FÉDÉRATION AÉRONAUTIQUE INTERNATIONALE
Avenue Mon-Repos 24 - CH-1005 Lausanne - Switzerland
Tel +41 21 345 1070; Fax +41 21 345 1077; sec@fai.org

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:	IGC GNSS web site under "List of Approvals"
Notification to:	IGC email mailing list <igc-discuss@fai.org>
	Internet newsgroup rec.aviation.soaring
Copy:	Manufacturer concerned

10 June 2007

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. The version dated 20 August 2006 added that only Firmware version 2.11 and above be used for flights requiring accurate time evidence and also generally updated the wording. This version adds the Garmin 15-W GPS receiver board and also updates the wording to that used in other recent IGC-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.

(i-iii) GNSS System. The Global Navigation Satellite System (GNSS) used in this Recorder is the US NavstarGlobal Positioning System (GPS).

*(ii) Equipment Functions. This document is concerned only 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 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) Intellectual Property. 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) FAI Sporting Code Section 3. 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) Keep with the Equipment. 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

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MANUFACTURERS:

Dipl.-Ing Peter Zander, Oberdiller Strasse 38, D-82065 Baierbrunn, Munich, Germany
Tel: +49 89 793 78 90; Fax: +49 89 793 79 04
email: pzander@compuserve.com Web: www.zander-variometer.de
Contact: Peter Zander

Streamline Digital Instruments (SDI) Franz Pöschl GmbH
Mühlwinkel 4, D-83224 Staudach, Bavaria, Germany
Tel: +49 8641 5277 Fax: +49 8641 5276
Email: info@sdi-variometer.de Web: http://www.sdi-variometer.de
Contact: Franz Pöschl

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

EQUIPMENT:

1. HARDWARE

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

1.2 Dimensions and weight. The recorder consists of a rectangular metal case about 107 x 75 x 30 mm in size. Weight is about 320 grammes.

1.3 Connectors, lights. 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.

1.4 GPS receiver boards. In the original GP941, the Garmin GPS25 12-channel receiver was fitted. After February 2003 the Garmin GPS15H 12-channel receiver may be fitted and after May 2007 the Garmin 15W. 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.

1.5 Pressure altitude sensor. The MS 4434A sensor unit by Intersema Sensoric SA of Bevaix, Neuchatel, Switzerland, is used (see 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.

1.6 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.

1.7 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

For flights requiring accurate time evidence, firmware Version 2.11 or later must be used and for other flights, Version 2.04 or later.

2.1 Time recording. 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"

3. SOFTWARE

3.1 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 Recorder.

3.2 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.

3.3 Use of Latest Files - Free Availability. The DOS-based DATA, CONV and VALI files are copyright of the Recorder manufacturer but are freeware. The latest versions of these programs and files must be used and can be obtained directly from the IGC GNSS Internet site for software or through the main IGC site through a link. See the web site titles given at the beginning of this document.

CONDITIONS OF APPROVAL

4. Permitted Connections. The position of the connectors is described above under Hardware.

4.1 GPS Antenna. External antenna to 9mm circular BNC bayonet connector.

4.2 Power, PEV, Display. 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.

4.3 Download and Set-up. 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 PCand for setting up the recorder before flight.

4.4 Other connected units. Other units external to the main Recorder module such as displays, have not been tested as part of this IGC-approval. Their use is a matter between the manufacturer and customers.

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 9.1 and 9.2 on security seals. GFAC reserves the right to inspect production-standard equipment from time to time for security, general compliance with the IGC Specification and the calibration of sensors such as for pressure altitude.

6. Installation in a glider. . From the point of view of data recording, the unit may be fitted anywhere in the glider, subject to para 9 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 false data and any abuse of this may lead to a future requirement to place the antenna out of reach of the flight crew.

6.1 Sight Lines. Particularly in single-seat gliders, the position of any displays concerned with the recorder should not be remote from sight lines used for pilot lookout and scan for other aircraft and gliders.

7. Cockpit Noise Level Recording - ENL system. An ENL (Engine Noise Level) recording system is fitted and acoustic noise levels at the recorder are recorded with each fix using a microphone and frequency filter and weighting system.
This automatically produces an ENL (Engine Noise Level) value that becomes part of each fix in the IGC flight data file. The system is designed to highlight any engine noise but to produce low ENL values in gliding flight. This is essential for Motor Gliders in order to show that forward thrust was not applied 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 designed by the Zander company.

7.2 ENL figures. ENL figures in each fix in the IGC file are between 000 and 999 in steps of 004. . For details of ENL values to be expected under different conditions, see para B.4.

7.3 ENL IGC-approval - Engine Types. This document gives IGC-approval for the use of the above system for the validation of glide (non-powered) 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 Electric or other Quiet Engines. This approval does not include use with Motor Gliders with electric or other engines that produce little noise in the cockpit, particularly under reduced power such as for level flight. If an electric or another quiet engine is to be used, GFAC should be notified beforehand so that tests can be carried out.

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

8. Check of Installation in the Glider. There must be incontrovertible evidence that the FR was in the glider for the flight concerned, and was installed in accordance with IGC procedures. 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.

8.1 Observation of Installation before Takeoff or at Landing. For observation, either a preflight 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.

8.2 Sealing to the Glider before Flight. If para 8.1 cannot be met, 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 which 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.

9 Security Seals, Physical and Electronic.

9.1 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.

9.1.1 Sealing of data ports and plugs: no present requirement, but no attempt must be made to pass unauthorised data into the FR.

9.2. 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 IGC Validate 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.

9.3 Recorder found to be unsealed. If either physical or electronic security is found to have failed, 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 agent must carry out positive checks on the internal programs and wiring, and ensure that they work normally. If any evidence is found of tampering or unauthorised modification, a report must be made by the manufacturer or agent to the Chairman of GFAC and to the NAC of the owner. The IGC approval of that individual unit will be withdrawn until the unit is re-set and certified to be to the IGC-approved standard.

10. Analysis of Flight Data. Analysis for flights to be validated to IGC criteria should be through the use of a program that 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 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 done by checking the IGC data file with an authorised copy of the VALI-ZAN.EXE short program or, for the Colibri model 4, by using the validate function in the IGC Shell program. The VALI and IGC Shell programs must have originated from the current FAI/IGC web site for software listed at the beginning of this document. See Annex B for detail on how to use the validate systems.

11 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 the layout of the security microswitch and its shielding from possible interference. If in doubt, GFAC should be notified 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:
Chairman IGC GFAC, Bentworth Hall West,
Alton, Hampshire GU34 5LA, UK
Tel: +44 1420 564 195; Fax: +44 1420 563 140;
email: ian@ukiws.demon.co.uk

<u>NOTES FOR OWNERS AND PILOTS -</u>
<u>PART OF IGC APPROVAL</u>

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 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:

A1. **Antenna** - The antenna should be positioned in order to give sufficient signal strength for IGC purposes. No attempt must be made to inject false data via the antenna; any abuse of this may lead to a future requirement to position antennas out of reach of the flight crew.

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 entered also to the WGS84 Geodetic Datum (IGC rule).

A3 **Setting the Fix Interval**. The fast-fix facility operates when the Pilot Event (PEV) button is pressed and gives the number and interval of fixes that were set before flight by the pilot through the setup program. The fix interval for cruise flight between PEV events (such as between Waypoints) is set by the pilot before flight through the set-up program under the heading "Normal operation". There is therefore no need to set a very short fix interval for cruise flight because points of interest can be marked by PEV events and take advantage of the fast fix facility. Setting a short fix interval for cruise flight leads to IGC files of large byte size, particularly for long flights. This uses up more of the recorder's memory, causes downloading after flight to take a long time, increases the chance of data corruption and may also cause problems with some analysis programs because of the large number of fixes that have to be processed.

A3.1 IGC rules. IGC rules on fix intervals for cruise flight are an absolute maximum of 60 seconds (SC3 para 4.3.1 and Annex C to SC3, para 7.1) and 10 seconds for competitions complying with Annex A to SC3 (SC3A para 5.4C). SC3C para 7.1 says: "10 to 20 seconds has been found to be suitable, and does not use up as much memory as a more frequent setting for the whole flight. A more frequent fix interval is recommended near a Waypoint to ensure that a fix is recorded within its observation zone".

A4 **Checking the Recorder before a Claim Flight**. Pilots should check and analyse a selection of IGC files from their recorder before attempting flights that will require Validation. This is to ensure that the recorder is performing correctly and in accordance with this approval. It should be ensured that GPS fixes, pressure altitude and ENL values are recorded as expected. In particular, ENL values should be in accordance with the figures given in para B5. See also A8 on ENL and A13 on pressure altitude calibration.

A5 **Observing the Recorder installation in the glider**. The pilot must ensure that an OO has checked the place of the equipment in the glider and how it is fixed to the glider. If it may be difficult to obtain an OO immediately before takeoff, or to witness the landing, an OO should be asked to seal the Recorder to the glider, and **this can be done at any time or date before flight**. See para 8 in the conditions of approval. Regarding the position of displays concerned with the Recorder, see para 6 in the Conditions of Approval which refers to sight-lines and the need for pilot lookout and scan.

A6 **Independent Check of Takeoff**. The pilot must ensure that the time and point of takeoff has been independently witnessed and recorded for comparison with takeoff data in the IGC file from this recorder, see para B1.2.

A7 **Connection to Ports**. Although this approval does not presently require sealing of any ports or plugs, no attempt must be made to pass unauthorised data into the Recorder. See para 9.1.1 in the Conditions of Approval. For versions fitted with Flarm, see also 9.2 in the Conditions of Approval about the relation of the Flarm firmware with the recorder manufacturer's firmware.

A8 **Use in Motor Gliders** (including self-sustainers): The internal microphone and associated circuitry automatically records the level of acoustic noise at the recorder. This is recorded in the IGC file with each fix. The recorder must be placed so that engine noise is clearly received when the engine is giving power and must not be covered or insulated (even so, automatic gain should continue to ensure high ENL readings under engine power).

A8.1 Cockpit Noise. Pilots should note that cockpit noises other than the engine will produce ENL figures on the IGC file, and should avoid those that could be mistaken for use of engine. **Flight with the cockpit Direct Vision (DV) and/or ventilation panel(s) open can produce a low-frequency sound ("organ-pipe" note) which will register as high ENL. This is magnified if sideslip is present and in particular at high airspeeds. High airspeeds with cockpit panels open should therefore be avoided in case the ENL recorded is mistaken for use of engine**. High ENL may also be produced by stall buffet and spins, particularly in Motor Gliders if the engine bay doors flutter (vibrate or move in and out). Flight close to powered aircraft should also be avoided, except for normal aero-tow launches. For ENL levels that have been recorded on GFAC tests, see B.4.2.

A8.2 Pilot check of ENL figures. Pilots should check that the ENL figures produced by their recorder show a clear differentiation between engine-on and engine-off flight. ENL figures should be in accordance with those found in GFAC tests and listed in para B5. This may be vital on a later flight when a claim is made. If ENL figures are found to be significantly different to those in para B5, the recorder should be returned to the manufacturer for the ENL system to be re-set.

A9 **After Landing**. Until an OO has witnessed the Recorder installation to the glider, the pilot must not alter the installation or remove the Recorder from the glider. The pilot must ensure that there is evidence of the landing independent of the flight recorder data.

A9.1 After-flight calculation of security. After landing, the recorder calculates a digital signature for the IGC file for the flight, using a Public/Private Key encryption system. 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 (see paras 9.2 and 10 earlier).

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

A11 **Switching Off**. This is by switching off the external power or disconnecting the RS232 connector from the recorder.

A12 **Downloading the Flight Data**. This is by connecting a PC to the RS232 socket. The OO will carry out the actions given in para B3.3, and the OO's copy of the transferred flight data is sent to the organisation that will validate the flight, such as the National Airsport Control authority (NAC) of the Competition Organisation. The OO does not personally have to transfer the data from the Recorder, but witnesses the transfer and takes or is given a copy on standard electronic media such as a memory stick, diskette or equivalents. Different rules may apply for competition flights, for which a central data transfer facility may be used, but for a flight to the rules for IGC records and badges, the above continues to apply.

A12.1 Use of Portable PC at the glider. The PC used may be owned by the pilot or any other person. The PC should be set up for ease of data transfer, such as by easy access to the Zander or other download program. Transfer of flight data is witnessed by the OO, and the flight files in IGC format must be given to the OO for safe keeping and analysis on standard electronic media such as a memory stick, diskette or equivalents.

A13 **Calibration of Barograph Function**. Pilots are advised to have a barograph (pressure altitude) calibration carried out either by the manufacturer or 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.

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

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. This 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.

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**. It should be noted that, due to the portability of this Recorder, it would be easy to transfer it from one glider to another, or from a powered aircraft to a glider. Therefore, an OO shall witness and record the position of the Recorder in the glider, the type and serial number of the Recorder, the glider type and registration, date and time.

B1.1 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.

B1.2 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.

B1.3 Alternatively, an OO must witness the landing and have the glider under continuous observation until the Recorder installation is checked. This is to ensure that the installation is correct, and another Recorder has not been substituted in the glider before the data transfer (B3.3). See para 8 of the Conditions of Approval. Regarding the position of displays concerned with the Recorder, see para 6 in the Conditions of Approval which refers to sight-lines and the need for pilot lookout and scan.

B2 **Takeoff - Independent Evidence**. The time and point of takeoff shall be recorded, either by an OO, other reliable witnesses, or by other means such as an Air Traffic Control or official Club log of takeoffs and landings. After flight, this will be compared to the takeoff data from the Recorder.

B3 **Landing**

B3.1 Independent Evidence of Landing. The time and point of landing shall be recorded, either by an OO, other reliable witnesses, or by other means such as an Air Traffic Control or official Club log of takeoffs and landings. After flight, this will be compared to the landing data from the Recorder.

B3.2 Checking the Installation of the Recorder. As soon as practicable after landing, an OO shall inspect the installation of the Recorder in the glider (including any sealing to the glider), so that this can be compared to the check described in para B1 above. The transfer of flight data shall then take place in accordance with B3.3.

B3.3 Transferring the Flight Data. 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 papers are sent to them).

B3.3.1 Method. This Recorder 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 should 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 web site. The DATA program file can be executed on portable media 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.

3.3.2 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).

3.3.3 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.

3.3.4 Storage media. The OO may keep the required data files on industry-standard portable storage media such as a USB memory stick, card or floppy disk. The hard disk of a PC may also be used but at any time later the OO must be able to positively identify the flight data files as being from the flight concerned.

3.3.5 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.

B4. **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). There are two aspects to data analysis, checking the flight performance that is being claimed by using the fixes and other data in the IGC file, and Validation of the integrity of the downloaded data itself.

B4.1 Validation of Flight Data. The IGC Validation system checks three elements. (1) That the flight data in the IGC file is identical to that originally downloaded from the Recorder. (2) Checks the electronic security coding and general structure of the IGC file. (3) Checks that the Recorder has not been modified in an unauthorised way.

B4.2 Validation Method. The file VALI-ZAN.EXE that is used by the authority validating the flight performance shall be identical to that available on the current IGC GNSS web pages. If in doubt, use the file from the current IGC GNSS web pages. This system shall be used by the OO, the competition organisers, or the NAC as appropriate. Also by FAI if the data goes to them such as for a World Record. 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.

B5. **<u>Means of Propulsion (MoP) Record - Motor Gliders</u>**. 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 in GFAC tests are given below, in the sequence of a flight.

B5.1 <u>ENL during launching</u>. 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.

B5.2 <u>ENL during engine running</u>. 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 and Wankel (rotary) engines. Electric engines have not been tested.

B5.2.1 <u>Quiet engines</u>. This IGC-approval does not include use with Motor Gliders with electric or other engines that produce little noise in the cockpit (see Para 7 in the Conditions of Approval). If a quiet engine is to be used such as electric or otherwise, GFAC must be contacted as soon as possible so that tests can be carried out.

5.3 <u>ENL during gliding flight</u>. 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 ("organ-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.

5.4 <u>ENL during the approach to land</u>. 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.

5.4 <u>ENL during landing</u>. 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.

5.5 <u>ENL analysis</u>. 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).

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 FR can be calibrated in an altitude chamber in the same way as a drum barograph.

B6.1 Calibration method, making a calibration table. Recording at 4 second intervals starts when power is connected to the recorder, no special switching is required. No GPS fixes are required for a pressure altitude trace to be produced. 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 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 if pressure altitude is not available.

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 or regional augmentation system. The altitude accuracy from satellite-based systems will not be as good as accuracy in lat/long because the geometry of the position-lines is not as favourable for altitude compared to horizontal position. Also, different processing for GPS altitude is often used within receivers compared to processing of horizontal position. This can be added to by poor antenna positioning or faults in the antenna cable or connectors. Lat/long fix accuracy appears not to be affected and GFAC tests show typical accuracies in lat/long positions recorded in IGC files. Data analysts and NAC officials should allow for the above when comparing the GPS altitude and pressure altitude records. From GFAC tests after 1 May 2000 when the GPS Selective Availability error was removed for civilian receivers, lat/long errors average between 11 and 12m. This is taken from a sample of fixes from a moving vehicle at a number of surveyed points near 51N 001W for all recorders with 12 or more channels tested since the end of April 2000.

B6.3 Maximum Altitudes Recorded in the IGC file. The pressure altitude sensor and the GPS system itself are capable of recording to almost unlimited altitudes, certainly up to 30km/100,000ft. However, the type of processor in the recorder and the need for good resolution (lack of large 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.

B6.1.1 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.

B6.1.2 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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