John F. Kennedy Space Center

Metric Transition News

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METRIC FACILITIES CONFERENCE

In September, all NASA center facilities metric coordinators gathered in Orlando for the annual Facilities Engineering Metric Transition Conference. The group reviewed the status of metric transition by focusing on NASA's current metric construction pilot projects. NASA has 36 metric construction projects in various phases. There has been little difficulty with these projects as related to metric usage. Both large and small architecture and engineering firms have successfully completed metric designs at an average cost premium of 4 to 5 percent. Construction premiums average 2 to 3 percent. Because of the positive experience on the pilot projects, Code JX at NASA Headquarters has established a policy that the design and construction of all facilities shall use metric measurements beginning with Fiscal Year 1996 construction projects.

METRIC DOCUMENTATION

During the year, specifications and standards have been undergoing revisions to include metric units. The following documents have been released during 1994.

KSC-C-123, Surface Cleanliness of Fluid Systems, Specifications for
KSC-F-124, Fittings (Pressure Connections), Flared Tube, Specification for
KSC-E-166, Electrical Ground Support Equipment, Installation and Assembly, Specification for
KSC-W-167, Wiring Programming System Patchboards, Specification for
KSC-STD-C-0001, Protective Coating of Carbon Steel, Stainless Steel and Aluminum on Launch Structures and Ground Support Equipment, Standard for
KSC-STD-E-0010, Soldering of Electrical Connections, (Hand or Machine)
KHB 1200.1, Facility, System, and Equipment Handbook
79K09561, Material Selection List for Gaseous Oxygen and Air Service

METRIC BLOCK

Throughout the Government's metric transition period, the construction industry has been encouraged to provide products, materials, and services in hard metric quantities. The majority of the subindustries (e.g., doors and windows, ceiling systems and lighting, etc.) has accepted the challenge and cooperated by offering product literature and new sizes in metric units. One group of suppliers resisting the conversion to hard metric sizes is the concrete masonry (CMU) products industry, which is primarily composed of many small, local businesses. To provide hard metric CMU's would require that all these small, local companies buy new molds at a significant cost impact.

Until now, the General Services Administration (GSA) has been recommending that hard metric CMU, which measures 190 mm by 190 mm by 390 mm, be specified for metric construction when feasible. Now, GSA will be rewriting its metrication policy to allow hard metric CMU as an option to the U.S. size CMU, which measures 194 mm by 194 mm by 397 mm.

CONVERSIONS

Conversions from one unit to another are performed using factors that define the relationship between the two units, whether they are of the same or different measurement systems. Soft metric conversion is the method of using an accurate conversion factor to label a nonmetric measurement in metric units, primarily when the numerical value is an actual measurement or dimension, or a specific limit of a range. Soft conversion should be used when rounded numbers are not standard or usual for the application.

As an example, to soft convert 4 inches to millimeters, apply the conversion factor (1 in = 25.4 mm):

$$4 \text{ in} \times 25.4 \text{ mm/in} = 101.6 \text{ mm}$$

Hard metric is the method of changing a nonmetric value to a preferred size or to the nearest rounded value in SI units. This may be accomplished by simply substituting an approximate

metric size, or by changing from a rounded inch-pound quantity to the nearest rounded metric quantity.

For example, to do a hard metric conversion of 4 inches in millimeters, apply the conversion factor and round to the nearest reasonable value:

4 in x 25.4 mm/in = 101.6 mm
round to 100 mm

Round converted quantities to the appropriate number of significant digits based on how precise the number needs to be. Also, consider the practical aspects of measuring. For example, a requirement may state that a pole be located 10 ft from a building. The distance of 10 ft is a rounded measurement with only one significant digit. Therefore, the converted value should also be rounded to one significant digit. So, 10 ft x 0.3048 m/ft = 3.048 m, which should be rounded to 3 m. It is also quicker and easier to measure 3 m than to measure 3.048 m.

Another consideration is to make sure that the converted value does not exceed any limits defined by the original value. As an example, a requirement may specify that a temperature not exceed 100 °F. The exact conversion of this temperature is 37.78 °C. Rounding the Celsius temperature to 38.0 °C or even 37.8 °C would exceed the original limitation. In this case, the best conversion would be 37.7 °C. Note: When converting from degrees Fahrenheit to degrees Celsius, the accuracy of the Celsius temperature should be to the tenth of a degree.

THE PRESSURE'S ON!

Whether dealing with positive pressure or a vacuum, the SI unit for pressure is the pascal (Pa). Generally, lower pressures should be converted to kilopascals (kPa) and higher pressures to megapascals (MPa). Very low pressures or small changes in pressure may be best described in pascals. Conversion factors for ten pressure units are given in table 1. To perform a conversion using the table, multiply the original unit (shown in the first column) by the number in the same row and column under the desired unit. For example, to convert 5 torr to pascals, multiply 5 times 133.322, which equals 666.61 Pa.

WORD SEARCH

The following word search contains 17 pressure units and the words "pressure" and "vacuum." Units used are both metric and inch-pound and some are in terms of inches, pounds, pascals, and various length and area units. The answer to the puzzle will be published in the next issue.

Z G M Q A Y F R B E S L X T D W C U C K V L D
P A I I O B N J M I C R O N O F M E R C U R Y
H Z L P O U N D P E R S Q U A R E I N C H E M
I Y L J T G K X U L W F V E R E H P S O M T A
S H I K I L O P A S C A L V M U G E V F L A K
O R B P O U N D P E R S Q U A R E F O O T W E
D Q A C P N I N C H O F M E R C U R Y B T F T
P O R O X P B P N Q Y Q M R R V U Z S J A O O
T O O F E R A U Q S R E P L A D N U O P W T R
D Y N E P E R S Q U A R E C E N T I M E T E R
N D Q E O S R F S U P G S T F U H Q I S V E X
P N L A C S A P A G E M T C O T E N R W D F M
L C L Y R U C R E M F O R E T E M I L L I M W
M I B M J R E T A W F O H C N I K U A K L Z V
H H C N I E R A U Q S R E P S P I K C G Y F J
K Z S E I S T F M U F G O V H D R W S I X A Y
A R D B X B Q G H L C P N G P D O C A Z E N B
H W A J X I Y K Y J Q E Z K I A L H P B M A C

Table 1. Pressure Conversions

	bar	atm	torr (mmHg) (at 0 °C)	µmHg (micron)	psi	ksi	lb/ft²	Pa	kPa	MPa
1 bar =	1	0.9869	750.06	750,060	14.5038	0.014504	2088.55	100,000	100	0.1
1 atm =	1.0132534	1	760.002	760,002	14.69597	0.014696	2116.22	101,325	101.325	0.101325
1 torr = (1 mmHg) (at 0 °C)	0.00133	0.001316	1	1000	0.019336	0.0000193	2.7845	133.322	0.133322	0.0001333
1 µmHg = (micron)	$1.33x10^{-6}$	$1.3x10^{-6}$	0.001	1	0.000019	$1.93x10^{-8}$	0.002785	0.133322	0.000133	$1.333x10^{-7}$
1 psi =	0.06895	0.068046	51.717	51,717	1	0.001	144	6894.8	6.8945	0.006895
1 ksi =	68.94745	68.04587	51,717	51,717,000	1000	1	144,000	6,894,800	6894.5	6.8945
1 lb/ft² =	0.00048	0.000473	0.35913	359.131	0.00694	$6.94x10^{-6}$	1	47.880	0.04788	$4.788x10^{-5}$
1 Pa =	0.00001	$9.9x10^{-6}$	0.007501	7.50064	0.000145	$1.45x10^{-7}$	0.0208855	1	0.001	0.000001
1 kPa =	0.01	0.009869	7.500638	7500.638	0.145043	0.000145	20.8855	1000	1	0.001
1 MPa =	10	9.869233	7500.638	7,500,638	145.0432	0.1450432	20885.5	1,000,000	1000	1

Direct questions, comments, suggestions, or requests for previous issues or the SI (Metric) Handbook (KSC-DM-3673) to Elisa Artusa (DM-MGD-33, 407-867-7584, KSC Headquarters Building, Room 3649) or Larry Schultz (DF-PMO, 407-867-7705).