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

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References:
www.fai.org/gliding under Technology, then under IGC-approved FRs
GFAC web site for FR data: www.ukiws.demon.co.uk/GFAC

To:	IGC and GFAC Web sites	
Notification to:	IGC email mailing list <igc-discuss@fai.org>	
	Internet newsgroup rec.aviation.soaring	
Copy:	Manufacturer concerned	1 October 2013

IGC-APPROVAL FOR GNSS FLIGHT RECORDER

Recorder Name: **Zander GP940**
Level of Approval: **Badge flights up to and including Diamonds**

(i) General. 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. This document replaces those for this equipment that had earlier dates. IGC reserves the right to alter this approval in the future.

(i-i) Document history. Version 1 of the original approval was dated 10 November 1996. Version 2 dated 20 September 2004 brought the wording up-to-date to that used in recent IGC-approvals. Version 3in February 2010 removed the need for a ground engine run for motor gliders and replaces it with an in-flight engine run before the start of the claimed performance. The 2011 paper on FR Security by the IGC ANDS and GFA Committees that was approved at the 2012 IGC Plenary meeting recommended a reduction to "Diamonds" and this was made in two stages, to "All Badges" on 1 October 2012 and to "Diamonds" on 1 October 2013.

(i-ii) IGC-approval Levels. The Levels of IGC-approval are listed in para 1.1.4 of Annex B to the Sporting Code for Gliding (SC3B), and cover the use of FRs in flights for FAI/IGC badges, diplomas, records and in competitions.

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

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

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

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EQUIPMENT

1. HARDWARE

1.1 Version. IGC-approval applies to Hardware Version 1.16 or later. This is shown on the recorder case and in the first line of IGC files. For manufacturer notification of updates, see para 11.

1.2 Dimensions and Weight. The recorder is in a rectangular metal case about 107 x 75 x 30 mm in size, and weighs about 320 grammes. Connectors are described in para 4.

1.3 GPS receiver board. Motorola VP Oncore 8 channel (www.motorola.com).

1.4 Pressure altitude sensor. MS 5534A from Intersema Sensoric SA of Switzerland (www.intersema.ch), compensated for temperature variation. The FR case is vented to atmosphere and records "cockpit static" pressure.

1.5 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.

2. **FIRMWARE**. IGC-approval applies to firmware Version 1.16 or later. This is shown on the case and in the header record of IGC files. For manufacturer notification of updates, see para 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 is identical to when it was first transferred from the FR.

3.2 Versions to be used. For correct operation, Version 11 or later of the program files must be used, with a release date of 11 November 1997 or later.

3.3 Free availability. The DATA, CONV, and VALI files are copyright of the FR manufacturer and are freeware. Only the latest versions should be used and these may be obtained from the IGC GNSS Internet site for software. See the references at the beginning of this document.

4. CONNECTORS.

4.1 GPS Antenna. A 9mm circular BNC bayonet antenna connection is on one end of the case.

4.2 Male RS232 connector. This is on the case near the antenna port and is for power, the Pilot Event (PEV marker) button, also connection to a glider computer or display unit where available.

4.3 Female RS232 connector . This is on opposite end of the case to the antenna connector and is for transfer of flight data to a PC and for setting up the recorder before flight. A small red light indicator is also on this end of the case,

4.4 Extra units - such as displays. These have not been tested as part of this IGC-approval and are a matter between the manufacturer and customers.

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 6 and 7 on fitting to the cockpit and para 8 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 the engine vibration sensor and for pressure altitude.

6 **Installation in a glider**. In Motor Gliders, the position of the recorder in the cockpit must be suitable for recording vibration due to engine running, see para 7. For non-motor gliders, the FR may be fitted anywhere in the glider, subject to para 8 on sealing. 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.

7. **Engine recording - Vibration system - Requirement for firm attachment to glider structure**. The engine sensor inside the recorder detects vibration, not noise. Therefore, unless the Means of Propulsion (MoP) is sealed, inoperative, or not fitted, ***the recorder must be firmly and tightly attached to a part of the glider structure that is capable of transmitting the vibration caused by the MoP to the recorder case***. So that it will not be possible to remove the recorder from this position during flight without this being detected***, an Observer's seal must be applied that would be broken if the recorder is moved***. In order to prove that the attachment to the airframe is capable of transmitting vibration for the flight concerned, ***in the IGC file for the claim an engine-run of at least one minute duration must be carried out before the start of the glide performance*** to be claimed. The engine run must be clearly shown on the IGC file, and the sealing of the recorder to the airframe must be checked by the OO as intact after flight.

7.1 Vibration figures. Vibration figures in each fix in the IGC file are between 000 and 990 in steps of 10. The position in the file is in the same place as Environmental Noise Level (ENL) figures.

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

7.3 Engines and FR installations giving low vibration values. This approval does not include use with Motor Gliders with engines and FR installations that produce small vibration figures (such as electric, jet, and other engines), particularly under reduced power such as for level flight. Should vibration values be found to be too low, such a motor glider will require an FR with and Environmental Noise Level (ENL) system and/or an RPM-related 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 Vibration testing. For details of typical vibration values found on GFAC tests with piston engines, see para B.4.

8. **Check of Installation in the Glider**. There must be incontrovertible evidence that the recorder was in the glider for the flight concerned, and was installed and operated in accordance with IGC procedures. For Motor Gliders (including self-sustainers) the recorder must be attached and sealed to a part of the airframe that transmits vibration when the engine is running, see para 7 above. For non-motor gliders, the necessary evidence 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**. 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 operates if the case is opened.

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 no longer work. Any flight data files after this will fail the IGC Validate (VALI) test for electronic security. The VALI test will also fail if the ZAN or IGC file is not identical to when it was originally created., even by one character in the flight data. 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.

9.3 **Recorder 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.

9.4 **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 Airsport Control authority (NAC) of the owner (the National body that validates glider flights). 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 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 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 Validation program. The VALI program is on a single file and must be identical to that on 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 the IGC flight data file.

11. **Manufacturer's Changes to 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 details of later versions of hardware, firmware and software, also any changes to modules such as the GPS receiver, pressure altitude transducer, the layout of the security microswitch and any other factor that could affect the security of the FR and the IGC files produced from it.

Ian W 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 document - **NOTES FOR OWNERS AND PILOTS**

A(i) Status. To be read together with the main terms of approval to which this is an Annex.
A(ii) IGC-Approval level. All flights including world records, see para (i-ii).
A(iii) Copy of this document. It is recommended that a copy of this approval document is kept with the equipment, for the use of pilots and OOs.

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

A1 **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**. Latitudes and longitudes recorded by the FR must be to the WGS84 Geodetic Datum, and this type of 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 with reference to the WGS84 Geodetic Datum.

A.3 **FR installation in the glider**. For motor gliders, this recorder records vibration and must be attached and sealed by a Official Observer to a part of the glider structure that transmits vibration when the engine is running (see paras 7 & 8 before the annexes). For non-motor gliders, the pilot must ensure that an OO has checked the place of the Flight Recorder 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.

Cockpit Displays. See para 6 in the Conditions of Approval which refers to sight-lines and the need for pilot lookout and scan.
Fix Rate. Fixes are recorded at a constant 4 second interval there is no pilot setting to vary the fix rate. However, the pilot can mark a fix with a Pilot Event (PEV) by pressing the appropriate button on the wiring harness.

A4 **Takeoff**. The pilot must ensure that the time and point of takeoff has been independently witnessed and recorded for comparison with that recorded by this recorder, see para B2.

A5 **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. For a list of connectors, see para 4 in the main section before the annexes.

A6 **Use in Motor Gliders (including self-sustainers)**. A vibration sensor is built in to the FR unit and attached to the inside of the case, and must be used for checking the use of the Means-of-Propulsion (MoP), unless the MoP is sealed or inoperative. See para 7 of the Conditions of Approval, and note that ***in the IGC file for the claim, an engine run must be shown before the start of the glide performance***, to prove the working of the vibration recording system. The recording system is not suitable for low-vibration propulsion such as jet and electric engines and some 4-sroke engines that have low vibration levels.

A7 **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 B3, 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.

A7.1 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 may be used for transferring the data at the glider. 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 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 memory stick.

A8 **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 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 FR for takeoff and at landing, with QNH pressures for the appropriate times recorded by a local meteorological office.

A9 **Fight declarations**. Note that lat/longs can only be entered as degrees, minutes and seconds, there is no option for decimal minutes to be used. Before making a flight that is to be claimed and requires a pre-flight declaration, pilots are advised to check that they can successfully enter Waypoint data, and that an IGC file is produced that satisfies the Sporting Code on electronic pre-flight declarations.

A10 **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, and that the electronic Validation check can be carried out (the VALI-ZAN.exe file). In particular, for motor gliders, vibration values should be in accordance with the figures given in para B5.

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

Annex B to IGC-approval document - **NOTES FOR OFFICIAL OBSERVERS AND NACs**

B(I) Status. To be read together with the main terms of approval to which this is an Annex.
B(ii) IGC-Approval level. All flights including world records, see para (i-ii).
B(iii) Copy of this document. It is recommended that a copy of this approval document is kept with the equipment, for the use of pilots and OOs

B.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 and in first line of the IGC file.

B1.1 Motor Gliders, including Self-Sustainers. For motor gliders, this device records vibration rather than noise. Therefore, the OO must check that the recorder is firmly attached to a part of the airframe capable of transmitting vibration to the recorder when the engine is running, and that an OO seal is applied that will be broken if the recorder is moved, even by a small amount. More detail is in para 7 of the Conditions of Approval in this document.

B1.2 Non-motor gliders. 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. If sealing is to be used, the OO shall 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. This is to ensure that the installation is correct, and that another FR has not been substituted in the glider before the download of data (B3.3).

B1.3 Cockpit displays. On the position of any 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.

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 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 landing data from the Recorder.

B3.2 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 above. This is particularly important in the case of Motor Gliders (including self-sustainers), see B1 above). The transfer of flight data shall then take place in accordance with B3.3

B3.3 Downloading 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). 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 using the VALI-ZAN.exe program, for instance at National level (the NAC), and at FAI if the claim goes 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 to a PC. Use the standard IGC connector cable that 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 or equivalent should be available on the PC. This DATA-ZAN is available free from the IGC GNSS web site for software given at the beginning of this document. The DATA program file can be executed on either through 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/Windows7). 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.

B3.3.2 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. For the full key, see Appendix 1 to the IGC GNSS FR Specification, also listed in Annex C to the Sporting Code, SC3C.

B3.3.3 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.

B3.3.4 Storage media. The OO may keep the required data files on portable storage media such as a memory stick. 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.

B3.3.5 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 IGC electronic security system and may be checked at any time by using the VALI-ZAN.exe 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). 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). This checks the electronic security coding of the IGC file, 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.

B4.1 IGC file validation 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 message "Security Check OK" should appear. If there is a problem the messages will be "Security Check Not OK or "Electric seal faulty, Flight Data Invalid"; 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, will cause the VALI program to fail as indicated above.

B5. **Means of Propulsion (MoP) Vibration record -Motor Gliders**. See para 7 of the main body of this document before the annexes. The MoP must either be sealed or inoperative, or the built-in Vibration recording system used. This senses vibration transmitted to the recorder case to be transformed into three numbers that is added to each fix on the IGC file. Vibration values found during GFAC testing are shown below.

B5.1 Takeoff. Vibration values up to 200 for a short time were found on some takeoffs.

B5.2 In flight. Vibration values between 000 and 020 indicate gliding flight. Vibration values over 200 indicate engine running and 350 has been recorded at substantial power settings.

B5.3 Landing. Vibration values up to 250 were found on some landings, although higher values may indicate a firm landing or running over uneven ground.

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. 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.

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 when compared to the pressure altitude figures. This is not unusual with GPS receivers operating without a local differential beacon or other accuracy-enhancement 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 accurate altitude compared to horizontal position. This effect may be increased by poor antenna positioning in some gliders. Lat/long fix accuracy is not affected, but data analysts and NAC officials should allow for the above when comparing the GPS altitude and pressure altitude records.

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.

B6.3.1 Pressure Altitude. The maximum height tested by GFAC was 50,000 ft.

B6.4.2 GPS altitude. GPS altitude is recorded as distance above the WGS84 ellipsoid.

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