INTERNATIONAL STANDARD 1151/IV

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Terms and symbols for flight dynamics — Part IV : Parameters used in the study of aircraft stability and control

Termes et symboles de la mécanique du vol — Partie IV : Paramètres utilisés dans l'étude de la stabilité et du pilotage des avions

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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/IV (previously ISO 2764) was drawn up by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, and circulated to the Member Bodies in June 1972.

It has been approved by the Member Bodies of the following countries :

Austria	Germany	South Africa, Rep. of
Belgium	Italy	Spain
Brazil	Japan	Thailand
Czechoslovakia	Netherlands	Turkey
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France	Romania	U.S.S.R.

The Member Body of the following country expressed disapproval of the document on technical grounds :

U.S.A.

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International Standard ISO 1151/IV, *Terms and symbols for flight dynamics — Part IV : Parameters used in the study of aircraft stability and control*, is the fourth 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/V, *Terms and symbols for flight dynamics — Part V : Quantities used in measurements.*

ISO 1151/VI, *Terms and symbols for flight dynamics — Part VI : Aircraft geometry.*

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 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 aircraft is treated as rigid.

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

Terms and symbols for flight dynamics — Part IV : Parameters used in the study of aircraft stability and control

4.0 INTRODUCTION

This International Standard deals with some concepts used in a simplified study of the stability and control of an aircraft in motion in an atmosphere at rest or in uniform motion.

The body axis system (1.1.5) implied in the following is one in which the x-axis direction in near to the zero lift line of the aircraft.

4.1 AERODYNAMIC CENTRES

No.	Term	Definition	Symbol
4.1.1	Aerodynamic centre (for angle of attack)	The point on the intersection of the plane of symmetry and the x, y-plane, (1.1.5), about which the pitching moment remains constant, if second and higher order terms are neglected, when a small change is made in the angle of attack alone, i.e. : $\frac{\partial C_m}{\partial \alpha} = 0$ NOTES 1 A second order aerodynamic centre may be defined, if third and higher order terms are neglected, by the following conditions : $\frac{\partial C_m}{\partial \alpha} = 0 \quad \text{and} \quad \frac{\partial^2 C_m}{\partial \alpha^2} = 0$ These conditions define a unique point in the plane of symmetry, for each angle of attack. 2 These definitions may be applied to the complete aircraft, to a component of the aircraft or to a number of components in combination.	—
4.1.2	Aerodynamic centre for angle of sideslip	The point in the plane of symmetry about which the rolling and yawing moments remain constant, if second and higher order terms are neglected, when a small change is made in the angle of sideslip alone, i.e. : $\frac{\partial C_l}{\partial \beta} = 0 \quad \text{and} \quad \frac{\partial C_n}{\partial \beta} = 0$ NOTE — This definition may be applied to the complete aircraft, to a component of the aircraft or to a number of components in combination.	—

Aerodynamic centre for motivator deflection

Concepts similar to those defined in 4.1.1 and 4.1.2 and which relate to the moments produced by motivator deflection may be defined. For example, when a small change is made in the pitch motivator deflection alone, the aerodynamic centre for pitch motivator (aerodynamic centre for pitch motivator deflection) is the point about which the pitching moment produced remains constant.

4.2 MANŒUVRE AND NEUTRAL POINTS

The following points are defined for the longitudinal motion of an aircraft in symmetric flight.

In the definitions below, frictionless conditions are assumed in the control systems.

In each case, it is necessary to specify whether any other motivators or controls, which may affect the longitudinal motion, are free or fixed. In practice, if the motion is not symmetric it is also necessary to specify the conditions that characterize the lateral motion of the aircraft. In some circumstances, it may be useful to define the manœuvre points using the load factor instead of the lift coefficient.

No.	Term	Definition	Symbol
4.2.1	Manœuvre point, pitch motivator fixed	The point on the intersection of the plane of symmetry and the x, y-plane (1.1.5), about which the pitching moment remains constant when there is a small change in the lift coefficient, with the pitch motivator fixed, when the aircraft motion can be assumed to be quasi-steady and curvilinear, at constant speed, in a vertical plane. NOTE – In these flight conditions and if the centre of gravity of the aircraft is at this point, different load factors (1.5.7) can be obtained with the same pitch motivator position.	–
4.2.2	Manœuvre point, pitch motivator free	The point on the intersection of the plane of symmetry and the x, y-plane (1.1.5), about which the pitching moment remains constant when there is a small change in the lift coefficient, with the pitch motivator free, when the aircraft motion can be assumed to be quasi-steady and curvilinear, at constant speed, in a vertical plane. NOTE – In these flight conditions and if the centre of gravity of the aircraft is at this point, different load factors (1.5.7) can be obtained with the same hinge moment of the pitch motivator.	–
4.2.3	Manœuvre point, stick fixed	The point on the intersection of the plane of symmetry and the x, y-plane (1.1.5), about which the pitching moment remains constant when there is a small change in the lift coefficient, with the stick fixed, when the aircraft motion can be assumed to be quasi-steady and curvilinear, at constant speed, in a vertical plane. NOTE – In these flight conditions and if the centre of gravity of the aircraft is at this point, different load factors (1.5.7) can be obtained with the same stick position.	–
4.2.4	Manœuvre point, stick free	The point on the intersection of the plane of symmetry and the x, y-plane (1.1.5), about which the pitching moment remains constant when there is a small change in the lift coefficient with the stick free, when the aircraft motion can be assumed to be quasi-steady and curvilinear, at constant speed, in a vertical plane. NOTE – In these flight conditions and if the centre of gravity of the aircraft is at this point, different load factors (1.5.7) can be obtained with the same stick force.	–
4.2.5	Neutral point, pitch motivator fixed	The point on the intersection of the plane of symmetry and the x, y-plane (1.1.5), about which the pitching moment is constant when there is a small change of speed, with the pitch motivator fixed and in steady rectilinear flight. NOTES 1 If the centre of gravity of the aircraft is at this point, the pitch motivator position is constant for a small change of speed in steady rectilinear flight. 2 This point is the same as the aerodynamic centre (for angle of attack) only when the influence of speed on the pitching moment coefficient is negligible.	–

No.	Term	Definition	Symbol
4.2.6	Neutral point, pitch motivator free	The point on the intersection of the plane of symmetry and the x, y-plane (1.1.5), about which the pitching moment is constant when there is a small change of speed, with the pitch motivator free and in steady rectilinear flight. NOTE – If the centre of gravity of the aircraft is at this point, the hinge-moment of the pitch motivator is constant for a small change of speed, in steady rectilinear flight.	–
4.2.7	Neutral point, stick fixed	The point on the intersection of the plane of symmetry and the x, y-plane (1.1.5), about which the pitching moment is constant when there is a small change of speed, with the stick fixed and in steady rectilinear flight. NOTE – If the centre of gravity of the aircraft is at this point, the stick position is constant for a small change of speed, in steady rectilinear flight.	–
4.2.8	Neutral point, stick free	The point on the intersection of the plane of symmetry and the x, y-plane (1.1.5), about which the pitching moment is constant when there is a small change of speed, with the stick free and in steady rectilinear flight. NOTE – If the centre of gravity of the aircraft is at this point, the stick force is constant for a small change of speed, in steady rectilinear flight.	–

4.3 MANOEUVRE AND STATIC MARGINS

The following stability parameters are defined for the longitudinal motion of an aircraft in symmetric flight. In each case, it is necessary to specify whether any other motivators or controls, which may affect the longitudinal motion, are free or fixed. In practice, if the motion is not symmetric, it is also necessary to specify the conditions that characterize the lateral motion of the aircraft. It is assumed

- that there are frictionless conditions in the control systems, and
- that moments are taken about the centre of gravity.

In these conditions, each margin may be expressed as a function of the projection on the longitudinal axis of the distance between the corresponding point defined in 4.2 and the centre of gravity.

No,	Term	Definition	Symbol
4.3.1	Manoeuvre margin, pitch motivator fixed	The total derivative of the pitching moment coefficient, with reversed sign, with respect to the lift coefficient, when the aircraft motion can be assumed to be quasi-steady and curvilinear, at constant speed, in a vertical plane, with the pitch motivator fixed.	–
4.3.2	Manoeuvre margin, pitch motivator free	The total derivative of the pitching moment coefficient, with reversed sign, with respect to the lift coefficient, when the aircraft motion can be assumed to be quasi-steady and curvilinear, at constant speed, in a vertical plane, with the pitch motivator free.	–
4.3.3	Manoeuvre margin, stick fixed	The total derivative of the pitching moment coefficient, with reversed sign, with respect to the lift coefficient, when the aircraft motion can be assumed to be quasi-steady and curvilinear, at constant speed, in a vertical plane, with the stick fixed.	–

No.	Term	Definition	Symbol
4.3.4	Manoeuvre margin, stick free	The total derivative of the pitching moment coefficient, with reversed sign, with respect to the lift coefficient, when the aircraft motion can be assumed to be quasi-steady and curvilinear, at constant speed, in a vertical plane, with the stick free.	–
4.3.5	Static margin, pitch motivator fixed	The total derivative of the pitching moment coefficient, with reversed sign, with respect to the lift coefficient, in steady rectilinear flight, with the pitch motivator fixed.	–
4.3.6	Static margin, pitch motivator free	The total derivative of the pitching moment coefficient, with reversed sign, with respect to the lift coefficient, in steady rectilinear flight, with the pitch motivator free.	–
4.3.7	Static margin, stick fixed	The total derivative of the pitching moment coefficient, with reversed sign, with respect to the lift coefficient, in steady rectilinear flight, with the stick fixed.	–
4.3.8	Static margin, stick free	The total derivative of the pitching moment coefficient, with reversed sign, with respect to the lift coefficient, in steady rectilinear flight, with the stick free.	–