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of the
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References: See para (i-iv) below

To: IGC GNSS web site under "IGC-approval Documents"
FR Manufacturer, info to igc-news@fai.org, newsgroup rec.aviation.soaring

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IGC-APPROVAL DOCUMENT FOR GNSS FLIGHT RECORDER

Maker - Recorder Name:	**Triadis -**	**Recorder Unit Versions 1-3 (RU1, RU2, RU3)**
Levels of Approval:	**RU1 & 3 -**	**All flights (see para i-ii)**
	RU2 -	**Badges and Distance Diplomas (see para i-ii)**

(i) General. This document gives formal approval from the above date for the Recorder equipment described below to be used for validation of flights under the FAI Sporting Code Section 3 (Gliders and Motor Gliders), subject to the conditions and notes given later. Only the terms of the latest IGC-approval documents currently posted on the IGC web site are valid for use for IGC/FAI claims. IGC reserves the right to alter this approval in the future.

(i-i) Document Versions and Scope. The initial approval for the Triadis Recorder Unit Version 1 (RU1) was dated 14 February 2009. An update dated 31 March 2013 added Recorder Unit Version 3 (RU3) and RU2 was added 5 May 2013. Reference to the FAI/IGC web site was changed in the version dated 1 February 2020. A version dated 20 May 2020 included a new para (i-iv) with directions to the current web sites for documents related to the FR IGC-approval process, and the GFAC Chairman's new email address on page 4. This document changes the Chairman's address and contact e-mail address and removes references to the Chairman's website and other inactive website links

(i-ii) IGC-approval Levels. For RU1 and RU3 this is IGC Level 1 - all flights including world records. For RU2 this is IGC Level 2 - flights for all IGC Badges and Distance Diplomas. For the reasons, see para 9.2 on page 4. The Levels of IGC-approval are listed in Annex B to the Sporting Code (SC3B).

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

(i-iv) Current web sites. References for the latest versions of documents relating to IGC-approval of FRs (including the latest version of this document) are given in para 2 on page 1 of the main table that lists all IGC-approvals. The latest version of the table is available through www.fai.org/igc-documents . The detailed references are placed in the main FR table rather than in each IGC-approval document, so that if the reference changes, only the main table has to be updated rather than all IGC-approval documents.

*(ii) This IGC-approval 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.

MANUFACTURER

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1. HARDWARE

1.1 **Recorder Name**. Triadis Recorder Units Version 1,2 and 3 (RU1, RU2, RU3). The RU1 is also known as the Altair. This is shown in the header record of IGC-format files in the form: "HFFTYFrType:Triadis Altair RU1" (for RU2: "Triadis RU2", for RU3: "Triadis RU3").

1.2 **Hardware Version**. This is Version 1 for RU1, RU2 V1 for RU2 and Version 3 for RU3. The Version number is shown in the header record of IGC files in the form " HFRHWHardwareVersion: Triadis Altair RU V1.0" (or "RU2 V1.0", or " RU V3.0").

1.3 **Dimensions, Weight, Power Source**. The case of the RU1 is 86 x 57 x 26mm in size, less connectors that extend a further 10 mm from one of the 57 x 26mm ends. The RU2 & 3 are slightly smaller at 84 x 55 x 24 mm. In the RU 2 & 3, three pressure connectors for pitot, static and Total Energy extend 22mm from the opposite end to the connectors. The RU1 weighs about 150 grammes and the RU2 & 3 about 125 grammes. The RU1 works between 8 and 16 Volts DC and the RU 2 and 3 between 9 and 31 Volts DC. The RU1 has an internal LiIon battery for running the recorder, RU 2 and 3 require external power.

1.4 **GPS receiver**. RU1 has the 16-channel LEA-4P GPS receiver, RU 2 and 3 have the LEA6A, both from u-blox of Switzerland . The type of receiver and the number of channels are shown in the header record of IGC files in the form "HFGPS:uBloxLEA-4P,16,18000" (or LEA6A,16,18000). The last figure is the maximum altitude in metres processed by the recorder to the altitude resolution requirements of the IGC FR Specification.

1.5 **Pressure altitude sensor.** RU1 is fitted with the MS 5540 Pressure Altitude sensor and RU 2 and 3 with the MS5607-02BA01, both from Measurement Specialities (ex-Intersema) of Switzerland. This is shown in the header record of IGC files in the form "HFPRS PressAltSensor:IntersemaMS5540,15000" (or IntersemaMS5607,15000). The last figure is the maximum altitude processed by the recorder to the altitude resolution requirements of the IGC Specification. The pressure altitude system is compensated for temperature variation and calibrated to the ICAO ISA. The recorder case is not pressure-sealed and "cockpit static" pressure is recorded.

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

2. **FIRMWARE.** Firmware Version 1.0 is the IGC-approved standard for RU1, Version 2.0 for RU2 and Version 3.0 for RU3. See para 10 below on updates. The firmware version is listed in the header record of IGC files in the form: "HFRFWFirmwareVersion:1.0" (for RU2, Version 2.0, for RU3, Version:3.0).

3. SOFTWARE

3.1 Downloading Flight Data. Downloading is either through the RJ45 connector on the RU or to a USB memory stick on the Display Unit. For the RU, a cable with an RJ45 wired to the IGC standard supplies power and connects to a PC; downloading is through the IGC Shell system that is available from the IGC GNSS Recorder and the GFAC web sites (see the references at the top of Page 1).

3.1.1 IGC Shell Files. The file igcdll.zip should be downloaded into a specific directory in the PC that is named in advance (the name IGCshell is recommended). For the shell program to work, the Dynamic Link Library (DLL) file from the recorder manufacturer must be copied to the IGC Shell directory. For the RU1 & 2 units, the file IGC-TRI.DLL is available from the IGC GNSS Recorders and the GFAC web sites. For the RU3 the file IGC-TRI2.DLL should be used.

3.1.2 Latest versions. The latest versions of the files in igcdll.zip and the manufacturer's DLL files must be used, obtained from the IGC GNSS Recorder and GFAC web sites.

3.2 Validation of Flight Data. The IGC standard for electronic flight data is that the IGC file must pass the IGC Validate check that is part of the IGC Shell program, see B3.4 for more details. The IGC Validate procedure checks that the IGC file has correctly originated from a specific recorder and that it is identical to when it was initially downloaded.

4 Connectors and Display.

4.1 RJ45 Connector. An RJ45 connector is on a 57 x 26mm face. In RU1 this is for DC power, connecting to the Triadis Display Unit (DU), and for other functions. In RU 2 and 3 it can be connected to a Pilot Event (PEV) button and supply DC power when the Butterfly DU is not connected. In both RU1-3, a RJ45 plug wired to the IGC standard can be used to connect to a PC independent of the DU.

4.2 GPS Receiver Antenna. A SMC (Sub-Miniature type C) screw-type GPS antenna connector with 4mm female and 3.5mm male components is on a 57 x 26mm face.

4.3 Circular Connectors. RU1 has an 8mm diameter female 4-pin M8 connector on a 57 x 26mm face for an external PEV button and RPM signal interface, where a motor glider RPM-related variable is to be recorded in addition to ENL. RU2 and 3 has a 12mm diameter M12 CAN Bus socket for other units such as the Butterfly Display Unit to connect to the CAN Bus.

4.4. Display Unit (DU). The RU units can operate on their own or with a Display Unit (DU), but this IGC-approval applies only to the RU.

4.4.1 RU1. The RU1 is designed to be connected to the Triadis Altair DU via the RU1's RJ45 socket.
4.4.2 RU2 & 3. The RU2 and 3 are designed to be connected to the Butterfly Vario DU via the RU's 12mm socket. The DU is made by Triadis for Butterfly Avionics GmbH of Sandhausen, Germany .

5 **Security of the Equipment**. GFAC is presently satisfied with the physical and electronic security of this equipment in terms of the integrity of the recorded flight data and the level of this approval for the types of flights concerned. See paras 8.1 and 8.2 on security seals. GFAC reserves the right to inspect production-standard equipment 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 RU may be fitted anywhere in the glider, subject to para 7.4 on ENL and para 8 on sealing. However, the position of displays and operating buttons and controls used in flight in single-seat gliders 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**. A microphone and frequency filter and weighting system automatically produces an ENL (Environmental Noise Level) value with each fix. The system is designed to highlight any engine and propeller noise but to produce low ENL values in gliding flight. The ENL system is mandatory for Motor Gliders in order to show that the engine was not used to produce forward thrust during the part of the flight that contains the claimed glide performance. ENL data has also been shown to be useful for non-motor gliders in the case of accidents and incidents.

7.1 ENL Recording System Manufacturer. The ENL system is made by the recorder manufacturer Triadis.

7.2 ENL figures. ENL figures in each fix in the IGC file are between 000 and 999 in steps of 001.

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

7.3.1 Low-ENL Engine/Recorder combinations This approval does not include cockpit mounting of the FR when used with engines that produce small ENL values at the Recorder, particularly at low power when just producing positive forward thrust. Such engines include those that are electrically or jet powered, the latter because the noise is at higher frequencies than those for which the ENL system is designed. It may also apply to some 4-stroke engine/propeller combinations that are particularly quiet. If the FR position produces low-ENL values when the engine is run at low powers, there are two alternatives: (1) either the FR must be moved closer to the source of engine noise, or (2) another variable additional to ENL must be recorded in the IGC file under the MOP (Means of Propulsion) code, in accordance with Annex B to the Sporting Code for Gliding, para 1.4.2, particularly 1.4.2.4.

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

7.5 ENL testing. For details of typical ENL values found on GFAC tests with internal combustion engines, see para B.4.

8. **Check of Installation in the Glider**. There must be incontrovertible evidence that the recorder was in the glider for the flight concerned, and was installed and operated in accordance with IGC procedures. This can be achieved either: by independent Observation at takeoff or landing, or by sealing the Recorder to the glider at any time or date before takeoff and checking the seal after landing. For how this is to be done, see para B1 later in this document.

9 **Security - Physical and Electronic**.

9.1 Physical Security. Tamper-evident seals with the with the text "Security void if broken" are fitted over screws that hold the case together. In addition, an internal security mechanism activates if the case has been opened.

9.2 Electronic Security. RU1 & 2 have the same level of electronic security, RU3 has a higher level. The reason for the difference in IGC-approval level between RU1 and 2 is that RU1 was approved in 2009 and has "Grandfather Rights" at All Flights approval level, whereas RU2 was approved in 2013 under higher requirements that had been added since 2009 to the IGC FR Specification. If the internal security mechanism has been activated, the security record (G-record) will be removed from subsequent IGC files and a line placed in the IGC file header record that includes the words "SECURITY CHECK FAILED". Also, such files will fail the IGC Validation test for electronic security. This test will also fail if the IGC file being analysed is different from that originally downloaded from the Recorder, even by one character in the flight data area. Firmware updates are encrypted and the encryption key is known only to the manufacturer. The firmware state is checked during power-up. If corrupted or tampered firmware is detected, depending on the nature of the problem, either IGC files will not be generated or if they are, they will fail the IGC Validate test (see 3.2 above and B3.3.1.1 later).

9.3 Recorder found to be unsealed. If either physical or electronic security is found to have failed, before it can be used again for flights to the IGC standard, the Recorder must be returned to the manufacturer or his appointed agent for investigation and resealing. A statement should be included on how the unit became unsealed.

9.3.1 Checks before re-sealing. Whenever any unit is resealed, the manufacturer or his agent must carry out positive checks on the internal programs and wiring, and ensure that they work normally. If any evidence is found of tampering or unauthorised modification, a report must be made by the manufacturer or agent to the Chairman of GFAC and to the 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 **Manufacturer's Changes, later Versions of Hardware, Firmware and Software**. Notification of any intended change that might affect the recording function, the structure and security of IGC files, or security of the FR (both physical and electronic) 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. It includes changes to modules inside the recorder such as GPS receiver units, pressure altitude sensors, and so forth. If in doubt, GFAC should be notified.

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Annexes: A. Notes for owners and pilots.
B. Notes for Official Observers and NACs

Annex A - **NOTES FOR OWNERS AND PILOTS - PART OF IGC APPROVAL**

A(i) Status. To be read together with the main terms of approval to which this is an Annex.
A(ii) IGC-Approval level. See page 1 heading "Levels of Approval".
A(iii) Copy of this document. It is recommended that a copy of this 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 **WGS84 Earth Model**. This type of recorder is fixed on the WGS84 ellipsoid earth model and no selection or switching is required. However, it should be ensured that other lat/long data such as for start, turn and finish points, also use the WGS84 ellipsoid earth model (IGC rule).

A3 **Setting the Fix Interval**. The fast-fix facility operates when the Pilot Event (PEV) button is pressed. This is either through a cable connected to the RU or by a button on the Display Unit. The next fix in the IGC file is marked with the PEV code, and the next fixes at the fast rate selected in the set-up program, one second intervals being recommended. The fix interval for cruise flight is also set through the set-up program. There is therefore no need to set the cruise fix interval to a short value, because Waypoint Observation Zones and other points of interest can be marked by PEV events followed by fast fixes. Setting a short slow-interval would lead to IGC files of an unnecessarily large byte size being created for long flights. This uses up more 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 a maximum of 60 seconds (SC3 para 4.3.1 and Annex C to SC3, para 7.1) and 10 seconds for competitions using 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. It is the pilot's responsibility to ensure that the recorder is performing correctly and in accordance with this approval, for instance ensuring that GPS fixes, pressure altitude, ENL and other values are recorded as expected. In particular, ENL values should be in accordance with the figures given in para B5. See also A8 on ENL and A13 on pressure altitude calibration.

A5 **Pre-flight Declaration in the IGC file**. Electronic pre-flight declarations of Waypoints are made either through the Triadis Recorder Unit Tool that inputs directly into the Recorder Unit, the appropriate progam for the Display Unit, in the case of the Butterfly DU through the use of its buttons, or an equivalent program. Before making a flight that is to be claimed and requires a pre-flight declaration, pilots are advised to check that they can successfully carry this out. Also, that an IGC file is produced that satisfies the Sporting Code on electronic pre-flight declarations (for instance after an OO who is familiar with these SC3 rules has checked the IGC files).

A6 **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. On the position of the DU, see para 6 in the Conditions of Approval which refers to sight-lines and the need for pilot lookout and scan.

A7 **Takeoff**.

A7.1 Switch on. Pilots are advised to switch on at least 5 minutes before takeoff and check that GPS lock-on has occurred in time to establish a baseline of fixes before takeoff starts. GPS lock-on is indicated by the LED on the Recorder Unit flashing every 2 seconds, or by the Display Unit indicating lock-on.

A7.2 Independent evidence of Takeoff. The pilot must ensure that the time and point of takeoff has been independently witnessed and recorded for comparison with takeoff data in the IGC file from this recorder, see para B1.2.

A8 **Connection to Ports**. Although this approval does not presently require sealing of any ports or plugs, no attempt must be made to pass unauthorised data into the Recorder. See para 9.1.1 in the Conditions of Approval.

A9 **Use in Motor Gliders** (including self-sustainers): The internal microphone and associated circuitry automatically records the level of acoustic noise at the recorder. This is recorded in the IGC file with each fix. The recorder must be placed so that engine noise is clearly received when the engine is giving power and must not be covered or insulated (even so, automatic gain should continue to ensure high ENL readings under engine power).

A9.1 Cockpit Noise. Pilots should note that cockpit noises other than the engine will produce ENL figures on the IGC file, and should avoid those that could be mistaken for use of engine. **Flight with the cockpit Direct Vision (DV) and/or ventilation panel(s) open can produce a low-frequency sound (organ-pipe note) which will register as high ENL. This is magnified if sideslip is present and in particular at high airspeeds. High airspeeds and climbing with cockpit panels open should therefore be avoided in case the ENL recorded is mistaken for use of engine**. High ENL may also be produced by stall buffet and spins, particularly in Motor Gliders if the engine bay doors flutter (vibrate or move in and out). Flight 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.

A9.2 Pilot check of ENL figures. Pilots should check that the ENL figures produced by their recorder show a clear difference between engine-on and engine-off flight. ENL figures should be in accordance with those found in GFAC tests and listed in para B5. This may be vital on a later flight when a claim is made. If ENL figures are found to be significantly different to those in para B5 when using internal combustion engines, the recorder should be returned to the manufacturer for the ENL system to be re-set. For engines producing low ENL (such as electric or others), such a motor glider will require, in addition to ENL, an RPM-related variable to be recorded in the IGC file, in accordance with Annex B to the Sporting Code, para 1.4.2.4.

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

A10.1 After-flight calculation of security. After landing, the recorder calculates a digital signature for the IGC file for the flight. This process places security codes at the end of the IGC file for the last flight, which is then 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 of the IGC Shell program with the IGC-TRI.DLL file in the same directory (IGC-TRI2.DLL for the RU3). The digital signature is calculated and the IGC file is ended after a landing is detected.

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

A12 **Switching Off**. This is by disconnecting external power from the Recorder Unit which may come through the Display unit or used on its own. The RU1 has an internal battery which must also be switched off to avoid battery drain.

A13 **Downloading the Flight Data**. Downloading is either through a memory stick attached to the USB port on the display unit (when the display unit is connected to the recorder), or through the RJ45 connector on the recorder and the IGC Shell program. For more details, see B3.3.

A13.1 OO's actions. An OO will then carry out the actions given in para B3.3, and the OO's copy of the transferred flight data will be sent to the organisation that will validate the flight, such as the National Airsport Control authority (NAC). The OO does not personally have to transfer the data from the Recorder, but witnesses the transfer, and immediately after takes or is given a copy on electronic media such as a memory stick, storage card or equivalents.

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

A14 **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. 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.

Annex B - **NOTES FOR OFFICIAL OBSERVERS AND NACs - PART OF IGC APPROVAL**

B(i) Status. To be read together with the main terms of approval to which this is an Annex.
B(ii) IGC-Approval level. See page 1 heading "Levels of Approval".
B(iii) Copy of this document. It is recommended that a copy of this document is kept with the equipment, for the use of pilots and OOs.

B1 **Installation in the Glider**. An OO shall witness and record the position of the Recorder in the glider, the type and Serial Identification (S/ID) of the Recorder, the glider type and registration, date and time. Before flight, if requested, the OO shall then seal the Recorder to the glider in a way acceptable to his NAC and to IGC, and such sealing may be at any time or date before flight. If sealing is not used, either a 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. 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 Downloading the Flight Data. Downloading is through the RJ45 connector on the recorder or through a memory stick attached to the USB port on the display unit. If the RJ45 connector is used, a cable wired to the IGC standard is needed to supply power and to connect to a PC; downloading is through the IGC Shell program that is available from the IGC GNSS and GFAC web sites in the file igcdll.zip. The manufacturer's DLL file IGC-TRI.DLL must be in the IGC Shell directory (IGC-TRI2.DLL for the RU3). For the IGC Shell program, see paras 3.1/2 before the Annexes and also in B4 for Validation of IGC files. Security is maintained by coding embedded in the Recorder which is then independently checked later at the NAC (and at FAI if the claim goes to them).

B3.3.1 Files Produced. This process will automatically produce an *.IGC-format ASCII flight data file with the file name YYY-MM-DD-TRI-XXX-NN.IGC , where Y=year, M=month, D=day, XXX = Recorder Serial Identification (S/ID)/letters and N = flight number of the day (full key, Appendix 1 to the IGC GNSS Recorder Specification, copied in Annex C to the Sporting Code, SC3C).

B3.3.2 OO's Copy. A copy of the IGC file shall be retained securely by the OO such as by immediately copying them to storage media such as a memory stick, data card, or the hard disk of the OO's own PC. The IGC file shall be retained by the OO in safe keeping for later checking and analysis under NAC procedures. The OO may keep the required data file on industry-standard portable storage media. The hard disk of another PC may also be used but the OO must be able to positively identify the flight data file as being from the flight concerned. For this purpose, takeoff and landing data independent of the IGC file must also be available, see above in B2 and B3.1.

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

B4 **Validation and Analysis of Flight Data Files**. Before a Flight Performance is officially validated, the authority responsible for validation must check that the data in the IGC file has originated from the Recorder concerned, and is identical to the file that was downloaded from the Recorder to the PC. This is done by checking the IGC data file with an authorised copy of the IGC Shell program and using the Validate function in the IGC Shell menu (see below). The firmware manufacturer's DLL file will also be needed in the IGC Shell directory. The shell program and DLL file must be the same as those on the current FAI/IGC web site for software at the beginning of this document. A Data Analyst approved by the NAC shall carry out this IGC Validation check on the IGC file and then evaluate the detailed flight data using an analysis programme approved by the NAC concerned.

B4.1 IGC Shell Program. Download the IGC Shell program from the IGC GNSS web pages under "software" and place all the files in one directory (the name IGC Shell is recommended). These files are available on the IGC GNSS web pages through the file igcshell.zip. For the shell program to work with a particular Recorder, the appropriate Dynamic Link Library (DLL) file from the recorder manufacturer must be copied to the IGC Shell directory. After copying it to the directory that contains the IGC Shell files, execute IGC-SHELL.EXE. Set the path to the IGCshell directory using the "Set Directories" button on the screen. The IGCshell menu will now appear in a grey rectangular box with 9 software buttons for selecting the recorder type, recorder settings and flight logs. The recorder software box at the top should now include the line "Triadis recorders". This should be selected. With the recorder connected to the PC and the correct Com Port selected on the IGCshell screen, selections for data Download and Validation can now be made using the screen buttons provided. You can now download the flight data that appears directly in IGC format.

B4.1.1 Validation of IGC files. To gain access to the IGC file for this recorder, the DLL file from the recorder manufacturer (IGC-TRI.DLL for the RU1 & 2, IGC-TRI2.DLL for the RU3) must be in the same directory as the IGC Shell program. With the recorder connected to the PC and the IGC Shell program menu selected, select the manufacturer from the top menu box, press the "Validate" button and select the IGC file that is to be checked. If successful, the message "File has been successfully validated" appears. If there is a security problem, the message "Validation check failed" appears, together with a reason.

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

B5. **Means of Propulsion (MoP) Record - Motor Gliders**. The MoP must either be sealed or inoperative, or the built-in Environmental Noise

Level (ENL) system used. This has a microphone in the recorder that enables the acoustic noise at the recorder to be transformed into three numbers that is added to each fix on the IGC file. ENL values recorded on GFAC tests are given below, in the sequence of a flight.

B5.1 ENL during launching. During winch and aerotow launches, higher ENL values are to be expected than when soaring (B4.3), typically up to 180 for winch and 150 for aerotow. During the ground roll, short-term higher values have been recorded, probably due to wheel rumble, and values of 300 have been seen for one or two fixes.

B5.2 ENL during engine running. On engine running at powers needed to climb, an increase to over 700 ENL is expected. Over 900 is typical for a two-stroke engine, over 700 for a 4-stroke. An ENL value of 999 has been recorded with a two-stroke engine running at full power. During engine running, these high ENLs are produced for a significant time, and when altitude and speed are analysed it can be seen that substantial energy is being added, which can therefore be attributed to energy not associated with soaring. The values quoted above are for 2- and 4-stroke engines. Previous tests with Wankel (Rotary) engines indicate that they produce similar ENL values to 4-strokes.

B5.2.1 Engines producing low ENL signatures. This approval does not include use with Motor Gliders with engines that produce low ENL signatures (see Para 7.3 in the Conditions of Approval). Engines such as electric, jet, or a well-silenced 4-stroke produce low ENL values. Such a motor glider will require, in addition to ENL, an RPM-related variable to be recorded in the IGC file, in accordance with Annex B to the Sporting Code, para 1.4.2.4.

B5.3 ENL during gliding flight. ENL readings of less than 030 indicate normal quiet gliding flight. Short periods of higher ENL while gliding may indicate aerodynamic noises. In a high-speed glide, or in a noisy glider, the ENL may increase to 150. Particularly, sideslip or high speeds with the cockpit Direct Vision panel open can produce low frequency noise ("organ-pipe" effect) and ENL readings of up to 350 have been recorded. High ENL may also be recorded during stalling and spinning, particularly if the engine doors flutter or vibrate (move slightly in and out due to stall buffet, producing a clattering noise). Finally, where the engine is mounted on a retractable pylon, a high ENL reading will be shown if flying with the pylon up and engine not running, due to the high aerodynamic noise.

B5.4 ENL during the approach to land. ENL values are always higher on a landing approach due to aerodynamic noises such as due to airbrakes, undercarriage, sideslip, turbulence, etc. Short-term peaks due to specific actions such as opening airbrakes, lowering undercarriage, etc., will be noted as well as a generally higher level of ENL because the glider is no longer aerodynamically clean. ENL values of up to 150 have been recorded, although 080 is more typical.

B5.5 ENL during landing. During ground contact during takeoff and landing, short-duration ENL readings of up to 550 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.

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

B6 Altitude analysis and calibration

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

B6.1 Calibration method, making a calibration table. For a pressure altitude calibration, the GPS antenna must be disconnected before power is applied. When recording, this is detected and puts the recorder in calibration mode with a fix interval of 1 second. Recording starts after a pressure change of 1 metre per second for 5 seconds, and no GPS fixes are required for a pressure altitude trace to be produced. Date/time will be provided by the Real-Time Clock in the Recorder Unit (sustained by the small sustainer battery when external power is off) and this will be recorded in the IGC file and in the file name. The calibrator should be advised to make a short pressure change to trigger recording before starting the calibration itself. The calibrator will record the pressure steps used, for later comparison with the flight file. The stabilised pressure immediately before the altitude is changed to the next level, will be taken as the appropriate value unless the calibrator certifies otherwise. After calibration, the recorder must be turned off for at least 5 minutes before being turned on again to read out and download the calibration record.

B6.1.1 After Calibration. After the calibration, the data file containing the pressure steps is transferred to a PC as if it was flight data (see B3.3 above); this may be done by an NAC-approved person other than the calibrator who may not have this knowledge. The IGC format calibration data file will then be analysed, compared to the calibration pressure steps, and a correction table produced and authenticated by an NAC-approved person (for instance an OO or GNSS Recorder Data Analyst). The correction table will list true against indicated altitudes. This table can then be used to adjust pressure altitudes which are recorded during flight performances and which require correction before validation to IGC criteria. These include takeoff, start and landing altitudes for altitude difference and for comparison with independently-recorded QNH readings, and low and high points on gain-of-height and altitude claims. Only pressure altitude is valid for IGC altitude purposes except for proof of flight continuity (no intermediate landing) where GNSS altitude may also be used. and the file should be kept with the calibration paperwork so that it is not confused with other calibration files. As the original IGC file will have a nominal date/time, the file can be copied and the file name changed to one that can be identified as the calibration. A text editor can be used to change add a realistic date and time, although this will mean that the Validation check will fail and the original IGC file must also be kept unaltered.

B6.2 GPS altitude figures recorded in the IGC file. Occasional short-duration differences in the shape of the GPS Altitude/time graph have been noted compared to the pressure altitude figures. This is not unusual with GPS receivers operating without a local differential beacon. The altitude accuracy from satellite-based systems will not be as good as accuracy in lat/long, because satellite geometry is not as favourable for obtaining accurate altitude fixes compared to horizontal position. This effect may be increased by less-than ideal antenna positioning in some gliders. Data analysts and NAC officials should allow for the above when comparing the GPS altitude and pressure altitude records. Lat/long fix accuracy is not affected and tests on this recorder show it to be typical of that for a 12 channel GPS system. From GFAC tests, the lat/long error taken from a moving vehicle at a surveyed point in average reception conditions, shows an average error of between 11 and 12m for all recorders tested.

B6.3 Maximum Altitudes Recorded in the IGC file. The GPS system is capable of recording to almost unlimited altitudes, certainly up to 30km/100,000ft. The pressure altitude sensor is also capable or recording to high altitudes, although as air density reduces at height, a small pressure step becomes a large altitude difference. However, the type of processor in the recorder and the need for good resolution (small steps) across the altitude range, results in limitations in altitudes that can be recorded in the IGC file. The maximum altitudes for figures in IGC files that apply to this recorder are given below.

B6.3.1 Pressure Altitude. Pressure altitudes are recorded up to 15km (49,213 ft).

B6.3.2 GNSS altitude. GPS altitude is recorded up to 18km (59,055 ft).
