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Use of SI (Metric) Units

American Society of Agricultural and Biological Engineers

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1 Purpose and Scope

This Engineering Practice is intended as a guide for uniformly incorporating the International System of Units (SI). It is intended for use in implementing ASABE policy in accordance with ASABE Standardization Procedures.

2 Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies unless noted. For undated references, the latest approved edition of the referenced document (including any amendments) applies.

IEEE/ASTM SI-10, American National Standard for Use of the International System of Units (SI): The Modern Metric System

ISO 80000-1:2009, Quantities and units — Part 1: General

3 SI Units of Measure

3.1 Summary of SI units. SI consists of seven base units, two supplementary units, and a series of derived units consistent with the base and supplementary units. There is also a series of approved prefixes for the formation of multiples and submultiples of the various units. A number of derived units are listed in Table 1 including those with special names. Additional derived units without special names are formed as needed from base units or other derived units, or both.

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Table 1 – Derived units

Quantity	Unit	SI Symbol	Formula
acceleration	meter per second squared	–	m/s^2
activity (of a radioactive source)	disintegration per second	–	(disintegration)/s
angular acceleration	radian per second squared	–	rad/s^2
angular velocity	radian per second	–	rad/s
area	square meter	–	m^2
density	kilogram per cubic meter	–	kg/m^3
electrical capacitance	farad	F	A•s/V
electrical conductance	siemens	S	A/V
electrical field strength	volt per meter	–	V/m
electrical inductance	henry	H	V•s/A
electrical potential difference	volt	V	W/A
electrical resistance	ohm	Ω	V/A
electromotive force	volt	V	W/A
energy	joule	J	N•m
entropy	joule per kelvin	–	J/K
force	newton	N	$kg•m/s^2$
frequency	hertz	Hz	(cycle)/s
illuminance	lux	Lx	lm/m^2
luminance	candela per square meter	–	cd/m^2
luminous flux	lumen	ml	cd•sr
magnetic field strength	ampere per meter	–	A/m
magnetic flux	weber	Wb	V•s
magnetic flux density	tesla	T	Wb/m^2
magnetomotive force	ampere	A	–
power	watt	W	J/s
pressure	pascal	Pa	N/m^2
quantity of electricity	coulomb	C	A•s
quantity of heat	joule	J	N•m
radiant intensity	watt per steradian	–	W/sr
specific heat	joule per kilogram-kelvin	–	J/kg•K
stress	pascal	Pa	N/m^2
thermal conductivity	watt per meter-kelvin	–	W/m•K
velocity	meter per second	–	m/s
viscosity, dynamic	pascal-second	–	Pa•s
viscosity, kinematic	square meter per second	–	m^2/s
voltage	volt	V	W/A
volume	cubic meter	–	m^3
wavenumber	reciprocal meter	–	(wave)/m
work	joule	J	N•m

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3.2 Base and supplementary units. Table 2 provides a list of the seven base units and two supplementary units of SI. For definitions of these units, refer ISO 80000-1.

Table 2 – Base and Supplementary Units

	Term	Units
Base Units	meter (m)	unit of length
	second (s)	unit of time
	kilogram (kg)	unit of mass
	kelvin (K)	unit of thermodynamic temperature
	ampere (A)	unit of electric current
	candela (cd)	luminous intensity
	mole (mol)	the amount of a substance
Supplementary Units	radian (rad)	plane angle
	steradian (sr)	solid angle

3.3 SI unit prefixes. SI unit prefixes are shown in Table 3.

Table 3 – SI Unit Prefixes

Multiples & Submultiples	Prefix	SI Symbol
10^{18}	exa	E
10^{15}	peta	P
10^{12}	tera	T
10^{9}	giga	G
10^{6}	mega	M
10^{3}	kilo	k
10^{2}	hector	h
10^{1}	deka	da
10^{-1}	deci	d
10^{-2}	centi	c
10^{-3}	milli	m
10^{-6}	micro	µ
10^{-9}	nano	n
10^{-12}	pico	p
10^{-15}	femto	f
10^{-18}	atto	a

3.4 Derived units. Derived units are combinations of base units or other derived units as needed to describe physical properties, for example, acceleration. Some derived units are given special names; others are expressed in the appropriate combination of SI units. Some currently defined derived units are shown in Table 1.

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4 Rules for SI Usage

4.1 General. The established SI units (base, supplementary, derived, and combinations thereof with appropriate multiple or submultiple prefixes) should be used as indicated in section 4.

4.2 Application of prefixes. The prefixes given in Table 3 should be used to indicate orders of magnitude, thus eliminating insignificant digits and decimals, and providing a convenient substitute for writing powers of 10 as generally preferred in computation. For example:

— 12 300 m or 12.3 x 10^3 m becomes 12.3 km

— 0.0123 mA or 12.3 x 10^{-6} A becomes 12.3 μA

It is preferable to apply prefixes to the numerator of compound units, except when using kilogram (kg) in the denominator, because kg is a base unit of SI and should be used in preference to the gram. For example:

— Use 200 J/kg, not 2 dJ/g

With SI units of higher order, such as m^2 or m^3, the prefix is also raised to the same order. For example:

— mm^2 is $(10^{-3}\ m)^2$ or $10^{-6}\ m^2$

4.3 Selection of prefix. When expressing a quantity by a numerical value and a unit, a prefix should be chosen so that the numerical value lies between 0.1 and 1000, except where certain multiples and submultiples have been agreed for particular use. The same unit, multiple, or submultiple should be used in tables even when the series exceeds the preferred range of 0.1 to 1000. Double prefixes and hyphenated prefixes should not be used. For example:

— use GW not kMW

4.4 Capitalization. Except for liter (L) symbols for SI units are only capitalized when the unit is derived from a proper name; for example N for Isaac Newton. When spelled out as words, SI units (for example, kelvin and newton) are not capitalized. Numerical prefixes given in paragraph 3.1.2 and their symbols are not capitalized; except for the symbols M (mega), G (giga), T (tera), P (peta) and E (exa).

4.5 Plurals. When spelled out as words, SI units form their plurals in the usual manner. SI symbols are always written in singular form. For example:

— 50 newtons, 50 N

— 25 millimeters, 25 mm

4.6 Punctuation. Because some countries use a comma for the decimal marker and some countries use a dot for the decimal marker, use spaces instead of commas for grouping numbers into threes (thousands). For example:

— 6 357 831.376 88 not 6,357,831.376,88

4.7 Derived units. The product of two or more units in symbolic form is preferably indicated by a dot midway in relation to unit symbol height. The dot may be dispensed with when there is no risk of confusion with another unit symbol. For example:

— Use N•m, but Nm is acceptable

A solidus (oblique stroke, /), a horizontal line, or negative powers may be used to express a derived unit formed from two others by division. For example:

— m/s

— $\frac{m}{s}$

— $m \cdot s^{-1}$

Only one solidus should be used in a combination of units unless parentheses are used to avoid ambiguity.

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