Federal Standard 376B, Preferred Metric Units for General Use by the Federal Government, Jan 27, 1993

Foreword

This standard was developed by the Standards and Metric Practices Subcommittee of the Metrication Operating Committee, which operates under the Interagency Council on Metric Policy. It is the basic Federal standard that lists metric units recommended for use throughout the Federal government, and is specified in the *Federal Standardization Handbook*, issued by the General Services Administration in accordance with 41 CFR 101-29. Before issue, it was coordinated with the departments and agencies of the Interagency Council on Metric Policy.

The General Services Administration has authorized the use of this Federal standard by all Federal agencies.

Civilian Agency Coordinating Activity:
Federal Supply Service, General Services Administration

Military Agency Coordinating Activity:
Standardization Program, Office of the Assistant Secretary (Production and Logistics), Department of Defense

Preparing Activity:
Metric Program, National Institute of Standards and Technology, Technology Administration, Department of Commerce

Changes

When a federal agency determines that there is a need for a revision of this standard, a written request for revision should be submitted to the General Services Administration, Federal Supply Service, Environmental and Engineering Policy Division (FCRE), Washington, DC 20406. The request shall include data that support the proposed change. The Metric Program, National Institute of Standards and Technology, as custodian of this standard, will coordinate all proposed changes with the Metrication Operating Committee.

Table of Contents

1. SCOPE

This standard lists preferred metric units (See 4.1) recommended for use throughout the Federal Government. It gives guidance on the selection of metric units required to comply with the provisions of the Metric Conversion Act of 1975 (P.L. 94-168), as amended by the Omnibus Trade and Competitiveness Act of 1988 (P.L. 100-418), and Executive Order (EO) 12770 of July 25, 1991. The guidance in this standard applies to, but is not limited to, the drafting of laws, regulations, contracts, and purchase orders; and the preparation of reports, statistical tables, and databases.

2. AUTHORITATIVE DOCUMENT

The following document forms the authoritative basis of this standard to the extent specified herein:

American National Standard for Metric Practice, ANSI/IEEE Std 268-1992, Institute of Electrical and Electronics Engineers, Inc.

3. DEFINITIONS

3.1 **SI Units.** Units belonging to the International System of Units, which is abbreviated SI (from the French *Le Système International d'Unités*), as interpreted or modified for use in the United States by the Secretary of Commerce (55 F.R. 52242, Dec. 20, 1990).

3.2 **Inch-pound Units.** Units based upon the yard and the pound, commonly used in the United States, and defined by the National Bureau of Standards (now the National Institute of Standards and Technology). In this standard, the term inch-pound unit includes other customary units, such as the degree Fahrenheit, used extensively in the United States at present. Some inch-pound units used in the United States, such as the gallon, have the same name as units previously used in other countries but differ in magnitude.

4. GENERAL REQUIREMENTS

4.1 **Preferred Metric Units**. Preferred metric units for use throughout the Federal Government are:

The SI units (together with their multiples and submultiples);

Three other metric units—the liter, hectare, and metric ton—that are accepted for use with the SI units because of their practical importance; and

A small number of other metric units, listed in Section 5, that are accepted because of their use in specialized fields.

The preferred metric units listed in Section 5 of this standard have been selected in accordance with the recommendations of ANSI/IEEE Std 268.

4.1.1 **SI Base Units and Supplementary Units.** The SI is constructed from seven base units for independent quantities[1] plus the two supplementary units for plane angle and solid angle.

Quantity	Unit Name	Unit Symbol
length	meter	m
mass[2]	kilogram	kg
time	second	s
electric current	ampere	A
thermodynamic temperature	kelvin	K
amount of substance	mole	mol
luminous intensity	candela	cd
plane angle	radian	rad
solid angle	steradian	sr

4.1.2 **SI Derived Units.** Derived units are formed by combining base units, supplementary units, and other derived units according to the algebraic relations linking the corresponding quantities. The symbols for derived units are obtained by means of the mathematical signs for multiplication, division, and use of exponents. For example, the SI unit for velocity is the *meter per second* (m/s or $m \cdot s^{-1}$), and that for angular velocity is the *radian per second* (rad/s or $rad \cdot s^{-1}$). Some derived SI units have been given special names and symbols, as follows:

[1] As used in this standard, "quantity" is the technical word for measurable attributes of phenomena or matter.

[2] In commercial and everyday use, and in many technical fields, the term "weight" is usually used as a synonym for mass. This is how "weight" is used in most United States laws and regulations. See the note at 5.2.1 for further explanation.

Quantity	Unit Name	Unit Symbol	Expression in Terms of Other SI Units
Absorbed dose, specific, energy imparted, kerma, absorbed dose index	gray	Gy	J/kg
Activity (of a radionuclide)	becquerel	Bq	1/s
Celsius temperature	degree Celsius	°C	K
Dose equivalent	sievert	Sv	J/kg
Electric capacitance	farad	F	C/V
Electric charge, quantity of electricity	coulomb	C	A· s
Electric conductance	siemens	S	A/V
Electric inductance	henry	H	Wb/A
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	1/s
Illuminance	lux	lx	lm/m^2
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

4.1.3 **SI Prefixes.** The common metric prefixes are:

Multiplication Factor	Prefix Name	Prefix Symbol
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}	deka	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

These prefixes are part of SI. They are attached to an SI unit name or symbol to form what are properly called "multiples" and "submultiples" of the SI unit. Prefixes produce units that are of an appropriate size for the application, e.g., millimeter or kilometer. Examples that show reasonable choices of multiples and submultiples for many practical applications are given in Section 5. While all combinations are technically correct, many are not used in practice. The prefixes deci, deka, and hecto are rarely used; prefixes that are multiples or submultiples of 1000 are generally preferred. When the unit name is written in full, the prefix is written in full: megahertz, not Mhertz. When the unit symbol is used, the prefix symbol is used: MHz, not megaHz. Only one prefix should be used in forming a multiple of an SI unit, e.g., Mg, not kkg; or μV, not mmV. Prefix symbols for the values a million or greater are capitalized and those below a million are written in lower case.

4.1.4 **Editorial Style.** The names of all SI units begin with a lower case letter except, of course, at the beginning of a sentence or when other grammar rules dictate capitalizing nouns. There is one exception: in "degree Celsius" the term "degree" is lower case but "Celsius" is always capitalized. Unit symbols are always written in lower case except for the liter and those units derived from the name of a person (e.g., W for watt, Pa for pascal, etc.). SI symbols are unique "letter shorthand" for unit names—they are not abbreviations and should therefore not be followed by a period (except at the end of a sentence). Likewise, symbols stand for both the singular and plural of the unit and should not have an "s" added. SI units are always written in an upright typeface with a space between the numeric value and the symbol. See ANSI/IEEE Std 268 and other documents listed in the Bibliography for further usage rules.

4.2 **Accepted Units.** For practical reasons a number of non-metric units are accepted for use. These include units of time (minute, hour, etc.), units of plane angle (degree, etc.), and a few units for special applications, such as the nautical mile, used in navigation. Section 5 includes accepted units and shows their areas of application. These units may be used in full compliance with the provisions of the amended Metric Conversion Act, EO 12770, and the **Federal Register** Notice, "Metric System of Measurement; Interpretation of the International System of Units for the United States" (55 F.R. 52242, Dec. 20, 1990).

4.3 **Unacceptable Metric Units.** Many older metric practices do not comply with the amended Metric Conversion Act, EO 12770, and 55 F.R. 52242. Particular care shall be taken to avoid introducing non-SI practices into the United States in areas where such practices are not now established. The units listed in the following three subsections shall not be used.

4.3.1 **CGS Units.** Units with special names peculiar to the various cgs (centimeter-gram-second) systems shall not be used. Among these units are the following that have been commonly used:

erg, dyne, gal	used in mechanics;
poise, stokes	used in fluid dynamics;
stilb, phot, lambert	used in photometry;
emu, esu, gauss, oersted, maxwell, gilbert, biot, franklin, abampere, abvolt, statvolt, etc.	used in electricity and magnetism.

4.3.2 **Deprecated Names or Symbols.** Other units from older versions of the metric system and metric jargon that shall not be used include:

Incorrect term	Correct Unit
kilo	kilogram
are	square dekameter
candle or candlepower	candela
fermi	femtometer
gamma	nanotesla
micron	micrometer
millimicron	nanometer
mho	siemens
γ	microgram
λ	cubic millimeter or microliter

4.3.3 **Miscellaneous Non-SI Units Not to be Used.** Additional units that are not accepted for use include the following:

- ångström
- calorie
- *g* as a unit of acceleration (g = 9.81 m/s^2)
- grade or gon [1 grade = (π/200) rad]
- kilogram-force
- langley (1 langley = 1 cal/cm^2)
- metric carat
- metric horsepower
- millimeter of mercury
- millimeter, centimeter, or meter of water
- standard atmosphere (101.325 kPa)
- technical atmosphere (98.0665 kPa)
- torr (133.322 Pa)

4.4 **Conversion.** Conversion factors in Section 5 are shown from inch-pound units to metric units, generally to seven significant digits. The first column, labeled **From**, lists inch-pound and other units commonly used to express the quantities; the second column, labeled **To**, gives SI units or other preferred units; and the third column, labeled **Multiply By**, gives the conversion factors by which the numerical value in **From** units must be multiplied to obtain the numerical value in **To** units. For conversion from inch-pound units to metric units, multiply by the factor. For example, to convert 10.1 feet to meters multiple by 0.3048; the answer is 3.078 meters, which can be rounded to 3.08 meters (see Section 4.5 on rounding). For conversion from metric units to inch-pound units, 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 can be rounded to 17.8 yards.

4.5 **Rounding.** For rounding of metric values obtained by conversion from inch-pound values, the following simplified rules are suggested. A more complete treatment of rounding rules is given in Appendix C of ANSI/IEEE Std 268.

4.5.1 If the inch-pound value is expressed by a combination of units such as feet and inches, or pounds and ounces, it should first be converted to the smaller unit.

Examples: 12 ft 5 in = 149 in
1 lb 3-1/2 oz = 19.5 oz

4.5.2 Multiply the inch-pound value by the conversion factor. If the first significant[3] digit of the metric value is equal to or greater 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.

Examples: 11 mi x 1.609 = 17.699 km, which rounds to 18 km
61 mi x 1.609 = 98.149 km, which rounds to 98 km

If the first significant digit of the metric value is smaller than the first significant digit of the inch-pound value, round to one more significant digit.

Examples: 66 mi x 1.609 = 106.194 km, which rounds to 106 km
8 ft x 0.3048 = 2.4384 m, which rounds to 2.4 m

4.5.3 When the digits to be discarded begin with a 5 or more, increase the last

[3]One or more zeroes at the beginning of a number are not treated as significant.

digit retained by one.

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

4.5.4 It is essential to use good judgment in estimating the precision required in conversions.

Example: A length given as 8 ft would ordinarily convert to 2.4 m. If, however, the measurement given as 8 ft is believed to be valid to the nearest 1/10 inch, it should be treated as 8.00 feet and considered as having three significant digits. The rounded dimension would then be 2.438 m instead of 2.4 m.

Do not retain more digits than is appropriate for the situation.

Example: A nautical chart shows a landmark to be 75 ft in height; from subsection 4.5.2 this rounds to 22.8 m, but a value of 23 m would be more reasonable for the application.

4.5.5 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.

Example: For most applications 10 ft rounds to 3 m, but if a safety code requires 10 feet of clearance from a high voltage line, a conversion to 3.05 meters must be used until new studies show 3 meters of clearance to be sufficient.

4.5.6 Normally, temperatures expressed in a whole number of degrees Fahrenheit should be converted to the nearest 0.5 K (or degree Celsius). As with other quantities, the number of significant digits to retain will depend upon the implied accuracy of the original temperature.

5. DETAILED REQUIREMENTS

This section gives detailed requirements for the selection of units, consistent with ANSI/IEEE Std 268. The subsections list conversion factors to the appropriately sized metric unit, either an SI unit with appropriate prefix or a non-SI unit that is accepted for use with SI. ANSI/IEEE Std 268, which has been recommended by the Metrication Operating Committee of the Interagency Council on Metric Policy for use by all agencies and departments of the Federal Government, lists conversion factors to SI units only. The SI units are the coherent set of base, supplementary, and derived units without prefixes, except for the base unit kilogram.

Government agencies may develop supplemental lists of accepted units applicable to their special fields. Such supplemental lists shall be consistent with this Federal Standard and with ANSI/IEEE Std 268.

Other Derived Quantities. It is not practical to list all quantities, but others not listed can be readily derived using the conversion factors given. For example, to convert from inches per second to centimeters per second, multiply by 2.54; to convert from Btu per pound to joules per kilogram, multiply by (1055.056)/(0.453 592 37) or 2326.

Note on Mixed Units and Fractions. Mixed units, which are commonly used with inch-pound units, are not used in metric practice. Thus, while a distance may be given in inch-pound units as 27 ft, 5 in, metric practice shows a length as 3.45 m rather than 3 m, 45 cm. Binary fractions (such as 1/2 or 3/8) are not used with metric units. For example, a person's weight is given as 70.5 kg, not 70-1/2 kg.

Preferred units for various quantities are grouped in the following subsections by: Space and Time, Mechanics, Heat, Electricity and Magnetism, Light, and Radiology. (These groupings are consistent with the groupings in ANSI/IEEE Std 268.) The quantities under each group are listed in italic type. The first column, labeled **From**, lists inch-pound and other units commonly used to express the quantities; the second column, labeled **To**, gives SI units or other preferred units; and the third column, labeled **Multiply By**, gives the conversion factors (generally to seven significant digits) by which the numerical value in **From** units must be multiplied to obtain the numerical value in **To** units. SI units and their submultiples or multiples, in the **To** column, are in bold type. The liter, hectare, and metric ton and other accepted units (see 4.2), in the **To** column, are in normal type. Conversion factors, in the **Multiply By** column, that are exact are in bold type.

From	To	Multiply By

5.1 Quantities of Space and Time

5.1.1 *Plane angle*

NOTE: No change in U.S. customary usage is required for plane angle units. The **radian**, which is the SI unit, is most frequently used in scientific or technical work and in forming derived units. Use of the degree and its decimal fractions is permissible. Use of the minute and second is discouraged except for specialized fields such as cartography.

5.1.2 *Solid angle*

NOTE: No change in U.S. customary usage is required for solid angle units. The **steradian**, which is the only unit commonly used to express solid angle, is an SI unit.

5.1.3 *Length*

From	To	Multiply By
ångström	**nanometer (nm)**	**0.1**
fathom	**meter (m)**	**1.828 8**
foot	**meter (m)**	**0.304 8**
foot [U.S. survey]	**meter (m)**	0.304 800 6

NOTE: In 1893 the U.S. foot was legally defined as 1200/3937 meters. In 1959 a refinement was made to bring the foot into agreement with the definition used in other countries, i.e. 0.3048 meters. At the same time it was decided that any data in feet derived from and published as a result of geodetic surveys within the U.S. would remain with the old standard, which is named the U.S. survey foot. The new length is shorter by exactly two parts in a million. The five-digit multipliers given in this standard for acre and acre-foot are correct for either the U.S. survey foot or the foot of 0.3048 meters exactly. Other lengths, areas, and volumes are based on the foot of 0.3048 meters.

From	To	Multiply By
inch	**centimeter (cm)**	**2.54**
	millimeter (mm)	**25.4**
microinch	**micrometer (µm)**	**0.025 4**
mil	**millimeter (mm)**	**0.025 4**
	micrometer (µm)	**25.4**

From	To	Multiply By
yard	**meter (m)**	**0.914 4**

5.1.3 *Length* (continued)

From	To	Multiply By
mile	**kilometer (km)**	**1.609 344**
nautical mile	**kilometer (km)**	**1.852**

NOTE: The nautical mile is an accepted unit for use in navigation.

From	To	Multiply By
point	**millimeter (mm)**	0.351 46
pica	**millimeter (mm)**	4.217 5

5.1.4 *Area*

From	To	Multiply By
acre	**square meter (m^2)**	4 046.9
	hectare (ha)	0.404 69

NOTE: The hectare, equal to 10 000 m^2, is accepted for use with SI.

From	To	Multiply By
circular mil	**square millimeter (mm^2)**	0.000 506 708
square inch	**square centimeter (cm^2)**	**6.451 6**
	square millimeter (mm^2)	**645.16**
square foot	**square meter (m^2)**	**0.092 903 04**
square yard	**square meter (m^2)**	0.836 127 4
square mile	**square kilometer (km^2)**	2.589 988

5.1.5 *Volume*

From	To	Multiply By
acre-foot	**cubic meter (m^3)**	1 233.5
barrel, oil	**cubic meter (m^3)**	0.158 987 3
(42 U.S. gallons)	liter (L)	158.987 3

NOTES: (1) The liter, equal to 0.001 m^3, is accepted for use with SI. (2) A variety of barrel

From	To	Multiply By

sizes have been used for other commodities.

cubic yard	**cubic meter (m^3)**	0.764 555

5.1.5 *Volume* (continued)

cubic foot	**cubic meter (m^3)**	0.028 316 85
	liter (L)	28.316 85
board foot	**cubic meter (m^3)**	0.002 359 737
register ton	**cubic meter (m^3)**	2.831 685

NOTE: The register ton is a unit of volume used to express the capacity of a ship. For example, a 20 000 ton freighter has a capacity of approximately 57 000 m^3, measured in accordance with established procedures.

bushel	**cubic meter (m^3)**	0.035 239 07

NOTE: Agricultural products that are sold by the bushel in the United States are often sold by weight in other countries. There can be a considerable variation in the weight per unit volume due to differences in variety, size, or condition of the commodity, tightness of pack, degree to which the container is heaped, etc. The following conversion factors are used by the U.S. Department of Agriculture for statistical purposes:

Crop	Weight per bushel (kg)
barley	21.8
corn, shelled	25.4
oats	14.5
potatoes, soybeans, wheat	27.2

gallon	liter (L)	3.785 412
quart (liquid)	liter (L)	0.946 352 9
pint (liquid)	liter (L)	0.473 176 5
fluid ounce	milliliter (mL)	29.573 53

NOTE: In the United States, the cup, tablespoon, and teaspoon are defined as 8, 1/2, and 1/6 fluid ounces, respectively. For practical usage the metric equivalents are 250 mL, 15 mL, and 5 mL.

cubic inch	**cubic centimeter (cm^3)**	16.387 06

From	To	Multiply By

5.1.6 *Time*

NOTE: No change in customary U.S. usage is required for time units. The **second** is the SI unit of time, but the minute and hour, as well as the day, week, year, etc., are accepted units.

5.1.7 *Velocity*

From	To	Multiply By
foot per second	**meter per second (m/s)**	**0.304 8**
mile per hour	kilometer per hour (km/h)	1.609 3
knot	kilometer per hour (km/h)	**1.852**

NOTE: The knot, or nautical mile per hour, is an accepted unit for use in navigation.

5.1.8 *Acceleration*

From	To	Multiply By
inch per second squared	**meter per second squared (m/s^2)**	**0.025 4**
foot per second squared	**meter per second squared (m/s^2)**	**0.304 8**
standard acceleration of gravity (*g*)	**meter per second squared (m/s^2)**	**9.806 65**

5.1.9 *Flow rate*

From	To	Multiply By
cubic foot per second	**cubic meter per second (m^3/s)**	0.028 316 85
cubic foot per minute	**cubic meter per second (m^3/s)**	0.000 471 947
	liter per second (L/s)	0.471 947 4
cubic yard per minute	liter per second (L/s)	12.742 58
gallon per minute	liter per second (L/s)	0.063 090 2
gallon per day	liter per day (L/d)	3.785 412

From	To	Multiply By

5.1.10 *Fuel efficiency*

mile per gallon	kilometer per liter (km/L)	0.425 143 7

NOTE: To convert fuel efficiency in miles per gallon to fuel consumption in liters per 100 kilometers, use the formula: 235.2 / number of miles per gallon = number of liters per 100 kilometers

5.2 Quantities of Mechanics

5.2.1 *Mass (weight)*

NOTE: There is ambiguity in the use of the term "weight" to mean either *force* or *mass*. In general usage, the term "weight" nearly always means *mass* and this is the meaning given the term in U.S. laws and regulations. Where the term is so used, weight is expressed in **kilograms** in SI. In many fields of science and technology the term "weight" is defined as the *force* of gravity acting on an object, i.e., as the product of the *mass* of the object and the local acceleration of gravity. Where weight is so defined, it is expressed in **newtons** in SI.

ton (long)	**kilogram (kg)**	1 016.047
	metric ton (t)	1.016 047

NOTE: The metric ton (referred to as "tonne" in many countries), equal to 1000 kg, is accepted for use with SI.

ton (short)	**kilogram (kg)**	**907.184 74**
	metric ton (t)	0.907 184 7
slug	**kilogram (kg)**	14.593 90
pound	**kilogram (kg)**	**0.453 592 37**
ounce, troy	**gram (g)**	31.103 48
ounce, avoirdupois	**gram (g)**	28.349 52
grain	**milligram (mg)**	64.798 91

5.2.2 *Moment of mass*

pound foot	**kilogram meter (kg·m)**	0.138 255 0

From	To	Multiply By
5.2.3 *Density*		
ton (short) per cubic yard	**kilogram per cubic meter (kg/m^3)**	1 186.553
	metric ton per cubic meter (t/m^3)	1.186 553
pound per cubic foot	**kilogram per cubic meter (kg/m^3)**	16.018 46
5.2.4 *Concentration (mass)*		
pound per gallon	gram per liter (g/L)	119.826 4
ounce per gallon	gram per liter (g/L)	7.489 152
5.2.5 *Momentum*		
pound foot per second	**kilogram meter per second (kg·m/s)**	0.138 255 0
5.2.6 *Moment of inertia*		
pound square foot	**kilogram square meter ($kg \cdot m^2$)**	0.042 140 11
5.2.7 *Force*		
pound-force	**newton (N)**	4.448 222
poundal	**newton (N)**	0.138 255 0
5.2.8 *Moment of force, torque*		
pound-force foot	**newton meter (N·m)**	1.355 818
pound-force inch	**newton meter (N·m)**	0.112 984 8
5.2.9 *Pressure, stress*		
standard atmosphere	**kilopascal (kPa)**	**101.325**

NOTE: The SI unit for pressure and stress is the **pascal**, which is equal to the newton per square meter. This unit, its multiples, and submultiples are preferred for all applications.

From	To	Multiply By

5.2.9 *Pressure, stress* (continued)

From	To	Multiply By
bar	**kilopascal (kPa)**	**100**

NOTE: The bar and its submultiples are accepted for limited use in meteorology only. It is not accepted for use in the U.S. for other applications, e.g., as the unit of fluid pressure in pipes and containers. The appropriate SI multiples, e.g., **kilopascal** or **megapascal**, should be used instead.

From	To	Multiply By
millibar	**kilopascal (kPa)**	**0.1**
pound-force per square inch	**kilopascal (kPa)**	6.894 757
kilopound-force per square inch	**megapascal (MPa)**	6.894 757
pound-force per square foot	**kilopascal (kPa)**	0.047 880 26
inch of mercury	**kilopascal (kPa)**	3.386 38
foot of water	**kilopascal (kPa)**	2.988 98
inch of water	**kilopascal (kPa)**	0.248 84
millimeter of mercury	**kilopascal (kPa)**	0.133 322 4

NOTE: The actual pressure corresponding to the height of a vertical column of fluid depends upon the local acceleration of gravity and the density of the fluid, which in turn depends upon the temperature. The conversion factors given here are conventional values adopted by the International Organization for Standardization (ISO).

From	To	Multiply By
torr	**pascal (Pa)**	133.322 4

5.2.10 *Viscosity (dynamic)*

From	To	Multiply By
centipoise	**millipascal second (mPa· s)**	**1**

5.2.11 *Viscosity (kinematic)*

From	To	Multiply By
centistokes	**square millimeter per second (mm^2/s)**	**1**

From	To	Multiply By

5.2.12 *Energy, work, heat*

kilowatthour	**megajoule (MJ)**	**3.6**

NOTE: The kilowatthour is accepted as a unit of electrical energy only. The SI unit of energy, the **joule**, which is equal to the newton meter or the watt second, is recommended for all applications.

calorie (as used in physics)	**joule (J)**	**4.184**

NOTE: The calorie listed here is the thermochemical calorie. Other values of the calorie have been used.

calorie (as used in nutrition)	**kilojoule (kJ)**	**4.184**

NOTE: The calorie used in nutrition is the same as the thermochemical kilocalorie. All use of the calorie is deprecated.

Btu	**kilojoule (kJ)**	1.055 056

NOTE: The British Thermal Unit (Btu) used in this standard is the International Table Btu adopted by the Fifth International Conference on Properties of Steam, London, 1956.

therm (U.S.)	**megajoule (MJ)**	**105.480 4**
horsepower hour	**megajoule (MJ)**	2.684 520
foot pound-force per second	**joule (J)**	1.355 818

5.2.13 *Power*

NOTE: Power is the rate of energy transfer. The SI unit for all forms of power—mechanical, electrical, and heat flow rate—is the **watt**.

ton, refrigeration	**kilowatt (kW)**	3.516 85
Btu per second	**kilowatt (kW)**	1.055 056

From	To	Multiply By
Btu per hour	**watt (W)**	0.293 071 1

5.2.13 *Power* (continued)

From	To	Multiply By
horsepower (550 foot pounds-force per second)	**watt (W)**	745.699 9
horsepower, electric	**watt (W)**	**746**
foot pound-force per second	**watt (W)**	1.355 818

5.3 Quantities of Heat

5.3.1 *Temperature*

NOTE: The SI unit for customary temperature is the **degree Celsius** (°C). In inch-pound units customary temperature is expressed in degrees Fahrenheit. The formula for converting customary temperature is: $t_C = (t_F - \mathbf{32}) / \mathbf{1.8}$

The SI unit for thermodynamic temperature T_K is the **kelvin** (K). Celsius temperature is defined by the equation: $t_C = T_K - \mathbf{273.15\ K}$.

The inch-pound unit for thermodynamic temperature is the degree Rankine. The formula for converting thermodynamic temperature is: $T_K = T_R / \mathbf{1.8}$.

A temperature interval may be expressed in SI either in kelvins or in degrees Celsius, as convenient. The formula for converting a temperature interval _t in degrees Fahrenheit into SI is: _t_K = _t_C = _t_F /**1.8**

5.3.2 *Linear expansion coefficient*

From	To	Multiply By
reciprocal degree Fahrenheit	reciprocal **kelvin** (**K**$^{-1}$) or reciprocal **degree Celsius** (°**C**$^{-1}$)	**1.8**

5.3.3 *Heat*

NOTE: Heat is a form of energy. See 5.2.12

5.3.4 *Heat flow rate*

NOTE: Heat flow rate is a form of power. See 5.2.13

From	To	Multiply By

5.3.5 *Thermal conductivity*

Btu inch per hour square foot degree Fahrenheit	**watt per meter kelvin [W/(m· K)]**	0.144 227 9

5.3.6 *Coefficient of heat transfer*

Btu per hour square foot degree Fahrenheit	**watt per square meter kelvin [W/(m^2· K)]**	5.678 263

5.3.7 *Heat capacity*

Btu per degree Fahrenheit	**kilojoule per kelvin (kJ/K)**	1.899 108

5.3.8 *Specific heat capacity*

Btu per pound degree Fahrenheit	**kilojoule per kilogram kelvin [kJ/(kg· K)]**	**4.186 8**

NOTE: The quantities 5.3.5 through 5.3.8 are defined in terms of temperature interval. Therefore K may be replaced by °C.

5.3.9 *Entropy*

Btu per degree Rankine	**kilojoule per kelvin (kJ/K)**	1.899 108

5.3.10 *Specific entropy*

Btu per pound degree Rankine	**kilojoule per kilogram kelvin [kJ/(kg· K)]**	**4.186 8**

5.3.11 *Specific internal energy*

Btu per pound	**kilojoule per kilogram (kJ/kg)**	**2.326**

5.4 Quantities of Electricity and Magnetism

NOTE: The common electrical units **ampere** (A), **volt** (V), **ohm** (Ω), **siemens** (S), **coulomb** (C), **farad** (F), **henry** (H), **weber** (Wb), and **tesla** (T) are SI units that are already in use in the United States. The various cgs units shall no longer be used.

From	To	Multiply By

5.4.1 *Magnetic field strength*

oersted	**ampere per meter (A/m)**	79.577 47

5.4.2 *Magnetic flux*

maxwell	**nanoweber (nWb)**	**10**

5.4.3 *Magnetic flux density*

gauss	**millitesla (mT)**	**0.1**

5.4.4 *Electric charge*

ampere hour	**coulomb (C)**	**3 600**

5.4.5 *Resistivity*

ohm circular mil per foot	**nanoohm meter (nΩ· m)**	1.662 426

5.4.6 *Conductivity*

mho per centimeter	**siemens per meter (S/m)**	**100**

5.5 Quantities of Light and Related Electromagnetic Radiation

NOTE: No change in U.S. customary usage is required for the following quantities: radiant intensity, watt per steradian (W/sr); radiance, watt per steradian square meter (W/[sr· m^2]); irradiance, watt per square meter (W/m^2); luminous intensity, candela (cd); luminous flux, lumen (lm); and quantity of light, lumen second (lm· s).

5.5.1 *Wavelength*

ångström	**nanometer (nm)**	**0.1**

5.5.2 *Luminance*

lambert	**candela per square meter (cd/m^2)**	3 183.099
candela per square inch	**candela per square**	1 550.003

From	To	Multiply By
	meter (cd/m^2)	
5.5.2 *Luminance* (continued)		
footlambert	**candela per square meter (cd/m^2)**	3.426 259
5.5.3 *Luminous exitance*		
lumen per square foot	**lumen per square meter (lm/m^2)**	10.763 91
5.5.4 *Illuminance*		
footcandle	**lux (lx)**	10.763 91
5.6 **Quantities of Radiology**		
5.6.1 *Activity (of a radionuclide)*		
curie	**megabecquerel (MBq)**	**37 000**
5.6.2 *Absorbed dose*		
rad	**gray (Gy)**	**0.01**
	centigray (cGy)	**1**
5.6.3 *Dose equivalent*		
rem	**sievert (Sv)**	**0.01**
	millisievert (mSv)	**10**
millirem	**millisievert (mSv)**	**0.01**
	microsievert (µSv)	**10**
5.6.4 *Exposure (x and gamma rays)*		
röentgen	**coulomb per kilogram (C/kg)**	**0.000 258**

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Alphabetical Index

V

W

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