



PRD Fasteners Ltd
Producers of High Integrity Fasteners and CNC Machined Components

THE ENGINEERS FRIEND

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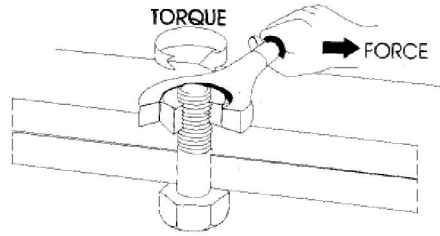
The Engineers Friend is a useful point of reference for engineers. With information courtesy of W. Christie Ltd, PRD hope to assist you with this new handbook, for you to print and use when needed. If there is any other technical information, not included in this handbook, where you would like further assistance, please do not hesitate to [call PRD Fasteners Ltd on 01902 636246](tel:01902636246).

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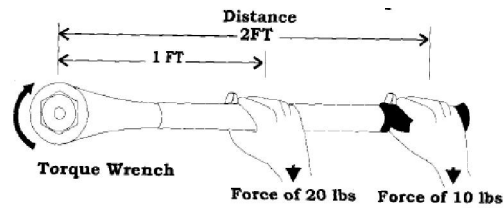
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THE DEFINITION OF TORQUE

"Torque is the application of a force acting at a radial distance and tending to cause rotation."



HOW TO MEASURE TORQUE



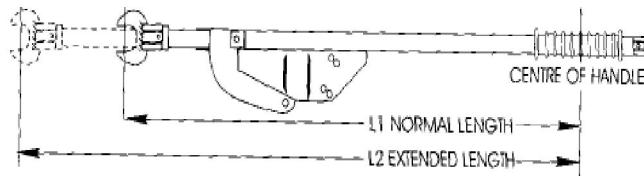
TORQUE = FORCE X DISTANCE

Therefore:- Position 1: 20lbs x 1ft = 20lbf/ft
Position 2: 10lbs x 2ft = 20lbf/ft

FORMULAE FOR CALCULATING THE EFFECT OF TORQUE WRENCH EXTENSIONS

$$M2 = M1 \times \frac{L2}{L1}$$

Where L1 is the normal length and L2 is the extended length, M1 is the set torque and M2 the actual torque applied to the nut.



Example: Torque setting 100 Nm

L1 = 500 L2 = 650 (units of length not important, this is a ratio.)

$$M2 = 100 \times \frac{650}{500} = 130 \text{ Nm}$$

STANDARD CALCULATION FOR NUT SIZES GIVEN THREAD TYPES UNC & UNF

The across flat section of the nut which is either regular hex, 1 1/2 times the bolt diameter or heavy hex, 1 1/2 times the bolt diameter plus 1/8-inch.

Example: 1 1/4 inch bolt

$$1 \frac{1}{4} \times 1 \frac{1}{2} = 1 \frac{1}{2} \text{ - inch A./F. Regular hex nut}$$

Example: 1 1/4 inch bolt

$$(1 \frac{1}{4} \times 1 \frac{1}{2}) + \frac{1}{8} \text{ - inch} = 2 \text{ inch A.F. heavy hex nut.}$$

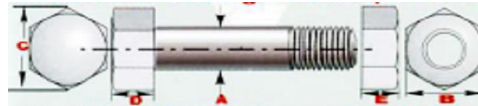
DIMENSIONS & TORQUE FOR SOCKET HEAD CAP SCREWS



Nominal Thread size (B Max)	Pitch	A Max	H Max	W Max	Maximum Tightening Torques		Induced Load kN
					Unplated $\mu = 0.125$	Plated $\mu = 0.044$	
					Nm	Nm	
M3	0.50	5.50	3.00	2.5	2.1	1.6	3.99
M4	0.70	7.00	4.00	3.0	4.6	3.5	6.75
M5	0.80	8.50	5.00	4.0	9.5	7.1	11.10
M6	1.00	10.00	6.00	5.0	16.0	12.0	15.60
M8	1.25	13.00	8.00	6.0	39.0	29.0	28.70
M10	1.50	16.00	10.00	8.0	77.0	58.0	45.70
M12	1.75	18.00	12.00	10.0	135.0	101.0	66.70
(M14)	2.00	21.00	14.00	12.0	215.0	161.0	91.30
M16	2.00	24.00	16.00	14.0	330.0	248.0	126.00
(M18)	2.50	27.00	18.00	14.0	455.0	341.0	153.00
M20	2.50	30.00	20.00	17.0	650.0	488.0	197.00
(M22)	2.50	33.00	22.00	17.0	870.0	652.0	245.00
M24	3.00	36.00	24.00	19.0	1100.0	825.0	284.00
M27	3.00	40.00	27.00	19.0	1650.0	1238.0	374.00
M30	3.50	45.00	30.00	22.0	2250.0	1688.0	454.00
M33	3.50	50.00	33.00	24.0	3050.0	2287.0	550.00
M36	4.00	54.00	36.00	27.0	3850.0	2888.0	664.00
M42	4.50	63.00	42.00	32.0	6270.0	4700.0	889.00

Stated Torque and induced load figures are to be understood as guidelines only. For metric normal thread forms. Figures result in preload of 80% of value proof.

METRIC AND BLACK HEXAGON BOLTS (BS4190)



Nominal Size & Thread Dia.	Pitch of Thread (Coarse Pitch Series)	Unthreaded Shank Dia. A		Width across Flats B		Width across corners C		Height of Head D		Thickness of Nut E	
		Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
		M5	0.8	5.48	4.52	8.00	7.64	9.2	8.63	3.875	3.125
M6	1	6.48	5.52	10.00	9.64	11.5	10.89	4.375	3.625	5.00	4.70
M8	1.25	8.58	7.42	13.00	12.57	15.0	14.20	5.875	5.125	6.50	6.14
M10	1.5	10.58	9.42	17.00	16.57	19.6	18.72	7.450	6.550	8.00	7.64
M12	1.75	12.70	11.30	19.00	18.48	21.9	20.88	8.450	7.550	10.00	9.64
M16	2	16.70	15.30	24.00	23.16	27.7	26.17	10.450	9.550	13.00	12.57
M20	2.5	20.84	19.16	30.00	29.16	34.6	32.95	13.900	12.100	16.00	15.57
(M22)	2.5	22.84	21.16	32.00	31.00	36.9	35.03	14.900	13.100	18.00	17.57
M24	3	24.84	23.16	36.00	35.00	41.6	39.55	15.900	14.100	19.00	18.48
(M27)	3	27.84	26.16	41.00	40.00	47.3	45.20	17.900	16.100	22.00	21.48
M30	3.5	30.84	29.16	46.00	45.00	53.1	50.85	20.050	17.950	24.00	23.48
(M33)	3.5	34.00	32.00	50.00	49.00	57.7	53.37	22.050	19.950	26.00	25.48
M36	4	37.00	35.00	55.00	53.80	63.5	60.79	24.050	21.950	29.00	28.48
(M39)	4	40.00	38.00	60.00	58.80	69.3	66.44	26.050	23.950	31.00	30.38
M42	4.5	43.00	41.00	65.00	63.80	75.1	72.09	27.050	24.950	34.00	33.38
(M45)	4.5	46.00	44.00	70.00	68.80	80.8	77.74	29.050	26.950	36.00	35.38
M48	5.00	49.00	47.00	75.00	73.80	86.6	83.39	31.050	28.950	38.00	37.38
(M52)	5.00	53.20	50.80	80.00	78.80	92.4	89.04	34.250	31.750	42.00	41.38
M56	5.5	57.20	54.80	85.00	83.60	98.1	94.47	36.250	33.750	45.00	44.38
(M60)	5.5	61.20	58.80	90.00	88.60	103.9	100.12	39.250	36.750	48.00	47.38
M64	6	65.20	62.80	95.00	93.60	109.7	105.77	41.250	38.750	51.00	50.26
M68	6	69.20	66.80	100.00	98.60	115.5	111.42	44.250	41.750	54.00	53.26

METRIC TORQUE LUBRICATION CHART FOR GRADE B7*

Bolt Size	Bolt Tension (Lbs)	Min Yield (Psi)	Lubricant / (Coefficient of Friction μ)			
			Molybdenum Disulfide ($\mu=0.06$)	Copper Based ($\mu=0.10$)	Nickel Based ($\mu=0.11$)	Dry ($\mu=0.20$)
			Torque Required Lbf.Ft (Nm)			
M16	11257	105000	54 (73)	82 (111)	89 (121)	153 (207)
M20	17664	105000	106 (144)	161 (218)	175 (237)	299 (405)
M24	25453	105000	182 (247)	277 (376)	301 (408)	515 (698)
M27	33681	105000	266 (361)	408 (553)	444 (602)	764 (1036)
M30	40930	105000	362 (491)	554 (751)	602 (816)	1035 (1403)
M33	51211	105000	489 (663)	752 (1020)	818 (1109)	1412 (1914)
M36	60063	105000	631 (856)	968 (1312)	1052 (1426)	1811 (2455)
M39	72395	105000	814 (1104)	1256 (1703)	1366 (1852)	2360 (3200)
M45	97252	105000	1258 (1706)	1944 (2636)	2116 (2869)	3661 (4964)
M48	109297	105000	1518 (2058)	2341 (3174)	2546 (3452)	4397 (5961)
M52	131465	105000	1944 (2636)	3012 (4084)	3279 (4446)	5682 (7704)
M56	151598	105000	2412 (3270)	3731 (5058)	4060 (5505)	7027 (9527)
M64	200790	105000	3601 (4882)	5582 (7568)	6078 (8241)	10536 (14285)
M72	262201	105000	5173 (7014)	8074 (10947)	8799 (11930)	15327 (20780)
M80	300195	105000	6461 (8760)	10142 (13751)	11063 (14999)	19345 (26228)
M90	389311	95000	9301 (12610)	14689 (19915)	16036 (21741)	28159 (38178)
M100	489782	95000	12860 (17436)	20411 (27673)	22299 (30232)	39288 (53267)
M110	475269	75000	13487 (18286)	21486 (29131)	23486 (31842)	41484 (56244)
M125	625290	75000	20041 (27172)	32097 (43517)	35110 (47602)	62235 (84378)

Equivalent to 50% of the bolt yield
 * Grade B7 Equivalents: Metric (9.9), SAE J429 (5+), astm GRADES (A193 & B16)

IMPERIAL TORQUE LUBRICATION CHART FOR GRADE B7*

Bolt Size (Inch)	Bolt Tension (Lbs)	Min Yield (Psi)	Lubricant / (Coefficient of Friction μ)			
			Molybdenum Disulfide ($\mu=0.06$)	Copper Based ($\mu=0.10$)	Nickel Based ($\mu=0.11$)	Dry ($\mu=0.20$)
			Torque Required Lbf.Ft (Nm)			
0.625	10305	10500	52 (71)	79 (107)	85 (115)	146 (198)
0.750	15466	10500	92 (125)	139 (188)	151 (205)	258 (350)
0.875	21525	10500	146 (198)	223 (302)	24 (328)	415 (563)
1.000	28323	10500	219 (297)	333 (451)	362 (491)	620 (841)
1.125	38902	10500	331 (449)	508 (689)	553 (750)	953 (1292)
1.250	49560	10500	459 (622)	710 (963)	773 (1048)	1338 (1814)
1.375	61530	10500	616 (835)	959 (1300)	1044 (1415)	1816 (2462)
1.500	74760	10500	804 (1090)	1258 (1706)	1372 (1860)	2393 (3245)
1.625	89250	10500	1027 (1392)	1614 (2188)	1761 (2388)	3081 (4177)
1.750	105000	10500	1288 (1746)	2031 (2754)	2216 (3004)	3888 (5217)
1.875	122325	10500	1592 (2158)	2519 (3415)	2751 (3730)	4836 (6557)
2.000	140700	10500	1937 (2626)	3074 (4168)	3358 (4553)	5914 (8018)
2.250	181125	10500	2766 (3750)	4411 (5980)	4822 (6538)	8521 (11553)
2.500	226800	10500	3805 (5159)	6091 (8258)	6663 (9034)	11806 (16007)
2.750	251750	95000	4602 (6239)	7392 (10022)	8089 (10967)	14367 (19479)
3.000	302100	95000	5976 (8102)	9526 (13052)	10540 (14290)	18753 (25425)
3.250	357675	95000	7613 (10322)	12294 (16668)	3464 (18254)	23995 (32532)
3.500	418000	95000	9627 (12915)	15414 (20898)	6887 (22895)	30137 (40860)
3.750	482600	95000	11723 (15894)	19006 (25768)	20826 (28236)	37212 (50452)
4.000	551950	95000	14237 (19303)	23119 (31345)	25340 (34356)	45324 (61450)
4.250	494250	75000	12492 (18292)	21941 (29748)	24053 (32611)	43062 (58383)
4.500	556500	75000	16028 (21731)	26098 (35384)	28616 (38798)	51274 (69517)

Equivalent to 50% of the Proof Value*

TORQUE/LOAD FOR METRIC FASTENERS

Preload figures (Pv) and stated torques (MA) are to be understood as guidelines only for metric normal thread forms. Figures are based upon a friction value of 0.14 and preload of 75% of proof value.

Thread Size	A/F Size	8.8		10.9		12.9	
		Pv N	MA Nm	Pv N	MA Nm	Pv N	MA Nm
M 2	4	863	0,373	1216	0,520	1461	0,628
M 2.3	4.5	1245	0,598	1755	0,843	2099	1,010
M 2.8	5	1598	0,863	2246	1,206	2697	1,451
M 3.3	5.5	2206	1,344	3109	1,883	3727	2,256
M 3.5	6	2962	2,060	4168	2,893	5001	3,481
M 4	7	3825	3,040	5374	4,315	6453	5,148
M 5	8-9	6257	6,031	8806	8,483	10591	10,200
M 6	10	8836	10,300	12405	14,710	14906	17,652
M 7	11-12	12945	17,162	18191	24,517	21771	28,439
M 8	13-14	16230	25,497	22751	35,304	27360	42,168
M 10	15-17	25791	50,014	36284	70,608	43541	85,317
M 12	19-21	37657	87,279	52956	122,60	63547	147,10
M 14	22-23	51681	138,30	72667	194,20	87279	235,40
M 16	24-26	71196	210,80	100027	299,10	120131	357,90
M 18	27	86494	289,30	121602	411,90	146118	490,30
M 20	30	111305	411,90	156415	578,60	187796	696,30
M 22	32	139254	559,00	195642	784,50	234378	941,40
M 24	36	160338	711,00	225552	1000	270662	1196
M 27	41	210842	1049	296159	1481	355980	1775
M 30	46	255952	1422	359902	2010	432471	2403
M 33	50	319695	1932	449142	2716	539363	3266
M 36	55	374612	2481	527595	3491	632526	4197
M 39	60	451104	3226	633506	4531	760992	5443
M 42	65	515827	3991	725688	5609	870826	6727
M 45	70	604087	4992	850232	7012	1019886	8414
M 48	75	679597	6021	956144	8473	1147372	10150
M 52	80	815909	7747	1147372	10885	1377827	13092
M 56	85	940453	9650	1323891	13582	1588669	16279
M 60	90	1098339	11964	1544540	16867	1853447	20202
M 64	95	1245438	14416	1750478	20300	2098612	24320
M 68	100	1425787	17615	2005013	24771	2406016	29725
M 72	105	1620036	21081	2278175	29645	2733810	35575
M 76	110	1826672	24973	2568758	35118	3082510	42141
M 80	115	2045697	29314	2876782	41222	3452115	49467
M 90	130	2647453	42525	3722982	59801	4467578	71761
M 100	145	3326624	59200	4678066	83250	5613679	99900

METRIC FINE FASTENERS (80% OF PROOF VALUE)

Thread Size	8.8		10.9		12.9	
	Pv N	MA Nm	Pv N	MA Nm	Pv N	MA Nm
M 8x1	17750	26,63	25007	37,51	30008	45,01
M 10x1.25	27753	51,07	39030	71,82	46777	86,07
M 12x1.25	42463	92,99	59820	131,0	71588	156,78
M 12x1.5	39913	87,81	55898	122,98	67175	147,79
M 14x1.5	57369	146,29	80904	206,30	97085	247,57
M 16x1.5	77472	221,57	108853	311,31	130428	373,02
M 18x1.5	101008	319,19	142196	449,34	170635	539,21
M 20x1.5	127486	451,30	179461	635,29	215745	763,74
M 22x1.5	157886	598,39	231629	877,87	265759	1007,23
M 24x2	179461	760,91	252030	1068,61	303024	1284,82
M 27x2	233397	1129,64	328521	1590,04	394225	1908,05
M 30x2	294198	1571,02	413839	2209,90	496214	2649,78

**PROOF VALUE (Newtons) ISO METRIC
ISO METRIC COARSE THREAD
PROPERTY CLASS**

Thread Size	8.8	10.9	12.9
M3	2920	4180	4880
M3.5	3940	5630	6580
M4	5100	7290	8520
M5	8230	11800	13800
M6	11600	16700	19500
M7	16800	24000	38000
M8	21200	30400	35500
M10	33700	28100	56300
M12	40900	70000	81800
M14	66700	9500	112000
M16	9100	130000	152000
M18	115000	159000	186000
M20	147000	203000	238000
M22	182000	252000	294000
M24	212000	293000	342000
M27	275000	381000	445000
M30	337000	466000	544000
M33	416000	567000	673000
M36	490000	378000	792000
M39	586000	810000	947000

**PROOF VALUE (Newtons)
ISO METRIC FINE THREAD**

Thread Size	8.8	10.9	12.9
M8x1	22700	32500	38000
M10x1	37400	53500	627000
M10x1.25	35500	50800	59400
M12x1.25	53400	76400	89300
M12x1.5	51100	73100	85500
M14 1.5	72500	104000	121000
M16x1.5	96900	139000	162000
M18x1.5	130000	179000	210000
M20x1.5	163000	226000	264000
M22x1.5	200000	276000	323000
M24x2	230000	319000	372000
M27x2	298000	412000	481000
M30x2	373000	515000	602000
M33x2	457000	632000	738000
M36x3	519000	718000	839000
M39x3	618000	855000	999000

TORQUE CONVERSION FACTORS (read down)

UNITS TO BE CONVERTED ▼	INTERNATIONAL SYSTEM - S.I.			IMPERIAL			METRIC		
	mN.m	cN.m	N.m	ozf.in	lbf.ft	lbf.ft	gf.cm	Kgf.cm	Kgf.m
1 mN.m =	1	0,1	0,001	0.142	0.009	0,0007	10.2	0.01	0.0001
1 cNm =	10	1	0,01	1.416	0.088	0.007	102	0.102	0.001
1 N.m =	1000	100	1	141.6	8.851	0.738	10 197	10.20	0.102
1 ozf.in =	7.062	0.706	0,007	1	0.0625	0.005	72	0.072	0.0007
1 lbf.in =	113	11,3	0,113	16	1	0.083	1152.1	1.152	0.0115
1 lbf.ft =	1356	135,6	1,356	192	12	1	13.826	13.83	0.138
1 gf.cm =	0.098	0,01	0,0001	0.014	0.0009	0.000 07	1	0.001	0.000 01
1 Kgf.cm =	98.07	9.807	0.098	13.89	0.868	0.072	1000	1	0.01
1 Kgf.m =	9807	980,7	9.807	1389	86.8	7.233	100 000	100	1

IMPACT SOCKET SIZE COMPARISON CHART

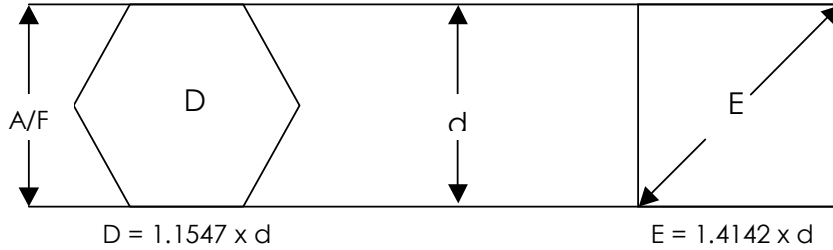
BRITISH SIZES				TOLERANCE (Imp.)	
BSW	UNC	A/F	MM	MIN	MAX
			10	.397	.400
		13/32		.408	.411
			11	.436	.440
		7/16		.440	.444
3/16				.448	.451
		15/32		.471	.475
			12	.475	.480
		1/2		.504	.508
			13	.515	.520
1/4				.529	.533
		17/32		.535	.539
			14	.555	.560
		9/16		.566	.570
		19/32	15	.597	.601
5/16				.604	.608
		5/8		.630	.635
			16	.634	.639
		21/32		.660	.665
			17	.673	.678
		11/16		.692	.697
3/8			18	.715	.720
		23/32		.723	.728
		3/4	19	.755	.760
		25/32		.786	.791
			20	.792	.797
		13/16		.817	.822
7/16				.825	.830
			21	.832	.837
			22	.871	.876
	1/2	7/8		.880	.885
		29/32	23	.911	.917
1/2				.926	.932
		15/16		.943	.949
			24	.950	.956
		31/32		.974	.980
			25	.990	.996
		1"		1.006	1.012
9/16				1.016	1.022
			26	1.029	1.035
	5/8	1.1/16	27	1.069	1.076
5/8			28	1.107	1.114
		1.1/8		1.132	1.139
			29	1.149	1.156
			30	1.188	1.196
		1.3/16		1.195	1.202
11/16				1.207	1.214
			31	1.227	1.234
		3/4	1.1/4	1.258	1.266
			32	1.267	1.274
3/4			33	1.308	1.316
			34	1.321	1.330
			35	1.348	1.356
		1.3/8		1.383	1.391
13/16				1.398	1.406
			36	1.425	1.433
	7/8	1.7/16		1.446	1.455
			37	1.465	1.473
7/8				1.489	1.498
		1.1/2	38	1.509	1.518
			39	1.544	1.553
		1.9/16		1.570	1.578
15/16			40	1.589	1.598
			41	1.623	1.632
		1"	1.5/8	1.635	1.645
			42	1.662	1.672
1"				1.680	1.690
		1.11/16	43	1.698	1.708
		1.3/4		1.760	1.770
1.1/16			45	1.781	1.791
	1.1/8	1.13/16	46	1.823	1.834
			47	1.864	1.875
1.1/8				1.871	1.882
		1.7/8		1.886	1.898
			48	1.906	1.917
		1.15/16	49	1.948	1.959
			50	1.979	1.990
	1.1/4	2"	51	2.012	2.024
1.1/4			52	2.062	2.074
		2.1/16		2.074	2.086

BSW	UNC	A/F	MM	MIN	MAX
			53	2.098	2.110
		2.1/8	54	2.137	2.149
			55	2.177	2.189
	1.3/8	2.3/16		2.201	2.214
1.3/8			56	2.233	2.246
		2.1/4	57	2.264	2.277
			58	2.295	2.307
		2.5/16		2.325	2.339
			59	2.334	2.348
	1.1/2	2.3/8	60	2.389	2.403
1.1/2			61	2.424	2.438
		2.7/16	62	2.452	2.466
			63	2.492	2.504
		2.1/2		2.515	2.530
			64	2.535	2.550
	1.5/8	2.9/16	65	2.577	2.592
1.5/8				2.595	2.610
			66	2.613	2.628
		2.5/8	67	2.640	2.655
			68	2.692	2.707
		2.11/16		2.702	2.717
	1.3/4	2.3/4	70	2.765	2.780
1.3/4				2.776	2.792
			71	2.810	2.826
		2.13/16		2.830	2.848
			72	2.850	2.865
		2.7/8	73	2.893	2.911
			74	2.928	2.943
	1.7/8	2.15/16	75	2.954	2.970
			76	3.008	3.024
1.7/8		3"	77	3.037	3.054
		3.1/16	78	3.077	3.092
	2"	3.1/8	79	3.141	3.157
2"			80	3.168	3.186
		3.3/16	81	3.203	3.219
		3.1/4	83	3.270	3.290
		3.5/16	84	3.332	3.352
			85	3.366	3.386
2.1/8		3.3/8	86	3.392	3.409
		3.7/16		3.457	3.477
	2.1/4	3.1/2	89	3.518	3.535
2.1/4			90	3.565	3.585
		3.9/16	91	3.582	3.602
		3.5/8	92	3.645	3.665
		3.11/16	94	3.707	3.727
2.3/8		3.3/4	95	3.768	3.786
		3.13/16	97	3.832	3.852
	2.1/2	3.7/8	99	3.893	3.912
2.1/2				3.910	3.930
		3.15/16	100	3.957	3.977
		4"	102	4.020	4.040
2.5/8		4.1/16		4.082	4.102
		4.1/8	105	4.145	4.165
2.3/4		4.3/16		4.200	4.220
	2.3/4	4.1/4	108	4.270	4.290
		4.5/16		4.332	4.352
2.7/8			110	4.350	4.370
		4.3/8	111	4.395	4.415
		4.7/16	113	4.457	4.477
		4.1/2		4.522	4.544
3"			115	4.550	4.570
		4.9/16		4.584	4.606
	3"	4.5/8		4.648	4.670
		4.3/4	120	4.772	4.794
3.1/4			123	4.875	4.895
		4.7/8	124	4.900	4.925
	3.1/4	5"	127	5.030	5.058
3.3/8				5.120	5.149
		5.1/8	130	5.148	5.170
3.1/2		5.3/16		5.200	5.220
		5.1/4		5.280	5.308
	3.1/2	5.3/8		5.400	5.428
		5.1/2	140	5.525	5.550
3.3/4		5.9/16	141	5.575	5.600
		5.5/8	143	5.655	5.685
3.7/8	3.3/4	5.3/4		5.780	5.815
		5.7/8	150	5.906	5.939
4"			151	5.975	6.000
		6"	153	6.031	6.062
	4"	6.1/8	155	6.150	6.185

DISTANCE ACROSS CORNERS OF SQUARE, HEXAGONS AND AREAS OF THE SAME

$$\text{Area of a hexagon} = \frac{A/F}{2} \times \frac{A/F}{4} \times 6$$

$$\text{Area of a square} = \text{Length of side}^2$$



FORMULA FOR CIRCUMFERENCE AND AREA OF A CIRCLE

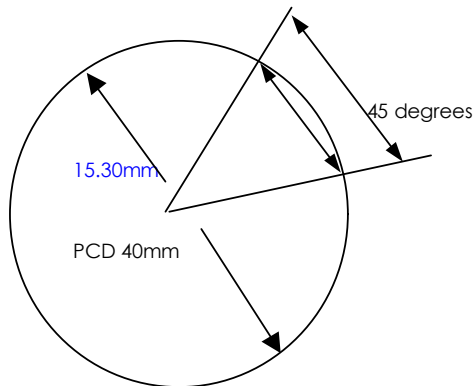
$$\text{Circumference of a circle} = \pi \times \text{Diameter}$$

$$\text{Area of a Circle} = \pi \times \text{Radius}^2$$

$$\pi = 3.1415926536$$

FORMULA FOR CHORDAL LENGTH ON A PCD

$$\text{CHORDAL LENGTH} = \text{SINE OF } \frac{1}{2} \text{ THE ANGLE} \times \text{PCD}$$



$$\text{Angle} = 45^\circ \text{ degrees}$$

$$\frac{1}{2} \text{ Angle} = 22.5 \text{ degrees}$$

$$\text{Sine } 22.5 = 0.3826 \times 40\text{mm PCD}$$

$$\text{Chordal Length} = 15.30\text{mm}$$

COMMON CHORDAL LENGTHS

Chordal length = sine x ½ angle Number x PCD

No of Spaces	SINE x 1/2 ANGLE NUMBER	No of Spaces	SINE x 1/2 ANGLE NUMBER
3	0.866025	27	0.116092
4	0.707106	28	0.111964
5	0.587785	29	0.108118
6	0.500000	30	0.104528
7	0.433883	31	0.101168
8	0.382683	32	0.098017
9	0.342020	33	0.095096
10	0.309017	34	0.092268
11	0.281732	35	0.089639
12	0.258819	36	0.087155
13	0.239315	37	0.084805
14	0.222520	38	0.082579
15	0.207911	39	0.080466
16	0.195090	40	0.078459
17	0.183749	41	0.076549
18	0.173648	42	0.074730
19	0.164594	43	0.072995
20	0.156434	44	0.071339
21	0.149042	45	0.069756
22	0.142314	46	0.068242
23	0.136166	47	0.066792
24	0.130526	48	0.065403
25	0.125333	49	0.064070
26	0.120536	50	0.062790

FORUMLA FOR CYLINDA CAPABILITY

Formula: Force (lbs) = Pressure Psi x Area (Sq. inch)

Example:

Piston Diameter = 3 1/2" Rod Diameter = 1 1/2"

Pressure available = 80psi

$$\begin{aligned} \text{Load from piston side} &= \pi R^2 \times \text{Psi} \\ &= 3.142 \times 1.75 \times 1.75 \times 80 \\ &= 780 \text{ lbs} \end{aligned}$$

$$\begin{aligned} \text{Load from piston rod side} &= \pi R^2 - \pi r^2 = 80 \\ &= (\pi \times 1.75 \times 1.75) - (\pi \times 0.75 \times 0.75) \times 80 \\ &= 9.622 - 1.767 \times 80 \\ &= 628 \text{ lbs} \end{aligned}$$

FORMULA TO CALCULATE HORSE POWER

$$\text{Horse Power} = \frac{2\pi (N \times T)}{33000}$$

$$T = \text{HP} \times \frac{33000}{2\pi \times N}$$

(N = Speed rpm) (T = Torque Lbf/Ft)

TEMPERATURE CONVERSION

(Fahrenheit to Centigrade/Celsius)

$$^{\circ}\text{F} = (1.8 \times ^{\circ}\text{C}) + 32$$

$$^{\circ}\text{C} = (^{\circ}\text{F} - 32) \times 0.555$$

WEIGHT OF STEEL

Plate / Sheet (Kg./Sq. Metre) Thickness (mm) x 7.85

Flat / Square (Kg. / Sq. Metre) Thickness(mm) x Width (mm) x 0.00785

Rounds (Kg. / Metre) Diameter ² (mm) x 0.00615

Hexagon (Kg. Metre) A/F² x 0.006798

WIRE GAUGE SIZES (S.W.G)

Gauge	Ins	mm	Gauge	Inns	mm
6	0.192	4.48	16	0.064	1.63
8	0.160	4.06	18	0.048	1.21
10	0.128	3.25	20	0.036	(0.91)
12	0.104	2.64	22	0.028	(0.71)
14	0.080	2.03	24	0.022	(0.56)

MATERIAL CHARACTERISTICS

Material	Density g/cm ³	Expansion 1/°C	Melting Point °C	Module of Elasticity N/mm
Aluminium	2.7	0.000024	660.1	72000
Lead	11.3	0.000029	327.3	16000
Iron (Steel)	7.86	0.000012	1540	210000
Gold	19.3	0.000014	1063	79000
Copper	8.9	0.000017	1083	126000
Zinc	7.1	0.000026	419	94000
Glass	2.2-2.9	0.000008	800-1500	68000
Air	0.0013	0.0036		
Wood	0.5-0.7			
				10000
Plastics				
PS	1.05	0.00008		3400
PP	0.9	0.00018		1200
ABS	1.05	0.00010		2500

ROCKWELL • BRINELL • TENSILE CONVERSION

Ropckwell "C" Scale	Brinell Hardness Number	Approx. Tensile Strength		Ropckwell "C" Scale	Brinell Hardness Number	Approx. Tensile Strength	
		Mpa	KSI			Mpa	KSI
60	654	2320	336	42	398	1340	194
59	634	2260	328	41	387	1300	188
58	615	2200	319	40	377	1250	181
57	595	2140	310	39	367	1210	176
56	577	2080	301	38	357	1170	170
55	560	2010	292	37	347	1140	165
54	543	1950	283	36	337	1100	160
53	524	1890	274	35	327	1070	155
52	512	1830	265	34	318	1030	150
51	500	1770	257	33	309	1010	147
50	488	1720	249	32	301	980	142
49	476	1660	241	31	294	960	139
48	464	1610	233	30	285	940	136
47	453	1550	225	29	279	910	132
46	442	1510	219	28	272	890	129
45	430	1460	212	27	265	870	126
44	419	1420	206	26	259	850	123
43	408	1380	200	25	253	830	120

CONVERSION TABLES

Imperial To Metric		Metric to Imperial	
Length			
1 inch	= 25.4mm	1 mm	= 0.03937 inch
1 foot	= 304.0mm	1 cm	= 0.3937 inch
1 yard	= 0.9144metre	1 metre	= 3.2808 feet
1 yard	= 3 feet	1 metre	= 1.09936 yards
2 yards	= 1 Fathom	1 km	= 0.6214 mile
220 yards	= 1 Furlong	1 mile	= 1.6093 km
5 1/2 yards	= 1 pole	1 mile	= 1760 yards
4 poles	= 1 chain		
10 chains	= 1 furlong		
Weight			
1 ounce	= 28.35 grammes	1 gramme	= 0.035274 oz
1 pound	= 0.4536kg	1 kilogramme	= 2.204621 lbs
1 ton	= 1.01605 tonnes	1 tonne	= 0.9842 ton
1 ton	= 2240 lbs	1 (Pa) Pascal	= 1N/m ²
1 tonne	= 2276 lbs		
Area			
1 inch ²	= 645.16mm ²	1 mm ²	= 0.00155 inch ²
1 foot ²	= 0.0929m ²	1 metre ²	= 10.765 foot ²
1 acre	= 0.4047 hectares	1 hectare	= 2.471 acres
1 acre	= 4840 yd ²	1 mile ²	= 258.998 hectares
144 inches ²	= 1 foot ²	9 foot ²	= 1 yard ²
30¼ yards	= 1 square pole	40 square poles	= 1 rood
4 roods	= 1 acre	640 acres	= 1 square mile
Volume			
1 inch ³	= 16.387cm ³	1 cm ³	= 0.610 cubic inches
1 foot ³	= 0.02832m ³	1 dm ³	= 0.0353 cubic feet
1 fluid oz	= 28.41 millilitres	1 m ³	= 1.3080 cubic yards
1 pint	= 0.5683 litre	1 litre	= 1.76 pints
1 gallon	= 4.5461 litres	1 hectolitre	= 21.997 gallons
1728 inches ³	= 1 foot ³	27 feet ³	= 1 yard ³
Velocity			
1 ft/min	= 5.08 mm/sec	1 mm/sec	= 0.19685 feet/min
1 mile/hour	= 1.609334 km/hour	1 km/hour	= 0.621371 miles/hour
Stress			
1 lbf/in ²	0.006895 N/m ²	1 N/m ²	= 145.038 lbf/in ²
1 tonf/in ²	15.444 N/m ²	1 N/mm ²	= 0.6350tonf/in ²
1 Ksi	6.895 Mpa	1 Kgf/mm ²	= 9.807MPa
1 Mpa	145 Psi	1 Ksi	= 1000 Psi
1 Psc	0.0069 Mpa		
Density			
1 lb/ft ³	= 16.085kg/m ³	1 kg/m ³	= 0.062428 lb/ft ³
1 lb/gallon	= 0.099766 g/cm ³	1 g/cm ³	= 10.0224 lb/gallon
Pressure			
1 in H ₂ O	= 1.868 mm Hg	1 mm Hg	= 0.5352 in H ₂ O
1 bar	= 0.9869 atm	1 atm	= 1.013 bar
1 lbf/ft ²	= 47.88 N/m ²	1 N/m ²	= 0.02089 lbf/ft ²
1 Bar	= 14.503 Psi		
Flow rates			
1 gall/min	= 0.2728 m ³ /hour	1 m ³ /hour	= 3.666 gallons/min
1 ft ³ /min	= 0.4719 litres/min	1 litre/sec	= 2.119 ft ³ /minute
Energy			
1 BTU	= 1.0551 kj	1 kj	= 0.9478 BTU
1 Hp/Hr	= 0.7457 kw h	1 kw h	= 1.3410 Hp
1 Ft/lbf	= 0.3238 calories	1 Cal	= 3.0880 ft lb
Force			
1 lb f	= 4.448 N	1 N	= 0.2248 lb f
1 ton.f	= 9.964 kN	1 Kn	= 0.1004 ton.f

INCH TO METRIC CONVERSIONS

Fractions of an inch, in sixty-fourths to decimals of an inch and to millimetres

Inch	Decimal	Mm	Inch	Decimal	Mm
1/64	0.015625	0.396875	33/64	0.515625	13.096875
1/32	0.031250	0.793750	17/32	0.531250	13.493750
3/64	0.046875	1.190625	35/64	0.546875	13.890625
1/16	0.062500	1.587500	9/16	0.562500	14.287500
5/64	0.078125	1.984375	37/64	0.578125	14.684375
3/32	0.093750	2.381250	19/32	0.593750	15.081250
7/64	0.109375	2.778125	39/64	0.609375	15.478125
1/8	0.125000	3.175000	5/8	0.625000	15.875000
9/64	0.140625	3.571875	41/64	0.640625	16.271875
5/32	0.156250	3.968750	21/32	0.656250	16.668750
11/64	0.171875	4.365625	43/64	0.671875	17.065625
3/16	0.187500	4.762500	11/16	0.687500	17.462500
13/64	0.203125	5.159375	45/64	0.703125	17.859375
7/32	0.218750	5.556250	23/32	0.718750	18.256250
15/64	0.234375	5.953125	47/64	0.734375	18.653125
1/4	0.250000	6.350000	3/4	0.750000	19.050000
17/64	0.265625	6.746875	49/64	0.765625	19.446875
9/32	0.281250	7.143750	25/32	0.781250	19.843750
19/64	0.296875	7.540625	51/64	0.796875	20.240625
5/16	0.312500	7.937500	13/16	0.812500	20.637500
21/64	0.328125	8.334375	53/64	0.828125	21.034375
11/32	0.343750	8.731250	27/32	0.843750	21.431250
23/64	0.359375	9.128125	55/64	0.859375	21.828125
3/8	0.375000	9.525000	7/8	0.875000	22.250000
25/64	0.390625	9.921875	57/64	0.890625	22.621875
13/32	0.406250	10.318750	29/32	0.906250	23.018750
27/64	0.421875	10.715625	59/64	0.921875	23.415625
7/16	0.437500	11.112500	15/16	0.937500	23.812500
29/64	0.453125	11.509375	61/64	0.953125	24.209375
15/32	0.468750	11.906250	31/32	0.968750	24.606250
31/64	0.484375	12.303125	63/64	0.984375	25.003125
1/2	0.500000	12.700000	1	1.000000	25.400000

RECOMMENDED TAPPING AND CLEARANCE DRILL SIZES

I.S.O.. Metric Thread (Coarse Pitch Series)			
Normal size of Tap (mm)	Pitch (mm)	Tapping Drill Size (mm)	Clearance Drill Size (mm)
1.0	0.25	0.75	1.05
1.1	0.25	0.85	1.15
1.2	0.25	0.95	1.25
1.4	0.30	1.10	1.45
1.6	0.35	1.25	1.65
1.8	0.35	1.45	1.85
2.0	0.40	1.60	2.05
2.2	0.45	1.75	2.25
2.5	0.45	2.05	2.60
3.0	0.50	2.50	3.10
3.5	0.60	2.90	3.60
4.0	0.70	3.30	4.10
4.5	0.75	3.70	4.60
5.0	0.80	4.20	5.10
6.0	1.00	5.00	6.10
7.0	1.00	6.00	7.20
8.0	1.25	6.80	8.20
9.0	1.25	7.80	9.20
10.0	1.50	8.50	10.20
11.0	1.50	9.50	11.20
12.0	1.75	10.20	12.20
14.0	2.00	12.00	14.25
16.0	2.00	14.00	16.25
18.0	2.50	15.50	18.25
20.0	2.50	17.50	20.25
22.0	2.50	19.50	22.25
24.0	3.00	21.00	24.25
27.0	3.00	24.00	27.25
30.0	3.50	26.50	30.50
33.0	3.50	29.50	33.50
36.0	4.00	32.00	36.50
39.0	4.00	35.00	39.50
42.0	4.50	37.50	42.50
45.0	4.50	40.50	45.50
48.0	5.00	43.00	48.50
52.0	5.00	47.00	53.00
56.0	5.50	50.50	57.00

BRITISH STANDARD WHITWORTH THREAD (BSW)

Normal Size of Tap	Tapping Drill Size (mm)	Clearance Drill Size (mm)
1/8"	2.55	3.30
3/16"	3.70	4.90
1/4"	5.10	6.50
5/16"	6.50	8.10
3/8"	7.90	9.70
7/16"	9.30	11.30
1/2"	10.50	13.00
9/16"	12.10	14.50
5/8"	13.50	16.25
11/16"	15.00	17.75
3/4"	16.25	19.25
7/8"	19.25	22.50
1"	22.00	25.75
1.1/8"	24.75	29.00
1.1/4"	28.00	32.00
1.1/2"	33.50	38.50
1.3/4"	39.00	45.00
2"	44.50	51.00

BRITISH ASSOCIATION THREAD (B.A.)

Normal Size of Tap	Tapping Drill Size (mm)	Clearance Drill Size (mm)
0	5.10	6.10
1	4.50	5.40
2	4.00	4.80
3	3.40	4.20
4	3.00	3.70
5	2.65	3.30
6	2.30	2.90
7	2.05	2.60
8	1.80	2.25
9	1.55	1.95
10	1.40	1.75
11	1.20	1.60
12	1.05	1.40
13	0.98	1.30
14	0.80	1.10
15	0.70	0.98
16	0.60	0.88

TAPPING DRILLS (mm) FOR FRACTIONAL THREADS

Nom. Dia. TAP	UNC	UNF	BSW	BSF
1/16			1.15	
3/32			1.90	
1/8			2.55	
5/32			3.10	
3/16			3.70	4.00
7/32			4.40	4.60
¼	5.10	5.50	5.10	5.30
5/16	6.60	6.90	6.50	6.80
3/8	8.00	8.50	7.90	8.30
7/16	9.40	9.90	9.30	9.70
½	10.80	11.50	10.50	11.10
9/16	12.20	12.90	12.10	12.70
5/8	13.50	14.50	13.50	14.00
11/16			15.00	15.50
¾	16.50	17.50	16.25	16.75
7/8	19.50	20.40	19.25	19.75
1	22.25	23.25	22.00	22.75
1 1/8	25.00	26.50	24.75	25.50
1 ¼	28.00	29.50	28.00	28.50
1 3/8	30.75	32.75	30.50	31.50
1 ½	34.00	36.00	33.50	34.50
1 5/8			36.00	38.00
1 ¾	39.50		39.00	40.50
1 7/8			41.50	44.00
2	45.00		44.50	47.00

BRITISH STANDARDS PIPE THREAD (BSP)

Nominal Size of Thread	Tapping Drill Size (mm)	
	BSP.PL. (Rp)	BSP.F.(G)
1/8 (0.383)	8.60	8.80
¼ (0.518)	11.50	11.80
3/8 (0.656)	15.00	15.25
½ (0.825)	18.75	19.00
5/8 (0.902)		21.00
¾ (1.041)	24.25	24.50
7/8 (1.189)		28.25
1 (1.309)	30.40	30.75
1 ¼ (1.650)	39.00	39.50
1 ½ (1.882)	45.00	45.00
2 (2.347)		51.00
2 ½ (2.960)	56.75	57.00

TAPPING DRILLS (mm) FOR NUMBER SIZE THREADS

Tap Number	BA	UNC	UNF
0	5.10		1.25
1	4.50	1.55	1.55
2	4.00	1.85	1.90
3	3.40	2.10	2.15
4	3.00	2.35	2.40
5	2.65	2.65	2.70
6	2.30	2.85	2.95
7	2.05		
8	1.80	3.50	3.50
9	1.55		
10	1.40	3.90	4.10
11	1.20		
12	1.05	4.50	4.70

BRITISH STANDARD TAPER PIPE THREAD (BSP.Tr) Rc

Nominal Size of Thread	Tapping Drill Size (mm)*	
	With Reamer	Without Reamer
1/8 (0.383)	8.00	8.40
¼ (0.518)	10.80	11.20
3/8 (0.656)	14.25	14.75
½ (0.825)	17.75	18.25
¾ (1.041)	23.00	23.75
1 (1.309)	29.00	30.00
1 ¼ (1.650)	37.50	38.50
1 ½ (1.882)	43.50	44.50
2 (2.347)	55.00	56.00
2 ½ (2.960)	70.00	71.00

AMERICAN NATIONAL TAPER PIPE (NPT)

Nominal Size of Thread	Tapping Drill Size (mm)*	
	With Reamer	Without Reamer
1/16 (0.311)	6.00	6.30
1/8 (0.405)	8.40	8.70
¼ (0.534)	10.70	11.10
3/8 (0.671)	14.25	14.50
½ (0.836)	17.50	18.00
¾ (1.046)	22.75	23.25
1 (1.308)	28.50	29.00
1 ¼ (1.653)	37.50	38.00
1 ½ (1.892)	43.50	44.00
2 (2.366)	55.00	56.00
2 ½ (2.960)	66.00	67.00

*We strongly recommend the use of a taper reamer to follow the tapping drill