

**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 1-12
EFFECTIVE 1 OCTOBER 2018**

FÉDÉRATION AÉRONAUTIQUE INTERNATIONALE

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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 (ANDS) committee, the IGC GNSS Flight Recorder Approval Committee (GFAC) and by the IGC Sporting Code Committee, (SCC) to whom suggestions for change should be made in the first instance for subjects within their areas of responsibility. Amendments can also be proposed by the above and by IGC nations, their delegates and other Specialists, including for the agenda for the IGC Plenary meeting. Comments on proposed amendments will be made to the Plenary by the appropriate Specialist or Committee Chairman and the detail of any amendment confirmed by the IGC Bureau before publication. 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.

Amendments to this document normally take effect on the 1 October following the IGC meeting at which changes were notified and/or discussed, unless an earlier date is needed to allow for significant flights for which amended procedures are required before such flights can be validated, to make corrections, or to bring the document into line with other IGC documents. Or, for publication later than 1 October, if there are unavoidable delays in finalising detailed wording or if corrections have to be made.

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	1 October 2015			
11	24 April 2018			
12	1 October 2018			
13				
14				
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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 rules and procedures 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 parts of SC3.

2. **Scope.** SC3B deals with devices that use Global Navigation Satellite Systems (GNSS) such as IGC-approved Flight Recorders (FRs) and the lower level NAC-approved Position Recorders. It also contains 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 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, so that it can be used without constant reference to other documents. Amendments to it are the responsibility of GFAC together with the IGC Airspace, Navigation and Display Systems (ANDS) committee, with the approval of the IGC Bureau, consulting the IGC Sporting Code Committee (SCC) where applicable.

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 in para 4. Amendments to the TS are the responsibility of GFAC and the IGC Airspace, Navigation and Display Systems (ANDS) committee, where necessary consulting other experts. As the TS is not part of the Sporting Code, an amendment can be made at any time, generally not more than once in a calendar year unless particular matters need to be covered such as after IGC Plenary meetings or after new features in the FR area have been developed.

The TS is intended for the use of manufacturers and designers of hardware and software, IGC Committee members, expert advisors, and technical experts on GNSS Flight Recorders, including in FAI National Airsport Control authorities (NACs). However, pilots and OOs using IGC Flight Recorders may find much of interest including a comprehensive Glossary of Terms and on GNS Systems and Flight Recorders, also the detailed structure of the IGC flight data file that records Lat/Long fixes and other data 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:

For SC3 and its annexes (SC3A, SC3B, SC3C) : www.fai.org/igc-documents , click on "Flight Recorders", then "IGC-approved Flight Recorders - Approval Documents" or "IGC-approved Flight Recorders - Technical Specification" or "IGC Shell program for Validation of IGC files, plus FR Manufacturer DLL files".

GFAC web site for copies of the above 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.** See page (i)

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 and put forward to GFAC for IGC-approval, unless the context indicates otherwise.

A High Altitude Flight Recorder (HAFR) is a special design for validation of altitude performances over 15,000 metres.

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 are more basic than the IGC-approved FR, and are approved for use by individual NACs. These may be only used for evidence for Silver and Gold badge flights under IGC procedures for NAC-approved PRs . See the Glossary under "Position Recorder".

7. **Terms and Abbreviations.** As well as the Glossary of Terms that follows, other 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/documents , scroll down to "Sporting Codes", then "Sporting Code - General Section".

GLOSSARY OF TERMS AND ABBREVIATIONS

This contains explanations of terms and abbreviations used in this document. More detailed definitions 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, for instance ChF - Swiss Francs. FAI Headquarters is in Lausanne, Switzerland, and payments to FAI are normally made in Swiss France.

Ellipsoid - An ellipse is a two-dimensional curved figure with two diameters, a "major axis" and a "minor axis". An Ellipsoid is a three-dimensional version, its surface being formed by the rotation of the ellipse about its minor axis (see <https://en.wikipedia.org/wiki/Ellipsoid>). For an earth model, the semi-major axis is the radius at the equator and the semi-minor axis is the radius at the poles. An example is the WGS84 ellipsoid, see later under WGS84.

Engine - any device fitted to an airframe, capable of producing forward thrust when combined with a propulsion device such as a propeller or by gases ejected through a jet pipe. It includes engines with pistons, electric motors, and jet engines. The overall system is also referred to as a Means of Propulsion (MoP), see below. (AL12)

ENL - Environmental Noise Level. A system used inside IGC-approved GNSS Flight Recorders for detecting when a Piston engine driving a propeller is supplying forward thrust. Acoustic noise at the Flight Recorder between 100 and 200 Hz is recorded by a microphone inside the FR and is shown with each fix as three numbers between 000 and 999. See also under MoP and para 1.4.2.

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

FES - Front Electric System. A motor glider electric engine mounted in the nose, driving propeller blades that fold back flush with the fuselage when not in use. Originally the letter "S" stood for Sustainer but with improvements in battery technology many FES/glider combinations are capable of self-launching. (AL11)

Geoid - The WGS 84 Geoid is a theoretical worldwide surface of equal gravitational potential. This is similar to a water surface at mean sea level (MSL) less tides and wind. See para 2.4.6.1 and <https://en.wikipedia.org/wiki/Geoid>.

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

GNSS - Global Navigation Satellite System. These are satellite-based navigation systems including, in alphabetical order, Beidou 2 (China), Galileo (Europe), GLONASS (Russia), GPS (USA). These systems have a constellation of satellites in oblique earth orbit, and receivers on or near to the Earth's surface are able to process the data to display accurate geographical position.

High Altitude Flight Recorder (HAFR) - A special type of IGC-approved Flight Recorder designed for accurate altitude recording at high altitude. A HAFR is required for IGC altitude claims above 15,000 metres (49,213ft), see paras 1.3.4 and 2.1.2.2.

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, have increased). Commonly used in civil aviation on types of aircraft already certificated by a Regulatory Authority. Detail on its application to IGC-approved GNSS Flight Recorders is in para 1.1.5.2.

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. When testing of critical areas is successful, an IGC-approval document is issued. See chapter 1.

ISA - International Standard Atmosphere. A defined relationship between atmospheric pressure and an assumed altitude at that pressure level. An example is the ICAO ISA that is used in aviation worldwide for aircraft pressure altimeters and is defined 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. It is abbreviated JPG which is also used as a file suffix such as image.jpg.

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/MOP - Means of Propulsion. MoP is an FAI generic term for an engine system, for instance where gliders have engines, motorised hang gliders, para gliders with engines, etc. Also, the three-letter code MOP is used in an IGC file (paras 1.4.2.4 -5) for a separate MOP sensor for engines where the ENL sensor inside the FR does not give high enough figures for engine running.

NAC - National Airsport Control. The authority in a nation recognised by FAI for the supervision of Sporting aspects of Air Sports in the nation. Normally this will be the National Aero Club. Matters specific to an individual Air Sport may be delegated to the National organisation for that Sport. Duties to FAI include compliance with rules and procedures given in Sporting Codes and other documents published by FAI and its Sporting Commissions.

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 observing, taking, checking, processing, confirming 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 hundred Pascals are called a hectoPascal, abbreviated hPa, the same as a millibar (mB), see above. It is named after the French mathematician Blaise Pascal, and was adopted as the SI pressure unit in 1971.

Position Recorder (PR) - a stand-alone GPS recorder, data from which may be used only for the validation of Silver and Gold badge flights under IGC rules for PRs. Types of PRs are approved by individual NACs rather than by GFAC on behalf of IGC, although GFAC gives advice to NACs on PR matters. The IGC flight data file format is used, but a 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 NAC-approved Position Recorders are given in the main volume of SC3. More detail is in Annex C (SC3C) under "Position Recorder" or "PR", and current references include in para 6 on Recorders, Appendix 3 on Badge procedures, and Appendix 5 on GNSS recording. A specimen approval document for NAC Position Recorders is available on the IGC and GFAC web pages, together with guidance notes. Also see below under Validation.

SC3 - Sporting Code Section 3, the number 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 Championships, also other gliding championships that use Annex A rules. This Annex B (SC3B) is about equipment used in the flight validation process. Annex C (SC3C), is the OO and Pilot Guide and amplifies the main volume of SC3 with more detailed procedures. Annex D (SC3D) contains rules for the Official IGC Ranking List for individual pilots and countries.

SCC - The IGC Sporting Code Committee
Specification - See Technical Specification.
T&E - Test and Evaluation.

Technical Specification - the Technical Specification for IGC-approved GNSS Flight Recorders, unless indicated otherwise.

Validation, VALI check - IGC file Validation is the process of checking that electronic flight data in the 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. The IGC Shell program checks the Digital Signature that is part of the IGC 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.

A significantly less rigorous form of file validation may apply to NAC-approved Position Recorders (PRs, see above) where Validation of the file at any time may be provided either by part of the program that downloads the data or by another method accepted by the NAC and checked GFAC for correct operation. When a flight data file from an NAC 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.

WGS 84 - World Geodetic System 1984. A system that uses an ellipsoid model of the Earth's surface (the "WGS84 ellipsoid"), gravity coefficients, formulas for the Earth's angular velocity, a WGS84 Geoid, (an equipotential surface approximating to local sea levels, see above under Geoid), various constants, conversion factors and co-ordinate systems. The WGS84 system definition document is Technical Report 8350 of the US National Geospatial-Intelligence Agency (NGA).

The US GPS system uses the WGS84 ellipsoid as the reference frame for horizontal position (Lat/Long) and this ellipsoid is also used by ICAO, Civil Aviation Regulatory Authorities, FAI and IGC. For accurate distance on the surface of the WGS84 ellipsoid between two Lat/Longs, the Vincenty formula is used (https://en.wikipedia.org/wiki/Vincenty's_formulae), for instance in the FAI world distance calculator (www.fai.org/how-to-set-a-record/121-cia/34839-world-distance-calculator) (when set to WGS84), and through other Vincenty-based distance calculation programs available from the Web.

The WGS84 ellipsoid has an Equatorial radius of exactly 6378,137 metres and a Polar radius of 6356,752.3142 m. See the Glossaries in the Technical Specification for IGC GNSS Flight Recorders, and the General Section of the FAI Sporting Code (web references, page (v)). For other ellipsoids with radii within 1 metre of WGS84 (such as that used by the European Galileo GNS System), see para A8 in the IGC FR Technical Specification.

CHAPTER 1

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

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 members and advisors are agents of IGC; FAI Commissions such as IGC are agents of FAI; the legal entity is FAI; Swiss law applies.

When a Flight Recorder (FR) system is submitted for IGC-approval, GFAC examines it for compliance with IGC rules and procedures. These cover hardware, firmware (inside the FR), software external to the FR (where relevant to FR matters), output in the IGC file format, and physical and electronic security of the Flight Recorder and its output data.

Other aspects are matters between customers and FR manufacturers, including cockpit displays, navigational features, proximity warning devices, and post-flight analysis systems.

This document covers normal FR design, but other designs will be assessed and tested by GFAC and given IGC-approval if security of data and other provisions of this document can be demonstrated to the satisfaction of GFAC.

See 1.1.4 for the levels of approval that apply to different types of flights, starting with world records.

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 recording and Validation of flights to IGC standards. Such other purposes include, but are not limited to, navigation, airspace avoidance, traffic alert, proximity-warning and/or anti-collision functions, terrain avoidance, any other matters concerning flight safety; and uses of FRs outside IGC such as by other Air Sports and General Aviation (GA) in light aircraft.

1.1.2 **IGC Flight Recorder Operating Procedures.** Operating procedures and limitations for each type of Flight Recorder are specified by GFAC in the IGC-approval document for each type of FR. The IGC-approval process has the objective of making procedures on the day of flight as simple as possible. This is particularly important when the time available before flight for carrying out extra checks may be short. Also, after flight it must be quick and easy to download data in the IGC flight data format to a PC.

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, or that the data in the Flight Recorder that was in the glider could be interfered with without this being detected. Unless the FR is part of a permanent and secure fit in the Instrument Panel, 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, to avoid the need for extra OO observation. 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, and it should be marked with the glider registration, the date, time and OO's name, signature, and identification number.

1.1.2.2 Other procedures specific to the type of Flight Recorder may be required, such as stowage of specific 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 part of the IGC-approval document, and will depend on the Flight Recorder design and the results of GFAC tests.

1.1.3 **IGC-Approval Documents for Flight Recorders.** The IGC-approval document for each type of Flight Recorder is published by GFAC on behalf of IGC. Before the approval document is finalised, it is circulated in successive drafts to GFAC members and their technical advisors, other experts, and the FR manufacturer. When published, the document includes procedures for checking the recorder, installation in the glider, and operation for flights to be validated. 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; manufacturer details; information on hardware (including the type of GPS receiver and pressure transducer); internal firmware; connections; external software; installation; security; engine recording; and other advice that might be useful to pilots, OOs and NACs. The introduction page includes legal disclaimers agreed by FAI lawyers on subjects such as liability, resolution of disputes, intellectual property, and flight safety. The main body of the document is followed by 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 may be useful to pilots.

Annex B contains notes, recommendations and advice for Official Observers and bodies validating flight performances such as National Airport Control authorities (NACs). It includes pre-flight procedures including checking installation and serial number; after-flight procedures including ensuring that the installation has not been changed; downloading IGC files; 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, those to be expected in flight; also figures from an additional Means-of-Propulsion (MOP) sensor if such a system is fitted.

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 the characteristics show major differences, the FR should be re-set by the manufacturer or his authorised agent to those given in the IGC-approval. This particularly applies to the ENL and MOP figures recorded in IGC files which must be similar to those given in the IGC-approval document, to the IGC Shell program for checking the electronic validity of downloaded IGC files (see 1.1.10.1 on the IGC Shell program), 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 Annex B to the IGC-approval document for the particular type of recorder. Where the FR uses static pressure from the glider's instrument system (rather than pressure at the recorder case, so-called "cockpit static"), the tubes and 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 static pressure 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 annexes is kept with each FR, so that it can be consulted by pilots and OOs as required. A copy of the current IGC-approval document in printed or electronic form should be included with each recorder sold or updated.

1.1.3.2.1 Valid versions of the IGC-approval and manufacturer's DLL files. The latest versions of IGC-approval documents and the FR Manufacturer's DLL files for use with the IGC Shell program are posted on the IGC and GFAC web sites. Only these versions are valid for use with claims under IGC procedures; earlier versions must not be used.

1.1.4 IGC-approval Levels. 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, as determined by GFAC. Reduced levels also apply where the security of a type of recorder submitted for Approval is below the requirements of 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" (see 1.1.5.2 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 1.1.5.3. This level may be used for new types of recorders that do not meet the current Specification in some areas, as decided by GFAC. 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 of data, as assessed by GFAC and after procedures in Appendix A to this document have been followed.

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 1.1.5.3. 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 security or other problem has been found that could compromise the integrity of flight data. It also includes FRs used in other FAI Air Sports that use the basic IGC file format but have not been through the IGC-approval process and do not have an IGC-approval document.

1.1.5.2 Grandfather rights and approval levels. The term "Grandfather Rights" describes a system similar to that used in the Regulation of Commercial Air Transport where already-approved clearances are continued after rules and procedures are changed, so that aircraft and equipment in Service does not have to be constantly modified or even grounded while modifications take place. In the case of IGC recorders, approval levels and other provisions are continued even though the Technical Specification is changed (generally, requirements being increased over time). However, where the technical standard of a particular type of Recorder falls well below the current Specification, particularly on security aspects such as low resistance to hacking or production of incorrect IGC files, the IGC-approval level of that type of Recorder may be lowered in accordance with procedures given in Appendix A to this document.

1.1.5.3 Competitions. The above paras apply to record, badge and distance diploma flights to be validated to the standards of IGC. For IGC competition flights, the types of recorders that may be accepted are at the discretion of the competition organisers, subject to any higher level rules and procedures under which the competition operates. For instance, Regional or National competition rules or Sporting Code Annex A (SC3A) procedures for World and other Championships that use SC3A 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 first in confidence with the manufacturer, then with the IGC ANDS committee and, if necessary, with the IGC Bureau (approval levels, para 1.1.4). Further procedures, Appendix A to this document

1.1.5.5 **Compliance with IGC-approval standards.** If after IGC-approval of a type of FR it is found that the provisions of the Approval are not being fulfilled by production-standard FRs, the type Approval may be withdrawn or modified pending compliance with standards agreed by GFAC. (AL11)

1.1.6 **World Records.** Evidence must be from a type of FR that is IGC-approved for World Record flights. See 1.1.4 on approval levels and 2.2.4.1 on High Altitude Flight Recorders (HAFRs) for altitude records above 15,000 metres.

1.1.7 **Cockpit displays.** Some IGC-approved FRs with cockpit displays have options for display of Blind Flying Instruments (BFI) such as Artificial Horizon or Turn Indicators. The operation of such instruments is recorded in the IGC file under the BFI code and more detail is given in the Technical Specification document for IGC FRs. For some gliding competitions, cloud flying is prohibited and BFI systems must either be disabled or proved not to be used.

In some gliding competitions the fitting of proximity warning systems such as Flarm to IGC-approved FRs may be required, for instance as a separate Flarm module within the overall FR or in the form of Flarm primary firmware in a case by Flarm or in a case by another manufacturer. (AL11)

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 GNS 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 seal must be fitted to the recorder case in such a way that it will be broken if the case is opened and it must not be possible to peel off the seal intact. A system must also be fitted that operates if the recorder case is opened, for instance based on a security microswitch or microswitches inside the case, but other solutions will be considered that can be shown to give the same level of security, to the satisfaction of GFAC. For microswitches, the switch or switches must be shielded so that they cannot be prevented from operating as the case is opened, such as by inserting a specially-shaped tool to hold down the operating arm of the switch. Flights after security is breached may continue to produce IGC files, but such files must be clearly marked as insecure and must fail the IGC 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 details that are part of any re-set procedure must be restricted to the 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 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 IGC file is identical to that which was in the recorder when the flight file was ended and was 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 then fail the IGC validation check. Then, restore the original character and the file should once again pass the Validation program.

1.1.11 **Proof of presence of the Flight Recorder in the aircraft.** There must be incontrovertible evidence that the Flight Recorder that provides the evidence for the flight 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, the IGC file contains virtually all the evidence for the flight. There is little problem for FRs that are part of a permanent and secure fit in an Instrument Panel, but proof of presence is particularly important with small types of FR that can easily be transferred from one aircraft to another. There are two methods: (1) OO inspection of the FR installation, and (2) independent evidence of takeoff, landing and other evidence for the claimed flight, for comparison with data in the IGC file for the flight. This is amplified below:

1.1.11.1 **OO inspection and/or sealing to the glider.** If an OO is not present to witness and to 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 after a flight to be claimed.

1.1.11.2 **Check of takeoff, landing, and other data, independent of the Flight Recorder.** 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. 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 officially by local meteorological offices and airfields) can be compared to drift in thermals in the IGC file data. (2) conditions found by other aircraft and gliders in the same area at a similar time, including those from other IGC files for comparison, and (3) direct observation of the aircraft by other pilots or witnesses.

1.1.12 **Anomalies in evidence.** Any anomalies in evidence for a claim under IGC rules from a 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 FR 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).** This is a committee whose members are appointed by IGC to test, evaluate, and approve individual types of GNSS Flight Recorders in accordance with IGC procedures. In addition to the GFAC members, technical advisors give specialist advice and receive relevant correspondence. GFAC may also delegate specialist work to other experts but is responsible for co-ordinating the work and for producing IGC-approval documents and other recommendations. The detail of the work and any opinions expressed in GFAC discussion are confidential to GFAC, their advisors and other IGC officials who may be involved.

1.2.1 **Appointment of GFAC Members.** The GFAC Chairman and GFAC members are appointed by IGC. Any changes between IGC Plenary meetings are approved by the IGC Bureau and confirmed at the next IGC Plenary.

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 may wish to apply for IGC-approval for a new type of GNSS FR are advised to contact the GFAC Chairman as early as possible during the design process. This should be before any commitment to large-scale purchase of specialised components and before design-fix, because discussion with GFAC may reveal that changes must be made before IGC-approval can be agreed. The GFAC Chairman will notify the applicant of current IGC-approval procedures, including the initial application, other documentation, sending of hardware for GFAC testing, and payment of the IGC-approval fee to FAI for the IGC account.

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 GNS Systems, electronic security, or other specialised technology), but the GFAC Chairman must be copied with all correspondence so that he is aware of the issues involved and can inform GFAC members as appropriate.

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 information is available. This 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 to 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 from 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 format can be checked for compliance with the latest IGC standard.

1.3.2.2. **When hardware is available.** Recorders should not normally be sent until GFAC comments have been made on the specification for the type of FR, and IGC files have been sent to GFAC. 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. GFAC will test the hardware and the Chairman will keep the FR manufacturer informed of comments and any required changes before IGC-approval can be considered. A fee is payable for IGC-approval work, see 1.3.5.

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

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.** A detailed description of security 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 **Altitude - Calibrations and Checks.** The pressure altitude figures in the IGC file must be calibrated with respect to the ICAO ISA, see para 2.1.1 for detail on calibrations. A calibration table listing ISA and IGC file figures and the IGC file from which the figures were obtained, must be forwarded to GFAC when an FR is sent for testing. See also para 2.2 on comparing pressure and GNSS altitudes.

1.3.4.2.1 **HAFRs.** An IGC-approved High Altitude Flight Recorder (HAFR) must be used for altitude claims above 15,000 metres, for more detail see para 2.1.2.2 and Appendix 6 to SC3C. For IGC-approval of a HAFR, an independent check of the GPS altitude figures in its IGC files is required using a high quality GPS signal generator at an NAC-approved facility. Differences between the signal generator figures and GPS altitudes in the IGC file are used to make a table that is sent to GFAC together with the IGC file on which it is based, similar to a pressure altitude calibration table. A pressure altitude calibration to at least the same altitude as the GPS altitude check must also be provided. (AL11)

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, annotated GFAC and the name of the Manufacturer and type of FR) before IGC-approval can be given. The full fee is normally payable for IGC-approval of a new type of FR, but where an FR is closely related to one that is already approved, or is a relatively small modification to an existing FR, a reduced fee will be charged, at the discretion of the GFAC Chairman, depending on the amount of testing and other work involved. If FAI does not receive the appropriate fee, an IGC-approval may not be issued or an existing IGC-approval may be withdrawn pending receipt of the fee by FAI.

The fee should be paid when hardware is sent to the GFAC Chairman for evaluation, certainly before the IGC-approval document is issued. 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 may 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 GFAC Chairman. At the time of writing (year 2018) the fee is 1000 Euros for testing a new type of Flight Recorder for IGC-approval. The current scale of fees is part of the application data.

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 circumstances. GFAC testing is intended to be of a non-destructive nature, but GFAC, IGC or FAI 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 from person to person unless the manufacturer can send separate equipment to each. Any excess expenses incurred by individuals (such as post, excise and tax), shall be paid by the Flight Recorder manufacturer into the FAI account (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.** In some cases, GFAC may decide that a report is needed from an 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 will 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 **Engine Recording Systems - General.** Engine recording is by IGC ENL and MOP systems that are designed to differentiate between conditions of forward engine thrust, and gliding flight without the use of engine. The IGC Environmental Noise Level (ENL) system has a sensor inside the FR and is most sensitive to acoustic sound between 100 and 200 Hz. It was originally designed to record the operation of two-stroke engines, but also records high ENL numbers with Forward Electric Systems (FES) if the FR is installed just behind the engine and its retractible propeller. Where the ENL system does not produce high enough readings with types of engine and FR installations, an additional sensor under the MOP code must be fitted so that a high engine signal can be recorded as three MOP numbers in each fix line in the IGC file, in addition to the three ENL numbers. Critical cases are covered in 1.4.2.2-4 below and more detail is in SC3 Annex C (SC3C) Chapter 11, and Chapter 5 of the FR Specification.

1.4.2.1 **Engine Power.** A combination of engine and propeller noise at high power should give ENL figures between 800 and 999. Most two-stroke engines produce ENL values over 900 at high power, as do Forward Electric Systems (FES) if the FR is installed just behind the engine and its retractible propeller. Four-stroke and Wankel (Rotary) engines give lower figures but which may be enough to differentiate between power-on and power-off flight, depending on where the FR is mounted. However, high power is not the critical case, see the next para.

1.4.2.2 Critical ENL Cases

1.4.2.2.1 Power-on. The critical power-on case for testing ENL is not full power, it is when positive forward thrust is just generated. Under such conditions, recorded ENL must be high enough to differentiate from the power-off cases below. If it is not, a separate sensor under the MOP code must be fitted (see 1.4.2.4 and chapter 5 of the FR Specification). This may apply to some rear-mounted 4-strokes, electric, and jet engines, unless the FR itself is mounted close to the engine, propeller or jet pipe, as applicable.

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 cockpit panels open - this can be mistaken for running the engine and should be avoided. 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 when thermalling the glider will be climbing and the ENL could be more easily be mistaken for use of engine.

1.4.2.3 ENL system design. The three ENL numbers as recorded in IGC files must differentiate between the "quiet engine" and the "noisy cockpit" cases. This is done by 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 gliders with engines, and powered aircraft. Experience has shown that peak sensitivity between about 100 and 200Hz with a typical "bell curve" (the statistical "normal distribution") for sensitivity either side of the peak frequency, gives a good ENL response to piston engine and propeller noise, and less response to cockpit noises in soaring flight.

1.4.2.4 Low-ENL installations - additional MOP sensor. Where an engine and FR installation produces ENL values that make it difficult to differentiate between power-on and power-off flight (as assessed by GFAC using the criteria in 1.4.2.2), an additional engine recording system shall be provided that produces three extra numbers in the IGC file under the three-letter code "MOP", standing for Means of Propulsion. The type of MOP sensor is described in an extra MOP line in the IGC file header record, and may either sense acoustic sound at high or low frequencies, current flow to electric engines, fuel flow to piston or jet engines, or any other variable tested and approved by GFAC for the engine type. The MOP sensor can be either connected to the FR by cable, or be inside the FR in addition to its ENL system. It must be capable of clearly indicating any forward engine thrust and be secure from any attempt to modify the system so that some engine running is not recorded. For more detail, see para 1.4.2.5 below and para 5.4 in the IGC FR Technical Specification.

1.4.2.5 Engine Recording - Pilot and Glider Owner responsibilities. Pilots and owners of gliders with engines of any type should note the above paras on engine recording, and should check that figures in IGC files produced by their individual recorder installation, particularly for ENL (and MOP where fitted), indicate a clear difference between engine-off flight and any flight with the engine developing positive thrust. See also Chapter 11 of Annex C to the Code (SC3C) for more information and diagrams on engine recording. (AL12)

1.4.2.5.1 ENL and MOP figures. The three ENL figures (and the three extra MOP figures where available) in each IGC file fix line, should be approximately similar to those found in GFAC tests and listed in the IGC-approval document for the type of FR and engine sensor concerned. The figure with engine-off should not exceed 400 (generally it should be much less) and the figure when the engine produces forward thrust should not be less than 700. If either ENL or MOP figures are outside these margins, there is a risk that glide performances may not be able to be validated, see below.

1.4.2.5.2 Checking Individual Glider Installations. Pilots are cautioned that flight Validations have been lost in the past where installations of FR engine recording systems in individual gliders fail to differentiate clearly between engine-on and engine-off conditions. This may be either (1) because use of engine does not produce high enough ENL/MOP figures in the IGC file, or (2) because the particular installation allows unwanted high figures to be recorded in gliding flight which could be confused with use of engine. Pilots are also advised that any change that could affect the engine recording system in an individual glider can alter the ENL/MOP readings, and before attempting a flight that requires Validation, pilots should check that their current system clearly differentiates between engine-off and conditions of forward engine thrust. Some specific conditions follow.

1.4.2.5.2.1 Cockpit-mounted ENL systems. With cockpit-mounted ENL systems, pilots should avoid flight conditions that produce high ENL figures in gliding flight with the particular glider installation. Such conditions may include flight with DV panels open, particularly with sideslip when thermalling, and at high speed. In some gliders, flight with DV panels open at some speeds can produce a so-called "organ pipe" noise that records as high ENL, and opening DV panels at such speeds should be avoided. High ENL can also occur with operation of airbrakes and undercarriage, but as this is normally when descending before landing this is easy to distinguish from engine running.

1.4.2.5.2.2 MOP sensor placement. In some MOP systems that record high-frequency sound, high MOP has been found in gliding flight because the sensor has inadvertently been placed where high frequency sound is present, probably due to vibration at certain airspeeds of the structure on which the sensor has been mounted. In such cases the sensor must be moved to another position so that low MOP values are always recorded in gliding flight but the sensor continues to record high values with forward engine thrust.

1.4.2.5.3 Pilot and Owner actions if IGC files do not clearly show use of engine. If ENL, MOP and other figures in IGC files make it difficult for an OO to distinguish between engine-off flight and flight with forward engine thrust, action must be taken before flight Validations are compromised. Possible actions include moving the engine sensor to a more favourable position to record use of engine (if the sensor is separate from the main FR), moving the whole FR to a more favourable position (where this is possible with a small FR), or returning the recorder and/or the engine sensor to the manufacturer or his authorised agent for the ENL and/or MOP systems to be re-set.

1.5 **IGC-APPROVAL.** 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 1.1.4 for levels). Drafts of approval documents will be circulated to GFAC members and its technical advisors, and to the Flight Recorder manufacturer. The final version of the IGC-approval document is the responsibility of GFAC, in its capacity as 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 be where one of the FR systems is assessed as needing improvement, or could involve an approval with limitations, such as an approval level other than "all flights", or pending improvement of the ENL and/or MOP systems.

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 the engine sensor system (ENL, and/or MOP) either was not included, or was assessed by GFAC as not being adequate. In this case an IGC-approval might be issued without the engine sensor, pending further development which satisfies GFAC, after which the sensor would then be added to the Approval document through an 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, internal firmware or external 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.

1.6.1.2 **Action on Changes.** GFAC may decide to note the changes, or decide that a formal evaluation of such changed features is required. If the changes are extensive, GFAC may decide that another approval process is required.

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

1.6.3 **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.

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

1.6.3.2 **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.

1.6.3.3 **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 by the manufacturer or another organisation approved by the manufacturer.

1.6.3.3.1 **Pilot aspects - Validation of Flights.** Pilots should be aware that if they are using a recorder for which there is no manufacturer support, in the event of anomalies in IGC files it may not be possible to validate such flights.

1.6.3.4 **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 all flights that require validation to IGC criteria, except Silver and Gold badge flights which may also use a less secure "NAC-approved Position Recorder" (NAC PR). Flights in gliding championships must also comply with the rules in Annex A to the IGC Sporting Code (SC3A). For the different levels of IGC-approval from world records to badges, see para 1.1.4. Where validation is not required to IGC standards, evidence is at the discretion of the organisation responsible for validating the flight.

1.7.1 **IGC File Format.** For the format of the IGC Flight Data file, see the IGC FR Technical Specification . For a performance to be validated to IGC standards, 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 IGC standards, the choice of criteria is at the discretion of those responsible for validating the flight, such as the (non-gliding) NAC, competition officials or, for non-IGC FRs, other FAI Air Sport Commissions or General Aviation organisations.

1.8 **NOTIFICATION AND ISSUE OF IGC-APPROVAL DOCUMENTS.** 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 sent to the email list "IGC-discuss". The complete IGC-approval document will be posted on the FAI/IGC and GFAC web sites, together with the FR Manufacturer's DLL file for validating the integrity of IGC files.

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 an FR for 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 document may be altered or the approval removed.

1.10 **COMMENTS OR QUESTIONS.** If any comments, problems or questions arise during use of an IGC-approved Flight Recorder, the FR manufacturer should be contacted, and a copy sent to the GFAC Chairman. See also para 1.1.12.

For further detail, see the Technical Specification for IGC Flight Recorders, web reference on page (v)

CHAPTER 2

ALTITUDE AND TIME RECORDING

2.1 **PRESSURE ALTITUDE.** Pressure altitude is part of the IGC flight data file format on each B-record time line, and is referenced to the International Standard Atmosphere (ISA) of the International Civil Aviation Organisation (ICAO). Pressure altitude to the ICAO ISA is used in civil and military aircraft worldwide for altitude reporting to other aircraft and to Air Traffic authorities.

Details of the ICAO ISA are in ICAO Document 7488, in which tables 3 and 4 contain exact conversions of pressures to ISA altitudes, see www.icao.int. General descriptions of the ISA are in other web sources such as Wikipedia (http://en.wikipedia.org/wiki/International_Standard_Atmosphere).

The assumptions made in the ICAO ISA include sea level conditions of 15°C and an atmospheric pressure of 760 mm of mercury (Hg), equivalent to a pressure of 1013.25 millibars or hectoPascals (mb / hPa). The ICAO ISA assumes a temperature lapse rate of 6.5°C for each altitude increase of 1000 metres (1.98°C or 3.56°F per 1000 ft), up to an altitude of 11,000m which is assumed to be the "Tropopause", above which is the "Stratosphere" in which initially a constant temperature of -56.5°C is assumed as altitude increases. Although the real atmosphere varies with the season and from day-to-day, the use of the ICAO ISA ensures that aircraft can report pressure altitude to the same scale, whether or not such figures correspond to geometric height above the earth's surface.

2.1.1 FR Pressure Altitude Calibration. The FR manufacturer should calibrate the pressure altitude sensor in the FR to the ICAO ISA before the FR is sold, and a HAFR (para 1.3.4.2.1) must also be checked for correct operation and recording of GNSS altitude. In all cases, before a claim is made that requires figures for maximum altitude, gain-of-altitude, or altitude loss between start and finish points, a calibration to IGC standards must be made. For all FRs before or immediately after initial sale, on set-up and calibration of their pressure altitude system, the sea level setting should correspond to 1013.25 hPa within 1.0 hPa, within 3.0 hPa up an altitude of 2000 metres, and within 1% of altitudes above 2000 metres. This also applies to NAC-approved Position Recorders (PRs) that can record pressure altitude.

2.1.1.1 It is desirable that the calibrator is familiar with the type of FR being calibrated. However, technicians carrying out calibrations in aviation organizations not associated with gliding will follow their normal procedures and expect that the FR will record once it is switched on. It is therefore the FR owner's responsibility to set-up the FR before a calibration, and the fix interval should be set to a minimum value such as 1 second. If the FR has no internal power, a battery must be provided so that it can be placed in the altitude chamber with the FR. Before the calibration run, the pressure altitude in the chamber should be changed by about 1000m for a short time so that the FR will detect the pressure change and start recording in the absence of a GPS signal to start fix recording.

2.1.2 Recording of calibration data

2.1.2.1. After the calibration, the IGC file containing the pressure steps is downloaded to a computer as if it was flight data. The stabilised pressure immediately before the altitude is changed at each pressure step shall be taken as the value of the step unless the calibrator certifies otherwise. The IGC file will then be analysed, compared to the calibration pressure steps, and a correction table produced and certified by the calibrator, otherwise by another NAC-approved person.

2.1.2.2. The correction table will list true ISA against indicated altitudes and a table is in para 2.1.1.2.5. Tables such as this must be used to adjust pressure altitudes recorded during a soaring performance. These include altitudes at take-off, start, maximum, minimum, and landing altitudes. These are used for calculation of low and high points on gain-of-height and altitude claims, start-to-finish altitude differences for distance claims, and separation from Controlled Airspace.

2.1.2.3. Some FRs can display pressure altitude directly on a screen, but the figures may not be the same as those recorded in the IGC file because various FR settings can affect the screen altitudes. The figures in the IGC file must always be used in analysing flight altitudes, after being corrected to the ICAO ISA.

2.1.2.4. OOs responsible for validating flights will need to see the latest calibration file when assessing any claim that is made with the Recorder. A copy of the calibration IGC file must be retained by the OO supervising the calibration, and also by the calibration organisation.

2.1.2.5. A specimen Pressure Altitude calibration table follows:

PRESSURE ALTITUDE CALIBRATION TABLE (example)

Flight recorder type / model / serial no.

Name / place of calibration facility

Flight recorder calibrated against:

Reference manometer type / model / serial no.

on [date]

in accordance with

FAI Sporting Code Section 3, Gliding, Annex B, Flight Recorder Calibration Procedure

QFE (local pressure at calibration site) = XXXX.X Mb / hPa

T = YY °C

The readings have been corrected to ISA temperature.

The IGC file is available and is held at:

ICAO ISA Alt (ft)	FR reads (ft)	Correction
0	10	-10
1000	1005	-5
2000	2000	0
3000	2975	+25
4000	3950	+50
5000	4950	+50
6000	5920	+80
8000	7910	+90
10000	9910	+90
12000	11910	+90
14000	13890	+110
16000	15865	+135
18000	17860	+140
20000	19865	+135
22000	21885	+115
24000	23880	+120
26000	25925	+75
28000	27890	+110
30000	29875	+125
32000	31875	+125
34000	33925	+75

[Signature]

[Name of Calibrator]

[date]

[Organisation]

Authorised ISA pressure altitude calibrator for the National Aero Club of

[country]

2.2 GNSS ALTITUDE.

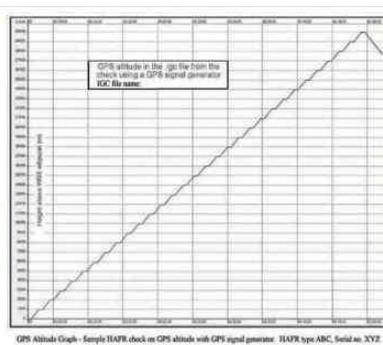
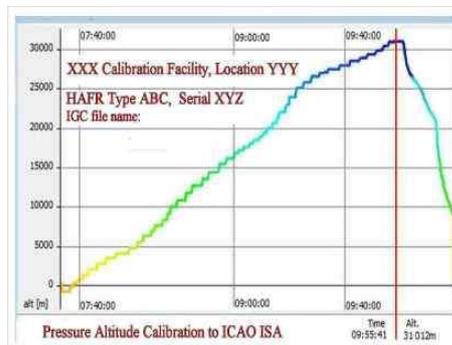
2.2.1 Flights below 15,000 metres. Below 15,000 metres, pressure altitude corrected to the ICAO ISA is used for altitude figures in IGC claims. If pressure altitude recording fails, GNSS altitude may be used, but only for evidence of flight continuity (proof of "no intermediate landing").

2.2.1.1 NAC Position Recorders (PRs). An NAC-approved PR may be used for or Silver and Gold badge flights only, and if pressure altitude is not recorded in its IGC file, GNSS altitude may be used for measurement purposes with a 100 metre (328.084ft) increment over SC3 altitude requirements, in accordance with SC3 procedures for PRs. This is because of the different scales used in obtaining altitude from pressure and GNSS sensors, and short-term variations of GNSS altitude figures that have been seen in IGC files where low-cost GNSS receivers are used (also see 2.4.1 below).

2.2.2 Flights above 15,000 metres - IGC High Altitude Flight Recorders (HAFRs). For altitude claims for flights over 15,000 metres (49,212.6 ft) evidence must be from an IGC-approved type of HAFR. Above 15,000m, IGC uses GNSS altitude rather than pressure altitude for accurate measurement because pressure change with altitude has become very small. An IGC HAFR is specially designed and tested so that that GNSS altitude in its IGC files is without short-term variations or other anomalies. See also para 1.3.4.2 of this document, the main volume of SC3 para 3.5.3b, Appendix 6 to SC3C, and para 2.2.4.1 in the FR Technical Specification. (AL11)

2.2.2.1 Pre- and post-flight checks on GNSS altitudes recorded in IGC files. The GNSS altitudes in the IGC file from the HAFR used for an altitude claim above 15,000 metres must have been independently checked and documented before the claim for accuracy and freedom from anomalies. They must also be checked after an altitude claim above 15,000m to ensure that processing of GNSS altitude by the FR has not changed, for instance due to other updates, changes, or faults in the FR that have occurred since the initial check, which could be up to 5 years before the claim flight. These checks must be carried out at an NAC-approved instrument laboratory, at which a high quality GPS signal generator is used to inject signals of precise GPS altitudes into the FR's antenna connector.

The pre-flight check is required up to the maximum altitude for which the HAFR is to be approved for record claims. Differences between the IGC file figures and those from the signal generator are then listed in a table that is used to correct figures for the altitude claim in a similar way to correcting IGC file pressure altitudes to the ICAO ISA. The diagrams show an example of a GNSS altitude check made as part of IGC-approval of a HAFR and are also included in Appendix 6 of Annex C (SC3C).



Test organisation: _____		
Date of test: _____ IGC file name: _____		
Name of letter or head of Test Team: _____		
Signal generator type: _____		
SigGenSpecification/Certificate of Performance: _____		
HAFR Type: ABC	Serial # (from IGC file name): XYZ	
Signal generator above WGS84 ellipsoid (metres)	IGC file (metres)	Correction (m) to be applied to IGC file value
0	25	25
1000	972	22
2000	1975	23
3000	2977	23
4000	3978	22
5000	4979	21
6000	5979	21
7000	6980	20
8000	7980	20
9000	8980	20
10000	9981	19
11000	10981	19
12000	11981	19
13000	12982	18
14000	13982	18
15000	14982	18
16000	15983	17
17000	16983	17
18000	17983	17
19000	18984	16
20000	19984	16
21000	20984	16
22000	21984	16
23000	22985	15
24000	23985	15
25000	24985	15
26000	25985	15
27000	26986	14
28000	27986	14
29000	28986	14
30000	29986	14

Table with figures from same IGC file as graph shown

The time period required for these checks are the same as the Sporting Code requirements for pressure altitude calibrations. That is, within 5 years before and two months after the flight, except that if the claim flight is made from a site remote from GNSS altitude checking facilities, the after-flight period starts when the FR is returned to a location at which GNSS checks can be carried out at a facility approved by the NAC dealing with the claim.

The minimum requirement for the post-flight GNSS altitude check is for check points to be recorded above and below (and close to) the claimed altitudes. A full check over the complete altitude range is not essential, but could provide the official pre-flight check for a later claim.

A pressure altitude calibration is also required within 5 years before the claim up to at least the altitude to be claimed, but there is no requirement for a post-flight pressure altitude calibration for altitude claims above 15,000 metres because GNSS altitude will be used for the claim. (AL11)

2.2.2.2 Check of Altitude figures in the IGC file for the Claim. The shape of the pressure altitude graph with time must be compared to the shape of the GNSS altitude graph and should be similar without upward or downward short-term "spikes" in GNSS altitude, or other anomalies. A spike in GNSS altitude is a short term increase or decrease not shown in the pressure altitude curve, possibly due to a temporary reduction in GNSS signal strength at the recorder. Altitude figures in such spikes must be ignored in calculations for IGC altitude performances. (AL11)

2.3 COMPARISON OF PRESSURE AND GNSS ALTITUDES. This applies to GNSS and pressure altitude evidence from IGC-approved Flight Recorders, also to NAC-approved Position Recorders where these record pressure altitude.

2.3.1 Comparison of GNSS and Pressure Altitude figures. The digital altitude data from a GNSS receiver is in the form of vertical distance above the WGS84 ellipsoid, rather than above Mean Sea Level (MSL) or the pressure altitude zero datum of the ICAO International Standard Atmosphere which is 1013.25 hPa (hectoPascals) the same numbers as millibars (mb). Analysis of pressure and GNSS altitudes from many thousands of IGC flight data files shows that GNSS altitudes from early types of IGC-approved FRs are not consistent enough for use as accurate measurements of altitude. In addition, low-cost GNSS

receivers are designed primarily for lat/long position and there is little extra processing of raw GNSS altitude, leading to short-term variations ("noise") in the GNSS altitude figures in an IGC file. In older types of FRs there have been examples of "GNSS altitude unlock" and other obvious anomalies in GNSS altitude, fortunately not affecting lat/long fix accuracy due to the extra processing applied to lat/long fixes in the GNSS receiver.

2.3.1.1 **HAFRs.** In the case of an IGC High Altitude Flight Recorder (HAFR, see para 2.1.2.2), a particularly accurate GNSS altitude output is required for validation of flights above 15,000 metres. Here, the pressure gradient with altitude has fallen to the extent that IGC has decided to use GNSS altitude for measurement purposes.

2.3.1.2 **NAC PRs.** If an NAC Position Recorder (PR) is used that does not record pressure altitude, an extra 100 metres is required over the altitude criteria in the Sporting Code because these criteria are set for pressure altitude, for instance Silver C height gain is 1000 metres of pressure altitude gain and Gold C height is 3000 metres of pressure altitude gain.

2.3.2 **GNSS altitude accuracy.** GNSS navigation systems are based on the time-difference of signals from a constellation of satellites received by a GNSS receiver on the ground or in aircraft. Figures for horizontal position are more accurate than those for altitude, due to the geometry of position-lines from the satellites. Altitude figures are less accurate than those for lat/long by factors between 1.8 and 2.2, sometimes more if anomalies are present. The ratio will vary with the number of satellites in a fix, at high latitudes, and receiver characteristics such as algorithms in the particular type of GNSS receiver for calculating horizontal and vertical position. Other factors include reduced GNSS signal strength due to flight in valleys, poor antenna position or cable connections, etc.

2.3.2.1 **Data in IGC files.** So-called "dead reckoning", predicted data, or run-on of previous values without new data from satellites, is not permitted 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 file as zero GNSS altitude. Showing 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, during which valid pressure altitudes in the IGC file will continue to produce evidence of flight continuity, position data being lost.

2.3.2.2 **Glider Installations.** Poor antenna installation will magnify errors, particularly in GNSS altitude figures. Examples include mounting of the antenna near to material such as carbon fibre or metal that can reduce the signal or cause multipath effects. Other adverse conditions include high 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 short-term anomalies in GNSS fixes in the IGC file, particularly in altitude.

2.3.3 **GNSS altitude - Zero-Datum.** In IGC-approved recorders, the WGS84 ellipsoid is the zero-datum for GNSS altitude.

2.3.3.1 **Other altitude datums.** 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", an approximation to mean sea level (MSL). The WGS84 Geoid is an irregular worldwide surface of equal gravitational potential that varies from the WGS84 ellipsoid by between +65m and -102m.

2.4 **TIME MEASUREMENT.** The time system used for IGC purposes shall be based on Universal Time Coordinated (UTC), or local times based on known differences from UTC. An IGC-approved GNSS Recorder (FR or PR) is used for accurate time measurement because GNS 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 worldwide GNS System.

Note on GPS 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 automatically made in IGC-approved Flight Recorders and no action by pilots or OOs is required. In 2018, UTC was 19 seconds later than GPS internal system time. Since this difference will increase with time, corrections in IGC-approved Flight Recorders will change so that time outputs are to the correct UTC. For more detail, see http://en.wikipedia.org/wiki/Leap_second

APPENDIX A

CHANGES OF IGC-APPROVAL LEVEL

A1 Lowering of approval level. If GFAC proposes to lower the approval level of a type of IGC-approved recorder, this will be discussed 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 considered appropriate at this stage.

A1.1 After these discussions, if GFAC still recommends a lowering of the approval level, it will then make a detailed recommendation to the IGC Bureau. The Bureau will then assess the evidence and make a decision. If the Bureau decides to seek opinions from other than 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 (www.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 a B- fix-record line(s)) 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 it has been found that 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 GFAC and the IGC 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.

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 normally be between 3 and 12 months after the date of the public announcement.

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 1000 Euros to the IGC account at FAI. 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 with copies to the Chairmen of the IGC ANDS and GFA Committees. 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 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, 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. A decision will normally be made within one calendar month of receiving evidence from the appellant, but if technical detail has to be assessed the timescale may be longer. The decision will be communicated to the appellant before any public announcement is made.

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