INDIANA

DEPARTMENT
OF
TRANSPORTATION

STANDARD
SPECIFICATIONS

2024

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MEASUREMENTS

The first two paragraphs of 109.01, Measurement of Quantities reads as follows:

(a) General Requirements

All measurements of work completed under the contract will be according to the English System unless otherwise specified.

The standard measures shown in this publication are primarily in the English System of Units such as feet and inches, pounds, gallons, and acres. Any metric equivalents, shown in parentheses, are intended only for those contracts in which they are specified, or to maintain consistency with industry standards. No guarantee is provided, explicit or implicit, that the units are accurate conversions.

The following table and general notes are provided to assist you in becoming familiar with the metric system.

SI UNITS AND CONVERSION FACTORS

MEASUREMENT	ENGLISH UNIT	ENGLISH UNIT SYMBOL	MULTIPLIER FOR CONVERSION FROM ENGLISH UNIT TO SI UNIT (*)	SI UNIT	SI SYMBOL
Acceleration	foot per second squared	ft/sec^2	0.304 8 exactly	meter per second squared	m/s^2
	mile per hour squared	mi/h^2	1.060 93	kilometer per hour squared	km/h^2
Area	square inch	sq in.	645.16 exactly	square millimeter	mm^2
	square foot	sq ft	0.092 9	square meter	m^2
	square yard	sq yd	0.836 1	square meter	m^2
	acre	ac	0.404 7	hectare	ha
	square mile	sq mi	2.59	square kilometer	km
Density	pound per cubic foot	lb/cu ft	16.018 46	kilogram per cubic meter	kg/cu m
Energy	foot·pound force	ft lbf	1.355 8	joule	J
	kilowatt hour	kW h	3 600 000. exactly	joule	J
Force/Weight (Gravity of Force)	pound force	lbf	4.448 2	newton	N
	kilopound force	kip	4.448 2	kilonewton	kN
	ton	t	8.896 4	kilonewton	kN
Length	inch	in.	25.4 exactly	millimeter	mm
	foot	ft	0.304 8 exactly	meter	m
	yard	yd	0.914 4 exactly	meter	m
	mile	mi	1.609 3	kilometer	km
Mass	ounce	oz	28.349 5	gram	g
	pound mass	lbm	0.453 6	kilogram	kg
	ton mass	t	0.907 2	megagram	Mg
Power	horsepower (550 ft·lbf/s)	hp	745.669 9	watt	W
Pressure/Stress	pound per square inch	lb/sq in.	6.894 8	kilopascal	kPa
	pound per square foot	lb/sq ft	0.047 88	kilopascal	kPa
	kilopound per square inch	kip/sq in.	6.894 8	megapascal	MPa
Speed/Velocity	foot per second	ft/s	0.304 8 exactly	meter per second	m/s
	mile per hour	mph	1.609 3	kilometer per hour	km/h

Temperature	degree Fahrenheit	°F	(°F -32)/1.8(**) exactly	degree Celsius	°C
Volume, Fluid	cubic inch	cu in.	16.387 1	milliliter	mL
	fluid ounce	fl oz	29.573 4	milliliter	mL
	gallon	gal.	3.785 4	liter	L
	1000 gallons	kGAL.	3.785 4	kiloliter	kL
Volume, Solid	cubic inch	cu in.	16.387.06 exactly	cubic millimeter	mm^3
	cubic foot	cu ft	0.028 32	cubic meter	m^3
	bushel	bu	0.035 24	cubic meter	m^3
	cubic yard	cu yd	0.764 6	cubic meter	m^3
	1000 feet board measure	MFBM	2.359 7	cubic meter	m^3

(*) Conversion from SI unit to English unit may be made by dividing the SI unit by the conversion factor shown in this column.

(**) This is a formula, and not a multiplier. The Fahrenheit temperature is substituted for °F in the formula to attain the Celsius temperature. Conversion from Celsius temperature to Fahrenheit temperature may be made by substituting the Celsius temperature for °C in the formula (1.8 x °C) +32. This is an exact conversion.

Angles will continue to be measured in degrees, minutes, and seconds instead of radians.

GENERAL NOTES

1. The SI unit of millimeter shall be used to convert inches to millimeters.

2. The SI unit of Mass is the Kilogram (Kg) which shall be used for smaller masses expressed in pounds. The megagram (Mg) shall be used for larger masses expressed in tons.

3. All units peculiar to the various cgs systems (measurement systems constructed by using the centimeter, gram, and second as base units) shall be avoided.

4. In commercial and everyday use, the term weight nearly always means mass; thus, when one speaks of a person's weight, the quantity referred to is mass. In Science and Technology, the term weight of a body has usually meant the force that, if applied to the body, would give it an acceleration equal to the local acceleration of free fall g (acceleration of gravity). When the term is used, it is important to know whether mass or force is intended and to use SI Units properly, by using Kilograms for Mass or Newtons for Force. The use of force of gravity (mass times acceleration of gravity) instead of weight with this meaning is recommended. Because of the dual use of the term weight as a quantity, this term shall be avoided in technical practice except under circumstances in which its meaning is completely clear.

5. The term load means either mass or force, depending on its use. A load that produces a vertically downward force because of the influence of gravity acting on a mass may be expressed in mass units. Any other load is expressed in force units.

6. A quantity stated as limits, such as "not more than" or "maximum", shall be handled so that the stated limit is not violated.

7. Conversion of quantities shall be handled with careful regard to the implied correspondence between the accuracy of the data and the given number of digits. In all conversions, the number of significant digits retained shall be such that accuracy is neither sacrificed nor exaggerated. For example, a length of 125 ft converts exactly to 38.1 m. If however, the 125 ft length has been obtained by rounding to the nearest 5 ft, the conversion shall be given as 38 m. The proper conversion procedure is to multiply a value by a conversion factor that is more accurate than is required, the result is then rounded to the appropriate number of significant digits.

8. For calculation of results, avoid rounding of intermediate quantities. For reporting results, the rule for addition and subtraction is that the answer shall contain no significant digits farther to the right than occur in the least precise number. The rule for multiplication and division is that the product or quotient shall contain no

more significant digits than are contained in the number with the fewest significant digits used in the multiplication.

9. When a figure is to be rounded to fewer digits than the total number available, the standard “5” up procedures shall be used as follows:

    (a) When the first digit discarded is less than 5, the last digit retained shall not be changed. For example, 3.46325, if rounded to three digits, would be 3.463; if rounded to two digits, would be 3.46.

    (b) When the first digit discarded is 5 or greater, the last digit retained shall be increased by one unit. For example, 8.37652, if rounded to three digits, would be 8.377; if rounded to two digits would be 8.38.

10. Refer to ASTM SI10 American National Standard for Use of the International System of Units (SI) for other conversion factors.

11. This specification book uses the word “shall” to describe the Contractor’s responsibilities. The word “will” is used to describe the Department’s responsibilities. The words “shall” and “will” are not required to be followed by the words “by the Contractor” or “by the Department” to retain these meanings.