

METRIC MANAGEMENT AND TRAINING

How should design and construction firms, product manufacturers, code officials, and others in the construction industry prepare for metric? The American National Metric Council and the U.S. Metric Association recommend the following management and training measures, which apply to organizations large and small:

Provide top level commitment. Top level management must provide a firm commitment to metric. This includes: announcing a formal metric policy, forming a metric committee, and appointing a metric coordinator to chair the committee and act as the organization's metric representative.

Set milestones. Establish a realistic, organization-wide metrication schedule with milestones and a completion date.

Collect information. Begin a metric reference library. See the July-August issue of this newsletter for a list of metric construction references or refer to the more complete list in the *Metric Guide to Federal Construction*.

Develop training objectives. Write carefully worded, measurable training objectives with the goal of **"enabling employees to perform their jobs with the same or greater degree of efficiency using metric."**

Define the learner population. Determine who needs to know metric and to what extent they need to know it. Some employees may require an in-depth working knowledge of metric whereas others may never need to know it at all. Most probably will need to know only a few metric units.

Determine training needs. There are three kinds or levels of training: metric awareness training to help all employees overcome fear and resistance to change, management training to educate the people responsible for the transition to metric, and implementation training to teach specific metric skills to specific employees.

Train at the right time. Training should take place just prior to when an employee will use the new knowledge on the job; **earlier training is ineffective.**

Train only as needed. Train only as necessary to meet the goal of "enabling employees to perform their jobs with the same or greater degree of efficiency using metric." Training is not a panacea, and massive training programs are wasteful. **Often, training can be performed completely on-the-job.**

Train people to "think" metric. Link metric measurements to familiar objects. Avoid converting to inch-pound units as much as possible. For linear measurements use dual unit tape measures (see "Metric References" below).

Monitor the metrication program. Make sure training matches the organization's metric transition schedule. If something changes, adjust either the training or the schedule.

Don't hide costs. There is a cost to metric conversion, both in time and money. Plan for it in advance, and monitor costs as transition takes place.

General metric publications and materials are available from the U.S. Metric Association, 10245 Andasol Avenue, Northridge, CA 91325, phone 818-368-7443, and the American National Metric Council, 1735 North Lynn Street, Suite 950, Arlington, VA 22209-2022, phone 703-524-2007.

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METRIC RESOURCES

Dual unit tape measures. The use of dual unit tape measures is considered one of the best ways to learn metric on the job because they provide a quick and easy means of "visualizing" linear dimensions in metric. Stanley Tools, Lufkin, U.S. Tape, Starrett Tools, and others make dual unit tape measures. Check larger hardware stores or call Stanley Tools at 1-800-262-2161, Lufkin at 912-362-7511, or U.S. Tape at 703-256-1500.

Metric drawing scales. Metric architect and engineer scales are available from graphic arts supply stores. Popular models are the Staedtler-Mars 987-18-1, Alvin 117 PM, and Charvoz 30-1261.

Metric plumbing template. A metric plumbing template is available from American Standard. Call Ms. Barbara Munson at 703-841-9585.

Metric guides. Two metric guides are available from the Publications Department, National Institute of Building Sciences (NIBS), 1201 L St., N.W., Suite 400, Washington DC 20005; phone 202-289-7800 (bulk orders are available at a discount):

Metric Guide for Federal Construction (34 pg, \$15). Written specifically for the construction industry and reviewed by metric experts throughout the country. Includes a background on the federal metric laws, facts on metric in construction, an introduction to metric units, a primer on metric usage for architects, engineers, and the trades, requirements for metric drawings and specifications, guidance on metric management and training, and a listing of current metric construction references.

GSA Metric Design Guide, second draft edition (78 pg loose-leaf, \$8, \$5 if ordered with above guide). Interim design guide developed by GSA for use by federal project managers and their A/Es. Contains practical architectural, civil, structural, mechanical, and electrical design information, a list of available "hard" metric products, sample drawings, and related reference information.

Both guides also are available in electronic form on the Construction Criteria Base (CCB), a large database of construction criteria and standards on optical disk. For more information about the CCB, call NIBS at the above number.

FEDERAL METRIC PROJECTS GAIN MOMENTUM

The **General Services Administration**, which serves as the "federal landlord," now has over \$1 billion in metric projects in the planning, design, or construction stages.

The **National Institute of Standards and Technology** is planning about \$1 billion in facilities work for its campuses in Gaithersburg, Maryland, and Denver, Colorado. Work is scheduled to be in metric.

Most of the **Department of Energy's** \$8.2 billion Super Collider project will be constructed in metric.

Two new **Smithsonian Institution** facilities with a total cost of over \$150 million will be built in metric.

The **Army Corps of Engineers, Air Force, Office of the Secretary of Defense, NASA,** and the Public Health Service are conducting over \$60 million in metric pilot projects with significantly more work in planning.

The \$400-\$500 million **Defense Medical Facilities** program for FY 95 is scheduled to be in metric.

The **Department of State** continues to build in metric with current projects totaling \$275 million.

BASIC METRIC

There are seven metric base units of measurement, six of which are used in design and construction. (The seventh, mole, is the amount of molecular substance and is used in physics.)

Quantity	Unit (Symbol)
length	meter (m)
mass	kilogram (kg)
time	second (s)
electric current	ampere (A)
temperature	k (K)
luminous intensity	candela (cd)

Note that "weight" in common practice often is used to mean "mass."

Celsius temperature (°C) is more commonly used than kelvin (K), but both have the same temperature gradients. Celsius temperature is simply 273.15 degrees warmer than kelvin, which begins at absolute zero. For instance, water freezes at 273.15 K and at 0 °C; it boils at 373.15 K and at 100 °C. To move between Celsius and kelvin, add or subtract 273.15.

VISUALIZING METRIC

A few basic comparisons that help in visualizing metric are well worth remembering:

- One millimeter (mm) is about 1/25 inch or slightly less than the thickness of a dime.
- One meter (m) is the length of a yardstick plus about 3-1/3 inches.
- One gram (g) is about the mass (weight) of a large paper clip.
- One kilogram (kg) is about the mass (weight) of a softbound model building code book (2.2 pounds).

- One liter (L) is about the volume of a 4 inch cube (100 mm x 100 mm x 100 mm)--a little over one quart. One liter of water has a mass of 1 kilogram.
- One inch is just a fraction (1/64 inch) longer than 25 mm (1 inch = 25.4 mm; 25 mm = 63/64 inch).
- Four inches are about 1/16 inch longer than 100 mm (4 inches = 101.6 mm; 100 mm = 3-15/16 inches).
- One foot is about 3/16 inch longer than 300 mm (12 inches = 304.8 mm; 300 mm = 11-13/16 inches).
- Four feet are about 3/4 inch longer than 1200 mm (4 feet = 1219.2 mm; 1200 mm = 3 feet, 11¼ inches).
- The metric equivalent of a typical 2-foot by 4-foot ceiling grid is 600 x 1200 mm, so metric ceiling tiles and lighting fixtures are about 3/8 inch smaller in one dimension and 3/4 inch smaller in the other.
- Similarly, the metric equivalent of a 4 by 8 sheet of plywood or drywall is 1200 x 2400 mm so metric sheets are about 1-1/2 inches shorter and 3/4 inch narrower.
- "Rounding down" from multiples of 4 inches to multiples of 100 mm makes dimensions exactly 1.6 percent smaller and areas about 3.2 percent smaller. About 3/16 inch is lost in every linear foot.

METRIC MODULES AND GRIDS

The basic metric module is 100 mm (about 4 inches; see above). Submodules in preferred order are 50 mm (about 2 inches), 25 mm (about 1 inch), 20 mm, 10 mm, and 5 mm. Multimodules in preferred order are 300 mm (about 1 foot), 600 mm (about 2 feet), 1200 mm (about 4 feet), 3000 mm (about 10 feet), and 6000 mm (about 20 feet). For buildings, the metric planning grid is usually 600 mm.

**METRIC DRAWING
SCALES**

Metric scales are true ratios and are the same for both architectural and engineering drawings. Preferred scales are:

1:1	Same as full size
1:5	Close to 3" = 1'-0"
1:10	Between 1" = 1'-0" and 1-1/2" = 1'-0"
1:20	Between 1/2" = 1'-0" and 3/4" = 1'-0"
1:50	Close to 1/4" = 1'-0"
1:100	Close to 1/8" = 1'-0"
1:200	Close to 1/16" = 1'-0"
1:500	Close to 1" = 40'-0"
1:1000	Close to 1" = 80'-0"

METRIC FACTS: Area

How wide? How long? From these questions we get area. The metric unit for area is the square meter (m²). It is one of the system's simpler derived units. Derived units are those made from a combination of one or more of the seven base units. The square meter is the area enclosed by a square with 1-meter sides. It is equal to 10.76 square feet. But the square meter is too large for much mechanical engineering work so the square millimeter (mm²) is used. To translate this into customary units, 1 in² = 645.16 mm². For areas much larger than the square meter, the square kilometer is used (km²). There are 2.59 km² in a square mile.

Problem: What is the approximate cross-sectional area in square meters of a rectangular duct that measures 4 ft x 5 ft?

Solution: 4 ft x 5 ft = 20 ft² 20 ft² x (1 m²/10.76 ft²) = 1.86 m²

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Metric in Construction is a bimonthly newsletter published by the Construction Metrication Council to inform the building community about metrication in U.S. construction. The Construction Metrication Council was created by the National Institute of Building Sciences to provide industry-wide, public and private sector support for the metrication of federal construction and to promote the adoption and use of the metric system of measurement as a means of increasing the international competitiveness, productivity, and quality of the U.S. construction industry.

The National Institute of Building Sciences is a nonprofit, nongovernmental organization authorized by Congress to serve as an authoritative source on issues of building science and technology.

The Council is an outgrowth of the Construction Subcommittee of the Metrication Operating Committee of the federal Interagency Council on Metric Policy. The Construction Subcommittee was formed in 1988 to further the objectives of the 1975 *Metric Conversion Act*, as amended by the 1988 *Omnibus Trade and Competitiveness Act*. To foster effective private sector participation, the activities of the subcommittee were transferred to the Council in April 1992. The Council is supported by funds from contributing federal agencies.

Membership in the Council is open to all public and private organizations and individuals with a substantial interest in and commitment to the Council's purposes. The Council meets monthly in Washington, D.C.; publishes the *Metric Guide to Federal Construction* and this bimonthly newsletter; and coordinates a variety of industry metrication task groups. For membership information, call the Council at the above phone number.

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