PUB 729

Lawrence Berkeley Laboratory

GUIDELINES FOR METRICATION

JULY, 1993

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Prepared for the U.S. Department of Energy under Contract DE-AC03-76SF00098

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GUIDELINES FOR METRICATION AT LAWRENCE BERKELEY LABORATORY

Preamble: Goals of Metrication

Recognizing the value of adopting the common worldwide language of measurement, Lawrence Berkeley Laboratory has embarked on a program to implement the use of the metric system throughout its operations. The Laboratory's adoption of this program is in part a response to the legislative and executive mandates of the Federal government. By fostering metric usage, the Laboratory will further the purpose behind these mandates, that of enhancing the global competitiveness of U.S commerce. Metrication will also facilitate the realization of the Laboratory's research goals by unifying the languages of science and engineering.

1.0 Purpose of Document

This document provides a set of guidelines for the metric transition process already under way at Lawrence Berkeley Laboratory. LBL has embarked upon this course in response to Section 5164 of the Trade and Competitiveness Act of 1988, Executive Order 12770 of 1991, and DOE Order 5900.2. The core provision of DOE Order 5900.2 is Section 7b, which states:

> Metric usage shall be required except to the extent that such use is impractical, or is likely to cause significant inefficiencies to, or loss of markets by United States firms, or an inability of the Department to fulfill its responsibilities under the laws of the Federal Government and the United States.

LBL's metrication policy is meant to comply with this requirement by aggressively fostering metrication. The purpose of these guidelines is to optimize the coherence and the cost-effectiveness of the metrication process.

2.0 Scope of Metrication

Lawrence Berkeley Laboratory aims to implement the use of the International System of Units (SI) throughout its operations as rapidly as it is reasonable and cost effective to do so. In principle, all research programs, facilities, and equipment are subject to metrication. However, the Lab's Divisions are granted considerable latitude to determine the pace and stages of metric conversion. In general, postponement of metrication should only be allowed in situations where metric conversion would seriously impede Lab operations.

3.0 Definitions

Metric System—In general parlance, any of a number of closely related decimal unit systems, including the centimeter-gram-second (cgs) system, the meter-kilogram-second (MKS) system, the meter-kilogram-second-ampere (MKSA) system, and the current International System of Units (SI). As used in this document, the expressions *metric, metric system,* and *metric units* are to be understood as referring exclusively to the International System of Units.

International System of Units (SI)—The modern metric system, that is, the system of decimal units currently defined and sanctioned by the International Bureau of Weights and Measures, which operates under the authority of the General Conference on Weights and Measures. The name International System of Units (abbreviated SI, from the French *Système International d'Unités*) was adopted in 1960 by the General Conference on Weights and Measures,

Metrication—The process of expanding the use of SI units and phasing out the use of non-SI units.

Inch-Pound System—The system of measurement units most commonly used in the United States at present. This system is based on such units as the inch, the pound, the second, the degree Fahrenheit. It is also frequently referred to as the 'English System' or the 'U.S. System.'

Hard Metric Usage (or Practice)—Exclusive and direct use of SI units, that is, without first converting measurements made using inch-pound or other non-SI units into SI equivalents. Hard metric usage generally means that a product will differ physically from an analogous product designed and produced using the inch-pound system. For example, a mechanical designer working in the inch-pound system might specify the thickness of a flat metal part as 1 inch. Working in 'hard metric,' the same designer might specify the thickness of this part as 25 mm.

Soft Metric Usage (or Practice)—The conversion of inch-pound or other non-SI measurements to equivalent SI units, within the established measurement tolerances. In general, 'soft metric' products will not differ physically from analogous products fabricated using the inch-pound system. Working in 'soft metric', the mechanical designer in the example above would specify that the flat metal part in question is to be exactly 25.4 mm thick.

Metric Design—Design work that incorporates SI usage. For the purposes of this document, metric design generally means hard metric design, although soft metric design will be acceptable during the transitional period.

Dual Dimensioning—The inclusion of both SI and non-SI dimensions in drawings and publications.

Dual Indication—The inclusion of both SI and non-SI units and calibrations on instruments and gauges.

Hybrid Practice—Mixing SI units and non-SI units in an activity or a product.

4.0 Policy Statement

Henceforth the Lab will require the use of the modern metric system, the International System of Units (abbreviated SI, from the French *Système International d'Unités),* except when safety considerations dictate otherwise or when metric usage would entail excessive costs or otherwise seriously impede Lab operations. Exceptions will also be allowed for programs whose DOE sponsors specify the use of the inch-pound system. Division directors will have broad

responsibility for the course and pace of metrication within their respective divisions. The goal for LBL as a whole is to convert completely to metric usage within the next few years.

5.0 Responsibilities

All Laboratory planning, design, procurement, manufacturing, installation, integration, testing, operation, and maintenance are to be performed in a manner consistent with the provisions of this document. Division directors will be responsible for ensuring adherence to these guidelines within their respective divisions.

6.0 Implementation Guidelines

6.1 SI Units: Definitions

SI as currently defined is based on seven units that are considered dimensionally independent: the meter, the kilogram, the second, the ampere, the kelvin, the mole, and the candela. All other units are derived from these base units and two supplemental units that are considered dimensionless derived units, the radian and the steradian. Authorized definitions of the base and supplemental units are given in sections X1.12.1 through X1.12.9 (pp. 14–15) of ASTM E 380-92, *Standard Practice for Use of the International System of Units (SI) (the Modernized Metric System)*. For definitions of derived units that have special names, see section X1.13 (p. 15) of the same document. For a list of some commonly used derived units that do not have special names, see Table 4 (p. 3) of that document.

6.2 Metric Practice

Metric practice will conform to the provisions of ASTM E 380-92 and subsequent revisions of that document. ASTM E 380-92 prescribes standards of usage governing the following issues:

- Use of prefixes (section 4.2, p. 3).
- Permissible use of non-SI units under some circumstances (section 4.3.2, p. 4).
- Obsolete metric units and names to be avoided (section 4.3.4, p. 5).
- Specific SI units, including those expressing mass, force, and weight, temperature, linear dimensions, rotational mechanics, impact energy absorption, and pressure and vacuum (section 4.4, pp. 5–7).
- Use of nominal dimensions in naming customary items (section 4.4.3.1, p. 6).
- Writing numbers, numerals, and unit names and symbols (section 4.5, pp. 7–8).
- Conversion, rounding, and tolerances (section 5, pp. 8–12).
- Correct use of significant digits to indicate the accuracy of measured, converted, or computed quantities (section 5.3, pp. 9–10).

ASTM E 380-92 also provides two comprehensive tables of conversion factors, one alphabetical (pp. 18–24) and the other organized by categories of units (pp. 25–32). Appendix X3 (p. 17) of that document provides a guide to the use of these tables.

NOTE: Contrary to the style used in ASTM E 380-92, LBL drawings and publications will use the spellings *meter* and *liter* instead of *metre* and *litre*. LBL also expressly sanctions the use of the degree Celsius in place of the Kelvin in all contexts except formal scientific publications.

Adoption of a metric standard for fasteners will be coordinated with the other national laboratories by the Mechanical Engineering Department. LBL will adopt metric codes and standards governing other specific disciplines and trades as they become available.

6.3 New Design and Development

Metric design is preferred in all new projects. Major projects nearing completion that have been designed and constructed in the inch-pound system may be completed in that system. Material, components, parts, subassemblies, and semifabricated materials of commercial design will be specified in SI units except in cases where exemptions are granted on the basis of the criteria listed in Section 6.8 below. Bulk materials will be specified and accepted in SI units for projects and items designed and specified using SI units.

6.4 Repair, Modification, and Retrofit of Existing Inch-Pound Facilities and Equipment

Repair, modification, and retrofit of existing facilities and equipment of inch-pound design using SI-designed items is permissible. However, decisions concerning such modification will be determined on a case-by-case basis, with due consideration given to the technical and economic feasibility of using SI and to other relevant factors, such as safety. Final decision in such cases will be made by the project leader with the concurrence of the responsible Division director. In general, increasing use of SI-designed items is strongly encouraged.

6.5 Tools and Equipment

For the foreseeable future, shop, laboratory, and general-purpose tools and test equipment used by LBL personnel must enable them to work in either SI or inch-pound units or in both, depending on which system they encounter in their work situations. Purchase and assignment of tools and equipment must take this requirement into account, though gradual conversion to pure metric usage is expected to reduce its importance over time.

6.6 Technical Documentation

Technical documentation and LBL publications will comply with the following requirements:

1) Specifications and engineering drawings for new designs and modifications of existing designs. Beginning immediately, these engineering documents are to incorporate SI units in either of two ways. The preferred method will be SI units only. Alternatively, dual dimensioning may be used. Where dual dimensioning is used, the general rule will be for SI units to be given first, with the corresponding non-SI units following in parentheses. In cases where safety is a prime consideration and with the approval of the responsible division Director, engineering documents may use dual dimensioning with inch-pound units first and SI units following in parentheses.

2) Engineering calculations. All engineering calculations that contribute to metric designs will be done in SI units.

3) LBL publications. Metric units are to be used in all LBL reports and publications. Exclusive use of SI units is preferred wherever possible, but dual dimensioning will be allowed during the transitional period. Where dual dimensions are used, the preferred format will be SI units first and the corresponding inch-pound units in parentheses. For cases in which safety is a prime concern, publications may provide dual dimensions with inch-pound units first and SI units following in parentheses.

6.8 Deviation from SI Usage

Deviation from SI usage may be allowed at the discretion of each Division director. Acceptable criteria for allowing continued use of non-SI units include such factors as:

- safety considerations
- unavailability of applicable metrics standards
- unavailability of metric materials
- seriously adverse cost effects of metrication
- DOE instructions regarding the units to be used in specific projects or activities.

7.0 References

American Society for Testing and Materials. Standard Practice for Use of the International System of Units (SI) (the Modernized Metric System), ASTM E 380-92. Philadelphia, 1992.