GNSS FLIGHT RECORDER APPROVAL COMMITTEE (GFAC)
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: 24 May 2020

IGC-APPROVAL DOCUMENT FOR GNSS FLIGHT RECORDER
Level of Approval: IGC Level 3 - see para (i-ii) below
Recorder Name: LXNAV Flarm PowerMouse-IGC

(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. 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 was dated 31 July 2013. The IGC/FAI web reference and the contact details for Flarm were updated on 1 February 2002. This version includes 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.

(i-ii) IGC-approval Level. This is IGC Level 3, badge flights up to and including 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.

MANUFACTURERS

Case and packaging of internal parts: LXNAV d.o.o., Kidriceva ulica 24, 3000 Celje, Slovenia
Email & Web: info@lxnav.com & www.lxnav.com
Contact: Erazem Polutnik, Uroš Krašovic

Internal firmware: FLARM Technology Ltd, Hinterbergstrasse 15, CH-6330 Cham, Switzerland
Email & Web: www.flarm.com +41 415 102 660 info@flarm.com
Chief Technology Officer: Dr Urban Mäder +41 415 102 666

IGC-allocated manufacturer codes for IGC files:
3-letter code FLA, single letter code G.
This FR has Flarm firmware in a case by LXNAV, and firmware manufacturer codes are used in IGC files.

1.1 **Recorder Name**. LXNAV Flarm PowerMouse-IGC
shown in the IGC file header record in the form : HF FTY FR Type: LXNAV,PowerMouse-IGC

1.2 **Hardware Version**. Version 1.0 was the original IGC-approved hardware standard. The Version number is shown in the header record of IGC files in the form "H FR HW HardwareVersion:1.0" which can be seen by using a text editor to view the start of the IGC file. See para 9 below for later Versions.

1.3 **Dimensions, Weight, Power Source**. The recorder unit is 84 x 54 x 25 mm in size with connectors adding a further 9mm to the 84mm side. Weight is about 130 grammes. It is powered from an external DC source between 12 and 24 Volts through one of the RJ11 connectors, 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.** On one 54 x 25mm end there are sockets for a USB stick and two 6-pin RJ11 connectors. The RJ11 connectors supply power to the FR and connect to FLARM displays in one or two cockpits. On the other 54 x 25mm end there are two 5mm diameter SMA connectors for FLARM antennas, a 4mm screw connector for a GPS antenna, and a 4mm socket for a Blue Tooth antenna.

1.5 **GPS receiver**. A u-blox 8 receiver by u-blox of Switzerland (www.u-blox.com) is fitted. This is shown in the header record of IGC files in the form " HFGPSu-blox 8,56ch,50000m" which can be seen by using a text editor to view the start of the IGC file. The figures at the end of this line refer to the maximum number of channels that could be processed by this receiver and the maximum GPS altitude in metres that is processed by this FR for figures that appear in IGC files. In this FR, only signals from the US GPS system are processed. It should be noted that with firmware changes to the configuration in this FR, the u-blox 8 receiver is capable of also processing signals from the European Galileo and the Russian GLONASS GNSS systems - this is why the potential number of channels that can be processed by the u-blox 8 receiver is shown in the IGC file as 56, its full potential.

1.6 **Pressure altitude sensor.** A MS 5607 Pressure Altitude sensor by MEAS Switzerland (www.meas-spec.com) is fitted. This is compensated for temperature variation and calibrated to the ICAO ISA. It is shown in the header record of IGC files in the form: "HFPRSPressAltSensor:MEAS,MS5607,25000m". The final number is the maximum Pressure Altitude in metres that is processed in this FR for figures that appear in IGC files. 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 (TA) function. The Flarm TA function (Proximity Warning of other Flarm-equipped gliders and aircraft) is not part of this IGC-approval, which concerns only the recording function. Users of the TA function are advised to check National and other regulations on such systems, and to check for updates to the TA software issued by the Flarm company. 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**. The internal firmware is a Flarm module that provides the GPS recorder function, creation of IGC files, after-flight validation of IGC file integrity using IGC Shell or related programs (see para 3.1), and other Flarm features (see para 1.7.1). This approval is for Flarm firmware version 6.5 or later. Earlier firmware versions are not IGC-approved and apply to units made before IGC-approval. The firmware version is listed in the header record of IGC files in the form: "HFRFWFirmwareVersion:FLARM6.51". This can be seen by using a text editor to view the start of the IGC file.

3. **SOFTWARE.** Downloading of flight data is through the USB socket on the end of the case and is automatic when the unit is powered up again after being shut down at the end of a flight. 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.

3.1 **Validity of Flight Data**. The IGC standard for electronic flight data is that the IGC file must pass the electronic IGC VALIDATE check. That is, by using the Validate function of the IGC Shell program together with the Flarm 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. 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 of takeoff and landing (7.1 below) must agree with the equivalent data in the IGC file used for flight Validation.

4 **Security of the Equipment**. When 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. See para (i-ii) on page 1 for IGC-approval levels and 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.

5 **Installation in a glider**. From the point of view of data recording, the unit may be fitted anywhere in the glider, subject to para 6.4 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.

6 **Noise Level Recording - ENL system**. An Environmental Noise Level (ENL) system is fitted inside the FR with a microphone, frequency filter and weighting system that automatically produces an ENL 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.

6.1 ENL Recording System Manufacturer. The ENL system in this recorder is by LXNAV.

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

6.3 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 in Motor Gliders that give substantial ENL values from the Recorder when the engine is run at positive thrust, such as two-stroke piston engines.

6.3.1 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 power, there are two alternatives: (1) either the FR must be moved closer to the source of engine noise, or (2) a type of FR used that records another variable additional to ENL 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.

6.4 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.

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

7. **Check of Installation in the Glider**. This FR is very small and light, and could easily be transferred to another glider or aircraft. There must be incontrovertible evidence that the recorder was in the glider for which the Performance is being claimed 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.

7.1 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.

7.2 Sealing to the Glider before Flight. If direct observation under para 7.1 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 because it

has to be torn on removal and is difficult to put back without evidence that it has been removed. 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 seal for the previous glider must be removed and the recorder re-sealed in its new position.

8 **Security - Physical and Electronic**. 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. They should carefully cross-check the data in the IGC file for which there is also independent evidence from other reliable sources. Examples include takeoff and landing positions and times, and general soaring conditions at the time and location when compared to data from other gliders. 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.

8.1 Physical Security. A tamper-evident seal with the manufacturer's name is fitted over one or more of the case securing screws. Also, if the recorder module inside the case is interfered with or is not working properly, if IGC files continue to be produced they will fail the IGC electronic Validation check (see paras 3.1, 8.2, 8.2.1).

8.1.1 Sealing of data ports and connectors: no present requirement, but no attempt must be made to pass unauthorised data into the Recorder.

8.2 Electronic Security. The IGC Validation test for electronic security (para 3.1 above) will 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. It will also fail if IGC files are produced from a recorder that is not working properly (see 8.2.1). 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, but only the recorder function is part of this IGC-approval.

8.2.1 Power-up check. The firmware state is automatically checked during power-up. If corrupted firmware is detected (such as due to unserviceability or an attempt to make unauthorised changes), an error code is shown on any connected display, and the recorder or the Flarm traffic alert function (depending on which has been detected as corrupt) will not operate.

8.3 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.

8.3.1 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.

9 **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.

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

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 para (i-ii) on page 1.
A(iii) Copy of this document. It is recommended that a copy of this approval document is kept with the equipment for the use of pilots and OOs.

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

A1 **Flarm Traffic Alert and GPS Antennas**. The fitting to the Flarm Traffic Alert antenna should be checked, as well as the connecttion to the GPS antenna. The FR unit and its antennas should be positioned to give sufficient signal strength for Traffic Alert and fix recording, and no attempt must be made to insert false data into the antennas.

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 in claim calculations other lat/long data such as for start, turn and finish points, is also entered to the WGS84 Geodetic Datum.

A3 **Setting the Fix Interval, Glider and Pilot Data, and Pre-flight Declaration**. These are set by the pilot before flight through the Flarm set-up program which places a"flarmcfg.txt" file on the USB stick used with the recorder in a format that can be read by the recorder's Flarm firmware. Pilots should consider using a USB stick that has a light that indicates activity, because the FR unit itself has no indication of when it is connected and recording - after power is applied to the recorder, the light on such a USB stick will first flash and then become steady. The flarmcfg.txt file has separate lines for fix interval, pilots, glider and pre-flight declaration. These lines in the flarmcfg file can be also changed directly by using a text editor instead of the Flarm set-up program, although care should be taken to only alter the required data and not other parts of the flarmcfg file.

A 3.1 Fix Interval. This can either be set through the Flarm set-up program, or a text editor used with the flarmcfg file on the memory stick by changing the figure at the end of the "Logger interval" section, for instance to read "LOGINT,5" for a 5 second fix interval. Pilots should note that there is no separate "fast fix" and Pilot Event" (PEV) facility with automatic 1 second fixing. Therefore, for other than very long flights, pilots are advised to set a relatively short fix interval such as 5 or even 2 seconds, bearing in mind that the shorter the fix interval, the larger will be the IGC file for a flight with a greater possibility of data corruption within the file. IGC rules on fix intervals for flight between Waypoints are an absolute maximum of 60 seconds (SC3 4.3.1 and Annex C to SC3, 7.1) and 10 seconds maximum for competitions under Annex A to SC3 (SC3A 5.4C).

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. 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. For security of IGC flight data files, see paras 3.1 and 4 on page 3 of this document.

A5 **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. 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 7 on page 3. On the position of connected displays, see para 5 on page 3 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 8.1.1 on page 4.

A8 **Use in Motor Gliders** (including self-sustainers): The internal microphone system automatically records the level of acoustic noise at the recorder, putting an ENL value for each fix in the IGC file. The recorder must be placed so that high ENL values are recorded when the engine is giving forward thrust and must not be covered or insulated (although automatic gain should continue to ensure high ENL readings under engine power). See also para 6 in the main body of this document, particularly 6.3 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 ENL 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 or his agent 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 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 **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 for Flarm firmware, with the IGC-FLA.DLL file in the same directory as the IGC file to be checked (see para 2 about Firmware on page 2).

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

A11 **Switching Off**. This is by switching off DC power to the RJ11 plug that supplies power to the Recorder, or by disconnecting the RJ11 plug itself.

A12 **Downloading Flight Data**. Downloading is to an attached USB stick and is automatic for the last 20 IGC files when the Recorder is switched on again after a flight, having first switched off after flight for at least 5 minutes. For a flight to be validated to IGC standards, the OO must carry out the actions given in para B3.3, and the OO's copy of the transferred flight data sent to the organisation that will validate the flight, such as the National Airsport Control authority (NAC). Different rules may apply for competitions, for which a central data analysis facility may be used, but for performances to IGC standards, IGC rules must be followed and relaxations for competition purposes do not apply.

A13 **Calibration of Pressure Altitude Function**. Pilots are advised to have a pressure altitude calibration carried out by an NAC-approved calibrator before any GNSS Recorder is used for a claimed flight performance. For the procedure, see para B6. A valid IGC-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.

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 para (i-ii) on page 1.
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 - Data Security. See para 8 in the main body of this document on page 3.

B1 **Installation in the Glider**. 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, or an OO must witness the landing and have the glider under continuous observation until the Recorder installation is checked. This is to ensure that the installation is correct and un-altered, and another Recorder has not been substituted in the glider before the after-flight transfer of flight data (B3.3). This is particularly important because this Recorder is very small and light, and it would be easy to transfer from one glider to another, or from a powered aircraft to a glider. On the position of displays attached to the Recorder and checking the installation, see paras 5 and 7 on page 3.

B2 **Takeoff - Independent Evidence**. The time and point of takeoff needs to 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 and after 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 and copying of flight data should then take place in accordance with B3.3.

B3.3 Transferring the Flight Data. This takes place automatically to a connected USB stick on switch-on after the Recorder has first been switched off after flight and five minutes has elapsed. The OO must take a copy of the IGC file for the flight as soon as possible after landing, and keep the file secure until it is transferred to the organisation that is to validate the flight. The OO should carry out the IGC electronic Validation check (B3.3.1 below) as soon as possible after gaining possession of the IGC file.

B3.3.1 Files Produced. The IGC file has 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).

B3.3.2 OO's Copy. A copy of the IGC file for the claim flight 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 on page 3 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).

B3.3.3 IGC File Validation. For electronic Validation of the flight data in the IGC file, use the Validate function of the IGC Shell program. 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). For the shell program to work, the appropriate Dynamic Link Library (DLL) file from the firmware manufacturer must be copied to the IGC Shell directory. In this case, after copying IGC-FLA.DLL to the directory that contains the IGC Shell files, execute IGC-SHELL.EXE. Set the path to the IGC shell directory using the "Set Directories" button on the screen. The IGC shell 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 that starts "Flarm Technology". This should be used and the IGC file concerned should be selected. The screen will then show that the flight data has been validated, or not. If not, ask the pilot to download the flight data again and go through the above procedure a second time.

B3.3.3.1 Latest File Versions. The latest versions of IGC shell and Flarm DLL files must be used, obtainable from the IGC GNSS site for software listed at the beginning of this document.

B3.3.4 Competitions. Different rules may apply for competitions, for which a central data analysis 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. 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 firmware manufacturer is Flarm and its DLL file IGC-FLA.DLL is also needed in the IGC Shell directory (see para A9 and para 2 on page 2 about Firmware). The shell program and DLL file must be the same versions as those on the current FAI/IGC web site for software shown 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 (for a list of analysis programmes, 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 firmware manufacturer's DLL as 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 are 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 750 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. 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, unless the recorder itself is positioned close to the source of noise. For these, see Para 7 on page 3.

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, 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 up to 150 have been recorded on landing approaches.

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 or squeak. 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 non-atmospheric energy is being added. Short term peaks in ENL (up to 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 must 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 which exact pressures can be set and recorded.

B6.1 Calibration method, making a calibration table. Set the fix rate to one second (for instance by changing the appropriate line in the "flarmcfg.txt" file on the USB stick to "LOGINT,1"). With the Recorder outside the calibration chamber, obtain GPS lock (this starts recording and marks the time and date on the IGC file), then, without delay, put the Recorder in the pressure chamber and start the calibration.

B6.1.1 Pressure Steps in the calibration IGC File. The calibrator will record the pressure steps used, for later comparison with flight files. 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.

B6.1.2 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 if the calibrator does not have this knowledge. The IGC format calibration 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 must list true against indicated altitudes. This table can then be used to adjust pressure altitudes which are recorded during flight performances and which need correction before validation is made 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 for specially-approved High Level Flight Recorders (HAFR) for altitude records above 15,000 metres) and the file should be kept with the calibration paperwork so that it is not confused with other calibration files. If the original IGC file has 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 is increased by less-than ideal antenna positioning. 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 multi-channel GPS system. From recent GFAC tests, the lat/long error taken from a moving vehicle at a surveyed point in average reception conditions, shows an average error of about 11m and between 6 and 7 metres for surveyed points with a clear horizon 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 theoretically recorded up to 25 km (82,021 ft), but this type of FR is not an IGC-approved High altitude Flight Recorder (HAFR) and in accordance with IGC Sporting Code procedures for HAFRs can not be used to validate IGC altitude performances above 15km

B6.3.2. GNSS altitude. GPS altitude is theoretically recorded up to 50 km (124,042 ft) but this type of FR is not an IGC-approved High altitude Flight Recorder (HAFR) and in accordance with IGC Sporting Code procedures for HAFRs can not be used to validate IGC altitude performances above 15km

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