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Terms and symbols for flight dynamics – Part I : aircraft motion relative to the air

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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 (originally draft No. 2117) was drawn up by Technical Committee ISO/TC 20, *Aircraft and space vehicles.*

It was approved in April 1971 by the Member Bodies of the following countries :

Austria	Greece	South Africa, Rep. of
Belgium	Israel	Spain
Czechoslovakia	Italy	Thailand
Egypt, Arab Rep. of	Japan	Turkey
France	Netherlands	United Kingdom
Germany	New Zealand	U.S.S.R.

No Member Body expressed disapproval of the document.

This International Standard cancels and replaces ISO Recommendation R1151-1969.

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International Standard ISO 1151, *Terms and symbols for flight dynamics – Part I : Aircraft motion relative to the air,* is the first 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 1152, *Terms and symbols for flight dynamics – Part II : Motions of the aircraft and the atmosphere relative to the Earth.* [1]

ISO 1153, *Terms and symbols for flight dynamics – Part III : Derivatives of forces, moments and their coefficients.*

ISO 2764, *Terms and symbols for flight dynamics – Part IV : Parameters used in the study of aircraft stability and control.* [2]

ISO 2765, *Terms and symbols for flight dynamics – Part V : Quantities used in measurements.* [2]

In these International Standards, the term "aircraft" denotes an aerodyne having a fore-and-aft plane of symmetry. This plane is determined by the geometrical characteristics of the aircraft. When there are more than one fore-and-aft planes of symmetry, the reference plane of symmetry is arbitrary and it is necessary to indicate the choice made.

Angles of rotation, angular velocites 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.

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.

1) In course of transformation into an International Standard. (At present, ISO/R 1152.)

2) At present at the stage of draft.

CONTENTS

Terms and symbols for flight dynamics – Part I : aircraft motion relative to the air

1.0 INTRODUCTION

This International Standard deals with the motion of the aircraft in an atmosphere at rest or in uniform motion.

To fully account for the effects of aeroelasticity and of the Earth's curvature would necessitate more detailed consideration of certain aspects of the definitions given, although these have been framed in such a way that they can be more generally interpreted. The definitions of the axes apply as they stand when the Earth's surface is treated as a plane, that is, when the Earth's radius is taken as infinite, and, in the case of the body axes, when the aircraft is treated as rigid.

1.1 AXIS SYSTEMS

No.	Term	Definition	Symbol
1.1.1	Earth-fixed axis system	A system with both origin O_o and axes fixed with respect to the Earth, chosen to suit the problem.	x_o, y_o, z_o
1.1.2	Normal earth-fixed axis system	An earth-fixed axis system (1.1.1) in which the z_o-axis is vertically downward.	x_o, y_o, z_o but x_g, y_g, z_g is an accepted alternative.
1.1.3	Aircraft-carried earth axis system	A system in which each axis has the same direction as the corresponding earth-fixed axis, with origin O, fixed in the aircraft, usually at the centre of gravity.	x_o, y_o, z_o
1.1.4	Aircraft-carried normal earth axis system	A system in which each axis has the same direction as the corresponding normal earth-fixed axis, with origin O, fixed in the aircraft, usually at the centre of gravity.	x_o, y_o, z_o but x_g, y_g, z_g is an accepted alternative.
1.1.5	Body axis system	Axis system fixed in the aircraft with origin O, usually the centre of gravity, containing the longitudinal axis, the transverse axis and the normal axis according to the following definitions :	x, y, z
	Longitudinal axis	An axis in the plane of symmetry or, if the origin lies outside this, in a parallel plane through the origin, and in some suitable forward direction.	x
	Transverse axis	An axis normal to the plane of symmetry, and positive to starboard.	y
	Normal axis	An axis in the plane of symmetry or, if the origin lies outside this, in the parallel plane through the origin, normal to the longitudinal axis, positive in the ventral sense (when viewed from the origin O).	z
1.1.6	Air-path axis system	Axis system with aircraft fixed origin O, usually the centre of gravity, and containing the following axes :	x_a, y_a, z_a
	x_a-axis (air-path axis)	An axis in the direction of the aircraft velocity (1.3.1).	x_a
	y_a-axis	An axis normal to the air-path axis and the z_a-axis defined below. It is positive to starboard.	y_a
	z_a-axis	An axis in the plane of symmetry, or, if the origin lies outside this, in the parallel plane through the origin and normal to the air-path axis. In normal flight conditions it is therefore ventral (when viewed from the origin O).	z_a

1.2 ANGLES

Orientation of the aircraft velocity with respect to the body axis system (see Figure 1).

No.	Term	Definition	Symbol
1.2.1	Angle of sideslip	The angle that the aircraft velocity (1.3.1) makes with the plane of symmetry of the aircraft. It is positive when the aircraft velocity component along the transverse axis (1.1.5) is positive. It has by convention the range $-\frac{\pi}{2} \leqslant \beta \leqslant \frac{\pi}{2}$	β
1.2.2	Angle of attack	The angle between the longitudinal axis (1.1.5) and the projection of the aircraft velocity (1.3.1) on the plane of symmetry. It is positive when the aircraft velocity component along the normal axis (1.1.5) is positive. It has by convention the range $-\pi < \alpha \leqslant \pi$	α

Transition from the aircraft-carried normal earth axis system to the body axis system is effected by the rotations Ψ, Θ, Φ defined below, taken in that order (see Figure 2).

NOTE — Analogous angles can be defined with respect to any aircraft-carried earth axis system. The same symbols Ψ, Θ, Φ, with appropriate suffixes as necessary, may then be used. On the other hand, the terms azimuth angle, inclination angle and bank angle refer only to the special case where the z_o-axis is vertical.

No.	Term	Definition	Symbol
1.2.3	Azimuth angle	The rotation (positive if clockwise) about the z_o (z_g)-axis which brings the x_o (x_g)-axis into coincidence with the projection of the longitudinal axis (1.1.5) on the horizontal plane through the origin *O*.	Ψ
1.2.4	Inclination angle (elevation)	The rotation in a vertical plane, following the rotation Ψ (1.2.3) and which brings the displaced x_o (x_g)-axis into coincidence with the longitudinal axis (1.1.5). It is positive when the *x*-axis lies above the horizontal plane through the origin *O*. It has by convention the range $-\frac{\pi}{2} \leqslant \Theta \leqslant \frac{\pi}{2}$	Θ
1.2.5	Bank angle	The rotation (positive if clockwise) about the longitudinal axis (1.1.5) which brings the displaced y_o (y_g)-axis into its final position *y* from the position it reached after rotation through Ψ (1.2.3).	Φ

Transition from the aircraft-carried normal earth axis system to the air-path axis system is effected by the rotations χ_a, γ_a and μ_a defined below, taken in that order (see Figure 3).

No.	Term	Definition	Symbol
1.2.6	Air-path azimuth angle (air-path track angle)	The rotation (positive if clockwise) about the z_o (z_g)-axis which brings the x_o (x_g)-axis into coincidence with the projection of the air-path x_a-axis (1.1.6) on the horizontal plane through the origin *O*.	χ_a
1.2.7	Air-path inclination angle (air-path climb angle)	The rotation in a vertical plane, following the rotation χ_a (1.2.6) which brings the displaced x_o (x_g)-axis into coincidence with the air-path x_a-axis (1.1.6). It is positive when the x_a-axis lies above the horizontal plane through the origin *O*. It has by convention the range $-\frac{\pi}{2} \leqslant \gamma_a \leqslant \frac{\pi}{2}$	γ_a
1.2.8	Air-path bank angle	The rotation (positive if clockwise) about the air-path x_a-axis (1.1.6) which brings the displaced y_o (y_g)-axis into its final position y_a from the position it reached after rotation through χ_a (1.2.6).	μ_a

1.3 VELOCITIES AND ANGULAR VELOCITIES

No.	Term	Definition	Symbol
1.3.1	Aircraft velocity	The velocity of the origin *O* of the body axis system (1.1.5) (usually the centre of gravity) relative to the air unaffected by the aerodynamic field of the aircraft. The corresponding scalar quantity is the airspeed.	$\vec{V}$ (V)
1.3.2	Speed of sound	The velocity of propagation of a sound wave in the ambient air unaffected by the aerodynamic field of the aircraft.	a
1.3.3	Mach number	The ratio of the airspeed (1.3.1) to the speed of sound (1.3.2). Equal to V/a	*M* is recommended. However the symbols *Ma* and $\mathcal{M}$ may be used if otherwise there would be a possibility of confusion.

No.	Term	Definition	Symbol
1.3.4	Aircraft velocity components	The components of the velocity $\vec{V}$, for any of the axis systems used. In the axis systems 1.1.1 to 1.1.4 : component along the x_o-axis component along the y_o-axis component along the z_o-axis In the body axis system (1.1.5) : component along the longitudinal axis component along the transverse axis component along the normal axis NOTE — In the air-path axis system (1.1.6) the component along the x_a-axis is $u_a = V$.	 u_o v_o w_o u v w In certain computations the velocity components may be written V_i where i is a dummy subscript.
1.3.5	Aircraft angular velocity	The angular velocity (corresponding scalar quantity) of the body axis system (1.1.5) relative to the Earth.	$\vec{\Omega}$ (Ω)
1.3.6	Angular velocity components Rate of roll Rate of pitch Rate of yaw	The components of the angular velocity $\vec{\Omega}$, for any of the axis systems. In the axis systems 1.1.1 to 1.1.4 : component about the x_o-axis component about the y_o-axis component about the z_o-axis In the body axis system (1.1.5) : component about the longitudinal axis component about the transverse axis component about the normal axis	 p_o q_o r_o p q r In certain computations the angular velocity components may be written Ω_i where i is a dummy subscript.

No.	Term	Definition	Symbol
1.3.7	Normalized angular velocities	The normalized form of the components of the angular velocity (1.3.5), formed as follows : In the body axis system (1.1.5) :	
	Normalized rate of roll	$\frac{pl}{V}$	p^*
	Normalized rate of pitch	$\frac{ql}{V}$	q^*
	Normalized rate of yaw	$\frac{rl}{V}$	r^*
		where l is the reference length (1.4.6). Similar normalized quantities can be formed for the other axis systems.	Analogous quantities using a constant reference speed in place of V (1.3.1) may also be defined. These require different symbols.

1.4 AIRCRAFT INERTIA, GEOMETRIC AND DYNAMIC CHARACTERISTICS

No.	Term	Definition	Symbol
1.4.1	Aircraft mass	The current mass of the aircraft.	m
1.4.2	Moments of inertia	The moments of inertia of the aircraft with respect to the body axes x, y, z (1.1.5). Moment of inertia about the longitudinal axis is $\int (y^2 + z^2)\mathrm{d}m$	I_x
		Moment of inertia about the transverse axis is $\int (z^2 + x^2)\mathrm{d}m$	I_y
		Moment of inertia about the normal axis is $\int (x^2 + y^2)\mathrm{d}m$	I_z (*A, B, C* are acceptable alternatives)
1.4.3	Products of inertia	The products of inertia of the aircraft with respect to the body axes x, y, z (1.1.5). These are : $\int yz\,\mathrm{d}m$ $\int zx\,\mathrm{d}m$ $\int xy\,\mathrm{d}m$	I_{yz} I_{zx} I_{xy} (*D, E, F* are acceptable alternatives)
1.4.4	Radius of gyration	The square root of the ratio of the moment of inertia to the aircraft mass (1.4.1) : for the longitudinal axis (1.1.5) $\sqrt{I_x/m}$	r_x
		for the transverse axis (1.1.5) $\sqrt{I_y/m}$	r_y
		for the normal axis (1.1.5) $\sqrt{I_z/m}$	r_z

No.	Term	Definition	Symbol
1.4.5	Reference area	An area used in forming various non-dimensional quantities. For the complete aircraft the most commonly used reference area is the gross wing area (i.e. the area obtained by continuing the edges within the fuselage and the nacelles). NOTE — Hinge moment coefficients are not usually based on this reference area.	S
1.4.6	Reference length	A length used in forming non-dimensional coefficients of the aerodynamic moments and various normalized quantities. In a given document this length has a specified constant value. In the absence of a length having some aerodynamic significance the choice should correspond to an easily established geometric feature. NOTE — Hinge moment coefficients are not usually based on this reference length.	l
1.4.7	Wing span	The distance between the two planes parallel to the plane of symmetry, tangential to the wing surface and lying wholly outside the aircraft.	b
1.4.8	Normalized mass	Non-dimensional coefficient defined as follows : $$\frac{m}{\frac{1}{2}\rho_e S l}$$ where m is the aircraft mass (1.4.1); ρ_e is a datum (air) density (3.3.2); S is the reference area (1.4.5); l is the reference length (1.4.6).	μ ('m^*)
1.4.9	Dynamic unit of time	A quantity defined as follows : $$\frac{m}{\frac{1}{2}\rho_e V_e S} = \frac{\mu l}{V_e}$$ where m is the aircraft mass (1.4.1); ρ_e is a datum (air) density (3.3.2); V_e is a datum speed (3.3.1); S is the reference area (1.4.5); l is the reference length (1.4.6); μ is the normalized mass (1.4.8).	τ
1.4.10	Aerodynamic unit of time	A quantity defined as follows : $$\frac{l}{V_e}$$ where l is the reference length (1.4.6); V_e is a datum speed (3.3.1).	τ_A

1.5 FORCES, MOMENTS, COEFFICIENTS AND LOAD FACTORS

No.	Term	Definition	Symbol
1.5.1	Resultant force	The resultant vector (magnitude of the resultant vector) of the system of forces acting on the aircraft including the (airframe) aerodynamic forces and the propulsion forces, but excluding the gravitational, inertial and reaction forces due to contact with the Earth's surface. NOTE — In the special cases where only the (airframe) aerodynamic forces or the propulsive forces are considered, a distinguishing symbol is necessary (see 1.6).	$\vec{R}$ (R)
1.5.2	Components of the resultant force	The components of the resultant force vector, $\vec{R}$. In the body axis system (1.1.5) : component along the longitudinal axis component along the transverse axis component along the normal axis In the air-path axis system (1.1.6) : component along the x_a-axis component along the y_a-axis component along the z_a-axis	 X Y Z X_a Y_a Z_a
1.5.3	Force coefficients	Non-dimensional coefficients of the components of the resultant force (1.5.2), formed as follows : In the body axis system (1.1.5) : X force coefficient is $X/\frac{1}{2}\rho V^2 S$ Y force coefficient is $Y/\frac{1}{2}\rho V^2 S$ Z force coefficient is $Z/\frac{1}{2}\rho V^2 S$ In the air-path axis system (1.1.6) : X_a force coefficient is $X_a/\frac{1}{2}\rho V^2 S$ Y_a force coefficient is $Y_a/\frac{1}{2}\rho V^2 S$ Z_a force coefficient is $Z_a/\frac{1}{2}\rho V^2 S$ where ρ is the density of the ambient air unaffected by the aerodynamic field of the aircraft. NOTE — These definitions are not the ones usually used in helicopter studies.	 C_X C_Y C_Z C_{Xa} C_{Ya} C_{Za}

No.	Term	Definition	Symbol
1.5.4	Resultant moment	The resultant moment of the system of forces forming the resultant force of 1.5.1 about a reference point, usually the centre of gravity.	
1.5.5	Components of the resultant moment	The components of the resultant moment.	
		In the body axis system (1.1.5) :	
	Rolling moment	component about the longitudinal axis	L
	Pitching moment	component about the transverse axis	M
	Yawing moment	component about the normal axis	N
		In the air-path axis system (1.1.6) :	
		component about the x_a-axis	L_a
		component about the y_a-axis	M_a
		component about the z_a-axis	N_a
1.5.6	Moment coefficients	Non-dimensional coefficients of the components of the resultant moment (1.5.5) formed as follows :	
		In the body axis system (1.1.5) :	
	Rolling moment coefficient	$L/\frac{1}{2}\rho V^2 S l$	C_l
	Pitching moment coefficient	$M/\frac{1}{2}\rho V^2 S l$	C_m
	Yawing moment coefficient	$N/\frac{1}{2}\rho V^2 S l$	C_n
		In the air-path axis system (1.1.6) :	
		$L_a/\frac{1}{2}\rho V^2 S l$	C_{la}
		$M_a/\frac{1}{2}\rho V^2 S l$	C_{ma}
		$N_a/\frac{1}{2}\rho V^2 S l$	C_{na}
		where ρ is the density of the ambient air unaffected by the aerodynamic field of the aircraft. NOTE — These definitions are not the ones usually used in helicopter studies.	
1.5.7	Load factor vector	Ratio of the resultant force (magnitude of the resultant force) (1.5.1) to the magnitude of the weight of the aircraft, defined by the relationship : $\vec{n} = \frac{\vec{R}}{mg} \quad \left(n = \frac{R}{mg}\right)$ where m is the aircraft mass (1.4.1); g is the acceleration due to gravity. NOTES 1 A similar load factor vector may be defined for landing and take off conditions with the introduction of the resultant force which includes in this case forces due to contact with the Earth's surface. 2 Other load factors may be defined in a different way, in particular, local load factors.	$\vec{n}$ (n)

No.	Term	Definition	Symbol
1.5.8	Components of the load factor vector	Components of the load factor vector $\vec{n}$ (1.5.7) formed as follows : In the body axis system (1.1.5) : component along the longitudinal axis $n_x = \frac{X}{mg}$ component along the transverse axis $n_y = \frac{Y}{mg}$ component along the normal axis $n_z = \frac{Z}{mg}$ In the air-path axis system (1.1.6) : component along the x_a-axis $n_{xa} = \frac{X_a}{mg}$ component along the y_a-axis $n_{ya} = \frac{Y_a}{mg}$ component along the z_a-axis $n_{za} = \frac{Z_a}{mg}$ NOTE — Both $-n_z$ and $-n_{za}$ are often replaced by n.	n_x n_y n_z n_{xa} n_{ya} n_{za}

1.6 THRUST, (AIRFRAME) AERODYNAMIC FORCE AND THEIR COMPONENTS

The system of forces defined in 1.5.1 represented by the resultant force $\vec{R}$, cannot be separated uniquely into forces attributed to the propulsive system and forces attributed to the airframe. In each particular case, this separation can be done arbitrarily by first defining the propulsive force called thrust; the (airframe) aerodynamic force then follows by subtracting the thrust from the resultant force.

In the following paragraphs,

a) the thrust components, and

b) the (airframe) aerodynamic force components,

have been defined in the body axis system and in the air-path axis system.

No.	Term	Definition	Symbol
1.6.1	Thrust	The resultant vector (magnitude of the resultant vector) of the system of forces attributed to the propulsive system (see 1.6).	$\vec{F}$ (F)
1.6.2	(Airframe) aerodynamic force	The force (magnitude of the force) defined by the relationship : $\vec{R}^A = \vec{R} - \vec{F}$ where $\vec{R}$ is the resultant force (1.5.1); $\vec{F}$ is the thrust (1.6.1). NOTE — Where there is no possibility of confusion the superscript A may be dropped.	$\vec{R}^A$ (R^A)

No.	Term	Definition	Symbol
1.6.3	Components of the thrust	Components of the thrust $\vec{F}$. In the body axis system (1.1.5) : component along the longitudinal axis component along the transverse axis component along the normal axis In the air-path axis system (1.1.6) : component along the x_a-axis component along the y_a-axis component along the z_a-axis	 F_x F_y F_z F_{xa} F_{ya} F_{za}
1.6.4	Components of the (airframe) aerodynamic force	Components of the (airframe) aerodynamic force $\vec{R}^A$. In the body axis system (1.1.5) : component along the longitudinal axis component along the transverse axis component along the normal axis In the air-path axis system (1.1.6) : component along the x_a-axis component along the y_a-axis component along the z_a-axis NOTE — Where there is no possibility of confusion the superscript A may be dropped.	 X^A Y^A Z^A X_a^A Y_a^A Z_a^A
1.6.5	Axial force	The component of $\vec{R}^A$ (1.6.2) along the x-axis of the body axis system (1.1.5) but in the reverse sense, i.e. $-X^A$	1)
1.6.6	Transverse force or side force	The component of $\vec{R}^A$ (1.6.2) along the y-axis of the body axis axis system (1.1.5), i.e. $+Y^A$	1)
1.6.7	Normal force	The component of $\vec{R}^A$ (1.6.2) along the z-axis of the body axis system (1.1.5) but in the reverse sense, i.e. $-Z^A$	1)
1.6.8	Drag	The component of $\vec{R}^A$ (1.6.2) along the x_a-axis of the air-path axis system (1.1.6) but in the reverse sense, i.e. $-X_a^A$	1)
1.6.9	Cross-stream force or lateral force	The component of $\vec{R}^A$ (1.6.2) along the y_a-axis of the air-path axis system (1.1.6), i.e. $+Y_a^A$	1)
1.6.10	Lift	The component of $\vec{R}^A$ (1.6.2) along the z_a-axis of the air-path axis system (1.1.6) but in the reverse sense, i.e. $-Z_a^A$	1)

1) In the absence of agreement on suitably simple symbols, the forces considered in 1.6.5 to 1.6.10 are expressed in terms of the symbols of 1.6.4. To aid discussion on a national basis with a view to obtaining an acceptable international set of symbols, a table showing the correspondence between the symbols in use, or coming into use, in the various countries, is given in the Appendix.

1.7 COEFFICIENTS OF THE COMPONENTS OF THE (AIRFRAME) AERODYNAMIC FORCE

In the definitions listed hereafter :

ρ is the density of the air unaffected by the aerodynamic field of the aircraft;

V is the aircraft velocity (1.3.1);

S is the reference area (1.4.5).

No.	Term	Definition	Symbol
1.7.1	—	Non-dimensional coefficients of the components of the (airframe) aerodynamic force (1.6.4) formed as follows : In the body axis system (1.1.5) : $X^A / \frac{1}{2} \rho V^2 S$ $Y^A / \frac{1}{2} \rho V^2 S$ $Z^A / \frac{1}{2} \rho V^2 S$ In the air-path axis system (1.1.6) : $X^A_a / \frac{1}{2} \rho V^2 S$ $Y^A_a / \frac{1}{2} \rho V^2 S$ $Z^A_a / \frac{1}{2} \rho V^2 S$ NOTE – Where there is no possibility of confusion the superscript A may be dropped.	 C^A_X C^A_Y C^A_Z C^A_{Xa} C^A_{Ya} C^A_{Za}
1.7.2	Axial force coefficient	Non-dimensional coefficient formed as follows : Axial force/$\frac{1}{2} \rho V^2 S$ (the axial force is as defined in 1.6.5).	1)
1.7.3	Transverse force coefficient or side force coefficient	Non-dimensional coefficient formed as follows : Transverse force/$\frac{1}{2} \rho V^2 S$ (the transverse force is as defined in 1.6.6).	1)
1.7.4	Normal force coefficient	Non-dimensional coefficient formed as follows : Normal force/$\frac{1}{2} \rho V^2 S$ (the normal force is as defined in 1.6.7).	1)
1.7.5	Drag coefficient	Non-dimensional coefficient formed as follows : Drag/$\frac{1}{2} \rho V^2 S$ (the drag is as defined in 1.6.8).	1)

1) See table in the Appendix.

No.	Term	Definition	Symbol
1.7.6	Cross-stream force coefficient or lateral force coefficient	Non-dimensional coefficient formed as follows : Cross-stream force/$\frac{1}{2}\rho V^2 S$ (the cross-stream force is as defined in 1.6.9).	1)
1.7.7	Lift coefficient	Non-dimensional coefficient formed as follows : Lift/$\frac{1}{2}\rho V^2 S$ (the lift is as defined in 1.6.10).	1)

1) See table in the Appendix.

1.8 MOTIVATOR DEFLECTIONS

The motion of an aircraft is controlled through the deflection (angular or linear displacement) of moving elements called "motivators", which are operated by the controls used by the pilot or by other means.

Deflection of these motivators modifies the forces and moments acting on the aircraft.

Positive deflections of these motivators cannot be defined in a unique way for all types of motivators, but it is essential to define the positive sense in any particular case.

For a flap-type motivator with hinge-line parallel to one of the axes of the body system (1.1.5), a positive deflection corresponds to a clockwise rotation for an observer looking in the positive direction of the axis parallel to the hinge-line.

This rule can also be applied to any flap the deflection of which mainly produces a force parallel to the normal axis (for example, aileron or pitch motivator), as the hinge-line can be imagined rotated if necessary to bring it parallel to the transverse axis by the smallest rotation. Similarly for any flap the deflection of which produces a force parallel to the transverse axis (for example, rudder) the hinge-line can be imagined as being brought parallel to the normal axis. In each case a positive deflection in the aligned position would remain positive with the hinge-line put back in its proper place.

When there is a deliberate intention to produce a mixture of forces parallel to the transverse and normal axes by the deflection of one flap (for example, a "V" arrangement where two flaps produce control equivalent to the action of pitch motivator and yaw motivator), its hinge-line should be considered as being brought parallel to the nearest axis. When the hinge-line is parallel to the plane making angles of $\pi/4$ with x, y- and x, z-planes of the body axis system (1.1.5) the transverse axis is chosen.

The datum from which the deflection is measured is arbitrary.

NOTE — The following paragraphs refer to the positions and displacements of motivators, not to the pilot's controls.

No.	Term	Definition	Symbol
1.8.1	Deflection	Angular or linear displacement of a motivator. The positive sense is defined in the introduction to 1.8. NOTE — From an aerodynamic viewpoint, it may be helpful to introduce a motivator deflection other than that of the conventional definition given here. In that case it is desirable that this alternative be denoted by another symbol.	δ_i The subscript i identifying the motivator considered may be a number or letter.

No.	Term	Definition	Symbol
1.8.2	Roll-motivator deflection	Deflection of a motivator producing a rolling moment (for instance, deflection of ailerons or elevons, etc.). NOTE — This term and symbol may be used for a single equivalent deflection, in place of a number of deflections δ_1, δ_2 ... in the equations of motion for the aircraft. The definition of equivalence should be given.	δ_l or ξ
1.8.3	Pitch-motivator deflection	Deflection of a motivator producing a pitching moment (for instance, deflection of the elevator or elevons, etc.). NOTE — This term and symbol may be used for a single equivalent deflection, in place of a number of deflections δ_1, δ_2 ... in the equations of motion for the aircraft. The definition of equivalence should be given.	δ_m or η
1.8.4	Yaw-motivator deflection	Deflection of a motivator producing a yawing moment (for instance, deflection of the rudder). NOTE — This term and symbol may be used for a single equivalent deflection, in place of a number of deflections δ_1, δ_2 ... in the equations of motion for the aircraft. The definition of equivalence should be given.	δ_n or ζ
1.8.5	—	δ_X may be used for motivator deflections mainly giving changes of forces in direction of *x*-axis. (For instance pitch of propeller blades, air brake position, etc.)	δ_X
1.8.6	—	δ_Y may be used for motivator deflections mainly giving changes of forces in direction of *y*-axis.	δ_Y
1.8.7	—	δ_Z may be used for motivator deflections mainly giving changes of forces in direction of *z*-axis.	δ_Z

1.9 HINGE MOMENTS

No.	Term	Definition	Symbol
1.9.1	Hinge moment	Moment about the hinge line of all the forces acting on a motivator apart from that due to the actuator. It is positive when in the positive sense as defined in the introduction of 1.8.	–
1.9.2	Aerodynamic hinge moment	Moment about the hinge line of the aerodynamic forces acting on a motivator. It is positive when in the positive sense as defined in the introduction of 1.8.	–
1.9.3	(Aerodynamic) hinge moment coefficient	Non-dimensional coefficient of the aerodynamic hinge moment (1.9.2), formed as follows : Aerodynamic hinge moment/$\frac{1}{2}\,\rho V^2 S\,l$ where ρ is the density of the air unaffected by the aerodynamic field of the aircraft; V is the aircraft velocity (1.3.1); S is the reference area (1.4.5); l is the reference length (1.4.6). NOTE – For S, l, V and ρ, other quantities S_i, l_i and, possibly, V_i and ρ_i, appropriate to a particular motivator denoted by the subscript "i" may be used. In this case, S_i, l_i, V_i and ρ_i must be defined.	–