

ISO

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION

ISO RECOMMENDATION R 1153

SYMBOLS FOR FLIGHT DYNAMICS

PART III

DERIVATIVES OF FORCES, MOMENTS AND THEIR COEFFICIENTS

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BRIEF HISTORY

The ISO Recommendation R 1153, *Symbols for flight dynamics – Part III : Derivatives of forces, moments and their coefficients*, was drawn up by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, the Secretariat of which is held by the British Standards Institution (BSI).

Work on this question led to the adoption of a Draft ISO Recommendation.

In November 1967, this Draft ISO Recommendation (No. 1486) was circulated to all the ISO Member Bodies for enquiry. It was approved, subject to a few modifications of an editorial nature, by the following Member Bodies .

Belgium	Italy	Switzerland
Czechoslovakia	Netherlands	Turkey
France	New Zealand	U.A.R.
Germany	Poland	United Kingdom
India	Spain	U.S.S.R.
Israel	Sweden	Yugoslavia

One Member Body opposed the approval of the Draft :

U.S.A.

The Draft ISO Recommendation was then submitted by correspondence to the ISO Council, which decided, in November 1969, to accept it as an ISO RECOMMENDATION.

FOREWORD

ISO Recommendation R 1153, *Symbols for flight dynamics – Part III : Derivatives of forces, moments and their coefficients*, is the third in a series of ISO Recommendations, the purpose of which is to define the principal terms used in flight dynamics and to specify symbols for these terms. *

In these ISO Recommendations, 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 $\frac{\pi}{2}$ about the x-axis brings the y-axis into the position previously occupied by the z-axis.

Numbering of sections and clauses

Each of the ISO Recommendations represents a Part of the whole study on 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 Recommendation with the number of the Part it represents.

* See in Appendix X the list of ISO Recommendations already published and the studies under way about symbols for flight dynamics.

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* A section 3.5, “Derivatives of the non-dimensional coefficients of the components of the resultant force and moment with respect to motivator deflections”, is at present at the stage of draft proposal.

SYMBOLS FOR FLIGHT DYNAMICS

PART III

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INTRODUCTION

This ISO Recommendation deals with the derivatives of forces, moments and their coefficients.

In this ISO Recommendation, the effects of the Earth's curvature are not considered; for the purpose of the definition of Earth axes, the Earth's surface is treated as a plane, that is, the Earth's radius is taken as infinite.

Aeroelastic effects would introduce further quantities, which are not considered in this ISO Recommendation.

Two groups of derivatives are usually involved in flight dynamic studies.

The first group is composed of partial derivatives of the non-dimensional coefficients of force and moment components with respect to normalized variables.

The second group is composed of normalized forms of the partial derivatives of force and moment components with respect to the basic variables of the motion.

Derivatives of the first group

Aerodynamic data are usually quoted in terms of these derivatives. They are meaningful when they relate to those forces and moments which obey the laws of aerodynamic similarity but their use may be extended to include forces not of this type, for example propulsion forces.

In this ISO Recommendation, it is assumed that the force and moment coefficients depend only on the following variables * :

- the angle of attack (1.2.2);
- the sideslip angle (1.2.1);
- the normalized angular velocities (1.3.7);
- the Mach number (1.3.3);
- the normalized forms of the derivatives, with respect to time, of the angle of attack, the angle of sideslip, and the airspeed (3.1).

Derivatives of the second group

The derivatives of the second group relate to components of the resultant force and moment arising from all forces and moments acting on the aircraft, excluding the gravitational, inertial and reaction forces due to contact with the Earth (1.5.1).

It is usual to restrict the number of variables used in forming these derivatives to the following ** (1.3.4 and 1.3.6) :

$$u, v, w, p, q, r, \dot{u}, \dot{v}, \dot{w},$$

where the dot refers to differentiation with respect to time.

These partial derivatives are then normalized by dividing by an appropriate constant quantity based on a datum flight condition (normally an equilibrium condition and denoted by a suffix e).

Remark on the written form of the derivative

The partial derivative, $\partial A / \partial \lambda$, of a quantity A , with respect to a variable λ , may be written A_{λ} or A^{λ} according to the custom of the country. The first form, A_{λ} , is used in this ISO Recommendation.

* In exceptional circumstances it may prove necessary to increase the number of variables, for example to include Reynolds number.

** In exceptional circumstances it may prove necessary to increase the number of variables, for example to include altitude.