TECHNICAL SPECIFICATION FOR IGC-APPROVED GNSS FLIGHT RECORDERS

AMENDMENT LIST NUMBER 6
Effective 25 November 2020

Page ii, chapter 5 heading, change "Means of Propulsion" to "Engine". Reason, to avoid confusion with MOP systems that are described in Chapter 5 together with ENL systems inside the FR

Page iii Contents, change 1.10 title from "Problems" to "Comments", the current chapter heading

Page iv Para 3, add: ... and the IGC Sporting Code (SC) Committee will be copied for information and to give them the opportunity to propose inputs to this document.

Page v, italic notes under the heading, add: *Explanations of technical terms are also available on the web from sources such as Wikipedia*

Page v, add (as in Sc3B): Accuracy - this term refers to how close different measurements are to the correct value, compared to the term "precision" which is the closeness of measurements to each other. It is therefore possible to have a set of close measurements (high precision) that have a systematic error and so have low accuracy. The preferred situation is to have both high accuracy and high precision of data points.
See: https://en.wikipedia.org/wiki/Accuracy_and_precision (AL6)

Page v, under ADS-B, add: For further details, see:
https://en.wikipedia.org/wiki/Automatic_dependent_surveillance_%E2%80%93_broadcast and
https://www.skybrary.aero/index.php/Automatic_Dependent_Surveillance_Broadcast_(ADS-B)

Page v, under ARINC, add: For further details, see: https://en.wikipedia.org/wiki/ARINC

Page v, add: CAS - these initials can mean Calibrated Air Speed, Controlled Air Space, or Chief of the Air Staff, depending on the context in which the initials are used. Calibrated Air Speed is the Indicated Airspeed (IAS) on a cockpit airspeed indicator, corrected for instrument and position error. (AL6)

Page vi, add (as in SC3B): Declaration - The pre-flight recording of pilot name(s), glider type and identification, and any waypoint coordinates required to certify a soaring performance in accordance with SC3 procedures for that type of performance. The date and time when the latest declaration was received by the FR after action by the pilot or a system used by the pilot, is recorded in the first line of the C-Record at the beginning of of the IGC file. (AL6)

Page vii under Fix, transfer the reference to Pressure Altitude to the second sentence.
Under Spurious fix, add at end: Early GNSS recorders showed a number of spurious fixes in their IGC files but this is less common with more modern FR systems.

Page viii, Geoid and page xii WGS84 Geoid, to read: Several Geoid definitions exist with differences in the exact shape and resolution of the Geoid surface, unlike the WGS84 ellipsoid which is a smooth surface based solely on an equatorial and a polar diameter. For these reasons, IGC FR files use the WGS84 Ellipsoid as the GNSS altitude zero datum rather than one of several different Geoids of differing complexity.

Page ix, add (as in SC3B): JPEG - Joint Photographic Experts Group. This Group developed a system for compressing digital data for pictures and diagrams so that the byte size is smaller than the un-compressed version. It is abbreviated JPG which is also used as a file suffix such as image.jpg. (AL6)

Page ix, add (as in SC3B): Mb - Millibar. A unit of pressure, one thousandth of a Bar (one million dynes per square centimetre), the same as a hectoPascal (hPa). The ICAO International Standard Atmosphere (ISA) defines sea level pressure as exactly 1013.25mb / hPa. The reason for this irregular number (compared to exactly 1010 or 1000mb), is that it is equivalent to the previous international standard which was 76 cm of a mercury column at 15 degrees centigrade and corrected for local gravity. (AL6)

Page x, add (as in SC3B): Pascal - The International Standard (SI) unit of pressure, defined as a pressure of one Newton of force per square metre (one Newton is the force needed to accelerate 1 Kg mass at 1 metre/sec/sec, equivalent to 0.225 lb force or 4.45 Newtons per pound force). One hundred Pascals are a hectoPascal, abbreviated hPa (the same as a millibar (mB), see above), named after the French mathematician Blaise Pascal, and was adopted as the SI pressure unit in 1971. (AL6)

Page x, under PKC, add: at the time this paper was Classified and only later revealed in the Public Domain.
Also, add at the end: For more detail on Private keys, see G2.1.1.2.

Page x, add: Precision - see above under "Accuracy"

Page xi, add: Public/Private Key. See above under PKC, Public/private Key Cryptography. (AL6)

Page xi, add: Reach, Reaching - when this refers to a Turn Point (TP), it refers to complying with IGC criteria for reaching the Point. Unlike activites such as air racing at low level where the aircraft must fly round a ground feature such as a pylon, IGC require that there must be proof that a glider has entered the Observation Zone (OZ) relevant to the TP. (AL6)

Page xi, update web references for SC3 and SHA, also under Serial ID delete references to three characters because in the long file name the ID can have more than three, and add: "see A2.5 on file naming"

Page 1 italic note under the heading, add: (SC3B)

Para 1.1.3 line 5, add "IGC-approved procedures"

1.1.3.2 line 2 to read: "made available to users of the FR"

1.1.5.2 line 5, add: "Grandfather Rights"

1.1.10 line 5, add: "so that it could be re-installed without evidence that it had been removed"
Add at the end: For more detail on Private keys, see G2.1.1.2.

1.1.10 line 7 to read: Other systems may be considered if they can be shown to give the same level of security, to the satisfaction of GFAC, and for more detail see Appendix G on Security.

1.1.10, add at the end: see para G4 on requirements for security systems with and without microswitches.

1.1.10.1, add para numbers and headings to the two sub-paras on Validation Pass and Validation Fail

1.1.11.2, second sentence to end: Flight Recorder data for starting the takeoff roll and finishing the landing run.

1.2, add at end of first sentence: (see para 1.4.1).

1.3.2.2, change heading to: "FR hardware for IGC testing"

1.3.5.1, first words to read: At the date of this document (year 2020) ...

1.4.1, re-number existing 1.4.1 as 1.4.3, and add new 1.4.1: **GFAC Testing and the IGC FR Technical Specification**. Tests by GFAC will include drives in vehicles over known routes and exact points, and flights in gliders, motor gliders and/or powered aircraft. These are sometimes known as Proof Drives and Proof Flights (see the Glossary under "Proof ..."). Comparisons will be made with FRs that are already IGC-approved, and the IGC file structure of the FR under test will be checked for compliance with the current IGC FR Technical Specification (TS). This will include functions such as Pre-Flight Declarations (see the Glossary under Declaration), accuracy of fixes, recording of correct pressure and GNSS altitudes, and the required number of pre-flight and after-flight fixes to establish where the takeoff roll started and the landing run finished, and other Specification requirements. (AL6)

1.4.2 line 4, add: "subject to testing"

1.4.2.3 line 2, add: the FR manufacturer (reason, clarity of who takes the action covered in this sentence)
Line 3 to read: " ... tested by GFAC in a range of gliders, gliders with engines, and powered aircraft."

1.4.2.4, add at end: "and Chapter 5"

1.6.1.2, add: "and an updated FR sent to GFAC for testing"

1.6.2, add: "after a decision by GFAC"

1.6.3.1 and 1.6..3.2, change "Organisation" to "Manufacturer"

1.6.3.3, add: In this situation, GFAC may consider lowering the IGC-approval level of such Frs.

1.7.1 on the IGC file format, add: See the Glossary under ENL, Fix, Missed Fixes, and MOP.

1.8, add: 1.8.1 Valid Approval Document. Only the latest published IGC-approval document for a given type of FR is valid for IGC purposes. (AL6)

1.9.1, add: ... to the FR manufacturer.

1.10, add at end: ... on Anomalies in Evidence.

2.2.2, add: "see Annex A for the detail" and , "see also para 3.11"

2.2.3.1, add: "above the WGS 84 Ellipsoid for GNSS altitude"

2.2.4.1 paras: re-number the para on GNSS Receiver to 2.2.4.1.1 and the para on GNSS Altitude data to 2.2.4.1.2.
In the re-numbered 2.2.4.1.2, add the following words from SC3B 2.2.2.1 plus the four diagrams:
GNSS altitudes above the WGS84 Ellipsoid in the IGC file from the HAFR used for an altitude claim above 15,000 metres must have been independently checked and documented before the claim for accuracy and freedom from anomalies. They must also be checked ***after*** an altitude claim above 15,000m to ensure that processing of GNSS altitude by the FR has not changed, for instance due to other updates, changes, or faults in the FR that have occurred since the initial check, which could be up to 5 years before the claim flight. These checks must be carried out at an NAC-approved instrument laboratory, at which a high quality GPS signal generator is used to inject signals of precise GPS altitudes above the WGS84 Ellipsoid into the FR's antenna connector.

Add the following text, the wording taken from SC3B 2.2.2.1:
2.2.4.1.3 The pre-flight check is required up to the maximum altitude for which the HAFR is to be approved for record claims. Differences between the IGC file figures and those from the signal generator are then listed in a table that is used to correct figures for the altitude claim in a simular way to correcting IGC file pressure altitudes to the ICAO ISA. The diagrams show an example of a GNSS altitude check made as part of IGC-approval of a HAFR and are from Appendix 6 of SC3C. (AL6)

2.2.4.1.4 The time periods for these checks are the same as SC3 requirements for pressure altitude calibrations. That is, within 5 years before and two months after the flight, except that if the claim flight is made from a site remote from GNSS altitude checking facilities, the after-flight period starts when the FR is returned to a location at which GNSS checks can be carried out at a facility approved by the NAC dealing with the claim. (AL6)

2.2.4.1.5 The minimum requirement for the post-flight GNSS altitude check is for check points to be recorded above and below (and close to) the claimed altitudes. A check over the complete altitude range is not essential, but could provide the official pre-flight check for a later claim. (AL6)

2.2.2.1.6 A pressure altitude calibration is also required within 5 years before the claim up to at least the altitude to be claimed, but there is no requirement for a post-flight pressure altitude calibration for altitude claims above 15,000 metres because GNSS altitude will be used for the claim. (AL6)

2.2.5 on engine recording, add "See Chapter 5 for more detail"

2.2.9 on units, change to: (Based on a Pressure equivalent to 760mm of Mercury at 15 degrees Centigrade)

2.2.11, new para (wording from SC3B): 2.2.11 Approval level changes. If GFAC proposes to change the approval level of a type of IGC FR, generally to lower the level, or to remove the approval, this will first be discussed with the FR manufacturer. The manufacturer will be given the opportunity of offering an upgrade that will retain the existing approval level for modified recorders. The IGC ANDS Committee will be informed, and the IGC Bureau may also be informed if considered appropriate at this stage. Further detail on changes of IGC-approval Level is in Appendix A to SC3B (the IGC Sporting Code Annex B on equipment requirements for Validation of flights). (AL6)

3.5.1 on pre-takeoff baseline of fixes, add to the first sentence: ... at not less than 1 second intervals in the minute before takeoff movement is detected (see Appendix A para A1.1.1 for more detail).

3.9.2 on pre-flight declarations, add after the first sentence: The most recent declared start, finish and turn points appear in the C-record of the IGC file together with the date and time that the FR received the declaration.

3.11, update FAI web reference to www.fai.org/igc-documents

3.11 text, add: "if not up to date, advise the GFAC Chairman so that action can be taken"

3.11.1 for FRs using binary download format, add: "for some old FR designs"
also add: "the program external from the FR".

3.12, add: "averaging programs still allow all real manoeuvres to be shown when the IGC file is analysed."

3.12.1 to start: "Some GNSS receiver modules designed for use in ground vehicles"
add at the end: "this was seen in early GPS systems tested by GFAC"

4.4.2, add at the end: "see para 2.2.3.2"

5, main chapter heading, change "Means of Propulsion" to "Engine", reason, to avoid confusion with MOP systems that are described in Chapter 5 together with ENL systems inside the FR

5.4.1, add: "unless it can be shown that other positions give high enough MOP values when the engine generates positive thrust"

5.4.2, add: "If appropriate MOP numbers cannot be demonstrated, a different type of sensor must be used."

6.1, last line add: "from the same IGC file"

6.1.1 to read: Individual FRs must not have the same security keys as those for other recorders from that manufacturer, so that if the key for one FR is broken, the rest of the product range will still be secure. For the number of different Private keys required, see G2.1.1.2. (AL6)

A1.1.1.1 Pre-takeoff Baseline, increase fixes from 20 to 30 (we have had problems with only 20 fixes), to read: Pre-takeoff Baseline. For types of FRs that start recording fixes in the IGC file after movement is detected (compared to types of FRs that record fixes in the IGC file after switch-on), a pre-takeoff baseline must be provided consisting of a continuous series of at least 30 valid fixes at a steady fix rate throughout the minute before takeoff movement is detected (Chapter 3 para 3.5.1 also refers). For this, when movement is detected, the pre-takeoff baseline fixes are placed in the first B-record lines in the IGC file (in current IGC-approved FRs this is achieved through a memory circuit that continuously stores the correct number of fixes ready for insertion into the B record at the appropriate time).

A2.1 line 3 on characters in IGC file lines, add "Generally" at the start of the sentence (to allow for more than 99 characters in some cases)

A2.2 table, I record to read: List of additional information after the basic B-record data
J record to read: List of additional information after the basic K-record data

A2.3 on the G (Security) record to read: "allows the validity of the in-flight data to be checked at any time through the IGC VALI system" , also change "flight" to "fix" to read: " integrity of fix data"

A2.4 on units, to read: "GNSS altitude above the WGS84 ellipsoid"

A2.5 on short and long file name styles: since for new types of FRs the long name is now mandatory, put this para first (as A2.5.1) followed by the para on the short file name (A2.5.2).

In the short file name para, add: "This was an earlier IGC system but for recent and new types of FR is now replaced by the long name style above"

A2.5.5 line 1 on file names, add: "outside the contents of the file"

A2.5.6 table in page 20: for EW Avionics and New Technologies, add: "No longer making IGC FRs" and in Note 1, add: "(also see A2.5.1 and A3.1)".

A3.1 line 2, delete "three character" ,

A3.1 table: the line for "Unique FR ID" to read: "three or more bytes" , delete reference to only three characters and add: "See A2.5 for long and short IGC file names. Note that non-IGC FRs may not conform and use different ID systems."

A3.2.1 Source Codes, add: "In recent types of FR,"

A3.2.2 after "F=FR", add: "O=other source"

A3.2.4 table, add: H F FRS SECURITY OK or SECURITY SUSPECT: TEXTSTRING CRLF

A3.2.4 notes, add: FRS SECURITY line - see next page in the A3.2.5 table under HF FRS (AL6)

A3.2.5 table, change last column to read:
Format: HF FRS SECURITY OK , or
HF FRS SECURITY SUSPECT: Text String with reason CRLF
Format line 2 above is used where security is suspect, for instance if FR firmware has changed in an unauthorised way or if the security microswitch has operated. The text string should be a description of the likely fault, such as: "internal firmware changed FR re-set needed" or "Security Micro Operated FR re-set needed" (AL6)

A3.5.4 replace references to before the day of flight with: " This can be before the day of flight, unless a later declaration is received by the FR which replaces the earlier one."

A4.2 line 9, add: "should not be used for an Event record after every fix (B-record line), so that the IGC file does not become unnecessarily large. "

A4.3, GPS satellite ID sentence to read: "In the US GPS system, SVN is the Space Vehicle Number of each satellite, and PRNs are "Pseudo-Random Noise" sequences, or Gold codes, that each satellite transmits to differentiate itself from other satellites (SV Numbers are not transmitted)."

A4.5.2, Logbook records after flight, add: "in a line starting LPFC"

A5 under Geodetic datum add: " ... and GPS altitude figures in IGC files, for IGC-approval this must be the WGS84 Ellipsoid"

A5 list, add: Geodetic Datum - see above under Datum, Geodetic

G2.1.1.2, add: The Private Key(s) stored in an individual FR are used in the validation of IGC-format files originating from that FR. For Level 1 and 2 FRs, unique Private Key(s) shall be provided for each individual FR, and the private keys used in one FR shall not be stored in other FRs. For Level 3 FRs, Private Key(s) for each type of FR may be provided from a bank of at least 1000 keys that can be re-used when all have been used for the first time in FRs of that type. Only private keys to be used by the individual FR shall be stored in that FR. At the FR manufacturer, the detail of private keys must be kept strictly confidential to the fewest number of people.

New para: G4.1.1 Non-microswitch Systems. If a new FR design does not include a security microswitch, to obtain IGC-approval its internal firmware must be specially designed so that it will detect any subsequent errors in the firmware or deliberate attempts to change or interfere with it. After any such errors or deliberate interference ("hacking"), either no IGC files should be produced at all, or files downloaded must be clearly marked as invalid and must fail the IGC file Validation check. Applications for IGC-approval must submit analysis showing how equivalent security of the private key protection and detection of unauthorised interference with the hardware or internal firmware are achieved, and how firmware updates can be applied while maintaining security. The manufacturer must be able to demonstrate the above to the satisfaction of GFAC before approval can be considered at any IGC-approval level. GFAC will consult the IGC ANDS Committee and other experts if required. If the above cannot be achieved, microswitch-based security will be required for the new FR design before IGC-approval can be given. (AL6)

Page 56 (Specimen first page), web references updated
