AMENDMENT LIST NUMBER 5
to
THE SECOND EDITION OF
THE TECHNICAL SPECIFICATION FOR
IGC-APPROVED GNSS FLIGHT RECORDERS

Effective 30 August 2019

Glossary

page ii, change title of 5.4 to "MOP Systems in addition to ENL"

page v on CRLF, change "line" to "field" because some subject fields in an IGC file are longer than a single line.

page v on Datum, add "in which the equatorial and polar radii are defined" & "and worldwide civil aviation".

page vi, ECC: change to: For IGC flight recorder purposes, ECC with a 256 bit private key is accepted by GFAC as equivalent to RSA with a 3072 bit private key, 192 ECC with 1536 RSA, 160 ECC with 1024 RSA.

page vi, add: EGM - Earth Gravitational Model. A worldwide surface calculated to have equal gravity ("equipotental") rather than a simple geometric Earth Model such as an Ellipsoid. Examples include EGM84, EGM96 and EGM 2008, as defined by the US National Geospatial Agency (NGA). See below under "Geoid", and more detail is at https://en.wikipedia.org/wiki/Earth_Gravitational_Model (AL5)

page vii, change Serial Number to Serial ID, here and elsewhere in the document. Although the IGC system started with numbers only, for many years alphanumerics have been used and many people have been confused by continuing use of the term "Number".

page vii on ECC, add: 224 ECC with 2048 RSA, and 106 ECC with 512 RSA .

Page vii, add: FES - Front Electric System. An electric engine mounted in the nose, driving propeller blades that fold back flush with the fuselage when not in use. Originally the letter "S" stood for Sustainer but with improvements in battery technology many FES systems are capable of self-launching. (AL5)

page viii on Grandfather rights, add: The term is used in Commercial Aircraft certification, and ...

Page viii on Geoids, add: The surface of an equipotential Geoid is irregular and therefore, unlike an Ellipsoid (qv), can not be defined by a simple formula. Such Geoids include various Earth Gravitational Models, see above under "EGM". For these reasons, IGC FR files use the WGS84 Ellipsoid as the GPS altitude zero datum rather than one of several different Geoids.

page viii on HAFRs, add: with respect to the WGS84 Ellipsoid, which is the IGC datum for zero GPS altitude.

page vii on Leap Seconds, change date to 2019 and leap seconds to 18.

page ix, MoP - last sentence to read: and produces three numbers in each fix line in an IGC file under the ENL code (and in some FRs also under the MOP code), see under ENL and MOP.

Page ix, MOP - Second sentence to start: The MOP sensor is designed to be placed so as to receive a high signal ...

page x on Observation Zones, for Start and Finish add: "Straight lines for"

page xi, under UTC, after GMT, add: and is also known as "Z time" or "Zulu Time" because UTC times carry the suffix "Z". It is maintained by the Bureau International des Poids et Mesures (BIPM - www.bipm.org), headquartered in Sevres, France.

page xii, under WGS84, add: In 1989, ICAO adopted WGS-84 as the standard geodetic reference for world aviation, see: https://gis.icao.int/eganp/webpdf/REF08-Doc9674.pdf (138 pages). The large page counts of these two documents show the complexity of defining an earth model in detail. This also shows why IGC uses the relatively simple WGS84 Ellipsoid earth model as a datum for Lat/long and GPS altitude figures in IGC flight data files, rather than more complex figures.

Main body

1.1.3.1 and 1.4.2, delete "external" before MOP

1.1.4.2 and 1.1.4.3, change the reference for competition flights to 1.1.5.3.

1.1.5.2, Grandfather Rights, add: For more detail on changes of IGC-approval levels, see Annex E, particularly E2.2.

New para 1.1.5.5 Compliance with IGC-approval standards. If after IGC-approval of a type of FR, it is found that the provisions of the Approval are not being fulfilled by production-standard FRs, the type Approval may be withdrawn pending compliance with the standards agreed by GFAC for IGC-approval to be issued. (AL5)

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

In some gliding competitions the fitting of proximity warning systems such as Flarm to IGC-approved FRs may be required, for instance as a separate Flarm module within the overall FR or in the form of Flarm primary firmware in a case by Flarm or in a case by another manufacturer. (AL5)

1.1.10 second sentence to read: A manufacturer's physical seal must be fitted to the recorder case in such a way that it will be broken if the case is opened and it must not be possible to peel off the seal intact. A system must also be fitted that operates if the recorder case is opened, for instance based on a security microswitch or microswitches inside the case, but other solutions will be considered that can be shown to give the same level of security, to the satisfaction of GFAC. For microswitches, the switch or switches must be shielded so that they cannot be prevented from operating as the case is opened, such as by inserting a specially-shaped tool to hold down the operating arm of the switch. (AL5)

1.3.3.2, add at the end: and any required changes before IGC-approval can be considered .

1.3.4.2.1 on HAFRs, second sentence to read: For IGC-approval of a HAFR, an independent check of GPS altitude figures above the WGS84 Ellipsoid in its IGC files is required using a high quality GPS signal generator at an NAC-approved facility that also uses figures above the WGS84 Ellipsoid that is the GPS altitude zero-altitude datum.
also, add to the third sentence: similar to a pressure altitude calibration table. A pressure altitude calibration to at least the same altitude as the GPS altitude check must also be provided.

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

1.4.2, modify as follows: 1.4.2 **Engine Recording Systems - General**. Engine recording is by IGC ENL and MOP systems that are designed to differentiate between conditions of forward engine thrust, and gliding flight without the use of engine. The low-frequency Environmental Noise Level (ENL) system inside the FR is most sensitive to acoustic sound between 100 and 200 Hz. It was originally designed to record the operation of two-stroke engines, but also records high ENL numbers with Forward Electric Systems (FES) if the FR is installed just behind the engine and its retractible propeller. Where the ENL system in the recorder does not produce high enough readings with particular types of engine and FR installations, an additional sensor under the MOP code must be used so that a high engine signal can be recorded as three MOP numbers in each fix line in the IGC file, in addition to the three ENL numbers. Critical cases are in 1.4.2.2-4 below, more detail is in Chapter 5 and SC3 Annex C (SC3C) Chapter 11.

1.4.2.4 on low ENL, add: The type of MOP sensor is described in an extra MOP line in the IGC file header record, and may either sense acoustic sound at high or low frequencies, current flow to electric engines, fuel flow to piston or jet engines, or any other variable tested and approved by GFAC for the engine type.

1.4.2.5, new para: Engine Recording. IGC files produced by individual recorder installations, particularly for ENL (and MOP where fitted), should indicate a clear difference between engine-off flight and any flight with the engine developing positive thrust. See also Chapter 11 of Annex C to the Code (SC3C) for more information and diagrams on engine recording. (AL5)

1.4.2.5.1 ENL and MOP figures. The three ENL numbers (and the three extra MOP numbers where available) in each IGC file fix line, should be approximately similar to those found in GFAC tests and listed in the IGC-approval document for the type of FR and engine sensor concerned. The figure with engine-off should not exceed 400 even in high-noise gliding flight (generally it should be much less) and the figure when the engine produces forward thrust should not be less than 700. If either ENL or MOP figures are outside these margins, there is a risk that glide performances may not be able to be validated, see 1.4.2.5.3.

1.4.2.5.2 Checking Individual Glider Installations. Flight Validations have been lost in the past where installations of FR engine recording systems in individual gliders fail to differentiate clearly between engine-on and engine-off conditions. This may be either (1) because use of engine does not produce high enough ENL/MOP figures in the IGC file, or (2) because the particular installation allows unwanted high figures to be recorded in gliding flight which could be confused with use of engine. Some specific conditions follow.

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

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

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

1.5.1, add: or pending improvement of systems such as ENL and/or MOP

2.2.4.1 on HAFRs, add to the first sentence: with respect to the WGS84 Ellipsoid
To end: For other references on IGC HAFRs, see SC3 para 4.5.3, SC3B para 2.1.2.2, and SC3C Appendix 6 which has an example of a GPS altitude check using a signal generator.

2.2.4.1a to start: GNSS altitude data must be with respect to the WGS84 Ellipsoid which is the IGC GPS altitude zero datum.

2.2.4.1c Title: change the word Calibration to Check.

Change wording to: ... para 2.1.2, which requires that the integrity and accuracy of altitude figures in IGC files from the HAFR used for the claim is checked by an approved Instrument Laboratory that includes altitudes on either side of the altitude(s) in the claim.

At the end, add: More information on checking the performance of HAFRs before and after claim flights is in Annex C to SC3 (SC3C), Appendix 6.

3.1 line 1, add: and GPS altitude

3.4, add: For GNSS systems where leap-second corrections need to be applied to obtain current UTC, the correction must be applied in the FR so that accurate UTC is always shown in times in IGC files. For leap seconds in the US GPS system, see page viii under GPS System Time) (AL5).

3.5 add after the first sentence: In any case, recording should always begin when the FR is switched on and horizontal or vertical movement is detected (from GPS or pressure altitude), and no special switching should be required.

3.7 line 2, change 10 minutes to 5 minutes. This wording about the minimum time static before closing an IGC file is to allow for being in ridge or wave, but 10 minutes without horizontal or vertical movement is unrealistic and we have already allowed some FRs to switch-off automatically after 5 minutes with no change of position.

Line 3, change 5 minutes to 2, to allow for battery change-over or loss of power, less likely than in the past due to improved battery technology. There is also the possibility of using this time to carry out an un-recorded engine run, so

it should be as short as practicable.

4.3 re-write as follows (no change of meaning): FRs designed to be mounted in an instrument panel will normally have an external tube connected the static pressure sensor inside the FR, the tube to be connected to the instrument panel static pressure system. FRs without this tube-static connection will record the pressure inside the FR case, so-called "cockpit static". (AL5)

4.4.2 on Pressure Altitude calibrations, add "of FRs".

5.1, add: The baseline figure with a serviceable ENL and MOP system and no signal is 010; a figure of 000 should indicate that the system may be unserviceable.

5.3.2 on Power-off conditions, add: In some glider installations, unexpected high noise levels have been found, probably due to aerodynamic vibration on or near the component on which the sensor is mounted - in these cases the sensor must be moved to a place free of unwanted noise in gliding flight.

5.4, second sentence to read: The MOP sensor may be external to the FR and connected to it in a secure way approved by GFAC, or be included inside the FR in addition to the ENL system. In either case, this should enable the MOP sensor to be placed to receive a high signal from the engine type for which it is designed, whenever forward thrust is developed. Guidelines for the positioning of the sensor for different types of engines will be given in the IGC-approval document.

5.4.1 on sensor position, add: "The sensor position must also be free from other noise which could occur in gliding flight and could be mistaken for use of engine."

5.4.2 Heading to read: Type of Sensor and IGC file Header Record.

Add at the end: If more than one type of MOP system is fitted, the letters MOP in the IGC file are followed by a number so that each system can be described separately in the header record. In each fix (B) record line, the first MOP system is to use the three letters MOP, other systems use MP2, MP3 and so forth.

5.5 on obsolete engine sensors, delete (no longer needed), and re-number 5.6 as 5.5 and 5.7 as 5.6. Search the document for cross-references to 5.6 (several) and change to 5.5.

5.5.2 second sentence, add "in some IGC files".

5.6.1 (new 5.5.1) Replace "power for low-speed cruise" with "power for positive engine thrust", and in line 3, add "under engine power". At the end, add "if the ENL signal is high enough in the particular installation".

5.6. change "at point of sale" to "on initial operational use " (so that the assessment is by the purchaser and not the manufacturer), and add, "The design must be able to allow for updates required by amendments to IGC FR documents."

6.1 line 1, to read:"Security procedures to protect hardware, firmware and software ... "

6.2 in line 1 correct the words to "recorder case", and on case labels, add the following in the last sentence: (so-called "no-peel Labels" or "non-removable Stickers")

6.3.5 and 6.3.6 duplicate each other. Combine the wording in 6.3.5 and delete 6.3.6. The new 6.3.5 to read:

6.3.5 Connectors and fittings for data download from FR to PC. The types of IGC-approved connectors or fittings on the FR case for download of flight data are specified in Appendix F. Some fittings such as memory cards and USB memory sticks do not need a PC to be connected to the recorder for flight data to be downloaded.

6.4 middle sentence to read: It is recommended that USB connections are to international and IGC standards for the RJ45, see Appendix E.

Appendices

A1.1 Second sentence on the IGC file format to be shortened to: It was approved by the IGC Plenary in March 1995 for use with IGC-approved Flight Recorders.

A1.1.1, second sentence, add: "before, during and after flight". Also, last sentence to read: Unless fix recording is continuous after switching on, the thresholds for starting fix recording are a speed of 15 kph or a pressure altitude change of 1 metre per second for 5 seconds, and see below how to record a pre-takeoff baseline.

A2.1 to read: **File Structure**. An IGC-format file consists of fields of characters, in some cases all on one line, each giving a set of data such as for a GNSS fix and other information. Each field starts with an upper-case letter denoting one of the Record types listed in para A2.2., and ends with CRLF (Carriage Return Line Feed). The B, I, J, L and K records are limited to 99 characters, excluding CRLF which is hidden and does not appear in text form.

A2.3, to allow for data calculated after flight that is placed after the G record in the IGC file in the form of another L-record. The wording ensures that the validation process for in-flight data is not affected:

First sentence to read: A2.3 **Record Order**. The A-Record is always the first in the file, and the last that is relevant to the data recorded in flight is the Security (G) Record that may be used at any time later to check the in-flight data through the IGC VALI system.

Last sentence to read: It should be noted that in some cases, other data is calculated ***after flight*** such as statistical data for the flight. This may be placed at the end of the IGC file after the G record in the form of another L record but ***it is essential that*** the integrity of flight data before the G record and the VALI system for checking the flight data are not affected by such additions. (AL5)

A2.3 table, delete "always last" for the G-record, and add at the end : L - Data added after the flight is completed

A2.5.6.1, delete reference to the CONV-XXX.EXE program file, now obsolete.

A2.5.5 second sentence to read: The IGC electronic security system applies to flight data within the file itself and after-flight checks of the integrity of IGC-format flight data files.

A 2.5.6, table of Manufacturer codes on page 20: in the last column, add "No longer making IGC FRs" to the lines for Cambridge, Data Swan, Peschges, Scheffel, SDI, Zander.

A3.1, replace "unique to the manufacturer" by "for the particular FR".

A3.2.3, add: and GPS altitudes

A3.2.4 on header records, change the wording in the first paragraph to : In what follows, extra spaces between items are added so that it is easier to see the items; these spaces are not present in actual IGC files when viewed in text format:

Also add: Glider ID line - some FR manufacturers give lists of glider types that, when selected, automatically appear in the Glider ID line. However, to allow for types not in such lists, it must also be possible to enter the glider type manually.

Under MOP: to read "internal/external", and add: (+ peak frequency sensitivity Hz/KHz).
Also add at the end: If more than one type of MOP system is fitted, these should be numbered MOP2, MOP3 etc in the header record, followed by the details of each system as given above. In the I-record line for additional data these are identified as MP2, MP3, etc

In the notes on page 22, delete the following (no longer relevant): Before Amendment 4 the second line was for three numbers for Fix Accuracy (FXA) in metres. This has now been removed because it is not relevant to a Header record and is used in individual B- (Fix) records under the FXA code.

A3.2.7.5 under GPS altitude, WGS84 Ellipsoid, add: (mandatory zero-datum for IGC FRs)

A3.3, delete the following, now obsolete: The data stored in the I-record is part of the data to be signed (see A3.6 on signing and the G record) AL1.

A3.6, replace "Up to 75 bytes per line" with: "As required for the appropriate security level".

A4.1, delete the following, now obsolete: The data stored in the B-record is part of the data to be signed (see A3.6 on signing and the G record).
Second para, add: with respect to the WGS84 Ellipsoid

A4.3, third sentence on satellite IDs, replace "will be assigned by GFAC as the need arises" by "it is the nearest equivalent". Also delete the following, now obsolete: The data stored in the F-record is part of the data to be signed (see A3.6 on signing and the G record) (AL1).

A4.4, delete the following, now obsolete: The data stored in the K-record is part of the data to be signed (see A3.6 on signing and the G record) (AL1).

A4.5 to start: Logbook Records are comments that can be placed anywhere in the file after H, I and J records and the term "comment record" may be more descriptive rather than "logbook". In the file they may either be before the G (security) record at the end of the in-flight data, or after the G-record ***although it is essential*** that the security of the in-flight data and its after-flight Validation check is not affected, see A2.3 on Record Order within the file and A7 on how new TLCs are to be notified to GFAC.

A 4.5.4, after this para on Flarm, add the missing heading: A4.5.5 Format. The general format of the L Record ...

A5 Competition Class line, add 20m and Club Classes

A5 under Fix Accuracy, add "Estimated Position Error" before EPE

A5, delete line on GNSS Connect/disconnect, now obsolete

A7 second sentence to read: If a manufacturer proposes to use a TLC not listed below, they should inform GFAC giving its proposed initials, general purpose, a definition suitable for publication in this document, number of bytes, units to be used, etc. If agreed by GFAC, the new TLC will be added to the list below at the next Specification update. Meanwhile, this system of early notification will enable GFAC to inform manufacturers if another manufacturer has already submitted a TLC for the same function, or there is already a proposed TLC that uses the same code letters but for a different function. (AL5)

TLCs, add:

EGT - exhaust gas temperature in degrees C (for jet engines)
GSP - Groundspeed - used in some FRs, the figures based on special algorithms that make accurate calculations.
Note: in other FRs, Groundspeed can be calculated after flight from a succession of fixes (AL5)
LCU - L - Data from SeeYou after flight, not needed for flight validation but used for flight analysis (AL5)
MP2, 3 etc - MOP systems in addition to the first one
MCU - L- Data from SeeYou after flight, not needed for flight validation but used for flight analysis (AL5)
RPM - revolutions per minute
JPT - jet pipe temperature
TRT - True Track - used in some FRs based on special algorithms to make accurate calculations. Note: in other FRs, Groundspeed can be calculated after flight from a succession of fixes (AL5)

New TLCs to be added (Currently used by LXNAV):
COT - Controller temperature (for instance for FES) degrees C
CUR - Electrical current, Amperes
FFL - Fuel Flow, litres per hour
FLE - Fuel level, centilitres.
LEB - Battery left - state of charge, percent
MOT - Motor temperature, degrees C
VOL - Electrical Volts

Obsolete TLCs - list under a new sub-para: A7.1 Obsolete Three Letter Codes (TLCs) - these may be still in use in old recorders used in some FAI Air Sports:

CCN	E	Camera Connect
CDC	E	Camera Disconnect
DOB	H	Date of Birth of the pilot, now use DB1
PHO	E	Photo taken (shutter-press)
SCM	H	Second Crew Member Name, now use CM2

Engine codes
In some old models of recorders where ENL (now mandatory) and MOP (where required) are not used, the EON/EOF or EUP/EDN codes were used. EON/EOF was based on functions such as ignition ON/OFF, generator output, etc. EUP/EDN was used for a microswitch sensor for engine bay doors open/closed or pylon up/down.

EDN	E	Engine down
EOF	E	Engine off
EON	E	Engine on
EUP	E	Engine up

A8, add to the first sentence: and GPS altitudes
also, number the second para on other Earth Models as A8.1

B1, delete the words: "failure recovery".

B2 last sentence, replace MOP with "engine" to avoid confusion with MOP recording in IGC files.

B4.1.1, last sentence to start: The lat/long of the feature at the right angle in the IGC file will also be compared ...

C1.6 on history, delete, no longer needed

Appendix E - Changes of IGC-approval level. Updated wording to bring this annex into line with what was in the GFAC report dated 8 January 2019 that was part of the 2019 IGC Plenary agenda and approved by the Plenary. The main update is a more comprehensive para E2.2 on FR security:

> E2.2 FR Security. Evidence that the security of the FR itself has been compromised, or could relatively easily be compromised. This includes where it has been found that security devices in the FR could be by-passed or where the length of security keys or other features in old recorder designs is considered by ANDS and GFAC to make them vulnerable to interference or hacking, after which IGC files might continue to pass the Validation check. This includes cases where security keys are significantly below the current figures for new types of recorders as given in the current IGC FR Specification document (for instance para G2.1.2). For existing recorders with security keys or other features that are not considered a current or foreseeable future major threat to interference or hacking, the "Grandfather Rights" principle continues to apply where approval levels for these recorders are not changed even though the key length or other features for completely new recorder designs has been increased. (AL5)

G2.1.2, in first sentence, add "and ECC ". Also, change second sentence to: For "all flights" IGC-approval of new designs of FR using RSA, a modulus of at least 3072 bits is required, and the equivalent for systems other than RSA (see the Glossary under DSA, ECC, PKC and RSA).

G4, add the words "Digital Signature" in full before the abbreviation.

G6.3, remove the following words which are already covered in G6.1: "The manufacturer's reprogramming process may re-enter the Private Key (PK) and for this reason, only the minimum number of people should have knowledge of the manufacturer's process for external programming."
