FÉDÉRATION AÉRONAUTIQUE INTERNATIONALE
INTERNATIONAL GLIDING COMMISSION

FAI AIRCRAFT CLASSES D AND DM
GLIDERS AND MOTOR GLIDERS

ANNEX B
to
FAI SPORTING CODE SECTION 3

REQUIREMENTS FOR EQUIPMENT USED IN THE VALIDATION OF FLIGHT PERFORMANCES

EDITION 3 WITH AMENDMENTS 1-9
EFFECTIVE 1 OCTOBER 2014

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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 document 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, 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 this document, together with an explanation of why they are needed.

Like other parts of the Sporting Code Section 3, amendments to this document take effect on 1 October following the IGC meeting at which the amendment was agreed, unless an earlier date is agreed. By the issue date, an amended SC3B will be made available through the FAI/IGC and GFAC web sites.

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	31 March 2011			
7	1 October 2011			
8	1 October 2012			
9	1 October 2014			
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 the criteria of IGC and FAI. Although SC3B is published and amended as a stand-alone document, it is a sub-document of the FAI Sporting Code Section 3 for Gliders and Motor Gliders (abbreviated "SC3") and should be read in conjunction with other documents where appropriate.

2. **Scope**. SC3B deals with devices that use Global Navigation Satellite Systems (GNSS) such as IGC-approved Flight Recorders (FRs) and IGC Position Recorders, devices that record Pressure Altitude (including stand-alone barographs), and with devices that record accurate time. It also contains the Terms of Reference for the IGC GNSS Flight Recorder Approval Committee (GFAC) that deals with FRs on behalf of IGC. Other material needed by pilots and Official Observers is in the main body of SC3 and amplified in its Annexes. These are Annex A (SC3A, Rules for World and Continental Soaring Championships), this Annex B (SC3B), Annex C (SC3C, the Official Observer and Pilot Guide) and Annex D (SC3D, Rules for the Official IGC Ranking List). Annex C amplifies the material in the main SC3 document and gives more detailed procedures. This Annex B includes quotes from SC3 and Annex C, in order to aid clarity on the subject concerned, so that this document can be used without constant reference to others.

3. **Technical Specification for IGC-approved GNSS Flight Recorders**. A separate Technical Specification (TS) document for IGC-approved FRs is issued on behalf of IGC, and is available through the web references given in para 4 below. Amendments to it are made by the IGC Airspace, Navigation and Display Systems (ANDS) committee and the GNSS Flight Recorder Approval Committee (GFAC). These committees consult a range of independent experts and the manufacturers of IGC-approved Flight Recorders, GNSS receiver units and pressure altitude sensors. As the TS is a technical document and not part of the Sporting Code, an amendment can be made at any time, but generally not more than once in a calendar year unless particular matters need to be covered such as after IGC Plenary meetings.

The TS is mainly for the use of manufacturers and designers of hardware and software, IGC Committee members, consultants and expert advisors, and technical experts on GNSS Flight Recorders in FAI National Airsport Control authorities (NACs). 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 detailed 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. **Other IGC documents and Web References**: Other IGC documents are as follows:
   SC3 and its annexes (SC3A, SC3B, SC3C): www.fai.org/igc-documents
   IGC-approved Flight Recorders, list of IGC-approval documents and Technical Specification:
   www.fai.org/gnss-recording-devices/igc-approved-flight-recorders
   Free software for IGC-approved Flight Recorders: www.fai.org/gnss-recording-devices/free-software
   GFAC web site for Flight Recorder material (useful if there are difficulties in finding FR material on the FAI/IGC Web site): www.ukiws.demon.co.uk/GFAC

5. **Amendments to this 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.

In addition to IGC-approved GNSS FRs, the term "Position Recorder" (PR) is also used in the Sporting Code for gliding, for GPS recorder units that may be used under procedures for IGC PRs in SC3 and Annex C to SC3 for evidence for Silver and Gold badge flights. See the Glossary under "Position Recorder". (AL5)

7. **Terms and Abbreviations**. As well as the Glossary of Terms that follows, more comprehensive Glossaries are included in the Technical Specification for IGC-approved GNSS Flight Recorders, and also 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/fai-documents

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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.

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, defined by two radii, a "major axis" and a "minor axis". For an earth model, the major axis is the radius at the equator and the minor axis is the radius at the poles. An example is the WGS84 ellipsoid, see under WGS84.

ENL - Environmental Noise Level. A system used inside IGC-approved GNSS Flight Recorders, designed for detecting when a Piston/Propellor 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 at the FR, this allows engine running to be differentiated from the other noises associated with soaring flight such as flight with cockpit panels open for ventilation or cooling. See also under MoP and para 1.4.2 in this document. (AL5)

FAI – The Fédération Aéronautique Internationale, with headquarters in Lausanne, Switzerland. The body and legal entity under which IGC and other Air Sport Commissions exist and operate. See www.fai.org

Geoid - The WGS 84 Geoid is a theoretical worldwide surface of equal gravitational potential. This is similar but not the same as a water surface at mean sea level (MSL). See para 2.4.6.1, and the other FAI Glossaries.

GFAC – The IGC GNSS Flight Recorder Approval Committee. See para 1.2 of this document.

GNSS - Global Navigation Satellite System, a generic title for satellite-based navigation systems such as Beidou 2 (China), Galileo (Europe), GLONASS (Russia), GPS (USA), and other systems with a constellation satellites in oblique orbit, receivers giving accurate position on and near the Earth's surface. For more detail, see the Glossaries in the Technical Specification for GNSS Flight Recorders, and in the FAI Sporting Code General Section.

High Altitude Flight Recorder (HAFR) - A special type of IGC-approved Flight Recorder designed for accurate altitude recording at high level and required for altitude claims above 15,000 metres (49,213ft). More detail, para 2.1.2.2. (AL9)

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

Grandfather rights – A term used where the formal Approval of a type of equipment is continued without alteration, although the Specification conditions have changed with time (generally, increased). Commonly used in civil aviation regarding designs certificated by the Regulatory Authority in the past. Detail on its application to IGC-approved GNSS Flight Recorders is in para 1.1.4.5

ICAO - International Civil Aviation Organisation (www.icao.int). HQ in Montreal, Canada. See also under ISA.

IGC – The International Gliding Commission of FAI (www.fai.org/gliding)

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, on behalf of IGC. Successful evaluation leads to the issue of an IGC-approval document. See chapter 1.

ISA - International Standard Atmosphere. A defined relationship between atmospheric pressure and an assumed altitude at that pressure level. The most common example is the ICAO ISA that is used in aviation worldwide for pressure altitude. The ISA to be used for FAI/IGC matters is given in ICAO Document 7488 tables 3 and 4, available through www.icao.int. More detail, para 2.1.1.1

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. Also the three-letter code MOP in an IGC flight data file, see para 1.4.2.4 on a separate MOP sensor

connected to an IGC FR by cable, for installations where the internal FR ENL sensor does not give high enough figures on the IGC file to differentiate engine running from noises in soaring flight.

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 organisation in the nation concerned.

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, checking and supervising evidence for claims.

OZ - Observation Zone. For valid "reaching" of a Waypoint, there must be proof of presence in the relevant OZ, such as from GPS fixes in an IGC flight data file. 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 of 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 (PR) - a stand-alone GPS recorder unit, data from which may be used under IGC rules for the validation of types of badge flights that are listed in the main volume of the Sporting Code (SC3). The IGC flight data file format is used, but an IGC PR has a lower technical and security standard compared to an IGC-approved Flight Recorder (FR), and the IGC Technical Specification for GNSS FRs is advisory rather than a requirement. Rules and procedures for IGC Position Recorders are given in the main volume of SC3, including para 1.1.5 and the appendix to Chapter 4. More detail is in Annex C (SC3C) including para 6 on Recorders, para 11 on Calibration, Appendix 3 on Badge procedures, and Appendix 5 on GNSS recording. A specimen approval document for IGC Position Recorders is available on the IGC and GFAC web pages, together with guidance notes. (AL9)

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 that use Annex A rules. This Annex B (SC3B) is about equipment used in the flight validation process. Annex C (SC3C), the OO and Pilot Guide, amplifies SC3 and gives more detailed procedures for use by pilots, OOs and NACs. Annex D (SC3D) contains 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.

WGS 84 - World Geodetic System 1984. A co-ordinate system based on an ellipsoid mathematical model of the earth. It includes many variables such as gravity coefficients, formulas for the Earth's angular velocity, a WGS84 ellipsoid and a WGS84 geoid, (an irregular 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 exactly 6378,137 metres and a Polar radius of 6356,752.3 m, a "flattening" of 21,384.7 m. See the Glossaries in the Technical Specification for IGC-approval GNSS Flight Recorders, and the General Section of the FAI Sporting Code (web references, page (v)).

Validation, VALI check - Validation is the process of checking that electronic flight data in the IGC file has the accuracy and integrity to be used in the overall flight validation process. This is by using an IGC-XXX.DLL file together with the IGC shell program, where XXX are the identification letters of the FR manufacturer. This program checks the Digital Signature that is part of the IGC-format file that was initially downloaded 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 downloaded. See para 1.1.10.1 for more details.

A less rigorous form of file validation applies to IGC Position Recorders (PRs, 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 IGC PR 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 part of the Validation process. (AL5)

CHAPTER 1

Based on Chapter 1 of the Technical Specification for IGC Flight Recorders

GNSS FLIGHT RECORDERS
IGC-APPROVAL AND OTHER PROCEDURES

1.1 **IGC 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. GFAC and its advisors are agents of IGC; FAI Commissions such as IGC are agents of FAI; the legal entity is FAI and Swiss law applies. 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. Other aspects are matters between customers and manufacturers, including the presentation of cockpit displays, navigational features, proximity warning devices, and post-flight analysis systems. The full level of IGC-approval indicates that the equipment meets the standards of data integrity, accuracy and security that are required for the certification of flights for IGC World Records. See 1.1.4 for the different levels of IGC-approval for types of flights for which a Flight Recorder may be used, also 1.1.7 for the position of displays in the cockpit.

1.1.1 **FAI Liability**. FAI has no liability for the consequences of the use of Flight Recorders covered by this document 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, traffic alert, proximity-warning and/or anti-collision functions, any other matters concerning flight safety; and uses outside IGC such as by other FAI Airsports.

1.1.2 **IGC Flight Recorder Operating Procedures**. Operating procedures for each type of Flight Recorder are 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 secure flight data to a PC in the IGC flight data format. *(See also SC3C paras 6.3 - 6.7)*

1.1.2.1 GFAC will specify procedures that minimise the possibility that either one Flight Recorder could be substituted in the glider by another that was not carried on the flight in question, or that the data in the Flight Recorder that was in the glider could be interfered with without this being detected. This may require either continuous observation of the glider before takeoff and/or after landing, or the physical sealing of the Flight Recorder to the glider by an OO at any time or date beforehand, to 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 broken. This can be achieved by marking it with the glider registration, the date, time and OO's name, signature, and the OO's identification number.

1.1.2.2 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, and will depend on the Flight Recorder design and the results of the GFAC test and evaluation process.

1.1.3 **IGC-Approval Documents for Flight Recorders**. The IGC-approval document for each type of Flight Recorder is produced by GFAC on behalf of IGC. Before the approval document is finalised, it is circulated in draft to GFAC members, other technical experts and consultants, and the manufacturer concerned. When finally issued, the document includes detailed procedures for checking the recorder, installation in the glider, and operation for flights that are to be 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 on the IGC and GFAC web pages.

1.1.3.1 Format of IGC-approval documents. These documents have a standard format which consists of an introduction (including legal disclaimers agreed by FAI on subjects such as on flight safety and intellectual property); manufacturer details; details of hardware (including the type of GPS receiver and pressure transducer); firmware and software; connections; installation; security; engine recording; and advice on making suggestions for future changes. There are two annexes. Annex A contains notes and recommendations for owners and pilots, including procedures and checks before, during and after flight, and other advice that might be useful to pilots. Annex B contains notes, recommendations and advice for Official Observers and bodies validating flight performances such as National Airsport Control authorities (NACs). Annex B includes pre-flight procedures including checking installation and serial number; after-flight procedures including ensuring that the installation has not been changed; how to download IGC files to a PC; checking validity of data in IGC files; and pressure altitude calibrations. Annex B also contains details of Environmental Noise Level (ENL) figures recorded during GFAC testing and to be expected in various phases of flight; also figures from an external Means-of-Propulsion (MOP) sensor if such a system is available in the type of FR concerned.

1.1.3.1.1 Checks on individual recorders. It is the responsibility of owners and pilots to check that the characteristics of the recorder correspond to those in the IGC-approval document. If they do not, the recorder should be re-set to the characteristics given in the IGC-approval, by the manufacturer or his authorised agent. This particularly applies to the system for checking the electronic validity of downloaded IGC files (see 1.1.10.1 on the IGC Shell program), to the ENL and MOP figures recorded in IGC files which must be similar to those given in Annex B to the IGC-approval document, and to pressure altitude calibrations which must be with respect to the ICAO International Standard Atmosphere (ICAO ISA). For the critical cases in ENL and MOP recording, see 1.4.2 and 5.6.

OOs shall inspect recorder installations before and after flight in accordance with the provisions of Annex B to the IGC-approval document for the type of recorder concerned. Where the FR uses static pressure from the glider's instrument system (rather than "cockpit static"), the tubing and the pressure connection to the FR shall also be checked to ensure that they are out-of-reach of pilots so that no unauthorised changes to the pressure altitude recorded by the FR can be made in flight.

1.1.3.2 IGC-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. A copy of the current IGC-approval document in either written or electronic form should be included with each recorder sold or updated.

1.1.3.2.1 Valid versions of the IGC-approval and program files. The latest versions of IGC-approvals and the FR Manufacturers DLL files (or the earlier short progam files) are posted on the IGC and GFAC web sites. Only these versions are valid for use with claims under IGC procedures. Earlier versions of the IGC-approval document and DLL/program files must not be used in the validation of flights to FAI/IGC criteria.

1.1.4 **Levels of IGC-approval**. 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, and will be determined by GFAC. Reduced levels also apply 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 three levels of IGC-approval are listed below:

1.1.4.1 Level 1 - IGC-approval for all flights. This applies to Flight Recorders that may be used for evidence for all flights up to and including IGC world records. For new types of recorders, compliance with the current Specification is required. For types with existing IGC-approvals to this level, "Grandfather Rights" (1.1.4.5 below) apply unless there are major differences compared to the current Specification, as assessed by GFAC.

1.1.4.2 Level 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 is not valid for evidence for IGC/FAI world records. For competition flights, see 1.1.4.6. This level may be used for new recorders that do not meet the current Specification in relatively small areas. For types of FR that are already IGC-approved, this level may be used for those which are now below the current Specification standard, particularly on security or accuracy of data, as assessed by GFAC.

1.1.4.3 Level 3 - IGC-approval for badge flights up to Diamonds. This applies to Flight Recorders that may be used for evidence for FAI/IGC Silver, Gold and Diamond badge flights but not for higher badges and diplomas, and records. For competition flights, see 1.1.4.6. This level may be used for recording systems that have significantly lower standards of security and other characteristics compared to those for higher levels of approval, as assessed by GFAC.

1.1.5 **Other approval-related aspects**

1.1.5.1 Recorders that are not IGC-approved. This applies to types of Flight Recorders that have either not been tested by GFAC and approved to IGC standards, 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. It also includes FRs used in other FAI Airsports that use the basic IGC file format but have not been submitted for IGC-approval.

1.1.5.2 Grandfather rights and approval levels. The term "Grandfather Rights" is used 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 being increased. That is, the recorder would be subject to additional limitations or would not be at its existing approval level 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 or Sporting Code. A similar policy is adopted in civil aviation by other aviation organisations such as the FAA and EASA for designs that are already-certificated. However, GFAC reserves the right to change an approval document where it considers that the current Specification or Sporting Code is sufficiently different to those under which the original approval was issued.

1.1.5.3 Competitions. The above sub paras apply to record, badge and distance diploma flights to be validated to IGC standards of evidence. For competition scoring, 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 under which 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.

1.1.5.4 **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 (approval levels, para 1.1.4). A recommendation will be made to the IGC Bureau at an appropriate stage. Further procedures, Appendix E.

1.1.6 **World Records**. Evidence must be from a Flight Recorder that is IGC-approved for World Record flights (SC3 para 3.0.b). See 1.1.4 on approval levels and 2.2.4.1 on High Altitude Flight Recorders (HAFRs) for use above 15,000 metres.

1.1.7 **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 visually scanning outside the cockpit. Displays and instruments that need regular checking should not be mounted in positions away from angles needed for external view, and should be in prominent positions close to the pilot's normal view of the outside world. Although IGC cannot control the layout of instrument panels, it can draw attention to the potential dangers. Particularly in single-seaters, the position of displays connected to a Flight Recorder should not be remote from sight lines used for lookout and scan for other aircraft, and displays should not be positioned so as to obstruct potential sight lines that might be needed for lookout.

1.1.8 **Antenna Positioning**. If the GNSS antenna is accessible to the crew in flight, no attempt must be made to inject any data that would alter that from the GNSS system concerned. Any abuse of this may lead to a future IGC requirement to place the antenna out of reach of the flight crew.

1.1.9 **Sealing of data ports and plugs**. Wherever possible, 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.

1.1.10 **IGC Standard of Security for the Flight Recorder and the IGC Flight Data File**. For IGC-approval to be given, the type of Flight Recorder must be protected by both physical and electronic security. A manufacturer's physical seal must be fitted to the recorder case in such a way that it will be broken if the case is opened. Also, a system must be incorporated that makes the internal electronic security system inoperative if the recorder case is opened in an unauthorised way or otherwise becomes insecure. Flights made after any such event should continue to produce IGC files, but such files must be clearly marked as insecure and must fail the IGC electronic Validate check (see 1.1.10.1 below). Re-set of a recorder to a secure state must only be made by 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.

1.1.10.1 Electronic Validation of IGC Flight Data Files. The IGC electronic Validation system checks the security and validity of data in an IGC file, and can be used at any time to check a file. To use the IGC Shell program, the manufacturer's IGC-XXX.DLL file must be in the IGC Shell directory (XXX = manufacturer three-letter code allocated by GFAC). Having executed IGC-Shell.exe, scroll down to the FR manufacturer in the box at the top of the display, press the display's Validate button, highlight the IGC file to be checked and click "Open". The result of the validation check will then be shown in a box in the middle of the display. Older recorders for which the manufacturer has not provided a DLL file for the IGC Shell program have a VALI-XXX.EXE program file instead. The IGC Shell program, DLL and VALI files are available on the FAI/IGC and GFAC web sites

If an IGC file passes the IGC electronic validation check, it shows (1) that the IGC file has originated correctly from a serviceable FR that has not been opened or modified in an unauthorised way, and (2) that the flight data in the IGC file is identical to that which was originally downloaded immediately after flight.

The IGC validation program will reject an IGC file if only one character in the flight data is not the same as when originally downloaded. This can be checked by copying an IGC file that passes the Validation check, and, on the copied file, using a text editor to change one character (such as one figure in a Lat/long, ENL or other flight data). The resulting IGC file should fail the IGC validation check. Then, restore the original character and the Validation program should once again pass the file.

1.1.11 **Proof of presence of the Flight Recorder in the aircraft**. There must be incontrovertible evidence that the particular Flight Recorder was present and recording in the particular aircraft for the flight concerned. The procedures given in the IGC-approval document shall ensure this as far as possible. This is particularly important because, unlike other elements in the verification process, a FR and its IGC file contain virtually all the evidence for the flight. Proof of presence is particularly important with small, lightweight types of FR that can easily be transferred from one aircraft to another. Two methods are employed: (1) OO inspection of the FR installation, and (2) independent evidence of takeoff, landing and other evidence for the claimed flight (independent of the FR and its IGC file). These methods are amplified below:

1.1.11.1 OO inspection and/or sealing to the glider. If an OO is not present to witness and check the Flight Recorder installation at takeoff or landing (or immediately before and after these times), the FR 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 clearly marked with the time, date and with the OO's identification, so that the OO can identify it later.

1.1.11.2 Check of takeoff and landing, independent of the Flight Recorder data. The times and points of takeoff and landing, shall be recorded either by an OO, other reliable witnesses independent of the pilot, 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 (SC3C para 8.1). This is intended as a simple independent check of these parts of the FR data. Following this, the rest of the data may be accepted as valid evidence for the claim, subject to (1) any anomalies being satisfactorily explained, (2) compatibility of the data with independently-known conditions for the flight and (3) the IGC file for the claim passing the IGC Electronic Validate check (1.1.10.1 above). Known conditions that can be independently checked include: (1) Wind observations at relevant altitudes (including those recorded by local meteorological offices and Air Traffic Control) compared to thermal and other drift from the IGC file data. (2) conditions experienced by other aircraft and gliders in the same area and at similar time, including those from other IGC files for comparison, and (3) direct observation of the aircraft by other pilots, witnesses, etc.

1.1.12 **Anomalies in evidence.** Any anomalies in evidence for a claim under IGC rules from an IGC-approved 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 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.

1.2 **IGC GNSS FLIGHT RECORDER APPROVAL COMMITTEE (GFAC)**. A committee of at least five persons shall be appointed by IGC to test, evaluate, and approve individual types of GNSS Flight Recorders in accordance with para 1.1. A number of technical advisors will be used by GFAC to receive relevant GFAC correspondence and give advice. GFAC may delegate specialist work to other experts but is responsible for co-ordinating the work and for producing final IGC-approval documents and any wider recommendations. The detail of the work and any opinions expressed within GFAC discussion are confidential to GFAC and any other advisors or 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 communications to and from GFAC, and within GFAC.

1.3 **NOTIFICATION BY MANUFACTURERS**. Manufacturers who wish to apply for IGC-approval for their equipment should make contact with the GFAC Chairman as early as possible during the design process. In the manufacturer's own interest, this should be before any design-fix, and before 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 notify the applicant of the current procedures for the approval process, including the application form and documentation requirements.

1.3.1 **Correspondence with GFAC**. Manufacturers applying for IGC-approval must correspond with GFAC through its chairman who will inform other members and technical advisors, and co-ordinate any responses to the manufacturer. In cases where specialist matters are being discussed, the Chairman may authorise direct correspondence between a manufacturer and a specialist GFAC advisor (such as on the detail of GNSS systems, electronic security, or recording technology), but the GFAC Chairman must be copied with all correspondence so that he is aware of progress and of the issues involved and can inform GFAC as appropriate.

1.3.2 **Submission of a new model of IGC Flight Recorder**. Details of the intended design should be sent to the GFAC Chairman as soon as available. These should include a brief specification, drawings, draft manual (if it exists at this stage), commonality with 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 technical advisors and co-ordinate comments that will be sent to the manufacturer. For communication, use email with attached files in standard formats such as MS Word for text and JPG for diagrams and pictures. Details sent by the manufacturer will be treated as confidential to GFAC and its advisors.

1.3.2.1. IGC flight data files. As soon as IGC-format files are available from early Flight Recorder hardware, copies should be emailed 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 type of FR concerned, and IGC files have been produced and sent. When a complete or beta test version is available, and ***before the fix-of-design stage is reached***, notify the GFAC Chairman. When the Chairman requests, send an example of the equipment for initial evaluation and feedback. The GFAC evaluation team will test the hardware and report to GFAC members and technical advisors, and to the Flight Recorder manufacturer.

1.3.2.3 Fee to FAI. When hardware is sent for testing, the FR manufacturer should fill in the application forms provided by the GFAC Chairman and pay the appropriate fee to FAI for the IGC/GFAC sub-account. IGC-approval will not be issued until the appropriate fee is paid. See also para 1.3.5.

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

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

1.3.4 **Documentation**. The recorder manufacturer or applicant for IGC-approval shall provide information to GFAC on how the particular type of Flight Recorder meets the IGC Specification.

1.3.4.1 Security Protection. A detailed description of security protection must be provided, including the design features that prevent deliberate or inadvertent misuse, or production of false data. GFAC members and their advisors will keep such information confidential.

1.3.4.2 Pressure Altitude Calibration. The pressure altitude recording system in the Flight Recorder must be calibrated to the ICAO ISA using IGC/FAI procedures. A calibration table and the IGC file for the calibration from which the figures in the table were obtained, must be forwarded to GFAC when a FR is sent. For more detail on the accuracy of calibrations, see paras 2.5 and 2.6.

1.3.5 **Fees and expenses for IGC-approval**. The appropriate fee must be deposited by the applicant in the FAI account (for the IGC Sub-account, anotated GFAC and the name of the Manufacturer and type of FR) before IGC-approval can be given. This should normally be done when hardware is 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, on IGC or FAI. If the receipt of payment is delayed, IGC-approval will not be given until the 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 ANDS and GFA Committees. At the time of writing (year 2014) the fee is 1000 Euros for an application for testing a new type of Flight Recorder for IGC-approval. 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 current scale of fees is part of the application data that is available from the GFAC Chairman.

1.4 **TEST AND EVALUATION FOR IGC-APPROVAL**. GFAC will complete Test and Evaluation (T&E) as soon as practicable on receipt of all of the appropriate material, normally within 120 days unless there are unforeseen difficulties. The testing carried out by GFAC is intended to be of a non-destructive nature, but GFAC, IGC, FAI and their agents are not liable for any damage to, or loss of, any equipment. See Appendix B on GFAC Test and Evaluation. If other GFAC members wish to test equipment themselves, the equipment sent to the Chairman will be sent on from person to person unless the manufacturer can send separate equipment to each. Any excess expenses incurred by individuals (such as postal, excise and tax), shall be paid by the Flight Recorder manufacturer into the FAI account (noted for the IGC/GFAC sub-account) 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 attachments) is needed from a recognised independent testing laboratory. In this case, the applicant will be responsible for the expense of this report in addition to the application fee. The applicant shall be given the opportunity to withdraw the application before incurring this expense. Such requirements may arise if test or evaluation is required that is outside the expertise or facilities available to GFAC members and their advisers.

1.4.2 **ENL System - General**. The IGC Environmental Noise Level (ENL) system within the FR 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. Critical cases are covered in 1.4.2.2 below, and are particularly important with low-noise engines such as those using electric power, and low-ENL engines such as jets, see 1.4.2.4. Pilots flying such powered gliders must ensure that they have FR(s) with engine-recording systems that clearly differentiate any engine running that generates forward thrust from any soaring condition, so that their flights can be validated to IGC standards.

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 999. Most two-stroke engine systems produce ENL values over 900 at high power 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 flight. Some electric and jet engines at high power have also been shown to give moderate ENL values; however, high power is not the critical case in differentiating between power-on and power-off flight, see below.

1.4.2.2 Critical ENL Cases

1.4.2.2.1 Power-on. The critical power-on case that is used for testing ENL is not full power, it is when any positive forward thrust is generated by the engine. Under such conditions, recorded ENL must be high enough to differentiate from the power-off cases below; if it is not (such as with electric and small jet engines), an extra system operating under the MOP code must be fitted (see 1.4.2.4 and chapter 5).

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, because this can be mistaken for running the engine. This can produce ENL figures up to 300, more if sideslip is present and 400 has been seen. Another high-noise case is high speed flight with the cockpit panel(s) open, but this is not as confusing as thermalling with panels open because in the latter case the glider will be climbing and could be more easily be mistaken for use of engine.

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 between about 70 and 300Hz with a typical "bell curve" (the "normal distribution" in statistics) sensitivity either side of the peak frequency, gives a good ENL response to piston engine and propeller noise, and less response to other cockpit noises.

1.4.2.4 Low-ENL Motor Gliders. Where an engine system produces low ENL values that make it difficult to differentiate between power-on and power-off flight (as assessed by GFAC using the criteria in 1.4.2), 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 "MOP" (see Chapter 5), indicating any forward thrust generated by the engine system. This applies to quiet engines such as those with electrical power, and others such as jets for which the frequency response or direction of noise does not register highly enough on ENL systems in cockpit-mounted recorders. This will be subject to GFAC evaluation and decision on the type of motor glider concerned.

1.5 **IGC-APPROVAL**. GFAC shall either approve, conditionally approve, or require modifications to the FR manufacturer's design before IGC-approval to the appropriate level can be given (see 1.1.4 for levels). Drafts of approval documents will be circulated to GFAC members and associated experts, and to the Flight Recorder manufacturer. The final version of the IGC-approval document is the responsibility of GFAC, which is an agent of IGC and FAI (see para 1.1).

1.5.1 **Limitations before IGC-approval**. If GFAC decides that IGC-approval cannot be given to the appropriate level without changes being made (see 1.1.4 for IGC-approval levels), GFAC will inform the manufacturer of what is required in order to gain 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 one calendar month 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 three months, subject to not meeting 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 document by amendment.

1.6 **APPLICANT'S AGREEMENT**. When an IGC-approval is issued, the 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 needed. This shall require a fee of up to that for a new FR type.

1.6.3 **Changes in IGC-approvals**. An existing IGC-approval document may be modified or removed at any time.

1.6.4. **Manufacturer's 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 to GFAC without delay, so that the approval document can be updated.

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.

1.6.4.2 Significant changes in the Organisation. If significant changes have been made in the Organisation listed in the IGC-approval document under "Manufacturer", GFAC reserves the right to require a new IGC-approval process for the types of flight recorder concerned. In this case, a signature or re-signature will be required on an approval application, and GFAC may require 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 a name by another Organisation, or a change of structure or of key personnel within the same Organisation.

1.6.4.3 Cease of Manufacture and/or Support. Where a manufacturer ceases to make a particular type of recorder, GFAC shall be informed. The manufacturer must state whether support for the type will continue such as updates and/or repairs to existing recorders.

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 reduce any anomalies in IGC files, it may not be possible to validate such flights.

1.6.4.4 Exclusions. FAI, and their agents 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 the IGC approval and others issued by IGC Air Sport Commissions.

1.7 **Use of IGC Flight Recorders**. A GNSS Flight Recorder operated in accordance with its IGC-approval document shall be used for flights that require validation to FAI/IGC criteria (SC3, para 3.0.b) and World Championships (SC3 Annex A). An IGC-approved Flight Recorder must be used for evidence for FAI/IGC Badge, Diploma, Record and Competition flights except where an IGC Position Recorder (PR) is used for some badge flights under IGC SC3 procedures. For the different levels of IGC-approval for Flight Recorders from world records to badges, see para 1.1.4. IGC-approved FRs may also be used by NACs for flights under their jurisdiction, where IGC standards are specified such as for national and regional records, and competitions. Where flight validation is not required to IGC standards, evidence is at the discretion of those responsible for validating the flight.

1.7.1 **IGC File Format**. For the format of the IGC Flight Data file, see the FR Technical Specification Chapter 3 and Appendix A. These references give the sequence of data in the IGC file and the detail on how it is to be shown. In the case of older types of recorder with Grandfather Rights (para 1.1.3.4.5) and some types of IGC Position Recorder, there may be some differences compared to the current IGC file format, but for a performance to be validated to IGC standards, in all cases the file must pass the IGC electronic Validation check (see para 1.1.10.1).

1.7.2 **Non-IGC FRs**. Where flight validation is not required to FAI/IGC standards, the choice of criteria is at the discretion of those responsible for validating the flight, such as competition officials or, for non-IGC FRs, other FAI Air Sport Commissions.

1.8 **Notification and Issue of IGC-approval Documents and 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 email list. The complete IGC-approval document will be posted on the FAI/IGC and GFAC web sites. In addition, the FR Manufacturers DLL file (or, for older types of recorder, the short program files) for validating the integrity of such files (and downloading in the case of some FRs), will also be posted on the same web sites.

1.9 **Production Standards**. IGC reserves the right to inspect and test examples of products covered by IGC-approvals, for the purpose of checking compliance with the standards and conditions of their IGC-approval.

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 one set of hardware for such testing.

1.9.2 **Results of testing**. If any problems are found or questions are raised, GFAC will correspond with the manufacturer. If this cannot be done to the satisfaction of GFAC, the terms of the IGC-approval may be altered under the authority of para 1.6.3 above.

1.10 **PROBLEMS OR QUESTIONS IN USE**. If any problems or questions arise during use of IGC-approved Flight Recorders, the GFAC Chairman should be notified in the first instance. See also para 1.1.12.

If further technical detail is required, consult the Technical Specification for IGC-approved GNSS Flight Recorders, available on the GFAC and IGC web pages.

CHAPTER 2
ALTITUDE RECORDING

2.1 **ALTITUDE EVIDENCE AND CONTROL**. The following methods of measurement apply (SC3 4.7.2):

2.1.1. **Pressure Altitude data with time**. A graphical presentation of pressure altitude against time is derived from an IGC-approved and calibrated pressure altitude sensor and time-recording system. The presentation may be from an IGC flight data file, shown on a monitor screen or a printout. It may also be from the recording instrument in hard copy (such as a paper or metal foil trace from a drum barograph), or by a printer connected to an electronic barograph. For GNSS recording devices the time (UTC) recorded as part of fix data, is particularly accurate because GNSS systems measure time-differences between different satellite signals, and so very accurate time is an integral part of such systems.

2.1.1.1. Official FAI/IGC pressure altitude calibration scale – The ICAO ISA. This is the International Standard Atmosphere (ISA) of the International Civil Aviation Organisation (ICAO) and is used in civil and military aircraft worldwide for the calibration of pressure altimeters and for altitude reporting to other aircraft and to Air Traffic authorities. The details of the ICAO ISA used by FAI/IGC is given in ICAO Document 7488. Tables 3 and 4 in ICAO 7488 contains exact conversions of pressures to altitudes and is available through www.icao.int. General descriptions are in other web sources such as Wikipedia [1].

The ICAO ISA assumes a temperature at sea level of 15C and an atmospheric pressure of 760 mm of mercury (1013.25 mb or hPa). It then assumes a constant temperature lapse rate of 6.5ºC per 1000 metres altitude (1.98ºC or 3.56ºF per 1000 ft), up to an altitude of 11,000m (-). 11,000m is assumed to be the Tropopause, above which a constant temperature of -56.5ºC is assumed in the Stratosphere. The ICAO ISA is used in calibration of aircraft altimeters and electronic altitude sensors, worldwide. Although the real atmosphere varies, internationally agreed conversions are needed so that all aircraft can report pressure altitude to the same scale, whether or not such figures correspond to geometric height on a given day.

2.1.2 **GNSS altitude.** In the data from an IGC-approved Flight Recorder (FR), 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 on altitude evidence generally and below for IGC PRs and HAFRs.

2.1.2.1 IGC Position Recorders (PRs). In an IGC PR, if pressure altitude is not recorded in its IGC-format flight data file, GNSS altitude may be used for measurement purposes with an increment over the appropriate SC3 altitude requirements, in accordance with SC3 procedures for IGC PRs. This is because of the different scales used in deriving altitude from pressure and GPS sensors, and short-term variations of GPS altitude figures seen in IGC files where low-cost GPS receivers are used (also see 2.4.1 below). At the date of publication of this amendment, the increment is 100 metres (328 ft). SC3 references are listed above in the Glossary entry for Position Recorders. (AL9)

2.1.2.2 IGC High Altitude Flight Recorders (HAFRs). For altitude claims from flights over 15,000 metres (49,213ft) evidence must be from an IGC-approved HAFR. Above 15,000m, IGC uses GPS altitude for measurement purposes because the pressure change with altitude has become very small, but the GPS altitude recorded in the IGC file must be from a type of recorder specially designed and tested to ensure that the GPS altitude data in the IGC file is without short-term variations or other anomalies. See IGC procedures for HAFRs, particularly SC3 para 4.5.3 and para 2.2.4.1 in the Technical Specification for IGC-approved Flight Recorders. (AL9)

2.2 FLIGHT RECORDERS AND BAROGRAPHS

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

2.2.2 **Other Altitude Recorders**. Altitude sensors that are not part of an IGC-approved GNSS Flight Recorder may be used in accordance with IGC rules, for instance for IGC Position Recorders (PRs) for some badge flights under SC3 rules and procedures for IGC PRs. For FAI/IGC World Records and other badge flights, distance diplomas and competition flights, 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.

[1] http://en.wikipedia.org/wiki/International_Standard_Atmosphere

2.2.2.1.1 Altitude sensors. Altitude is derived from a pressure sensor such as an electronic (piezo-electric) device or an aneroid capsule. An aneroid is a sealed and partially-evacuated flat circular container that contracts and expands as outside pressure rises and falls, its small movements 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 (see 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 barographs must be able to produce a secure, accurate barogram which can then be 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 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 Records, Badge, Diploma and Competition flights** Evidence is required from an IGC-approved GNSS Flight Recorder for IGC record, badge, distance diploma, and competition flights, except where SC3 allows the use of IGC Position Recorders (PRs) for the lower levels of badge flights. For absolute altitude and gain of height performances, the data from the Recorder must substantiate the circumstances of the whole flight. These include takeoff, track over ground, wind drift with altitude, landing, etc, not just those directly related to altitude.

2.4 **FLIGHT RECORDER ALTITUDE EVIDENCE**. This applies to GNSS altitude and pressure altitude evidence from IGC-approved Flight Recorders and IGC Position Recorders.

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 many 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. This is why, if an IGC Position Recorder (PR) is used, an extra 100 metres is required over the SC3 altitude criteria (that are set for pressure altitude). It is also why a special High Altitude Flight Recorder (HAFR – para 2.1.2.2) is required for flights above 15,000 metres.

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, the IGC FR Technical Specification requires that it is recorded in the IGC format file as zero GNSS altitude. 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). In IGC recorders, the WGS84 ellipsoid is used as the zero-datum for GNSS altitude. However, the output of GNSS altitude in some non-IGC-approved Flight Recorders may be with respect to a different ellipsoid, or with respect to a surface of equal gravitation potential described in the WGS84 manual as the WGS84 Geoid and being an approximation to mean sea level (MSL). In all cases, GNSS altitude is not the same as the pressure altitude to the ICAO ISA that is used universally in aviation for altitude reporting.

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. 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 2.1.2

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 are given in para 4.4.4 of the main volume of SC3.

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.

2.6 **CALIBRATION PROCEDURES**. SC3C Appendix 5 gives guidance on calibration of mechanical barographs. Calibration of the pressure altitude function of an IGC GNSS Recorder (FRs, and PRs with pressure altitude recording) should follow a similar procedure with the 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, several Recorders 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. For IGC-approval FRs, guidance on calibration procedures and switching, is given in Annex B to the IGC-approval document for the particular type of Flight Recorder.

2.6.1 **Electronic Barographs, including IGC Recorders**. Electronic sensors that are used inside electronic barographs and IGC GNSS 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 ICAO International Standard Atmosphere (see 2.1.1.1). 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 within 1 millibar (1mb at SL = 26.9 feet (8.2m));
Up to an altitude of 2000 metres - within 3 millibars (3mb at 2000m = 98.1 feet (29.9m));
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 definitive 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. The IGC file for the calibration must be retained by either the calibrator or the supervising OO, for reference in case of a query.

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 GNSS Recorder (FR or PR), because GNSS systems employ highly accurate time signals as part of their method of operation. This includes Recorders using the USA's GPS, Russian GLONASS, European Galileo, Chinese Beidou 2 or any other GNSS system. At the time of the latest revision of this document (2014), only Flight Recorders using the GPS system have so far been IGC-approved.

Note on Leap Seconds; The internal system time used by the USA 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. At the end of year 2014, UTC was 16 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. For more detail, see http://en.wikipedia.org/wiki/Leap_second

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 with an output in seconds.

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 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.

APPENDIX A
CHANGES OF IGC-APPROVAL LEVEL

(amended by AL 8 dated October 2012)

A1 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 with the manufacturer and then with the IGC ANDS Committee. As much notice as possible will be given to the manufacturer so that there is the opportunity of offering an upgrade that will retain the existing approval level. The IGC Bureau may also be informed if appropriate.

A1.1 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 will then assess all of the evidence and make a decision. If the Bureau decides to seek opinions from other than FAI and IGC Officials and Committees, confidential or proprietary information will be avoided in such correspondence.

A1.2 If the decision is to lower the approval level, this will be announced on the IGC web page, to the FAI IGC discussion group (igc-discuss@fai.org) and on the international soaring newsgroup (rec.aviation.soaring) avoiding confidential or proprietary information. The next IGC Plenary meeting will be informed as part of the normal procedure for confirmation of Bureau decisions that were made between Plenaries.

A2 Factors in Lowering Approval Levels. These include the following.

A2.1 False Data. Evidence that flight data from an IGC-approved recorder has been, or can relatively easily be, manipulated or altered. For instance, if it can be shown that the secure areas in an IGC file (such as data in fix-record line(s) (lines prefixed "B") can be changed and the file continues to pass the IGC electronic Validation check.

A2.2 FR Security. Evidence that the security of the FR itself has been compromised, or could relatively easily be compromised. This includes where security devices in the FR could be by-passed.

A2.3 Dates of Change. In the above cases, the lowering of IGC-approval level will take effect at a date agreed between ANDS/GFAC and the Bureau. Where there is a risk that compromised data could be submitted for flight claims from other recorders of the same type, this could be a date soon after the public announcement of the Bureau decision.

A2.4 Other factors. If the approval level is to be lowered for reasons other than those above, the date of implementation will be decided by the Bureau. This will not normally be less than between 6 and 12 months after the date of the public announcement of the Bureau decision.

A3 Appeal against a lowering of approval level. The manufacturer of the recorder or any entity with a direct interest (which must be shown in the appeal papers) in that type of recorder (the "appellant") may appeal to the IGC Bureau to have the decision reviewed. Pending the result of the appeal, the decision and its implementation timescale will stand.

A3.1 Making an Appeal. Within one calendar month of the public announcement, the appellant must notify the IGC President, and pay an appeal fee of 500 Euros to the IGC account at FAI [2] The fee is refundable if the appeal is upheld. The full case for the appeal must be received by the IGC President or his nominee within a further calendar month. Communication should be by email and include attachments, pictures and diagrams as appropriate.

A3.2 Appellant's Agreement. In submitting the appeal, the appellant agrees to accept the result, which is at the sole discretion of FAI as the legal entity, its agent IGC, its agents the IGC Bureau, Committee members and advisors. The appellant also agrees not to institute proceedings against the FAI or its agents including any person who was involved on behalf of FAI or IGC.

A3.3 Appeal Evidence. The appeal must include evidence in support so that the Bureau can assess it and consider whether their previous decision should be changed. Where technical evidence is submitted, this will be assessed by technical experts nominated by the Bureau which will include the ANDS and GFA Committees and their technical advisors, and, where necessary, independent experts.

A3.4 Decision on the Appeal. The decision on the appeal is the responsibility of the IGC Bureau, but it may nominate specific members and/or experts to deal with the detail of the appeal and make recommendations to the full Bureau. A decision will normally be made within one calendar month of receiving all of the evidence from the appellant, but if technical detail has to be assessed the timescale may be longer. The decision will be sent to the appellant before any public announcement is made.

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[2] References for the FAI account are available from the FAI office and the Chairmen of the IGC ANDS and GFA Committees

FÉDÉRATION AÉRONAUTIQUE INTERNATIONALE

INTERNATIONAL GLIDING COMMISSION
FAI AIRCRAFT CLASSES D AND DM
GLIDERS AND MOTOR GLIDERS

ANNEX B
to
FAI SPORTING CODE
SECTION 3

REQUIREMENTS
FOR EQUIPMENT USED FOR
THE VALIDATION OF FLIGHT PERFORMANCES

REAR COVER