Metric Design Guide

CCB Application Notes: 1. Character(s) preceded & followed by these symbols (À Ù) or (Ú ¿) are super- or subscripted, respectively. EXAMPLES: 42mÀ3Ù = 42 cubic meters COÚ2¿ = carbon dioxide 2. All degree symbols have been replaced with the word deg. 3. All plus or minus symbols have been replaced with the symbol +/-. 4. All table note letters and numbers have been enclosed in square brackets in both the table and below the table. 5. Whenever possible, mathematical symbols have been replaced with their proper name and enclosed in square brackets. METRIC DESIGN GUIDE (PBS-PQ260) September 1995 U.S. General Services Administration Public Buildings Service . TABLE OF CONTENTS TABLE OF CONTENTS

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METRIC DESIGN GUIDE Introduction Pub. L. 100-418 designated the metric system as the preferred system of weights and measures for U.S. trade and commerce. This law also directed all Federal procurement, grants, and other business-related activities to be metric by September 1992, unless this was impractical or likely to cause loss of markets to U.S. firms. Presidential Executive Order 12770, July 29, 1991, designated the Secretary of Commerce to direct and coordinate metric conversion efforts by all Federal departments and agencies, and authorized the development of specific dates for metric conversion in industries where September 1992 was impractical. Executive Order 12770 also authorized the Secretary to create an Interagency Council on Metric Policy (ICMP) to assist the effort. The ICMP established 10 working subcommittees, each responsible for the conversion of Federal procurement in a major industry. The Construction Subcommittee was established to oversee metric conversion in the Federalconstruction industry. In industries where a September 1992 conversion deadline was not feasible, the Executive order authorized a department or agency to consult the Secretary of Commerce to

establish a more feasible date. The Construction Subcommittee evaluated the construction industry and proposed an alternate conversion date of January 1, 1994. This date allowed time to revise standards after some experience with pilot projects. The Subcommittee requested this time because, in the spirit of the law, it was going to propose using as many modular hard-dimension products as are made at any given time. The General Services Administration (GSA) order, GSA Metric Program (ADM 8000.1B), dated November 11, 1992, required that all procurement be in the metric system of measurement by October 1992 or waivers be issued, supported by an assessment. This order established the alternative dateof January 1, 1994, for construction. Cooperation between Government and the private sector has been vigorously pursued as required by the Executive order. The Construction Subcommittee established a Construction Metrication Council in the National Institute of Buildings Sciences. The meetings of the Construction Metrication Council are attended by Federal agencies involved in construction, professional societies, trade organizations, product manufacturers, labor representatives, code organizations, and design firms. Attendance at the Council is extended to other parties interested in monitoring and assisting the metric conversion of the Federal construction community. Page 1PBS-PQ260. METRIC DESIGN GUIDE All GSA designs for renovation and new construction started after January 1, 1994, are being done in the metric system. Most Federal agencies involved in construction have already committed significant projects to be designed and built in metric. Many private firms and governmental agencies involved with international construction have provided input and feedback to the material presented here. This document was coordinated with available private sector and professional society metric design guidance. Whenever possible, existing guidance has simply been adopted. Where private guidance did not exist, the most feasible direction has been developed and presented. There are several "metric" systems in use in the world. The U.S. Government has adopted the International System of Units, abbreviated SI, from the French Systme international d'units. SI is used by major professional and code organizations. An objective of the development of this document has been to minimize the impact on design firms, contractors, and product manufacturers, while still complying with the national directive of increasing U.S. competitiveness. Due to the developmental nature of metric design in the United States it is probable that this document will be updated occasionally to incorporate new metric design information and metric product manufacturers. PBS-PQ260 Page 2. METRIC DESIGN GUIDE International Acceptance U.S. industrial firms have sometimes been excluded from dealing in international markets because they are unable to deliver goods measured in metric terms. Others are increasingly unwilling to overcome this hurdle to utilize our products. U.S. firms in many cases then have to produce two sizes of a particular product. U.S. firms will enjoy enhanced export potential by conducting business in the international language of measurement. Many companies have taken the initiative to understand foreign markets and become fluent in metric.

Simplicity Metric is decimal-based, and therefore simpler and faster to use. Trying to multiply 27 feet, 8-5/8 inches, by 32 feet, 6-7/16 inches, to obtain area demonstrates the complexity of our current system. English dimensions have to be converted to be added or multiplied, while metric ones do not. The Canadian Construction Association reports that metric produced direct benefits, in terms of reductions in design costs and time, increased efficiencies in construction operations, and improved material and component dimensioning techniques, when commercial construction in Canada switched to the metric system years ago. The U.S. Government in its own operations could expect the same advantages as stated in Pub. L. 100-418. Product Variations Many organizations and some businesses have viewed metric conversion as an opportunity, and simultaneously selected fewer standard product sizes, reducing inventories and required manufacturing equipment. This opportunity exists with us as well. One Unit For Each Property The metric system simplifies building engineering by using only one unit for each physical property. Examples: Page 3 PBS-PQ260. METRIC DESIGN GUIDE Pressure. While the English system has pounds per square inch (psi), pounds per square foot (psf), tons per square foot (tons/SF), inches of water (inHÚ2¿O), inches of mercury (inHg), and kips/SF, the SI metric system has only one pressure unit, the pascal (Pa). If more than 1 000 Pa are present, the kilopascal (kPa) is used. If more than 1 000 000 Pa, the Megapascal (MPa). Power. The English system has watts (W), British thermal units (Btu's), horsepower (hp), tons, boiler hp, and other units. SI uses only W, kilowatts (kW), or milliwatts (mW), depending on the size of the number. An example of metric simplicity: If an additional light fixture produces 600 W of heat, how many additional Btu's of cooling are needed to prevent a room temperature rise? Exactly how much will this add to system requirements? This must be calculated when using English units. In SI, all thermal power units are measured in W. The fixture produces 600 W, so the net system capacity must increase by 600 W. Standards See Standard for Metric Practice (ASTM E380), SI Guide for HVAC & R (ASHRAE), and Handbook of Fundamentals (ASHRAE) for accepted units and conversion tables. Summary The American construction community is able to meet the metric conversion challenge in Federal construction, and it is in our long-term strategic interest to do so. There will be some initial effort involved, but close cooperation between the public and private sector will allow the goals to be successfully met. Page 4. PBS-PQ260 METRIC DESIGN GUIDE A project is "metric" when: ù Specifications show SI units only. ù Drawings show SI units only. ù Construction takes place in SI units only. ù Inspection occurs in SI units only. This does not imply that building products change. Over 95 percent of the products used in building construction today will undergo no physical change in metric construction. Dimensions of products will be identified in drawings, specifications, and product literature in metric units. These products will be spaced or cut in the factory or field to round metric dimensions. There are a few products that can be purchased in a slightly different size in order to be

efficiently used in metric construction. This is generally called hard conversion. GSA will call all products round- numbered products whether they are manufactured in a different size or cut to size later. Spacing of materials such as stud spacing or floor- to-floor height or field-cutting materials to length should never be considered hard but merely round numbers. As international standards are developed, other products may be manufactured in round sizes to enhance their market potential. Dual Dimensions Dual-dimensioning is a wasted effort. When English measurements are present, U.S. readers will use them and ignore the metric measurement. A project that is round in one measurement system will be unround in the other, and therefore more difficult to design and particularly build in the other system. Summary It is important that drawings and specifications be metric exclusively. Most dimensions, particularly linear ones, should be round to avoid seriously impacting the largest cost component of a construction project, which is field labor. Page 5 PBS-PQ260. METRIC DESIGN GUIDE Over 95 percent of currently used building products will not be sized differently in metric construction. Product literature and engineering data on these products should be requested with metric dimensions. Product literature may contain both metric and English dimensions. Since product literature costs can be substantial, firms without metric product literature need only develop a supplement to their existing literature. Supplements will be accepted as submittals for an interim period. In the future, as standard international metric product sizes are developed by the International Standards Organization (ISO) or another standards organization, more products may undergo modification to be compatible in the world market. Listed below are examples of standard products that can be utilized on a metric project today. Architectural ù Carpeting. ù Door hardware. ù Elevators and escalators. ù Filing and shelving units. ù Kitchen equipment. ù Landscaping products. ù Lavatory units. ù Paint products. ù Resilient base. ù Revolving entrance doors. ù Roofing membranes. ù Systems furniture. ù Toilets. ù Toilet partitions. ù Vertical blinds. PBS-PQ260 Page 6 . METRIC DESIGN GUIDE Civil ù Caisson forms. ù Reinforced concrete pipe. Structural ù Steel deck. ù Structural steel shapes. Mechanical ù Air handling units. ù Boilers. ù Chillers. ù Fan coil units. ù Pumps of any type. ù Heating, ventilating, and air-conditioning (HVAC) control systems. ù Pipe. ù Plumbing fixtures. ù Pumps. ù Valves. Electrical ù Cable trays. ù Conduit. ù Copper wire sizes (eventually metric sizes may be used). ù Fiber optic cables. ù Fire alarm systems and components. ù Junction boxes. ù Motors. ù Panelboards. ù Receptacles. ù Switches. ù Switchgear. ù Transformers. ù Underfloor duct systems. ù UPS systems. Page 7 PBS-PQ260. METRIC DESIGN GUIDE Custom Products Custom products may be specified in any size. These products are made to fit a specific project in any measurement system and may therefore be specified in round metric sizes. Specific firms which are able to make these products are listed later in this document. Examples: ù Aluminum curtainwall systems. ù Wood doors. ù Glass. ù Interior stonework. ù Precast facade systems. ù Metal ductwork. ù Windows. Not all dimensions of custom

products will change. For example, while the length and width of curtainwall panels can be specified in round metric sizes, the cross-section of the extrusion does not need to change for construction. The dimensions of the cross-section can be a mathematical conversion or any number the industry decides to name the product. This also applies to window systems or ceiling grid systems where length and width or height are critical and the section dimensions are not. Modular Products Modular products may be slightly different sizes in metric projects. The size of the product has been modified in order to be efficiently utilized in a metric project. A handful of currently used building products may undergo hard conversion to fit a round metric project. Examples of products that may be physically changed: ù Suspended ceiling tiles and grids. ù Fluorescent lighting fixtures (lay-in type only). ù Air diffusers and grilles (lay-in type only). ù Brick and CMU (see Architectural/Masonry for contractor options). ù Drywall. (see Architectural/General section for contractor options). ù Raised access flooring. PBS-PQ260 Page 8 . METRIC DESIGN GUIDE SI drawings preferably use only millimeters (mm) to avoid fractions and to eliminate the repetitious suffix. The following note on drawings will avoid confusion: "ALL DIMENSIONS ARE MILLIMETERS (mm) UNLESS OTHERWISE NOTED." Decimal mm (such as: 2 034.5) are not required on SI drawings unless a high precision part or product thickness is being detailed. A whole number such as: 2 035 is adequate. Dual dimensions should not be used. Shop drawings or catalog data using the same dimensions as on contract documents will avoid errors in translation. Space Between Groups. A space separating groups of three digits on drawing dimensions will allow faster and more accurate dimensional interpretation. Example: A 20 meter dimension can be shown as 20 000. Scales. American Institute of Architects (AIA) preferred metric scales, all multiples of 1, 2, or 5. See Graphic Standards for other scale information. Metric Current 1:2 1:2 1:5 3"-1' 1:10 -1/2"-1', 1"-1' 1:20 3/4"-1', 1/2"-1' 1:50 1/4"-1' 1:100 1/8"-1' 1:200 1/16"-1', 1"-20' 1:500 1/32"-1', 1"-40', 1"-50' 1:1000 1"-80', 1"-100' Sheet Sizes. While there are standard SI drawing sizes, any size may be used until new ones are issued through the usual supply process. Page 9 PBS-PQ260. METRIC DESIGN GUIDE Millimeters (mm) SI specifications have used mm for almost all measurements, even large ones. Use of mm is consistent with dimensions in major codes, such as the National Building Code (Building Officials and Code Administrators International, Inc.) and the National Electric Code (National Fire Protection Association). Use of mm leads to integers for all building dimensions and nearly all building product dimensions, so use of the decimal point is almost completely eliminated. Even if some large dimensions seem to have many digits there still will usually be fewer pencil or CAD strokes than conventional English Dimensioning Meters (m) Meters have been used where large, round metric sizes are meant or where it is already customary, such as in surveying. Example: "Contractor will be provided an area of 5 by 20 meters for storage of materials." Centimeters (cm) Centimeters are typically not used in U.S.

specifications. This is consistent with the recommendations of AIA and the American Society of Testing Materials (ASTM). Centimeters are not used in major codes. Use of centimeters leads to extensive usage of decimal points and confusion to new readers. Whole millimeters are being used for specification measurements, unless extreme precision is being indicated. A credit card is about 1 mm thick. Example 1 - Mortar Joint Thickness. If a 3/8-inch mortar joint between brick is needed, this would convert to 9.525 mm. Whole mm are used. Specify 10 mm joint thickness. Example 2 - Stainless Steel Thickness. Bath accessories are commonly made from 22-gage (0.034-inch) thick stainless steel.Exact conversion is 0.8 636 mm. This is a PBS-PQ260 Page 10. METRIC DESIGN GUIDE precision measurement. However, since gage is a name and not a dimension, it is acceptable to use 22-gage on metric drawings and specifications until an industry converts sizes. Rounding and Conversion Simple Mathematical Rounding. This leads to many problems. An example is to take an existing criteria dimension, such as 12 feet, convert it mathematically to 3 658 mm, and use this dimension. Builders, faced with entire drawing sets of awkward, nonrounded numbers, will find that metric is more difficult. In projects to date, a number of builders converted back to be able to measure with English tapes. They also made conversion mistakes, causing rebuilding and delay. It is very important to make job site labor more efficient by professionally rounding dimensions. Professional Rounding. This technique takes the result of simple mathematical rounding, and applies professional judgment. The basic module of metric design is 100 mm. Following are two examples of professional judgment in rounding design criteria that have already been included in GSA metric criteria in the Facilities Standards for the Public Buildings Service (PBS-PQ100.1): Example 1: Conversion of a code requirement. Step 1. Determine the nonoffending direction. 1993 National Building Code Article 1011.3 requires 44 inches (1 118 mm) of unobstructed pedestrian corridor width. However,1 118 mm is not a round number. It should be rounded to facilitate the cleanest construction possible. Narrower doesn't meet the code. The nonoffending direction is larger. Step 2. Select the largest feasible module. ù 1 200 mm is feasible, so this represents a choice however GSA corridors are usually above code minimums. 1 500 may be more like current usuage. ù Every effort should be made to keep design dimensions in increments of 100 mm. In each case, the user must determine the acceptable choice, bu the user is encouraged to present clean, rounded metric dimensions as alternatives. Simple mathematically converted dimensions will lead to an increase in project cost and time. Page 11 PBS-PQ260. METRIC DESIGN GUIDE Example 2: Conversion of an existing design practice. Professional rounding used when converting conventional design dimensions. Ceiling Height. A common office ceiling height is 9 feet. Simple mathematical conversion yields 2 743 mm. This is an awkward dimension and can decrease productivity in use. Since this is above code requirements, there is no close minimum requirement. Step 1. Determine the metric design tolerance. If, instead of 9 feet, the installed height varies by a few

inches, the visual and technical requirements will still be met and cannot be detected by casual observation. This variation in actual height becomes a "design tolerance." The selection of design tolerance is a professional judgment. Step 2. Determine the acceptable design range. A range is a simple mathematical conversion, such as 2 743, plus and minus 50 mm. Acceptable design range becomes 2 693 to 2 793. Step 3. Select a preferred dimension. 2 700 and 2 800 are within an acceptable design range. 2 700 will cost less than 2 800 and is usually given first priority. Example: Some roof flashing systems require fasteners at a minimum 24 inches on center, which mathematically converts to 609.6 mm. More fasteners would probably be acceptable at a slight increase in material cost. Selection of equivalent distance yields 600, which will be easier to install. PBS-PQ260 Page 12. METRIC DESIGN GUIDE Module New GSA office building construction should use a 600 mm planning module. This is the closest to the common 24-inch module and products are made this size. See page 3-19 of the metric version of PBS-PQ100.1 Drywall Major drywall manufacturers currently offer round metric sizes in minimum order quantities. Only sheet length and width are classified in round metric. Standard sheet width is 1 200 mm. Lengths are available in 2 400 mm and several longer sizes. Thicknesses remain the same to minimize code impact. Standard thicknesses are 12.7 mm and 15.9 mm. Some architects are showing these as 13 and 16mm on drawings. Standard stud spacing is 400 mm, as it is the closest to 16 inches and is an even multiple of the sheet size. If drywall is installed horizontally across studs then the contractor could purchase drywall with the vertical dimension in a converted English size so only the length is round metric. This may widen the availability in smaller purchases. Since a minimum order quantity can be significant, its use must be evaluated for each project. Currently this may be as high as a truckload, or about 700, of 1 200 by 2 400 sheets.) If minimum quantities will not be satisfied, then English-size drywall as shown above can be used and cut even though the project is metric, as is done in Canada. These decisions can be left to the marketplace to determine by specifying stud spacing and drywall thickness but not length and width. Doors A common metric door size is 900 by 2 100 mm. This may be used on metric projects where other project specific design criteria are satisfied. Door thicknesses will remain the same, being identified by the nominal mm equivalent such as 45. A 950 by 2 150 door size is used in Canada as it matches metric block coursing. Ceiling Systems Manufacturers make round-metric-size tiles and grids for use in metric projects. The most common sizes are 600 by 600, and 600 by 1 200 mm. Page 13 PBS-PQ260. METRIC DESIGN GUIDE Masonry walls have a critical wall thickness for fire resistance and compressive strength. They also are never relocated after construction. Beyond this, it is not important what dimension the height and width of a masonry unit is except for appearance, ability to accommodate metric window and door openings, having even coursing for ties and round dimensions between openings for ease of builder measurement, and weight of the unit for lifting. Project requirements then should be limited to these

factors, with total competitive pricing determining the dimensioning. It should be noted that there are a number of proprietary, nonmortar joint, concrete block systems using English measurements, with builder labor advantages, that also require a local manufacturer to have different molds for concrete masonry units, as do metric units. Brick The "metric modular brick" is the most common. Its size is 90 by 57 by 190 mm (3-9/16 by 2-1/4 by 7-1/2 inches). American modular brick is: ù 3-5/8 by 2-1/4 by 7-5/8 inches (92 by 57 by 194 mm) when 3/8-inch joint is used. ù 3-1/2 by 2-3/16 by 7-1/2 inches (89 by 56 by 190 mm) when 1/2-inch joint is used. The standard American modular brick used with a 1/2-inch joint is so close to the metric modular brick that it can be used with only a slight variation in joint thickness during field installation. Three vertical courses of metric modular brick with 10 mm joints equals 201 mm, which is rounded to 200. Other sizes of metric brick are identified in Graphic Standards. Block A standard American "8-inch" block is 194 by 194 by 397 mm for use with mortar joints. A nonmortar joint stacking block is usually 203 by 203 by 406 mm. GSA has used 190 by 190 by 390 mm metric blocks on some projects, which is the size that companies shown in the Product Information section responded to. The National Concrete Masonry Association may set a size standard in the future.
PBS-PQ260 Page 14 . METRIC DESIGN GUIDE Most specification references use gage number followed by the decimal inch thickness. Example: 22 gage (0.034 inch). Use current standard sheet thicknesses. Show only the gage number on metric documents until a metric standard is developed. Example of usage: Provide grab bar with a minimum wall thickness of 18 gage (0.051 inch). Replace with: Provide grab bar with minimum wall thickness of 18 gage. Page 15 PBS-PQ260. METRIC DESIGN GUIDE The two primary Federal agencies involved in the production of survey information for public use are the National Geodetic Survey (NGS) and the U.S. Geological Survey (USGS). The databases for these two agencies are metric. NGS, which maintains a database of hundreds of thousands of horizontal and vertical survey control points on which U.S. surveys are based, has been metric since 1983. USGS, which produces topographic maps of terrain elevations, has digitally mapped the U.S. surface. The ground distance between each pair of digitized points is 30 meters. Survey and mapping data necessary to do metric design and construction in the United States are available. Most states have adopted metric in their state plane coordinate systems. The following information has been used on site plans and topographic maps. Contour intervals utilize either 1.000, 0.500, or 0.250 m as contour intervals, depending on site slope. Elevation measurements are given in m. Benchmark elevations are converted from feet to m. Examples: Benchmark is 314.15 feet. Convert to 95.753m. Sample Contour Lines: _____ 106. 0 _____ _____ 105. 5 _____ PBS-PQ260 Page 16. METRIC DESIGN GUIDE Concrete strength is specified in MPa. The following strengths, which are used in Canada, may be used in metric construction. It is a good practice to use round numbers so that additional accuracy over English

designations is not implied. The general purpose concrete strengths are reduced from six strengths to four strengths. Strengths above 35 MPa can be specified in 5 MPa intervals (40, 45, 50, 55, etc.). ACI 318 M, which is the metric version, is now used as a standard. Exact Previous Conversion Specify psi MPa MPa 2 500 17.23 20 3 000 20.67 20 or 25 (See note below) 3 500 24.12 25 4 000 27.56 30 4 500 31.01 35 5 000 34.45 35 Note: If code requires 3 000 psi, then 25 MPa must be used; otherwise, it is a professional judgment on 20 or 25. Page 17 PBS-PQ260. METRIC DESIGN GUIDE Metric projects have used ASTM A615M reinforcing bars for general purpose applications. The M after A615 indicates a metric specification. A615M reinforcing bar comes in Grades 300 and 400, indicating 300 and 400 MPa yield strength. There are 8 bar sizes, which replace the 11 English bar sizes. The Concrete Reinforcing Steel Institute (CRSI) is requesting that ASTM develop a new metric standard as the existing one uses bar numbers that are neither the bar diameter nor the overall diameter. The existing metric standard is merely different, it was never a true hard dimensioned product. Project managers are advised to check with the State Department of Transportation in their area to see what they are currently specifying as highways use proportionally more of this product than buildings. While many firms can make metric rebar, and there are fewer sizes to evaluate and install, minimum order quantities apply. Canadians add M after each bar size to avoid confusion with larger English sizes. Nominal Actual Cross-Section Diameter Diameter Area (mm) (mm) (mm) 10 11.3 100 15 16.0 200 20 19.5 300 25 25.2 500 30 29.9 700 35 35.7 1 000 45 43.7 1 500 55 56.4 2 500 Some applications may need A616M, A617M, A706M, or A775M. PBS-PQ260 Page 18 . METRIC DESIGN GUIDE There are three world steel shape standards: ù ASTM A6/A6M (American). ù Japanese Industrial Standard (JIS). ù Deutsches Instituet fuer Normung (DIN) (German). A fourth is the BI, or British Imperial. None is dominant worldwide, but each is used extensively. There is no international standard issued by ISO, the official international group that develops worldwide standards. An ISO standard is currently undergoing development, and will probably involve selection of shapes from the three primary world standards, coupled with elimination of redundant shapes. Metric Projects Since no international trend exists on standardization of steel shapes, the American Institute of Steel Construction (AISC) recommends that metric projects use the same steel shapes currently used, but use the metric dimensions listed in ASTM A6/A6M. A6/A6M lists both inch and mm dimensions of shapes. All load and resistance factor design (LRFD) property, shape, and specification design data are available in metric from AISC for A6/A6M steel shapes. (Phone orders: AISC, Chicago, IL, 312-670-5414.) Structural calculations done in metric are easier to review and have a lower probability of error. Fasteners ASTM A325M and A490M are standards for structural metric bolts. There are seven standard metric bolt sizes, which replace the nine bolts currently used. Standard sizes are 16, 20, 22, 24, 27, 30, and 36 mm. Many manufactured products now use metric fasteners either in part or for all of a product. There are hundreds of firms

making metric fasteners, screws, and bolts. Page 19 PBS-PQ260. METRIC DESIGN GUIDE Calculations are in kPa, but floorloading can be in kilograms (kg) per square meter because many dead and live loads are given in kg. The following chart gives kPa strength ratings that can be used to replace the psf strength rating and not imply a greater accuracy: Previous New Percent (psf) (kPa) Stronger 50 2.5 4.4 80 4 1.8* 100 5 4.4 120 6 4.4 150 7.5 4.4 200 10 4.4 250 12 0.2 300 15 4.4 350 17 1.4 400 20 4.4 450 22 2.1 500 24 0.2 *GSA office floor standard, PBS-PQ100.1. PBS-PQ260 Page 20. METRIC DESIGN GUIDE Temperature Celsius is used for temperature designations in new or modernization building projects. Renovation projects where the entire mechanical system is not to be changed may retain Fahrenheit. All major manufacturers of HVAC control systems offer products in Celsius. Air Distribution Many manufacturers of diffusers and registers indicate they currently offer sizes to fit a round metric ceiling grid. Ductwork Rectangular metal ductwork is a custom-made product. Typically, English- dimensioned ductwork is only shown to the nearest 2-inch increment. Round metric sizes are easier to measure (example: 300 by 600 mm) on a metric project. Prefabricated flexible round duct is specified in converted sizes. Units. See the ASHRAE SI Guide. Page 21 PBS-PQ260. METRIC DESIGN GUIDE Steel pipe and copper tube sizes will not now change. American sizes are used in many parts of the world and should be designated by nominal mm size. Hard metric pipe size may be used in the future. ASTM B88M, which gives standard hard metric copper tube sizes, will not be used until ample product availability can be established. During transition to metric the following should be on at least the mechanical first sheet: "ALL SIZES ARE INDUSTRY STANDARD ASTM A53 PIPE AND ASTM B88 TUBE DESIGNATED BY THEIR NOMINAL MILLIMETER (mm) DIAMETER EQUIVALENT. SEE CHART BELOW." Nominal Size Inch mm 1/2 15 3/4 20 1 25 1-1/4 32 1-1/2 40 2 50 2-1/2 65 3 80 3-1/2 90 4 100 5 125 6 150 8 200 10 250 12 300 PBS-PQ260 Page 22 . METRIC DESIGN GUIDE Conduit will not now change size in metric. It will be classified by a nominal mm size. During transition to metric the following should be placed on at least the first electrical sheet. These are NEMA standards. "ALL CONDUIT SIZES ARE INDUSTRY STANDARD ENGLISH SIZE CONDUIT DESIGNATED BY THEIR ROUNDED NOMINAL MILLIMETER (mm) DIAMETER EQUIVALENT. SEE CHART BELOW." Nominal Size Inch mm 1/2 16 3/4 21 1 27 1-1/4 35 1-1/2 41 2 53 2-1/2 63 3 78 3-1/2 91 4 103 5 129 6 155 Wire Size Use AWG or MCM until availability of wire manufactured to ASTM B682, standard metric conductor sizes, is determined. Round metric sizes per the above standard are substantially larger than round English sizes in secondary circuit use. Fiber optic cables are already metric. Page 23 PBS-PQ260. METRIC DESIGN GUIDE Lighting Fixtures Round metric lay-in type fixture sizes are used when using around- metric-sized ceiling grid. Many domestic manufacturers currently manufacture or can produce round metric sizes of 600 by 600 mm and 600 by 1 200 mm. The 600 by 600 mm size with sockets on one end is easier to manufacture in metric and mav have more

competition. See PBS-PQ100.1 for GSA criteria for general ceiling lighting, including life-cycle cost requirements. Caution must be used to not take an older design and merely round off fixture dimensions or spacing because new energy requirements may substantially change a lighting layout from previous ones. American manufacturers have produced metric fixtures either by modifying existing production machinery or they already had machinery that was specifically made for the metric market. To date, metric fixtures are being sold, in building quantities, at the same price as English sized fixtures. Some manufacturers, even those who have competitively sold metric fixtures, claim that their costs are higher for metric production. Sources and costs of these products should be checked before requesting a project bid or proposal. Spare building fixtures for Property Management replacements beyond the Initial Space Alteration should also be considered to extend the time required before small purchases are needed. PBS-PQ260 Page 24 . METRIC DESIGN GUIDE This directory lists domestic manufacturers of commercial building products in one of the following classes: ù Manufacturers who make products that will not change size during metric conversion, but have developed product literature with metric dimensions in it. ù Manufacturers who currently manufacture or can manufacture round metric product sizes. Each section will identify if the product being discussed is a converted odd dimension product or a round metric product size. All building products in this directory are made in the United States. Firms interested in being included in this directory may do so by contacting the Construction Metrication Council of the National Institute of Building Sciences, 1201 L Street, NW., Washington, DC 20005. Air Diffusers and Grilles Lay-in air distribution grilles and diffusers use round metric sizes. Those that are wall mounted or ceiling mounted in drywall or cut in tile may use converted dimensions. Many companies making metric sizes simply modify their existing product. Example: ù The actual width of a nominal 24- by 24-inch (610 by 610 mm) diffuser is usually about 23-3/4 inch (604 mm). ù To produce the same product for a nominal 600 by 600 grid, each edge must be slightly shorter, or about 590 mm (23-1/4 inch). The following manufacturers can make round metric sizes for lay-in type applications. ù Acutherm, Emeryville, CA, a manufacturer of variable air volume air distribution devices, can manufacture its products in round metric sizes (Jim Kline, 510-428-1064). ù Aireguide, Hialeah, FL, a large manufacturer of air distribution products, can make 80 to 90 percent of its products in round metric sizes (Daryl Gray, 305-888-1631). ù Carnes, Verona, WI, one of the larger manufacturers of air distribution products, regularly makes round metric sizes (Dick Laughlin, 608-845-6411). Page 25 PBS-PQ260. METRIC DESIGN GUIDE ù Donco Air Products, Albion, IA, a small fixture manufacturer but a major manufacturer of light troffer diffusers, can manufacture light troffer, slot, and lay-in diffusers in round metric sizes up to 1 500 mm length (Ron Jansen/Marc Vandegrift, Engineering, 515-488-2211). ù Duralast, New Orleans, LA, can make its primary diffuser product in a 600 by 600 mm variation

(Ron Vinson (distributor), 504-837-2346). ù J & J Register, El Paso, TX, can make round metric sizes (Chris Smith, 915-852-9111). ù Juniper Industries, Middle Valley, NY, has previously made and can currently produce metric-size diffusers and grilles (Steve Liebermann, 718-326-2546). ù Krueger, Inc., Tucson, AZ, a large manufacturer of grilles and diffusers, has the capability to manufacture round metric sizes (Steve Bowser, 602-622-7601). ù Reliable Metal Products, Geneva, AL, a subsidiary of Hart & Cooley, is a medium-size manufacturer of air distribution products and can make about 90 percent of its products in round metric sizes (John Bowers, 205-684-3621). ù Rock Island Register, Rock Island, IL, can make its standard product, a 2- by 2-foot diffuser, in a 600 by 600 mm size (John Howarth, 309-788-5611). ù Sommerville Metalcraft, Cranfordsville, IL, can produce grilles and diffusers in round metric sizes (Paul Moehling, 800-654-3124). ù Thermo Kinetics, Greenville, SC, can make its standard grilles and diffusers in round metric sizes (Terry Rutledge, 803-277-8080). ù Titus Products, Richardson, TX, a major manufacturer of air distribution grilles and products, indicates a number of products currently available in round metric sizes (Dave Loren, 214-699-1030). PBS-PQ260 Page 26. METRIC DESIGN GUIDE Carpet Although a few companies can make round-metric-size carpet tiles, this material may be procured by specifying other salient characteristics and allowing the competitive process to determine sizes, since all carpeting, tiles, and roll goods are cut at boundaries. Curtainwall Systems Curtainwall systems are obtainable in round metric sizes. Length and width of the panels are available in any size. The other dimensions are typically in converted metric. ù Kalwell Corporation, Manchester, NH, is able to produce any size metric curtainwall system (Bruce Keller, 800-258-9777). ù Kawneer Company, Norcross, GA, has been supplying curtainwall systems in metric units to foreign markets and can handle any metric order (Enrique Morales/Edward Bugg, 703-433-2711). ù Profile Systems, Gerald, MO, subsidiary of the Maune Company, can produce in any size (Grant Maune, 800-962-8100). Doors Domestic manufacturers produce hollow metal doors and wooden doors in any length and width desired. Round metric sizes can therefore be specified. Some firms producing round metric metal doors: ù Allied Steel Products, FL (Bill Desin, 305-624-3333). ù American Steel Products, Farmingdale, NY, can make any size metric door (Hank, 516-293-7100). ù Amweld Building Products, OH, has made and can make metric sizes (Mike Scott/Fred Bloom Jr., 216-527-4385). ù Ceco Door Division, Oak Brook, IL, a major manufacturer in the door industry, can make any round-metric-size door (Norb Bruzan, 312-242- 2000). ù Duolock, Portland, OR, a division of Alumax, a major U.S. manufacturer of aluminum products, can make any size metric door (Clem Grant, 800- 678-0566). Page 27 PBS-PQ260. METRIC DESIGN GUIDE ù SW Fleming, CA, MA, PA, SC (William Strong, 800-263-7515). ù Howard Industries, FL, has made and can make metric sizes (Bob Voigt/Joe Sixto, 305-888-1521). ù Republic Builders Products, TN (Jim Jackson, 901-352-3383). ù Steelcraft Manufacturing Company, OH, has been making metric sizes for export (Bill Ball/Claude Frederick, 513-745-6400).

ù Tex Steel Corporation, TX (George Maldonado, 512-423-0912). Firms producing round-metric-size wood doors: ù Eagle Plywood and Door Manufacturing, NJ (Tony Shiffano, 908-769-7650). ù Marlite, OH (Donald Sweitzer, 216-343-6621). ù Michigan Birch Door, MI, with a minimum of six doors (Roger Eger, 313-949-2020). ù Mohawk Flush Doors, PA (Don Enigk, 717-473-3557). ù Vancouver Door, WA (Gary Geppert, 206-845-9581). Drywall The largest drywall manufacturers either actively sell metric-size drywall or have the capability to produce it. Standard metric drywall width is 1 200 mm. Lengths are available in any size. Thicknesses are 12.7 and 15.9 mm, which correspond to English sizes. Minimum order quantities apply, but are typically about a truckload, or 700 sheets. ù Celotex, FL (George Mitchel, 813-873-4027). ù Centex American Gypsum (Lex Dominey, 800-545-6302). ù Domtar Gypsum, MI (Jim Hanser/George Shortreed, 313-930-4700). PBS-PQ260 Page 28. METRIC DESIGN GUIDE ù Georgia Pacific, GA (Bronwyn Dawkins, 404-521-4000). ù James Hardie Gypsum, NV (Todd Thomas, 310-787-6950/Alex Beaman, 800-995-0950 x210). ù Temple Inland (Jim Rush, 800-231-6060). ù USG Interiors International, Chicago, IL (William Nelson, 312-606-5383/David Vanosdall, 312-606-3804). Elevators All U.S. manufacturers can provide data and drawings in metric. Some product lines are produced in round metric dimensions HVAC Controls. All of the major manufacturers of HVAC controls currently offer products that will operate in Celsius. Some of those firms are: ù Johnson Controls. ù Barber Coleman. ù Robertshaw. ù Andover. ù Honeywell. Contact your local representative for ordering information. Lighting Fixtures When a round metric 600 by 600 or 600 by 1 200 ceiling grid is installed, round metric lay-in type fixture sizes must match. Many fixture manufacturers currently produce or can produce both modular metric sizes and still utilize currently used standard bulb sizes. When other than a lay-in type of lighting fixture is used in a project, then size is not critical and can be specified as an approximate size as in other equipment. The following companies produce both 600 by 600 and 600 by 1 200 fixtures unless otherwise noted. ù American Fluorescent, IL, supplies fixtures in orders of at least 500 fixtures (Gary Stabelfeldt, 708-249-5970). Page 29 PBS-PQ260. METRIC DESIGN GUIDE ù Bieber Lighting Corporation, CAS, supplies fixtures in orders of at least 50 fixtures (Bob Bieber, 800-243-2375/213-776-4744). ù C. W. Cole and Co., CA, supplies fixtures in orders of at least 20 fixtures (Frank Dayley/Jose Lopez, 818-443-2473). ù Day-O-Lite Manufacturing, RI, supplies fixtures with no minimum stated (Arthur Goldstein, 401-467-8232). ù Hasco Electric Corp., CT, supplies fixtures in orders of at least 20 (Anthony Vabaro, 203-531-9400). ù Holcor, IL, supplies fixtures in orders of 5 to 10 fixtures (Mark Nelson/Kathy Dykstra, 312-376-9780). ù Holophane, OH, supplies fixtures in orders of at least 100 fixtures (Bob Catone, 614-345-9631). ù Louisville Lamp, KY, supplies fixtures with no minimum stated (Mike Davidson, 502-964-4094). ù Lumispec, PA, supplies in orders of at least 30 fixtures (Eric Papougenis, 215-228-3830). ù Mark Lighting, NJ, supplies

fixtures in orders of at least 50 fixtures (George Miller, 201-000-0000). ù Midwest Chandelier, KS, supplies in 600 by 1 200 size, in orders of at least 50 fixtures (Tom Lefkovitz/Doug Pasternak, 913-281-1100). ù Prudential Lighting, CA, supplies lensed fixtures only in orders of at least 75 fixtures (Tammy Swaim, 213-746-0360). ù Simkar Lighting, PA, supplies fixtures but has a premium on orders of less than 20 fixtures (Robert McCully, 215-831-7700). ù Solar Kinetics, TX, supplies fixtures with no stated minimum (Sandy McCrea, 214-556-2376). ù Thomas Industries Day-Bright, MS (Joe Kolarik, 601-842-7212). PBS-PQ260 Page 30. METRIC DESIGN GUIDE ù USI/Columbia Lighting, WA, supplies fixtures with no stated minimum, but is a large company (Mark Johnson/Fred Smith, 509-924-7000). ù Wellmade Metal Products, CA, supplies fixtures in orders of at least 100 (Bernie Shane, 510-562-1878). Masonry Many companies can make metric brick and block sizes. Unless otherwise stated, there will generally be lead time and cost impact on this product. ù Adams Products, NC, can make metric block (several hundred block orders are acceptable) (Buddy Ray, 919-467-2218/Cheryl Gaw, 919-488-4120/Betty Hughes, 919-523-5136). ù Amcor Block, UT, can make metric block (Gayland Smith, 801-295-5470). ù Basalite, CA, can supply (Jim Mayer, 916-678-1901). ù Betco Block is supplying metric block to GSA (minimum order is 150 mÀ2Ù) (MD, Scott Harper, 301-654-2312/NY, Steve Nagel, 518-756-2125/VA, Robert Carmody, 703-591-2770). ù Buehner Block, UT, can supply metric block (Ron Hoffmann/Kent Mortensen, 801-467-5456). ù Burns and Russell, MD (Michelle McVey, 800-638-3188). ù Clarkes Block, GA, can supply (L.E. Wells, 912-234-3436). ù Colorado Concrete Manufacturing, CO, can supply metric block (Karl Dolder/Thor Kaumeyer, (303- 390-5477). ù Concrete Mold Components, CA, can supply molds (Maurice Alhadeff, 213-636-7534). ù Dagostino Building Blocks, NY (Ken Dagostino, 518-374-3116). ù Elco, PA, can produce metric block. Several hundred block orders acceptable (William Albright, 717-274-3661). Page 31 PBS-PQ260. METRIC DESIGN GUIDE ù Featherlight Building Products, TX, can produce metric block (Wade Albritton/H.V. Moss, 512-472-2424). ù Goria Enterprises, NC, can make metric block (Ken Mayo, 919-375-5821). ù Grand Blanc Cement, MI, can supply metric block and metric molds, all shapes (Michael Hicks/Ron Hunt, 800-875-7500). ù Hagerstown Block, MD, can make metric block (301-733-3510). ù E.P. Henry, NJ, can supply hard metric block (Stephen Reale/Mariane Anzaldo, 609-845-6200). ù Adolph Jandris, MA (Tony Raila, 508-632-0089). ù Jewell Concrete Products, TX, can make metric block. Several hundred block orders are acceptable (Walter Grisham, 817-772-3440/Tom Call, 903- 592-0752). ù Marquart Block, IA, can supply hard metric block (John Thiele/Scott Shimp, 319-233-8421). ù Miller Materials, MO, can make metric block (several hundred block orders are acceptable) (Charles Kreutzer, 816-444-2244). ù Mission Masonry, CO, supplied metric block to the GSA Denver facility (303-841-6089). ù Phoenix, Inc., MD (John Cissel/Don Bowers, 301-698-4010). ù Plasticrete, CT (Joe Rescigno, 800-243-6934). ù Proudfoot Corporation, CT, has made metric molds in the past,

can supply metric sizes (Michael Thompson/James Loseth, 203-459-0031). ù Reading Rock, Inc., OH (Stan Bass, 513-874-2345). ù Sherman International, AL (Dannie Rodgers, 205-252-6900). ù Southern Brick & Block, VA (Ron Peters, 804-353-6681). PBS-PQ260 Page 32. METRIC DESIGN GUIDE ù Superlite Block, AZ. Several hundred block orders acceptable(John Graves, 602-352-3500). ù Trenwyth Industries, PA, makes many metric block sizes (Linda Adcock 800-233-1924). ù Tricon Enterprises, MA (Monica Maracaccio, 508-697-6112). ù Glen Gery Corporation, Wyomissing, PA, can make metric modular brick (Ron Hunsicker, Baltimore, 301-837-3170). ù Ochs Brick and Tile, Springfield, MN, can make metric modular brick (Rod Schutt, Plant Manager, 612-944-1450/Bob Larson, Sales Manager, 612-944- 1450). ù U.S. Brick, Streetsville, Ontario, has 12 plants in the United States that can make metric modular brick (Ron Spencer, 416-821-8800 (Ontario)). Since there are many U.S. brick and block manufacturers, check with your usual supplier to see if they can make the metric modular brick. Plywood ù Amer-Ply, NJ, can supply metric sheets. No minimum order quantity (Mr. Matthew, 908-352-8111). ù Boise-Cascade, ID, has made metric before, can supply metric (Jan Blechschmidt, 206-572-8300). ù Champion International, WA, makes metric sheet sizes and thicknesses. Metric available for underlayment, sheathing, and sanded products. Metric concrete form panels can be ordered. Minimum order is one truckload (Jim DiStefano, 206-572-8300 (form panels)/Steve Williams, 206-572-8300 (plywood, western)/Jim Clark, TN, 901-731-4550 (plywood, southern)). ù Furman Lumber, MA, can supply metric from their usual suppliers (Chris Hemingway, 508-670-3800/Offices: CT, FL, GA, MD, NJ, NY, PA, TX, VA). ù Multnomah, OR, can supply 50 - 100 piece orders (Paul Brooks/Anne Snyder, 503-297-4738). ù Murphy Plywood OR, can make metric plywood (John Murphy/Mark Gryziec, 503-459-3225). Page 33 PBS-PQ260. METRIC DESIGN GUIDE ù Oregon Strand Board, OR, can make metric engineering panels, similar to plywood, at no additional cost. Minimum order is one truckload (Joe Maliszewski, 503-466-5177). ù Potlatch, WA, has exported metric, can make metric sizes (C. D. Whitney/Mac Ryerse, 509-328-0930). ù Roseburg F

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