Designation: E 621 – 94 (Reapproved 1999)$^{\epsilon 1}$

Standard Practice for Use of Metric (SI) Units in Building Design and Construction[1] (Committee E-6 Supplement to E380)

This standard is issued under the fixed designation E 621; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

ε[1] NOTE—Section 11 was added editorially in April 1999.

INTRODUCTION

The International System of Units (SI) was developed by the General Conference on Weights and Measures (CGPM), which is an international treaty organization. The abbreviation SI, derived from the French "Système International d'Unités," is used in all languages.

SI is a rational, coherent, international, and preferred measurement system which is derived from earlier decimal metric systems but supersedes all of them.

The use of the metric system in the United States was legalized by an Act of Congress in 1866, but was not made obligatory.

The *Meric Conversion Act of 1975*, as amended by the *Omnibus Trade and Competitiveness Act of 1988*, established the modernized metric system (SI) as the preferred system of measurement in the United States and required that, to the extent feasible, it be used in all federal procurement, grants, and business-related activities. Executive Order 12770 of July 25, 1991, *Metric Usage in Federal Government Programs*, mandated that federal agencies prepare metric transition plans, add metric units to their publications, and work with other governmental, trade, professional, and private sector metric organizations on metric implementation.

In the building design and construction community the application of SI units, together with preferred numerical values, will simplify and speed up calculations and facilitate all measurement intensive activity.

This document has been prepared to provide a single, comprehensive, and authoritative standard for SI units to be used in building design, product manufacture, and construction applications.

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[1] This practice is under the jurisdiction of ASTM Committee E-6 on Performance of Buildings and is the direct responsibility of Subcommittee E06.62 on Coordination of Dimensions for Building Materials and Systems.
Current edition approved Nov. 15, 1994. Published February 1995. Originally published as E 621 – 78. Last previous edition E 621 – 84 (1991)ε1.

1. Scope

1.1 This standard outlines a selection of SI units, with multiples and submultiples, for general use in building design and construction.

1.2 In addition, rules and recommendations are given for the presentation of SI units and symbols, and for numerical values shown in conjunction with SI.

1.3 A selection of conversion factors appropriate for use within the construction community is given in Appendix X1.

1.4 The SI units included in this document comply with and augment the ASTM Standard for Metric Practice E 380– 82 and are generally consistent with International Standards Organization (ISO) 1000 – 1981 SI Units and Recommendations for the Use of Their Multiples and Certain Other Units, and the ISO/31 Series of Standards, Quantities, and Units of SI.

2. Terminology

2.1 *Definitions:*

2.1.1 *SI*—The International System of Units (abbreviation for "le Système International d'Unités) as defined by the General Conference on Weights and Measures (CGPM)—based upon seven base units, two supplementary units, and derived units, which together form a coherent system.

2.1.2 *quantity*—measurable attribute of a physical phenomenon. There are base units for seven quantities and supplementary units for two quantities upon which units for *all* other quantities are founded.

2.1.3 *unit*—reference value of a given quantity as defined by CGPM Resolution or ISO Standards. There is *only one* unit for each quantity in SI.

2.1.4 *coherent unit system*—system in which relations between units contain as numerical factor only the number "one" or "unity," because all derived units have a unity relationship to the constituent base and supplementary units.

2.1.5 *numerical value of a quantity*—magnitude of a quantity expressed by the product of a number and the unit in which the quantity is measured.

3. The Concept of SI

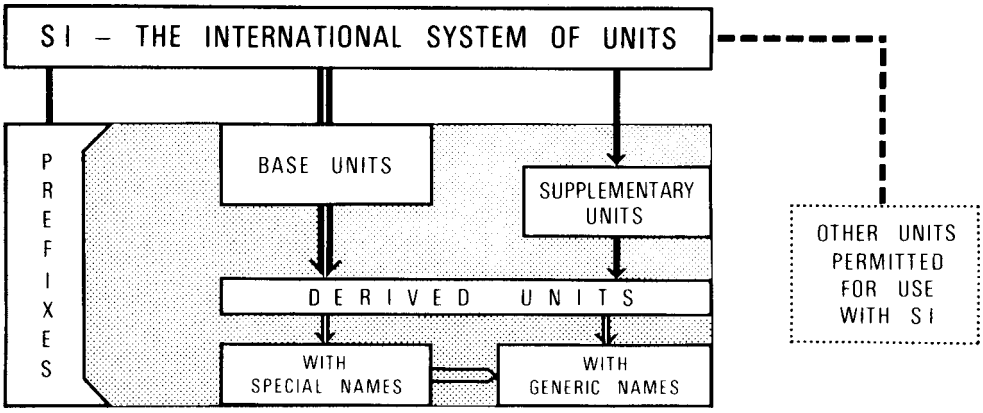
3.1 The International System of Units (SI) was developed to provide a universal, coherent, and preferred system of measurement for world-wide use and appropriate to the needs of modern science and technology.

3.2 The principal features of SI are:

3.2.1 There is only one recognized unit for each physical quantity.

3.2.2 The system is fully coherent; this means that all units in the system relate to each other on a unity (one-to-one) basis.

3.2.3 A set of internationally agreed prefixes can be attached to units to form preferred multiples and submultiples of 10



raised to a power that is a multiple of 3. This provides for convenient numerical values when the magnitude of a quantity is stated.

3.2.4 Units and their prefixes are represented by a set of standardized and internationally recognized symbols.

3.3 Because of their practical significance, the use of additional non-SI units in conjunction with SI is permitted for some quantities.

3.4 SI units, permissible non-SI units, and prefixes are discussed in Sections 4, 5, and 6.

3.5 The diagram below shows graphically the types of units within SI or associated with SI:

4. SI Units

4.1 The International System of Units (SI) has three classes of units:

4.1.1 Base units for independent quantities,

4.1.2 Supplementary units for plane angle and solid angle, and

4.1.3 Derived units.

4.2 The seven base units and two supplementary units are unique units which, except for the kilogram (Note 1), are defined in terms of reproducible phenomena.

NOTE 1—The primary standard for mass is the international prototype kilogram maintained under specified conditions at the International Bureau of Weights and Measures (BIPM) near Paris in France.

4.3 Derived units can all be defined in terms of their derivation from base and supplementary units. They are listed in two categories:

4.3.1 Derived units with *special* names and symbols, and

4.3.2 Derived units with *generic* or complex names.

4.4 A chart, indicating diagrammatically the relationship between the base units, supplementary units, and derived units that have been given special names, is shown in Appendix X2.

4.5 Table 1 contains base, supplementary, and derived units of significance in design and construction, listing:

4.5.1 Quantity,

4.5.2 Unit name,

4.5.3 Unit symbol,

4.5.4 Unit formula,

4.5.5 Unit derivation (in terms of base and supplementary units), and

4.5.6 Remarks.

5. Non-SI Units for Use with SI

5.1 There is an additional group of acceptable, but non-coherent traditional units retained in association with SI, because of their practical significance in general applications.

5.2 Non-SI units of significance to design and construction are shown in Table 2, under two categories:

5.2.1 Units for general use, and

5.2.2 Units for limited application only.

5.3 Appendix X3 shows a group of superseded metric units not recommended for use with SI in design and construction applications.

6. SI Unit Prefixes

6.1 SI is based on the decimal system of multiples and submultiples, and therefore the use of common fractions is minimized. Multiples are formed by attaching standard prefixes to SI units.

6.2 Preferred multiples range in geometric steps of 1000 (10^3) up to 10^{18}; submultiples range in geometric steps of 1/1000 (10^{-3}) down to 10^{-18}.

6.3 *Preferred Multiples and Submultiples*—The preferred prefixes shown in Table 3 are relevant in design and construction. Prefixes outside the range 10^{-6} (micro) to 10^6 (mega) will occur only in rare instances.

6.4 *Other Multiples for Limited Application*—SI includes a number of additional historically used multiples and submultiples, shown in Table 4, but these should be avoided as far as possible.

7. Rules and Recommendations for the Use of SI

7.1 Two tables of rules and recommendations have been prepared to facilitate the correct application of SI units and symbols and the correct presentation of units, symbols, and numerical values shown in conjunction with units and symbols.

7.2 Table 5 gives "Rules and Recommendations for the Presentation of SI Units and Symbols."

7.3 Table 6 gives guidance on "Presentation of Numerical Values with SI."

7.4 The tables provide a convenient reference guide for the editorial checking of metric documents to ensure that the presentation of data is in line with accepted practice.