

**THE FAI INTERNATIONAL GLIDING COMMISSION (IGC)  
GLOBAL NAVIGATION SATELLITE SYSTEM (GNSS)  
FLIGHT RECORDER APPROVAL COMMITTEE (GFAC)**

References:

FAI web site: <http://www.fai.org>

IGC web site: <http://www.fai.org/gliding>

IGC GNSS web site: <http://www.fai.org/gliding/gnss>

IGC GNSS site for software: <http://www.fai.org/gliding/gnss/freeware.html>

To: FAI for IGC email mailing list  
Internet newsgroup rec.aviation.soaring  
IGC GNSS web site under "List of Approvals"

Copy: Manufacturer concerned

20 August 2006

**IGC-APPROVAL DOCUMENT  
FOR GNSS FLIGHT RECORDER  
FOR ALL GLIDER FLIGHTS (Subject to recorder Firmware Version, see (i.ii) below)  
RECORDER TYPE - ZANDER/SDI GP941 GNSS FLIGHT RECORDER**

*(i) This document gives IGC-Approval from the above date for the GNSS Flight Recorder equipment described below to be used for validation of flights under the rules and procedures in 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.*

*(i-i) Document history. The original IGC-approval document for this type of recorder was issued on 30 October 2001. On 12 February 2003 an update added the GP941A with a different GPS receiver board. This version adds that only Firmware version 2.11 and above be used for flights requiring accurate time evidence and also generally updates the wording to that used in other recent approval documents.*

*(i-ii) IGC-approval Level. This IGC-approval is for "all glider flights", including world records, subject to the use of Firmware version 2.11 or above for flights requiring accurate time evidence. More detail is under "Firmware" below. The Levels of IGC-approval are listed in the Sporting Code for Gliding, Annex B para 1.1.3.3.*

*(ii) This IGC-approval document is concerned with the functions of the equipment that are concerned with recording of data. More specifically, with the accuracy and reliability of the resulting data for the exclusive sole purpose of validation and certification of flight performances to the criteria of IGC and FAI. 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 above mentioned validation and certification purposes. Other functions of the equipment are not part of this IGC-approval and the relevance of this document does not extend beyond the specific validation and certification purposes mentioned above. In particular this applies to any function linked with aspects that could be critical to flight safety such as navigation, airspace avoidance, terrain avoidance and any aircraft proximity-warning and/or anti-collision functions. This document does not constitute any approval, guarantee and/or any statement by GFAC, IGC and/or FAI as to the reliability or accuracy of the equipment for operation in flight and any liability in connection therewith is hereby expressly excluded.*

*(iii) 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) deals with equipment used in flight validation, Annex C to the Code (SC3C) consists of 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.*

*(iv) 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:**

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Email: info@sdi-variometer.de  
Web: <http://www.sdi-variometer.de>  
Contact: Franz Pöschl

(Note that Zander is responsible for electronic design, FR firmware and PC software. SDI is responsible for mechanical engineering and production).

## **EQUIPMENT:**

### **HARDWARE**

**Hardware Versions.** Version 2 or later. This is shown in the header record of IGC-format flight files in the form "HF RHW Hardware version: 2".

**Dimensions, connectors, light indicator.** The recorder consists of a rectangular metal case about 107 x 75 x 30 mm in size, weight of about 320 grammes. A 9mm circular BNC bayonet antenna connection is on one end together with a male 9-pin RS232 connector, and a female RS232 on the other end together with a small red light indicator.

**GPS receiver board.** For the basic GP941, the Garmin GPS25 12-channel receiver is fitted. After February 2003 the Garmin GPS15H 12-channel receiver may be fitted. These receivers are by Garmin International Inc of Olathe, Kansas, USA, see <http://www.garmin.com>. The type of receiver will be shown in the IGC-file header record and units with the GPS15 are designated GP941A.

**Pressure altitude sensor.** The MS 4434A sensor unit by Intersema Sensoric SA of Bevaix, Neuchatel, Switzerland, is used (see [www.intersema.ch](http://www.intersema.ch)). It is compensated for temperature variation and calibrated by the recorder manufacturer to the ICAO International Standard Atmosphere (ICAO ISA). The recorder case is not pressure-sealed and "cockpit static" pressure is recorded on the IGC file.

**National regulations.** These may apply to electrical and electronic equipment, such as the EC "CE" mark for compliance with EC directives on EMC and voltages. Compliance with such regulations is not the responsibility of FAI. This equipment has the EU CE mark.

### **FIRMWARE**

For flights requiring accurate time evidence, Version 2.11 or later must be used. For other flights, Version 2.04 or later. The reason for the distinction is that in pre-2.11 recorders, incremental time from initial lock-on is used instead of continuous time updates from the GPS signal from which the relevant fix is obtained. In conditions of poor GPS reception this has been shown to lead to time errors in the IGC file which can be cumulative rather than regularly corrected from good GPS data. This situation is corrected in V2.11 and the upgrade to this version is available free to recorders sent to the manufacturers SDI and Zander at the addresses given above. The firmware version is shown in the header record of IGC-format flight files in the form "HF RFW Firmware Version: 2.11"

### **SOFTWARE**

**Program file functions.** The short program file DATA-ZAN.EXE is for transferring flight data from the FR to a PC and automatically produces a \*.ZAN binary file and an \*.IGC file for the last flight, leaving a menu on screen for transfer of other flight data. The file CONV-ZAN.EXE is for conversion of a \*.ZAN flight data file to the IGC format, if the IGC

file is not available, or as a later check of the IGC file. The file VALI-ZAN.EXE checks the security and integrity of an \*.IGC file, and ensures that data that is designed to be secure has not been altered since it was transferred from the FR.

**Versions to be used.** For correct operation, Version 18 or later of the program files must be used. The initial release date was 6 September 2001 for the V18 DATA and CONV programs, 11 October 2001 for the VALI program. These program files are backward compatible with the earlier Zander GP940 recorder.

**Free availability.** The DATA, CONV, and VALI files are copyright of the FR manufacturer and are freeware. The latest versions may be obtained from the IGC GNSS Internet site for software or through the IGC/GNSS site through a link. See the site titles given at the beginning of this document.

## **CONDITIONS OF APPROVAL**

1. **Permitted Connections.** The position of the connectors is described above under Hardware.
  - 1.1 External antenna to 9mm circular BNC bayonet connector.
  - 1.2 RS232 9-pin female connector wired specifically for this type of recorder, to the male RS232 connector on the case. For power, Pilot Event (PEV marker) button, also connection to a glider computer or display unit where available.
  - 1.3 Male 9-pin RS232 connector wired to the IGC-standard, to the female RS232 connector on the case. For transfer of flight data to a PC and for setting up the recorder before flight.
  - 1.4 Extra peripheral units such as displays have not been tested as part of this IGC-approval and are a matter between the manufacturer and customers.
2. **Security of the Equipment.** GFAC is presently satisfied with the physical and electronic security of this equipment. See para 4 on security seals.
  - 2.1. **Installation in a glider.** The FR may be fitted anywhere in the glider, subject to para 3.2 on sealing and that in Motor Gliders the position is suitable for recording Engine Noise Levels (ENL). If the GPS antenna is accessible to the crew in flight, no attempt must be made to inject data; any abuse of this may lead to a future requirement to place the antenna out of reach of the flight crew. Particularly in single-seat gliders, the position of any ancillary displays connected to the recorder should not be remote from sight lines used for pilot lookout and scan for other aircraft and gliders.
  - 2.2. **Motor gliders.** A microphone and frequency filter and weighting system automatically produces an ENL (Engine Noise Level) value with each fix. ENL figures vary between 000 and 999 in steps of 004. The system is designed to highlight any engine noise but to produce only low ENL values in normal quiet gliding flight. The FR should be positioned in the glider so that it can receive a high level of engine and/or propeller noise when power is being generated. GFAC has tested the FR in motor gliders with two-stroke and 4-stroke engines, but not with Wankel or electric power sources. For details of typical ENL values, see para B.4.
    - 2.2.1. **Electric engines.** If an electric engine is to be used, GFAC should be notified beforehand so that tests can be carried out in order to establish ENL values.
  - 2.3. **Sealing of data ports and plugs:** no present requirement, but no attempt must be made to pass unauthorised data into the FR.
3. **Check of Installation in the Glider.** There must be incontrovertible evidence that the particular FR was present in the glider for the flight concerned. This can be achieved either by observation at takeoff or landing or by sealing the FR to the glider at any time or date before takeoff and checking the seal after landing.
  - 3.1. **Observation of Installation before Takeoff or at Landing.** The recorder may be sealed to the glider in accordance with 3.2. Otherwise, either a pre-flight check of the installation must be made 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 FR installation is checked. This is to ensure that the installation is in accordance with the rules, and that another FR has not been substituted before the data is transferred to a PC after flight.

3.2. **Sealing to the Glider before Flight.** If direct observation under para 3.1 cannot be achieved, the FR must be sealed to the glider by an OO at any time or date before flight so that it cannot be removed without breaking the seal. The sealing method must be acceptable to the NAC and IGC. Paper seals must be marked in a manner such that there is incontrovertible proof after the flight that seals have not been tampered with, such as by marking with the glider registration, the date, time and OO's name and signature. It should be possible for the OO to recognise the seal markings afterwards. The use of adhesive plastic tape is not satisfactory for IGC-approved sealing because it can be peeled off and re-fitted. Gummed paper tape is recommended, as used for sealing drum-type barographs. The OO must seal the FR unit to glider parts 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 FR is sealed to such removable part, if such a part is transferred between gliders, any FR seal for the previous glider must be removed.

#### 4. **Security Seals, Physical and Electronic.**

4.1. **Physical Security.** A silver-coloured tamper-evident seal with the manufacturer's name, is fitted over one of the case securing screws next to the maker's label. In addition, an internal security mechanism is included that activates if the case of the FR is opened. If the FR case has been opened, breaching physical security, subsequent IGC files will fail the VALI check (see para B3).

4.2. **Electronic Security.** If the internal security mechanism has been activated (such as by opening the case), any data in the memory will be lost, settings will revert to defaults, and the electronic security algorithms in the FR will be trashed. Any flight data files subsequently produced will fail the VALI test for electronic security. This test will also fail if the \*.ZAN or \*.IGC file has been altered in any way after being transferred from the FR.

4.3. **FR found to be unsealed.** If either physical or electronic security is found to have failed, the FR 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.

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

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

6. **Manufacturer's Changes.** 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. This includes changes of any sort, small or large. If in doubt, notify the change so that the responsibility for any possible action passes from the manufacturer to GFAC.

Ian Strachan  
Chairman, IGC GFAC

Annexes:

- A. Notes for owners and pilots
- B. Notes for Official Observers and NACs

Any Queries to:  
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Annex A to IGC Approval

**NOTES FOR OWNERS AND PILOTS  
PART OF IGC APPROVAL FOR  
RECORDER TYPE - ZANDER GP941**

A(i). **Status.** To be read together with the main terms of approval to which this is an Annex.

A(ii). **IGC-Approval level.** This type of recorder is IGC-approved for all flights including world records subject to the use of firmware version 2.11 or above for performances requiring accurate timing. 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:

A.1. **Antenna** - That the antenna is positioned in order to give sufficient signal strength for IGC purposes. No deliberate attempt must be made to inject data via the antenna, and any abuse of this may lead to a future requirement to position antennas out of reach of the flight crew.

A.2. **Geodetic Datum.** Latitudes and longitudes recorded by the FR must be to the WGS84 Geodetic Datum, or the flight data will be invalid for IGC purposes. This recorder is fixed on the WGS84 Datum. No pilot action is required except to ensure that other lat/long data such as for start, turn and finish points, is also entered to the WGS84 Geodetic Datum (IGC rule).

A.3. **FR installation in the glider.** The pilot must ensure that an OO has checked the place of the Flight Recorder in the glider and how it is fixed to the glider. If it may be difficult to find an OO immediately before takeoff, or to witness the landing, you should ask an OO to seal the FR to the glider, and **this can be done at any time or date before flight**. See para 3 in the conditions of approval. Regarding the position of any ancillary displays connected to the FR, see para 2.1 in the Conditions of Approval which refers to sight-lines and the need for pilot lookout and scan.

A.4. **Takeoff** - The pilot must ensure that the time and point of takeoff has been independently witnessed and recorded for comparison with that recorded by the GNSS FR, see para B1.2.

A.5. **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 FR. See paras 2.3 and 3 in the conditions of approval.

A.6. **Use in Motor Gliders** (including self-sustainers): The internal microphone and associated circuitry records an ENL (Engine Noise Level) value between 000 and 999 with each fix. The ENL system is automatically enabled and no pilot action is required. The FR should not be covered or insulated, although even so, automatic gain should continue to ensure high ENL readings under power.

A6.1 **Cockpit noise.** Pilots should note that other cockpit noises will produce ENL readings, and avoid those which could be mistaken for use of engine. Generally the frequency filtering built in to the FR will avoid any problems, but it should be noted that **sideslipping and/or flight at high speed with the cockpit Direct Vision (DV) panel open can produce a low-frequency sound (organ pipe note) which will register as high ENL**, as will spins and stall buffet, particularly in Motor Gliders if the engine bay doors flutter. 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.

A.7. **After Flight** - The pilot must ensure that the time and point of landing has been independently witnessed and recorded for comparison with that recorded by the Recorder (see para B2.1). Until an OO has witnessed the FR

installation to the glider, the pilot must not alter the installation or remove the FR from the glider. The OO will carry out the actions given in para B2.3, and the OO's copy of the transferred flight data will be sent to the NAC. The OO does not personally have to transfer the data from the FR, 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 IGC record and badge rules, the above continues to apply.

0.1.1. Use of Portable PC at the glider. So that there is no need to disturb the cockpit installation or any sealing to the glider, a portable (laptop/notebook) PC can be used for transferring the data at the glider. The portable PC may be owned by the pilot or any other person. It should be set up for ease of downloading, such as by easy access to the current DATA-ZAN.EXE program file or an equivalent program from the manufacturer that carries out the same function. Transfer of flight data is witnessed by the OO, and the flight data in both ZAN and IGC formats is then given to the OO on portable media such as a floppy diskette.

A.1. **Calibration of Barograph Function.** Pilots are advised to have a barograph calibration carried out either by the manufacturer or by an NAC-approved calibrator before any GNSS FR is used for a claimed flight performance. For the procedure, see para B5. 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 FR for takeoff and at landing, with QNH pressures for the appropriate times recorded by a local meteorological office.

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

Annex B to IGC Approval

**NOTES FOR OFFICIAL OBSERVERS AND NACs -  
PART OF IGC APPROVAL FOR  
RECORDER TYPE - ZANDER GP941**

A(i). Status. To be read together with the main terms of approval to which this is an Annex.

A(ii). IGC-Approval level. This type of recorder is IGC-approved for all flights including world records subject to the use of firmware version 2.11 or above for performances requiring accurate timing. 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.

**B.1. Installation and Takeoff Records**

B.1.1. **Installation in the Glider.** An OO shall witness and record the position of the FR in the glider, the type and serial number of the particular FR, the glider type and registration, date and time. The serial number of each individual recorder consists of three characters made up of letters and/or numbers and is shown on the case. Before flight, if requested, the OO shall then seal the FR 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 FR installation is checked. This is to ensure that the installation is correct, and that another FR has not been substituted in the glider before the data transfer (B2.3). See paras 2 and 3 of the Conditions of Approval. Regarding the position of any ancillary displays connected to the FR, see para 2.1 in the Conditions of Approval which refers to sight-lines and the need for pilot lookout and scan.

B.1.2. **At Takeoff.** 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. This will be compared to the FR takeoff data.

**B.2. Landing.**

B.2.1. **At 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. This will be compared to the FR landing data.

B.2.2. **Checking the Installation of the FR.** As soon as practicable after landing, an OO shall inspect the installation of the FR in the glider (including any sealing to the glider), so that this can be compared to the check described in para B1.1 above. The transfer of flight data shall then take place in accordance with B2.3.

B.2.3. **Transferring the Flight Data.** The flight data can be transferred to a portable PC at the glider, without disturbing the installation of the FR (see para A7.1). If a portable PC is not available, the OO shall check and break any sealing to the glider, and take the FR 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 FR which is then independently checked later at the NAC (and at FAI if the claim goes to them).

**Method:** This FR has a small internal battery and the use of external power is not essential for data to be transferred from FR to a PC. Use the standard IGC connector cable which has a 9-pin RS232 male connector for the FR and a RS232 female connector for the PC. The connector on the FR is the female RS232 on the end face that has the red light, not the male RS232 on the end face with the antenna connection. A current version of the short program file DATA-ZAN.EXE must be available on the PC. This program is available free from the IGC GNSS web site for software given at the beginning of this document, or through a link from the main [fai.org/gliding/gnss](http://fai.org/gliding/gnss) web site. The DATA program file can be executed on either a floppy diskette or on the PC hard disk. When the DATA program is executed, the software version is shown at the top of the menu (see under software on page 1, which gives the required version). This program file executes in the normal way such as either by typing at a DOS prompt "DATA-ZAN, enter"; or by double-clicking "DATA-ZAN" in a Windows file list (File Manager for W3x, Windows Explorer for W95/98/ME or NT/2000/XP). If settings such as the COM port, Baud rate, etc. need to be changed, the help menu is accessed by typing the file name, space, hyphen, then the letter h.

**Files produced.** This process will automatically produce both a \*.ZAN binary format file and an \*.IGC-format flight data file both with the file name YMDCXXXF, where Y=year, M=month, D=day, C=manufacturer, XXX = FR Serial Number/letters and F = flight number of the day (full key, Appendix 1 to the IGC GNSS FR Specification, also listed in Annex C to the Sporting Code, SC3C).

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

**Storage media.** The OO may keep the required data files on a floppy diskette or other industry-standard portable storage media. The hard disk of a PC may also be used but the OO must be able to positively identify the flight data files as being from the flight concerned.

**Competitions:** Different rules may apply for competition flights, for which a central data transfer facility may be used. For ease of identification within the competition, file names may be changed, for instance to the glider competition number or the pilot's name. Integrity of data within the file is preserved by the electronic security system and may be checked at any time by using the VALI-ZAN program file.

B.3. **Analysis of Flight Data Files.** A Data Analyst approved by the NAC will then evaluate the flight using an analysis program approved by the NAC concerned (list, see the IGC GNSS web site under SOFTWARE). In addition to checking flight data, an authenticated version of the file VALI-ZAN.EXE shall be used by the NAC and by FAI (if the data goes to them) to check the electronic security coding, that the FR had not been interfered with, and that the flight data in the \*.IGC file has not been altered since it was transferred from the FR. The version number of the VALI file is shown at the top of the screen when the file is executed. The latest version of VALI-ZAN should be used and is available from the IGC GNSS web site for software given at the beginning of this document.

**Method:** at the appropriate prompt or run function, type VALI-ZAN.EXE followed by a space and the name of the file to be checked. The messages "electronic seal o.k." and "security check o.k." should appear. If there is a problem the messages will be "Electronic seal faulty! Flight data invalid! Return FDR to manufacturer for reset!"; in this case the NAC or other validating authority must investigate the reason. It should be noted that GFAC tests include ensuring that the change of a single character in an otherwise-correct IGC file, cause the VALI program to fail as indicated above.

B.4. **Means of Propulsion (MoP) Record - Motor Gliders.** The MoP must either be sealed or inoperative, or the built-in microphone system used that records a three-number Engine Noise Level (ENL) with each fix on the IGC file. See para 2.2 for more details on the ENL system. ENL values recorded on GFAC tests are given below, in the sequence of a flight.

B.4.1. **ENL during launching.** During winch and aerotow launches, higher average ENL values are to be expected than when soaring (B4.3). Up to ENL 180 for winch and 160 for aerotow have been recorded. During the ground roll, short-term higher values up to 348 have been seen, probably due to wheel rumble.

B.4.2. **ENL during engine running.** On engine running at powers needed to climb, an increase to over 700 ENL is expected. Over 900 is typical for a two-stroke engine, over 700 for a 4-stroke. An ENL value of 999 has been recorded with a two-stroke engine running at full power. During engine running, these high ENLs are produced for a significant time, and when altitude and speed are analysed it can be seen that substantial energy is being added, which can therefore be attributed to energy not associated with soaring. The values quoted above are for 2- and 4-stroke engines. Wankel (rotary) and electric engines have not been tested. There is no reason to believe that Wankel engines will not produce similar values to 4-strokes.

B.0.0.1. **Electric Power.** If an electric engine is to be used, please contact GFAC as soon as possible so that tests can be carried out.

B.4.3. **ENL during gliding flight.** ENL readings of less than 050 indicate normal gliding flight in a quiet cockpit environment. In a high-speed glide or in an aerodynamically-noisy glider, ENL may increase to about 200. Short periods of higher ENL while gliding (up to about 300 ENL) may indicate aerodynamic noises such as due to airbrakes, lowering the undercarriage, sideslip, etc, and are normal before landing. Particularly, sideslip or high speed with the cockpit Direct Vision (DV) panel open can produce low frequency noise (Aorgan-pipe@ effect) and ENL readings of up to 340 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.

B.4.4. **ENL during the approach to land.** ENL values are always higher on a landing approach due to aerodynamic noises such as due to airbrakes, undercarriage, sideslip, turbulence, etc. Short-term peaks due to specific actions such as opening airbrakes, lowering undercarriage, etc., will be noted as well as a generally higher level of ENL because the glider is no longer aerodynamically clean. ENL values of up to 300 have been recorded, although 216 is more typical in an aerodynamically noisy glider, and 100 in a quiet machine.

B.4.5. **ENL during landing.** During ground contact during takeoff and landing, short-duration ENL readings up to 348 have been recorded, probably due to wheel rumble. Unlike engine running these last only for a short time, showing a short spike on the noise/time trace.

B.4.6. **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/high airspeed, 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).

B.5. **Altitude analysis and calibration.** Flight data files will be analysed in accordance with Sporting Code procedures. Part of this is to compare the general shapes of the GNSS and pressure altitude fix records with time and to ensure that no major differences are seen that could indicate malpractice or manufactured (false) data. As part of this process, the FR can be calibrated in an altitude chamber in the same way as a drum barograph.

B.5.1. **Calibration method, making a calibration table.** Recording at 4 second intervals starts when power is connected to the recorder, no special switching is required. The calibrator will record the pressure steps used, for later comparison with the flight file. The stabilised pressure immediately before the altitude is changed to the next level, will be taken as the appropriate value unless the calibrator certifies otherwise. After the calibration, the data file containing the pressure steps is transferred to a PC as if it was flight data (see B2.3 above); this may be done by

an NAC-approved person other than the calibrator who may not have this knowledge. The IGC format calibration data file will then be analyzed, compared to the calibration pressure steps, and a correction table produced and authenticated by by an NAC-approved person (for instance an OO or GNSS FR Data Analyst). The correction table will list true against indicated altitudes. This table can then be used to adjust pressure altitudes which are recorded during flight performances and which require correction before validation to IGC criteria. These include takeoff, start and landing altitudes for altitude difference and for comparison with independently-recorded QNH readings, and low and high points on gain-of-height and altitude claims. Only pressure altitude is valid for IGC altitude purposes except for proof of flight continuity (no intermediate landing) where GNSS altitude may also be used.

**B.5.2. GPS altitude figures recorded in the IGC file.** Occasional short-duration differences in the shape of the GPS altitude/time graph have been noted when compared to the pressure altitude figures. This is not unusual with GPS receivers operating without a local differential beacon or other accuracy enhancing system. 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 recording altitude compared to horizontal position. This effect may be increased by less-than-ideal antenna positioning in some gliders. Lat/long fix accuracy is not affected and is typical of that for a 12 channel GPS system, but data analysts and NAC officials should allow for the above when comparing the GPS altitude and pressure altitude records.

**B.5.3. Maximum Altitudes Recorded in the IGC file.**

B.5.3.1. **Pressure Altitude.** The recorder is designed to have a pressure altitude capability up to 10km (32,808ft). Above this altitude, figures may be recorded but accuracy is not guaranteed.

B.5.3.2. **GNSS altitude.** The GP 941 has 16-bit resolution and the maximum positive recorded value is theoretically 32,767m (107,503ft). However, US limitations on the recording of GPS altitude by non-military GPS receivers may limit recording to 60,000ft (18,288m).

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