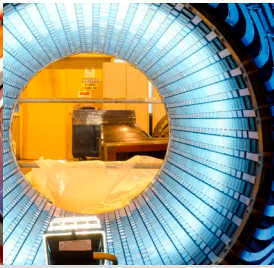
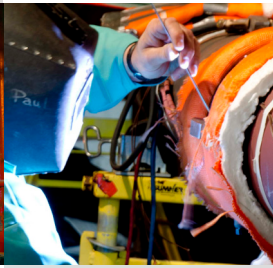




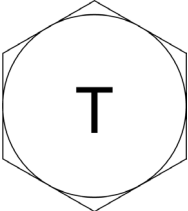
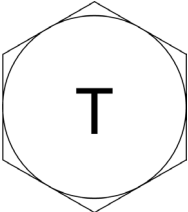
THE OUTAGE EXPERT
PROCESS, HABITS, CULTURE

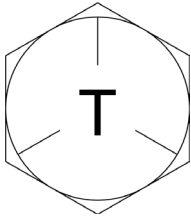
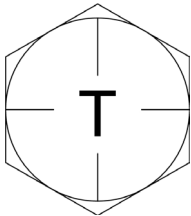


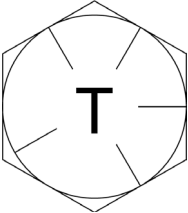
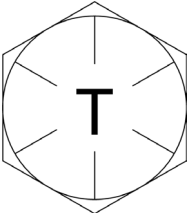
BOLTING
STUFF THAT WORKS

Bolt Size In.	Standard Thread (Coarse)			8 Thread (Fine Threads)			Nut Dimensions	
	No. of Thread Per In	Root Area Sq In	Tap Drill In.	No. of Threads Per In.	Root Area Sq. In	Tap Drill In.	Across Flats, In.	Across Corners, In.
1/2	13	.126	27/64	No. 8 Thread Series Below 1"			7/8	.969
5/8	11	.202	17/32				1 - 1/16	1.175
3/4	10	.302	21/32				1 - 1/4	1.383
7/8	9	.419	49/64				1 - 7/16	1.589
1	8	.551	7/8	8	.551	7/8	1 - 5/8	1.796
1 - 1/8	7	.693	63/64	8	.728	1	1 - 13/16	2.002
1 - 1/4	7	.890	1 - 7/64	8	.929	1 - 1/8	2	2.209
1 - 3/8	6	1.054	1 - 7/32	8	1.155	1 - 1/4	2 - 3/16	2.416
1 - 1/2	6	1.294	1 - 21/64	8	1.405	1 - 3/8	2 - 3/8	2.622
1 - 5/8	5 - 1/2	1.515	1 - 29/64	8	1.680	1 - 1/2	2 - 9/16	2.828
1 - 3/4	5	1.744	1 - 35/64	8	1.980	1 - 5/8	2 - 3/4	3.035
1 - 7/8	5	2.049	1 - 1/16	8	2.304	1 - 3/4	2 - 15/16	3.242
2	4 - 1/2	2.300	1 - 25/32	8	2.652	1 - 7/8	3 - 1/8	3.449
2 - 1/4	4 - 1/2	3.020	2 - 1/32	8	3.423	2 - 1/8	3 - 1/2	3.862
2 - 1/2	4	3.715	2 - 1/4	8	4.292	2 - 3/8	3 - 7/8	4.275
2 - 3/4	4	4.618	2 - 1/2	8	5.259	2 - 5/8	4 - 1/4	4.688
3	4	5.621	2 - 3/4	8	6.324	2 - 7/8	4 - 5/8	5.102

Pipe Size In.	Threads Per In.	Pitch of Threads In.	Effective Thread Length In.	Total Length of Thread In.	Tap Drill Size In.
1/8	27	.0370	.264	.3924	11/32
1/4	18	.0556	.402	.5946	7/16
3/8	18	.0556	.408	.6006	37/64
1/2	14	.0714	.534	.7815	23/32
3/4	14	.0714	.548	.7935	59/64
1	11 - 1/2	.0870	.683	.9845	1 - 5/32
1 - 1/4	11 1/2	.0870	.707	1.0085	1 - 1/2
1 - 1/2	11 1/2	.0870	.724	1.0252	1 - 47/64
2	8	.1250	.757	1.0532	2 - 7/32
2 - 1/2	8	.1250	1.138	1.5713	2 - 5/8
3	8	.1250	1.200	1.6337	3 1/4
3 1/2	8	.1250	1.250	1.6837	3 - 3/4
4	8	.1250	1.300	1.7337	4 1/4
5	8	.1250	1.406	1.8407	-
6	8	.1250	1.513	1.9467	-
8	8	.1250	1.713	2.1467	-
10	8	.1250	1.925	2.3587	-
12	8	.1250	2.125	2.5587	-

Grade Marking	Specification	Material	SAE	Nominal	Tensile	Brinell
	SAE - Grade 0	Steel	C1010 C1018	All Sizes
	SAE - Grade 1 ASTM - A 307	Low Carbon Steel	C1010 C1018 C1020	All Sizes	55,000	207 Max
	SAE - Grade 2	Low Carbon Steel	C1018 C1020	Up to 1/2" Over 1/2" to 3/4" Over 3/4" to 1"	69,000 64,000 55,000	241 Max 241 Max 207 Max
	SAE - Grade 3	Medium Carbon Steel Cold Worked	C1035	Up to 1/2" Over 1/2" to 5/8"	110,000 100,000	207 - 269 207 - 269

Grade Marking	Specification	Material	SAE	Nominal	Tensile	Brinell
	SAE - Grade 5 ASTM - A 325	Medium Carbon Steel Quenched & Tempered	C1035 C1038	Up to 3/4" Over 3/4" to 1" Up to 3/4" Over 3/4" to 1"	120,000 115,000 120,000 115,000	241 - 285 223 - 285 241 - 262 236 - 362
	SAE - Grade 6	Medium Carbon Steel Quenched & Tempered	C1041	Up to 5/8" Over 5/8" to 3/4"	140,000 1,333,000	265 - 331 269 - 331

Grade Marking	Specification	Material	SAE	Nominal	Tensile	Brinell
	SAE - Grade 7	Medium Carbide Alloy Steel, Quenched & Tempered, Roll Threaded After Heat Treatment	1335 3135	Up to 1 1/2"	133,000	269 - 231
	SAE - Grade 8 ASTM - A 354 Grade BD	Medium Carbon Alloy Steel, Quenched & Tempered	1335 3135	Up to 1 - 1/2"	150,000	302,352

Data for Use With Machine Bolts and Cold Rolled Steel Stud Bolts Load in Pounds on Bolts and Stud Bolts when Torque Loads are Applied

Nominal Diameter of Bolt (inches)	Number of Threads (per inch)	Diameter at Root of Thread (inches)	Area at Root of Thread (sq. in)	STRESS					
				7,500 PSI		15,000 PSI		30,000 PSI	
				Torque Ft. Lbs.	Compression, Lbs.	Torque Ft. Lbs.	Compression, Lbs.	Torque Ft. Lbs.	Compression, Lbs.
1/4	20	.185	.027	1	203	2	405	4	810
5/16	18	.240	.045	2	338	4	675	8	1350
3/8	16	.294	.068	3	510	6	1020	12	2040
7/16	14	.345	.093	5	698	10	1395	20	2790
1/2	13	.400	.126	8	945	15	1890	30	3780
9/16	12	.454	.162	12	1215	23	2430	45	4860
5/8	11	.507	.202	15	1515	30	3030	60	6060
3/4	10	.620	.302	25	2265	50	4530	100	9060
7/8	9	.731	.419	40	3143	80	6285	160	12570
1	8	.838	.551	62	4133	123	8265	245	16530
1 1/8	7	.939	.693	98	5190	195	10380	390	20760
1 1/4	7	1.064	.890	137	6675	273	13350	545	26700
1 3/8	6	1.158	1.054	183	7905	365	15810	730	31620
1 1/2	6	1.283	1.294	219	9705	437	19410	875	38820
1 5/8	5 1/2	1.389	1.515	300	11363	600	22725	1200	45450
1 3/4	5	1.490	1.744	390	13080	775	26160	1550	52320
1 7/8	5	1.615	2.049	525	15368	1050	30735	2100	61470

Data for Use with Alloy Steel Stud Bolts Load in Pounds on Stud Bolts when Torque Loads are Applied

Nominal Diameter of Bolt (inches)	Number of Threads (per inch)	Diameter at Root of Thread (inches)	Area at Root of Thread (sq. in)	STRESS					
				30,000 PSI		45,000 PSI		60,000 PSI	
				Torque Ft. Lbs.	Compression, Lbs.	Torque Ft. Lbs.	Compression, Lbs.	Torque Ft. Lbs.	Compression, Lbs.
1/4	20	.185	.027	4	810	6	1215	8	1620
5/16	18	.240	.045	8	1350	12	2020	16	2700
3/8	16	.294	.068	12	2040	18	3060	24	4080
7/16	14	.345	.093	20	2790	30	4185	40	5580
1/2	13	.400	.126	30	3780	45	5670	60	7560
9/16	12	.454	.162	45	4860	68	7290	90	9720
5/8	11	.507	.202	60	6060	90	9090	120	12120
3/4	10	.620	.302	100	9060	150	13590	200	18120
7/8	9	.731	.419	150	12570	240	18855	320	25140
1	8	.838	.551	245	16530	368	24795	490	33060
1 1/8	8	.963	.728	355	21840	533	32760	710	43680

Data for Use with Alloy Steel Stud Bolts Load in Pounds on Stud Bolts when Torque Loads are Applied

Nominal Diameter of Bolt (inches)	Number of Threads (per inch)	Diameter at Root of Thread (inches)	Area at Root of Thread (sq. in)	STRESS					
				30,000 PSI		45,000 PSI		60,000 PSI	
				Torque Ft. Lbs.	Compression, Lbs.	Torque Ft. Lbs	Compression, Lbs.	Torque Ft. Lbs	Compression, Lbs.
1 1/4	8	1.088	.929	500	27870	750	41805	1000	55740
1 3/8	8	1.213	1.155	680	34650	1020	51975	1360	69300
1 1/2	8	1.338	1.405	800	42150	1200	63225	1600	84300
1 5/8	8	1.463	1.680	1100	50400	1650	75600	2200	100800
1 3/4	8	1.588	1.980	1500	59400	2250	89100	3000	118800
1 7/8	8	1.713	2.304	2000	69120	3000	103680	4000	138240
2	8	1.838	2.652	2200	79560	3300	119340	4400	159120
2 1/4	8	2.088	3.423	3180	102690	4770	154035	6360	205380
2 1/2	8	2.338	4.292	4400	128760	6600	193140	8800	257520
2 3/4	8	2.588	5.259	5920	157770	8880	236655	11840	315540
3	8	2.838	6.324	7720	189720	11580	284580	15440	379440

Data for Use with Alloy Steel Stud Bolts Load in Pounds on Stud Bolts when Torque Loads are Applied

Nominal Diameter of Bolt (inches)	Number of Threads (per inch)	Diameter at Root of Thread (inches)	Area at Root of Thread (sq. in)	STRESS					
				30,000 PSI		45,000 PSI		60,000 PSI	
				Torque Ft. Lbs.	Compression, Lbs.	Torque Ft. Lbs.	Compression, Lbs.	Torque Ft. Lbs.	Compression, Lbs.
1/4	20	.185	.027	4	810	6	1215	8	1620
5/16	18	.240	.045	8	1350	12	2020	16	2700
3/8	16	.294	.068	12	2040	18	3060	24	4080
7/16	14	.345	.093	20	2790	30	4185	40	5580
1/2	13	.400	.126	30	3780	45	5670	60	7560
9/16	12	.454	.162	45	4860	68	7290	90	9720
5/8	11	.507	.202	60	6060	90	9090	120	12120
3/4	10	.620	.302	100	9060	150	13590	200	18120
7/8	9	.731	.419	150	12570	240	18855	320	25140
1	8	.838	.551	245	16530	368	24795	490	33060
1 1/8	8	.963	.728	355	21840	533	32760	710	43680

Data for Use with Alloy Steel Stud Bolts Load in Pounds on Stud Bolts when Torque Loads are Applied

Nominal Diameter of Bolt (inches)	Number of Threads (per inch)	Diameter at Root of Thread (inches)	Area at Root of Thread (sq. in)	STRESS					
				30,000 PSI		45,000 PSI		60,000 PSI	
				Torque Ft. Lbs.	Compression, Lbs.	Torque Ft. Lbs	Compression, Lbs.	Torque Ft. Lbs	Compression, Lbs.
1 1/4	8	1.088	.929	500	27870	750	41805	1000	55740
1 3/8	8	1.213	1.155	680	34650	1020	51975	1360	69300
1 1/2	8	1.338	1.405	800	42150	1200	63225	1600	84300
1 5/8	8	1.463	1.680	1100	50400	1650	75600	2200	100800
1 3/4	8	1.588	1.980	1500	59400	2250	89100	3000	118800
1 7/8	8	1.713	2.304	2000	69120	3000	103680	4000	138240
2	8	1.838	2.652	2200	79560	3300	119340	4400	159120
2 1/4	8	2.088	3.423	3180	102690	4770	154035	6360	205380
2 1/2	8	2.338	4.292	4400	128760	6600	193140	8800	257520
2 3/4	8	2.588	5.259	5920	157770	8880	236655	11840	315540
3	8	2.838	6.324	7720	189720	11580	284580	15440	379440

Data for Use with Alloy Steel Stud Bolts Load in Pounds on Stud Bolts when Torque Loads are Applied

Nominal Diameter of Bolt (inches)	Number of Threads (per inch)	Diameter at Root of Thread (inches)	Area at Root of Thread (sq. in)	STRESS					
				30,000 PSI		45,000 PSI		60,000 PSI	
				Torque Ft. Lbs.	Compression, Lbs.	Torque Ft. Lbs.	Compression, Lbs.	Torque Ft. Lbs.	Compression, Lbs.
1/4	20	.185	.027	4	810	6	1215	8	1620
5/16	18	.240	.045	8	1350	12	2020	16	2700
3/8	16	.294	.068	12	2040	18	3060	24	4080
7/16	14	.345	.093	20	2790	30	4185	40	5580
1/2	13	.400	.126	30	3780	45	5670	60	7560
9/16	12	.454	.162	45	4860	68	7290	90	9720
5/8	11	.507	.202	60	6060	90	9090	120	12120
3/4	10	.620	.302	100	9060	150	13590	200	18120
7/8	9	.731	.419	150	12570	240	18855	320	25140
1	8	.838	.551	245	16530	368	24795	490	33060
1 1/8	8	.963	.728	355	21840	533	32760	710	43680

Data for Use with Alloy Steel Stud Bolts Load in Pounds on Stud Bolts when Torque Loads are Applied

Nominal Diameter of Bolt (inches)	Number of Threads (per inch)	Diameter at Root of Thread (inches)	Area at Root of Thread (sq. in)	STRESS					
				30,000 PSI		45,000 PSI		60,000 PSI	
				Torque Ft. Lbs.	Compression, Lbs.	Torque Ft. Lbs	Compression, Lbs.	Torque Ft. Lbs	Compression, Lbs.
1 1/4	8	1.088	.929	500	27870	750	41805	1000	55740
1 3/8	8	1.213	1.155	680	34650	1020	51975	1360	69300
1 1/2	8	1.338	1.405	800	42150	1200	63225	1600	84300
1 5/8	8	1.463	1.680	1100	50400	1650	75600	2200	100800
1 3/4	8	1.588	1.980	1500	59400	2250	89100	3000	118800
1 7/8	8	1.713	2.304	2000	69120	3000	103680	4000	138240
2	8	1.838	2.652	2200	79560	3300	119340	4400	159120
2 1/4	8	2.088	3.423	3180	102690	4770	154035	6360	205380
2 1/2	8	2.338	4.292	4400	128760	6600	193140	8800	257520
2 3/4	8	2.588	5.259	5920	157770	8880	236655	11840	315540
3	8	2.838	6.324	7720	189720	11580	284580	15440	379440

CLASS 300 FLANGES

Pipe Size	DRILLING		Length of Stud Bolt 1 1/16" Raised Face	Wrench Size
	# of Bolts	Diameter of Bolts		
1/2	4	1/2	2 1/2	7/8
3/4	4	5/8	3	1 1/16
1	4	5/8	3	1 1/16
1 1/4	4	5/10	3 1/4	1 1/16
1 1/2	4	3/4	3 1/2	1 1/4
2	8	5/8	3 1/2	1 1/16
2 1/2	8	3/4	4	1 1/4
3	8	3/4	4 1/4	1 1/4
3 1/2	8	3/4	4 1/4	1 1/4
4	8	3/4	4 1/2	1 1/4
5	8	3/4	4 3/4	1 1/4
6	12	3/4	4 3/4	1 1/4
8	12	7/8	5 1/2	1 7/16
10	16	1	6 1/4	15/8
12	16	1 1/8	6 3/4	1 13/16
14	20	1 1/8	7	1 13/16
16	20	1 1/4	7 1/2	2
18	24	1 1/4	7 3/4	2
20	24	1 1/4	8	2
24	24	1 1/2	9	2 3/8

CLASS 150 FLANGES

Pipe Size	DRILLING		Length of Stud Bolt 1 1/16" Raised Face	Wrench Size
	# of Bolts	Diameter of Bolts		
1/2	4	1/2	2 1/4	7/8
3/4	4	1/2	2 1/2	7/8
1	4	1/2	2 1/2	7/8
1 1/4	4	1/2	2 3/4	7/8
1 1/2	4	1/2	2 3/4	7/8
2	4	5/8	3 1/4	1 1/16
2 1/2	4	5/8	3 1/2	1 1/16
3	4	5/8	3 1/2	1 1/16
3 1/2	8	5/8	3 1/2	1 1/16
4	8	5/8	3 1/2	1 1/16
5	8	3/4	3 3/4	1 1/4
6	8	3/4	4	1 1/4
8	8	3/4	4 1/4	1 1/4
10	12	7/8	4 1/2	1 7/16
12	12	7/8	4 3/4	1 7/16
14	12	1	5 1/4	1 5/8
16	16	1	5 1/4	1 5/8
18	16	1 1/8	5 3/4	1 13/16
20	20	1 1/8	6 1/4	1 13/16
24	20	1 1/4	6 3/4	2

CLASS 600 FLANGES

Pipe Size	DRILLING		Length of Stud Bolt 1 1/16" Raised Face	Wrench Size
	# of Bolts	Diameter of Bolts		
1/2	4	1/2	3	7/8
3/4	4	5/8	3 1/2	1 1/16
1	4	5/8	3 1/2	1 1/16
1 1/4	4	5/8	3 3/4	1 1/16
1 1/2	4	3/4	4 1/4	1 1/4
2	8	5/8	4 1/4	1 1/16
2 1/2	8	3/4	4 3/4	1 1/4
3	8	3/4	5	1 1/4
3 1/2	8	7/8	5 1/2	1 7/16
4	8	7/8	5 3/4	1 7/16
5	8	1	6 1/2	1 5/8
6	12	1	6 3/4	1 5/8
8	12	1 1/8	7 1/2	1 13/16
10	16	1 1/4	8 1/2	2
12	20	1 1/4	8 3/4	2
14	20	1 3/8	9 1/4	2 3/16
16	20	1 1/2	10	2 3/8
18	20	1 5/8	10 3/4	2 9/16
20	24	1 5/8	11 1/4	2 9/16
24	24	1 7/8	13	2 15/16

CLASS 400 FLANGES

Pipe Size	DRILLING		Length of Stud Bolt 1 1/16" Raised Face	Wrench Size
	# of Bolts	Diameter of Bolts		
1/2	4	1/2	3	7/8
3/4	4	5/8	3 1/2	1 1/16
1	4	5/8	3 1/2	1 1/16
1 1/4	4	5/8	3 3/4	1 1/16
1 1/2	4	3/4	4 1/4	1 1/4
2	8	5/8	4 1/4	1 1/16
2 1/2	8	3/4	4 3/4	1 1/4
3	8	3/4	5	1 1/4
3 1/2	8	7/8	5 1/2	1 7/16
4	8	7/8	5 1/2	1 7/16
5	8	7/8	5 3/4	1 7/16
6	12	7/8	6	1 7/16
8	12	1	6 3/4	1 5/8
10	16	1 1/8	7 1/2	1 13/16
12	16	1 1/4	8	2
14	20	1 1/4	8 1/4	2
16	20	1 3/8	8 3/4	2 3/16
18	24	1 3/8	9	2 3/16
20	24	1 1/2	9 1/2	2 3/8
24	24	1 3/4	10 1/2	2 3/4

CLASS 1500 FLANGES

Pipe Size	DRILLING		Length of Stud Bolt 1 1/16" Raised Face	Wrench Size
	# of Bolts	Diameter of Bolts		
1/2	4	3/4	4 1/4	1 1/4
3/4	4	3/4	4 1/2	1 1/4
1	4	7/8	5	1 7/16
1 1/4	4	7/8	5	1 7/16
1 1/2	4	1	5 1/2	1 5/8
2	8	7/8	5 3/4	1 7/16
2 1/2	8	1	6 1/4	1 5/8
3	8	1 1/8	7	1 13/16
4	8	1 1/4	7 3/4	2
5	8	1 1/2	9 3/4	2 3/8
6	12	1 3/8	10 1/4	2 3/16
8	12	1 5/8	11 1/2	2 9/16
10	12	1 7/8	13 1/4	2 15/16
12	16	2	14 3/4	3 1/8
14	16	2 1/4	16	3 1/2
16	16	2 1/2	17 1/2	3 7/8
18	16	2 3/4	19 1/2	4 1/4
20	16	3	21 1/4	4 5/8
24	16	3 1/2	24 1/4	5 3/8
24	24	1 7/8	13	2 15/16

CLASS 900 FLANGES

Pipe Size	DRILLING		Length of Stud Bolt 1 1/16" Raised Face	Wrench Size
	# of Bolts	Diameter of Bolts		
1/2	4	3/4	4 1/4	1 1/4
3/4	4	3/4	4 1/2	1 1/4
1	4	7/8	5	1 7/16
1 1/4	4	7/8	5	1 7/16
1 1/2	4	1	5 1/2	1 5/8
2	8	7/8	5 3/4	1 7/16
2 1/2	8	1	6 1/4	1 5/8
3	8	7/8	5 3/4	1 7/16
4	8	1 1/8	6 3/4	1 13/16
5	8	1 1/4	7 1/2	2
6	12	1 1/8	7 1/2	1 13/16
8	12	1 3/8	10	8 3/4
10	16	1 3/8	10 3/4	9 1/4
12	20	1 1/2	8 3/4	10
14	20	1 5/8	9 1/4	10 3/4
16	20	1 5/8	11 1/4	2 9/16
18	20	1 7/8	12 3/4	2 15/16
20	20	2	13 3/4	3 1/8
24	20	2 1/2	17 1/4	3 7/8
24	24	1 3/4	10 1/2	2 3/4