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 1-15
31 MARCH 2025

FÉDÉRATION AÉRONAUTIQUE INTERNATIONALE
Maison du Sport International, Avenue de Rhodanie 54, CH 1007 Lausanne, Switzerland
www.fai.org sec@fai.org

Rights to FAI international sporting events

All international sporting events organised wholly or partly under the rules of the FédérationAéronautique Internationale (FAI) Sporting Code {Reference 1, below} are termed FAI International Sporting Events {2}. Under FAI Statutes {3}, FAI owns and controls all rights relating to FAI International Sporting Events. FAI Members {4} shall, within their national territories {5}, enforce FAI ownership of FAI International Sporting Events and require them to be registered in the FAI Sporting Calendar {6}.

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

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

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

References

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

AMENDMENT LIST (AL) RECORD

Amendments to this 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. Contact details (correct at October 2024)

ANDS Committee Chairman: Rick Sheppe rws@sover.net
GFA Committee Chairman: Peter Purdie gfac@fai.org
Sporting Code Committee Chairman: Howard Mills hmills@t-online.de

Amendments can also be proposed by IGC nations, their delegates and other Specialists, including via the agenda for the annual IGC Plenary meeting. Comments on proposed amendments will be made to the Plenary by the appropriate Specialist or Committee Chairman and the IGC Bureau will be notified of any amendment 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 normally take effect on 1 October following the IGC meeting at which changes were notified or discussed, unless an earlier date is needed to allow for significant circumstances for which amended procedures are required before flights can be validated, to make corrections, or to bring this 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 are required.

AL	ACTION DATE	AMENDED BY	NAME	DATE
1	1 October 2003			
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 2014			
11	21 April 2018			
12	1 October 2018			
13	1 October 2019			
14	1 October 2020			
15	31 March 2025	Incorporated in this document		
16				
17				
18				
19				
20				

CONTENTS

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 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 that are listed in para 2.

2. **Scope.** SC3B deals with devices that use data from Global Navigation Satellite Systems (GNSS), such as IGC-approved Flight Recorders (FRs) and lower level NAC-approved Position Recorders (PRs). 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 IGC Pilot 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 Annex B are the responsibility of GFAC together with the IGC Airspace, Navigation and Display Systems (ANDS) committee, consulting the IGC Sporting Code Committee (SCC) where applicable, and notifying the IGC Bureau where policy issues are involved.

3. **Technical Specification for IGC-approved GNSS Flight Recorders**. A detailed Technical Specification (TS) for IGC-approved FRs is available through the web references in para 4. It contains hardware, software and other requirements for IGC-approval as a Secure Flight Recorder (SFR), the detailed structure of IGC flight data files, glossary definitions including those referring to technical detail, and procedures on FR security. Its first Chapter on overall IGC FR policy is based on Chapter 1 of Annex B to the Sporting Code for Gliding (SC3B). Amendments to the TS are the responsibility of GFAC and the IGC ANDS committee (see para 2 above), consulting the IGC Sporting Code Committee and other experts where required. 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 important matters arise at IGC Plenary meetings or where new situations occur.

3.1 TS Users. 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. 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 stores Lat/Long fixes and other data for post-flight analysis and validation of flight performances to IGC standards.

4. **Other documents and Web References:**

for SC3 and its annexes (SC3A, SC3B, SC3C, SC3D) : www.fai.org/igc-documents
for Flight Recorders, 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".

General Section of the FAI Sporting Code - through: www.fai.org/documents
scroll down to "Sporting Codes", then "Sporting Code - General Section".

5. **Amendments**. See page (ii)

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.

The term "logger" is sometimes met (instead of "IGC FR") but is not used by IGC because of when translated to other languages the word "logger" is not precise whereas "IGC-approved Flight Recorder" is a precise definition.

The terms "Specification", "Technical Specification", and "TS" refer to the IGC FR Technical Specification document, see paras 3 and 4 above

In addition to IGC-approved GNSS FRs, the term "Position Recorder" (PR) is also used for types of GPS recorder that are more basic than the IGC-approved FR. PRs may be approved for use by individual NACs, but only for evidence for Silver and Gold badge flights under IGC rules and 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 in the Technical Specification for IGC-approved GNSS Flight Recorders, also in other sub-sections of SC3, and the General Section (GS) of the FAI Sporting Code. See the web references in para 4 above.

GLOSSARY OF TERMS AND ABBREVIATIONS

This contains explanations of terms and abbreviations that are relevant to the contents of this document. More detailed definitions are available in the Technical Specification for IGC-Approved GNSS Flight Recorders, and more general definitions are in the General Section of the FAI Sporting Code

Accuracy - closeness of measurements to a specific value, compared to "precision" which is the closeness of measurements to each other. It is therefore possible to have a set of close measurements (high precision) that have a systematic error and so have low accuracy. The preferred situation is to have both high accuracy and high precision of data points.
See: https://en.wikipedia.org/wiki/Accuracy_and_precision

ANDS committee - The Air traffic, Navigation and Display Systems committee of IGC.

Calibration The formal definition of calibration by the International Bureau of Weights and Measures (BIPM) is the following: "Operation that, under specified conditions, in a first step, establishes a relation between the quantity values with measurement uncertainties provided by measurement standards and corresponding indications with associated measurement uncertainties (of the calibrated instrument or secondary standard) and, in a second step, uses this information to establish a relation for obtaining a measurement result from an indication." This definition states that the calibration process is purely a comparison. In the context of this Specification, the second step is the creation of a Calibration Chart which can be applied to the Pressure Altitude figures in the IGC File to give a more accurate measurement. See https://en.wikipedia.org/wiki/Calibration

CH, Ch - Confederation Helvetica, the Swiss Confederation, for instance ChF - Swiss Francs. FAI Headquarters is in Lausanne, Switzerland, and payments to FAI are made in ChF.

Declaration - The pre-flight recording of pilot name(s), glider type and identification, and any waypoint coordinates required to certify a soaring performance in accordance with SC3 procedures for that type of performance. The date and time when the latest declaration was received by the FR after action by the pilot or a system used by the pilot, is recorded in the first line of the C-Record at the beginning of of the IGC file. (AL14)

EGM - Earth Gravitational Model. A worldwide surface calculated to have equal gravity ("equipotental") rather than a geometric and simpler Earth Model such as an Ellipsoid (see below). Examples include EGM84, EGM96 and EGM 2008, defined by the US National Geospatial Agency (NGA). See below under "Geoid", and more detail is at https://en.wikipedia.org/wiki/Earth_Gravitational_Model

Ellipse and Ellipsoid - An ellipse is a two-dimensional smoothly 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). When an ellipsoid is used to model the shape of the earth, the semi-major axis is the radius at the equator and the semi-minor axis is the radius at the poles. The WGS84 Ellipsoid is used for location and measurement purposes by ICAO, the US GPS system, FAI, and IGC, see later under "WGS84".

Engine - a device fitted to an airframe capable of producing forward thrust when combined with a propulsion system 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 in FAI documents as a "Means of Propulsion" (MoP), see below.

ENL - Environmental Noise Level. A system inside IGC-approved GNSS Flight Recorders for detecting when an engine system is supplying forward thrust. The IGC ENL system is particularly designed for Piston engines driving a propeller, and records acoustic noise at peak frequencies between 100 and 200 Hz through a microphone inside the FR. ENL figures are shown with each fix in an IGC file in the form of three numbers between 000 and 999. See also 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 FAI 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.

Fix - For IGC flight analysis of FR data, a fix is a sample of near-simultaneous data from GNSS satellites that includes horizontal and vertical position (lat/long, GNSS altitude), time (UTC). This is recorded in each B-record line in IGC files. Other variables are recorded with each fix record, including fix accuracy (EPE/FXA), satellites in view, low-frequency acoustic noise (ENL), Pressure Altitude, and other variables recorded by the FR in a format specified by IGC. See also Missed Fix under "M" below. (AL14)

Fix Time. The time of a fix is recorded in IGC files at the beginning of each B-record line. These lines are normally in time-order, but small anomalies in the order have been seen in some IGC files, including when a 1 second fix rate is selected. Such small time-order anomalies in B-record lines do not affect the validity of IGC-file data used for certifying flight continuity, fix positions, and other data required for verification of the flight. (AL14)

Geoid - The WGS84 Geoid is a theoretical worldwide surface of equal gravitational potential, similar to a water surface at mean sea level (MSL) less tides and wind. See para 2.3.3.1 and https://en.wikipedia.org/wiki/Geoid . The surface of a Geoid is irregular and therefore, unlike an Ellipsoid (qv), cannot be defined by a simple formula. Geoids include various Earth Gravitational Models, see above under "EGM". For the above reasons, IGC FR files use the WGS84 Ellipsoid as the zero GPS altitude datum rather than one of several different Geoids.

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

GNSS - Global Navigation Satellite System(s). These are satellite-based navigation systems including, in alphabetical order, Beidou 2 (China), Galileo (Europe), GLONASS (Russia), GPS (USA). These 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. By knowing the exact position of the satellites and accurate time, together with an assumed mathematical model of the earth's shape, position on the earth's surface can be calculated. See above under Ellipsoid and later under WGS84.

GPS - Global Positioning System. The term "GPS" is sometimes used as a general term for satellite-based navigation systems, where the more precise general term should be "GNSS" (see above). In its more exact meaning, the term applies to the US Global Positioning System, the GNS System of the USA that became operational in January 1980. See http://en.wikipedia.org/wiki/Global_Positioning_System

High Altitude Flight Recorder (HAFR) -A special type of IGC-approved Flight Recorder designed for accurate recording of GPS altitudes above the WGS84 Ellipsoid. A HAFR is required for IGC altitude claims above 15,000 metres (49,213ft), see paras 1.3.4 and 2.2.2.

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 conditions of the IGC FR Technical Specification have changed with time (generally, 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 this applies to IGC Flight Recorders, it refers to one of the Approval levels that are listed in para 1.1.4. The IGC GNSS Flight Recorder Approval Committee (GFAC) tests and evaluates GNSS FRs and issues Documents. 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, see www.icao.int. In the ICAO ISA, sea level pressure is defined as exactly 1013.25mb/hPa. The reason for the two places of decimals (compared to a number such as 1010 or 1000mb), is that it is equivalent to the previous international standard which was 76 cm of a mercury column at 15 degrees centigrade.
See mB below and para 2.1.1. (AL14)

JPEG - Joint Photographic Experts Group. This Group developed 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).

Missed Fix/Fixes - Occasionally GNSS Fixes in the normal sequence in an IGC file are missed, for a variety of reasons. These can include poor GNSS reception at high angles of bank, flight in valleys or in mountainous terrain, poor antenna connection or performance, and so forth. As long as proof of Takeoff, Start, presence in Observation Zones, Finish, Landing, and flight continuity (no intermediate landing) is not compromised, small breaks in GNSS fixing will not invalidate the

overall flight performance. See above under Fix and 2.3.2.2 on the use of IGC file pressure altitude to prove flight continuity in the temporary absence of GNSS fixes. (AL14)

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.

The three-letter code MOP in capital letters is used in an IGC file (paras 1.4.2.4 -5) for a separate MOP sensor for engines, for instance where the ENL sensor does not give high enough figures during engine running. See para 1.4.2.4.

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 such as the SC3 series of documents for Gliding.

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 International Standard (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 an PR has a lower technical and security standard compared to an IGC-approved Flight Recorder (FR). Rules and procedures for NAC-approved Position Recorders are given in the main volume of SC3. More detail is in Annex C (SC3C), search for "Position Recorder" or "PR". 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.

Pressure Reference An instrument with traceable accuracy to a standard with better uncertainty than 0.1 hPa, used for comparison with an Approved Flight Recorder for calibration purposes

Precision - see above under "Accuracy"

Proof Drive or Flight - A method of checking that a Flight Recorder produces a correct IGC flight data file. Under the control of an OO or other official, the GNSS FR is driven in a vehicle or on a flight in a glider or other aircraft, over a course with known co-ordinates. A proof drive in hilly terrain can be used to check FR altitude, and a proof flight can check altitude data and other figures such as the use of engine in a motor glider. A proof drive including a sharp turn at a surveyed point can be used to check GNSS fix accuracy and is used by GFAC for this purpose with each FR tested. (AL14)

qv - quod vide, Latin for "which see", followed by a reference, which the reader is invited to look up. (AL14)

Reach, Reaching - when this refers to a Turn Point (TP), it refers to complying with IGC criteria for reaching the Point. Unlike activates such as air racing at low level where the aircraft must fly round a ground feature such as a pylon, IGC require that a glider must enter the Observation Zone (OZ) relevant to the TP. (AL14)

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, and applies to 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, drafted by the IGC Sporting Code Committee, 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

Spheroid - A term sometimes used instead of "Ellipsoid" - the latter is preferred because it is more precise.

Specification, Spec - See Technical Specification.

T&E - Test and Evaluation.

Technical Specification - the detailed Technical Specification (TS) document for IGC-approved GNSS Flight Recorders, unless indicated otherwise. More detail is in paras 3 and 4 of "Preliminary Remarks" on page iv of this document.

Traceability –Measurement The term *measurement traceability* or *metrological traceability* is used to refer to an unbroken chain of comparisons relating an instrument's measurements to a known standard. Calibration to a traceable standard can be used to determine an instrument's bias, precision, and accuracy. In many countries, national standards for weights and measures are maintained by a National Metrological Institute (NMI) which provides the highest level of standards for the calibration / measurement traceability infrastructure in that country. Examples of government agencies include the National Physical Laboratory, UK (NPL) the National Institute of Standards and Technology (NIST) in the USA, the Physikalisch-Technische Bundesanstalt (PTB) in Germany, and the Instituto Nazionale di Ricerca Metrologica (INRiM) in Italy. As defined by NIST, "Traceability of measurement requires the establishment of an unbroken chain of comparisons to stated references each with a stated uncertainty." (See also Calibration.)

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. Some older recorders do not have a DLL, but use DOS programs VALI-xxx.EXE. In both cases see para 1.1.10.1.

> Validation - NAC PRs. A significantly less rigorous form of file validation may apply to some 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 by 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 and some NAC PRs, where the signature generation and Validation program originates from the FR/PR manufacturer and the checking of serviceability and sealing of the FR/PR itself is part of Validation.

Vertical fix accuracy - The geometry of the lines-of-position between GNSS satellites and the surface of the earth is such that errors in recorded GNSS altitude are generally between 1.8 and 2.2 times those for lat/long, depending on the exact geometry of the position lines used in a fix. When Vertical Fix Accuracy is included in an IGC data file, it is through the VXA three-letter code, and uses the 2-sigma (95.45%) probability for vertical position error. (AL14)

Waypoint, way point (WP). Either (a) a precisely specified point or point feature on the surface of the earth using a word description and/or a set of coordinates, or (b) a set of precise coordinates not represented by any specific earth feature. An IGC Waypoint may be a Start point, a Turn point, or a Finish point and has a defined Observation Zone (OZ). A waypoint may also be used as a reference point for defining an area that is to be reached as part of an area task. (AL14)

WGS 84 - World Geodetic System 1984. This includes an ellipsoid model of the Earth's surface with an Equatorial radius of 6378,137.0 metres and a Polar radius of 6356,752.3142 metres, the "WGS84 ellipsoid". The overall WGS84 system is complex and includes gravity coefficients, formulas, the Earth's angular velocity, a WGS84 Geoid (an equal gravity surface approximating to local sea levels, see above under EGM and Geoid), various constants, conversion factors, coordinate systems - the definition documents that are referenced below are over 100 pages long. The original WGS84 System definition document was Technical Report 8350 of the National Imagery and Mapping Agency (NIMA) of the US National Geospatial Agency (NGA), see https://earth-info.nga.mil/GandG/publications/tr8350.2/tr8350_2.html. In 1989, ICAO adopted WGS-84 as the standard geodetic reference for world aviation, see: https://gis.icao.int/eganp/webpdf/REF08-Doc9674.pdf. Also see under WGS84 in Annex C to SC3, the Technical Specification for IGC GNSS Flight Recorders, and in the General Section of the FAI Sporting Code.

> Distance Calculations. For calculations of accurate distances on the surface of the WGS84 ellipsoid between two Lat/Longs, the Vincenty formula is accepted as an international standard (https://en.wikipedia.org/wiki/Vincenty's_formulae). It is used in the FAI world distance calculator when set to WGS84 (https://www.fai.org/page/world-distance-calculator), and through other Vincenty-based distance calculation programs available on the Web.

Words, meaning, In this document the words "must", "shall", and "may not" indicate mandatory requirements; "should" indicates a recommendation; "may" indicates what is permitted; "will" indicates what is going to happen. Where the context is 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*.

CHAPTER 1
IGC-APPROVAL AND RELATED PROCEDURES

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 follows 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, headquartered in Lausanne, Switzerland; and 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 IGC-approval), correct output in the IGC file format, physical and electronic security of the Flight Recorder and its output data. Other capabilities of FRs are matters between customers and FR manufacturers, and include cockpit displays, navigational features, proximity warning devices, and other characteristics not subject to IGC FR rules and procedures. See 1.1.4 for IGC approval levels that apply to different types of flights such as world records, IGC badges and diplomas, and competitions.

1.1.1 **FAI and IGC Liability**. FAI and IGC have no liability for the consequences of the use of Flight Recorders covered by this document other than for validation and certification of flights to IGC standards. 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 other branches of Aviation.

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.

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 later 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 to the glider by an OO at any time or date beforehand, to avoid the need for extra OO observation on the day of flight. 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 will be part of the IGC-approval document, and will depend on the Flight Recorder design and GFAC test and evaluation.

1.1.3 **IGC-Approval Documents for Flight Recorders.** 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, and is produced by GFAC on behalf of IGC. Before an Approval document is finalised, it is circulated in successive drafts to GFAC members and their technical advisors, other experts, and the FR manufacturer. When finally issued, the document includes procedures for checking the recorder, installation in the glider, and how it is to be operated for flights to be validated to IGC criteria.

1.1.3.1 Format of IGC-approval documents. These documents have a standard format including 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 (IP), and flight safety. The main body of the document is followed by annexes, including the following:

Annex A contains notes and recommendations for owners and pilots, including procedures and checks before, during and after flight, and other advice for pilots.

Annex B contains notes, recommendations and advice for Official Observers and bodies validating flight performances such as National Airsport Control authorities (NACs). It includes pre-flight procedures including checking installation and FR serial identity (S/ID); after-flight procedures including ensuring that the installation has not been changed; downloading IGC files; Annex B also contains details of Environmental Noise Level (ENL)

figures recorded during GFAC testing, those expected in flight; also figures from an additional Means-of-Propulsion (MOP) sensor if such a system is fitted.

1.1.4 **Levels of IGC-approval.** The IGC-approval document for individual types of Flight Recorders specifies procedures to be used and any limitations on types of flights to which the approval applies. 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 recorder has either been compromised or is below the requirements of the current Specification, where other features do not meet the current Specification, and IGC approval may be withdrawn until critical areas can be improved. The three levels of IGC-approval follow.

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 completely new designs of recorders, compliance with the current Specification is required. For types with existing IGC-approvals to this level, "Grandfather Rights" (1.1.5.2 below) apply unless there are major differences compared to the current Specification, particularly old security features, 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.

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 IGC approval 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, or do not comply with important current requirements. 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 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. Continuity of the original approval is so that owners and manufacturers are not constantly required to carry out updates unless major differences exist 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 level where it considers that the current Specification or Sporting Code is sufficiently different to those under which the original approval was issued, particularly on matters of data security. For more detail on changes of IGC-approval levels, see Appendix A, particularly para A2.2.

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 with the IGC ANDS committee and with the manufacturer, and, if considered necessary, with the IGC Bureau (approval levels, para 1.1.4). For further procedures, see 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 modified or withdrawn or pending compliance with standards agreed by GFAC.

1.1.6 **World Records**. Evidence must be from a type of FR that is IGC-approved at Level 1 for World Record flights. See 1.1.4 on approval levels, and 2.2 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.

1.1.7.1 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.

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 Validating IGC Flight Data Files**. 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. In any case, a system must also be fitted that operates if the recorder case is opened, for instance based on a security microswitch or switches inside the case. Other solutions may be considered if they 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 confidential details that are part of any re-set procedure (such as Private Keys) 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.DLLfile 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 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. These .EXE programs are 16-bit programs and will not run on the 64-bit Operating Systems found on modern PCs. Further information and avoidance of this problem can be found at https://www.fai.org/sites/default/files/frs_without_dll_2.pdf and in Appendix B of this document. The IGC Shell program, DLL and VALI files are on the FAI/IGC web sites.

1.1.10.1.1 Validation - Pass. 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.

1.1.10.1.2 Validation - Fail. The IGC validation program is designed to 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 Validation.

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 in the following sub paras.

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 data for starting the takeoff roll and finishing the landing run. This is intended as a simple independent check of these parts of the FR data. Following this, the rest of the FR 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, if necessary, 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 by the OO concerned or by the body that will validate the flight (such as the NAC) as soon as an anomaly is discovered, so that other supporting evidence is not lost due to the passage of time. It is vital 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 an IGC committee whose members are appointed by IGC to test, evaluate, and approve individual types of GNSS Flight Recorders in accordance with IGC procedures (see para 1.4.1). 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 members are confirmed at the annual IGC Plenary meeting.

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 contact 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 must be made before IGC-approval can be considered. The GFAC Chairman will notify the applicant of the current procedures for the approval process, including data that must be provided, the fee to FAI/IGC, 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 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, the latest documents including drafts should be sent as soon as they are available. The GFAC 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 FR 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.

1.3.2.3 Fee to FAI. When hardware is sent for testing, the FR manufacturer should fill in the IGC FR application forms 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.

1.3.3 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 that are relevant to the changes apply.

1.3.4 Documentation. The FR manufacturer applying for IGC-approval shall provide information to GFAC on how the particular type of FR 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 in IGC files. GFAC members and their advisors will keep such information confidential, but it must be provided by the FR manufacturer if IGC-approval is to proceed.

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 IGC-approval of a HAFR, an independent check of GPS altitude figures above the WGS84 Ellipsoid in its IGC files is required using a high quality GPS signal generator at an NAC-approved facility that also uses figures above the WGS84 Ellipsoid that is the GPS altitude zero altitude datum. Differences between the signal generator figures and GPS altitudes in the IGC file are used to make a correction 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. See para 2.1.2.2 and Appendix 6 to SC3C which includes a specimen table and GPS altitude graph.

1.3.5 **Fees and expenses for IGC-approval.** The appropriate fee must be paid by the applicant to the FAI account for the IGC Sub-account, marked for GFAC with 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.

1.3.5.1 At the time of writing (year 2024) the fee is 1200 CHf (Swiss Francs) for an application for testing a new type of Flight Recorder for IGC-approval. 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.

1.4 **TEST AND EVALUATION FOR IGC-APPROVAL**. GFAC will complete Test and Evaluation (T&E) as soon as practicable after receipt of all of the requested and appropriate material. This will normally be within 120 days unless there are unforeseen circumstances, or requested data is not supplied. 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. If individual GFAC members wish to test equipment themselves, the equipment originally sent to the GFAC Chairman will be sent from person to person unless the manufacturer can send separate equipment to GFAC members wishing to test the equipment. Any expenses incurred by individuals (such as post, excise and tax), shall be paid by the Flight Recorder manufacturer into the IGC/GFAC sub-account at FAI, so that individual GFAC members do not have to pay these expenses themselves.

1.4.1 GFAC Testing and the IGC FR Technical Specification. Tests by GFAC will include drives in vehicles over known routes and exact points, and flights in gliders, motor gliders and/or powered aircraft. These are sometimes known as Proof Drives and Proof Flights (see the Glossary under "Proof ... "). Comparisons will be made with FRs that are already IGC-approved, and the IGC file structure of the FR under test will be checked for compliance with the current IGC FR Technical Specification (TS). This will include functions such as Pre-Flight Declarations (see the Glossary under Declaration), accuracy of fixes, recording of correct pressure and GNSS altitudes, and the required number of pre-flight

and after-flight fixes to establish the points of starting the takeoff roll and finishing the landing run, and other TS requirements. (AL14)

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 thrust from the engine system, and gliding flight without the use of engine. The low frequency IGC Environmental Noise Level (ENL) system uses a sensor inside the FR and is most sensitive to acoustic noise between 100 and 200 Hz. It was originally designed to record the operation of two-stroke piston engines, but may also record reasonable ENL numbers with Forward Electric Systems (FES) if the FR is installed just behind the engine and its retractable propeller (subject to testing to show this). Where the ENL system does not produce high enough readings with certain types of engine and FR installations, either the FR location must be changed or an additional sensor under the MOP code must be fitted so that three high MOP numbers are produced in each IGC file fix line in addition to ENL. Difficult cases for Engine recording are in 1.4.2.2 - 1.4.2.5 below, and more detail is in SC3 Annex C (SC3C) Chapter 11, and Chapter 5 of the FR Specification.

1.4.2.1 High 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 and some give the maximum of 999. 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. Some rear-mounted electric and jet engines at high power have also been shown to give moderate ENL values, 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 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 unless the FR is mounted close to the engine, a separate sensor under the MOP code must be fitted (see 1.4.2.4 and chapter 5 of the FR Specification).

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 because the ENL figures 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 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 numbers. The three ENL numbers in IGC files should clearly differentiate between the "quiet engine" and the "noisy cockpit in the glide" cases. This is done by the FR manufacturer 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 , motor gliders, and powered aircraft. Experience has shown that peak sensitivity between 100 and 200Hz with a typical "bell curve" (the statistical "normal distribution") either side of the peak frequency, gives a good ENL response to piston engine/propeller noise, and less response to cockpit noises in gliding flight.

1.4.2.4 Low-ENL installations - additional engine sensor using the MOP code. Where an engine and FR installation produces ENL values that make it difficult to differentiate between power-on and power-off flight (using the criteria in 1.4.2.2), an additional engine recording system must be provided that produces three extra numbers in IGC file fix records under the three-letter code "MOP", standing for "Means of Propulsion". The type of sensor is described in an extra MOP line in the IGC file header record, and may sense acoustic sound at high or low frequencies, electrical 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 either be connected to the FR by cable, or be inside the FR in addition to its ENL system, and must be capable of clearly indicating any forward engine thrust. This applies to relatively 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, unless the FR itself is placed close to the engine and/or propeller and where FR ENL figures can be shown to comply with the critical cases in 1.4.2.2. For more detail, see para 1.4.2.5 below and para 5.4 in the IGC FR Technical Specification.

1.4.2.4.1 Approval of individual type installations. An approval for use of an acoustic ENL system on electric of jet equipped gliders may be issued if flight tests demonstrate that the flight recorder clearly differentiates the use of the engine at low power levels. Such an approval shall be for a specific Flight Recorder and Glider Type. The approval shall by added as an Appendix to the Flight Recorder approval giving details of the Glider Type and full installation details. Testing for compliance with para. 1.4.2.5.2 must be carried out before issuing such an approval.

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 system developing positive thrust. Failure to do so could result in claims being rejected due to lack of proof that the engine was not run during the Soaring part of the flight. See also Chapter 11 of Annex C to the Sporting Code for gliding (SC3C) for more information and diagrams on engine recording.

1.4.2.5.1 ENL and MOP figures. The three ENL figures in each IGC file fix (B-record) line, and the three extra MOP figures where available, 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 maximum engine-off figure should not exceed 300 (it should be much less) and the figure when the engine produces any forward thrust should not be less than 600. 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 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 that could be confused with use of engine. Pilots are therefore advised that, before attempting a flight that requires validation, they should check that their current ENL/MOP system clearly differentiates between the engine-off glide and when forward engine thrust is present. 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 DV panels open 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 it can usually be distinguished from engine running.

1.4.2.5.2.2 MOP sensor placement. In some MOP installations designed to record the high-frequency sound of jet engines, high MOP has been found in gliding flight because the sensor has inadvertently been placed where high frequency sound is present in gliding flight, 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. The risk of not moving the sensor to a better position is that flight validations could be lost due to lack of clear evidence that no engine running had occurred in the gliding part of the flight.

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.

1.4.3. 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 an independent testing laboratory. In this case, the applicant will be responsible for the expense of this report as well as the original 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.

1.5 **IGC-APPROVAL**. GFAC shall either approve, conditionally approve, or require modifications, to the applicant's design of Flight Recorder (see 1.1.4 for approval levels). Drafts of approval documents will be circulated to GFAC members and 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 "IGC Level 1- All Flights", or an approval with limitations pending improvement of systems such as ENL and/or MOP. 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, or to modify the FR under test such as by a firmware update. GFAC will aim to complete this review within three months, subject to not meeting 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 ENL or MOP system either was not included, or was assessed by GFAC as needing improvement. In this case an IGC-approval might be issued without the engine sensor, pending further development which satisfies GFAC, after which the sensor would be added to the Approval document through an amendment.

1.6 **APPLICANT'S AGREEMENT.** When an IGC-approval is published, the applicant agrees to the following:

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.

1.6.1.1 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 named 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 may be required on an approval application, certifying that the new Organisation will comply with current IGC procedures, and GFAC may require to test Recorders produced by the changed Organisation. What changes are considered significant will be assessed by GFAC and include: transfer of manufacturing to a different Organisation, acquisition of a name by another Organisation, or a change of structure or or key personnel within the current Organisation.

1.6.3.3 Cease of Manufacture and/or Support. If an FR manufacturer goes out of business or ceases to make a particular type of FR, GFAC will assess the situation. If the manufacturer is still operating, it must state whether support for the FR type will continue including updates and/or repairs by the manufacturer or another organisation approved by the manufacturer. In this situation, GFAC may consider lowering the IGC-approval level of such FRs.

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.

1.7 **USE OF IGC FLIGHT RECORDERS.** An IGC-approved 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" (NACPR). Flights in gliding championships that use IGC rules must also comply with 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. See the IGC FR Technical Specification for detail on the required content of IGC files. In particular, for a performance to be validated to IGC standards, the file must pass the IGC electronic Validation check (see para 1.1.10.1). See the Glossary under ENL, Fix, Missed Fixes, and MOP.

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 other aviation organisations.

1.8 **NOTIFICATION AND ISSUE OF IGC-APPROVAL DOCUMENTS**. Notification of a new or amended IGC approval document will be 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.

1.8.1 Valid Approval Document. Only the latest published IGC-approval document for a given type of FR is valid for IGC purposes.

1.9 **PRODUCTION STANDARDS**. IGC reserves the right to inspect and test examples of products covered by IGC approvals, to check 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 (iv)

CHAPTER 2

ALTITUDE AND TIME RECORDING

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

2.1.1 For details of the ICAO ISA, see ICAO Document 7488, in which tables 3 and 4 contain 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 .

2.1.2 The assumptions made in the ICAO ISA include sea level conditions of 15ºC and an atmospheric pressure of hectoPascals or 1013.25 millibars (mb / hPa), equivalent to a 76 cm column of Mercury (see under ISA in the Glossary of Terms). The ICAO ISA assumes a temperature lapse rate of 6.5ºC for each altitude increase of 1000 metres (1.98ºC or 3.56ºF per 1000 ft), up to an altitude of 11,000mwhich is assumed to be the "Tropopause", above which is the "Stratosphere" in which initially a constant temperature of -56.5ºC is assumed as altitude increases. Although the real atmosphere varies with from day-to-day, the use of the ICAO ISA ensures that all aircraft can report pressure altitude to the same scale, whether or not such figures correspond to exact height above the earth's surface.

2.1.3 FR Altitude Calibrations. For Records, Diamond Altitude and Diploma claims a calibration in the format described in the Flight recorder Specification Chapter 4 and dated either less than 5 years before or 2 months after the performance being validated must be available before a claim is approved which requires figures for maximum altitude, gain-of altitude, or altitude loss between start and finish points (except see para. 2.2.2.1.1 or HAFRs). One of the calibration methods and procedures detailed in the latest version of the IGC Flight Recorder Specification Para.4.5 should be used. FR manufacturers 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 with respect to the WGS84 Ellipsoid (more detail in para 2.2). 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 ±0.5 hPa/mb, and the error in pressure no more than 1.5 hPa/mb up to the maximum altitude specified in the FR IGC Approval document. This also applies to NAC-approved Position Recorders (PRs) that can record pressure altitude. (AL15)

2.1.3.1 It is desirable that the person making the calibration is familiar with the type of FR being calibrated. However, technicians carrying out calibrations in organizations not associated with gliding will follow their normal procedures and expect that the FR will start to 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 small 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 1000 metres for a short time so that the FR will detect the pressure change and start recording in the absence of a GPS signal indicating change of position.

2.1.4 Recording of calibration data

2.1.4.1. After the calibration, the IGC file containing the pressure steps is downloaded to a computer in the same way as 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 or another NAC-approved person.

2.1.4.2. The correction table will list accurate ISA against indicated altitudes and an example of such a table is shown after para 2.1.4.5. Tables such as this must be used to adjust pressure altitudes recorded during a soaring performance. This 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 (CAS).

2.1.4.3. 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, for instance to display height above the base airfield. The figures in the IGC file must always be used in analysing flight altitudes, after being corrected to the ICAO ISA.

2.1.4.4. OOs responsible for validating flights will need to see the latest calibration table (see below) 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.

2.1.4.5. A specimen Pressure Altitude calibration table follows:

IGC Flight Recorder calibration certificate

Device under test:

Type: GARRECHT INGENIEURGESELLSCHAFT,VOLKSLOGGER 1.0
Serial number: GCS0002LK
IGC file name: 491A2LK1.IGC

has been calibrated on 29 Jun 2024 by:

GBR-007 A.N.Other
1600 Pennsylvania Avenue, Washington DC

Correction Table:

ISA altitude (ft)	Device reads (ft)	Correction (ft)
0	-76	76
1000	927	73
2000	1912	88
3000	2931	69
4000	3917	83
5000	4912	88
6000	5905	95
8000	7909	91
10000	9885	115
12000	11865	135
14000	13855	145
16000	15816	184
18000	17823	177
20000	19815	185
22000	21767	233
24000	23721	279
26000	25743	257
28000	27715	285
30000	29698	302

This calibration is valid from **29 Jun 2024** for the period specified in FAI Sporting Code.
As this is a FAI/IGC approved flight recorder, the .IGC calibration file is held on record at this facility.

Reference manometer:

Type: acme
Serial number: 1234
Manometer calibration date: 28 Feb 2018 Manometer certificate number: abc
Test conditions: QFE: 1013.87 hPa, temperature: 17°C

.....
Calibrator's stamp/signature

Data prepared with FR-cal v0.7.0. Certificate printed with FR-cal v0.7.0.

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 above the WGS84 Ellipsoid from IGC files may be used, but only for evidence of flight continuity (that is, proof of "no intermediate landing").

2.2.1.1 NAC Position Recorders (PRs). An NAC-approved PR may be used for Silver and Gold badge flights only. If pressure altitude is not recorded in its IGC file, GNSS altitude may be used for measurement purposes with a 100 metre (328 ft) 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 **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. For such claims, GNSS altitude is used for accurate measurement (rather than pressure altitude), because pressure change with altitude has become small, and above 15,000m an IGC-approved HAFR must be used for altitude record claims. An IGC HAFR is specially designed and tested so that that GNSS altitude above the WGS84 Ellipsoid in its IGC files should not not have 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 of the FR Technical Specification.

2.2.2.1 Pre- and post-flight checks on GNSS altitudes recorded in IGC files. GNSS altitudes above the WGS84 Ellipsoid in the IGC file from the HAFR used for an altitude claim above 15,000 m 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 any reason that may have occurred since the initial check, which could be up to 5 years before the claim flight. These checks must be carried out at a NAC-approved instrument laboratory, using a high quality GPS signal generator to inject signals of precise GPS altitudes above the WGS84 Ellipsoid into the FR's antenna connector.

2.2.2.1.1. 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 listed in a table used to correct figures for the altitude claim in a similar way to correcting IGC file pressure altitudes to the ICAO ISA. The diagram on the right shows an example of a GNSS altitude check made as part of IGC-approval of a HAFR.

2.2.2.1.2 The time periods for these checks are the same as SC3 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.

2.2.2.1.3 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 check over the complete altitude range is not essential, but could provide the official pre-flight check for a later claim.

2.2.2.1.4 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.

Example - Table of GPS altitudes - HAFR test with GPS Signal Generator

HAFR: Type: ABC Serial Number (from IGC file name): XYZ

Test organisation:

Date of test:

Name of Tester or Head of Test Team:

GPS Signal Generator used, type:

SigGenSpecification, Ref:

SigGen Certificate of Performance, Ref:

GPS Altitude zero datum used: WGS84 Ellipsoid (ref: IGC FR Specification)

Signal Generator figure above WGS84 Ellipsoid metres	IGC File GPS Altitude metres	Correction in metres to be applied to figure in IGC file to obtain altitude above WGS84 Ellipsoid
0	+32	32
1000	972	28
2000	1975	25
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

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.

2.2.2.2.1 Altitude figures in any "spikes" must be ignored in calculations for IGC altitude performances.

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 were 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 may be 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 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 figure above the WGS84 Ellipsoid in the IGC file is required for validation of flights above 15,000 metres. At such high altitudes, air density and pressure gradient has fallen to the extent that IGC has decided to use GNSS altitude for measurement purposes because it does not suffer from reduction of accuracy at high pressure altitudes.

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. As Silver C height gain is 1000 metres of pressure altitude gain and Gold C height is 3000metres of pressure altitude gain, in a PR without pressure altitude, 1100mGPS altitude is required for Silver C and 3100m GPS altitude for Gold C.

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. GNSS altitude figures are less accurate than those for lat/long by factors generally between 1.8 and 2.2, sometimes more if anomalies in processing GNSS altitude are present in FR systems. A special case is IGC approved High Altitude Flight Recorders (HAFRs) that are specifically designed to record accurate GPS altitudes above the WGS84 Ellipsoid which will be used instead of pressure altitude for high-level altitude claims. In a normal GPS fix, the ratio between the accuracy of lat/long and altitude will vary with the number of satellites in a fix 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 IGC files - Predicted Data not allowed. So-called "deduced (ded) reckoning" (predicted data) based on previous fixes but without new satellite data, is not permitted in IGC files.

2.3.2.2 GNSS altitude not available. If GNSS altitude is not available in a fix in an IGC file, it shall be recorded in the B-record line as zero GNSS altitude, so that to OOs and others checking the flight data the lack of GNSS altitude data is clearly shown 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 must continue to produce evidence of flight continuity, position data not being recorded.

2.3.2.3 Glider Installations. Poor antenna installation will magnify errors, particularly in GNSS altitudes. Examples include mounting of the antenna near to or inside fuselage 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 GPS altitude.

2.3.3 GNSS altitude - Zero-Datum. In IGC-approved recorders, the zero-datum for GNSS altitude figures in IGC files is the surface of the WGS84 ellipsoid.

2.3.3.1 Other altitude datums - Equipotential Geoids. The output of GNSS altitude in some non-IGC approved Flight Recorders may be with respect to a surface calculated to be of equal gravitation potential known as a "Geoid", approximating to mean sea level (MSL) at the fix location. A "WGS84 Geoid" is described in the WGS84manual and there are other Geoids such as the EGM (Earth Gravitational Model) series, see under "EGM" and "Geoid" in the Glossary on page (v). Such Geoids have an irregular worldwide surface, and the WGS84Geoid varies from the WGS84 ellipsoid between +85 metres near Iceland and -107 metres south of India.

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) 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.

2.4.1 Leap Seconds; The internal system time used by the USA's 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 2020, UTC was 18 seconds later than GPS internal system time because the latter continues to be based on January 1980 time when the GPS system first came on line. For more detail, see http://en.wikipedia.org/wiki/Leap_second

---

APPENDIX A - CHANGES OF IGC-APPROVAL LEVEL

A1 Approval level changes. If GFAC intends to change the approval level of a type of IGC FR, generally to lower the level, or in some cases to remove the approval, this will first be discussed with the FR manufacturer. The manufacturer will be given the opportunity of offering an upgrade that will retain the existing approval level for modified recorders. The IGC ANDS Committee will be informed, and 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 discuss with the ANDS Committee and then inform the IGC Bureau.

A1.2 If the decision is to lower or remove the approval level together with the date on which it is to take effect, after the IGC Bureau has had time to comment on the proposal, the decision will be announced to the FAI IGC discussion group (igcdiscuss@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, ANDS and GFAC activities between Plenaries.

A2 Factors in Lowering Approval Levels. These include the following

A2.1 False or Incorrect Flight Data in IGC Files. Evidence that flight data in IGC files from a particular type of IGC-approved recorder has been, or can relatively easily be manipulated, altered, or is incorrect. For instance, if it can be shown that flight data 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 or where the length of security keys in old recorder designs is considered to make them vulnerable to interference or hacking, after which IGC files might continue to pass the Validation check.

A2.2.1 This includes cases where security key lengths or other features are significantly below the current requirements for new types of recorders as given in the current IGC FR Specification document, for instance Specification para G2.1.2 on Digital Signature Systems such as RSA and equivalents.

A2.2.2 For other recorders with security keys or other features that are not considered a current or foreseeable future major threat to interference or hacking, the "Grandfather Rights" principle continues to apply in which approval levels are not changed even though the key length or other features for completely new recorder designs has been increased.

A2.3 Dates of Change. The lowering or removal of IGC-approval level will take effect at a date agreed by GFAC and ANDS, and notified to 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 FR manufacturer is notified.

A2.4 Other factors. If the approval level is to be lowered or removed for reasons other than those above, the date of implementation will be decided by GFAC and the ANDS Committee, and the Bureau will be notified.

A3 Appeal against lowering or removal of IGC-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 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 being notified of the change of Approval level, 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 by email should 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, ANDS and GFAC 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 ANDS, GFAC, and the IGC Bureau, can assess it and consider whether the decision should be changed. Where technical evidence is submitted, this will be assessed by the ANDS and GFA Committees, their advisors and other experts that may be nominated.

A3.4 Decision on the Appeal. The IGC Bureau will confirm or modify the decision that was recommended by the ANDS and GFAC Committees. This 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.

APPENDIX B –
VALIDATING LEGACY SECURE FLIGHT RECORDERS WITHOUT IGC DLLs

B1 Target Audience.

This Appendix is intended for Official Observers reviewing Performance Claims by Legacy Flight Recorders where no IGC-Compliant DLL has been provided by the Manufacturer. Downloading of Flight Recorders is the Pilot's responsibility and is outside the scope of this appendix.

B2 The Problem.

The older DOS programs provided by manufacturers are 16-bit programs, which will not run on modern 64-bit PC Operating Systems which are now becoming the norm. This problem does not affect 32-bit Operating Systems.

B3 The Solution.

There is in fact more than one solution, but this is a solution that should resolve the problem in all cases.
It is recommended by GFAC to validate claims in the DOS environment provided by DOSBOX, an X86 emulator. DOSBOX can be downloaded from https://www.dosbox.com/ where you will also find Tutorials and a Manual. The installation is very simple and does not need further explanation here.

B4 The Application.

Having Installed DOSBOX, there is a configuration file:
C:\Users*myusername*\AppData\Local\DOSBox\dosbox-0.74-2.conf
There is should be no need to alter the configuration, but you may find it useful to add actions to be taken every time the environment is created in the [autoexec] section. For instance, you may find it useful to put all the DOS programs into a single folder and then edit the config file [autoexec] section as follows:

```
[autoexec]
# Lines in this section will be run at startup.
# You can put your MOUNT lines here.:
mount C: C:\Users\myusername\Documents\myfolder
mount D: C:\Users\myusername\Documents\LIB
C:
PATH=D:\;Z:\
```

Use a simple text editor for this (such as notepad) and not a Word Processor (such as Word) to edit the Windows file C:\Users*myusername*\AppData\Local\DOSBox\dosbox-0.74-2.conf (or whatever it is called in your version of Windows) do not attempt to edit in DOSBOX.

In the above example, in DOSBOX; **C:** is your working folder and **D:** is your library folder. Note that when a drive is MOUNTed, it is in fact a windows folder. It is bad practice to mount a physical drive. An alternative, simpler approach would be to put programs and data files in the same location.

```
[autoexec]
# Lines in this section will be run at startup.
# You can put your MOUNT lines here.:
mount C: C:\Users\myusername\Documents\myfolder
C:
```

Where *myfolder* contains both.
For more information on the MOUNT command please refer to the manual.
That is all the basics; you are now ready to validate your first claim.

B5 Validating an IGC file.

Proceed as follows:

1. Load DOSBOX.
2. Copy the IGC file to be validated to c:\Users*myusername*\Documents*myfolder*
3. In DOSBOX use the command RESCAN to update the drive contents lists.
   THIS IS MOST IMPORTANT.
4. Use the command VALI-*xxx filename.igc* where *xxx* is the three-letter-code of the manufacturer and *filename.igc* is the name of the file to be validated.

If you need to convert a Flight Recorder binary file (such as *filename*.ZAN) to an IGC file, this can be done in the DOSBOX environment using CONV-xxx instead of VALI-xxx.

B6 Exceptions.

It has been found that it may be necessary to copy VALI-ZAN.EXE from D: to C: for correct operation.
The reason for this is not clear.

B7 Comments.

Any comments should be addressed to gfac@fai.org.

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