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Foreword

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This document was prepared by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 8, *Aerospace terminology*.

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Rotorcrafts – Flight dynamics – Vocabulary

1 Scope

This document defines terms used in the field of rotorcrafts flight dynamics and aerodynamics, for example, rotorcraft design documents, with regard to rotorcrafts geometry and dynamic characteristics.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1 Basic definitions and classification

3.1.1
rotorcraft
rotary wing aircraft
heavier-than-air aircraft that depends principally for its support in flight on the aerodynamical generated by one or more rotors

3.1.2
helicopter
rotorcraft (3.1.1) that primarily depends on engine driven rotors for motion at all stage of flight

3.1.3
gyroplane
autogyro
gyrocopter
rotaplane
rotorcraft (3.1.1) whose rotors are not engine-driven, except for initial starting, but are made to rotate by action of the air when the rotorcraft is moving; and whose means of propulsion, consisting usually of conventional propellers, is independent of the rotor system

3.1.4
gyrodyne
compound helicopter
compound gyroplane
rotorcraft (3.1.1) with a rotor system that is normally driven by its engine for takeoff, hovering and landing like a *helicopter* (3.1.2), and has an additional propulsion system that is independent of the rotor system

3.1.5
convertiplane
aircraft which uses rotor power for vertical takeoff and landing (vtol) and converts to fixed-wing lift in normal flight

Note 1 to entry: Convertiplanes may be divided into two broad classes, based on whether the rotor is fixed as in a *helicopter* (3.1.2) or tilts to provide thrust in forward flight, as a proprotor. a proprotor may be in a tilt rotor or tilt wing configuration.

3.1.6
tiltrotor aircraft
rotorcraft (3.1.1) which generates lift and propulsion by way of one or more tiltable (rotating) powered propellers, or proprotors, mounted on rotating engine pods or nacelles usually at the ends of a fixed wing

Note 1 to entry: Orientation of wings is fixed. For vertical flight, the rotors are angled so the plane of rotation is horizontal.

3.1.7
tiltwing aircraft
aircraft with a wing that is horizontal for conventional forward flight and rotates up for vertical takeoff and landing

3.1.8
helicopter configuration
combination of features, defining *main rotor* (3.2.1) system, anti-torque system (for *single rotor helicopter* (3.1.9)), flight control system

3.1.9
single rotor helicopter
helicopter (3.1.2) with one (main) rotor that provides lift and propulsive force

Note 1 to entry: Single rotor helicopters may be divides into four or more types depending of anti-torque system:

— with *tail rotor* (3.2.2) (classic configuration);

— with *fenestrone* (3.2.25);

— with *notar* (3.2.26) (no tail rotor) system;

— *tip jets* (3.2.24) (no anti-torque system required).

3.1.10
dual rotor helicopter
twin-rotor helicopter
helicopter (3.1.2) with two counter-rotating *main rotors* (3.2.1) rotors

3.1.11
tandem rotors helicopter
dual rotor helicopter (3.1.10) with two horizontal *main rotors* (3.2.1) assemblies mounted one behind the other

3.1.12
side-by-side rotors
transverse rotors helicopter
dual rotor helicopter (3.1.10) with a set of counter-rotating *main rotors* (3.2.1) assemblies which are located in the same plane side-by-side on the *helicopter* (3.1.2) and where the *stagger* (3.5.15) is greater than the diameter of the disk

3.1.13
coaxial rotors helicopter
dual rotor helicopter (3.1.10) with a pair of counter-rotating *main rotors* (3.2.1) mounted one above the other on the same shaft and turning in opposite directions

3.1.14
intermeshing rotors helicopter
synchropter
dual rotor helicopter (3.1.10) with a set of two counter-rotating *main rotors* (3.2.1) with each rotor mast mounted on the *helicopter* (3.1.2) with a slight angle to the other so that the *blades* (3.2.5) intermesh without colliding

3.1.15
multicopter
multirotor
rotorcraft (3.1.1) with more than two rotors that provide lift

3.1.16
quadcopter
quadrocopter
quadrotor
multicopter (3.1.15) that is lifted and propelled by four rotors

3.1.17
hexacopter
multicopter (3.1.15) that is lifted and propelled by six rotors

3.1.18
octocopter
multicopter (3.1.15) that is lifted and propelled by eight rotors

3.2 Basic elements

3.2.1
main rotor
combination of a rotary wing and a control system that generates the aerodynamic lift force that supports the weight of the *helicopter* (3.1.2), and the thrust that counteracts aerodynamic drag in forward flight

3.2.2
tail rotor
smaller rotor mounted so that it rotates vertically or near-vertically at the end of the tail of a traditional *single rotor helicopter* (3.1.9) to compensate *main rotor* (3.2.1) torque moment

3.2.3
main rotor hub
toe unit for the rotor *blades* (3.2.5) attachment to rotor shaft

Note 1 to entry: The hub is located at the top of the mast.

3.2.4
hinge
mechanism that holds the *blades* (3.2.5) proper to the hub and allows free angular motion with zero moment transfer

3.2.5
blade
main working unit of rotor working as rotating wing which provides lift due to rotation about rotor shaft axis

3.2.6
horizontal hinge
flapping hinge
hinge (3.2.4) which allows the *blade* (3.2.5) to move up and down with respect to the plane of rotor rotation

Note 1 to entry: This movement is called flapping.

3.2.7
vertical hinge
lead-lag hinge
drag hinge
hinge (3.2.4) which allows the *blade* (3.2.5) to move back and forth in the plane of rotor rotation

Note 1 to entry: This movement is called lead-lag, dragging, or hunting.

3.2.8
axial hinge
feathering hinge
hinge (3.2.4) along the *feathering* (3.2.32) axis of *blade* (3.2.5) that allows to change the pitch of rotor blades due to pilot input to the collective or cyclic control

3.2.9
articulated rotor
rotor system with each *blade* (3.2.5) attached to the rotor hub through a series of *hinges* (3.2.4) (horizontal and (or) vertical) that let the blade move independently of the others

3.2.10
fully articulated rotor
rotor system with each *blade* (3.2.5) attached to the rotor hub through a series of *hinges* (3.2.4) (horizontal and vertical) that let the blade move independently of the others

Note 1 to entry: The blades in this case are allowed to flap, and lead or lag independently of each other.

3.2.11
hingeless rotor
rotor with no actual mechanical *hinges* (3.2.4) that achieves flapping and lead-lag motion by elastically flexing

3.2.12
rotor with separated hinges
rotor system for which the distances of *horizontal hinge* (3.2.6) from the rotor hub isn't equal to zero

3.2.13
rotor with joined hinges
fully articulated rotor (3.2.10) system for which the *horizontal hinge* (3.2.6) and *vertical hinge* (3.2.7) are located at the same distances from the rotor hub

3.2.14
rigid rotor
rotor system in which the *blades* (3.2.5) accommodate flapping and lead-lag motions by bending the elastic elements at the corner part of blade without *horizontal hinge* (3.2.6) and *vertical hinge* (3.2.7)

3.2.15
semirigid rotor
teetering
seesaw
rotor system normally composed of two *blades* (3.2.5) that meet just under a common flapping or teetering *hinge* (3.2.4) perpendicular to rotor shaft axis and mounted at the top of rotor shaft

3.2.16
semi-articulated rotor
rotor in which the *blade* (3.2.5) is attached to hub by two *hinges* (3.2.4) instead of three (without *horizontal hinge* (3.2.6) or *vertical hinge* (3.2.7))

3.2.17
rotor head with universal joint
gimballed rotor hub tilts with respect to the rotor shaft to accommodate *blade* (3.2.5) flapping or which tilts the blades (rotor disk) creating a force that pulls the autogiro in the direction of the tilt

3.2.18
swashplate
device that translates input via the *helicopter* (3.1.2) flight controls into motion of the *main rotor* (3.2.1) *blades* (3.2.5)

Note 1 to entry: A swashplate is used to transmit three of the pilot's commands from the non-rotating fuselage to the rotating rotor hub and main rotor blades.

3.2.19
blade element
spanwise piece of the *blade* (3.2.5)

Note 1 to entry: A blade element has a spanwise dimension of any length (usually an elementary spanwise length).

3.2.20
blade tip
part of rotor *blade* (3.2.5) which is the most distant from rotor axis

3.2.21
blade root
part of the *blade* (3.2.5) that attaches to the *blade grip* (3.2.22)

3.2.22
blade grip
blade fork
part of the hub assembly to which the rotor *blades* (3.2.5) are attached

3.2.23
external point of rotor blade
crossing point of *rotor blade axis* (3.3.9) with the plane tangential to surface of *blade tip* (3.2.20) and perpendicular to *blade* (3.2.5) axis

3.2.24
tip jets
rotor system which is driven by jet nozzles at the tip of rotor *blades* (3.2.5) powered by ram-jets, pulse-jets, or rockets or by high pressure air provided by a compressor

3.2.25
fenestrone
fan-in-tail
ducted fan
protected *tail rotor* (3.2.2) of a *helicopter* (3.1.2) operating like a rotor mounted within a cylindrical shroud or duct

3.2.26
notar
air-blowing system to compensate *main rotor* (3.2.1) torque moment

3.2.27
interleaving rotors
two rotor disks which are located in the same horizontal plane and where the *stagger* (3.5.15) is greater than the radius of the disk, but less the diameter of the disk

3.2.28
intermeshing rotors
two rotor disks which are located in different planes and where the *stagger* (3.5.15) is less than the radius of the disk

3.2.29
bearringless rotor
hingeless rotor (3.2.11) wherein the *feathering* (3.2.32) bearing is replaced by a torsionally soft elastic element

3.2.30
advancing blade
blade (3.2.5) moving in the same direction as the *helicopter* (3.1.2)

3.2.31
retreating blade
blade (3.2.5), located in a semicircular part of the rotor disk, in which the blade direction is opposite to the direction of flight

3.2.32
blade feather
feathering
rotation of the *blade* (3.2.5) around the spanwise (pitch change) axis

3.3 Coordinate axis and planes

3.3.1
helicopter body axis coordinate system
right rectangular system of the coordinates which has been rigidly connected with a fuselage. the origin o_1 is the centre of mass of a fuselage

Note 1 to entry: The longitudinal axis (O_1X_1) is directed to a *helicopter* (3.1.2) nose perpendicular to a shaft of the *main rotor* (3.2.1).

Note 2 to entry: The normal axis (Z_1Y_1) is directed parallel to a shaft of the main rotor and points downwards.

Note 3 to entry: The transverse axis (O_1Z_1) is completing system.

3.3.2
longitudinal axis of helicopter body axis
axis (O_1X_1) which is directed to a *helicopter* (3.1.2) nose perpendicular to a shaft of the *main rotor* (3.2.1)

3.3.3
normal axis of helicopter body axis
axis (O_1Y_1) which is directed parallel to a shaft of the *main rotor* (3.2.1) and points downwards

3.3.4
transverse axis of helicopter body axis
axis (O_1Z_1) which completes the system

3.3.5
stability axis coordinate system
hub-wind axis
rectangular coordinate system, with origin in a point of intersection of an axis of rotor rotation with the plane of *main rotor* (3.2.1), having the normal axis (O_hY_h) parallel to axis of the main rotor rotation, directions of longitudinal axis (O_hX_h) and transverse axis (O_hZ_h) are defined by the direction of the air speed vector projection to the plane of rotation of a main rotor

3.3.6
longitudinal axis of stability coordinate system
longitudinal axis (O_hX_h) which is perpendicular to *rotor rotation axis* (3.3.10) and having the same direction as the rotor air speed vector projection to the plane of rotation of a *main rotor* (3.2.1)

3.3.7
normal axis of stability coordinate system
normal axis (O_hY_h) coinciding with the axis of rotor rotation and having opposite direction as direction of lift

3.3.8
transverse axis of stability coordinate system
transverse axis (O_hZ_h) which is perpendicular to the plane formed by (O_hX_h) and (O_hY_h) axis and directed to forward moving *blade* (3.2.5)

3.3.9
rotor blade axis
straight line around which the angular orientation of *blade* (3.2.5) cross-section is changed due to influence of actuator of rotor control system

3.3.10
rotor rotation axis
geometric axis of *main rotor* (3.2.1) shaft or bearing, rotor being rotating around this axis

3.3.11
rotor rotation plane
plane perpendicular to *rotor rotation axis* (3.3.10), forming by rotated *blade* (3.2.5) axis with zero flapping angle

3.3.12
blade rotation plane
plane parallel to the tip path plane through the hub centre

3.3.13
hub plane
plane perpendicular to the shaft axis through the centre of the hub

3.3.14
tip pass plane
TPP
no-flapping plane
plane containing flight path of *blade tips* (3.2.20) at their rotation around shaft axis

3.3.15
tip path axis
disc axis
axis perpendicular to the plane through the *blade tips* (3.2.20) and, for zero offset *horizontal hinges* (3.2.6), which is therefore the axis of no flapping

3.3.16
no-feathering axis
axis relative to which the cyclic *feathering* (3.2.32) vanishes the axis through the centre of the hub and perpendicular to the swash plates