



FÉDÉRATION AÉRONAUTIQUE INTERNATIONALE

**ANNEX B
to
FAI SPORTING CODE
SECTION 3**

**FAI AIRCRAFT CLASSES D AND DM
GLIDERS AND MOTOR GLIDERS**

**REQUIREMENTS
FOR EQUIPMENT USED FOR
THE VALIDATION OF FLIGHT PERFORMANCES**

**EDITION 3 WITH AMENDMENTS 1-5
EFFECTIVE 1 OCTOBER 2009**

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Permission and authority to exploit any rights to any commercial activity at such events, including but not limited to advertising at or for such events, use of the event name or logo for merchandising purposes and use of any sound and/or image, whether recorded electronically or otherwise or transmitted in real time, must be sought by way of prior agreement with FAI. This includes specifically all rights to the use of any material, electronic or other, that forms part of any method or system for judging, scoring, performance evaluation or information utilised in any FAI International Sporting Event {7}.

Each FAI Air Sport Commission {8} is authorised to negotiate prior agreements on behalf of FAI with FAI Members or other entities as appropriate, of the transfer of all or parts of the rights to any FAI International Sporting Event (except WorldAir Games events {9}) which is organised wholly or partly under the Sporting Code section {10} for which that Commission is responsible {11}. Any such transfer of rights shall be by "Organiser Agreement" {12} as specified in the current FAI Bylaws Chapter 1, para 1.2 Rules for Transfer of Rights to FAI International Sporting Events.

Any person or legal entity which accepts the responsibility for organising an FAI Sporting Event, whether or not by written agreement, in doing so also accepts the proprietary rights of FAI as stated above. Where no formal transfer of rights has been established, FAI retains all rights to the event. Regardless of any agreement or transfer of rights, FAI shall have, free of charge for its own archival and/or promotional use, full access to any sound and/or visual images of any FAI Sporting Event, and always reserves itself the right to have any and all parts of any event recorded, filmed and/or photographed for such use, without charge.

References

- {1} FAI Statutes, Chapter 1, para 1.6
- {2} FAI Sporting Code, General Section, Chapter 3, para 3.1.3.
- {3} FAI Statutes, Chapter 1, para 1.8.1
- {4} FAI Statutes, Chapter 5, para 5.1.1.2; 5.5; 5.6 and 5.6.1.6
- {5} FAI Bylaws, Chapter 1, para 1.2.1
- {6} FAI Statutes, Chapter 2, para 2.3.2.2.5,
- {7} FAI Bylaws, Chapter 1, para 1.2.3
- {8} FAI Statutes, Chapter 5, para 5.1.1.2; 5.5; 5.6, 5.6.1.6
- {9} FAI Sporting Code, General Section, Chapter 3, para 3.1.7
- {10} FAI Sporting Code, General Section, Chapter 1, paras 1.2. and 1.4
- {11} FAI Statutes, Chapter 5, para 5.6.3
- {12} FAI Bylaws, Chapter 1, para 1.2.2

AMENDMENT LIST (AL) RECORD

Amendments to this Annex B can be put forward by the IGC Air traffic, Navigation and Display Systems committee of IGC (ANDS), the IGC GNSS Flight Recorder Approval Committee (GFAC) and by the IGC Sporting Code Committee, to whom suggestions for change should be made in the first instance for subjects in their areas of responsibility. Amendments can also be proposed by the above and by IGC nations and their delegates and other Specialists, for inclusion in the agenda for the IGC Plenary meeting; comments on them will be made to the Plenary by the appropriate Specialist or Committee Chairman. Amendments should be proposed in a form of words suitable for direct incorporation into Annex B, together with an explanation of why they are needed.

Like other parts of the Sporting Code Section 3, amendments to Annex B take effect on 1 October following the IGC meeting at which it was agreed that an amendment should take place (unless an earlier date is agreed for the subject concerned). By the issue date, a fully amended SC3B will be made available through the web reference: www.fai.org/gliding/sporting_code

AL	ACTION DATE	AMENDED BY	NAME	DATE
1	1 October 2003	Incorporated in this document		
2	1 October 2004			
3	1 October 2005			
4	1 October 2007			
5	1 October 2009			
6				
7				
8				
9				
10				

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PRELIMINARY REMARKS

1. **Title and Status.** This document, short title "SC3B", contains rules, procedures and guidelines applying to equipment used in the flight verification process, before final validation of flight performances to FAI/IGC criteria. Although SC3B is published and amended as a stand-alone document, it is a sub-document of the FAI Sporting Code Section 3 (Gliders and Motor Gliders) (abbreviated "SC3") and should be read in conjunction with other documents where the subject matter is appropriate.

2. **Scope.** This document deals with IGC-approved Global Navigation Satellite System (GNSS) Flight Recorders, pressure recording devices (barographs), and timepieces. It also contains the terms of reference for the operation of the IGC GNSS Flight Recorder Approval Committee (GFAC). Other material needed by pilots and Official Observers is placed in the main body of SC3 and amplified in its three Annexes. These are Annex A (SC3A, Rules for World and Continental Soaring Championships), this Annex B (SC3B), and Annex C (SC3C, the Official Observer and Pilot Guide). Annex C amplifies the material in the main document SC3 and gives more detailed procedures. This Annex B includes quotes from SC3 and Annex C in order to aid clarity on the subject concerned. This is so that Annex B can be used without constant direct reference to other documents. However, the prime authority for such wording is the source document and the wording should be referred to in the original document should any question arise or should the source document be amended.

3. **Technical Specification for IGC-approved GNSS Flight Recorders.** A separate document with this title is issued on behalf of IGC, and is available through the web reference given in para 4 below. Amendments to it are made on the advice of the IGC ANDS committee and the GNSS Flight Recorder Approval Committee (GFAC). These committees consult a range of independent experts, the manufacturers involved with IGC-approved Flight Recorders, and, where appropriate, the manufacturers of GNSS receiver units. As it is a technical document and is not part of the Sporting Code, an amendment can be made at any time in response to circumstances, but is generally not made more frequently than once in a calendar year. It is intended for the use of manufacturers and designers of hardware and software, GFAC members and associated consultants and expert advisors, and technical experts on GNSS Flight Recorders in National Airport Control authorities (NACs) that are members of FAI. However, pilots and OOs using GNSS Flight Recorders will find much of interest including a comprehensive Glossary of Terms and Abbreviations covering the GNSS and recorder area, also the structure of the IGC flight data file that records regular fixes and other data use for post-flight analysis and validation of flight performances to IGC standards.

4. **Publication on the Web.** IGC documents are available as follows:

SC3 and its annexes (SC3A, SC3B, SC3C): http://www.fai.org/gliding/sporting_code

Technical Specification for IGC-approved GNSS Flight Recorders:

www.fai.org/gliding/gnss/tech_spec_gnss.asp

IGC-approved Flight Recorders, complete list and all IGC-approval documents:

www.fai.org/gliding/system/files/igc_approved_frs.pdf

Free software for IGC-approved Flight Recorders: www.fai.org/gliding/gnss/freeware.asp

5. **Amendments to the Document.** See page (i) for details.

6. **Nomenclature – key words.** In this document the words "must", "shall" and "may not", indicate mandatory requirements that must be complied with if IGC standards are to be met. The word "should" indicates a recommendation that is preferred but not mandatory. The word "may" indicates what is permitted; and "will" indicates what is going to happen. Where appropriate, words of the male gender should be taken as generic and include persons of the feminine gender. Advisory notes and guidance are in italic script. The terms "Flight Recorder" or "FR" refer to GNSS Flight Recorders that are either IGC-approved or being designed for IGC-approval, unless the context indicates otherwise. The term "logger" is sometimes met (instead of GNSS FR) but is not used by IGC because of difficulties in translation to other languages. It should be noted that in the Sporting Code for gliding (SC3), in addition to IGC-approved GNSS FRs, the term "Position Recorder" is also used, to denote GPS units that may be used under NAC procedures for position (Lat/Long) evidence for Silver and Gold badge flights only. See the Glossary under "Position Recorder". (AL5)

7. **Terms and Abbreviations.** As well as the Glossary of Terms that follows, a more comprehensive Glossary of terms is included in the Technical Specification for IGC-approved GNSS Flight Recorders and in the General Section (GS) of the FAI Sporting Code. See the web reference for the Technical Specification in para 4 above. The General Section of the FAI Sporting Code is available through: www.fai.org/system/files/GS_2009.pdf

GLOSSARY OF TERMS AND ABBREVIATIONS

This contains explanations of terms and abbreviations used in this document. More detailed Glossaries are available in the Technical Specification for IGC-Approved GNSS Flight Recorders, and in the General Section of the FAI Sporting Code.

*IGC-approved Flight Recorder Specification: http://www.fai.org/gliding/gnss/tech_spec_gnss.asp
FAI Sporting Code General Section: www.fai.org/system/files/GS_2009.pdf*

ANDS Committee – The Air traffic, Navigation and Display Systems committee of IGC

CH, Ch - Confederation Helvetica, the Swiss Confederation
ChF - Swiss Francs.

Ellipsoid - A three-dimensional ellipse. An example is the WGS84 ellipsoid, see under WGS84.

ENL - Environmental Noise Level. More specifically, a system used in IGC-approved GNSS Flight Recorders for detecting when a Means of Propulsion (MoP) is supplying forward thrust. Acoustic noise at the Flight Recorder is measured by a microphone system inside the FR and is recorded with each fix as three numbers between 000 and 999. For engine systems that generate sufficient noise, this allows flight with engine running to be differentiated from the lower noises associated with soaring flight. See para 1.4.2 in this document. (AL5)

FAI – The Fédération Aéronautique Internationale, headquarters in Lausanne, Switzerland. The body under which IGC and other Air Sport Commissions exist and operate. See <http://www.fai.org>

Geoid - The WGS 84 Geoid is a theoretical worldwide surface of equal gravitational potential. This is similar but not exactly the same as a worldwide water surface at mean sea level. See para 2.4.6.1 of this document, and the other Glossaries mentioned under the heading above.

GFAC – The IGC GNSS Flight Recorder Approval Committee.

GNSS - Global Navigation Satellite System, a generic title for satellite-based navigation systems such as the Russian GLONASS, US GPS, and the European Galileo system. For more detail, see the other Glossaries in the Technical Specification for GNSS Flight Recorders, and in the FAI Sporting Code General Section.

hPa - Hecto Pascal. A unit of pressure, the same as a millibar (mB), see under mB and Pascal

Grandfather rights - This term is used for a situation where the approval of a type of equipment is continued without alteration, although the Specification conditions have changed with time (generally, increased). Detail on its application to IGC-approved GNSS Flight Recorders is in para 1.1.3.3.5

ICAO - International Civil Aviation Organisation. Headquartered in Montreal, Canada. See also under ISA below.

IGC – The International Gliding Commission of FAI.

IGC-approval – where applied to GNSS Flight Recorders, this is the process in which the IGC GFA Committee tests and evaluates recorders that are submitted by their manufacturers for use to IGC standards of evidence. Successful evaluation leads to the issue of an IGC-approval document. See chapter 1 of this document.

ISA - International Standard Atmosphere. A defined relationship between atmospheric pressure and an assumed altitude at that pressure level, the most common example being the ICAO ISA that is used in aviation worldwide. The ISA to be used for FAI/IGC matters is given in ICAO Document 7488 tables 3 and 4, available in the FAI Office and on the Web. More detail is in para 2.1.1.1.1 of this document.

JPEG - Joint Photographic Experts Group. A system for compressing digital data for pictures and diagrams so that the byte size is smaller than the un-compressed version, for sending or storing images.

mB - Millibar. A unit of pressure, one thousandth of a Bar (one million dynes per square centimetre), the same as a hectoPascal (hPa). On the ICAO ISA the assumed sea level pressure is 760mm of a mercury column, equivalent to exactly 1013.25mb / hPa by international convention.

MoP - Means of Propulsion. FAI generic term for an engine system, particularly in motor gliders, motorised hang gliders, para gliders, etc.

MS - In one meaning, Microsoft, the company that produces software such as the Windows operating system and the Word word-processing system, amongst others.

NAC - National Airsport Control. The authority in a nation recognised by FAI as supervising sporting aspects of airports in the nation concerned. Delegation can be made from the central national body to specialist sport bodies such as the gliding association or society in the nation.

OO - Official Observer, an individual nominated by an NAC (or one of its delegated bodies) on behalf of FAI and IGC, for the purpose of witnessing, taking and supervising evidence for claims.

OZ - Observation Zone. For valid reaching of a Waypoint, there must be proof of presence in the relevant OZ. The size and shape of the OZ is defined in the Sporting Code for Gliding (SC3)

Pascal - The SI unit of pressure, defined as a pressure of one Newton.force per square metre. One hundredth of a Pascal is a hectoPascal, abbreviated hPa, the same as a millibar (mB), see above. It is named after Blaise Pascal, the French mathematician, and was adopted as the SI pressure unit in 1971.

Position Recorder - a stand-alone GPS unit (different to an IGC-approved Flight Recorder), data from which may be used for position (Lat/Long) evidence for Silver and Gold badge flights only. This is under special rules and procedures given in the Sporting Code for Gliding (SC3) that allow NACs to approve the use of such units for this purpose. For altitude measurement, IGC uses Pressure Altitude to the ICAO ISA and this is required for Silver and Gold flights in the normal way. The IGC criteria for barographs and their calibration, apply, including Chapter 2 of this document. Rules and procedures for Position Recorders are given in the appendix to SC3 Chapter 4, and in Annex C (SC3C) para 6.1 and Appendix 5 on Pressure Altitude Calibrations. (AL5)

SC3 - Sporting Code Section 3, the section of the FAI Sporting Code for Gliders and Motor Gliders. It has four annexes, lettered A-D. Annex A (SC3A) contains rules and procedures for world and other gliding championships. This Annex B (SC3B) is about equipment used in the flight validation process. Annex C (SC3C) is titled the OO and Pilot Guide, amplifies the material in SC3 and gives more detailed procedures for use by pilots and OOs in the field. Annex D (SC3D) contains the Rules for the Official IGC Ranking List for individual pilots and countries.

Specification - See Technical Specification.

T&E - Test and Evaluation.

Technical Specification - In this document, the Technical Specification for IGC-approved GNSS Flight Recorders, unless indicated otherwise. The web reference is given earlier.

WGS 84 - World Geodetic System 1984. A co-ordinate system based on a mathematical model of the earth. It includes many variables such as gravity constants and coefficients, formulas for the Earth's angular velocity, a WGS84 ellipsoid and a WGS84 geoid, (an equipotential surface approximating to local sea levels) with associated constants, conversion factors and co-ordinate systems. The WGS84 System Definition Document is Technical Report 8350, obtainable from the US National Geospatial-Intelligence Agency (NGA). The WGS84 ellipsoid is used as the primary earth model for horizontal position (Lat/Long) in the US GPS system, is used by ICAO, and also by IGC for the accurate measurement of distance. It has an Equatorial radius of 6378.1370 km and a Polar radius of 6356.7523 km, a flattening of 21.3847 km. For more detail, see the Glossaries for the Technical Specification for IGC-approval GNSS Flight Recorders, and the General Section of the FAI Sporting Code (web references at the beginning of this Glossary).

Word - In one specialised meaning, the Microsoft Word word-processing system.

Validation, VALI check - For data from an IGC-approved GNSS Flight Recorder, Validation is the process of determining that electronic flight data (the IGC file) has the integrity to be used in the overall flight validation process. Electronic flight data is validated by using the appropriate MS Windows IGC-XXX.DLL with the IGC shell program, or the DOS-based VALI-XXX program, where XXX are the identification letters for the FR manufacturer. This program checks the Digital Signature that is part of the IGC-format file that was transferred from the FR, indicates that data has originated correctly from a serviceable and sealed FR, and that the data in the IGC file being checked is identical to that initially transferred from the FR.

A less rigorous form of file validation applies to Position Recorders (see above) where Validation of the file at any time later may be provided either by part of the program that downloads the data or by another method accepted by the NAC and GFAC. When a flight data file from a Position Recorder is checked later by the appropriate Validation function, it must show that the file is identical to when it was originally downloaded. This differs from IGC-approved FRs, where the signature generation and Validation program originates from the FR manufacturer and the serviceability and sealing of the FR itself is also checked as part of the Validation process. (AL5)

CHAPTER 1

GNSS FLIGHT RECORDERS **IGC-APPROVAL AND OTHER PROCEDURES**

1.1 **IGC-approved Flight Recorders - Policy and General.** IGC-approval of a particular type of GNSS Flight Recorder is achieved after Test and Evaluation (T&E) by the IGC GNSS Flight Recorder Approval Committee (GFAC), whose terms of reference are given below. When a Flight Recorder system is submitted for IGC-approval, GFAC examines it for compliance with IGC rules and procedures for hardware, firmware, software, output data in the standard IGC data file format, and security of the Flight Recorder system and its output data both physical and electronic. The "all flights" level of IGC-approval indicates that the equipment meets the standards of availability, continuity, integrity, accuracy, and security that are required for the certification of flights for FAI/IGC World Records and all FAI/IGC Badges and Diplomas. Other levels of approval also apply, see para 1.1.3.3. Conditions that apply in large championships must also be taken into account. Other aspects of Flight Recorders are matters between customers and manufacturers, including the presentation of cockpit displays (para 1.1.5), navigational features, and post-flight analysis systems that use the IGC flight data file format.

1.1.1 **FAI Liability.** FAI takes no responsibility for and has no liability for the consequences of the use of IGC-approved Flight Recorders for purposes other than post-flight validation and certification of flights to FAI/IGC procedures. Such other purposes include, but are not limited to, navigation, airspace avoidance, terrain avoidance, or other matters concerning flight safety.

1.1.2 **Operating Procedures for a Flight Recorder Type.** Operating procedures for each type of Flight Recorder will be specified by GFAC in the IGC-approval document. The IGC-approval process has the objective of making procedures on the day of flight as simple as possible. This is particularly important before flight when the time available for carrying out extra independent checks may be short. Also, after flight it must be quick and easy to download the flight data to a memory device or PC, so that the IGC flight data format may be obtained. However, GFAC must specify procedures that minimise the possibility that either the Flight Recorder in the glider could be changed for another one that was not carried on the flight, or that the data in the Flight Recorder in the glider or downloaded after flight could be interfered with without this being detected. Particularly with small, portable Flight Recorders, this may require either continuous observation of the glider before takeoff and/or after landing, or the physical sealing of the Flight Recorder unit to the glider by an OO at any time or date beforehand. This will avoid the need for extra OO observation of the installation before takeoff. Such a seal must be applied and marked in a manner such that there is incontrovertible proof after the flight that it has not been compromised. This can be achieved by marking it with the glider registration, the date, time and OO's name, signature, and the OO identification number. Other procedures specific to the type of Flight Recorder concerned may be required, such as stowage of certain modules out of reach of the flight crew, or limitations on the types of flight for which the recorder may be used. Such procedures and limitations will be an integral part of the IGC-approval document for the type of equipment concerned, and will depend on the Flight Recorder design and the results of the test and evaluation process.

1.1.3 **IGC-Approval Documents for Specific Types of Flight Recorder.** The IGC-approval document for each Flight Recorder type is produced by GFAC on behalf of IGC. Before the approval document is finalised, it will be circulated several times in successive drafts to GFAC members, other technical experts and consultants, and the manufacturer concerned. When finally issued, the IGC-approval document will give the detailed procedures under which equipment must be checked, installed in the glider, and operated for flights that are to be validated and certificated to FAI/IGC standards. The definitive version of the IGC-approval document for a particular type of flight recorder is that which is currently available from the IGC GNSS web page.

1.1.3.1 **Format of IGC-approval documents.** These documents have a standard format which consists of a title; document conditions and limitations; version numbers and other details for hardware, firmware and software; external connections to the Flight Recorder; types of GPS receiver and pressure transducer fitted; and a list of Conditions of Approval including security matters. There are two annexes. Annex A contains notes for pilots and Annex B contains notes for Official Observers and National Airport Control authorities (NACs). Annex B includes checks that apply to that type and model of Flight Recorder, downloading flight data to a memory device or PC, procedures for checking the validity of the IGC file data and pressure altitude calibrations. Also, for those Flight Recorders fitted with an Environmental Noise Level (ENL) system, Annex B contains details of ENL figures recorded during GFAC testing and to be expected in various phases of flight.

1.1.3.1.1 Pilot checks on individual Flight Recorders. It is the responsibility of owners of FRs and pilots using them, to check that the characteristics of their FR(s) correspond to those described in the relevant IGC-approval documents. If they do not, the FR should be returned to the manufacturer or his authorised agent to be re-set. For instance, this applies to Environmental Noise Level (ENL) figures recorded in IGC files and also to pressure altitude calibrations. Pressure altitude calibrations must be close to the ICAO international standard atmosphere (ISA) and be within the limits given in 2.6.1. ENL figures must be similar to those described in Annex B to the IGC-approval document, and pilots and OOs should note the critical ENL cases that are described later in 1.4.2. (AL4)

1.1.3.2 Approval Document kept with the Flight Recorder. It is recommended that an up-to-date copy of the approval document including its two annexes is kept with each unit of the equipment, so that it can be consulted by pilots and OOs as required.

1.1.3.2.1 Valid versions of the IGC-approval and program files. Only the latest version of the IGC-approval document is valid for use with IGC/FAI claims. This is the version that is posted on the IGC web site. Similarly, the only valid versions of the FR manufacturer's DLL file (for downloading the IGC file after flight and Validating IGC files at any time), or, for older FRs, the equivalent short program files DATA, CONV and VALI, are those posted on the IGC web site. Other versions must not be used in the validation process of flights to FAI/IGC criteria. (AL5)

1.1.3.3 Levels of IGC-approval. (SC3 para 4.6.4) The IGC-approval document for individual types of Flight Recorders will specify procedures to be used and any limitations on types of flights for which the approval is valid. Reduced levels of approval apply to types of Flight Recorders that do not meet the requirements for "all flights" approval at the time that the approval is given, but where GFAC agrees that a more limited IGC-approval can be given. Reduced levels also apply in cases where the security of a type of FR has been compromised (but not sufficiently for approval to be withdrawn), or is below the requirements of the current Specification, or where other features do not meet the current Specification. The following levels of IGC-approval apply:

1.1.3.3.1 IGC-approval for all flights. This applies to Flight Recorders that may be used for evidence for all flights up to and including FAI/IGC world records. For new types of FRs, complete compliance with the current Specification is required. For types with existing IGC-approvals to this level, "Grandfather Rights" (1.1.3.3.5 below) apply unless there are major differences compared to the current Specification. (AL1)

1.1.3.3.2 IGC-approval for IGC/FAI badge and Diploma flights. This approval level applies to Flight Recorders that may be used for evidence for all IGC/FAI badge and distance Diploma flights, but must not be used for evidence for IGC/FAI world record flights. For competition flights, see 1.1.3.3.6. This level may be used for new types of FRs that do not meet the current Specification in some areas. For types of FR that are already IGC-approved, this level may be used for those whose characteristics are now significantly below the standard of the current Specification, particularly on security or accuracy of data. These assessments will be at the discretion of the IGC GFA Committee (GFAC). For types of FR with existing IGC-approvals to this level, Grandfather Rights apply (1.1.3.3.5 below). (AL1)

1.1.3.3.3 IGC-approval for badge flights up to Diamonds. This approval level applies to Flight Recorders that may be used only for evidence for FAI/IGC Silver, Gold and Diamond badge flights, although for competition flights, see 1.1.3.3.6. This level may be used for recording systems that have significantly lower standards of security and other characteristics compared to those with higher levels of approval. For instance, this level includes systems that use a separate off-the-shelf GNSS unit (for the design and security of which, IGC has no influence) connected to the Flight Recorder unit by cable. These assessments will be at the discretion of the IGC GFA Committee (GFAC). (AL1)

1.1.3.3.4 No IGC-approval. This applies to types of Flight Recorders that have either not been tested and approved by GFAC to IGC standards, or have not been awarded an IGC-approval as above, or to FRs that were previously IGC-approved but where a major security or other problem has been shown to exist which could compromise the integrity of flight data from other FRs of the same type that are in service. (AL1)

1.1.3.3.5 Grandfather rights and approval levels. The term "Grandfather Rights" is used for a situation where the conditions of an original IGC-approval are continued with time, even though the provisions of the IGC Specification or Sporting Code have changed, generally increased. That is, the FR would be subject to additional limitations or would not be approved for particular categories of flights if it were submitted for IGC approval as a new model. Continuity of the original approval is so that owners and manufacturers are not constantly required to carry out updates as the Specification or Sporting Code changes with time, unless a major difference exists in the type of FR compared to the current

Specification. A similar policy is adopted in civil aviation by other aviation organisations such as the FAA and JAA with regard to already-certificated designs. (AL1)

1.1.3.3.6 Competitions. The above sub paras apply to record, badge and distance diploma flights to be validated to FAI/IGC rules and procedures. For competition flights, the types of FRs that may be accepted are (a) at the discretion of the competition organisers and (b) subject to any particular rules and procedures that may apply to the organisers. For instance, Regional or National competition rules, or Sporting Code Annex A procedures for World and other Championships that use Annex A rules. (AL1)

1.1.4 Changes of approval level. If GFAC proposes to lower the approval level of a type of IGC-approved FR, this will be discussed in confidence, first with the IGC ANDS committee and then with the manufacturer (for approval levels, see paras 1.1.3.3). The Bureau may also be informed if appropriate at this stage. Such lowering of level may apply to a particular type of FR or to a specific modification state or a hardware and/or firmware version of the type. As much notice as possible will be given so that the manufacturer can be given the opportunity of offering an upgrade that will retain the existing approval level. After these discussions, if GFAC still decides to recommend a lowering of the approval level it will then make a detailed recommendation to the IGC Bureau. The Bureau may decide to make a public announcement and ask for comments. The Bureau will then assess all of the evidence and make a decision. If they accept the GFAC recommendation to lower the approval level, the details will be announced immediately but the next IGC Plenary meeting will be asked for confirmation as part of the normal procedure for confirmation of Bureau decisions that were made between Plenaries. Announcements will be made on the FAI IGC discussion group (igc-discuss@fai.org) and on the international soaring newsgroup (rec.aviation.soaring) but will not include confidential or proprietary information. (AL2)

1.1.4.1 Data integrity factors. Factors that may lead to a lowering of approval level, particularly from "all flights" to a lower level, include the following. Evidence that flight data generated from an IGC-approved FR has been or can be manipulated, altered or falsified. For instance, if it can be shown that the secure parts of an IGC flight data file can be changed and it still passes the electronic Validation check. Also, evidence that the security function or functions have been compromised, or if IGC experts in data security assess or demonstrate that security could relatively easily be compromised by commonly-available equipment and methods. This includes a situation where it can be shown that the security microswitch can be by-passed. In these cases, the lowering of approval level will take effect at a date agreed between GFAC and the Bureau. In serious cases such as where there is a risk that compromised data could be submitted for flight claims from other FRs of the same type, this could be the date of the public announcement of the Bureau decision. (AL2)

1.1.4.2 Other factors. If the approval level is to be lowered for reasons other than those given in 1.1.4.1 above, the date of implementation will be decided by the Bureau and will not normally be before 12 months after the date of the public announcement of the Bureau decision. (AL2)

1.1.4.3 Appeal against a lowering of approval level. If it is decided to lower the approval level of a type or version of an FR, the manufacturer of the FR or any entity with an interest may appeal to the IGC Bureau to have the decision reviewed. The organisation or individual making the appeal must notify the IGC President of an intention to appeal within one calendar month of the public announcement of the lowering of the approval level. Notification by email or fax is acceptable and will be acknowledged using the same medium. Pending the appeal, the decision and its implementation timescale will stand. In submitting the appeal, the organisation or individual making the appeal agrees to accept the result, which is at the sole discretion of FAI as the legal entity and its agent IGC, and also agrees not to institute proceedings against the FAI or its agent IGC or against any person who was involved on behalf of FAI or IGC. (AL2)

1.1.4.3.1 Procedure and evidence. The Bureau will then appoint a tribunal of either three or five persons, one of whom will be nominated as Tribunal President. These persons must have an understanding of the technical area concerned but must have no direct commercial or strong personal interest in the result. Evidence shall be given in the English language and be sent by email to the Tribunal President. Tribunal members will correspond with each other by email. Evidence may include proprietary or confidential information that must not be divulged to the Public Domain. Such evidence must be kept confidential to the Tribunal members and parties authorised by the Tribunal to see it, such as the manufacturer, the appellant (if different), the IGC ANDS and GFA committees and authorised technical experts used by IGC. Evidence should be submitted by email in commonly-used formats such as MS Word for text and JPEG for pictures and diagrams. GFAC, and if appropriate the ANDS committee, will present evidence to the tribunal supporting the change of approval level. Evidence from the organisation or individual making the appeal is covered in 1.1.4.3.2 below. Within 3 calendar months of receipt of appeal documentation from the appellant, unless exceptional circumstances prevail, the tribunal shall reach a decision and notify the IGC President of their findings

and recommendations. These may include proprietary and confidential information. The President will pass these on to the Bureau and to the GFA and ANDS committees. An edited summary without any proprietary or confidential information and suitable for the Public Domain will be prepared. This will be announced as soon as it is agreed by the Bureau and the manufacturer, the organisation or individual making the appeal (if not the manufacturer), and the GFA and ANDS Committees have been given time to comment. (AL2)

1.1.4.3.2 Appeal documentation and financial deposit. Appeal documentation from the organisation or individual making the appeal must be received by the Tribunal President within three calendar months of the date that the proposed change in approval level was announced in the public domain. The financial deposit for the appeal must be received by FAI within the same three calendar month period. The amount of deposit will be that specified for appeals under the FAI Sporting Code General Section (GS Chapter 9) unless decided otherwise by the IGC Bureau. The deposit is payable in Swiss Francs (ChF) and the amount can be obtained on request to the IGC President or the Chairmen of the GFA or ANDS committees. The deposit must be lodged with the FAI account in Zurich and banker's drafts must be marked "IGC account for IGC GNSS FR appeal" so that FAI and the IGC Treasurer will know what it is for. Bank and other transfer charges must be paid by the applicant so that the full deposit is received in the FAI account without any deductions for transfer or other bank charges by either the sending or receiving bank. The deposit is not returnable unless the case of the organisation or individual making the appeal is accepted without reservation, although a partial refund may be made if recommended by the Tribunal. (AL2)

1.1.5 **World Records.** Evidence must be from a Flight Recorder that is IGC-approved for World Record flights (SC3 para 3.0.3). See 1.1.3.3 above on Flight Recorder levels.

1.1.6 **Cockpit displays.** IGC is concerned at the potential risk of collision between gliders, due to over-concentration on cockpit displays where the pilot would be better advised to be scanning outside the cockpit. Displays and instruments that need regular checking, should not be mounted in remote positions in the cockpit, but should be in prominent positions close to angles suitable for external view. Although IGC cannot control the layout of instrument panels and other cockpit installations, it can draw attention to the potential dangers. Particularly in single-seat gliders, the position of any displays connected to the Flight Recorder should not be remote from sight lines used for pilot lookout and scan for other aircraft and gliders. Neither should displays be positioned so as to obstruct sight lines that might be needed for pilot lookout and scan.

1.1.7 **Antenna Positioning.** If the GNSS 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.

1.1.8 **Sealing of data ports and plugs.** Wherever possible, the IGC-approval will not involve sealing of ports and plugs before flight, but no attempt must be made by users to pass unauthorised data into the Flight Recorder. Any abuse of this may lead to a requirement for sealing.

1.1.9 **Security of the Flight Recorder module.** For IGC-approval to be given, the Flight Recorder module must be protected by both physical and electronic security mechanisms, the detail of which is given in the Technical Specification for IGC-approved GNSS Flight Recorders. A manufacturer's seal must also be fitted in such a way that it will be broken if the case is opened. In addition, a system must be incorporated that trashes (makes inoperative) the internal electronic security system if the FR case is opened or otherwise becomes insecure. Flights made after any such event must continue to produce IGC-format data files, but such files must be clearly marked as insecure. Such files must also fail the electronic Validate check that is available through free software from the gliding/gnss web pages. Re-set of a FR to a secure state must only be through the manufacturer or his authorised agent and the knowledge of confidential details that are part of any re-set procedure (including private keys) must be restricted to the absolute minimum number of people. (AL1)

1.1.10 **Proof of presence of the Flight Recorder in the Glider.** There must be incontrovertible evidence that the particular Flight Recorder was present and recording in the particular glider for the flight concerned. The procedures given in the IGC-approval document shall ensure this as far as possible. This is particularly important in the case of a GNSS Flight Recorder because, unlike other equipment used in the verification process, it contains nearly all of the evidence for the flight. It is even more important with the small, lightweight types of Flight Recorder that can easily be transferred from one glider to another. Two methods are employed: (1) OO inspection of the Flight Recorder installation, and (2) evidence of takeoff, landing and other evidence for the claimed flight that is independent of the flight recorder concerned. These are amplified below:

1.1.10.1 OO inspection and/or sealing to the glider. If an OO is not present to witness takeoff or landing and to check the Flight Recorder installation immediately before and after these times, the Flight Recorder unit that is to be used for flight validation must be sealed to the glider structure by an OO. This may be

carried out at any time or date before flight as long as the sealing is timed, dated and with the OO's identification clearly marked so that the OO can identify it later if necessary.

1.1.10.2 Check of takeoff and landing details, independent of the Flight Recorder data. The time and point of takeoff, and later 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 Flight Recorder takeoff and landing data (SC3 Annex C para 11.3). This is intended as a simple but effective independent check of the integrity of these aspects of the Flight Recorder data.

Following this, the rest of the data may be accepted as valid evidence for the claim, subject to (1) any anomalies in the data being satisfactorily explained, (2) compatibility of the data with independently-known conditions for the flight and (3) subject to the IGC file for the claim passing the electronic Validate check. The Validate check confirms that the data has correctly originated from the individual Flight Recorder and is identical to when it was originally downloaded.

Known conditions that can be independently checked include the following: (1) Wind observations at relevant altitudes (including those recorded officially by local meteorological offices and airfields) compared to thermal and other drift from the IGC file data. (2) soaring conditions experienced by other gliders in the same area and at similar time, including those available on IGC data files for comparison, and (3) direct observation of the glider by other pilots, witnesses, etc. (AL2)

1.1.11 **Anomalies in evidence.** Any anomalies in evidence from a GNSS Flight Recorder should be referred to the GFAC Chairman for further investigation and to obtain an opinion from GFAC and its technical experts on whether the flight data can be accepted for an FAI/IGC claim. This should be done as soon as an anomaly is discovered, by the OO concerned or by the body that will validate the flight (such as the NAC) so that other supporting evidence is not lost due to the passage of time. It is important that the FR is kept in its original state and is not re-set or modified until the investigation is completed. (AL2)

1.2 **IGC GNSS Flight Recorder Approval Committee (GFAC).** A committee of at least 5 persons shall be appointed by IGC to test, evaluate, and approve individual types of GNSS Flight Recorders in accordance with para 1.1. GFAC members may delegate specialist work to other experts but are responsible for co-ordinating the work and for producing final recommendations and IGC-approval documents on behalf of IGC. The detail of the work and any opinions expressed within GFAC discussion are confidential to GFAC and any other experts and IGC officials who may be involved.

1.2.1 **Appointment of GFAC Members.** GFAC members will be appointed by IGC for an agreed period, and members will be eligible for re-appointment. Members will select the GFAC chairman from amongst their number.

1.2.2 **Working Language.** The English language shall be used for formal communications to and from GFAC, and within GFAC.

1.3 **Notification and Application by Manufacturers.** Manufacturers are encouraged to make contact with the GFAC Chairman as early as possible during the design process for a new type of Flight Recorder that may be submitted later for IGC-approval. In the manufacturer's own interest, this should be before any design-fix is made, or any commitment to large-scale purchase of specialised components. This is because initial discussion with GFAC on the intended design may reveal that changes have to be made before IGC-approval can be considered. The GFAC Chairman will provide the applicant with the current procedures for the approval process, such as the application form and documentation requirements.

1.3.1 **Correspondence with GFAC.** Manufacturers must correspond with GFAC through its chairman, who will inform other members as necessary and co-ordinate any responses to the manufacturer. In cases where specialist matters are being discussed, the Chairman may authorise direct correspondence with an appropriate specialist GFAC advisor. This may be, for instance, on electronic security matters or compliance with the exact format for IGC files, but the Chairman must be copied with all correspondence, to be aware of progress and of the issues involved.

1.3.2 **Submission of a new model of Flight Recorder.** Details of the intended design should be sent to the GFAC Chairman as soon as they are available. These should include a brief specification, drawings, draft manual (if it exists at this stage), commonality with any existing models, etc. Manufacturers should not wait until these documents are final, drafts should be sent as soon as they are available. The Chairman will circulate such details to GFAC members and appropriate technical advisors and will co-ordinate comments that will be sent back to the manufacturer. For communication, email is the recommended method in the form of text or attached files in word-processed format (such as MS Word). For diagrams and pictures, use a compressed format such as JPEG (*.jpg file), at not more than 200kB per graphic unless requested

otherwise. The details sent by the manufacturer will be treated as confidential to GFAC and any other experts who may be involved.

1.3.2.1. IGC-format data files. As soon as specimen IGC-format files are available from Flight Recorder hardware (for instance, Beta test or earlier versions), send copies to the GFAC chairman so that the exact format can be checked for compliance with the IGC standard.

1.3.2.2. When FR hardware is available. Flight Recorders should not be sent until GFAC comments have been made on the specification of the Flight Recorder and initial IGC files have been produced and sent. When a complete prototype or alpha/beta test version is available, and before the fix-of-design stage is reached, notify the GFAC Chairman. When the Chairman requests, send a single example for initial evaluation and feedback. The Chairman's evaluation team will test the hardware and report to GFAC members, relevant technical experts and to the Flight Recorder manufacturer.

1.3.2.3 Fee to FAI. When hardware is sent, the Flight Recorder manufacturer must apply to FAI on the forms provided and pay the appropriate fee to FAI, unless this has been done earlier. Detail, para 1.3.5.

1.3.2.4. Sending Further Hardware. All individual GFAC members have the right to ask for hardware for testing themselves. Therefore, after appropriate correspondence between the Chairman and the Flight Recorder manufacturer, and after any necessary changes have been made to the prototype equipment already evaluated, the chairman will notify the manufacturer of those GFAC members who wish to receive equipment to the latest standard for testing. Further detail is in para 1.4.

1.3.3 **Re-approval after changes to an FR.** For re-approval or continued approval of a type of Flight Recorder after changes have been made to its design, the provisions of 1.3.2 that are relevant to the changes, continue to apply.

1.3.4 **Documentation.** The Flight Recorder manufacturer or applicant for IGC-approval shall provide information to GFAC on how the particular model of FR is intended to meet the IGC Specification.

1.3.4.1 Security Protection. A detailed description of security protection must be provided, that is, the design features that prevent deliberate or inadvertent misuse or production of false data. Both physical and electronic security must be addressed with respect to the IGC Specification at the time. Such information will be held in confidence by GFAC members and their advisors.

1.3.4.2 Pressure Altitude Calibration. The pressure altitude recording system in the Flight Recorder must be calibrated using standard FAI/IGC procedures for barograph calibration, and a calibration table and the IGC file for the calibration must be forwarded with any hardware that is sent. Corrections in the calibration table should be within the limits given in para 2.6.1.1.

1.3.5 **Fees and expenses.** The appropriate fee must be deposited in FAI's IGC account by the applicant when hardware is sent to the GFAC Chairman for evaluation. Expenses such as customs duties and national taxes for postage of FR hardware must be paid by the applicant and not be an expense on GFAC members, IGC or FAI. If the receipt of payment is delayed, IGC-approval will not be given until the appropriate fee is received and all expenses attributable to the manufacturer have been paid. The fee is adjusted by IGC from time to time and details are available from the Chairmen of the IGC GNSS and GFA Committees. At the time of writing (year 2009) the fee is 1000 Euros for an application for and testing of a new type of GNSS Flight Recorder. For changes or modifications to an existing IGC-approved design, the fee depends on the complexity of the required evaluation as determined by GFAC, and may be the same or less. The precise method of deposit will be given on the application form available from the GFAC Chairman. (AL5)

1.4 **Test and Evaluation (T&E).** Upon receipt of all of the formal application material, GFAC will complete T&E as soon as practicable and normally within 120 days, unless there are unforeseen difficulties. The testing carried out by GFAC will be of a non-destructive nature but GFAC, IGC or FAI is not liable for any damage to, or loss of, any equipment. A sample test and evaluation schedule that may be used is at Appendix 2 to the IGC Specification. The evaluation period starts when all members of GFAC who have expressed a wish to test the hardware themselves, have received all of the required equipment and documentation in good order and ready to test. The GFAC Chairman will notify the manufacturer of the contact details of individuals to whom hardware should be sent. If the Flight Recorder manufacturer is not able to send equipment to all at the same time, equipment will be sent from GFAC individual to GFAC individual. In this case, the target evaluation period does not apply although the evaluation will be completed as soon as practicable in the circumstances prevailing. Any excess expenses incurred by individuals (such as postal, excise and tax), shall be paid by the Flight

Recorder manufacturer into the FAI account on request so that individuals can be re-imbursed and do not have to pay these expenses themselves.

1.4.1 **Laboratory Testing.** GFAC may decide that a report on the Flight Recorder (or a particular aspect of the FR and/or its peripherals) is needed from a recognised independent testing laboratory. In this case, the applicant will be responsible for the expense in addition to the application fee. The applicant shall be given the opportunity to withdraw the application before incurring this expense. This circumstance might arise if test or evaluation is required that is outside the expertise or facilities available to GFAC members and their advisers, who work voluntarily on behalf of IGC in their own time.

1.4.2 **ENL System - General.** An Environmental Noise Level (ENL) system is designed to differentiate between any engine running that generates forward thrust, and any flight condition encountered in normal soaring flight without the use of engine. Pilots and OOs should note that the critical engine-on case with all motor gliders is not when the engine is run at high power. Also, the critical engine-off case is not a quiet glide with a well-sealed cockpit. These critical cases are covered below, and are particularly important with low-noise engines such as those using electric power, which are also covered in 1.4.2.4. Pilots flying such motor gliders should ensure that engine-recording systems have been provided in accordance with Sporting Code requirements so that their flights can be validated to IGC standards. (AL4)

1.4.2.1 **High Engine Power.** A combination of engine and propeller noise at high power are expected to give ENL figures over 800 out of the maximum three ENL numbers that are available in the IGC file, of 999. Most two-stroke systems produce ENL values over 900 and some give the maximum of 999. Four-stroke and Wankel (rotary) engines give lower figures but normally enough to differentiate between power-on and power-off. Some electric engines at high power have also been shown to give moderate ENL values (much is propeller noise); however, high power is not the critical case in terms of differentiating between power-on and power-off flight, see below. (AL4)

1.4.2.2 Critical Noise-level Recording Cases

1.4.2.2.1 **Power-on.** The critical power-on case that is used for testing ENL, is just sufficient power for level flight in still air. At this condition, recorded ENL must be high enough to differentiate from the Power-Off cases below. A more critical condition is where engine could be used to extend glide angle rather than fly level or climb, but is more difficult to test than the "level flight" case. (AL4)

1.4.2.2.2 **Power-off.** The critical ENL power-off case is not a quiet, well-sealed cockpit. It is a noisy cockpit, typically thermalling with air vents and cockpit panels open. This can produce ENL figures up to 300, more if sideslip is present and 400 has been seen. Another noisy case is high speed flight with the cockpit panel(s) open, but this is not as realistic as thermalling with panels open because in the latter case the glider will be climbing. (AL4)

1.4.2.3 **ENL numbers.** The three ENL numbers as recorded in IGC files must therefore differentiate between the "quiet engine" and the "noisy cockpit" cases. This is done by carefully selecting the frequency and gain at which the ENL system is most sensitive. The ENL system is then tested by GFAC in a range of motor gliders, gliders and powered aircraft. Experience has shown that peak sensitivity at frequencies between about 70 and 300Hz gives good (high) response to engine and propeller noise and less response to cockpit noises, combined with a typical "bell curve" (the statistical "normal distribution") of overall shape of sensitivity with frequency. (AL4)

1.4.2.4 **Low noise Motor Gliders.** Where the engine system produces low ENL values that make it difficult to differentiate between power-on and power-off flight, an additional system shall be provided in the motor glider concerned. This system must produce a signal that is shown in the IGC file under the three-letter code "RPM" (as defined in the Technical Specification for IGC-approved Flight Recorders), as an indication of forward thrust generated by the engine system. This will be subject to GFAC evaluation and decision on the type of motor glider concerned. (AL4)

1.5 **IGC-Approval.** On behalf of IGC, GFAC shall either approve, or require modifications to the applicant's unit before IGC-approval to the appropriate level can be given (see 1.1.3.3 for levels). Drafts of approval documents will be circulated beforehand to GFAC members and associated experts, also to the Flight Recorder Manufacturer concerned. The final version is the responsibility of GFAC alone.

1.5.1 **Limitations before Approval.** If it is decided that IGC-approval cannot be given to the appropriate level without changes being made (see 1.1.3.3 for IGC-approval levels), GFAC will inform the manufacturer of what is required in order to gain IGC-approval. This may involve an approval with limitations, such as an approval level other than "all flights" or an approval without an ENL system. If the

manufacturer notifies GFAC within 21 days that it is wished that the approval process should continue, the manufacturer will be expected to resubmit a modified Flight Recorder for further review by GFAC within the next six months. GFAC will aim to complete this review within 60 days, subject to not encountering any unforeseen difficulties. *If this procedure is followed, no extra fee will be payable but the initial fee will continue to be held. An example might be where a motor glider Means-of-Propulsion (MoP) sensor system either was not included, or was assessed by GFAC as not being adequate. In this case an IGC-approval might be issued without the MoP sensor system, pending the development of a system which satisfies the IGC Specification, which would then be added to the Approval by amendment.*

1.6 Applicant's Agreement on Issue of IGC-approval. When an IGC-approval is issued, an applicant agrees to the following conditions:

1.6.1 Changes to an IGC-approved Flight Recorder. Notification of any intended change to hardware, firmware or software must be made by the manufacturer or applicant to the Chairman of GFAC so that a decision can be made on any further testing which may be required. This includes changes of any sort, large or small.

1.6.2 Action on Changes. GFAC may decide that a formal evaluation of such changed features is required, or, if the changes are extensive, that another full approval process is required. This shall require a fee of up to that for a new type of GNSS Flight Recorder. Where someone other than the Flight Recorder manufacturer or the current applicant has notified GFAC of the change concerned that led to a further approval process, the fee shall be that for a new type of GNSS Flight Recorder, since the applicant was obliged to notify GFAC earlier.

1.6.3 Changes in IGC-approvals. FAI may remove or alter the existing approval of any Flight Recorder at any time.

1.6.4 Manufacturer details. An IGC-approval is for the named product or products manufactured by (or under the control of) the Organisation whose details are given in the approval document in the paragraph headed "Manufacturer". Any changes to these details shall be sent by the Organisation to GFAC without delay, so that the approval document can be kept up-to-date. (AL2)

1.6.4.1 Transfer to another Organisation. An IGC-approval will only be transferred to another Organisation after consultation by GFAC with the previous and future Organisations, followed by amendment of the approval document. (AL2)

1.6.4.2 Significant changes. If significant changes have been made in the Organisation listed in the IGC-approval document under "Manufacturer", FAI reserves the right to require a new IGC-approval process for the types of Flight Recorder affected. In this context, the approval process will require the signature or re-signature of an approval application and GFAC may wish to test FR equipment produced by the changed Organisation. What changes are considered significant will be as assessed by GFAC and include transfer of manufacturing responsibility to a different Organisation, acquisition of the name by another Organisation, or a change of structure or of key personnel within the same Organisation. (AL2)

1.6.4.3 Cease of Manufacture and/or Support. Where a manufacturer ceases to manufacture a particular type of FR, GFAC shall be informed. The manufacturer shall state whether support for the type will continue such as updates and/or repairs to existing FRs. (AL2)

1.6.4.3.1 Pilot aspects. Pilots should be aware that if they are using a FR for which there is no manufacturer support, in the event of anomalies in the electronic data (IGC file) without manufacturer support to analyse the data it may not be possible to validate such flights. (AL2)

1.6.4.4 Exclusions. The IGC-approval process is not concerned with, and FAI, IGC and GFAC have no responsibility for, matters related to: (1) Intellectual Property (IP) and Intellectual Property Rights (IPR) or, (2) the relations of the Organisation with any others except with FAI and its agents or as they affect FAI, its agents and this approval. (AL2)

1.7 Use of Flight Recorders within Nations. An IGC-approved GNSS Flight Recorder operated in accordance with its IGC-approval document must be used for all flights that require validation to FAI/IGC standards, including World Records (SC3, para 3.0.c) and World Championships (SC3 Annex A). An IGC-approved Flight Recorder must also be used for evidence for FAI/IGC Badge and Diploma Flights except that, for Silver and Gold badge flights only, evidence from a Position Recorder may be used under special Sporting Code rules (see

the Glossary under "Position Recorder" for definition and SC3 references). IGC-approved FRs may also be used by NACs for other flights where FAI/IGC standards are specified by the NAC such as for competitions, national and regional records. For the different levels of IGC-approval, see para 1.1.3.3. Where flight validation is not required to FAI/IGC criteria, the choice of criteria is at the discretion of those responsible for validating the flight. (AL5)

1.8 Notification and Issue of IGC-approval Documents and Free DLL and Program Files. Notification of issue of a new or amended IGC-approval document will be posted on the Internet newsgroup rec.aviation.soaring (r.a.s.) and also on the FAI IGC-discuss list. The complete IGC-approval document will be posted on the web site www.fai.org/gliding/gnss. In addition, the FR Manufacturers DLL file (or for older FRs, the short program files) for transferring IGC files to a PC from the Flight Recorder, and for validating the integrity of such files, will also be posted for free access. (AL5)

1.9 Production standards. FAI reserves the right to inspect and test examples of products manufactured, updated or serviced, for the purpose of checking compliance with the standards and conditions of the IGC-approval. (AL2)

1.9.1 **Testing production equipment.** Such testing will be carried out by GFAC and may be at any time and without prior notice. GFAC may obtain FR units under its own arrangements such as from owners or sales outlets, but, if requested by GFAC, the Organisation listed in the IGC-approval document under "Manufacturer" shall supply, or cause to be supplied, hardware required for such testing. (AL2)

1.9.2 **Results of testing.** If any problems are found or questions are raised, GFAC will correspond with the manufacturer so that any residual problems can be corrected. If this cannot be done to the satisfaction of GFAC, FAI reserve the right for the approval to be altered. (AL2)

1.10 Problems in Use. If any problems arise during practical usage of IGC-approved Flight Recorders, the GFAC Chairman should be notified in the first instance.

If further technical detail is required, consult the Technical Specification for IGC-approved GNSS Flight Recorders. For the web reference, see para 4 of the Preliminary Remarks to this Annex B. Note that this Chapter 1 is repeated for the benefit of manufacturers in the form of Chapter 1 of the Technical Specification.

CHAPTER 2

ALTITUDE RECORDING

2.1 Altitude Evidence and Control (SC3 para 4.7, extract and expansion)

2.1.1 **Altitude evidence.** Altitude data requirements may be fulfilled by any of the following methods of measurement (SC3 4.7.2):

2.1.1.1 **Altitude data with time - barograms.** A barogram is a graphical presentation of pressure altitude against time. For FAI/IGC purposes it is derived from an IGC-approved and calibrated pressure altitude sensor and time-recording system. The presentation may be produced by the recording instrument in hard copy (such as a paper or metal trace from a drum barograph), by a printer connected to an electronic barograph, or be shown on a monitor screen or a printout from it. For a GNSS Flight Recorder the UTC (time) recorded as part of the data from a GNSS fix, is particularly accurate because the principle of GNSS systems is one of time-difference and so very accurate time is an integral part of such systems.

2.1.1.1.1 **Official FAI/IGC pressure altitude calibration scale – The ICAO ISA.** This is the International Standard Atmosphere (ISA) of the International Civil Aviation Organisation (ICAO). The ICAO ISA is used in civil and military aircraft worldwide for the calibration of pressure altimeters. The ISA to be used for FAI/IGC matters is given in ICAO Document 7488 tables 3 and 4, and contains exact conversions of pressures to altitudes. A copy of is held for reference at FAI HQ and is also available through www.icao.int/cgi/isbn_txt.pl?16 and other web pages. The ICAO ISA assumes a temperature and pressure at sea level of 15C and 760 mm of mercury (or 1013.25 mb/hPa). Above sea level, it assumes a constant temperature lapse rate from sea level of 6.5°C per 1000m (1.98°C/3.56°F per 1000 ft), up to an altitude of 11,000m (-56.5°C). 11,000m is assumed to be the Tropopause, above which constant temperature in the Stratosphere (-56.5°C) is assumed. Pressure figures from this ISA are used in calibration of barographs and electronic altitude sensors. Although the real atmosphere varies from day to day, for standardisation purposes a set of internationally agreed figures are needed. This ensures that all calibrations are to the same scale, whether or not such figures correspond to geometric height on a given day. A similar principle is used in calibrating aircraft pressure altimeters, so that all aircraft worldwide have a common standard for pressure altitude readings in the cockpit. (AL5)

2.1.1.2 **GNSS altitude.** Where this is recorded in an IGC-approved FR or a Position Recorder, GNSS Altitude may be used for evidence of flight continuity (proof of "no intermediate landing") if pressure altitude recording has failed. See also para 2.4. (AL5)

2.2 Barographs and Flight Recorders

2.2.1 **IGC-approved GNSS Flight Recorders.** The pressure altitude recording system fitted to all IGC-approved Flight Recorders is a barograph system in its own right. Such systems must comply with other rules in the Sporting Code (SC3 and its Annexes) for barographs and their calibration.

2.2.2 **Other Barographs – Silver and Gold badge flights.** Barographs and pressure-altitude sensors that are not part of an IGC-approved GNSS Flight Recorder may be used on flights for FAI/IGC Silver and Gold badges in conjunction with a Position Recorder (see the Glossary for Position Recorder with SC3 references). For FAI/IGC World Records, Diamond badge flights and distance diplomas, an IGC-approved GNSS Flight Recorder must be used (see para 2.3 below and SC3 para 4.5.2).

2.2.2.1 **Mechanical barographs.** A strip of recording material such as paper or thin metal foil is attached to a drum that rotates slowly with time through a clockwork or electrical mechanism. The recording medium may be mounted on the drum itself or is pulled by a smaller drum. A mechanical stylus or scribe moves up and down in proportion to pressure altitude, and marks the recording medium either by direct pressure or by making holes in it. Most direct-pressure systems use recording material that is smoked after attachment to the drum, the scribe removing the smoking as the drum rotates, leaving an altitude trace. The recording material is carefully removed after flight and the trace of altitude with time is preserved for measurement purposes by the use of a fixative spray or liquid.

2.2.2.1.1 Altitude sensors. Altitude is generally derived from a pressure sensor such as an aneroid capsule, although in some electrically-powered designs an electronic (piezo-electric) sensor is used. An aneroid is a sealed and partially-evacuated flat circular container that contracts and expands as outside pressure rises and falls, small movements of the aneroid being magnified by a lever system.

2.2.2.1.2 IGC Approval. No special IGC-approval is required for mechanical barographs as long as they satisfy FAI/IGC calibration requirements (para 2.5).

2.2.2.2 Electronic barographs. These devices record pressure altitude and elapsed time, using an electronic pressure altitude sensor and a real- or elapsed-time electronic clock. The resulting barogram is stored in electronic form inside the unit during the flight. Results are presented after flight by downloading data either to a printer or a PC.

2.2.2.2.1 Accuracy and calibration. IGC-approved electronic barographs must be able to produce a secure, accurate barogram calibrated to the ICAO ISA. In particular, the design must be such that the relationship of pressure against altitude and time must not be able to be altered after the last independent IGC/FAI calibration that has been carried out in accordance with para 2.6.

2.2.2.2.2 IGC Approval. Test and Evaluation (T&E) is carried out by the IGC GFA Committee, using the same methods that are used for testing the pressure altitude systems of GNSS Flight Recorders. After an IGC-approval document has been issued by GFAC and published on the IGC web pages, that type of electronic barograph shall be accepted for worldwide use.

2.3 Altitude evidence for world records, Badge and Diploma flights For record, badge and distance diploma flights except Silver and Gold, evidence is required from a GNSS Flight Recorder. This includes flights for absolute altitude and gain of height performances, for which the data from the Flight Recorder must substantiate all of the claimed circumstances of the whole flight. These include the takeoff, track over the ground, wind drift with altitude, landing, etc, not just those directly related to altitude alone.

2.4 Flight Recorder altitude evidence

2.4.1 **Comparison of GNSS and Pressure Altitude figures** The digital altitude data supplied by a GNSS receiver is in the form of vertical distance above a mathematically defined surface (such as the WGS84 ellipsoid) rather than Mean Sea Level (MSL), or a pressure altitude datum such as 1013.25 hPa (hectoPascals) or mb (millibars). In addition, analysis of both pressure and GNSS altitude has been made from several thousands of IGC flight data files from worldwide sources in both hemispheres. This has shown that the GNSS altitude figures from IGC files are not consistent enough to satisfy Sporting Code requirements for use as accurate measurements of altitude such as high and low points, start and finish points. The GNSS altitude anomalies are not just attributable to satellite geometry, there have been many recorded instances of "altitude unlock" and others of obvious anomalies of GPS altitude, fortunately not seeming to affect lat/long fix accuracy. This may be due to the low-cost GPS receiver modules that are generally used and are not designed with altitude recording in mind. Investigation by GFAC continues. However, all IGC-approved GNSS Flight Recorders incorporate a pressure altitude sensor that allows a barogram to be produced which conforms to Sporting Code criteria.

2.4.2 **GNSS altitude accuracy** GNSS navigation systems are based on the time-difference of signals at a ground receiver from a constellation of satellites. Figures for horizontal position are more accurate than those for altitude, due to the typical geometry of satellites as their signals are received. Altitude figures less accurate than those for lat/long by factors between 1.8 and 2. The ratio will vary with numbers of satellites used in a fix, the latitude of the receiver, and receiver factors such as the algorithms used in the GPS receiver for calculating horizontal and vertical fix positions, signal strength due to topography, antenna position, and so forth.

2.4.2.1 **Data in IGC files**. Where GNSS altitude is not available from GNSS position-lines, it is recorded in the IGC format file as zero GNSS altitude. This is an IGC Specification requirement. So-called "dead reckoning", predicted data, or run-on of previous values without new data from satellites, is not permitted in IGC file data. In the case of altitude, using zero altitude instead of the last recorded value, enables any lack of valid GNSS altitude to be clearly seen during post-flight analysis. This will occur if fixes revert from 3D to 2D. It will also occur if fixing is lost for a time, the pressure altitude values in the IGC file continuing to produce evidence of flight continuity but position data being lost. In addition, differences in many IGC files have been noted in the shape of the GPS altitude record, compared to that for pressure altitude. Fortunately for validation of presence in Observation Zones, at the time that these differences occur, lat/long figures appear to remain valid.

2.4.2.2 **Glider Installations.** Poor antenna installation will magnify errors, particularly in GNSS altitude figures. Examples include mounting the antenna where material such as carbon fibre or metal can attenuate the signal or cause multipath effects. Other adverse conditions include angles of bank or pitch at which antenna gain could be reduced (for directional types of antennas); use of non-aviation quality materials in antenna cabling or GNSS installation; and insecure antenna connections that may be disturbed by flight conditions such as turbulence or manoeuvre (loose wires or connections). Pilots are encouraged to check that their glider installations are giving the best signal strength at all times in order to minimise the chance of short-term anomalies in GNSS fixes in the IGC data file, particularly in GNSS altitude.

2.4.3 **GNSS altitude - Zero-Datum.** (SC3C Appendix 4 para 1.5). The output of GNSS altitude within some Flight Recorders may be configured either with respect to the selected ellipsoid (the WGS84 ellipsoid is required for FAI/IGC evidence), or with respect to an approximate sea level surface described in the WGS84 manual as the WGS84 Geoid. In either case, GNSS altitude is therefore not the same as the pressure altitude that is used universally in aviation.

2.4.3.1 **WGS84 Ellipsoid and Geoid.** The WGS84 Geoid is an irregular surface of equal gravitational potential that varies from the WGS84 ellipsoid by between +65m and -102m.

2.4.3.2 **IGC Standard, the WGS84 Ellipsoid.** The IGC Technical Specification states that GNSS altitude figures in the IGC file shall be those above the WGS84 ellipsoid.

2.4.4 **GNSS altitude recorded in an IGC file.** For how GNSS altitude may be used, see para 2.1.1.4.

2.5 **Pressure Altitude Calibration, Before and After Flight.**

2.5.1 **Altitude and Gain-of-Height Records.** Calibrations both before and after the flight are required. The least favourable calibration of the two shall be used making the calculations for the record. Calibration intervals shall be in accordance with 2.5.3 and 2.5.4 below.

2.5.2 **Other Altitude Requirements.** For badges, start height verification, and altitude difference calculation, either a before-flight or an after-flight calibration is required. Calibration intervals shall be in accordance with 2.5.3 and 2.5.4 below.

2.5.3 **Before Flight.** For IGC-approved GNSS Flight Recorders and electronic barographs, the date of calibration must be within two years of the flight. For other types of barographs, the date of calibration must be within one year of the flight.

2.5.4. **After Flight.** The date of calibration must be within one calendar month after the flight.

2.6 **Calibration Procedures.** SC3C Appendix 5 gives guidance on calibration of mechanical barographs. Calibration of the pressure altitude function of an IGC-approved GNSS Flight Recorder should follow a similar procedure with the Flight Recorder running in the pressure chamber at a fast fix rate, connected to a battery that is also in the chamber unless the Flight Recorder is internally powered. In a large pressure chamber, Flight Recorders and mechanical barographs can be calibrated at the same time. In the absence of GNSS fixes, most Flight Recorders either start recording on detecting a change of pressure altitude (1 m/s for 5 seconds is a typical threshold), on switching-on or on connecting power. Guidance on calibration procedures and any switching required, is given in Annex B to the IGC-approval document for the particular type of Flight Recorder.

2.6.1 **Electronic Barographs, including IGC-approved Flight Recorders.** Electronic sensors that are used inside electronic barographs and IGC-approved GNSS Flight Recorders generally have factory-adjustable settings for sea level pressure and also a gain setting for the rest of the altitude range. These must be set so that the output corresponds closely to the FAI pressure altitude criteria (the ICAO International Standard Atmosphere, Document 7488 tables 3 and 4, held at the FAI Office and available on the Web). Large corrections must not apply after initial calibrations. This is because outputs of electronic barographs and Flight Recorders are in metres or feet directly and are not simply the distance of a needle on a drum. In competitions, such figures are used for checking start heights, airspace, etc., and in large competitions having to make large calibration corrections is an unnecessary burden on the organisers.

2.6.1.1 Calibration accuracy requirement. On set-up and calibration before or immediately after initial sale the FR must correspond with the ICAO ISA to the following accuracies:

Sea Level must correspond to 1013.25 mb (ICAO ISA SL) within 1 millibar;

Up to an altitude of 2000 metres - within 3 millibars;

Above 2000m - within one percent of altitude.

2.6.1.2 Recording of calibration data. After the calibration in the pressure chamber, the data file containing the pressure steps shall be transferred to a PC as if it was flight data. This may be done by an NAC-approved person other than the calibrator, who may not know the switching and actions required. During 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. The IGC file for the calibration will then be analysed, compared to the calibration pressure steps, and a correction table produced and authenticated by an NAC-approved person. The correction table will list true against indicated altitudes, and the associated IGC data file shall be retained as a record of the calibration.

CHAPTER 3

TIME RECORDING EQUIPMENT

3.1 Time measurement. Time data requirements may be fulfilled by any of the following measuring methods. The time system used shall be based on Universal Time Coordinated (UTC) or local times based on the local hours or half-hours difference from UTC.

3.1.1. Recording device with an accurate real time output in UTC. An example is an IGC-approved GNSS Flight Recorder, because GNSS systems employ highly accurate time signals as part of their method of operation. This includes FRs using the US GPS, the Russian GLONASS systems, the European Galileo system, or any other similar system. At the time of the latest revision of this document (2009), only Flight Recorders using the GPS system have so far been IGC-approved.

Note on Leap Seconds: The internal system time used by the US GPS system is with respect to UTC when the system first became operational on 6 January 1980. However, time outputs of most GPS equipment are made in current UTC using an internal correction for the so-called "leap seconds" that have been added since 1980 as the earth slows down. This is normally done automatically in GPS receivers that have a time output since the leap second correction is part of the system. The correction to UTC is always made for the time output from IGC-approved Flight Recorders and no action by pilots or OOs is required. In year 2009, UTC was 15 seconds later than GPS internal system time. Since this difference will increase with time, corrections in IGC-approved Flight Recorders will change as necessary so that time outputs will continue to be in the correct UTC. (AL3)

3.1.2. Direct observation from the ground. This is by an Observer with direct access to approved time measuring equipment such as a calibrated timepiece. Pilots and OOs should use timing devices with outputs in seconds whenever possible. If a timepiece is used that displays minutes and not seconds, 59 seconds must be added to each measurement to allow for the possibility that the reading was taken just before the minute changeover.

3.1.3. Mechanical barograph. This can be used for the measurement of approximate time differences such as exceeding the 5 hour badge duration requirement by an indisputable margin. However, this does not include use in the timing of speed flights, for which such a system is not accurate enough.

3.2 Time evidence

3.2.1. Evidence of timing and time recording of flights must be under the control of an OO. Time recording equipment carried on board a glider must be capable of being either physically or electronically sealed. Where a human action is required, the equipment shall be sealed and unsealed only by an OO.

3.2.2. The equipment must be designed, positioned and sealed if necessary so that the time settings cannot be altered by the crew during flight.

3.3 Pilot event inputs. If a means is provided for the pilot to make inputs into a device for remote recording of flight events, such inputs must be confined to functions not critical to the validation of the flight. *For example, it is permissible for a pilot to make a mark on the time base to register an event such as a waypoint Observation Zone, particular geographical point, thermal or other position, or in GNSS systems to change the sampling rate in flight.*

3.4 Timing device calibration. Chronographs, clocks, watches and other time recording equipment shall be checked against official radio-based time signals both before and after the flight. Any error found shall be taken into account and allowed for in the calculations. However, UTC recorded in a validated IGC flight data file from an IGC-approved Flight Recorder may be used as official time and does not require a separate calibration.

FÉDÉRATION AÉRONAUTIQUE INTERNATIONALE

**ANNEX B
to
FAI SPORTING CODE
SECTION 3**

**FAI AIRCRAFT CLASSES D AND DM
GLIDERS AND MOTOR GLIDERS**

**REQUIREMENTS
FOR EQUIPMENT USED FOR
THE VALIDATION OF FLIGHT PERFORMANCES**

REAR COVER