Rules for SAE Use of SI (Metric) Units—SAE J916b

SAE Recommended Practice
Last Revised July 1976

**THIS IS A PREPRINT AND WILL
APPEAR IN THE NEXT EDITION
OF THE SAE HANDBOOK**

PREPRINT

The ϕ symbol is for the convenience of the user in locating areas where technical revisions have been made to the previous issue of the report. If the symbol is next to the report title, it indicates a complete revision of the report.

1. Introduction—In the spring of 1969 the SAE Board of Directors issued a statement that "SAE will include SI[1] units in SAE Standards and other technical reports." Much investigation has attended the determination of units of measure for use, since measurement practice all over the world is to some degree in a state of transition. Engineering use of measurement units in nearly every metric country of the world, and in all of those nations adopting metric units, is confronted with the struggle between the noncoherent technical metric units, such as kilogram-force and calorie, and the SI units, such as newton and joule.

This document establishes the rules for the use of SI units in SAE reports, including specifications and standards. It must be remembered that a technical committee may produce its reports in any units it feels are proper for the users—U. S. customary, SI, or other metric. However, if the units used are not SI as covered here, they must be followed by SI units.

Throughout this document, SI is intended to include recognized SI units as established by the international General Conference on Weights and Measures, and a limited number of other units that are not formal SI units. These other units are all included in ISO 1000, which is a world-wide document for use by all ISO[2] committees.

By careful contact with other countries, the General Conference, and ISO, this document will be updated as often as necessary to keep the use of SI units in SAE reports as nearly as possible in harmony with the units that will be adopted for United States and world use.

2. Units Approved for Use—All SAE documents produced under the Board of Directors' directive to "include SI units" must include as applicable:

2.1 Base Units of SI

length	—metre (m)
mass	—kilogram (kg)
time	—second (s)
electric current	—ampere (A)
thermodynamic temperature	—kelvin (K)
amount of substance	—mole (mol)
luminous intensity	—candela (cd)

2.2 Supplementary Units of SI

plane angle	—radian (rad)
spherical angle	—steradian (sr)

2.3 Recognized Derived Units of SI with Special Names

absorbed dose	—gray (Gy)
activity (of radionuclides)	—becquerel (Bq)
electric capacitance	—farad (F)
electric conductance	—siemens (S)
electric inductance	—henry (H)
electric potential diff.	—volt (V)
electric resistance	—ohm (Ω)
energy	—joule (J)
force	—newton (N)
frequency	—hertz (Hz)
illuminance	—lux (lx)
luminous flux	—lumen (lm)
magnetic flux	—weber (Wb)
magnetic flux density	—tesla (T)
power	—watt (W)
pressure or stress	—pascal (Pa)
quantity of electricity	—coulomb (C)

See ANSI Z210.1, paragraph 2, for more complete description.

2.4 Other Units that May Be Used for SAE

plane angle	—degree (°) (decimal divisions preferred)
time	—minute (min), hour (h), day (d), week, and year
temperature	—degree Celsius (°C)
volume	—litre
navigation	—knot, nautical mile

When these units are used, they need not be followed by SI units unless it suits the purpose of the document.

The litre which the General Conference established as a special name for the cubic decimetre, is approved for SAE use, normally for fluid measurement only, and the only prefix use allowed is ml.

TABLE 1—SI UNIT PREFIXES

Multiples and Submultiples	Prefixes	Symbols	Pronunciations
10^{18}	exa	E	ex'a
10^{15}	peta	P	pet'a
10^{12}	tera	T	ter'a
10^{9}	giga	G	ji'ga
10^{6}	mega	M	meg'a
10^{3}	kilo	k	kil'o
10^{2}	hecto	h	hek'to
10	deka	da	dek'a
10^{-1}	deci	d	des'i
10^{-2}	centi	c	sen'ti
10^{-3}	milli	m	mil'i
10^{-6}	micro	μ	mi'kro
10^{-9}	nano	n	nan'o
10^{-12}	pico	p	pe'co
10^{-15}	femto	f	fem'to
10^{-18}	atto	a	at'to

In the case of time, committees are urged to use the second and its multiples, but the units given above are permitted.

2.5 Other derived units as formed from those covered above.

3. Units Not Approved for Use as SI—Gravimetric force units, such as kilogram-force, or kilogram-force per square millimetre, which have been common in some countries, must not be used in SAE reports. Similarly, calorie, bar, angstrom, tonne, and dyne are not SI units and are not to be used. However, as stated in paragraph 1, this restriction does not preclude use of these units where a committee considers them to be the proper units for the users of the report, and provided they are followed with SI units in parentheses.

4. Multiplying Prefixes—Table 1 lists the prefixes to be used with SI units, observing the rules given in paragraph 5.

5. Rules for Use of Units

5.1 Requirements of this document establish the use of SI units in one of the following manners:

5.1.1 As regular units followed by other units in parentheses.

5.1.2 In parentheses following other units.

5.1.3 As regular units where presently usable by the user, in which case no units need be added in parentheses.

5.1.4 Under special circumstances it is permissible to deviate from these rules. See Appendix 2.

5.2 SI units must be those shown in Appendix A (Table A-1) or their decimal multiples, except as covered in paragraph 6.2. Other "pseudo" SI units shall not be used unless approval has been given by the Publication Advisory Committee of the SAE Technical Board. If units for quantities not included in Appendix A and not clearly covered by paragraph 6.2 are required, the above committee should be contacted for guidance.

An apparent anomaly exists in the use of the joule for work ($J = N \cdot m$) and the use of $N \cdot m$ for torque or bending moment. These are, however, entirely different units. In the former, the unit of work results from unit force moving through unit distance. In the latter, there is no implication of movement, and unit force acts at right angles to the lever arm of unit length. This would be readily seen if vectors were incorporated in the unit symbols. For these reasons, it is important to express work or energy in joules and moment of force or torque in newton metres, not joules.

5.3 Prefixes

5.3.1 Use of prefixes representing 10 raised to a power which is a multiple of 3 is recommended. In the case of prefixed units which carry exponents, such as units of area and volume, this may not be practical, however, and any listed prefix may be used.

5.3.2 Compound prefixes, such as milli-micro, are never used.

5.3.3 It is recommended that prefixes not be used in the denominator of a compound unit except for the kilogram (kg). (Since the kilogram is a base unit of SI, this particular multiple is not a violation and should be used in place of the gram: for example, use 200J/kg, not 2 dJ/g.)

2

TABLE 2—ABBREVIATIONS AND SYMBOLS FOR UNITS OTHER THAN SI

Unit Name	Symbol	Abbreviation	Unit Name	Symbol	Abbreviation
brake horsepower	bhp		horsepower	hp	
Brinell hardness number	Bhn		hour	h	hr
British thermal unit	Btu		inch	in	
calorie	cal		inch of water		in H₂O
candlepower		cp	inch of mercury		in Hg
cubic foot per minute	ft³/min	cfm	inch pound	in-lb	
cubic foot per second	ft³/s	cfs	kilocycle	kc	
cycle per minute	c/min	cpm	litre	l	
cycle per second	c/s	cps	mile	mile	
cycle	c		mile per hour	mile/h	mph
decibel	dB		minute (time)	min	
degree (angle)	°	deg	minute (angle)	'	min
degree Celsius (centigrade)	°C		ounce	oz	
degree Fahrenheit	°F		part per million		ppm
degree Rankine	°R		pint	pt	
dram	dr		pound	lb	
foot	ft		pound force	lbf	
footcandle	fc		pound force per square inch	lbf/in²	psi
foot per minute	ft/min		pound force per square inch absolute		psia
foot per second	ft/s		pound force per square inch gage		psig
foot pound	ft-lb		quart	qt	
friction horsepower	fhp		revolution per minute		rpm
gallon	gal		Saybolt universal second		SUS
gallon per minute	gal/min	gpm	second (angle)	"	sec
gallon per second	gal/s	gps	yard	yd	

5.3.4 When expressing a quantity by a numerical value and a unit, prefixes should preferably be chosen so that the numerical value lies between 0.1 and 1000. This is, of course, not true where certain multiples and units have been agreed to for particular use, or where tabular use requires the same unit, in a series, even though this means exceeding the preferred range of 0.1 to 1000.

5.3.5 The prefix becomes a part of the symbol or name with no separation (meganewton, MN).

5.3.6 Errors in *calculations* can be minimized if all quantities are expressed in SI units, and prefixes are replaced by powers of 10.

5.3.7 With SI units of higher order, such as m² or m³, the prefix is also raised to the same order; for example, 1 mm³ is $(10^{-3} m)^3$ or 10^{-9} m³.

5.4 Symbols and Abbreviations—Unit symbols and abbreviations are given in Tables 2 and A-1.

5.4.1 QUANTITY SYMBOLS are single letters representing the magnitude of physical quantities (*I* for electric current, *e* for the charge of an electron).

5.4.2 UNIT SYMBOLS are letters or groups of letters representing the units in which physical quantities are measured (m for metre, W · h for watt hour).

5.4.3 ABBREVIATIONS are shortened forms of words or phrases formed in various ways that have been accepted (com for common, amb for ambient).

5.4.4 SYMBOLS AND ABBREVIATIONS—This distinction is not always clear. Some expressions are both symbols and abbreviations (ft, in, yd). In some cases, particularly certain U.S. units of measure, both abbreviations and symbols exist. The abbreviation for cubic foot per minute is cfm, the symbol is ft³ min. Ampere is abbreviated amp but the symbol is A.

5.4.5 LETTER STYLE—Quantity symbols are single letters of the English or Greek alphabet, and are printed in italic (slanting) type (*A* for area, *m* for mass, *M* for moment).

Unit symbols are letters or groups of letters from the English alphabet, except Ω for ohm, the plane angle unit degree (°), and the multiplier prefix micro (μ). They are printed in roman or upright type.

Abbreviations are always letters from the word being abbreviated, except for rare cases when the abbreviation is taken from another language (no for number).

5.4.6 CAPITALIZATION[3]—Quantity symbols are established in upper or lower case and this use must always be maintained (*f*-frequency, *F*-force, *m*-mass, *M*-moment).

Unit symbols are always lower case, except that the first letter is upper case if the word is derived from a proper name (Hz, s, A).

These rules for capitalization must be followed for the SI symbols and multipliers even in applications where all other lettering is upper case (except computer language).

5.4.7 PLURAL—The form of symbols and abbreviations is the same for singular or plural (1 in, 10 in, 1 s, 27 s).

5.4.8 MATHEMATICAL EXPRESSIONS—Quantity symbols are used in the conventional fashion (product ab, quotient a/b or ab^{-1}, exponent a^x).

Unit symbols are used somewhat differently, since they are sometimes two or more letters (product a · b, quotient a/b, exponent a^x).

The solidus ( ) must not be repeated in the same expression unless ambiguity is avoided by parentheses. In complicated cases, negative powers or parentheses should be used. Use m/s² or m · s⁻², but not m s s. Use m · kg · (s³ · A), or m · kg · s⁻³ · A⁻¹, but not m · kg/s³/A.

Only symbols may be used in mathematical expressions.

Compound unit names are handled differently.[3]

5.4.9 Periods are not used after symbols or abbreviations. The same abbreviation is used for related noun, verb, adverb, etc. (inclusion, include, inclusive are all abbreviated incl). When these rules would cause confusion, spell out the word. Words of four letters or less are not abbreviated.

5.4.10 When writing a quantity, a space should be left between the numerical value and a unit symbol—for example, write 35 mm, not 35mm. An exception occurs when the symbols for degree of plane angle or degree Celsius are used, in which case the space is omitted—25°C.

5.5 Miscellaneous

5.5.1 With nominal sizes that are not measurements but are names for items, no conversion should be made: for example, ¼-20 UNC thread, 1 in pipe, 2 x 4 lumber.

5.5.2 The decimal point used by SAE is the dot on the line (.) for quantities in either U. S. customary or SI units.

To facilitate the reading of numbers having five or more digits, the digits should be placed in groups of three separated by a space instead of a comma, counting both to the left and to the right of the decimal point. In the case of four digits, the spacing is optional. This style also avoids confusion caused by the use elsewhere of commas to express decimal points. For example, use:

1 532 or 1532 instead of 1,532
132 541 816 instead of 132,541.816
983 769.788 16 instead of 983,769.78816

5.5.3 Surface finish expressed in microinches should be converted to micrometres (μm). Also, linear dimensions on engineering drawings will customarily be given in millimetres regardless of length.

6. General

6.1 The principal departure of SI from the gravimetric form of metric engineering units is the separate and distinct units for mass and force. The kilogram is restricted to the unit of mass. The newton is the unit of force and should be used in place of the kilogram-force. The newton instead of the kilogram-force should be used in combination units which include force; for example, pressure or stress (N/m² = Pa), energy (N · m = J), and power (N · m/s = W).

Considerable confusion exists in the use of the term weight to mean either force or mass.

In scientific use, the term *weight* of a body usually means a force related to gravity.[4] This force varies in time and space, and weight, if used to mean force varies also, observed values differing by over 0.5% at various points on the earth's surface.

---

[3]Handling of Unit Names—Names of units are never capitalized except at the beginning of sentences or in titles. (Modifiers used in unit names are capitalized if proper names; for example, degree Farenheit.) Compound unit names are formed with a space for product and the word "per" for quotient. Prefixes become part of the word: ampere (A), milliampere (mA), ampere second (A · s), metre per second (m/s).

---

[4]The force which if applied to the body would give it acceleration equal to the local acceleration of free fall.

In commercial and everyday use, the term weight is nearly always synonymous with mass. Thus, in speaking of a person's weight, the quantity referred to is mass.

Because of this dual use, it is wise to avoid the term weight, except under circumstances in which its meaning is completely clear. When the term is used, it is important to know whether mass or force is intended, and to use SI units properly as clarified in the first paragraph of this section, using kilograms for mass and newtons for force.

6.2 Many units for rates are not shown in Appendix A, but should be derived from approved units. For example, the proper unit for mass per unit time is kg/s.

6.3 Expressions that can be stated as a ratio of the same unit, such as 0.006 inch per inch, should be changed to a designation of a ratio such as 0.006:1. Where an expression might be shown in two different units one of which is a multiple of the other, reduce the expression to a common unit and show it as a ratio. Example: 1.50 in per ft = 0.125 ft per ft. Express as a ratio 0.125:1.

6.4 It has been internationally recommended that pressure units themselves should not be modified to indicate whether the pressure is "absolute" (that is, above zero) or "gage" (that is, above atmospheric pressure). If, therefore, the context leaves any doubt as to which is meant, the word "pressure" must be qualified appropriately.

> "... at a gage pressure of 13 kPa" or
> "... at an absolute pressure of 13 kPa" or
> "... reached an absolute pressure of 13 kPa",
> etc.

7. Conversion Techniques—Conversion of quantities between systems of units involves careful determination of the number of significant digits to be retained. To convert "1 quart of oil" to ".9463529 litre of oil" is, of course, nonsense because the intended accuracy of the value does not warrant expressing the conversion in this fashion.

This section provides information to be used as a guide in the conversion of quantities specified in SAE standards. In certain circumstances, reasons may exist for using other guidance. For example, in the case of interchangeable dimensions on engineering drawings, a more specific approach is outlined in SAE J390, Dual Dimensioning, although the methods given here will usually produce the same results.

All conversions, to be logically established, *must* depend upon an intended precision of the original quantity—either implied by a specific tolerance, or by the nature of the quantity. The first step in conversion is to establish this precision.

7.1 Precision of a Value—It is absolutely necessary to determine the intended precision of a value before converting.

The intended precision of a value *should* relate to the number of significant digits shown. The implied precision is plus or minus one-half unit of the last significant digit in which the value is stated. This is true because it may be assumed to have been rounded from a greater number of digits, and one-half unit of the last significant digit retained is the limit of error resulting from rounding. For example, the number 2.14 may have been rounded from any number between 2.135 and 2.145. Whether rounded or not, a quantity should always be expressed with this implication of precision in mind. For instance, 2.14 in implies a precision of ±0.005 in, since the last significant digit is in units of 0.01 in.

Two problems interfere with this, however:

(a) Quantities *may* be expressed in digits which are not intended to be significant. The dimension 1.1875 in may be a very precise one in which the digit in the fourth place is significant, or it may in some cases be an exact decimalization of a rough dimension 1³/₁₆ in, in which case the dimension is given with too many decimal places relative to its intended precision.

(b) Quantities *may* be expressed omitting significant zeros. The dimension 2 in may mean "about 2 in," or it may, in fact, mean a very precise expression which should be written 2.0000 in. In the latter case, while the added zeros are not significant in establishing the value, they are very significant in expressing the proper intended precision.

Therefore, it is necessary to determine an approximate implied precision before converting. This can usually be done by a knowledge of the circumstances, or information on the accuracy of measuring equipment.

If accuracy of measurement is known, this will provide a convenient lower limit to the precision of the dimension, and in some cases may be the only basis for establishing it. The implied precision should never be smaller than the accuracy of measurement.

A tolerance on a dimension will give a good indication of the intended precision, although the precision will, of course, be much smaller than the tolerance. A dimension of 1.635 ± 0.003 in obviously is intended to be quite precise, and the precision implied by the number of significant digits is correct (±0.0005 in, total 0.001 in). A dimension of 4.625 ± 0.125 in is obviously a different matter. The use of thousandths of an inch to express a tolerance of

0.25 in is probably the result of decimalization of fractions, and the expression is probably better written 4.62 ± 0.12, with an implied precision of ±0.005 (total implied precision 0.01 in). The circumstances, however, should be examined and judgment applied.

A rule of thumb often helpful for determining implied precision of a toleranced value is to assume it is one-tenth of the tolerance. Since the implied precision of the converted value should be no greater than that of the original, the total tolerance should be divided by 10, converted, and the proper significant digits retained in both the converted value and converted tolerance such that total implied precision is not reduced—that is, such that the last significant digit retained is in units no larger than one-tenth the converted total tolerance.

EXAMPLE: 200 ± 15 psi. Tolerance is 30 psi, divided by 10 is 3 psi, converted is about 20.7 kPa. The value (200 psi) converted is 1378.9514 ÷ 103.421335 kPa which should be rounded to units of 10 kPa, since 10 kPa is the largest unit smaller than one-tenth the converted tolerance. The conversion should be 1380 ± 100 kPa.

The conversion should be 1380 ± 100 kPa.

EXAMPLE: 25 ± 0.1 oz of alcohol. Tolerance is 0.2 oz, one-tenth of tolerance is 0.02 oz, converted is about 0.6 cm³. The converted value (739.34 ± 2.957 cm³) should be rounded to units of 0.1 cm³ and becomes 739.3 ± 3.0 cm³.

7.2 Conversion Procedure—In the sections that follow, the "total implied precision" discussed in paragraph 7.1 is referred to as "TIP."

7.2.1 First determine TIP.

7.2.2 Convert the dimension, TIP, and the tolerance if any, by the accurate conversion factor given in this document or ANSI Z210.1.

7.2.3 Choose the smallest number of decimals to retain, such that the last digit retained is in units equal to or smaller than the converted TIP.

7.2.4 Round off to this number of decimals by the following rules:

7.2.4.1 Where the digit next beyond the last digit to be retained is less than 5, the last digit retained should not be changed. Example: 4.46325 if rounded to three places would be 4.463.

7.2.4.2 Where the digits beyond the last digit to be retained amount to more than 5 followed by zeros, the last digit retained should be increased by one. Example: 8.37652 if rounded to three places would be 8.377.

7.2.4.3 Where the digit next beyond the last digit to be retained is exactly 5, the last digit retained, if even, is unchanged; but if odd, the last digit is increased by one. Example: 4.36500 becomes 4.36 when rounded to two places. 4.35500 also becomes 4.36 when rounded.

7.2.5 EXAMPLES

7.2.5.1 Test pressure 200 ± 15 psi
TIP not evident in this case
Total tolerance 30 psi, divided by 10 is 3 psi converted equals 20.68 kPa, for TIP use 10 kPa
Units to use, 10 kPa
200 ± 15 psi equals 1378.9514 ± 103.421 355 kPa, round to 1380 ± 100 kPa

7.2.5.2 A stirring rod 6 in long
Estimate of TIP. Assume intended precision ±¹/₁₆ in, TIP = ¹/₈ in
Converted TIP ¹/₈ × 25.4 = 3.17 mm
Units to use, 1 mm
6 in equals 152.4 mm, round to 152 mm

7.2.5.3 50 000 psi tensile strength
Estimate of TIP 400 psi from nature of use and precision of measuring equipment
Converted TIP 2.8 MPa
Units to use, 1 MPa
50 000 psi equals 344.737 85 MPa, round to 345 MPa

7.2.5.4 5.163 in length
Estimate of TIP 0.001 in (significant digits judged correct)
Converted TIP 0.0254 mm
Units to use, 0.01 mm
5.163 in equals 131.1402 mm, round to 131.14 mm

7.2.5.5 12.125 in length
Estimate of TIP 0.06 in from nature of use
Converted TIP 1.524 mm
Units to use 1 mm
12.125 in equals 307.975 mm, round to 308 mm

7.2.6 In dealing with toleranced quantities or quantities that establish limits, the rounding may be required in one direction only. When "maximum" or "minimum" are specified and judgment shows that these terms are mandatory, a maximum quantity must be rounded downward and a minimum rounded upward. The following illustrations show rounding of a dimension to two decimal places under different circumstances.

> Dimension converted to 131.7625 mm
> Round to two decimal places

(a) Normal dimension, untoleranced
   Round to 131.76 mm (closest to original)
(b) Dimension stated as "minimum"
   Round to 131.77 mm (rounded *up*)
(c) Dimension stated as "maximum"
   Round to 131.76 mm (rounded *down*)

Similarly, a toleranced quantity may be rounded as in item (a). However, if critical it may be first converted to limits and each limit rounded in the appropriate fashion depending on the nature of the individual limit. For absolute maintenance of the original limits, the upper limit should be rounded down and the lower limit rounded up. (This is method B described in ANSI Z210.1.)

8. Temperature Conversion—The SI unit for temperature is the kelvin. SAE will use kelvins principally for thermodynamics, but the Celsius temperature scale (formerly called Centigrade) will also be commonly used.

The Celsius scale is related to the kelvin scale as follows:
   One degree Celsius equals one kelvin exactly. Celsius temperature (t_C) is related to kelvin temperature (T_K) as follows:

$$T_K = 273.15 + t_C \text{ exactly}$$

The Celsius scale is related to the Fahrenheit scale as follows:
   One degree Celsius equals $9/5$ of a degree Fahrenheit, exactly. Celsius temperature (t_C) is related to Fahrenheit temperature (t_F) as follows:

$$t_C = 5/9 (t_F - 32)$$

APPENDIX A

TABLE A.1—LIST OF SI UNITS FOR SAE USE[a]

Quantity	Unit	Symbol	Other Units or Limitations	Quantity	Unit	Symbol	Other Units or Limitations
Space and Time				**Heat**			
plane angle	radian	rad	degree (decimalized)	temperature—thermodynamic[b]	kelvin	K	degree Celsius (°C)
solid angle	steradian	sr		temperature—common use	degree Celsius	°C	kelvin (K)
length	metre	m	nautical mile (navigation only)	linear expansion coefficient		K^{-1}	$°C^{-1}$
area	square metre	m^2	—	quantity of heat	joule	J	—
volume	cubic metre	m^3	litre (l) preferably for fluid	heat flow rate	watt	W	—
				density of heat flow rate		W/m^2	—
time	second	s	minute (min), hour (h), day (d), week and year	thermal conductivity		$W/(m \cdot °C)$	
				coefficient of heat transfer		$W/(m^2 \cdot K)$	$W/(m^2 \cdot °C)$
angular velocity	radian per second	rad/s		heat capacity		J/K	J/°C
velocity	metre per second	m/s	kilometre per hour (km/h) for vehicle speed, knot for navigation only	specific heat capacity		$J/(kg \cdot K)$	$J/(kg \cdot °C)$
				specific energy		J/kg	—
Periodic and Related Phenomena				**Electricity and Magnetism**			
frequency	hertz	Hz		electric current	ampere	A	—
rotational frequency	revolution per second	r/s (rps)	revolution per minute r/min (rpm)	electric charge	coulomb	C	—
				volume density of charge		C/m^3	—
Mechanics				surface density of charge		C/m^2	—
mass	kilogram	kg		electric field strength		V/m	—
density		kg/m^3		electric potential	volt	V	—
momentum		$kg \cdot m/s$		capacitance	farad	F	—
moment of momentum		$kg \cdot m^2/s$	—	current density		A/m^2	—
angular momentum		$kg \cdot m^2/s$	—	magnetic field strength		A/m	—
acceleration		m/s^2		magnetic flux density	tesla	T	—
moment of inertia		$kg \cdot m^2$	—	magnetic flux	weber	Wb	—
force	newton	N	—	self-inductance	henry	H	—
moment of force (torque)	newton metre[c]	$N \cdot m$	—	permeability		H/m	—
				magnetization		A/m	—
pressure and stress	pascal	Pa	(pascal = newton per square metre)	resistance, impedance	ohm	Ω	—
				conductance	siemens	S	—
viscosity (dynamic)	pascal second	$Pa \cdot s$	—	resistivity		$\Omega \cdot m$	—
viscosity (kinematic)	square metre per second	m^2/s	—	conductivity		S/m	—
				reluctance		H^{-1}	—
surface tension	newton per metre	N/m	—	**Light**			
energy work	joule	J	kilowatt hour (kW·h)	luminous intensity	candela	cd	—
power	watt	W	—	luminous flux	lumen	lm	—
impact strength		J	—	illuminance	lux	lx	—
				luminance		cd/m^2	—
				Chemistry			
				amount of substance	mole	mol	—

[a] Conversion factors between SI units and U.S. customary are given in Table A.2 and in ANSI Z210.1.

[b] Preferred use for temperature and temperature interval is degrees Celsius (°C), except for thermodynamic and cryogenic work where kelvins may be more suitable. For temperature interval 1 K = 1°C exactly.

[c] Or newton metre per radian, N·m/rad

5

TABLE A.2–COMMONLY USED CONVERSION FACTORS (FOR OTHERS, SEE ANSI Z210.1)

Quantity	To Convert	Multiply by[a]	Quantity	To Convert	Multiply by[a]
acceleration	ft/s² to m/s²	3.048* E − 01	power	hp (550 ft·lbf/s) to W	7.456 999 E + 02
	standard gravity units to m/s²	9.806 65* E + 00	pressure, stress	kgf/m² to Pa	9.806 65* E + 00
area	in² to m²	6.451 600* E − 04		poundal/ft² to Pa	1.488 164 E + 00
	ft² to m²	9.290 304* E − 02		lbf/ft² to Pa	4.788 026 E + 01
bending torque	kgf·m to N·m	9.806 65* E + 00		lbf/in² to Pa	6.894 757 E + 03
	lbf·in to N·m	1.129 848 E − 01		in Hg (60 F) to Pa (pressure only)	3.376 85 E + 03
	lbf·ft to N·m	1.355 818 E + 00	stress	see pressure	
	ozf·in to N·m	7.061 552 E − 03	temperature	°C to K	$t_K = t_C + 273.15$
energy work	Btu (IT) to J	1.055 056 E + 03		°F to K	$t_K = (t_F + 459.67)/1.8$
	calorie (IT) to J	4.186 8* E + 00		°F to °C	$t_C = (t_F - 32)/1.8$
	ft·lbf to J	1.355 818 E + 00	temperature interval	°C to K	1.0* E + 00
flow (volumetric)	ft³/min to m³/s	4.719 474 E − 04		°F to K or °C	1/1.8* E + 00
	gal (U.S.)/min to m³/s	6.309 020 E − 05	torque	see bending	
force	kgf to N	9.806 65* E + 00	work	see energy	
	lbf to N	4.448 222 E + 00	velocity	ft/min to m/s	5.08* E − 03
	poundal to N	1.382 550 E − 01		ft/sec to m/s	3.048* E − 01
heat capacity	Btu (IT)/lb to J/kg	2.326 000*		km/h to m/s	2.777 778 E − 01
length	in to m	2.54* E − 02		mile/h to m/s	4.470 4* E − 01
	ft to m	3.048* E − 01		mile/h to km/h	1.609 344* E + 00
	mile to m	1.609 344* E + 03	viscosity	centipoise to Pa·s	1.000 000* E − 03
mass	oz (avoir) to kg	2.834 952 E − 02		centistokes to m²/s	1.000 000* E − 06
	lb (avoir) to kg	4.535 924 E − 01	volume	ft³ to m³	2.831 685 E − 02
	slug to kg	1.459 390 E + 01		U.S. gallon to m³	3.785 412 E − 03
	ton (long) to kg	1.016 047 E + 03		in³ to m³	1.638 706 E − 05
	ton(short) to kg	9.071 847 E + 02		oz (fluid, U.S.) to m³	2.957 353 E − 05
plane angle	degree to rad	1.745 329 E − 02			

Exact relationships are followed by an asterisk.

[a] The factors are written as a number equal to or greater than one and less than ten with six or less decimal places. This number is followed by the letter E (for exponent), a plus or minus symbol, and two digits which indicate the power of 10 by which the number must be multiplied to obtain the correct value. For example,

3.523 907 E − 02 is 3.523 907 × 10² or 0.035 239 07

SAENORM.COM : Click to view the full PDF of j916b_197607

Ø **APPENDIX B**

As covered in 5.1, SI units are required in SAE reports. To assist committees in carrying out this requirement in special circumstances, some qualifying rules are covered here.

B1. In standards that have alternative or optional procedures based on apparatus calibrated in either U. S. customary or SI units, converted values need not be included. If optional procedures or dimensions produce equally acceptable results, the options may be shown by using the word "or" rather than parentheses: for example, in a 2-in gage length metal tension test specimen, the gage length may be shown as "2 in or 50 mm."

B2. A specific equivalent, for example 1.00 in (25.4 mm), need be inserted only the first time it occurs in each paragraph.

**B3.** Special instructions cover the use of tabular material.

Case 1. Limited Tabular Material—Provide SI equivalents in tables in parentheses or in separate columns.
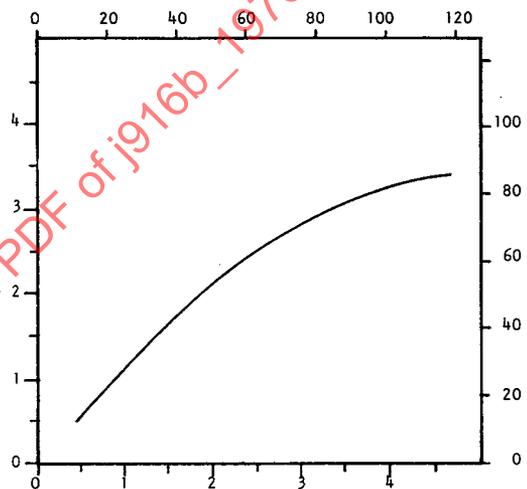
STRAIGHT WHEEL GRINDERS

H	L		R
	in	(mm)	
3/8-24 UNF-2A	1-1/8	(28.58)	Governed by thickness of wheel used
1/2-13 UNC-2A	1-3/4	(44.45)	
5/8-11 UNC-2A	2-1/8	(53.98)	
5/8-11 UNC-2A	3-1/8	(79.38)	
3/4-10 UNC-2A	3-1/4	(82.55)	

B4. Graphs and charts may be handled in several ways depending on the circumstances. In adding SI units to a graphic presentation of data, the practice of specific addition of metric conversions to existing ordinate or abscissa values should be avoided.
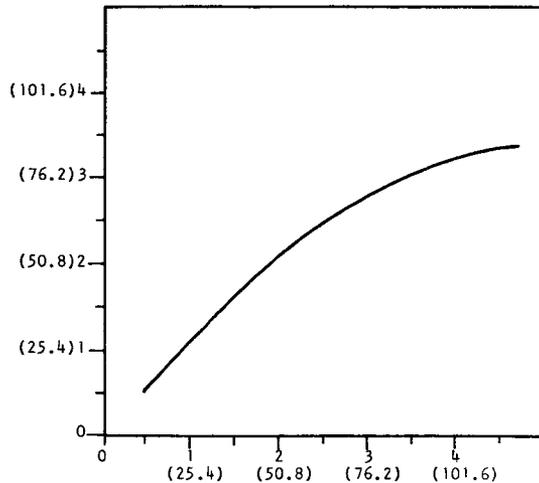
ACCEPTABLE PRACTICE
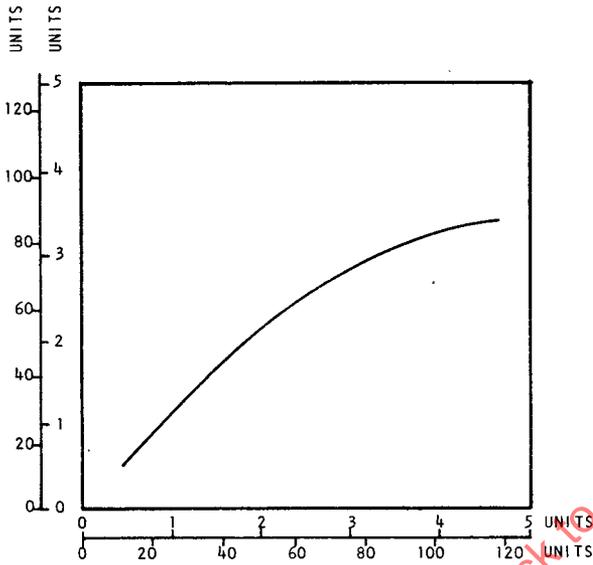
ACCEPTABLE PRACTICE

UNACCEPTABLE PRACTICE