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 1-4
EFFECTIVE 1 OCTOBER 2007

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Rights to FAI international sporting events

All international sporting events organised wholly or partly under the rules of the Fédération Aéronautique Internationale (FAI) Sporting Code {Reference 1} are termed FAI International Sporting Events {2}. Under the FAI Statutes {3}, FAI owns and controls all rights relating to FAI International Sporting Events. FAI Members {4} shall, within their national territories {5}, enforce FAI ownership of FAI International Sporting Events and require them to be registered in the FAI Sporting Calendar {6}. 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 ANDS Committee, 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 delegates and other Specialists for inclusion in the agenda for the IGC Plenary meeting and 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.

Like other parts of the Sporting Code Section 3, amendments to Annex B take effect on 1 October following the IGC meeting at which they were agreed (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 http://www.fai.org/sporting_code/sc3.html

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			
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CONTENTS

PRELIMINARY REMARKS

1 **Title and Status**. This document, short title "SC3B", contains the basic 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 Global Navigation Satellite System (GNSS) Flight Recorders, barographs, cameras, 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 in its Annex C (SC3C). SC3 gives principles and rules, and is designed to be brief. Its Annex C, titled the OO and Pilot Guide, amplifies the SC3 material and gives more detailed procedures for use in the field. This Annex B includes quotes from SC3 and Annex C in order to aid clarity on the subject of the chapter heading 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 by FAI 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 boards. 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 Airsport 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.

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

SC3 and its annexes (SC3A, SC3B, SC3C): http://www.fai.org/sporting_code/sc3.html

Technical Specification for IGC-approved GNSS Flight Recorders:
http://www.fai.org/gliding/gnss/tech_spec_gnss.asp

IGC-approved Flight Recorders, complete list and all IGC-approval documents:
http://www.fai.org/gliding/gnss/approved_gnss_flight_recorders.asp

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

5 **Amendments**. See page (i) for details.

6 **Nomenclature**. 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 term "Flight Recorder" or "Recorder" is used in this document and refers to types of GNSS Flight Recorders that are either IGC-approved or being designed or submitted for IGC-approval, unless the context indicates otherwise. The term "logger" is sometimes met (instead of Recorder) but is not used by IGC because of difficulties in translation into other languages.

7 **Terms and Abbreviations**. As well as the short Glossary 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 GS of the FAI Sporting Code is available through: http://www.fai.org

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GLOSSARY OF TERMS AND ABBREVIATIONS

This contains 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 Flight Recorder Specification: **http://www.fai.org/gliding/gnss/tech_spec_gnss.asp**
FAI Sporting Code General Section: http://www.fai.org/sporting_code/scgdownload.asp#1

ANDS Committee - Air traffic, Navigation and Display Systems committee of IGC, previously the GNSS Committee

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 - Engine Noise Level. More specifically, a system used in IGC-approved GNSS Flight Recorders for the detection of the operation of a Means of Propulsion (MoP) when the MoP is supplying forward thrust. Ambient noise is measured by a microphone system inside a Flight Recorder and is recorded with each fix. For engine systems that generate sufficient noise, this allows flight with engine running to be differentiated from soaring flight. See para 1.4.2 in this document. (AL4)

FAI - 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 - A theoretical worldwide surface of equal gravitational potential. 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 above.

GFAC - GNSS Flight Recorder Approval Committee, of IGC.

GNSS - Global Navigation Satellite System(s), 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.

Grandfather rights - This term is used for a situation where the approval of a type of equipment is continued unaltered 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 (AL1)

ICAO - International Civil Aviation Organisation. Headquartered in Montreal, Canada.

IGC - International Gliding Commission of FAI

ISA - International Standard Atmosphere. A defined relationship between ambient pressure and an assumed altitude at that pressure level, the most common example being the ICAO ISA that is used in aviation worldwide.
JPEG - Joint Photographic Experts Group. A system for compressing digital data for pictures and diagrams so that the byte size is smaller for sending or storing.

Mb - Millibar. A unit of pressure, one thousandth of a Bar. On the ICAO ISA the assumed sea level pressure is 760mm of a mercury column, equivalent to 1013.25mb.

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

MS - 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 airsports 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, 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.

SC3 - Sporting Code Section 3, the section of the FAI Sporting Code for Gliders and Motor Gliders. It has three stand-alone annexes. 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 SC3 material and gives more detailed procedures for use by pilots and OOs in the field.

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.

WGS84 - World Geodetic System 1984. A world model that includes an ellipsoid, geoid, gravitational assumptions, etc. The WGS84 ellipsoid is used as the primary earth model in the US GPS system, is used by ICAO, and also by IGC for the accurate measurement of distance. For more detail see the other Glossaries mentioned above.

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

Validation, VALI check - For GNSS Recorder data, the process of determining that electronic flight data 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 recorder 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 the FR, and that the data in the IGC file is identical to that initially transferred from the FR.

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 both physical and electronic. The full 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. Other levels of approval also apply. Conditions that frequently occur in large competitions must also be taken into account. Other aspects are matters between customers and manufacturers, including the presentation on cockpit displays, navigational features, and post-flight analysis systems. See 1.1.3.3 for levels of approval for types of flights for which a Flight Recorder may be used, also 1.1.5 for the position of displays in the cockpit.

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 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 transfer the flight data to a PC in the IGC flight data format. However, GFAC must specify procedures that minimise the possibility that either one Flight Recorder could be substituted in the glider concerned by another one that was not carried on the flight in question, or that the data in and from the Flight Recorder that was in the glider 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 evaluation process. (Amplification of SC3C para 1.7)

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 criteria. 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 an introduction; standards; version numbers for hardware, firmware and software; connections to the Flight Recorder; types of GPS receiver and pressure transducer; and a list of Conditions of Approval. There are two annexes. Annex A contains notes for pilots and Annex B contains notes for Official Observers and National Airsport Control authorities (NACs). Annex B includes checks that apply to that type and model of Flight Recorder, transferring flight data to a PC, procedures for checking the validity of the IGC file data and pressure altitude calibrations. Also, for those Flight Recorders fitted with an Engine 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 recorders. It is the responsibility of owners of recorders and pilots using them, to check that the recorder characteristics correspond to those described in the IGC-approval document. If they do not, the individual recorder should be returned to the manufacturer or his authorised agent to be re-set to the IGC criteria. This particularly applies to Engine Noise Level (ENL) figures recorded in IGC format files and also to pressure altitude calibrations. Altitude calibrations must be close to the ICAO standard atmosphere and should 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 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. The latest version is that which is currently posted on the IGC web site. Similarly, the only valid versions of the short programs DATA, CONV and VALI are those posted on the current IGC web site. Other versions of the IGC-approval and/or program files must not be used in the validation of flights to FAI/IGC criteria. (AL1)

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 full approval at the time that the approval is given. They also apply in cases where the security of a type of recorder has either been compromised 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 recorders, 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 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 IGC/FAI world record flight evidence. For competition flights, see 1.1.3.3.6. This level may be used for new recorders that do not meet the current Specification in some areas. For types of recorder that are already IGC-approved, this level may be used for those whose characteristics are now significantly below the current Specification standard, particularly on security or accuracy of data. These assessments will be at the discretion of the IGC GFA Committee (GFAC). For types of recorder 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 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 recorders 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 recorders 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. That is, the recorder 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 recorder 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 recorders that may be accepted are (a) at the discretion of the competition organisers and (b) subject to any higher level 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 recorder, 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 early stage. Such lowering of level may apply to a particular type of recorder 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 domain announcement asking 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 recorder 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 easily 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 recorders 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 a recorder, the manufacturer of the recorder 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 in favour of 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 and 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 change in approval level was announced in the public domain. The appeal financial deposit must be received by FAI within the same three calendar month period. The amount of deposit will normally 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 Recorder 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**. Verification 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 by 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 instrument panels in remote positions, but should be in prominent positions close to angles suitable for external view. Although IGC cannot control the layout of instrument panels, it can draw attention to the potential dangers. Particularly in single-seat gliders, the position of any ancillary 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 potential 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 be fitted in such a way that it will be broken if the case is opened. Also, a system must be incorporated that trashes (makes inoperative) the internal electronic security system if the recorder 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 recorder 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 (such as 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 vital in the case of a GNSS Flight Recorder because, unlike other equipment used in the verification process, it contains virtually all the evidence for the flight. It is particularly 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 two methods 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 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 passing the electronic VALIDATE check on the IGC file for the claim. The VALIDATE check shows that the data has correctly originated from the individual Flight Recorder and is the same as it was when 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 recorder 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. 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 practicable during the design process for a new type of Flight Recorder that may be submitted 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 could 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 (such as on electronic security matters), but the Chairman must be copied with all correspondence so that he is 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 IGC-format files are available from early Flight Recorder hardware, 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 recorder hardware is available. 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 a recorder**. 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 recorder manufacturer or applicant for IGC-approval shall provide information to GFAC on how the particular model of Flight Recorder 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 forwarded with any hardware that is sent.

1.3.5 **Fees and expenses**. The appropriate fee must be deposited in FAI's IGC account by the applicant when hardware is first sent to the GFAC Chairman for evaluation. Expenses such as customs duties and national taxes for postage of recorder 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 2003) the fee is 1500 Swiss Francs (ChF) 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.

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 Flight Recorder 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 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 and 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. Pilots flying such motor gliders should ensure that engine-recording systems have been provided in accordance with Sporting Code requirements (including this paragraph and in particular 1.4.2.4) so that their flights can be validated to IGC standards. (AL4)

1.4.2.1 High Engine Power. A combination of engine and propellor noise at high power are expected to give ENL figures over 800 out of the maximum ENL in the IGC file of 999. Most two-stroke systems give over 900 and some ENL systems give the maximum of 999. Four stroke and Wankel rotary engines give lower figures but still enough to differentiate between power-on and power-off. Electric engines at high power have also been shown to give reasonably high ENL (much is propellor noise), but 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 differentiation is power for low-speed cruise, that 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 on some recorders. 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 100Hz gives good (high) response to engine and propeller noise and less response to cockpit noises, combined with a typical "bell curve" (normal distribution curve) 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, conditionally 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 **Conditional Approval.** Conditional approval means that some changes are needed before approval can be given to the appropriate level when the factors which led to the conditional approval have been changed (see 1.1.3.3 for levels). However, wherever possible an IGC-approval document will be issued which will include appropriate limitations until changes are made and the limitations can be removed. *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 including 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.*

1.5.2 **Requirement for Modifications**. If it is decided that IGC-approval cannot be given to the appropriate level without modifications being made (see 1.1.3.3 for levels), GFAC will supply the manufacturer with details of what is required in order to gain IGC-approval in the future. If the manufacturer notifies GFAC within 21 days that he wishes the approval process to continue, he will be expected to resubmit a modified Flight Recorder for further review by GFAC within the next 180 days. 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.*

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, small or large.

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 recorder 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 recorder, GFAC shall be informed. The manufacturer shall state whether support for the type will continue such as updates and/or repairs to existing recorders. (AL2)

1.6.4.3.1 Pilot aspects. Pilots should be aware that if they are using a recorder 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**. A GNSS Flight Recorder operated in accordance with its IGC-approval document shall be used for all flights that require validation to FAI/IGC criteria including World Records (SC3, 3.0.3) and World Championships (SC3 Annex A). It shall also be used for evidence for FAI/IGC Badge Flights unless photographic evidence or direct observation is used (SC3, 3.0.3, 4.3, 4.6.2f). It may also be used by NACs, at their discretion, for other flights where FAI/IGC validation criteria are specified by the NAC. 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, such as, for competitions, appropriate competition officials.

1.8 **Notification and Issue of IGC-approval Documents and Free 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 http://www.fai.org/gliding/gnss. In addition the associated 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.

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 this 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 recorder 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 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), or by a printer connected to an electronic barograph. It may also be shown on a monitor screen that displays altitude data that is calibrated to IGC standards (such as from an IGC-approved electronic barograph or Flight Recorder), together with the digital record of the altitudes concerned. For a GNSS Flight Recorder the UTC (time) recorded as part of the data from a GNSS fix, is definitive because GNSS systems function through the use of very accurate time signals.

2.1.1.1.1 Official FAI/IGC pressure altitude calibration scale. This is the International Standard Atmosphere (ISA) of the International Civil Aviation Organisation (ICAO). The ICAO ISA is also used in civil and military aviation for calibration of pressure altimeters. A copy of ICAO document 7488, tables 3 and 4 is held for reference at FAI HQ, and contains exact conversions of pressures to altitudes. For more detail on barographs and Flight Recorders, see para 2.2.

2.1.1.2 **Optical measurement from the ground**. Altitude may also be derived by trigonometrical calculations using devices such as a height frame or theodolite mounted on the ground. This may be used for assessment of start height if evidence from an IGC-approved GNSS Flight Recorder is not available.

2.1.1.3 **Radar measurement**. Radar ranging, if accurate enough for the purpose and corrected to obtain vertical distance, may be used if evidence from an IGC-approved Flight Recorder is not available.

2.1.1.4 **GNSS altitude output from an IGC-approved Flight Recorder.** This may be used for evidence of flight continuity (no intermediate landing) if pressure altitude recording has failed, but not for accurate measurement of altitude because of the differences from ICAO pressure altitude which is the IGC standard for accurate measurement of altitude. Also see para 2.4.

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 Code (SC3) for barographs and their calibration.

2.2.2 **Other Barographs - FAI 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 badges. For FAI/IGC World Records, an IGC-approved GNSS Flight Recorder shall be used (para 2.3).

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) with respect to the claimed flight.

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 accordance with paras 2.1.1.1, 2.5 and 2.6. 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. Since world records require GNSS Flight Recorder evidence, electronic barographs can only be used for the validation of other flights such as FAI/IGC badges, in combination with other evidence in accordance with the Sporting Code for gliding.

2.3 **Altitude evidence for world records** (Based on SC3C para 2.3) Evidence is required from a GNSS Flight Recorder that is IGC-approved for world record flights. This includes flights for world record 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. See also paras 1.1.3 and 1.1.4.

2.4 **Flight Recorder altitude evidence**

2.4.1 **Comparison of GNSS and Pressure Altitude figures** (Based on SC3C para 5.3, plus GFAC analysis results reported to IGC). The digital altitude data supplied by a GNSS receiver is in the form of vertical distance above a mathematically defined surface rather than sea level or a pressure altitude datum such as 1013.25 hPa (hectoPascals) or mb (millibars). Analysis of both pressure and GNSS altitude has been made from several hundreds 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 at precise times 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 major altitude anomalies, fortunately not seeming to affect lat/long fix accuracy. This may be due to the low-cost receiver boards 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 the Sporting Code.

2.4.2 **GNSS altitude accuracy** (SC3C Appendix 5 para 3a, expanded). For navigation systems based on the time-difference of signals at a ground receiver from a constellation of satellites, figures for horizontal position will normally be more accurate than those for altitude. Due to the typical geometry of satellites as their signals are received, altitude figures are likely to be less accurate than for lat/long by factors between 1.5 and 2, occasionally more. The ratio will vary with numbers of satellites used in a fix, the latitude of the receiver station, and receiver factors such as the algorithms used in the GPS receiver board 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" or run-on of previous values without new fix data, 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, for reasons that are still under investigation, in some IGC files occasional differences have been noted in the shape of the GPS altitude record with time, 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 consistent with adjacent fixes for times where the shapes of the pressure and GNSS altitude records are similar.

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 5 para 1.9). The output of GNSS altitude within a Flight Recorder can be configured either with respect to the selected ellipsoid (the WGS84 ellipsoid for FAI/IGC evidence), or with respect to an approximate sea level surface known as the Geoid.

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. GNSS altitude is therefore not the same as the pressure altitude that is used universally in aviation.

2.4.3.2 **IGC Standard, the 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**. (SC3 4.4.7)

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 IGC-approved 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 8 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 appropriate switching required, is given in Annex B to the IGC-approval document for the particular model 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). 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 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 recorder 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. 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-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. 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

CAMERAS

Note: Photographic evidence is not acceptable for World Record Flights, for which evidence from an IGC-approved Flight Recorder is required (IGC decision, 1999, see SC3 para 3.0.3).

3.1 **Photographic Control Method** (SC3 4.6.3, extract). The following method shall be used:

3.1.1 Mounting in the cockpit. The camera must be held in fixed mountings in the cockpit so that every photograph will show the wingtip. The lens housing should be positioned inside the canopy or camera window so that the random line mentioned below will show on the film, except with open-cockpit gliders where this does not apply. (Annex C para 3.4).

3.1.2 Sealing the camera. The camera must be sealed unless the same OO is controlling both the pre-flight photograph(s) and the processing of the film, in which case sealing is not necessary. When a time-recording camera is used to supply time evidence, it must be sealed by an OO before the flight in such a way that the film cannot be removed and the time adjusting mechanism cannot be accessed until the seal is broken by an OO after flight.

3.1.2.1 Sealing to glider structure. The method of sealing a camera to the glider structure, must be acceptable to the NAC and to IGC and it must be possible for the OO to identify the seal afterwards. 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, such as by marking it with the glider registration, the date, time and OO's name, signature, or OO identification number. (Annex C para 1.7, extract).

3.1.3 **Before takeoff - OO's canopy mark**. Just before takeoff, an OO shall mark the outside of the canopy or window across the front of the lens with a random line. The flight declaration shall then be displayed for the pilot to photograph with the camera installed. The random line should be dark or opaque and at least 3 mm wide if it is to show on the image. (SC3 para 4.6.3a(iii)). If the mark is too light or narrow, the result may be that it does not appear on the photo. (Annex C para 3.4).

3.1.3.1 The canopy mark - appearance on the photos. The mark placed on the canopy will appear as an out-of-focus "shadow" across the photograph. After flight, the OO will verify that this shadow matches the shape and orientation of the mark that was made, and that it appears on the declaration photo and all photos of waypoints. When using a new camera, the pilot is advised to take test photos to confirm that canopy marks can be seen. To achieve this, it is recommended that the distance from the lens to the canopy should be greater than the focal length of the lens. (Based on Annex C para 3.4).

3.1.4 **After flight**. Following landing and the completion of the photographic sequence, an OO shall take charge of the film and have it developed. Every effort is to be made to preserve the film as a continuous strip. However, if it is cut or broken while out of control of the pilot or OO, this evidence remains valid if close examination of the pieces show that they form the original continuous length of film. An OO shall describe the circumstances under which the film was broken or cut. (SC3 para 4.6.3a(iv))

3.2 **Photograph Sequence**. (SC3 4.6.3, extract) The film shall contain photographs in the following sequence:

3.2.1 If a time camera is used, the pre-flight clock synchronisation photo(s).

3.2.2. The pre-flight declaration (if any).

3.2.3 At least one photograph showing indisputable evidence of the presence of the glider in each of the observation zone(s) of the way point(s) claimed, in the correct sequence.

3.2.4. The glider on the landing field with surrounding features and its registration markings appearing clearly on the photo, or the above declaration with landing time added.

3.2.5. If a time camera has been used, the post-flight clock synchronisation photo.

Note: Photographs of the preflight declaration (SC3, 3.2.2) and waypoints (SC3, 3.2.3) must show the shape of the canopy mark on the film image. Additional photographs which may have been taken after the declaration and before the landing must also show the canopy mark.

3.3 **Camera characteristics**

3.3.1 **Recording medium - Film only**. A camera used for flight validation must record images on a continuous length of photographic film, with all images appearing on the film in the sequence in which they were taken. Following landing and the completion of the photographic sequence, an OO shall take charge of the film and have it developed. Digital images on electronic medium are not acceptable because their sequence in time is difficult to establish in a clear and secure manner. If the film is inadvertently cut, see para 3.1.4.

3.3.2 **Film, camera and lens size**. No special type of camera is required and most types of camera that use 35mm film are generally acceptable. Incontrovertible evidence of presence in waypoint Observation Zones is what matters, irrespective of the system that produced the evidence. Cameras using larger or smaller film sizes may not be able to fulfil IGC requirements for photographic evidence and large format devices may be too big to fit the cockpit mounting.

3.3.2.1 Lens focal lengths. A 'normal' focal length is recommended, so that the angles on the photo correspond approximately to those in the real world from the same eye-point. For a camera using 35mm film, the 'normal' focal length is about 50mm. Very wide angle (fisheye) and narrow angle (telephoto) lenses are not recommended. This is because distortion of the image may make features difficult to orientate with respect to each other when the photos are assessed. This may prevent validation, particularly if the photo was taken from near the edge of an Observation Zone (see Annex C Chapter 16 for validation techniques).

3.3.3 **Useful features**. Some features that have proved useful include:

3.3.3.1 Motor drive. This avoids manually winding film while manoeuvring at a waypoint Observation Zone.

3.3.3.2 Automatic exposure. This generally gives a good result, except where a large area of bright cloud in an individual photo might reduce exposure of ground features to a critical level. Tests with the camera in the glider under different lighting conditions are advised, before a claim flight is made.

3.3.3.3 Infinity focus. A fixed focus at or close to infinity is recommended. A variable focus camera can have its focus fixed by using simple aids such as adhesive tape to prevent its focus control moving. However, automatic focus systems may focus on the wing when the camera is mounted, and cause the ground to be out-of-focus.

3.3.3.4 Screw mounting socket. This is fitted to many cameras so that time exposures can be taken using a tripod. In the case of use in gliders, it allows a standard mount to be used in the cockpit.

3.3.3.5 Flash gun switch plug. This is needed if a type of Flight Recorder is used where the switch contact is used to record a mark on a timebase. Certain types of barographs and Flight Recorders use this method of recording the time at which photos are taken.

3.3.4 **NAC selection of camera types**. Evidence on film that does not clearly show the images required for the verification process, shall be rejected. To make the verification process easier, NACs may specify types of camera and recording media (film) that may be used for recording evidence for flights made within their area of jurisdiction to be validated.

CHAPTER 4

TIME RECORDING EQUIPMENT

4.1 **Time measurement** (based on SC3 para 4.5.1). 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.

4.1.1. Recording device with an accurate real time output in UTC. An example is an IGC-approved Flight Recorder that uses a system that employs highly accurate time signals as part of its method of operation. This includes recorders using either the US GPS or the Russian GLONASS systems, also the future European Galileo system. However, at the time of the latest revision of this document (2003), only Flight Recorders using the GPS system have so far been IGC-approved. *It should be noted that internal system time used by the US GPS system is with respect to UTC when it first became operational on 6 January 1980. However, time outputs of most GPS equipment are made in current UTC by 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 2006, UTC was 14 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)*

4.1.2. Direct observation from the ground. This is by an Observer with direct access to approved time measuring equipment such as a synchronised 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 is to be added to each duration measured to allow for the possibility that the reading was taken just before the minute changeover.

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

4.1.4. Time camera. This can be used for the measurement of time differences allowed by the Code (SC3) for time cameras, such as Start Time Interval (STI). This does not include the timing of speed and duration flights, for which the integrity of time camera evidence is difficult to control except as part of organised procedures in centralised competitions.

4.2 **Time evidence** (SC3 4.5.2)

4.2.1. 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.

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

4.3 **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.*

4.4 **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