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# Flight dynamics — Concepts, quantities and symbols — Part 7: Flight points and flight envelopes

*Mécanique du vol — Concepts, grandeurs et symboles — Partie 7: Points de vol et domaines de vol*

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ISO 1151/7-1985 (E)

## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

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ISO 1151, *Flight dynamics — Concepts, quantities and symbols*, comprises, at present, seven parts:

*Part 1 : Aircraft motion relative to the air.*

*Part 2 : Motions of the aircraft and the atmosphere relative to the Earth.*

*Part 3 : Derivatives of forces, moments and their coefficients.*

*Part 4 : Parameters used in the study of aircraft stability and control.*

*Part 5 : Quantities used in measurements.*

*Part 6 : Aircraft geometry.*

*Part 7 : Flight points and flight envelopes.*

ISO 1151 is intended to introduce the main concepts, to include the more important terms used in theoretical and experimental studies and, as far as possible, to give corresponding symbols.

In all the parts comprising ISO 1151, the term "aircraft" denotes a vehicle intended for atmosphere or space flight. Usually, it has an essentially port and starboard symmetry with respect to a plane. That plane is determined by the geometric characteristics of the aircraft. In that plane, two orthogonal directions are defined: fore-and-aft and dorsal-ventral. The transverse direction, on the perpendicular to that plane, follows.

When there is more than one plane of symmetry, or when there is none, it is necessary to introduce a reference plane. In the former case, the reference plane is one of the planes of symmetry. In the latter case, the reference plane is arbitrary. In all cases, it is necessary to specify the choice made.

Angles of rotation, angular velocities and moments about any axis are positive clockwise when viewed in the positive direction of that axis.

All the axis systems used are three-dimensional, orthogonal and right-handed, which implies that a positive rotation through $\pi/2$ around the $x$-axis brings the $y$-axis into the position previously occupied by the $z$-axis.

**Numbering of sections and clauses**

With the aim of easing the indication of references from a section or a clause, a decimal numbering system has been adopted such that the first figure is the number of the part of ISO 1151 considered.

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# Flight dynamics — Concepts, quantities and symbols — Part 7: Flight points and flight envelopes

## 7.0 Introduction

This part of ISO 1151 is intended to define the concepts and terms used in flight dynamics studies to specify aircraft flight conditions and envelopes.

It is necessary, for this purpose, to give definitions specifying the terms: mission, controls, geometric configuration, situation of the systems, state of the aircraft, environment, etc.

These concepts are necessary for safety analyses, for qualification purposes, and they apply to the analysis of operational, experimental or simulated flights, taking into account potential failures and likely environmental conditions.

The following International Standards are necessary as reference documents for application of this part of ISO 1151:

ISO 2533, *Standard atmosphere.*

ISO 5878, *Reference atmospheres for aerospace use.*



## 7.1 Accomplishment of a mission

| No. | Term | Definition |
|---|---|---|
| 7.1.1 | Mission | The purpose of a flight achieved while respecting some constraints, among others, of time and of space.<br><br>NOTE — The objective and the constraints can be specified in a flight plan. |
| 7.1.2 | Flight programme | The preschedule of intermediate objectives required to fulfil the mission (7.1.1) within an authorized flight envelope (7.7.1).<br><br>NOTE — Provision can be made in the flight programme for some conditional changes of intermediate objectives according to circumstances arising during the flight (failure, meteorology, traffic, etc.). |
| 7.1.3 | (Flight) phase | The portion of the flight characterized by an intermediate objective.<br><br>*Examples:* take-off, climb, cruise, descent, approach, landing.<br><br>The intermediate objective is defined with some tolerance as to the accuracy with which the objective is considered to have been achieved, such that the following phase can be initiated under conditions that allow it to be executed. |
| 7.1.4 | (Flight) sub-phase | The portion of a (flight) phase (7.1.3) characterized by an elementary objective.<br><br>*Examples:* "ground run" in the "take-off" phase, "flare" and "ground run" in the "landing" phase.<br><br>The elementary objective is defined with some tolerance as to the accuracy with which the objective is considered to have been achieved, such that the following sub-phase can be initiated under conditions that allow it to be executed.<br><br>NOTE — Following the breakdown of a phase into sub-phases, certain parameters can often be considered as constants during the sub-phase (for example: mass characteristics of the aircraft, state of the atmosphere, etc.). |

## 7.2 Controls, geometric configuration and condition of systems

| No. | Term | Definition |
|---|---|---|
| 7.2.1 | Controls* | The set of elements located in the cockpit and operated by the crew to fly the aircraft.<br><br>*Examples:* stick; throttles; undercarriage and flap selection levers; switches to engage autopilot or dampers; pressurization and air conditioning controls; etc. |
| 7.2.1.1 | Piloting control | A control (7.2.1) operated by the pilot, in a continuous or intermittent manner, during a sub-phase (7.1.4) in order to comply with the piloting rules (7.5.1) and to achieve the objective of that sub-phase. |
| 7.2.1.2 | Selector | A control (7.2.1) put into a position by the crew, as laid down in the flight manual, at the beginning of a sub-phase (7.1.4) and which remains in that position throughout that sub-phase. |
| 7.2.2 | (Geometric) configuration | The set of quantities characterizing the relative positions of the various components (6.0.2) of the aircraft, that can be controlled by selectors (7.2.1.2).<br><br>NOTES<br>1 The list of quantities is restricted to those involved in the problem under consideration.<br>2 The geometric configuration defined above shall not be confused with the geometric state (6.1.17) of which it forms only a part. |
| 7.2.3 | Situation of the systems | The set of parameters defining the operating behaviour of the aircraft systems concerned with flight dynamics.<br><br>NOTE — The list of parameters is restricted to those involved in the problem under consideration. |

* The same control can be a piloting control (7.2.1.1) during one sub-phase (7.1.4) and a selector (7.2.1.2) during another sub-phase.

*Example:* The throttle is a selector during the "take-off" phase and a piloting control during the "approach" phase.

## 7.3 State of the aircraft

For a given type of aircraft, there exists a technical reference definition that specifies the geometric shape, the nominal mass, the nominal distribution of masses, the influence on the centre of gravity of the aircraft of the quantities of fuel distributed in internal tanks, the systems which can be used (inertial navigation system, air data system, artificial stabilization systems, etc.).

For each mission, it is necessary to complete the reference definition with a description of the internal and external stores required for the accomplishment of that mission.

| No. | Term | Definition |
|---|---|---|
| 7.3.1 | Situation of loads carriage | For a given mission (7.1.1), the situation of the loads carriage is defined by the list of the different internal or external loads (passengers, freight, containers and pallets, fixed or jettisonable fuel tanks, internally or externally carried stores, etc.), with their positions, that modify the mass, the mass distribution, and, in certain cases, the geometric form of the aircraft. [1)]<br><br>NOTE — Internal fuel is not included in these loads. For flight refuelling tankers, fuel is considered to be a load. |

1) For certain missions, the situation of loads carriage (7.3.1) can be modified during a transition sub-phase (for example: by jettisoning stores or dropping parachutists). (See note 1 in 7.3.2.2.)

| No. | Term | Definition |
|---|---|---|
| 7.3.2 | Selected situation | During a sub-phase (7.1.4), the selected situation is defined as the list of the set of "positions" of the different selectors (7.2.1.2).<br><br>For each sub-phase, there is a single selected situation, defined either in the flight manual for operational flights or in the study programme for experimental flights.<br><br>The selected situation can be divided into two sub-sets: a selected geometric configuration (7.3.2.1) and a selected situation of the systems (7.3.2.2).<br><br>NOTE – An order to change the "position" of a selector may not be associated with a geometric displacement of the selector itself, but may be achieved by appropriate signalling. |
| 7.3.2.1 | Selected geometric configuration | During a sub-phase (7.1.4), the selected geometric configuration is defined by the list of the set of "positions" of only those selectors (7.2.1.2) concerned with the geometric configuration (7.2.2) of the aircraft. |
| 7.3.2.2 | Selected situation of the systems | During a sub-phase (7.1.4), the selected situation of the systems is defined by the list of the set of "positions" of only those selectors (7.2.1.2) concerning the systems (7.2.3).<br><br>NOTES<br><br>1 Certain sub-phases, called transition sub-phases, are characterized by the change either in the "position" of components or in the state of the systems controlled by the change in "position" of one or of several selectors. The duration of the transition sub-phase is then determined by the time taken to change the position of the components or the state of the system.<br><br>*Example:* sub-phase "undercarriage out".<br><br>2 In certain studies, and in particular during a flight test, it may be useful to study the behaviour of the aircraft in positions of the components or for system functions that do not usually occur during operational flights.<br><br>For example, the flight can be studied at low incidence with leading edge slats extended or at high incidence with slats retracted, even though in operational flight the position of the slats can be automatically fixed by the incidence and the speed.<br><br>To describe those particular selected situations (7.3.2), it is necessary to indicate that the automatic system has been made inoperative by a selector activated specifically for that purpose. |
| 7.3.3 | Failure situation | During a sub-phase (7.1.4), the failure situation is defined by the list of the set of abnormal positions of components (6.0.2) and of the set of abnormal functions of the systems.<br><br>NOTES<br><br>1 The failure of a system, the operation of which is not involved in a sub-phase, shall be taken into consideration in defining the failure situation, because it can modify the probability of failures in that sub-phase or in other sub-phases.<br><br>2 In line with the definition above, the non-operation of one of the lines of a redundant system shall be considered as a failure, even if the other lines maintain the function of the system. In those conditions, the failure situation is said to be a "partial failure situation".<br><br>3 In the case of a flight or simulator test, or of a training flight, a failure may be provoked or simulated. |
| 7.3.4 | Real situation | During a sub-phase (7.1.4), the real situation is the result of the selected situation (7.3.2) and of the failure situation (7.3.3).<br><br>The real situation may be broken down into two sub-sets: real geometric configuration (7.3.4.1) and real situation of the systems (7.3.4.2). |

| No. | Term | Definition |
|---|---|---|
| 7.3.4.1 | Real geometric configuration | During a sub-phase (7.1.4), the real geometric configuration is the result of the selected geometric configuration (7.3.2.1) and of the failure situation (7.3.3). |
| 7.3.4.2 | Real situation of the systems | During a sub-phase (7.1.4), the real situation of the systems is the result of the selected situation of the systems (7.3.2.2) and of the failure situation (7.3.3). |
| 7.3.5 | State of the aircraft | The state of the aircraft, during a sub-phase (7.1.4), is the result of a situation of loads carriage (7.3.1), a real situation (7.3.4), a mass and a mass distribution of the aircraft.<br><br>NOTE — In some cases, for calculations, for flight tests or simulated flight tests, it may be useful to define the state of the aircraft independently of the sub-phase. |

## 7.4 Environment

| No. | Term | Definition |
|---|---|---|
| 7.4.1 | State of the atmosphere | The set of physical parameters characterizing, at a point, the atmosphere considered as undisturbed by the aircraft and having an influence on the motion of the aircraft and on the behaviour of the crew.<br><br>Usually, the following parameters and certain gradients, when necessary, are taken into consideration: pressure (5.1.1), temperature (5.1.2), density (5.1.3), humidity, wind speed (2.2.3), intensity and distribution of turbulence, visibility, icing conditions.<br><br>The point considered is either the actual point at which the aircraft is, or one of the points at which it is likely to be, during its flight.<br><br>NOTES<br>1 During a sub-phase (7.1.4), it is often possible to consider that the state of the atmosphere does not vary.<br>2 The state of the atmosphere can be affected by the presence of other aircraft. |
| 7.4.2 | Model state of the atmosphere | The state of the atmosphere for which the values of the parameters listed in 7.4.1 are defined as a function of the altitude, the geographic coordinates and the time. |
| 7.4.3 | Standard state of the atmosphere | The model state of the atmosphere (7.4.2) for which the values of the parameters listed in 7.4.1 are identical to those of ISO 2533, as a function of the geometric altitude or the geopotential altitude of the point considered.<br><br>NOTES<br>1 ISO 2533 assumes that the air is clean, dry and motionless with respect to the Earth.<br>2 Particular states of the atmosphere, derived from the standard state, are usually defined by increments of temperature $\Delta T$ with respect to the temperature in the standard atmosphere of ISO 2533, $\Delta T$ being independent of the pressure altitude (5.3.1). |
| 7.4.4 | Reference state of the atmosphere | The model state of the atmosphere (7.4.2) for which the values of the parameters listed in 7.4.1 are identical to those of one of the reference atmospheres given in ISO 5878, as a function of the geometric altitude or of the geopotential altitude of the point considered.<br><br>The reference atmosphere used shall be specified.<br><br>NOTE — ISO 5878 gives, for the reference atmospheres that it defines, the mean values of the characteristics of the atmosphere as a function of altitude for different latitudes and times of the year. |

| No. | Term | Definition |
|---|---|---|
| 7.4.5 | State of the runway | The set of physical parameters of the runway affecting the motion of the aircraft and the behaviour of the crew, during the sub-phases (7.1.4) of the phases (7.1.3) "take-off" and "landing".<br><br>The following parameters are taken into consideration: length, width, mean slope, profile in elevation, material, roughness, water, snow, ice.<br><br>NOTES<br><br>1 For mobile runways (for example, runway on a ship), a similar definition may be given.<br><br>2 For aircraft that take off and alight on water, a similar definition can be given for the state of the water surface. |

## 7.5 Flight points

| No. | Term | Definition |
|---|---|---|
| 7.5.1 | Piloting rules | The set of positions in which the crew shall put the selectors (7.2.1.2) and set of values for the various flight parameters or of the relationships between those parameters which shall be maintained, manually or automatically, in order that the objective of the sub-phase (7.1.4) is achieved.<br><br>The parameters considered are the position with respect to a reference trajectory, calibrated airspeed (5.6.1), the Mach number (1.3.3), the attitude angles of the aircraft, etc.<br><br>Piloting rules shall be given with tolerances; these tolerances shall be compatible with the tolerances of the sub-phase objective.<br><br>NOTE — Piloting rules are specified in the flight manual for the operational flights and in the programme of tests for real or simulated experimental flights. |
| 7.5.2 | Piloting work | The work the crew is required to do, during a sub-phase (7.1.4), in order to comply with the piloting rules (7.5.1). |
| 7.5.3 | Supplementary rules | The set of instructions relating to the action the crew shall take during a sub-phase (7.1.4), but excluding those instructions laid down in the piloting rules (7.5.1).<br><br>The supplementary rules concern, for example, the use of the radio, the reading and verification of check lists, etc.<br><br>NOTE — Supplementary rules are specified in the flight manual for operational flights and in the programme of tests for real or simulated experimental flights, or are imposed by air traffic regulations. |
| 7.5.4 | Supplementary work | The work the crew is required to do, during a sub-phase (7.1.4), in order to comply with the supplementary rules (7.5.3). |
| 7.5.5 | Flight point;<br>flight case | During a sub-phase (7.1.4), the chosen set of flight conditions consisting of:<br><br>— the state of the aircraft (7.3.5);<br>— the state of the atmosphere (7.4.1);<br>— the state of the runway (7.4.5), if appropriate;<br>— the piloting rules (7.5.1);<br>— the supplementary rules (7.5.3).<br><br>NOTE — In some cases, this set may be reduced, for example: pressure altitude (5.3.1), Mach number (1.3.3), load factor (1.5.9). |