TORQUE DATA - MAINTENANCE PRACTICES

1. General

A. To ensure security of installation and prevent overstressing of components during installation, the torque values outlined in this section and other applicable chapters of this manual should be used during installation and repair of components.

B. The torque value tables, listed in this section, are standard torque values for the nut and bolt combinations shown. Components which require special torque values will have those values listed in the applicable maintenance practices section.

C. Torque is typically applied and measured using a torque wrench. Different adapters, used in conjunction with the torque wrench, may produce an actual torque to the nut or bolt which is different from the torque reading. Figure 201 is provided to help calculate actual torque in relation to specific adaptors used with the torque wrench.

D. Free Running Torque Value.

(1) Free running torque value is the torque value required to rotate a nut on a threaded shaft, without tightening. Free running torque value does not represent the torque values listed in the tables of this section. Torque values listed in the tables represent the torque values above free running torque.

EXAMPLE: If final torque required is to be 150 inch-pounds and the free running torque is 25 inch-pounds, then the free running torque must be added to the required torque to achieve final torque of 150 +25 = 175 inch-pounds.

(2) Breakaway torque value is the value of torque required to start a nut rotating on a thread shaft, and does not represent free running torque value. It should be noted that on some installations the breakaway torque value cannot be measured.

E. General Torquing Notes.

(1) These requirements do not apply to threaded parts used for adjustment, such as turnbuckles and rod ends.

(2) Torque values shown are for clean nonlubricated parts. Threads should be free of dust, metal filings, etc. Lubricants, other than that on the nut as purchased, should not be used on any bolt installation unless specified.

(3) Assembly of threaded fasteners, such as bolts, screws and nuts, should conform to torque values shown in Table 201.

(4) When necessary to tighten from the bolt head, increase maximum torque value by an amount equal to shank friction. Measure shank friction with a torque wrench.

(5) Sheet metal screws should be tightened firmly, but not to a specific torque value.

(6) Straight threaded connections using O-rings or gaskets for seal, such as AN924 or AN6298 nuts, and fittings conforming to MS33656, Style E, need not be tightened to a specific torque value, but shall be installed per AND10064.

(7) Countersunk washers used with close tolerance bolts must be installed correctly to ensure proper torquing (refer to Figure 202).

(8) For Hi-Lok Fasteners used with MS21042 self-locking nuts. Fastener and nut should be lubricated prior to tightening.

(9) Tighten accessible nuts to torque values per Table 201. Screws attached to nutplates, or screws with threads not listed in Table 201 should be tightened firmly, but not to a specific torque value. Screws used with dimpled washers should not be drawn tight enough to eliminate the washer crown.

(10) Table 201 is not applicable to bolts, nuts and screws used in control systems or installations where the required torque would cause binding, or would interfere with proper operation of parts. On these installations, the assembly should be firm but not binding.

(11) Castellated Nuts.

(a) Self-locking and non self-locking castellated nuts, except MS17826, require cotter pins and should be tightened to the minimum torque value shown in Table 201. The torque may be increased to install the cotter pin, but this increase must not exceed the alternate torque values.

(b) MS17826 self-locking, castellated nuts shall be torqued per Table 201.

(c) The end of the bolt or screw should extend through the nut at least two full threads including the chamfer.

(12) Joints containing wood, plastics, rubber or rubberlike materials should be torqued to values approximately 80 percent of the torque at which crushing is observed, or to the requirements of Table 201, whichever is lower, or as specified.

2. Torque Requirements for Bolts, Screws and Nuts

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A. Use Table 201 to determine torque requirements for bolts, screws and nuts.

Table 201. Torque Values Nuts, Bolts and Screws (Steel) (Inch-Pounds)

Size of Bolt, Nut or Screw	Fine Threaded Series (Tension Type Nuts)		Fine Threaded Series (Shear Type Nuts Except MS17826)		MS17826 Nuts	
	Standard	**Alternate**	**Standard**	**Alternate**	**Standard**	**Alternate**
8-32	12-15	- -	7-9	- -	- -	- -
10-32	20-25	20-28	12-15	12-19	12-15	12-20
1/4-28	50-70	50-75	30-40	30-48	30-40	30-45
5/16-24	100-140	100-150	60-85	60-100	60-80	60-90
3/8-24	160-190	160-260	95-110	95-170	95-110	95-125
7/16-20	450-500	450-560	270-300	270-390	180-210	180-225
1/2-20	480-690	480-730	290-410	290-500	240-280	240-300
9/16-18	800-1000	800-1070	480-600	480-750	320-370	320-400
5/8-18	1100-1300	1100-1600	660-780	660-1060	480-550	480-600
3/4-16	2300-2500	2300-3350	1300-1500	1300-2200	880-1010	880-1100
7/8- 14	2500-3000	2500-4650	1500-1800	1500-2900	1500-1750	1500-1900
1-14	3700-4500	3700-6650	2200-3300	2200-4400	2200-2700	2200-3000
1-1/8-12	5000-7000	5000-10000	3000-4200	3000-6300	3200-4200	3200-5000
1-1/4-12	9000-11000	9000-16700	5400-6600	5400-10000	5900-6400	5900-7000

- Fine Thread Tension application Nuts include: AN310, AN315, AN345, MS17825, MS20365, MS21044 through MS21048, MS21078, NAS679, NAS1291
- Fine Thread Shear application Nuts include: AN316, AN320, MS21025, MS21042, MS21043, MS21083, MS21245, NAS1022, S1117

Table 202. Torque Values Nuts, Bolts and Screws (Steel) (Newton meters)

Size of Bolt, Nut or Screw	Fine Threaded Series (Tension Type Nuts)		Fine Threaded Series (Shear Type Nuts Except MS17826)		MS17826 Nuts	
	Standard	**Alternate**	**Standard**	**Alternate**	**Standard**	**Alternate**
8-32	1.4-1.7	- -	0.8-1.0	- -	- -	- -
10-32	2.3-2.8	2.3-3.2	1.4-1.7	1.4-2.2	1.4-1.7	1.4-2.3
1/4-28	5.6-7.9	5.6-8.5	3.4-4.5	3.4-5.4	3.4-4.5	3.4-5.0
5/16-24	11.3-15.8	11.3-17.0	6.8-9.6	6.8-11.3	6.8-9.0	6.8-10.1
3/8- 24	18.0-21.4	18.0-29.4	10.7-12.4	10.7-19.2	10.7-12.4	10.7-14.1
7/16-20	50.8-56.5	50.8-63.2	30.5-33.8	30.5-44.0	20.3-23.7	20.3-25.4
1/2-20	54.2-77.9	54.2-82.4	32.7-46.3	32.7-56.4	27.1-31.6	27.1-33.8
9/16-18	90.3-112.9	90.3-120.8	54.2-67.8	54.2-84.7	36.1-41.8	36.1-45.1
5/8-18	124.2-146.8	124.2-180.7	74.5-88.1	74.5-19.7	54.2-62.1	54.2-67.7
3/4-16	259.8-282.4	259.8-378.5	46.8-169.4	46.8-248.5	99.4-114.1	99.4-124.2
7/8-14	282.4-338.9	282.4-545.3	169.4-203.3	169.4-327.6	169.4-197.7	169.4-214.6
1-14	418.0-508.4	418.0-751.3	248.5-372.8	248.5-497.1	248.5-305.0	248.5-338.9

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1-1/8-12	564.9-790.8	564.9-1129.8	338.9- 474.5	338.9-711.8	361.5-474.5	361.5-564.9
1-1/4-12	1016.8-1242.8	1016.8-1886.8	610.1-745.7	610.1-1129.8	666.6-723.1	666.6-790.8

- Fine Thread Tension application Nuts include: AN310, AN315, AN345, MS17825, MS20365, MS21044 through MS21048, MS21078, NAS679, NAS1291
- Fine Thread Shear application Nuts include: AN316, AN320, MS21025, MS21042, MS21043, MS21083, MS21245, NAS1022, S1117

3. Torque Requirements for Hi-Lok Fasteners

A. Use Table 203 to determine torque requirements for Hi-Lok fasteners.

NOTE: This table is used in conjunction with MS21042 Self-Locking nuts.

Table 203. Torque Values For Hi-Lok Fasteners (Alloy Steel, 180 to 200 KSI)

NOMINAL FASTENER DIAMETER	TORQUE VALUE (INCH-POUNDS)
6-32	8 to 10
8-32	12 to 15
10-32	20 to 25
1/4-28	50 to 70
5/16-24	100 to 140
3/8-24	160 to 190
7/16-20	450 to 500
1/2-20	480 to 690

4. Torque Requirements for Electrical Current Carrying And Airframe Ground Fasteners

A. Use Table 204 to determine torque requirements for threaded electrical current carrying fasteners.

(1) Torque values shown are clean nonlubricated parts. Threads shall be free of dust and metal filings. Lubricants, other than on the nut as purchased, shall not be used on any bolt installations unless specified in the applicable chapters of this manual.

(2) All threaded electrical current carrying fasteners for relay terminals, shunt terminals, fuse limiter mount block terminals and bus bar attaching hardware shall be torqued per Table 204.

NOTE: There is no satisfactory method of determining the torque previously applied to a threaded fastener. When retorquing, always back off approximately 1/4 turn or more before reapplying torque.

B. Use Table 205 to determine torque requirements for threaded fasteners used as airframe electrical ground terminals.

Table 204. Torque Values For Electrical Current Carrying Fasteners

FASTENER DIAMETER	TORQUE VALUE (INCH-POUNDS)
6-32	8 to 12
8-32	13 to 17
10-32	20 to 30
3/16	20 to 30
1/4	40 to 60
5/16	80 to 100
3/8	105 to 125
1/2	130 to 150

Table 205. Torque Values For Airframe Electrical Ground Terminals

FASTENER DIAMETER	TORQUE VALUE (INCH-POUNDS)

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5/16	130 to 150
3/8	160 to 190

5. Torque Requirements for Straight Threaded Fittings

A. Use Table 206 to determine torque requirements for straight threaded fittings.

Table 206. Torque Values For Straight Threaded Fittings (Inch-Pounds)

Tube Outside Diameter	Steel Tubing		6061-0 Aluminum 5052-0 Aluminum Tubing or Aluminum Hose Insert		6061-T Aluminum Tubing (Steel Sleeve)		
	Minimum Torque	Maximum Torque	Minimum Torque	Maximum Torque	Tube Wall ** (Inches)	Minimum Torque	Maximum Torque
1/8	45	55	20	30	---	---	---
3/16	90	100	30	40	0.028	45	55
1/4	135	150	40	65	0.022 0.018 0.035 0.049	80 80 80 90	105 105 105 115
5/16	180	200	60	80	0.028 0.035 0.042	80 80 125	105 105 175
3/8	270	300	75	125	0.028 0.035 0.049	125 125 125	175 175 175
1/2	450	500	150	250	0.028 0.015 0.049 0.058 0.065	135 200 400 400 400	180 300 500 500 500
5/8	700	800	200	450	All	500	600
3/4	1100	1150	300	500	All	600	700
1	1200	1400	500	700	All	1000	1300
1 1/4	1300	1450	600	900	All	1300	1500
1 1/2	1350	1500	600	900	All	1400	1700
2	1500	1700	600	900	---	---	---

** Tube wall thickness is applicable to 6061-T aluminum tubing only.

6. Torque Requirements for Tubes and Hoses

A. Use Table 207 to determine torque requirements for tubes and hoses.

Table 207. Torque Values for Tubing and Hoses (Inch-Pounds)

Hose Size	Tubing O.D	Aluminum Tubing (Flared)		Steel Tubing (Flared)		Aluminum Tubing (Flareless)		Steel Tubing (Flareless)	
		Min Torque	Max Torque	Min Torque	Max Torque	Min Torque	Max Torque	Min Torque	Max Torque
-3	3/16	- - -	- - -	90	100	75	90	90	100
-4	1/4	40	65	135	150	80	100	135	150
-5	5/16	60	80	180	200	100	130	180	200

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-6	3/8	75	125	270	300	100	130	270	300
-8	1/2	150	250	450	500	200	240	450	500
-10	5/8	200	350	700	800	360	400	700	800
-12	3/4	300	500	1100	1150	390	430	1100	1150
-16	1	500	700	1200	1400	600	900	1200	1400
-20	1 1/4	600	900	1300	1450	600	900	1300	1450
-24	1 1/2	600	900	1350	1500	600	900	1350	1500

Hose Size	Tubing O.D.	Aluminum Fittings Oxygen Lines Only		Steel Hose End (Flared)		Steel Hose End (Flareless)	
		Min	Max	Min	Max	Min	Max
-3	3/16	- - -	- - -	70	100	95	105
-4	1/4	- - -	- - -	70	120	135	145
-5	5/16	100	125	85	180	175 dry	195 dry
-6	3/8	- - -	- - -	100	250	215	245
-8	1/2	- - -	- - -	210	420	470	510
-10	5/8	- - -	- - -	300	480	620	680
-12	3/4	- - -	- - -	500	850	855	945
-16	1	- - -	- - -	700	1150	1140	1260
-20	1 1/4	- - -	- - -	- - -	- - -	- - -	- - -
-24	1 1/2	- - -	- - -	- - -	- - -	- - -	- - -

7. Torque Requirements for V-Band Clamps

A. V-band clamps are used on engine bleed air lines and on the starter/generator. Clamp torque is dependent on V-band size and manufacturer. Clamps should be torqued according to torque value stamped on each individual clamp.

CAUTION: Do not exceed torque value stamped on clamp.

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Figure 201 : Sheet 1 : Torque Wrench and Adapter Formulas

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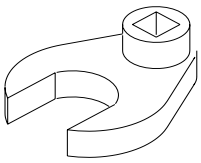
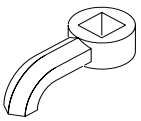
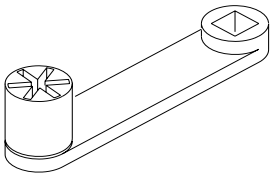
NOTE: WHEN USING A TORQUE WRENCH ADAPTER WHICH CHANGES THE DISTANCE FROM THE TORQUE WRENCH DRIVE TO THE ADAPTER DRIVE, APPLY THE FOLLOW−ING FORMULAS TO OBTAIN THE CORRECTED TORQUE USE EITHER ENGLISH OR METRIC VALUES AS REQUIRED.



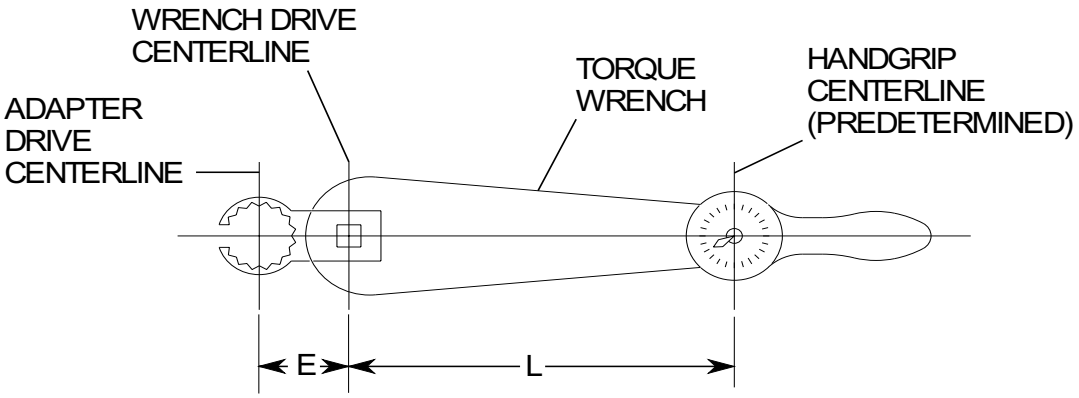
SHORT OPEN END ADAPTER



SETSCREW ADAPTER



HOSE CLAMP ADAPTER



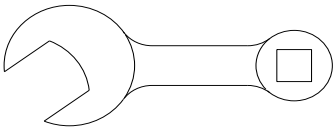
FORMULA $\frac{T \times L}{L - E} = Y$

EXAMPLE (WITH "E" AS PLUS DIMENSION)

T = 135 IN−LB (15.3 Nm)
Y = UNKNOWN
L = 10.0 INCH
E = 1.5 INCH

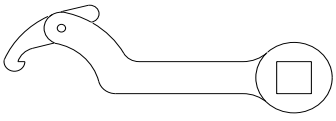
$Y = \frac{135 \times 10}{10 + 1.5} = \frac{1350}{11.5} = 117.39$

Y = 117 INCH−POUNDS (13.2 Nm)



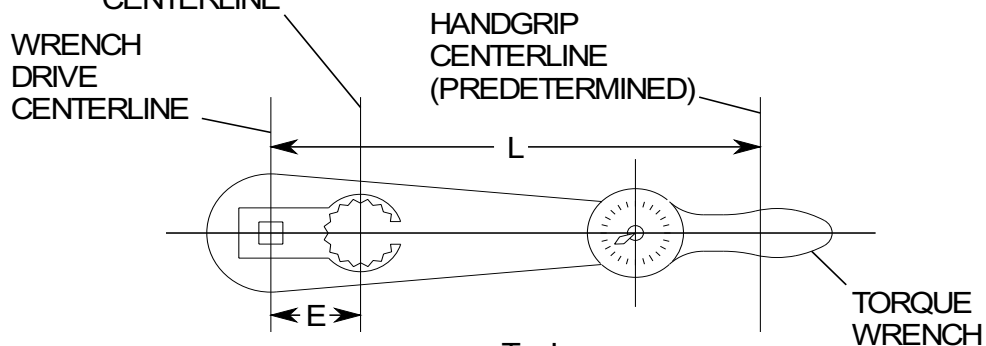
OPEN−END WRENCH ADAPTER

FLARE NUT WRENCH ADAPTER



SPANNER WRENCH ADAPTER

LEGEND
T = ACTUAL (DESIRED) TORQUE
Y = APPARENT (INDICATED) TORQUE
L = EFFECTIVE LENGTH LEVER
E = EFFECTIVE LENGTH OF EXTENSION



FORMULA $\frac{T \times L}{L - E} = Y$

EXAMPLE (WITH "E" AS MINUS DIMENSION)

T = 135 IN−LB (15.3 Nm)
Y = UNKNOWN
L = 10.0 INCH
E = 1.5 INCH

$Y = \frac{135 \times 10}{10 - 1.5} = \frac{1350}{8.5} = 158.82$

Y = 159 INCH−POUNDS (18.0Nm)

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Figure 202 : Sheet 1 : Washer Installation close Tolerance Bolts

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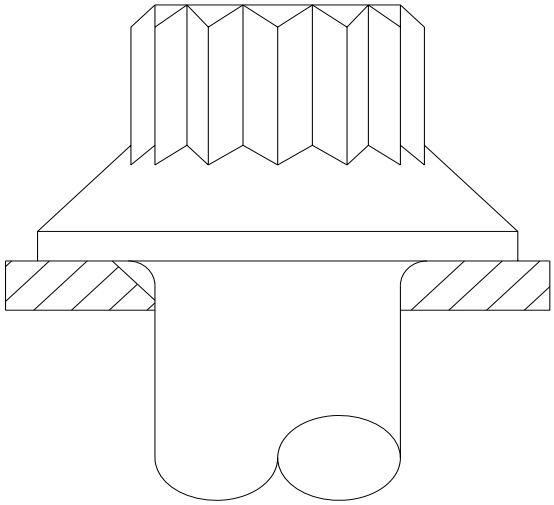
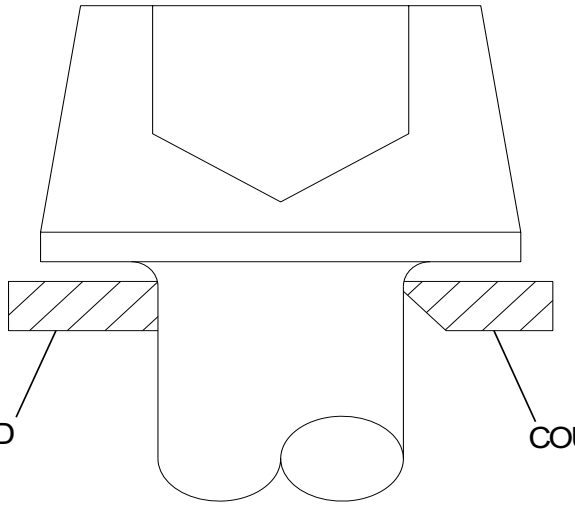
EXTERNAL WRENCHING HEAD



CORRECT INSTALLATION

INSTALL WASHER WITH COUNTERSUNK
FACE NEXT TO BOLT HEAD RADIUS

INTERNAL WRENCHING HEAD



STANDARD
WASHER

COUNTERSINK WASHER

INCORRECT INSTALLATION

CAUTION: NEVER INSTALL STANDARD WASHER OR COUNTERSUNK WASHER IN REVERSE WHEN USING BOLTS WITH RADIUS UNDER THE HEAD.

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