TH220B & TH330B
Telehandler Service Manual

31200262

S/N TBF00100 & After
S/N TBG00100 & After

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Specifications

Torque Specifications - TH220B, TH330B, TH360B, TH560B & TH580B Telehandlers

S/N TBF00100 & After
S/N TBG00100 & After
S/N TBH00100 & After
S/N TBP00100 & After
S/N TBJ00100 & After

Important Safety Information

Most accidents that involve product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or to other persons.

The hazards are identified by the "Safety Alert Symbol" and followed by a "Signal Word" such as "DANGER", "WARNING" or "CAUTION". The Safety Alert "WARNING" label is shown below.

The meaning of this safety alert symbol is as follows:

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning explains the hazard and can be either written or pictorially presented.

Operations that may cause product damage are identified by "NOTICE" labels on the product and in this publication.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are, therefore, not all inclusive. If a tool, procedure, work method or operating technique that is not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and for others. You should also ensure that the product will not be damaged or be made unsafe by the operation, lubrication, maintenance or repair procedures that you choose.

The information, specifications, and illustrations in this publication are on the basis of information that was available at the time that the publication was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service that is given to the product. Obtain the complete and most current information before you start any job. Caterpillar® dealers have the most current information available.

When replacement parts are required for this product Caterpillar recommends using Caterpillar replacement parts or parts with equivalent specifications including, but not limited to, physical dimensions, type, strength and material.

Failure to heed this warning can lead to premature failures, product damage, personal injury or death.

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Specifications Section

General Information

⚠ WARNING

Mismatched or incorrect fasteners can result in damage or malfunction, or personal injury.

Take care to avoid mixing metric dimensioned fasteners and inch dimensioned fasteners.

Introduction to Torque

"Torque" is measured in terms of force and distance. Force is the amount of pushing or pulling applied at the end of the lever. Distance is the length of the lever that is being used. Torque values are given in the following units: NEWTON meters (Nm), pound inches (lb in), and pound feet (lb ft)

This manual is intended to provide the operator with a reference. This manual will provide the standard torque settings for the following: bolts, nuts, plugs, fittings, and clamps.

Exceptions to these torques are given in the Service Manual, if necessary.

Be sure to use a torque wrench that has the proper range. Torque wrenches must be used properly in order to ensure that the correct torque is applied. Always use a smooth pull for torque wrenches. Do not jerk a torque wrench. Do not use adapters that change the length of the torque wrench. For the correct use of your torque wrench, refer to the instructions that were packaged with your torque wrench.

Prior to installation of any hardware, ensure that components are in near new condition. Bolts and threads must not be worn or damaged. Threads must not have burrs or nicks. Hardware must be free of rust and corrosion. Clean reused fasteners with a noncorrosive cleaner. Lightly lubricate the threads of reused fasteners. Lightly lubricate the mating surface of the head of reused fasteners. Other applications for lubricating fasteners may also be specified in the Service Manual. The Service Manual may also specify the use of sealants and compounds.

Note: Do not use sealants that are not specified in the Service Manual. Do not use compounds that are not specified in the Service Manual. Clean old compound from the bolt and from the hole before installation.

Torque-Turn

The torque-turn method is used when precise control over clamping force is required. There is an initial torque and an additional turn. The initial torque is required to bring all parts of the joint into contact. The additional turn provides the desired clamping force. Ensure that all fasteners have been torqued before you perform the additional turns. Turn the fastener according to the specified amount. The specified amount will normally be equal to or greater than 90°. The specified amount will normally be in 30° increments. Turns of 120° or 180° are preferred. Turns of 120° or 180° are easily measured by the points of the hex head of the fastener. Lubrication may be specified in order to reduce the effort that is required for the final turn. The use of the torque-turn method will allow the following:

- Increase the life of the fastener.
- Maximize the potential clamping force of a fastener.

Typical applications are the following:

- Track bolts
- Sprocket bolts
- Connecting rod bolts
- Engine Cylinder Heads
- Drive Shaft bolts

Note: Too much tension on the bolt will cause the bolt to be stretched beyond the point of yield. The bolt will be permanently stretched. The bolt will loosen the grip on the parts that are being fastened. If the bolt is tightened again, the bolt will break. Do not reuse bolts that have been permanently stretched.

Torque Sequence

Unless the bolt tightening sequence is specified by the Service Manual, the fasteners should be tightened in a cross pattern. Use Step 1 through Step 5 unless the tightening sequence is specified:

1. Hand tighten all fasteners. Larger fasteners may require the use of a small hand wrench.
2. Torque all fasteners to 40% of full torque.
3. Torque all fasteners to 70% of full torque.
4. Torque all fasteners to full torque by using a cross pattern. Large flanges may require additional passes.
5. Apply at least one final full torque to all fasteners in a clockwise direction until all torque is uniform. Large flanges may require additional passes.

Note: Final torque may be a turn.

Metric (ISO) Fasteners

Metric (ISO) Nuts and Bolts

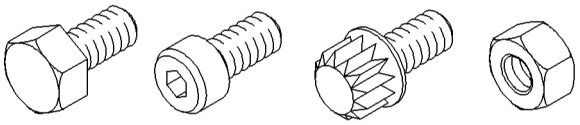

Illustration 1 g00909614

Note: The following table has the recommended standard torque values for Metric nuts and bolts for use on Perkins engines.

Table 1

Thread Size mm	Torque
M6	5 Nm (44 lb in)
M8	22 Nm (16 lb ft)
M10	44 Nm (32 lb ft)
M12	78 Nm (60 lb ft)
M14	124 Nm (90 lb ft)
M16	177 Nm (130 lb ft)
M18	200 Nm (150 lb ft)
M20	400 Nm (300 lb ft)
M24	790 Nm (580 lb ft)

Note: The difference between Caterpillar standard torque values and Perkins standard torque values are due to different classes of fasteners. Caterpillar uses class 10.9 fasteners. Perkins uses class 8.8 fasteners. The different class of fasteners have different tensile strengths.

Metric (ISO) Taperlock Studs

Note: The following table has the recommended standard torque values for metric nuts and bolts for use on Perkins engines.

Table 2

Thread Size mm	Torque
M6	5 Nm (44 lb in)
M8	11 Nm (97 lb in)
M10	18 Nm (13 lb ft)
M12	25 Nm (18 lb ft)

Metric (ISO) Machine Screws

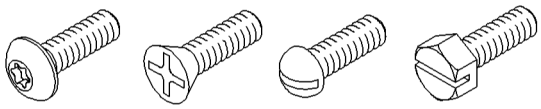

Illustration 2 g00908932

Table 3

Thread Size mm	Torque
M1.6	0.10 ±0.01 Nm (0.9 ±0.1 lb in)
M2	0.15 ±0.01 Nm (1.3 ±0.1 lb in)
M2.5	0.35 ± 0.05 Nm (3.1 ±0.4 lb in)
M3	0.50 ± 0.05 Nm (4.4 ±0.4 lb in)
M4	1.70 ± 0.25 Nm (15.0 ± 2.2 lb in)
M5	2.25 ± 0.25 Nm (19.9 ± 2.2 lb in)

Hex Button Head Screw and Set Screw

Illustration 3 g01186742

Table 4

Thread Size mm	Torque
M3	.6± .1 Nm (5 ± 0.9 lb in)
M4	2± .3 Nm (18±3 lb in)
M5	4± .5 Nm (35 ± 4 lb in)
M6	6± 1 Nm (55±9 lb in)
M8	15 ±3 Nm (11 ± 2 lb ft)
M10	30 ± 7 Nm (22 ± 5 lb ft)
M12	50 ± 10 Nm (37 ± 7 lb ft)
M14	80 ± 15 Nm (60 ± 11 lb ft)
M16	125 ± 20 Nm (90 ± 15 lb ft)
M20	250 ± 40 Nm(185 ± 30 lb ft)
M24	425 ± 50 Nm (310 ± 37 lb ft)
M30	850 ± 100 Nm (620 ± 75 lb ft)
M36	1500 ± 200 Nm (1100 ± 150 lb ft)

English (SAE) Fasteners

English (SAE) Nuts and Bolts

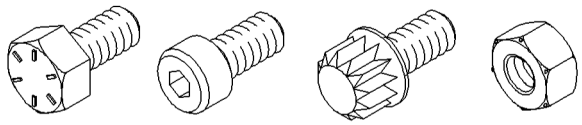

Illustration 4 g00908911

Table 5

Thread Size Inch	Torque
1/4	12 ± 3 N m (9 ± 2 lb ft)
5/16	25 ± 6 Nm (18 ± 4 lb ft)
3/8	47 ± 9 Nm (35 ± 7 lb ft)
7/16	70 ± 15 N m (5 0 ± 11 lb ft)
1/2	105 ±20 N m (7 5 ± 15 lb ft)
9/16	160 ± 30 N m (1 2 0 ± 2 2 lb ft)
5/8	215 ±40 N m (1 6 0 ± 30 lb ft)
3/4	370 ± 50 Nm (275 ± 37 lb ft)
7/8	620 ± 80 Nm (460 ± 60 lb ft)
1	900 ± 100 Nm(660±75 lb ft)
1 1/8	1300 ± 150Nm(960± 110 lb ft)
1 1/4	1800 ± 200 Nm (1320 ± 150 lb ft)
1 3/8	2400 ± 300 Nm (1780 ± 220 lb ft)
1 1/2	3100 ± 350 Nm (2280 ± 260 lb ft)

English (SAE) Taperlock Studs

Table 6

Thread Size Inch	Standard Torque
1/4	8 ± 3 Nm (6 ± 2 lb ft)
5/16	17 ± 5 Nm (13 ± 4 lb ft)
3/8	35 ± 5 Nm (26 ± 4 lb ft)
7/16	45 ± 10 N m (3 3 ± 7 lb ft)
1/2	65 ± 10 N m (4 8 ± 7 lb ft)
5/8	110 ±20 N m (8 0 ± 15 lb ft)
3/4	170 ± 30 N m (1 2 5 ± 2 2 lb ft)
7/8	260 ±40 N m (1 9 0 ± 30 lb ft)
1	400 ± 60 Nm (300 ± 44 lb ft)
1 1/8	525 ± 60 Nm (390 ± 44 lb ft)
1 1/4	750 ± 80 Nm (550 ± 60 lb ft)
1 3/8	950 ± 125 Nm(700±90 lb ft)
1 1/2	1200 ± 150Nm(880± 110 lb ft)

English (SAE) Machine Screws

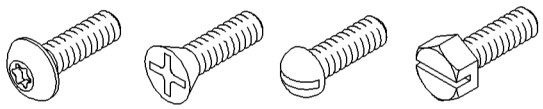

Illustration 5 g00908932

Table 7

Thread Size No.	Torque
0-80	0.10 ±0.01 Nm (0.9 ±0.1 lb in)
1-64	0.15 ±0.01 Nm (1.3 ±0.1 lb in)
2-56	0.25 ± 0.02 Nm (2.2 ± 0.2 lb in)
3-48	0.35 ± 0.05 Nm (3.1 ± 0.4 lb in)
4-40	0.50 ± 0.05 Nm (4.4 ± 0.4 lb in)
5-40	0.70 ± 0.10 Nm (6.2 ± 0.9 lb in)
6-32	0.90 ± 0.10 Nm (8.0 ± 0.9 lb in)
8-32	1.70 ± 0.25 Nm (15.0 ± 2.2 lb in)
10-24	2.25 ± 0.25 Nm (19.9 ± 2.2 lb in)
12-24	3.40 ± 0.60 Nm (30.1 ± 5.3 lb in)

Hex Button Head Screw and Set Screws

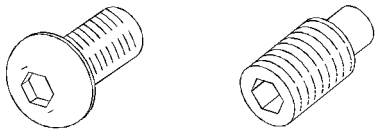

Illustration 6 g01186972

Table 8

Thread Size inch	Torque
#4 &#5	.6± .1 Nm (5±0.9 lb in)
#6 & #8	2± .3 Nm (18±3 lb in)
#10 &#12	4± .5 Nm (35±4 lb in)
1/4	6± 1 Nm (55± 9 lb in)
5/16	13±3Nm(115±27 lbin)
3/8	25±6Nm(18±4 lb ft)
7/16	40±8Nm(20±6 lb ft)
1/2	60 ± 12Nm (44±9lbft)
9/16	85 ± 15Nm (65± 11 lb ft)
5/8	115±20Nm(85± 15 lb ft)
3/4	200 ± 40 Nm (150 ± 30 lb ft)
7/8	325 ± 40 Nm (240 ± 30 lb ft)
1	500 ± 65 Nm (370 ± 48 lb ft)
1 1/8	700 ± 90 Nm (520 ± 65 lb ft)
1 1/4	1000 ± 125 Nm (740 ± 90 lb ft)
1 3/8	1300 ± 150 Nm (960 ± 110 lb ft)
1 1/2	1700 ± 200 Nm (1260 ± 150 lb ft)

Ground Engaging Tool (G.E.T.) Fasteners

Ground Engaging Tools (G.E.T.) are secured by many types of bolts. Refer to Table 9 for the correct torque for the following combinations of fasteners for G.E.T.:

- plow bolts and nuts
- hex head bolts and nuts

Table 9

Thread Size Inch	Torque(1)	
	Nm	lb ft
5/8 inch	270 ± 40	200 ± 30
3/4 inch	475 ± 60	350 ± 45
7/8 inch	750 ± 90	550 ± 65
1 inch	1150 ± 150	850 ± 110
1 1/4 inch	2300 ± 300	1700 ± 220

(1) These values are only for Caterpillar bolts for cutting edges.

⚠ WARNING

Personal injury can result when installing plow bolts. The appropriate safety equipment must be worn when striking the plow bolts. To avoid injury to your eyes and ears, wear protective glasses and hearing protection during this procedure.

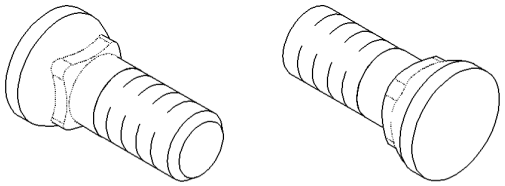

Illustration 7 g00909058

Plow bolts must be installed properly. Refer to the following procedure for the correct installation of plow bolts.

1. Clean all surfaces that contact the bolt. Remove all occurrences of the following conditions:rust, paint, nicks, and burrs
2. Tighten the nut to the correct torque. Refer to Table 9 for the correct torque.
3. Use a hammer to strike the head of the bolt. The bolt must be struck with significant force.

Note: The head of the bolt may be recessed below the mounting surface. Use a suitable punch in order to transfer the hammer blow to the bolt head.

4. Tighten the nut to the correct torque. Refer to Table 9 for the correct torque.

Installation of Fittings

Note: The tightening sequence of the fasteners that attach a tube assembly or hose assembly to the machine is very critical to the proper function of the machine. The sealing surfaces of the tube assembly or hose assembly should be secured squarely. The sealing surfaces of the tube assembly or hose assembly should be tightened to the serviced component (control valve, cylinder, hydraulic motor, etc). Perform this procedure prior to the final tightening of any clamps or clips that are used in order to fasten the tube assembly or the hose assembly to the machine.

Fittings have different connections. Fittings may have two completely different ends. Be sure to use the proper torque for the end of the fitting that is used. The following list contains some common types of fittings.

- Straight Thread O-Ring (STOR)
- Adjustable Straight Thread O-Ring (STOR)
- O-Ring Face Seal (ORFS)
- Tapered Pipe Thread (NPT and NPTF)
- 37 Degree Flare Fitting
- 45 Degree Flare Fitting
- 45 Degree Inverted Flare Fitting
- Split Flange Coupling

Installation of Split Flange Couplings

1. For a metal tube to hose installation, install the tube and tighten all bolts finger tight at the rigid end.
2. Install the hose and tighten all bolts finger tight.
3. Put the hose in a position so that the hose does not make contact with the machine or with another hose.

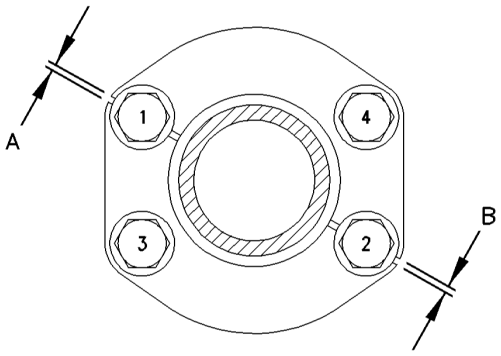

Illustration 8 g00906528

4. Tighten the bolts on both connections to the proper torque. Follow the prescribed torque sequence for split flange connections. Refer to Illustration 8. Add the measurement of gap (A) to the measurement of gap (B). The total must not exceed 4.0 mm (0.16 inch).
5. Start the engine.
6. Move the implement control levers to all of the positions.
7. Look at the hose during movement of the implement. Ensure that the hose is not in contact with the machine or with other hoses.

Note: For hoses that cross an articulation hitch, check for contact during articulation. For hoses that connect to the steering system, check for contact during steering.

8. Shut off the engine.
9. If the hose contacts other hoses or the machine during the test, loosen the bolts and reposition the hose. Repeat steps 3 through 8 until there is no contact.

Installation of Adjustable STOR Fittings

This type of fitting is used in many applications. One end of the fitting will be an adjustable STOR fitting. The other end will be different. Always use the same installation procedure for the STOR end. Adjustable STOR fittings can be positioned before tightening.

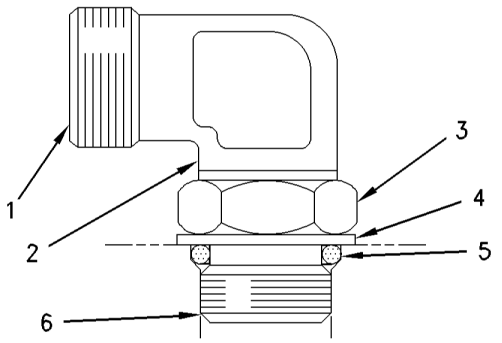

Illustration 9 g00906575

Elbow Body Assembly

(1) End that connects to the tube or hose. (2) Fitting body. (3) Locknut. (4) Backup washer. (5) O-ring seal. (6) End that is assembled to the mating part.

1. Put locknut (3), backup washer (4) and O-ring seal (5) as far away from the threads as possible. Hold these components in this position. Turn the fitting into the mating part. Turn the fitting until backup washer (4) contacts the surface of the mating part.

Note: Excessive use of the wrench will distort the washer. Distortion of the washer will prevent proper sealing.

2. Put the fitting assembly in the correct position, loosen fitting (2) until the correct assembly position is achieved. Do not loosen the fitting more than 360 degrees. Install the tube or hose hand tight in order to verify the orientation of the fitting. Tighten the fitting (2) to the torque that is shown in the correct chart for the fitting that is used. Tighten locknut (3) to the torque that is shown in the correct chart for the fitting that is used. Use a backup wrench, when the locknut is tightened.

Note: Torque the fitting prior to the locknut.

Note: If the fitting is not adjustable, the hex on the body replaces the locknut. To install this type of fitting, tighten the hex against the face of the mating part.

Excessive tightening of the connectors can cause failure. Connectors that are under tightened can also cause failures. The following failures occur:

- Excessive tightening can expand a loose ferrule into the nut. This will cause the ferrule to lock up in the nut and the nut will not function properly.
- Excessive tightening can split the nut on the end of the tube or can split the ferrule.
- Excessive tightening can gall or excessive tightening can strip the threads of the nut.

Note: If the above conditions occur due to excessive tightening, the damaged fluid connector must be scrapped and the fluid connectors must be replaced.

Straight Thread O-Ring Fittings

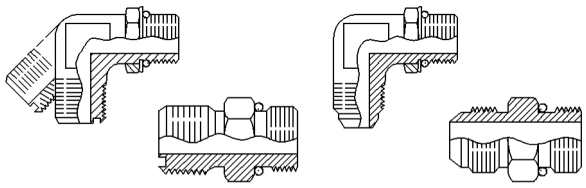

Illustration 10 g00911924

Note: For torques for plugs, refer to Specifications, "Plugs".

Note: Straight Thread O-Ring fittings for medium pressure usage will have shorter threaded ends than high pressure fittings. The torque value for medium pressure Straight Thread O-Ring fittings will be lower than the torque values that are required for Straight Thread O-Ring fittings for high pressure fittings.

Table 10

Ferrous Straight Thread O-Ring Fitting Torques for Mating with Ferrous Materials Medium Pressure use with 37° Flare Fittings		
Nominal Outer Diameter of the Tube	**Thread Size Inch**	**Standard Torque Tolerance (+10% - 0%)**
3.18 mm (.125 inch)	5/16 - 24	8 + 1 Nm (6 + 1 lb ft)
4.76 mm (.188 inch)	3/8 - 24	13 + 1.5 Nm (10 + 1.1 lb ft)
6.35 mm (.250 inch)	7/16 - 20	17 + 2 Nm (13+ 1.5 lb ft)
7.94 mm (.312 inch)	1/2 - 20	28 + 3 Nm (21 + 2 lb ft)
9.52 mm (.375 inch)	9/16 - 18	34 + 3 Nm (25 + 2 lb ft)
12.70 mm (.500 inch)	3/4 - 16	55 + 6 Nm (41 + 4 lb ft)
Ferrous Straight Thread O-Ring Fitting Torques for Mating with Ferrous Materials Medium Pressure use with 37° Flare Fittings		
Nominal Outer Diameter of the Tube	**Thread Size Inch**	**Standard Torque Tolerance (+10% - 0%)**
15.88 mm (.625 inch)	7/8 - 14	80 + 8 Nm (60 + 6 lb ft)
19.05 mm (.750 inch)	1 1/16- 12	100 + 10 Nm (75 + 7 lb ft)
22.22 mm (.875 inch)	1 3/16 - 12	135 + 13 Nm (100+ 10 lb ft)
25.40 mm (1.000 inch)	1 5/16 - 12	150 + 15 Nm (110+ 11 lbft)
31.75 mm (1.250 inch)	1 5/8 - 12	290 + 25 Nm (215+ 18 lb ft)
38.10 mm (1.500 inch)	1 7/8 - 12	325 + 30 Nm (240 + 22 lb ft)
50.80 mm (2.000 inch)	2 1/2 - 12	420 + 40 Nm (310 + 30 lb ft)

Note: Use 50 percent of the torque values from Table 10 when the fitting or the port material is nonferrous.

Note: Straight Thread O-Ring fittings for high pressure usage will have longer threaded ends than medium pressure fittings. The torque value for high pressure Straight Thread O-Ring fittings will be higher than the torque values that are required for Straight Thread O-Ring fittings for medium pressure fittings.

Table 11

Ferrous Straight Thread O-Ring Fittings Torques for Mating with Ferrous Materials High Pressure use with O-Ring Face Seal Fittings		
Nominal Outer Diameter of the Tube	**Thread Size Inch**	**Standard Torque Tolerance (+10% - 0%)**
4.76 mm (0.188 inch)	3/8 - 24	12 + 2 Nm (9 + 1 lb ft)
6.35 mm (0.250 inch)	7/16 - 20	22 + 2 Nm (16+ 1 lb ft)
7.94 mm (0.312 inch)	1/2 - 20	30 + 3 Nm (22 + 2 lb ft)
9.52 mm (0.375 inch)	9/16 - 18	48 + 5 Nm (35 + 4 lb ft)
12.7 mm (0.500 inch)	3/4 - 16	82 + 8 Nm (60 + 6 lb ft)
15.88 mm (0.625 inch)	7/8 - 14	140 + 14 Nm (105+ 10 lb ft)
19.05 mm (0.750 inch)	1 1/16- 12	190 + 15 Nm (140+ 11 lb ft)
22.22 mm (0.875 inch)	1 3/16 - 12	250 + 20 Nm (185+ 15 lb ft)
Ferrous Straight Thread O-Ring Fittings Torques for Mating with Ferrous Materials High Pressure use with O-Ring Face Seal Fittings		
Nominal Outer Diameter of the Tube	**Thread Size Inch**	**Standard Torque Tolerance (+10% - 0%)**
25.40 mm (1.000 inch)	1 5/16 - 12	300 + 30 Nm (220 + 22 lb ft)
31.75 mm (1.250 inch)	1 5/8 -12	350 + 35 Nm (260 + 26 lb ft)
38.10 mm (1.500 inch)	1 7/8 - 12	415 + 40 Nm (305 + 30 lb ft)

Note: Use 50 percent of the torque values from Table 11 when the fitting or the port material is nonferrous.

Table 142

Metric Ferrous Straight Thread O-Ring Fittings Torques for Mating with Ferrous Materials		
Ref Nominal Outer Diameter of the Tube	**Thread Size**	**Standard Torque Tolerance (+10% -0%)**
4 mm	M8X 1	10.5 + 1 Nm (95 + 9 lb in)
5 mm	M10X 1	2 1 + 2 Nm (15+ 1.5 lb ft)
6 mm	M12X 1.5	37 + 3 Nm (27 + 2 lb ft)
8 mm	M14X 1.5	47 + 4 Nm (35 + 3 lb ft)
10 mm	M16X 1.5	58 + 6 Nm (43 + 4 lb ft)
12 mm	M18X 1.5	75 + 7 Nm (55 + 5 lb ft)
16 mm	M22X 1.5	105 + 10 Nm (75 + 7 lb ft)
20 mm	M27X2	180 + 15 Nm (135+ 11 lb ft)
22 mm	M30X2	225 + 20 Nm (165+ 15 lb ft)
25 mm	M33X2	325 + 30 Nm (240 + 22 lb ft)
30 mm	M42X2	350 + 35 Nm (260 + 26 lb ft)
38 mm	M48X2	440 + 40 Nm (320 + 30 lb ft)
50 mm	M60X2	525 + 50 Nm (390 + 37 lb ft)

Note: Use 50 percent of the torque values from 12 when the fitting or the port material is nonferrous.

Plugs

Straight Thread O-Ring Plugs (Hex Drive)

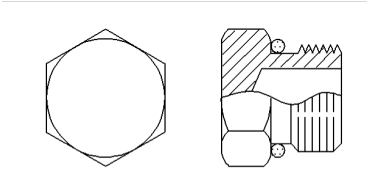

Illustration 11 g00911999

Table 13

Thread Size Inch	Torque Tolerance (+10% - 0%)
5/16	9+ 1 Nm (80 + 9 lb in)
3/8	17+ 1.5 Nm (13 + 1 lb ft)
7/16	23 + 2 Nm (17 + 1.5 lb ft)
1/2	28 + 3 Nm(21 + 2 lb ft)
9/16	34 + 3 Nm (25 + 2 lb ft)
3/4	60 + 6 Nm (44 + 4 lb ft)
7/8	115 + 10 Nm (85 + 7 lbft)
1 1/16	140+ 14 Nm (105 + 10 lb ft)
1 3/16	190+ 19 Nm (140 + 14 lb ft)
1 5/16	210 + 20Nm(155 + 15 lb ft)
1 5/8	290 + 25Nm(215 + 18 lb ft)
1 7/8	325 + 30 Nm (240 + 22 lb ft)
2 1/2	420 + 40 Nm (310 + 30 lb ft)

Note: Use 50 percent of the torque values from Table 13 when the fitting or the port material is nonferrous.

Straight Thread O-Ring Plugs (Socket Drive)

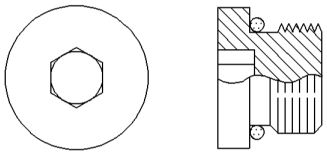

Illustration 12 g00912006

Note: The socket may be hexagonal or a square recessed drive.

Table 14

Thread Size Inch	Torque Tolerance (+10% - 0%)
5/16	5 + 1 Nm (44 + 9 lb in)
3/8	11 + 1 Nm(97 + 9 lb in)
7/16	16+ 1.5Nm(12 + 1 lb ft)
1/2	20 + 2Nm(15 + 1.5 lb ft)
9/16	35 + 3.5 Nm (26+ 3 lb ft)
3/4	70 + 7 Nm (50 + 5 lb ft)
7/8	100+ 10 Nm (75 + 7 lb ft)
1 1/16	170+ 15Nm(125 + 11 lb ft)
1 3/16	215 + 20Nm(160 + 15 lb ft)
1 5/16	270 + 25 Nm (200 + 18 lb ft)
1 5/8	285 + 25Nm(210 + 18 lb ft)
1 7/8	370 + 35 Nm (275 + 26 lb ft)
2 1/2	415 + 40 Nm (305 + 30 lb ft)

Drain Plugs with Straight Thread

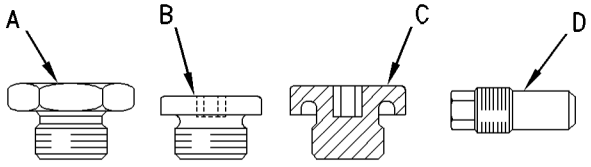

Illustration 13 g00912008

Note: Plug (A), plug (B) and plug (C) are used with a gasket. Conical seal plug (D) does not use a gasket.

Table 15

Type of Plug	Thread Size Inch	Torque Tolerance (+10% - 0%)
A	1/2 - 13	20 + 5Nm(15 + 4 lb ft)
	5/8 - 11	35 + 5 Nm (26 + 4 lb ft)
	3/4 - 12 3/4 - 16	50 + 5 Nm (37 + 4 lb ft)
	7/8 - 14 1 1/8- 12	70+ 15Nm(52 + 11 lb ft)
B	1 5/16 - 12 1 1/2 - 12	90+ 15Nm(66 + 11 lb ft)
	2 - 12	125+ 15 Nm (92+ 11 lb ft)
C	1 1/8- 12	70+ 15Nm(52 + 11 lb ft)
	1 5/16 - 12	90+ 15Nm(66 + 11 lb ft)
D	1/2 - 20	11 + 4Nm(97 + 35lbin)
	7/8 -14	55 + 7Nm(41 + 5 lb ft)
	1 3/8 -13	90 + 15Nm(66 + 11 lb ft)
	1 1/2 - 12	110+ 15Nm(81 + 11 lb ft)

Note: Use 50% of the values in Table 15 when either the plug or the port material is nonferrous.

Straight Thread O-Ring Plugs (Mechanical Joint Tube Assemblies)

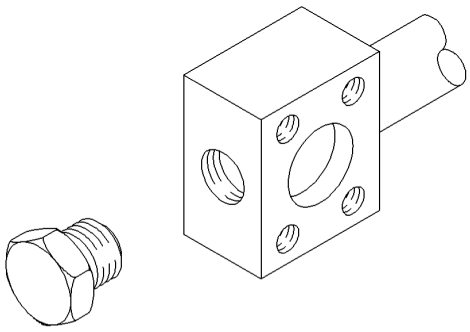

Illustration 14 g00912010

Note: When you tighten the plug, the torque must not be transmitted to the joint between the tube and the elbow.

Table 16

Thread Size Inch	Torque
7/8	125 ± 15 Nm (92 ± 11 lb ft)
1 1/16	175 ± 15 Nm (130 ± 11 lb ft)
1 3/16	250±20Nm(185± 15 lb ft)
1 1/4	250±20Nm(185± 15 lb ft)
1 5/16	370±20Nm(275± 15 lb ft)
1 5/8	420 ± 25 Nm (310 ±20 lb ft)
1 7/8	525 ± 35 Nm (390 ±25 lb ft)
2 1/2	900 ± 50 Nm (665 ±40 lb ft)

O-Ring Face Seal Fittings

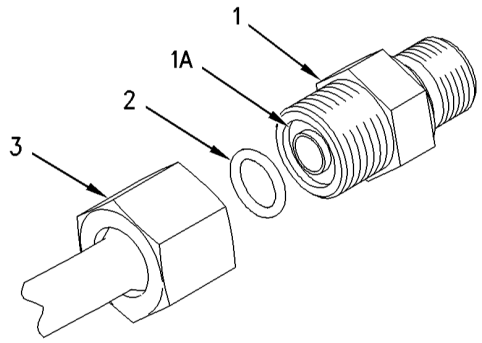

Illustration 15 g00906427

O-ring face seal fitting (ORFS fitting)

(1) O-ring face seal connector
(1A) O-ring groove
(2) O-ring seal
(3) Nut for the O-ring face seal

Table 17

Ferrous ORFS Fitting	
Thread Size Inch	**Standard Torque for Nut (3)**
9/16 - 18	25 + 3 Nm (18 + 2 lb ft)
11/16 - 16	40 + 4 Nm (30 + 3 lb ft)
13/16 - 16	55 + 5 Nm (41 + 4 lb ft)
1 - 14	86 +8 Nm (65 + 6 lb ft)
1 13/16 - 12	125 + 15 Nm (90 + 11 lb ft)
1 7/16 - 12	165 + 15 Nm (120 + 11 lb ft)
1 11/16 - 12	200 + 20 Nm (150 + 15 lb ft)
2 - 12	245 + 20 Nm (180 + 15 lb ft)

Bulkhead Nuts

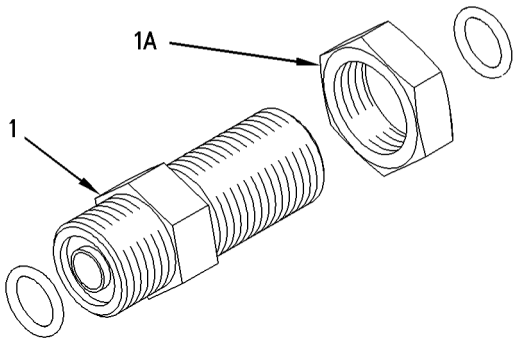

Illustration 16 g00909138

Bulkhead connector (ORFS) (1) and bulkhead nut (1A).

Note: The bulkhead connector may have different connections. The type of fluid connection does not affect the torque for nut (1A).

Note: When you assemble the fluid connection, do not use the bulkhead nut (1A) as leverage for a backup wrench. Use the hex on the body (1) of the connector for leverage.

Table 2018

Thread Size Inch	Torque
5/16	6± 1 Nm (53 ± 9 lb in)
3/8	8± 1 Nm (71 ± 9 lb in)
7/16	14 ± 1.5 Nm (10 ± 1 lb ft)
1/2	17 ±2 Nm (13 ± 1.4 lb ft)
9/16	22 ±2 Nm (16 ± 1.4 lb ft)
11/16	31 ± 3 Nm (23 ± 2 lb ft)
3/4	37 ± 4 Nm (27 ± 3 lb ft)
13/16	40 ± 4 Nm (30 ± 3 lb ft)
7/8	44 ± 4 Nm (32 ± 3 lb ft)
Thread Size Inch	**Torque**
1	61 ± 6 Nm (45 ± 4 lb ft)
1 1/16	70 ± 7 Nm (52 ± 5 lb ft)
1 3/16	91 ± 10 Nm (67 ± 7 lb ft)
1 5/16	113 ± 10 Nm (83 ± 7 lb ft)
1 7/16	125 ± 12 Nm (92 ± 9 lb ft)
1 5/8	150 ± 15 Nm (110 ± 11 lb ft)
1 11/16	150 ± 15 Nm (110 ± 11 lb ft)
1 7/8	155 ± 15 Nm (115 ± 11 lb ft)
2	170 ± 17 Nm (125 ± 13 lb ft)
2 1/2	220 ±20 Nm (160 ± 15 lb ft)

Note: Bulkhead nuts are designed to secure fluid connectors firmly in position.

Flare Fittings

The torques in Table 21 are for 37 degree flare fittings. The torques in Table 22 are for 45 degree flare fittings and 45 degree inverted flare fittings.

37 Degree Flare Fitting

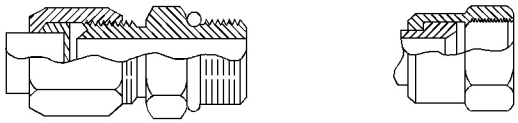

Illustration 17 g01185483

(1) 37 degree flare fitting. (2) Swivel nuts.

Table 19

Nuts for 37 Degree Flare Fittings		
Nominal Outer Diameter of the Tube	**Thread Size Inch**	**Standard Torque Tolerance (+ 10% - 0%)**
3.18 mm (.125 inch)	5/16	5.0 + 1 Nm (44 + 9 lb in)
4.76 mm (.188 inch)	3/8	11 + 1 Nm (100 + 9 lb in)
Nuts for 37 Degree Flare Fittings		
Nominal Outer Diameter of the Tube	**Thread Size Inch**	**Standard Torque Tolerance (+ 10% - 0%)**
6.35 mm (.250 inch)	7/16	16 + 1.5 Nm (12+ 1.1 lb ft)
7.94 mm (.312 inch)	1/2	20 + 2 Nm (15+ 1.5 lb ft)
9.52 mm (.375 inch)	9/16	27 + 3 Nm (20 + 2 lb ft)
12.70 mm (.500 inch)	3/4	58 + 6 Nm (43 + 4 lb ft)
15.88 mm (.625 inch)	7/8	74 + 7 Nm (55 + 5 lb ft)
19.05 mm (.750 inch)	1 1/16	108 + 10 Nm (80 + 7 lb ft)
22.22 mm (.875 inch)	1 3/16	135 + 13 Nm (100+ 10 lb ft)
25.40 mm (1.000 inch)	1 5/16	156 + 15 Nm (115+ 11 lb ft)
31.75 mm (1.250 inch)	1 5/8	217 + 20 Nm (160+ 15 lb ft)
38.10 mm (1.500 inch)	1 7/8	251 + 25 Nm (185+ 18 lb ft)
50.80 mm (2.000 inch)	2 1/2	339 + 30 Nm (250 + 22 lb ft)

Note: Use 50 percent of the torque values from Table 21 when the fitting or the port material is nonferrous.

45 Degree Flare and 45 Degree Inverted Flare Fittings

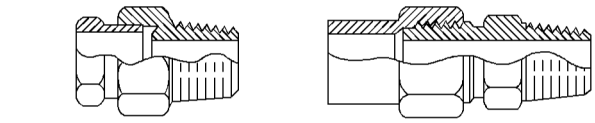

Illustration 18 g01185492

(1) 45 Degree Inverted Flare Fittings. (2) 45 Degree Flare Fittings.

Table 20

45 Degree Flare Fittings and 45 Degree Inverted Flare Fittings		
Nominal Outer Diameter of the Tube	**Thread Size Inch**	**Standard Torque**
3.18 mm (.125 inch)	5/16	5.0 ± 1.5 Nm (44 ± 13 lbin)
4.76 mm (.188 inch)	3/8	8.0 ± 1.5 Nm (70 ± 13 lbin)
6.35 mm (.250 inch)	7/16	11 ± 2 Nm (100 ± 18 lbin)
7.94 mm (.312 inch)	1/2	17 ± 3 Nm (13 ± 2 lbft)
9.52 mm (.375 inch)	5/8	30 ± 3 Nm (22 ± 2 lb ft)
11.11 mm (.438 inch)	11/16	30 ± 3 Nm (22 ± 2 lb ft)
12.70 mm (.500 inch)	3/4	38 ± 4 Nm (28 ± 3 lb ft)
15.88 mm (.625 inch)	7/8	50 ± 5 Nm (37 ± 4 lb ft)
19.05 mm (.750 inch)	1 1/16	90 ± 8 Nm (65 ± 6 lb ft)
22.22 mm (.875 inch)	1 1/4	100 ± 10 Nm (75 ± 7 lb ft)

Air Conditioning Fittings

Illustration 19 g01185521

(1) O-ring seal. (2) 45 degree flare fitting.

Table 21

Air Conditioning Fittings			
Thread Size Inch	O-Ring Fitting End	45 Degree Flare Fitting End	
	Torque	Torque for Steel Tubes	Torque for Aluminum Tubes
5/8- 18	14 ±4 Nm (10 ±3 lbft)	30 ± 3 Nm (22 ± 2 lb ft)	23 ±3 Nm (17 ±2 lbft)
3/4 - 16	27 ±4 Nm (20 ± 3 lb ft)	52 ± 5 Nm (38 ± 4 lb ft)	33 ±4 Nm (24 ± 4 lb ft)
7/8 - 14 1 - 14	40 ± 4 Nm (30 ± 3 lb ft)	60 ± 7 Nm (44 ± 5 lb ft)	38 ±4 Nm (28 ± 3 lb ft)
1 1/16-14	45 ± 5 Nm (33 ± 4 lb ft)	75 ± 8 Nm (55 ± 6 lb ft)	50 ±5 Nm (37 ± 4 lb ft)

Air Brake Fittings

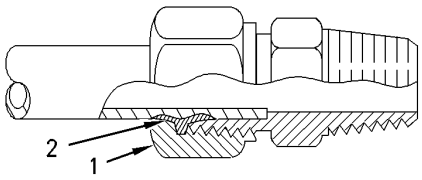

Illustration 20 g00909062

Put nut (1) and sleeve (2) over the tube. Push the tube into the counterbore of the fitting body as far as possible. There are two methods that may be used to tighten the nut. Tighten the nut with one of two methods.

- Tighten nut (1) to the torque that is specified in Table 22.
- Tighten nut (1) by the number of turns that is specified in Table 22. The number of turns is for the turns after the nut is finger tight.

Table 22

Nominal Outer Diameter of the Tube	Torque	Turn Tightening	
		Nonmetallic Tubing	Copper Tubing
6.35 mm (0.250 inch)	11 ± 3 Nm (8 ± 2 lb ft)	3	2
9.53 mm (0.375 inch)	20 ± 3 Nm (15 ± 2 lb ft)	4	2
12.70 mm (0.500 inch)	35 ±6 Nm (26 ± 4 lb ft)	4	2
15.88 mm (0.625 inch)	40 ± 6 Nm (30 ± 4 lb ft)	3 1/2	3
19.05 mm (0.750 inch)	50 ±6 Nm (37 ± 4 lb ft)	3 1/2	3

Note: Clean the connectors and the seals and lubricate the connectors and seals by using Refrigerant Mineral Oil. This is a special oil that is compatible with R-134a.

Tapered Pipe Thread Fittings

Torque is based on the diameter of the thread. The torque values are identical for coarse threads and fine threads.

Note: The following table has the recommended standard torque value for tapered pipe thread fitting for use on all Caterpillar equipment and Mitsubishi engines. Use Table 23 as a general recommendation only. Actual values may vary due to variations in the material of the connector. Actual values may vary due to variations in the characteristics of the threads.

Table 23

Tapered Pipe Thread Fittings		
Diameter of the Pipe Thread (Inch)	Standard Torque	
	Threads with 5P-3413 Pipe Sealant	Threads without Pipe Sealant
1/16	10Nm(90 lb in)	10Nm(90 lb in)
1/8	16 Nm (12 lb ft)	16 Nm (12 lb ft)
1/4	20 Nm (15 lb ft)	25 Nm (18 lb ft)
3/8	35 Nm (26 lb ft)	45 Nm (33 lb ft)
1/2	45 Nm (33 lb ft)	60 Nm (44 lb ft)
3/4	60 Nm (44 lb ft)	75 Nm (55 lb ft)
1	75 Nm (55 lb ft)	90 Nm (65 lb ft)
1 1/4	95 Nm (70 lb ft)	110Nm(80 lb ft)
1 1/2	110 Nm (80 lb ft)	130Nm(95lb ft)
2	130 Nm (95 lb ft)	160 Nm (120 lb ft)

Note: Use 50 percent of the torque values from Table 25 when the fitting, the plug, or the port material is nonferrous.

Note: Use 50 percent of the torque values from Table 25 when a tapered thread is mated with a straight thread.

Miscellaneous Fittings

Hi Duty Tube Fittings (Shear Sleeve)

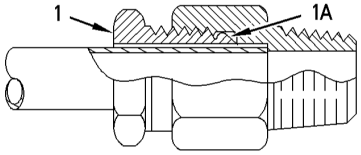

Illustration 21 g00909648

Put nut (1) over the tube and push the tube into the counterbore of the fitting body as far as possible. Turn the nut with a wrench until a small decrease in torque is felt. The small decrease in torque indicates that the sleeve (1A) has been broken off of the nut. Hold the tube in order to prevent the tube from turning. Tighten the nut for an additional 1 1/2 turns.

SAE Flareless Fittings

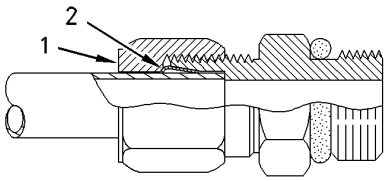

Illustration 22 g00909647

Installing a New Flareless Fitting

Put nut (1) and sleeve (2) over the tube. The head end of the sleeve should be next to the nut. The head end has a shoulder. The nut will be seated against this shoulder when the nut is tightened. Push the tube into the counterbore of the fitting body as far as possible. Turn nut (1) clockwise until the sleeve grips the tube. The sleeve must prevent all movement of the tube. Tighten the nut for an additional 1 1/4 turns. The sleeve should be seated and the sleeve should give a locking action.

Installing a Used Flareless Fitting

Less turns are required for a used fitting. Put nut (1) and sleeve (2) over the tube. The head of the sleeve should be next to the nut. Push the tube into the counterbore of the fitting body as far as possible. Tighten the nut until a sudden increase in torque is felt. Next, tighten the fitting for an additional 1/6 to 1/3 turn in order to seat the sleeve.

Flex Fittings

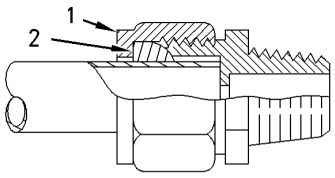

Illustration 23 g00909645

Put nut (1) and sleeve (2) over the tube and push the tube into the counterbore of the fitting body as far as possible. Tighten the nut until the nut is against the hex part of the fitting body.

Hose Clamps

Worm Drive Band Type Clamps

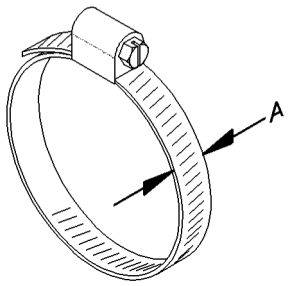

Illustration 24 g00910017

Table 24

Width (A) of Clamp	Torque for New Hose
7.9 mm (0.31 inch)	0.9 ± 0.2 N m (8 ± 2 lb in)
13.5 mm (0.53 inch)	4.5 ± 0.5 N m (4 0 ± 4 lb in)
15.9 mm (0.63 inch)	7.5 ± 0.5 N m (6 5 ± 4 lb in)
Width (A) of Clamp	**Torque for Reused Hose(1)**
7.9 mm (0.31 inch)	0.7 ± 0.2 N m (6 ± 2 lb in)
13.5 mm (0.53 inch)	3.0 ± 0.5 N m (2 7 ± 4 lb in)
15.9 mm (0.63 inch)	4.5 ± 0.5 N m (4 0 ± 4 lb in)

(1) Use this value when the hose is reused. The clamp may be new or reused.

Constant Torque Hose Clamps

Use a constant torque hose clamp in place of any worm drive band type clamp. Ensure that the constant torque hose clamp is the same size as the worm drive band type clamp. Due to extreme temperature changes, the hose will heat set. Heat setting can cause worm drive band type clamps to loosen. Loose hose clamps can result in leaks. There have been reports of component failures that have been caused by worm drive band type clamps that have loosened. The constant torque hose clamp will help prevent these failures.

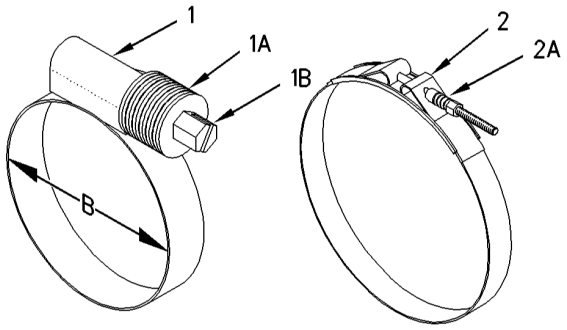

Illustration 25 g00906389

(1) Constant Torque Hose Clamp (Belleville Washer)

(2) Constant Torque Hose Clamp (Tee bolt and Spring)

Use a torque wrench for proper installation of all constant torque hose clamps. There are two types of constant torque hose clamps: Belleville washer (1) and Tee bolt and spring (2)

When the constant torque hose clamp (Belleville washer) (1) is assembled correctly, the Belleville washers (1A) are nearly collapsed flat. The proper torque for screw (1B) is based on the diameter (B) of the clamp. Refer to the following table for the correct torque.

Table 25

Diameter (B)	Standard Torque
Up to 50.8 mm (2 inch)	7.5±0.5Nm(65±5 lb in)
Greater than 50.8 mm (2 inch)	11 ± 1 Nm(95± 10 lb in)

The correct torque for the constant torque hose clamp (tee bolt and spring) (2) is 7.5 ± 1 Nm (65 ± 10 lb in).

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Manufactured by JLG under license from Caterpillar

CATERPILLAR®

31200269
December 15, 2006

Disassembly and Assembly

TH220B and TH330B Telehandlers Engine Supplement

S/N TBF00100 & After
S/N TBG00100 & After

Important Safety Information

Most accidents that involve product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or to other persons.

The hazards are identified by the "Safety Alert Symbol" and followed by a "Signal Word" such as "DANGER", "WARNING" or "CAUTION". The Safety Alert "WARNING" label is shown below.

The meaning of this safety alert symbol is as follows:

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning explains the hazard and can be either written or pictorially presented.

Operations that may cause product damage are identified by "NOTICE" labels on the product and in this publication.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are, therefore, not all inclusive. If a tool, procedure, work method or operating technique that is not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and for others. You should also ensure that the product will not be damaged or be made unsafe by the operation, lubrication, maintenance or repair procedures that you choose.

The information, specifications, and illustrations in this publication are on the basis of information that was available at the time that the publication was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service that is given to the product. Obtain the complete and most current information before you start any job. Caterpillar® dealers have the most current information available.

When replacement parts are required for this product Caterpillar recommends using Caterpillar replacement parts or parts with equivalent specifications including, but not limited to, physical dimensions, type, strength and material.

Failure to heed this warning can lead to premature failures, product damage, personal injury or death.

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Disassembly and Assembly Section

Battery - Remove and Install

Removal Procedure

⚠ WARNING

Batteries give off flammable fumes that can explode resulting in personal injury.

Prevent sparks near the batteries. They could cause vapors to explode. Do not allow the jump start cable ends to contact each other or the machine.

Do not smoke when checking battery electrolyte levels.

Electrolyte is an acid and can cause personal injury if it contacts skin or eyes.

Always wear eye protection when starting a machine with jump start cables.

Improper jump start procedures can cause an explosion resulting in personal injury.

Always connect the positive (+) to positive (+) and the negative (-) to negative (-).

Jump start only with an energy source with the same voltage as the stalled machine.

Turn off all lights and accessories on the stalled machine. Otherwise, they will operate when the energy source is connected.

1. Turn the battery disconnect switch to the OFF position. Refer to Operation and Maintenance Manual, "Battery Disconect Switch (if equipped)".

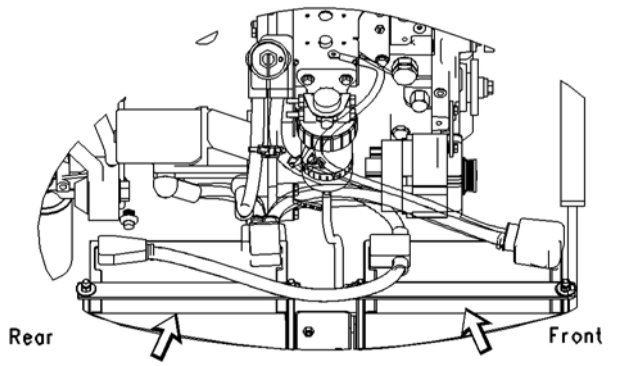

Illustration 1 g00909832

2. The following procedure shows the removal of the front battery which is an attachment. Use the same procedure when you are removing the rear battery.

Illustration 2 g00909220

3. Pull back the terminal cover (1) in order to disconnect positive cable (2). Pull back the terminal cover (3) in order to disconnect negative cable (4).

Illustration 3 g00909235

4. 4. Remove nuts (5), the washers and hold down bracket (6).

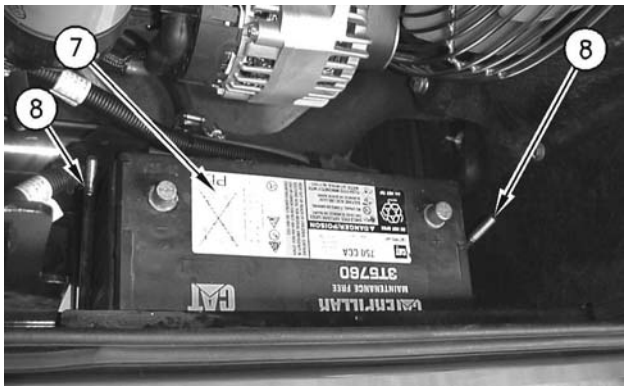

Illustration 4 g00909831

5. With the aid of a second person or with the aid of a suitable lifting device, remove battery (7). The weight of the battery is approximately 25 kg (55 lb). Remove studs (8).

Installation Procedure

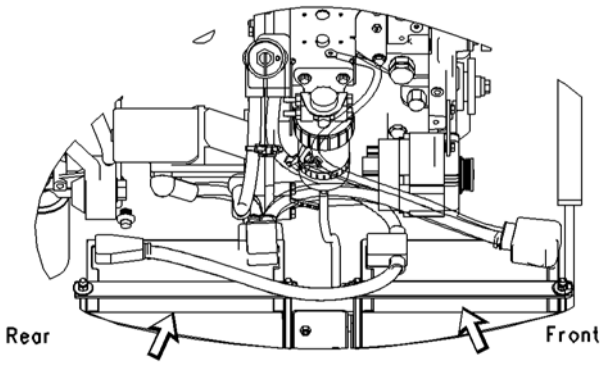

Illustration 5 g00909832

1. The following procedure shows the installation of the front battery which is an attachment. Use the same procedure when you are installing the rear battery.

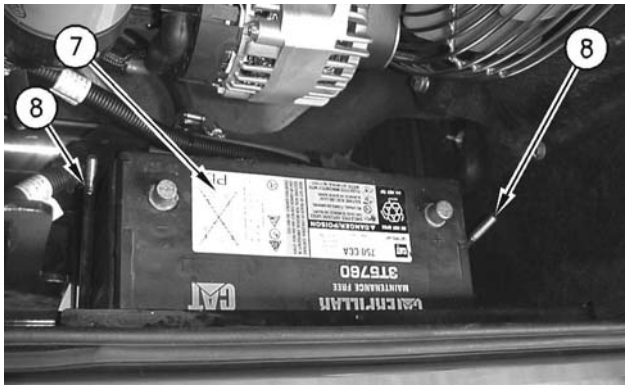

Illustration 6 g00909831

2. Install studs (8). With the aid of a second person or with the aid of a suitable lifting device, install battery (7). The weight of the battery is approximately 25 kg (55 lb).

Illustration 7 g00909235

3. Install hold down bracket (6), nuts (5), and the washers.

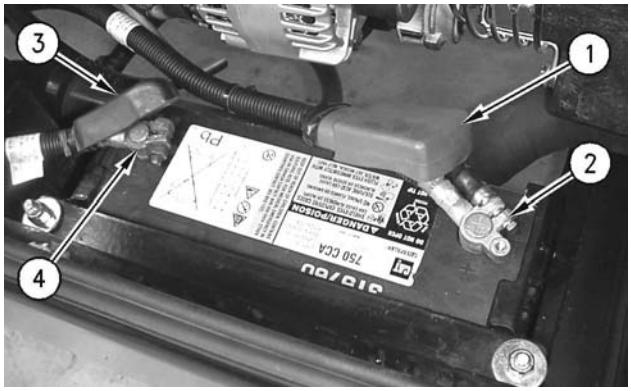

Illustration 8 g00909220

4. Connect positive cable (2) and slide terminal cover (1) into position. Connect Negative cable (4) and slide terminal cover (3) into position.
5. Turn the battery disconnect switch to the ON position. Refer to Operation and Maintenance Manual, "Battery Disconect Switch (if equipped)".

Alternator - Remove and Install

Removal Procedure

1. Turn the battery disconnect switch to the OFF position. Refer to Operation and Maintenance Manual, "Battery Disconnect Switch (if equipped)".
2. Put identification marks on all wires for installation purposes.

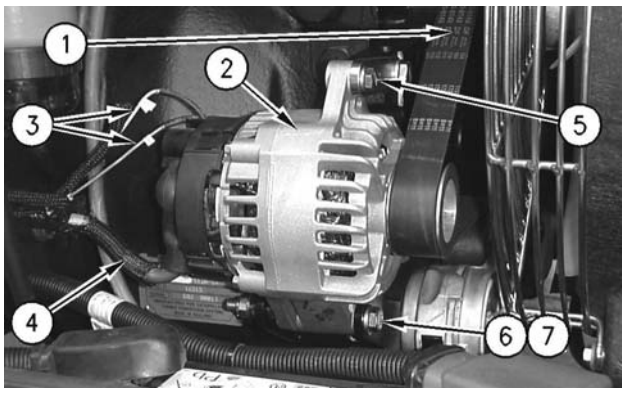

Illustration 9 g00908444

3. Remove belt (1) from alternator (2). Refer to Operation and maintenance Manual, "Belts - Inspect/Adjust/Replace".
4. Disconnect wires (3) and positive cable (4).
5. Remove bolt (5), the washer, nut (6), bolt (7) and the washers before removing alternator (2) from the machine.

Installation Procedure

1. Clean all parts and inspect all parts. If any parts are worn or damaged, use new Caterpillar parts for replacement.

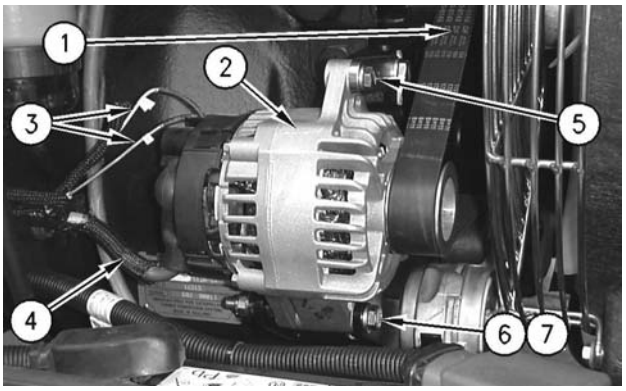

Illustration 10 g00908444

2. Position alternator (2) onto the machine. Install bolt (7), nut (6) and washers. Install bolt (5) and the washer.
3. Connect wires (3) and positive cable (4) to alternator (2).
4. Install belt (1) from alternator (2). Refer to Operation and maintenance Manual, "Belts - Inspect/Adjust/Replace".
5. Turn the battery disconnect switch to the ON position. Refer to Operation and Maintenance Manual, "Battery Disconnect Switch (if equipped)".

Electric Starting Motor -Remove and Install

Removal Procedure

Note: Put identification marks on all wires for installation purposes.

1. Move the battery disconnect switch to the OFF position.

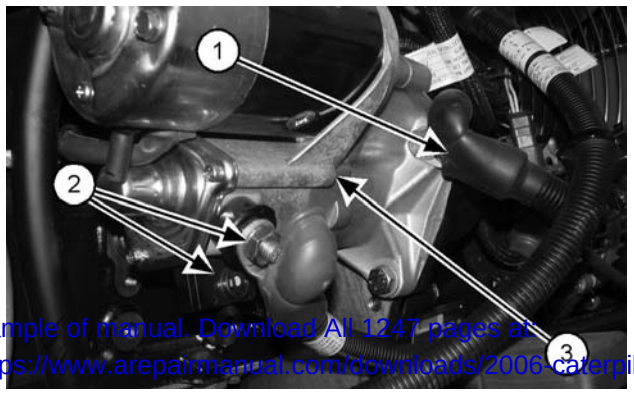

Illustration 11 g01010265

2. Disconnect wire clamp(1). Disconnect wire assembly (2) from electric starting motor (3).

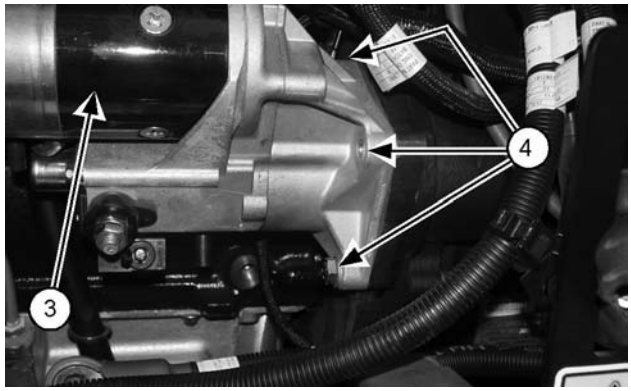

Illustration 12 g01010285

3. Remove bolts (4). Remove electric starting motor (3).

Installation Procedure

1. Install electric starting motor (3) into the machine.

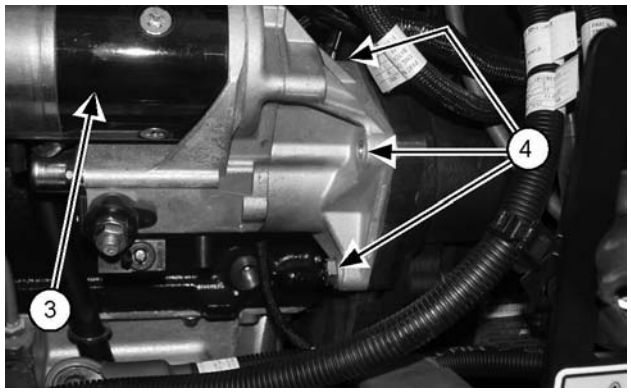

Illustration 13 g01010285

2. Install bolts (4) in order to secure electric starting motor (3) to the engine.

Note: Do not tighten the center bolt at this time.

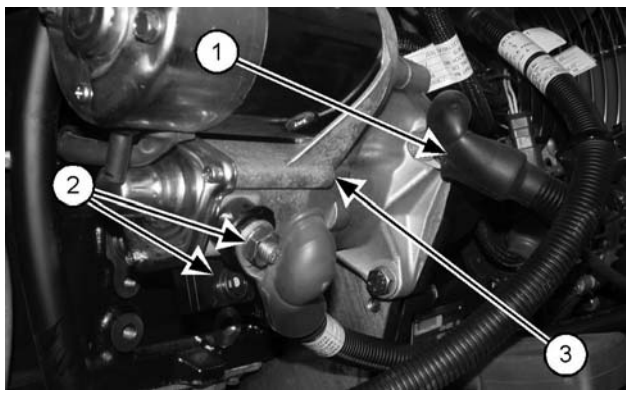

Illustration 14 g01010265

3. Install wire assembly (2) onto electric starting motor (3).