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**IEEE Recommended Practice:
Rules for the Use of Units of the
International System of Units**

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Foreword

In March 1966, the Institute of Electrical and Electronics Engineers published IEEE Standard 268-1966, Recommended Practice for Units in Published Scientific and Technical Work, a document that has had wide influence both inside and outside the IEEE.

The five years since then have seen ever increasing use of the metric system. The United Kingdom, Canada, and Australia have announced their intention of "going metric," and the United States is studying the problem. The question seems no longer to be "whether" but rather "when" and "how."

In support of the principle of international standardization, the IEEE Standards Committee reviews international standards recommendations, particularly those of the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC), in its area of interest. This document is technically identical with ISO Recommendation R1000 except that in accordance with other IEEE recommendations the spellings "kilogram," "meter," "liter," and "deka-" have been used in place of "kilogramme," "metre," "litre," and "deca-." ISO R1000 was drawn up by Technical Committee ISO/TC 12 (Quantities, Units, Symbols, Conversion Factors, and Conversion Tables) and was first published in 1969. It was reviewed and recommended for adoption by the IEEE Standards Coordinating Committee on Quantities and Units and was adopted by the IEEE Standards Committee on December 3, 1970.

By adopting ISO R1000 as an IEEE Recommended Practice, the Standards Committee continues its service of providing authoritative information on the metric system. Observant readers will note, for example, that the base unit for thermodynamic temperature is now called the kelvin, instead of "degree Kelvin." It is now properly given the symbol K, without the symbol °. This is a result of a decision taken by the General Conference of Weights and Measures in 1967.

Comments concerning this document may be sent to the Secretary, IEEE Standards Committee, 345 East 47 Street, New York, N.Y. 10017.

At the time it reviewed and recommended IEEE Std 322-1971, the IEEE Standards Coordinating Committee on Quantities and Units had the following membership:

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IEEE Recommended Practice: Rules for the Use of Units of the International System of Units

1. SCOPE

This Recommended Practice gives rules for the use of units of the International System of Units and for forming and selecting decimal multiples and submultiples of the SI units for application in the various fields of technology.

2. GENERAL

2.1 The name *Système International d'Unités* (International System of Units), with the abbreviation **SI**, was adopted by the 11th *Conférence Générale des Poids et Mesures* in 1960.

The coherent units are designated "SI units."

2.2 The International System of Units is based on the following six base units

meter (m) ampere (A)
kilogram (kg) kelvin (K)
second (s) candela (cd)

as units for the base quantities: length, mass, time, electric current, thermodynamic temperature, and luminous intensity.

2.3 The SI units for plane angle and solid angle, the radian (rad) and the steradian (sr) respectively, are called supplementary units in the International System of Units.

2.4 The expressions for the derived SI units are stated in terms of base units; for example, the SI unit for velocity is meter per second (m/s).

For some of the derived SI units special names and symbols exist; those approved by the *Conférence Générale des Poids et Mesures* are listed below:

Quantity	Name of SI Unit	Symbol	Expressed in Terms of Basic or Derived Unit
frequency	hertz	Hz	1 Hz = 1 s ⁻¹
force	newton	N	1 N = 1 kg·m/s ²
work, energy, quantity of heat	joule	J	1 J = 1 N·m
power	watt	W	1 W = 1 J/s
quantity of electricity	coulomb	C	1 C = 1 A·s
electric potential, potential difference, tension, electromotive force	volt	V	1 V = 1 W/A
electric capacitance	farad	F	1 F = 1 A·s/V
electric resistance	ohm	Ω	1 Ω = 1 V/A
flux of magnetic induction, mag- netic flux	weber	Wb	1 Wb = 1 V·s
magnetic flux density, magnetic induction	tesla	T	1 T = 1 Wb/m ²
inductance	henry	H	1 H = 1 V·s/A
luminous flux	lumen	lm	1 lm = 1 cd·sr
illumination	lux	lx	1 lx = 1 lm/m ²

It may sometimes be advantageous to express derived units in terms of other derived units having special names; for example, the SI unit of electric dipole moment ($A \cdot s \cdot m$) is usually expressed as $C \cdot m$.

2.5 Decimal multiples and submultiples of the SI units are formed by means of the prefixes given below:

Factor by Which the Unit Is Multiplied	Prefix	Symbol
10^{12}	tera	T
10^9	giga	G
10^6	mega	M
10^3	kilo	k
10^2	hecto	h
10	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

The symbol of a prefix is considered to be combined with the symbol to which it is directly attached, forming with it a new unit symbol which can be raised to a positive or negative power and which can be combined with other unit symbols to form symbols for compound units.

Examples:

$$\begin{aligned}
 1 \text{ cm}^3 &= (10^{-2} \text{ m})^3 = 10^{-6} \text{ m}^3 \\
 1 \mu\text{s}^{-1} &= (10^{-6} \text{ s})^{-1} = 10^6 \text{ s}^{-1} \\
 1 \text{ mm}^2/\text{s} &= (10^{-3} \text{ m})^2/\text{s} = 10^{-6} \text{ m}^2/\text{s}
 \end{aligned}$$

Compound prefixes should not be used; for example, write nm (nanometer) instead of $m\mu\text{m}$.

3. RULES FOR THE USE OF SI UNITS AND THEIR DECIMAL MULTIPLES AND SUBMULTIPLES

3.1 The SI units are *preferred*, but it will not be practical to limit usage to these; in addition, therefore, their decimal multiples and submultiples, formed by using the prefixes, are required.

In order to avoid errors in calculation it is essential to use coherent units. Therefore, it is strongly recommended that in calculations only SI units themselves be used, and not their decimal multiples and submultiples.

3.2 The use of prefixes representing 10 raised to a power which is a multiple of 3 is especially recommended.

Note:

In certain cases, to ensure convenience in the use of the units, this recommendation cannot be followed.

3.3 It is recommended that only one prefix be used in forming the decimal multiples or submultiples of a derived SI unit, and that this prefix be attached to a unit in the numerator.

Note:

In certain cases convenience in the use requires attachment of a prefix to both the numerator and the denominator at the same time, and sometimes only to the denominator.

4. NUMERICAL VALUES

4.1 When expressing a quantity by a numerical value and certain unit it has been found suitable in most applications to use units resulting in numerical values between 0.1 and 1000 .

The units which are decimal multiples and submultiples of the SI units should therefore be chosen to provide values in this range; for example,

Observed or Calculated Values	Can Be Expressed As
12 000 N	12 kN
0.003 94 m	3.94 mm
14 010 N/m ²	14.01 kN/m ²
0.0003 s	0.3 ms

4.2 The rule according to clause 4.1 cannot, however, be consistently applied. In one and the same context the numerical values expressed in a certain unit can extend over a considerable range; this applies especially to tabulated numerical values. In such cases it is often appropriate to use the same unit, even when this means exceeding the preferred value range 0.1 to 1000 .

5. LIST OF UNITS

For a number of commonly used quantities, examples of decimal multiples and submultiples of SI units, as well as of some other units which may be used, are given in the **Appendix** to this document.