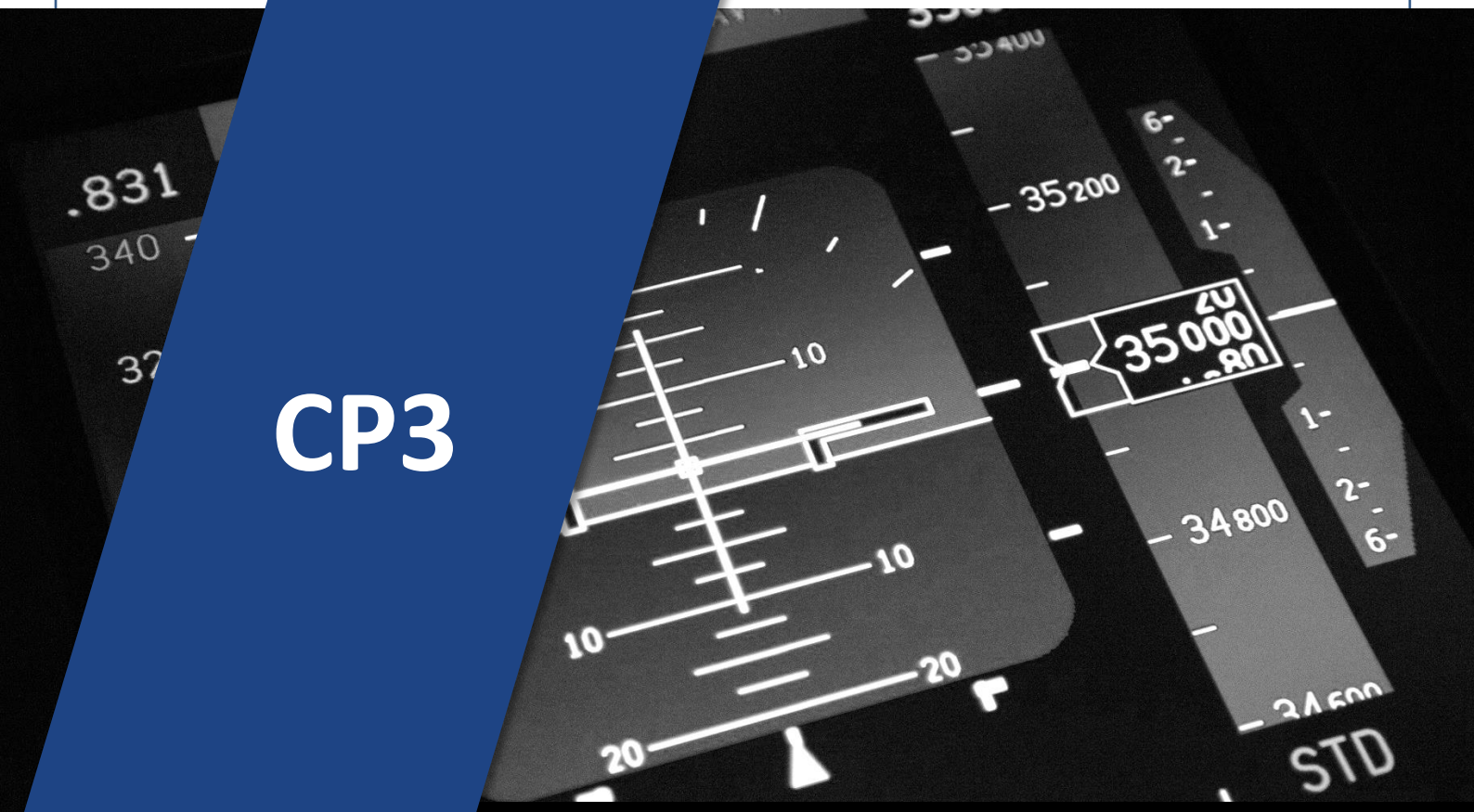
Units of measurement

For use in air and ground operations



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Isle of Man Government
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CIVIL AVIATION ADMINISTRATION

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1. Table of Contents

2. Revision history

Version	Date	Details
1	October 2016	Initial issue
2	March 2019	General update
3	June 2022	Common reference systems: • horizontal reference system • vertical reference system • temporal reference system Definitions of: • “Gregorian calendar” • “calendar”

Copies of this document are available in large print upon request.

3. Overview

The document contains specifications for the use of a standardised system of units of measurement in civil aviation air and ground operations. This standardised system of units of measurement is based on the International System of Units (SI) and certain non-SI units considered necessary to meet the specialised requirements of civil aviation.

4. Applicability

This document applies to any person exercising the privileges of a licence, approval or certificate issued and validated by the Department for Enterprise of the Isle of Man Government and any person conducting air or ground operations that are subject to the Airports and Civil Aviation Act 1987 (of Tynwald) or any legislation made under the Civil Aviation Act 1982 (of Parliament) or the Air Navigation (Isle of Man) Order 2015[*].

A person to whom this document applies must use the units of measurement defined in Section 5 and identified in Section 6 along with the prefixes detailed in Section 7. Conversion between SI and non-SI units must be completed in accordance with Section 8. Dates and times are to be written in the formats described in Section 9.

[*] SI 2015/870 as amended by SI 2016/155

5. Definitions

When the following terms are used concerning units of measurement they have the following meanings:

Term	Meaning
Ampere (A)	The ampere is that constant electric current which, if maintained in two straight parallel conductors of infinite length, of negligible circular cross-section, and placed 1 metre apart in a vacuum, would produce between these conductors a force equal to 2×10^{-7} newton per metre of length.
Bar (b)	The pressure or stress of 100,000 newton per square metre.
Becquerel (Bq)	The activity of a radionuclide having one spontaneous nuclear transition per second.
Calendar	Discrete temporal reference system that provides the basis for defining temporal position to a resolution of one day
Candela (cd)	The luminous intensity, in the perpendicular direction, of a surface of 1/600,000 square metre of black body at the temperature of freezing platinum under a pressure of 101,325 Newtons per square metre.
Celsius temperature (t°C)	The Celsius temperature is equal to the difference $t°_C = T-T_0$ between two thermodynamic temperatures T and T_0 where T_0 equals 273.15 kelvin.
Coulomb (C)	The quantity of electricity transported in 1 second by a current of 1 ampere.
Degree Celsius (°C)	The special name for the unit kelvin for use in stating values of Celsius temperature.
Farad (F)	The capacitance of a capacitor between the plates of which there appears a difference of potential of 1 volt when it is charged by a quantity of electricity equal to 1 coulomb.
Foot (ft)	The length equal to 0.3048 metre exactly.
Gray (Gy)	The energy imparted by ionizing radiation to a mass of matter corresponding to 1 joule per kilogram.
Gregorian calendar	Calendar in general use; first introduced in 1582 to define a year that more closely approximates the tropical year than the Julian calendar.

Henry (H)	The inductance of a closed circuit in which an electromotive force of 1 volt is produced when the electric current in the circuit varies uniformly at a rate of 1 ampere per second.
Hertz (Hz)	The frequency of a periodic phenomenon of which the period is 1 second.
Human performance	Human capabilities and limitations which have an impact on the safety and efficiency of aeronautical operations.
Joule (J)	The work done when the point of application of a force of 1 newton is displaced a distance of 1 metre in the direction of the force.
Kelvin (K)	A unit of thermodynamic temperature which is the fraction 1/273.16 of the thermodynamic temperature of the triple point of water.
Kilogram (kg)	The unit of mass equal to the mass of the international prototype of the kilogram.
Knot (kt)	The speed equal to 1 nautical mile per hour.
Litre (L)	A unit of volume restricted to the measurement of liquids and gases which is equal to 1 cubic decimetre.
Lumen (lm)	The luminous flux emitted in a solid angle of 1 steradian by a point source having a uniform intensity of 1 candela.
Lux (lx)	The illuminance produced by a luminous flux of 1 lumen uniformly distributed over a surface of 1 square metre.
Metre (m)	The distance travelled by light in a vacuum during 1/299,792,458 of a second.
Mole (mol)	The amount of substance of a system which contains as many elementary entities as there are atoms in 0.012 kilogram of carbon-12. Note: When the mole is used, the elementary entities must be specified and may be atoms, molecules, ions, electrons, other particles or specified groups of such particles.
Nautical mile (NM)	The length equal to 1,852 metres exactly.
Newton (N)	The force which when applied to a body having a mass of 1 kilogram gives it an acceleration of 1 metre per second squared.
Ohm (Ω)	The electric resistance between two points of a conductor when a constant difference of potential of 1 volt, applied between these two points, produces in this conductor a current of 1 ampere, this conductor not being the source of any electromotive force.

Pascal (Pa)	The pressure or stress of 1 newton per square metre.
Radian (rad)	The plane angle between two radii of a circle which cut off on the circumference an arc equal in length to the radius.
Second (s)	The duration of 9,192,631,770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the caesium-133 atom.
Siemens (S)	The electric conductance of a conductor in which a current of 1 ampere is produced by an electric potential difference of 1 volt.
Sievert (Sv)	The unit of radiation dose equivalent corresponding to 1 joule per kilogram.
Steradian (sr)	The solid angle which, having its vertex in the centre of a sphere, cuts off an area of the surface of the sphere equal to that of a square with sides of length equal to the radius of the sphere.
Tesla (T)	The magnetic flux density given by a magnetic flux of 1 weber per square metre.
Tonne (t)	The mass equal to 1,000 kilograms.
Volt (V)	The unit of electric potential difference and electromotive force which is the difference of electric potential between two points of a conductor carrying a constant current of 1 ampere, when the power dissipated between these points is equal to 1 watt.
Watt (W)	The power which gives rise to the production of energy at the rate of 1 joule per second.
Weber (Wb)	The magnetic flux which, linking a circuit of one turn, produces in it an electromotive force of 1 volt as it is reduced to zero at a uniform rate in 1 second.

6. Units of measurement

6.1 Direction/space/time

Ref no.	Quantity	Unit to be used (symbol)
6.1.1	altitude	ft
6.1.2	area	m^2
6.1.3	distance (long)† (when required to one decimal place)	NM
6.1.4	distance (short)	m
6.1.5	elevation	ft
6.1.6	endurance	h and min
6.1.7	height	ft
6.1.8	latitude	° ' "
6.1.9	length	m
6.1.10	longitude	° ' "
6.1.11	plane angle (when required, decimal subdivisions of the degree shall be used)	°
6.1.12	runway length	m
6.1.13	runway visual range	m
6.1.14	tank capacities (aircraft)‡	L
6.1.15	time	s min h d week month year
6.1.16	visibility§	km
6.1.17	volume	m^3 L
6.1.18	wind direction (wind directions other than for a landing and take-off expressed in degrees true; for	°

† As used in navigation, generally in excess of 4000m.
‡ Such as aircraft fuel, hydraulic fluids, water, oil and high pressure oxygen vessels.
§ Visibility of less than 5km may be given in m.

	landing and take-off wind directions expressed in degrees magnetic)	

6.2 Mass-related

Ref no	Quantity	Unit to be used (symbol)
6.2.1	air density	kg/m^3
6.2.2	area density	kg/m^2
6.2.3	cargo capacity	kg
6.2.4	cargo density	kg/m^3
6.2.5	density (mass density)	kg/m^3
6.2.6	fuel capacity (gravimetric)	kg
6.2.7	gas density	kg/m^3
6.2.8	gross mass or payload	kg t
6.2.9	hoisting provisions	kg
6.2.10	linear density	kg/m
6.2.11	liquid density	kg/m^3
6.2.12	mass	kg
6.2.13	moment of inertia	$kg \cdot m^2$
6.2.14	moment of momentum	$kg \cdot m^2/s$
6.2.15	momentum	$kg \cdot m/s$
6.2.16	weight	kg t

6.3 Force-related

Ref no.	Quantity	Unit to be used (symbol)
6.3.1	air pressure (general)	kPa
6.3.2	altimeter setting	hPa
6.3.3	atmospheric pressure	hPa

6.3.4	bending moment	kN· m
6.3.5	force	N
6.3.6	fuel supply pressure	kPa
6.3.7	hydraulic pressure	kPa
6.3.8	modulus of elasticity	MPa
6.3.9	pressure	kPA
6.3.10	stress	MPa
6.3.11	surface tension	mN/m
6.3.12	thrust	kN
6.3.13	torque	N · m
6.3.14	vacuum	Pa

6.4 Mechanics

Ref no.	Quantity	Unit to be used (symbol)
6.4.1	airspeed**	kt
6.4.2	angular acceleration	rad/s^2
6.4.3	angular velocity	rad/s
6.4.4	energy or work	J
6.4.5	equivalent shaft power	kW
6.4.6	frequency	Hz
6.4.7	ground speed	kt
6.4.8	impact	J/m^2
6.4.9	kinetic energy absorbed by brakes	MJ
6.4.10	linear acceleration	m/s^2
6.4.11	power	kW
6.4.12	rate of trim	°/s

** Airspeed is sometimes reported in flight operations in terms of the ratio MACH number.

6.4.13	shaft power	kW
6.4.14	velocity	m/s
6.4.15	vertical speed	ft/min
6.4.16	wind speed[††]	Kt

6.5 Flow

Ref no.	Quantity	Unit to be used (symbol)
6.5.1	engine airflow	kg/s
6.5.2	engine waterflow	kg/h
6.5.3	fuel consumption (specific) piston engines turbo-shaft engines jet engines	 kg/(kW·h) kg/(kW·h) kg/(kN·h)
6.5.4	fuel flow	kg/h
6.5.5	fuel tank filing rate (gravimetric)	kg/min
6.5.6	gas flow	kg/s
6.5.7	liquid flow (gravimetric)	g/s
6.5.8	liquid flow (volumetric)	L/s
6.5.9	mass flow	kg/s
6.5.10	oil consumption gas turbine piston engines	 kg/h g/(kW·h)
6.5.11	oil flow	g/s
6.5.12	pump capacity	L/min
6.5.13	ventilation airflow	m^3/min
6.5.14	viscosity (dynamic)	Pa ·s
6.5.15	viscosity (kinematic)	m^2/s

[††] A conversion of 1kt = 0.5m/s may be used for the representation of wind speed.

6.6 Thermodynamics

Ref no.	Quantity	Unit to be used (symbol)
6.6.1	coefficient of heat transfer	$W/(m^2 \cdot K)$
6.6.2	heat flow per unit area	J/m^2
6.6.3	heat flow rate	W
6.6.4	humidity (absolute)	g/kg
6.6.5	coefficient of linear expansion	$°C^{-1}$
6.6.6	quantity of heat	J
6.6.7	temperature	°C

6.7 Electricity and magnetism

Ref no.	Quantity	Unit to be used (symbol)
6.7.1	capacitance	F
6.7.2	conductance	S
6.7.3	conductivity	S/m
6.7.4	current density	A/m^2
6.7.5	electric current	A
6.7.6	electric field strength	C/m^2
6.7.7	electric potential	V
6.7.8	electromotive force	V
6.7.9	magnetic field strength	A/m
6.7.10	magnetic flux	Wb
6.7.11	magnetic flux density	T
6.7.12	power	W
6.7.13	quantity of electricity	C
6.7.14	resistance	Ω

6.8 Light and related electromagnetic radiations

Ref no.	Quantity	Unit to be used (symbol)
6.8.1	illuminance	lx
6.8.2	luminance	cd/m^2
6.8.3	luminous exitance	lm/m^2
6.8.4	luminous flux	lm
6.8.5	luminous intensity	cd
6.8.6	quantity of light	lm · s
6.8.7	radiant energy	J
6.8.8	wavelength	M

6.9 Acoustics

Ref no.	Quantity	Unit to be used (symbol)
6.9.1	frequency	Hz
6.9.2	mass density	kg/m^3
6.9.3	noise level	dB‡‡
6.9.4	period, periodic time	s
6.9.5	sound intensity	W/m^2
6.9.6	sound power	W
6.9.7	sound pressure	Pa
6.9.8	sound level	dB (see Note E)
6.9.9	static pressure (instantaneous)	Pa
6.9.10	velocity of sound	m/s
6.9.11	volume velocity (instantaneous)	m^3/s
6.9.12	wavelength	m

‡‡ The decibel (dB) is a ratio which may be used as a unit for expressing sound pressure level and sound power level. When used, the reference level must be specified.

6.10 Nuclear physics and ionizing radiation

Ref no.	Quantity	Unit to be used (symbol)
6.10.1	absorbed dose	Gy
6.10.2	absorbed dose rate	Gy/s
6.10.3	activity of radionuclides	Bq
6.10.4	dose equivalent	Sv
6.10.5	radiation exposure	C/kg
6.10.6	exposure rate	C/kg · s

7. Unit prefixes

Multiplication factor		Prefix	Symbol
1 000 000 000 000 000 000	$= 10^{18}$	exa	E
1 000 000 000 000 000	$= 10^{15}$	peta	P
1 000 000 000 000	$= 10^{12}$	tera	T
1 000 000 000	$= 10^{9}$	giga	G
1 000 000	$= 10^{6}$	mega	M
1 000	$= 10^{3}$	kilo	k
100	$= 10^{2}$	hecto	h
10	$= 10^{1}$	deca	da
0.1	$= 10^{-1}$	deci	d
0.01	$= 10^{-2}$	centi	c
0.001	$= 10^{-3}$	milli	m
0.000 001	$= 10^{-6}$	micro	µ
0.000 000 001	$= 10^{-9}$	nano	n
0.000 000 000 001	$= 10^{-12}$	pico	p
0.000 000 000 000 001	$= 10^{-15}$	femto	f
0.000 000 000 000 000 001	$= 10^{-18}$	atto	a

8. Non-SI units

The following non-SI units shall be used in lieu of or in addition to SI units as primary units of measurement but only as specified in the section 'Units of measurement', above.

Quantity	Unit	Symbol	Definition (in terms of SI units)
Distance (long)	nautical mile	NM	1 NM = 1 852 m
Distance (vertical)[§§]	foot	ft	1 ft = 0.304 8 m
Mass	tonne	T	1 t = 10^3 kg
Plane angle	degree minute second	° ' "	1° = (π/180) rad 1' = (1/60)° = (π/10 800) rad 1" = (1/60)' = (π/648 000) rad
Speed	knot	kt	1 kt = 0.514 444 m/s
Temperature	degree Celsius	°C	1 unit °C = 1 unit °K[***]
Time	minute hour day week, month, year	Min h d ---	1 min = 60 s 1h = 60 min = 3 600 s 1 d = 24 h = 86 400 s
Volume	litre	L	1 L = 1 dm^3 = $10^{-3}m^3$

The following units are approved for temporary use only, in line with

Non-SI alternative unit	Termination date
Knot	Not established
Nautical mile	Not established
Foot	Not established

[§§] Altitude, elevation, height, vertical speed

[***] See section 'Conversion on units'

9. Date and time format

9.1 Presentation of date

Where dates are presented in all-numeric form, the sequence year-month-day should be used. The elements of the date should be:

- four digits to represent the year (the century digits may be omitted where no possible confusion could arise from such an omission)
- two digits to represent the month
- two digits to represent the day

Where it is desirable to separate the elements to aid visual understanding, only a space or hyphen should be used as a separator. As an example, 4 March 2019 may be written as:

- 20190304 or 190304
- 2019-03-04 or 19-03-04
- 2019 03 04 or 19 03 04

It is emphasised that this sequence should only be used where an all-numeric presentation is intended. Presentations using a combination of figures and words may still be used if required (e.g. 4 March 2019).

9.2 Presentation of time

Where the time of day is to be written in an all-numeric form, the sequence hours-minutes-seconds shall be used.

Hours should be represented by two digits from 00 to 23 in the 24-hour timekeeping system and may be followed by decimal fractions of an hour or by minutes and seconds. Where decimal fractions of an hour are used, the normal decimal separator should be used followed by the number of digits necessary to provide the required accuracy.

Minutes should likewise be represented by two digits from 00 to 59 followed by either decimal fractions of a minute or by seconds. Seconds should also represented by two digits from 00 to 59 followed by decimal fractions of a second if required.

Where it is necessary to facilitate visual understanding a colon should be used to separate hours and minutes and minutes and seconds. For example, 20 minutes and 18 seconds past 9 o'clock in the evening may be written as:

- 213720 or 21:37:20 in hours, minutes and seconds
- 2120.3 or 21:20.3 in hours, minutes and decimal fractions of a minute
- 21.338 in hours and decimal fractions of an hour

9.3 Combination of date and time groups

This presentation lends itself to a uniform method of writing date and time together when necessary. In such cases, the sequence of elements year-month-day-hour-minute-second should be used. It may be

noted that not all the elements need be used in every case – in a typical application, for example, only the elements day-hour-minute might be used.

10. Common reference systems

10.1 Horizontal reference system

World Geodetic System — 1984 (WGS-84) shall be used as the horizontal (geodetic) reference system for air navigation. Reported aeronautical geographical coordinates (indicating latitude and longitude) shall be expressed in terms of the WGS-84 geodetic reference datum.

10.2 Vertical reference system

Mean sea level (MSL) datum, which gives the relationship of gravity-related height (elevation) to a surface known as the geoid, shall be used as the vertical reference system for air navigation.

10.3 Temporal reference system

The Gregorian calendar and Coordinated Universal Time (UTC) shall be used as the temporal reference system for air navigation. When a different temporal reference system is used, this shall be indicated in GEN 2.1.2 of the Aeronautical Information Publication (AIP).