LC 1098

PREFERRED METRIC UNITS FOR GENERAL USE BY THE FEDERAL GOVERNMENT

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This Letter Circular comprises a list of Preferred Metric Units for Use by the Federal Government that was developed by the Metric Practice and Preferred Units Division of the Operating Committee of the Interagency Committee on Metric Policy.

The National Bureau of Standards is pleased to make this list available to promote consistency and uniformity of the use of the metric system by all agencies of the Federal Government. Comments and suggestions should be sent to J.V. Odom, Director of the Metric Practice and Preferred Units Division, c/o National Bureau of Standards, Washington, D.C. 20234.

U.S. DEPARTMENT OF COMMERCE/National Bureau of Standards Washington, D.C. 20234

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Metric Practice and Preferred Units Division
Operating Committee
Interagency Committee on Metric Policy

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Foreword

The following Table lists preferred metric units (SI units and units accepted for use with SI) recommended for use throughout the Federal Government. Some Government agencies will develop supplemental lists applicable to their special fields. Such supplemental lists may, if desired by the preparing Agency, include all listings in this Table.

This Table is consistent with American National Standard Z210.1-1976 (ASTM E 380-76, IEEE 268-1976), in which conversion factors to SI units only are listed; SI units are the coherent set of base, supplementary, and derived units without prefixes, except for the base unit kilogram. In this table, conversion factors to the appropriate sized metric unit (SI unit with prefix as needed or non-SI unit accepted for use with SI) are listed.

A. Arrangement. The listings are in the same order as in ISO Standard 1000. The index following the Table is in alphabetical order and includes listings of quantities (Col. 2 of Table), inch-pound units (Col. 3), and metric units (Col. 4). Some of the listings in Column 3 of the Table (inch-pound units) are metric units that are now in common use.

B. Rates and Other Derived Quantities. It is not practical to list all quantities but others such as rates can be readily derived. For example, to convert from in/s to cm/s multiply by 2.54; to convert from Btu/lb to J/kg multiply by 1.055 056/0.453 592 37 or 2.326 000.

C. Conversion Factors. Conversion factors are shown from inch-pound values to metric values, generally to seven significant digits.

Exact conversion factors are indicated by an asterisk (*).

For conversion from metric values to inch-pound values, divide rather than multiply by the factor. For example, to convert 16.3 meters to yards divide by 0.9144; the answer is 17.826 yards, which rounds to 17.8 yards.

D. Rounding. The following guidance on rounding is quoted from the ANMC Metric Editorial Guide, third edition, and is applicable to converting to inch-pound values as well as to metric values: For everyday rounding of metric values obtained by converting untoleranced inch-pound values, the following simplified rules are suggested, but for more sophisticated rounding rules, see ANSI/Z210.1-1976, Section 4.

(a) If the inch-pound value is expressed by a combination of units such as feet and inches, or pounds and ounces, first express it in terms of the smaller unit.

Example: 14 ft 5 in = 173 in

(b) When the digits to be discarded begin with a 5 or more, increase by one unit the last digit retained.

Example: 8.3745, if rounded to three digits, would be 8.37; if rounded to four digits, 8.375

(c) Multiply the inch-pound value by the conversion factor. If the first significant* digit of the metric value is equal to or larger than the first significant digit of the inch-pound value, round the metric value to the same number of significant digits as there are in the inch-pound value.

Example: 11 mi x 1.609 km/mi = 17.699 km
which rounds to 18 km

61 mi x 1.609 km/mi = 98.149 km
which rounds to 98 km

If smaller, round to one more significant digit.

Examples: 66 mi x 1.609 km/mi = 106.194 km
which rounds to 106 km

8 ft x 0.3048 m/ft = 2.4384 m
which rounds to 2.4 m

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* One or more zeroes at the beginning of a number are not called "significant." Zeroes at the end of a number are not considered significant unless their use results in a number that is closer to the true value than would be the case if the number were increased or decreased by 1.

(d) Exceptions: It is sometimes better to round to one less digit than specified above. For example, according to Rule (c), 26 pounds per square inch air pressure in an automobile tire would be converted as follows:

26 psi** x 6.895 kPa/psi = 179.27 kPa
which rounds to 179 kPa

but 180 kPa, where the zero is not a significant digit, would usually be better because tire pressures are not expected to be very precise.

The rules do not apply to conversion of ^{o}F to ^{o}C.

(e) The simplified rules given above do not eliminate the necessity for using good judgment. If you believe that a dimension given as 8 ft is valid to the nearest 1/10 inch, you should consider it to mean 96.0 inches [per (a)] and treat it as having 3 significant digits. The rounded dimension would then be 2.438 m instead of 2.4 m.

** Abbreviation for pounds-force per square inch (lbf/in^2).

Where an inch-pound value represents a maximum or minimum limit that must be respected, the rounding must be in the direction that does not violate the original limit.

E. Notes. In the following Table reference is made to these notes. Note identification is shown in parenthesis in last column.

(a) In these expressions °C indicates temperature intervals. Therefore °C may be replaced with K if desired without changing the value or affecting the conversion factor. For example, in item 4-7.1 thermal conductivity, 1 W/(m·°C) = 1 W/(m·K).

(b) Not to be confused with kcal. The unit, kcal, is often called Calorie, with capital C as its symbol, especially in nutrition.

(c) If you wish to convert fuel efficiency (mi/gal) to fuel consumption (L/100 km), use the formula

$$235.215 \div (\text{mi/gal}) = \text{L/100 km}$$

(d) In surveying and cartography, use is made of the U.S. survey mile (usually called the U.S. statute mile), based on the U.S. survey foot which is longer than the international foot by two parts per million. The factors used in this Table for survey mile, acre, acre foot, and square survey mile are based on the U.S. survey foot. Factors for all other old length, area, and volume values are based on the international foot.

(e) Use of the degree and its decimal submultiples is permissible when the radian is not a convenient unit. Use of the minute and second is discouraged except for special fields such as cartography.

(f) The nautical mile (nmi) equals 1852 meters exactly. The knot is equal to one nautical mile per hour.

(g) These listed equivalences between metric and inch-pound kitchen measures are based on a metric cup of 250 mL, a metric tablespoon of 15 mL, and a metric teaspoon of 5 mL.

(h) "Weight" is the common non-technical term for "mass."

PREFERRED METRIC UNITS

FOR GENERAL USE BY THE FEDERAL GOVERNMENT

ISO	Quantity	From Inch-Pound Units	To Metric Units	Multiply By
1. Space and time				
1-1.1	plane angle	rad	rad	*1.0
		° (degree)	rad	0.017 453 29
		° (degree)	o	*1.0 (e)
		' (minute)	'	*1.0 (e)
		" (second)	"	*1.0 (e)
1-2.1	solid angle	sr	sr	*1.0
1-3.1	length	nmi	nmi	*1.0 (f)
		mi (survey)	km	1.609 347 (d)
		mi (int)	km	*1.609 344 (d)
		fathom	m	*1.828 8
		yd	m	*0.914 4
		ft (survey)	m	0.304 800 6 (d)
		ft (int)	m	*0.304 8 (d)
		in	cm	*2.54
		in	mm	*25.4

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ISO	Quantity	From Inch-Pound Units	To Metric Units	Multiply By
1-3.1 (cont.)	length (cont.)	mil	µm	*25.4
		micron	µm	*1.0
		µin	µm	*0.025 4
		A°	nm	*0.1
1-3.1a	fuel efficiency	mi/gal	km/L	0.415 143 7 (c)
1-4.1	area	mi^2 (survey)	km^2	2.589 998 (d)
		acre	ha	0.404 687 3 (d)
		acre	m^2	4 046.873 (d)
		yd^2	m^2	0.836 127 4
		ft^2	m^2	*0.092 903 04
		in^2	cm^2	*6.451 6
		in^2	mm^2	*645.16
		circular mil	$µm^2$	506.707 5
1-5.1	volume	acre foot	dam^3	1.233 489 (d)
		yd^3	m^3	0.764 554 9
		bbl(oil)(42 gallons)	m^3	0.158 987 3
		ft^3	m^3	0.028 316 85
		ft^3	L	28.316 85
		board foot	m^3	0.002 359 737

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ISO	Quantity	From Inch-Pound Units	To Metric Units	Multiply By
1-5.1 (cont.)	Volume (cont.)	bushel	L	35.239 07
		peck	L	8.809 768
		gallon (liq)	L	3.785 412
		quart (liq)	L	0.946 352 9
		pint (liq)	L	0.473 176 5
		fl oz	mL	29.573 53
		in^3	cm^3	16.387 06
		cup	mL	236.588 2
		cup	metric cup	1. (g)
		tablespoon	mL	14.786 76
		tablespoon	metric tablespoon	1.0 (g)
		teaspoon	mL	4.928 922
		teaspoon	metric teaspoon	1.0 (g)
1-6.1	time	d	d	*1.0
		h	h	*1.0
		min	min	*1.0
		s	s	*1.0
1-8.1	angular velocity	rad/s	rad/s	*1.0

ISO	Quantity	From Inch-Pound Units	To Metric Units	Multiply By
1-10.1	velocity	knot	knot	*1.0 (f)
		mi/h	km/h	*1.609 344
		ft/s	m/s	*0.304 8
1-11.1	acceleration	ft/s^2	m/s^2	*0.304 8
2. Periodic and related phenomena				
2-3.1	frequency	c/s	Hz	*1.0
2-3.2	rotational frequency	r/s (formerly rps)	r/s	*1.0
		r/min (formerly rpm)	r/min	*1.0
3. Mechanics				
3-1.1	mass (weight)	ton (long)	t (metric ton)	1.016 047 (h)
		ton (short)	t (metric ton)	*0.907 184 74 (h)
		slug	kg	14.593 90 (h)
		lb (avdp)	kg	*0.453 592 37 (h)
		oz (troy)	g	31.103 48 (h)
		oz (avdp)	g	28.349 52 (h)
		grain	mg	*64.798 91 (h)

ISO	Quantity	From Inch-Pound Units	To Metric Units	Multiply By
3-1.1a	moment of mass	lb·ft	kg.m	0.138 254 9
3-2.1	density	ton(short)/yd^3	t/m^3	1.186 553
		lb/ft^3	kg/m^3	16.018 46
3-5.1	momentum	lb·ft/s	kg·m/s	0.138 255 0
3-6.1	angular momentum	$lb·ft^2/s$	$kg·m^2/s$	0.042 140 09
3-7.1	moment of inertia	$lb·ft^2$	$kg·m^2$	0.042 140 09
3-8.1	force	kip	kN	4.448 222
		lbf	N	4.448 222
		poundal	N	0.138 255 0
3-10.1	moment of force, torque	lbf·ft	N·m	1.355 818
		lbf·in	N·m	0.112 984 8
3-11.1	pressure	atm (std)	kPa	*101.325
		bar	kPa	*100.00
		lbf/in^2	kPa	6.894 757
		inHg	kPa	3.38

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ISO	Quantity	From Inch-Pound Units	To Metric Units	Multiply By
3-11.1 (cont.)	pressure (cont.)	ftH_2O	kPa	2.99
		inH_2O	kPa	0.249
		mmHg	kPa	0.133
		mbar	kPa	*0.1
3-11.2	stress	kip/in^2 (formerly ksi)	GPa	0.006 894 757
		lbf/in^2 (formerly psi)	MPa	0.006 894 757
		lbf/in^2 (formerly psi)	kPa	6.894 ~~575~~ 757
		lbf/ft^2	kPa	0.047 880 26
3-19.1	viscosity (dynamic)	cP (centipoise)	mPa·s	*1.0
3-20.1	viscosity (kinematic)	cSt (centistokes)	mm^2/s	*1.0
3-21.1	surface tension	lbf/ft	N/m	14.593 90
3-22.1	energy, work	kWh	MJ	*3.6
		cal_{th}	J	*4.184 (b)
		Btu_{IT}	kJ	1.055 056
		ft·lbf	J	1.355 818

ISO	Quantity	From Inch-Pound Units	To Metric Units	Multiply By
3-23.1	power	ton (refrigeration)	kW	3.516 800
		Btu_{IT}/s	kW	1.055 056
		hp(550 ft·lbf/s)	kW	0.745 699 9
		hp (electric)	kW	*0.746
		Btu_{IT}/h	W	0.293 071 1
4. Heat				
4-1.1	thermodynamic temperature	^{o}F	K	$*T_K = (to_F + 459.67)/1.8$
4-2.1	Celsius temperature	^{o}F	^{o}C	$*t_{^{o}C} = (t_{^{o}F} - 32)/1.8$
4-1.1a	temperature interval	^{o}F	K	*1/1.8 (a)
4-2.1a	temperature interval	^{o}F	^{o}C	*1/1.8 (a)
4-3.1	linear expansion coefficient	$^{o}F^{-1}$	K^{-1} or $^{o}C^{-1}$	*1.8 (a)
4-4.1	heat, quantity of heat	See 3-22.1		

ISO	Quantity	From Inch-Pound Units	To Metric Units	Multiply By
4-5.1	heat flow rate	See 3-23.1		
4-7.1	thermal conductivity	$Btu \cdot in/(ft^2 \cdot h \cdot {}^\circ F)$	$W/(m \cdot {}^\circ C)$	0.144 228 (a)
4-8.1	coefficient of heat transfer	$Btu/(ft^2 \cdot h \cdot {}^\circ F)$	$W/(m^2 \cdot {}^\circ C)$	5.678 26 (a)
4-10.1	heat capacity	$Btu/{}^\circ F$	$kJ/{}^\circ C$	1.899 108 (a)
4-11.1	specific heat capacity	$Btu/(lb \cdot {}^\circ F)$	$kJ/(kg \cdot {}^\circ C)$	*4.186 8
4-13.1	entropy	$Btu/{}^\circ F$	kJ/K	1.899 108
4-14.1	specific entropy	$Btu/(lb \cdot {}^\circ F)$	kJ/(kg·K)	*4.186 8
4-16.1	specific energy	Btu_{IT}/lb	kJ/kg	*2.326
5. Electricity and Magnetism (any suitable prefix)				(i)
5-1.1	electric current	A	A	*1.0
5-2.1	electric charge	C	C	*1.0
		Ah	C	*3600.0

ISO	Quantity	From Inch-Pound Units	To Metric Units	Multiply By
5-6.1	electric potential, potential difference, electromotive force	V	V	*1.0
5-11.1	capacitance	F	F	*1.0
5-21.1	magnetic field strength	oersted	A/m	79.577 47
5-24.1	magnetic flux density	gauss	μT	*100.0
5-25.1	magnetic flux	maxwell	nWb	*10.0
5-27.1	inductance	H	H	*1.0
5-41.1	electric resistance	Ω	Ω	*1.0
5-42.1	conductance	mho	S	*1.0
5-43.1	resistivity	ohm circular mil per foot	nΩ·m	1.662 426
5-44.1	conductivity	mho/cm	S /m	*100.0

ISO	Quantity	From Inch-Pound Units	To Metric Units	Multiply By
6. Light and related electromagnetic radiations				
6-3.1	wavelength	A°	nm	*0.1
6-11.1	radiant intensity	W/sr	W/sr	*1.0
6-12.1	radiance	$W/(sr \cdot m^2)$	$W/(sr \cdot m^2)$	*1.0
6-14.1	irradiance	W/m^2	W/m^2	*1.0
6-19.1	luminous intensity	cd	cd	*1.0
6-20.1	luminous flux	lm	lm	*1.0
6-21.1	quantity of light	lm·s	lm·s	*1.0
6-22.1	luminance	lambert (L)	cd/cm^2	0.318 309 9
		cd/in^2	cd/cm^2	0.155 000 3
		footlambert (fL)	cd/m^2	3.426 259
6-23.1	luminous exitance	lm/ft^2	lm/m^2	10.763 91

ISO	Quantity	From Inch-Pound Units	To Metric Units	Multiply By
6-24.1	illuminance	fc	lx	10.763 91
6-50.1	activity (of a radionuclide)	curie (Ci)	MBq	*37 000.
6-51.1	absorbed dose	rad	Gy (gray)	*0.01
6-52.1	dose equivalent	rem	Sv (sievert)	*0.01
6-53.1	exposure (x- and gamma rays)	roentgen (R)	C/kg	0.000 258

* Denotes exact conversion factor

Alphabetical Index for Quantities, Units, and Notes