FÉDÉRATION AÉRONAUTIQUE INTERNATIONALE

TECHNICAL SPECIFICATION
FOR IGC-APPROVED
GNSS FLIGHT RECORDERS

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AMENDMENT LIST (AL) RECORD

Formal amendments are agreed in accordance with IGC procedures for this document, and are published by FAI via links on the IGC GNSS web page http://www.fai.org/gliding/gnss . The full web reference for the complete version of this document, including amendments, is: http://www.fai.org/gliding/gnss/tech_spec_gnss.asp

Amendments should be proposed to the Chairman of the IGC GNSS Committee and the Chairman of GFAC either directly or through the FAI Secretariat (for the FAI address, see the Preliminary Remarks page after the contents list that follows), preferably in a form of words suitable for direct incorporation in this document. (AL2)

When holders of hard copies of this document have incorporated an amendment in the main text, they should insert a copy of the amendment list instructions after this page, so that at a later date, the subjects of the amendment may easily be identified.

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0	1 Oct 1997	Original issue		
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CONTENTS

APPENDIX 1 - IGC DATA FILE STANDARD

APPENDIX 2 - SAMPLE TEST AND EVALUATION SCHEDULE

APPENDIX 3 - WINDOWS-BASED SHORT PROGRAMS FOR DATA TRANSFER AND CONVERSION TO IGC FORMAT, AND VALIDATION OF DATA

PRELIMINARY REMARKS

1 **Title and Status**. This document contains the rules, procedures, and specifications applying to equipment which is to be IGC-approved for validation of flight performances to FAI/IGC criteria. It is published by FAI through a link on the IGC/GNSS web page http://www.fai.org/gliding/gnss. The full web reference for this document is http://www.fai.org/gliding/gnss/tech_spec_gnss.asp

2 **Target Audience**. This document is intended for FR manufacturers and potential manufacturers, IGC, FAI and NAC officials, GFAC members and their advisors, producers of analysis programs for IGC flight data, and any other organisation or individual interested in the detailed specification of IGC GNSS FRs. Other material concerned with validation of flights to IGC criteria is in the FAI Sporting Code Section 3 (Gliders and Motor Gliders) and its annexes, which are Annex A (SC3A, Championships), Annex B (SC3B, Equipment used for flight validation), and Annex C (SC3C, Official Observer and Pilot Guide). These are all public domain documents available from the FAI/IGC web site http://www.fai.org/gliding (AL3)

3 **Amendments**. Proposals for amendments should be sent to the Chairman of the GNSS subcommittee and to the Chairman of GFAC, preferably in the form of draft wording for direct insertion, with reasons for the proposed changes or additions. Amendments may be issued at any time with the agreement of the IGC GNSS and GFA Committees and with the approval of the IGC President. (AL3)

3.1 FAI Office. If you do not have a communications address for the Chairmen of the IGC GNSS and GFA Committees, initially use the FAI Office:
c/o FAI Secretariat, Fédération Aéronautique Internationale, Avenue Mon Repos 24, 1005 Lausanne, Switzerland
Tel: +41 21 345 1070 Fax: +41 21 345 1077
Email: sec@fai.org Web: http://www.fai.org (AL2)

4 **Nomenclature**. In this document the words "must", "shall", and "may not" indicate mandatory requirements; "should" indicates a recommendation; "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.

GLOSSARY
OF TERMS AND ABBREVIATIONS

This expands the glossaries in the main volume of Section 3 of the Sporting Code (SC3) including its Annexes, and includes more specialised terms concerned with GNSS. See also the Definitions listed in para 5.0 of Appendix 1 to this document (IGC file structure), and the list of Three-Letter Codes (TLC) given in para 7.0 of Appendix 1 and to be used in the IGC data file.

Numerical

2D Position - A navigational position in terms of plan (horizontal) position (ie lat/long). In GNSS systems, at least three position lines (ie correct data from three satellites) are needed for a 2D fix.

3D Position - A navigational position in terms of plan position and altitude. In GNSS systems, at least four position lines (ie correct data from four satellites) are needed for a 3D fix. The geometry of the lines-of-position between the satellites and the surface of the earth is such that errors in recorded GPS altitude are between 1.8 and 2.2 times those in latitude and longitude. In addition, probably because of less-than-ideal installations in gliders, significant short-term additional inaccuracies in GPS altitudes have been recorded in IGC files, including GPS altitude unlocks and short-term occasionally major variations compared to pressure altitude. Source: GFAC report to IGC in 2001, posted on the fai.org/gliding web site. (AL6)

4D Position - A navigational position in terms of plan position, altitude, and time. Since highly accurate time is an integral part of the principle of operation of a GNSS system, it is automatically available with every GNSS fix.

Alphabetical

ACIAS - availability, continuity, integrity, accuracy, and security , for instance of stored data

Analysis - Study of flight data with a view to authentication and verification of a flight.

API - Application Programming Interface. A set of functions that an application can call to tell the operating system to perform a task. (AL4)

ARINC - Aeronautical Radio Incorporated, the company which the US FAA uses to develop and publish numbered standards, eg ARINC 510 for avionic interfaces with simulators. Many avionic standards use ARINC protocols.

Authentication - see under Validation. (AL6)

CEP - Circular Error Probable, or Circular Error of Probability, normally to a 50% level of probability unless stated otherwise.

Constellation - The group of satellites used to determine the GNSS fix. This may be used to verify the validity of the recorded flight data. It is recorded on the IGC file in the form of the F Record (details, Appendix 1).

CRLF - `Carriage Return' followed by a `Line Feed'. These two characters, represented by the hex numbers 0D and 0A, are usually used to denote the end of a record (category of data) in the IGC file.

Data Analyst - A person knowledgeable in analysis of electronic flight data and authorized by an NAC to carry out analysis on their behalf.

Datum - The GNSS Geodetic Datum (qv). The Sporting Code for gliding states that the WGS 84 Geodetic Datum shall be used for all lat/long co-ordinates that are recorded and transferred from the FR after flight.

Digital Signature (DS) - see under Security.

DLL - Dynamic-Link Library. In Microsoft Windows, a DLL is a small program containing functions that other programs or resources can call or use. Outside MS Windows, DLLs are used in areas such as Distributed Interactive Simulation (DIS) links and other processing. (AL4)

DOP - Dilution of Precision - The reduction of precision in a GNSS fix due to the geometry of the constellation of satellites used for the fix. Computed by a GNSS receiver for each fix, see also EPE. DOP can be estimated in various ways, including, HDOP (Horizontal position), GDOP (Geometric), PDOP (Position, overall), TDOP (Time) and VDOP (Vertical position). EPE also varies with constellation position. Some definitions from RTCA sources are given below. (AL5)

GDOP - Geometric Dilution of Position - The ratio of position error of a multilateration system (see definition of Multilateration). More precisely, it is the ratio of the standard deviation of the position error to the standard deviation of the measurement errors, assuming all measurement errors are statistically independent and have a zero mean and the same standard distribution. GDOP is the measure of the quality (sometimes, "goodness") of the geometry of the multilateration sources as seen by the observer; a low GDOP is desirable, a high GDOP undesirable. (See also PDOP, HDOP and VDOP.)

HDOP - Horizontal Dilution of Position - The ratio of user-referenced horizontal position error to measurement error of a multilateration system. (See GDOP for a more detailed description.)

PDOP - Position Dilution of Position - The ratio of user-referenced three-dimensional position error to measurement error of a multilateration system. PDOP is the root-sum-square of HDOP and VDOP.

VDOP - Vertical Dilution of Position - The ratio of user-referenced vertical position error to meassurement error of a multilateration system (see GDOP for a more detailed description).

Download - Not generally used in this document because of possible ambiguity. Some manufacturers use the term in the sense of "downloading data from the FR into a PC", but others use "upload" for this process in the sense of "uploading data into a PC from the FR". In this document, the term `transfer' is used instead. Normal usage in avionics is to refer to data being transferred from an aircraft module such as a flight recorder to a PC and unless indicated to the contrary this should be taken as the meaning. (AL6)

DSA - Digital Signature Algorithm. In its specialist meaning, an asymmetric system of Public/Private Key Cryptography (PKC) used in the US National Institute of Standards and Technology Digital Signature Standard (DSS). It is comparable in performance and strength to an RSA (qv) signature with the same key length, and uses a protocol called SHA-1 as the message digest algorithm. Signing a message takes about 1/2 the computation of RSA thus reducing data transfer times from FR to PC, and some computation can be done "on the fly" while the recorder is operating normally. However, DSA takes more computation than RSA to verify a signature, the IGC VALI process taking longer than RSA (but the VALI process is not time-critical, whereas data transfer from FR to PC is). More detail on the implementation of DSA can be found via http://csrc.nist.gov/publications/fips/fips186-2/fips186-2.pdf.
GFAC will give advice as necessary. (AL4)

Ellipsoid - A three-dimensional ellipse, the same as an oblate (flattened) spheroid. The term ellipsoid is preferred compared to spheroid or Geoid (qv) because it is mathematically unambiguous. An ellipsoid is the best simple mathematical model of the overall shape of the Earth and the currently accepted best simple overall earth model, WGS 84, is ellipsoid based, as are other geodetic datums (qv).

EMI - ElectroMagnetic Interference. Interference with the working of equipment (hardware, software or firmware) due to ElectroMagnetic radiation external to the equipment. May be due to Radio Frequency (RF) radiation from radios in the aircraft or glider itself, or from powerful RF sources outside the aircraft such as from radar and other equipment transmitting in the RF bands.

EPE - Estimated Position Error - An estimate by a GNSS receiver of the probability of position error in each fix, taking into account the geometry factors of DOP (qv below) with the addition of factors such as received signal strength. The probability used in the calculation should be stated so that the significance of the size of the resulting shape (frequently a circular error) is known. Probabilities are frequently calculated to a 2-sigma (95.45%) level, implying that there is about a 95% (19 out of 20) chance that the true position is inside the shape concerned. This probability figure applies to a single fix in isolation and is increased by taking into account adjacent fixes and with knowledge of how gliders are flown. The EPE value appears in the IGC file as a three number group in metres through the FXA code. (AL3)

EUROCAE - European Organization for Civil Aviation Equipment. The European counterpart of the US RTCA, see under RTCA. It has fewer members than RTCA but carries out joint projects. National aviation authorities often refer to RTCA/EUROCAE documents. (AL5)

Fix - For IGC flight analysis, a fix is a sample of simultaneous data from GNSS satellites that successfully records the parameters required for assessment. A sample is where the FR is set to record UTC, latitude, longitude, both GNSS and pressure altitude, fix accuracy (EPE/FXA), and any other variable required with each sample and specified by IGC. See 2D, 3D, 4D and the definitions below. A flight log consists of a series of fixes in time order. Fixes are recorded as individual lines in the B record in the IGC file, separated by CRLF. (AL6)

Fix, Spurious - A GNSS fix with a significant error in time or two-dimensional position (Lat/long). Determined by analysing the fix concerned and adjacent fixes; the spurious fix will generally show an anomalous position (a side-step in 2-D position or in altitude, or both) and involve an unlikely groundspeed between it and adjacent correct fixes. It may or may not have a high EPE or DOP (see above). For flight analysis purposes such as proving presence in an Observation Zone, spurious fixes must be rejected. See SC3 Annex C (Pilot and Observer Guide) for examples and diagrams. (AL3)

Fix, Valid. For IGC flight analysis purposes, a valid fix is a fix that successfully records the minimum parameters required for the analysis concerned, and is not assessed as Spurious (see above). For the purpose of assessing presence in an Observation Zone, the geographical position shall be taken as the centre of the co-ordinates of the fix, ignoring any error circles.

FR - Flight Recorder. In IGC terms, a device recording data for the purpose of flight validation to IGC/FAI criteria, such as a GNSS FR. A GNSS FR is a device capable of producing an IGC flight data file, and includes a GNSS receiver, pressure altitude sensor (IGC requirement), and a memory storage device. It may also include other facilities such as those for detecting operation of the Means of Propulsion (MoP) in a Motor Glider, the input of Way Points and flight declarations, etc.

FR Serial Number (S/N) - A unique set of three alphanumeric characters allocated by the manufacturer as means of identification of a individual FR. It is used at the beginning of data transferred from the FR to a computer and appears in the IGC file as part of the A Record. If complete and unambiguous identification is required, the S/N shall be prefixed by the manufacturer's name and the FR model number. (AL5)

GD - Geodetic Datum, see below

Geodetic Datum (GD) - When a mathematical model of the earth's shape is fixed at a particular orientation and position with respect to the Earth, it constitutes a so-called `Geodetic Datum', over which a grid of latitude and longitude (or other geographic reference system) can be constructed. Most Geodetic Datums are based on the shape of an ellipsoid; WGS 84 is an example. Having fixed a geodetic datum, map projection methods are then used to represent the three-dimensional earth model on a two-dimensional map.

Geoid - Sometimes used loosely to mean an earth model. In Geodesy it has a more precise meaning, the shape of a theoretical equipotential surface due to the gravity effect of the earth's mass and terrain, but without external gravity (ie no spin, no tides). In this more precise meaning, a geoid is therefore a smooth but irregular surface over the whole earth, close to sea level. The maximum differences between the WGS84 Geoid and the WGS84 Ellipsoid are +65m at 60N 030W (S of Iceland, geoid above the ellipsoid) and -102m on the equator at 080E (S of India, geoid below the ellipsoid). The variation depends on the gravity effects of mountains, ocean trenches, crustal thickness and density. It is used in the form of an electronic `look-up table' in many GNSS receiver system to indicate an approximate Sea Level datum for GPS altitude readings, but will not correspond exactly with Above Sea Level (ASL) altitudes given on local maps. It was used in the past in the selection of the ellipsoid (qv) that was the `best fit' for the region concerned. See also Ellipsoid and Spheroid.

GFAC - GNSS FR Approval Committee of IGC. See IGC Approvals and also Chapter 1.

GLONASS - The Russian GNSS system, the initials standing for GLObal NAvigation Satellite System. Unlike the US GPS system, GLONASS alters its system time on the date and time of every leap-second and is inoperative while doing so (see under GNSS, GPS, and UTC). Its system time is based on Moscow time rather than UTC.

GNSS - Global Navigation Satellite System. A system for the determination of position, velocity and time, that includes one or more satellite constellations, receivers, and system integrity monitoring, augmented as necessary to support the required navigation performance. It includes the Russian GLONASS, the US GPS, and the projected European Galileo system. It implies the use of equipment that receives signals from the relevant constellation of Navigational Satellites in earth orbit. Such equipment calculates time delays between signals from different satellites and, by knowing the exact position of the satellites and the exact time to great accuracy, together with an assumed mathematical model of the earth's shape (see Ellipsoid and Geodetic Datum) is able to calculate position information on the earth's surface in four dimensions (4-D, see above) through software programs.

GNSS equipment for flight verification - includes the GNSS receiver and associated Flight Recorder (FR) system, including the antenna and all associated hardware such as the processing, data storage, cockpit display and keyboard modules, pressure-altitude sensor (IGC requirement), and the MoP sensor for Motor Gliders. It also includes the associated software and firmware (Such as ROM) both in the glider GNSS equipment and also where used for transferring data into and from the glider equipment from PCs. Software processing using PCs includes the analysis and presentation of flight data, and may also include the preparation of data about gliding sites, turn points, time zones, geodetic datums, pilot information, and so forth; for transfer into the glider GNSS equipment, in accordance with the procedures in this code.

GNSS Altitude - Altitude calculated solely from GNSS position lines. In the IGC format file, GNSS altitude must be referenced to the WGS84 ellipsoid (that is, not a Geoid). Where GNSS altitude is not available from GNSS position-lines (2D fix, altitude drop-out), it shall be recorded in the IGC format file as zero so that the situation can be clearly identified during post-flight analysis. Note that in other GNSS systems, GNSS altitude may be set to show approximate altitudes above local sea level by calculating distance above a Geoid (normally through an electronic look-up table giving geoid heights above and below the selected ellipsoid) rather than distance above the ellipsoid appropriate to the selected Geodetic Datum. (AL3)

GPS - Global Positioning System, the US GNSS administered jointly by the Department of Defense (DoD) and the Department of Transportation (DoT). Signals are normally available from 24 out of 27 satellites in six circular orbital planes at 55 degrees to the equator at an altitude of 20,200km and a period of 12 hours. The control segment of GPS consists of five monitor stations, three ground antennas and a master control station. Receiver-processors (GPS units) provide 3-D position and precise timing to the user.

GPS system time - is the continuous and highly accurate time kept by the GPS satellites. It began as UTC for 6 Jan 1980 when the system first became operational, and maintains that time frame. It does not change with the 'leap seconds' additions that are made to UTC to allow for the slowing down of the Earth's rotation (see under UTC). In year 2003, UTC was 13 seconds later than GPS System Time. However, the GPS system keeps track of leap seconds corrections, and these are sent as part of the satellite's message to users. Most receivers use the GPS satellite message automatically to compensate and output UTC rather than GPS time. In some GPS receivers, stored track records do not take leap seconds into account and output in GPS system time, whereas NMEA data outputs generally include leap seconds and times are corrected to UTC. (AL3)

Grandfather rights. This term is used for a situation where the approval of a type of equipment is continued unaltered although the Specification conditions have changed with time (generally, increased). Detail on its application to IGC-approved GNSS Flight Recorders is in para 1.1.3.3.5. (AL6)

Hard/Soft Data/Storage - Hard data or storage is that which is not lost when the unit concerned is switched off or its battery fails or is removed. Soft data is otherwise.

Horizontal fix accuracy - the best prediction for the horizontal 2-sigma error of the overall position error. Included in the IGC data file in the B (fix) record through the FXA three-letter code. (AL4)

ICAO - International Civil Aviation Organisation with its HQ in Montreal, Canada

IGC Approval - Certain equipment is subject to a special approval process before it can be used in the verification of flight performances to IGC/FAI criteria. GNSS Flight Recorders (FRs) are examples, and the IGC GNSS Flight Recorder Approval (GFA) Committee (GFAC) test and evaluate GNSS FRs and issue approvals on behalf of IGC.

International Standard Atmosphere (ISA) - The ISA to be used for FAI matters is given in ICAO Document 7488 tables 3 and 4. It assumes a temperature and pressure at sea level of 15C and 760 mm of mercury (or 1013.25 mb/hPa). Above sea level, it assumes a constant temperature lapse rate from sea level of 6.5C per 1000 m (1.98C/3.56F per 1000 ft) rise in height, up to an altitude of 11,000 m (-56.5C) . 11,000m is assumed to be the Tropopause, above which constant temperature (-56.5C) is assumed. Pressure figures from this ISA are used in calibration of barographs, because although the real atmosphere varies from day to day, for calibration purposes a set of internationally agreed figures are needed so that all calibrations are to the same datum, whether or not such figures correspond to `true' height on a given day. A similar principle is used in calibrating pressure altimeters for aircraft, so that all aviation activities have a common standard of pressure height indication in the cockpit.

ISA - International Standard Atmosphere

ISO - International Standards Organisation

Latitude - In a GNSS IGC flight data format, this is a seven character numeric group expressed as two figures for the degrees, two figures for the minutes and three figures representing tenths, hundredths and thousandths of minutes followed by the N or S character.

Leap Second - see under UTC

Longitude - In a GNSS IGC flight data format, this is an eight character numeric group expressed as three figures for the degrees, two figures for the minutes and three figures representing tenths, hundredths and thousandths of minutes followed by the E or W character.

MoP - Means of Propulsion, for Motor Gliders. A MoP Recorder is a recorder used in motor gliders which is capable of producing an after-flight record of operation of the Means of Propulsion (MoP) against a timebase for the flight. The timebase may be that of a barograph or of a GNSS FR. It must be shown that the sensor and its method of operation is such that a record will always be made when the MoP is operated so as to provide a forward thrust force, irrespective of pilot actions in the cockpit.

> MoP Inoperative - The MoP is not in a position to generate propulsion, such as when a pylon-mounted engine or propeller is stowed in the fuselage and physically cannot generate propulsion in this position, or a propeller can be shown to be feathered. In the case of the Stemme (patent) retractable propeller, that the nose-cone into which the propeller retracts, is closed.
>
> MoP Operative - The MoP is in a position to generate propulsion, but is not necessarily generating forward thrust. In most aircraft this indicates that the MoP pylon is extended, or that the engine doors are opened, or that the prop is unfeathered, or, in the case of the Stemme (patent) retractable propeller, that the nose-cone into which the propeller retracts, is opened.
>
> MoP On - The MoP starts to or is generating forward thrust. Generally by showing in some way that the propeller has started rotating, or that a jet engine has begun giving thrust.
>
> MoP Stop - The MoP stops generating forward thrust. Generally by showing in some way that the propeller has stopped rotating, or that a jet engine has ceased giving thrust.

Multilateration - literally, having many sides, the shape of such a geometric figure. Therefore, in navigation systems, the obtaining of a fix from multiple lines of position which, if plotted out, would form a multi-sided figure (sometimes called a "cocked hat" by navigators). (AL5)

NMEA - National Marine Electronics Association. NMEA is an international body with its HQ in North Carolina, USAand publishes data standards for interfacing marine electronic devices. As GNSS was developed for the marine as well as the aviation market, most GNSS manufacturers use NMEA standards to interface GNSS to peripheral devices. NMEA data is divided into groups called "sentences" identified by three-letter codes, the details being given in documents such as NMEA 0813. For instance the sentence GGA gives GPS fix data, GNS gives fix data for all GNSS systems (US GPS, Russian GLONASS, European Galileo and any other systems), GSA gives the satellites in view at any one time. Some GNSS receiver boards output NMEA data directly and others use manufacturer's binary or other output formats. In the latter case, where NMEA data is mentioned in this document the FR manufacturer must show that equivalent data that is acceptable to GFAC is recorded on the IGC data file. (AL4)

OZ - Observation Zone. A volume of airspace within which a valid GNSS fix (or a photo) is required to validate an IGC event such as start, reaching a turn point, and finish of a flight performance. The Sporting Code for gliding defines the shape of such OZ, that for a turn point being a 90 degree area, the bisector of which is opposite the bisector of the two legs making up a turn point, or opposite to the first course leg for a start, and the last course leg for a finish. Start and finish lines are also permitted as well as the 90 degree angle.

PGP - Pretty Good Privacy. A commercial system for electronic security that uses RSA asymmetric keys, first publicised by Philip R Zimmerman in June 1991 through a public Internet bulletin board. The US authorities initially tried to prosecute Zimmerman for a security breach, but after 3 years gave up the attempt. See http://www.pgp.com . The rights of Zimmerman's company PGP, Inc., were later sold to Network Associates, http://www.nai.com . It has been estimated that over 500 million copies of PGP are in use worldwide, and the `padlock' symbol on a PC screen normally indicates that the PGP system is available. (AL4)

Pilot Event (PEV Code) - The pilot records an event in time and space, generally by pressing an `event button' that takes an additional GNSS fix and marks the time as a pilot-recorded event. It has no significance in the flight verification process for IGC flight performances but may be required in competitions (such as to identify a start), and be useful to the pilot as a reminder of what happened at that time. May also be used to start a sequence of fixes at short time intervals (fast-fix facility).

PKC - Public/private Key Cryptography. A system where the recipient of a message has an encryption system that is not secret (the Public Key) and is used by people sending messages to him. However, the mathematical factors that make up the Public Key are only held by the recipient (the Private Key), and are needed before the message can be de-coded. The PKC principle was discovered in May 1975 by Whitfield Diffie, Martin Helman and Ralph Merkle (DHM) of the Electrical Engineering Department of Stanford University, USA, and previously in 1973 by James Ellis and Clifford Cocks of the classified Government Communications HQ organisation in the UK. The first commonly available practical application of PKC was the RSA system (qv). (AL4)

Pressure Altitude - In a GNSS FR, this is a five numeric group indicating the pressure altitude in metres with respect the International Standard Atmosphere (ISA) used in aviation, to a sea level datum of 1013.25 HPa. The pressure recorded in the *.IGC file may either be "cockpit static" (vented within the FR box), or use a tube connection to the pressure from glider instrument system static tubing. If the pressure altitude signal within the FR is used for other purposes such as cockpit instrument readings which can be set to other datums such as QNH or QFE, a one-way transmission system must be used from the sensor so that the IGC file always records the required ISA to the 1013 sea level datum irrespective of other settings used for flight instruments. The permitted use of instrument-static is intended for a GNSS FR mounted in the instrument panel. With such an installation, an OO as part of the inspection of the FR installation must check the tubing and the pressure connection to the FR to ensure that they will be out-of-reach of the aircrew in flight. This is to prevent alteration to the IGC-file pressure altitude record by any method. (AL4)

Proof Drive or Flight - A method of checking that a Flight Recorder produces a correct IGC flight data file. Under the strict control of an OO or other official, the GNSS/FR is taken on a drive 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 appropriate altitude data from the FR, and a proof flight can check not only altitude data but other records such as of the means-of-propulsion in a motor glider. A proof drive including an identifiable 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

Pseudorange - a measure of the apparent propagation time from the satellite to the receiver antenna, expressed as a distance. The distance from the user to a ranging source (for instance a satellite) plus an unknown user clock offset distance. With four ranging source signals it is possible to compute position and offset distance. If the user clock offset is known, three ranging source signals would suffice to compute a position. (AL5)

RAIM - Receiver Autonomous Integrity Monitoring - A technique whereby a civil GNSS receiver/processor determines the integrity of the GNSS navigation signals without reference to sensors or non-military integrity systems other than the receiver itself. This is achieved by a consistency check among redundant pseudo-range measurements (pseudo-range is the distance from the user to a satellite plus an unknown user clock offset distance). With four satellite signals it is possible to compute position and offset distance, and if the user clock offset is known, three satellite signals suffice to compute a position. RAIM works by automatically comparing the position line obtained from each GNSS satellite with other position lines obtained from the constellation of satellites being received at any one time. Any anomalous (`rogue') position lines are then discarded for the purpose of calculating the 3-D fix for the time concerned. A numeric code is used which indicates 0 if RAIM is satisfied and 5 when not. In theory, RAIM calculations based on four position lines (three good ones and the `rogue') but in practical terms, 6 satellites are normally needed. See also WAAS.

RSA - A system of Public/Private Key Cryptography (PKC), developed by Ronald Rivest, Adi Shamir and Leonard Adelman of MIT, employing an asymmetric system for key exchange. First published in an article in Scientific American in August 1977, and the company RSA Security Inc was formed to apply it commercially. More detail on the implementation of RSA can be found in the book "Applied Cryptography" by Bruce Schneier, 2nd edition, ISBN 0-471-11709-9. An overview of various cryptographic algorithms can be found in http://www.ssh.fi/tech/crypto/algorithms.html. High Speed RSA Implementation (PDF file) is in: ftp://ftp.rsasecurity.com/pub/pdfs/tr201.pdf. Details of the FIPS 180 Secure Hash Standard are in http://www.itl.nist.gov/fipspubs/fip180-1.htm. Cryptographic libraries with source code in C and C++ are in: http://www.cs.auckland.ac.nz/~pgut001/cryptlib and http://www.eskimo.com/~weidai/cryptlib.html. GFAC will give advice as necessary. (AL4)

RTCA Inc - a US not-for-profit corporation concerned with aviation and aviation electronic systems. It functions as a US Federal Advisory Committee and develops recommendations on aviation issues based on consensus. Nearly 300 organizations are members, about one-quarter being non-US, one of which is FAI. The initials RTCA originally stood for Radio Technical Commission for Aeronautics, a previous government body which was discontinued. The initials RTCA no longer have a longer official form, but these words appear on the bottom of its letter pages in italics: Requirements, Technology and Concepts for Aviation. (AL5)

Security - Digital Signature (DS) - A Digital Signature (DS) is a set of encrypted data generated by an FR and transferred form the FR with the flight data. Mathematically, the DS corresponds with (matches) the flight data in such a way that any subsequent alteration of any part of the flight data destroys the correspondence (the data match) and so the alteration is detectable. See Chapter 2 para 2.8.3.

Soft/Hard Data - See under Hard Data.

Spheroid - A three-dimensional oblate (flattened) sphere in the form of a three dimensional ellipse (an ellipsoid). The term ellipsoid is preferred to spheroid because it is mathematically unambiguous, whereas `flattening' of a sphere could imply shapes other than an ellipse.

Spurious Fix - see under Fix

Start - The beginning of a task, ie the point from which measurement of the flight performance commences. Usually crossing a start line or exiting a Start Point Observation Zone.

Total Energy Altitude (TEAlt) - The combination of the gliders potential and kinetic energy expressed as a hypothetical `zero-energy' altitude, expressed in metres. eg TAS 300 kph (162 knots) gives a height increment of 354 m (1160 ft) for the purpose of calculating TEAlt, 250 kph (155 knots) gives an altitude increment of 245.5 m (805 ft); 200 kph (124 knots) an increment of 157.6 m (517 ft); 150 kph (81 knots) an increment of 88.4 m (290 ft), and 100 kph (62 knots) an increment of 39.32 m (129 ft).

Track - The true track (continuous sequence of actual 2D positions) on the ground over the over which the aircraft has flown.

Turn or Way Point Confirmation- The indication that the glider has reached the TP/WP to the criteria laid down in the IGC sporting code, for instance by demonstrating presence in the OZ by the use of photography or a GNSS FR. In Sporting Code terminology this is "reaching" the turn point. There is no obligation to actually fly round the point itself.

Upload - Not used in this document because of possible ambiguity. `Transfer' used instead, see under Download.

UTC - Universal Time Co-ordinated. Used to be called Greenwich Mean Time (GMT) and is virtually the same as GMT other than for astronomical purposes. A so-called `leap second' is added at midnight on agreed dates such as 30 Jun or 31 Dec and is used to change UTC by a whole second at a time, to allow for the slowing down of the Earth's rotation. The period between the addition of the next leap second varies between one and two years, and is agreed internationally. Between 1980 and 2003, 13 leap-seconds were added. The IGC data file requirement (Appendix 1) requires times in data files to be in UTC. See also GLONASS, GNSS and GPS. (AL3)

Validation, VALI check. For GNSS FR data, the process of determining that electronic flight data has the integrity to be used in the overall flight validation process. Electronic flight data is validated by using the appropriate VALI-XXX.EXE program (XXX = manufacturer identification letters) or its MS Windows equivalent (see Appendix 3). This program checks the Digital Signature that is part of the IGC-format file that was transferred from the FR, indicates that data has originated correctly from the FR, and that the data in the IGC file is the same as that initially transferred from the FR. The VALI programs for all IGC-approved recorders are available on the IGC/GNSS web pages. (AL6)

Vertical fix accuracy - the best prediction for the vertical 2-sigma component of the overall position error. When included in the IGC data file, through the VXA three-letter code. (AL4)

WAAS - Wide-Area Augmentation System. A system made up of an integrity and reference monitoring network, processing facilities, geostationary satellites, and control facilities. Wide area reference stations and integrity monitors are widely dispersed data collection sites that contain GPS/WAAS ranging receivers which monitor all signals from the GPS, as well as the WAAS geostationary satellites. The reference stations collect measurements from the GPS and WAAS satellites so that differential corrections, ionospheric delay information, GPS/WAAS accuracy, WAAS network time, GPS time and UTC time can be determined. The monitored data are forwarded to the central data processing sites for determination of the correction and other data as well as verifying residual error bounds for each satellite. These sites also generate navigation messages for the geostationary satellites and WAAS messages. This information is modulated on the GPS-like signal and broadcast to users from geostationary satellites. See also RAIM.

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 coordinates not represented by any specific earth feature. A waypoint may be a start point, a turn point, or a finish point and has an associated observation zone (Sporting Code Section 3, definitions, para 1.1.2). It may also be used as a reference point for defining an area that is to be reached as part of a task. The area concerned is within the clockwise angle between two true bearings from the point and a minimum and maximum distance from the WP. (Based on Sporting Code Section 3 Annex A para 19, Assigned Area tasks). (AL6)

WGS 84 - World Geodetic System 1984. A co-ordinate system based on a mathematical model of the earth and including many variables such as gravity constants and coefficients, formulas for the Earth's angular velocity, a WGS84 ellipsoid and a WGS84 geoid, (equipotential surface approximating to local sea levels) with associated constants, conversion factors and co-ordinate systems. For the purpose of GNSS, the ellipsoid model is important, and is the currently accepted best overall simple mathematical model for the earth's shape and upon which all IGC GNSS fixes and calculations are initially based. Fix position and distance calculations can then be transformed to any of over 200 other ellipsoids (local Geodetic Datums). Some similar systems to WGS84 include the International Terrain Reference Frame (ITRF, eg ITRF96) but lat/long differences between these systems are generally less than 1m with respect to WGS84.

WGS84 Ellipsoid. The ellipsoid radii for WGS 84 are as follows:
Major Axis (the Equator), radius = 6378.1370 km
Minor axis (Polar), radius = 6356.7523 km (flattening 21.3847 km)
Orientation The minor axis is between the Earth's centre of mass and the Terrestrial Pole as defined by the Bureau Internationale de l'Heure (BIH). In approximate terms, this is the Earth's spin axis.

WGS84 Geoid. The maximum differences between the WGS84 Geoid and the WGS84 Ellipsoid are +65m at 60N 030W (S of Iceland, geoid above the ellipsoid) and -102m on the equator at 080E (S of India, geoid below the ellipsoid). A table of WGS84 Geoid heights with respect to the WGS84 Ellipsoid is available in MS Excel format from FAI (via the GFAC Chairman). See also under Geoid in this Glossary.

CHAPTER 1

GNSS FLIGHT RECORDERS
IGC-APPROVAL AND OTHER PROCEDURES

This Chapter is based on Chapter 1 of Annex B
to the FAI Sporting Code Section 3 (Gliders and Motor Gliders)

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

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

1.1.2 **Operating Procedures for a Flight Recorder Type**. Operating procedures for each type of Flight Recorder will be specified in the IGC-approval document by GFAC, with the objective of making procedures on the day of flight as simple as possible. This is particularly important before flight when the time available for carrying out extra independent checks may be short. Also, after flight it must be quick and easy to transfer the flight data to a PC in the IGC flight data format. However, GFAC must specify procedures which minimise the possibility that either one Flight Recorder could be substituted in the glider concerned by another one, or that the Flight Recorder in the glider could be interfered with without this being detected. Particularly with small portable Flight Recorders, this may require either continuous observation of the glider before takeoff and/or after landing, or the physical sealing of the Flight Recorder unit to the glider by an OO at any time or date beforehand. This will avoid the need for extra OO observation of the installation before takeoff. Such a seal must be applied and marked in a manner such that there is incontrovertible proof after the flight that it has not been compromised, such as by marking it with the glider registration, the date, time and OO's name, signature, or OO identification number. Other procedures specific to the type of Flight Recorder concerned may be required, such as stowage of certain modules out of reach of the flight crew, or limitations on the types of flight for which the recorder may be used. Such procedures and limitations will be an integral part of the IGC-approval document for the type of equipment concerned, and will depend on the Flight Recorder design and the results of the evaluation process. (Amplification of annex C para 1.7)

1.1.3 **IGC-Approval Documents for Specific Types of Flight Recorder**. The IGC-approval document for each Flight Recorder type is produced by GFAC on behalf of IGC. Before the approval document is finalised, it is circulated several times in successive drafts to GFAC members, other technical experts and consultants, and the manufacturer concerned. When finally issued, the IGC-approval document gives the detailed procedures under which equipment must be checked, installed in the glider, and operated. This document is definitive in terms of how the type of Flight Recorder is to be operated for flights that are to be validated and certificated to FAI/IGC criteria.

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

1.1.3.2 Document kept with the Flight Recorder. It is recommended that a copy of the approval document including its two annexes is kept with each unit of the equipment, so that it can be consulted by pilots and OOs as required. For the latest version of any IGC-approval document, see the complete list through the web page given in para 4 of the Preliminary Remarks.

1.1.3.3 Levels of IGC-approval. (Expanding the general policy given in SC3 para 4.6.4) The IGC-approval document for individual types of Flight Recorders will specify procedures to be used and any limitations on types of flights for which the approval is valid. Reduced levels of approval apply to types of Flight Recorders that do not meet the requirements for full approval at the time that the approval is given. They also apply in cases where the security of a type of recorder has either been compromised or is below the requirements of the current Specification, or where other features do not meet the current Specification. The following levels of IGC-approval apply: (1.1.3.3 and its sub paras, AL6)

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

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

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

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

1.1.3.3.5 Grandfather rights and approval levels. The term "Grandfather Rights" is used for a situation where the conditions of an original IGC-approval are continued with time even though the provisions of the IGC Specification or Sporting Code have changed. That is, the recorder would be subject to additional limitations or would not be approved for particular types of flight performances if it were submitted for IGC approval as a new model. Continuity of the original approval is so that owners and manufacturers are not constantly required to carry out updates as the Specification of Sporting Code changes with time, unless a major anomaly is found to exist in the type of recorder. A similar policy is adopted in civil aviation by the FAA and JAA with regard to already-certificated designs. Where GFAC proposes to reduce the approval level of an existing type of IGC-approved recorder, as much notice as possible will be given to the manufacturer so that he can inform owners and offer upgrades where possible that will retain the existing approval level. The notice will be at least one calendar year unless an urgent security problem can be shown to exist which could lead to false or corrupt flight data being submitted in a claim.

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

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

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

1.1.6 **Antenna Positioning**. If the GNSS antenna is accessible to the crew in flight, no attempt must be made to inject data; any abuse of this may lead to a future requirement to place the antenna out of reach of the flight crew.

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

1.1.8 **Security of the Flight Recorder module**. For IGC-approval, the Flight Recorder module must be protected by both physical and electronic security mechanisms, the detail of which is given in the Technical Specification for IGC-approved GNSS Flight Recorders. A manufacturer's seal must be fitted in such a way that it will be broken if the case is opened. Also, a system must be incorporated that trashes the internal electronic security system if the recorder case is opened or otherwise becomes insecure. Flights made after any such event must continue to produce IGC-format data files, but such files must be clearly marked as insecure. These files must also fail the electronic VALIDATE check that is available through free software from the gliding/gnss web pages. Re-set of a recorder to a secure state must only be through the manufacturer or his authorised agent and the knowledge of the details of any re-set procedure must be restricted to the minimum number of people. (AL6)

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

1.1.9.1 OO inspection and/or sealing to the glider. If an OO is not present to witness takeoff or landing and to check the Flight Recorder installation immediately before and after these times, the Flight Recorder unit must be sealed to the glider structure by an OO. This may be carried out at any time or date before flight as long as the sealing is timed, dated and with the OO's identification clearly marked so that the OO can identify it later if necessary.

1.1.9.2 Check of takeoff and landing details, independent of the Flight Recorder data. The time and point of takeoff, and later of landing, shall be recorded either by an OO, other reliable witnesses, or by other means such as an Air Traffic Control or official Club log of takeoffs and landings. This shall be compared to the Flight Recorder takeoff and landing data (SC3 para 11.3). This is intended as a simple but effective independent check of the integrity of these aspects of the Flight Recorder data. Following this, the rest of the data may be accepted as valid evidence for the claim, subject to lack of anomalies, compatibility with the known conditions for the flight (wind, soaring conditions, direct observation by witnesses, etc.) and passing the electronic VALIDATE check on the IGC file that shows that the data has correctly originated from the individual Flight Recorder and has not subsequently been altered.

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

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

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

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

1.3.1 **Correspondence with GFAC**. Manufacturers must correspond with GFAC through its chairman who will inform other members as necessary and co-ordinate any responses to the manufacturer. In cases where specialist matters are being discussed, the Chairman may authorise direct correspondence with an appropriate GFAC advisor, but the Chairman must be copied with all correspondence.

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

1.3.2.1. IGC-format data files. As soon as IGC-format files are available from early Flight Recorder hardware, send copies to the GFAC chairman so that the exact format can be checked for compliance with the IGC standard.

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

1.3.2.3. Fee to FAI. When hardware is sent, the Flight Recorder manufacturer should apply to FAI on the forms provided and pay the appropriate fee. Detail, para 1.3.5.

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

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

1.3.4 **Documentation**. Each applicant shall provide information to GFAC on how their model of Flight Recorder is intended to meet the IGC Specification.

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

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

1.3.5 **Fees**. The appropriate fee should be deposited in FAI's IGC account by the applicant when hardware is first sent to the GFAC Chairman for evaluation. If payment is delayed, IGC approval will not be given until the appropriate fee is received and all expenses attributable to the manufacturer have been paid to FAI. The fee is adjusted by IGC from time to time and details are available from the Chairmen of the IGC GNSS and GFA Committees. At the time of writing (year 2002) the fee is 1500 Swiss Francs (ChF) for an application for a new type of GNSS Flight Flight Recorder. The fee is the same or less for changes or modifications to an existing IGC-approved design, depending on the complexity of the required evaluation as determined by GFAC. The precise method of deposit will be given on the application form available from the GFAC Chairman.

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

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

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

1.5.1 **Conditional Approval.** Conditional approval means that some changes are needed before approval can be given to the appropriate level when the factors which led to the conditional approval have been changed (see 1.1.3.3 for levels). However, wherever possible an IGC-approval document will be issued which will include appropriate limitations until changes are made and the limitations can be removed. *An example might be where a motor glider Means-of-Propulsion (MoP) sensor system either was not included, or was assessed by GFAC as not being adequate. In this case an IGC-approval might be issued without including the MoP sensor system, pending the development of a system which satisfies the IGC Specification, which would then be added to the Approval by amendment.*

1.5.2 **Requirement for Modifications**. If it is decided that IGC-approval cannot be given to the appropriate level without modifications being made (see 1.1.3.3 for levels), GFAC will supply the manufacturer with details of what is required in order to gain IGC-approval in the future. If the manufacturer notifies GFAC within 21 days that he wishes the approval process to continue, he will be expected to resubmit a modified Flight Recorder for further review by GFAC within the next 180 days. GFAC will aim to complete this review within 60 days, subject to not encountering any unforeseen difficulties. *If this procedure is followed, no extra fee will be payable but the initial fee will continue to be held.*

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

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

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

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

1.7 **Use of Flight Recorders within Nations**. A GNSS Flight Recorder operated in accordance with its IGC-approval document shall be used for all flights that require validation to FAI/IGC criteria including World Records (SC3, 3.0.3), and World Championships (SC3 Annex A). It shall also be used for evidence for FAI/IGC Badge Flights unless photographic evidence or direct observation is used (SC3, 3.0.3, 4.3, 4.6.2f). It may also be used by NACs, at their discretion, for other flights where FAI/IGC validation criteria are specified by the NAC. For the different levels of IGC-approval, see para 1.1.3.3. Where flight validation is not required to FAI/IGC criteria, the choice of criteria is at the discretion of those responsible for validating the flight.

1.8 **Notification and Issue of IGC-approval Documents and Free Programs**. Notification of issue of a new or amended IGC-approval document will be posted on the Internet newsgroup rec.aviation.soaring (r.a.s.) and also on the FAI IGC email mailing list. The complete IGC-approval document will be posted on the web site http://www.fai.org/gliding/gnss. In addition the associated short programs for transferring IGC files to a PC from the Flight Recorder, and for validating the integrity of such files, will also be posted for free access.

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

CHAPTER 2

EQUIPMENT REQUIREMENTS FOR GNSS FLIGHT RECORDERS

2.1 INTRODUCTION

2.1.1 **IGC Responsibility**. Where GNSS equipment is used for primary evidence of Flight Performance Verification, IGC has a duty to ensure that checks and balances and design requirements are used to preserve the integrity of evidence, such as by taking appropriate action to prevent anomalies or cheating, and also to ensure the use of common data formats wherever possible.

2.1.2 **Role of the IGC GNSS FR Approval Committee (GFAC)**. The GFAC will evaluate GNSS FR equipment on behalf of IGC in accordance with procedures given in Chapter 1 of Annex B to the Sporting Code for Gliding, which is the basis of Chapter 1 of this document.

2.1.2.1 **Requirements which will be closely evaluated** - include appropriate levels of simplicity for pilots, OOs and others; reliability; security of data; the minimisation of anomalies and the elimination of opportunities for cheating; and compliance with standards for the IGC data file and other common IGC file requirements.

2.1.3. **Changes in rules or procedures**. Where changes in rules or procedures are made which affect GNSS FRs, the following timescale applies for the incorporation of such changes in all of a given type of FR, taken from the date of first notification of the change to the FR manufacturer. The date of submission is taken as the date of receipt of the appropriate fee by FAI or the date of receipt of all equipment required for testing by the individuals notified to the manufacturer by the GFAC Chairman who are to receive the hardware (see 1.3.3.1), whichever date is the later. (AL4)

2.1.3.1 FRs not yet submitted to GFAC or FRs under formal evaluation for IGC approval. A change must be incorporated before IGC-approval is given, or within 6 months of notification of the change if this is a later date.

2.1.3.2. FRs already having IGC approval. Changes involving internal alterations to FR units will not normally be required, except for units returned to the manufacturers or agents for other reasons (such as firmware or hardware updates), when changes can be incorporated at the same time. A software change outside the FR unit itself shall be made available within six months of the notification of the change to the manufacturer. See 1.1.3.3.5 on Grandfather Rights.

2.1.3.3 Exceptions. Where a manufacturer makes a case for a different procedure to the above, this may be agreed by GFAC. Conversely GFAC may believe that a change must be made notwithstanding the above. If in doubt, the President of IGC will arbitrate.

2.2 **FUNCTIONAL REQUIREMENTS**. The following is a list of functions expected to be available or to be calculated from flight data from the FR hardware: Takeoff point/time/altitude, Start point/time/altitude, flight continuity, flight path, reaching declared or other turn points, finish point/time/altitude, distance flown, speed, landing point/time/altitude, and any national requirements such as non-violation of airspace or other altitude restrictions.

2.3 **GENERAL REQUIREMENTS**. Record data during flight in latitude, longitude, altitude and time in such a manner that flight continuity and the flight path are shown; transfer recorded data after flight to a computer for further processing, analysis and flight verification; have a unique FR serial number nominated by the manufacturer and un-modifiable by the user.

2.4 **REQUIREMENTS FOR DATA RECORDING**. Continuous recording in accordance with the Sporting Code for Gliding including its annexes (these give fix time interval settings such as a maximum setting of 60 seconds for establishing flight continuity and recommend settings of 4, 2 or 1 sec when near to Observation Zones); setting of fix-recording frequency (constant or variable time between fixes); a receiver capable of processing data from at least 12 satellites at one time; initialisation and/or reset of data storage; GNSS clock time recording with correction to and output as UTC (i.e. applying the leap-second correction); position lat/long recording to the WGS 84 Geodetic datum; GNSS-calculated altitude recording; pressure altitude recording with or without GNSS recording, with continuous time clock function (para 2.6.6.1.1); fix validity recording; error circle recording; recording of IDs of satellites used in position determination; pilot-activated event input (PEV code); retention of recorded data until officially transferred for analysis by the NAC; retention of data validity as battery voltage falls (until final failure causes recording to cease, but previously recorded data must not be lost, see Appendix 1 para 7 for use of the Three Letter Code LOV for low voltage); and recording any other parameter defined as mandatory in the IGC data file standard given in Appendix 1. (AL6)

2.4.1 Creation of IGC data file. After switching on the FR, the subsequent commencement, cessation and rate of recording fixes for transfer after flight may be by automatic or pre-set means; subject to providing a sufficient baseline of valid fixes on the ground both before and after flight in order to establish takeoff and landing altitudes as well as the exact positions and times of takeoff and landing, and satisfying the requirements for demonstration of flight continuity. For baselines and other details, see Appendix 1 para 1.1.1. (AL3)

2.4.2. Standard of signals. Receivers must be able to determine whether ranging signals are marked unhealthy or not, so that the receivers only use ranging signals in the navigation solution which are not marked unhealthy. If in doubt refer to GFAC before the design is fixed (AL3).

2.4.3 Desirable Features: Output-only port for remote in-flight data display with turn point and other information; recording interval variation either automatic near turn points or through fast fix button; automatic activation of recording when movement detected (see Appendix 1 para 1.1.1.1 for movement thresholds and baselines before takeoff and after landing); flight declaration with date/time of entering (see Appendix 1 para 4.2, the C-record); preservation of flight data in situations of impact, damage or crash; low power consumption. (AL6)

2.4.4 Fix Interval (Sampling Rate) Settings. The Sporting Code for gliders states that for a flight to be validated to IGC rules, the setting for fix interval (sampling rate) must not be greater than one minute. This maximum interval could apply to cruising flight between waypoints in the case of recorders that have settings for variable fix intervals including the facility for fast fix rates near Observation Zones (OZ). However, for recorders with a fixed setting for fix interval, one minute is too long because in a short transit of an OZ fixes might not be recorded in the OZ. Also, a short fix interval is required for barograph calibrations (see 2.4.4.2). Manufacturers are encouraged to provide variable fix intervals that allow for cruising flight and short fix intervals for flight near and in Observation Zones and for pressure altitude calibrations. Requirements are as follows: (para 2.4.4 new with AL6)

2.4.4.1 Recorders with variable fix interval settings. The fast-fix setting for use near or within Observation Zones shall include settings for 5 seconds or less, 1 or 2 seconds being preferred. The fast-fix system must be activated after a pilot event (PEV) mark and may also be initiated automatically on detecting a particular range from a OZ or Waypoint. The cruise fix setting for use between waypoints shall not be greater than 60 seconds and shall allow for choice of intermediate settings such as 10 and 20 seconds. It should be noted that in thermalling flight, fix intervals of over 30 seconds may not record the turns clearly whereas with 20 seconds or less, turns can be identified during after-flight analysis.

2.4.4.2 Recorders with fixed fix intervals. The maximum fix interval for flight shall be 10 seconds and for calibration of the pressure altitude sensor, 5 seconds. Preferred settings are 5 seconds for flight and 2 seconds for calibration. The calibration setting may be obtained through a special calibration mode which must be capable of being set before the recorder is taken to the calibration laboratory and must continue without additional switching until the calibration is complete and the recorder can be returned to flight mode. It must also be easy to be set to the calibration mode and back to flight mode, for instance by the calibration laboratory. Although some calibration officials cannot be expected to make adjustments to the recorder settings except to switch it on and carry out the calibration, others may want to make the switching and such a capability must be incorporated.

2.5 **OPERATING PROCEDURES**. IGC-approvals apply not only to the equipment itself, but may include mandatory operating procedures (such as checks by OOs or others, sealing, stowage, etc) where these relate to the integrity of evidence used for flight verification.

2.6 **PRINCIPLES**

2.6.1 **Date and time**. The Sporting Code requires that there must be proof, independent of the GNSS FR, that the flight data recorded on and transferred from the FR took place on the day and at the times shown on the transferred data. This is to ensure that a FR record cannot be artificially manufactured in advance and used later.

2.6.2 **Data file standard**. The data recorded in the FR and transferred after flight to a PC must be capable of analysis in the form of the IGC data file standard format given in Appendix 1. Data may be transferred from the FR in another form (eg binary code) as long as it can then be transformed into the IGC format through the programs covered in para 2.9.

2.6.3 **Memory used for flight data**. The memory used for storage of the flight data to be used in the flight verification process must be of a type and design so that it cannot be accessed, combined (such as in a storage device with software partitions), altered or corrupted by other data legitimately or otherwise present in the equipment. Any write-access for mandatory flight recording information to the memory, which originates other than from secure or otherwise approved sensors (such as GNSS, pressure transducer, approved MoP sensor) must be detected by the FR and shall invalidate the flight record. When the memory is full, flight data shall continue to be recorded, over-writing the earliest data previously recorded rather than stopping recording. (AL5)

2.6.3.1 Preservation of memory data. The design shall preserve memory data wherever possible so that recent flight data can be transferred to a PC either by normal or emergency methods. This should cover conditions of impact (for instance, accidental dropping of the recorder), damage, and crash. Wherever possible, non-volatile memory should be used that does not depend on a sustainer battery for retention of data. If a sustainer battery is used, its position and wiring to the memory unit should be made as secure as possible with respect to impact or other damage. (AL6)

2.6.4 **Identification of corrupt, false, or inaccurate data**. Any flight data that is corrupt, false, or inaccurate, either though inadvertent or deliberate causes should be positively identified and recorded as such wherever possible. This is mainly achieved by the use of the VALI-XXX.EXE program file and the MS Windows equivalent (Appendix 3), but all other measures should be taken to preserve the integrity and security of data in IGC data files. (AL6)

2.6.5 **Integral Pressure-Altitude Sensor**. A GNSS FR used for IGC flight verification evidence shall have an integral altitude sensor capable of producing an output of pressure altitude in the same way as a barograph and having a fixed sea level datum of 1013.25 HPa at 15°C (ie recording Flight Levels rather than height above ground or sea level). The pressure altitude measurement system must be compensated for temperature changes. The system will be tested by GFAC for accuracy and freedom from anomalies in recording pressure altitude, and the sensor must be of a type that is acceptable to GFAC. The altitude sensor shall be within the FR unit and its primary function is to append accurate pressure altitude data to each fix (B Record), continuing to record fixes with pressure altitude if the GNSS is inoperative for all or part of the flight.

2.6.5.1 Use of pressure altitude data. If data is used for other purposes such as a cockpit display, it shall be ensured that the data transmission from the FR is outbound only; it must not be possible to alter the pressure altitude fix record by any inbound data from sources external to the FR.

2.6.5.2 Start of recording and calibrations. The IGC FR pressure-altitude sensor and recording system is an electronic barograph in its own right, and is subject to the same rules and procedures as for barographs. See para 2.10 on calibration accuracy. For calibrations in an altitude chamber it must be possible to produce an IGC-format file of the pressure changes, without the need for any special switching of the FR except to switch it on before starting the calibration. For FRs which do not record continuously after switching on, this may be achieved by ensuring that a small rate of change of pressure altitude is enough to start recording fixes of pressure altitude with time. This will also ensure that pressure-altitude fixes are produced in flight in the absence of any GNSS data. Experience in the past has shown that a suitable trigger value is a pressure change of 1 metre per second for 5 seconds.

2.6.5.3 Baselines. An adequate baseline must be recorded for the take-off and landing (see Appendix 1 para 1.1.1.1), for comparison with any independent measurement of airfield pressure at take-off and after landing.

2.6.5.4 Cockpit or instrument static sources. For stand-alone FRs, the pressure recorded in the *.IGC file must be "cockpit static" (vented within the FR box), but for FRs mounted in the instrument panel (for instance, near to other pressure instruments), the pressure recorded may either be "cockpit static", or use a tube connection to the pressure from glider instrument system static tubing. See also the Glossary item on Pressure Altitude. (AL5)

2.6.5.5 Fix interval during Calibrations. A short fix interval is required so that the pressure level in the altitude chamber, once set, does not have to be held for an extended period. Ideally it should be possible to set a 1 or 2 second fix interval before the calibration starts. The minimum requirement is that during a pressure altitude calibration it shall be possible to set a fix interval of 5 seconds or less. For recorders with non-variable fix rates in excess of 5 seconds, this may be set through a special calibration mode. Any such special calibration mode should be easy to set by the pilot or owner of the recorder and subsequently be continued until re-set to flight mode later. This is so that a calibration centre only has to switch the recorder on and carry out the calibration without any extra switching. Some calibration officials may want to make the switching and such a capability must be available. (AL6)

2.6.6 **Programming of GNSS Navigational Reference Data**. The GNSS navigational reference data must not be changed in the time between the OO's checks on the FR before flight, and the OO's checks and the transfer of data from the FR after flight. Presentation and manipulation of approved data on cockpit displays by a pilot in flight is not part of programming and is therefore allowed. Programming in this context includes any action that could change the source or method of calculation for 4-D position data during flight. This includes:

2.6.6.1 Any change which could alter the geographic co-ordinates (eg latitude and longitude, or grid), GNSS-altitude, GNSS clock time and its correction to UTC, or the record of satellite constellation (the satellites used in fixes) in a data sample other than by movement of the glider itself, and specifically:

2.6.6.1.1 A continuous time clock function is required during the operation of the FR, in addition to the date and time derived from the GNSS fixes themselves. This is in order to maintain time when GNSS fixing is not occurring, and to give an accurate date/time if the GNSS fails and the FR has to be operated in pure barograph mode. This is to ensure that owners of IGC-approved GNSS FRs can use the unit as a pure barograph in the event of complete lack of GNSS fixes (for whatever reason, an example being a fault or damage to the antenna, its cable or connectors). For GNSS boards which do not incorporate a Real-time Clock (RTC) module capable of providing an accurate time base if time from GNSS fixes is not available, a separate RTC similar to that used in a PC must be fitted in order to sustain the time base. The sustainer battery for the clock shall supply the power to trash security if the case is opened at any time in an unauthorised manner. (AL3)

2.6.6.2 Any change of Geodetic Datum setting. The Sporting Code for gliding states that the lat/long data in all files transferred from the FR after flight must be to the WGS 84 Geodetic datum. Therefore, any change from this must either be impossible by the design of the FR, or must be recorded on the flight data file Any GPS fix data that is not to the WGS84 Geodetic Datum will not be validated for flights to IGC/FAI criteria.

2.6.7 **Allowed Changes** - Programming of the GNSS navigational reference data does not include the following, which are therefore allowed to be changed, operated or affected in flight, including by flight-crew actions:

2.6.7.1 **Navigational target points**. Controls (eg switches or buttons) accessible to the flight crew may be used which select different pre-set points as navigational targets or Waypoints. eg Start, Turn and Finish Points, and other points of interest.

2.6.7.2 **Data sampling interval settings**. The settings for the time interval between data samples may be changed, either automatically (for instance at Waypoint Observation Zones) or by manual switching. The maximum time setting for data sampling for the purpose of establishing flight continuity is 1 minute (SC3 para 4.3.1). It must also be possible to set a data sampling interval of less than 5 sec for use near Observation Zones, so that pilots can use this shorter interval when near and in the OZ, as recommended in Annex C to the Code (SC3C) para 9.2. (AL3)

2.6.7.3 **Pilot event marker**. This is where an extra fix is recorded and the code PEV (Pilot Event) appears in the flight data for the fix concerned, following a specific pilot action such as pressing a button. The PEV code on the flight data must only appear as a result of this pilot action and not as a result of any other action or function. It is strongly recommended that a series of fixes at a shorter interval than usual (fast fix function) follow a PEV event, but the PEV code must only appear on the fix for the time at which the pilot took the action. Where the action is pressing a button or switch, not more than one button or switch shall need to be pressed to obtain the PEV event. (AL2)

2.6.7.4 **Camera connection**. A connection to a camera may be used which takes an additional GNSS data sample on shutter press, marking the event with the appropriate three-letter code (Codes, Appendix 1 para 7, PHO for photo).

2.6.7.5 **Motor glider MoP record**. Before IGC-approval for a Motor Glider Means of Propulsion (MoP) recording system in the FR, the operation of the MoP itself or other functions associated with operating the MoP, must be recorded in a specific and unambiguous way. Systems must have a microphone inside the FR that records cockpit noise with every fix using the ENL system, unless the proposed alternate system can be shown to have a similar integrity and security protection against mis-interpretation and misuse, either accidental or deliberate. For ENL systems, a low but positive ENL value in normal gliding flight shall be recorded so that the system is self-validating with each fix. Other systems that depend on wiring that cannot be inspected for its whole run, will not be approved by IGC as they can be modified without this being detected. Some types of microswitch can be held open or closed (for instance by a magnet) in order to avoid engine running being detected, and these will not be approved by IGC. In the case of microswitch- or vibration- based systems, any IGC-approval will include the provision that an OO must carry out a MoP test both before and after flight, and for the FR having to run continuously between these two supervised MoP tests, unless it can be shown that integrity can be proved without these procedures. Microswitches can be used to detect functions such as engine bay doors open/closed, pylon up/down, nose cone propeller cover extended/retracted (for designs such as the Stemme), etc. Further information on the preferred ENL system is in para 2.11.1 (AL6)

2.6.7.5.1 Fix sampling time for MoP record. The prime method used for showing MoP activation (a condition in which it would be possible to generate forward thrust) must record a fix immediately if the MoP activation condition is detected, irrespective of the fix sample rate setting.

2.6.7.6 **Other functions**. Other functions may be operated in flight that can be shown not to affect the GNSS navigational reference data or the integrity of other evidence for flight validation. This will be evaluated by GFAC.

2.6.8 **Units and Conversion Factors**. Where conversions have to be made, the following are agreed by FAI, shall be used and are taken from international agreements:

Feet to metric distances:	1 inch = 1/12 foot = 2.54 centimetres exactly
Miles:	International Statute Mile = 5280 feet exactly
	International Nautical Mile = 1852 metres exactly
Speed:	Knots are Nautical Miles per hour
	"mph" refers to Statute Miles per hour (AL6)

2.7 EQUIPMENT REQUIREMENTS

2.7.1 **GNSS FR Equipment Requirements**. In order to achieve the general conditions of the previous paras, the equipment requirements and procedures in the following paras shall be followed, and other provisions of the Sporting Code for Gliding (SC3) and its Annexes complied with, subject to the terms of the IGC-approval. The type of GPS receiver board used will be tested for accuracy and freedom from anomalies in recording lat/long and altitude, and must be of a type that is acceptable to GFAC . (AL5)

2.7.2 **Security of Data between GNSS Receiver and the FR Memory**. The user, and particularly the flight crew, must be denied access to the line carrying the inbound signal containing the data to be used in the flight verification process (eg the NMEA protocol inbound signal), to the FR memory (the ingoing data line). See 2.7.3 for the principles to be adopted. The GNSS receiver and the flight data memory module of the Flight Recorder must either be in a sealable enclosure with the connections between them entirely within the enclosure, or the GNSS receiver and flight data memory modules must be in separate sealable enclosures with positive security protection being included for data being transferred between them.

2.7.2.1 **Type of seal**. The enclosure must have a tamper-proof physical seal across a joint or screw, so that the seal will be broken if the case is opened. For the internal security mechanism, see para 2.8.4. (AL5)

2.7.2.2 **Wiring**. Only the following wires may pass through the boundaries of the sealed enclosure:

2.7.2.2.1 Electrical power. Wires carrying electrical power to the GNSS receiver and FR. The power input must be designed for use with a 12V DC battery system unless agreed otherwise by GFAC. A 12V powered recorder must not produce anomalies in output data in the range between 10 and 16 volts. (AL6)

2.7.2.2.2 Antenna, the GNSS receiver antenna (aerial) cable. The antenna, its wiring and connection to the FR are critical parts of the system without which GPS fixes will not be obtained. In case of a defect, the components external to the FR case must be easy to replace with serviceable ones. Therefore, for FRs with external antenna connections, any antenna connector on the FR case must be to a type of antenna cable connector that is commonly-available worldwide, be separate from other connectors and be designed and specified for low energy antenna signals, including the GPS frequencies around 1.5 GHz. It is recognised that some FR designs have antennas that are integral with the recorder case and an external connector does not apply. The IGC standard external antenna connectors on the FR case are the 9mm BNC bayonet, and, where a smaller connector is desired, the SMC (Sub-Miniature type C) screw fitting with 4mm female and 3.5mm male components. Where a screw fitting is used in a glider installation, it is recommended that it is prevented from un-screwing by the use of locking agent that will hold it firm but allow it to be unscrewed later if required. Push-pull antenna connectors will not be IGC-approved because they can become disconnected in a glider installation if the wire is inadvertently put under tension (push-pull connectors are those that can be disconnected solely by a pull-action rather than by a turn or screw action). Where the antenna connector on the FR case is not the 9mm diameter BNC bayonet type, for GFAC testing a short interface cable must be provided so that antennas with BNC connectors can be used for test purposes. Since GPS antennas with BNC connectors are commonly available, where an FRs does not have a BNC connector on the the case, it is recommended that production equipment includes an interface cable so that a BNC antenna connection can be used if the original antenna has to be replaced (such as during a competition). (AL6)

2.7.2.2.3 Data cable. Where the equipment is configured as a receiver module and a separate recorder unit, the cable and its connections used for transmitting data to the recorder unit must be specially designed so that alteration of GNSS fixes, the flight log or the Geodetic Datum is not possible; except as signalled by genuine fix and other data from the receiver module. See 2.8.1 and 2.8.2 on data security for conditions where a separate GNSS module may be used.

2.7.2.2.4 Cable to cockpit navigation display. A cable for transmitting data to a cockpit display for approved navigation information, with appropriate controls for switching the display information in an approved manner. The cable must be buffered by the manufacturer such that no alteration to GNSS fixes, the flight log or geodetic datum in the FR is possible through this cable.

2.7.2.2.5 Cables for approved functions. A cable or cables for the approved functions provided that no alteration of GNSS fixes, the flight log or the Geodetic Datum, is possible by signals sent through these cables. These functions include an Event Marker, Camera connection, and Motor Glider MoP sensor.

2.7.2.2.6 Connector cable for data transfer from FR to PC. The types of IGC-approved connectors on the FR case for transfer of flight data are specified in 2.7.2.2.7. The PC is expected to have a 9-Pin RS232 male connector for data input unless it only has USB connectors, in which case see 2.7.2.2.6.2. If the FR case has the IGC-approved type of RS232 connector, no special extra cable is required to be supplied by the manufacturer. If the FR case has an IGC-approved connector other than the RS232, the FR manufacturer shall provide a cable that connects to the FR at one end and has a female RS232 connector on the other end. This RS232 will either be connected directly to the PC or, for PCs with only USB connectors, via an interface connector provided by the pilot, OO, or the owner of the PC. (AL6)

2.7.2.2.6.1 IGC standard cable for data transfer. It is expected that all persons involved in transferring data from FR to PC will have access to a cable for data transfer with RS232 connectors, male for the FR end and female for the PC end. This shall have straight-through wiring, for instance, female pin 2 is connected to male pin 2, and so forth. 'Cross-Over', 'Null Modem', Gender Changer or Manufacturer-Specific cables must not be used because their wiring does not conform with the IGC standard and their use could damage the FR or the PC, or lead to loss of data. (AL5)

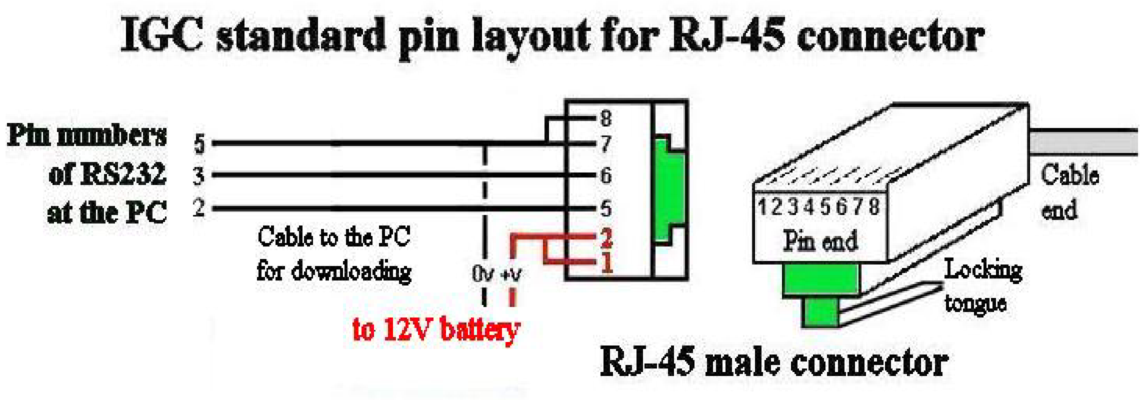
2.7.2.2.6.2 USB connectors. For PCs with USB connectors and without a RS232 port, a conversion cable from USB to RS232 must be supplied, normally by the owner of the PC, so that it can be used with the IGC connectors and cables specified above. With the trend towards USB ports, this will be kept under review, but provision needs to be made for the use of older PCs as well as new ones and it is anticipated that RS232 PC connections will be part of this Specification for some time. (AL5)

2.7.2.2.7 Connectors on the FR case - data transfer and other functions. IGC-approved types of connectors for data transfer to a PC are listed below, one of which shall be fitted on the FR case. The RJ-45 is recommended because the IGC-standard wiring includes both power and data transfer facilities. Connectors that include functions other than the transfer of data are covered in 2.7.2.2.7.3 below. Because in some installations the FR case in a panel-mounted system may be difficult to access, an extension cable must be supplied so that one of the IGC-approved connectors is always readily available for connecting a PC for data transfer. When the recorder is fitted to the instrument panel, the manufacturer's instructions must make the point that the IGC standard connector on the extension cable must be available in a convenient place in the glider for transferring data to a PC, if necessary by use of a further extension cable to the PC itself. (AL6)

2.7.2.2.7.1 Option 1 - 9-pin RS232 connector. This is a 9-way D-type Subminiature female connector with RS232 standard pin assignments, as used in existing systems such as Cambridge, Print Technik and Zander. Pin 2 is for RXD (data from FR to PC), pin 3 for TXD (data from PC to FR), and pin 5 for GND (signal ground). Other pins may be used (for example to implement Hardware Flow Control), provided that they conform to the RS232 standard pin assignments as implemented on PCs, and allow connection of the FR to a PC using a Standard 1:1 cable. If other pins are used then they must be to the PC standard, and not free for any purpose (such as Voltage Supply) unless this is agreed by GFAC. (AL1)

2.7.2.2.7.2 Option 2 - 8-pin RJ-45 connector. This is a female 12 x 6 mm RJ-45 socket with 8 connections. It is also used for ISDN and Ethernet connections (but with different pin allocations). In the IGC layout, with the male plug end held towards the observer and the pins uppermost, the locking tongue underneath and the cable running away from the observer, pins are numbered 1-8 from left to right. IGC functions are listed below and also in the diagram.

Pins	**Function**
1&2	Volts +
3&4	Spare, for future application with GFAC approval
5	TX
6	RX
7&8	Earth (Volts -ve)



2.7.2.2.7.2 Connectors for other functions. Connectors that include functions other than the transfer of data can be of any type as long as the cable connector can be securely attached to the FR case (that is, it can be secured by screws or clips and cannot be detached by a straight pull force). Power and backup download facilities may be included. Such functions include connections to other units such as those with variometer, speed-to-fly or final glide facilities. (AL6).

2.7.2.2.7.3 "Grandfather Rights" for RJ-11 telephone connector with 6 pins. The RJ-11 was an IGC-approved connector but was withdrawn for new types of recorder by Amendment 6. This was because it had been found that after repeated use the locking tongue can break off, leading to the use of sticky tape or other methods to secure the connector to the recorder. The slightly larger RJ-45 is a significant improvement over the RJ-11 because it is stronger, has more pins and its cable is (normally) shielded. The details of the RJ-11 pin layout continue to be included below so that users of equipment with RJ-11 connectors that has "Grandfather Rights" know what pin layout to use when making up connectors for transfer of data. The IGC RJ-11 system used a female 9 x 6 mm RJ-11 socket on the recorder with pin assignments as follows: (AL6)

Pin	Function
1	Volts +
2	Spare (For future application (FFA) with GFAC approval. (Some recorders use this for an external LCD)
3	Spare (remarks as for pin 2)
4	Rx
5	Tx
6	Ground

2.7.3 **Non-Accessibility to Flight Crew**. Any switches, buttons, electrical plugs and sockets associated with the GNSS receiver unit and its associated FR must be inaccessible to the crew in flight, except where the IGC-approval for the equipment concerned specifically allows it. Antennas may be separate from the main unit in order that they can be placed in the glider in the best position for reception of signals.

2.7.3.1 **Possibility of re-programming in flight**. It must be shown that any in-flight transfer of data to or from the FR, or the use of an un-approved connection for data transfer, will either be apparent on the after-flight data or can be shown to be impossible because of the design. If this is detected, the flight data shall then be invalid for IGC purposes.

2.7.3.2 **Stowage out of reach of flight crew**. The equipment design may be such that stowage out of reach of the flight crew is required. Such stowage may be to the rear of the crew in an compartment inaccessible in flight (similar to a barograph stowage), or mounted in or behind the instrument panel. In the case of instrument panel mounting, the crew must not be able to gain access in flight to wiring, plugs, data ports, or hardware, except that which is part of the specific IGC-approval for the equipment.

2.7.3.3 **Geodetic datum**. The Geodetic Datum is recorded in the IGC file header (H) record. Any changes to it must be recorded in the output data, unless it can be shown that the equipment is such that it is physically impossible to change the Geodetic Datum between the OO's checks before and after flight. This can be achieved by fixing the design to WGS84, or by physical sealing after setting WGS84 by a method allowed in the IGC-approval for the equipment. The Sporting Code (SC3) states that the WGS 84 Geodetic Datum shall be used for all lat/long co-ordinates which are recorded and transferred from the FR after flight.

2.7.3.4 **Connecting cables**. If the design of the FR includes separate units connected by cable (not including the antenna), the whole run of any cables used to transfer data on fixes outside any sealed units must be continuous between the units without any other breaks or connectors. The cables must be shielded against electronic interference. The cables must be connected in such a way that any disconnection is positively shown; this may be by a physical seal or by an electronic device which records automatically after the initial connection if the cable becomes disconnected. It is recommended that, for ease of inspection by the OO, the cable should be installed so that it is clearly visible throughout its whole length.

2.7.4 **Identification of Corrupt, False, or Inaccurate Data**. A method should be included to positively identify any corrupt, false or inaccurate data and to record it as such, whether such data originates from inadvertent or deliberate causes. This may be achieved at various stages in the process such as: by a program within the FR marking suspect fixes such as any with a high EPE/FXA or where the components of the fix are not consistent with each other; or after flight by using a PC-based approved analysis program which calculates the groundspeed between the centre of each fix and highlights (for further manual analysis) any fixes between which calculated groundspeeds are unlikely.

2.7.4.1 **Averaging Algorithms**. Most commercial GPS boards used in FRs include averaging or dead-reckoning algorithms that, when the vehicle carrying the FR is moving above a low speed threshold, reduce short-term variations of fix position and produce straighter series of fixes which correspond more closely to real positions. If the system employed has a forward-prediction effect (sometimes called "DEDuced" or "dead reckoning", where fixes are not derived from GNSS lines-of-position but are predicted from past velocity), it has been shown that a glider running in to a Turn Point at high speed and losing GNSS lock can "throw forward" a series of predicted fixes and so be able to record fixes in an Observation Zone when the glider has not reached the Zone. It is recognised that GPS receiver board manufacturers are reluctant to divulge details of their programs, but IGC-approval will not be given if testing shows that a high-speed run followed by a sharp turn, can throw fixes forward of the true position of the glider. FR manufacturers must ensure that any such averaging programs in the GPS board they use, operate only over short time periods and cannot be used by pilots to produce false fix records, particularly close to Observation Zones. Fixes recorded on the IGC data file must be based on real GNSS position-lines. Predicted fixes must not be recorded such as those from so-called Dead Reckoning (DR) and other forward-prediction algorithms designed for use on the ground if signal is lost due to terrain masking. If such a system is available on the GNSS board, it must either be permanently disabled or set at a time constant of less than 5 seconds if it is to be used for fixes recorded in an IGC flight data file. (AL3)

2.7.5 **Unique Serial and Version Numbers**. Each FR shall have three-character alphanumeric Serial Number (S/N) unique to that manufacturer, marked physically on the case and also in the electronic memory so that it is included on all output data. Output data must include the S/N, the version number of the hardware and firmware (or software) standard, and details of the GPS board and Pressure Altitude sensor inside the FR concerned (details are in Appendix 1 in the H (Header) record). The case of the recorder must be permanently marked with the name of the recorder manufacturer, type/model and S/N. Where a display is available, the recorder make, type, S/N and version number(s) must be shown on that display for at least 10 seconds before it changes to another presentation, so that it can easily be written down by an OO before flight. Other details on the display are optional because they are included in the IGC file header record. Where a recorder is designed to be mounted in an instrument panel, the data above must be easy to see and record from the cockpit without having to look at or make adjustments to the back of the panel. The required data must be available to an OO without having to access the back of the panel. For instance be on the display after switching on or by permanent marks on the front of the case including inside the instrument display itself. (AL5)

2.8. **SECURITY - PRINCIPLES**. Security procedures and hardware, firmware and software standards must be used so that no alteration of data may occur without such alteration being detectable. The method of ensuring that GNSS FR flight data is secure is through the generation of a digital signature (DS) in the FR, which becomes part of all flight data transferred from the FR. PCs, transfer software, email, and portable storage media such as a diskette may be used to transmit data taken from the FR to the validating authority (NAC or FAI). Regardless of the level of physical control used in handling and transmitting data between the FR and the validating authority, the DS must enable detection of any alteration of data throughout the transfer process from the FR and at any time afterwards. Individual FRs must have different security keys to others, so that if the key for one FR is broken, the rest of the product range will still be secure. (AL4)

2.8.1 **Levels of IGC-approval**. Security aspects are important factors in the types of flights for which a recorder is given IGC-approval. The detail on approval levels is in para 1.1.3.3. (AL6)

2.8.2. **Recorder units connected by cable to a separate GNSS receiver**. For FRs approved for use only for Silver, Gold and Diamond Badge flights, IGC will permit recorders with separate GNSS receiver units to be used subject to the other provisions of this Specification and Sporting Code Section 3. In particular they must have the ability to generate the IGC format flight data file and have a standard of physical and electronic security appropriate to badge flights up to Diamond, as determined by GFAC. (AL5)

2.8.2.1 Higher level approvals. Before an approval to a higher level than Diamonds can be considered, the security of electronic flight data from the GNSS unit to the FR must be to a similar standard as that required for such data which is transferred from the FR unit itself to storage media. A separate receiver must be securely physically sealed, and the data stream from the GNSS receiver to an FR unit must contain both an electronic identification of the individual receiver unit (so that in the event of a query on the data, it can be identified and inspected), and also a digital signature (DS) system no less secure than that required for data from the FR unit itself. (AL5)

2.8.3 **Digital Signature**. A Digital Signature (DS) is generated by the GNSS FR and must be transferred to the PC at the same time as the flight data. The DS will be used as a check that the data originated correctly from an individual FR and that there has been no change in the data between the initial data transfer from the FR to the PC, and the data used for final flight validation.

2.8.3.1 **Message Digest**. The Message Digest (MD) is essentially a hashing value (a mathematical function) of the content of the IGC format file (the flight data itself with the alphabetical records), and represents an image of the whole file. The MD is encrypted using the private key of the FR, and once encrypted becomes the Digital Signature (DS) that is added to the file to be transferred to the PC and appears in the G record of the IGC file format. The flight data (the Message) is not encrypted. A MD is generated with an algorithm of the FR manufacturer's choice. Knowledge of the private key used to encrypt the MD must be restricted to as few a number of people as possible, and the manufacturer must keep a register of people with this knowledge. Flights made by any persons using an individual FR for which they have this knowledge will not be validated for IGC purposes. It must not be possible to access the security algorithms by dis-assembly of the FR, for instance through an EPROM reader. FRs approved for all flights (2.8.1) must have an asymmetric algorithm such as RSA, or have a system providing equivalent security as decided by GFAC. FRs for flights up to and including lower levels approved by IGC must have algorithms which are complex enough to discourage malpractice but need not be to the same level of security as FRs for all flights. GFAC may require the FR manufacturer to present and defend the design of the signature-generating algorithm, but knowledge of details will be kept to a small number of experts in data security who will be under an agreement of confidentiality.

2.8.3.1.1 RSA, DSA and data transfer times. In the case of RSA (for meaning, see the Glossary), a key of at least 512 bits will be required, and, for non-RSA systems, a key length giving equivalent security as decided by GFAC. With progress in computing and the possibility of even asymmetric cryptographic systems being broken, such key lengths and other security aspects will be kept under review and revised from time to time. It is expected that new designs of GNSS FRs will have more capable processors and more memory than earlier designs, so that larger key sizes should not present a problem. The DSA system (see Glossary) is a permissible alternative to RSA and may give shorter times for data transfer from the GNSS FR to a PC. With the DSA system it may be possible to make security calculations while the FR is recording data, which may save time during data transfer to a PC after the flight. A 100kB IGC data file must transfer with full security encoding from the FR to a Pentium 100 PC in 1 minute or less. The time to execute the VALI program (para 2.9) is considered to be less critical. For more information on RSA and DSA, see the Glossary, and for advice on these matters, consult GFAC, initially through its Chairman. (AL5)

2.8.3.2. **Checking at the NAC**. The NAC will use the VALI program (para 2.9) to check the IGC flight data file. If the VALI check is successful, this shows that the file content is an exact copy of the file transferred from the FR, and that the FR output conforms to the manufacturer's criteria. The system is similar to that used for encrypting and checking files and mail on the Internet. The DS from the G record is decrypted in order to get the original MD using a public key (related to the private key) which is stored independently of the FR. This public key is in the appropriate VALI program file. For further advice, contact the GFAC Chairman who will refer questions to appropriate experts in software security for flight data files.

2.8.4. **Unauthorised changes**. If a FR is opened or otherwise interfered with (such as electronically), a mechanism must exist so that any subsequent data from that FR will be detected as not having the correct DS. This shall be achieved by a system that operates if the FR case is opened and deletes the encryption key(s) required to compute a valid DS, such as a microswitch or equivalent system. The principle being that if the security mechanism of the FR is activated, any data originated after such activation must not have a valid security signature from the FR, until the recorder is re-set by a secure and authorised method. It is permissible to retain data for flights that were in the memory when the security system operated. If such flight data has the previous valid security signature and will pass the VALIDATE check, it must be stored in such a way that it cannot be altered even though the recorder itself is insecure. Otherwise such retained files must fail the VALIDATE check once downloaded. This system may only be re-set to normal after being returned to the manufacturer or his authorised agent for re-initialisation. Knowledge of the method of re-initialisation must be restricted to the minimum number of persons and controlled so that unauthorised persons cannot gain the knowledge. See para 2.9 on validation (VALI file) programs. (AL6)

2.8.4.1 If the security mechanism has operated. If the internal security mechanism (for instance a microswitch) has operated, the recorder shall continue to produce flight data in the IGC file format, although such data must fail the various security tests and cannot be used for flights that require validation to IGC/FAI criteria. Authorised agents of FR Manufacturers or anyone else shall not be given (or acquire over time) lists of codes or keys for re-initialisation purposes, that could be used again without reference to the FR Manufacturer. The system must be protected in the case where an agent might transfer to another manufacturer or even be involved in hacking at a future date. The normal procedure shall be that a security code or key is transmitted by the FR manufacturer to an authorised agent for the re-sealing of an individual recorder on a specific date, the code or key being itself coded or using a "one-use pad" system. This is so that an agent or anyone else cannot, over time, collect a database that would allow recorders to be initialised without reference to the FR manufacturer and that could be used later in some illicit way. The use of publicly known algorithms is preferred, so that the level of security can be assessed by GFAC. Also, to prevent loading of invalid programs, if application code with an invalid signature is loaded, the battery backed RAM must be cleared. (AL5)

2.8.5 **Use of Computers with a FR.** There must be security devices (sometimes called a "firewall") which prevent a computer that is connected to the FR being used for unauthorised changes to the internal programming of the FR or of data stored in the FR, both on the ground and in flight. Although current IGC-approvals normally state that a portable PC shall not be connected in flight (except where specifically tested and approved for a particular FR such as the use of small Palmtops for display and other purposes), there is no way of preventing this, particularly in a two-seat glider. The worst-case in terms of security, which must be taken into account, is that a powerful portable is connected to the FR, unsupervised by an OO, with the intention of breaking security or injecting false data either on the ground or in flight. How this is prevented by design features, should be stated when applications are made for IGC-approval. This will also be tested by GFAC. (AL2)

2.8.6 **Changes and upgrades - maintenance of security**. Changes and upgrades may involve replacement of components, including GPS receivers, processors, boards, ROMs of various types, and microchips. These may only be carried out at the FR Manufacturer's facility or that of an authorised agent, so that the physical and electronic security of the updated FR is re-set to the standards required by this document and of the IGC-approval for the FR concerned. Where firmware can be re-programmed without component replacement by using tools external to the FR (such as where EEPROMs, flash PROMs are used, and any equivalent systems), manufacturers must restrict the knowledge of such tools/firmware to a minimum number of persons. Any security codes (including Private Keys) embedded in such tools/firmware must be known to as few a number of people at the manufacturer's facility as possible. This is to reduce the possibility of reverse engineering of such tools/firmware by unauthorised persons such as potential "hackers". It is expected that the secret Private Key (PK) for the Asymmetric Algorithm will be stored in RAM, so that opening of a cover or the FR case removes the maintaining supply to the RAM, thus erasing the PK. Where components have to be physically replaced, the PK is trashed as above when the cover or FR case is opened to gain access to the component to be replaced, and the PK then has to be re-entered. Where external reprogramming of the Firmware is possible using EEPROM or Flash Prom (or any future system), it must not be possible to replace the firmware without the PK being made invalid. The manufacturer's reprogramming process may re-enter the PK and for this reason, only the minimum number of people should have knowledge of the manufacturer's process of external programming. It may be possible for unauthorised persons to reprogram the EEPROM or Flash Memory, but without the PK, this must not result in a working recorder that will pass future VALI checks. (AL2)

2.9 DATA TRANSFER, CONVERSION, AND VALIDATION - DATA, CONV & VALI PROGRAMS

This refers to the DATA, COM and VALI functions that are executed through either the MS Windows-based system described in Appendix 3 or by self-executing DOS-based short program files. For new types of recorder the Appendix 3 system is mandatory and the DOS files may be produced as an addition. References in the document to the DOS program files should be taken as also applying to their Windows-based Appendix 3 equivalents where the context makes this possible. For existing types of recorders, Appendix 3 software shall be produced by 1 July 2004. This software will be made available by IGC as freeware on FAI internet reference: ftp://www.fai.org/gliding/software/gps/pc (also through a link from http://www.fai.org/gliding/gnss). Manufacturers shall check from time to time that their program files on these web references are up to date. FR manufacturers must also distribute them as part of their normal software package to customers and their literature and manuals shall remind customers to check the web site above from time to time in case updated versions have been made available. (AL6)

2.9.1 Format of transferred data from the FR. The data transferred from the FR may be either in a manufacturer's proprietary file format (such as binary), or in the IGC file format described in Appendix 1. In the IGC file format, whether obtained on transfer from the FR or on later conversion, the source of the G-record (security record) must be from the FR itself and not, for instance, from the DATA program. In all cases, data transferred from the FR shall be checked against the appropriate VALI program by the NAC before a flight achievement is validated.

2.9.2 Conversion of Data to the IGC Format. Where the transferred data is in a different file format to the IGC format, the original must then be converted to a separate IGC-format file so that the NAC can use IGC files for analysis.

2.9.3 Short Program Files for Transfer and Conversion to the IGC File Format. Short electronic program files shall be produced by a FR manufacturer solely for the transfer of data from each type of FR and conversion to the IGC data format given in Appendix 1. The Windows version must be in accordance with Appendix 3. The DOS version must be capable of fitting, uncompressed, and executing its programs on a 1.4 Mb floppy diskette, with enough spare room for flight files to be transferred from the FR, and must work without other requiring other files or programs except the operating system of the PC. For PCs using one of the MS Windows OS, the DOS files must be capable of executing correctly either through the self-booting floppy disk described above, or from the main Hard Disk with Windows running, if necessary through the DOS window (where one exists in the OS concerned). Both DOS and Windows (appendix 3) programs will be placed on the gliding/gnss web pages for free general use for the recorders concerned. The program file names include the letters XXX, which is the individual manufacturer's three letter code given in Appendix 1. These files are in addition to the FR Manufacturer's main software program (if any) and are to help pilots, OOs and others who wish to have the simplest and quickest method of data transfer from the FR, and conversion for the IGC format for later analysis. This includes officials at competitions responsible for transferring data from many FRs each day to a PC for analysis and scoring. There is no obligation for a FR manufacturer to have any further software programs, because analysis and flight validation can be carried out from the IGC format file using one of the many programs developed independently for this purpose and listed on the IGC web pages.

2.9.3.1 Parameters (switches) for DOS program files. These are passed to the appropriate DOS program files and are listed below. To denote the switch, either a forward slash (/) or a minus sign (-) may be used, with a space between the filename and the / or - symbol. However, there is no space between the switch and its parameter, eg space-p2 or /p2 = COM2 port, spaceb19200 or /b19200 = baud 19.2k, space-d[path] or /d[path] = path for files created (no brackets needed, just the path), space-nXYZ01AUG or /nXYZ01AUG for flight by glider XYZ on 1 August. Approved switches are as follows:

-p1, -p2 = COM ports (default COM1)

-b19200 Baud rate (default 19200)

-d [path] defines path where the file(s) will be created. A Null parameter defines current path (which is also the default).

-q Quiet mode i.e. non-interactive, for use in batch processing. Transfers all flights not on disk unless-o is also used, in which case all available flights are transferred. Default is the use of the interactive menu.

-o Overwrite existing files. Default is do not overwrite.

-x = manufacturer's proprietary. This is to allow manufacturers to have their own specific parameters without compromising switches IGC may define at a later date. e.g. /xh to define Hardware Flow Control.

-v = Version number of file, display

-b = Baud, if absent, defaults to FR's natural baud rate.

-i = DATA file does not also convert to IGC file format (ie needs separate action with CONV file)

-? = Help/instruction menu. How to operate the program, description of switches, etc.

-n [file] Define a filename to be used other than the IGC default, for instance for ease of identification of a glider flight file in a large competition. In a comp the glider registration or pilot's name will be more useful than the normal file name. All details in the normal file name are in secure parts of the file, and the file name itself is not secure (that is, protected by the digital signature system) and can be changed by any PC operator. In the case where more than one file is transferred, second and subsequent files will have -2, -3, etc. appended to the filename. After -n is used, in the IGC format the IGC suffix must be retained so that it will be recognised by analysis programs designed for this format, and in any binary format the file name should be converted to the new one but the manufacturer's binary suffix retained (AL2)

Exit code = 00 means transfer program is satisfactory.
Exit code = 04 means transfer program found minor errors.
Exit code = 16 means transfer program found fatal errors.

An example, for instance for use in a competition: DATA-XXX -q -nEE25JUL
In this case, the transfer program of the manufacturer XXX will transfer the last flights, without

questioning to the user (quiet), and it will create the file EE25JUL.IGC in the current directory for the glider Echo Echo in a competition on 25 July. This format will be more useful to the competition organisers than the conventional IGC filename which is designed for records and badges under OO supervision. (AL2)

2.9.3.2 Data transfer from FR to PC - DATA program. The program file DATA-XXX.EXE and its Windows equivalent (appendix 3) shall transfer the flight data from the FR memory to a PC and shall also convert transferred data to the IGC file format at the same time. The DATA DOS file shall be as small as possible, must work alone (not depending on any other files or programs), and is not expected to exceed 200 kb. Similar programs which will work on Mac computers may also be produced, but where evidence is submitted to NACs and FAI on portable disks, the disk must be formatted for use on PCs, although email is now normally used and the IGC file can be sent as an attachment. Appendix 1 para 1.1.1 gives the conditions for which the DATA program and the FR must produce a separate IGC flight data file. The DATA program file shall be the shortest software program that can transfer data from the FR to a PC and can help to ensure that data is in the hands of an OO at the earliest possible time after flight. For those FRs that have a more comprehensive manufacturer's software program in addition to the short program files, the DATA program provides a free and rapid option for data transfer in the absence of other programs. (AL5)

2.9.3.2.1 Last flight. On executing the DATA program, the data from the last flight must automatically be transferred to the PC to the same directory as the DATA program, without needing special switching or keyboard actions on the recorder. Transfer of the data on the last flight shall be as quick as possible (at competitions up to 100 FRs may be involved and long time transfers cannot be tolerated for obtaining individual IGC files). (AL5)

2.9.3.2.2 Options through menu. After the automatic transfer of the last flight, options must be offered through a menu for transferring data from other flights in the FR memory. The menu shall list all flights in the FR memory in reverse chronological order, giving the date/times of start and finish of recording and the duration of the recording. After the automatic transfer of the last flight, it must be possible to scroll to and highlight other flights for downloading either individually or collectively. If a selected flight is already in the PC memory, it shall be possible to bypass the further downloading of that particular flight. All erase and overwrite actions must have a second check keystroke to avoid inadvertent erasure or overwriting of data already in memory in the FR or the computer. (AL5)

2.9.3.2.3 Execution of program. No special switching or keyboard actions on the recorder shall be required for the DATA program to work, although a timeout function of at least 60 seconds is acceptable after the FR is switched on during which contact with a PC may be made. A 100kB IGC data file must transfer with full security encoding from the FR to a Pentium 100 PC in 1 minute or less. (AL5)

2.9.3.2.4 Ports. The DATA program must be capable of downloading via serial COM ports 1 and 2, and manufacturers shall include compatibility with other COM ports, LTP ports, USB ports, and shall allow (wherever possible) for any future commonly-available ports. For COM ports, only the port number is required; for other ports the three-letter designation of the port type plus the port number is required. For Example: DATA-XXX -pLPT1, or /pUSB2. (note the space between the file name and the switch). The DATA, COM and VALI files will be made available as freeware on the FAI internet reference: http://www.fai.org/gliding/gnss/freeware.asp (also through a link from http://www.fai.org/gliding/gnss), and manufacturers shall check from time to time that their program files are up to date. FR manufacturers must also distribute them as part of their normal software package to customers. (AL5)

2.9.3.2.5 Integrity of data. If a problem is detected in the integrity of the recorder or the data (such as if the recorder has been opened in an unauthorised manner) and the recorder has a screen display, the words describing the problem must stay on screen until positive action is taken to proceed to the next stage in the data transfer process. This is so that the person viewing the screen can take notice of the message, even if distracted when the message first comes up. (AL5)

2.9.3.3 Conversion to *.IGC Format - the CONV file. Unless data is always produced from the FR in the IGC file format, a separate program CONV-XXX.EXE or its Windows equivalent (Appendix 2) shall be provided. This shall produce an individual IGC file either for each time that the FR was switched off for more than 5 minutes, or for each flight recorded (detail, Appendix 1 para 1.1.1). For conversion of a flight data file, a short menu may be provided, otherwise for the DOS program, type "CONV-XXX" followed by a space and the name of the file to be converted, then "enter". The DOS file is not expected to exceed 100kb in size.

2.9.3.4 Programs. The DATA and CONV programs shall not need high PC speeds and large amounts of RAM, and must, when used for data transfer after flight, the DOS program must be capable of being used on a 1.4 Mb diskette (including a self-booting diskette) without any interaction with the PC Hard Disk or any other files. The DATA and CONV programs may be copyright but must be freeware and will be placed on the IGC GNSS web page for general access. FR manufacturers' programs which insert extra data into the FR (such as pilot and glider data, and lists of turn points), and/or conduct flight analysis, are not affected and are a matter between customers and the FR manufacturer.

2.9.3.4.1 Data transfer. It must be possible to transfer data from the secure storage medium of the FR directly to the serial port of a low-specification PC (such as at the glider on the field, using a 486/33 laptop PC) and to create the IGC file for the flight on the PC hard disk or a standard 1.4MB floppy disk by use of the DATA program. For this data transfer, the connector fitted to the body of the FR storage device must be one of the IGC options specified in para 2.7.2.2.7. This is so that pilots, OOs and competition organisers only have to provide facilities for the connectors specified rather than a larger number of other connectors. In addition to this basic method of transferring flight data from the FR storage to a PC, other methods of creating and storing the IGC file are permissible as long as the resulting IGC file is identical to that produced by the basic method, and satisfies any later checks made against the VALI program.

2.9.3.4.2 Other methods. These include the use of separate software programs which include data transfer (such as part of a manufacturer's integrated program for setup, transfer and analysis), also the use of PalmPCs and PC cards for data transfer from the FR storage so that storage of secure IGC files is ensured before the analysis and validation process. If in doubt about a particular type of device, consult GFAC beforehand. Such methods and devices will be tested by GFAC during the evaluation of the FR and any storage devices, to ensure that the IGC data file produced is identical to that produced after the basic process using the DATA program on a low-range PC. (AL4)

2.9.3.5 Digital Signature (DS) check - the VALI program. The program file VALI-XXX.EXE and its Windows equivalent (Appendix 3) shall be produced by an FR manufacturer for validating or authenticating the DS of the IGC-format file. There may be more than one type of program for different types of FR from a particular manufacturer, see the next sub-para. If there is an intermediate format (such as binary) which is transferred from the FR before conversion to the IGC format, it must be ensured that DS data is transferred to the IGC file during conversion, so that when using the VALI program with the IGC file, the check is a genuine one based on the data transferred from the FR. The VALI program may be copyright but shall be freeware, and may be copied by NACs. The DOS VALI program is not expected to exceed 100kb in size.

2.9.3.5.1 Operation of VALI program file. The VALI program must work without requiring other files or programs other than the flight data file it is checking and the PC operating system. For authentication of a flight data file, a short menu may be provided, otherwise for the DOS version type "VALI-XXX" followed by a space and the name of the file to be authenticated, then "enter". The result shall be presented clearly on screen, either pass or fail. If "pass", the words "Validation check passed, data indicated as correct" shall appear. If "fail", after "Validation check failed", a likely reason shall be given if possible, for instance "File data may have been altered", or "security microswitch may have operated, recorder case may have been opened". The result must remain on screen until a positive action is take to change it. NACs may copy the VALI file for use by their agents such as OOs, Data Analysts, and competition organisers. However, it should be assumed that anyone attempting to produce false flight data has access to the VALI file, and the complexity of the Digital Signature adjusted appropriately. Validation software must also work correctly if the CRLF at the end of a line is replaced by CR or LF. This will make it possible that a file transferred in ASCII mode from a MS operating system to a UNIX system and in binary mode from a UNIX system to a MS operating system, will continue to pass the VALI check. (AL5)"

2.9.3.6 Multiple Programs - File Names. If a manufacturer needs more than one program for different types of FRs, first the hyphen shall be deleted and a number added (DATA-XXX is followed by DATAXXX2). After XXX9 only the first two letters of the manufacturer's code shall be used, plus a number eg DATAXX10, XX11, etc.

2.9.3.7 Other ways of producing the short program file functions. It is a requirement that the DATA, CONV (where relevant) and VALI programs are produced, for placing on the IGC GNSS web pages for general use. In addition, other versions may be produced which fulfil the same functions, for instance as part of a manufacturer's more comprehensive program for the FR, as long as the resulting IGC flight data file continues to pass the check for security and integrity when this is carried out later at the NAC or FAI using the latest version of the VALI program (AL3)

2.10 **Accuracy of Pressure Altitude Sensor - Calibration and Resolution**. An IGC-approved FR must have a pressure-altitude sensor and is an electronic barograph in its own right. Electronic sensors used inside electronic barographs and FRs have settings that can be adjusted by the FR manufacturer for sea level pressure and there is also a gain setting for the rest of the altitude range. The output from the sensor system will be converted to digital altitudes through an Analogue-to-Digital converter and these digital altitudes will be used as the pressure altitude element in the IGC data file. The capability of the A-to-D converter (10-bit, 16-bit, etc) will govern the size of any steps (altitude resolution) in the altitude output to the IGC file, for which a limiting value is given below in 2.10.2. (AL6)

2.10.1 **Calibration**. The pressure altitude sensor adjustments must be set by the manufacturer so that the output corresponds closely to the FAI pressure altitude criteria (the ICAO International Standard Atmosphere, Document 7488 tables 3 and 4). Large corrections must be reduced by adjustment so that, for instance in competitions, constant reference to calibration tables for individual FRs can be avoided. On set-up and calibration before or immediately after initial sale:

(a) the sea level setting must correspond to the required ISA (1013.25 mb) within 1 millibar;
(b) up to an altitude of 2000 metres, calibration correction must be within 3 millibars;
(c)above 2000m, calibration correction must be within one percent of altitude.
(Source: Annex B to Sporting Code, Chapter 3).

If larger calibration corrections are found due to drift with elapsed time, it must be possible to re-set the altitude sensor to the above criteria by returning the FR either to the manufacturer or his authorised agent. Such agent must also be qualified to re-set security on re-sealing the FR.

2.10.2 **Size of pressure altitude steps - Resolution**. The maximum permissible step in digital recording of altitude in the IGC file is one third of a hectoPascal (millibar) throughout the height range of the FR. On the ICAO ISA at sea level, one hPa is 27.0 ft (8.23m) in altitude. Therefore, 0.33 hPa is 9 feet or 2.74m. The height difference for 1/3 hPa increases with altitude in accordance with the ICAO ISA. (AL6)

2.11 **Means of Propulsion (MoP) detection systems.** Although the ENL system is preferred, a number of types of MoP detection and recording systems have been IGC-approved for GNSS FRs. Tests will be carried out by GFAC and requirements for individual types of FRs will be given in the IGC-approval documents. Manufacturers must ensure that production standards and settings are the same as those in the FR that was tested and approved by GFAC, or the guidance which is published in the IGC-approval and other documents will not be valid. Individual recorders must be tested before sale to ensure that the MoP detection system is producing results similar to those described in Annex B of the IGC approval document for that type of recorder. (AL6)

2.11.1 Engine Noise Level (ENL) systems. These systems record a three-number ENL value with each fix. They must be capable of utilising all of the whole numbers between 000 and 999. ENL is the preferred method for recording MoP operation, because no wiring external to the FR is needed, nor any special mounting of the FR in the cockpit, nor, for IGC-approved ENL systems, is a specific engine-run needed on each flight to "prove" the system. However, in design, careful processing of the raw noise signal is required (frequency filtering and weighting) so that a MoP developing forward thrust always gives a characteristically high ENL value, whereas ENL values associated with normal gliding flight, are significantly lower, including aerodynamically noisy areas of flight such as high speed and flight with canopy panels open under sideslip conditions. (AL3)

2.11.1.1 Default settings. Where a motor glider Engine Noise (ENL) function is incorporated, the default setting must ensure that this function is enabled for ENL recording. This is because in gliders without a motor, an ENL record has still been found useful as additional evidence during flight analysis. See also 2.6.3.1 on preservation of memory data. (AL6)

2.11.1.2 Recorded ENL values. Figures at or close to the maximum ENL value of 999 should be recorded in the IGC file as a result of loud noises such as the running of 2-stroke engines under high power and with the GNSS FR in a typical position in a glider cockpit. Less noisy engines (4-stroke and Wankel (rotary) engines) may not produce such high figures, but must still result in ENL values over 750 (and preferably 800) when forward thrust is being produced, so that engine or propeller running can be clearly identified. At the other end of the scale, quiet gliding flight must result in low but positive ENL readings so that the system is seen to be self-checking with each fix. Periods showing 000 are not acceptable and figures varying around 020 should be achieved in quiet flight in a well-sealed sailplane. Other cockpit noises such as in gliding flight with cockpit ventilation and other panels open (with and without sideslip) must be recorded at sufficiently low values so that they cannot be mistaken for use of engine. In the case of sideslip with panels open at thermalling speeds, ENL should be less than 300 and preferably 200. See also Appendix 2 para 8.5 on flight testing of ENL systems. (AL6)

2.11.1.3 Covering the FR. In the event of the FR being covered either inadvertently or deliberately with noise-insulating material, the design must ensure that ENL levels are maintained as far as possible; this is also intended to cover the case of quieter engines such as those which are electrically-powered. (AL3)

2.11.1.4. GFAC ENL testing. It is strongly recommended that with a type of ENL system that is not yet IGC-approved, the recorder that is sent for initial GFAC testing has special facilities so that the frequency of peak sensitivity and also the ENL gain settings (and any other variables relevant to the ENL system concerned), can be adjusted by the GFAC tester. This is so that recorders for which the ENL settings are found unsatisfactory for IGC-approval, do not have to be returned to the manufacturer for adjustments that could easily have been made during GFAC testing itself. Experience has shown that a peak frequency sensitivity of between 50 and 100 Hz discriminates between engine noise (both 2- and 4-stroke) and cockpit noises during gliding flight. It is emphasised that an IGC-approval, once given, applies to all types of motor gliders worldwide. An ENL system must not only work with a noisy engine and a quiet, well sealed glider cockpit. Tests will also be made with quieter motor glider engines and in glide conditions of high cockpit noise such as with canopy panels open. For more detail on ENL tests, see Appendix 2 para 8.5. (AL6)

2.11.2 Vibration sensors. This is where vibration is recorded instead of noise levels, the results being shown as a three digit number in the IGC file in the same way as ENL values. Similar tests will be carried out to those for ENL systems, and similar readings are expected which must distinguish clearly between MoP generation of thrust, and gliding flight. However, correct vibration levels recorded will depend on firm mounting of the FR to the airframe, and soft mounting has been shown to result in no reading at all even when a powerful engine was in operation. To ensure that the FR mounting is transmitting the required vibration, the IGC-approval will normally require that an engine-run is carried out on each flight before the soaring performance, and that the FR cannot be moved during flight to a less-sensitive position. The FR unit must be firmly attached to a part of the glider structure that is capable of transmitting the vibration caused by the MoP to the case of the FR. The FR must be sealed to the glider unless the FR is out of reach of the flight crew and an engine run is carried out during the flight to prove the recording system. Where the FR is sealed by an OO to the glider structure, the engine-run which proves the system may be carried out at any time between sealing and unsealing the FR. (AL2)

2.11.3 Microswitch-based systems. These involve cabling external to the FR which runs to a microswitch which is permanently attached to a MoP function such as engine-bay doors, pylon erect or retract, etc. Operation of the microswitch causes a three-letter code to be generated and added to the IGC file for the appropriate time, signifying that the appropriate engine function has operated (for instance, EOF, EON, EUP, see para 7 of Appendix 1). The system must be fail-safe in the sense that failure must give an indication as if the MoP had operated. To ensure that the FR and cable are correctly connected and have remained connected during flight, the IGC-approval will normally require that the cable to the microswitch must be easy for an OO to inspect along its complete length to ensure that there are no breaks in it (unless they are sealed by an OO) and that other functions such as unauthorised switches are not attached to it. The motor sensor must be operated both before and after the flight performance with continuous operation of the FR in between, so as to mark the flight data file with the appropriate codes. (AL2)

APPENDIX 1
TO IGC SPECIFICATION FOR GNSS FRs

DATA FILE STANDARD FOR GNSS FLIGHT RECORDERS -
- THE IGC DATA FILE FORMAT

1. INTRODUCTION

1.1 Background, and IGC file production. The IGC Data File Standard was initially developed by a group consisting of representatives of IGC, glider FR manufacturers and a number of independent software developers mainly concerned with flight data analysis programs. After discussion and development during 1993 and 1994 it was initially defined in December 1994 and became part of official IGC/FAI documents after approval by IGC in March 1995. It has been refined and developed afterwards, through regular amendments. It provides a common world standard data format for the verification of badge, record, and competition flights to FAI/IGC criteria. The Standard may also be used by other FAI sports and activities.

1.1.1 Production of Flight Data File. It must be possible to produce a separate and complete IGC flight data file for each flight including all record types (para 2.2 following) relevant to the flight such as header records, flight declaration, etc. Two ways of achieving this are by continuous recording of fixes between the times that the FR was switched on and off, or, for FRs that have a "standby" state on switch-on, only recording fixes after pre-set movement and pressure-change thresholds are exceeded (ceasing recording when changes are below the thresholds, but see 1.1.1.2 on short periods without external power). (AL3)

1.1.1.1 Thresholds for starting and stopping recording, also Power-on Protocol for creating new IGC files. The following thresholds before fixes are recorded have been found suitable in the past: lat/long change, 10-15 km/hr; pressure altitude change, 1 metre per second for 5 seconds. Pre-takeoff and after-landing baselines of at least 20 fixes must be provided. For the pre-takeoff baseline, a small memory circuit can be used that continuously stores the appropriate number of previous fixes and, when movement is detected, puts them into the flight data record. After landing, this can be achieved by a time delay before stopping the recording of fixes. Since this condition may also apply to a period in wave or ridge lift with little or no vertical or horizontal movement, a new IGC file must not be started while power is still applied, even when no movement is being detected and no fixes are being recorded. Note that this "power-on protocol" is also needed for barograph calibrations so that a new file is not produced while the calibrator is making small adjustments to the pressure at each level of the calibration. A new IGC file is produced under the "Power-off Protocol" that is described under 1.1.1.2 below. (AL5)

1.1.1.2 Loss of external power for short periods - Power-off Protocol for creating new IGC files. To allow for events such as changing or switching batteries in flight, a period of 5 minutes with no external power shall be allowed to elapse before a new Flight Data File is created on powering up again. After this period has elapsed a new IGC file must be produced, so that if several flights are made on one day, each has a complete IGC data file of its own. (AL3)

1.1.1.3 Data transfer to a PC. If the data for several flights is held in the FR memory, it must be ensured that when the data is transferred, all record types in IGC files that are subsequent to the first file are those relevant to each subsequent individual flight. If any record types are changed between flights (such as declaration, pilot name, etc.) the changes must be included in the subsequent (but not previous) flight data files. (AL3)

1.2 **REVISION CONTROL**. The IGC flight data file format is revised through the normal amendment process for this document. See amendment procedures and list of amendment on page (i).

2. GENERAL

2.1 **FILE STRUCTURE**. An IGC-format file consists of lines of characters, each line giving a set of data such as for a GNSS fix. Each line starts with an upper-case letter denoting one of the Record types listed in para 2.2., and ends with CRLF (Carriage Return Line Feed). Each line is limited to 76 characters in length, excluding the CRLF which is hidden and does not appear in text form. Some Record types take up only one line, some such as task and header take up several lines. For instance, the task/declaration (C) Record includes a line for each Waypoint, and the Header (H) Record includes separate lines for GNSS FR type, pilot name, glider identification, etc. The order of Record types within an IGC file is given in para 2.3. Some Record types occur only in only one place in the file (single instance Records), others such as fixes re-occur as time progresses (multiple instance Records). Only characters listed as valid in para 6 shall be used in the file. If others such as accented characters (acutes, hatcheks, umlauts, etc) in names of airfields and turn points, are used in a manufacturer's proprietary (original) file format, such characters shall be converted to a valid character as part of the conversion to the IGC format. This is so that analysis programs designed for the IGC format do not have to recognise non-standard characters.

2.2 **RECORD TYPES**. The Record types are prefixed by upper case letters as follows:

IGC DATA FILE FORMAT - RECORD TYPE IDENTIFICATION LETTERS	
A - FR manufacturer and identification B - Fix C - Task/declaration D - Differential GPS E - Event F - Constellation G - Security	H - File header I - List of extension data included at end of each fix (B) Record J - List of data included in each extension (K) Record K - Extension data L - Logbook/comments M, N, etc. - Spare

2.3 **RECORD ORDER**. The FR I/D (A) Record is always the first in the file and the last is the Security (G) Record. After the single-line A record is the multi-line Header (H) Record, followed by the I and J Records that list extension data which applies to later Record types in the file. These are followed by other Record types indicating that certain data is recorded in the file, including the task/declaration (C) Record, and the initial Satellite Constellation (F). Time-specific Records follow, placed in the file in time order using either GNSS fix-time (if the GNSS is locked on) or the FR Real Time Clock (RTC); these are B (fix), E (event), F (constellation change) & K (extension data). The logbook/comments (L) Record data may be placed anywhere after the H, I and J Records and can have several lines throughout the file depending on the nature of the comments included.

The following sequence of Record types is typical, although in a real flight data file there will be many more fix (B) record lines than shown here:

IGC DATA FILE FORMAT - ORDER OF RECORD TYPES IN AN IGC FILE	
A - FR manufacturer and identification (always first) H - File header I - Fix extension list, of data added at end of each B record J - Extension list of data in each K record line C - Task/declaration (if used) L - Logbook/comments (if used) D - Differential GPS (if used) F - Initial Satellite Constellation B - Fix plus any extension data listed in I Record B - Fix plus any extension data listed in I Record E - Pilot Event (PEV) B - Fix plus any extension data listed in I Record K - Extension data as defined in J Record	B - Fix plus any extension data listed in I Record B - Fix plus any extension data listed in I Record F - Constellation change B - Fix plus any extension data listed in I Record K - Extension data as defined in J Record B - Fix plus any extension data listed in I Record E - Pilot Event (PEV) B - Fix plus any extension data listed in I Record B - Fix plus any extension data listed in I Record B - Fix plus any extension data listed in I Record K - Extension data as defined in J Record L - Logbook/comments (if used) G - Security record (always last)

2.4 **UNITS**. Data in the IGC file shall use the following unit system:
Time - UTC. Note that UTC is not the same as GPS internal system time which is different by 13 seconds in 2003 due to the addition of 'leap seconds' since the GPS system first became operational in January 1980. The correction to UTC available within the GPS system must be applied to time data in IGC files. (AL6)
Distance - Kilometres and decimal kilometres. For FAI/IGC conversions from feet and miles, see para 2.6.8 (AL6)
Speed - Kilometres per hour. For FAI/IGC conversions from nautical miles per hour (knots) and statute miles per hour (mph), see para 2.6.8 (AL6)
Date (of the first line in the B record) - UTC DDMMYY (day, month, year). See para 2.5.4 (AL6)

Direction - True
Lat/Long - Degrees, minutes and decimal minutes with N,S,E,W designators
Altitude - Metres, separate GNSS and pressure values.
Pressure - Hectopascals (the same as millibars) to two decimal places, for instance altimeter subscale setting, but see * below under PPPPpp

The above items shall be recorded in the flight log as follows:

Time - HHMMSSsss (UTC)
HH - Hours fixed to 2 digits with leading 0 where necessary
MM - Minutes fixed to 2 digits with leading 0 where necessary
SS - Seconds fixed to 2 digits with leading 0 whre necessary
sss - number of direction decimals (the number of fields recorded are those available for direction in the Record concerned, less fields already used for HHNNSS)

Distance - DDDDddd, kilometres up to 9999 with leading zeros as required and then three decimal places (that is, the last figure is metres)

Speed - SSSsss
SSS - fixed to 3 digits with leading 0
sss - number of speed decimals (the number of fields recorded are those available for speed in the Record concerned, less fields already used for SSS)

Date - DDMMYY
DD - number of the day in the month, fixed to 2 digits with leading 0 where necessary
MM - number of the month in year, fixed to 2 digits with leading 0 where necessary
YY - number of the year modulo 100, fixed to 2 digits with leading 0 where necessary

Direction DDDddd
DDD - fixed to 3 digits with leading 0 where necessary
ddd - number of direction decimals (the number of fields recorded are those available for direction in the Record concerned, less fields already used for DDD)

Lat/Long - D D M M m m m N D D D M M m m m E
DD - Latitude degrees with leading 0 where necessary
DDD - Longitude degrees with leading 0 or 00 where necessary
MMmmmNSEW - Lat/Long minutes with leading 0 where necessary, 3 decimal places of minutes (mandatory, not optional), followed by North, South, East or West letter as appropriate

Altitude - AAAAAaaa
AAAAA - fixed to 5 digits with leading 0
aaa - number of altitude decimals (the number of fields recorded are those available for altitude in the Record concerned, less fields already used for AAAAA)

PPPPpp - Pressure in hPa (mb) with two decimal places, PPPPpp fixed to 6 digits with leading zero for settings in the 900 range). For altimeter subscale settings, 1013.25 mb (ISA Sea Level) has an PPPPpp code of 101325, and 980 mb has a code of 098000.
* An altimeter setting (and any change to it) may be recorded, for instance where the FR feeds a cockpit display (three-letter code ATS, see para 7). However, it must not be used to change the pressure altitude recorded with each fix in the IGC file, which must remain with respect to the ISA sea level datum (1013.25 mb) at all times.

GNSS Altitude. Where GNSS altitude is not available from GNSS position-lines such as in the case of a 2D fix (altitude drop-out), it shall be recorded in the IGC format file as zero so that the lack of valid GNSS altitude can be clearly seen during post-flight analysis. (AL3)

2.5 **FILE NAMING**

2.5.1 Short file name style: YMDCXXXF.IGC

Y = Year; value 0 to 9, cycling every 10 years
M = Month; value 1 to 9 then A for 10, B=11, C=12.
D = Day; value 1 to 9 then A=10, B=11, C=12, D=13, E=14, F=15, G=16, H=17, I=18, J=19, K=20, L=21, M=22, N=23, O=24, P=25, Q=26, R=27, S=28, T=29, U=30, V=31.
C = manufacturer's IGC code letter (see table below)
XXX = unique FR Serial Number (S/N); 3 alphanumeric characters
F = Flight number of the day; 1 to 9 then, if needed, A=10 through to Z=35

2.5.2 Long file name style. This uses a full set of characters in each field, a hyphen separating each field. For instance, if the short name for a file from manufacturer X is 36HXABC2.IGC, the equivalent long file name is 2003-06-17-XXX-ABC-02.IGC. Long file names may be generated by software that is compatible with long file names, although the DOS versions of the DATA, CONV and VALI programs must continue to generate and use short file names. (AL3)

2.5.3 FR Serial Number (S/N). The three-character FR S/N must be used in the A-record and be imprinted on the case of the recorder unless there is an easily-accessible electronic display which includes the S/N.

2.5.3.1 Existing FRs using serial numbers with coded systems where the XXX translates to a different five-number numerical code which is used in the A-record, have "Grandfather Rights" and do not need to be changed. New FRs must use the three-alphanumeric system described above.

2.5.4. Date of flight - the date used in the file name and in the H-record (DTE code) is the UTC date of the first valid fix in the flight log transferred after flight. That is, the date applicable to the time in the first line in the B (fix) record, not the date at the time of switching on, or of take-off. This is particularly important for recorders operated in time zones where they are switched on close to midnight UTC. (AL6)

2.5.5. Security of file name. The file name is not protected by the electronic security system, which only applies to data within the file itself (see chapter 2, para 2.8). File names may be changed for specific purposes such as competitions, where it may be found more convenient to change from the IGC name system in which the file is originally transferred from the FR (para 2.5), to a system using glider competition number or pilot name. No loss of data or security occurs, since all of the data in the IGC file name is repeated in the file itself in the A and H records. (AL2) Example:
16AFXYZ2.IGC = 10 June 2001, Filser FR number XYZ, Flight 2 of the day.

2.5.6 Manufacturer codes. Single- and three-character codes are tabulated below. Manufacturers applying and paying the fee for IGC-approval who are not listed should apply to the Chairman of GFAC for allocation of codes. Manufacturers using the IGC file format but not applying for IGC-approval should use the X and XXX codes, see note 2 at the end:

IGC DATA FILE FORMAT - CODES FOR MANUFACTURERS OF IGC-APPROVED FLIGHT RECORDERS (AL5)

Single Char. Code	Three Char. Code	Manufacturer's Name	Single Char. Code	Three Char. Code	Manufacturer's Name
A	GCS	Garrecht	S	SDI	Streamline Data Instruments
B			T		
C	CAM	Cambridge	U		
D			V		
E	EWA	EW Avionics	W	WES	Westerboer
F	FIL	Filser	X	XXX	Other manufacturers, see note below

G			Y		
H	SCH	Scheffel	Z	ZAN	Zander
I			0		
J			1		
K			2		
L	LXN	LX Navigation	3		
M			4		
N			5		
O			6		
P	PES	Peschges	7		
Q			8		
R	PRT	Print Technik	9		

Notes:

1. Where possible, the initial letter of a manufacturer's name will be allocated for the single-character code. Where this letter is already allocated, the next letter in the manufacturer's name will be used, and so forth.

2. X and XXX are general designations for IGC format files from manufacturers who do not produce an IGC-approved recorder. Such recorders will not have been tested and evaluated by GFAC and may not fulfil certain aspects of the IGC Specification such as security protections, recording of pressure altitude, ENL or other variables. There is no guarantee that the file will conform exactly to the IGC format, although specimen files will be checked for compliance with the IGC format if emailed to the GFAC chairman for evaluation. Even after this procedure, no compliance guarantee can be made because the type of recorder will not have completed a full GFAC evaluation. It should be noted that although the file name will not contain the information, the details of the manufacturer and the recorder model concerned will be identifiable (if the file conforms to the IGC standard) because they will be included in the H (Header) record, see below under H Record in the line: HFFTYFRTYPE:MANUFACTURERSNAME,FRMODELNUMBER CRLF

3. The three-letter codes PFC, PLT and OOI will not be used since they could cause confusion in the L record.

2.5.7 Mandatory Records. Certain records are mandatory for any IGC file. They are summarised as follows:

Record type in file order	**Appendix 1 reference**	**Remarks**
A	3.1	Manufacturer and unique ID for FR
H	3.3.1	Header record
I	3.4	FXA extension is mandatory
B	4.1	Fix record (lat/long/alt etc.)
F	4.2	Satellites used in B records
G	3.2	Security record

3 **SINGLE INSTANCE DATA RECORDS**. These records only occur once in each IGC-format data file, but each record type may contain several lines prefixed with its type letter.

3.1 **A RECORD - FR ID NUMBER**. The A Record must be the first record in an FR Data File, and includes the three-character GNSS FR Serial Number (S/N) unique to the manufacturer of the FR that recorded the flight (AL3). Format of the A Record:

A M M M N N N T E X T S T R I N G CR LF

A record - Description	Size	Element	Remarks
Manufacturer	3 bytes	MMM	Alphanumeric, see para 2.5.6
Unique ID	3 bytes	NNN	Valid characters alphanumeric (AL3)
ID extension	Optional	TEXT STRING	Valid characters alphanumeric

3.2 **G RECORD - SECURITY**. The G Record verifies that the data has not been altered during or following the flight. The FR manufacturer must provide a VALI program (see para 2.9.3.4 in the main body of this document) to check the integrity of the file with the security code. The security code must be generated by the FR, not by the computer extracting the flight data. Flight analysis software from sources other than the manufacturer should ignore the detailed data in this record, but can use the G record as a marker for the position of other data and records in the IGC file. All records must be included in the security mechanism, except the H records which have the O or P source, and any L records which do not have the Manufacturer ID (because some L records may be put in by the pilot).

Format of G Record:
G S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S CR LF
G S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S CR LF
G S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S CR LF
G S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S CR LF
G S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S CR LF
G S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S S CR LF
etc

G record - Description	Size	Element	Remarks
Security code	Up to 75 bytes per line	SSSSS	Valid characters alphanumeric, see Chapter 2, para 2.8.3.1 on security key length. (AL3)

The G Record must not use any non-printing character, because whitespace is often removed when ASCII files are transmitted across data communication networks.

3.3 **H RECORD - FILE HEADER** The H-Record is used to store data such as the date on which fixes are first recorded in the B-Record of the IGC file (that is, the day of a flight unless made in a time zone many hours from UTC), the name of the pilot, glider, the type of FR used, the type of GNSS receiver and pressure altitude sensor, amongst other things. There are several different subtypes of the H-Record which are recorded on separate lines prefixed H. All Three Letter Codes (CCC) that bear the H flag in section 7 are possible subtypes of the H-Record.

The line entries in the H-record may be created by the FR (source code F), or, for items such as pilot and glider names, by the Pilot or OO (P and O source records) either before or after flight. Only H-Record data with source code F is covered by the security code and VALI check system.

The general format of the H-Record is: record identifier, source of information (S), record subtype identifer (CCC), long name of the record subtype, colon, actual information (TEXTSTRING). The long name is intended as an aid for people reading the file. For official purposes only the source of information, the record subtype (CCC) and the actual information are definitive.

GNSS Geodetic Datum. The long name, a colon and the name of the Geodetic Datum set (WGS84 = IGC number 100, see para 8) come after the IGC-assigned number for the GPS-Datum, which is located directly behind the record subtype identifer DTM.

3.3.1 Required records. The following H records are required, in the order given below:

HFDTEDDMMYY CRLF
HFFXAAAA CRLF
HPPLTPILOT:TEXTSTRING CRLF
HPGTYGLIDERTYPE:TEXTSTRING CRLF
HPGIDGLIDERID:TEXTSTRING CRLF
HFDTMNNNGPSDATUM:TEXTSTRING CRLF
HFRFWFIRMWAREVERSION:TEXTSTRING CRLF
HFRHWHARDWAREVERSION:TEXTSTRING CRLF
HFFTYFRTYPE:MANUFACTURERSNAME,FRMODELNUMBER CRLF
HFGPS:MANUFACTURERSNAME,MODEL,CHANNELS,MAXALT CRLF (AL3)
HFPRSPRESSALTSENSOR:MANUFACTURERSNAME,MODEL,MAXALT CR LF (AL3)

H record - Description	**Size**	**Element**	**Remarks**
Data source	1 byte	F, O or P	Placed after leading H: F=FR,O=OO, P=Pilot. Use F if the data is transferred from the FR even though it was originally entered by a pilot or OO. This is to ensure that data that is entered before flight is protected by the security system in the recorder, and if it is changed after flight it will fail the VALI check.
Record subtype	3 bytes	CCC	Alphanumeric, placed after data source, see para 7 for TLCs
UTC Date	6 bytes	DDMMYY	Valid characters 0-9
FXA accuracy category, metres	3 bytes	AAA	Valid characters 0-9 (Default 500)
Lines on Glider and Pilot	As required	Text String	After relevant TLC (eg PLT for Pilot name)
GPS Datum	3 bytes	NNN	WGS 84 must be used, 100 =WGS84 (see para 8)
Lines on FR name, firmware, hardware	As required	Text String	After relevant TLC (eg FTY for FR type)
HFGPS line	As required	Text String	Gives the GPS engine manufacturer and type, number of channels, and the maximum GNSS altitude in metres that could be recorded in the IGC file. Use comma separators between each piece of information. For the Russian GLONASS system use the code GLO instead of GPS (listed in para 7). If another GNSS system is used, apply to GFAC for an appropriate three-letter code. (AL3)
HFPRS line	As required	Text String	Gives the pressure altitude sensor (Manufacturer and type) and maximum pressure altitude in metres that could be recorded in the IGC file. Use comma separators between each piece of information. (AL3)

HF FRS line	As required	Text String	Format: HF FRS SECURITY SUSPECT USE VALI PROGRAM: TEXTSTRING CRLF Must be used where security is suspect, for instance if the recorder's physical security system (microswitch) has operated. The words before the colon are mandatory. The reason for referring to the VALI program is that this is the only complete way of carrying out a full security check. This must not be seen as a replacement for the full VALI check, which also detects any changes after data transfer. The text string shall be a description of the likely fault, such as: "Security Microswitch operated, recorder needs to be re-set" (AL6)

3.3.2 Additional H records. These are optional. Additional data may be appended after the mandatory records. Two additional records (Comp ID and class) are shown below.
H S C I D C O M P E T I T I O N I D : T E X T S T R I N G CR LF
H S C C L C O M P E T I T I O N C L A S S : T E X T S T R I N G CR LF

3.3.3 Names and identifications.

Similar names. Where there may be people with names which are similar or the same (Smith/Schmidt), full initials or other names should be used. In addition, a TLC of DOB for Date-of-Birth is available, and if used, this must be in the line following the pilot's name in the format DDMMYY (the same format as used for date of flight in the H record).

Name of any second crew member (code SCM), family name first then other names or initials without punctuation but separated by spaces (for instance, SMITH B S, or SMITH BERNALD)

Sufficient characters should be made available to allow for long names and identifications. Such as, for glider registration, allow for a registration such as XXXX-AAAA (where XXXX is the designator of the Nation or National Airsport Body), requiring at least 9 characters to be available in this field. Manufacturers should provide for more rather than less characters in these fields so that flight declarations are easily made in full (AL3).

Club or organisation from which flown or operated (code CLB), with nation (for instance LASHAM UK, ELMIRA US). Where there is not space to put the Nation in full, the two-letter codes from the ISO 3166 list of National designators should be used (these are also used for Nations in Internet addresses). Some ISO 3166 two-letter National Codes are as follows (AL3):

ISO 3166 TWO-LETTER NATIONAL CODES		
AR - ARGENTINA AT - AUSTRIA AU - AUSTRALIA BE - BELGIUM BR - BRAZIL CA - CANADA CH - SWITZERLAND CL - CHILE CN - CHINA CO - COLOMBIA CZ - CZECH REPUBLIC DE - GERMANY DK - DENMARK EC - ECUADOREE - ESTONIA EG - EGYPT ES - SPAIN	FI - FINLAND FR - FRANCE GR - GREECE HR - CROATIA (HRVATSKA) HU - HUNGARY ID - INDONESIA IE - IRELAND IL - ISRAEL IN - INDIA IS - ICELAND IT - ITALY JP - JAPAN KR - KOREA (S) LT - LITHUANIALV - LATVIA MX - MEXICO MY - MALAYSIA	NL - NETHERLANDS NO - NORWAY NZ - NEW ZEALAND PL - POLAND PT - PORTUGAL RU - RUSSIA SE - SWEDEN SI - SLOVENIA SK - SLOVAKIA TR - TURKEY TW - TAIWAN UK - UNITED KINGDOM US - UNITED STATES UY - URUGUAYVE - VENEZUELA ZA - SOUTH AFRICA

3.4 **I RECORD - EXTENSIONS TO THE FIX (B) RECORD**. The I record defines any extensions to the fix (B) Record in the form of a list of the appropriate Three-Letter Codes (CCC), data for which will appear at the end of subsequent B Records. Only one I-Record line is included in each file, located after the H record and before the first B Record. The Fix Accuracy (FXA) must be included, in the form of the Estimated Position Error figure (see

Glossary under EPE). This shall be followed by SIU and ENL if these are recorded in the FR concerned. Note that although the SIU number is optional in the B record, the F Record (satellite constellation used) is mandatory, see para 4.3. The format of the I Record is as follows:

I N N S S F F C C C S S F F C C C CR LF

I Record - Description	Size	Element	Remarks
Number of extensions	2 bytes	NN	Valid characters 0-9
Start byte number	2 bytes	SS	Valid characters 0-9
Finish byte number	2 bytes	FF	Valid characters 0-9
3-letter Code	3 bytes	CCC	Alphanumeric, see para 7 for list of codes

The byte count starts from the beginning of the B Record, taking the first B in the line as byte one. Example:

I 01 36 40 FXA CR LF
This shows that Fix Accuracy (FXA) is recorded between bytes 36 and 40 on each B-record line. And, for a device that also records Satellites In Use (SIU) and Engine Noise Level (ENL):

I 03 36 38 FXA 39 40 SIU 41 43 ENL CR LF
This shows that on each B-record line, Fix Accuracy (FXA) is recorded between bytes 36 and 38, Satellites In Use (SIU) between bytes 39 and 40, and Engine Noise Level (ENL) between bytes 41 and 43. To aid clarity, some spaces have been inserted in the example line above, these should not be used in the actual B record in the IGC file.

3.5 **J RECORD - EXTENSIONS TO THE K RECORD**. The K record is used for data that needs to be updated as a flight progresses but is not required as often as fix (B) Records. The J record is a single line that defines what data will be in subsequent K-record lines. It fulfils the same function for the K Record as the I Record (3.4 above) does for the fix (B) record, and operates in the same way. It is placed in the file immediately after the I record line, before the first B Record. The format of the J Record is as follows:

J N N S S F F C C C S S F F C C C CR LF

Description	Size	Element	Remarks
Number of extensions	2 bytes	NN	Valid characters 0-9
Start byte number	2 bytes	SS	Valid characters 0-9 (from start of K Record)
Finish byte number	2 bytes	FF	Valid characters 0-9
3-letter Code	3 bytes	CCC	Alphanumeric, see para 7

Example:
J 0 1 0 8 1 2 H D T CR LF

This shows that True Heading (HDT) is recorded between bytes 8 and 12 on each K-record line.

3.6 **C RECORD - TASK**. The C Record is used to specify tasks and to make flight declarations. It is placed in the IGC file before the first fix (B) record and after the H, I and J records.

3.6.1 Lines in the C Record. The first line contains the UTC-date and UTC-time of the declaration, the local date of the intended day of flight, the task ID, the number of turn points of the task and a textstring which can be used to describe the task (500k triangle, etc). The recorder must be configured so that a pilot can enter the intended flight date in local time, not the UTC date which will be different in countries with large time offsets from UTC (The Three-Letter Code for Time Zone Offset is TZN, see the list in para 7). The other lines contain the WGS84 lat/long coordinates and a textstring for the place or point concerned. These include the take-off airfield, start point, turn points, finish point and landing airfield. After the first line, the other lines contain the WGS84 lat/long co-ordinates of the point followed by a text string for the place or point concerned. The text describing the type of point (see example below) is mandatory so that the nature of the points can be clearly seen by viewing the IGC file, other text descriptions of the point are optional. (AL6)

3.6.2 IGC terminology. "Waypoint or way point " refers to a either a start-, turn- or finish-point. The term "Turn Point" refers to a point in a measured course between the start and finish point. The points that must be specified exactly in an official IGC flight declaration are the intended start-, turn- and finish-points (Sporting Code Section 3, para 4.2). The number of turn points will be nil for a straight goal flight, one for an out-and-return, two for a triangle, three for 3-TP distance, more for some competition tasks. (AL6)

3.6.3 Takeoff and Landing. The two lines in the C-record format for takeoff airfield and landing airfield (or out-landing location if this applies), are for general information rather than being part of the official IGC Flight Declaration. They can be entered approximately or, if the co-ordinates are difficult to obtain or are not entered, the recorder shall default to 00000000N000000000E for these two lines. (AL6)

3.6.4 Number of Turn points and C-Record lines. From the above it can be seen that the number of turn points will be four less than the number of lines after line 1 (that is, those lines that contain lat/long data). These four non-turn point data lines are for takeoff airfield, exact start, exact finish, and landing airfield/location. The number of turn points is included as a sub-field in line 1 of the C-record and is placed immediately before the optional text string at the end of the line (in the form TT in the illustration below). (AL6)

3.6.5 Area Tasks. The incorporation of this facility in a Flight Recorder is optional. In some competitions, an area to be reached is specified with respect to a Waypoint in terms of distances and true bearings from the point. If a recorder has a facility to enter this in the C record, the following system shall be followed in the IGC file: At the end of the relevant Waypoint line in the C record, minimum and maximum distances follow in kilometers from the WP, followed by bearing 1 and bearing 2 in degrees true from the WP and then the word AREA after the type of point. In the case of competitions using units other than kilometres (such as statute or international nautical miles), a conversion must be made so that the IGC file continues to be in kilometres (and decimal kilometres as necessary). The area is clockwise from bearing 1 to 2. In the case of circular areas round a point the two bearings used shall be 000 to 360 and the minimum distance will be zero. Where an area referenced to a Waypoint is to be specified, after the C record line that defines the Waypoint but before CRLF at the end of the line, add: "DDDDdddDDDDdddBBBbbbBBBbbbAREA"
The two distances Dd are first minimum distance from the WP in km and decimal kilometres, then maximum distance. The two bearings Bb are in degrees and decimal degrees true from the WP, the task area extending clockwise from bearing 1 to 2.
For instance: "C....0012000 0032000 122000 182000TURN AREA" would be an area from 12 to 32 km from the WP between the bearings 122 and 182 from the Point. (AL6)

The format of C Record is as follows, using N latitude and E longitude for the example:

C D D M M Y Y H H M M S S F D F M F Y I I I I T T T E X T S T R I N G CR LF
C D D M M M M M N D D D M M M M M E TAKEOFF CR LF
C D D M M M M M N D D D M M M M M E START CR LF
C D D M M M M M N D D D M M M M M E TURN CR LF
C D D M M M M M N D D D M M M M M E TURN CR LF
C D D M M M M M N D D D M M M M M E FINISH CR LF
C D D M M M M M N D D D M M M M M E LANDING CR LF

And for an area referenced to a Turn Point:
C DD MMMMMN DDD MMMMME 0012000 0032000 122000 182000TURN AREA CR LF (AL6)

C record - Description	Size	Element	Remarks
Date UTC	6 bytes	DDMMYY	Valid characters 0-9
Time UTC	6 bytes	HHMMSS	Valid characters 0-9

<table>
<tr><td>Flight date</td><td>6 bytes</td><td>FDFMFY</td><td>Valid characters 0-9, taken from the FR, if not used, fill with zeros (AL2)</td></tr>
<tr><td>Task number on the day</td><td>4 bytes</td><td>IIII</td><td>Valid characters alphanumeric, may be an ID reference or a 1-2-3 sequence. The last declaration before takeoff is the definitive declaration (a task need not be declared on the day of the flight, an electronic declaration is valid until superseded by another valid declaration).</td></tr>
<tr><td>Number of Task TPs</td><td>2 bytes</td><td>TT</td><td>Valid characters 0-9. 1 for an out-and-return, two for a triangle, etc.</td></tr>
<tr><td>TO or A/F LatLon</td><td rowspan="6">17 bytes</td><td rowspan="6">DDMMmmmN
DDDMMmmmE
to the WGS84 Geodetic Datum</td><td rowspan="6">Plus textstring for any local turn point code numbers, letters, name or brief description, but the latitude and longitude is definitive. The declared start point, turn points, and the finish point with their Latitude and Longitude are mandatory; the takeoff/landing or airfield data are not part of the IGC declaration requirement given in the Sporting Code for Gliding (SC3) but are useful extra data particularly where remote starts or finishes are used. If the coordinates of a point which is not part of the official task are difficult to include beforehand (such as takeoff, landing, or the fields for takeoff and landing), they should be set to 00000000N000000000E.</td></tr>
<tr><td>Start LatLon</td></tr>
<tr><td>T/P LatLon</td></tr>
<tr><td>T/P LatLon</td></tr>
<tr><td>Finish LatLon</td></tr>
<tr><td>Land or A/F LatLon</td></tr>
</table>

3.7 **D RECORD - DIFFERENTIAL GPS**. This indicates that differential GPS is being used. It is placed in the IGC file before the first fix (B) record after the H, I, J and C records. The format of the D Record is as follows:

D Q S S S S CR LF

Description	Size	Element	Remarks
GPS Qualifier	1 byte	Q	Use 1=GPS, 2=DGPS
DGPS Station ID	4 bytes	SSSS	

These parameters correspond to the NMEA GGA GPS quality indication. The absence of a D Record indicates that differential GPS was not used. Any use of DGPS is subject to GFAC approval, and it must be shown that the use of GPS preserves the integrity of basic lat/long and other flight data.

4. **MULTIPLE INSTANCE DATA RECORDS**. These are record types that can re-occur at different times in the course of the IGC file, unlike single instance records that occur in each file only in one place.

4.1 **B RECORD - FIX**. Not counting the last CRLF, this includes 35 bytes for its basic data plus those for characters that are defined in the I Record. Such as Fix Accuracy (FXA, in the form of the Estimated Position Error figure, see Glossary under EPE), Satellites In Use (SIU, optional) and Engine Noise Level (ENL for motor gliders, optional). The required basic data is: UTC, WGS84latitude, WGS84 longitude, fix validity, Fix Accuracy, pressure altitude and GNSS-altitude. All of the information within each B-record must have a data issue time within 0.1 seconds of the time given in the B-record. Where NMEA data is used within the FR, fix data should be taken either from the GGA or GNS sentences. GGA is specific to the US GPS system. GNS is intended for all GNSS systems (GPS, GLONASS, Galileo and future systems), and should be used if it is available from the GNSS board installed. The three characters for FXA and two for satellites in use (SIU), should be derived from parts of the fix sentence used and are described in both the NMEA GGA and GNS as `Horizontal DOP' and `number of satellites in use'. In the B Record FXA (HDOP) should be recorded as a three-figure group in metres and SIU as a two group number. SIU is an optional record and may be used to back up the more detailed satellite data in the mandatory F-record. Leading zeros should be included as necessary. Because earlier IGC-approved GNSS FRs may not have FXA and SIU in their B-records, the position of this data in each B record line must be indicated (for instance to analysis programs) by including them in the I record which designates the positions of additional fields in the B record. FXA should be placed after the two groups for altitude, followed by optional fields such as SIU and then ENL for Motor Gliders. In each B-record line, FXA would therefore normally occupy bytes 36, 37 and 38, SIU bytes 39 and 40, ENL either 39-41 or 41-43 depending whether SIU is used. The format of the basic data is:

B H H M M S S D D M M M M M N D D D M M M M M E V P P P P P G G G G G CR LF

B record - Description	**Size**	**Element**	**Remarks**
Time UTC	6 bytes	HHMMSS	Valid characters 0-9
Latitude	8 bytes	DDMMmmmN/S	Valid characters N, S, 0-9
Longitude	9 bytes	DDDMMmmmE/W	Valid characters E,W, 0-9
Fix validity	1 byte.	A or V	Use A in the IGC file to denote a 3-D fix and V for a 2-D fix. Where data in NMEA format is used within the FR, in the GSA sentence (DOP and active satellites), put A in the IGC file for GSA mode 3, and V for GSA mode 2. In the future, other characters may be used in this field in the B record to denote other meanings, and will be notified in future amendments. (AL4).
Press Alt.	5 bytes	PPPPP	Altitude to the ICAO ISA above the 1013.25 HPa sea level datum, valid characters 0-9
GNSS Alt.	5 bytes	GGGGG	Altitude above the WGS84 ellipsoid, valid characters 0-9

To append the Fix Accuracy (FXA, mandatory), Satellites in Use (SIU, optional) and Engine Noise Level (ENL, optional) or any other variable to each fix, these have to be defined earlier in the I Record (so that, for instance, they will be recognised by analysis programs). For instance:

I 0 3 3 6 3 8 F X A 3 9 4 0 S I U 4 1 4 3 E N L CR LF

and the resulting B Record becomes:

B H H M M S S D D M M M M M N D D D M M M M M E V P P P P P
G G G G G A A A S S N N N CR LF

B record - Description	**Code**	**Size**	**Element**	**Remarks**
Fix Accuracy	FXA	3 bytes	AAA	Valid characters 0-9, metres, mandatory parameter after Amendment 4
Satellites in Use	SIU	2 bytes	S S	Valid characters 0-9
Engine noise	ENL	3 bytes	NNN	Valid characters 0-9

4.2 **E RECORD - EVENTS**. The E-record records specific events on the IGC file, typically a pilot-initiated event (PEV code). It is placed before the individual fix (B) Record for the same time that records where and when the event occurred. Events must have a Three Letter Code (TLC) from section 7. More than one event record may be used at the same time, but Events initiated within the FR (as opposed to by the pilot) are only expected to be occasional in the time-history of the flight file and should not be used for making additional records with every fix. This may confuse the analysis programs designed for use with this file format, which often search for and highlight event records. If a FR manufacturer wishes to insert additional information with each fix, this should be through an extension to the B record, first listing the information Code (CCC) in the I-record.

If a manufacturer wants to add a new type of event, a new Three Letter Code (para 7) should be requested from GFAC. The manufacturer must provide an exact definition of the event and a proposed coding. GFAC may decide that the proposal should not be treated as an event but that the information should be incorporated into the B- or K-record in the normal way for these records by listing in the I and J records.

The form of the E-Record is record identifer, time, TLC, textstring. Some examples follow:

E 1 0 4 5 3 3 P E V CR LF
B 1 0 4 5 3 3 4 9 4 5 3 3 3 N 0 1 1 3 2 4 4 4 E A 0 1 3 5 7 0 1 5 0 1 CR LF
This indicates a pilot initiated event (PEV) at 10:45:33 UTC, and the associated B record shows the location 49:45.333 N 11:32.444 E, at the pressure altitude 1357 metres and GNSS altitude 1501 metres.

Some events require more than just the TLC for interpretation:
E 1 0 4 5 4 4 A T S 1 0 2 3 1 2 CR LF
The altimeter setting in a display device connected to the FR was changed to 1023.12 hPa at the time 10:45:44

E 1 0 4 5 5 5 E O N CR LF
B 1 0 4 5 5 5 4 9 4 5 3 3 3 N 0 1 1 3 2 4 4 4 E A 0 1 3 3 7 0 1 5 6 7 CR LF
The engine was turned on (EON) at 10:45:55 UTC, and the B record shows the location 49:45.333 N 11:32.444 E, at the pressure altitude 1337 metres and GNSS altitude 1567 metres.

E 1 0 4 7 3 3 C G D 1 0 3 CR LF
The geodetic datum was changed to Bessel (IGC number 103, see para 8) at 10:47:33 UTC.
This would invalidate the recording for IGC purposes, for which WGS84 must be used.

4.3 **F RECORD - SATELLITE CONSTELLATION**.
This has been a mandatory record since 2001. For the US GPS system, the satellite ID for each satellite is the PRN of the satellite in question, for other satellite systems the ID will be assigned by GFAC as the need arises. Where NMEA data is used within the FR, the ID should be taken from the GSA sentence that lists the IDs of those satellites used in the fixes which are recorded in the B record. The F Record is not recorded continuously but at the start of fixing and then only when a change in satellites used is detected. (AL4)

Format of F Record:
F HH MM SS AA BB CC DD EE FF GG CR LF

Description	Size	Element	Remarks
Time UTC	6 bytes	HHMMSS	Valid characters 0-9
Satellite ID	2 bytes for each satellite used	AABBCC Or 01, 02 etc	Valid characters alphanumeric

4.4 **K RECORD - DATA NEEDED LESS FREQUENTLY THAN FIXES**. The K record is for data that may be needed less frequently than fix (B) records. The K record should have a default interval of 20 seconds. As an example, if the B-record records every 5 seconds, the K-record could be set to record every 20 seconds, for instance containing true heading (HDT). The contents of the K record are listed in the J record. The following J Record specifies the information in the K Record in the next line:

J 0 8 1 2 H D T CR LF
K H H M M S S 0 0 0 9 0 CR LF
This K Record states that the true heading (TLC = HDT) is 090 (East).

4.5 **L RECORD - LOG BOOK/COMMENTS**. L-Records can be placed anywhere in the file after H, I and J records but before the G-record. The L-Record allows multiple free format text lines to be added to the flight data records at any time in the time-sequence, although this record is not itself time-stamped. It can be initiated by a program in the FR, by pilots or official observers, and the term "comment record" may be more descriptive rather than "logbook". The FR Manufacturer three-letter ID (para 2.5) should be used in the case of data initiated by the FR, and in this case the manufacturer should state how to interpret this type of L-Record for the benefit of writers of software for the IGC format. In other cases this field (MMM below) will also be three spaces, initiated by the pilot (code PLT) or OO (OOI) as required. In the case of Free Flights where waypoints are claimed post-flight by the pilot, the PFC (Post-Flight Claim) code shall be used followed by the Waypoints in the same format as the C Record (Pre-flight declaration). It is expected that this data will be inserted by a software program (for instance, after transfer of the flight data to a PC immediately after flight, by a program outside the FR) rather than added manually, so that it is in the correct format and can be recognised by analysis programs that are designed to read Post-Flight Claim data and present the flight on screen together with the PFC waypoints. Note that L records when originated by a pilot or OO must not affect the VALI check for the rest of the file data. The format of the L Record is as follows: (AL5)

L MMM T E X T S T R I N G CR LF
L PLT T E X T S T R I N G CR LF

L PFC TEXT AS C RECORD CR LF

Description	**Size**	**Element**	**Remarks**
Manufacturer input	3 bytes	MMM	Manufacturer's code, see para 2.5
Pilot input	3 bytes	PLT	Text string after PLT
OO input	3 bytes	OOI	Text string after OOI
After flight pilot input	3 bytes	PFC	For free flight after-flight choice of course

The L records which have the FR Manufacturer's ID MMM must be included in the digital signature (security system) for the file. Other L records (eg those put in by the pilot (PLT) or an OO (OOI)) will not be covered by the digital signature for the file, see para 3.2. Examples of pilot inputs:

LPLT This flight was my second 1000km attempt
LPLT from Eagle Field

5. <u>DEFINITIONS</u>

Airspeed - The true airspeed of the aircraft in kph, for systems with air data input.
Alphanumeric - Valid alpha and/or numeric character from the list of valid characters (para 6).
Competition Class - The IGC/FAI competition class of the aircraft.
Constellation - The precise satellites from which data was used to determine the GNSS fix. This may be used to verify the validity of the flight data.
Course - The direction between two points expressed as degrees magnetic or true.
Datum - The GNSS datum (co-ordinate system) in use.
Engine Down - The Means of Propulsion (MoP) (eg engine and propeller) is stowed and not in a position to generate thrust.
Engine Noise Level (ENL) - Ambient noise at the FR expressed as three numbers, maximum 999. This continuously-recorded active parameter registers a positive baseline level (ie not a zero level) even when the MoP is not in operation, and so produces a continuous check of the integrity of the MoP-recording system.
Engine Off - The Means of Propulsion (MoP) is in a condition where thrust cannot be generated.
Engine On - The Means of Propulsion (MoP) is in a condition when thrust could be generated.
Engine RPM - This is a parameter related to engine RPM so that true RPM may be derived if necessary.
Engine Up - The propulsion unit pylon is extended or the engine or propeller doors are open, in a condition in which thrust can be generated on starting the engine.
Equipment Events - These are events generated solely by the FR (such as detecting takeoff), as opposed to events generated after flight by the analysis of the FR flight data (such as establishing presence in a Turn Point Observation Zone or crossing a start or finish line).
Finish - The end of a task, such as crossing a finish line, entering a finish observation zone, or (for some distance flights) landing. Definitions, Sporting Code (SC3) main volume.
Fix Accuracy - The accuracy of the fix concerned expressed as EPE in metres, normally to a 2-sigma probability. See EPE in the Glossary.
FR Serial Number - a three-character alphanumeric which is unique within all FRs of all types from that manufacturer, and is allocated by the manufacturer to identify an individual FR. It is used in the first (A) record (see this appendix, para 3.1) and in the IGC file name (para 2.5).

Glider ID - The unique registration alphanumeric of the individual aircraft.
Glider Type - The manufacturer and precise model number of the aircraft.
GNSS Altitude - A five numeric character group indicating the GNSS altitude in metres above the ellipsoid.
GNSS Connect - Where a separate GNSS unit is used, indicates GNSS connection to the FR module
GNSS Disconnect - Where a separate GNSS unit is used, indicates GNSS disconnection from the FR module.
Ground Speed - The ground speed in kph.
Heading - The direction in which the aircraft is pointed (the longitudinal axis) in degrees true or magnetic.
Latitude - A seven character alphanumeric group expressed as two figures for the degrees, two figures for the minutes and three figures representing tenths, hundredths and thousandths of minutes followed by the N or S character. Where this is inserted into a FR such as part of a flight declaration, the N/S character must be capable of being entered in either upper or lower case. For IGC purposes lat/long must be referenced to the WGS84 Geodetic Datum.
Longitude - An eight character alphanumeric group expressed as three figures for the degrees, two figures for the minutes and three figures representing tenths, hundredths and thousandths of minutes followed by the E or W character. Where this is inserted into a FR such as part of a flight declaration, the N/S character must be capable of being entered in either upper or lower case. For IGC purposes lat/long must be referenced to the WGS84 Geodetic Datum.
On Task - The pilot is attempting a Task.
OO ID - This is a series of alphanumerics that is entered by an OO into the FR before flight. It consists of a minimum of four characters and is confidential to the OO.
Photo - A photograph has been taken, such as of a turn point.
Pilot Event (PEV code)- The pilot has marked a particular time. This may represent a number of different occurrences or events such as crossing a start line (or marking the intention to cross shortly) or arriving at a point.
Pressure Altitude - This is a five numeric group indicating the pressure altitude in metres above the 1013.25 HPa sea level datum and the ICAO ISA above.
RAIM - Receiver Autonomous Integrity Monitoring (when used) - This is used to indicate the quality of GNSS navigation data, see the Glossary section.
Record Extension - This allows extra information to be added to the fix (B) and extension (K) data records.
Security data (Digital Signature) - This is used to verify that the flight data has not be altered during or since the flight.
Start - The start of an official soaring performance. For definitions, see the Sporting Code (SC3).
Supplemental Data Fix - The use of external non-satellite data to assist the GNSS unit determine the position, such as a ground.-based beacon
Task - The main points of an intended flight. Normally an intended start, turn points and finish.
Total Energy Altitude - The combination of the gliders potential and kinetic energy expressed in metres of effective altitude.
Track - The true track (flight path) over the ground that the aircraft has achieved.
Turn point Validation - Proof of presence in the relevant Observation Zone for the point concerned.

6. **VALID CHARACTERS**. These consist of all printable ASCII characters from Hex 20 to Hex 7E, except those tabulated below as reserved. A text string is a sequence of valid characters. The following table shows the character first and then the hexadecimal code, and the second table presents the same information in hex order:

NUMBERS	**LETTERS**				**SYMBOLS** Res = reserved		**RESERVED CHARACTERS**
	Upper Case		**Lower Case**				
0 = Hex 30	A = Hex 41	N = 4E	a = Hex 61	n = 6E	space= Hex 20	/ = 2F	CR = 0D
1 = 31	B = 42	O = 4F	b = 62	o = 6F	Res = 21	: = 3A	LF = 0A
2 = 32	C = 43	P = 50	c = 63	p = 70	" = 22	; = 3B	$ = 24
3 = 33	D = 44	Q = 51	d = 64	q = 71	# = 23	< = 3C	* = 2A
4 = 34	E = 45	R = 52	e = 65	r = 72	Res = 24	= = 3D	, = 2C
5 = 35	F = 46	S = 53	f = 66	s = 73	% = 25	> = 3E	! = 21
6 = 36	G = 47	T = 54	g = 67	t = 74	& = 26	? = 3F	\ = 5C
7 = 37	H = 48	U = 55	h = 68	u = 75	' = 27	[= 5B	^ = 5E
8 = 38	I = 49	V = 56	i = 69	v = 76	(= 28	Res = 5C	~ = 7E
9 = 39	J = 4A	W = 57	j = 6A	w = 77	) = 29	] = 5D	
	K = 4B	X = 58	k = 6B	x = 78	@ = 40	Res = 5E	
	L = 4C	Y = 59	l = 6C	y = 79	` = 60	_ = 5F	
	M = 4D	Z = 5A	m = 6D	z = 7A	Res = 2A	{ = 7B	
					+ = 2B	| = 7C	
					Res = 2C		
					- = 2D		
					. = 2E		

						} = 7D Res = 7E	

And the same information in hex order:

<table>
<tr><th colspan="4">VALID CHARACTERS IN HEX ORDER
Res = reserved</th><th>RESERVED CHARACTERS</th></tr>
<tr>
<td>20 = space
21 = Res
22 = "
23 = #
24 = Res
25 = %
26 = &
27 = '
28 = (
29 =)
2A = Res
2B = +
2C = Res
2D = -
2E = .
2F = /
30 = 0
31 = 1
32 = 2
33 = 3
34 = 4
35 = 5
36 = 6
37 = 7</td>
<td>38 = 8
39 = 9
3A = :
3B = ;
3C = <
3D = =
3E = >
3F = ?
40 = @
41 = A
42 = B
43 = C
44 = D
45 = E
46 = F
47 = G
48 = H
49 = I
4A = J
4B = K
4C =L
4D = M
4E =N
4F =O</td>
<td>50 = P
51 = Q
52 = R
53 = S
54 = T
55 = U
56 = V
57 = W
58 = X
59 = Y
5A = Z
5B = [
5C = Res
5D =]
5E = Res
5F = _
60 = `
61 = a
62 = b
63 = c
64 = d
65 = e
66 = f
67 = g</td>
<td>68 = h
69 = i
6A = j
6B = k
6C = l
6D = m
6E = n
6F = o
70 = p
71 = q
72 = r
73 = s
74 = t
75 = u
76 = v
77 = w
78 = x
79 = y
7A = z
7B = {
7C = |
7D = }
7E = Res</td>
<td>0D = CR
0A = LF
24 = $
2A = *
2C = ,
21 = !
5C = \
5E = ^
7E = ~

These characters are reserved (not to be used) because they could be confusing if used in a text string, for instance due to other meanings or alternative keystrokes</td>
</tr>
</table>

7. **<u>THREE-LETTER CODES (TLC)</u>** These are shown as CCC in the formats earlier in this appendix. Their meanings are listed below together with the Records in which they can be used. If a manufacturer wants to add a new type of event, a new TLC should be requested from GFAC. The manufacturer should provide an exact definition of the event and a proposed coding. GFAC may decide that the proposal should not be treated as an event but that the information should be incorporated into the B- or K-record.

TLC	**Record Type Used with**	**TLC meaning, and notes on how it is to be used**
ATS	H E	Altimeter Pressure Setting. Although an altimeter pressure setting may be recorded (for instance where the FR feeds a cockpit display), it must not be used to change the pressure altitude recorded with each fix, which must remain with respect to the ISA sea level datum of 1013.25 mb at all times
CCL	H	Competition class
CCN	E	Camera Connect
CDC	E	Camera Disconnect
CGD	E	Change of geodetic datum
CID	H	Competition ID
CLB	H	Club or organisation, and country, from which flown or operated (eg Elmira US, Lasham UK). For Nation, use the ISO 3166 two-letter codes, some of which are given in para 3.3.3 of Appendix A
DAE	I, B, J, K	Displacement east, metres
DAN	I, B, J, K	Displacement north, metres

DOB	H	Date of Birth of the pilot in the previous line of the H record (DDMMYY)
DTE	H	Date, expressed as DDMMYY
DTM	H	Geodetic Datum in use for lat/long records (for IGC purposes this must be set to WGS84)
EDN	E	Engine down. See note on line for EON
ENL	I, B	Engine Noise Level, recorded from 000 to 999. This is the preferred MoP recording method because it requires no cables or sensors external to the FR, and is self-validating, recording a positive value with each fix.
EOF	E	Engine off. See note on line for EON
EON	E	Engine on. Note: Where ENL or RPM are not used as the primary indicator of MoP operation, event records and the EON/EOF or EUP/EDN codes shall be used. A combination of the two methods may be used, eg EON/EOF based on a parameter such as ignition ON/OFF, a minimum generator output, EUP/EDN for engine bay doors open/closed or pylon up/down; plus RPM based on prop or engine rpm, or ENL for noise level at the FR.
EUP	E	Engine up. See note on line for EON
FIN	E	Finish
FRS	H	Flight Recorder Security. To be used where a security fault has been detected such as the recorder internal security system (microswitch) having operated. (AL6)
FTY	H	FR Type (Manufacturer's name, FR Model Number)
FXA	B, I, J, K	Fix accuracy. When used in the B (fix) record, this is the EPE (Estimated Position Error) figure in metres (MMMM) for the individual fix concerned, to the 2-Sigma (95.45%) level unless specified differently (AL3)
FXA	H	Fix Data Accuracy Category. When used in the header record, this is a general indication of potential fix accuracy and indicates a category of receiver capability rather than an exact figure such as applies to each recorded fix in the B, I, J or K records, see above. If in doubt, use a three figure group in metres that refers to a typical EPE radius achieved by the receiver in good reception conditions. (AL3)
GCN	E	GNSS (Separate module) Connect
GDC	E	GNSS (Separate module) Disconnect
GID	H	Glider ID
GLO	H	GLONASS, the Russian GNSS system, manufacturer, model, etc. (AL3)
GPS	H	GPS Receiver Type & Version letter/number
GSP	I, B, J, K	Ground speed, give units (kt, kph, etc.)
GTY	H	Glider type, manufacturer, model
HDM	I, B, J, K	Heading Magnetic
HDT	I, B, J, K	Heading True
IAS	I, B, J, K	Airspeed Indicated (IAS), give units (kt, kph, etc.)
LOV	E	Low voltage. Must be set for each FR at the lowest voltage at which the FR will operate without the possibility of recorded data being degraded by the voltage level. Not to be used to invalidate a flight if the flight data appears correct when checked in the normal way, but a warning to check fix data particularly carefully. (AL1)
ONT	E	On Task - attempting task
OOI	H	OO ID - OO equipment observation

PEV	E	Pilot EVent - Pilot initiated action such as pressing a button
PFC	L	Post-Flight Claim. For Free Flights where waypoints are claimed post-flight. (AL5)
PHO	E	Photo taken (shutter-press)
PLT	H	Pilot, name, add DOB if any ambiguity
PRS	H	Pressure Altitude Sensor, manufacturer, model, etc. (AL3)
RAI	I, B, J, K	RAIM - GPS Parameter, see Glossary
REX	I, B, J, K	Record extension - Manufacturer defined data defined in the I or J record as appropriate, normally in the form of a TLC (which, if a new variable is agreed, may be a new TLC allocated by GFAC at the time). Any use must be approved by GFAC, and published so that there will be no doubt on how it is being used. (AL4)
RFW	H	Firmware Revision Version of FR
RHW	H	Hardware Revision Version of FR
RPM	I, B	Engine rpm, or another MoP parameter that varies in a similar way.
SCM	H	Second Crew Member's Name
SEC	G	Security - Log security data
SIT	H	Site, Name, region, nation etc.
SIU	I, B	Satellites in use. A two-character field from the NMEA GGA or GNS sentences, as appropriate, or equivalent data agreed by GFAC. (AL4)
STA	E	Start event
SUP		Supplemental data fix - External data input as required
TAS	I, B, J, K	Airspeed True, give units (kt, kph, etc.)
TEN	I, B, J, K	Total Energy Altitude in metres
TPC	E	Turn point confirmation - Equipment generated event (not valid for flight validation which requires independent checking of fixes and relevant Observation Zones)
TPL		Turn point list as required
TRM	I, B, J, K	Track Magnetic
TRT	I, B, J, K	Track True
TZN	H	Time Zone Offset, hours from UTC to local time.
UNT	H	Units of Measure
VXA	I, B, J, K	Vertical Fix Accuracy, Three characters in metres from the VDOP part of the NMEA GSA sentence, or equivalent data agreed by GFAC. (AL4)
WDI	I, B, J, K	Wind Direction
WVE	I, B, J, K	Wind Velocity

8. **GNSS GEODETIC DATUMS** The Sporting Code for gliding states that the WGS 84 Geodetic Datum (serial 100 below) shall be used for all lat/long co-ordinates that are recorded and transferred from the FR after flight. Other Geodetic Datums have been numbered by IGC as follows.

ame Locations in which used	ame Locations in which used
000 ADINDAN - Ethiopia, Mali, Senegal, Sudan 001 AFGOOYE - Somalia 002 AIN EL ABD 1970 - Bahrain Island, Saudi Arabia 003 ANNA 1 ASTRO 1965 - Cocos Island 004 ARC 1950 - Botswana, Lesotho, Malawi, Zaire, Zambia, Zimbabwe 005 ARC 1960 - Kenya, Tanzania 006 ASCENSION ISLAND 1958 - Ascension Island 007 ASTRO BEACON "E" - Iwo Jima Island 008 AUSTRALIAN GEODETIC 1966 - Australia, Tasmania Island 009 AUSTRALIAN GEODETIC 1984 - Australia, Tasmania Island 010 ASTRO DOS 71/4 - St. Helena Island 011 ASTRONOMIC STATION 1952 - Marcus Island 012 ASTRO B4 SOROL ATOLL - Tern Island 013 BELLEVUE (IGN) - Efate and Erromango Islands 014 BERMUDA 1957 - Bermuda Islands 015 BOGOTA OBSERVATORY - Colombia 016 CAMPO INCHAUSPE - Argentina 017 CANTON ASTRO 1966 - Phoenix Islands 018 CAPE CANAVERAL - Florida, Bahama Islands 019 CAPE - South Africa 020 CARTHAGE - Tunisia 021 CHATHAM 1971 - Chatham Island (New Zealand) 022 CHUA ASTRO - Paraguay 023 CORREGO ALEGRE - Brazil 024 DJAKARTA (BATAVIA) - Sumatra Island (Indonesia) 025 DOS 1968 - Gizo Island (New Georgia Islands) 026 EASTER ISLAND 1967 - Easter Island 027 EUROPEAN 1950 (ED50) - Austria, Belgium, Denmark, Finland, France, Germany, Gibraltar, Greece, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland 028 EUROPEAN 1979 (ED79) - Austria, Finland, Netherlands, Norway, Spain, Sweden, Switzerland 029 FINLAND HAYFORD 1910 - Finland030 GANDAJIKA BASE - Republic of Maldives 031 GEODETIC DATUM 1949 - New Zealand 032 Ordnance Survey of Great Britain 1936 (OSGB36) - UK 033 GUAM 1963 - Guam Island 034 GUX 1 ASTRO - Guadalcanal Island 035 HJOESEY 1955 - Iceland 036 HONG KONG 1963 - Hong Kong 037 INDIAN - Bangladesh, India, Nepal 038 INDIAN - Thailand, Vietnam 039 IRELAND 1965 - Ireland 040 ISTS 073 ASTRO 1969 - Diego Garcia 041 JOHNSTON ISLAND 1961 - Johnston Island 042 KANDAWALA - Sri Lanka 043 KERGUELEN ISLAND - Kerguelen Island 044 KERTAU 1948 - West Malaysia, Singapore 045 L.C. 5 ASTRO - Cayman Brac Island 046 LIBERIA 1964 - Liberia 047 LUZON - Mindanao Island 048 LUZON - Philippines (excluding Mindanao Island) 049 MAHE 1971 - Mahe Island 050 MARCO ASTRO - Salvage Islands 051 MASSAWA - Eritrea(Ethiopia)	052 MERCHICH - Morocco 053 MIDWAY ASTRO 1961 - Midway Island 054 MINNA - Nigeria 055 North American 1927 (NA27) - Alaska 056 NA27 - Bahamas (excluding San Salvador Island) 057 NA27 - Central America 058 NA27 - Canal Zone 059 NA27 - Canada (including Newfoundland Island) 060 NA27 - Caribbean 061 NA27 - Mean Value (CONUS) 062 NA27 - Cuba 063 NA27 - Greenland (Haynes Peninsula) 064 NA27 - Mexico 065 NA27 - San Salvador Island 066 NA83 - Alaska, Canada, Central America, CONUS, Mexico 067 NAPARIMA, BWI -Trinidad and Tobago 068 NAHRWAN - Masirah Island (Oman) 069 NAHRWAN - Saudi Arabia 070 NAHRWAN - United Arab Emirates 071 OBSERVATORIO 1966 - Corvo and Flores Islands (Azores) 072 OLD EGYPTIAN - Egypt 073 OLD HAWAIIAN - Mean Value 074 OMAN - Oman 075 PICO DE LAS NIEVES - Canary Islands 076 PITCAIRN ASTRO 1967 - Pitcairn Island 077 PUERTO RICO - Puerto Rico, Virgin Islands 078 QATAR NATIONAL - Qatar 079 QORNOQ - South Greenland 080 REUNION - Mascarene Island 081 ROME 1940 - Sardinia Island 082 RT 90 - Sweden 083 SOUTH AMERICAN 1956 - Bolivia, Chile, Colombia, Ecuador, Guyana, Peru, Venezuela084 SOUTH AMERICAN 1956 - Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Guyana, Paraguay, Peru, Venezuela, Trinidad, Tobago 085 SOUTH ASIA - Singapore 086 PROVISIONAL SOUTH CHILEAN 1963 - South Chile 087 SANTO (DOS) - Espirito Santo Island 088 SAO BRAZ - Sao Miguel, Santa Maria Islands (Azores) 089 SAPPER HILL 1943 - East Falkland Island 090 SCHWARZECK - Namibia 091 SOUTHEAST BASE - Porto Santo and Madeira Islands 092 SOUTHWEST BASE - Faial, Graciosa, Pico, Sao Jorge, Terceira Islands 093 TIMBALI 1948 - Brunei and East Malaysia (Sarawak and Sabah) 094 TOKYO - Japan, Korea, Okinawa 095 TRISTAN ASTRO 1968 - Tristan da Cunha 096 Reserved For Future Use 097 VITI LEVU 1916 - Viti Levu Island (Fiji Islands) 098 WAKE-ENIWETOK 1960 - Marshall Islands 099 World Geodetic System 1972 (WGS72) 100 World Geodetic System 1984 (WGS84) 101 ZANDERIJ - Surinam 102 CH-1903 - Switzerland 103 Bessel 1847 - Austria

9. EXAMPLE IGC-FORMAT FILE

9.1 The IGC file format starts with the A Record and is followed by the H (header) and other records. The record letter is always at the start of the appropriate line in the file when it is viewed in text format. For more details of formats for individual records, see the relevant paragraphs earlier in this Appendix.

9.2 In this example, spaces have been used between subject fields to make the layout and sequence clearer to a reader. In a real IGC-format file there should be no spaces in any record except within a text string as a word separator.

9.3 CRLF = line terminator, not flight data.

9.4 In a real file there would be many more B records at the preset fix intervals for cruise and fast fix rates.

9.5 In the example below, some notes appear in brackets. These are not part of the file format itself. Also, for clarity, some spaces are used in B-record lines between different variables that are recorded, but no spaces should be used in the IGC file itself.

A XXX ABC FLIGHT:1
HFFXA 035
HFDTE 160701
HFPLT PILOT: Bill Bloggs
HFGTY GLIDERTYPE: Schleicher ASH-25
HFGID GLIDERID: ABCD-1234
HFDTM100 GPSDATUM: WGS-1984
HFRFW FIRMWAREVERSION:6.4
HFRHW HARDWAREVERSION:3.0
HFFTY FRTYPE: Manufacturer, Model
HFGPS MarconiCanada: Superstar,12ch, max10000m CR LF
HFPRS PRESSALTSENSOR: Sensyn, XYZ1111, max11000m CR LF
HFCID COMPETITIONID: XYZ-78910
HFCCL COMPETITIONCLASS:15m Motor Glider
HFSCM SECONDCREW: John Smith
I 02 36 38 FXA 39 41 ENL CRLF
J 01 08 12 HDT CRLF
(The following example of a C (Declaration) record)
(is for a 500 km triangle to be flown from)
(Lasham gliding centre in the UK)
C 150701 213841 160701 0001 02 500K Tri
C 5111359N 00101899W Lasham Clubhouse
C 5110179N 00102644W Lasham Start S, Start
C 5209092N 00255227W Sarnesfield, TP1
C 5230147N 00017612W Norman Cross, TP2
C 5110179N 00102644W Lasham Start S, Finish
C 5111359N 00101899W Lasham Clubhouse
(The following example starts with the F record of 9 satellite IDs, then)
(the B (fix) record starts with altitudes of 280m (pressure), 421m (GPS))
(and FXA (HDOP radius) 205m, SIU 09 and ENL 950:)
F160240 04 06 09 12 36 24 22 18 21 CRLF
B160240 5407121N 00249342W A 00280 00421 0205 09 950 CRLF
D 20331 CRLF
E160245 PEV CRLF
B160245 5107126N 00149300W A 00288 00429 0195 09 020 CRLF
B160250 5107134N 00149283W A 00290 00432 0210 09 015 CRLF
B160255 5107140N 00149221W A 00290 00430 0200 09 012 CRLF
F160300 06 09 12 36 24 22 18 21 CRLF
(satellites in use reduce from 9 to 8 as ID 04 is no longer received)
B160300 5107150N 00149202W A 00291 00432 0256 08 009 CRLF
E160305 PEV CRLF
B160305 5107180N 00149185W A 00291 00435 0210 08 015 CRLF
B160310 5107212N 00149174W A 00293 00435 0196 08 024 CRLF
K160248 090 CRLF
(note that this is specified in the J record)
(as being HDT, true heading)
(in the above K record HDT is 090 (East))
B160248 5107220N 00149150W A 00494 00436 0190 08 018 CRLF
B160252 5107330N 00149127W A 00496 00439 0195 08 015 CRLF
L XXX RURITANIAN STANDARD NATIONALS DAY 1 CRLF
L XXX FLIGHT TIME: 4:14:25, TASK SPEED:58.48KTS CRLF
G REJNGJERJKNJKRE31895478537H43982FJN9248F942389T433T CRLF
G JNJK2489IERGNV3089IVJE9GO398535J3894N358954983O0934 CRLF
G SKTO5427FGTNUT5621WKTC6714FT8957FGMKJ134527FGTR6751 CRLF
G K2489IERGNV3089IVJE39GO398535J3894N358954983FTGY546 CRLF
G 12560DJUWT28719GTAOL5628FGWNIST78154INWTOLP7815FITN CRLF

------------- ends -------------

APPENDIX 2 TO GNSS FR SPECIFICATION
SAMPLE TEST AND EVALUATION SCHEDULE

The following tests may be carried out under the auspices of each member of the GFAC. Members may delegate detailed testing and assessment to other experts who are bound by the same confidentiality as GFAC itself. Results, assessments and opinions will be confidential to GFAC members, their advisors and to IGC or FAI officials who may be involved if IGC or FAI policy may be affected. These tests are not necessarily all and GFAC reserve the right to carry out any other non-destructive testing where it is deemed relevant to assessing the probable validity of flight data.

1 **GENERAL REQUIREMENTS**. The following aspects will be evaluated: ease of operation in an air sport environment from badge and record flights to large competitions, integrity of data, fix accuracy, recording of errors and anomalies, security against unauthorised input and changes to data, failure recovery, and standard IGC file structure.

2 **EVALUATION AND ANALYSIS**. The following aspects will be evaluated through an analysis program independent of the FR manufacturer, using the IGC file format: presenting all and selected segments of the flight path in graphical plan views, also vertical views of GNSS and pressure altitude with time. Including checks on required data such as fix accuracy (FXA) and Pilot Event (PEV), and checks on indications of Means of Propulsion operation, such as ENL recording.

3 **PHYSICAL INSPECTION OF THE EQUIPMENT**

3.1 Quality of construction and components.

3.2 Layout and type of components. Susceptibility to inadvertent or deliberate production of invalid flight data. Sealing, shielding, access, construction of the recorded flight data processor memory and relation to other components, data streams and memories. Crashworthiness aspects including preservation of flight data after imapct or damage.

4 **SYSTEM ACCURACY AND RECORDING CAPABILITY**

4.1 Ground Tests. Several ground runs of the equipment will be made. Runs of up to 12 hours may be undertaken in order to check, amongst other things, memory capacity for long flights. Some runs will be made with the equipment mounted in a vehicle driven over a test course recorded in position, height and time (the Proof Drive mentioned in the Definitions section). Accuracy will be recorded over surveyed ground positions. These will include tests for any "throw forward" dead-reckoning fixes not based on actual satellite lines-of-position. Tests will be made first with the antenna connected and then with the antenna disconnected on arriving at the point. Fix records must closely compare with those from any control equipment.

4.1.1 The pressure-altitude recording system will be calibrated using standard procedures for barograph calibration, and a calibration chart will be produced. The sea level setting must correspond to the required ISA (1013.25 mb) within 1 millibar; up to an altitude of 2000 metres within 3 millibars; and above this, within one percent of altitude. The FAI pressure altitude criteria will be used (the ICAO International Standard Atmosphere, Document 7488 tables 3 and 4). See also Chapter 2, para 2.10, and Chapter 3 of Annex B to the Sporting Code (SC3B).

4.1.2 Temperature of the equipment may be varied during the test runs between +40C and -20C, depending on facilities available to the tester.

4.2 Flight Tests. Flight data should closely compare with that from any control equipment. See Chapter 1, para 1.3.3.1.1 on fix accuracy and error rates.

5 **ANTI-TAMPERING PROTECTION**

5.1 General. Tests will be made to assess the susceptibility of the equipment as a whole to corruption of the recorded flight data by inadvertent or deliberate means.

5.2 Minimum standard. The minimum standard is a positive and recorded identification on every occasion that false data is produced or introduced into the recorded flight data store.

5.3. Evaluation and tests. These will be made to determine that the electronic and physical security of the FR has been provided with protection to minimize the possibility that a determined attempt to bypass the security features will succeed. For instance, any security microswitch must be undefeatable (as far as is physically possible), being fitted in such a position (for instance with shields or guards where necessary) to protect against the insertion of a specially shaped tool into the case of the recorder which might hold down the microswitch while the case is being opened, thereby allowing unauthorised design changes to be made without the security mechanism being activated. GFAC will open the cases of types of recorders that are under test, evaluate these features and require changes where these are these are deemed to be necessary to preserve security in subsequent worldwide operation of the type. (AL5)"

6 **POWER SOURCE**. Measurements of power consumption will be made, and, where relevant, of battery characteristics under different conditions of charge and temperature. Misleading results must not be produced as voltage falls and the LOV code must be generated before results become inaccurate. (AL3)

7 **ELECTROMAGNETIC INTERFERENCE**. Susceptibility to ElectroMagnetic Interference (EMI) will be assessed to the current European JAA and US FAA requirements. FR data memories must be resistant to levels of EMI that could be experienced in flight, so that the integrity of flight data is preserved. Also, some GNSS equipment designed primarily for ground use, may cease to operate or produce spurious results when in the presence of high-powered EM radiation such as from powerful ground-based transmitters. Tests will be made with hand-held radios (as frequently used in gliders) using VHF transmissions at up to 1 watt RMS. Transmission distances tested will be down to 1 foot for FR units designed for mounting close to the pilot's head, and 3 feet for panel-mounted units. No adverse effects should be shown on the FR, its GPS board, data memory, its security devices, and its output data.

8 **FLIGHT TESTS**. Flight tests will be made in several types of glider or motor glider, or, during periods of poor weather, in light aircraft.

8.1 Accuracy. Flights will take place either on accurately-recorded routes or over accurately-surveyed points, or in aircraft fitted with known GNSS FR equipment used as a "control". Flight data will be compared between the control GNSS and the output of the equipment under test.

8.2 Security. Security protection and procedures before and after flight, and the role of OOs, will be assessed. The effect of mis-switching will be investigated, and deliberate attempts will be made to insert false data after the pre-flight OO inspection. The possibility of transferring false data after flight will also be assessed.

8.3. Manoeuvring flight. Tests will be carried out in manoeuvring flight to check for anomalies. FRs will be tested under rapid pitch, roll and turn, and also at extreme attitudes and in high-G situations. The possibility of "throwing forward" fixes by turning rapidly after a high speed run, will also be assessed.

8.4. Pressure altitude recording. Tests will be made on the barograph (pressure-altitude recording) function. On flight tests it will be ensured: that the barograph function continues if GPS signal is lost; that re-lock occurs quickly once signal is restored; and that in the event of total GPS failure, the FR functions as a barograph after switching on. These tests will involve disconnecting and re-connecting the antenna, or, for FRs with fixed antennas, covering up the antenna with material impervious to RF signals (such as metal sheet or foil).

8.5 Means-of-Propulsion (MoP) recording system. Tests will be made on systems for recording the operation of the Means of Propulsion for motor gliders. Where Engine Noise Level (ENL) or vibration sensors are used, tests will be made with the FR in a number of types of glider and motor glider. These will include glass-construction machines with low aerodynamic cockpit noise, also machines with higher cockpit noise in gliding flight. If the required conditions are not shown, modifications to the ENL system must be made until they are. For other aspects of ENL systems, see the main body of this Specification, para 2.11.1.

8.5.1 Tests with MoP running. Operation of both two-stroke and four-stroke engines will be tested at all available power settings. Results will be analysed to ensure that a clear difference in the IGC file data is shown between all types of gliding flight, and any engine running at positive thrust settings. A critical test will be with a relatively quiet engine, typically a 4-stroke engine in a motor glider at power for level flight

8.5.2 Tests without MoP running. For gliding flight, tests will be made with the cockpit ventilation and other panels open, both straight at high speed and during turns. In many gliders an "organ pipe" noise can be heard in the cockpit and ENL will be recorded for this condition. A particular test that will be made is thermalling with cockpit panels open because this is often done when it is hot, and if the ENL is too high under this condition it could be mistaken for a climb under power. (AL6)

----------------- end of Appendix 2 ----------------

APPENDIX 3 TO GNSS FR SPECIFICATION

Windows-based short programs for data transfer and conversion to IGC format, and validation of data (revised AL5)

1. **INTRODUCTION**.

1.1 General. This appendix describes an IGC standard for Manufacturer-supplied Windows Dynamic Link Libraries (DLLs) in a 32-bit Windows environment, for the DATA, CONV and VALI functions that are described in para 2.9 of the main part of this Specification.

1.2 Availability on the IGC GNSS web site. The DLLs shall be freeware and be made available through links from the IGC/GNSS web site http://www.fai.org/gliding/gnss/freeware.asp. IGC will supply a sample control program, in both source and executable form. This will load a DLL and call each of the Application Programming Interface (API) functions specified below. This control program will also be available through links from the IGC web site.

1.3 Functions supported. All such DLLs shall support the functions described in the API below.

1.4 Control program. A Control Program must check responses from the DLLs and also perform checks for the existence of a file before calling on a DLL to open it for reading (e.g. ConvertLog or ValidateLog) and to query overwriting an existing file (e.g. DownloadLog and ConvertLog). The Control Program shall also select the COM port to be used.

1.5 DLL Naming. The name shall be of the form IGC-XXXy.DLL where XXX is the Manufacturer's three Letter Code as defined in Appendix 1 para 2.5.7. A manufacturer's DLL shall be able to handle all GNS FRs in the product range concerned. In case this cannot be achieved, the symbol "y" above is an optional alphanumeric for other DLLs from a given manufacturer.

1.6 The provision of these DLLs is not a mandatory requirement at this time. However, Flight Recorder Manufacturers are strongly advised to provide such DLLs, because this is expected to become a requirement in the future. This is to allow for problems encountered running the 'Short DOS programs' on some PCs, and may replace the requirement for DOS programs in a future edition of this document.

1.7 If problems are encountered by any FR manufacturer in implementing a DLL due to the provisions of section 2 of this Appendix, this shall be reported to GFAC chairman as soon as possible. Changes from section 2 will not normally be considered unless the request is due to hardware characteristics of a Flight Recorder approved before the publication of amendment 5. This provision is likely to be withdrawn in the next amendment so manufacturers are urged to ensure that they can comply in due course.

2. **APPLICATION PROGRAMMING INTERFACE (API)FOR MANUFACTURER-SUPPLIED DLLs**

2.1 General. A standard API is described below in para 3. It includes the functions mentioned in para 1.1 for the operating systems Windows 95/98/ME, NT/2000, and subsequent releases. The API shall be implemented by a DLL supplied by each flight recorder manufacturer, which exports a defined set of functions for use by control programs. These control programs may include third-party flight evaluation applications, competition scoring software, and generic programs for the use of pilots, official observers and contest directors.

2.2 Control programs. The DLLs shall be designed to be stored in a common directory on the computer of the end-user. The control program shall use the Win32 *LoadLibrary* or *LoadLibraryEx* functions to load a DLL using run-time linking. The control program shall then query it for the entry point of each API function by name, using the Win32 *GetProcAddress* function.

2.3 Functions and descriptions. In the API descriptions below, DWORD, BOOL, TCHAR, LPTSTR, and LPCTSTR are standard Win32 API types defined as long, bool, char, char *, and const char *, respectively, for the required ANSI (as opposed to UNICODE) DLL build. HWND is a 32 bit window handle. FALSE is integer 0, TRUE is any non-zero integer value.

3 **<u>API SUB-ROUTINE DESCRIPTIONS</u>.** The standard API follows. Titles of main sub-routines are in bold, underlined, and end in the letters DLL, FR or LOG. They are followed by relevant data such as parameters, return values, and remarks.

3.1 **<u>IdentifyDLL</u>**

DWORD IdentifyDLL(LPTSTR value, DWORD size)

The *IdentifyDLL* function obtains an identifying string, which the control program shall enter in a listbox used to select the appropriate DLL.
Parameters
value
[out] pointer to buffer to receive string.
size
[in] size of the buffer pointed to by *value*.
Return Values
Function returns number of bytes in returned string, if actual length of string exceeds *size*, the string shall be truncated to *size* -1 bytes.
Remarks
The string consists of six fields, separated by the "pipe" character ("|", 0x7C) , the manufacturer three letter
code and optional alphanumeric, the manufacturer name, supported FR name(s), DLL software revision number, and two comma separated lists of zero or more file extensions. The first list of extensions identifies manufacturer proprietary log files, if any, which can be converted to IGC format using the *ConvertLog* function. The second list identifies log files (possibly including IGC format) that can be authenticated by the *ValidateLog* function. A terminating NUL character is always appended to the string (but not included in the returned count). Maximum permitted length of the string (excluding the terminating NUL character) is 127 characters. Example:

XXX|Acme Instruments|XL 100, 200|2.0|XL1,XL2|XL1,XL2,IGC

3.2 **<u>LoadIconDLL</u>**

HICON LoadIconDLL()

The control program calls *LoadIconDLL* to load a unique 32x32x4 (16 color) icon that may be used to identify the DLL.
Return Values
Returns the handle for the loaded icon. If there is an error, returns a null handle.

InitializeDLL

void InitializeDLL(HWND windowHandle, BOOL quietMode)

3.3 **<u>InitializeDLL</u>** This is an initialization function that must be called before any of the other functions, with the exception of *IdentifyDLL* and *LoadIconDLL*.
Parameters

windowHandle
[in] Handle for the control programs main window, or NULL if there is none.
quietMode
[in] if TRUE, application is operating in quiet (non-interactive) mode.
Remarks
The window handle shall be stored in the DLL, and is normally used as the parent handle for any dialog boxes displayed by DLL functions, unless overridden by a call to *SetWindowDLL*. These dialogs shall be centered within the parent window. If quiet mode is requested, the DLL functions shall only display dialogs resulting from non-recoverable error conditions, progress and informational dialogs shall not be displayed.

3.4 **<u>SetWindowDLL</u>**

VOID SetWindowDLL(HWND windowHandle)

The control program shall call this function to set a new top-level window handle. This handle shall be used as the parent window for any dialog boxes displayed by DLL functions, unless overridden by another call to *SetWindowDLL.*

Parameters
windowHandle
[in] Handle for the control programs new top level window.

3.5 **KeepAwakeIntervalDLL**

DWORD KeepAwakeIntervalDLL()

The *KeepAwakeIntervalDLL* function is used to obtain the nominal time interval between calls to *KeepAwakeFR.*

Return Values
Returns the interval in milliseconds. If 0 is returned, *KeepAwakeFR* calls are not required (and shall be ignored).

3.6 **UseSerialOptionsDLL**

BOOL UseSerialOptionsDLL()

The *UseSerialOptionsDLL* function is called by the control program to determine if there are any user settable connection options which may be set using the dialog provided by *SerialOptionsDLL*. If there are none, the control program shall not call *SerialOptionsDLL.*

Return Values
Returns TRUE if there are user settable serial options (and *SerialOptionsDLL* shall be called), FALSE if not

3.7 **SerialOptionsDLL**

DWORD SerialOptionsDLL(LPTSTR options, DWORD size)

The *SerialOptionsDLL function* displays a modal dialog box requesting any user settable connection options (line speed, flow control, etc.) needed to configure a serial port for use with the manufacturers FRs.
Parameters
options
[out] pointer to buffer which shall receive the connection options.
size
[in] size of the buffer pointed to by *options* in bytes.
Return Values
If successful, function returns number of bytes in the returned option string. if actual length of string exceeds size, the string shall be truncated to size -1 bytes. If cancelled, returns 0 and options string is left unmodified. If error, a modal dialog is displayed, and -1 is returned.

Remarks
This dialog shall not include selection of the serial communication device. Maximum permitted length of the returned string (excluding the terminating NUL character) is 63 characters. The string is intended for use in a subsequent call to *SerialConnectFR*, the actual format of the string is determined by the manufacturer. The control program may choose to store this string in the registry or a file for use in future sessions.

3.8 **SerialConnectFR**

BOOL SerialConnectFR(LPCTSTR device, LPCTSTR options)

The *SerialConnectFR* function is used to establish communication with a FR connected through a serial port.

Must be called prior to using *KeepAwakeFR, IdentifyFR, IdentifyLogFR, DownloadLogFR,* and/or *DisconnectFR*.

Parameters
device
[in] name of the serial communication device device ("COM1", etc.).
options
[in] string returned by a previous call to *SerialOptionsDLL*, or NULL to use the default device options. The format of this string is determined by the manufacturer.
Return Values
Returns TRUE if connection established, FALSE otherwise.
Remarks
If a connection cannot be established, the function shall display a modal dialog box detailing the problem.

3.9 **KeepAwakeFR**

BOOL KeepAwakeFR()

The *KeepAwakeFR* function is used to prevent the FR from disconnecting during idle periods between calls to *ConnectFR* and *DisconnectFR*. If *KeepAwakeIntervalDLL* returns a non-zero value, the control program must call *KeepAwakeFR* each time that interval elapses.
Return Values
Returns TRUE if the FR still connected or FALSE if connection has been broken.

3.10 **IdentifyFR**

DWORD IdentifyFR(LPTSTR value, DWORD size)

The *IdentifyFR* function is used to obtain the manufacturer id/serial number, the FR model name/number, and the FR sealed status for the connected FR.
Parameters
value
[out] pointer to a buffer which shall receive the string result.
size
[in] size of the buffer pointed to by *value* in bytes.
Returned Values
Function returns number of bytes in returned string, if actual length of string exceeds *size*, the string shall be truncated to *size* -1 bytes.
Remarks
The string consists of three fields, separated by the "pipe" character ("|", 0x7C), the manufacturer id/serial number (formatted MMMNNN, where MMM is the manufacturer id, and NNN is the serial number), the FR model name/number, and the FR sealed status ("SEALED" if sealed, "UNSEALED" if not). Maximum permitted length of the string (excluding the terminating NUL character) is 63 characters. Example:

AXL01F|XL 100|SEALED

For types of recorders with original IGC-approvals dated before 2003, if the FR Serial Number cannot be returned (for instance due to firmware limitations), a Serial Number of 000 shall be used. (AL6)

3.11 **IdentifyLogFR**

DWORD IdentifyLogFR(DWORD index, LPSTR value, DWORD size)

The *IdentifyLogFR* function is used to obtain information on a log stored in the currently connected FR.

Parameters
index
[in] index of the desired log, starting with 0.

value
[out] pointer to the buffer which shall received the returned string.
size
[in] size of the buffer pointed to by *value*.

Return Values
IdentifyLogFR returns number of bytes in the returned string, if actual length of string exceeds *size*, the string shall be truncated to *size* -1 bytes. If the value specified for *index* exceeds the number of logs present in the FR (minus 1, as indexing starts with 0), *IdentifyLogFR* shall return 0.

Remarks
The returned string consists of seven fields, separated by the "pipe" character ("|", 0x7C), the default log file name (including extension), log start UTC date (formatted YYYY-MM-DD, example "2000-05-12", zero padding required), log start UTC time (formatted HH:MM:SS, example "17:09:22", zero padding required), log end UTC time (formatted HH:MM:SS), pilot name, competition id, and competition class. Maximum permitted length of the returned string (excluding the terminating NUL character) is 127 characters. Example:

0B8X01F1.XL1|2000-11-08|20:05:21|01:21:09|J. Doe|XYZ|15M

Logs are indexed in descending start date/time order, the log at index 0 is the most recent log. When retrieving information on all of the logs stored within the FR, a control program shall start by calling *IdentifyLogFR* with *index* 0, incrementing *index* by 1 until *IdentifyLogFR* returns 0.

3.12 **DownloadLogFR**

BOOL DownloadLogFR(DWORD index, LPCTSTR fileName)

The *DownloadLogFR* function is used to download a log file from the currently connected FR.
Parameters
index
[in] the index of the desired log, starting with 0.
fileName
[in] a null terminated string containing the name of the file (which may include a path) to which the log shall be downloaded. If NULL, the default file name shall be used in the current working directory.
Return Values
DownloadLogFR returns TRUE if successful, FALSE if there was an error.
Remarks
If a file with the specified name and path already existed, it shall be overwritten. If there is an error, *DownloadLogFR* shall display a modal dialog box giving the details. If the quietMode flag was set to TRUE in the call to *InitializeDLL*, the download shall occur silently, without any dialog boxes displayed, unless there is an error. If quietMode was set to FALSE, *DownloadLogFR* shall display a modal dialog box with a progress indicator and a cancel download button.

3.13 **DisconnectFR**

VOID DisconnectFR()

DisconnectFR is called after the control program has completed interaction with the FR, to close the communication device.

3.14 **UseConvertLog**

BOOL UseConvertLog()

The *UseConvertLog* function is called by the control program to determine if the DLL *ConvertLog* function is needed to convert from a proprietary log file format to IGC. If it does not, the control program shall not offer the user the option of converting log files.
Return Values
Returns TRUE if conversion from proprietary format to IGC is required, FALSE if not

3.15 **ConvertLog**

BOOL ConvertLog(LPCTSTR fileName, LPCTSTR igcFileName)

ConvertLog converts the log file specified by *fileName* to an IGC format file specified by *igcFileName*.
Parameters
fileName
[in] a null terminated string containing the name of an existing log file (which may include a path) in the manufacturer proprietary format.
igcFileName
[in] a null terminated string containing the name of the IGC file (which may include a path) to be created.
Return Values
Returns TRUE if successful, FALSE if there is an error.
Remarks
If a file with the specified *igcFileName* already exists, it shall be overwritten. If there is an error, the function shall display a modal dialog with the details.

3.16 **ValidateLog**

BOOL ValidateLog(LPCTSTR fileName)

ValidateLog is called to authenticate the digital signature on a specified log file.
Parameters
fileName
[in] a null terminated string containing the name of an existing log file (which may include a path) to be validated.
Return Values
Returns TRUE if file can be validated, FALSE otherwise.

Remarks
If the log was not produced by a supported flight recorder, is in an unsupported format, or the digital signature is invalid, the function shall display a modal dialog detailing the problem, then return FALSE.
If quietMode was set to FALSE in the call to *InitializeDLL* and the validation takes more than a few seconds, *ValidateLog* shall display a modal dialog box with a progress indicator and a cancel validation button.

4. PROGRAMMING FRAMEWORK FOR CONTROL PROGRAMS

In order to utilise the freeware DLLs described earlier in this appendix, a Control program is required. Authors of Analysis Software, Scoring Software etc. may wish to incorporate the facilities of such a program into their products. In order to assist Flight Recorder manufacturers and other Software writers, the following files are provided on the IGC website at http://www.fai.org/gliding/gnss/freeware.asp.

Working Sample Shell Program.
Source of Shell Program.
Dummy DLL file (to assist in Shell Program testing).
Source of Dummy DLL. (can be used as a Template for Manufacturer's DLL code)

These files are provided free of charge and with no warranties of any kind. If portions of the source files are used in any product, then the copyright conditions in the source files must be observed.

*[**Note**: paragraph 4 is also used on the IGC web site as an introduction to the files for free downloading.]*

---------------- *Appendix 3 ends* ----------------