NISTIR 4855

RECOMMENDED AGENCY PROCEDURES FOR IMPLEMENTING FEDERAL METRIC POLICY

James B. McCracken
Gary P. Carver

U.S. DEPARTMENT OF COMMERCE
Technology Administration
National Institute of Standards
and Technology
Metric Program
Technology Services
Gaithersburg, MD 20899

NIST

NISTIR 4855

RECOMMENDED AGENCY PROCEDURES FOR IMPLEMENTING FEDERAL METRIC POLICY

James B. McCracken
Gary P. Carver

U.S. DEPARTMENT OF COMMERCE
Technology Administration
National Institute of Standards
and Technology
Metric Program
Technology Services
Gaithersburg, MD 20899

May 1992

U.S. DEPARTMENT OF COMMERCE
Barbara Hackman Franklin, Secretary

TECHNOLOGY ADMINISTRATION
Robert M. White, Under Secretary for Technology

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY
John W. Lyons, Director

RECOMMENDED AGENCY PROCEDURES FOR IMPLEMENTING FEDERAL METRIC POLICY

I. PURPOSE AND SCOPE

The primary purpose of these recommended procedures is to assist federal agencies in their transition to the use of metric units[1] in regulations, data requests, recordkeeping, and reports. Although this document is intended for federal use, it may also be useful to state and local government agencies and other organizations.

II. BACKGROUND

The policy of the United States, as stated by Congress,[2] is to require that each federal agency, by a date certain and to the extent economically feasible by the end of fiscal year 1992, use the metric system in contracts, grants and other business related activities. The federal Interagency Council on Metric Policy (ICMP)[3] recommends that, in support of the national metric goals and the "Metric Conversion Policy for Federal Agencies" [1], federal agencies ensure:

---

[1] The "modernized" metric system is known as the International System of Units or SI (from the French "Le Systeme International d'Unites," which is abbreviated SI), and which is interpreted or modified for use in the United States by the Secretary of Commerce (55 FR 52242, Dec. 20, 1990). (See reference [1].)

[2] *Metric Conversion Act of 1975* (P.L. 94-168, 89 Stat. 1007; 15 U.S.C. 205 *et seq*, as amended by the Omnibus Trade Act of 1988, P. L. 100-418.)

[3] The ICMP is an interagency council chartered by the Secretary of Commerce under authority of EO 12770 (see reference [1]) whose members are senior policy officials representing 39 Federal Agencies that assist in formulating Federal metric policies, in consultation with the private sector.

-- That existing measurement-sensitive[4] regulations or requirements are amended as necessary to accommodate the transition to use of the metric system; and that metric units are the preferred units in new or revised regulations or requirements.

-- That metric measurement expressions used are both meaningful and practical and not mere mathematical conversions of inch-pound[5] values.

III. REFERENCE DOCUMENTS

There are a number of federal metric-related reference documents. These include the Executive Order on metric implementation [1], the interpretation of the metric system [1], guidance on using the metric system [2], and metrication in building design [3]. Metric-related documents published by the General Services Administration (GSA) include a federal standard listing preferred metric and inch-pound units and conversion values for use with those units [4], metric usage requirements in the Federal Acquisition Regulations [5], guidance on using metric units in federal product descriptions [6], guidance on preparing metric construction designs [7], and guidance on using metric units in federal information processing [8]. Documents have also been published by the Departments of Defense and Agriculture, as well as other agencies. In the private sector there are also many current and authoritative documents, including metric guidance for the manager [9], metric editorial guidance [10], metric construction

---

[4] A "measurement-sensitive" law, regulation, recordkeeping requirement or reporting requirement is one whose application or meaning depends substantially on some measured quantity (e.g., mandatory product or performance criteria or standards, such as emission levels, and/or size or weight limitations in shipping.) The mere presence of dimensions or measurement terms does not necessarily make an item "measurement sensitive."

[5] The term "inch-pound" units includes but is not limited to units based upon the inch and the pound commonly used in the United States. Note that "inch-pound" units having the same names in other countries may differ in magnitude.

guidance [11], and information on metric training materials [12]. Many of the above documents list other useful reference documents.

IV. AGENCY ACTIONS

A. When an agency implements preferred use of metric units, it should clearly define the policies, procedures, and conventions involved in its implementation. Common understanding of the agency's ground rules is key to successful implementation of change.

B. Agencies should be sensitive to the level of transition of all parties affected by their planned actions, because many sectors of the economy will differ in their approach to and/or willingness to complete their transition to the use of metric units. Depending on the extent of the use of metric units by affected parties, an agency might:

1. Use metric units as the primary units in all measurement-sensitive transactions. (For example, this would be done where an industry already uses metric units exclusively or has clearly indicated a decision to do so.); or

2. Use, on an interim basis, both metric and inch-pound units while clearly indicating a policy of preferring metric units with timetables and processes to achieve metric only usage. (For example, this might be done where an agency's measurement-sensitive mission needs cannot be met fully using available metric products.)

In those cases where the sole use of metric units would compromise good communication or other units have been specified as a contractual requirement, quantities should be expressed in metric units followed, in parentheses, by the same quantities expressed in the other units. Exceptions may sometimes be necessary for commercial devices, technical standards, or quantities having special legal significance; examples include commercial weights and measures devices and the related laws and regulations. However, even in such cases, quantities expressed in metric units should be used whenever possible with the inch-pound units following in parentheses.

C. Agencies should be aware that the acceptability of particular measurement units to a given industry or sector may not be apparent. Therefore, it is important to ensure adequate opportunity for comments by any affected industries, as well as the general public, on proposed changes in the measurement units to be used. *Federal Register* notices, press releases, or the like should be used for this purpose.

D. Federal metric policy [1] specifically prescribes that agencies shall:

1. Establish plans and dates for use of the metric system in procurements, grants and other business-related activities;

2. Coordinate, through the ICMP, metric transition plans with other federal agencies, state and local governments, and the private sector;

3. Require maximum practical use of metric units in areas where federal procurement and activity represents a predominant influence on industry standards (e.g., weapon systems or space exploration.) Strongly encourage metrication in industry standards where federal procurement and activity is not the predominant influence, consistent with the legal status of the metric system as *the preferred system of weights and measures for United States trade and commerce;*[6]

4. Assist in resolving metric-related problems brought to the attention of the agency that are associated with agency actions, activities, or programs undertaken in compliance with these guidelines or other laws or regulations;

5. Identify measurement-sensitive agency policies, procedures, regulations, standards, specifications, procurements, and legislative

---

[6] *Metric Conversion Act,* sec 3(1).

proposals and ensure that they are updated to remove barriers to transition to the metric system;

6. Consider cost effects of metric use in setting agency policies, programs, and actions and determine criteria for the assessment of their economic feasibility. Such criteria should appropriately weigh both agency costs and national economic benefits related to changing to the use of metric units;

7. Provide for full public involvement and timely information about significant metrication policies, programs, and actions;

8. Seek out ways to increase understanding of the metric system of measurement through educational information and guidance and in agency publications;

9. Consider, particularly, the effects of agency metric policies and practices on small business; and

10. Consistent with the Federal Acquisition Regulation System (48 CFR), accept, without prejudice, products and services dimensioned in metric units when they are offered at competitive prices and meet the needs of the Government, and ensure that acquisition planning considers metric requirements.

V. PRACTICAL AND MEANINGFUL MEASUREMENT EXPRESSIONS

A. Whenever possible, federal agencies should use the units recommended in Federal Standard 376 [4]. Conversion factors, rounding, and other elements of metric system usage not listed in Federal Standard 376, or for units not covered in Federal Standard 376, should be based on the latest editions of the reference documents listed in Federal Standard 376.[7]

---

[7] Both the American National Standards Institute (ANSI) and the American Society for Testing and Materials (ASTM), publish Metric Practice Standards, ANSI 268 and ASTM E380, respectively.

B. Agencies may be able to benefit from the experience of counterpart agencies in other countries where the metric system has been recently adopted. For instance, many British and Canadian agencies have already resolved problems similar to those that may also arise in the U.S. Government's transition.

C. Common sense, based on the knowledge and experience of the agency, should be the most important determinant in choosing practical and meaningful values, more precisely called "magnitudes," for the particular purposes involved. Many approaches can be used for selecting magnitudes in one measurement system in place of those of another. The following "approaches" are offered not as rules or restrictions, but to illustrate factors agencies may need to consider:[8]

1. Exact Mathematical Conversion: This process is used to obtain an exact change in measurement units only—without altering the magnitude. The metric equivalent to an inch-pound magnitude is determined by multiplying by the appropriate conversion factor. The result is then normally rounded in a manner that reflects the precision of the original inch-pound value. In exact mathematical conversion, the primary concern is the necessary degree of precision. The new values should have the same degree of precision as that of the value from which the conversion is made. This approach produces what is referred to as "soft" metric conversion.

2. Adaptive Conversion: This process changes a magnitude in one system to a magnitude in another that is reasonably equivalent. Above all, this process should result in conversions to

[8] For more technical guidance concerning significant digits, precision, accuracy, and tolerances, refer to the appropriate national standards cited in Footnote 7.

magnitudes that are meaningful and practical in application.[9] Judgments in this process are often subjective and may require balancing of competing interests, including magnitudes employed in international standards and practices in the same or similar areas of application. This approach comes closer to producing what is referred to as "hard" metric conversion.

3. Size Substitution: In this approach an inch-pound standard size is replaced with an accepted metric standard size for a particular purpose. Size substitution might be used in taxing, selling, or packaging liquids by the liter –instead of by the pint or quart (as for milk), or instead of by the gallon (as for gasoline), or the choice of square meters instead of square yards (as for textiles). This is usually done to conform to international practice, that is, to adopt an internationally recognized standard or convention for trade and communication. This approach produces a "hard" metric conversion.

D. Conversion of the values of quantities should 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 should be such that accuracy is neither sacrificed nor exaggerated:

1. Net content values on package labels are often shown in both inch-pound and metric units. The converted values, normally in parentheses, are often rounded to an appropriate degree of precision. The following table illustrates the above three approaches applied to the same inch-pound values:[10]

---

[9] Often overlooked in conversion is the need to allow for differences in the absolute size of the measurement units involved. For example, 36 inches would normally be converted to 91 centimeters, not 91.44 centimeters, or to 914 millimeters, not 914.4 millimeters. For details see Fed. Std. 376 Section 4.5.

[10] An exception to conventional rounding practices may be observed on certain grocery and other consumer items, where the converted quantity is rounded down to avoid overstatement of contents. This practice, which is still recommended by the

Nominal Value:	1 lb[11]	5 lb	10 lb
Exact Mathematical Conversion:	454 g	2.27 kg	4.54 kg
Adaptive Conversion:	450 g	2.25 kg	4.5 kg
Size Substitution:	500 g	2.5 kg	5.0 kg

2. The speed limits on the nation's interstate highway network, 55 or 65 miles per hour (mph), is an exact magnitude imposed by law. A "Exact Mathematical Conversion" of 55 mph yields 88.514 kilometers per hour (km/h). "Adaptive Conversion" would yield 88 km/h (or the even more awkward magnitude of 88.5 km/h). "Size Substitution" yields the more practical speed limit of 90 km/h, as widely chosen in Canada. Similarly the 65 mph limit might become 100 km/h.

3. Contracts for drilling water wells might require sampling geologic materials at specific depth intervals, usually 10 feet. Because these drilling depths are not measured precisely (perhaps they vary by ± 1 ft), it would not seem practical to convert contract specifications to metric intervals of 3.05 meters. A practical and meaningful conversion for this purpose might be 3 meter intervals.

National Conference on Weights and Measures, calls for dropping all digits of the converted quantity beyond the first three digits where converted metric units are also displayed. The Federal Trade Commission recommends and the Food and Drug Administration requires direct mathematical conversion with rounding procedures such as those set forth in Federal Standard 376.

[11] The value "1 lb" could conceivably be intended to represent 1, 1.0, 1.00, 1.000, or 1.0000 lb, or even greater accuracy, as might the 5 and 10 lb values. The converted value must be carried to a sufficient number of digits to maintain the accuracy implied or required in the original quantity.

4. A Federal Communications Commission rule included a requirement that "two new classes of stations, classes C1 and C2, with expected service ranges of 72 kilometers (45 miles) and 52 kilometers (32 miles), respectively, will be allowed to operate in Zone II." Note that instead of an exact mathematical conversion, a practical and meaningful "adaptive conversion" was chosen that satisfied the agency's purposes.

5. A recommended regulation on liquid measurement adopted by the National Conference on Weight and Measures states: "On a retail device with a designed maximum discharge rate of 25 gallons per minute (100 L/min) or greater, the maximum and minimum discharge rates shall be marked on an exterior surface of the device and shall be visible after installation." A practical and meaningful "adaptive conversion" satisfied the agency's purposes, avoiding a more precise but less practical magnitude such as 96 L/min.

6. The maximum truck body width allowed under the Surface Transportation Assistance Act of 1982 is 102 inches. A question arose as to whether trucks manufactured to the common European truck width of 2.6 meters (102.36 inches) would be allowed on U.S. highways. Common sense prevailed over unnecessary precision in this ruling; the Federal Highway Administration determined the 2.6 meter truck width to be acceptable.

7. An EPA regulation[12] specifies: "The sampling point for monitoring emissions shall be in the duct at the centroid of the cross section of the smoke stack if the cross sectional area is less than 50 ft^2 (4.645 m^2) or at a point no closer to the wall than 3 ft (0.914 m) if the cross sectional area is 50 ft^2 (4.645 m^2) or more." In this case EPA chose "exact mathematical conversion," since comparability between new and historical data was desired.

---

[12] 40 CFR, Part 57.404(a)(3).

However, a practical and meaningful "adaptive conversion" might have produced: "The sampling point for monitoring emissions shall be in the duct at the centroid for smoke stacks having a radius ≤1.2 m. For stacks >1.2 m the sampling point shall be at a point ≤92 cm from the stack wall." This would not have necessitated moving existing fixed measuring devices and would have allowed newly installed devices to collect samples in the same area of the smoke plume as devices installed under the inch-pound regulation.

E. Occasionally, product names may contain nominal dimensions. Such commercial designations are generally not true measurements and therefore should not be translated arbitrarily to metric units. For example, the "two by four," a nominal description of common lumber, is not actually 2 in. x 4 in. in cross section. Translation to precise metric units could therefore be misleading.

VI. DATA REQUESTS, RECORDKEEPING, AND REPORTS

It is often necessary to keep historical and current data comparable and consistent in precision, when some of the data are in inch-pound and some are in metric units.

A. Reports and Questionnaires - Each agency should decide what units will be used in reports it generates or requires from the private sector. Whenever the agency receives data in one system of units but reports it in another, it is recommended that the agency assume the burden of making the needed conversion. When metric transition is underway, overlap periods may be allowed.

Forms can be designed in a variety of ways to provide respondents with options as to which units they use. Dual columns, rows, or pages might be used when choice of units by the respondent is permitted. Alternative versions of the questionnaire (i.e., inch-pound and metric versions) might be provided.

B. Records - During a transition period from one measurement system to another, units from both systems must be accommodated. Agencies may encounter a wide variety of problems during such time and should plan how they will identify, co-mingle, convert, and ultimately standardize the recording of data. A typical problem arises in collecting and storing temperature data. Where no decimal value has been used for data recorded in degrees Fahrenheit (e.g., 93 °F), reports in degrees Celsius might use increments of 0.5 °C to keep approximately the same degree of precision. This is warranted because the Celsius degree is 1.8 times larger than the Fahrenheit degree. (NOTE: An expression containing one digit to the right of the decimal point suggests an accuracy of at least ±0.1. Such precision is not intended in this case and should be disclaimed if necessary.)

C. Recordkeeping -- ADP Considerations - Metric conversion, particularly during transition, may require computer software modifications. Special protocols may be needed to allow for the recording, processing, and display of information in the desired units. Also, the duration for maintaining dual units and any need to convert or provide conversion tables for historical data should be considered. Issues such as these should be coordinated by responsible ADP and/or statistical services personnel and the agency metric coordinator. The metric coordinator should be responsible for keeping all parties informed of proposed metric conversions in the agency.

VII. ASSISTANCE

Assistance in interpreting or implementing these recommendations, or in determining practical and meaningful metric values, is available from the Metric Program Office, U. S. Department of Commerce, National Institute of Standards and Technology, Room A146, Bldg. 411, Gaithersburg, MD 20899, telephone (301) 975-3690. Information on the status of metric conversion for a given industry sector might be obtained from relevant trade associations or the American National Metric Council (ANMC), 1735 N. Lynn St., Suite 950, Arlington, VA 22209-2022 and/or the U.S. Metric Association, 10245 Andasol Ave., Northridge, CA 91325-1504. These organizations are involved in planning for the metric transition in the private sector.

REFERENCES

1. *Interpretation of the SI and Metric Conversion Policy for Federal Agencies*, NIST SP 814*, which includes:
   Metric System of Measurement; Interpretation of the International System of Units for the United States, (55 FR 52242, Dec. 20, 1990); *Metric Conversion Policy for Federal Agencies*, 15 CFR Part 1170; and *Metric Usage in Federal Government Programs*, Executive Order 12770 of July 25, 1991 (56 FR 35801, July 29, 1991).

2. *Guide for the Use of the International System of Units, The Modernized Metric System*, NIST SP 811*.

3. *Metrication in Building Design, Production, and Construction -- A Compendium of 10 Papers*, NBS SP 530*.

4. *Preferred Metric Units for General Use by the Federal Government*, Federal Standard 376. The current version, 376A, dated May 5, 1983 is available from the General Services Administration, Specification Unit (WFSIS), Room 6039, 7th and D Streets, S.W., Washington, DC 20407.

5. *Specifications, Standards, and Other Purchase Descriptions*, Part 10(10.02) Federal Acquisition Regulation System (48 CFR), FAC 90-4, April 15, 1991.

6. *Use of Metric System Measurement in Federal Product Descriptions*, GSA Federal Property Management Regulation (FPMR), Final Rule, 41 CFR Part 101-29.

7. *Metric Design Guide, 2nd Edition*, GSA Office of Design and Construction, April 1992.

8. *Use of Metric Measures in FIP Acquisitions*, GSA Federal Information Resources Management Regulation (FIRMR), Bulletin C-31, January 2, 1992.

9. *Metrication for the Manager, 2nd Edition*, John T. Benedict, co-published by: Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, PA 15096-0001 and American National Metric Council, 1735 N. Lynn St., Suite 950, Arlington, VA 22209-2022.

10. *Metric Editorial Guide*, American National Metric Council, 1735 N. Lynn St., Suite 950, Arlington, VA 22209-2022.

11. *Metric Guide for Federal Construction,* National Institute of Building Sciences, 1201 L Street N.W., Washington, DC 20005.

12. *Freeman Training/Education Metric Materials List,* U.S. Metric Association, 10245 Andasol Ave., Northridge, CA 91325.

* Available from the National Technical Information Service, 5285 Port Royal Rd., Springfield, VA 22161

NIST-114A
(REV. 3-90)

U.S. DEPARTMENT OF COMMERCE
NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY

BIBLIOGRAPHIC DATA SHEET

1. PUBLICATION OR REPORT NUMBER
NISTIR-4855

2. PERFORMING ORGANIZATION REPORT NUMBER

3. PUBLICATION DATE
June 1992

4. TITLE AND SUBTITLE
Recommended Agency Procedures for Implementing Federal Metric Policy

5. AUTHOR(S)
James B. McCracken and Gary P. Carver

6. PERFORMING ORGANIZATION (IF JOINT OR OTHER THAN NIST, SEE INSTRUCTIONS)
U.S. DEPARTMENT OF COMMERCE
NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY
GAITHERSBURG, MD 20899

7. CONTRACT/GRANT NUMBER

8. TYPE OF REPORT AND PERIOD COVERED
Final

9. SPONSORING ORGANIZATION NAME AND COMPLETE ADDRESS (STREET, CITY, STATE, ZIP)
U.S. Department of Commerce
National Institute of Standards and Technology
Metric Program Office
Gaithersburg, MD 20899

10. SUPPLEMENTARY NOTES

11. ABSTRACT (A 200-WORD OR LESS FACTUAL SUMMARY OF MOST SIGNIFICANT INFORMATION. IF DOCUMENT INCLUDES A SIGNIFICANT BIBLIOGRAPHY OR LITERATURE SURVEY, MENTION IT HERE.)

Recommendations to assist Federal Agencies in the transition to use of metric units in regulations, data requests, recordkeeping and reporting requirements are presented. Although intended for Federal Agency use, the recommendations may be useful to state and local government agencies and other organizations.

12. KEY WORDS (6 TO 12 ENTRIES; ALPHABETICAL ORDER; CAPITALIZE ONLY PROPER NAMES; AND SEPARATE KEY WORDS BY SEMICOLONS)
Metric, Metrication, Metric Policy

13. AVAILABILITY

[X] UNLIMITED

[ ] FOR OFFICIAL DISTRIBUTION. DO NOT RELEASE TO NATIONAL TECHNICAL INFORMATION SERVICE (NTIS).

[ ] ORDER FROM SUPERINTENDENT OF DOCUMENTS, U.S. GOVERNMENT PRINTING OFFICE, WASHINGTON, DC 20402.

[X] ORDER FROM NATIONAL TECHNICAL INFORMATION SERVICE (NTIS), SPRINGFIELD, VA 22161.

14. NUMBER OF PRINTED PAGES
17

15. PRICE
A02

ELECTRONIC FORM