



RWANDA CIVIL AVIATION REGULATIONS

PART 38: UNITS OF MEASUREMENT

Consolidated to include Special Regulations issued since last amendment of Ministerial Order N°01/CAB.M/019 OF 06/02/2019 Establishing Civil Aviation Regulations.

Part 38

Units of Measurement

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SUBPART A: GENERAL

38.001 CITATION & APPLICABILITY

- (a) These Regulations may be cited as the Civil Aviation (Units of Measurement to be used in Air and Ground Operations), Regulations.
- (b) These Regulations shall be applicable to all aspects of civil aviation air and ground operations and shall be used by the persons and organizations that engage in or provide services for civil aviation.
- (c) The Civil Aviation Technical Standards (Units of Measurement) published by the Authority are applicable to the provision of civil aviation air and ground operations in Rwanda.

38.003 SUMMARY OF AMENDMENTS AND REVISION HIGHLIGHTS

- (a) The summary of amendments and revision highlights to this Part are contained in Appendix 1 to 38.003.

New: Internal: Special Regulation RSR/01/2020: Effective 15 November 2020

38.005 DEFINITIONS & ABBREVIATIONS

- (a) When the following terms are used in this Part, they have the following meanings—
 - Ampere (A).** 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;
 - Becquerel (Bq).** The activity of a radionuclide having one spontaneous nuclear transition per second;
 - 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 $t^{\circ}\text{C} = T - T_0$ 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;
 - 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;

- International System of Units (SI).** A complete, coherent system which includes three classes of units base units, supplementary units; and derived units;
- Litre (L).** A unit of volume restricted to the measurement of liquids and gases which is equal to 1 cubic decimeter;
- 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;
- 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.

38.010 [RESERVED]

38.015 [RESERVED]

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SUBPART B: STANDARD APPLICATION OF UNITS OF MEASUREMENT

38.020 SI UNITS

- (a) The International System of Units developed and maintained by the General Conference of Weights and Measures (CGPM) shall, subject to Regulation 38.025 and Regulation 38.035 be used as the standard system of units of measurement for all aspects of civil aviation air and ground operations.
- (b) The prefixes and symbols listed in Appendix 1 to 38.020 shall be used to form names and symbols of the decimal multiples and sub-multiples of SI units.

38.025 NON-SI UNITS FOR PERMANENT USE WITH THE SI

- (a) The non-SI units listed in Appendix 1 to 38.025 shall be used either in lieu of, or in addition to, SI units as primary units of measurement but only as specified in Appendix 1 to 38.035 of these regulations.

38.030 NON-SI ALTERNATIVE UNITS PERMITTED FOR TEMPORARY USE WITH THE SI

- (a) The non-SI units listed in Appendix 1 of 38.030 shall be permitted for temporary use as alternative units of measurement but only for those specific quantities listed in Appendix 1 to 38.035.

38.035 APPLICATION OF SPECIFIC UNITS

- (a) The application of units of measurement for certain quantities used in civil aviation air and ground operations shall be in accordance with Appendix 1 to 38.035 of these regulations.

38.040 DESIGN, PROCEDURES & TRAINING

- (a) The means and provisions for design, procedures and training shall be established for operations in environments involving the use of standard and non-SI alternatives of specific units of measurement, or the transition between environments using different units, with due consideration to human performance.

38.045 USE OF ALTERNATIVE NON-SI UNITS

- (a) The use in international civil aviation operations of the alternative non-SI units listed in Appendix 1 to 38.035 shall be terminated on the dates listed in Appendix 1 to 38.045.

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APPENDICES**APPENDIX 1 TO 38.003.- SUMMARY OF AMENDMENTS AND REVISION HIGHLIGHTS**

This Appendix contains a summary of all amendments and revision highlights to this Part since the issuance of the original regulation.

Amended Regulation	Amendment Source	Revision	Description of Revision
38.003	Internal	Special Regulation RSR/01/2020 Effective 15 November 2020	Inserted a new summary of Amendments and Highlight of Revisions.
Appendix 1 to 38.003	Internal	Special Regulation RSR/01/2020 Effective 15 November 2020	Added a new Appendix providing details to the summary of Amendments and Highlight of Revisions.

New: Internal: Special Regulation RSR/01/2020: Effective 15 November 2020

APPENDIX 1 TO 38.020: SI UNIT PREFIXES

<i>Multiplication factor</i>		<i>Prefix</i>	<i>Symbol</i>
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

Civil Aviation Regulations

APPENDIX 1 TO 38.025: NON-SI UNITS FOR PERMANENT USE WITH THE SI

<i>Specific quantities in Appendix 1 to 38.035 related to</i>	<i>Unit</i>	<i>Symbol</i>	<i>Definition (in terms of SI units)</i>
mass	tonne	t	1 t = 1000 kg
plane angle	Degree	°	$1^\circ = (\pi / 180) \text{ rad}$
	Minute	'	$1' = (1/60)^\circ = (\pi / 10\,800) \text{ rad}$
	Second	"	$1'' = (1/60)' = (\pi / 648\,000) \text{ rad}$
temperature	degree Celsius	°C	1 unit °C = 274.15 unit K
time	Minute	Min	1 min = 60 s
	Hour	H	1 h = 60 min = 3 600 s
	Day	d	1 d = 24 h = 86 400 s
	week, month, year		
volume	litre	L	1 L = 1 dm ³ = 10 ⁻³ m ³

APPENDIX 1 TO 38.030: NON-SI UNITS FOR TEMPORARY USE WITH THE SI

Specific quantities in appendix 1 to 38.035 related to:	unit	Symbol	Definition (in terms of SI unites)
Distance (long)	Nautical mile	NM	1 NM = 1852 m
Distance (vertical) (a)	foot	ft	1 ft = 0.304 8 m
Speed	knot	kt	1 kt = 0.51444 m/s
Vertical speed	Foot per minute	fpm	

(a) Altitude , elevation, height

APPENDIX 1 TO 38.035: STANDARD APPLICATION OF SPECIFIC UNITS OF MEASUREMENT

<i>Ref. No.</i>	<i>Quantity</i>	<i>Primary unit (symbol)</i>	<i>Non-SI alternative unit (symbol)</i>
1. Direction/Space/Time			
1.1	altitude	m	ft
1.2	area	m ²	
1.3	distance (long) ^{a)}	km	NM
1.4	distance (short)	m	
1.5	elevation	m	ft
1.6	endurance	h and min	
1.7	height	m	ft
1.8	latitude	° ' "	
1.9	length	m	
1.10	longitude	° ' "	
1.11	plane angle (when required, decimal subdivisions of the degree shall be used)	°	
1.12	runway length	m	
1.13	runway visual range	m	
1.14	tank capacities (aircraft) ^{b)}	L	
1.15	time	s min h d week month year	
1.16	visibility ^{c)}	km	
1.17	volume	m ³	
1.18	wind direction (wind directions other than for a landing and take-off shall be expressed in degrees true; for landing and take-off wind directions shall be expressed in degrees magnetic)	°	

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STANDARD UNITS (MASS-RELATED, FORCE-RELATED, MECHANICS)

<i>Ref. No.</i>	<i>Quantity</i>	<i>Primary unit (symbol)</i>	<i>Non-SI alternative unit (symbol)</i>
2. Mass-related			
2.1	air density	kg/m ³	
2.2	area density	kg/m ²	
2.3	cargo capacity	kg	
2.4	cargo density	kg/m ³	
2.5	density (mass density)	kg/m ³	
2.6	fuel capacity (gravimetric)	kg	
2.7	gas density	kg/m ³	
2.8	gross mass or payload	kg	
		t	
2.9	hoisting provisions	kg	
2.10	linear density	kg/m	
2.11	liquid density	kg/m ³	
2.12	mass	kg	
2.13	moment of inertia	kg · m ²	
2.14	moment of momentum	kg · m ² /s	
2.15	momentum	kg · m/s	
3. Force-related			
3.1	air pressure (general)	kPa	
3.2	altimeter setting	hPa	
3.3	atmospheric pressure	hPa	
3.4	bending moment	kN · m	
3.5	force	N	
3.6	fuel supply pressure	kPa	
3.7	hydraulic pressure	kPa	
3.8	modulus of elasticity	MPa	
3.9	pressure	kPa	
3.10	stress	MPa	
3.11	surface tension	mN/m	
3.12	thrust	kN	
3.13	torque	N · m	
3.14	vacuum	Pa	
4. Mechanics			
4.1	airspeed ^①	km/h	kt
4.2	angular acceleration	rad/s ²	
4.3	angular velocity	rad/s	
4.4	energy or work	J	
4.5	equivalent shaft power	kW	
4.6	frequency	Hz	
4.7	ground speed	km/h	kt
4.8	impact	J/m ²	
4.9	kinetic energy absorbed by brakes	MJ	
4.10	linear acceleration	m/s ²	
4.11	power	kW	
4.12	rate of trim	°/s	

STANDARD UNITS (FLOW & THERMODYNAMICS)

<i>Ref. No.</i>	<i>Quantity</i>	<i>Primary unit (symbol)</i>	<i>Non-SI alternative unit (symbol)</i>
4.13	shaft power		kW
4.14	velocity		m/s
4.15	vertical speed		m/s
4.16	wind speed ^{e)}		m/s
			ft/min
			kt
5. Flow			
5.1	engine airflow		kg/s
5.2	engine waterflow		kg/h
5.3	fuel consumption (specific)		
	piston engines		kg/(kW · h)
	turbo-shaft engines		kg/(kW · h)
	jet engines		kg/(kN · h)
5.4	fuel flow		kg/h
5.5	fuel tank filling rate (gravimetric)		kg/min
5.6	gas flow		kg/s
5.7	liquid flow (gravimetric)		g/s
5.8	liquid flow (volumetric)		L/s
5.9	mass flow		kg/s
5.10	oil consumption		
	gas turbine		kg/h
	piston engines (specific)		g/(kW · h)
5.11	oil flow		g/s
5.12	pump capacity		L/min
5.13	ventilation airflow		m ³ /min
5.14	viscosity (dynamic)		Pa · s
5.15	viscosity (kinematic)		m ² /s
6. Thermodynamics			
6.1	coefficient of heat transfer		W/(m ² · K)
6.2	heat flow per unit area		J/m ²
6.3	heat flow rate		W
6.4	humidity (absolute)		g/kg
6.5	coefficient of linear expansion		°C ⁻¹
6.6	quantity of heat		J
6.7	temperature		°C

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STANDARD UNITS (ELECTRICITY, LIGHT, ACOUSTICS)

<i>Ref. No.</i>	<i>Quantity</i>	<i>Primary unit (symbol)</i>	<i>Non-SI alternative unit (symbol)</i>
7. Electricity and magnetism			
7.1	capacitance	F	
7.2	conductance	S	
7.3	conductivity	S/m	
7.4	current density	A/m ²	
7.5	electric current	A	
7.6	electric field strength	C/m ²	
7.7	electric potential	V	
7.8	electromotive force	V	
7.9	magnetic field strength	A/m	
7.10	magnetic flux	Wb	
7.11	magnetic flux density	T	
7.12	power	W	
7.13	quantity of electricity	C	
7.14	resistance	Ω	
8. Light and related electromagnetic radiations			
8.1	illuminance	lx	
8.2	luminance	cd/m ²	
8.3	luminous exitance	lm/m ²	
8.4	luminous flux	lm	
8.5	luminous intensity	cd	
8.6	quantity of light	lm · s	
8.7	radiant energy	J	
8.8	wavelength	m	
9. Acoustics			
9.1	frequency	Hz	
9.2	mass density	kg/m ³	
9.3	noise level	dB ^{a)}	
9.4	period, periodic time	s	
9.5	sound intensity	W/m ²	
9.6	sound power	W	
9.7	sound pressure	Pa	
9.8	sound level	dB ^{b)}	
9.9	static pressure (instantaneous)	Pa	
9.10	velocity of sound	m/s	
9.11	volume velocity (instantaneous)	m ³ /s	
9.12	wavelength	m	

STANDARD UNITS (NUCLEAR PHYSICS)

<i>Ref. No.</i>	<i>Quantity</i>	<i>Primary unit (symbol)</i>	<i>Non-SI alternative unit (symbol)</i>
10. Nuclear physics and ionizing radiation			
10.1	absorbed dose	Gy	
10.2	absorbed dose rate	Gy/s	
10.3	activity of radionuclides	Bq	
10.4	dose equivalent	Sv	
10.5	radiation exposure	C/kg	
10.6	exposure rate	C/kg · s	
a) As used in navigation, generally in excess of 4 000 m. b) Such as aircraft fuel, hydraulic fluids, water, oil and high pressure oxygen vessels. c) Visibility of less than 5 km may be given in m. d) Airspeed is sometimes reported in flight operations in terms of the ratio MACH number. e) A conversion of 1 kt = 0.5 m/s is used in ICAO Annexes for the representation of wind speed. f) 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.			

APPENDIX 1 TO 38.045: TERMINATION DATES FOR NON-SI ALTERNATIVE UNITS

<i>Non-SI alternative unit</i>	<i>Termination date</i>
Knot Nautical mile	not established ^{a)}
Foot	not established ^{b)}

a) No termination date has yet been established for use of nautical mile and knot.
 b) No termination date has yet been established for use of the foot.