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Revised

# ISO

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION

# ISO RECOMMENDATION

# R 1152

## SYMBOLS FOR FLIGHT DYNAMICS

## PART II

## MOTIONS OF THE AIRCRAFT AND THE ATMOSPHERE RELATIVE TO THE EARTH

1st EDITION

November 1969





For each individual country the only valid standard is the national standard of that country.

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## BRIEF HISTORY

The ISO Recommendation R 1152, *Symbols for flight dynamics – Part II : Motions of the aircraft and the atmosphere relative to the Earth,* 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. 1485) 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 | Yugoslavia |
| Israel | Sweden | |

Two Member Bodies opposed the approval of the Draft :

U.S.A.
U.S.S.R.

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 1152, *Symbols for flight dynamics – Part II : Motions of the aircraft and the atmosphere relative to the Earth,* is the second 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 Recommendations already published and the studies under way about symbols for flight dynamics.

CONTENTS

ISO Recommendation R 1152 November 1969

# SYMBOLS FOR FLIGHT DYNAMICS

## PART II

## MOTIONS OF THE AIRCRAFT AND THE ATMOSPHERE RELATIVE TO THE EARTH



### INTRODUCTION

This ISO Recommendation deals with the motions of the aircraft and the atmosphere relative to the Earth.

In this ISO Recommendation,

(1) 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;

(2) the motion of the air is defined at a given instant and in the space surrounding the aircraft (outside its aerodynamic field) by a single vector. The wind gradients and the turbulence in the air surrounding the aircraft are not taken into account.

To fully account for aeroelastic effects, certain aspects of the definition of the flight-path axis system would need to be considered in greater detail. The definition applies as it stands to the rigid aircraft.

## 2.1 AXIS SYSTEM

| No. | Term | Definition | Symbol |
|---|---|---|---|
| 2.1.1 | Flight-path axis system | A system with origin *0* fixed in the aircraft (usually at the centre of gravity) and in which the $x_k$-axis is in the direction of the flight-path velocity (2.2.1). The two other axes are chosen to suit the problem. | $x_k, y_k, z_k$ |

## 2.2 VELOCITIES

| No. | Term | Definition | Symbol |
|---|---|---|---|
| 2.2.1 | Flight-path velocity | The velocity of the origin *0* of the aircraft body axis system (1.1.5) (usually the centre of gravity) relative to the Earth. The corresponding scalar quantity is the flight-path speed.<br>NOTE. – The projection of the flight-path velocity on the horizontal plane is called the ground speed. | $\vec{V}_K$ ($V_K$) |
| 2.2.2 | Components of flight-path velocity | The components of the flight-path velocity ($\vec{V}_K$) for any of the axis systems used :<br>In the axis systems 1.1.1 to 1.1.4 :<br>component along $x_o$-axis<br>component along $y_o$-axis<br>component along $z_o$-axis<br>In the body axis system (1.1.5) :<br>component along the longitudinal axis<br>component along the transverse axis<br>component along the normal axis<br>NOTE. – In a flight-path axis system (2.1.1) the component along the $x_k$-axis is $u_{Kk} = V_K$. | <br><br><br>$u_{Ko}$<br>$v_{Ko}$<br>$w_{Ko}$<br><br>$u_K$<br>$v_K$<br>$w_K$ |
| 2.2.3 | Wind velocity | The velocity relative to the Earth of the air surrounding the aircraft. The corresponding scalar quantity is the wind speed.<br>NOTE. – In navigation and meteorology the wind velocity is usually taken to refer to the horizontal component of $\vec{V}_W$. | $\vec{V}_W$ ($V_W$) |

| No. | Term | Definition | Symbol |
|---|---|---|---|
| 2.2.4 | Wind velocity components | The components of the wind velocity $\vec{V}_W$ for any of the axis systems used :<br>In the axis systems 1.1.1 to 1.1.4 :<br>component along $x_o$-axis<br>component along $y_o$-axis<br>component along $z_o$-axis<br>In the body axis system (1.1.5) :<br>component along the longitudinal axis<br>component along the transverse axis<br>component along the normal axis<br>In the flight-path axis system (2.1.1) :<br>component along $x_k$-axis<br>component along $y_k$-axis<br>component along $z_k$-axis | <br><br>$u_{Wo}$<br>$v_{Wo}$<br>$w_{Wo}$<br><br>$u_W$<br>$v_W$<br>$w_W$<br><br>$u_{Wk}$<br>$v_{Wk}$<br>$w_{Wk}$ |

## 2.3 FLIGHT-PATH ANGLES

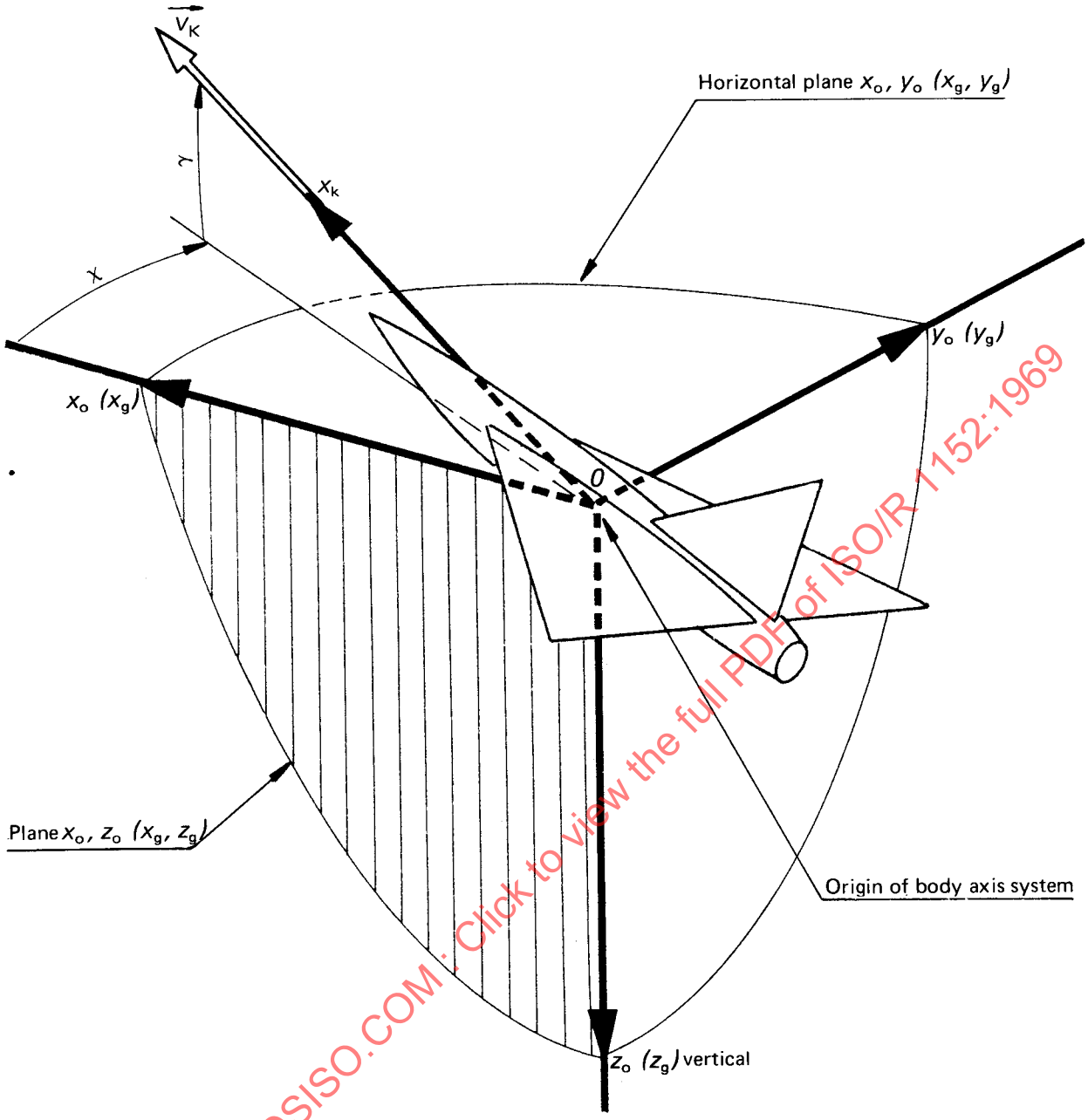
Orientation of the flight-path velocity with respect to the aircraft-carried normal earth axis system (see Fig. 1).

| No. | Term | Definition | Symbol |
|---|---|---|---|
| 2.3.1 | Flight-path azimuth angle (angle of track*) | The angle through which the $x_o$ ($x_g$)-axis of the aircraft-carried normal earth axis system (1.1.4) has to be rotated about the $z_o$ ($z_g$)-axis to bring the former axis into coincidence with the projection of the flight-path velocity (2.2.1) on the horizontal plane through the origin *0*. It is positive in the clockwise sense.<br>*NOTE. – In navigation, the term "angle of track" has reference to a particular direction of the $x_o$-axis. | $\chi$ |
| 2.3.2 | Angle of climb (flight-path inclination angle) | The angle between the flight-path velocity (2.2.1) and the horizontal plane.<br>It is positive when the flight-path velocity is above the horizontal plane through the origin *0*.<br>It has by convention the range<br>$-\frac{\pi}{2} \leqslant \gamma \leqslant \frac{\pi}{2}$ | $\gamma$ |

## 2.4 WIND DIRECTION ANGLES

Orientation of the wind velocity with respect to the normal earth-fixed axis system (see Fig. 2).

| No. | Term | Definition | Symbol |
|---|---|---|---|
| 2.4.1 | Wind azimuth angle | The angle through which the $x_o$ ($x_g$)-axis of the normal earth-fixed axis system (1.1.2) has to be rotated about the $z_o$ ($z_g$)-axis to bring the former axis into coincidence with the projection of the wind velocity (2.2.3) on the horizontal plane through the origin $O_o$.<br>It is positive in the clockwise sense.<br>It has by convention the range<br>$0 \leqslant \chi_W < 2\pi$<br>NOTE. – If the $x_o$ ($x_g$)-axis is directed towards North, the wind azimuth angle differs by 180° from the wind direction used in meteorology. | $\chi_W$ |
| 2.4.2 | Wind elevation angle | The angle between the wind velocity (2.2.3) and the horizontal plane.<br>It is positive when the wind is directed upwards.<br>It has by convention the range<br>$-\frac{\pi}{2} \leqslant \gamma_W \leqslant \frac{\pi}{2}$ | $\gamma_W$ |






IN RED : Aircraft-carried normal earth axis system

NOTE. – The angles shown are positive.

FIG. 1 – **Flight-path angles**