

**LIBERIA
CIVIL AVIATION REGULATIONS**

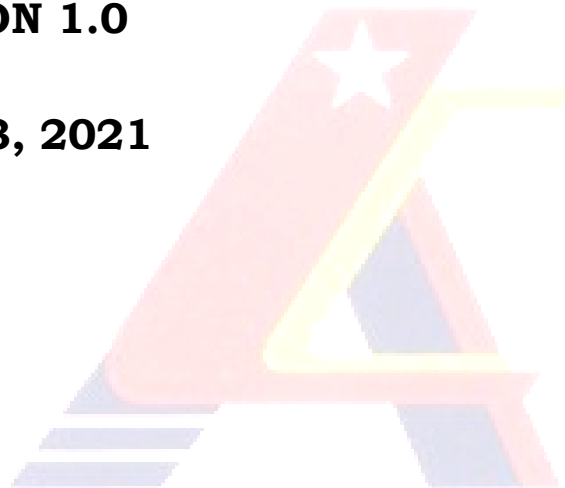


PART 22

**UNITS OF MEASUREMENTS TO BE USED IN
AIR AND GROUND OPERATIONS**

EDITION 1.0

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EXTRAORDINARY

The Government of the Republic of Liberia announces that the Liberia Civil Aviation Authority, pursuant to its mandate under the Liberia Civil Aviation Act of 2019, and specifically consistent with Subchapter XII, Section 1218 (1), has issued on August 11, 2021 its Regulation N0. LCAA/LCAR/001/2021, herein under:

CONCERNING LIBERIA CIVIL AVIATION REGULATIONS

BY ORDER OF THE PRESIDENT

AMB. DEE-MAXWELL SAAH KEMAYAH, SR.
MINISTER OF FOREIGN AFFAIRS

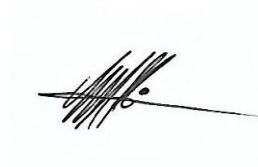
MINISTRY OF FOREIGN AFFAIRS
MONROVIA, LIBERIA



AUTHORITY TO PROMULGATE CIVIL AVIATION REGULATIONS

IN EXERCISE OF THE POWERS CONFERRED ON THE DIRECTOR GENERAL OF LIBERIA CIVIL AVIATION AUTHORITY UNDER THE LIBERIA CIVIL AVIATION ACT OF 2019 THESE REGULATIONS ARE MADE.

DATE: 13th July 2021



SIGNATURE: _____

Hon. Moses Y. Kollie
DIRECTOR GENERAL

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INTRODUCTION

Part 22 is about units of measurement to be used in international civil aviation. It makes use of the metric system as the primary international standard.

This part contains table of units based essentially on the metric system, but it also contains four additional interim tables of units for use by States unable to use the primary table. The unit of measurement covers all aspects of air and ground operations and not just air-ground communications. The Part has the International System of Units, known as SI from the "System International Units", as the basic standardized system to be used in civil aviation.

The SI units recognize a number of non-SI units which may be used permanently in conjunction with SI units in aviation. These include the liter, the degree Celsius, the degree for measuring plane angle, etc

There are some non-SI units which have a special place in aviation and which have been retained, at least temporarily. These are the nautical mile and the knot, as well as the foot when it is used in the measurement of altitude, elevation or height only.

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PART 22— UNITS OF MEASUREMENTS TO BE USED IN AIR AND GROUND OPERATIONS

22.1 DEFINITIONS

(a) When the following terms are used in the Standards and Recommended Practices concerning the units of measurement to be used in all aspects of international civil aviation air and ground operations, they have the following meanings:

- (1) **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 meter apart in vacuum, would produce between these conductors a force equal to 2×10^{-7} newtons per meter of length.
- (2) **Becquerel (Bq).** The activity of a radionuclide having one spontaneous nuclear transition per second.
- (3) **Candela (cd).** The luminous intensity, in the perpendicular direction, of a surface of 11600 000 square meter of black body at the temperature of freezing platinum under a pressure of 101 325 newtons per square meter.
- (4) **Celsius temperature ($t^{\circ}\text{C}$).** 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.
- (5) **Coulomb (C).** The quantity of electricity transported in 1 second by a current of 1 ampere.
- (6) **Degree Celsius ($^{\circ}\text{C}$).** The special name for the unit Kelvin for use in stating values of Celsius temperature.
- (7) **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.
- (8) **Foot (ft).** The length equal to 0.304 8 meter exactly.
- (9) **Gray (Gy).** The energy imparted by ionizing radiation to a mass of matter corresponding to 1 joule per kilogram.
- (10) **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.
- (11) **Hertz (Hz).** The frequency of a periodic phenomenon of which the period is 1 second.

- (12) **Human performance.** Human capabilities and limitations which have an impact on the safety and efficiency of aeronautical operations.
- (13) **Joule (J).** The work done when the point of application of a force of 1 newtons is displaced a distance of 1 meter in the direction of the force.
- (14) **Kelvin (K).** A unit of thermodynamic temperature which is the fraction 1/273.16 of the thermodynamic temperature of the triple point of water.
- (15) **Kilogram (kg).** The unit of mass equal to the mass of the international prototype of the kilogram
- (16) **Knot (kt).** The speed equal to 1 nautical mile per hour.
- (17) **Liter (L).** A unit of volume restricted to the measurement of liquids and gases which is equal to 1 cubic decimeter.
- (18) **Lumen (lm).** The luminous flux emitted in a solid angle of 1 steradian by a point source having a uniform intensity of 1 candela.
- (19) **Lux (lx).** The illuminance produced by a luminous flux of 1 lumen uniformly distributed over a surface of 1 square meter.
- (20) **Meter (m).** The distance travelled by light in a vacuum during 1/299 792 458 of a second.
- (21) **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. (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.
- (22) **Nautical mile (NM).** The length equal to 1 852 meters exactly.
- (23) **Newton (N).** The force which when applied to a body having a mass of 1 kilogram gives it an acceleration of 1 meter per second squared
- (24) **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.
- (25) **Pascal (Pa).** The pressure or stress of 1 newtons per square meter.
- (26) **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
- (27) **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

- (28) **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.
- (29) **Sievert (Sv)**. The unit of radiation dose equivalent corresponding to 1 joule per kilogram.
- (30) **Steradian (sr)**. The solid angle which, having its vertex in the center 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
- (31) **Tesla (T)**. The magnetic flux density given by a magnetic flux of 1 Weber per square meter.
- (32) **Tonne (t)**. The mass equal to 1 000 kilograms.
- (33) **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.
- (34) **Waft (W)**. The power which gives rise to the production of energy at the rate of 1 joule per second.
- (35) **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.

22.2 APPLICABILITY

- (a) This Regulation contains specifications for the use of a standardized system of units of measurement in international civil aviation air and ground operations. This standardized system of units of measurement is based on the International System of Units (SI) and certain non-SI units considered necessary to meet the specialized requirements of international civil aviation. See Attachment A for details concerning the development of the SI.
- (b) The provisions contained in this Regulation shall be applicable to all aspects of international civil aviation air and ground operations.

22.3 STANDARD APPLICATIONS OF UNITS OF MEASUREMENT

22.3.1 SI UNITS

The International System of Units developed and maintained by the General Conference of Weights and Measures (CGPM) shall, subject to the provisions of 22.3.2 and 22.3.3, be used as the standard system of units of measurement for all aspects of international civil aviation air and ground operations.

22.3.1.1 Prefixes

The prefixes and symbols listed in Table 3-1 shall be used to form names and symbols of the decimal multiples and sub-multiples of SI units.

Note 1. — As used herein the term SI unit is meant to include base units and derived units as well as their multiples and sub-multiples.

Note 2. — See Attachment B for guidance on the general application of prefixes.

Table 3-1. 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

22.3.2 NON-SI UNITS

22.3.2.1 Non-SI units for permanent use with the SI

The non-SI units listed in Table 3-2 shall be used either in lieu of, or in addition to, SI units as primary units of measurement but only as specified in Table 3-4.

Table 3-2. Non-SI units for use with the SI

<i>Specific quantities in Table 3-4 related to</i>	<i>Unit</i>	<i>Symbol</i>	<i>Definition (in terms of SI units)</i>	
mass	tonne	t	1 t = 10 ³ kg	
plane angle	degree	°	1° = (π/180) rad	
	minute	'	1' = (1/60)° = (π/10 800) rad	
	second	"	1" = (1/60)' = (π/648 000) rad	
temperature	degree Celsius	°C	1 unit °C = 1 unit K ^{a)}	
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	liter	L	1 L = 1 dm ³ = 10 ⁻³ m ³	

a) See Attachment C, Table C-2 for conversion.

22.3.2.2 Non-SI alternative units permitted for temporary use with the SI

The non-SI units listed in Table 3-3 shall be permitted for temporary use as alternative units of measurement but only for those specific quantities listed in Table 3-4.

Note.— It is intended that the use of the non-SI alternative units listed in Table 3-3 and applied as indicated in Table 3-4 will eventually be discontinued in accordance with individual unit termination dates established by the Council. Termination dates, when established, will be given in 22.4.

22.3.3 APPLICATION OF SPECIFIC UNITS

- (a) The application of units of measurement for certain quantities used in international civil aviation air and ground operations shall be in accordance with Table 3-4.

Note. — Table 3-4 is intended to provide standardization of units (including prefixes) for those quantities commonly used in air and ground operations. Basic Annex provisions apply for units to be used for quantities not listed.

- (b) Means and provisions for design, procedures and training should 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.

Note. — Guidance material on human performance can be found in the Human Factors Training Manual (Doc 9683).

Table 3-3. Non-SI alternative units permitted for temporary use with the SI

<i>Specific quantities in Table 3-4 related to</i>	<i>Unit</i>	<i>Symbol</i>	<i>Definition (in terms of SI units)</i>
distance (long)	nautical mile	NM	1 NM = 1 852 m
distance (vertical) ^{a)}	foot	ft	1 ft = 0.304 8 m
speed	knot	kt	1 kt = 0.514 444 m/s

a) altitude, elevation, height, vertical speed.

Table 3-4. 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 Non-SI

<i>Ref. No.</i>	<i>Quantity</i>	<i>Primary unit (symbol)</i>	<i>alternative unit (symbol)</i>
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 d week month	
	visibility ^{c)}	year	
1.16		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)	°	
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

4.3	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	
4.13	shaft power	kW	
4.14	velocity	m/s	
4.15	vertical speed	m/s	ft/min
4.16	wind speed ^{e)}	m/s	kt

5. Flow

5.1	engine airflow	kg/s
5.2	engine waterflow	kg/h
	fuel consumption (specific) piston engines	kg/(kW · h)
5.3	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	kg/h
	gas turbine	g/(kW · h)
	piston engines (specific)	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

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 ^{e)}
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 ^{f)}
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

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.

22.4 TERMINATION OF USE OF NON-SI ALTERNATIVE UNITS

Introductory Note. — The non-SI units listed in Table 3-3 have been retained temporarily for use as alternative units because of their widespread use and to avoid potential safety problems which could result from the lack of international coordination concerning the termination of their use. As termination dates are established by the Council, they will be reflected as Standards contained in this Chapter. It is expected that the establishment of

such dates will be well in advance of actual termination. Any special procedures associated with specific unit termination will be circulated to all States separately from this Annex.

The use in international civil aviation operations of the alternative non-SI units listed in Table 3-3 shall be terminated on the dates listed in Table 4-1.

Table 4-1. Termination dates for non-SI alternative units

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