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Section 1001


GENERAL TORQUE SPECIFICATIONS


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TORQUE SPECIFICATIONS - DECIMAL HARDWARE

Use the torques in this chart when special torques are not given. These torques apply to fasteners with both UNC and UNF threads as received from suppliers dry, or when lubricated with engine oil. Not applicable if special graphities, Molydisulfide greases, or other extreme pressure lubricants are used.

Grade 5 Bolts, Nuts, and Studs		
		
Size	Pound-Inches	Newton metres
1/4 inch	108 to 132	12 to 15
5/16 inch	204 to 252	23 to 28
3/8 inch	420 to 504	48 to 57
Size	Pound-Feet	Newton metres
7/16 inch	54 to 64	73 to 87
1/2 inch	80 to 96	109 to 130
9/16 inch	110 to 132	149 to 179
5/8 inch	150 to 180	203 to 244
3/4 inch	270 to 324	366 to 439
7/8 inch	400 to 480	542 to 651
1.0 inch	580 to 696	787 to 944
1-1/8 inch	800 to 880	1085 to 1193
1-1/4 inch	1120 to 1240	1519 to 1681
1-3/8 inch	1460 to 1680	1980 to 2278
1-1/2 inch	1940 to 2200	2631 to 2983


Grade 8 Bolts, Nuts, and Studs		
		
Size	Pound-Inches	Newton metres
1/4 inch	144 to 180	16 to 20
5/16 inch	288 to 348	33 to 39
3/8 inch	540 to 648	61 to 73
Size	Pound-Feet	Newton metres
7/16 inch	70 to 84	95 to 114
1/2 inch	110 to 132	149 to 179
9/16 inch	160 to 192	217 to 260
5/8 inch	220 to 264	298 to 358
3/4 inch	380 to 456	515 to 618
7/8 inch	600 to 720	814 to 976
1.0 inch	900 to 1080	1220 to 1465
1-1/8 inch	1280 to 1440	1736 to 1953
1-1/4 inch	1820 to 2000	2468 to 2712
1-3/8 inch	2380 to 2720	3227 to 3688
1-1/2 inch	3160 to 3560	4285 to 4827


NOTE: Use thick nuts with Grade 8 bolts.

TORQUE SPECIFICATIONS - METRIC HARDWARE

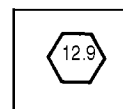
Use the following torques when specifications are not given.

These values apply to fasteners with coarse threads as received from supplier, plated or unplated, or when lubricated with engine oil. These values do not apply if graphite or Molydisulfide grease or oil is used.

Grade 8.8 Bolts, Nuts, and Studs		
		
Size	Pound-Inches	Newton metres
M4	24 to 36	3 to 4
M5	60 to 72	7 to 8
M6	96 to 108	11 to 12
M8	228 to 276	26 to 31
M10	456 to 540	52 to 61
Size	Pound-Feet	Newton metres
M12	66 to 79	90 to 107
M14	106 to 127	144 to 172
M16	160 to 200	217 to 271
M20	320 to 380	434 to 515
M24	500 to 600	675 to 815
M30	920 to 1100	1250 to 1500
M36	1600 to 1950	2175 to 2600

Grade 10.9 Bolts, Nuts, and Studs		
		
Size	Pound-Inches	Newton metres
M4	36 to 48	4 to 5
M5	84 to 96	9 to 11
M6	132 to 156	15 to 18
M8	324 to 384	37 to 43
Size	Pound-Feet	Newton metres
M10	54 to 64	73 to 87
M12	93 to 112	125 to 150
M14	149 to 179	200 to 245
M16	230 to 280	310 to 380
M20	450 to 540	610 to 730
M24	780 to 940	1050 to 1275
M30	1470 to 1770	2000 to 2400
M36	2580 to 3090	3500 to 4200

Grade 12.9 Bolts, Nuts, and Studs



Usually the torque values specified for grade 10.9 fasteners can be used satisfactorily on grade 12.9 fasteners.

TORQUE SPECIFICATIONS - STEEL HYDRAULIC FITTINGS

Tube OD Hose ID	Thread Size	Pound- Inches	Newton metres
37 Degree Flare Fitting			
1/4 inch 6.4 mm	7/16-20	72 to 144	8 to 16
5/16 inch 7.9 mm	1/2-20	96 to 192	11 to 22
3/8 inch 9.5 mm	9/16-18	120 to 300	14 to 34
1/2 inch 12.7 mm	3/4-16	180 to 504	20 to 57
5/8 inch 15.9 mm	7/8-14	300 to 696	34 to 79
Tube OD Hose ID	Thread Size	Pound- Inches	Newton metres
3/4 inch 19.0 mm	1-1/16-12	40 to 80	54 to 108
7/8 inch 22.2 mm	1-3/16-12	60 to 100	81 to 135
1.0 inch 25.4 mm	1-5/16-12	75 to 117	102 to 158
1-1/4 inch 31.8 mm	1-5/8-12	125 to 165	169 to 223
1-1/2 inch 38.1 mm	1-7/8-12	210 to 250	285 to 338

Tube OD Hose ID	Thread Size	Pound- Inches	Newton metres
Straight Threads with O-ring			
1/4 inch 6.4 mm	7/16-20	144 to 228	16 to 26
5/16 inch 7.9 mm	1/2-20	192 to 300	22 to 34
3/8 inch 9.5 mm	9/16-18	300 to 480	34 to 54
1/2 inch 12.7 mm	3/4-16	540 to 804	57 to 91
Tube OD Hose ID	Thread Size	Pound- Inches	Newton metres
5/8 inch 15.9 mm	7/8-14	58 to 92	79 to 124
3/4 inch 19.0 mm	1-1/16-12	80 to 128	108 to 174
7/8 inch 22.2 mm	1-3/16-12	100 to 160	136 to 216
1.0 inch 25.4 mm	1-5/16-12	117 to 187	159 to 253
1-1/4 inch 31.8 mm	1-5/8-12	165 to 264	224 to 357
1-1/2 inch 38.1 mm	1-7/8-12	250 to 400	339 to 542

Split Flange Mounting Bolts		
Size	Pound- Inches	Newton metres
5/16-18	180 to 240	20 to 27
3/8-16	240 to 300	27 to 34
7/16-14	420 to 540	47 to 61
Size	Pound- Feet	Newton metres
1/2-13	55 to 65	74 to 88
5/8-11	140 to 150	190 to 203

TORQUE SPECIFICATIONS - STEEL HYDRAULIC FITTINGS

Nom. SAE Dash Size	Tube OD	Thread Size	Pound-Inches	Newton metres	Thread Size	Pound-Inches	Newton metres
O-ring Face Seal End					O-ring Boss End Fitting or Lock Nut		
-4	1/4 inch 6.4 mm	9/16-18	120 to 144	14 to 16	7/16-20	204 to 240	23 to 27
-6	3/8 inch 9.5 mm	11/16-16	216 to 240	24 to 27	9/16-18	300 to 360	34 to 41
-8	1/2 inch 12.7 mm	13/16-16	384 to 480	43 to 54	3/4-16	540 to 600	61 to 68
					Thread Size	Pound-Inches	Newton metres
-10	5/8 inch 15.9 mm	1-14	552 to 672	62 to 76	7/8-14	60 to 65	81 to 88
Nom. SAE Dash Size	Tube OD	Thread Size	Pound-Inches	Newton metres	1-1/16-12	85 to 90	115 to 122
					1-3/16-12	95 to 100	129 to 136
-12	3/4 inch 19.0 mm	1-3/16-12	65 to 80	90 to 110	1-5/16-12	115 to 125	156 to 169
-14	7/8 inch 22.2 mm	1-3/16-12	65 to 80	90 to 110	1-5/8-12	150 to 160	203 to 217
-16	1.0 inch 25.4 mm	1-7/16-12	92 to 105	125 to 140	1-7/8-12	190 to 200	258 to 271
-20	1-1/4 inch 31.8 mm	1-11/16-12	125 to 140	170 to 190			
-24	1-1/2 inch 38.1 mm	2-12	150 to 180	200 to 254			

Section 2402

2402

SPECIFICATION DETAILS 4-390 Diesel Engine

IMPORTANT: *This engine was made using the metric measurement system. All measurements and checks must be made with metric tools to make sure of an accurate reading when inspecting parts.*

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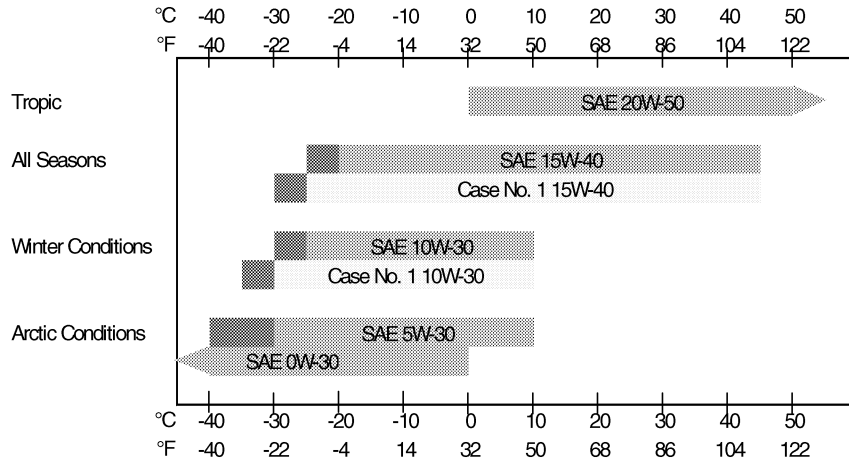
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RUN-IN INSTRUCTIONS

Engine Lubrication

Fill the 4-390, 4T-390, and the 4TA-390 engine crankcase with a high quality SAE 15W-40 service classification oil.

Lower viscosity lubricating oils can aid in starting the engine and provide sufficient lubricating oil flow at temperatures below -5°C [23°F]. Please refer to the following chart.



NOTE: The continuous use of low viscosity lubricating oils can decrease engine life.

NOTE: When using Case No. 1 engine oil, the use of an engine oil heater or a jacket water heater is required.

NOTE: CC/CD or CD/SF engine oils can be used where CE oil is not available. When these oils are used, reduce the oil change interval to one-half the normal maintenance interval.

Install new oil filters after the engine is rebuilt.

Run-In Procedure for Rebuilt Engines (with a Dynamometer)

The following procedure must be followed when using a PTO dynamometer to Run-In the engine. The dynamometer will control the engine load at each speed and will remove stress on new parts during Run-In.

During the Run-In, continue to check the oil pressure, coolant level and coolant temperature.

- Step 1 Disconnect the wire to the electric shut-off on the injection pump so that the engine will not start. Crank the engine for 30 seconds until there is oil pressure, then reconnect the wire.
- Step 2 Remove the air from the cooling system at the temperature sending unit or aftercooler, if equipped.
- Step 3 Run the engine at 800 RPM for 3 to 5 minutes. The oil pressure should be a minimum of 1009 kPa. Check for leaks.
- Step 4 Increase the engine speed to 1200 RPM and increase the test load to 25% of the rated load. The coolant temperature should be a minimum of 70°C. Run the engine for 5 minutes.
- Step 5 Check the blowby. If the reading is steady, increase the engine speed to peak torque speed and increase the load to 50% of the peak torque load. Run the engine for 5 minutes.
- Step 6 Check the blowby. If the reading is steady, increase the engine speed to full throttle and increase the load until the RPM falls to rated torque speed. Run the engine for 5 minutes.
- Step 7 Check the gauges. If the readings are within limits, increase the load until the engine speed decreases to the peak torque RPM. Run the engine for 5 minutes.
- Step 8 Completely remove the load and reduce the engine speed to 1000 RPM. Run the engine for 3 to 5 minutes.
- Step 9 Shut off the engine.

Run-In Procedure for Rebuilt Engines (without a Dynamometer)

- Step 1 Disconnect the wire to the electric shut-off on the injection pump so that the engine will not start. Crank the engine for 30 seconds until there is oil pressure, then reconnect the wire.
- Step 2 Remove the air from the cooling system at the temperature sending unit or aftercooler, if equipped.
- Step 3 Run the engine at 800 RPM for 5 minutes. Check the oil pressure.
- Step 4 Run the engine under light load at 1200 RPM for 5 minutes. The coolant temperature should be a minimum of 71° C.
- Step 4 Run the engine under light load at 2200 RPM for 5 minutes.

Run-In Procedure (Agriculture Equipment)

For the first 8 hours of field operation stay one gear lower than normal. For the next 12 hours DO NOT "lug" the engine. Prevent "lugging" by moving the lever to a lower gear. The engine must not be "lugged" below the rated engine RPM during early hours of life.

Run-In Procedure (Construction Equipment)

For the first 8 hours, operate the engine at full throttle maintaining a normal load. Avoid converter or hydraulic stall. The engine must not be "lugged" below the Rated Engine RPM (Do not stall the engine more than 10 seconds).

IDENTIFICATION MARKS

Crankshaft

Letter N = Nitroc Hardened, crankshaft must be rehardened to a minimum hardness of 450 HV 0.2 rockwell any time the crankshaft has been reconditioned.

Cylinder Block

Letter X = The cylinder block has been refaced and up to 0.25 mm has been removed. Use a thicker head gasket (one notch).

Letter XX = The cylinder block has been refaced and up to 0.50 mm has been removed. Use a thicker head gasket (two notches).

Cylinder Head

Letter G = Thermostat passage in cylinder did not need to be machined.

Letter M = Thermostat passage in cylinder head was machined.

Letter V = Valve seats have been machined.

Letter X = The cylinders in the cylinder block have been bored oversize. Use a head gasket with oversize cylinder holes (two notches). This gasket is used for standard replacement, 0.5 mm oversize and 1.0 mm oversize bore.

Letter XX = The cylinder block has been refaced and up to 0.25 mm has been removed use a thicker head gasket (one notch).

Letter XXX = The cylinder block has been refaced and up to 0.50 mm has been removed. Use a thicker head gasket (two notches).

Numbers = RH rear corner of cylinder head indicates the amount of material removed from the cylinder head.

ENGINE SPECIFICATION DETAILS

Cylinder Block

	Metric Value
Type	Non-Sleeved
Material	Cast Iron
ID of Cylinder	102.00 to 102.04 mm
Maximum Service Limit	102.116 mm
Cylinder Out of Round (Maximum)	0.038 mm
Cylinder Taper (Maximum)	0.076 mm
0.5 mm Oversize Piston	
Machine Cylinder Bore to	102.40 to 102.44 mm
Hone to (Finished Diameter)	102.50 to 102.54 mm
1.00 mm Oversize Piston	
Machine Cylinder Bore to	102.90 to 102.94 mm
Hone to (Finished Diameter)	103.00 to 103.04 mm
Warpage (Maximum)	0.075 mm
Maximum Material Removal	0.50 mm

Service Cylinder Sleeve

Type	Dry, Can Be Replaced
Material	Cast Iron
Machine Cylinder Block Bore to	104.485 to 104.515 mm
Installation	Press Fit
Machine Sleeve Bore to:	
Standard Size Piston (Finished Diameter)	102.00 to 102.04 mm
0.5 mm Oversize Piston	
Machine Cylinder Bore to	102.40 to 102.44 mm
Hone to (Finished Diameter)	102.50 to 102.54 mm
1.0 mm Oversize Piston	
Machine Cylinder Bore to	102.90 to 102.94 mm
Hone to (Finished Diameter)	103.00 to 103.04 mm

Piston

Type Cam Ground

Material Aluminum Alloy

OD at 12 mm From the Bottom, 90 Degrees Piston Pin

Standard Size Piston 101.873 to 101.887 mm

Minimum Service Limit 101.823 mm

0.5 mm Oversize Piston 102.373 to 102.387 mm

Minimum Service Limit 102.323 mm

1.0 mm Oversize Piston 102.873 to 102.887 mm

Minimum Service Limit 102.823 mm

ID of Piston Pin Bore 40.006 to 40.012 mm

Maximum Service Limit 40.025 mm

Width of 1st Ring Groove (Top) 2.465 to 2.485 mm

Width of 2nd Ring Groove (Intermediate) 2.425 to 2.445 mm

Width of 3rd Ring Groove (Oil Ring) 4.040 to 4.060 mm

Protrusion Above Cylinder Block (Maximum) 0.660 mm

Protrusion Above Cylinder Block (Minimum) 0.280 mm

Piston Pin

Type Full Float

Pin Length

Short Style 74.42 to 75.80 mm

Long Style 82.42 to 82.94 mm

OD of Pin 39.997 to 40.003 mm

Minimum Service Limit 39.990 mm

Piston Rings

No. 1 Compression 4T-390 Engine	Key Stone Type (Barrel Face)
End Gap in 102.02 ID	0.4 to 0.70 mm
No. 1 Compression 4-390 Engine	Rectangular Type (Barrel Face)
End Gap in 102.02 ID	0.25 to 0.55 mm
Maximum Service Limit	0.806 mm
Side Clearance	0.075 to 0.120 mm
Maximum Service Limit	0.15 mm
No. 2 Compression	Rectangular Type (Tapper Face)
End Gap in 102.02 ID	0.25 to 0.55 mm
Maximum Service Limit	0.806 mm
Side Clearance	0.075 to 0.120 mm
Maximum Service Limit	0.15 mm
No. 3 Oil Control Rings	Two Piece
End Gap in 102.02 ID	0.25 to 0.55 mm
Maximum Service Limit	0.806 mm
Side Clearance	0.130 mm

Cylinder Head

Cylinder Head Height (New)	94.75 to 95.25 mm
Warpage (Maximum)	0.20 mm
Maximum Material Removal	1.00 mm
Minimum Head Height	93.75 mm
Engines Manufactured in U.S.A.:	
Prior to Engine Serial Number 45511034	Injector Nozzle 9 mm
Engine Serial Number 45511034 and After	Injector Nozzle 7 mm
Engines Manufactured in Darlington England:	
Prior to Engine Serial Number 21092870	Injector Nozzle 9 mm
Engine Serial Number 21092870 and After	Injector Nozzle 7 mm
Engines Manufactured in Neuss Germany:	
Prior to Engine Serial Number 52107489	Injector Nozzle 9 mm
Engine Serial Number 52107489 and After	Injector Nozzle 7 mm

Lifters

Material	Hardened Iron
OD of Lifter	15.961 to 15.977 mm
Minimum Service Limit	15.960 mm
Bore Diameter in Block	16.000 to 16.030 mm
Maximum Service Limit	16.055 mm

Connecting Rod

Bushing	Steel Backed Leaded Bronze
Bushing ID Installed (Ream to Size)	40.053 to 40.067 mm
Maximum Service Limit	40.092 mm
Bearing Liners	Replaceable
Journal ID Without Bearing Liners	72.987 to 73.013 mm
Bearing Oil Clearance	0.038 to 0.116 mm
Maximum Service Limit	0.129 mm
Side Clearance	0.100 to 0.300 mm
Maximum Service Limit	0.330 mm
Connecting Rod Bend (Maximum)	
Without Bushing	0.200 mm
With Bushing	0.150 mm
Connecting Rod Twist (Maximum)	
Without Bushing	0.500 mm
With Bushing	0.300 mm
Connecting Rod Bolt Maximum	59.25

Crankshaft

Type	Hardened Steel, Balanced
Main Bearing Liners	Replaceable
End Clearance, Center Main Bearing Cap	0.13 to 0.25 mm
Center Main Bearing Thrust Surface Thickness	
Standard	2.50 mm
0.50 mm Oversize	2.72 to 2.78 mm
1.00 mm Oversize	2.97 to 3.03 mm
Connecting Rod Journal	
OD, Standard	68.987 to 69.013 mm
Maximum Service Limit	68.962 mm
0.25 mm OD Undersize, Grind to	68.737 to 68.763 mm
Maximum Service Limit	68.712 mm
0.50 mm OD Undersize, Grind to	68.487 to 68.513 mm
Maximum Service Limit	68.462 mm
0.75 mm OD Undersize, Grind to	68.237 to 68.263 mm
Maximum Service Limit	68.212 mm
1.00 mm OD Undersize, Grind to	67.987 to 68.013 mm
Maximum Service Limit	67.962 mm
Connecting Rod Journal Maximum Taper	0.013 mm
Journals Out of Round Maximum	0.050 mm
Undersize Main Bearing Liners For Service	0.25, 0.50, 0.75 and 1.00 mm
Main Bearing Oil Clearance	0.041 to 0.119 mm
Maximum Service Limit	0.140 mm
Main Bearing Journal	
OD, Standard	82.987 to 83.013 mm
Maximum Service Limit	82.962 mm
0.25 mm OD Undersize, Grind to	82.737 to 82.763 mm
Maximum Service Limit	82.712 mm
0.50 mm OD Undersize, Grind to	82.487 to 82.513 mm
Maximum Service Limit	82.462 mm
0.75 mm OD Undersize, Grind to	82.237 to 82.263 mm
Maximum Service Limit	82.212 mm
1.00 mm OD Undersize, Grind to	81.987 to 82.013 mm
Maximum Service Limit	81.962 mm
Main Bearing Journal Bore ID No Liners	87.982 to 88.018 mm
Maximum Service Limit	88.031 mm

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