are followed, the IGC flight data files should automatically appear on the card. If using the RJ45 connector, the free IGC Shell program is needed. For the Shell program, download the program from the IGC GNSS web pages under "software" and place all the files in one directory (the name IGC Shell is recommended). These files are available on the IGC GNSS web pages through the file IGC Shell.zip. 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. After copying it to the directory that contains the IGC Shell files, execute IGC-SHELL.EXE. Set the path to the IGCshell directory using the "Set Directories" button 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 now include the line "Flarm Technology 1.5". This should be selected. With the recorder connected to the PC and the correct Com Port selected on the IGCshell screen, selections for data Download and Validation can now be made using the screen buttons provided. You can now download the flight data which appears directly in IGC format.

B3.3.1.1   Validation of IGC files. With the recorder connected to the PC and the IGC Shell program menu selected, select the manufacturer from the top menu box, press the "Validate" button and select the IGC file that is to be checked. If successful, the message "File has been successfully validated" appears if security has been breached the message "Validation check failed" appears with a likely reason. Also see para 3 of the main part of this document on security of IGC files.

B3.3.1.2   Latest File Versions. The latest versions of the IGC shell and DLL files must be used. These can be obtained from the IGC GNSS site for software listed at the beginning of this document. The file IGC-FLA.DLL is available on the IGC GNSS web site and incorporates the January 2013 security update (IGC-FLA.DLL was the pre-update standard).

B3.3.2 Files Produced. This process will automatically produce an *.IGC-format ASCII flight data file with the file name YMDMXXXF.IGC, where Y=year, M=month, D=day, E= manufacturer, XXX = Recorder Serial Number/letters and F = flight number of the day (full key, Appendix 1 to the IGC GNSS Recorder Specification, copied in Annex C to the Sporting Code, SC3C).

B3.3.3 OO's Copy. A copy of the IGC file shall be retained securely by the OO such as by immediately copying to a separate memory stick, PC card, or the hard disk of the OO's PC. The IGC file shall be retained by the OO in safe keeping for later checking and analysis under NAC procedures. Also see para 3 of the main part of this document on security of IGC files. For Validation of the flight, the OO must be able to positively identify the IGC file as being from the flight concerned (for this purpose, takeoff and landing data independent of the IGC file must also be available, see above in B2 and B3.1).

B3.3.4 Competitions. Different rules may apply for competitions, for which a central data transfer facility may be used (also see para 3 of the main part of this document on security of IGC files). For ease of identification within the competition, file names may be changed, for instance to the glider competition number or the pilot's name, but the flight data inside the file must be un-altered and pass the IGC electronic Validation check described in B3.3.1 above that checks its structure and integrity.

B4 **Analysis of the IGC file by the Authority that validates the Flight Performance**. 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 a PC. This is done by checking the recorder details and serial number with the local OO and checking the IGC file with a current copy of the IGC Shell program and using the Validate function in the IGC Shell menu. The manufacturer's DLL file will also be needed in the IGC Shell directory. The shell program and DLL file must be the same version as those on the current FAI/IGC web site for software at the beginning of this document. A Data Analyst approved by the NAC shall carry out this IGC Validation check on the IGC file and then evaluate the detailed flight data using an analysis programme approved by the NAC concerned (list, see the IGC GNSS web site under SOFTWARE).

B4.1 Method for Validation of IGC file data. Use the IGC Shell program together with the manufacturer's DLL as explained in B3.3.1 above. Scroll to the IGC file to be checked and use the Validate software button.

B5. **Means of Propulsion (MoP) Record - Motor Gliders**. The MoP must either be sealed or inoperative, or the built-in Engine Noise Level (ENL) system used. This has a microphone in the recorder that enables the acoustic noise at the recorder to be transformed into three numbers that is added to each fix on the IGC file. ENL values recorded on GFAC tests are given below, in the sequence of a flight. For Low-ENL recorder/engine combinations, see para 7 in the main body of this document.

B5.1 ENL during launching. During winch and aerotow launches, higher ENL values are to be expected than when soaring (B4.3), typically up to 180 for winch and 150 for aerotow. During the ground roll, short-term higher values have been recorded, probably due to wheel rumble, and values of 300 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. Previous tests with Wankel (Rotary) engines indicate that they produce similar ENL values to 4-strokes.

B5.2.1 Low-ENL engines. This approval does not include use with Motor Gliders with electric or other engines that produce low ENL values at the recorder. For these, see Para 7 in the Conditions of Approval.

B5.3 ENL during gliding flight. ENL readings of less than 030 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 150. 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 150 have been recorded, although 080 is more typical.

B5.5 ENL during landing. During ground contact during takeoff and landing, ENL readings of up to 550 have been recorded, probably due to wheel rumble. 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 Recorder is calibrated in an altitude chamber in the same way as a drum barograph.

B6.1 Calibration method, making a calibration table. For a pressure altitude calibration, the GPS antenna must be disconnected before power is applied. When recording, this is detected and puts the recorder in calibration mode with a fix interval of 1 second. Recording starts after a pressure change of 1 metre per second for 5 seconds, and no GPS fixes are required for a pressure altitude trace to be produced. Without GPS lock, a nominal date/time will be recorded in the IGC file and in the file name. The calibrator should be advised to make a short pressure change to trigger recording before starting the calibration itself. The calibrator will record the pressure steps used, for later comparison with the flight file. The stabilised pressure immediately before the altitude is changed to the next level, will be taken as the appropriate value unless the calibrator certifies otherwise.

B6.1.1 After Calibration. After the calibration, the data file containing the pressure steps is transferred to a PC as if it was flight data (see B3.3 above); this may be done by an NAC-approved person other than the calibrator who may not have this knowledge. The IGC format calibration data file will then be analysed, compared to the calibration pressure steps, and a correction table produced and authenticated by an NAC-approved person (for instance an OO or GNSS Recorder Data Analyst). The correction table will list true against indicated altitudes. This table can then be used to adjust pressure altitudes which are recorded during flight performances and which require correction before validation to IGC criteria. These include takeoff, start and landing altitudes for altitude difference and for comparison with independently-recorded QNH readings, and low and high points on gain-of-height and altitude claims. Only pressure altitude is valid for IGC altitude purposes except for proof of flight continuity (no intermediate landing) where GNSS altitude may also be used. and the file should be kept with the calibration paperwork so that it is not confused with other calibration files. As the original IGC file will have a nominal date/time, the file can be copied and the file name changed to one that can be identified as the calibration. A text editor can be used to change add a realistic date and time, although this will mean that the Validation check will fail and the original IGC file must also be kept unaltered.

B6.2 GPS altitude figures recorded in the IGC file. Occasional short-duration differences in the shape of the GPS Altitude/time graph have been noted compared to the pressure altitude figures. This is not unusual with GPS receivers operating without a local differential beacon. The altitude accuracy from satellite-based systems will not be as good as accuracy in lat/long, because satellite geometry is not as favourable for obtaining accurate altitude fixes compared to horizontal position. This effect may be increased by less-than ideal antenna positioning in some gliders. Data analysts and NAC officials should allow for the above when comparing the GPS altitude and pressure altitude records. Lat/long fix accuracy is not affected and tests on this recorder show it to be typical of that for a 12 channel GPS system. From GFAC tests after 1 May 2000 when the GPS Selective Availability accuracy reduction system was removed, the lat/long error taken from a moving vehicle at a surveyed point in average reception conditions, shows an average error of between 11 and 12m for all recorders tested since that date.

B6.3 Maximum Altitudes Recorded in the IGC file. The GPS system is capable of recording to almost unlimited altitudes, certainly up to 30km/100,000ft. 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 altitudes are recorded up to 8191 m (26,873 ft).

B6.3.2. GNSS altitude. GPS altitude is recorded up to 8191 m (26,873 ft).