

**The idea** for developing metric standards worldwide comes from a preferred numbering system. Its first known application was in the 1870's by Charles Renard, a French army captain who reduced the different diameters of rope for military balloons from 425 to 17.

**Nominal metric sizes** are identical where the metric systems have been in use for several years. These reflect preferred sizes for components such as threaded fasteners, steel plates, sheets, and bars used throughout the world. The accompanying table shows how the general system works.

**For example**, if a designer was choosing a hydraulic cylinder, bolt, or plate thickness, the sizes in the First-choice column would be preferred. Second- and Third-choice columns are self-explanatory. The table extends to smaller

and larger sizes.\* For instance, 60 mm sizes would be a preferred choice as would 2.5 mm devices.

**The three columns** to the far right are the originating Renard numbers. In the First-choice column, each succeeding number is 1.6 times the previous, with some rounding. These three columns provide the basis for the values on the left side of the table. The inch values show close corresponding English units.

**The form of the first table** carries through to other tables in the standard. The number series shown are recommended to reduce the number of standard sizes for items such as screw threads, steel plates, steel sheets, round steel bars, lifting capacities, and hydraulic cylinder diameters.

Preferred Sizes (mm)			Customary Sizes			Preferred Numbers		
First Choice	Second Choice	Third Choice	mm	inch Fractions	inch Decimals	First Choice	Second Choice	Third Choice
4			3.97	5/32	0.156	4		
		4.5	4.37	11/64	0.172			4.5
	5		4.76	3/16	0.188		5	
		5.5	5.56	7/32	0.219			5.6
6			6.35	1/4	0.25	6.3		
		7	7.14	9/32	0.281			7.1
	8		7.94	5/16	0.313		8	
		9	8.73	11/32	0.344			9
10			9.53	3/8	0.375	10		
		11	11.11	7/16	0.438			11.2
	12		12.7	1/2	0.5		12.5	
		14	14.29	9/16	0.563			14
16			15.88	5/8	0.625	16		
		18	17.46	11/16	0.688			18
	20		19.05	3/4	0.75		20	
		22	22.23	7/8	0.875			22.4
25			25.4	1	—	25		
		28	28.58	1-1/8	1.125			28
	30		30.16	1-3/16	1.188		31.5	
		35	34.93	1-3/8	1.375			35.5
40			39.69	1-9/16	1.563	40		

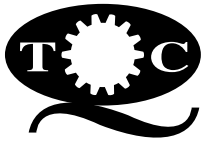
\*The values in the first three columns of the table may be extended to cover smaller or larger sizes by multiplying or dividing sizes by 10.

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## A FEW WORLD STANDARDS FOR ROUND COLD-FINISHED STEEL BARS\*

Country	National Standard	ISO Product Tolerance				Other ISO Shaft Tolerance
Global	ISO 1829	h11	h9	h7	h6	h5, h8 (second choice)
USA	ANSI B4.2	h11	h9	h7	h6	
Japan	JIS G3 123	h11	h9	h7	h6	h13, h12, h10, h8
Germany	DIN 668	h11				
	59360.1		h9	h7	h6	
France	NF A47-411	h11	h9			h10
U.K.	BS 4500	h11	h9	h7	h6	
Italy	UNI 468, 469	h11	h9			
	UNI 5953			h7		
Australia	AS 1654	h11	h9	h7	h6	

ISO 1829, ANSI B4.2, BS 4500 and AS 1654 are preferred tolerance standards.

## PREFERRED FITS FOR SHAFTS AND HOLES\*

Hole Basis	Shaft Basis	Description
H11/c11	C11/h11	<b>Loose running</b> fits are for wide commercial tolerances or allowances on external members
H9/d9	D9/h9	<b>Free running</b> fits are good for large temperature variations, high running speeds, or heavy journal pressure, but not where accuracy is essential.
H8/f7	F8/h7	<b>Close running</b> fits are for running on accurate machines and for accurate locations at moderate speeds.
H7/g6	G7/h6	<b>Sliding</b> fits are not intended to run freely, but to move and turn freely and locate accurately.
H7/h6	H7/h6	<b>Location clearance</b> provides snug fits for locating stationary parts, but can be freely assembled and disassembled.
H7/k6	K7/h6	<b>Location transition</b> fits are for accurate locations, a compromise between clearance and interference.
H7/n6	N7/h6	<b>Location transition</b> fits are for more accurate locations where greater interference is permissible.
H7/p6	P7/h6	<b>Location interference</b> fits are for parts requiring rigidity and alignment with prime accuracy of location but without special bore-pressure requirements.
H7/s6	S7/h6	<b>Medium drive</b> fits are for ordinary steel parts or shrink fits on light sections. These provide the tightest usable fit with cast iron.
H7/u6	U7/h6	<b>Force</b> fits are suitable for parts which can be highly stressed or for shrink fits where the heavy pressing forces required are impractical.

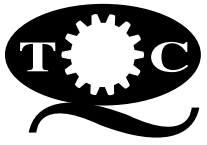
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Quantity	Conventional		SI Unit	Conversion Factors
	Inch Unit	Metric Unit		
<b>Length</b>	Inch Inch	Meter m	Metre m	1 inch = 25.4 mm 1 mm = 0.03937 inch 1 m = 3.2808 ft 1 ft = 0.3048 m
<b>Area</b>	Square Inch inch <sup>2</sup>	Square Centimeter cm <sup>2</sup>	Square Metre m <sup>2</sup>	1 inch <sup>2</sup> = 6.4516 cm <sup>2</sup> 1 cm <sup>2</sup> = 0.155 inch <sup>2</sup> 1 m <sup>2</sup> = 10.764 ft <sup>2</sup> 1 ft <sup>2</sup> = 0.092903 m <sup>2</sup>
<b>Mass</b>	Pound Mass lb	Kilogram Mass kg	Kilogram Mass kg	1 lb = 0.45359237 kg 1 kg = 2.2046 lb
<b>Force</b>	Pound Force lbf	Kilogram Force kgf	Newton N	1 lbf = 0.45359237 kgf 1 lbf = 4.44822 N 1 kgf = 2.2046 lbf 1 kgf = 9.80665 N 1 N = 0.1019716 kgf 1 N = 0.224809 lbf
<b>Stress Pressure</b>	Pounds Per Square Inch lbf/inch <sup>2</sup>	Kilogram Per Square Centimeter kgf/cm <sup>2</sup>	Pascal N/m <sup>2</sup> (Pa)	1 MPa (megapascal) = 10 <sup>6</sup> N/m <sup>2</sup> = N/mm <sup>2</sup> 1 kPa (kilopascal) = 10 <sup>3</sup> N/m <sup>2</sup> 1 lbf/inch <sup>2</sup> = 0.070307 kgf/cm <sup>2</sup> 1 lbf/inch <sup>2</sup> = 7.0307 X 10 <sup>-4</sup> kgf/mm <sup>2</sup> 1 lbf/inch <sup>2</sup> = 6.8947 X 10 <sup>-3</sup> N/mm <sup>2</sup> (MPa) 1 kgf/cm <sup>2</sup> = 14.2233 lbf/inch <sup>2</sup> 1 kgf/cm <sup>2</sup> = 9.80665 X 10 <sup>-2</sup> N/mm <sup>2</sup> (MPa)
<b>Torque Work</b>	Inch • Pounds lbf • inch	Kilogram- Meters kgf • m	Newton- Metres N • m	1 lbf • inch = 1.1521 kgf • cm 1 kgf • cm = 0.8679 lbf • inch 1 lbf • inch = 0.1129848 N • m 1 kgf • m = 9.80665 N • m 1 kgf • cm = 9.80665 X 10 <sup>-2</sup> N • m 1 N • m = 8.85 lbf • inch 1 N • m = 10.19716 kgf • cm
<b>Power</b>	lbf • ft/min	kgf • m/s	N • m/s	1 kW = 1000 N • m/s 1 kW = 60000 N • m/min 1 kW = 44220 lbf • ft/min 1 kW = 1.34 hp 1 hp = 75 kgf • m/s 1 hp = 44741 N • m/min 1 hp = 33000 lbf • ft/min 1 hp = 0.7457 kW
<b>Velocity</b>	Feet Per Second ft/sec	Meters Per Second m/sec	Metres Per Second m/s	1 ft/sec = 0.3048 m/sec 1 inch/sec = 2.54 cm/sec 1 ft/min = 0.00508 m/sec 1 mile/hr = 0.44704 m/sec 1 km/hr = 0.27777 m/sec 1 mile/hr = 1.609344 km/hr
<b>Acceleration</b>	Feet Per Second Square ft/sec <sup>2</sup>	Meter Per Second Square m/sec	Metre Per Second Square m/sec <sup>2</sup>	1 ft/sec <sup>2</sup> = 0.3048 m/sec <sup>2</sup>

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