Sporting Code Section 3
Annex B
Draft 6 of Annex B dated 27 December 2001

Changes from draft 4
(draft 5 was sent only to Bernald, Marc and Ross, to clear certain points):

Preliminary remarks, addition to para 2 on sources (after comment from Ross)
1.1.5 - addition of last sentence (from Bernald)
1.7, new last sentence
2.1.1.1, reference to ICAO ISA added
2.2.2.2, GFAC approval of Electronic Barographs added
New 2.2 on barographs and flight recorders, mechanical baros added to previous wording.
2.4.2 on GPS altitude accuracy made less specific, after comments from Bernald and Marc
Chapter 3 - Cameras. Changes as a result of comments from Ross
4.1.1, only GPS systems so far IGC-approved (ie not GLONASS or Galileo) (asked for by Bernald)

Notes for the Bureau
Contents compared to previous edition that is presently on the IGC web pages

Glossary. Removed. It is now duplicated by the more comprehensive Glossary in the IGC Flight Recorder Specification. A cross-reference to the Specification is included, also a hyperlink to the IGC web page.

Chapter 1. IGC general policy on GNSS Flight Recorders, plus terms of reference for GFAC. Revised in accordance with current practice. The previous wording was drafted in early 1995. No policy change, just up-to-date wording in a more logical order.

Chapter 2. Altitude recording. As before plus some background material from SC3 and SC3C.

Chapter 3. Cameras. This chapter was previously blank. Ross thought it should be used rather than deleted. Therefore, at the start of drafting some of the more important points were extracted from SC3 and SC3C. This led to some additional guidance being developed which amplifies SC3 and SC3C. The resulting chapter is put forward as useful and unique guidance on the subject, suitable for Annex B.

Chapter 4. Timing devices. Comment as for Chapter 3.

Appendix 1. **Interpretation of GNSS FR data.** Removed, now updated and included in SC3C.

This new Edition 3. No change of policy is intended in this draft, just a better statement of existing policy and procedures which will resurrect Annex B as a viable document.

Future action. Placing the final draft before the Bureau for consideration and issue when the Bureau is satisfied.

Date of effect. At the March 2001 IGC Plenary, the Bureau were authorised to issue the new Annex B when they were satisfied with it.

FÉDÉRATION AÉRONAUTIQUE INTERNATIONALE

ANNEX B
to
FAI SPORTING CODE
SECTION 3

FAI AIRCRAFT CLASSES D AND DM
GLIDERS AND MOTOR GLIDERS

REQUIREMENTS
FOR EQUIPMENT USED
FOR FLIGHT VALIDATION

EDITION 3 DATED XX YYY 2002

AMENDMENT LIST (AL) RECORD

Amendments to this Annex B can be proposed to IGC by its Sporting Code Specialist, the IGC GNSS Committee, or the GNSS Flight Recorder Approval Committee (GFAC), to whom suggestions for change should be made in the first instance in their areas of interest. Amendments can also be proposed by IGC delegates for inclusion in the IGC agenda, although in this case, comments on them will be made to IGC by the appropriate Specialist or Committee. Amendments should be proposed in a form of words suitable for direct incorporation into the Code.

Like other parts of the Sporting Code Section 3, amendments to Annex B take effect on 1 October following the IGC meeting at which they were agreed (unless an earlier date is agreed for the subject concerned). By the issue date, a fully amended SC3B will be made available through the web reference http://www.fai.org/sporting_code/sc3.html

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CONTENTS

PRELIMINARY REMARKS

1 Title and Status. This document, abbreviated as SC3B, contains the basic rules, procedures and guidelines applying to the equipment covered in this document that is used in the flight verification process before final validation of flight performances to FAI/IGC criteria. Although SC3B is published and amended as a stand-alone document, it is a sub-document of the FAI Sporting Code Section 3 (Gliders and Motor Gliders) and should be read in conjunction with other documents where the subject matter is appropriate.

2 Scope. This document gives the principles involved in the use of some types of hardware that are used in flight validation. Such hardware includes Global Navigation Satellite System (GNSS) Flight Recorders (FRs), barographs, cameras, and timepieces. It also contains the terms of reference for the operation of the IGC GNSS Flight Recorder Approval Committee (GFAC). Other material needed by pilots and Official Observers is placed in the main body of SC3 and in Annex C (SC3C). SC3 gives principles and rules, and is designed to be brief. Annex C, titled the OO and Pilot Guide, amplifies the SC3 material and gives more detailed procedures for use in the field. This Annex B includes quotes from SC3 and Annex C in order to aid clarity on the subject of the chapter heading concerned. This is so that this Annex can be used without constant direct reference to other documents. However, the prime authority for such wording is the source document and the wording should be referred to in the original document should any question arise.

3 Technical Specification for IGC-approved GNSS Flight Recorders. A separate document with this title is issued by FAI on behalf of IGC, and is available through the web reference given in para 4 below. Amendments are made on the advice of the IGC GNSS and Flight Recorder Approval Committees, who consult a range of independent experts, the manufacturers involved with IGC-approved recorders, and, where appropriate, GNSS receiver board manufacturers. As it is a technical document and is not part of the Sporting Code, an amendment can be made at any time in response to circumstances, but is generally not made more frequently than once in a calendar year. It is intended for the use of manufacturers and designers of hardware and software, GFAC members and associated consultants and expert advisors, and technical experts on GNSS FRs in NACs. However, pilots and OOs using GNSS Recorders will find much of interest including a comprehensive Glossary of Terms and Abbreviations.

4 Publication on the Web. IGC documents are available as follows:

SC3 and its annexes (SC3A, SC3B, SC3C): http://www.fai.org/sporting_code/sc3.html

Technical Specification for IGC-approved GNSS FRs: http://www.fai.org/gliding/gnss/tech_spec_gnss.asp

IGC-approved Flight Recorders, complete list and all IGC-approval documents:
http://www.fai.org/gliding/gnss/approved_gnss_flight_recorders.asp

Free software for IGC-approved Recorders: http://www.fai.org/gliding/gnss/freeware.asp

5 Amendments. See page (i) for details.

6 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.

7 Terms And Abbreviations. A comprehensive Glossary of Terms and Abbreviations is included in the Technical Specification for IGC-approved GNSS FRs, and should be consulted where necessary. See the reference to the Technical Specification in para 4 above.

CHAPTER 1

GNSS FLIGHT RECORDERS (FRs)
IGC-APPROVAL AND OTHER PROCEDURES

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 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 recorder system both physical and electronic. Full 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. 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 also 1.1.5 for cockpit displays. Reduced levels of approval may apply to types of Flight Recorders with characteristics below those required for full approval at the time that the approval is given (see 1.1.3.3 below).

1.1.1 **FAI Liability**. FAI takes no responsibility or liability for the consequences of the use of IGC-approved 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 Recorder Type**. Operating procedures for each type of recorder will be specified 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 recorder could be substituted in the glider concerned by another one, or that the recorder in the glider could be interfered with without this being detected. Particularly with small portable recorders, this may require either continuous observation of the glider before takeoff and/or after landing, or the physical sealing of the recorder unit to the glider by an OO at any time or date beforehand (thereby avoiding the need for extra OO observation 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 recorder concerned may be required, such as stowage of certain modules out of reach of the flight crew. Such procedures will be an integral part of the IGC-approval document for the type of equipment concerned, and will depend on the 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 Recorder**. The IGC-approval document for each 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 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 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 Recorder, procedures for checking the validity of the IGC file data, pressure altitude calibrations, and, for those 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 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 examples, see the complete list of IGC-approval documents through the web page given in para 2 of the Preliminary Remarks to this Annex B.

1.1.3.3 Levels of IGC-approval. (SC3 para 4.6.4) The IGC-approval document for individual types of 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 which do not meet the requirements for full approval at the time that the approval is given. The following levels of IGC-approval apply:

1.1.3.3.1 Full IGC-approval. This applies to Recorders that may be used for evidence for all flights up to and including FAI/IGC world records.

1.1.3.3.2. IGC-approval for badge flights up to Diamonds. This applies to Recorders that may be used only for evidence for Silver, Gold and Diamond badge flights. They may have lower standards of security compared to Recorders with full approval. This level also includes systems that use a separate GNSS unit connected to the Recorder unit by cable.

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 Recorder levels.

1.1.5 **Cockpit displays**. IGC is concerned at 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 a 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 Recorder. Any abuse of this may lead to a requirement for sealing.

1.1.8 **Security of the Recorder module**. For IGC-approval, the 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 will be fitted in such a way that it will be broken if the case is opened. Also, a system such as a microswitch will be fitted that causes the internal electronic security system to be trashed if the case is opened. Subsequently, IGC data files from the recorder will fail the electronic VALIDATE check that is available through free software from the gliding/gnss web pages.

1.1.9 **Proof of presence of the Recorder in the Glider**. There must be incontrovertible evidence that the particular Recorder was present in the particular glider for the flight concerned. The procedures in the IGC-approval document shall ensure this as far as possible. This is vital in the case of a GNSS FR because, unlike other equipment used in the verification process, the Recorder contains virtually all the evidence for the flight. It is particularly important with the small, lightweight types of Recorder which can easily be transferred from one glider to another. If an OO is not present to witness takeoff or landing and to check the Recorder installation close to these times, sealing of the Recorder unit to the glider structure by an OO must be carried out at any time or date before flight so that it can be shown that the particular Recorder was in the particular glider for the flight claimed. See also 1.1.9.1 below on independent takeoff and landing data.

1.1.9.1 **Check of takeoff and landing details, independent of the 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 will be compared to the

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 recorder data. Following this, the rest of the data may be accepted as valid evidence for the claim, subject to the electronic VALIDATE check on the IGC file which shows that the data has correctly originated from the individual 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**. Manufacturers are encouraged to make contact with the GFAC Chairman as early as practicable during the design process for a new type of 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 **Submission of a new model of 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, a compressed format such as *.jpg should be used, 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.

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

1.3.1.2. When hardware is available. Hardware should not be sent until GFAC comments have been made on the specification of the 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 Recorder Manufacturer.

1.3.1.3. Fee to FAI. When hardware is sent, the Recorder manufacturer should apply to FAI on the forms provided and pay the appropriate fee. Detail, para 1.3.4.

1.3.1.4. 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 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.

1.3.2 **Re-approval after changes**. For re- or continued- approval of a Recorder after changes have been made after an existing IGC-approval, the provisions of 1.3.1 that are relevant, continue to apply.

1.3.3 **Documentation**. Each applicant shall provide information to GFAC on how their model of recorder is intended to meet the IGC Specification. Particularly, 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.

1.3.3.2 Pressure Altitude Calibration. The pressure altitude recording system in the 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.

1.3.4 **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 FR. 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 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 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 **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.

1.5 **Approval**. On behalf of IGC, GFAC shall either approve, conditionally approve, or require modifications to the applicant's unit. Drafts of approval documents will be circulated beforehand to GFAC members and associated experts, also to the 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 full approval can be given, when the factors which led to the conditional approval have been changed. 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 without modifications being made, 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 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 To inform the GFAC Chairman if changes (of whatever nature) are made to an IGC-approved model of Recorder.

1.6.2 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 the fee for a new type of GNSS FR. Where someone other than the Recorder manufacturer has notified FAI of the change concerned which led to a further approval process, the fee shall be that for a new type of GNSS FR, since the manufacturer was obliged to notify FAI earlier.

1.6.3 FAI may remove or alter the existing approval of any Recorder at any time.

1.7 **Laboratory Testing**. FAI may decide that a report on the Recorder (or a particular aspect of the 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.

1.8 **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 is specified. For the different levels of IGC-approval, see para 1.1.3.2. 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.

1.9 **Notification and Issue of IGC-approval Documents and Free Program Files**. 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 program files for transferring IGC files to a PC from the Recorder, and for validating the integrity of such files, will also be posted for free access.

1.10 **Problems in Use**. If any problems arise during practical usage, the GFAC Chairman should be notified in the first instance.

1.11 **Changes to an IGC-approved 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.

If further technical detail is required, consult the Technical Specification for IGC-approved GNSS Flight Recorders. For the web reference, see para 2 of the Preliminary Remarks to this Annex B. Note that this Chapter 1 is repeated for the benefit of manufacturers in the form of Chapter 1 of the Technical Specification.

CHAPTER 2

ALTITUDE RECORDING

2.1 **Altitude Evidence and Control** (SC3 para 4.7, extract and expansion)

2.1.1 **Altitude evidence**. Altitude data requirements may be fulfilled by any of the following measuring methods (SC3 4.7.2):

2.1.1.1 **Altitude data with time - barograms**. A barogram is a graphical presentation of pressure altitude against time derived from an IGC-approved and calibrated pressure altitude sensor and a time-recording system. The presentation may be produced by the instrument in hard copy, such as a paper or metal trace from a drum barograph, or a printer connected to an electronic barograph. It may also be shown on a monitor screen that displays altitude data that is validated to IGC standards such as from an IGC-approved Flight Recorder or electronic barograph, together with the digital record of the altitudes concerned. For a Flight Recorder or Electronic Barograph, the digital figure recorded for the time concerned, is definitive. The official FAI/IGC pressure altitude calibration scale is the International Standard Atmosphere (ISA) of the International Civil Aviation Organisation (ICAO). The ICAO ISA is also used in civil and military aviation for calibration of pressure altimeters. A copy of ICAO document 7488, tables 3 and 4 is held for reference at FAI HQ, and contains exact conversions of pressures to altitudes. For more detail on barographs and flight recorders, see para 2.2.

2.1.1.2 **Optical measurement from the ground** Altitude may also be derived by trigonometrical calculations using devices such as a height frame or theodolite mounted on the ground. This may be used for assessment of start height if IGC-approved Flight Recorder altitude evidence is not available.

2.1.1.3 **Radar measurement**. Radar ranging, if accurate enough for the purpose, and corrected to obtain vertical distance, may be used if IGC-approved Flight Recorder altitude evidence is not available.

2.1.1.4 **GNSS altitude output of an IGC-approved flight recorder.** For continuity of flight purposes only, not for accurate altitude measurement because of its differences compared to ICAO Pressure Altitude. See para 2.4.

2.2 **Barographs and Flight Recorders**

2.2.1 **IGC-approved GNSS Flight Recorders**. The pressure altitude recording system fitted to all IGC-approved Flight Recorders is a barograph system in its own right, and must comply with other rules in the Code for barographs and their calibration.

2.2.2 **Other Barographs - FAI badge flights**. Barographs that are not part of an IGC-approved GNSS Flight Recorder may be used on flights for FAI/IGC badges, but for FAI/IGC World Records, an IGC-approved GNSS Flight Recorder is required, see para 2.2.3 below.

2.2.2.1 Mechanical barographs. A strip of recording material such as paper or thin metal foil is attached to a drum that rotates slowly with time through a clockwork or electrical mechanism. The recording medium may be mounted on the drum itself or is pulled by a smaller drum. A mechanical stylus or scribe moves up and down in proportion to pressure altitude, and marks the recording medium either by direct pressure or by punching holes in it. Most direct-pressure systems use recording material that is smoked after attachment to the drum, the scribe removing the smoking as the drum rotates, leaving an altitude trace. Altitude is generally derived from a pressure sensor such as an aneroid capsule, although in some electrically-powered designs an electronic sensor is used. An aneroid is a sealed and partially-evacuated flat circular container that contracts and expands as outside pressure rises and falls, small movements of the aneroid being magnified by a lever system. The recording material is carefully removed after flight and the trace of altitude with time is preserved for measurement purposes. No special IGC-approval is required for these devices as long as they satisfy FAI/IGC calibration requirements with respect to the claimed flight.

2.2.2.2 Electronic barographs. These record pressure altitude and elapsed time, using an electronic pressure altitude sensor and a real- or elapsed-time electronic clock. The resulting barogram is stored in electronic form inside the unit during the flight. Results are presented after flight by downloading data either to a printer or a PC. Testing and written acceptance of a given type of electronic barograph either by three NACs or through a GFAC approval shall make that type acceptable for worldwide use but for FAI badge flight validation only, in combination with other evidence in accordance with the Sporting Code. The IGC GFA Committee will also test and evaluate electronic barographs on request, using the same system that is used for testing the pressure altitude systems on GNSS Flight Recorders.

2.3 **Altitude evidence for world records** (Based on SC3C para 2.3)

Evidence from an IGC-approved GNSS Flight Recorder is required for world record flights. This includes flights for absolute altitude and gain of height performances, for which the Recorder flight data must substantiate all of the claimed circumstances of the flight, not just those directly related to altitude. See also para 1.1.4 in this Annex B.

2.4 **Flight recorder altitude evidence**

2.4.1 **Comparison of GNSS and Pressure Altitude figures** (Based on SC3C para 5.3, plus analysis results reported to IGC). The digital altitude data supplied by a GNSS receiver is in the form of vertical distance above a mathematically defined surface rather than actual sea level or a pressure altitude datum such as 1013.25 HPa/Mb. For the range of relatively inexpensive GPS receiver boards generally used in IGC-approved Recorders, tests involving the analysis of hundreds of IGC flight data files have shown that the GNSS altitude figures recorded in IGC files are not consistent enough to satisfy Sporting Code requirements for use as accurate measurements of altitude at precise times such as high and low points, start and finish points. However, all IGC-approved GNSS Flight Recorders incorporate a pressure altitude sensor which allows a barogram to be produced which conforms to the Code.

2.4.2 **GNSS altitude accuracy** (SC3C Appendix 5 para 3a, expanded). For navigation systems based on the time-difference of signals at a ground receiver from a constellation of satellites, figures for horizontal position will always be more accurate than those for altitude. Due to the typical geometry of satellites as their signals are received, altitude figures are likely less accurate than for lat/long by factors between 1.5 and 2, occasionally more. The ratio will vary with numbers of satellites used in a fix, the latitude of the receiver station, and receiver factors such as the algorithms used in the GPS receiver board for calculating fix positions, signal strength due to topography, antenna position, and so forth.

2.4.2.1 **Data in IGC files.** Where GNSS altitude is not available from GNSS position-lines, it is recorded in the IGC format file as zero GNSS altitude. This is an IGC Specification requirement. So-called "dead reckoning" or run-on of previous values without new fix data, is not permitted in IGC file data. In the case of altitude, using zero altitude instead of the last recorded value, enables any lack of valid GNSS altitude to be clearly seen during post-flight analysis. This will occur if fixes revert from 3D to 2D. It will also occur if fixing is lost for a time, the pressure altitude values in the IGC file continuing to produce evidence of flight continuity but position data being lost. In addition, for reasons that are still under investigation, in some IGC files occasional differences have been noted in the shape of the GPS altitude record with time, compared to that for pressure altitude. Fortunately for validation of presence in Observation Zones, at the time that these differences occur, Lat/long figures appear to remain consistent with adjacent fixes for times where the shapes of the pressure and GNSS records are similar.

2.4.2.2 **Glider Installations.** Poor GNSS antenna installation will magnify altitude error, for instance mounting the antenna where material such as carbon fibre or metal can interfere with the signal during any phase of flight. Other adverse conditions include large angles of bank; use of non-aviation quality materials; and insecure antenna connections that may not compensate for in-flight aircraft structural movement (loose wires or connections). Pilots are encouraged to check that their glider installations are giving the best signal strength at all times in order to minimise the chance of short-term anomalies in GNSS altitude figures in the IGC data file.

2.4.3 **GNSS altitude - Zero-Datum - Ellipsoid or Geoid** (SC3C Appendix 5 para 1.9). The output of GNSS altitude within a Flight Recorder can be configured either with respect to the selected ellipsoid (the WGS84 ellipsoid for FAI/IGC evidence), or with respect to an approximate sea level surface known as the Geoid.

2.4.3.1 **WGS84 Ellipsoid and Geoid.** The WGS84 Geoid is an irregular surface of equal gravitational potential which varies from the WGS84 ellipsoid by between +65m and -102m. GNSS altitude is therefore not the same as the pressure altitude that is used universally in aviation. The IGC Technical Specification specifies that GNSS altitude figures in the IGC file shall be those above the WGS84 ellipsoid.

2.4.4 **GNSS altitude record in an IGC file.** This may be used for evidence of flight continuity (no intermediate landing) if the pressure altitude trace has failed, but not for accurate measurement of altitude because of the differences to Pressure Altitude which is the IGC standard for altitude measurement.

2.5 **Pressure Altitude Calibration, Before and After Flight**. (SC3 4.4.7)

2.5.1 **Altitude and Gain of Height Records**. Calibrations both before and after the flight are required. The least favourable calibration of the two shall be used making the calculations for the record. Calibration intervals shall be in accordance with 2.5.3 and 2.5.4 below.

2.5.2 **Other Altitude Requirements**. For badges, start height verification, and altitude difference calculation, either a before- or an after-flight calibration is required. Calibration intervals shall be in accordance with 2.5.3 and 2.5.4 below.

2.5.3 **Before Flight**. For IGC-approved GNSS Flight Recorders and IGC-approved electronic barographs, the date of calibration must be within two years of the flight. For other types of barographs, the timescale is within one year of the flight.

2.5.4. **After Flight**. The date of calibration must be within one calendar month after the flight.

2.6 **Calibration Procedures**. SC3C Appendix 8 gives guidance on calibration of mechanical barographs. Calibration of the pressure altitude function of an IGC-approved GNSS Flight Recorder should follow a similar procedure with the Recorder running in the pressure chamber, connected to a battery that is also in the chamber unless the Recorder is internally powered. In a large pressure chamber, Flight Recorders and mechanical barographs can be calibrated at he same time. In the absence of GNSS fixes, most Flight Recorders either start recording on detecting a change of pressure altitude (1 m/s for 5 seconds is a typical threshold) or on switch-on. Guidance on calibration procedures and any appropriate switching required, is given in Annex B to the IGC-approval document for the particular model of recorder.

2.6.1 **Electronic Barographs, including IGC-approved Flight Recorders**. Electronic sensors used inside electronic barographs and IGC-approved GNSS Flight Recorders generally have factory-adjustable settings for sea level pressure and also a gain setting for the rest of the altitude range. These must be set so that the output corresponds closely to the FAI pressure altitude criteria (the ICAO International Standard Atmosphere, Document 7488 tables 3 and 4, held at the FAI Office). Large corrections should not apply after initial calibrations, because outputs of electronic barographs and Flight Recorders are in metres or feet directly and are not simply the distance of a needle on a drum.

2.6.1.1 Calibration accuracy requirement. On set-up and calibration before or immediately after initial sale, it is expected that the sea level setting will correspond to the required ISA (1013.2 mb) within 1 millibar; up to an altitude of 2000 metres within 3 millibars; and above this, within one percent of altitude.

2.6.1.2 Recording of calibration data. After the calibration in the pressure chamber, the data file containing the pressure steps shall be transferred to a PC as if it was flight data. This may be done by an NAC-approved person other than the calibrator, who may not know the switching and actions required. The stabilised pressure immediately before the altitude is changed to the next level, will be taken as the appropriate value unless the calibrator certifies otherwise. The IGC-format calibration data file will then be

analysed, compared to the calibration pressure steps, and a correction table produced and authenticated by an NAC-approved person. The correction table will list true against indicated altitudes, and the associated IGC data file shall be retained as a record of the calibration.

CHAPTER 3
CAMERAS

Note: Photographic evidence is not acceptable for World Record Flights, for which evidence from an IGC-approved Flight Recorder is required (IGC decision, 1999, see SC3 para 3.0.3).

3.1 **Photographic Control Method** (SC3 4.6.3, extract). The following method shall be used:

3.1.1 Mounting in the cockpit. The camera must be held in fixed mountings in the cockpit so that every photograph will show the wingtip. The lens housing should be positioned inside the canopy or camera window so that the random line mentioned below will show on the film, except with open-cockpit gliders were this does not apply. (Annex C para 3.4).

3.1.2 Sealing the camera. The camera must be sealed unless the same OO is controlling both the pre-flight photograph(s) and the processing of the film, in which case sealing is not necessary. When a time-recording camera is used to supply time evidence, it must be sealed by an OO before the flight in such a way that the film cannot be removed and the time adjusting mechanism cannot be accessed until the seal is broken by an OO after flight.

3.1.2.1 Sealing to glider structure. The method of sealing a camera to the glider structure, must be acceptable to the NAC and to IGC. It must be possible for the OO to identify the seal afterwards. 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. (Annex C para 1.7, extract).

3.1.3 **Before takeoff - OO's canopy mark**. Just before takeoff, an OO shall mark the outside of the canopy or window across the front of the lens with a random line. The flight declaration shall then be displayed for the pilot to photograph with the camera installed. The random line should be dark or opaque and at least 3 mm wide if it is to show on the image. (SC3 para 4.6.3.a.iii). If the mark is too light or narrow, the result may be that it does not appear on the photo. (Annex C para 3.4).

3.1.3.1 The canopy mark - appearance on the photos. The mark placed on the canopy will appear as an out-of-focus "shadow" across the photograph. After flight, the OO will verify that this shadow matches the shape and orientation of the mark that was made, and that it appears on the declaration photo and all photos of way points. When using a new camera, the pilot is advised to take test photos to confirm that canopy marks can be seen. To achieve this, it is recommended that the distance from the lens to the canopy should be greater than the focal length of the lens. (Based on Annex C para 3.4).

3.1.4 **After flight**. Following landing and the completion of the photographic sequence, an OO shall take charge of the film and have it developed. Every effort is to be made to preserve the film as a continuous strip. However, if it is cut or broken while out of control of the pilot or OO, this evidence remains valid if close examination of the pieces show that they form the original continuous length of film. An OO shall describe the circumstances under which the film was broken or cut. (SC3 para 4.6.3.a.(iv))

3.2 **Photograph Sequence**. (SC3 4.6.3, extract) The film shall contain photographs in the following sequence:

3.2.1 If a time camera is used, the pre-flight clock synchronisation photo(s).

3.2.2. The pre-flight declaration (if any).

3.2.3 At least one photograph showing indisputable evidence of the presence of the glider in each of the observation zone(s) of the way point(s) used, in the correct sequence.

3.2.4. The glider on the landing field with surrounding features and its registration markings appearing clearly on the photo, or the above declaration with landing time added.

3.2.5. If a time camera has been used, the post-flight clock synchronisation photo(s)..

Note: Photographs of the preflight declaration (SC3, 3.2.2) and waypoints (SC3, 3.2.3) must show the shape of the canopy mark on the film image. Additional photographs which may have been taken after the declaration and before the landing must also show the canopy mark .

3.3 **Camera characteristics**

3.3.1 **Recording medium - Film only**. A camera used for flight validation must record images on a continuous length of photographic film, with all images appearing on the film in the sequence in which they were taken. Following landing and the completion of the photographic sequence, an OO shall take charge of the film and have it developed. Digital images on electronic medium are not acceptable because their sequence in time is difficult to establish in a clear and secure manner. If the film is inadvertent cut, see para 3.1.4.

3.3.2 **Film, camera and lens size**. No special type of camera is required. Most types of camera that use 35mm film are generally acceptable. Incontrovertible evidence of presence in Waypoint Observation Zones is what matters, irrespective of the camera system that produced the evidence. Cameras using larger or smaller film sizes may not be able to fulfil IGC requirements for photographic evidence, or, for large format devices, the physical constraints of fitting into a cockpit mounting.

3.3.2.1 Lens focal lengths. A 'normal' focal length is recommended, so that the angles on the photo correspond approximately to those in the real world from the same eye-point. For a camera using 35mm film, the 'normal' focal length is about 50mm. Very wide angle (fisheye) and narrow angle (telephoto) lenses are not recommended. This is because distortion of the image may make features difficult to orientate with respect to each other when the photos are assessed. This may prevent validation, particularly if the photo was taken from near the edge of an Observation Zone (see Annex C Chapter 16 for validation techniques).

3.3.3 **Useful features**. Some features that have proved useful include:

3.3.3.1 Motor drive. This avoids manually winding film while manoeuvring at a waypoint Observation Zone.

3.3.3.2 Automatic exposure. This generally gives a good result, except where a large area of bright cloud in an individual photo might reduce exposure of ground features to a critical level. Tests with the camera in the glider under different lighting conditions are advised, before a claim flight is made.

3.3.3.3 Infinity focus. A fixed focus at or close to infinity is recommended. A variable focus camera can have its focus fixed by using simple aids such as adhesive tape to prevent its focus control moving. However, automatic focus systems may focus on the wing when the camera is mounted, and cause the ground to be out-of-focus.

3.3.3.3 Screw mounting socket. This is fitted to many cameras so that time exposures can be taken using a tripod. In the case of glider photographic evidence, it allows a standard mount to be used in the cockpit.

3.3.3.4 Flash gun switch plug. This is needed if a type of recorder is used where the switch contact is used to record a mark on a timebase. Certain types of barographs and flight recorders use this method of recording the time at which photos are taken.

3.3.4 **NAC selection of camera types**. Evidence on film that does not clearly show the images required for the validation process shall be rejected. To help this, NACs may specify types of camera and recording media (film) that may be used for recording evidence for flights to be validated to FAI/IGC criteria.

CHAPTER 4

TIME RECORDING EQUIPMENT

4.1 **Time measurement** (SC3 para 4.5.1). Time data requirements may be fulfilled by any of the following measuring methods:

4.1.1. A recording device with an accurate real time output, such as an IGC-approved Flight Recorder using a system that employs accurate time signals as part of its method of operation. Such as the US GPS and Russian GLONASS systems, also the future European Galileo system. However, at the time of printing (2002), only Flight Recorders using the GPS system have so far been IGC-approved.

4.1.2. By direct observation from the ground by an observer with direct access to approved time measuring equipment (e.g. a synchronised timepiece). If a timepiece displaying only minutes is used, 59 seconds is to be added to each duration measured to allow for the possibility that the reading was taken just before the minute changeover. Pilots and OOs should use timing devices with outputs in seconds whenever possible.

4.1.3. With a barograph, to measure time differences (except speed flights),

4.1.4 With a time camera, to measure time differences (except speed and duration flights)

4.2 **Time evidence** (SC3 4.5.2)

4.2.1. Evidence of timing and time recording of flights must be under the control of an OO. Time recording equipment carried on board a glider must be capable of being either physically or electronically sealed. Where a human action is required, the equipment shall be sealed and unsealed only by an OO.

4.2.1. The equipment must designed and positioned so that the time parameters cannot be altered by the crew during flight.

4.3 **Pilot event inputs**. If a means is provided for the pilot to make inputs into a device for remote recording of flight events, such inputs must be confined to functions not critical to the validation of the flight. *For example, it is permissible for a pilot to make a mark on the time base to register an event such as a Waypoint Observation Zone, particular geographical point, thermal or other position, or in GNSS systems to change the sampling rate in flight.*

4.4 **Timing device calibration**. Chronographs, clocks, watches and other time recording equipment shall be checked against official radio-based time signals both before and after the flight. Any error found shall be taken into account and rounded up in the calculations. However, the GNSS time recorded in a validated IGC flight data file from an IGC-approved Flight Recorder may be used as official time and does not require a separate calibration.

FÉDÉRATION AÉRONAUTIQUE INTERNATIONALE

ANNEX B
to
FAI SPORTING CODE
SECTION 3

FAI AIRCRAFT CLASSES D AND DM
GLIDERS AND MOTOR GLIDERS

REQUIREMENTS
FOR EQUIPMENT USED
FOR FLIGHT VALIDATION

EDITION 3

REAR COVER