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Terms and symbols for flight dynamics —
Part VI : Aircraft geometry

Termes et symboles de la mécanique du vol —
Partie VI : Géométrie de l'avion

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FOREWORD

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO member bodies). The work of developing International Standards is carried out through ISO technical committees. Every member body interested in a subject for which a technical committee has been set up 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.

International Standard ISO 1151/VI was developed by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, and was circulated to the member bodies in September 1976.

It has been approved by the member bodies of the following countries :

Austria	Ireland	Romania
Belgium	Italy	Spain
Brazil	Japan	Sweden
Czechoslovakia	Korea, Rep. of	United Kingdom
France	Mexico	U.S.S.R.
Germany	Philippines	Yugoslavia
India	Poland	

The member body of the following country expressed disapproval of the document on technical grounds :

U.S.A.

International Standard ISO 1151/VI, *Terms and symbols for flight dynamics —
Part VI : Aircraft geometry*, is the sixth in a series of International Standards, the
purpose of which is to define the principal terms used in flight dynamics and to
specify symbols for these terms.

Other International Standards in this series, which will be further extended in the
future, are at present as follows :

ISO 1151/I, *Terms and symbols for flight dynamics — Part I : Aircraft motion
relative to the air.*

ISO 1151/II, *Terms and symbols for flight dynamics — Part II : Motions of the
aircraft and the atmosphere relative to the Earth.*

ISO 1151/III, *Terms and symbols for flight dynamics — Part III : Derivatives of
forces, moments and their coefficients.*

ISO 1151/IV, *Terms and symbols for flight dynamics — Part IV : Parameters used
in the study of aircraft stability and control.*

ISO 1151/V, *Terms and symbols for flight dynamics — Part V : Quantities used in
measurements.*

In these International Standards, the term "aircraft" denotes an aerodyne
essentially symmetrical with respect to a fore and aft plane. This plane is
determined from the geometrical characteristics of the aircraft. When there is no
fore and aft plane of symmetry, or when there are more than one planes of
symmetry, it is necessary to introduce a reference plane. This reference plane is
arbitrary and it is necessary to indicate the choice made.

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

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

The Earth's surface is treated as a plane.

Numbering of sections and clauses

Each of these International Standards represents a part of the whole study on terms
and symbols for flight dynamics.

To permit easier reference to a section or a clause from one part to another, a
decimal numbering has been adopted which begins in each International Standard
with the number of the part it represents.

CONTENTS

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1) In preparation.

Terms and symbols for flight dynamics —
Part VI : Aircraft geometry

6.0 INTRODUCTION

6.0.1 This International Standard defines certain notions used for the geometric description of an aircraft for the purpose of flight dynamic studies[1].

It does not give all the definitions that permit the detailed description of the shape of the aircraft.

6.0.2 The aircraft is considered to be made up of various components. These components are in practice grouped in sub-sets forming the "main parts" of the aircraft.

A main part consists of a basic component and usually some other components that are either fixed or movable. The positions of movable components with respect to the basic component can be varied during flight.

Examples

Components \ Main parts	Fuselage	Wing	Tailplane	...
Basic components	Cabin	Centre section	Fixed surface	...
Fixed components	Tail cone	Fixed portions	—	...
Movable components	Droop nose Landing gear doors	Variable sweep portions Flaps Ailerons Slats	Pitch motivator Tab	...

Moreover, the position of a main part with respect to another main part can be varied in flight. Examples : The rotation of the tailplane with respect to the fuselage, the rotation of the engine nacelles of a vertical take-off and landing aircraft with respect to the wing.

The breakdown of the aircraft into main parts and components depends on the problem studied. For example, a high-lift system composed of several flaps can be considered as a single component if the law of relative motion of the various flaps is defined (for example, during the study of approach at different deflections); in that case, the position of the component is defined by a single parameter which is the position of the high-lift system control. On the other hand, under other circumstances, each flap must be considered as a component (for example, during a wind-tunnel study aimed at defining the law of relative motion of the various flaps).

6.0.3 The basic component is used to define the relative positions of the various components composing the main part to which it belongs by means of reference axis systems within each component (6.1.9). The basic component is equally used to define the relative position of the main part to which it belongs with respect to the other main parts by means of reference axis systems within each main part (6.1.13).

To define the position of each main part with respect to the aircraft, it is necessary to define an axis system $x_R y_R z_R$, called the aircraft reference axis system (6.1.4).

That axis system need not be the body axis system (1.1.5) the axes of which are chosen from flight dynamic considerations. Usually, the axes of the aircraft reference axis system are coincident with the axes of the fuselage axis system.

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1) In other fields (manufacturing, etc.) it may be necessary to introduce other notions.

6.0.4 For the basic component of the fuselage, the terms "forward", "starboard" and "ventral" have their generally accepted meanings.

The forward, starboard and ventral directions for any component follow from its general orientation with respect to the fuselage.

It is emphasised that the terms "forward", "starboard" and "ventral" are a necessary part of the definition of each component, but do not refer to the direction of motion of the aircraft, to its position with respect to the Earth, or to the position of the pilot in the aircraft. Thus the forward direction of the fuselage of a vertical take-off and landing aircraft remains the same irrespective of the direction in which the aircraft is flying.

On the basis of these conventions the axis system fixed in each component, called the "reference axis system" (6.1.9), would usually be oriented with the x-axis in the forward direction, the y-axis to starboard and the z-axis in the ventral direction.

6.0.5 The reference points (6.1.7), axes (6.1.8) and axis systems (6.1.9) for each component can be determined from datum points and lines marked on the aircraft or on drawings.

The complete definition of the geometric shape of each component must be given with respect to its reference axis system (6.1.9).

6.0.6 It is assumed possible to extract from the set of components a sub-set that constitutes the major part of the aircraft in which the individual components are either symmetrical, or are symmetrically disposed, in the port and starboard sense with respect to a plane which is called the aircraft reference plane (6.1.1).

6.0.7 In order to describe a component or a main part, it may be convenient to introduce one or more overall parameters representative of the shape of the component or the main part (example : the maximum cross-sectional area and the length of the fuselage). The relative positions of different components or different main parts depend on the action of the pilot or of certain systems and of the inertial and aerodynamic load state. These relative positions define the geometric state of the aircraft (6.1.17).

6.0.8 If, in the course of a flight dynamic study, certain geometrical quantities vary (for example, the span and wing area of a variable-sweep aircraft), it is recommended that one of the possible values of each of these geometric quantities should be chosen as the reference quantity.

6.1 GENERAL CHARACTERISTICS

No.	Term	Definition	Symbol
6.1.1	Aircraft reference plane	The plane with respect to which a sub-set of the components that constitutes the major part of the aircraft is symmetrically disposed in the port and starboard sense. This plane is the $z_R x_R$ plane of the aircraft reference axis system (6.1.4). NOTE — In the most frequent case, the aircraft reference plane is coincident with the fuselage reference plane (6.4.3).	$z_R x_R$
6.1.2	Aircraft reference point	A suitably chosen point fixed in the aircraft reference plane (6.1.1).	—
6.1.3	Aircraft reference axis	A suitably chosen straight line fixed in the aircraft reference plane (6.1.1) passing through the aircraft reference point (6.1.2) and in the forward direction.	x_R
6.1.4	Aircraft reference axis system	A right-handed orthogonal axis system fixed in the aircraft with origin at the aircraft reference point (6.1.2), with x-axis coincident with the aircraft reference axis (6.1.3) and with the z_R-axis in the aircraft reference plane (6.1.1). The y_R-axis completes the axis system and is to starboard. NOTE — In the most frequent case, the aircraft reference axis system coincides with the fuselage axis system (6.4.1).	$x_R y_R z_R$
6.1.5	Setting of the body axis system with respect to the aircraft reference axis system	The set of geometric quantities (in general three co-ordinates and three orientation angles) that defines the position of the body axis system (1.1.5) with respect to the aircraft reference axis system (6.1.4).	—

No.	Term	Definition	Symbol
6.1.6	Setting angle of the longitudinal axis with respect to the aircraft reference axis	The angle through which the aircraft reference axis (6.1.3) must be turned about the y_R-axis of the aircraft reference axis system (6.1.4) to bring it parallel to the longitudinal axis (1.1.5) in the special case where the transverse axis (1.1.5) is parallel to the y_R-axis. The angle is positive when the rotation is made in the positive sense of rotations in the aircraft reference plane (6.1.1).	—
6.1.7	Reference point (of a component)	A suitably chosen point fixed in the component.	—
6.1.8	Reference axis (of a component)	A straight line fixed in the component passing through the reference point (6.1.7) and in a suitably chosen direction.	—
6.1.9	Reference axis system (of a component)	A right-handed orthogonal axis system, fixed in the component, with origin at the reference point (6.1.7), made up of three reference axes (6.1.8) usually chosen in the following manner : the x_i-axis is directed forward; the y_i-axis is to starboard; the z_i-axis completes the system.	$x_i y_i z_i$ x_i y_i z_i NOTE — The subscript i is a number or letter subscript that denotes the component considered.
6.1.10	Setting of one component with respect to another component	The set of geometric quantities (in general three co-ordinates and three orientation angles) that defines the position of the reference axis system of a component (6.1.9) with respect to the reference axis system of another component.	—
6.1.11	Reference point of a main part	The reference point (6.1.7) of the basic component of a main part (6.0.2).	—
6.1.12	Reference axis of a main part	The reference axis (6.1.8) of the basic component of a main part (6.0.2).	—
6.1.13	Reference axis system of a main part	The reference axis system (6.1.9) of the basic component of a main part (6.0.2).	—
6.1.14	Setting of a main part with respect to another main part	The set of geometric quantities (in general three co-ordinates and three orientation angles) that defines the position of the reference axis system of a main part (6.1.13) with respect to the reference axis system of another main part.	—
6.1.15	Setting of a main part with respect to the aircraft reference axis system	The set of geometric quantities (in general three co-ordinates and three orientation angles) that defines the position of the reference axis system of a main part (6.1.13) with respect to the aircraft reference axis system (6.1.4).	—
6.1.16	Geometric state of a main part	The set of quantities characterizing the relative positions of the various components of a main part.	—
6.1.17	Geometric state of an aircraft	The set of quantities characterizing the relative positions of the various main parts.	—

The co-ordinates of a point P in the reference axis system $x_i y_i z_i$ are designated by x_{iP}, y_{iP} and z_{iP}. The index i is a numerical or literal index that indicates the reference axis system. The index P is a numerical or literal index that indicates the given point P.

3

The relative position of a point P (x_{iP}, y_{iP}, z_{iP}) with respect to a point Q (x_{iQ}, y_{iQ}, z_{iQ}) is defined by the differences between the co-ordinates of these points with respect to the reference axis system $x_i y_i z_i$.

NOTE — The index i may be omitted if there is no danger of confusion.

No.	Term	Definition	Symbol
6.1.18	–	The difference between the x co-ordinates of the point Q and of the point P in the chosen reference axis system. $x_{iPQ} = x_{iQ} - x_{iP}$	x_{iPQ}
6.1.19	–	The difference between the y co-ordinates of the point Q and of the point P in the chosen reference axis system. $y_{iPQ} = y_{iQ} - y_{iP}$	y_{iPQ}
6.1.20	–	The difference between the z co-ordinates of the point Q and of the point P in the chosen reference axis system. $z_{iPQ} = z_{iQ} - z_{iP}$	z_{iPQ}

6.2 OVERALL DIMENSIONS OF THE AIRCRAFT

For a given geometric state of the aircraft (6.1.17), overall dimensions of the aircraft are defined as follows.

No.	Term	Definition	Symbol
6.2.1	Overall length (of the aircraft)	The distance between the two planes parallel to the $y_R z_R$ plane of the aircraft reference axis system (6.1.4), just touching the surface of the aircraft and lying wholly outside it.	l_R
6.2.2	Overall width (of the aircraft)	The distance between the two planes parallel to the aircraft reference plane (6.1.1), just touching the surface of the aircraft and lying wholly outside it.	b_R
6.2.3	Overall height (of the aircraft)	The distance between the two planes parallel to the $x_R y_R$ plane of the aircraft reference axis system (6.1.4), just touching the surface of the aircraft and lying wholly outside it.	h_R

For a given geometric state of the aircraft (6.1.17), corresponding overall dimensions are defined for the aircraft resting on a horizontal ground plane with the y_R-axis of the aircraft reference axis system (6.1.4) parallel to that plane.

No.	Term	Definition	Symbol
6.2.4	Ground overall length (of the aircraft)	The distance between the two planes perpendicular to the ground plane, parallel to the y_R-axis of the aircraft reference axis system (6.1.4), just touching the surface of the aircraft and lying wholly outside it.	l_o
6.2.5	Ground overall width (of the aircraft)	The distance between the two planes perpendicular to the ground plane, parallel to the x_R-axis of the aircraft reference axis system (6.1.4), just touching the surface of the aircraft and lying wholly outside it. NOTE — For the same geometric state of the aircraft (6.1.17), the quantities defined in 6.2.2 and 6.2.5 are identical.	b_o
6.2.6	Ground overall height (of the aircraft)	The distance between the ground plane and the plane parallel to that plane, just touching the surface of the aircraft and lying wholly outside it.	h_o

6.3 GROUND LIMIT ANGLES

Ground limit angles represent the extreme angular positions that the aircraft may assume on the ground plane. These angles depend on the geometric state of the aircraft (6.1.17) taking into account the mass distribution, the undercarriage and the tyre distortion, etc.

In order to represent the extreme angular positions that the aircraft may assume at lift-off and touch-down, the limit angles are defined only when no reaction forces are exerted at the various contact points and when inertia forces are zero, in which case, the undercarriage is in the position resulting from the action of its own weight only.

In these extreme angular positions, at least two points of the aircraft structure are in contact with the ground plane.

NOTE — Other ground limit angles can be defined in an analogous manner when the ground reaction forces are not zero.

No.	Term	Definition	Symbol
6.3.1	Ground limit angle in pitch	The absolute value of the angle between the aircraft reference axis (6.1.3) and the ground plane when the aircraft main undercarriage and that part of the aircraft lying aft of the main undercarriage are just in contact with the ground plane with no reaction forces and with the y_R-axis parallel to the ground plane. NOTE — An analogous angle may be defined in the nose-down sense, but is less likely to arise as a result of intentional action.	—
6.3.2	Ground limit angle in roll	The absolute value of the angle between the y_R-axis of the aircraft reference axis system (6.1.4) and the ground plane when : — either the outboard starboard wheel(s) of the main undercarriage and that part of the aircraft lying outboard of the starboard wheel(s), — or the outboard port wheel(s) of the main undercarriage and that part of the aircraft lying outboard of the port wheel(s), are just in contact with the ground plane with no reaction forces and with the aircraft reference axis (6.1.3) parallel to the ground plane. NOTES 1 The values of port and starboard ground limit angles are the same, unless the aircraft is not symmetrical. 2 The concept of the ground limit angle in roll may be generalized to cases in which the x_R-axis need not be parallel to the ground plane.	—

6.4 FUSELAGE

The main part designated "FUSELAGE" is defined by listing the various components that constitute it and specifying the basic component.

In such a listing it is necessary to indicate whether certain ancillary components disposed on the fuselage (nose probe, braking parachute housing, air intakes, etc.) are considered part of the fuselage.

For example, in the case of an aircraft incorporating a cabin and twin booms, the fuselage may be defined, depending on the problem treated, as being made up of :

— either the cabin (the basic component) alone, without the twin booms and without the nose probe;

— or the cabin (the basic component) with the twin booms and with the nose probe.

No.	Term	Definition	Symbol
6.4.1	Fuselage axis system	The reference axis system of the basic component (6.1.13) of the fuselage. NOTES 1 If the fuselage has a plane of symmetry parallel to the aircraft reference plane (6.1.1), the x_F- and z_F-axes are in that plane of symmetry. 2 If the fuselage has two fore and aft planes of symmetry and if one of them is parallel to the aircraft reference plane (6.1.1), the x_F-axis is the line of intersection of those planes of symmetry and the z_F-axis is parallel to the aircraft reference plane (6.1.1). In particular, if the fuselage is a body of revolution, the x_F-axis is the axis of revolution. 3 In the most frequent case, the fuselage axis system coincides with the aircraft reference axis system (6.1.4).	$x_F y_F z_F$