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

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
Free software: http://www.fai.org/gliding/gnss/freeware.asp

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

1 October 2004

IGC-APPROVAL FOR PRINT TECHNIK GR1000 GNSS FLIGHT RECORDER FOR ALL IGC BADGE AND DISTANCE DIPLOMA FLIGHTS AND GR1000A MODEL FOR ALL FLIGHTS

EDITION 3 OF APPROVAL DOCUMENT

(i) Status. This document gives formal approval for this GNSS Recorder equipment to be used for the validation of flights under the rules and procedures of the FAI Sporting Code Section 3 (Gliders and Motor Gliders), subject to the conditions and notes given later. This document replaces those with earlier dates and only the IGC-approvals posted on the IGC web site are valid for use for IGC/FAI claims. IGC and FAI reserve the right to alter the terms of this approval in the future.

(i-i) Approval history. The original IGC-approval for these recorders was issued on 20 March 1997. Edition 2 dated 28 March 2004 contained updated wording that was used in other current IGC-approval documents. This Edition 3 adds the updated model GR1000A.

(ii) Approval levels. The types of flights for which IGC-approval is given, depend on the model number within the GR1000 series.

(ii-i) GR1000A. This model, introduced as an upgrade in August 2004, is IGC-approved for all flights including for world records.

(ii-ii) GR1000 original model. This model is IGC-approved for all IGC Badge and Distance Diploma flights. World record flights are not included in this approval.

(ii-iii) Other flights including competitions. Use in competitions and for flights other than those to IGC Sporting Code rules is at the discretion the body responsible for validating the types of flight concerned.

(iii) GFAC tests. These are concerned primarily with the data from this recorder that is in the IGC data format. Particular concerns are its accuracy and security, ease of transfer from the recorder to a PC, and conformity of the IGC file and the recorder design generally with the IGC Technical Specification for such recorders. Other aspects of the recorder system may not be tested and are a matter between the Recorder manufacturer and customers.

(iv) References. The attention of NACs, 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 (SC3B) deals with equipment used in flight validation (Chapter 1, GNSS Flight Recorders). Annex C (SC3C) is entitled "Official Observer and Pilot Guide" and consists of guidelines and procedures for the flight validation process. A separate document published by FAI is entitled "Technical Specification for IGC-Approved Flight Recorders" Copies of all of these documents may be obtained from the FAI/IGC web sites listed above and links are provided from the main IGC web site.

(v) Exclusions. This approval is not concerned with, and FAI has no responsibility for, matters related to: (a) Intellectual Property (IP) and Intellectual Property Rights (IPR) or, (b) the relations of the Organisation with any others except with FAI and its agents or as they affect FAI, its agents and this approval.

(vi) Standards and Procedures. This approval document is concerned solely with the standards of, and procedures relating to, the hardware, firmware and software for the type(s) of recorder described below and manufactured, updated or serviced by the Organisation listed below under "Manufacturer" and updated or serviced by such Organisation or its agents authorised by it to carry out such work.

(vii) Keep with recorder. It is recommended that a copy of this approval including its two annexes is kept with each unit of the equipment.

MANUFACTURER:
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Email: print@gps.at
Manufacturer codes: Three-letter, PRT. One letter, R.
Contacts: Peter Stiassny, Max Spousta

HARDWARE
Model numbers. Both the GR1000 and GR1000A models are similar externally. The model number is shown on the LCD on start-up.
GR1000 original model. This has a NiCad memory battery and the original electronic security system.
GR1000A model. This has a Lithium-based memory battery and an improved electronic security system.
Description, size, weight. The recorder has a rectangular metal case about 160mm long, 100mm broad and 40mm high. Weight is about 520 grammes. An LCD about 65 x 15mm in size is on one of the large faces and below are four buttons marked from left to right, down, up, right and OK. Connectors are on both end faces and details are given below under Conditions of Approval.
GPS receiver board. Magellan GPS OEM 10 channel.
Versions. **GR1000**. Hardware version 3.3 or earlier.
GR1000A. Hardware version 5.0 or later.
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 is understood to have the EU CE mark.

FIRMWARE
The firmware version is shown on the LCD after switching on**.**
GR1000. Firmware version 3.3.
GR1000A. Firmware version 5.0 or later.

SOFTWARE

Short program files. These have file names DATA-PRT and VALI-PRT. The DATA program is for transferring flight data from a recorder to a PC and outputs to the PC directly in *.IGC file format. The VALI program is for validation of the security and integrity of *.IGC files at any time after initial downloading from the recorder. The DATA and VALI files are copyright of the Recorder manufacturer but are freeware. The latest versions may be obtained from the FAI site for free software given at the beginning of this document and when the VALI program is used it must be the version from the current web site.

Manufacturer's software program. The Print Technik GR1000 program can be used to input waypoints into the recorder.

Other programs. For downloading data after flight from the recorder to a computing device, any program or sub-routine may be used. Such a program may be embedded in a larger program, such as in software that is designed so that Official Observers and others can download many different types of recorder. The criterion for valid flight data is that the resulting flight data file passes the VALI check that is described above and where the VALI program has originated from the current IGC web pages.

CONDITIONS OF APPROVAL:

1 **Permitted Connections to the Recorder**. The connections are on the two end faces. The face above the LCD has the antenna, external display and power connectors and also an on-off switch. The face below the LCD and buttons has connections to a PC and Printer. Connectors are listed below:

1.1 Antenna connection. This can be a 9mm BNC bayonet fitting or a 9mm screw fitting.
1.2 9 pin male power socket to 12 volt power plug.
1.3 15-pin female socket to the manufacturer's display module.
1.4 9-pin RS232 female fitting for the cable connecting the recorder to the PC. A PC must not be connected between the takeoff of the claimed flight and the transfer of data after flight by an OO.
1.5.. 25-pin female connector to external printer.

2. **Security of the Equipment**. GFAC is presently satisfied with the security of this equipment for the types of flights listed above in (ii) above, subject to para 4 overleaf on the physical security seal.

2.1. **Installation in the glider** The recorder may be fitted anywhere in the glider, subject to para 3.2 on sealing and, for Motor Gliders, that 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. **Sealing of data ports and plugs**: no present requirement, but no attempt must be made to pass unauthorised data into the Recorder.

3. **Check of Installation in the Glider**. There must be incontrovertible evidence that the recorder was in the glider for the flight concerned. This can be achieved either by observation at takeoff or landing or by an OO sealing the recorder to the glider at any time or date before takeoff and the seal being checked after landing.

3.1. **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 recorder installation is checked. This is to ensure that the installation is in accordance with the rules, and that another recorder has not been substituted before the data is transferred to a PC after flight.

3.2. **Sealing to the Glider**. If para 3.1 cannot be met, the recorder must be sealed to the glider by an OO at any time or date before flight so that it cannot be removed without breaking the seal. The sealing method must be acceptable to the NAC and IGC. Paper seals must be marked in a manner such that there is incontrovertible proof after the flight that seals have not been tampered with, such as by marking with the glider registration, the date, time and OO's name and signature. 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 Recorder unit to glider parts that are part of the minimum standard for flight. It is accepted that such parts can be removed for purposes such as servicing; such parts include the canopy frame, instrument panel, and centre-section bulkhead fittings. If the recorder is sealed to such removable part, if such a part is transferred between gliders, any seal for the previous glider must be removed.

4. **Security Seals**. The screw heads on the case of the Recorder unit are sealed with the manufacturer's seal, which must not be broken. An internal security mechanism is also included and if the case is opened, flight data, turn points and other settings are deleted. Subsequently the electronic security check on IGC flight data files (VALI program) will fail. On switching on, the LCD should show "GR1000 SECURITY SEAL OK" for a short time. If the Recorder is found to be unsealed either physically or electronically, it must be returned to the manufacturer or his appointed agent for investigation and resealing, with a statement of how the unit became unsealed. Whenever any unit is resealed, the manufacturer or agent must carry out positive checks on the internal programmes 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.

4. **Motor gliders**. A microphone and frequency filter and weighting system automatically produces an ENL (Engine Noise Level) value with each fix between ENL values of 000 and 999. The system is designed to emphasise engine noise but at the same time produce positive but low ENL values in normal gliding flight. The Recorder should be positioned in the glider so that it can receive a good amount of engine and/or propellor noise when power is being generated. GFAC has tested the Recorder in motor gliders with two-stroke and 4-stroke engines, but not with Wankel or electric power sources. For details see para B.4.

4.1 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.

5. **Analysis of Flight Data**. This may be through any analysis programme that is approved by the relevant NAC. For a list of those which use the *.IGC file format, see the IGC GNSS web site under SOFTWARE).

5.1 VALI check. The validating agency must check that the IGC file is valid and unaltered, by the use of the latest version of the VALI-PES.EXE short program file that is available on the FAI gliding/gnss web site for free software given in the header above. See para B3.2 for how to use.

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.

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, England
Tel: +44 1420 564 195; Fax: +44 1420 563 140;
email: ian@ukiws.demon.co.uk

Annex A to IGC-approval document

NOTES FOR OWNERS AND PILOTS
PART OF IGC APPROVAL FOR PRINT TECHNIK GR1000 AND GR1000A

To be read together with the main terms of approval to which this is an Annex. It is recommended that a copy of this approval document including annexes 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**. Check that the recorder and its 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. Any abuse of this may lead to a future requirement to position antennas out of reach of the flight crew.

A2 **Geodetic Datum**. For flights to be validated to IGC/FAI standards, the WGS84 Geodetic Datum must be set. The GR1000 allows eight different Datums to be set, but it is emphasised that only WGS84 is a valid Datum for IGC/FAI purposes (IGC rule) and therefore pilots must ensure that it is set.

A3 **Cockpit Indications**. Lat/long can be shown on the LCD. For validation of presence in an IGC Observation Zone, pilots are recommended to fly a sufficient distance into an Observation Zone to ensure fixes in the Zone.

A3.1 Fix intervals. Fix intervals can be set through the setup menu between 5 and 60 seconds. In the air, extra fixes can be generated at any time by pressing the OK button which is on the right of the four buttons under the LCD. This also marks that fix in the IGC file and fulfils the Pilot Event (PEV) function. It also starts a set of 12 fixes at 5 seconds interval (1 minute). Near a Waypoint Observation Zone the 5 second interval is recommended.

A3. **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, you should ask an OO to seal the Recorder to the glider, and this can be done at any time or date before flight. See para 3 in the conditions of approval.

A4. **Takeoff**. The pilot must ensure that the time and point of takeoff has been witnessed and recorded for comparison with that recorded by the GNSS Recorder, see para B1.2.

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 Recorder. See paras 2.3 and 3 in the conditions of approval.

A6. **Use in Motor Gliders (including self-sustainers)**.

A.6.1 ENL system inoperative or not being used. Any Means of Propulsion (MoP) must either be sealed or inoperative, or a separate approved MoP recorder used.

A.6.2 Recorders with ENL system. The internal microphone and associated circuitry automatically 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 Recorder should not be covered or insulated, although even so, automatic gain should continue to ensure high ENL readings under power.

A6.2.1 Cockpit noise. Pilots should note that cockpit noises other than the engine will produce ENL readings, and should avoid those that could be mistaken for use of engine. Generally the frequency filtering built in to the Recorder will avoid any problems, but it should be noted that **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, particularly if sideslip is present**, as will spins and stall buffet, 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 B4.2. Pilots should analyse their flights and ensure that their recorder produces ENL values similar to those given in B4.2. If not, the recorder should be returned to the manufacturer or agent for re-calibration to B4 values.

A7. **After Flight** - The pilot must ensure that the time and point of landing has been witnessed and recorded for comparison with that recorded by the GNSS Recorder (see para B2.1). 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 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 Recorder, but witnesses the transfer and 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.

A8. **Calibration of Barograph Function**. Pilots are advised to have a barograph calibration carried out by an NAC-approved calibrator before any GNSS Recorder is used for a claimed flight performance. An IGC-format file showing the pressure steps used in the calibration must be recorded and kept. Altitude and height claims obviously require a calibration, but speed and distance claims also need a calibration for calculating the accurate altitude difference of the glider between 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.

A9 **Warning for original GR1000 models - Keep internal NiCad charged**.. You are recommended to switch the recorder on and charge it at least every 3 months to keep the internal Nickel Cadmium battery charged. A 10 hour charge is recommended by the manufacturer. If not, memory data and recorder security may be lost and the recorder will have to have a security re-set by the manufacturer of an agent authorised to carry out such work. The later GR1000A model has a longer-lasting Lithium-based internal battery.

Annex B to IGC-approval document

NOTES FOR OFFICIAL OBSERVERS AND NACs -
PART OF IGC APPROVAL FOR PRINT TECHNIK GR1000 AND GR1000A

This should be read together with the main terms of approval to which this is an Annex. It is recommended that a copy of this approval document is kept with the equipment concerned, for the use of pilots and Official Observers (OOs). OOs should note that the GR1000A is IGC-approved for all flights including world records, the original GR1000 model is IGC-approved for all IGC Badge and Distance Diploma flights and not for world record flights. See para (ii) at the beginning of this document.

B1. **Installation and Takeoff Records**

B1.1. **Installation in the Glider**. An OO shall witness and record the position of the recorder in the glider, the type and serial number of the recorder, the glider type and registration, date and time. On switching on, the LCD sequence includes VERSION (3.3 for original GR1000 models, 5.0 or later for GR1000A models), S/N (serial number of the individual recorder), and "GR1000 SEAL VERIFIED OK". The procedures in this paragraph and the sub-paras below are to ensure that the installation is correct, and that another Recorder has not been substituted in the glider before the transfer of flight data (B2.3). See paras 2 and 3 of the Conditions of Approval.

B1.1.1. Sealing to the glider. At any time or date before flight, if requested, the OO may seal the Recorder to the glider structure in a way acceptable to his NAC and to IGC. This is the preferred option because it makes it easier for the pilot on the day of flight.

B1.1.2. If sealing is not used. Either a pre-flight check of the installation must be made on the day of flight or an OO must witness the landing, but see the qualifications that follow. After the pre-flight check on the day, the glider must be under continuous observation by an OO until it takes off on the flight concerned. Where an OO witnesses the landing, the glider must be under continuous observation until the Recorder installation is checked.

B1.2. **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 shall be compared to the Recorder takeoff data.

B2. **Landing**.

B2.1. **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 shall be compared to the Recorder landing data.

B2.2. **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 B1.1 above. The transfer of flight data shall then take place in accordance with B2.3.

B2.3. **Transferring the Flight Data to a PC**. If a portable PC is available, the flight data may be transferred at the glider without disturbing the installation of the Recorder. If a portable PC is not available, the OO shall check and break any sealing to the glider, and take the Recorder 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 Recorder and in the downloaded file. This is then independently checked later at the NAC (and at FAI if the claim goes to them).

Method: Connect the PC to the male 9-pin RS232 data port on the recorder by a cable with female RS232 connectors at each end. Either use an authenticated version of the free DATA-PRT.EXE (a floppy disk can be used, or the computer hard disk), or use the manufacturer's program "GR1000", following the instructions given in the menu.

A IGC-format flight data file will be produced with the file name YMDRXXXF.IGC, where Y=year, M=month, D=day, R= manufacturer, XXX = Recorder Serial Number and F = flight number of the day (full key, Appendix 1 to the IGC GNSS Recorder Specification).

A copy of the downloaded file shall be retained securely by the OO such as by immediately copying it to a separate diskette or PC card, or by the use of a PC independent of the pilot. The downloaded file for the flight shall be retained by the OO in safe keeping for later checking and analysis under NAC procedures.

Competitions: Different rules may apply for competition flights, for which a central data transfer facility may be used, but for flights to IGC record and badge rules the above must be followed, and allowed for in competition procedures.

B.3. **Analysis of flight data**. A Data Analyst approved by the NAC will then evaluate the flight using an analysis program approved by the NAC concerned. For a list of programs that analyse the IGC flight data file format, see the IGC GNSS web site under SOFTWARE. First, the version of the program VALI-PRT.EXE that is on the FAI gliding/gnss web site shall be used by the organisation validating the flight to check the integrity of the file for the flight. This organisation may be the NAC and later FAI for data sent to FAI for checking. The VALI program checks the electronic security coding in the file, that the Recorder from which it was downloaded has not been interfered with, and that the flight data is identical to when it was initially downloaded.

Method: at the appropriate prompt or run function, type VALI-PRT.EXE followed by a space and the full name of the file to be checked (which must be in the same directory as the VALI program file and can be on a floppy disk). The message "SECURITY CHECK passed" should appear, not "SECURITYCHECK failed!". In the latter case the flight data is invalid and the circumstances of the failure should be investigated before the recorder security is re-set by the manufacturer or an agent authorised to carry out such work.

B4. **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 350 for winch and 300 for aerotow have been recorded. During the ground roll, short-term higher values up to 600 have been seen, probably due to wheel rumble, particularly on hard surfaces.

B.4.2 **ENL during engine running**. On engine running at powers needed to climb, an increase to an average of over 650 ENL is expected. Over 850 is typical for a two-stroke engine, over 700 for a 4-stroke. An ENL value of 996 has been recorded with both two- and four-stroke engines 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. 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.4.2.1. **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 200 indicate normal gliding flight in a quiet cockpit environment in a well-sealed glider. In a high-speed glide or in an aerodynamically-

noisy glider, ENL may increase to about 300. Short periods of higher ENL while gliding (up to about 350 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) or ventilation panel(s) open can produce low frequency noise ("organ-pipe" effect) and ENL readings of up to 450 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 400 have been recorded, although 300 is more typical in an aerodynamically noisy glider, and 200 in a quiet machine.

B.4.5 **ENL during landing**. During ground contact during landing, short-duration ENL values up to 650 have been recorded, probably due to wheel squeak and rumble, particularly on hard surfaces. Unlike engine running these last only for a short time, showing a short spike on the noise/time record.

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 cockpit panel combined with sideslip and /or 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 shall be analysed in accordance with Sporting Code procedures. Part of this is to compare the general shapes of the GNSS altitude and pressure altitude records with time and to ensure that no major differences are seen that could indicate a problem in recording or even artificially-manufactured (false) data. As part of this process, the Recorder must be calibrated in an altitude chamber in the same way as a drum barograph.

B.5.1 **Calibration method, making a calibration table**. The Recorder can be calibrated in an altitude chamber in the same way as a drum barograph. To put the recorder in calibration mode, push and hold the up, down and right buttons (the left three out of four) and switch on the recorder. Keep pressed until the display shows "TESTMODE OK". Press the OK button to start the calibration mode. The recorder and its battery can then be placed in the pressure chamber and the calibration started. The calibrator should be asked to record the pressure steps used, for later comparison with the IGC file for the calibration. 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, at a non-gliding calibration centre, may not have this knowledge. The IGC format calibration data file will then be analysed, compared to the calibration pressure steps, and a correction table produced and authenticated by an NAC-approved person (for instance an OO or GNSS Recorder Data Analyst). The correction table will list true against indicated altitudes. This table can then be used to adjust pressure altitudes which are recorded during flight performances and which require correction before validation to IGC criteria. These include takeoff, start and landing altitudes for altitude difference and for comparison with independently-recorded QNH readings, and low and high points on gain-of-height and altitude claims. Only pressure altitude is

valid for IGC altitude purposes except for proof of flight continuity (no intermediate landing) where GNSS altitude may also be used.

B.5.2 **GPS altitude figures recorded in IGC flight files**. Occasional short-duration differences in the shape of the GPS altitude/time graph for flights 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 systems. The altitude accuracy from satellite-based systems will not be as good as accuracy in lat/long, because satellite geometry is not as favourable for obtaining accurate altitude fixes compared to fixes of horizontal position. This effect will be increased by poor antenna positioning in the glider. Data analysts and NAC officials should allow for the above when comparing the GPS altitude and pressure altitude records. Lat/long fix accuracy is not affected. From GFAC tests after 1 May 2000 when the GPS Selective Availability error was removed, the lat/long error taken from a moving vehicle at a surveyed point, averages between 11 and 12m for all 12 channel recorders tested since that date.

B.5.3 **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 in IGC files that apply to this recorder are given below.

B.5.3.1 **Pressure Altitude**. The maximum pressure altitude tested by GFAC (1997) was 37,000 ft on the ICAO ISA.

B.5.3.2 **GNSS altitude**. This is recorded in figures above the WGS84 ellipsoid. GNSS altitude is not used for the purpose of IGC altitude measurement (for instance gain of height and altitude performances), for which pressure altitude to the ICAO ISA is required.
