

ENGINEERING BOLT TORQUE SPECIFICATION: SAE GRADE 2; SAE GRADE 5; SAE GRADE 8; AND SAE GRADE C BOLTS, SAE J429.

PURPOSE:

To establish a uniform means of identifying Thomas Built Buses, Inc. requirements for bolt torque.

ABSTRACT:

This Specification identifies the mechanical and material requirements for determining bolt torque.

SCOPE:

All drawings of component parts or assemblies, requiring specific bolt torque call-outs will note this Specification.

RESPONSIBILITIES:

All personnel concerned with the design, review, procurement, manufacture, or quality assurance of bolted components or assemblies will ensure that the requirements of this Specification are implemented. Engineering is responsible for determining the bolt torque.

ENGINEERING CALLOUT:

10) TORQUE: BOLT INSTALLATION TORQUE PER 69001172.

REFERENCE:

ENGINEERING SPECIFICATIONS MASTER LIST, 68152329.

GENERAL:

Two stresses are applied to a bolt during wrenching: torsion and tension. Correct tension is the goal. Approximately 90% of the applied torque is used to overcome friction. The friction factor is changed by the addition of some form of lubrication. The 0.20 dry torque coefficient is approximately constant for the normal as-received bolt condition for the noted bolt diameters, coarse and fine threads in this Specification. The 0.15 lubricated torque coefficient is approximately constant for the bolts with conversion coatings for the noted bolt diameters, coarse and fine threads in this Specification. Conversion coatings are used to extend the life of zinc, phosphate and cadmium plating. All torque values, in this Specification, are based on the use of through hardened flat washers under the bolt head and nut or just under the bolt head for tapped hole assemblies. Verify bolt selection and torque value with Engineering before joining parts or assemblies without through hardened flat washers under the bolt head and / or nut.

THREAD SELECTION:

Stress concentrations and thread loading is lower in the coarse threaded bolts than in the fine thread bolts. Coarse threads provide greater flank engagement due to their deeper threads. A coarse thread has a greater resistance to stripping than that of a fine thread and tightens with only 2/3 the revolutions required for fine threads, possibly reducing assembly times. Fine threads are typically used for applications where fine adjustments are required. There is more metal in the fine series, consequently it can support more load. The fine thread bolts will produce about 10% more clamping force than the coarse threads.

DELIVERY MUST CONFORM EXACTLY WITH DRAWING SPECIFICATIONS AND, WHERE REQUIRED BY Q.A., WITH APPROVED Q.A. SAMPLES. ABSOLUTELY NO CHANGES ARE PERMITTED WITHOUT PRIOR APPROVAL BY THOMAS BUILT BUSES. THIS INCLUDES CHANGES TO: SOFTWARE, MATERIALS, INTERNAL COMPONENTS AND MANUFACTURING PROCESSES.	REV	CHG NO.: ECR_8468	CHG DATE: 02/24/11	THOMAS BUILT BUSES, INC. HIGH POINT, NC USA		
	B	REV BY: Y.SHAW	CHECKED BY: D.HARRIS			
	REVISION DESCRIPTION				THE INFORMATION CONTAINED HEREIN IS CONFIDENTIAL AND PROPRIETARY TO THOMAS BUILT BUSES, INC. AND SHALL NOT BE COPIED, REPRODUCED, DISCLOSED, PUBLISHED, OR USED FOR ANY PURPOSE WITHOUT THE EXPRESS WRITTEN PERMISSION OF THOMAS BUILT BUSES, INC. COPYRIGHT © THOMAS BUILT BUSES, INC. ALL RIGHTS RESERVED.	
	1) REVISED TABLE 2) ADDED TABLE *REV A ERN: 11186-1*				ENG/DES: BRR DATE: 05/22/01 REVIEWER: BRR DATE: 05/22/01 APPROVER: S.JAVONOVICH DATE: 02/24/11	SIZE A UNIT OF MEASURE INCH
REFER TO ENGINEERING SPECIFICATION MASTER LIST DRAWING NUMBER 68152329	TOLERANCE UNLESS OTHERWISE SPECIFIED			BOLT TORQUE SPECIFICATION, SAE GRADE 2, SAE GRADE 5, SAE GRADE 8, AND SAE GRADE C, SAE J429		
	DECIMAL INCH .xxx ±0.15 .xx ±0.03 .x ±0.06	METRIC [mm] .xxx ±0.5 .xx ±1.0 .x ±1.5	ANGULAR ±1°			
	WORD DRAWING		SHEET 1 OF 14			

BOLT MATERIAL:

The three physical grades of steel referenced in this Specification are SAE Grade 2; SAE Grade 5 and SAE Grade 8. The Grade 2 material is low or medium carbon steel; Grade 5 is medium carbon steel, quenched and tempered; Grade 8 is medium carbon alloy steel, quenched and tempered.

GRADE IDENTIFICATION MARKING:

SAE Grade 5 bolts shall have three radially spaced lines on the head. SAE Grade 8 shall have 6 AND SAE grade 2 does not require SAE grade marks.

MANUFACTURER IDENTIFICATION:

Bolt manufacturer's identification symbols on the bolt head are required per SAE.

FLEXIBLE JOINTS:

Flexible joints should be tightened to their working load. Selecting the correct bolt for use on a flexible joint depends on the type of compressible material being used. The total pre-load on all the fasteners in this type of connection must be just sufficient to compress the material and provide the desired clamping force without detrimental crushing of the compressible material. The torque values in this Specification may not be suitable for compressible joints or assemblies. Verify bolt selection and torque value with Engineering before joining compressible joints.

MILD STEEL PARTS OR ASSEMBLIES:

Through hardened flat washers will distribute the bolt load when joining mild steel parts or assemblies. If through hardened flat washers are not used when joining mild steel parts or assemblies, the torque values in this Specification may not be applicable. Verify bolt selection and torque value with Engineering before joining mild steel parts or assemblies without through hardened flat washers under the bolt head and / or nut.

TORQUE SPECIFICATIONS:

The assembly torque for the bolt grades noted in this Specification are recommended with the following qualifications:


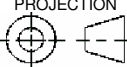
1. All torque values shown in this Specification are for turning the nut while holding the head of the bolt with a wrench, with the exception of socket head cap screws. If the assembly calls for tightening by the bolt head, increase the value shown by 20% (multiply by 1.20). This allows for the natural torsional twist of the bolt shank.
2. Torque values are calculated at 75% of the proof load.
3. All dry torque values are given for the "as received" bolt condition.
4. All torque values are based on the use of through hardened flat washers under the bolt head and nut or just under the bolt head for tapped hole assemblies.
5. Tolerances on bolt torque call-outs are $\pm 10\%$.

EXTENSION OF BOLT THROUGH NUT

A minimum of 1-1/2 threads and a maximum of 5/8 inch (15mm) of threaded bolt should extend through a nut when it has been properly tightened. This pertains to bolts 4 inches (100mm) in length and shorter

LOCKWASHER-FLATWASHER COMBINATION

A flat washer together with a lock washer as a pair tend to defeat each other's purpose and will not be used.

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REFER TO ENGINEERING SPECIFICATION MASTER LIST DRAWING NUMBER 68152329	TOLERANCE UNLESS OTHERWISE SPECIFIED			BOLT TORQUE SPECIFICATION, SAE GRADE 2, SAE GRADE 5, SAE GRADE 8, AND SAE GRADE C, SAE J429		
	DECIMAL INCH	METRIC [mm]	ANGULAR			
	.xxx ±.015 .xx ±.03 .x ±.06	.xxx ±0.5 .xx ±1.0 .x ±1.5	± 1°			
WORD DRAWING	SHEET 2 OF 14	69001172				

LOCKWASHERS

Lock washers (split or toothed) are not to be use next to aluminum surfaces Except when use to provide a good electrical ground

SAE GRADE 2, FINE (UNF) THREADS, TORQUE SPECIFICATIONS:

MATERIAL DESCRIPTION: Low carbon steel.

MECHANICAL PROPERTIES: 1/4" dia. thru 3/4" dia. – 55,000 psi Proof load; 74,000 psi Tensile; Rockwell "B" Scale – B80 min - B100 max.


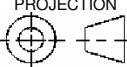
7/8" dia. thru 1 1/2" dia. – 33,000psi Proof load; 60,000 psi Tensile; Rockwell "B" Scale – B80 min - B100 max.

THREADS PER INCH – FINE (UNF)	BASIC MAJOR DIA. (D)	STRESS AREA SQUARE INCH	PROOF LOAD (LBS.)	TENSILE STRENGTH (LBS.)	CLAMP LOAD (LBS.) (W)	(T) ASSEMBLY TORQUE		THREADS PER INCH – FINE (UNF)
						"DRY" (0.20K)	"LUBRICATED" (0.15K)	
4-48	.1120	.0066	360	490	270	6 in-lbs	5 in-lbs	4-48
6-40	.1380	.0101	550	745	410	12 in-lbs	9 in-lbs	6-60
8-36	.1640	.0147	800	1080	600	20 in-lbs	15 in-lbs	8-36
10-32	.1900	.0200	1100	1480	825	31 in-lbs	23 in-lbs	10-32
1/4-28	.2500	.0364	2000	2690	1500	76 in-lbs	56 in-lbs	1/4-28
5/16-24	.3125	.0580	3200	4290	2400	12 ft-lbs	9 ft-lbs	5/16-24
3/8-24	.3750	.0878	4850	6500	3640	23 ft-lbs	17 ft-lbs	3/8-24
7/16-20	.4375	.1187	6500	8780	4875	36 ft-lbs	27 ft-lbs	7/16-20
1/2-20	.5000	.1599	8800	11830	6600	55 ft-lbs	40 ft-lbs	1/2-20
9/16-18	.5625	.2030	11200	15020	8400	80 ft-lbs	60 ft-lbs	9/16-18
5/8-18	.6250	.2560	14100	18940	10580	110 ft-lbs	85 ft-lbs	5/8-18
3/4-16	.7500	.3730	20500	27600	15380	190 ft-lbs	150 ft-lbs	3/4-16
7/8-14	.8750	.5090	16800	30540	12600	180 ft-lbs	140 ft-lbs	7/8-14
1-14	1.0000	.6800	21900	39780	16430	280 ft-lbs	210 ft-lbs	1-14
1 1/8-12	1.1250	.8560	28200	51360	21150	400 ft-lbs	300 ft-lbs	1 1/8-12
1 1/4-12	1.2500	1.0730	35400	64380	26550	550 ft-lbs	420 ft-lbs	1 1/4-12
1 3/8-12	1.3750	1.3750	43400	78900	32550	750 ft-lbs	560 ft-lbs	1 3/8-12
1 1/2-12	1.5000	1.5810	52200	94860	39150	980 ft-lbs	730 ft-lbs	1 1/2-12

NOTES:

The heavy line in the chart denotes the change from in-lbs. to ft-lbs.

All torque values are based on the use of through hardened flat washers under the bolt head and nut or just under the bolt head for tapped hole assemblies.

DELIVERY MUST CONFORM EXACTLY WITH DRAWING SPECIFICATIONS AND, WHERE REQUIRED BY Q.A., WITH APPROVED Q.A. SAMPLES. ABSOLUTELY NO CHANGES ARE PERMITTED WITHOUT PRIOR APPROVAL BY THOMAS BUILT BUSES. THIS INCLUDES CHANGES TO: SOFTWARE, MATERIALS, INTERNAL COMPONENTS AND MANUFACTURING PROCESSES.	REV B	CHG NO.: ECR_8468	CHG DATE: 02/24/11	 THOMAS BUILT BUSES, INC. HIGH POINT, NC USA	
		REV BY: Y.SHAW	CHECKED BY: D.HARRIS		
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	TOLERANCE UNLESS OTHERWISE SPECIFIED			BOLT TORQUE SPECIFICATION, SAE GRADE 2, SAE GRADE 5, SAE GRADE 8, AND SAE GRADE C, SAE J429	
	DECIMAL INCH .xxx ±0.15 .xx ±.03 .x ±.06	METRIC [mm] .xxx ±0.5 .xx ±1.0 .x ±1.5	ANGULAR ±1°	 THIRD ANGLE PROJECTION	WORD DRAWING
				69001172	


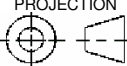
SAE GRADE 2, COARSE (UNC) THREADS, TORQUE SPECIFICATIONS:

MATERIAL DESCRIPTION: Low carbon steel.

MECHANICAL PROPERTIES: 1/4" dia. thru 3/4" dia. – 55,000psi Proof load; 74,000psi Tensile; Rockwell "B" Scale – B80 min - B100 max.
7/8" dia. thru 1 1/2" dia. – 33,000 psi Proof load; 60,000psi Tensile; Rockwell "B" Scale – B80 min - B100 max.

THREADS PER INCH – COARSE (UNC)	BASIC MAJOR DIA. (D)	STRESS AREA SQUARE INCH	PROOF LOAD (LBS.)	TENSILE STRENGTH (LBS.)	CLAMP LOAD (LBS.) (W)	(T) ASSEMBLY TORQUE		THREADS PER INCH – COARSE (UNC)
						"DRY" (0.20K)	"LUBRICATED" (0.15K)	
4-40	.1120	.0060	330	440	250	5 in-lbs	4 in-lbs	4-40
6-32	.1380	.0090	490	660	375	10 in-lbs	8 in-lbs	6-32
8-32	.1640	.0140	770	1030	580	19 in-lbs	14 in-lbs	8-32
10-24	.1900	.0175	960	1300	725	27 in-lbs	21 in-lbs	10-24
1/4-20	.2500	.0318	1750	2350	1320	66 in-lbs	50 in-lbs	1/4-20
5/16-18	.3125	.0524	2880	3880	2160	11 ft-lbs	8 ft-lbs	5/16-18
3/8-16	.3750	.0775	4250	5730	3200	20 ft-lbs	15 ft-lbs	3/8-16
7/16-14	.4375	.1063	5870	7870	4340	32 ft-lbs	24 ft-lbs	7/16-14
1/2-13	.5000	.1419	7800	10500	5850	50 ft-lbs	35 ft-lbs	1/2-13
9/16-12	.5625	.1820	10000	13470	7500	70 ft-lbs	55 ft-lbs	9/16-12
5/8-11	.6250	.2260	12450	16720	9350	100 ft-lbs	75 ft-lbs	5/8-11
3/4-10	.7500	.3340	18350	24720	13800	175 ft-lbs	130 ft-lbs	3/4-10
7/8-9	.8750	.4620	15250	27720	11450	170 ft-lbs	125 ft-lbs	7/8-9
1-8	1.0000	.6060	20000	36360	15000	250 ft-lbs	190 ft-lbs	1-8
1 1/8-7	1.1250	.7630	25200	45780	18900	350 ft-lbs	270 ft-lbs	1 1/8-7
1 1/4-7	1.2500	.9690	32000	58140	24000	500 ft-lbs	380 ft-lbs	1 1/4-7
1 3/8-6	1.3750	1.1550	38050	69300	28600	670 ft-lbs	490 ft-lbs	1 3/8-6
1 1/2-6	1.5000	1.4050	46400	84300	34800	870 ft-lbs	650 ft-lbs	1 1/2-6

NOTES:
The heavy line in the chart denotes the change from in-lbs. to ft-lbs.
All torque values are based on the use of through hardened flat washers under the bolt head and nut or just under the bolt head for tapped hole assemblies.

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TOLERANCE UNLESS OTHERWISE SPECIFIED												
DECIMAL INCH .xxx ±0.15 .xx ±0.3 .x ±0.6	METRIC [mm] .xxx ±0.5 .xx ±1.0 .x ±1.5	ANGULAR ±1°		WORD DRAWING	SHEET 4 OF 14	69001172						


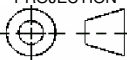
SAE GRADE 5, FINE (UNF) THREADS, TORQUE SPECIFICATIONS:

MATERIAL DESCRIPTION: Medium carbon steel, quenched and tempered.

MECHANICAL PROPERTIES: 1/4" dia. Thru 1" dia. – 85,000 psi Proof load; 74,000psi Tensile; Rockwell "C" Scale – C25 min - C34 max.
1 1/8" dia. Thru 1 1/2" dia. – 74,000 psi Proof load; 105,000 psi tensile; Rockwell "C" Scale – C19 min - C30 max.

THREADS PER INCH – FINE (UNF)	BASIC MAJOR DIA. (D)	STRESS AREA SQUARE INCH	PROOF LOAD (LBS.)	TENSILE STRENGTH (LBS.)	CLAMP LOAD (LBS.) (W)	(T) ASSEMBLY TORQUE		THREADS PER INCH – FINE (UNF)
						"DRY" (0.20K)	"LUBRICATED" (0.15K)	
4-48	.1120	.0066	560	792	420	9 in-lbs	7 in-lbs	4-48
6-40	.1380	.0101	860	1212	640	18 in-lbs	13 in-lbs	6-40
8-36	.1640	.0147	1250	1764	940	31 in-lbs	23 in-lbs	8-36
10-32	.1900	.0200	1700	2400	1285	49 in-lbs	36 in-lbs	10-32
1/4-28	.2500	.0364	3100	4370	2320	10 ft-lbs	86 in-lbs	1/4-28
5/16-24	.3125	.0580	4950	6960	3700	19 ft-lbs	14 ft-lbs	5/16-24
3/8-24	.3750	.0878	7450	10540	5600	35 ft-lbs	25 ft-lbs	3/8-24
7/16-20	.4375	.1187	10100	14240	7550	55 ft-lbs	40 ft-lbs	7/16-20
1/2-20	.5000	.1599	13600	19190	10700	90 ft-lbs	65 ft-lbs	1/2-20
9/16-18	.5625	.2030	17250	24360	12950	120 ft-lbs	90 ft-lbs	9/16-18
5/8-18	.6250	.2560	21750	30720	16950	180 ft-lbs	130 ft-lbs	5/8-18
3/4-16	.7500	.3730	31700	44760	23800	300 ft-lbs	220 ft-lbs	3/4-16
7/8-14	.8750	.5090	43270	61080	29800	440 ft-lbs	320 ft-lbs	7/8-14
1 1/4-1	1.0000	.6800	57800	81600	38800	640 ft-lbs	480 ft-lbs	1-14
1 1/8-12	1.1250	.8560	63300	89880	47500	880 ft-lbs	660 ft-lbs	1 1/8-12
1 1/4-12	1.2500	1.0730	79400	112660	59600	1240 ft-lbs	920 ft-lbs	1 1/4-12
1 3/8-12	1.3750	1.3150	97300	138070	73000	1680 ft-lbs	1260 ft-lbs	1 3/8-12
1 1/2-12	1.5000	1.5810	117000	166000	87700	2200 ft-lbs	1640 ft-lbs	1 1/2-12

NOTES:
The heavy line in the chart denotes the change from in-lbs. to ft-lbs.
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		SHEET 5 OF 14	69001172									

SAE GRADE 5, COARSE (UNC), TORQUE SPECIFICATIONS:

MATERIAL DESCRIPTION: Medium carbon steel, quenched and tempered.


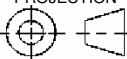
MECHANICAL PROPERTIES: 1/4" dia. Thru 1" dia. – 85,000 psi Proof load; 120,000psi Tensile; Rockwell "C" Scale – C25 min - C34 max.
1 1/8" dia. Thru 1 1/2" dia. – 74,000 psi Proof load; 105,000 psi Tensile; Rockwell "C" Scale – C19 min - C30 max.

THREADS PER INCH – COARSE (UNC)	BASIC MAJOR DIA. (D)	STRESS AREA SQUARE INCH	PROOF LOAD (LBS.)	TENSILE STRENGTH (LBS.)	CLAMP LOAD (LBS.) (W)	(T) ASSEMBLY TORQUE		THREADS PER INCH COARSE (UNC)
						"DRY" (0.20K)	"LUBRICATED" (0.15K)	
4-40	.1120	.0060	500	700	380	8 in-lbs	6 in-lbs	4-40
6-32	.1380	.0090	750	1000	580	16 in-lbs	12 in-lbs	6-32
8-32	.1640	.0140	1200	1700	900	30 in-lbs	22 in-lbs	8-32
10-24	.1900	.0175	1500	2100	1120	43 in-lbs	32 in-lbs	10-24
1/4-20	.2500	.0318	2700	3800	2020	8 ft-lbs	75 in-lbs	1/4-20
5/16-18	.3125	.0524	4450	6290	3340	17 ft-lbs	13 ft-lbs	5/16-18
3/8-16	.3750	.0775	6600	9300	4940	30 ft-lbs	23 ft-lbs	3/8-16
7/16-14	.4375	.1063	9050	12760	6800	50 ft-lbs	35 ft-lbs	7/16-14
1/2-13	.5000	.1419	12050	17030	9050	75 ft-lbs	55 ft-lbs	1/2-13
9/16-12	.5625	.1820	15500	21840	11600	110 ft-lbs	80 ft-lbs	9/16-12
5/8-11	.6250	.2260	19200	27120	14400	150 ft-lbs	110 ft-lbs	5/8-11
3/4-10	.7200	.3340	28390	40080	21300	260 ft-lbs	200 ft-lbs	3/4-10
7/8-9	.8750	.4620	39270	55440	27000	400 ft-lbs	300 ft-lbs	7/8-9
1-8	1.0000	.6060	51510	72720	35500	580 ft-lbs	440 ft-lbs	1-8
1 1/8-7	1.1250	.7630	56450	80110	42300	800 ft-lbs	600 ft-lbs	1 1/8-7
1 1/4-7	1.2500	.9690	71700	101740	53800	1120 ft-lbs	840 ft-lbs	1 1/4-7
1 3/8-6	1.3750	1.1550	85450	121270	64100	1460 ft-lbs	1100 ft-lbs	1 3/8-6
1 1/2-6	1.5000	1.4050	103950	147520	78000	1940 ft-lbs	1460 ft-lbs	1 1/2-6

NOTES:

The heavy line in the chart denotes the change from in-lbs. to ft-lbs.

All torque values are based on the use of through hardened flat washers under the bolt head and nut or just under the bolt head for tapped hole assemblies.

DELIVERY MUST CONFORM EXACTLY WITH DRAWING SPECIFICATIONS AND, WHERE REQUIRED BY Q.A., WITH APPROVED Q.A. SAMPLES. ABSOLUTELY NO CHANGES ARE PERMITTED WITHOUT PRIOR APPROVAL BY THOMAS BUILT BUSES. THIS INCLUDES CHANGES TO: SOFTWARE, MATERIALS, INTERNAL COMPONENTS AND MANUFACTURING PROCESSES.	REV B	CHG NO.: ECR_8468	CHG DATE: 02/24/11	 THOMAS BUILT BUSES, INC. HIGH POINT, NC USA	
		REV BY: Y.SHAW	CHECKED BY: D.HARRIS		
	REVISION DESCRIPTION				<small>THE INFORMATION CONTAINED HEREIN IS CONFIDENTIAL AND PROPRIETARY TO THOMAS BUILT BUSES, INC. AND SHALL NOT BE COPIED, REPRODUCED, DISCLOSED, PUBLISHED, OR USED FOR ANY PURPOSE WITHOUT THE EXPRESS WRITTEN PERMISSION OF THOMAS BUILT BUSES, INC. COPYRIGHT © THOMAS BUILT BUSES, INC. ALL RIGHTS RESERVED.</small>
	1) REVISED TABLE 2) ADDED TABLE *REV A ERN: 11186-1*				ENG/DES: BRR DATE: 05/22/01 REVIEWER: BRR DATE: 05/22/01 APPROVER: S.JAVONOVICH DATE: 02/24/11
REFER TO ENGINEERING SPECIFICATION MASTER LIST DRAWING NUMBER 68152329	TOLERANCE UNLESS OTHERWISE SPECIFIED			SIZE A UNIT OF MEASURE INCH	
	DECIMAL INCH .xxx ±0.15 .xx ±0.3 .x ±0.6	METRIC [mm] .xxx ±0.5 .xx ±1.0 .x ±1.5	ANGULAR ±1°		BOLT TORQUE SPECIFICATION, SAE GRADE 2, SAE GRADE 5, SAE GRADE 8, AND SAE GRADE C, SAE J429
	THIRD ANGLE PROJECTION 				

SAE GRADE 8, FINE (UNF), TORQUE SPECIFICATIONS:


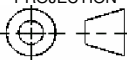
MATERIAL DESCRIPTION: Medium carbon alloy steel, quenched and tempered.

MECHANICAL PROPERTIES: 1/4" dia. Thru 1 1/2" dia. – 120,000
C33 min - C39 max.

psi Proof load; 150,000psi Tensile; Rockwell "C" Scale –

THREADS PER INCH – FINE (UNF)	BASIC MAJOR DIA. (D)	STRESS AREA SQUARE INCH	PROOF LOAD (LBS.)	TENSILE STRENGTH (LBS.)	CLAMP LOAD (LBS.) (W)	(T) ASSEMBLY TORQUE		THREADS PER INCH – FINE (UNF)
						"DRY" (0.20K)	"LUBRICATED" (0.15K)	
4-48	.1120	.0066	800	1000	600	13 in-lbs	10 in-lbs	4-48
6-40	.1380	.0101	1200	1500	920	25 in-lbs	19 in-lbs	6-40
8-36	.1640	.0147	1750	2200	1320	43 in-lbs	32 in-lbs	8-36
10-32	.1900	.0200	2400	3000	1800	68 in-lbs	51 in-lbs	10-32
1/4-28	.2500	.0364	4350	5460	3280	14 ft-lbs	10 ft-lbs	1/4-28
5/16-24	.3125	.0580	6950	8700	5220	25 ft-lbs	20 ft-lbs	5/16-24
3/8-24	.3750	.0878	10500	13170	7900	58 ft-lbs	35 ft-lbs	3/8-24
7/16-20	.4375	.1187	14250	17800	10700	80 ft-lbs	60 ft-lbs	7/16-20
1/2-20	.5000	.1599	19200	23980	14400	120 ft-lbs	90 ft-lbs	1/2-20
9/16-18	.5625	.2030	24350	30450	18250	170 ft-lbs	120 ft-lbs	9/16-18
5/8-18	.6050	.2560	30700	38400	23000	240 ft-lbs	180 ft-lbs	5/8-18
3/4-16	.7500	.3730	44750	55950	33600	420 ft-lbs	320 ft-lbs	3/4-16
7/8-14	.8750	.5090	61600	76350	45800	660 ft-lbs	500 ft-lbs	7/8-14
1-14	1.0000	.6800	79550	99450	59700	1000 ft-lbs	740 ft-lbs	1-14
1 1/8-12	1.1250	.8560	102700	128400	77000	1440 ft-lbs	1080 ft-lbs	1 1/8-12
1 1/4-12	1.2500	1.0730	128800	160950	96600	2000 ft-lbs	1500 ft-lbs	1 1/4-12
1 3/8-12	1.3150	1.3150	157800	197250	118400	2720 ft-lbs	2040 ft-lbs	1 3/8-12
1 1/2-12	1.5000	1.5810	189700	237150	142200	3560 ft-lbs	2660 ft-lbs	1 1/2-12

NOTES:
The heavy line in the chart denotes the change from in-lbs. to ft-lbs.
All torque values are based on the use of through hardened flat washers under the bolt head and nut or just under the bolt head for tapped hole assemblies.

DELIVERY MUST CONFORM EXACTLY WITH DRAWING SPECIFICATIONS AND, WHERE REQUIRED BY Q.A., WITH APPROVED Q.A. SAMPLES. ABSOLUTELY NO CHANGES ARE PERMITTED WITHOUT PRIOR APPROVAL BY THOMAS BUILT BUSES. THIS INCLUDES CHANGES TO: SOFTWARE, MATERIALS, INTERNAL COMPONENTS AND MANUFACTURING PROCESSES.	REV B	CHG NO.: ECR_8468	CHG DATE: 02/24/11	 THOMAS BUILT BUSES, INC. HIGH POINT, NC USA	
		REV BY: Y.SHAW	CHECKED BY: D.HARRIS		
	REVISION DESCRIPTION				<small>THE INFORMATION CONTAINED HEREIN IS CONFIDENTIAL AND PROPRIETARY TO THOMAS BUILT BUSES, INC. AND SHALL NOT BE COPIED, REPRODUCED, DISCLOSED, PUBLISHED, OR USED FOR ANY PURPOSE WITHOUT THE EXPRESS WRITTEN PERMISSION OF THOMAS BUILT BUSES, INC. COPYRIGHT © THOMAS BUILT BUSES, INC. ALL RIGHTS RESERVED.</small>
	1) REVISED TABLE 2) ADDED TABLE *REV A ERN: 11186-1*				ENG/DES: BRR DATE: 05/22/01 REVIEWER: BRR DATE: 05/22/01 APPROVER: S.JAVONOVICH DATE: 02/24/11
REFER TO ENGINEERING SPECIFICATION MASTER LIST DRAWING NUMBER 68152329	TOLERANCE UNLESS OTHERWISE SPECIFIED			SIZE A UNIT OF MEASURE INCH	
	DECIMAL INCH .xxx ±0.15 .xx ±0.3 .x ±0.6	METRIC [mm] .xxx ±0.5 .xx ±1.0 .x ±1.5	ANGULAR ±1°		
	THIRD ANGLE PROJECTION 				
BOLT TORQUE SPECIFICATION, SAE GRADE 2, SAE GRADE 5, SAE GRADE 8, AND SAE GRADE C, SAE J429				WORD DRAWING SHEET 7 OF 14 69001172	


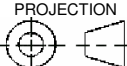
SAE GRADE 8, COARSE (UNC), TORQUE SPECIFICATIONS:

MATERIAL DESCRIPTION: Medium carbon alloy steel, quenched and tempered.

MECHANICAL PROPERTIES: 1/4" dia. Thru 1 1/2" dia. – 120,000 psi Proof load; 150,000psi Tensile; Rockwell "C" Scale – C33 min - C39 max.

THREADS PER INCH – COARSE (UNC)	BASIC MAJOR DIA. (D)	STRESS AREA SQUARE INCH	PROOF LOAD (LBS.)	TENSILE STRENGTH (LBS.)	CLAMP LOAD (LBS.) (W)	(T) ASSEMBLY TORQUE		THREADS PER INCH – COARSE (UNC)
						"DRY" (0.20K)	"LUBRICATED" (0.15K)	
4-40	.1120	.0060	700	900	540	12 in-lbs	9 in-lbs	4-40
6-32	.1380	.0090	1100	1350	820	23 in-lbs	17 in-lbs	6-32
8-32	.1640	.0140	1700	2100	1260	41 in-lbs	31 in-lbs	8-32
10-24	.1900	.0175	2100	2600	1580	60 in-lbs	45 in-lbs	10-24
1/4-20	.2500	.0318	3800	4770	2860	12 ft-lbs	9 ft-lbs	1/4-20
5/16-18	.3125	.0524	6300	7860	4720	25 ft-lbs	18 ft-lbs	5/16-18
3/8-16	.3750	.0775	9300	11620	7000	45 ft-lbs	35 ft-lbs	3/8-16
7/16-14	.4375	.1063	12750	15940	9550	70 ft-lbs	55 ft-lbs	7/16-14
1/2-13	.5000	.1419	17050	21280	12750	110 ft-lbs	80 ft-lbs	1/2-13
9/16-12	.5625	.1820	21850	27300	16400	150 ft-lbs	110 ft-lbs	9/16-12
5/8-11	.6250	.2260	27100	33900	20350	230 ft-lbs	170 ft-lbs	5/8-11
3/4-10	.7500	.3340	40100	50100	30100	380 ft-lbs	280 ft-lbs	3/4-10
7/8-9	.8750	.4620	55450	69300	41600	600 ft-lbs	460 ft-lbs	7/8-9
1-8	1.0000	.6060	72700	90900	54500	900 ft-lbs	680 ft-lbs	1-8
1 1/8-7	1.1250	.7630	91550	114450	68700	1280 ft-lbs	960 ft-lbs	1 1/8-7
1 1/4-7	1.2500	.9690	116300	145350	87200	1820 ft-lbs	1360 ft-lbs	1 1/4-7
1 3/8-6	1.3750	1.1550	138600	173250	104000	2380 ft-lbs	1780 ft-lbs	1 3/8-6
1 1/2-6	1.5000	1.4050	168600	210600	126500	3160 ft-lbs	2360 ft-lbs	1 1/2-6

NOTES:
 The heavy line in the chart denotes the change from in-lbs. to ft-lbs.
 All torque values are based on the use of through hardened flat washers under the bolt head and nut or just under the bolt head for tapped hole assemblies.


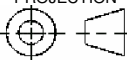
DELIVERY MUST CONFORM EXACTLY WITH DRAWING SPECIFICATIONS AND, WHERE REQUIRED BY Q.A., WITH APPROVED Q.A. SAMPLES. ABSOLUTELY NO CHANGES ARE PERMITTED WITHOUT PRIOR APPROVAL BY THOMAS BUILT BUSES. THIS INCLUDES CHANGES TO: SOFTWARE, MATERIALS, INTERNAL COMPONENTS AND MANUFACTURING PROCESSES.	REV B	CHG NO.: ECR_8468	CHG DATE: 02/24/11	 THOMAS BUILT BUSES, INC. HIGH POINT, NC USA		
		REV BY: Y.SHAW	CHECKED BY: D.HARRIS			
	REVISION DESCRIPTION		THE INFORMATION CONTAINED HEREIN IS CONFIDENTIAL AND PROPRIETARY TO THOMAS BUILT BUSES, INC. AND SHALL NOT BE COPIED, REPRODUCED, DISCLOSED, PUBLISHED, OR USED FOR ANY PURPOSE WITHOUT THE EXPRESS WRITTEN PERMISSION OF THOMAS BUILT BUSES, INC. COPYRIGHT © THOMAS BUILT BUSES, INC. ALL RIGHTS RESERVED.			
	1) REVISED TABLE 2) ADDED TABLE		ENG/DES: BRR		DATE: 05/22/01	SIZE A
REFER TO ENGINEERING SPECIFICATION MASTER LIST DRAWING NUMBER 68152329	*REV A ERN: 11186-1*		REVIEWER: BRR	DATE: 05/22/01	BOLT TORQUE SPECIFICATION, SAE GRADE 2, SAE GRADE 5, SAE GRADE 8, AND SAE GRADE C, SAE J429	
	TOLERANCE UNLESS OTHERWISE SPECIFIED		APPROVER: S.JAVONOVICH	DATE: 02/24/11	WORD DRAWING	
	DECIMAL INCH .xxx ±0.15 .xx ±.03 .x ±.06	METRIC [mm] .xxx ±0.5 .xx ±1.0 .x ±1.5	ANGULAR ±1°	 THIRD ANGLE PROJECTION		SHEET 8 OF 14

**SAE GRADE C, ZINC-YELLOW PLATED CAPSCREWS, W/ ZINC-YELLOW WASHERS,
& WAX COATED PREVAILING TORQUE NUTS**

SIZE	GRADE C			
	CLAMP LOAD	TORQUE (FT-LBS.) (.093)		
		MIN.	TARGET	MAX.
1/4-20	3244	5.5	6	7
1/4-28	3713	6	7	8
5/16-18	5345	11	13	14
5/16-24	5916	13	14	16
3/8-16	7905	20	23	26
3/8-24	8956	23	26	29
7/16-14	10812	33	37	41
7/16-20	12138	36	41	46
1/2-13	14484	49	56	63
1/2-20	16320	56	63	71
9/16-12	18564	71	81	90
9/16-18	20706	80	90	101
5/8-11	23052	98	112	125
5/8-18	26112	112	126	141
3/4-10	34068	175	198	221
3/4-16	38046	195	221	247
7/8-9	47124	282	319	357
7/8-14	51918	311	352	394
1-8	61812	423	479	535
1-12	67626	463	524	586
1-14	69360	474	537	600
1 1/8-7	77826	599	679	758
1 1/8-8	80580	620	703	785

NOTES:

- * Clamp Load @ Target Torque
- * All Clamp Load Values are derived from dynamic torques (i.e. while nut is in motion)
- * Add 20% to torque values for torque applied to bolt head
- * Torque constant (k) =0.93

DELIVERY MUST CONFORM EXACTLY WITH DRAWING SPECIFICATIONS AND, WHERE REQUIRED BY Q.A., WITH APPROVED Q.A. SAMPLES. ABSOLUTELY NO CHANGES ARE PERMITTED WITHOUT PRIOR APPROVAL BY THOMAS BUILT BUSES. THIS INCLUDES CHANGES TO: SOFTWARE, MATERIALS, INTERNAL COMPONENTS AND MANUFACTURING PROCESSES.	REV B	CHG NO.: ECR_8468	CHG DATE: 02/24/11	 <p>THOMAS BUILT BUSES, INC. HIGH POINT, NC USA</p> <p><small>THE INFORMATION CONTAINED HEREIN IS CONFIDENTIAL AND PROPRIETARY TO THOMAS BUILT BUSES, INC. AND SHALL NOT BE COPIED, REPRODUCED, DISCLOSED, PUBLISHED, OR USED FOR ANY PURPOSE WITHOUT THE EXPRESS WRITTEN PERMISSION OF THOMAS BUILT BUSES, INC. COPYRIGHT © THOMAS BUILT BUSES, INC. ALL RIGHTS RESERVED.</small></p>
		REV BY: Y.SHAW	CHECKED BY: D.HARRIS	
	REVISION DESCRIPTION			
	1) REVISED TABLE 2) ADDED TABLE			
REFER TO ENGINEERING SPECIFICATION MASTER LIST DRAWING NUMBER 68152329	*REV A ERN: 11186-1*			THE INFORMATION CONTAINED HEREIN IS CONFIDENTIAL AND PROPRIETARY TO THOMAS BUILT BUSES, INC. AND SHALL NOT BE COPIED, REPRODUCED, DISCLOSED, PUBLISHED, OR USED FOR ANY PURPOSE WITHOUT THE EXPRESS WRITTEN PERMISSION OF THOMAS BUILT BUSES, INC. COPYRIGHT © THOMAS BUILT BUSES, INC. ALL RIGHTS RESERVED.
	TOLERANCE UNLESS OTHERWISE SPECIFIED			SIZE A
	DECIMAL INCH .xxx ±.015 .xx ±.03 .x ±.06	METRIC [mm] .xxx ±0.5 .xx ±1.0 .x ±1.5	ANGULAR ±1°	UNIT OF MEASURE INCH
	THIRD ANGLE PROJECTION 			BOLT TORQUE SPECIFICATION, SAE GRADE 2, SAE GRADE 5, SAE GRADE 8, AND SAE GRADE C, SAE J429
WORD DRAWING			SHEET 9 OF 14	69001172

**PHOSPHATE AND OIL CAPSCREWS GRADE 8 & 8.2 W/ZINC PLATED HARDENED
WASHER AND CADMIUM PLATED AND WAX COATED LOCKNUTS
(Nut factor =.113)**

Bolt Size	Torque (ft-lb)			Torque (N.M)				
	Load (lb)	Min	Target	Max	Load (N)	Min	Target	Max
1/4-20	3,244	7	8	9	14,430	10	11	12
1/4-28	3,713	8	9	10	16,516	11	12	13
5/16-18	5,345	14	16	19	23,775	19	22	25
5/16-24	5,916	15	17	20	26,315	21	24	27
3/8-16	7,905	25	28	31	35,163	34	38	42
3/8-24	8,956	28	32	35	39,838	38	43	48
7/16-14	10,843	40	45	50	48,232	54	61	68
7/16-20	12,107	44	50	56	53,854	60	68	76
1/2-13	14,474	60	68	76	64,383	81	92	103
1/2-20	16,310	68	77	86	72,550	92	104	117
9/16-12	18,564	86	98	109	82,576	117	133	148
9/16-18	20,706	97	110	123	92,104	132	149	167
5/8-11	23,052	120	136	152	102,540	163	184	206
5/8-18	26,112	134	154	172	116,151	182	209	233
3/4-10	34,068	213	241	269	151,542	289	327	365
3/4-16	38,046	237	269	301	169,237	321	365	408
7/8-9	47,124	342	388	434	209,618	464	526	588
7/8-14	51,918	377	427	477	230,942	511	579	647
1 - 8	61,812	514	585	650	274,953	696	789	881
1 - 12	67,626	562	637	712	300,815	761	863	965
1 - 14	69,258	575	652	729	308,074	779	883	988


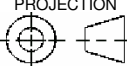
- * Clamp Load @ Target Torque
- * All Clamp Load Values are derived from dynamic torques (i.e. while nut is in motion)

DELIVERY MUST CONFORM EXACTLY WITH DRAWING SPECIFICATIONS AND, WHERE REQUIRED BY Q.A., WITH APPROVED Q.A. SAMPLES. ABSOLUTELY NO CHANGES ARE PERMITTED WITHOUT PRIOR APPROVAL BY THOMAS BUILT BUSES. THIS INCLUDES CHANGES TO: SOFTWARE, MATERIALS, INTERNAL COMPONENTS AND MANUFACTURING PROCESSES.	REV	CHG NO.: ECR_8468	CHG DATE: 02/24/11	THOMAS BUILT BUSES, INC. HIGH POINT, NC USA	
	B	REV BY: Y.SHAW	CHECKED BY: D.HARRIS		
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	1) REVISED TABLE 2) ADDED TABLE				ENG/DES: BRR DATE: 05/22/01 REVIEWER: BRR DATE: 05/22/01 APPROVER: S.JAVONOVICH DATE: 02/24/11
REV A ERN: 11186-1				SIZE A UNIT OF MEASURE INCH	
TOLERANCE UNLESS OTHERWISE SPECIFIED				BOLT TORQUE SPECIFICATION, SAE GRADE 2, SAE GRADE 5, SAE GRADE 8, AND SAE GRADE C, SAE J429	
DECIMAL INCH .xxx ±.015 .xx ±.03 .x ±.06	METRIC [mm] .xxx ±0.5 .xx ±1.0 .x ±1.5	ANGULAR ±1°			
REFER TO ENGINEERING SPECIFICATION MASTER LIST DRAWING NUMBER 68152329			WORD DRAWING SHEET 10 OF 14 69001172		

**METRIC FASTENER: ZINC- YELLOW PLATED CAPSCREWS CLASS 10.9 WITH
ZINC- YELLOW PLATED HARDENED WASHER AND ZINC PLATED PREVAILING TORQUE NUTS**

Bolt Size	Torque (ft-lb)				Torque (N.M)			
	Load (lb)	Min	Target	Max	Load (N)	Min	Target	Max
M6	3,186	4	4	5	14,181	6	6	7
M8	5,802	9	11	12	25,821	13	14	16
M8X1	6,214	10	11	13	27,656	14	16	17
M10	9,195	19	21	24	40,919	25	29	32
M10X1.25	10,225	20	24	26	45,505	28	32	36
M12	13,364	33	37	42	59,474	45	50	56
M12X1.5	13,996	34	38	43	62,155	46	52	58
M14	18,231	52	59	66	81,133	70	79	89
M14X1.5	19,816	56	64	71	88,188	76	87	97
M16	24,889	82	92	102	110,764	110	124	139
M16X1.5	26,474	86	97	109	117,819	117	132	148
M18	30,437	111	126	141	135,456	151	171	191
M18X1.5	34,242	125	142	159	152,388	169	192	215
M20	38,839	158	179	200	172,848	215	242	271
M20X1.5	43,119	175	198	222	191,896	237	269	301
M22	48,033	215	243	272	213,767	291	329	368
M22X1.5	52,789	236	267	299	234,932	319	362	405
M24	55,960	273	309	345	249,042	370	419	468
M24X2	60,874	296	336	376	270,912	402	458	509
M27	72,764	399	452	505	323,825	541	613	684
M27X2	78,629	431	489	546	349,928	584	662	740
M30	88,933	541	614	686	395,786	734	832	930
M30X2	98,445	600	680	759	438,116	813	921	1,029

- * Clamp Load @ Target Torque
- * All Clamp Load Values are derived from dynamic torques (i.e. while nut is in motion)

DELIVERY MUST CONFORM EXACTLY WITH DRAWING SPECIFICATIONS AND, WHERE REQUIRED BY Q.A., WITH APPROVED Q.A. SAMPLES. ABSOLUTELY NO CHANGES ARE PERMITTED WITHOUT PRIOR APPROVAL BY THOMAS BUILT BUSES. THIS INCLUDES CHANGES TO: SOFTWARE, MATERIALS, INTERNAL COMPONENTS AND MANUFACTURING PROCESSES.	REV B	CHG NO.: ECR_8468	CHG DATE: 02/24/11		THOMAS BUILT BUSES, INC. HIGH POINT, NC USA	
		REV BY: Y.SHAW	CHECKED BY: D.HARRIS			
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	1) REVISED TABLE 2) ADDED TABLE *REV A ERN: 11186-1*				ENG/DES: BRR DATE: 05/22/01 REVIEWER: BRR DATE: 05/22/01 APPROVER: S.JAVONOVICH DATE: 02/24/11	SIZE A
TOLERANCE UNLESS OTHERWISE SPECIFIED				BOLT TORQUE SPECIFICATION, SAE GRADE 2, SAE GRADE 5, SAE GRADE 8, AND SAE GRADE C, SAE J429		
DECIMAL INCH .xxx ±0.15 .xx ±.03 .x ±.06	METRIC [mm] .xxx ±0.5 .xx ±1.0 .x ±1.5	ANGULAR ±1°		WORD DRAWING	SHEET 11 OF 14	69001172
REFER TO ENGINEERING SPECIFICATION MASTER LIST DRAWING NUMBER 68152329						

SAE GRADE 8, COARSE (UNC) THREAD, HEX HEAD BOLTS & NUTS FOR BATTERY CABLE ATTACHMENTS

RECOMMENDED TORQUE VALUES FOR BATTERY CABLE ATTACHMENTS

STUD TERMINALS		
SIZE	TORQUE (FT/LB)	
	MIN	MAX
3/8 - 16	10	15
13FT/LB ± 2FT/LB		

(A)

TAPERED TERMINAL POSTS		
SIZE	TORQUE (FT/LB)	
	MIN	MAX
5/16 - 18	4.2	5.8
5FT/LB ± .8FT/LB		

(A)

SIDE TERMINALS		
SIZE	TORQUE (FT/LB)	
	MIN	MAX
3/8 - 16	5.8	7.5
6FT/LB ± .8FT/LB		

(B)

GLOSSARY OF FASTENER TERMS:

BOLT – An externally threaded fastener designed to hold components together in assembled parts and normally tightened or released by torquing a nut.

CLAMPING FORCE – Or preload, expressed in pounds, denotes the amount of tension force created that holds two or more pieces together when a fastener is tightened. In an ideal assembly, to prevent failure due to loosening, overloading, or fatigue, the clamping force produced must be greater than the external forces wanting to separate the connection. When multiple fasteners are used on one assembly, the clamping force of each fastener (determined by its grade, diameter and thread pitch) is combined. Their sums must be greater than the external loads applied to that assembly.

HEAD MARKING – SAE Grade 5 bolts shall be marked with 3 radially spaced symbols on the top surface of the bolt, per SAE J429. Additional registered marking symbols shall be used to identify the manufacturer. SAE Grade 8 bolts shall be marked with 6 radially spaced symbols on the top surface of the bolt, per SAE J429. Additional registered marking symbols shall be used to identify the manufacturer.

MAJOR DIAMETER – The distance across the crest or top of the threads on a bolt. This would be the same as the inside diameter of a tube that would slip snugly over the threads. This is the largest diameter of a screw thread.

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		REV BY: Y.SHAW	CHECKED BY: D.HARRIS	
	REVISION DESCRIPTION			
REFER TO ENGINEERING SPECIFICATION MASTER LIST DRAWING NUMBER 68152329		1) REVISED TABLE 2) ADDED TABLE		ENG/DES: BRR DATE: 05/22/01 REVIEWER: BRR DATE: 05/22/01 APPROVER: S.JAVONOVICH DATE: 02/24/11
		REV A ERN: 11186-1		SIZE UNIT OF MEASURE A INCH
		TOLERANCE UNLESS OTHERWISE SPECIFIED		BOLT TORQUE SPECIFICATION, SAE GRADE 2, SAE GRADE 5, SAE GRADE 8, AND SAE GRADE C, SAE J429
		DECIMAL INCH .xxx ±0.15 .xx ±.03 .x ±.06	METRIC [mm] .xxx ±0.5 .xx ±1.0 .x ±1.5	ANGULAR ±1°
				WORD DRAWING SHEET 12 OF 14 69001172

GLOSSARY OF FASTENER TERMS: (Continued)

MINOR DIAMETER – The distance across the base or root of the threads of a bolt. If the threads were carefully removed on a lathe, the remaining diameter would be the minor diameter. This is the smallest diameter of a screw thread.

PROOF LOAD – The load, just under the yield strength, that can be applied to a bolt without causing permanent set greater than 0.0005". This is the maximum safe load that the bolt can support. Torque values are established taking proof load into consideration.

DYNAMIC TORQUE - In attaining specified torque values, the reading should be taken from the nut end, during the tightening process and while nut is in motion.

RESIDUAL TORQUE - Unrelieved torsional stress in the bolt which is the result of the friction in the joint during tightening, will relax (decrease) in time, especially when vibration is present.


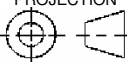
SHEAR – Force exerted 90° to the centerline or length of the bolt that tends to cut the bolt into two or more pieces.

SHEAR STRENGTH – The amount of force usually expressed in psi, required to shear the bolt into two pieces. This is referred to as single shear and usually has a value of about 67% of the tensile strength. Double shear, where shearing forces are applied at two points along the shank of the body, would cut the bolt into three pieces. Double shear strength is usually about 175% of the tensile strength.

TENSILE STRENGTH – This load (also called ultimate tensile strength), usually expressed in pounds per square inch (psi), required to cause failure in tension (stretch). The tensile strength, in pounds, of a given size bolt is obtained by multiplying the psi tensile strength by the stressed area. In metrics, the value is expressed in mega pascals (MPa).

TORQUE – The amount of twisting force, or twisting moment (expressed in inch-pounds or foot-pounds), applied to the nut, when a nut is used, or applied to the head of a bolt when it is being used as a cap screw (threaded into a tapped hole). Twelve inch-pounds or one foot-pound of torque would be created by exerting a one pound pull on a point of a wrench handle exactly 12" from the center of a bolt.

YIELD STRENGTH – The load, (usually expressed in psi) that is necessary to stretch the cap screw to the point where, after the load is removed, the cap screw will not return to its previous length. It is an established fact that when any steel is stretched .2% of its original length, or 0.002" for each inch of loaded length, or more, permanent set will occur. The yield strength, in pounds, for a given size and grade bolt is also called yield point.

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	B	REV BY: Y.SHAW	CHECKED BY: D.HARRIS			
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	1) REVISED TABLE 2) ADDED TABLE *REV A ERN: 11186-1*				ENG/DES: BRR DATE: 05/22/01 REVIEWER: BRR DATE: 05/22/01 APPROVER: S.JAVONOVICH DATE: 02/24/11	SIZE A UNIT OF MEASURE INCH
REFER TO ENGINEERING SPECIFICATION MASTER LIST DRAWING NUMBER 68152329	TOLERANCE UNLESS OTHERWISE SPECIFIED			BOLT TORQUE SPECIFICATION, SAE GRADE 2, SAE GRADE 5, SAE GRADE 8, AND SAE GRADE C, SAE J429		
	DECIMAL INCH .xxx ±0.15 .xx ±.03 .x ±.06	METRIC [mm] .xxx ±0.5 .xx ±1.0 .x ±1.5	ANGULAR ±1°			
	WORD DRAWING					SHEET 13 OF 14

BOLT HEAD GRADE MARKING:



*SAE J429 Grade 1
*SAE J429 Grade 2



SAE J429 Grade 5



*SAE J429 Grade 5.1



*SAE J429 Grade 7


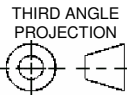


SAE J429 Grade 8



*SAE J429 Grade 8.2

- Verify with Engineering before use of these bolt grades.

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REFER TO ENGINEERING SPECIFICATION MASTER LIST DRAWING NUMBER 68152329	*REV A ERN: 11186-1*			SIZE	UNIT OF MEASURE	
	TOLERANCE UNLESS OTHERWISE SPECIFIED			A	INCH	
	DECIMAL INCH .xxx ±0.15 .xx ±0.03 .x ±0.06	METRIC [mm] .xxx ±0.5 .xx ±1.0 .x ±1.5	ANGULAR ±1°			BOLT TORQUE SPECIFICATION, SAE GRADE 2, SAE GRADE 5, SAE GRADE 8, AND SAE GRADE C, SAE J429
			WORD DRAWING	SHEET 14 OF 14	69001172	