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Part II

Department of Commerce

National Institute of Standards and Technology

Metric System of Measurement: Interpretation of the International System of Units for the United States; Notice

DEPARTMENT OF COMMERCE

National Institute of Standards and Technology

[Docket No. 980430113–8113–01]

Metric System of Measurement: Interpretation of the International System of Units for the United States

AGENCY: National Institute of Standards and Technology, Commerce.

ACTION: Notice.

SUMMARY: This notice restates the interpretation of the International System of Units (SI) for the United States by the Department of Commerce. This interpretation was last published by the Department of Commerce in the **Federal Register** on December 20, 1990 (55 FR 52242–52245). Since the publication of that notice, the international bodies that are responsible for the SI have made some changes to it. It has therefore become necessary to set forth a new interpretation of the SI for the United States that reflects these changes.

FOR FURTHER INFORMATION CONTACT: For information regarding the International System of Units, contact Dr. Barry N. Taylor, Building 225, Room B161, National Institute of Standards and Technology, Gaithersburg, MD 20899–0001, telephone number (301) 975–4220. For information regarding the Federal Government's efforts to coordinate the transition of the United States to the International System of Units, contact Mr. James B. McCracken, Metric Program, Building 820, Room 306, National Institute of Standards and Technology, Gaithersburg, MD 20899–0001, telephone number (301) 975–3690, email: metric__prg@nist.gov

SUPPLEMENTARY INFORMATION: Section 5164 of Public Law 100–418, the Omnibus Trade and Competitiveness Act of 1988, amended Public Law 94–168, the Metric Conversion Act of 1975. In particular, section 3 of the Metric Conversion Act (codified as amended 15 U.S.C. 205b) reads as follows:

''Sec. 3. It is therefore the declared policy of the United States—

''(1) to designate the metric system of measurement as the preferred system of weights and measures for United States trade and commerce;

''(2) to require that each Federal agency, by a date certain and to the extent economically feasible by the end of the fiscal year 1992, use the metric system of measurement in its procurements, grants, and other business related activities, except to the extent that such use is impractical or is likely to cause significant inefficiencies or loss of markets to United States firms, such as when foreign competitors are producing competing products in non-metric units;

''(3) to seek out ways to increase understanding of the metric system of measurement through educational information and guidance and in Government publications; and

''(4) to permit the continued use of traditional systems of weights and measures in nonbusiness activities.''

In the Metric Conversion Act of 1975, the ''metric system of measurement'' is defined as the International System of Units as established in 1960 by the General Conference of Weights and Measures (abbreviated CGPM after the French *Conférence Général des Poids et Mesures*) and interpreted or modified for the United States by the Secretary of Commerce (15 U.S.C. 205c). The Secretary has delegated this authority to the Director of the National Institute of Standards and Technology. In implementation of this authority, tables and associated text were published in the **Federal Register** of December 20, 1990 (55 FR 52242–52245), setting forth the interpretation for the United States of the International System of Units (abbreviated SI in all languages after the French *Systéme International d'Unités*).

The CGPM is an intergovernmental organization established by the Meter Convention (*Convention du Métre*), which was signed by the United States and 16 other countries in Paris in 1875 (nearly 50 countries are now members of the Convention). One of the responsibilities of the CGPM is to ensure that the SI reflects the latest advances in science and technology. Since the publication of the 1990 **Federal Register** notice, the CGPM has made two significant changes to the SI. These are (1) the addition of four new SI prefixes to form decimal multiples and submultiples of SI units; and (2) the elimination of the class of supplementary units (the radian and the steradian) as a separate class in the SI. Further, the International Committee for Weights and Measures (abbreviated CIPM after the French *Comité International des Poids et Mesures*), which comes under the authority of the CGPM, has made some new recommendations regarding units not part of the SI that may be used with the SI. It is therefore necessary to issue new tables and associated text that reflect these changes and which set forth a new interpretation of the SI for the United States. Thus this **Federal Register** notice supersedes the previous interpretation published in the **Federal Register** on December 20, 1990 (55 FR 52242–52245).

Classes of SI Units

There are now only two classes of units in the International System of Units: *base units* and *derived units.* The units of these two classes form a *coherent* set of units and are designated by the name ''SI units.'' Here, the term coherent is used to mean a unit system where all derived units are obtained from the base units by the rules of multiplication and division with no numerical factor other than the number 1 ever occurring in the expressions for the derived units in terms of the base units. The SI also includes *prefixes* to form decimal multiples and submultiples of SI units. Because units formed with SI prefixes are not coherent with SI units, the units so formed are designated by their complete name ''decimal multiples and submultiples of SI units'' in order to make a distinction between them and the coherent set of SI units proper. The SI units and their decimal multiples and submultiples together are often called ''units of the SI.''

SI Base Units

The SI is founded on seven SI *base units* for seven *base quantities* assumed to be mutually independent. These units and quantities are given in Table 1.

Table 1. SI base units

Base quantity	SI base unit: Name	SI base unit: Symbol
length	meter	m
mass[1]	kilogram	kg
time	second	s
electric current	ampere	A
thermodynamic temperature	kelvin	K
amount of substance	mole	mol
luminous intensity	candela	cd

[1] "Weight" in common parlance is often used to mean mass.

SI Derived Units

Other quantities, called *derived quantities,* are defined in terms of these seven base quantities through a system of quantity equations. SI *derived units* for these derived quantities are obtained from this system of equations and the seven SI base units in a coherent manner, which means, in keeping with the above discussion of the term coherent, that they are formed as products of powers (both positive and negative) of the SI base units corresponding to the base quantities concerned without numerical factors. Table 2 gives some examples of SI derived units.

Table 2. Examples of SI derived units

Derived quantity	SI derived unit: Name	SI derived unit: Symbol
area	square meter	m^2
volume	cubic meter	m^3
speed, velocity	meter per second	m/s
acceleration	meter per second squared	m/s^2
wave number	reciprocal meter	m^{-1}
mass density (density)	kilogram per cubic meter	kg/m^3
specific volume	cubic meter per kilogram	m^3/kg
current density	ampere per square meter	A/m^2
magnetic field strength	ampere per meter	A/m
amount-of-substance concentration (concentration)	mole per cubic meter	mol/m^3
luminance	candela per square meter	cd/m^2
mass fraction	kilogram per kilogram, which may be represented by the number 1	kg/kg = 1

Quantities of Dimension 1

The last entry of Table 2, mass fraction, is an example of certain derived quantities that are defined as the ratio of two mutually comparable quantities, that is, two quantities of the same kind. Since the coherent SI derived unit of such a derived quantity is the ratio of two identical SI units, that unit may also be expressed by the number one, symbol 1. Such quantities are called *quantities of dimension* 1, or *dimensionless quantities,* and the SI unit of all such quantities is the number 1. Examples of other derived quantities of dimension 1, and thus with a coherent SI derived unit that may be expressed by the number 1, are relative permeability, dynamic friction factor, refractive index, characteristic numbers such as the Mach number, and numbers that represent a count, such as a number of molecules. However, the number 1 is generally not explicitly shown in the expression for the value of a quantity of dimension 1. For example, the value of the refractive index of a given medium is expressed as $n = 1.51$ rather than as $n = 1.51 \times 1$. In a few cases a special name and symbol are given to the number 1 to aid understanding. The radian, unit symbol rad, and steradian, unit symbol sr, which are given in Table 3 and are discussed in connection with Table 4, are two such examples.

SI Derived Units With Special Names and Symbols

For ease of understanding and convenience, 21 SI derived units have been given special names and symbols. These are listed in Table 3, where it should be noted that the last three units of Table 3, the becquerel, unit symbol Bq, the gray, unit symbol Gy, and the sievert, unit symbol Sv, were specifically introduced by the CGPM with a view to safeguarding human health.

Table 3. SI derived units with special names and symbols

Derived quantity	SI derived unit			
	Special name	Special symbol	Expression in terms of other SI units	Expression in terms of SI base units
plane angle	radian	rad		$m \cdot m^{-1} = 1$
solid angle	steradian	sr		$m^2 \cdot m^{-2} = 1$
frequency	hertz	Hz		s^{-1}
force	newton	N		$m \cdot kg \cdot s^{-2}$
pressure, stress	pascal	Pa	N/m^2	$m^{-1} \cdot kg \cdot s^{-2}$
energy, work, quantity of heat	joule	J	$N \cdot m$	$m^2 \cdot kg \cdot s^{-2}$
power, radiant flux	watt	W	J/s	$m^2 \cdot kg \cdot s^{-3}$
electric charge, quantity of electricity	coulomb	C		$s \cdot A$
electric potential difference, electromotive force	volt	V	W/A	$m^2 \cdot kg \cdot s^{-3} \cdot A^{-1}$
capacitance	farad	F	C/V	$m^{-2} \cdot kg^{-1} \cdot s^4 \cdot A^2$
electric resistance	ohm	Ω	V/A	$m^2 \cdot kg \cdot s^{-3} \cdot A^{-2}$
electric conductance	siemens	S	A/V	$m^{-2} \cdot kg^{-1} \cdot s^3 \cdot A^2$
magnetic flux	weber	Wb	$V \cdot s$	$m^2 \cdot kg \cdot s^{-2} \cdot A^{-1}$
magnetic flux density	tesla	T	Wb/m^2	$kg \cdot s^{-2} \cdot A^{-1}$
inductance	henry	H	Wb/A	$m^2 \cdot kg \cdot s^{-2} \cdot A^{-2}$
Celsius temperature	degree Celsius	°C		K
luminous flux	lumen	lm	$cd \cdot sr$	$m^2 \cdot m^{-2} \cdot cd = cd$
illuminance	lux	lx	lm/m^2	$m^2 \cdot m^{-4} \cdot cd = m^{-2} \cdot cd$
activity (of a radionuclide)	becquerel	Bq		s^{-1}
absorbed dose, specific energy (imparted), kerma	gray	Gy	J/kg	$m^2 \cdot s^{-2}$
dose equivalent, ambient dose equivalent, directional dose equivalent, personal dose equivalent, equivalent dose	sievert	Sv	J/kg	$m^2 \cdot s^{-2}$

Degree Celsius

The derived unit in Table 3 with special name degree Celsius and special symbol °C deserves comment. Because of the way temperature scales used to be defined, it remains common practice to express a thermodynamic temperature, symbol T, in terms of its difference from the reference temperature $T_0 = 273.15$ K, the ice point. This temperature difference is called Celsius temperature, symbol t, and is defined by the quantity equation $t = T - T_0$. The unit of Celsius temperature is the degree Celsius, symbol °C. The numerical value of a Celsius temperature t expressed in degrees Celsius is given by

$$\frac{t}{°C} = \frac{T}{K} - 273.15 \,.$$

It follows from the definition of t that the degree Celsius is equal in magnitude to the kelvin, which in turn implies that the numerical value of a given temperature difference or temperature interval whose value is expressed in the unit degree Celsius (°C) is equal to the numerical value of the same difference or interval when its value is expressed in the unit kelvin (K). Thus temperature differences or temperature intervals may be expressed in either the degree Celsius or the kelvin using the same numerical value. For example, the Celsius temperature difference Δt and the thermodynamic temperature difference ΔT between the melting point of gallium and the triple point of water may be written as $\Delta t = 29.7546$ °C $= \Delta T = 29.7546$ K. (Note that the centigrade temperature scale is obsolete; the unit name degree centigrade should no longer be used.)

Use of SI Derived Units With Special Names and Symbols

The special names and symbols of the 21 SI derived units with special names and symbols given in Table 3 may themselves be included in the names and symbols of other SI derived units. This use is shown in Table 4. All of the SI derived units in Table 4, like those in Table 3, have been obtained from the SI base units in the same coherent manner discussed above.

Table 4. Examples of SI derived units whose names and symbols include SI derived units with special names and symbols

Derived quantity	SI derived unit		
	Name	Symbol	Expression in terms of SI base units
dynamic viscosity	pascal second	$Pa \cdot s$	$m^{-1} \cdot kg \cdot s^{-1}$
moment of force	newton meter	$N \cdot m$	$m^2 \cdot kg \cdot s^{-2}$
surface tension	newton per meter	N/m	$kg \cdot s^{-2}$
angular velocity	radian per second	rad/s	$m \cdot m^{-1} \cdot s^{-1} = s^{-1}$
angular acceleration	radian per second squared	rad/s^2	$m \cdot m^{-1} \cdot s^{-2} = s^{-2}$
heat flux density, irradiance	watt per square meter	W/m^2	$kg \cdot s^{-3}$
heat capacity, entropy	joule per kelvin	J/K	$m^2 \cdot kg \cdot s^{-2} \cdot K^{-1}$
specific heat capacity, specific entropy	joule per kilogram kelvin	$J/(kg \cdot K)$	$m^2 \cdot s^{-2} \cdot K^{-1}$
specific energy	joule per kilogram	J/kg	$m^2 \cdot s^{-2}$
thermal conductivity	watt per meter kelvin	$W/(m \cdot K)$	$m \cdot kg \cdot s^{-3} \cdot K^{-1}$
energy density	joule per cubic meter	J/m^3	$m^{-1} \cdot kg \cdot s^{-2}$
electric field strength	volt per meter	V/m	$m \cdot kg \cdot s^{-3} \cdot A^{-1}$
electric charge density	coulomb per cubic meter	C/m^3	$m^{-3} \cdot s \cdot A$
electric flux density	coulomb per square meter	C/m^2	$m^{-2} \cdot s \cdot A$
permittivity	farad per meter	F/m	$m^{-3} \cdot kg^{-1} \cdot s^4 \cdot A^2$
permeability	henry per meter	H/m	$m \cdot kg \cdot s^{-2} \cdot A^{-2}$
molar energy	joule per mole	J/mol	$m^2 \cdot kg \cdot s^{-2} \cdot mol^{-1}$
molar entropy, molar heat capacity	joule per mole kelvin	$J/(mol \cdot K)$	$m^2 \cdot kg \cdot s^{-2} \cdot K^{-1} \cdot mol^{-1}$
exposure (x and γ rays)	coulomb per kilogram	C/kg	$kg^{-1} \cdot s \cdot A$
absorbed dose rate	gray per second	Gy/s	$m^2 \cdot s^{-3}$
radiant intensity	watt per steradian	W/sr	$m^4 \cdot m^{-2} \cdot kg \cdot s^{-3} = m^2 \cdot kg \cdot s^{-3}$
radiance	watt per square meter steradian	$W/(m^2 \cdot sr)$	$m^2 \cdot m^{-2} kg \cdot s^{-3} = kg \cdot s^{-3}$

Radian and Steradian

As indicated in Table 3, the radian, unit symbol rad, and steradian, unit symbol sr, are the special names and symbols for the derived units of plane angle and solid angle, respectively. These units may be used or not in expressions for derived units as is convenient in order to distinguish between derived quantities that are not of the same kind but are of the same dimension (that is, derived quantities whose units when expressed in SI base units are the same). Table 4 includes some examples of derived units that use the radian and steradian.

SI Prefixes

Table 5 gives the 20 SI prefixes used to form decimal multiples and submultiples of SI units. It is important to note that the kilogram is the only SI unit with a prefix as part of its name and symbol. Because multiple prefixes may not be used, in the case of the kilogram the prefix names of Table 5 are used with the unit name ''gram'' and the prefix symbols are used with the unit symbol ''g.'' With this exception, any SI prefix may be used with any SI unit, including the degree Celsius and its symbol °C.

Table 5. SI prefixes

Factor	Name	Symbol	Factor	Name	Symbol
$10^{24} = (10^3)^8$	yotta	Y	10^{-1}	deci	d
$10^{21} = (10^3)^7$	zetta	Z	10^{-2}	centi	c
$10^{18} = (10^3)^6$	exa	E	$10^{-3} = (10^3)^{-1}$	milli	m
$10^{15} = (10^3)^5$	peta	P	$10^{-6} = (10^3)^{-2}$	micro	μ
$10^{12} = (10^3)^4$	tera	T	$10^{-9} = (10^3)^{-3}$	nano	n
$10^{9} = (10^3)^3$	giga	G	$10^{-12} = (10^3)^{-4}$	pico	p
$10^{6} = (10^3)^2$	mega	M	$10^{-15} = (10^3)^{-5}$	femto	f
$10^{3} = (10^3)^1$	kilo	k	$10^{-18} = (10^3)^{-6}$	atto	a
10^{2}	hecto	h	$10^{-21} = (10^3)^{-7}$	zepto	z
10^{1}	deka	da	$10^{-24} = (10^3)^{-8}$	yocto	y

Because the SI prefixes strictly represent powers of 10, it is inappropriate to use them to represent powers of 2. Thus 1 kbit = 10^3 bit = 1000 bit and *not* 2^{10} = 1024 bit, where 1 kbit is one kilobit.

Units Outside the SI

Certain units are not part of the International System of Units, that is, they are outside the SI, but are important and widely used. Consistent with the recommendations of the CIPM, the units in this category that are accepted for use in the United States with the SI are given in Tables 6 and 7.

Table 6. Units outside the SI that are accepted for use with the SI

Name		Symbol	Value in SI units
minute	time	min	1 min = 60 s
hour	time	h	1 h = 60 min = 3600 s
day	time	d	1 d = 24 h = 86 400 s
degree	plane angle	°	1° = (π/180) rad
minute	plane angle	′	1′ = (1/60)° = (π/10 800) rad
second	plane angle	″	1″ = (1/60)′ = (π/648 000) rad
liter		L	1 L = 1 $dm^3 = 10^{-3}$ m^3
metric ton		t	1 t = 10^3 kg
neper		Np	1 Np = 1
bel		B	1 B = (1/2) ln 10 Np[1]

[1] Although the neper is coherent with SI units and is accepted by the CIPM, it has not been adopted by the CGPM and is thus not an SI unit.

Liter and Metric Ton

The units liter and metric ton in Table 6 deserve comment. The liter and its symbol l were adopted by the CIPM in 1879. The alternative symbol for the liter, L, was adopted by the CGPM in 1979 in order to avoid the risk of confusion between the letter l and the number 1. Thus, although *both* l and L are internationally accepted symbols for the liter, to avoid this risk the preferred symbol for use in the United States is L. Neither a lowercase script letter l nor an uppercase script letter l are approved symbols for the liter. With regard to the metric ton, this is the name to be used in the United States for the unit with symbol t and defined according to 1 t = 10^3 kg. (The name ''metric ton'' is also used in some other English speaking countries, but the name ''tonne'' is used in many countries.)

Table 7. Units outside the SI that are accepted for use with the SI, but whose values in SI units are obtained experimentally

Name	Symbol	Value in SI units[1]
electronvolt[2]	eV	1 eV = $1.602\ 177\ 33(49) \times 10^{-19}$ J
unified atomic mass unit[3]	u	1 u = $1.660\ 540\ 2(10) \times 10^{-27}$ kg
astronomical unit[4]	ua	1 ua = $1.495\ 978\ 70(30) \times 10^{11}$ m

[1] The combined standard uncertainty (that is, estimated standard deviation) of the last two figures is shown in parentheses.
[2] The electronvolt is the kinetic energy acquired by an electron in passing through a potential difference of 1 V in vacuum.
[3] The unified atomic mass unit is equal to 1/12 of the mass of an unbound atom of the nuclide ^{12}C at rest and in its ground state.
[4] The astronomical unit is a unit of length approximately equal to the mean Earth-Sun distance. Its value is such that, when used to describe the motion of bodies in the solar system, the heliocentric gravitation constant is $(0.017\ 207\ 098\ 95)^2\ \mathrm{ua}^3 \cdot \mathrm{d}^{-2}$.

Other Units Outside the SI

Other units outside the SI that are currently accepted for use with the SI in the United States are given in Table 8. These units, which are subject to future review by the NIST Director on behalf of the Secretary of Commerce, should be defined in relation to the SI in every document in which they are used; their continued use is not encouraged. The CIPM currently accepts the use of all of the units given in Table 8 with the SI except for the curie, roentgen, rad, and rem. Because of the continued wide use of these units in the United States, especially in regulatory documents dealing with health and safety, this interpretation of the SI for the United States accepts their use with the SI. Nevertheless, use of the corresponding SI units is encouraged whenever possible, with values given in terms of the older units in parentheses if necessary.

Table 8. Other units outside the SI that are currently accepted for use with the SI, subject to future review

Name	Symbol	Value in SI units
nautical mile		1 nautical mile = 1852 m
knot		1 nautical mile per hour = (1852/3600) m/s
are[1]	a	1 a = 1 dam^2 = $10^2\ \mathrm{m}^2$
hectare[1]	ha	1 ha = 1 hm^2 = $10^4\ \mathrm{m}^2$
bar	bar	1 bar=0.1 MPa=100 kPa=1000 hPa=10^5 Pa
ångström	Å	1 Å = 0.1 nm = 10^{-10} m
barn	b	1 b = 100 fm^2 = $10^{-28}\ \mathrm{m}^2$
curie	Ci	1 Ci = 3.7×10^{10} Bq
roentgen	R	1 R = 2.58×10^{-4} C/kg
rad	rad[2]	1 rad = 1 cGy = 10^{-2} Gy
rem	rem	1 rem = 1 cSv = 10^{-2} Sv

[1] This unit and its symbol are used to express areas of land.
[2] When there is risk of confusion with the symbol for the radian, rd may be used as the symbol for rad.

Use of SI Prefixes With Units Outside the SI

Some SI prefixes are used with some of the units given in Tables 6, 7, and 8. For example, prefixes for both positive and negative powers of ten are used with the liter, the electronvolt, the unified atomic mass unit, the bar, and the barn. Prefixes for positive powers of ten are used with the metric ton, and prefixes for negative powers of ten are used with the neper and the bel, although the bel is most commonly used in the form of the decibel: 1 dB = 0.1 B.

Rules and Style Conventions

A number of rules and style conventions have been adopted internationally for the use of the SI to ensure that scientific and technical communication is not hindered by ambiguity. The most important of these are as follows:

1. Unit symbols are printed in roman (upright) type regardless of the type used in the surrounding text.

2. Unit symbols are printed in lower-case letters except that:

(a) the symbol or the first letter of the symbol is an upper-case letter when the name of the unit is derived from the name of a person; and

(b) the preferred symbol for the liter in the United States is L.

3. When the name of a unit is spelled out, it is always written with a lower-case initial letter unless it begins a sentence.

4. Unit symbols are unaltered in the plural.

5. Unit symbols are not followed by a period unless at the end of a sentence.

6. Symbols for units formed from other units by multiplication are indicated by means of a half-high (that is, centered) dot or space.

Example: N•m or N m

7. Symbols for units formed from other units by division are indicated by means of a solidus (oblique stroke,/), a horizontal line, or negative exponents.

$$\textbf{Example: } m/s, \ \frac{m}{s}, \text{ or } m \cdot s^{-1}$$

However, to avoid ambiguity, the solidus must not be repeated on the same line unless parentheses are used.

Examples:
m/s^2 or m•s^{-2} *but not:* m/s/s
m•kg/(s^3•A) or m•kg•s^{-3}•A^{-1} *but not:* m•kg/s^3/A

Negative exponents should be used in complicated cases.

8. Prefix symbols are printed in roman (upright) type regardless of the type used in the surrounding text, and are attached to unit symbols without a space between the prefix symbol and the unit symbol. This last rule also applies to prefix names attached to unit names.

Examples:
1 mL (one milliliter)
1 pm (one picometer)
1 GΩ (one gigaohm)
1 THz (one terahertz)

9. The dgrouping formed by a prefix symbol attached to a unit sybmbol constitutes a new inseparable symbol (forming a multiple or submultiple of the unit concerned) which can be raised to a positive or negative power and which can be combined with other unit symbols to form compound unit symbols.

Examples:
2.3 cm^3 = 2.3 $(cm)^3$ = 2.3 $(10^{-2}\ m)^3$ = 2.3×10^{-6} m^3
1 cm^{-1} = 1 $(cm)^{-1}$ = 1 $(10^{-2}\ m)^{-1}$ = 10^2 m^{-1}
5000 μs^{-1} = 5000 $(\mu s)^{-1}$
= 5000 $(10^{-6}\ s)^{-1}$
= 5000×10^6 s^{-1} = 5×10^9 s^{-1}

Prefix names are also inseparable form the unit names to which they are attached. Thus, for example, millimeter, micropascal, and meganewton are single words.

10. Compound prefix symbols, that is, prefix symbols formed by the juxtaposition of two or more prefix symbols, are not permitted. This rule also applies to compound prefix names.

Example: 1 nm (one nanometer) *but not:* 1 mμm (one millimicrometer)

11. An SI prefix symbol (and name) cannot stand alone, but must always be attached to a unit symbol (or name).

Example: 5×10^6/m^3 *but not:* 5M/m^3

12. In the expression for the value of a quantity, the unit symbol is placed after the numerical value and a space is left between the numerical value and the unit symbol. The only exceptions to this rule are for the unit symbols for degree, minute, and second for plane angle: °, ′, and ″, respectively (see Table 6), in which case no space is left between the numerical value and the unit symbol.

Example: α = 30°22′8″

This rule means that:

(a) The symbol °C for the degree Celsius is preceded by a space when one expresses the values of Celsius temperatures.

Example: t = 30.2 °C *but not:* t = 30.2°C or t = 30.2° C

(b) Even when the value of a quantity is used in an adjectival sense, a space is left between the numerical value and the unit symbol. (This rule recognizes that unit symbols are not like ordinary words or abbreviations but are mathematical entities, and that the value of a quantity should be expressed in a way that is as independent of language as possible.)

Examples:
a 1 m end gauge *but not:* a 1-m end gage
a 10 kΩ resistance *but not:* a 10-kΩ resistance

However, if there is any ambiguity, the words should be rearranged accordingly. For example, the statement ‘‘the samples were placed in 22 mL vials’’ should be replaced with the statement ‘’the samples were placed in vials of volume 22 mL, ’’ or ‘‘the samples were placed in 22 vials of volume 1 mL,’’ whichever was meant.

Note: When unit names are spelled out as is often the case in nontechnical writing, the normal rules of English apply. Thus, for example, ‘‘a roll of 35-millimeter film’’ is acceptable.

Obsolete Units

As stated in the 1990 **Federal Register** notice, metric units, symbols, and terms that are not in accordance with the foregoing interpretation are not accepted for continued use in the United States with the International System of Units. Accordingly, the following units and terms listed in the table of metric units in section 2 of the Act of July 28, 1866 (15 U.S.C. 205) that legalized the metric system of weights and measures in the United States are not accepted for use in the United States:

myriameter
stere
millier or tonneau
quintal
myriagram
kilo (for kilogram).

Additional Information on the SI

Additional information on the SI may be found in NIST Special Publication (SP) 811, *Guide for the Use of the International System of Units (SI),* by Barry N. Taylor. This publication is for sale by the Superintendent of Documents, but is also available online (as will be this notice) at URL http://physics.nist.gov/cuu. (Although the 1995 edition of SP 811 is the edition currently available in print and online, a new edition that fully reflects the contents of this notice is under preparation and will replace the 1995 edition.)

Although there is no formal comment period, public comments are welcome on a continuing basis. Comments should be submitted to Dr. Barry N. Taylor at the above address.

Dated: June 19, 1998.

Robert E. Hebner,

Acting Deputy Director.

[FR Doc. 98–16965 Filed 7–27–98; 8:45 am]

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