



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

of the
FÉDÉRATION AÉRONAUTIQUE INTERNATIONALE (FAI)

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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: 20 May 2020

IGC-APPROVAL FOR GNSS FLIGHT RECORDER

Level of Approval: IGC Level 2 - see para i-ii

Recorder Name: ClearNav-IGC V1.0

(i) General. This document gives formal approval from the above date for the Recorder equipment described below to be used for validation of flights under the FAI Sporting Code Section 3 (Gliders and Motor Gliders), subject to the conditions and notes given later. 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 approval for this type of recorder from the Nielsen-Kellerman company was dated 25 May 2009 and an update was issued on 20 April 2011. The manufacturer's location and contact details were transferred to ClearNav Instruments on 4 November 2017. This document only applies to the recorder function - other modules and functions of the recorder and units that may be linked to it are a matter between owners and the manufacturer. A change of IGC-approval level was notified in the version of this document dated 20 October 2019, and the change was made on 1 January 2020, see (i-ii) below. 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 2 (all IGC badges and distance diplomas). The Levels of IGC-approval are listed in Annex B to the Sporting Code for Gliding, para 1.1.3.3. Until the end of 2019 the IGC-approval level was Level 1 (all flights including world records), but this was changed due to increases in IGC Specification conditions for Level 1 that are not met by this type of FR.

(i-iii) GNSS System. The Global Navigation Satellite System (GNSS) used in this Recorder 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 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 Airspace 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

This FR was produced by the Nielsen-Kellerman company before the design was transferred to ClearNav Instruments.

Manufacturer Codes: Single letter: K, three letters: NKL

Current agent: ClearNav Instruments
Address: 2668 Husted Road, Williams, California 95987, USA
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Contact: Rex Mayes sales@clearnav.net

1. HARDWARE

1.1 **Recorder Name.** ClearNav Instruments ClearNav-IGC Version 1.0. This is shown in the header record of IGC-format files in the form: "HFFTYFRTYPE:Nielsen-Kellerman, ClearNav-IGC" (the original manufacturer's name was Nielsen-Kellerman). Note that non-IGC versions of this FR exist and are not covered by this Approval.

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-format flight files in the form "HFRHWHardwareVersion: NKL ClearNav-IGC V1.0"

1.3 **Dimensions, Weight, Power Source.** The recorder unit is 149 x 108 x 28mm in size, less connectors on the back including four attachment points for an external connector unit that stands off a further 16mm. A 112 x 85mm colour display is on one side of the recorder unit and is designed to be fitted in an instrument panel. The recorder unit weighs about 500 grammes and the external connector unit about 90 grammes without external cables. The recorder is powered by an external DC source between 8 and 17 Volts.

1.4 **External Features.** A number of connectors are on the back of the recorder unit and a SD Card receptacle is on one of the sides. More detail on connectors is given later in para 4.

1.5 **GPS receiver.** A 16-channel LEA-4H GPS receiver by u-blox of Switzerland (www.u-blox.com) is fitted. The type of receiver and the number of channels are shown in the header record of IGC files in the form "HFGPS:UBLOX,LEA-4H-0-000-1,16Ch,18km". The last figure is the maximum altitude in metres processed by the recorder to the altitude resolution requirements of para 2.2 of the IGC Specification.

1.6 **Pressure altitude sensor.** This is a MS 5534 or MS5540C Pressure Altitude sensor by Intersema (now owned by TE Connectivity Ltd of Schaffhausen, Switzerland - www.te.com). This is shown in the header record of IGC files in the form "HFPRSPRESSALTSSENSOR:Intersema,MS5534B,20km". The last figure is the maximum altitude processed by the recorder to the altitude resolution requirements of para 2.2 of the IGC Specification. The pressure altitude system is compensated for temperature variation and calibrated to the ICAO ISA. The recorder case is not pressure-sealed and "cockpit static" pressure is recorded on the IGC file.

1.7 **National and other regulations.** These regulations may apply to electrical and electronic equipment. Compliance with such regulations is not the responsibility of FAI.

1.8 **Attached modules.** Other modules are attached through the connectors on the external connector unit, see para 4.

2. **FIRMWARE.** Firmware Version 2009-5-8 (8 May 2009) was the original IGC-approved firmware standard. Later versions may be used if they are IGC-approved, see para 10 below for IGC-approval of updates. The firmware version is listed in the header record of IGC files in the form: "HFR FW Firmware Version: 2009-5-8".

3. SOFTWARE.

3.1 **Downloading of Flight Data.** Downloading is to a USB memory stick or SD card. After flight, one or the other is attached to the appropriate sockets on the recorder unit. File transfer is selected on the main screen through a menu which itself is selected through the keypad connected to one of the RJ-22 connectors on the back of the external connector unit.

3.2 Validation of Flight Data to IGC standards. Validation of the data in IGC files is through the Validation function of the IGC Shell system.

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

3.2.2 IGC Shell Files. The IGC Shell files should be downloaded into a specific directory in the PC that is named in advance (the name IGCshell is recommended). For the shell program to work with a recorder, the appropriate Dynamic Link Library (DLL) file from the recorder manufacturer must be copied to the IGC Shell directory. For this recorder, the file IGC-NKL.DLL is available on the IGC GNSS web site.

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

3.2.4 Free availability. The IGC Shell program is free and the manufacturer's DLL file is freeware but is copyright of the recorder manufacturer.

4. **CONNECTORS** Some external connectors are on the Display/Recorder unit and some are on the external connector unit that fits to the back of the display unit via the 15pin D-connector.

4.1 Display/Recorder Unit. Connectors are as follows:

4.1.1 GPS Receiver Antenna. A SMA (Sub-Miniature type A) screw-type GPS antenna connector with 7mm female and 6mm male components is at the top of the back of the display/recorder unit.

4.1.2 USB Connector. A 15mm female USB connector is on the back of the display/recorder unit between the 15 pin D connector and the GPS antenna connector. This is for uploading files and programs to the recorder and for downloading data from the recorder.

4.1.3 SD Card. One side of the display/recorder unit has a receptacle for a SD card. This, like the USB connector, is for uploading files and programs to the recorder and for downloading data from the recorder.

4.2 External Connector Unit. This fits either to the back of the display unit or via an extension cable to the 15pin D-connector. Other connectors are as follows:

4.2.1 Remote keypad. The keypad cable is connected to one of the RJ-22 sockets mentioned in 4.2.2 below. The keypad has nine buttons for setting up the recorder and making selections in flight. The yellow button is used for Pilot Event (PEV) marking and the fast fix function.

4.2.2 RJ-22 Connectors. Two 8mm 4-pin RJ-22 (4P4C) connectors are on the back of the external connector unit. One is used for the remote keypad that selects menus and functions on the main display. The other connector, when used, is for CANbus communication between other NKL products and to connect two ClearNav together in a 2-seat glider. Serial data from units such as Cambridge 302 or Flarm can be fed into one ClearNav and can communicate via the CANbus to a second ClearNav.

4.2.3 RJ-11 Connectors. Two 11mm 6-pin RJ-11 (6P6C) connectors are on the back of the external connector unit. When used, they allow the ClearNav to exchange RS-232 serial data with an external device such as a Cambridge 302, Flarm, etc.

CONDITIONS OF APPROVAL

5 **Security of the Equipment.** GFAC is presently satisfied with the physical and electronic security of this equipment in terms of the integrity of the recorded flight data and the level of this approval for the types of flights concerned. 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.** The position of the main display and operating buttons and controls used in flight in single-seat gliders should be close to sight-lines used for pilot lookout and scan for other aircraft and gliders. See also para 7.4 on ENL and para 8 on sealing.

7. **Cockpit Noise Level Recording - ENL system.** A microphone and frequency filter and weighting system automatically produces an ENL value (Environmental Noise Level) with each fix. The system is designed to highlight any engine noise but to produce low ENL values in gliding flight. For flights in Motor Gliders, the ENL figures in the IGC file must be analysed 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 the recorder manufacturer ClearNav Instruments.

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 internal-combustion engines that give substantial acoustic noise levels in the cockpit.

7.3.1 **Engines giving low ENL values.** This approval does not include use with Motor Gliders with engines that produce small ENL figures (such as electric and jet engines and others producing low ENL in IGC files), particularly under reduced power such as for level flight. If such an engine is to be used, GFAC should be notified beforehand so that tests can be carried out. Should ENL values be found to be too low, such a motor glider will require, in addition to ENL, another variable to be recorded in the IGC file, in accordance with para 1.4.2.4 of Annex B to the Sporting Code.

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 internal combustion 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. For how this is to be done, see para B1 later in this document.

9 **Security - Physical and Electronic.**

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

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. 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. Firmware updates for the recorder are encrypted and the encryption key is known only to the manufacturer. The firmware state of the recorder is checked during power-up, and if corrupted or tampered firmware is detected, IGC files will still be generated but will fail the IGC Validate test (see 3.2 and B3.3.1.1).

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 National Airspace Control authority (NAC) of the owner (the National body that validates flights to the criteria of IGC). 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 inside the recorder 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 concerned, for the use of pilots and Official Observers.

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

A1 **GPS Antenna.** The GPS antenna should be positioned to give sufficient signal strength for fix recording. No attempt must be made to inject false data via the antenna.

A2 **Geodetic Datum (Earth Model).** For IGC purposes, all latitudes and longitudes recorded by the Recorder must be to a Geodetic Datum (earth model) of WGS84. This type of recorder is fixed on the WGS84 datum and no selection or switching is required except to ensure that other lat/long data such as for start, turn and finish points, is also entered to the WGS84 Geodetic Datum (IGC rule).

A3 **Setting the Fix Interval.** The recorder fixes at a constant one second interval but IGC files can be downloaded at intervals of 1, 2, 4 and 10 seconds, the longer intervals being provided so that IGC files for long flights are not of excessive byte size. When the yellow Pilot Event (PEV) button on the Keypad is pressed, a series of audio bleeps is generated, the next fix in the IGC file is marked with the PEV code, and the next 60 fixes are downloaded at one second intervals. IGC files of very large byte size 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.

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 is the pilot's responsibility to ensure that the recorder is performing correctly and in accordance with this approval, for instance ensuring that GPS fixes, pressure altitude, ENL and other values are recorded as expected. In particular, for motor gliders, 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 **Pre-flight Declaration in the IGC file.** Electronic pre-flight declarations of Waypoints are made by selecting Start, Finish and Turn Points using the remote keypad, from Waypoint lists that have been uploaded into the recorder through the USB connector. Before making a flight that is to be claimed and requires a pre-flight declaration, pilots are advised to check that they can successfully carry this out, and that an IGC file is produced that satisfies the Sporting Code on electronic pre-flight declarations.

A6 **Observing the Recorder installation in the glider.** The pilot must ensure that an OO has checked the place of the recorder in the glider and how it is fixed to the glider. 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. On the position of the display, see para 6 in the Conditions of Approval which refers to sight-lines and the need for pilot lookout and scan.

A7 **Takeoff.**

A7.1 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.

A7.2 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 the recorder, see para B1.2.

A8 **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.

A9 **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 engine noise is clearly received when the engine is giving power and the recorder must not be covered or insulated (even so, automatic gain should continue to ensure high ENL readings under engine power).

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

A9.2 **Pilot check of ENL figures**. Pilots should check that the ENL figures produced by their recorder show a clear difference between engine-on and engine-off flight. ENL figures should be in accordance with those found in GFAC tests and listed in para B5. This may be vital on a later flight when a claim is made. If ENL figures are found to be significantly different to those in para B5 when using internal combustion engines, the recorder should be returned to the manufacturer for the ENL system to be re-set.

A9.2.1 **Low-noise motor gliders**. For engines producing low ENL figures in the IGC file (such as electric, jet or others), such a motor glider will require, in addition to ENL, another variable to be recorded in the IGC file, in accordance with Annex B to the Sporting Code, para 1.4.2.4.

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

A10.1 **After-flight calculation of security**. When the recorder is switched on again, having been switched off after landing, a digital signature is calculated 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 completed and stored in the memory ready for downloading. These codes are used to verify the integrity of the whole file at any later time by using the Validate function of the IGC Shell program with the IGC-NKL.dll file in the same directory.

A11 **Independent Check of Landing** - The pilot must ensure that the time and point of landing has been witnessed and recorded for comparison with IGC file data from the recorder (see para B2.1).

A12 **Switching Off**. This is by switching off the display/recorder unit or disconnecting external power.

A13 **Downloading the Flight Data**. Downloading is either through a USB memory stick or a SD card, either one or the other being inserted into the appropriate socket on the case of the Display/Recorder unit. For more details, see B3.3.

A13.1 **OO's actions**. For a flight to IGC standards of evidence, an OO will then 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 Airport Control authority (NAC). The OO does not personally have to transfer the data from the Recorder, but witnesses the transfer, and immediately after takes or is given a copy from the USB memory stick or SD card.

A13.2 **Competitions**. Different rules may apply for competition flights, for which pilots may be allowed to bring their own flight data on portable storage data to competition control, or a central data transfer facility may be used. However, for a flight to IGC rules such as for records and badges, OO monitoring as in A12.1 continues to apply.

A14 **Calibration of Barograph 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 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.

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 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 concerned, for the use of pilots and Official Observers.

B1 **Installation in the Glider.** The display/recorder unit is designed to be fitted to an instrument panel but can be mounted on a bracket in the cockpit as long as the screen is easy to view by the pilot without making it difficult for external lookout and scan. 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 pre-flight check of the installation must be made after which the glider must be under continuous observation by an OO until it takes off on the claimed flight, or, an OO must witness the landing and have the glider under continuous observation until the Recorder installation is checked. This is to ensure that the installation is 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 **Downloading the Flight Data.** Downloading is either through a USB memory stick attached to the USB connector on the back of the display/recorder unit, or through the SD card on the side of the display/recorder unit. To download, switch on the recorder and use the menu button on the keypad to select the "File Transfer" function on the main recorder screen. Downloading can be selected at fix intervals of either 1, 2, 4 or 10 seconds, the longer intervals being provided so that IGC files for long flights are not too large in size. Security of downloaded IGC files 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).

B3.3.1 **Files Produced.** This process will automatically produce an IGC-format ASCII flight data file using the long file name format given in para 2.5.2 of Appendix 1 of the Specification. As an example, this gives a file name for a flight on 1 January 2010 of 2010-01-01-NKL-ABC-01.IGC where NKL is the manufacturer's three-letter code, ABC is the serial number/letters for the specific recorder and 01 is the flight order on the day in question. If analysis software requires the short file name format, for the file above this would be 911KABC1.IGC and the file name can be changed by using a text editor without compromising the electronic security within the file itself.

B3.3.2 **OO's Copy.** A copy of the IGC file shall be retained securely by the OO such as by immediately copying it to storage media such as a memory stick, data card, or the hard disk of the OO's own PC. This IGC file shall be retained by the OO for later checking and analysis under NAC procedures. The OO must be able to positively identify the flight data file as being from the flight concerned, and takeoff and landing data independent of the IGC file must also be available, see above in B2 and B3.1.

B3.3.3 **Competitions.** Different rules may apply for competitions, for which pilots may be allowed to download their own flight data and take it to Competition Control on portable storage media such as a USB stick or memory card, or a central competition data transfer facility may be used. For ease of identification within the competition, file names may be changed, for instance to the glider competition number or the pilot's name. Integrity of data within the file is preserved by the electronic security system and may be checked at any time by using the Validation process described in B3.3.1 above.

B4 Validation of and Analysis of Flight Data Files. Before a Flight Performance is officially validated, the authority responsible for validation must check that the data in the IGC file has originated from the Recorder concerned, and is identical to the file that was downloaded from the Recorder to the PC. This is done by checking the IGC data file with an authorised copy of the IGC Shell program and using the Validate function in the IGC Shell menu (see below). The Recorder manufacturer's DLL file will also be needed in the IGC Shell directory. The shell program and DLL file must be the same 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 program approved by the NAC concerned (list, see the IGC GNSS web site under SOFTWARE).

B4.1 IGC Shell Program. Download the IGC Shell 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 igcdll.zip. For the shell program to work with a particular Recorder, the appropriate Dynamic Link Library (DLL) file from the recorder manufacturer must be copied to the IGC Shell directory. After copying it to the directory that contains the IGC Shell files, execute 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 IGC recorders". 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 that appears directly in IGC format.

B4.1.1 Validation of IGC files. To gain access to the IGC file for this recorder, the DLL file from the recorder manufacturer (IGC-NKL.DLL) must be in the same directory as the IGC Shell program. 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 there is a security problem, the message "Validation check failed" appears, together with a likely reason.

B4.1.2 Latest File Versions. The latest versions of the IGC shell and DLL files must be used. These can be obtained from the IGC GNSS site for software listed at the beginning of this document.

B4.2 Method. Use the IGC Shell program together with the manufacturer's DLL as explained in 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.

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 or tyre squeak, and values of 450 have been seen for one or two fixes.

B5.2 ENL during engine running. An ENL value of 999 has been produced by this type of recorder with a two-stroke engine running at full power and 600 with a 4-stroke engine at high 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. Previous tests with Wankel (Rotary) engines indicate that they produce similar ENL values to 4-strokes.

B5.2.1 Engines producing low ENL signatures. This approval does not include use with Motor Gliders with engines that produce low ENL signatures (see Para 7.3 in the Conditions of Approval). If such an engine (such as electric or otherwise) is to be used for flights to IGC standards of evidence, GFAC must be contacted as soon as possible so that tests can be carried out. For motor glider with an engine producing low ENL, the IGC-approved GNSS recorder must produce, in addition to ENL, an RPM-related variable to be recorded in the IGC file, in accordance with Annex B to the Sporting Code, para 1.4.2.4.

B5.3 ENL during gliding flight. ENL readings between 50 and 100 indicate slow-speed gliding flight. Flight with the canopy panel or panels open produces substantial extra noise inside the cockpit. ENL values of up to 300 have been produced when thermalling with the cockpit panel or panels open and with sideslip or at higher speeds, a loud low frequency noise can be produced ("organ-pipe" effect) and ENL readings of up to 500 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. With this type of recorder, ENL values of up to 150 have been recorded.

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

B5.6 ENL analysis. It is normally easy to see when an engine has been running and when it has not. Other data such as rates of climb and groundspeed, will indicate whether or not non-atmospheric energy is being added. Short term peaks in ENL (10 seconds or so) may be due to the other factors mentioned above such as undercarriage and/or airbrake movement, sideslip, open DV panel/sideslip, the nearby passage of a powered aircraft, etc. If in doubt, email the IGC file to the GFAC Chairman for further analysis and advice (see earlier for email address).

B6 Altitude analysis and calibration

Flight data files will be analysed in accordance with Sporting Code procedures. Part of this is to compare the general shapes of the GNSS and pressure altitude fix records with time and to ensure that no major differences are seen that could indicate malpractice or manufactured (false) data. As part of this process, the Recorder is calibrated in an altitude chamber in the same way as a drum barograph.

B6.1 Calibration method, making a calibration table. 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. 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. Downloading should be at the 1 second interval that can be selected through the screen display and the menu button on the keypad. 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 of 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 20km (59,055 ft).

B6.3.2. GNSS altitude. GPS altitude is recorded up to 18km (65,617 ft).