BOLT TORQUE DATA - MAINTENANCE PRACTICES

EFFECTIVITY: ALL

1. General

   A. To make sure that the components will be attached correctly and safety and not tightened too much, the torque values given in this section and other applicable chapters of this manual must be used during the installation and repair of components.

   B. The Tables of Torque Values, down in this section, give the standard reference torque values for the nut and bolt combinations shown in Tables 201/202/203/204. Special torque values for special installation instructions are given in maintenance practices and installation instructions applicable to the different components.

   C. It is not necessary to torque bolts, nuts, and screws installed in the control systems or other installations where the torque would interfere with the proper operation of parts. On such applications, the assembly must be firm, but not too tight, not to cause binding.

   D. The reference torque values given in Tables 201/202/203/204 are for clean threads installed without lubrication. Lubrication changes the torque values, which results in a higher value of torque than that specified.

   E. For Nut-Bolt assemblies, tightening torques should preferably be applied to the nut, while preventing the bolt or screw from turning while screwing.

   F. Tension-type nuts are those with a height approximately equal to the thread diameter. Shear-type nuts are those with a height approximately equal to half the thread diameter.

   G. When you install many bolts or screws, assemble them with manual initial torque, and then apply the correct final torque, from the center to the edges.

   H. When you install many bolts or screws in circle, first assemble them with a manual torque and then apply the correct final torque, in a crisscross pattern.

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BOLT TORQUE DATA - MAINTENANCE PRACTICES

EFFECTIVITY: ALL

2. Installation of Bolts/Machine Screws, Nuts, and Washers

A. Installation of Bolts/Machine Screws

(1) Bolts/Machine Screws with a diameter of 1/4 inch or less, which are drilled for cotter pins, must not be used with self-locking nuts.

(2) If the applicable maintenance instructions recommend that thread lubricant or antiseizure compounds be used, threads must have no other lubricants than those applied by the manufacturer. The use of lubricants will increase the preloading applied to the bolt, and unwanted material will decrease the preload.

(3) Lubricate stainless steel bolts and screws with antiseizure compound and use nuts of the same material. Use the torque values applicable to shear-type bolts when tightening stainless steel bolts.

B. Installation of Nuts

(1) The type of self-locking nuts used must obey these maintenance instructions:

1. Make sure that the bolt and nut threads are fully engaged.
2. Make sure that the base of the nut does not touch the surface.
3. Measure the drag torque of the self-locking nut with a torque wrench.
4. Make sure that the drag torque value obeys the range given in Table 205.
5. Replace the nut if it is not in the specific range.
6. Do the torque test again if the nut was replaced.
7. Add the drag torque value measured before and the standard torque together to get the final torque.
8. Apply the final torque found.

(2) Fiber or nylon insert self-locking nuts must not be used in areas where there can be high temperatures. Self-locking nuts must not be replaced with castellated nuts safetied with lockwire or cotter pins.

(3) Self-locking nuts must not be tapped.

(4) When you tighten castellated nuts for installation of cotter pin or safety wire, align the holes at the low range of the specified torque and continue to tighten until the slot aligns with the hole. If the slot cannot be aligned before you have the maximum torque value, a washer of a different thickness can be used, or a washer can be added, but the conditions given in paragraph C must be obeyed. The nut must not be loosened back from the specified torque to align the holes (Figure 201).

C. Installation of Washers

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(1) Use only the type and number of washers for an installation as specified in the applicable maintenance instructions, or as written in the instructions below. The incorrect type or quantity of washers can cause an incorrect preloading of the bolts when torqued.

(2) Washers can be added below the bolt head, nut, or the two of them to install cotter pins in castellated nuts, or to make an allowance for the collected tolerances for installation of self-locking nuts. The total number, in the two cases, must not be more than two washers. When the bolt length increments are more than 1/16 inch, three washers can be used unless more is specified for the installation.

(3) Where the length of a bolt will not permit the installation of the specified number of washers, a bolt of the same type, one increment longer or shorter, can be used if:

(a) The number of washer is not more than that specified above and;

(b) They do not touch on the threads or shank of the bolt.

(4) All bolts through aluminum alloy must have a cadmium-plated or aluminum-alloy washer installed below the bolt head or the nut, whichever of them is turned during tightening. Lock washers must not be used against aluminum alloy without a cadmium-plated washer below the lock washer to prevent damage to the surface. On magnesium alloys, use NAS1252 flat washer below the lock washer to prevent corrosive action between different metals.

(5) When bolts are used which have a radius below the bolt head, a countersunk washer must be used with the countersink near the radius below the bolt head. A changed countersunk washer or the installation of a standard washer can cause a bolt failure (Figure 202).

3. Use of Torque Wrenches

A. When you torque nuts and bolts, obey these usual practices related to the torque wrench:

(1) Use the correct type of torque wrench to apply the specified torques.

(2) Before the procedure, make sure that the torque wrenches are correctly calibrated and adjusted.

(3) Calibrate the torque wrenches regularly to make sure that they are accurate.

(4) When it is necessary to use an adapter, use Figure 203 to calculate the torque value.

(5) Where it is possible, tighten the nut end. Where the installation makes it necessary to tighten from the head bolt, use the procedures below:

(a) Bolts that can be installed by hand (loose fit) must be tightened from the head-end to the torque value (Tables 201/202/203/204).

(b) Bolts for which a driving force is necessary to install must be tightened to a torque value not greater than the value specified in tables 201/202/203/204 before the head seats.

(6) Torque castellated nuts to the lower torque limit, and then tighten until a nut slot is aligned with bolt hole. Do not loosen the nut to align the hole.

(7) Read the torque while nut turns. If you have the maximum permitted torque value and the nut does not turn, loosen the nut from one-half to one full turn and tighten it again.

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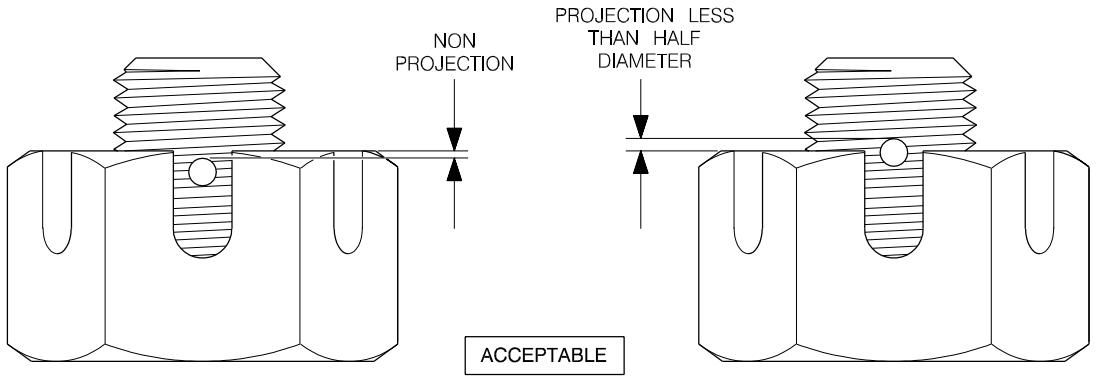
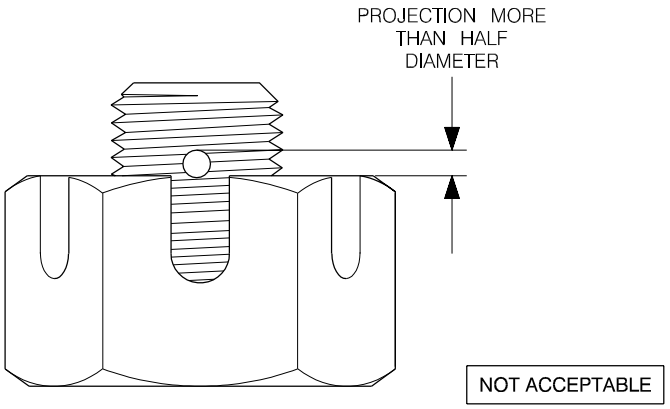
EFFECTIVITY: ALL

Castellated Nut Installation
Figure 201





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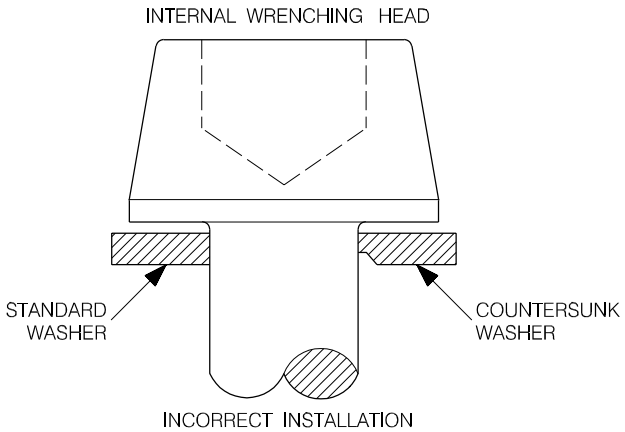
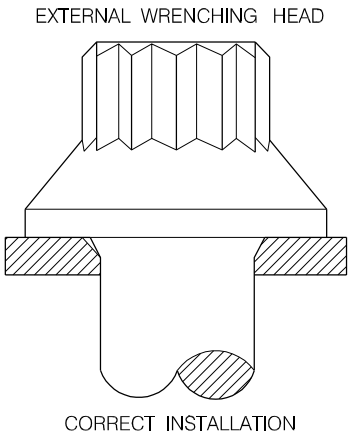
EFFECTIVITY: ALL

Washer Installation Close Tolerance Bolts
Figure 202



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



INSTALL WASHER WITH COUNTERSUNK FACE NEXT TO BOLT HEAD RADIUS

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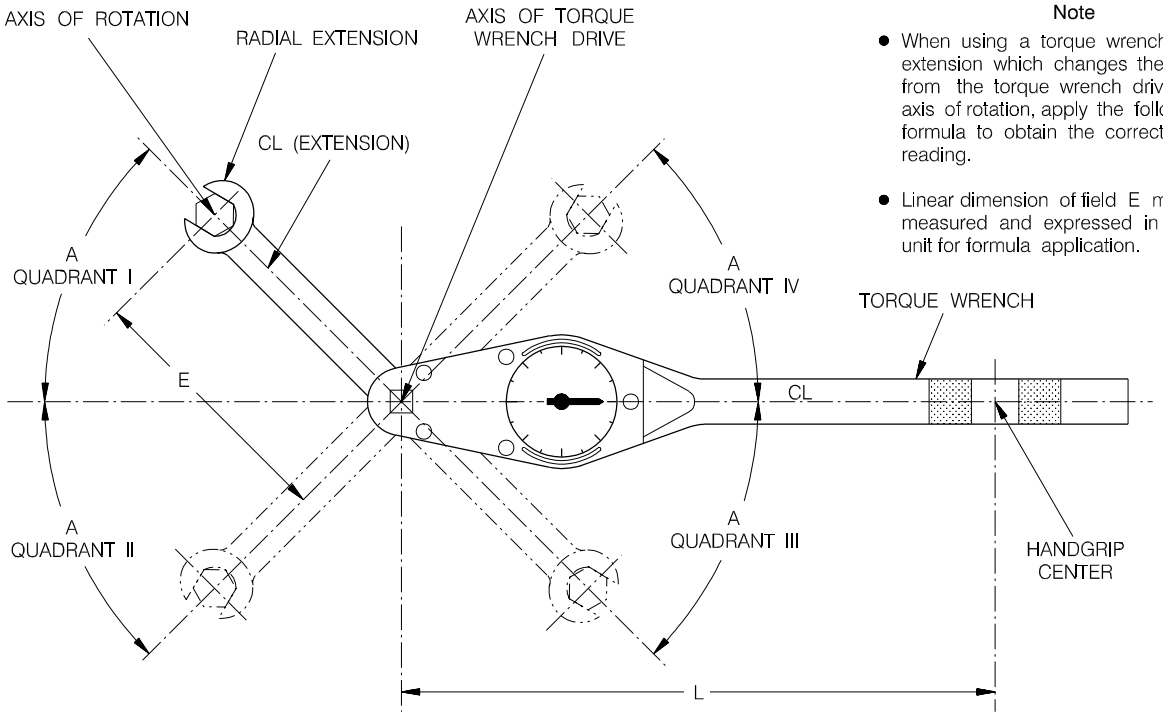
EFFECTIVITY: ALL

Use of Torque Wrenches
Figure 203 - Sheet 1



Note

- When using a torque wrench radial extension which changes the distance from the torque wrench drive to the axis of rotation, apply the following formula to obtain the correct torque reading.
- Linear dimension of field E must be measured and expressed in the same unit for formula application.

TORQUE CORRECTION METHOD USING TORQUE WRENCH RADIAL EXTENSION

SYMBOLS

T_i = INSTALLATION TORQUE
T_C = CORRECTED INSTALLATION TORQUE
L = EFFECTIVE TORQUE WRENCH LENGTH
E = EFFECTIVE EXTENSION LENGTH
C = CORRECTION FACTOR

FORMULA	APPLICATION
$T_C = T_i \frac{L}{L+(E \times C)}$	APPLICABLE WHEN RADIAL EXTENSION IS IN QUADRANT I OR II, AS SHOWN.
$T_C = T_i \frac{L}{L-(E \times C)}$	APPLICABLE WHEN RADIAL EXTENSION IS IN QUADRANT III OR IV, AS SHOWN.

EXAMPLE

T_i = 265 lb.in
T_C = ?
L = 6,30
E = 2,70
C = 0,50

STEP 1

$$T_C = 265 \left[\frac{6,30}{6,30+(2,70 \times 0,50)} \right]$$

STEP 2

$$T_C = 265 \left[\frac{6,30}{7,65} \right]$$

STEP 3

T_C = 265 x 0,824
T = 218,360 lb.in

CORRECTION FACTOR FOR EXTENSION RADIAL ORIENTATION	
ANGLE A* (DEGREES)	C (CORRECTION FACTOR)
0	1,000
5	0,996
10	0,985
15	0,966
20	0,940
25	0,906
30	0,866
35	0,819
40	0,766
45	0,707
50	0,643
55	0,574
60	0,500
65	0,423
70	0,342
75	0,259
80	0,174
85	0,087
90	0,000

* ANGLE BETWEEN CENTERLINE OF THE TORQUE WRENCH AND A LINE PASSING THROUGH BOTH THE AXIS OF ROTATION AND THE AXIS OF THE TORQUE WRENCH DRIVE, MEASURED IN PLANE OF ROTATION FOR THE NEAREST FIVE DEGREE MULTIPLE.

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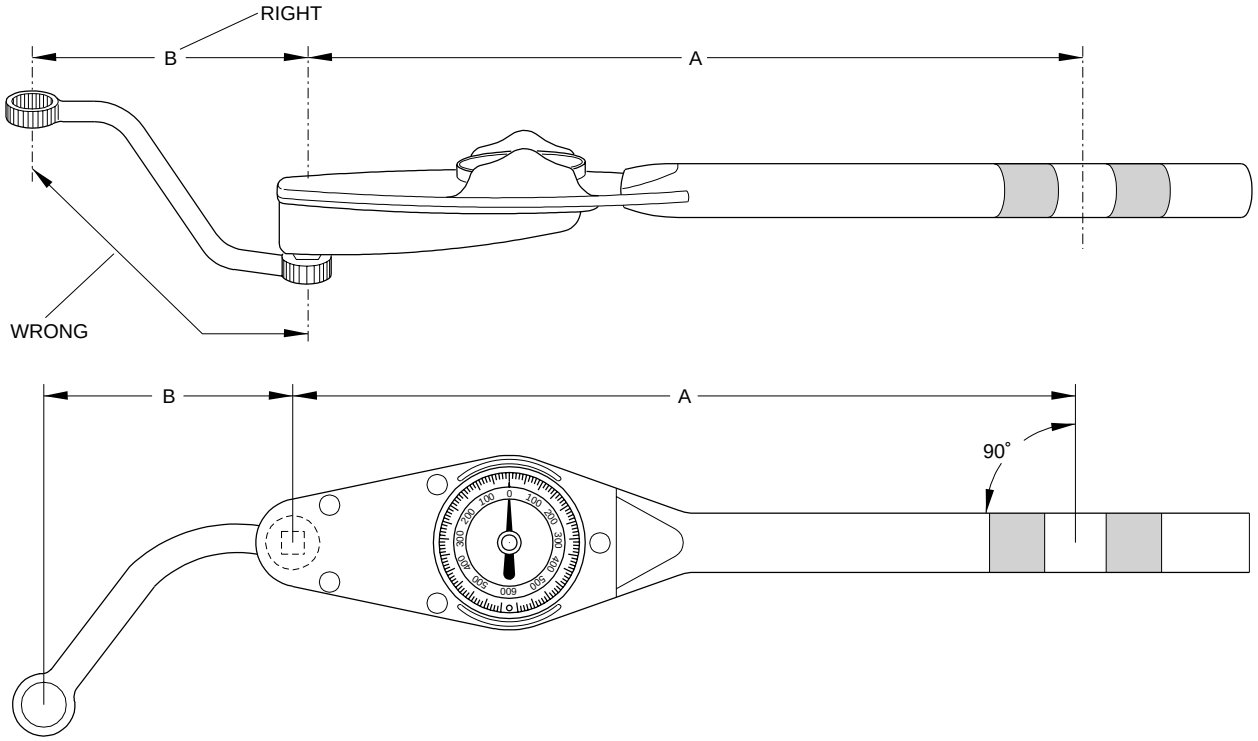
EFFECTIVITY: ALL

Use of Torque Wrenches
Figure 203 - Sheet 2



HOW TO COMPUTE TORQUE, USING ADAPTERS

IF AN ADAPTER EXTENSION IS COUPLED TO THE TORQUE WRENCH DRIVE, THUS INCREASINGS ITS LENGTH, THE DIAL READINGS WILL NOT REFLECT ACTUAL TORQUE. THE FORMULA BELOW WILL HELP TO CALCULATE THE AMOUNT TO BE READ ON THE DIAL.

$$\frac{\text{TORQUE WRENCH LENGTH+ADAPTER LENGTH}}{\text{TORQUE WRENCH LENGTH}} = \frac{\text{TORQUE APPLIED}}{\text{DIAL READING}}$$

EQUIVALENT TO $\frac{A+B}{A} = \frac{T}{D}$ WHERE:

A = DISTANCE FROM THE TORQUE WRENCH DRIVE TO THE CENTER OF OPERATOR HAND AT THE TORQUE WRENCH GRIP.

B = EXTENSION LENGTH PARALLEL TO HANDGRIP, MEASURE IT FROM THE SCREW TO TORQUE WRENCH LENGTH AND USE THE DISTANCE PARALLEL TO THE TORQUE WRENCH ONLY.

T = DESIRED TORQUE (ACTUAL TORQUE APPLIED TO THE SCREW OR NUT).

R = TORQUE WRENCH DIAL READING.

EXAMPLE GIVEN: A = 12" B = 6" T = 30 lb.ft

FIND R $\frac{A+B}{A} = \frac{T}{R}$ substituting $\frac{12+6}{12} = \frac{30}{R}$

THEREFORE: $R = \frac{12 \times 30}{12+6} = \frac{360}{18} = 20$ lb.ft

Note

: in lb.ft, just like R, A and B should be in the

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4. Inspection/Check

A. Inspection/Check of Nuts and Bolts

(1) The bolts must go through the self-locking part of the self-locking nuts. Rounded or chamfered ends must go not less than 1/32 inch through the nuts. If the installation does not meet the requirements below, refer to paragraph 2.C.

(2) Bolts with hole to be used with castellated nuts must not be more than 1/2 diameter above the nut.

(3) When you use self-locking nuts a second time, make sure that their gripping power is sufficient and the nuts will not loosen in service. Nuts which loosen easily must be discarded. To know if the gripping power is sufficient, turn the nut on the bolt until three threads are exposed. Attach a torque wrench to the nut and loosen the nut. The gripping power must be more than the minimum torque value specified in Table 205.

(4) The torque values given in Tables 202/203/204 are standard reference values for the bolt/nut specification shown in table 201. Special torque values for special installations are found in the installation instructions of the maintenance practices for each component where such special values are applicable.

NOTE: The torque values given in the tables 202/203/204 below are typical values for unspecified assembly torques. These values are for reference only and may not be used as an acceptance/rejection criterion for maintenance tasks which do not specify assembly torque values.

Table 201 - TORQUE REFERENCE TABLES ACCORDING BOLT/NUT SPECIFICATION

BOLT/NUT SPECIFICATION	TORQUE REFERENCE TABLE
AN3 thru AN20	Table 202
MS14181	Table 204
MS21134	Table 204
MS24677	Table 203
MS24693	Table 202
MS24694	Table 202
MS27039	Table 202
MS35206	Table 202
MS35207	Table 202
MS35214	Table 202
MS35265	Table 202
MS35275	Table 202
MS51957	Table 202
MS51958	Table 202
NAS428	Table 202
NAS464	Table 203
NAS514	Table 202
NAS517	Table 203
NAS600 thru NAS606	Table 203

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Table 201 - TORQUE REFERENCE TABLES ACCORDING BOLT/NUT SPECIFICATION (Continued)

BOLT/NUT SPECIFICATION	TORQUE REFERENCE TABLE
NAS623	Table 203
NAS1096	Table 202
NAS1101	Table 203
NAS1102	Table 203
NAS1271	Table 203
NAS1274	Table 203
NAS1303	Table 203
NAS1351	Table 203
NAS1352	Table 203
NAS1801	Table 203
NAS1992 thru NAS2000	Table 203
NAS2832 thru NAS2840	Table 204
NAS2852 thru NAS2860	Table 203
NAS6203 thru NAS6220	Table 203
NAS6303 thru NAS6320	Table 203
NAS6403 thru NAS6420	Table 203
NAS6703 thru NAS6720	Table 203
PE21094	Table 204
PE21101	Table 203
PE21107	Table 203
PE22078	Table 203

Table 202 - TYPICAL VALUES FOR UNSPECIFIED TORQUES (FOR APPLICABILITY, REFER TO TABLE 201)

BOLT OR SCREW DIAMETER / THREADS PER INCH	TORQUE		
(in - tpi)	(lb.in)	(N.m)	(kg.cm)
0.1640 - 36	7.0 to 9.0	0.8 to 1.0	8.0 to 10.0
0.1640 - 32	7.0 to 9.0	0.8 to 1.0	8.0 to 10.0
0.1900 - 32	12.0 to 15.0	1.4 to 1.7	14.0 to 17.0
1/4 - 28	30.0 to 40.0	3.4 to 4.5	35.0 to 46.0
5/16 - 24	60.0 to 85.0	6.8 to 9.6	69.0 to 98.0
3/8 - 24	95.0 to 110.0	10.7 to 12.4	109.0 to 127.0
7/16 - 20	270.0 to 300.0	30.5 to 33.9	311.0 to 346.0
1/2 - 20	290.0 to 410.0	32.8 to 46.3	334.0to 472.0
9/16 - 18	480.0 to 600.0	54.2 to 67.8	553.0 to 691.0
5/8 - 18	660.0 to 780.0	74.6 to 88.1	760.0 to 899.0

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Table 202 - TYPICAL VALUES FOR UNSPECIFIED TORQUES (FOR APPLICABILITY, REFER TO TABLE 201) (Continued)

BOLT OR SCREW DIAMETER / THREADS PER INCH	TORQUE		
(in - tpi)	(lb.in)	(N.m)	(kg.cm)
3/4 - 16	1300.0 to 1500.0	146.9 to 169.5	1498.0 to 1728.0
7/8 - 14	1500.0 to 1800.0	169.5 to 203.4	1728.0 to 2074.0
1-12	2200.0 to 3300.0	248.6 to 372.8	2535.0 to 3802.0
1.1/8 - 12	3000.0 to 4200.0	339.0 to 474.5	3456.0 to 4839.0
1.1/4 - 12	5400.0 to 6600.0	610.1 to 745.7	6221.0 to 7604.0
1.3/8 - 12	7000.0 to 9000.0	790.9 to 1016.9	8065.0 to 10369.0
1.1/2 - 12	10000.0 to 12000.0	1129.8 to 1355.8	11521.0 to 13825.0

Table 203 - TYPICAL VALUES FOR UNSPECIFIED TORQUES (FOR APPLICABILITY, REFER TO TABLE 201)

BOLT OR SCREW DIAMETER / THREADS PER INCH	TORQUE		
(in - tpi)	(lb.in)	(N.m)	(kg.cm)
0.1900 - 32	15.0 to 20.0	1.7 to 2.3	17.0 to 23.0
1/4 - 28	50.0 to 60.0	5.6 to 6.8	57.0 to 69.0
5/16 - 24	70.0 to 90.0	7.9 to 10.2	81.0 to 104.0
3/8 - 24	120.0 to 150.0	13.6 to 16.9	139.0 to 172.0
7/16 - 20	300.0 to 400.0	33.9 to 45.2	346.0 to 461.0
1/2 - 20	450.0 to 550.0	50.8 to 62.1	518.0 to 633.0
9/16 - 18	650.0 to 800.0	73.4 to 90.4	748.0 to 922.0
5/8 - 18	750.0 to 950.0	84.7 to 107.3	864.0 to 1094.0
3/4 - 16	1600.0 to 1900.0	180.8 to 214.7	1844.0 to 2189.0
7/8 - 14	2100.0 to 2600.0	237.3 to 293.8	2420.0 to 2996.0
1-12	2700.0 to 3300.0	305.1 to 372.8	3111.0 to 3802.0
1.1/8 - 12	3600.0 to 4400.0	406.7 to 497.1	4147.0 to 5069.0
1.1/4 - 12	6600.0 to 8000.0	745.7 to 903.8	7604.0 to 9216.0

Table 204 - TYPICAL VALUES FOR UNSPECIFIED TORQUES (FOR APPLICABILITY, REFER TO TABLE 201)

BOLT OR SCREW DIAMETER / THREADS PER INCH	TORQUE		
(in - tpi)	(lb.in)	(N.m)	(kg.cm)
0.1900 - 32	27.0 to 30.0	3.0 to 3.4	31.0 to 34.0

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Table 204 - TYPICAL VALUES FOR UNSPECIFIED TORQUES (FOR APPLICABILITY, REFER TO TABLE 201) (Continued)

BOLT OR SCREW DIAMETER / THREADS PER INCH	TORQUE		
(in - tpi)	(lb.in)	(N.m)	(kg.cm)
1/4 - 28	50.0 to 69.0	5.6 to 7.6	58.0 to 80.0
5/16 - 24	100.0 to 140.0	11.2 to 15.6	114.0 to 159.0
3/8 - 24	160.0 to 190.0	17.6 to 21.7	180.0 to 221.0
7/16 - 20	440.0 to 490.0	50.2 to 55.6	511.0 to 566.0
1/2 - 20	480.0 to 680.0	54.2 to 77.3	553.0 to 788.0
9/16 - 18	820.0 to 980.0	92.9 to 111.2	947.0 to 1134.0
5/8 - 18	1110.0 to 1270.0	125.1 to 143.7	1276.0 to 1465.0
3/4 - 16	2300.0 to 2450.0	260.3 to 282.0	2655.0 to 2876.0
7/8 - 14	2450.0 to 2950.0	276.6 to 333.5	2821.0 to 3401.0
1-12	3670.0 to 5470.0	414.9 to 618.2	4231.0 to 6304.0
1.1/8 - 12	4970.0 to 6950.0	561.3 to 785.0	5723.0 to 8005.0
1.1/4 - 12	8890.0 to 10870.0	1004.6 to 1228.4	10244.0 to 12526.0

Table 205 - TYPICAL DRAG TORQUE VALUES FOR SELF-LOCKING NUTS

NUT THREAD	DRAG TORQUE					
	MIN			MAX		
	(N.m)	(lb.in)	(kg.cm)	(N.m)	(lb.in)	(kg.cm)
0.1120 - 40UNC-3B	0.056	0.5	0.58	0.34	3	3.5
0.1380 - 32UNC-3B	0.113	1.0	1.15	0.68	6	6.9
0.1640 - 32UNC-3B	0.169	1.5	1.73	1.02	9	10.4
0.1900 - 32UNF-3B	0.226	2.0	2.30	2.03	18	20.7
0.2500 - 28UNF-3B	0.395	3.5	4.03	3.39	30	34.6
0.3125 - 24UNF-3B	0.734	6.5	7.49	6.78	60	69.1
0.3750 - 24UNF-3B	1.073	9.5	10.95	9.04	80	92.2
0.4375 - 20UNF-3B	1.582	14.0	16.13	11.30	100	115.2
0.5000 - 20UNF-3B	2.034	18.0	20.74	16.95	150	172.8
0.5625 - 18UNF-3B	2.712	24.0	27.65	22.60	200	230.4
0.6250 - 18UNF-3B	3.616	32.0	36.87	33.90	300	345.6
0.7500 - 16UNF-3B	5.649	50.0	57.61	45.19	400	460.8
0.8750 - 14UNF-3B	7.909	70.0	80.65	67.79	600	691.3
1.0000 - 12UNF-3B	10.395	92.0	106.00	90.39	800	921.7
1.1250 - 12UNF-3B	13.219	117.0	134.80	101.69	900	1036.9
1.2500 - 12UNF-3B	16.157	143.0	164.75	112.98	1000	1152.1

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(5) Where applicable, apply PINK-TORQUE SEAL F-925 to the inspected nut and bolt assembly.

5. Removal/Installation of Access Door Fasteners

A. Install Doors and Plates

NOTE: Access doors, cover plates, angles or channels which are attached by a series of bolts or screws and which must be tightened to a given torque value, must be tightened with an equal load.

(1) Install all bolts or screws finger-tight.

NOTE: Power tools can be used for this operation, but bolts or screws must not be tightened to the full torque value. Use controlled-torque power tools or hand tools to get the final torque.

(2) Apply a minimum torque to angle and channel fasteners. Start at the center of the part and go to the ends. Tighten the fasteners to the final torque value in the same sequence.

(3) Apply a minimum torque to access doors and cover plate fasteners. Tighten the fasteners alternately from side to side, corner to corner, or from end to end. Tighten to the final torque in the same sequence.

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