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AMENDMENT 1
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Flight dynamics — Concepts, quantities and symbols —

Part 9:
Models of atmospheric motions along the trajectory of the aircraft

AMENDMENT 1: Turbulence

Mécanique du vol — Concepts, grandeurs et symboles —
Partie 9: Modèles de mouvements atmosphériques le long de la trajectoire de l'avion

AMENDEMENT 1: Turbulence

Foreword

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Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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Page 1

Clause 9.0

Replace the existing clause 9.0 with the following:

"**9.0 Introduction**

This part of ISO 1151 deals with the concepts and quantities characterizing models of the air motions affecting the dynamic behaviour of the aircraft.

The aircraft motion is only influenced by the wind velocity field in the space surrounding the aircraft trajectory (8.2.1) and by its variations with time. In flight dynamic problems, it is usual to represent this field and its variations with time by considering mathematic models, which are schematic representations of the real wind.

In this part of ISO 1151, the following models are defined:

— constant wind (9.1);

— wind gradients (9.2);

— discrete gusts (9.3);

— three-dimensional wind models (9.4);

— vortices (9.5);

— continuous turbulence (9.6).

In these models it is assumed that the air motions are not perturbed by the presence of the aircraft itself. Other models can be defined by superposition of these models."

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Add the following new subclause:

"9.6 Continuous turbulence

9.6.1 General description of turbulence

At a given moment and in the space surrounding the aircraft trajectory (8.2.1), the field of turbulence velocities (9.6.1.2) may be represented by spectral functions of the dimensions of space.

In 9.6.1.1 to 9.6.1.9, these spectral functions are considered with respect to a given direction.

No.	Term	Definition	Symbol
9.6.1.1	Turbulence	Wind model characterized by a random and rapid variation of the wind velocity $\vec{V}_W$ (2.2.3) with respect to the mean velocity (9.1.3).	—
9.6.1.2	Turbulence velocity	Difference between the instantaneous local wind velocity $\vec{V}_W$ (2.2.3) and the mean wind velocity $\overline{\vec{V}_W}$ (9.1.3): $$\vec{V}_T = \vec{V}_W - \overline{\vec{V}_W}$$ NOTE — The temporal mean value of the turbulence velocity in all points of the considered space is zero.	$\vec{V}_T$
	Turbulence speed	The magnitude of turbulence velocity	V_T
9.6.1.3	Turbulence velocity components	— component of $\vec{V}_T$ along the x axis — component of $\vec{V}_T$ along the y axis — component of $\vec{V}_T$ along the z axis	u_T v_T w_T
9.6.1.4	Turbulence wave-length	Length of a particular period of a spectral function of the turbulence with respect to the considered direction.	l_T
9.6.1.5	Turbulence wave number Turbulence inverse wave-length	Inverse of turbulence wave-length (9.6.1.4): $$k_T = \frac{1}{l_T}$$	k_T
9.6.1.6	Turbulence spatial frequency	Quantity defined by: $$\Omega_T = \frac{2\pi}{l_T}$$ where l_T is the turbulence wave-length (9.6.1.4).	Ω_T
9.6.1.7	Basic air velocity	Difference of the instantaneous flight-path velocity $\vec{V}_K$ (2.2.1) and the mean wind velocity $\overline{\vec{V}_W}$ (9.1.3) given by: $$\vec{V}_B = \vec{V}_K - \overline{\vec{V}_W}$$	$\vec{V}_B$
	Basic airspeed	The magnitude of basic air velocity.	V_B
9.6.1.8	Turbulence frequency	Quotient of the basic airspeed V_B (9.6.1.7) by the turbulence wave-length l_T (9.6.1.4): $$f_T = \frac{V_B}{l_T}$$	f_T
9.6.1.9	Temporal frequency	Product of 2π and the turbulence frequency f_T (9.6.1.8) defined as follows: $$\omega_T = 2\pi f_T$$	ω_T

9.6.2 Gaussian turbulence models

For the establishment of the models given below, the following additional assumptions are made:

a) The turbulence is:

1) stationary, i.e. the statistical properties of the turbulence are independent of time;

2) homogeneous, i.e. the statistical properties of the turbulence are equal in all points of the considered space;

3) isotropic, i.e. the statistical properties of the turbulence do not depend upon the orientation of the axis system.

b) The axis system is the air path axis system (1.1.6).

c) The temporal probability distribution of the turbulence velocity is random (9.6.1.2), gaussian and zero mean.

d) Under these assumptions the turbulence velocity is characterized by nine spatial spectral densities:

$$\begin{bmatrix} \Phi_{ux}(\Omega_T) & \Phi_{vx}(\Omega_T) & \Phi_{wx}(\Omega_T) \\ \Phi_{uy}(\Omega_T) & \Phi_{vy}(\Omega_T) & \Phi_{wy}(\Omega_T) \\ \Phi_{uz}(\Omega_T) & \Phi_{vz}(\Omega_T) & \Phi_{wz}(\Omega_T) \end{bmatrix}$$

These nine spectral densities have two forms:

a) The longitudinal spatial spectral densities are those in which the turbulence velocity component is parallel to the axis of displacement, i.e.

$$\left[\Phi_{ux}(\Omega_T),\ \Phi_{vy}(\Omega_T)\ \text{and}\ \Phi_{wz}(\Omega_T)\right]$$

b) The normal spatial spectral densities are those in which the turbulence velocity component is normal to the axis of displacement, i.e.

$$\left[\Phi_{vx}(\Omega_T),\ \Phi_{wx}(\Omega_T),\ \Phi_{uy}(\Omega_T),\ \Phi_{wy}(\Omega_T),\ \Phi_{uz}(\Omega_T)\ \ \Phi_{vz}(\Omega_T)\right]."$$

ICS 01.060; 49.020

Descriptors: aircraft, aerodynamics, flight, flight dynamics, atmospheric disturbances, turbulence, concepts, definitions, symbols, quantities.

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