FAI Sporting Code

Section 8 – Astronautics

CLASS K
CLASS P

2009 Edition

Fédération Aéronautique Internationale

Maison du Sport International
Av. de Rhodanie 54
CH-1007 Lausanne
(Switzerland)
Tél. +41 (0)21 345 10 70
Fax +41 (0)21 345 10 77
E-mail: sec@fai.org
Web: www.fai.org

Approved by the FAI Astronautics Commission at its meeting on 17 April 2009

NOTE: Section 8 and General Section combined make up the complete Sporting Code for Astronautics

FEDERATION AERONAUTIQUE INTERNATIONALE

Avenue de Rhodanie 54 – CH-1007 Lausanne - Switzerland

INDEX

CHAPTER 1

INTRODUCTION

1.1 The purpose of this Code is to provide for the international recognition of flights in space by men and women and of their achievements.

1.2 VALIDITY AND SCOPE

The text of the present section of the Sporting Code contains regulations applicable to records set by manned spacecraft (Class K) or aerospacecraft (Class P). Chapters 2, 6, 7 and 8 deal with common conditions for certification of all records. Chapters 3 to 5 deal with specific records for all or certain categories of spaceships.

In accordance with the provisions of the General Section of the Sporting Code, FAI does not certify records of unmanned spaceships.

1.3 COMPLEMENTARY RULES

The General Section contains the rules and regulations that apply to all FAI-recognised activities. The General Section and Section 8 combined make up the Sporting Code for spacecraft and aerospacecraft.

1.4 AUTHORITY FOR THE CODE

The drafting and amendment of this code are the responsibility of the FAI Astronautics Commission (ICARE).

CHAPTER 2

DEFINITIONS AND CONDITIONS

2.1 MISSION

A mission comprises all the happenings and activities, scheduled or not, of a spaceship and its crew from the moment and place of take-off to the moment and place of termination of flight.

2.1.1 Near-space mission : A mission which remains entirely inside the sphere of influence of the Earth.

2.1.2 Outer-space mission : A mission which at least in part abandons the sphere of influence of the Earth.

2.2 DEFINITIONS AND CLASSES OF SPACESHIP

a) Spacecraft (Class K)
Vehicle capable of flight in space.

b) Aerospacecraft (Class P)
A craft capable of flight in space and of sustained and controlled flight in the atmosphere. It must also be capable of soft touch-down on land and/or sea.

c) Reusable Spaceship (Class K or Class P) : A spaceship capable of making two manned consecutive flights in such manner that a minimum of 90% (in mass) of the elements constituting the take-off empty mass of the first flight will be present in the take-off empty mass of the second flight.

2.3 CELESTIAL BODY

Accumulation of matter in space (excluding the planet Earth) with sufficient mass and density to allow a spaceship to orbit in free fall around it.

2.4 TIME

Time shall be recorded in UTC (Universal Time, Coordinated).

2.5 REFERENCE ELLIPSOID

The reference ellipsoid shall be that of the International Astronomical Union and its characteristics are at present:

semi-major axis = equatorial radius = 6,378,137.0 metres

semi-minor axis = polar radius = 6,356,752.3 metres

$$\frac{\text{equatorial radius - polar radius}}{\text{equatorial radius}} = 0.003352813$$

2.6 ALTITUDE

The altitude reached is approximately the difference between the distance of the space vehicle from the centre of the earth and the radius of the reference ellipsoid corresponding to the sub-spaceship point at the given time.

The altitude (h) of a spaceship is precisely defined as:

$$h = r - a + (a - b) \sin^2 \varphi$$

r = geocentric distance of the spaceship
φ = geocentric latitude

a, b = semi-major and semi-minor axes of the Earth reference ellipsoid.

Note: Altitude records will only be considered for near-space missions.

2.7 DISTANCE

2.7.1 Distance to Earth

The distance reached at the maximum separation between the Earth's centre and the spaceship at any given moment of the mission after discounting the equatorial radius of Earth. It shall be measured in the Galilean set of axes of the Solar System between the Earth's centre and the spaceship location.

The distance h from a spaceship to the Earth is precisely defined as:
h = r - a (see 2.6 for an explanation of the symbols).

Notes: 1. In practice, space distances are measured by electromagnetic signals. An electromagnetic signal sent from a radio telescope on Earth to the spaceship at time t_o is received by the spaceship at time t_1 (in the proper local time) and immediately returned to Earth where the return signal is received at time t_2 . The measurement is independent of t_1, but it is linked to t_1. The corresponding measure of distance D is given by: $D = c\ (t_2 - t_o)/\ 2$, where c is the theoretical velocity of light in vacuum : 299,792,458 m/s (with small corrections for electromagnetic propagation in the atmosphere) and the relationship between D, r and h, take into account the geographical position of the radio telescope.

2. Distance to earth records will only be considered for outer-space missions.

2.7.2 Distance in Near Space (for suborbital missions)

The distance D travelled in near space by a suborbital spacecraft or aerospacecraft is measured along the Von Karman ellipsoid (ellipsoid at 100 km altitude) in the geocentric set of axes rotating with Earth. That distance is measured between the point of entry into outer space (latitude φ_1, longitude L_1) and the point of exit (latitude φ_2, longitude L_2).

The latitude and longitude of a point of space are defined as those of the point on the Earth's surface at the vertical of which is the space point of interest. Due to small dissymmetry of the geoid, errors of up to 400 m are possible. Hence the accuracy of the following computations is of the order of a few hundred metres.

The distance D is a function of the three angles $\varphi 1$, $\varphi 2$, $(L_2 - L_1)$ and the semi-axes A and B of the Von Karman ellipsoid:

A = equatorial semi-axis = a + 100 km = 6,478,137.0 m
B = polar semi-axis = b + 100km = 6,456,752.3 m

The following quantities are required to complete the computation:

i) The "pseudo-latitudes" $\psi 1$ and $\psi 2$, which are proportional to the distance to the equator along the Von Karman ellipsoid.

$$\psi_1 = \varphi_1 - (0°.1421) \sin 2\varphi_1$$

$$\psi_2 = \varphi_2 - (0°.1421) \sin 2\varphi_2$$

ii) The angle α, the usual angle of spherical geometry between the directions ψ_1, L_1 and ψ_2, L_2 :

$$\cos \alpha = \sin \psi_1 \sin \psi_2 + \cos \psi_1 \cos \psi_2 \cos (L_2 - L_1) \quad ; \quad 0° \leq \alpha \leq 180°$$

iii) The inclination λ (on the equator) of the corresponding great circle :

$$\cos \lambda = \cos \psi_1 \cos \psi_2 \left| \sin (L_2 - L_1) \right| / \sin \alpha \quad ; \quad 0° \leq \lambda \leq 90°$$

iv) To within the stated accuracy, the distance D is then given by the following expressions, where the angle α is given in radians:

a) If $\alpha \leq 168°$:

$$D = \alpha [(3A + B) + (A - B) \cos 2\lambda] / 4$$

that is :

$$D = \alpha (6{,}472.79 + 5.35 \cos 2\lambda) \text{ km}$$

b) In all cases :

$$(A + B) \alpha / 2 \leq D \leq \alpha [(3A + B) + (A - B) \cos 2\lambda] / 4 \leq A \alpha$$

that is :

$$6{,}467.44\alpha \text{ km} \leq D \leq \alpha (6{,}472.79 + 5.35\cos 2\lambda) \text{ km} \leq 6{,}478.14\alpha \text{ km}$$

The largest possible value of D is between antipodal points and is 20,318.07 km, which corresponds to the lower limit of the final expression for $\alpha = \pi$ (and also to that expression when $\lambda = 90°$).

2.7.3 Distance Travelled (for suborbital missions)
The distance travelled is measured from the point of lift-off to the point of touch down at which the planned operation is terminated.

2.7.4 Distance covered on the surface of a celestial body
The distance from the astronaut to the spacecraft measured along the mean surface of the celestial body through the shortest distance between two points.

2.7.5 Distance in untethered free flight

Maximum distance between an untethered astronaut in free flight and the closer of either the spaceship he left or that towards which he is travelling. This distance is to be measured along a straight line from either spaceship. The astronaut must return to a spacecraft or aerospacecraft alive using and controlling his own propulsion system attached to the spacesuit. All motion out and back must be the result of prime mover(s) carried by the astronaut himself with no translational aid from the spaceship.

2.8 TAKE-OFF PLACE AND TIME
The centre of the precise place and the time at which the spacecraft starts moving by its own means without external human help. For outer-space missions the reference system will be astronomically fixed (Sun plus fixed Stars). For near space missions the reference axis will be centred at the Earth Centre but not rotating with Earth. For suborbital flights, as defined in paragraph 2.18.6, the reference axis will be centred at the Earth Centre and rotating with Earth.

2.9 TAKE-OFF EMPTY MASS
The total mass of the spaceship at take-off place and time, excluding the masses of the crew, the propellant and all other consumables needed for the mission. If part of the crew and their life support consumables are replaced by ballast, that ballast will not count for the total mass.

2.10 PAYLOAD

The payload is defined as the mass carried for scientific, technical, or operational reasons in the compartment(s) especially incorporated into the aerospacecraft design for such purpose and which is not required for the basic operation of the aerospacecraft or crew support.

2.11 GREATEST MASS

The greatest mass includes that of the astronauts, all equipment required for vehicle operation and crew support and mass of payload or cargo.

2.12 DURATION

2.12.1 Flight duration

This is the time measured from lift-off to touchdown at the point of termination of the performance.

2.12.2 Extravehicular duration in space

This is the time spent outside the spaceship, during which an astronaut does not depend for his survival on any connection with the spaceship but upon an autonomous life support system.

Note: Exit from and entry into the spaceship are defined as being the instant when the astronaut has completely overstepped the spaceship's outer cover.

2.12.3 Extravehicular duration on the surface of the celestial body

This is the time spent outside the spaceship on the surface of a celestial body during which an astronaut must rely for his survival only upon autonomous life support system excluding any connection with a non-integrated survival source.

Notes: 1. Exit from and entry into the spaceship are defined as being the instant when the astronaut has completely overstepped the spaceship's outer cover.

2. If one or more astronauts travel on the surface of the celestial body aboard an air-conditioned vehicle, the time spent in that vehicle will not count in the duration of stay outside the spacecraft.

2.12.4 Duration of stay in orbit around a celestial body

This is computed from the termination of thrust application necessary to establish the orbit up to the time of application of thrust required to leave the orbit.

2.12.5 Minimum time between two consecutive flights in a reusable vehicle.

This is time is measured from the time of termination of the first flight to the time of take off of the second flight.

Notes: 1. Both flights have to comply with all other conditions for completed space flights.

2. The record holder will be the crew commander of the second flight.

2.13 TERMINATION OF FLIGHT

For the purpose of the record, the place and time of termination of the flight shall be either the point and time at which the pilot touches the earth's surface or the point and time at which he receives assistance by any means external to the original spaceship which achieved the maximum performance.

Note : Temporary halts at non-manned space stations or places other than the planet Earth, either with the purpose of refurbishing the spacecraft or making repairs, are not considered termination of flight as long as all work is performed by the original crew, the same original crew resumes the mission, and no other human beings are involved.

2.14 ASTRONAUT

The word "astronaut" may apply both to crew members and to scientific personnel aboard the spacecraft playing an active part in the mission during the flight.

2.15 UNCOMPLETED FLIGHT

A flight is deemed to be uncompleted if :

a) an accident occurs during the flight resulting in the death of any member of the crew within 48 hours or,
b) any member of the crew definitively leaves the spaceship during the flight.

Note: In the case of space stations which qualify as spaceships under 2.16 below, 2.15 (b) above shall not apply.

2.16 SPACE STATION

Any place outside the planet Earth built by humans and capable of receiving visits from astronauts or spaceships for the purpose of making repairs, refurbishing the spaceship or loading/unloading passengers, astronauts or cargo.

2.17 MANNED SPACE STATION

Any space station which is occupied, continuously or otherwise, by one or more human beings for at least 30% of the year(s) in question. Any space station not fixed to a celestial body may qualify as a spaceship for the purpose of records.

2.18 RECORDS - SPECIAL CONDITIONS

2.18.1 All flights must exceed an altitude of 100 km in order to qualify for records.

2.18.2 A new world record must exceed the previous one by 5% based on the respective definitions.

2.18.3 The pilot and crew must be inside the spaceship component at take-off and all of them must reach the place of flight termination alive.

2.18.4 The pilot and crew of an aerospacecraft shall remain inside the vehicle during descent and landing. For spacecraft any method of descent and landing is acceptable provided the method is described in detail in the pre-flight plan.

2.18.5 For the purpose of all records (in particular for duration and distance records) the flight will start at take-off place and time and will finish at termination of flight as defined above.

2.18.6 A mission is sub-orbital if each of its arcs of trajectory above an altitude of 100 km has a length of less than 40,000 km (in the non-rotating geocentric set of axes).

2.18.7 For the purpose of certification of a record for mass lifted, one shall take into consideration the mass measured in kilogrammes on the ground of the spaceship and its crew, and all the parts attached to the spaceship and carried to a maximum altitude. Those parts of the spaceship which serve to place it in orbit shall not be included in the mass, but those parts used for further flight of the spaceship shall be included.

2.18.8 For the purpose of certification of a record of mass assembled in space on linked flights, the assembled mass is defined as the maximum total combined mass reached at any moment while linked, including that of the astronauts.

2.19 WOMEN'S RECORDS

Women's space records may be set in any of the authorized categories in Chapters 3, 4 and 5.

CHAPTER 3

ABSOLUTE SPACE RECORDS

Note : These records will be listed in either Category K or P, as appropriate, and the best performance will be called 'absolute record' .

3.1 DURATION

3.2 ALTITUDE

3.3 DISTANCE TO EARTH

3.4 (*Content deleted 1996*)

3.5 GREATEST MASS LIFTED TO ALTITUDE

3.6 EXTRAVEHICULAR DURATION IN SPACE

3.7 (*Intentionally blank)*

3.8 ACCUMULATED SPACE FLIGHT TIME
This concerns the total number of hours in space registered by one astronaut.

3.9 RECORDS OF MANNED LINKED FLIGHTS OF TWO OR MORE SPACESHIPS WITH CREWS BELONGING TO TWO OR MORE NATIONS
Provided that the spaceships are launched from different countries and all the elements of the flight are manned during at least a part of the mission, the following records apply (to be listed in Category K unless all linked spaceships are aerospacecraft) :

3.9.1 Assembled mass of spaceships linked in flight.

3.9.2 Total duration of flight of spaceships while linked.

3.9.3 Maximum altitude while linked.

3.9.4 Distance travelled while linked.

Note: The record under 3.9.4 applies only to outer space missions, and shall be measured in the Galilean set of axes.

3.10 DISTANCE IN UNTETHERED FREE FLIGHT OF AN ASTRONAUT IN SPACE OUTSIDE A SPACESHIP

CHAPTER 4

RECORDS FOR SPACECRAFT ONLY (CLASS K)

(Note : For Spaceship Records, see Chapter 3)

4.1 CATEGORIES OF MISSIONS

K1 Suborbital Missions
K2 Orbital Missions
K3 Missions to Celestial Bodies

4.2 CATEGORY RECORDS

4.2.1 K1 - Suborbital missions

Two categories of spacecraft :
- spacecraft with one astronaut ;
- spacecraft with more than one astronaut

for the following records :

4.2.1.1 Duration

4.2.1.2 Altitude

4.2.1.3 Greatest mass lifted to an altitude of 100 km

4.2.1.4 *Deleted 2008.*

4.2.1.5 Number of people in suborbital flight

4.2.1.6. Minimum time between two consecutive flights in a reusable vehicle.

4.2.2 K2 - Orbital missions

Two categories of spacecraft :

- spacecraft with one astronaut ;
- spacecraft with more than one astronaut

for the following records :

4.2.2.1 Duration.

4.2.2.2 Altitude

4.2.2.3 Greatest mass lifted to orbit

4.2.3 K3 - Missions to Celestial Bodies

Two categories of spacecraft :

- spacecraft with one astronaut ;
- spacecraft with more than one astronaut.

for the following records :

4.2.3.1 Duration of stay on the surface of the celestial body.

4.2.3.2 Extravehicular duration on the surface of the celestial body by an astronaut.

4.2.3.3 Duration of stay in orbit around a celestial body.

4.2.3.4 Greatest Mass landed on the celestial body.

4.2.3.5 Distance covered on the surface of the celestial body.
a) performance achieved on foot ;
b) performance achieved by whatever means.

4.2.3.6 Duration of a complete mission to a celestial body with return, including duration of stay on the surface of the celestial body.

4.2.3.7 Greatest mass of non terrestrial matter lifted from the surface of the celestial body and taken back to Earth or to a manned space station.

CHAPTER 5

RECORDS FOR AEROSPACECRAFT ONLY (CLASS P)

(Note : For Spaceship Records, see Chapter 3)

5.1 CATEGORIES OF MISSIONS

P1 Suborbital Missions
P2 Orbital Missions

5.2 CATEGORY RECORDS

5.2.1 P1 - Suborbital Flights

5.2.1.1 Flight Duration.

5.2.1.2 Altitude above the Earth's surface with or without manoeuvres of the aerospacecraft.

5.2.1.3 Greatest Mass lifted to an altitude of 100 km

5.2.1.4 Distance:

a) Distance in near space
b) Distance travelled

5.2.1.5 Number of people in suborbital flight.

5.2.1.6. Minimum time between two consecutive flights in a reusable vehicle.

5.2.2 P2 - Orbital Flights

5.2.2.1 Flight duration.

5.2.2.2 Altitude

5.2.2.3 Greatest Mass lifted to orbit.

5.2.2.4 *(Deleted 2009)*

5.2.2.5 Greatest Mass lifted to altitude by an aerospacecraft using air breathing propulsion system plus aerodynamic controls in a significant part of lifting trajectory.

CHAPTER 6

MEASUREMENTS

6.1 MEASUREMENT

The measurements required for an event may be made by any method sanctioned by the FAI.

6.2 UNITS OF MEASUREMENT

The units of measurement used in the record file shall be based on the international system.

CHAPTER 7

RECOGNITION OF RECORDS

7.1 In order that a record performance be recognised for one of the classes of records mentioned above, a record file must be submitted to the FAI containing at least all the particulars described in Chapter 8.

7.2 The FAI will only concern itself with whether or not the conditions of any particular category or class of record have been met. However, the record attempt, in its entirety, must be verified as to accuracy by instrumentation, which must be sanctioned and approved by the N.A.C. concerned.

7.3 The N.A.C. of one country may seek the aid of another N.A.C. in order to obtain the appropriate measurements, as required for an official record.

7.4 A report giving the details of the record attempt must be included with the request for certification.

CHAPTER 8

COMPOSITION OF A RECORD FILE

8.1. Every record submitted for certification shall be the subject of a file containing at least all the particulars relating to the circumstances and the control of the performance, to enable the authority responsible for the certification to decide whether all the conditions laid down have been fulfilled.

8.2 The record file shall contain, on the one hand, documents which will be of the same kind for every type of record and, on the other hand, documents which will differ with each type of record. The documents required for every record are the following:

8.2.1 A description of the record to which the file refers.

8.2.2 The names and nationalities of the pilot-in-command and members of the crew.

8.2.3 The number and date of the FAI Sporting Licence of the pilot-in-command and of any astronaut attempting to set world records.

8.2.4 The name and brief description of the spaceship and its identification marks.

8.2.5 The name and brief description of the launching vehicle and the mark, brief description, thrust and number of engines of this vehicle.

8.2.6 A brief description of any apparatus installed in the launching vehicle and spaceship used to assist lift-off, control and landing.

8.2.7 The original preflight programme as submitted to the N.A.C. and particulars of the actual achieved flight.

8.2.8 A report by an appointed official giving the date, time (to the nearest second), place of take-off (in coordinates of latitude, longitude, to the nearest minute), proof of identification of the spaceship and its Commander.

8.2.9 A report by an appointed official giving the date, time (to the nearest second), place of termination of the performance (in coordinates of latitude, longitude, to the nearest minute), or evidence as required by the FAI Sporting Code if landing took place where no Official was present, and proof of identification of the spaceship and its Commander.

8.3 For the purpose of certification of a record for mass of the spaceship, the record file shall contain a brief description of the instruments by which the mass was measured and a list of those parts of the vehicle making up the mass.

8.4. A record file shall contain a description of the instruments used, the readings of which are necessary for certification of the sporting performance. The type and number of these instruments shall be approved by the N.A.C. concerned.

8.5 A record file shall contain the calibration data of the instruments described. The former must be approved by a national instrument laboratory of the country concerned.