

Chapter 19. Metric Practice

Introduction

Every inspector should have or should acquire a working knowledge of the metric system of measurements because of expansion in the use of metric units instead of or alongside the customary U.S. units in American industry.

The pace of this expansion is erratic, and there is no target date by which the United States will have made a complete transition. It should be kept in mind that there is not just one unified system of metric practice around the world. Measurement practices all over the world are under various stages of change. There is a transition in progress from customary or local units and nonstandard metric units to the International System of Units (in French, "Le Système Internationale d'Unités"), officially abbreviated SI. The latest revision of the AWS A2.3, Metric Practice Guide for the Welding Industry, may be referred to for more information.

The SI System

SI is an updated metric system of measurements, established in 1960 as the International System of Units, officially recognized by all industrial nations. Features that make it superior to other metric systems and to the U.S. customary system are:

(1) Absolute base. SI does not define force in terms of the action of gravity. In SI units, for example, one newton force gives to a mass of one kilogram an acceleration of one meter per second squared. In European metric practice, the same mass is accelerated 9.806 650 meters

per second squared by a force of one kilogram, and in the U.S., a mass of one slug is accelerated 32.174 feet per second squared by a force of one pound.

(2) Coherence. Any derived unit of measurement is related to any other, or to its base units, without use of conversion factors. In SI units, a force of one newton through a distance of one meter produces work equal to one joule, which also equals the work of one watt of power in one second. In contrast, in the U.S., a force of one pound through a distance of one inch produces energy of 0.000107 Btu, which equals that produced by one horsepower in 0.000505 hours. While coherence is valuable in engineering calculations, it may lead to awkward sizes of units, such as the bar for pressure, which is compatible but not coherent with SI, since a conversion factor is introduced (one bar equals 100,000 newtons per meter squared). The calorie is also a compatible but noncoherent unit for the same reason.

(3) Unique units. Only one unit is used for each physical quantity. SI units for force, energy, and power remain unchanged whether mechanical, thermal, or electrical.

(4) A decimal system. The decimal relationships in the SI system make it a simple one to use. Decimal notation eliminates the fraction equivalents required in the U.S. customary system.

Units

SI consists of seven base units, two supplementary units, a series of derived units, and a series of prefixes for the forming of multiples or sub-multiples of the units.

204 / WELDING INSPECTION

The base units and their symbols are:

Quantity	Unit	Symbol
Length	*meter	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Luminous intensity	candela	cd
Amount of substance	mole	mol

*Sometimes spelled metre.

Supplementary units and their symbols are:

Quantity	Unit	Symbol
Plane angle	radian	rad
Solid angle	steradian	sr

Derived units and their symbols are:

Quantity	Unit	Symbol	Formula	Formula using derived units
Acceleration—linear	meter per second squared	none	m/s ²	—
Acceleration—angular	radian per second squared	none	rad/s ²	—
Area	meter squared	none	m ²	—
Density	kilogram per meter cubed	none	kg/m ³	—
Electromotive force	volt	V	m ² kg/s ³ A	W/A
Energy, work heat, impact strength	joule	J	m ² •kg/s ²	N•m
Force	newton	N	kg•m/s ²	—
Frequency	hertz	Hz	s ⁻¹	—
Luminous flux	lumen	lm	cd•sr	—
Magnetic flux	weber	wb	m ² kg/s ² A	V•S
Power	watt	W	m ² kg/s ³	I/S
Pressure, stress	pascal	Pa	kg/ms ²	N/m ²
Velocity—linear	meter per second	none	m/s	—
Velocity—angular	radian per second	none	rad/s	—
Volume	meter cubed	none	m ³	—

Prefixes are used in the SI system to indicate orders of magnitude. This simplifies numeric terms and may be more convenient than writing powers of ten as is general in compu-

tation. As an example, 12 900 meters or 12.9×10^3 meters would be written 12.9 kilometers. The following tabulation shows the prefixes, factors, and symbols.

Exponential Expression	Multiplication Factor	Prefix	Symbol
10^{18}	1 000 000 000 000 000 000	exa	E
10^{15}	1 000 000 000 000 000	peta	P
10^{12}	1 000 000 000 000	tera	T
10^9	1 000 000 000	giga	G
10^6	1 000 000	mega	M
10^3	1 000	kilo	k
10^2	100	hecto*	h
10	10	deka*	da
10^{-1}	0.1	deci*	d
10^{-2}	0.01	centi*	c
10^{-3}	0.001	milli	m
10^{-6}	0.000 001	micro	μ
10^{-9}	0.000 000 001	nano	n
10^{-12}	0.000 000 000 001	pico	p
10^{-15}	0.000 000 000 000 001	femto	f
10^{-18}	0.000 000 000 000 000 001	atto	a

*Not recommended. Prefixes should be selected in steps of 10^3 so that the resultant number before the prefix is between 0.1 and 1000.

Other units are in widespread use and are acceptable for use with, although not a part of, the SI system. These are:

Unit	Symbol	Value in SI units
minute	min	1 min = 60 s
hour	h	1 h = 60 min = 3600 s
day	d	1 d = 24 h = 86 400 s
degree (angular)	deg	1 deg = $(\pi/180)$ rad = 0.0175 rad
bar	bar	1 bar = 0.1 MPa = 10^5 Pa
liter	L*	1 L = 0.001 m ³ = 1 dm ³
degree Celsius	°C	1°C = 1 K (interval)
knot		1 nautical mile per hour = 0.5144 m/s
nautical mile		1 nautical mile = 1.852 km
angstrom	Å	1 Å = 0.1 nm = 10^{-10} m
atmosphere	atm	1 atm = 101 325 Pa
hectare	ha	1 ha = 1 hm ² = 10^4 m ²

*The lower case "el" is the recognized symbol for liter but on most typewriters (and typesetting machines) the lower case "ell" and the figure one are nearly identical. Accordingly, it is preferable to spell the word in full or use capital L. However, ml may be used for milliliter, because confusion would no longer be possible.

206 / WELDING INSPECTION

Some metric units have been used in particular applications, but the International Committee of Weights and Measures considers that they should not be used with SI. Some of these units are:

Unit	Value in SI units	Unit	Value in SI units
calorie**	1 cal = 4.184 J	kilogram force	1 kgf = 9.806 650 N
dyne	1 dyn = 10^{-5} N	micron	1 μ = 10^{-6} m
erg	1 erg = 10^{-7} J	torr	1 torr = 133.32 Pa

**Thermochemical

Recommended Units: The following chart shows the recommended SI units to be used in welding nomenclature. The selection of these terms was based on use of (1) SI base units where practicable, (2) numbers of reasonable size, and (3) accepted units currently in use or anticipated to be used.

Units Pertaining to Welding

Property	Unit	Symbol
area dimensions	millimeter squared	mm ²
current density	ampere per millimeter squared	A/mm ²
deposition rate	kilogram per hour	kg/h
electrical resistivity	ohm meter	$\Omega \cdot m$
electrode force (upset, squeeze, hold)	newton	N
flow rate (gas and liquid)	liter per minute	liter per min
fracture toughness	meganewton meter ^{-3/2}	MN $\cdot m^{-3/2}$
impact strength	joule	J = N $\cdot m$
linear dimensions	millimeter	mm
power density	watt per meter squared	W/m ²
pressure (gas and liquid)	pascal	Pa = N m ⁻²
tensile strength	pascal	Pa = N m ⁻²
thermal conductivity	watt per meter kelvin	W/m $\cdot K$
travel speed	millimeter per second	mm/s
volume dimensions	millimeter cubed	mm ³
wire feed rate	millimeter per second	mm/s

For converting from customary and commonly used U.S. units to SI units, the following table of general conversion factors is useful:

Property	To convert from	To	Multiply by
acceleration (angular)	revolution per minute squared	rad/s ²	$1.745\,329 \times 10^{-3}$
acceleration (linear)	in./min ²	m/s ²	$7.055\,556 \times 10^{-6}$
	ft/min ²	m/s ²	$8.466\,667 \times 10^{-5}$
	in./min ²	mm/s ²	$7.055\,556 \times 10^{-3}$
	ft/min ²	mm/s ²	$8.466\,667 \times 10^{-2}$
	ft/s ²	m/s ²	$3.048\,000 \times 10^{-1}$
angle, plane	deg	rad	$1.745\,329 \times 10^{-2}$
	minute	rad	$2.908\,882 \times 10^{-4}$
	second	rad	$4.848\,137 \times 10^{-6}$
area	in. ²	m ²	$6.451\,600 \times 10^{-4}$
	ft ²	m ²	$9.290\,304 \times 10^{-2}$
	yd ²	m ²	$8.361\,274 \times 10^{-1}$
	in. ²	mm ²	$6.451\,600 \times 10^2$
	ft ²	mm ²	$9.290\,304 \times 10^4$
	acre (U.S. Survey)	m ²	$4.046\,873 \times 10^3$
density	pound mass per inch cubed	kg/m ³	$2.767\,990 \times 10^4$
	pound mass per foot cubed	kg/m ³	$1.601\,846 \times 10^3$
energy, work, heat, and impact energy	foot pound force	J	1.355 818
	foot poundal	J	$4.214\,011 \times 10^{-2}$
	Btu*	J	$1.054\,350 \times 10^3$
	calorie*	J	4.184 000
	watt hour	J	$3.600\,000 \times 10^3$
force	kilogram force	N	9.806 650
	pound force	N	4.448 222
impact strength	(see energy)		
length	in.	m	$2.540\,000 \times 10^{-2}$
	ft	m	$3.048\,000 \times 10^{-1}$
	yd	m	$9.144\,000 \times 10^{-1}$
	rod (U.S. Survey)	m	5.029 210
	mile (U.S. Survey)	km	1.609 347
mass	pound mass (avdp)	kg	$4.535\,924 \times 10^{-1}$
	tonne (metric)	kg	$1.000\,000 \times 10^3$
	ton (short, 2000 lbm)	kg	$9.071\,847 \times 10^2$
	slug	kg	$1.459\,390 \times 10^3$

*Thermochemical

208 / WELDING INSPECTION

Property	To convert from	To	Multiply by
power	horsepower (550 ft·lbf/s)	W	$7.456\,999 \times 10^3$
	horsepower (electric)	W	$7.460\,000 \times 10^3$
	Btu/min*	W	$1.757\,250 \times 10$
	calorie per minute*	W	$6.973\,333 \times 10^{-2}$
	foot-pound force per minute	W	$2.259\,697 \times 10^{-2}$
pressure and stress	pound force per inch squared	Pa	$6.894\,757 \times 10^3$
	bar	Pa	$1.000\,000 \times 10^5$
	atmosphere	Pa	$1.013\,250 \times 10^5$
	kip/in. ²	Pa	$6.894\,757 \times 10^6$
temperature	degree Celsius, t_C	K	$t_K = t_C + 273.15$
	degree Fahrenheit, t_F	K	$t_K = (t_F + 459.67)/1.8$
	degree Rankine, t_R	K	$t_K = t_R/1.8$
	degree Fahrenheit, t_F	°C	$t_C = (t_F - 32)/1.8$
	kelvin, t_K	°C	$t_C = t_K - 273.15$
tensile strength	(see pressure)		
torque	inch pound force	N·m	$1.129\,848 \times 10^{-1}$
	foot pound force	N·m	1.355 818
velocity (angular)	revolution per minute	rad/s	$1.047\,198 \times 10^{-1}$
	degree per minute	rad/s	$2.908\,882 \times 10^{-4}$
	revolution per minute	deg/min	$3.600\,000 \times 10^2$
velocity (linear)	in./min	m/s	$4.233\,333 \times 10^{-4}$
	ft/min	m/s	$5.080\,000 \times 13^{-3}$
	in./min	mm/s	$4.233\,333 \times 13^{-1}$
	ft/min	mm/s	5.080 000
	mile/hour	km/h	1.609 344
volume	in. ³	m ³	$1.638\,706 \times 10^{-3}$
	ft ³	m ³	$2.831\,685 \times 10^{-2}$
	yd ³	m ³	$7.645\,549 \times 10^{-1}$
	in. ³	mm ³	$1.638\,706 \times 10^4$
	ft ³	mm ³	$2.831\,685 \times 10^7$
	in. ³	liter	$1.638\,706 \times 10^{-2}$
	ft ³	liter	$2.831\,685 \times 10$
	gallon	liter	3.785 412
work (see "energy" above)			

*Thermochemical

In the following table of special conversions for welding (U.S. to SI and SI to U.S.), preferred units are given in parentheses.

Property	To convert from	To	Multiply by
area dimensions (mm ²)	in. ²	mm ²	6.452×10^2
	mm ²	in. ²	1.550×10^{-3}
current density (A/mm ²)	A/in. ²	A/mm ²	1.550×10^{-3}
	A/mm ²	A/in. ²	6.452×10^2
deposition rate (kg/h)	lb/h	kg/h	0.45*
	kg/h	lb/h	2.2*
electrical resistivity ($\Omega \cdot m$)	$\Omega \cdot m$	$\Omega \cdot m$	1.000×10^{-2}
	$\Omega \cdot m$	$\Omega \cdot cm$	1.000×10^2
electrode force (N)	pound-force	N	4.448
	kilogram-force	N	9.807
	N	lbf	2.248×10^{-1}
energy, work, heat, and impact energy	foot pound force	J	1.356
	foot poundal	J	4.214×10^{-2}
	Btu*	J	1.054×10^3
	calorie*	J	4.184
	watt hour	J	3.600×10^3
flow rate (liter per minute)	ft ³ /h	liter per minute	4.719×10^{-1}
	gallon per hour	liter per minute	6.309×10^{-2}
	gallon per minute	liter per minute	3.785
	cm ³ /min	liter per minute	1.000×10^{-3}
	liter per minute	ft ³ /h	2.119
	cm ³ /min	ft ³ /h	2.119×10^{-3}
fracture toughness (MN·m ^{-3/2})	ksi·in. ^{-1/2}	MN·m ^{-3/2}	1.099
	MN·m ^{-3/2}	ksi·in. ^{-1/2}	0.910
heat input (J/m)	J/in.	J/m	3.397×10
	J/m	J/in.	2.540×10^{-2}
input, strength (see "energy")			
linear measurements (mm)	in.	mm	2.540×10
	ft	mm	3.048×10^2
	mm	in.	3.937×10^{-3}
	mm	ft	3.281×10^{-3}

*approximate conversion

210 / WELDING INSPECTION

Property	To convert from	To	Multiply by
power density (W/m ²)	W/in. ²	W/m ²	1.550×10^3
	W/m ²	W/in. ²	6.452×10^{-4}
	psi	Pa	6.895×10^3
	lb/ft ²	Pa	4.788×10^1
	N/mm ²	Pa	1.000×10^6
pressure (gas and liquid) (Pa)	Pa	psi	1.450×10^{-4}
	Pa	lb/ft ²	2.089×10^{-2}
	Pa	N/mm ²	1.000×10^{-6}
	torr	Pa	1.333×10^2
	(mm Hg at 0 °C)		
	micron	Pa	1.333×10^{-1}
	(μ m Hg at 0 °C)		
	Pa	torr	7.501×10^{-3}
tensile strength (Pa)	Pa	micron	7.501
	psi	Pa	6.895×10^3
	lb/ft ²	Pa	4.788×10^1
	N/mm ²	Pa	1.000×10^6
	Pa	psi	1.450×10^{-4}
	Pa	lb/ft ²	2.089×10^{-2}
thermal conductivity (W/m ² K)	Pa	N/mm ²	1.000×10^{-6}
	cal/cm ² s ² °C	W/m ² K	4.184×10^2
travel speed, wire feed speed (mm/s)	in./min	mm/s	4.233×10^{-1}
	mm/s	in./min	2.362

The following SI values are approximate equivalents for conversion on drawings, specifications, and so forth. These values are for conversion only and are not intended for new designs where a more rational series for sizing may be used.

Electrode sizes		Fillet sizes	
in.	mm	in.	mm
0.030	0.76	1/8	3
0.035	0.89	5/32	4
0.040	1.02	3/16	5
0.045	1.14	1/4	6
1/16	1.59	5/16	8
5/64	1.98	3/8	10
3/32	2.38	7/16	11
1/8	3.18	1/2	13
5/32	3.97	5/8	16
3/16	4.76	3/4	19
1/4	6.35	7/8	22
		1	25

Rules for conversion and rounding off have been published by AWS in document A2.3-75 as well as by other organizations such as ASTM. Generally, rounding and conversion are needed during a transition period, but since they may continue throughout the useful life of this revision of "Welding Inspection," the following guidelines are offered:

(1) Exact conversion from one system to another is seldom used, since most often this results in long decimal numbers that imply a higher degree of precision than was intended originally.

(2) The closest practical equivalency between inch and millimeter values will occur when the SI value contains one less decimal place than its inch equivalent. For example, 0.365 in. equals 9.27 mm. Fractional inch conversions are especially tricky, however, since these usually exaggerate the intended precision. For example, when changing 1-7/8 in. to mm,

unless the 1-7/8 in. dimension was intended to be 1.875 in., 47.63 mm may be more precise than necessary. For interchangeability of parts, allowed and required tolerances must be kept in mind in making inch-millimeter conversions, or vice versa, so that neither excessively tight tolerances nor excess clearances are inadvertently introduced. In these cases, the function of the assembly or feature must be addressed. If this requires that maximum and minimum limits in millimeters be within inch limits, maximum limits are rounded down and minimum limits

are rounded up.

(3) Two round-off methods, designated A and B, are described in document A2.3-75, and in Appendix B of the "Welding Handbook," Volume One, Seventh Edition. One of these sources should be consulted when more detailed information is needed.

(4) The following commonly used conversion tables are reprinted from the "Welding Handbook" for convenient reference by welding inspectors.

Commonly Used Metric Conversions

Inch-Millimeter Conversion

1 in. = 25.4 mm exactly

To convert inches to millimeters, multiply the inch value by 25.4.

To convert millimeters to inches, divide the millimeter value by 25.4.

Inch and Millimeter Decimal Equivalents of Fractions of an Inch

Inch			Inch		
Fraction	Decimal	Millimeter	Fraction	Decimal	Millimeter
1/64	0.015 625	0.396 875	33/64	0.515 625	13.096 875
1/32	0.031 250	0.793 750	17/32	0.531 250	13.493 750
3/64	0.046 875	1.190 625	35/64	0.546 875	13.890 625
1/16	0.062 500	1.587 500	9/16	0.562 500	14.287 500
5/64	0.078 125	1.984 375	37/64	0.578 125	14.684 375
3/32	0.093 750	2.381 250	19/32	0.593 750	15.081 250
7/64	0.109 375	2.778 125	39/64	0.609 375	15.478 125
1/8	0.125 000	3.175 000	5/8	0.625 000	15.875 000
9/64	0.140 625	3.571 875	41/64	0.640 625	16.271 875
5/32	0.156 250	3.968 750	21/32	0.656 250	16.668 750
11/64	0.171 875	4.365 625	43/64	0.671 875	17.065 625
3/16	0.187 500	4.762 500	11/16	0.687 500	17.462 500
13/64	0.203 125	5.159 375	45/64	0.703 125	17.859 375
7/32	0.218 750	5.556 250	23/32	0.718 750	18.256 250
15/64	0.234 375	5.953 125	47/64	0.734 375	18.653 125
1/4	0.250 000	6.350 000	3/4	0.750 000	19.050 000
17/64	0.265 625	6.746 875	49/64	0.765 625	19.446 875
9/32	0.281 250	7.143 750	25/32	0.781 250	19.843 750
19/64	0.296 875	7.540 625	51/64	0.796 875	20.240 625
5/16	0.312 500	7.937 500	13/16	0.812 500	20.637 500
21/64	0.328 125	8.334 375	53/64	0.828 125	21.034 375
11/32	0.343 750	8.731 250	27/64	0.843 750	21.431 250
23/64	0.359 375	9.128 125	55/64	0.859 375	21.828 125
3/8	0.375 000	9.525 000	7/8	0.875 000	22.225 000
25/64	0.390 625	9.921 875	57/64	0.890 625	22.621 875
13/32	0.406 250	10.318 750	29/32	0.906 250	23.018 750
27/64	0.421 875	10.715 625	59/64	0.921 875	23.415 625
7/16	0.437 500	11.112 500	15/16	0.937 500	23.812 500
29/64	0.453 125	11.509 375	61/64	0.953 125	24.209 375
15/32	0.468 750	11.906 250	31/32	0.968 750	24.606 250
31/64	0.484 375	12.303 125	63/64	0.984 375	25.003 125
1/2	0.500 000	12.700 000	1	1.000 000	25.400 000

Pressure and Stress Equivalents—Pounds-Force per Square Inch and Thousand Pounds-Force per Square Inch to Megapascals

This table may be used to obtain SI equivalents of values expressed in psi or ksi. SI values are usually expressed in kPa when original value is in psi and in MPa when original value is ksi.

This table may be extended to values below 1 or above 100 psi (or ksi) by manipulation of the decimal point and addition.

$$1 \text{ psi} = 6894.757 \text{ Pa}$$

To convert psi to pascals, multiply the psi value by $6.894\,757 \times 10^3$.

To convert pascals to psi, divide the pascal value by $6.894\,757 \times 10^3$.

psi	0	1	2	3	4	5	6	7	8	9
ksi										
	0	0.0000	6.8948	13.7895	20.6843	27.5790	34.4738	41.3685	48.2633	55.1581
	10	68.9476	75.8423	82.7371	89.6318	96.5266	103.4214	110.3161	117.2109	124.1056
	20	137.8951	144.7899	151.6847	158.5794	165.4742	172.3689	179.2637	186.1584	193.0532
	30	206.8427	213.7375	220.6322	227.5270	234.4217	241.3165	248.2113	255.1060	262.0008
	40	275.7903	282.6850	289.5798	296.4746	303.3693	310.2641	317.1588	324.0536	330.9483
	50	344.7379	351.6326	358.5274	365.4221	372.3169	379.2116	386.1064	393.0012	400.8959
	60	413.6854	420.5802	427.4749	434.3697	441.2645	448.1592	455.0540	461.9487	468.8435
	70	482.6330	489.5278	496.4225	503.3173	510.2120	517.1068	524.0015	530.8963	537.7911
	80	551.5806	558.4753	565.3701	572.2648	579.1596	586.0544	592.9491	599.8439	606.7386
	90	620.5281	627.4229	634.3177	641.2124	648.1072	655.0019	661.8967	668.7914	675.6862
	100	689.4757								682.5810

Reprinted by permission of ASTM.

Conversions for Farenheit – Celsius temperature scales (cont.)

°C	°F	°C	°F	°C	°F	°C	°F
432	810	1490	738	1360	2480	1043	1910
438	820	1508	743	1370	2498	1049	1920
443	830	1526	749	1380	2516	1054	1930
449	840	1544	754	1390	2534	1060	1940
454	850	1562	760	1400	2552	1066	1950
460	860	1580	766	1410	2570	1071	1960
466	870	1598	771	1420	2588	1077	1970
471	880	1616	777	1430	2606	1082	1980
477	890	1634	782	1440	2624	1088	1990
482	900	1652	788	1450	2642	1093	2000
488	910	1670	793	1460	2660	1099	2010
493	920	1688	799	1470	2678	1104	2020
499	930	1706	804	1480	2696	1110	2030
504	940	1724	810	1490	2714	1116	2040
510	950	1742	816	1500	2732	1121	2050
516	960	1760	821	1510	2750	1127	2060
521	970	1778	827	1520	2768	1132	2070
527	980	1796	832	1530	2786	1138	2080
532	990	1814	838	1540	2804	1143	2090
538	1000	1832	843	1550	2822	1149	2100
543	1010	1850	849	1560	2840	1154	2110
549	1020	1868	854	1570	2858	1160	2120
554	1030	1886	860	1580	2876	1166	2130
560	1040	1904	866	1590	2894	1171	2140
566	1050	1922	871	1600	2912	1177	2150
571	1060	1940	877	1610	2930	1182	2160
577	1070	1958	882	1620	2948	1188	2170
582	1080	1976	888	1630	2966	1193	2180
588	1090	1994	893	1640	2984	1199	2190
593	1100	2012	899	1650	3002	1204	2200
599	1110	2030	904	1660	3020	1210	2210
604	1120	2048	910	1670	3038	1216	2220
610	1130	2066	916	1680	3056	1221	2230
616	1140	2084	921	1690	3074	1227	2240
621	1150	2102	927	1700	3092	1232	2250
627	1160	2120	932	1710	3110	1238	2260
632	1170	2138	938	1720	3128	1243	2270
638	1180	2156	943	1730	3146	1249	2280
643	1190	2174	949	1740	3164	1254	2290
649	1200	2192	954	1750	3182	1260	2300
654	1210	2210	960	1760	3200	1266	2310
660	1220	2228	966	1770	3218	1271	2320
666	1230	2246	971	1780	3236	1277	2330
671	1240	2264	977	1790	3254	1282	2340
677	1250	2282	982	1800	3272	1288	2350
682	1260	2300	988	1810	3290	1293	2360
688	1270	2318	993	1820	3308	1299	2370
693	1280	2336	999	1830	3326	1304	2380
699	1290	2354	1004	1840	3344	1310	2390
704	1300	2372	1010	1850	3362	1316	2400
710	1310	2390	1016	1860	3380	1321	2410
716	1320	2408	1021	1870	3398	1327	2420
721	1330	2426	1027	1880	3416	1332	2430
727	1340	2444	1032	1890	3434	1338	2440
732	1350	2462	1038	1900	3452	1343	2450

$$C = 5/9 (F - 32) \quad F = 9/5 C + 32$$