CIVIL AVIATION DIRECTIVE – 5

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UNITS OF MEASUREMENT

CIVIL AVIATION AUTHORITY OF MALAYSIA

ISSUE 01
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Civil Aviation Directive Components and Editorial Practices

This Civil Aviation Directive is made up of the following components and are defined as follows:

Standards: Usually preceded by words such as *"shall"* or *"must"*, are any specification for physical characteristics, configuration, performance, personnel or procedure, where uniform application is necessary for the safety or regularity of air navigation and to which Operators must conform. In the event of impossibility of compliance, notification to the CAAM is compulsory.

Recommended Practices: Usually preceded by the words such as "*should"* or "*may*", are any specification for physical characteristics, configuration, performance, personnel or procedure, where the uniform application is desirable in the interest of safety, regularity or efficiency of air navigation, and to which Operators will endeavour to conform.

Appendices: Material grouped separately for convenience but forms part of the Standards and Recommended Practices stipulated by the CAAM.

Definitions: Terms used in the Standards and Recommended Practices which are not self-explanatory in that they do not have accepted dictionary meanings. A definition does not have an independent status but is an essential part of each Standard and Recommended Practice in which the term is used, since a change in the meaning of the term would affect the specification.

Tables and Figures: These add to or illustrate a Standard or Recommended Practice and which are referred to therein, form part of the associated Standard or Recommended Practice and have the same status.

Notes: Included in the text, where appropriate, Notes give factual information or references bearing on the Standards or Recommended Practices in question but not constituting part of the Standards or Recommended Practices;

Attachments: Material supplementary to the Standards and Recommended Practices or included as a guide to their application.

It is to be noted that some Standards in this Civil Aviation Directive incorporates, by reference, other specifications having the status of Recommended Practices. In such cases, the text of the Recommended Practice becomes part of the Standard.

The units of measurement used in this document are in accordance with the International System of Units (SI) as specified in CAD 5. Where CAD 5 permits the use of non-SI alternative units, these are shown in parentheses following the basic units. Where two sets of units are quoted it must not be assumed that the pairs of values are equal and interchangeable. It may, however, be inferred that an equivalent level of safety is achieved when either set of units is used exclusively.

Any reference to a portion of this document, which is identified by a number and/or title, includes all subdivisions of that portion.

Throughout this Civil Aviation Directive, the use of the male gender should be understood to include male and female persons.

Record of revisions

Revisions to this CAD shall be made by authorised personnel only. After inserting the revision, enter the required data in the revision sheet below. The *'Initials'* has to be signed off by the personnel responsible for the change.

Rev No.	Revision Date	Revision Details	Initials

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1 General

1.1 Citation

1.1.1 These Directives are the Civil Aviation Directive 5 – Units of Measurement To Be Used in Air and Ground Operations (CAD 5 – Unit of Measurement), Issue 01/Revision 00, and comes into operation on 15 April 2021.

1.1.2 This CAD contains the standards, requirements and procedures pertaining to the provision of Rules of the Air. The standards and requirements in this CAD are based mainly on standards and recommended practices (SARPs) stipulated in International Civil Aviation Organization (ICAO) Annex 5 to the Chicago Convention – Units of Measurement To Be Used in Air and Ground Operations.

1.2 Applicability

1.2.1 This CAD shall apply to any person involved in any aspect of civil aviation air and ground operations in Malaysia as specified in the First Schedule.

Note – refer Appendix 1 for list of person.

1.3 Revocation

1.3.1 This CAD revokes DGCA Directives – Units of Measurement To Be Used in Air and Ground Operations, published on 15 April 2016.

1.4 Definitions

1.4.1 In this CAD, unless the context otherwise requires—

Aerodrome Operator a person licenced under the Malaysian Aviation Commission Act 2015 [Act 771] to operate an aerodrome; or a person licenced under the Act to maintain or operate an aerodrome

Air Navigation Services means services provided to air traffic during all phases of operations to ensure their safe and efficient movement, and includes

a) air traffic control service for the arrival or departure of controlled flights, for controlled flights in controlled areas or for traffic within any manoeuvring area and other aerodrome traffic or any other air traffic control services;

b) air traffic advisory services provided within advisory airspace to ensure separation, in so far as practical, between aircraft which are operating on flight plans in accordance with the instrument flight rules;

c) flight information services;

d) alerting services provided to notify appropriate organisations regarding aircraft in need of search and rescue aid, and to assist the organisations as may be required;

e) communications, navigation and surveillance services;

f) meteorological services for air navigation;

g) search and rescue services;

h) aeronautical information services for the provision of aeronautical information and data necessary for the safety, regularity and efficiency of air navigation;

i) cartography services for air navigation; and

j) procedure for air navigation services;

1.4.2 Any reference to the word “kilogramme” in any subsidiary legislation made under the Civil Aviation Act 1969 is deemed to refer to a unit of measurement of “**mass**”

Ampere (A) means 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 vacuum, would produce between these conductors a force equal to 2 x 10-7 newton per metre of length;
Becquerel (Bq) means the activity of a radionuclide having one spontaneous nuclear transition per second;

Candela (cd) means the luminous intensity, in the perpendicular direction, of a surface of 1/600 000square metre of black body at the temperature of freezing platinum under a pressure of 101 325 Newtons per square metre;

Celsius temperature (t°C) means the celsius temperature is equal to the difference toc = T - To between two thermodynamic temperatures T and To where To equals 273.15 Kelvin;

Coulomb (C) means the quantity of electricity transported in 1 second by a current of 1 Ampere;

Degree Celsius (°C) means the special name for the unit Kelvin for use in stating values of Celsius temperature;

Farad (F) means 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) means the length equal to 0.304 8 metre exactly;

Gray (Gy) means the energy imparted by ionizing radiation to a mass of matter corresponding to 1Joule per Kilogram;

Henry (H) means 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 1Ampere per second;

Hertz (Hz) means the frequency of a periodic phenomenon of which the period is 1 second;

Human performance means the human capabilities and limitations which have an impact on the safety and efficiency of aeronautical operations;

International System of Units or **SI units** means a complete and coherent system which consists of base units as specified in Second Schedule, supplementary units as specified in Third Schedule and derived units as specified in Fourth Schedule;

Joule (J) means 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) means a unit of thermodynamic temperature which is the fraction 1/273.16 of the thermodynamic temperature of the triple point of water;

Kilogram (kg) means the unit of mass equal to the mass of the international prototype of the kilogram;

Knot (kt) means the speed equal to 1 Nautical mile per hour;

Litre (L) means a unit of volume restricted to the measurement of liquids and gases which is equal to 1 cubic decimetre;

Lumen (lm) means the luminous flux emitted in a solid angle of 1 steradian by a point source having a uniform intensity of 1 Candela;

Lux (lx) means the illuminance produced by a luminous flux of 1 lumen uniformly distributed over a surface of 1 square metre;

Metre (m) means the distance travelled by light in a vacuum during 1/299 792 458 of a second;

Mole (mol) means the amount of substance of a system which contains as many elementary entities as there are atoms in 0.012 Kilogram of carbon-12 and 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) means the length equal to 1 852 metres exactly;

Newton (N) means 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) means 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) means the pressure or stress of 1 Newton per square metre;

Radian (rad) means 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) means 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) means 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) means the unit of radiation dose equivalent corresponding to 1 joule per Kilogram;

Steradian (sr) means 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) means the magnetic flux density given by a magnetic flux of 1 Weber per square metre;

Tonne (t) means the mass equal to 1 000 Kilograms;

Volt (V) means 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) means the power which gives rise to the production of energy at the rate of 1 Joule per second; and

Weber (Wb) means 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.

2 Units of Measurements

2.1 International System of Units

2.1.1 Subject to paragraphs 2.2.1, 2.3.1 and 2.4.1, the International System of Units shall be used as the standard system of units of measurement in any aspect of civil aviation air and ground operations in Malaysia.

2.1.2 The prefixes and symbols as specified in Appendix 5 shall be used to form names and symbols of the decimal multiples and sub-multiples of International System of Units.

2.2 Application of Units of Measurement

2.2.1 The application of units of measurement for quantities used in international civil aviation air and ground operations shall be in accordance with Appendix 6.

2.3 Non-International System of Units for Permanent Use with The International System of Units

2.3.1 The Non-International System of Units as specified in Appendix 7 shall be used either in lieu of, or in addition to, the International System of Units as the primary units of measurement but only as specified in Appendix 6.

2.4 Non-International System of Units Alternative Units Permitted for Temporary Use with The International System of Units

2.4.1 The Non-International System of Units as specified in the Appendix 8 may be used, as the alternative units of measurement but only for those specific quantities as specified in Appendix 6, until directed otherwise by the Director General in the directives.

2.5 Conversion Factors

2.5.1 The conversion factors from the Non-International System of Units to the International System of Units shall be as specified in Appendix 9.

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3 Appendices

3.1 Appendix 1 – List of Person

3.1.1 List of person stated in Chapter 1 para 1.1.1 are as follows:

a) any person approved by the CEO of CAAM to conduct training for flight crew, aircraft maintenance engineer, flight operations officer/flight dispatcher or any other personnel;

b) an operator;

c) a person approved by the Director General for the design, manufacture or construction of aeronautical product;

d) a person approved by the Director General to conduct continuing airworthiness management, maintenance of aeronautical product and maintenance training;

e) an aerodrome operator; and

f) any person providing air navigation services.

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3.2 Appendix 2 – Base Units

Quantity	Unit	Symbol
amount of a substance	mole	mol
electric current	ampere	A
length	metre	m
luminous intensity	candela	cd
mass	kilogram	kg
thermodynamic temperature	kelvin	K
time	second	s

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3.3 Appendix 3 – Supplementary Units

Quantity	Unit	Symbol
plane angle	radian	rad
solid angle	steradian	sr

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3.4 Appendix 4 – Derived Units

Quantity	Unit	Symbol	Derivation
absorbed dose (radiation)	gray	Gy	J/kg
activity of radionuclides	becquerel	Bq	l/s
capacitance	farad	F	C/V
conductance	siemens	S	A/V
dose equivalent (radiation)	sievert	Sv	J/kg
electric potential, potential difference, electromotive force	volt	V	W/A
electric resistance	ohm	Ω	V/A
energy, work, quantity of heat	joule	J	N ·m
force	newton	N	kg ·m/s^2
frequency (of a periodic phenomenon)	hertz	Hz	l/s
illuminance	lux	lx	lm/m^2
inductance	henry	H	Wb/A
luminous flux	lumen	lm	cd ·sr
magnetic flux	weber	Wb	V ·s
magnetic flux density	tesla	T	Wb/m^2
power, radiant flux	watt	W	J/s
pressure, stress	pascal	Pa	N/m^2
quantity of electricity, electric charge	coulomb	C	A ·s

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3.5 Appendix 5 – SI 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

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3.6 Appendix 6 – Standard Application of Specific Units of Measurement

Ref. No	Quantity	Primary unit (SI unit symbol)	Non-SI alternative unit (symbol)
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 takeoff 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	

Ref. No	Quantity	Primary unit (SI unit symbol)	Non-SI alternative unit (symbol)
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	$kg \cdot m^2$	
2.14	moment of momentum	$kg \cdot m^2/s$	
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	k	
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[d)]	km/h	kt
4.2	angular acceleration	rad/s^2	
4.3	angular velocity	rad/s	
4.4	energy or work	J	

Ref. No	Quantity	Primary unit (SI unit symbol)	Non-SI alternative unit (symbol)
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	
5.3	fuel consumption (specific) piston engines turbo-shaft engines jet engines	 kg/(kW ·h) kg/(kW ·h) 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 piston engines (specific)	 kg/h 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	$W/(m^2 \cdot K)$	

Ref. No	Quantity	Primary unit (SI unit symbol)	Non-SI alternative unit (symbol)
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 magnesium			
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	

Ref. No	Quantity	Primary unit (SI unit symbol)	Non-SI alternative unit (symbol)
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 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.

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3.7 Appendix 7 – Non-SI Units for Use with The SI

Specific quantities in Seventh Schedule related to	Unit (Non-SI)	Symbol	Definition (in terms of SI units)
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
temperature	degree Celcius	°C	1 unit °C = 1 unit Ka)
time	minute hour day week, month, year	min h d —	1 min = 60 s 1 h = 60 min = 3 600 s 1 d = 24 h = 86 400 s
volume	litre	L	1 L = 1 dm3 = 10–3m3

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3.8 Appendix 8 – Non-SI Alternative Units Permitted for Temporary Use with The SI Units

Specific quantities in Seventh Schedule related to	Unit (Non-SI)	Symbol	Definition(in terms of SI units)
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
altitude, elevation, height, vertical speed			

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3.9 Appendix 9 – Conversion Factors to International System of Units

To convert from	to	Multiply by
abampere	ampere	(A) 1.000 000 ∗E + 01
abcoulomb	coulomb	(C) 1.000 000 *E + 01
abfarad	farad	(F) 1.000 000 *E + 09
abhenry	henry	(H) 1.000 000 *E – 09
abmho	siemens	(S) 1.000 000 *E + 09
abohm	ohm	(Ω) 1.000 000 *E – 09
abvolt	volt	(V) 1.000 000 *E – 08
acre(U.S. survey)	square metre (m^2)	4.046 873 E + 03
ampere hour	coulomb	(C) 3.600 000 *E + 03
are	square metre	(m^2) 1.000 000 *E + 02
atmosphere (standard)	pascal (Pa)	1.013 250 *E + 05
atmosphere (technical = 1 kgf/cm^2)	pascal (Pa)	9.806 650 *E + 04
bar	pascal (Pa)	1.000 000 *E + 05
barrel (for petroleum, 42 U.S. liquid gal)	cubic metre (m^3)	1.589 873 *E – 01
British thermal unit (International Table)	joule (J)	1.055 056 E + 03
British thermal unit (mean)	joule (J)	1.055 87 E + 03
British thermal unit (thermochemical)	joule (J)	1.054 350 E + 03
British thermal unit (39°F)	joule (J)	1.059 67 E + 03
British thermal unit (59°F)	joule (J)	1.054 80 E + 03
British thermal unit (60°F)	joule (J)	1.054 68 E + 03
Btu (International Table) ·ft/h · ft^2· °F (k, thermal conductivity)	watt per metre kelvin (W/m · K)	1.730 735 E + 00
Btu (thermochemical) ·ft/h · ft^2· °F	watt per metre kelvin (W/m · K)	1.729 577 E + 00
Btu (International Table) · in/h · ft^2· °F (k, thermal conductivity)	watt per metre kelvin (W/m · K)	1.442 279 E – 01
Btu (thermochemical) · in/h · ft^2· °F (k, thermal conductivity)	watt per metre kelvin (W/m · K)	1.441 314 E – 01
Btu (International Table) · in/s · ft^2· °F (k, thermal conductivity)	watt per metre kelvin (W/m · K)	5.192 204 E + 02
Btu (thermochemical) · in/s · ft^2· °F (k, thermal conductivity)	watt per metre kelvin (W/m · K)	5.188 732 E + 02
Btu (International Table)/h	watt (W)	2.930 711 E – 01
Btu (thermochemical)/h	watt (W)	2.928 751 E – 01
Btu (thermochemical)/min	watt (W)	1.757 250 E + 01

To convert from	to	Multiply by
Btu (thermochemical)/s	watt (W)	1.054 350 E + 03
Btu (International Table)/ft^2	joule per square metre (J/m^2)	1.135 653 E + 04
Btu (thermochemical)/ft^2	joule per square metre (J/m^2)	1.134 893 E + 04
Btu (thermochemical)/ft^2· h	watt per square metre (W/m^2)	3.152 481 E + 00
Btu (thermochemical)/ft^2· min	watt per square metre (W/m^2)	1.891 489 E + 02
Btu (thermochemical)/ft^2· s	watt per square metre (W/m^2)	1.134 893 E + 04
Btu (thermochemical)/in^2· s	watt per square metre (W/m^2)	1.634 246 E + 06
Btu (International Table)/h · ft^2· °F (C, thermal conductance)	watt per square metre kelvin (W/m · K)	5.678 263 E + 00
Btu (thermochemical)/h · ft^2· °F (C, thermal conductance)	watt per square metre kelvin (W/m^2· K)	5.674 466 E + 00
Btu (International Table)/s · ft^2· °F	watt per square metre kelvin (W/m^2· K)	2.044 175 E + 04
Btu (thermochemical)/s · ft^2· °F	watt per square metre kelvin (W/m^2· K)	2.042 808 E + 04
Btu (International Table)/lb	joule per kilogram (J/kg)	2.326 000 *E + 03
Btu (thermochemical)/lb	joule per kilogram (J/kg)	2.324 444 E + 03
Btu (International Table)/lb · °F (c, heat capacity)	joule per kilogram kelvin (J/kg · K)	4.186 800 *E + 03
Btu (thermochemical)/lb · °F (c, heat capacity)	joule per kilogram kelvin (J/kg · K)	4.184 000 E + 03
calibre (inch)	metre (m)	2.540 000 *E – 02
calorie (International Table)	joule (J)	4.186 800 *E + 00
calorie (mean)	joule (J)	4.190 02 E + 00
calorie (thermochemical)	joule (J)	4.184 000 *E + 00
calorie (15°C)	joule (J)	4.185 80 E + 00
calorie (20°C)	joule (J)	4.181 90 E + 00
calorie (kilogram, International Table)	joule (J)	4.186 800 *E + 03
calorie (kilogram, mean)	joule (J)	4.190 02 E + 03
calorie (kilogram, thermochemical)	joule (J)	4.184 000 *E + 03
cal (thermochemical)/cm^2	joule per square metre (J/m^2)	4.184 000 *E + 04
cal (International Table)/g	joule per kilogram (J/kg)	4.186 800 *E + 03

To convert from	to	Multiply by
cal (thermochemical)/g	joule per kilogram (J/kg)	4.184 000 *E + 03
cal (International Table)/g · °C	joule per kilogram kelvin (J/kg · K)	4.186 800 *E + 03
cal (thermochemical)/g · °C	joule per kilogram kelvin (J/kg · K)	4.184 000 *E + 03
cal (thermochemical)/min	watt (W)	6.973 333 E – 02
cal (thermochemical)/s	watt (W)	4.184 000 *E + 00
cal (thermochemical)/cm^2· min	watt per square metre (W/m^2)	6.973 333 E + 02
cal (thermochemical)/cm^2· s	watt per square metre (W/m^2)	4.184 000 *E + 04
cal (thermochemical)/cm · s · °C	watt per metre kelvin (W/m · K)	4.184 000 *E + 02
centimetre of mercury (0°C)	pascal (Pa)	1.333 22 E + 03
centimetre of water (4°C)	pascal (Pa)	9.806 38 E + 01
centipoise	pascal second (Pa · s)	1.000 000 *E – 03
centistokes	metre squared per second (m^2/s)	1.000 000 *E – 06
circular mil	square metre (m^2)	5.067 075 E – 10
clo	kelvin metre squared per watt (K · m^2/W)	2.003 712 E – 01
cup	cubic metre (m^3)	2.365 882 E – 04
curie	becquerel (Bq)	3.700 000 *E + 10
day (mean solar)	second (s)	8.640 000 E + 04
day (sidereal)	second (s)	8.616 409 E + 04
degree (angle)	radian (rad)	1.745 329 E – 02
°F · h · ft^2/Btu (International Table) (R, thermal resistance)	kelvin metre squared per watt (K · m^2/W)	1.761 102 E – 01
°F · h · ft^2/Btu (thermochemical) (R, thermal resistance)	kelvin metre squared per watt (K · m^2/W)	1.762 280 E – 01
dyne	newton (N)	1.000 000 *E – 05
dyne · cm	newton metre (N · m)	1.000 000 *E – 07
dyne/cm^2	pascal (Pa)	1.000 000 *E – 01
electronvolt	joule (J)	1.602 19 E – 19
EMU of capacitance	farad (F)	1.000 000 *E + 09
EMU of current	ampere (A)	1.000 000 *E + 01

To convert from	to	Multiply by
EMU of electric potential	volt (V)	1.000 000 *E – 08
EMU of inductance	henry (H)	1.000 000 *E – 09
EMU of resistance	ohm (Ω)	1.000 000 *E – 09
erg	joule (J)	1.000 000 *E – 07
erg/cm^2 · s	watt per square metre (W/m^2)	1.000 000 *E – 03
erg/s	watt (W)	1.000 000 *E – 07
ESU of capacitance	farad (F)	1.112 650 E – 12
ESU of current	ampere (A)	3.335 6 E – 10
ESU of electric potential	volt (V)	2.997 9 E + 02
ESU of inductance	henry (H)	8.987 554 E + 11
ESU of resistance	ohm (Ω)	8.987 554 E + 11
faraday (based on carbon-12)	coulomb (C)	9.648 70 E + 04
faraday (chemical)	coulomb (C)	9.649 57 E + 04
faraday (physical)	coulomb (C)	9.652 19 E + 04
fathom	metre (m)	1.828 8 E + 00
fermi (femtometre)	metre (m)	1.000 000 *E – 15
fluid ounce (U.S.)	cubic metre (m^3)	2.957 353 E – 05
foot	metre (m)	3.048 000 *E – 01
foot (U.S. survey)	metre (m)	3.048 006 E – 01
foot of water (39.2°F)	pascal (Pa)	2.988 98 E + 03
ft^2	square metre (m^2)	9.290 304 *E – 02
ft^2/h (thermal diffusivity)	metre squared per second (m^2/s)	2.580 640 *E – 05
ft^2/s	metre squared per second (m^2/s)	9.290 304 *E – 02
ft^3(volume; section modulus)	cubic metre (m^3)	2.831 685 E – 02
ft^3/min	cubic metre per second (m^3/s)	4.719 474 E – 04
ft^3/s	cubic metre per second (m^3/s)	2.831 685 E – 02
ft^4 (moment of section)	metre to the fourth power (m^4)	8.630 975 E – 03
ft·lbf	joule (J)	1.355 818 E + 00
ft·lbf/h	watt (W)	3.766 161 E – 04
ft·lbf/min	watt (W)	2.259 697 E – 02
ft·lbf/s	watt (W)	1.355 818 E + 00

To convert from	to	Multiply by
ft·poundal	joule (J)	4.214 011 E – 02
free fall, standard (g)	metre per second squared (m/s^2)	9.806 650 *E + 00
ft/h	metre per second (m/s)	8.466 667 E – 05
ft/min	metre per second (m/s)	5.080 000 *E – 03
ft/s	metre per second (m/s)	3.048 000 *E – 01
ft/s^2	metre per second squared (m/s^2)	3.048 000 *E – 01
footcandle	lux (lx)	1.076 391 E + 01
footlambert	candela per square metre (cd/m^2)	3.426 259 E + 00
gal	metre per second squared (m/s^2)	1.000 000 *E – 02
gallon (Canadian liquid)	cubic metre (m^3)	4.546 090 E – 03
gallon (U.K. liquid)	cubic metre (m^3)	4.546 092 E – 03
gallon (U.S. dry)	cubic metre (m^3)	4.404 884 E – 03
gallon (U.S. liquid)	cubic metre (m^3)	3.785 412 E – 03
gal (U.S. liquid)/day	cubic metre per second (m^3/s)	4.381 264 E – 08
gal (U.S. liquid)/min	cubic metre per second (m^3/s)	6.309 020 E – 05
gal (U.S. liquid)/hp· h (SFC, specific fuel consumption)	cubic metre per joule (m^3/J)	1.410 089 E – 09
gamma	tesla (T)	1.000 000 *E – 09
gauss	tesla (T)	1.000 000 *E – 04
gilbert	ampere (A)	7.957 747 E – 01
grad	degree (angular)	9.000 000 *E – 01
grad	radian (rad)	1.570 796 E – 02
gram	kilogram (kg)	1.000 000 *E – 03
g/cm^3	kilogram per cubic metre (kg/m^3)	1.000 000 *E + 03
$gram\text{-}force/cm^2$	pascal (Pa)	9.806 650 *E + 01
hectare	square metre (m^2)	1.000 000 *E + 04
horsepower (550 ft·lbf/s)	watt (W)	7.456 999 E + 02
horsepower (electric)	watt (W)	7.460 000 *E + 02
horsepower (metric)	watt (W)	7.354 99 E + 02
horsepower (water)	watt (W)	7.460 43 E + 02
horsepower (U.K.)	watt (W)	7.457 0 E + 02

To convert from	to	Multiply by
hour (mean solar)	second (s)	3.600 000 E + 03
hour (sidereal)	second (s)	3.590 170 E + 03
hundredweight (long)	kilogram (kg)	5.080 235 E + 01
hundredweight (short)	kilogram (kg)	4.535 924 E + 01
inch	metre (m)	2.540 000 *E – 02
inch of mercury (32°F)	pascal (Pa)	3.386 38 E + 03
inch of mercury (60°F)	pascal (Pa)	3.376 85 E + 03
inch of water (39.2°F)	pascal (Pa)	2.490 82 E + 02
inch of water (60°F)	pascal (Pa)	2.488 4 E + 02
in^2	square metre (m^2)	6.451 600 *E – 04
in^3(volume; section modulus)	cubic metre (m^3)	1.638 706 E – 05
in^3/min	cubic metre per second (m^3/s)	2.731 177 E – 07
in^4 (moment of section)	metre to the fourth power (m^4)	4.162 314 E – 07
in/s	metre per second (m/s)	2.540 000 *E – 02
in/s^2	metre per second squared (m/s^2)	2.540 000 *E – 02
kilocalorie (International Table)	joule (J)	4.186 800 *E + 03
kilocalorie (mean)	joule (J)	4.190 02 E + 03
kilocalorie (thermochemical)	joule (J)	4.184 000 *E + 03
kilocalorie (thermochemical)/min	watt (W)	6.973 333 E + 01
kilocalorie (thermochemical)/s	watt (W)	4.184 000 *E + 03
kilogram-force (kgf)	newton (N)	9.806 650 *E + 00
kgf· m	newton metre (N · m)	9.806 650 *E + 00
kgf· s^2/m (mass)	kilogram (kg)	9.806 650 *E + 00
kgf/cm^2	pascal (Pa)	9.806 650 *E + 04
kgf/m^2	pascal (Pa)	9.806 650 *E + 00
kgf/mm^2	pascal (Pa)	9.806 650 *E + 06
km/h	metre per second (m/s)	2.777 778 E – 01
kilopond	newton (N)	9.806 650 *E + 00
kW · h	joule (J)	3.600 000 *E + 06
kip (1 000 lbf)	newton (N)	4.448 222 E + 03
kip/in (ksi)	pascal (Pa)	6.894 757 E + 06

To convert from	to	Multiply by
knot (international)	metre per second (m/s)	5.144 444 E – 01
lambert	candela per square metre (cd/m^2)	1/π *E + 04
lambert	candela per square metre (cd/m^2)	3.183 099 E + 03
langley	joule per square metre (J/m^2)	4.184 000 *E + 04
lb · ft^2 (moment of inertia)	kilogram metre squared (kg · m^2)	4.214 011 E – 02
lb · in^2 (moment of inertia)	kilogram metre squared (kg · m^2)	2.926 397 E – 04
lb/ft· h	pascal second (Pa · s)	4.133 789 E – 04
lb/ft· s	pascal second (Pa · s)	1.488 164 E + 00
lb/ft^2	kilogram per square metre (kg/m^2)	4.882 428 E + 00
lb/ft^3	kilogram per cubic metre (kg/m^3)	1.601 846 E + 01
lb/gal (U.K. liquid)	kilogram per cubic metre (kg/m^3)	9.977 633 E + 01
lb/gal (U.S. liquid)	kilogram per cubic metre (kg/m^3)	1.198 264 E + 02
lb/h	kilogram per second (kg/s)	1.259 979 E – 04
lb/hp· h (SFC, specific fuel consumption)	kilogram per joule (kg/J)	1.689 659 E – 07
lb/in^3	kilogram per cubic metre (kg/m^3)	2.767 990 E + 04
lb/min	kilogram per second (kg/s)	7.559 873 E – 03
lb/s	kilogram per second (kg/s)	4.535 924 E – 01
lb/yd^3	kilogram per cubic metre (kg/m^3)	5.932 764 E – 01
lbf·ft	newton metre (N · m)	1.355 818 E + 00
lbf·ft/in	newton metre per metre (N · m/m)	5.337 866 E + 01
lbf· in	newton metre (N · m)	1.129 848 E – 01
lbf· in/in	newton metre per metre (N · m/m)	4.448 222 E + 00
lbf· s/ft^2	pascal second (Pa · s)	4.788 026 E + 01
lbf/ft	newton per metre (N/m)	1.459 390 E + 01
lbf/ft^2	pascal (Pa)	4.788 026 E + 01
lbf/in	newton per metre (N/m)	1.751 268 E + 02

To convert from	to	Multiply by
lbf/in^2(psi)	pascal (Pa)	6.894 757 E + 03
lbf/lb (thrust/weight (mass) ratio)	newton per kilogram (N/kg)	9.806 650 E + 00
light year	metre (m)	9.460 55 E + 15
litre	cubic metre (m^3)	1.000 000 *E – 03
maxwell	weber (Wb)	1.000 000 *E – 08
mho	siemens (S)	1.000 000 *E + 00
microinch	metre (m)	2.540 000 *E – 08
micron	metre (m)	1.000 000 *E – 06
mil	metre (m)	2.540 000 *E – 05
mile (international)	metre (m)	1.609 344 *E + 03
mile (statute)	metre (m)	1.609 3 E + 03
mile (U.S. survey)	metre (m)	1.609 347 E + 03
mile (international nautical)	metre (m)	1.852 000 *E + 03
mile (U.K. nautical)	metre (m)	1.853 184 *E + 03
mile (U.S. nautical)	metre (m)	1.852 000 *E + 03
mi^2 (international)	square metre (m^2)	2.589 988 E + 06
mi (U.S. survey)	square metre (m)	2.589 998 E + 06
mi/h (international)	metre per second (m/s)	4.470 400 *E – 01
mi/h (international)	kilometre per hour (km/h)	1.609 344 *E + 00
mi/min (international)	metre per second (m/s)	2.682 240 *E + 01
mi/s (international)	metre per second (m/s)	1.609 344 *E + 03
millibar	pascal (Pa)	1.000 000 *E + 02
millimetre of mercury (0°C)	pascal (Pa)	1.333 22 E + 02
minute (angle)	radian (rad)	2.908 882 E – 04
minute (mean solar)	second (s)	6.000 000 E + 01
minute (sidereal)	second (s)	5.983 617 E + 01
month (mean calendar)	second(s)	2.628 000 E + 06
oersted	ampere per metre (A/m)	7.957 747 E + 01
ohm centimetre	ohm metre (Ω · m)	1.000 000 *E – 02
ohm circular-mil per ft	ohm millimetre squared per metre (Ω · mm2/m)	1.662 426 E – 03

To convert from	to	Multiply by
ounce (avoirdupois)	kilogram (kg)	2.834 952 E – 02
ounce (troy or apothecary)	kilogram (kg)	3.110 348 E – 02
ounce (U.K. fluid)	cubic metre (m^3)	2.841 307 E – 05
ounce (U.S. fluid)	cubic metre (m^3)	2.957 353 E – 05
ounce-force	newton (N)	2.780 139 E – 01
ozf· in	newton metre (N · m)	7.061 552 E – 03
oz (avoirdupois)/gal (U.K. liquid)	kilogram per cubic metre (kg/m^3)	6.236 021 E + 00
oz (avoirdupois)/gal (U.S. liquid)	kilogram per cubic metre (kg/m^3)	7.489 152 E + 00
oz (avoirdupois)/in^3	kilogram per cubic metre (kg/m^3)	1.729 994 E + 03
oz (avoirdupois)/ft	kilogram per square metre (kg/m)	3.051 517 E – 01
oz (avoirdupois)/yd^2	kilogram per square metre (kg/m^2)	3.390 575 E – 02
parsec	metre (m)	3.085 678 E + 16
pennyweight	kilogram (kg)	1.555 174 E – 03
perm (0°C)	kilogram per pascal second metre squared (kg/Pa · s · m^2)	5.721 35 E – 11
perm (23°C)	kilogram per pascal second metre squared (kg/Pa · s · m^2)	5.745 25 E – 11
perm · in (0°C)	kilogram per pascal second metre (kg/Pa · s · m)	1.453 22 E – 12
perm · in (23°C)	kilogram per pascal second metre (kg/Pa · s · m)	1.459 29 E – 12
phot	lumen per square metre (lm/m^2)	1.000 000 *E + 04
pint (U.S. dry)	cubic metre (m^3)	5.506 105 E – 04
pint (U.S. liquid)	cubic metre (m^3)	4.731 765 E – 04
poise (absolute viscosity)	pascal second (Pa · s)	1.000 000 *E – 01
pound (lb avoirdupois)	kilogram (kg)	4.535 924 E – 01
pound (troy or apothecary)	kilogram (kg)	3.732 417 E – 01
poundal	newton (N)	1.382 550 E – 01
poundal/ft^2	pascal (Pa)	1.488 164 E + 00

To convert from	to	Multiply by
poundal· s/ft^2	pascal second (Pa · s)	1.488 164 E + 00
pound-force (lbf)	newton (N)	4.448 222 E + 00
quart (U.S. dry)	cubic metre (m^3)	1.101 221 E – 03
quart (U.S. liquid)	cubic metre (m^3)	9.463 529 E – 04
rad (radiation dose absorbed)	gray (Gy)	1.000 000 *E – 02
rem	sievert (Sv)	1.000 000 *E – 02
rhe	1 per pascal second (1/Pa · s)	1.000 000 *E + 01
roentgen	coulomb per kilogram (C/kg)	2.58 E – 04
second (angle)	radian (rad)	4.848 137 E – 06
second (sidereal)	second (s)	9.972 696 E – 01
slug	kilogram (kg)	1.459 390 E + 01
slug/ft· s	pascal second (Pa · s)	4.788 026 E + 01
slug/ft^3	kilogram per cubic metre (kg/m^3)	5.153 788 E + 02
statampere	ampere (A)	3.335 640 E – 10
statcoulomb	coulomb (C)	3.335 640 E – 10
statfarad	farad (F)	1.112 650 E – 12
stathenry	henry (H)	8.987 554 E + 11
statmho	siemens (S)	1.112 650 E – 12
statohm	ohm (Ω)	8.987 554 E + 11
statvolt	volt (V)	2.997 925 E + 02
stere	cubic metre (m^3)	1.000 000 *E + 00
stilb	candela per square metre (cd/m^2)	1.000 000 *E + 04
stokes (kinematic viscosity)	metre squared per second (m^2/s)	1.000 000 *E – 04
therm	joule (J)	1.055 056 E + 08
ton (assay)	kilogram (kg)	2.916 667 E – 02
ton (long, 2 240 lb)	kilogram (kg)	1.016 047 E + 03
ton (metric)	kilogram (kg)	1.000 000 *E + 03
ton (nuclear equivalent of TNT)	joule (J)	4.184 E + 09
ton (refrigeration)	watt (W)	3.516 800 E + 03
ton (register)	cubic metre (m^3)	2.831 685 E + 00
ton (short, 2 000 lb)	kilogram (kg)	9.071 847 E + 02

To convert from	to	Multiply by
ton (long)/yd^3	kilogram per cubic metre (kg/m^3)	1.328 939 E + 03
ton (short)/h	kilogram per second (kg/s)	2.519 958 E – 01
ton-force (2 000 lbf)	newton (N)	8.896 444 E + 03
tonne	kilogram (kg)	1.000 000 *E + 03
torr (mm Hg, 0°C)	pascal (Pa)	1.333 22 E + 02
unit pole	weber (Wb)	1.256 637 E – 07
W · h	joule (J)	3.600 000 *E + 03
W · s	joule (J)	1.000 000 *E + 00
W/cm^2	watt per square metre (W/m^2)	1.000 000 *E + 04
W/in^2	watt per square metre (W/m^2)	1.550 003 E + 03
yard	metre (m)	9.144 000 *E – 01
yd^2	square metre (m^2)	8.361 274 E – 01
yd^3	cubic metre (m^3)	7.645 549 E – 01
yd^3/min	cubic metre per second (m^3/s)	1.274 258 E – 02
year (calendar)	second (s)	3.153 600 E + 07
year (sidereal)	second (s)	3.155 815 E + 07
year (tropical)	second (s)	3.155 693 E + 07
Celsius temperature (t°C)	Kelvin temperature (tK)	tK = t°C + 273.15
Fahrenheit temperature (t°F)	Celsius temperature (t°C)	t°C = (t°F – 32)/1.8
Fahrenheit temperature (t°F)	Kelvin temperature (tK)	tK = (t°F + 459.67)/1.8
Kelvin temperature (tK)	Celsius temperature (t°C)	t°C = tK – 273.15
Rankine temperature (t°R)	Kelvin temperature (tK)	tK = t°R/1.8

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