CHAPTER 2 — TORQUE

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TORQUE

2-1. TORQUE VALUES

CAUTION

ALL TORQUE VALUES APPLY TO DRY THREADS. DO NOT USE THREAD LUBRICANT OR ANTI-SEIZE COMPOUND UNLESS SPECIFICALLY CALLED FOR IN THE APPLICABLE MAINTENANCE PUBLICATION. DRY FILM LUBRICANT MATERIALS APPLIED TO THE NUTS BY THE NUT MANUFACTURER SHALL NOT BE REMOVED.

1. Definition.

a. STANDARD TORQUE. A general torque requirement that is applied when a Specified Torque is not identified in the applicable maintenance publication. Standard Torque values are listed in Table 2-1 through Table 2-7. Unless otherwise specified, Standard Torque requires the addition of Tare Torque.

NOTE

When torques are specified in the applicable maintenance publication, they take preference over Standard Torque values given in Table 2-1 through Table 2-7.

b. SPECIFIED TORQUE. A specific torque identified in the applicable maintenance publication for a particular fastener. Unless otherwise specified, Specified Torque requires the addition of Tare Torque.

c. TARE TORQUE. Torque required to overcome resistance of self-locking nuts against mating bolt, screw, or stud threads. Tare torque must be measured using the same fastener combination that the torque will be applied to. Tare Torque is unique to that fastener combination. It is not acceptable to measure Tare Torque for one fastener combination and apply this Tare Torque value to all similar fasteners. The preferred method for measuring Tare Torque is to use a dial (indicator) type torque wrench, but may be measured by approaching the value with a “click” style torque wrench. The value must be measured after all threads are engaged and then compared to the Minimum Tare Torque Value (paragraph 2-2). If measured Tare Torque value is less than the minimum listed, the lock nut must be replaced.

d. ASSEMBLY TORQUE. The total torque value applied to a fastener (preferably the nut in a nut/bolt combination). Assembly Torque is the Standard Torque or Specified Torque, plus the Tare Torque. It is unique to that fastener combination. An adjacent fastener combination utilizing the same hardware may require a different Assembly Torque value. Variations in wear, stress, and finish will impact tare values of fasteners of the same size and type.

NOTE

Recommended Installation Torque for Threaded Studs is given in Table 2-8.

Recommended Installation Torque for Flared Fitting Nuts is given in Table 2-9.

Recommended Installation Torque for Flareless Fitting Nuts is given in Table 2-10.

Recommended Installation Torque for Dynamic Beam Seal Nuts is given in Table 2-11.

Recommended Pin and Nut Torque Values are given in Table 2-12.

e. INSTALLATION TORQUE. Unless otherwise stated in the applicable maintenance document, Installation Torque is the actual torque measured when installing the threaded fastener.

f. SHEAR LOAD. A dynamic force causing two parts in contact to move in a direction parallel to their point of contact.

g. TENSION LOAD. A static force applied 90° to the plane of rotation of contiguous parts.

2-2. STANDARD TORQUE — USE OF

CAUTION

DO NOT EXCEED THE MAXIMUM ALLOWABLE TORQUE VALUE. OVERSTRESSING OF THE BOLT OR

NUT MAY RESULT. IF THERE IS CONCERN THAT FASTENERS HAVE BEEN OVER-TORQUED, THE FASTENERS ARE TO BE REMOVED AND REPLACED. IN ADDITION, THE ASSEMBLY OR COMPONENT BEING ASSEMBLED IS TO BE INSPECTED FOR DAMAGE THAT MAY HAVE BEEN CAUSED FROM THE OVER-TORQUE.

1. The Standard Torque Charts (Table 2-1 through Table 2-7) list the Standard Torque for various combinations of bolts and nuts. The torque values listed do not include the Tare Torque (friction drag) of the self-locking feature.

CAUTION

RECOMMENDED STANDARD TORQUE RANGES ARE GIVEN IN TABLE 2-1 THROUGH TABLE 2-7. TARE TORQUE SHALL BE ADDED TO STANDARD TORQUE VALUE LISTED, UNLESS OTHERWISE STATED.

2. Standard Torque value charts usage.

a. To locate the correct Standard Torque for a bolt and nut, the following must be known:

(1) Type of bolt used (AN, MS, NAS, etc.).

(2) Type of nut used (AN, etc.).

(3) Thread size of bolt (10-32, 1/4-28, 5/16-24, 3/8-24, etc.).

b. When all three of the above values are known, refer to Table 2-1 through Table 2-7, as applicable.

(1) With reference to Table 2-1 through Table 2-7, locate the specific table that carries the primary bolt part number (designation) and the part number of the nut. Locate thread size and read across to obtain Standard Torque values.

CAUTION

TARE TORQUE MUST BE MEASURED ON THE SAME FASTENER COMBINATION THAT THE TORQUE WILL BE APPLIED TO USING A DIAL INDICATOR TYPE TORQUE WRENCH. MEASURE TARE TORQUE OF SELF LOCKING NUT TO BE INSTALLED AFTER ALL THREADS ARE ENGAGED. COMPARE VALUE TO MINIMUM TARE TORQUE VALUE LISTED BELOW. IF MEASURED TARE TORQUE IS LESS THAN MINIMUM LISTED, REPLACE SELF LOCKING FASTENER.

c. Measure Tare torque of self-locking nut to be installed using dial indicator type torque wrench. Minimum allowable Tare Torque value of self-locking bolts and nuts is as follows:

MINIMUM TARE TORQUE VALUE

THREAD SIZE	MINIMUM TARE TORQUE (INCH-POUNDS)
10-32	2.0 (0.23 Nm)
1/4-28	3.5 (0.40 Nm)
5/16-24	6.5 (0.73 Nm)
3/8-24	9.5 (1.07 Nm)
7/16-20	14.0 (1.58 Nm)
1/2-20	18.0 (2.03 Nm)
9/16-18	24.0 (2.71 Nm)
5/8-18	32.0 (3.62 Nm)
3/4-16	50.0 (5.65 Nm)
7/8-14	70.0 (7.91 Nm)
1-12	90.0 (10.17 Nm)
1-1/18-12	117.0 (13.22 Nm)
1-1/4-14	143.0 (16.16 Nm)
1-3/8-12	170.0 (19.21 Nm)
1-1/2-12	197.0 (22.26 Nm)

d. Calculate Assembly Torque by adding Standard Torque to the measured Tare Torque.

NOTE

When the Specified Torque is provided in the applicable maintenance publication, Assembly Torque is calculated by adding Specified Torque to the measured Tare Torque.

Example:

- Type of bolt: MS9088.
- Type of nut: MS14145.
- Thread size of bolt: 0.2500-28.
- Recommended shear load Standard Torque range: 30 to 40 inch-pounds.
- Measured Tare Torque of nut: 3.6 inch-pounds.
- Assembly Torque equals 35 inch-pounds + 3.6 inch-pounds = 38.6 inch-pounds.

2-3. DELETED

2-4. DELETED

2-5. SELF-LOCKING NUTS

For self-locking hardware (nuts, nut plates, inserts, etc.), the total Assembly Torque is the measured Tare Torque plus the Standard Torque or Specified Torque. In all cases, sufficient torque shall be applied to engage the locking element and seat the fastener.

2-6. RECOMMENDED GRIP LENGTH CONTROL REQUIREMENTS FOR THREADED FASTENERS

CAUTION

UNLESS OTHERWISE STATED IN THE APPLICABLE MAINTENANCE PUBLICATION, THE INFORMATION CONTAINED IN PARAGRAPH 2-6, PARAGRAPH 2-7, AND PARAGRAPH 2-8 SHALL NOT APPLY TO THE ASSEMBLY OR INSTALLATION OF DRIVE SYSTEM COMPONENTS. THE DRIVE SYSTEM INCLUDES ALL SHAFTS, COUPLINGS, GEARBOXES, AND BEARING HANGERS USED IN THE TRANSMISSION OF ENGINE POWER TO THE MAIN AND TAIL ROTORS OR TO ANY REMOTE OR TO ANY REMOTE MOUNTED ACCESSORY. DRIVE SYSTEM COMPONENTS ARE IDENTIFIED WITH A PART NUMBER WHICH HAS THE SECOND SET OF THREE DIGITS (UNIVERSAL CODE) OF: -040-, -044-, -140-, -340-, -342-, -344-, -540-, -620-, -640-, -644-, AND -645-.

1. Because of variations due to tolerance buildup in structure and fasteners, the adjustment of bolt and screw grip length is necessary where grip oriented standard bolts and screws are used. This adjustment shall be accomplished by changing the grip length of the bolt or screw and/or by use of standard (flat) washers in accordance with the requirements of paragraph 2-7 and paragraph 2-8. When the attachment hardware is changed from the original installation, a clearance check must be performed to ensure an improper clearance or foul condition does not exist.

2-7. BOLTS AND SCREWS GRIP LENGTH

NOTE

Grip length changes for reasons other than specified below are not permitted. The following is not applicable to studs or fully threaded fasteners used in threaded holes.

1. For standard bolts and screws, grip lengths specified in the applicable maintenance or parts publication may be changed one grip length only (longer or shorter) for the following reasons only:

a. To preclude threads from being in the bearing area: The shanks of structural fasteners shall be such that no threads are in the bearing area where the sheet or fitting next to the nut is 0.093 inch (2.3622 mm) or less in thickness. Where the sheet or fitting next to the nut is greater than 0.093 inch (2.3622 mm), a maximum of one and one half threads, including thread run out, is permitted in the bearing area, provided that these threads do not exceed 25% of the thickness of the section having threads in the bearing area.

b. To prevent nuts from bottoming out on the bolt or screw shank: Nut threads, which engage the first incomplete thread next to the bolt shank of a grip oriented fastener, are considered to be bottomed out and are not acceptable.

NOTE

The following does not apply where thread protrusions cannot be seen. Examples include: bolts or screws used with inserts, plate nuts, or barrel nuts; however, full nut thread engagement is required.

c. To prevent inadequate thread engagement: Unless otherwise stated in the maintenance publication, all threads of the nut shall be engaged and, as a minimum, the full round or chamfer plus one thread pitch on the bolt or screw shall protrude beyond the nut. Flat ended bolts or screws shall protrude a minimum of two thread pitches beyond the nut.

d. To prevent bolts or screws from bottoming out in blind threaded holes.

2. The provisions of the above do not apply to studs, fully threaded bolts, nor do they apply to bolts or screws used in conjunction with inserts, nut plates, or barrel nuts where thread protrusion cannot be seen.

2-8. PLAIN WASHER SUBSTITUTION REQUIREMENTS

CAUTION

DO NOT SUBSTITUTE WASHERS OF DIFFERENT PART NUMBERS. THE ADDITION OR SUBSTITUTION OF PLAIN, FLAT WASHERS TO JOINTS WHERE PARTICULAR WASHERS, I.E., CHAMFERED, CONCAVE, COUNTERBORED, DISSIMILAR METAL, KEYED, OR LOCK ARE SPECIFIED, IS NOT PERMITTED.

1. Additional plain, flat washers (thick or thin) of the same part number as those specified in the applicable maintenance or parts publication may be used when required for proper nut or cotter pin installation or to allow Assembly Torque to be attained. Not more than a total of three washers will be used: two under the nut for grip adjustment and one under the bolt or screw head for surface protection, unless otherwise specified by the applicable maintenance publications.

2. If the applicable maintenance publication does not specify the location of the washers, they shall be placed under the bolt or screw head or under the nut, whichever is being rotated during tightening, except where one washer, under the bolt or screw head is required for material protection.

2-9. SELECTION AND USE OF TORQUE WRENCH

WARNING

DO NOT EXCEED THE MAXIMUM ALLOWABLE TORQUE VALUE. OVERSTRESSING OF THE BOLT OR NUT MAY RESULT. IF THERE IS CONCERN THAT THE FASTENERS HAVE BEEN OVER-TORQUED, THE FASTENERS ARE TO BE REMOVED AND REPLACED. IN ADDITION, THE ASSEMBLY OR COMPONENT BEING ASSEMBLED IS TO BE INSPECTED FOR DAMAGE THAT MAY HAVE BEEN CAUSED FROM THE OVER-TORQUE.

1. Selecting Torque Wrench:

a. The accuracy of most torque wrenches tends to decrease at the extremes of the torque range. The torque value being measured should be between the 30 and 80% points of the torque wrench range. For example, a 0-100 inch-pound torque wrench should be used to apply a torque of 30-80 inch-pounds.

b. The graduation increments of the torque wrench should not be greater than 10 percent of the torque value being measured.

c. The torque wrench should be calibrated in the same torque units as the specified torque for the fastener.

d. The selected torque wrench should be within the calibration period specified by the torque wrench manufacturer or applicable local regulations.

2. Force Application on Torque Wrench Grip: A smooth steady force must be applied to obtain an accurate torque value. Rapid or jerky force can result in error in the torque applied.

NOTE

Ensure to add bolt shank friction during step 3.

3. Tightening Fastener on the Head End: When a fastener is tightened from the head end, some of the torque applied is absorbed in turning the bolt in the hole. The amount of torque absorbed will vary. For this reason, bolt shank friction shall also be measured and added to torque value.

a. If the fastener can be inserted through the hole and started into the nut by the fingers, use the Specified Torque range or Standard Torque range.

b. If the fastener is inserted through a hole that increases the tightening resistance, torque to the high limit of the torque range.

c. If the fastener is inserted into a threaded hole and if the hole thread length is more than the fastener diameter, use the provided torque range. If the hole thread length is less than the fastener diameter, use the lower limit of the torque range.

NOTE

Do not use the torque wrench to loosen fasteners.

4. Tightening New Fastener: Tighten the fastener to the Standard or Specified Torque value, as defined in paragraph 2-1. Loosen the fastener by backing off one-half turn. Retighten to desired Assembly Torque value. This aids in cleaning and smoothing the threads and results in more accurate torque.

5. Cotter Pin or Lockwire Hole Alignment: When tightening nuts which are secured by cotter pins or lockwire, stop the torque load just above the minimum Assembly Torque value. If required, additional tightening to the next hole alignment may be accomplished, provided the maximum Assembly Torque value is not exceeded.

6. Re-Torque: When a retorque is specified in the applicable maintenance publication or it is uncertain if a joint has been properly torqued, back off the faster one or two turns, then tighten to the required torque, as follows:

NOTE

Do not use torque wrench to loosen fasteners.

a. Remove all torque from the fastener (loosening) until no preload is on the fastener.

b. Measure the tare torque (paragraph 2-2).

c. Determine the Specified Torque or Standard Torque, as applicable, and add the measured Tare Torque to determine the Assembly Torque.

d. Torque the fastener to this Assembly Torque value.

e. If the fastener is one in a multi-fastener pattern requiring a torque sequence, then all the fasteners will require re-torque.

7. Fastener Thread Condition: Threads should be clean and free from nicks, burrs, paint, grease, and oil to obtain the correct torque. However, there are some applications specified in maintenance publications where lubrication or anti-seize compound is used on the threads. (Refer to OSN GEN-02-34.)

NOTE

Do not loosen fasteners during a Torque Check.

8. Torque Check: When a Torque Check is called out in the applicable maintenance publication, it should be accomplished by torquing in the tightening direction. Do not loosen the fastener(s). The value applied should be one of the following:

a. If the Assembly Torque is known from when the fastener was originally installed (i.e., recorded in a logbook), then this is the Assembly Torque for Torque Check purposes.

b. If the original Assembly Torque was not recorded, then the Assembly Torque for Torque Check purposes would be the minimum Specified Torque or minimum Standard Torque, as applicable, plus the minimum acceptable Tare Torque (paragraph 2-2).

c. If during the application of the Assembly Torque as detailed above, no motion is detected between the fasteners, then the joint is considered acceptable.

d. Joints which are having a Torque Check performed as a part of a Special Inspection, as required after a specified number of flight hours, only need to be tightened. Looseness may occur until the components “seat” themselves and the fasteners simply need to be tightened. This is not cause for disassembly; however, the fastener(s) will have to be

Torque Checked again at the same scheduled interval set for the first Torque Check until the assembly is completely seated. If a specific torque sequence is to be followed, as initially torqued, then this same sequence should be followed during the Torque Check. Some fasteners in the sequence may accept additional torque while others may not; this is acceptable.

e. Joints that have not retained torque will require disassembly and inspection. If the fastener(s) move, the assembly shall be rechecked for damage, corrosion, improper assembly, etc.; if no problem is found, the fastener(s) may be retorqued to the Assembly Torque value. In this case, the fastener(s) would have to be Torque Checked again at the same scheduled interval set for the first Torque Check.

NOTE

Do not use the torque wrench to back off fasteners.

9. Torque Verification: Checking fasteners accurately to determine if they have been tightened to the required Assembly Torque is not possible. When there is doubt as to whether a fastener has been tightened to the correct torque value, the fastener should be backed off from one-half to one full turn and retightened to the correct torque value.

10. Tightening Chilled or Heated Fastener: Do not tighten a chilled or heated fastener until it has returned to room temperature. Heated fastener may loosen when it cools. Chilled fastener may become overstressed when it warms.

11. Tightening Fastener on Part with a Slow Permanent Set: Hold desired torque until part is seated.

NOTE

Do not use the torque wrench to backoff fasteners.

12. Tightening Fasteners in a Series: If fasteners are to be torqued in a series, select a median torque value within the required Assembly Torque range. If some fasteners are tightened to the minimum value and others to the maximum, force is not distributed evenly. Unequal distribution of force may cause fastener failure. Do not apply final Assembly Torque during the first drawdown. After the median torque value is applied, loosen fasteners one at a time and apply final torque. Tightening in a diametrically opposite (staggered) sequence is desirable in most cases.

13. Tightening Fasteners with Concentric Attachment: The use of a concentric attachment which operates concentrically with the torque wrench drive square presents no particular problem. The torque value applied is the torque value indicated. Refer to Figure 2-1.

14. Tightening Fastener with Nonconcentric Attachment: The use of a nonconcentric attachment which does not operate concentrically with the drive square presents a mathematical problem. This type of attachment affects the lever length. The torque value applied is not the torque value indicated. It is necessary to calculate the effect of the lever length to determine the correct indicated torque value. Refer to Figure 2-2.

15. Force Application when Using Nonconcentric Attachment:

a. The point of force applied on a flexible beam-type torque wrench pivoted grip will not affect the calculated torque applied to the fastener.

b. The point of force applied on rigid frame and audible indicating torque wrench grips will affect the calculated torque applied to the fastener. See Figure 2-3 for proper and improper application of force and their effect.

2-10. MISCELLANEOUS TORQUING INFORMATION

1. The recommended torque range for worm gear clamps on oil, fuel, or coolant hose is 20 to 30 inch-pounds (2.26 to 3.39 Nm).

2. The recommended torque range for .1900-32 thread size bolts or screws mounting loop clamps is 12 to 15 inch-pounds (1.36 to 1.69 Nm).

3. The final installation torque for all non-metallic fitting nuts can be achieved by tightening the nut past the point of sharp torque rise, plus the following:

- For pipe threads: 1/4 turn (90°)
- For screw threads: 1/6 turn (60°) (one hex flat)

Table 2-1. Standard Torque for MS17825 and MS17826 Nuts on 125 KSI Minimum Ultimate Tensile Fasteners

THREAD SIZE	TORQUE RANGE			
	SHEAR		TENSION	
	INCH-POUNDS (Nm)	FOOT-POUNDS (Nm)	INCH-POUNDS (Nm)	FOOT-POUNDS (Nm)
0.1900-32 (10-32)	7-12 (0.8-1.4)		12-15 (1.4-1.7)	
0.2500-28	25-35 (2.8-4.0)		30-40 (3.4-4.5)	
0.3125-24	50-70 (5.6-7.9)		60-85 (6.8-9.6)	
0.3750-24	70-90 (7.9-10.2)		95-110 (10.7-12.4)	
0.4375-20	110-150 (12.4-16.9)		270-300 (30.5-33.9)	
0.5000-20	150-200 (16.9-22.6)			24-34 (32.5-46.1)
0.5625-18	200-300 (22.6-33.9)			40-50 (54.2-67.8)
0.6250-18	300-420 (33.9-47.5)			55-65 (74.6-88.1)
0.7500-16		45-62 (61.0-84.1)		108-125 (146.4-169.5)
0.8750-14		79-96 (107.1-130.2)		125-150 (169.5-203.4)
1.0000-12		125-150 (169.5-203.4)		183-275 (248.1-372.9)
1.1250-12		208-292 (282.0-395.9)		250-350 (339.0-474.5)
1.2500-12		292-375 (395.9-508.4)		450-500 (610.1-677.9)
NUTS	MS17826		MS17825	
125 KSI BOLTS & SCREWS	AN3 thru 20 AN21 thru 37 AN42 thru 49 AN173 thru 186	AN502 AN503 AN525 MS9088 thru 94	MS20073 thru 81 MS21091 MS24694 MS27039	NAS428 NAS1297

NOTES:

1. It is recommended that paragraph 2-1 through paragraph 2-10 be read and understood prior to tightening any threaded fasteners.
2. The Standard Torque values shown apply to any combination of bolt and nut shown unless otherwise specified. They are recommended for dry, coated or plated, unlubricated threads and are in addition to the actual locking torque (Tare Torque) value of each self-locking nut.
3. **To determine the Total Assembly Torque, add the Standard Torque from table to the Actual Measured Locking Torque (Tare Torque) of the nut.**
   Total Assembly Torque = Standard Torque (from table) + Measured Locking Torque (Tare Torque) of nut.

Table 2-2. Standard Torque for Specified Nuts on 125 KSI Minimum Ultimate Tensile Fasteners

THREAD SIZE	TORQUE RANGE			
	SHEAR		TENSION	
	INCH-POUNDS (Nm)	FOOT-POUNDS (Nm)	INCH-POUNDS (Nm)	FOOT-POUNDS (Nm)
0.1640-32 (8-32)	7-9 (0.8-1.0)		12-15 (1.4-1.7)	
0.1900-32 (10-32)	12-15 (1.4-1.7)		20-25 (2.3-2.8)	
0.2500-28	30-40 (3.4-4.5)		50-70 (5.6-7.9)	
0.3125-24	60-85 (6.8-9.6)		100-140 (11.3-15.8)	
0.3750-24	95-110 (10.7-12.4)		160-190 (18.1-21.5)	
0.4375-20	270-300 (30.5-33.9)			37-42 (50.2-56.9)
0.5000-20		24-34 (32.5-46.1)		40-58 (54.2-78.6)
0.5625-18		40-50 (54.2-67.8)		66-83 (89.5-112.5)
0.6250-18		55-65 (74.6-88.1)		91-108 (123.4-146.4)
0.7500-16		108-125 (146.4-169.5)		191-208 (259.0-282.0)
0.8750-14		125-150 (169.5-203.4)		208-250 (282.0-339.0)
1.0000-12		183-275 (248.1-372.9)		308-458 (417.6-621.0)
1.1250-12		250-350 (339.0-474.5)		416-583 (564.0-790.4)
1.2500-12		450-500 (610.1-677.9)		750-916 (1016.9-1241.9)
NUTS	AN316 AN320 MS14145 MS21025 MS21083 NAS1022	NAS1068 NAS1789 80-026 90-002 90-003 90-033	AN256 AN310 AN315 MS14144 MS20500 MS21043 MS21044 MS21047 thru 49 MS21051 thru 56 MS21058 thru 62 MS21069 thru 76 MS21080 MS21083 MS21086 MS21225 NAS509	NAS679 NAS1021 NAS1023 NAS1031 NAS1033 NAS1067 NAS1473 NAS1474 NAS1766 NAS1791 NAS1792 NAS1793 NAS1870 90-099 90-100 90-105
125 KSI BOLTS & SCREWS	AN3 thru 20 AN21 thru 37 AN42 thru 49 AN173 thru 186	AN502 AN503 AN525 MS9088 thru 94	MS20033 thru 46 MS20073 thru 81 MS21091 MS24694	MS27039 NAS428 NAS1003 thru 20 NAS1297

Table 2-2. Standard Torque for Specified Nuts on 125 KSI Minimum Ultimate Tensile Fasteners (Cont)

NOTES:

1. It is recommended that paragraph 2-1 through paragraph 2-10 be read and understood prior to tightening any threaded fasteners.
2. The Standard Torque values shown apply to any combination of bolt and nut shown unless otherwise specified. They are recommended for dry, coated or plated, unlubricated threads and are in addition to the actual locking torque (Tare Torque) value of each self-locking nut.
3. **To determine the Total Assembly Torque, add the Standard Torque from table to the Actual Measured Locking Torque (Tare Torque) of the nut.**
   Total Assembly Torque = Standard Torque (from table) + Measured Locking Torque (Tare Torque) of nut.
4. Fasteners listed in higher tensile categories (Table 2-2 through Table 2-5) may be used in conjunction with fasteners listed in lower tensile categories (Table 2-2 through Table 2-5). The lower category recommended Standard Torque is to be used to calculate the Total Assembly Torque (Note 3), regardless of the bolt tensile or nut strength relationship.

Table 2-3. Standard Torque for Specified Nuts on 160 KSI Minimum Ultimate Tensile Fasteners

THREAD SIZE	TORQUE RANGE			
	SHEAR		TENSION	
	INCH-POUNDS (Nm)	FOOT-POUNDS (Nm)	INCH-POUNDS (Nm)	FOOT-POUNDS (Nm)
0.0860-56 (2-56)	2-3 (0.2-0.3)			
0.1120-40 (4-40)	4-5 (0.5-0.6)			
0.1380-32 (6-32)	6-8 (0.7-0.9)			
0.1640-32 (8-32)	12-16 (1.4-1.8)			
0.1900-32 (10-32)	20-25 (2.3-2.8)		30-40 (3.4-4.5)	
0.2500-28	50-70 (5.6-7.9)		75-95 (8.5-10.7)	
0.3125-24	100-140 (11.3-15.8)		120-160 (13.6-18.1)	
0.3750-24	160-190 (18.1-21.5)			25-28 (33.9-38.0)
0.4375-20		37-42 (50.2-56.9)		39-43 (52.9-58.3)
0.5000-20		40-58 (54.2-78.6)		53-71 (71.9-96.3)
0.5625-18		66-83 (89.5-112.5)		83-100 (112.5-135.6)
0.6250-18		91-108 (123.4-146.4)		116-133 (157.3-180.3)
0.7500-16		191-208 (259.0-282.0)		200-216 (271.2-292.9)
0.8750-14		208-250 (282.0-339.0)		333-375 (451.5-508.4)
1.0000-12		308-458 (417.6-621.0)		433-583 (587.1-790.4)
1.1250-12		416-583 (564.0-790.4)		691-858 (936.9-1163.3)
1.2500-12		750-916 (1016.9-1241.9)		1441-1608 (1953.7-2180.2)
NUTS	90-099 90-100 AN256 AN310 AN315 MS14144 MS20500 MS21043 MS21044 MS21047 thru 49 MS21051 thru 56 MS21058 thru 62 MS21069 thru 76 MS21080 MS21083	MS21086 MS21225 NAS509 NAS679 NAS1021 NAS1031 NAS1033 NAS1067 NAS1473 NAS1474 NAS1766 NAS1791 NAS1792 NAS1793 NAS1870	50-048 90-099 MS21042 NAS577 NAS1291 NAS1770	NAS1771 NAS1772 NAS1773 NAS1778 NAS1805

Table 2-3. Standard Torque for Specified Nuts on 160 KSI Minimum Ultimate Tensile Fasteners (Cont)

160 KSI BOLTS, SCREWS & STUDS	20-057	120-266	NAS1101	NAS1580
	20-058	120-267	NAS1102	NAS1801
	20-092	120-268	NAS1103 thru 20	NAS1802
	20-099	120-269	NAS1121 thru 28	NAS6203 thru 20
	20-100	120-270	NAS1131 thru 38	NAS6303 thru 20
	20-113	120-271	NAS1141 thru 48	NAS6403 thru 20
	20-114	120-276	NAS1151 thru 58	NAS6603 thru 20
	20-116	120-278	NAS1161 thru 68	NAS6703 thru 20
	20-122	M87114/1	NAS1171 thru 78	NAS6803 thru 20
	50-047	M87114/2	NAS1181 thru 88	NAS7103 thru 16
	120-142 △6	M87114/3	NAS1189	NAS7203 thru 16
	120-184	MS16997 thru 98	NAS1190	NAS7303 thru 16
	120-186	MS20004 thru 24	NAS1191	NAS7500 thru 16
	120-212	MS27576	NAS1202 thru 10	NAS8100 thru 06
	120-220	NAS144 thru 158	NAS1218	NAS8200 thru 06
	120-225	NAS333 thru 340	NAS1223 thru 35	NAS8702 thru 16
	120-259	NAS464	NAS1266 thru 70	NAS8802 thru 16
	120-261	NAS517	NAS1303 thru 20	NAS9101 thru 06
	120-262	NAS583 thru 590	NAS1351 △5	NAS9201 thru 06
	120-264	NAS623	NAS1352 △5	
	120-265	NAS673 thru 678	NAS1402 thru 06	

NOTES:

1. It is recommended that paragraph 2-1 through paragraph 2-10 be read and understood prior to tightening any threaded fasteners.

2. The Standard Torque values shown apply to any combination of bolt and nut shown unless otherwise specified. They are recommended for dry, coated or plated, unlubricated threads and are in addition to the actual locking torque (Tare Torque) value of each self-locking nut.

3. **To determine the Total Assembly Torque, add the Standard Torque from table to the Actual Measured Locking Torque (Tare Torque) of the nut.**
   Total Assembly Torque = Standard Torque (from table) + Measured Locking Torque (Tare Torque) of nut.

4. Fasteners listed in higher tensile categories (Table 2-2 through Table 2-5) may be used in conjunction with fasteners listed in lower tensile categories (Table 2-2 through Table 2-5). The lower category recommended Standard Torque is to be used to calculate the Total Assembly Torque (Note 3), regardless of the bolt tensile or nut strength relationship.

△5 A-286 CRES and alloy steel only.

△6 120-142 shall use the shear values, regardless of nut type.

Table 2-4. Standard Torque for Specified Nuts on 180 KSI Minimum Ultimate Tensile Fasteners

THREAD SIZE	TORQUE RANGE			
	SHEAR		TENSION	
	INCH-POUNDS (Nm)	FOOT-POUNDS (Nm)	INCH-POUNDS (Nm)	FOOT-POUNDS (Nm)
0.1900-32 (10-32)	22-28 (2.5-3.2)		34-45 (3.8-5.1)	
0.2500-28	56-79 (6.3-8.9)		84-107 (9.5-12.1)	
0.3125-24	112-158 (12.7-17.9)		135-180 (15.3-20.3)	
0.3750-24	180-214 (20.3-24.2)			28-32 (38.0-43.4)
0.4375-20		42-47 (56.9-63.7)		44-48 (59.7-65.1)
0.5000-20		45-54 (61.0-73.2)		60-80 (81.3-108.5)
0.5625-18		74-93 (100.3-126.1)		93-112 (126.1-151.9)
0.6250-18		102-122 (138.3-165.4)		130-150 (176.3-203.4)
0.7500-16		215-234 (291.5-317.3)		225-243 (305.1-329.5)
0.8750-14		234-281 (317.3-381.0)		375-422 (508.4-572.2)
1.0000-12		346-515 (469.1-698.2)		487-656 (660.3-889.4)
1.1250-12		468-656 (634.5-889.4)		777-965 (1053.5-1308.4)
1.2500-12		844-1030 (1144.3-1396.5)		1621-1809 (2197.8-2452.7)
NUTS	MS21042 NAS577	NAS1291	MS14156 MS21133 EB – ( ) (ESNA)	LH 3830 (ESNA) 48FLW (SPS) NAS1805
180 KSI BOLTS & STUDS	20-065 20-069 20-087 20-096 20-102	20-104 20-105 20-109 20-118 120-064 △5	120-244 MS14157 MS21134 MS21250 NAS624 thru 644	NAS1972 thru 80 NAS2803 thru 10

Table 2-4. Standard Torque for Specified Nuts on 180 KSI Minimum Ultimate Tensile Fasteners (Cont)

NOTES:

1. It is recommended that paragraph 2-1 through paragraph 2-10 be read and understood prior to tightening any threaded fasteners.
2. The Standard Torque values shown apply to any combination of bolt and nut shown unless otherwise specified. They are recommended for dry, coated or plated, unlubricated threads and are in addition to the actual locking torque (Tare Torque) value of each self-locking nut.
3. **To determine the Total Assembly Torque, add the Standard Torque from table to the Actual Measured Locking Torque (Tare Torque) of the nut.**
   Total Assembly Torque = Standard Torque (from table) + Measured Locking Torque (Tare Torque) of nut.
4. Fasteners listed in higher tensile categories (Table 2-2 through Table 2-5) may be used in conjunction with fasteners listed in lower tensile categories (Table 2-2 through Table 2-5). The lower category recommended Standard Torque is to be used to calculate the Total Assembly Torque (Note 3), regardless of the bolt tensile or nut strength relationship.

△5 120-064 shall use the shear values, regardless of nut type.

Table 2-5. Standard Torque for Specified Nuts on 220 KSI Minimum Ultimate Tensile Fasteners

THREAD SIZE	TORQUE RANGE			
	SHEAR		TENSION	
	INCH-POUNDS (Nm)	FOOT-POUNDS (Nm)	INCH-POUNDS (Nm)	FOOT-POUNDS (Nm)
0.1900-32 (10-32)	28-34 (3.2-3.8)		41-55 (4.6-6.2)	
0.2500-28	69-96 (7.8-10.8)		103-131 (11.6-14.8)	
0.3125-24	138-192 (15.6-21.7)		165-220 (18.6-24.9)	
0.3750-24	220-261 (24.9-29.5)			34-38 (46.1-51.5)
0.4375-20		51-58 (69.1-78.6)		54-59 (73.2-80.0)
0.5000-20		55-80 (74.6-108.5)		73-98 (99.0-132.9)
0.5625-18		91-114 (123.4-154.6)		114-138 (154.6-187.1)
0.6250-18		125-148 (169.5-200.7)		160-183 (216.9-248.1)
0.7500-16		263-286 (356.6-387.8)		275-297 (372.9-402.7)
0.8750-14		286-344 (387.8-466.4)		458-516 (621.0-699.6)
1.0000-12		424-630 (574.9-854.2)		595-802 (806.7-1087.4)
1.1250-12		572-802 (775.5-1087.4)		950-1180 (1288.0-1599.9)
1.2500-12		1031-1260 (1397.9-1708.3)		1981-2211 (2685.9-2997.7)
NUTS	LH6520 (ESNA) 90-101	NAS1805	MS14164 MS21084 NAS1758 FN22 M (SPS)	LH3393 (ESNA) LH6422T (ESNA) LHEB220 (ESNA) MS14182
220 KSI BOLTS	20-071 20-088 20-089	20-097 20-098 20-101	20-106 20-112 MS14163	MS21297 MS14181

Table 2-5. Standard Torque for Specified Nuts on 220 KSI Minimum Ultimate Tensile Fasteners (Cont)

NOTES:

1. It is recommended that paragraph 2-1 through paragraph 2-10 be read and understood prior to tightening any threaded fasteners.
2. The Standard Torque values shown apply to any combination of bolt and nut shown unless otherwise specified. They are recommended for dry, coated or plated, unlubricated threads and are in addition to the actual locking torque (Tare Torque) value of each self-locking nut.
3. **To determine the Total Assembly Torque, add the Standard Torque from table to the Actual Measured Locking Torque (Tare Torque) of the nut.**
   Total Assembly Torque = Standard Torque (from table) + Measured Locking Torque (Tare Torque) of nut.
4. Fasteners listed in higher tensile categories (Table 2-2 through Table 2-5) may be used in conjunction with fasteners listed in lower tensile categories (Table 2-2 through Table 2-5). The lower category recommended Standard Torque is to be used to calculate the Total Assembly Torque (Note 3), regardless of the bolt tensile or nut strength relationship.

Table 2-6. Standard Torque for Steel and CRES Nuts on <125 KSI Minimum Ultimate Tensile Fasteners

THREAD SIZE	TORQUE RANGE INCH-POUNDS (Nm)
0.1900-32 (10-32)	4-6 (0.5-0.7)
0.2500-28	10-15 (1.1-1.7)
0.3125-24	21-31 (2.4-3.5)
0.3750-24	34-40 (3.8-4.5)
0.4375-20	97-108 (11.0-12.2)
0.5000-20	103-147 (11.6-16.6)

NOTES:

1. It is recommended that paragraph 2-1 through paragraph 2-10 be read and understood prior to tightening any threaded fasteners.
2. The Standard Torque values shown apply to any combination of bolt and nut shown unless otherwise specified. They are recommended for dry, coated or plated, unlubricated threads and are in addition to the actual locking torque (Tare Torque) value of each self-locking nut.
3. **To determine the Total Assembly Torque, add the Standard Torque from table to the Actual Measured Locking Torque (Tare Torque) of the nut.**
   Total Assembly Torque = Standard Torque (from table) + Measured Locking Torque (Tare Torque) of nut.

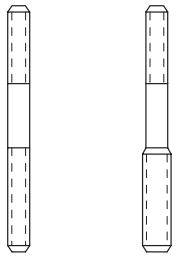
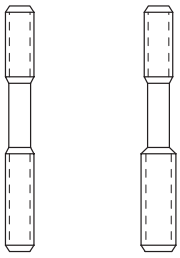
Table 2-7. Standard Torque for Non-Structural Small Diameter Fasteners

THREAD SIZE	TORQUE RANGE	
	MINIMUM	MAXIMUM
	INCH-POUNDS (Nm)	INCH-POUNDS (Nm)
0860-56 (#2)	0.5 (0.1)	1 (0.1)
.1120-40 (#4)	1 (0.1)	2 (0.2)
.1380-32 (#6)	2 (0.2)	6 (0.7)
.1640-32 (#8)	4 (0.5)	8 (0.9)

NOTES:

1. It is recommended that paragraph 2-1 through paragraph 2-10 be read and understood prior to tightening any threaded fasteners.
2. The Standard Torque values listed are recommended fastener torques for non-structural applications such as attachment of clips, trim, and flange mount connectors. They are applicable for aluminum, brass, CRES, and steel fasteners in wet or dry installations. These torques will not induce significant preload in the fastener. Torques are the minimum needed to keep the fastener from becoming loose in the joint. These values should be added to the Actual Measured Locking Torque of the nut.
3. **To determine the Total Assembly Torque, add the Standard Torque from table to the Actual Measured Locking Torque (Tare Torque) of the nut.**
   Total Assembly Torque = Standard Torque (from table) + Measured Locking Torque (Tare Torque) of nut.

Table 2-8. Recommended Installation Torque for Threaded Studs

THREAD SIZE		TORQUE RANGE	
			
NUT END	**STUD END**	**TYPE A**	**TYPE B**
0.1900-32 (10-32)	0.1900-24 (10-24)		30-40 in-lb (3.4-4.5 Nm)
0.1900-32 (10-32)	0.2500-20	30-40 in-lb (3.4-4.5 Nm)	30-40 in-lb (3.4-4.5 Nm)
0.2500-28	0.2500-20	50-95 in-lb (5.6-10.7 Nm)	50-70 in-lb (5.6-7.9 Nm)
0.2500-28	0.3125-18	50-110 in-lb (5.6-12.4 Nm)	50-80 in-lb (5.6-9.0 Nm)
0.3125-24	0.3125-18	100-225 in-lb (11.3-25.4 Nm)	100-130 in-lb (11.3-14.7 Nm)
0.3125-24	0.3750-16	100-240 in-lb (11.3-27.1 Nm)	100-160 in-lb (11.3-18.1 Nm)
0.3750-24	0.3750-16	175-375 in-lb (19.8-42.4 Nm)	175-250 in-lb (19.8-28.2 Nm)
0.3750-24	0.4375-14	175-475 in-lb (19.8-53.7 Nm)	175-325 in-lb (19.8-36.7 Nm)
0.4375-20	0.4375-14	20-54 ft-lb (27.1-73.2 Nm)	250-400 in-lb (28.2-45.2 Nm)
0.4375-20	0.5000-13	20-60 ft-lb (27.1-81.3 Nm)	250-525 in-lb (28.2-59.3 Nm)
0.5000-20	0.5000-13	33-83 ft-lb (44.7-112.5 Nm)	33-58 ft-lb (44.7-78.6 Nm)
0.5000-20	0.5625-12	33-95 ft-lb (44.7-128.8 Nm)	33-70 ft-lb (44.7-94.9 Nm)
0.5625-18	0.5625-12	50-120 ft-lb (67.8-162.7 Nm)	41-87 ft-lb (55.6-118.0 Nm)
0.5625-18	0.6250-11	50-137 ft-lb (67.8-185.7 Nm)	50-95 ft-lb (67.8-128.8)
0.6250-18	0.6250-11	75-166 ft-lb (101.7-225.1 Nm)	58-116 ft-lb (78.6-157.3 Nm)
0.6250-18	0.6875-11	75-200 ft-lb (101.7-271.2 Nm)	75-141 ft-lb (101.7-191.2 Nm)

NOTES:

1. It is recommended that paragraph 2-1 through paragraph 2-10 be read and understood prior to tightening any threaded fasteners.
2. **Installation torque shown in the table is the actual torque measured when installing the threaded stud into the parent material (i.e., gearbox case, etc.).**

Table 2-8. Recommended Installation Torque for Threaded Studs (Cont)

NOTES (CONT):

3. Threaded stud —

   Type A: The grip portion of the stud is approximately the same diameter as the pitch diameter of the nut end thread.

   Type B: The grip portion of the stud is less than the minor diameter of the nut end thread.

4. For nut Standard Torque, refer to Table 2-2, as applicable.

Table 2-9. Recommended Installation Torque for Flared Fitting Nuts

TUBE SIZE	FLARED FITTING NUTS (AN818) ⚠1		HOSE END FITTINGS AND HOSE ASSEMBLY (MS28740 AND MS28759)	RIGID TUBE CONNECTOR		
	ALUMINUM TUBING FLARE (MS33583 OR MS33584)	STEEL TUBING FLARE (MS33584)		DASH NO.	STEEL TUBING NAS 594 AND 596	ALUMINUM TUBING NAS 591 AND 593
3/16	30-45 in-lb (3.4-5.1 Nm)	90-100 in-lb (10.2-11.3 Nm)	70-100 in-lb (7.9-11.3 Nm)			
1/4	40-65 in-lb (4.5-7.3 Nm)	135-150 in-lb (15.3-16.9 Nm)	70-120 in-lb (7.9-13.6 Nm)	4	60-96 in-lb (6.8-10.8 Nm)	48-96 in-lb (5.4-10.8 Nm)
5/16	60-80 in-lb (6.8-9.0 Nm)	180-200 in-lb (20.3-22.6 Nm)	85-180 in-lb (9.6-20.3 Nm)	5	66-108 in-lb (7.5-12.2 Nm)	60-108 in-lb (6.8-12.2 Nm)
3/8	75-125 in-lb (8.5-14.1 Nm)	270-300 in-lb (30.5-33.9 Nm)	100-250 in-lb (11.3-28.2 Nm)	6	72-120 in-lb (8.1-13.6 Nm)	72-120 in-lb (8.1-13.6 Nm)
1/2	150-250 in-lb (16.9-28.2 Nm)	450-500 in-lb (50.8-56.5 Nm)	210-420 in-lb (23.7-47.5 Nm)	8	144-232 in-lb (16.3-26.2 Nm)	120-216 in-lb (13.6-24.4 Nm)
5/8	200-350 in-lb (22.6-39.5 Nm)	54-58 ft-lb (73.2-78.6 Nm)	300-480 in-lb (33.9-54.2 Nm)	10	204-360 in-lb (23.0-40.7 Nm)	144-360 in-lb (16.3-40.7 Nm)
3/4	300-500 in-lb (33.9-56.5 Nm)	75-83 ft-lb (101.7-112.5 Nm)	41-70 ft-lb (55.6-94.9 Nm)	12	300-540 in-lb (33.9-61.0 Nm)	216-540 in-lb (24.4-61.0 Nm)
1	41-58 ft-lb (55.6-78.6 Nm)	100-116 ft-lb (135.6-157.3 Nm)	58-95 ft-lb (78.6-128.8 Nm)	16	42-58 ft-lb (56.9-78.6 Nm)	480-696 in-lb (54.2-78.6 Nm)
1-1/4	50-75 ft-lb (67.8-101.7 Nm)			20	50 -75 ft-lb (67.8-101.7 Nm)	50-75 ft-lb (67.8-101.7 Nm)
1-1/2	50-75 ft-lb (67.8-101.7 Nm)			24	50-75 ft-lb (67.8-101.7 Nm)	50-75 ft-lb (67.8-101.7 Nm)
1-3/4				38	60-90 ft-lb (81.3-122.0 Nm)	62-90 ft-lb (84.1-122.0 Nm)
2				32	75-110 ft-lb (101.7-149.1 Nm)	75-100 ft-lb (101.7-135.6 Nm)
2-1/2				40	150-175 ft-lb (203.4-237.3 Nm)	110-150 ft-lb (149.1-203.4 Nm)
3				48	150-175 ft-lb (203.4-237.3 Nm)	
4				64	200-225 ft-lb (271.2-305.1 Nm)	

NOTES:

⚠1 For flared nuts installed with conical seal washers (AS4824 or 110-144), apply the recommended installation torque, wait 10 to 15 seconds, then again apply the same torque value to the nut. Refer to the applicable Illustrated Parts Breakdown (IPB) manual to make sure the washer installation is authorized on the fitting (Information Letter GEN-07-108).

2. See Table 2-10 for flareless fitting nuts.

Table 2-10. Recommended Installation Torque for Flareless Fitting Nuts

INSTALLATION WRENCH TORQUE, FLARELESS FITTINGS, AS 21922 BITE TYPE SLEEVE				
TUBE OD	**TUBE WALL THICKNESS**	**ALUMINUM FITTING, ALUMINUM TUBE**	**STEEL FITTING, ANNEALED CRES TUBE**	**STEEL OR TITANIUM FITTING, CRES 1/8 HARD TUBE**
		△1 INCH-POUNDS (Nm)	**△1 INCH-POUNDS (Nm)**	**△1 INCH-POUNDS (Nm)**
.125	.012			55 (6.2)
.188	.016			100 (11.3)
.188	.020		100 (11.3)	
.188	.028	80 (9.0)		
.250	.020		140 (15.8)	140 (15.8)
.250	.028	110 (12.4)	140 (15.8)	
.312	.020		190 (21.5)	190 (21.5)
.312	.028	140 (15.8)	190 (21.5)	
.375	.028	170 (19.2)		270 (30.5)
.375	.035		270 (30.5)	
.500	.028	280 (31.6)		
.500	.035	360 (40.7)		500 (56.5)
.500	.042		500 (56.5)	
.625	.028	360 (40.7)		
.625	.035	415 (46.9)		
.625	.042			700 (79.1)
.625	.058		700 (79.1)	
.750	.028	450 (50.8)		
.750	.049	450 (50.8)		
.750	.058			900 (101.7)
.750	.065		900 (101.7)	
1.000	.035	750 (84.7)		
1.000	.049	800 (90.4)		
1.000	.065	1200 (135.6)		1200 (135.6)
1.000	.083		1200 (135.6)	

NOTE:

Please see next page for notes.

Table 2-10. Recommended Installation Torque for Flareless Fitting Nuts (Cont)

INSTALLATION WRENCH TORQUE, FLARELESS FITTINGS, NAS 1760 FITTING ENDS,		
TUBE OD	**ALUMINUM FITTING**	**STEEL AND TITANIUM FITTING**
	⚠1 INCH-POUNDS (Nm)	**⚠1 INCH-POUNDS (Nm)**
.125	---	55 (6.2)
.188	80 (9.0)	100 (11.3)
.250	110 (12.4)	140 (15.8)
.312	140 (15.8)	190 (21.5)
.375	170 (19.2)	270 (30.5)
.500	280 (31.6)	500 (56.5)
.625	360 (40.7)	700 (79.1)
.750	450 (50.8)	900 (101.7)
1.000	750 (84.7)	1200 (135.6)
1.250	900 (101.7)	1600 (180.8)
1.500	900 (101.7)	2000 (226.0)
2.000	---	2000 (226.0)

NOTES:

⚠1 Torque values shown may be altered ±5%.

2. Flareless Fitting Nuts:

a. Nut turn method: When standard open end wrenches are used for assembly, the final installation torque for flareless tubing connections can be achieved by tightening the nut 1/6 to 1/3 turns (1 to 2 hex flats) past the point of sharp torque rise.

b. Torque method: When a torque wrench is used for assembly, the tightening torque for AS21922 bite type and NAS1760 style sleeves shall be in accordance with table.

c. Leaking joints: After installation, if leakage is encountered at the fitting joint, loosen the coupling nut and remove the tube end from the fitting. Do not attempt to prevent the leakage by overtorquing. Instead, inspect the seal areas of the sleeve and mating fitting for scratches, nicks, dents, foreign material, etc. Reassemble the joint with new parts, if necessary.

Table 2-11. Recommended Installation Torque for Dynamic Beam Seal Nuts

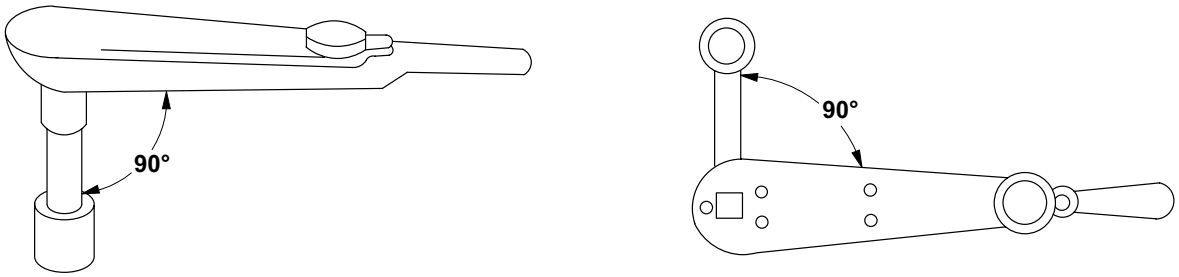
RECOMMENDED INSTALLATION TORQUE FOR DYNAMIC BEAM SEAL NUTS (OPERATING PRESSURES TO 3000 PSI TITANIUM, MATERIAL)		
FITTING SIZE	**TORQUE RANGE COUPLING NUTS**	**TORQUE MAXIMUM JAM NUTS**
	FOOT-POUNDS (Nm)	**FOOT-POUNDS (Nm)**
-03	5-9 (6.8-12.2)	7 (9.5)
-04	10-14 (13.6-19.0)	12 (16.3)
-05	10-16 (13.6-21.7)	13 (17.6)
-06	15-25 (20.3-33.9)	20 (27.1)
-08	30-40 (40.7-54.2)	35 (47.5)
-10	41-55 (55.6-74.6)	48 (65.1)
-12	50-70 (67.8-94.9)	60 (81.3)
-16	70-94 (94.9-127.4)	82 (111.2)
-20	90-120 (122.0-162.7)	105 (142.4)
-24	110-150 (149.1-203.4)	130 (176.3)

RECOMMENDED INSTALLATION TORQUE FOR DYNAMIC BEAM SEAL NUTS (OPERATING PRESSURES TO 5000 PSI TITANIUM, MATERIAL)		
FITTING SIZE	**TORQUE RANGE COUPLING NUTS**	**TORQUE MAXIMUM JAM NUTS**
	FOOT-POUNDS (Nm)	**FOOT-POUNDS (Nm)**
-04	10-14 (13.6-19.0)	12 (16.3)
-06	15-25 (20.3-33.9)	20 (27.1)
-08	30-40 (40.7-54.2)	35 (47.5)
-10	60-70 (81.3-94.9)	48 (65.1)
-12	70-80 (94.9-108.5)	60 (81.3)
-16	135-155 (183.0-210.2)	82 (111.2)

Table 2-12. Recommended Pin and Nut Torque Values

SHEAR		
PIN: 100-076, 100-085, 100-090		
NUT: MS21042, H541L, NAS1291		
THREAD SIZE	**RECOMMENDED TORQUE**	
	INCH-POUNDS	**Nm**
8-32	15-25	1.7-2.8
10-32	25-35	2.8-4.0
0.2500-28	60-80	6.8-9.0
.3125-24	130-160	14.7-18.1
.3750-24	200-240	22.6-27.1
.4375-20	270-330	30.5-37.3
.5000-20	370-430	41.8-48.6
NOTE: 1. The above values apply to any combination of pin and nut shown.		

TENSION		
PIN: 100-047, 100-048, 100-049, 100-059		
NUT: MS21042, H541L, NAS1291		
THREAD SIZE	**RECOMMENDED TORQUE**	
	INCH-POUNDS	**Nm**
8-32	30-40	3.4-4.5
10-32	40-50	4.5-5.6
0.2500-28	115-130	13.0-14.7
0.3125-24	200-250	22.6-28.2
0.3750-24	360-420	40.7-47.5
	FOOT-POUNDS	**Nm**
0.4375-20	44-56	59.7-75.9
0.5000-20	61-83	82.7-112.5
NOTE: 1. The above values apply to any combination of pin and nut shown.		



NOTE

Applied and indicated torque values are the same.

ALL_SPM_02_0001

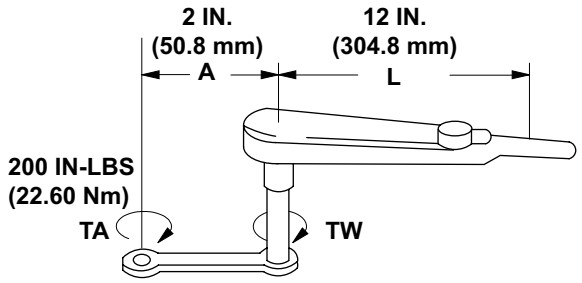
Figure 2-1. Torque Wrench Concentric Type Attachments

FORMULA TO OBTAIN CORRECT INDICATED TORQUE VALUE WHEN USING NONCONCENTRIC ATTACHMENT

$$TW = \frac{(TA) \times (L)}{(L) \pm (A)}$$

TW = INDICATED TORQUE VALUE ON TORQUE WRENCH
TA = ACTUAL TORQUE VALUE APPLIED TO FASTENER
L = LEVEL LENGTH
A = ATTACHMENT LENGTH

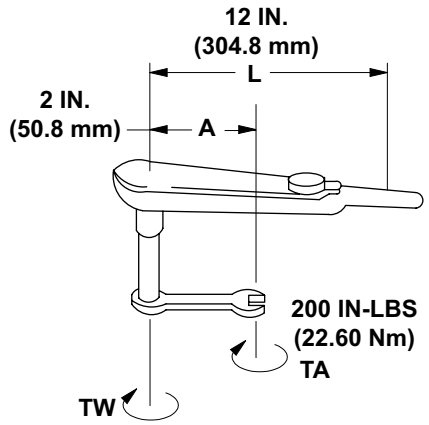
FORMULA



$$TW = \frac{200 \times 12}{12 + 2} = \frac{2400}{14} = 171.4 \text{ IN-LBS (19.37 Nm)}$$

RESULTS: FASTENER TORQUED 200 IN-LBS (22.60 Nm) WHEN WRENCH INDICATES 171.4 IN-LBS (19.37 Nm)

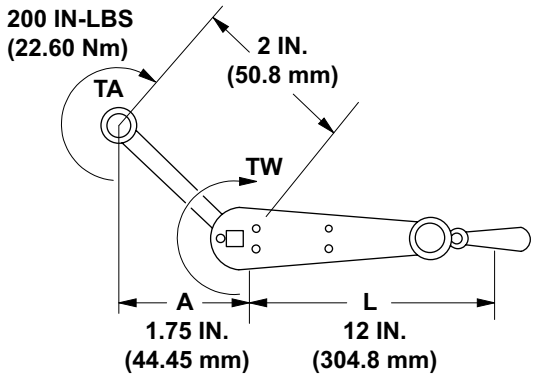
EXAMPLE 1



$$TW = \frac{200 \times 12}{12 - 2} = \frac{2400}{10} = 240 \text{ IN-LBS (27.12 Nm)}$$

RESULTS: FASTENER TORQUED 200 IN-LBS (22.60 Nm) WHEN WRENCH INDICATES 240 IN-LBS (27.12 Nm)

EXAMPLE 2



$$TW = \frac{200 \times 12}{12 + 1.75} = \frac{2400}{13.75} = 174.5 \text{ IN-LBS (19.72 Nm)}$$

RESULTS: FASTENER TORQUED 200 IN-LBS (22.60 Nm) WHEN WRENCH INDICATES 174.5 IN-LBS (19.72 Nm)

EXAMPLE 3

ALL_SPM_02_0002

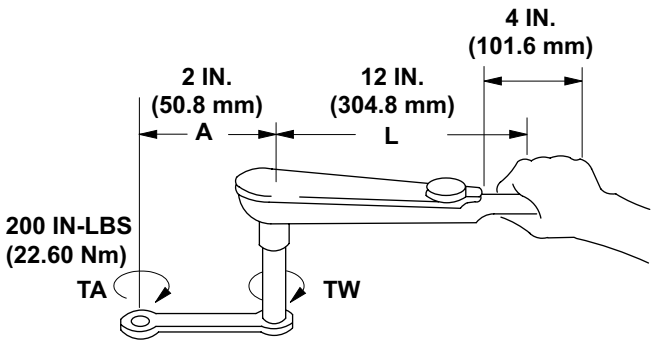
Figure 2-2. Torque Wrench Nonconcentric Type Attachments

FORMULA TO OBTAIN CORRECT INDICATED TORQUE VALUE WHEN USING NONCONCENTRIC ATTACHMENT

$$TW = \frac{(TA) \times (L)}{(L) \pm (A)}$$

TW = INDICATED TORQUE VALUE ON TORQUE WRENCH
TA = ACTUAL TORQUE VALUE APPLIED TO FASTENER
L = LEVEL LENGTH
A = ATTACHMENT LENGTH

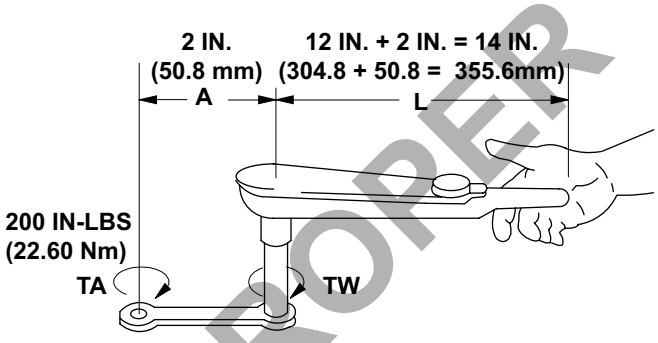
FORMULA



$$TW = \frac{200 \times 12}{12 + 2} = \frac{2400}{14} = 171.4 \text{ IN-LBS } (19.37 \text{ Nm})$$

RESULTS: FASTENER TORQUED 200 IN-LBS (22.60 Nm) WHEN WRENCH INDICATES 171.4 IN-LBS (19.37 Nm)

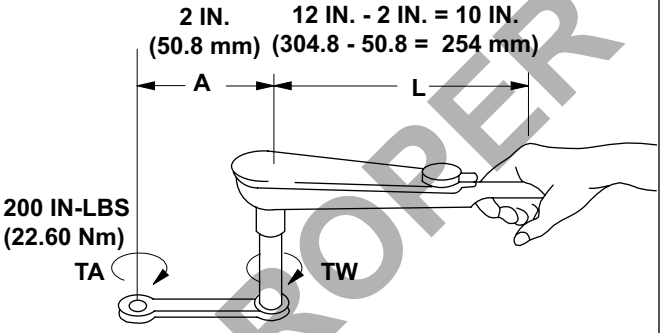
PROPER APPLICATION OF FORCE EXAMPLE 1



$$TW = \frac{200 \times (12 + 2)}{(12 + 2) + 2} = \frac{2800}{16} = 175 \text{ IN-LBS } (19.77 \text{ Nm})$$

RESULTS: FASTENER TORQUED 200 IN-LBS (22.60 Nm) WHEN WRENCH INDICATES 175 IN-LBS (19.77 Nm)

IMPROPER CALCULATION AND APPLICATION OF FORCE EXAMPLE 2



$$TW = \frac{200 \times (12 - 2)}{(12 - 2) + 2} = \frac{2000}{12} = 166.6 \text{ IN-LBS } (18.82 \text{ Nm})$$

RESULTS: FASTENER TORQUED 200 IN-LBS (22.60 Nm) WHEN WRENCH INDICATES 166.6 IN-LBS (18.82 Nm)

IMPROPER CALCULATION AND APPLICATION OF FORCE EXAMPLE 3

ALL_SPM_02_0003

Figure 2-3. Affect of Applied Force to Rigid Frame and Audible Indicating Torque Wrenches Using Nonconcentric Attachments